APPROVAL SUBMITTAL

MUNICIPAL

HARRIMANN, TN

US FILTER CONTROL SYSTEMS
PROJECT NUMBER - 504370
CUSTOMER PURCHASE ORDER NUMBER - 19124BA, 19125BA, 19126BA,

DECEMBER 14, 2005

SUBMITTED BY:

US FILTER CONTROL SYSTEMS
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Important information required – A504370CI - Rev. A

The information and designs contained in this submittal are derived from the contract drawings, specifications (the sections that have been provided to US Filter Control Systems (USFCS)), USFCS quotation, letters, phone conversations, site meetings, and other means of communications. USFCS has made a good faith effort in consolidating all this information into this submittal. Please review this submittal carefully and respond with any questions or comments that arise. If no comments or questions are received, USFCS will supply the system as represented in this submittal. Any change(s) to USFCS's scope of supply after receipt of the approved submittal documentation will be subject to an additional charge.

This submittal package requires the following information that is necessary to complete the design and /or calibrate the equipment. . **We will be unable to establish a shipment date until we receive the requested information.**

Hardees Pump Station
The Wetwell Range is 0 - ____ FT
The High Level Alarm is ON at ____ FT and OFF at ____ FT
The Low Level Alarm is ON at ____ FT and OFF at ____ FT
Pump 1is ON at ____ FT and OFF at ____ FT
Pump 2 is ON at ____ FT and OFF at ____ FT

Webb Pump Station
The Wetwell Range is 0 - ____ FT
The High Level Alarm is ON at ____ FT and OFF at ____ FT
The Low Level Alarm is ON at ____ FT and OFF at ____ FT
Pump 1 is ON at ____ FT and OFF at ____ FT
Pump 2 is ON at ____ FT and OFF at ____ FT
Pump 3 is ON at ____ FT and OFF at ____ FT

Woody Street Pump Station
The Wetwell Range is 0 - ____ FT
The High Level Alarm is ON at ____ FT and OFF at ____ FT
The Low Level Alarm is ON at ____ FT and OFF at ____ FT
Pump 1is ON at ____ FT and OFF at ____ FT
Pump 2 is ON at ____ FT and OFF at ____ FT
Pump 3 is ON at ____ FT and OFF at ____ FT

Sump Pumps
The Sump Pump motors are ____ HP and have a Service Factor rating of ____

Question:

1) Are the pumps required to shut down in both HAND and AUTO if a thermal/moisture condition occurs or just in auto?

2) The "control power" will be connected to circuit No.4 in the MCC lighting panel. Please verify that this the circuit designated for the supervisory control power.

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Project Summary and Functional Description

504370 - Harriman, TN

REVISION	1.0	1.1	1.2	1.3	1.4
DATE	11/7/05				
PURPOSE	For Approval				
ISSUED BY	DMM				
CHECKED BY	DMM				
CLIENT APPROVAL					

Section 1.1 Project Summary

001 1 Hardees Pump Station Control

Cutler-Hammer MCC pump station that will provide power for two constant-speed self-priming pumps. The MCC will operate on a 480 volt, 3 phase, 4 wire, 60 HZ incoming service. The Supervisory Section will monitor the wetwell level and provide controls for two constant-speed self-priming pumps in a pump-down mode of operation. The Supervisory Section will operate on 120 volt, 1 phase, 2 wire, 60 HZ power from the MCC lighting panel.

MCC To Include:

Qty.	Description
1	NEMA 1 gasketed motor control center
1	200 amp main circuit breaker
1	Current monitoring transducer with 4-20mA output to existing SCADA system
1	30 amp circuit breaker & three phase TVSS lighting arrestor
2	70 amp pump circuit breaker with ground fault protection
2	480/3/60 30.0 HP RVSS with internal bypass and RS485 to existing SCADA
2	7.5 KVAR PFC Capacitors with blown fuse indicators
1	External full voltage bypass for automatic emergency operation (one pump only)
1	30 amp feeder breaker for a remote mounted unit heater
1	60 amp circuit breaker, 25 KVA lighting transformer and 20 circuit distribution panelboard.

Supervisory Section To Include:

1	120 VAC incoming control power circuit breaker
1	Single phase surge protector
1	Condensation heater and thermoswitch
1	Model OI3000 operator interface module
1	White "Power On" P-T indicating light
1	Red "High Level" P-T indicating light
2	Red "Pump Failure" P-T indicating lights
2	Red "Pump Overtemp/Sealfail" P-T indicating lights
2	Green "Pump Running" P-T indicating lights
2	"Hand-Off-Auto" selector switches
1	Automatic full voltage bypass emergency operation circuit (one pump only)
2	"Reset" pushbutton
2	Running time Meters
1	"Alarm Silence" heavy duty, oil tight pushbutton
1	15 VDC power supply
1	12 VDC battery

1	12 VDC battery charging circuit
1	Analog input isolator (Level transducer)
1	Analog output isolator (Level Signal)
1	Model LC2000 logic controller
1	Ethernet I/O analog output module
1	Model MTL intrinsically safe transducer module
1	Backup high level alarm float switch circuit
1	Model IS6 backup high level alarm float switch intrinsically safe barrier
2	Pump failure detection circuits
1	High level alarm circuit
1	Lot of dry alarm & status contacts wired to terminals for the customers existing SCADA system
1	4-20ma Level Signal output to existing SCADA system
1	Wire numbers

002 1 Webb Pump Station Control

Cutler-Hammer MCC pump station that will provide power for two constant-speed self-priming pumps. The MCC will operate on a 480 volt, 3 phase, 4 wire, 60 HZ incoming service. The Supervisory Section will monitor the wetwell level and provide controls for three constant-speed self-priming pumps in a pump-down mode of operation. The Supervisory Section will operate on 120 volt, 1 phase, 2 wire, 60 HZ power from the MCC lighting panel.

MCC To Include:

Qty.	Description
1	NEMA 1 gasketed motor control center
1	200 amp main circuit breaker
1	Current monitoring transducer with 4-20mA output to existing SCADA system
3	30 amp circuit breaker & three phase TVSS lighting arrestor
4	60 amp pump circuit breaker with ground fault protection
3	480/3/60 20.0 HP RVSS with internal bypass and RS485 to existing SCADA
3	5 KVAR PFC Capacitors with blown fuse indicators
1	External full voltage bypass for automatic emergency operation (one pump only)
1	30 amp feeder breaker for a remote mounted unit heater
1	60 amp circuit breaker, 25 KVA lighting transformer and 20 circuit distribution panelboard.

Supervisory Section To Include:

1	120 VAC incoming control power circuit breaker
1	Single phase surge protector
1	Condensation heater and thermoswitch
1	Model OI3000 operator interface module

1	White "Power On" P-T indicating light
1	Red "High Level" P-T indicating light
3	Red "Pump Failure" P-T indicating lights
3	Red "Pump Overtemp/Sealfail" P-T indicating lights
3	Green "Pump Running" P-T indicating lights
3	"Hand-Off-Auto" selector switches
1	Automatic full voltage bypass emergency operation circuit (one pump only)
3	"Reset" pushbutton
3	Running time Meters
1	"Alarm Silence" heavy duty, oil tight pushbutton
1	15 VDC power supply
1	12 VDC battery
1	12 VDC battery charging circuit
1	Analog input isolator (Level transducer)
1	Analog output isolator (Level Signal)
1	Model LC2000 logic controller
1	Ethernet I/O analog output module
1	Model MTL intrinsically safe transducer module
1	Backup high level alarm float switch circuit
1	Model IS6 backup high level alarm float switch intrinsically safe barrier
3	Pump failure detection circuits
1	High level alarm circuit
1	Lot of dry alarm & status contacts wired to terminals for the customers existing SCADA system
1	4-20ma Level Signal output to existing SCADA system
1	Wire numbers

003 1 <u>Woody Street Pump Station Control</u>

Cutler-Hammer MCC pump station that will provide power for two constant-speed self-priming pumps. The MCC will operate on a 480 volt, 3 phase, 4 wire, 60 HZ incoming service. The Supervisory Section will monitor the wetwell level and provide controls for three variable-speed dry-pit pumps in a pump-down mode of operation. The Supervisory Section will operate on 120 volt, 1 phase, 2 wire, 60 HZ power from the MCC lighting panel.

MCC To Include:

Qty.	Description
1	NEMA 1 gasketed motor control center
1	350 amp main circuit breaker
1	Current monitoring transducer with 4-20mA output to existing SCADA system
1	30 amp circuit breaker & three phase TVSS lighting arrestor
3	125 amp pump circuit breaker with ground fault protection
3	Mount & Wire Danfoss VFDs with door-mounting kit (supplied by USFCS), x-line bypass motor starter, isolation contactors and and a 250VA control power transformer

1	External full voltage bypass for automatic emergency operation (one pump only)
1	30 amp feeder breaker for a remote mounted unit heater
1	60 amp circuit breaker, 25 KVA lighting transformer and 20 circuit distribution panelboard.

Supervisory Section To Include:

1	120 VAC incoming control power circuit breaker
1	Single phase surge protector
1	Condensation heater and thermoswitch
1	Model OI3000 operator interface module
1	White "Power On" P-T indicating light
1	Red "High Level" P-T indicating light
3	Red "Pump Failure" P-T indicating lights
3	Red "Pump Overtemp/Sealfail" P-T indicating lights
3	Green "Pump Running" P-T indicating lights
3	"Hand-Off-Auto" selector switches
1	Automatic full voltage bypass emergency operation circuit (one pump only)
1	"Bypass-VFD selector switch
3	"Reset" pushbutton
3	Running time Meters
1	"Alarm Silence" heavy duty, oil tight pushbutton
1	15 VDC power supply
1	12 VDC battery
1	12 VDC battery charging circuit
1	Analog input isolator (Level transducer)
4	Analog output isolator (Speed command and Level Signal)
1	Model LC2000 logic controller
1	Ethernet I/O analog output module
1	Model MTL intrinsically safe transducer module
1	Backup high level alarm float switch circuit
1	Model IS6 backup high level alarm float switch intrinsically safe barrier
3	Pump failure detection circuits
1	High level alarm circuit
1	Lot of dry alarm & status contacts wired to terminals for the customers existing SCADA system
1	4-20ma Level Signal output to existing SCADA system
1	Wire numbers

004 1 Hardees Sump Pump Control Panel

This panel will operate on a 230 volt, 1 phase, 2 wire, 60 HZ incoming service.

To Include:

Qty.	Description
1	NEMA 4X fiberglass wall mounted enclosure with inner door and panel
1	1 ½ HP maximum motor circuit breaker and starter
1	Control power Fuse
1	Green "Pump Running" indicating light
1	"Hand-Off-Auto" selector switch
1	Float switch circuit

005 1 Webb Sump Pump Control Panel

This panel will operate on a 230 volt, 1 phase, 2 wire, 60 HZ incoming service.

To Include:

Qty.	Description
2	NEMA 4X fiberglass wall mounted enclosure with inner door and panel
2	1 ½ HP maximum motor circuit breaker and starter
2	Control power Fuse
2	Green "Pump Running" indicating light
2	"Hand-Off-Auto" selector switch
1	Float switch circuit

006 1 Woody Street Sump Pump Control Panel

This panel will operate on a 230 volt, 1 phase, 2 wire, 60 HZ incoming service.

To Include:

Qty.	Description
3	NEMA 4X fiberglass wall mounted enclosure with inner door and panel
3	1 ½ HP maximum motor circuit breaker and starter
3	Control power Fuse
3	Green "Pump Running" indicating light
3	"Hand-Off-Auto" selector switch
1	Float switch circuit

007 1 Lot of Field Mounted Equipment

To Include:

Qty.	Description
3	Control Systems, Inc. Model 575 Submersible Level Transducer with 60' cable
3	Model S60 suspended float switches with weight and 60' cable
3	Model 101 GX drywell float switch
3	W/P Alarm Horn
3	Combustible Gas Detector
9	Cutler-Hammer oxidation inhibitors

008 1 Lot of Spare Parts

To Include:

Qty.	Description
30	Control Power fuses
30	Pilot Light Bulbs
1	Control Systems, Inc. Model 575 Submersible Level Transducer with 60' cable
2	IR emitters for Gas Meters

Section 1.2 Project Functional Description

HARDEES PUMP STATION

The control panel will control the operation of three softstart controlled pumps in a pump down mode of operation based on the wetwell level. A Model 575 submersible level transducer will sense the wetwell level. When the level rises to the lead pump ON setpoint the lead pump will start. If the level continues to rise to the lag1 pump On setpoint the lag1 pump will start. On a falling level, when the level reaches the lag pump OFF setpoint the lag pump will stop. When the level falls to the lead pump OFF setpoint the lead pump will stop.

If a pump is not in the "auto" position it will be taken out of the operating sequence. If a pump is required and the LC2000 controller does not receive a run input with in an adjustable amount of time, the pump will be failed and taken out of the operating sequence. To reset a failed pump, the "H-O-A" of the failed pump must be placed in the "Off" position and then returned to the "Auto" position.

The moisture and thermal sensors in the pumps are wired in series through normally closed contacts that energize a relay in the control panel. If either contact opens, the relay will de-energize and shut down the pump. If there is a thermal overload, the reset button can be used to restore the pump. However, if there is a moisture problem, the reset button cannot restore the pump as the switch in the pump is non-resettable and will need to be replaced.

Pump 1 has a bypass contactor for automatic emergency operation should the softstart fail. A 4-position switch, SOFTSTART/OFF/LINE/TEST will be used for selecting the mode of operation. In the Softstart position, the pump will ramp up to speed and than switch to the softstart's internal, up-to-speed bypass contactor. In the OFF position, the motor and softstart are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the softstart so service can be performed. In the test position, the

motor is operated at full speed from the AC line power. This allows the softstart to be given an operational test while continuing to run the motor at full speed in bypass. The contactors are interlocked to prevent the motor from being connected to the softstart and power line through the by-pass starter simultaneously.

The control sequence starts and stops the pumps through the softstarts. If the demand exceeds the capacity of one pump operating, the remaining pump will be staged on.

The controller will alternate the pumps in a lead/lag fashion but at 24-hour intervals so that each pump retains its lead or lag position for a 24-hour period and then alternates. The "time of alternation" is programmable by the operator through the time clock block. The time clock is a three function block that can be operator adjusted to alternate at one, two or three different times each day. It also has "day of the week" control. It is factory set to alternate seven days of the week at 8:00 AM.

The OI3000 operator interface will display the following:

- Wetwell Level
- Pump 1 Run Time
- Pump 2 Run Time
- Pump 1 Status
- Pump 2 Status

The OI3000 operator interface will display and annunciate the following alarms:

- Pump1 Failure
- Pump 2 Failure
- Pump 1 Overtemp/Sealfail
- Pump 2 Overtemp/Sealfail
- Softstart1 Failure
- Softstart2 Failure
- High Level
- Low Level
- Transducer Fail
- High Level (Float)

The keypad on the OI3000 operator interface will allow the operator to set the following setpoints:

- Lead Pump ON/OFF
- Lag Pump ON/OFF
- High/Low Level Setpoints
- Alternation FOFO with pump fail replace

Unpowered alarm contacts will be provided for the following:

- Low Level (Transducer)
- High Level (Transducer)
- High Level (Float)
- Pump 1 Run
- Pump 1 Fail
- Pump 1 Overtemp/Sealfail
- Pump 2 Run
- Pump 2 Fail
- Pump 2 Overtemp/Sealfail

The control panel will control the operation of three softstart controlled pumps in a pump down mode of operation based on the wetwell level. A Model 575 submersible level transducer will sense the wetwell level. When the level rises to the lead pump ON setpoint the lead pump will start. If the level rises to the lag1 pump On setpoint the lag1 pump will start, and if the level continues to rise to the lag2 pump On setpoint, the lag2 pump will start. On a falling level, when the level reaches the lag2 pump OFF setpoint the lag2 pump will stop. If the level continues to fall, lag1 and the lead pump will stop when the level falls to their respective OFF setpoints.

If a pump is not in the "auto" position it will be taken out of the operating sequence. If a pump is required and the LC2000 controller does not receive a run input with in an adjustable amount of time, the pump will be failed and taken out of the operating sequence. To reset a failed pump, the "H-O-A" of the failed pump must be placed in the "Off" position and then returned to the "Auto" position.

The moisture and thermal sensors in the pumps are wired in series through normally closed contacts that energize a relay in the control panel. If either contact opens, the relay will de-energize and shut down the pump. If there is a thermal overload, the reset button can be used to restore the pump. However, if there is a moisture problem, the reset button cannot restore the pump as the switch in the pump is non-resettable and will need to be replaced.

Pump 1 has a bypass contactor for automatic emergency operation should the softstart fail. A 4-position switch, SOFTSTART/OFF/LINE/TEST will be used for selecting the mode of operation. In the Softstart position, the pump will ramp up to speed and than switch to the softstart's internal, up-to-speed bypass contactor. In the OFF position, the motor and softstart are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the softstart so service can be performed. In the test position, the motor is operated at full speed from the AC line power. This allows the softstart to be given an operational test while continuing to run the motor at full speed in bypass. The contactors are interlocked to prevent the motor from being connected to the softstart and power line through the by-pass starter simultaneously.

The control sequence starts and stops the pumps through the softstarts. If the demand exceeds the capacity of one pump operating, the remaining pump will be staged on.

The controller will alternate the pumps in a lead/lag fashion but at 24-hour intervals so that each pump retains its lead or lag position for a 24-hour period and then alternates. The "time of alternation" is programmable by the operator through the time clock block. The time clock is a three function block that can be operator adjusted to alternate at one, two or three different times each day. It also has "day of the week" control. It is factory set to alternate seven days of the week at 8:00 AM.

The OI3000 operator interface will display the following:

- Wetwell Level
- Pump 1 Run Time
- Pump 2 Run Time
- Pump 3 Run Time
- Pump 1 Status
- Pump 2 Status
- Pump 3 Status
-

The OI3000 operator interface will display and annunciate the following alarms:

- Pump 1 Failure
- Pump 2 Failure
- Pump 3 Failure
- Pump 1 Overtemp/Sealfail
- Pump 2 Overtemp/Sealfail
- Pump 3 Overtemp/Sealfail
- Softstart1 Failure
- Softstart2 Failure
- Softstart3 Failure

- High Level
- Low Level
- Transducer Fail
- High Level (Float)

The keypad on the OI3000 operator interface will allow the operator to set the following setpoints:

- Lead Pump ON/OFF
- Lag1 Pump ON/OFF
- Lag2 Pump ON/OFF
- High/Low Level Setpoints
- Alternation FOFO with pump fail replace

Unpowered alarm contacts will be provided for the following:

- Low Level (Transducer)
- High Level (Transducer)
- High Level (Float)
- Pump 1 Run
- Pump 1 Fail
- Pump 1 Overtemp/Sealfail
- Pump 2 Run
- Pump 2 Fail
- Pump 2 Overtemp/Sealfail
- Pump 3 Run
- Pump 3 Fail
- Pump 3 Overtemp/Sealfail

WOODY STREET PUMP STATION

The control panel will control the operation of three VFD controlled pumps in a pump down mode of operation based on the wetwell level. A Model 575 submersible level transducer will sense the wetwell level. When the level rises to the lead pump ON setpoint the lead pump will start. If the level rises to the lag1 pump On setpoint the lag1 pump will start, and if the level continues to rise to the lag2 pump On setpoint, the lag2 pump will start. When the level reaches the lag2 pump OFF setpoint on a falling level, the lag2 pump will stop. On a falling level, when the level reaches the lag2 pump OFF setpoint the lag2 pump will stop. If the level continues to fall, lag1 and the lead pump will stop when the level falls to their respective OFF setpoints.

The control sequence starts/stops and controls the speed of the pumps through the variable frequency drives. The speed of the pumps will be based on the wetwell level, on rising level the speed increases and on falling level the speed decreases.

If a pump is not in the "auto" position it will be taken out of the operating sequence. If a pump is required and the LC2000 controller does not receive a run input with in an adjustable amount of time, the pump will be failed and taken out of the operating sequence. To reset a failed pump, the "H-O-A" of the failed pump must be placed in the "Off" position and then returned to the "Auto" position.

The moisture and thermal sensors in the pumps are wired in series through normally closed contacts that energize a relay in the control panel. If either contact opens, the relay will de-energize and shut down the pump. If there is a thermal overload, the reset button can be used to restore the pump. However, if there is a moisture problem, the reset button cannot restore the pump as the switch in the pump is non-resettable and will need to be replaced.

Pump 1 has a bypass contactor for automatic emergency operation should the drive fail. A 4-position switch, DRIVE/OFF/LINE/TEST will be used for selecting the mode of operation. In the DRIVE position, the pump will be operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so service can be performed. In the test position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. The contactors are interlocked to prevent the motor from being connected to the drive and power line through the by-pass starter simultaneously.

The controller will alternate the pumps in a lead/lag fashion but at 24-hour intervals so that each pump retains its lead or lag position for a 24-hour period and then alternates. The "time of alternation" is programmable by the operator through the time clock block. The time clock is a three function block that can be operator adjusted to alternate at one, two or three different times each day. It also has "day of the week" control. It is factory set to alternate seven days of the week at 8:00 AM.

The OI3000 operator interface will display the following:

- Wetwell Level
- Pump 1 Run Time
- Pump 2 Run Time
- Pump 3 Run Time
- Pump 1 Status
- Pump 2 Status
- Pump 3 Status
-

The OI3000 operator interface will display and annunciate the following alarms:

- Pump 1 Failure
- Pump 2 Failure
- Pump 3 Failure
- Pump 1 Overtemp/Sealfail
- Pump 2 Overtemp/Sealfail
- Pump 3 Overtemp/Sealfail
- VFD 1 Failure
- VFD 2 Failure
- VFD 3 Failure
- High Level
- Low Level
- Transducer Fail
- High Level (Float)

The keypad on the OI3000 operator interface will allow the operator to set the following setpoints:

- Lead Pump ON/OFF
- Lag1 Pump ON/OFF
- Lag2 Pump ON/OFF
- High/Low Level Setpoints
- Alternation FOFO with pump fail replace
- Ramp extremities

Unpowered alarm contacts will be provided for the following:

- Low Level (Transducer)
- High Level (Transducer)

- High Level (Float)
- Pump 1 Run
- Pump 1 Fail
- Pump 1 Overtemp/Sealfail
- Pump 2 Run
- Pump 2 Fail
- Pump 2 Overtemp/Sealfail
- Pump 3 Run
- Pump 3 Fail
- Pump 3 Overtemp/Sealfail

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Print Date: 12/14/05

Project Number: 504370

Task 7040

Task Name: Separate Parts (Field Mounted)

Quantity	Manufacturer Name	Manufacturer Part Number
3	Tyco/Scott Instruments	4688IR
	Gas Meter, Infrared Combustible Gas Transmitter	
3	AMETEK	575-S-B-0015-N-L-S-60FT
	TRANSDUCER, SUBMERSIBLE LEVEL	
3	USFCS	6011060010
	FLOAT/FLOOD SWITCH, 101GX, NEMA 4X	
3	ANCHOR SCIENTIFIC	8031360061
	Float, Susp., LSA-2-wire roto NO, 60 ft.	
3	EDWARDS SIGNAL	876-N5
	HORN, WEATHERPROOF, 120V	
9	HOFFMAN	A-HCI10E
	CORROSION PREVENTER, FOAM , 10CUFT CAPACITY	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Print Date: 12/14/05

Project Number: 504370

Task 7050

Task Name: Spare Parts

Quantity	Manufacturer Name	Manufacturer Part Number
2	Tyco/Scott Instruments	096-2193
	IR Emitters for 4688IR Infrared Combustible Gas Transmitter	
30	SYLVANIA	120MB
	LT BULB 120V 120MB / SYLVANIA	
1	AMETEK	575-S-B-0015-N-L-S-60FT
	TRANSDUCER, SUBMERSIBLE LEVEL	
30	BUSSMANN	FNQ-R-5
	FUSE, 5 AMP, Slow Blo Rej.Type, Class CC, 600V, 200KAIC	
30	BUSSMANN	MDL-1/2
	FUSE, 1/2 AMP, Slow Blo	
30	BUSSMANN	MDL-4
	FUSE, 4 AMP, Slow Blo, 200A@250V/10KA@125V	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Print Date: 12/14/05

Project Number: 504370

Task 7061

Task Name: Hardees Pump Station

Quantity	Manufacturer Name	Manufacturer Part Number
1	PHOENIX CONTACT	0441504
	GROUND BLOCK, USLKG 5	
1	ALLEN BRADLEY	1606-XLP50B
	POWER SUPPLY,120-240VAC IN,12-15VDC ADJ OUT,3.4A@15V,5	
1	PHOENIX CONTACT	2814016
	LOOP POWERED 4-20 MA ISOLATOR, MCR-1CLP-I/I-00	
4	PHOENIX CONTACT	2966906
	RELAY, SPDT, 12VDC, 6A, PLC-RSC-12DC/21 2966896 + 2961150	
7	PHOENIX CONTACT	2967235
	RELAY,DPDT 12VDC 6A, PLC-RSC-12DC/21-21	
4	PHOENIX CONTACT	3004171
	TERMINAL, FUSE HOLDER UK 6,3HESI	
57	PHOENIX CONTACT	3004362
	TB, UL, 600V, 30A, 10-30AWG, GRY, 6.2MM, UK5N	
1	PHOENIX CONTACT	5602776
	SURGE PROTECTOR (PT2-PE/S-120AC-ST) & PT-BE/FM Base, Lab	
1	USFCS	6013160002
	IS6 INTRINSICALLY SAFE MODULE- U.L.	
2	REDINGTON	711-0160
	METER RUN TIME 120VAC, 2.93" DIAMETER ROUND	
1	MTL	7728+
	INTRINSIC BARRIER 4-20mA	
3	SQUARE-D	9001SKR1BH13
	PUSHBUTTON, 1NO/1NC, MOMENTARY, BLK, FULL	
2	SQUARE-D	9001SKS46FBH2
	SWITCH, 3 POS SELECTOR, 4X, w/GLOVED HANDLE	
1	SQUARE-D	9001SKS88FBH3
	SWITCH, 4 POS SELECTOR, 4X, w/GLOVED HANDLE	
2	SQUARE-D	9001-SKT38G31
	PILOT LIGHT, PTT, 120VAC/DC FV, GRN CAP, 30mm, NEMA 4X	
5	SQUARE-D	9001-SKT38R31
	PILOT LIGHT,PTT,120VAC/DC, FV, RED CAP, 30mm, NEMA 4X	
1	SQUARE-D	9001SKT38W31
	PILOT LIGHT, PTT, 120VAC/DC FV, WHT CAP, 30mm, NEMA 4X	
1	TRANSTRONICS	BVUPS12PF-10
	BATTERY VOLTAGE UPS w/POWER FAIL & LOW CURRENT	
1	USFCS	ILK-AI8A04-BE
	Ethernet I/O 8AI/4 AO, 4-20 mA	
1	USFCS	ILK-DI8DO8-BE
	ETHERNET I/O DISCRETE,8 IN & 8 OUT, 12-24VAC/DC, 1A	
1	USFCS	ILK-ISOLINK-1
	POWER SUPPLY, ANALOG INPUT, LOOP ISOLATOR, CIS-00-B	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Print Date: 12/14/05

Project Number: 504370

Task 7061

Task Name: Hardees Pump Station

Quantity	Manufacturer Name	Manufacturer Part Number
1	USFCS	ILK-LC2000-131
	LC2000 LOGIC CONTROLLER, 12DI, 8DO, 6 AI, USFCS LABEL	
1	USFCS	ILK-OI3000
	OI3000 OPERATOR INTERFACE	
1	Cutler-Hammer	MCC-HARRIMAN,TN-504370
	MCC Per Quote (Hardees MCC)	
3	BUSSMANN	MDL-1/2
	FUSE, 1/2 AMP, Slow Blo	
1	BUSSMANN	MDL-4
	FUSE, 4 AMP, Slow Blo, 200A@250V/10KA@125V	
1	POWERSONIC	PS-1270
	BATTERY 12VOLT, 7 AH	
3	SQUARE-D	QOU110
	CB 1POLE 10AMP	
17	IDEC	RR3B-UL AC120V
	Relay 3PDT 120VAC, IND LIGHT	
1	IDEC	RTE-B2AF20
	TIMER, SIGNAL-TRIGGERED, OFF-DELAY, 0.1S-600H, 100-240VA	
1	CHROMALOX	SLA-4-5-85/100P-36-120V-100W
	100W, 4x5, 36" LEADS, 120V, w/PSAS & 85-100F T-STAT	
1	IDEC	SR2P-05
	Socket, 8-pin Octal, Snap-mount/surface mount, Raised	
18	IDEC	SR3B-05
	Socket, 11 Blade, Snap-Mount/Surface Mount	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Project Number: 504370

Task 7062

Task Name: Webb Pump Station

Print Date: 12/14/05

Quantity	Manufacturer Name	Manufacturer Part Number
1	PHOENIX CONTACT	0441504
	GROUND BLOCK, USLKG 5	
1	ALLEN BRADLEY	1606-XLP50B
	POWER SUPPLY,120-240VAC IN,12-15VDC ADJ OUT,3.4A@15V,5	
1	PHOENIX CONTACT	2814016
	LOOP POWERED 4-20 MA ISOLATOR, MCR-1CLP-I/I-00	
4	PHOENIX CONTACT	2966906
	RELAY, SPDT, 12VDC, 6A, PLC-RSC-12DC/21 2966896 + 2961150	
7	PHOENIX CONTACT	2967235
	RELAY,DPDT 12VDC 6A, PLC-RSC-12DC/21-21	
4	PHOENIX CONTACT	3004171
	TERMINAL, FUSE HOLDER UK 6,3HESI	
69	PHOENIX CONTACT	3004362
	TB, UL, 600V, 30A, 10-30AWG, GRY, 6.2MM, UK5N	
1	PHOENIX CONTACT	5602776
	SURGE PROTECTOR (PT2-PE/S-120AC-ST) & PT-BE/FM Base, Lab	
1	USFCS	6013160002
	IS6 INTRINSICALLY SAFE MODULE- U.L.	
3	REDINGTON	711-0160
	METER RUN TIME 120VAC, 2.93" DİAMETER ROUND	
1	MTL	7728+
	INTRINSIC BARRIER 4-20mA	
4	SQUARE-D	9001SKR1BH13
	PUSHBUTTON, 1NO/1NC, MOMENTARY, BLK, FULL	
3	SQUARE-D	9001SKS46FBH2
	SWITCH, 3 POS SELECTOR, 4X, w/GLOVED HANDLE	
1	SQUARE-D	9001SKS88FBH3
	SWITCH, 4 POS SELECTOR, 4X, w/GLOVED HANDLE	
3	SQUARE-D	9001-SKT38G31
	PILOT LIGHT, PTT, 120VAC/DC FV, GRN CAP, 30mm, NEMA 4X	
7	SQUARE-D	9001-SKT38R31
	PILOT LIGHT,PTT,120VAC/DC, FV, RED CAP, 30mm, NEMA 4X	
1	SQUARE-D	9001SKT38W31
	PILOT LIGHT, PTT, 120VAC/DC FV, WHT CAP, 30mm, NEMA 4X	
1	TRANSTRONICS	BVUPS12PF-10
	BATTERY VOLTAGE UPS w/POWER FAIL & LOW CURRENT	
1	USFCS	ILK-AI8A04-BE
	Ethernet I/O 8AI/4 AO, 4-20 mA	
1	USFCS	ILK-DI8DO8-BE
	ETHERNET I/O DISCRETE,8 IN & 8 OUT, 12-24VAC/DC, 1A	
1	USFCS	ILK-ISOLINK-1
	POWER SUPPLY, ANALOG INPUT, LOOP ISOLATOR, CIS-00-B	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Project Number: 504370

Task 7062

Task Name: Webb Pump Station

Print Date: 12/14/05

Quantity	Manufacturer Name	Manufacturer Part Number
1	USFCS	ILK-LC2000-131
	LC2000 LOGIC CONTROLLER, 12DI, 8DO, 6 AI, USFCS LABEL	
1	USFCS	ILK-OI3000
	OI3000 OPERATOR INTERFACE	
1	Cutler-Hammer	MCC-HARRIMAN,TN-504370
	MCC Per Quote (Webb MCC)	
3	BUSSMANN	MDL-1/2
	FUSE, 1/2 AMP, Slow Blo	
1	BUSSMANN	MDL-4
	FUSE, 4 AMP, Slow Blo, 200A@250V/10KA@125V	
1	POWERSONIC	PS-1270
	BATTERY 12VOLT, 7 AH	
4	SQUARE-D	QOU110
	CB 1POLE 10AMP	
21	IDEC	RR3B-UL AC120V
	Relay 3PDT 120VAC, IND LIGHT	
1	IDEC	RTE-B2AF20
	TIMER, SIGNAL-TRIGGERED, OFF-DELAY, 0.1S-600H, 100-240VA	
1	CHROMALOX	SLA-4-5-85/100P-36-120V-100W
	100W, 4x5, 36" LEADS, 120V, w/PSAS & 85-100F T-STAT	
1	IDEC	SR2P-05
	Socket, 8-pin Octal, Snap-mount/surface mount, Raised	
22	IDEC	SR3B-05
	Socket, 11 Blade, Snap-Mount/Surface Mount	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Project Number: 504370

Task 7063

Task Name: Woody Street Pump Station

Print Date: 12/14/05

Quantity	Manufacturer Name	Manufacturer Part Number
1	PHOENIX CONTACT	0441504
	GROUND BLOCK, USLKG 5	
1	ALLEN BRADLEY	1606-XLP50B
	POWER SUPPLY,120-240VAC IN,12-15VDC ADJ OUT,3.4A@15V,5	
4	PHOENIX CONTACT	2814016
	LOOP POWERED 4-20 MA ISOLATOR, MCR-1CLP-I/I-00	
7	PHOENIX CONTACT	2966906
	RELAY, SPDT, 12VDC, 6A, PLC-RSC-12DC/21 2966896 + 2961150	
7	PHOENIX CONTACT	2967235
	RELAY,DPDT 12VDC 6A, PLC-RSC-12DC/21-21	
4	PHOENIX CONTACT	3004171
	TERMINAL, FUSE HOLDER UK 6,3HESI	
66	PHOENIX CONTACT	3004362
	TB, UL, 600V, 30A, 10-30AWG, GRY, 6.2MM, UK5N	
1	PHOENIX CONTACT	5602776
	SURGE PROTECTOR (PT2-PE/S-120AC-ST) & PT-BE/FM Base, Lab	
1	USFCS	6013160002
	IS6 INTRINSICALLY SAFE MODULE- U.L.	
3	REDINGTON	711-0160
	METER RUN TIME 120VAC, 2.93" DIAMETER ROUND	
1	MTL	7728+
	INTRINSIC BARRIER 4-20mA	
4	SQUARE-D	9001SKR1BH13
	PUSHBUTTON, 1NO/1NC, MOMENTARY, BLK, FULL	
3	SQUARE-D	9001SKS46FBH2
	SWITCH, 3 POS SELECTOR, 4X, w/GLOVED HANDLE	
1	SQUARE-D	9001SKS88FBH3
	SWITCH, 4 POS SELECTOR, 4X, w/GLOVED HANDLE	
3	SQUARE-D	9001-SKT38G31
	PILOT LIGHT, PTT, 120VAC/DC FV, GRN CAP, 30mm, NEMA 4X	
7	SQUARE-D	9001-SKT38R31
	PILOT LIGHT,PTT,120VAC/DC, FV, RED CAP, 30mm, NEMA 4X	
1	SQUARE-D	9001SKT38W31
	PILOT LIGHT, PTT, 120VAC/DC FV, WHT CAP, 30mm, NEMA 4X	
1	TRANSTRONICS	BVUPS12PF-10
	BATTERY VOLTAGE UPS w/POWER FAIL & LOW CURRENT	
1	USFCS	ILK-AI8A04-BE
	Ethernet I/O 8AI/4 AO, 4-20 mA	
1	USFCS	ILK-DI8DO8-BE
	ETHERNET I/O DISCRETE,8 IN & 8 OUT, 12-24VAC/DC, 1A	
1	USFCS	ILK-ISOLINK-1
	POWER SUPPLY, ANALOG INPUT, LOOP ISOLATOR, CIS-00-B	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Project Number: 504370

Task 7063

Task Name: Woody Street Pump Station

Print Date: 12/14/05

Quantity	Manufacturer Name	Manufacturer Part Number
1	USFCS	ILK-LC2000-131
	LC2000 LOGIC CONTROLLER, 12DI, 8DO, 6 AI, USFCS LABEL	
1	USFCS	ILK-OI3000
	OI3000 OPERATOR INTERFACE	
1	Cutler-Hammer	MCC-HARRIMAN,TN-504370
	MCC Per Quote (Woody Street MCC)	
3	BUSSMANN	MDL-1/2
	FUSE, 1/2 AMP, Slow Blo	
1	BUSSMANN	MDL-4
	FUSE, 4 AMP, Slow Blo, 200A@250V/10KA@125V	
1	POWERSONIC	PS-1270
	BATTERY 12VOLT, 7 AH	
4	SQUARE-D	QOU110
	CB 1POLE 10AMP	
26	IDEC	RR3B-UL AC120V
	Relay 3PDT 120VAC, IND LIGHT	
1	IDEC	RTE-B2AF20
	TIMER, SIGNAL-TRIGGERED, OFF-DELAY, 0.1S-600H, 100-240VA	
1	CHROMALOX	SLA-4-5-85/100P-36-120V-100W
	100W, 4x5, 36" LEADS, 120V, w/PSAS & 85-100F T-STAT	
1	IDEC	SR2P-05
	Socket, 8-pin Octal, Snap-mount/surface mount, Raised	
27	IDEC	SR3B-05
	Socket, 11 Blade, Snap-Mount/Surface Mount	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Project Number: 504370

Task 7064

Task Name: Hardees Sunmp Pump

Print Date: 12/14/05

Quantity	Manufacturer Name	Manufacturer Part Number
1	PAKTRON	104MACQRL150
	RC SNUBBER, Q-ARC, .1uF +-20%, 125VAC, 150 OHM,UL	
1	BUSSMANN	16220-1
	POWER DISTRIBUTION BLOCK, 1 POLE, 1-#14-2/0 & 4-#14-#4	
1	BUSSMANN	16220-2
	POWER DISTRIBUTION BLOCK, 2 POLE, 1-#14-2/0 & 4-#14-#4	
4	PHOENIX CONTACT	3004362
	TB, UL, 600V, 30A, 10-30AWG, GRY, 6.2MM, UK5N	
1	SQUARE-D	8536SCO3V02S
	MS, SZ 1, NEMA, 3P, CLASS 30, 120V COIL	
1	SQUARE-D	9001SKP38G31
	PILOT LIGHT, STD, 120VAC/DC FV, GRN CAP, 30mm, NEMA 4X	
1	SQUARE-D	9001SKS46BH13
	SELECTOR SWITCH,3POS,NON-ILLUM,BLACK,1NO/NC,(KA1)SI	
1	SQUARE-D	9999AC04
	AUX. CONTACT BLOCK FOR SOLID STATE O.L.	
1	SQUARE-D	9999RR04
	MS, REMOTE RESET, 120VAC	
1	GENERAL ELECTRIC	9L15FCB001
	Arrestor Surge 1 Phase	
1	STAHLIN	BP1816AL
	PANEL, ALUMINUM, FOR 18 X 16 ENCLOSURE	
1	BUSSMANN	CHCC1DI
	FUSE HOLDER, 1P, w/INDICATOR	
1	BUSSMANN	CPB162-1
	COVER, POWER DIST. BLOCK, 1 POLE FOR 162 SERIES	
1	BUSSMANN	CPB162-2
	COVER, POWER DIST BLOCK, 2 POLE FOR 162 SERIES	
1	SQUARE-D	FAL22015
	CB, 240V, 15A, 2P, 10 KAIC @ 240V, 4 AWG MAX	
3	SQUARE-D	FB14.8
	THERMAL OVERLOAD, QUICK TRIP	
1	BUSSMANN	FNQ-R-5
	FUSE, 5 AMP, Slow Blo Rej.Type, Class CC, 600V, 200KAIC	
1	STAHLIN	RJ1816HPLW
	ENCL N4X, FIBERGLASS, 18 X 16 X 9, W/1816DF PNL	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Project Number: 504370

Task 7065

Task Name: Webb Sump Pump

Print Date: 12/14/05

Quantity	Manufacturer Name	Manufacturer Part Number
1	PAKTRON	104MACQRL150
	RC SNUBBER, Q-ARC, .1uF +-20%, 125VAC, 150 OHM,UL	
1	BUSSMANN	16220-1
	POWER DISTRIBUTION BLOCK, 1 POLE, 1-#14-2/0 & 4-#14-#4	
1	BUSSMANN	16220-2
	POWER DISTRIBUTION BLOCK, 2 POLE, 1-#14-2/0 & 4-#14-#4	
4	PHOENIX CONTACT	3004362
	TB, UL, 600V, 30A, 10-30AWG, GRY, 6.2MM, UK5N	
1	SQUARE-D	8536SCO3V02S
	MS, SZ 1, NEMA, 3P, CLASS 30, 120V COIL	
1	SQUARE-D	9001SKP38G31
	PILOT LIGHT, STD, 120VAC/DC FV, GRN CAP, 30mm, NEMA 4X	
1	SQUARE-D	9001SKS46BH13
	SELECTOR SWITCH,3POS,NON-ILLUM,BLACK,1NO/NC,(KA1)SI	
1	SQUARE-D	9999AC04
	AUX. CONTACT BLOCK FOR SOLID STATE O.L.	
1	SQUARE-D	9999RR04
	MS, REMOTE RESET, 120VAC	
1	GENERAL ELECTRIC	9L15FCB001
	Arrestor Surge 1 Phase	
1	STAHLIN	BP1816AL
	PANEL, ALUMINUM, FOR 18 X 16 ENCLOSURE	
1	BUSSMANN	CHCC1DI
	FUSE HOLDER, 1P, w/INDICATOR	
1	BUSSMANN	CPB162-1
	COVER, POWER DIST. BLOCK, 1 POLE FOR 162 SERIES	
1	BUSSMANN	CPB162-2
	COVER, POWER DIST BLOCK, 2 POLE FOR 162 SERIES	
1	SQUARE-D	FAL22015
	CB, 240V, 15A, 2P, 10 KAIC @ 240V, 4 AWG MAX	
3	SQUARE-D	FB14.8
	THERMAL OVERLOAD, QUICK TRIP	
1	BUSSMANN	FNQ-R-5
	FUSE, 5 AMP, Slow Blo Rej.Type, Class CC, 600V, 200KAIC	
1	STAHLIN	RJ1816HPLW
	ENCL N4X, FIBERGLASS, 18 X 16 X 9, W/1816DF PNL	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Print Date: 12/14/05

Project Number: 504370

Task 7066

Task Name: Woody Street Sump Pump

Quantity	Manufacturer Name	Manufacturer Part Number
1	PAKTRON	104MACQRL150
	RC SNUBBER, Q-ARC, .1uF +-20%, 125VAC, 150 OHM,UL	
1	BUSSMANN	16220-1
	POWER DISTRIBUTION BLOCK, 1 POLE, 1-#14-2/0 & 4-#14-#4	
1	BUSSMANN	16220-2
	POWER DISTRIBUTION BLOCK, 2 POLE, 1-#14-2/0 & 4-#14-#4	
4	PHOENIX CONTACT	3004362
	TB, UL, 600V, 30A, 10-30AWG, GRY, 6.2MM, UK5N	
1	SQUARE-D	8536SCO3V02S
	MS, SZ 1, NEMA, 3P, CLASS 30, 120V COIL	
1	SQUARE-D	9001SKP38G31
	PILOT LIGHT, STD, 120VAC/DC FV, GRN CAP, 30mm, NEMA 4X	
1	SQUARE-D	9001SKS46BH13
	SELECTOR SWITCH,3POS,NON-ILLUM,BLACK,1NO/NC,(KA1)SI	
1	SQUARE-D	9999AC04
	AUX. CONTACT BLOCK FOR SOLID STATE O.L.	
1	SQUARE-D	9999RR04
	MS, REMOTE RESET, 120VAC	
1	GENERAL ELECTRIC	9L15FCB001
	Arrestor Surge 1 Phase	
1	STAHLIN	BP1816AL
	PANEL, ALUMINUM, FOR 18 X 16 ENCLOSURE	
1	BUSSMANN	CHCC1DI
	FUSE HOLDER, 1P, w/INDICATOR	
1	BUSSMANN	CPB162-1
	COVER, POWER DIST. BLOCK, 1 POLE FOR 162 SERIES	
1	BUSSMANN	CPB162-2
	COVER, POWER DIST BLOCK, 2 POLE FOR 162 SERIES	
1	SQUARE-D	FAL22015
	CB, 240V, 15A, 2P, 10 KAIC @ 240V, 4 AWG MAX	
3	SQUARE-D	FB14.8
	THERMAL OVERLOAD, QUICK TRIP	
1	BUSSMANN	FNQ-R-5
	FUSE, 5 AMP, Slow Blo Rej.Type, Class CC, 600V, 200KAIC	
1	STAHLIN	RJ1816HPLW
	ENCL N4X, FIBERGLASS, 18 X 16 X 9, W/1816DF PNL	

USFilter

Submittal Bill Of Material

Project Name: HARRIMAN TN HARDEES WEBB WOO

Print Date: 12/14/05

Project Number: 504370

Task 7067

Task Name: Woody Street VFDs

Quantity	Manufacturer Name	Manufacturer Part Number
3	DANFOSS	175Z0850
	MOUNTING KIT FOR REMOTE KEYPAD	
3	Dan-Foss	VLT8072AT4C20STRODLF00A00C0
	VFD, 75HP, 106.0 AMPS, 460 V, Chassis	

PUBLICATION DIVIDER

LS DIRECT ACTING FLOAT SWITCH (B100)



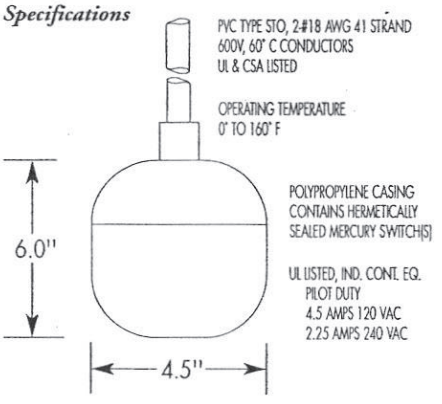
LS Features In Brief

Model LS floats deliver reliable service under extreme conditions.

- *Fixed or suspended installation*
- *Heavy-duty, Type STO #18/2 cable*
- *Tough, molded polypropylene body*
- *Dependable mercury to electrode tilt switch*
- *Completely potted switch and cable connections*
- *NO/NC switch configurations*
- *Standard cable lengths*

The Model LS Float Switch is a simple, dependable, level-sensing automatic pump or alarm control device that operates reliably in sewage wet wells, sumps, ditches or process vats. The float body is of high-density polypropylene and the cable jacket is flexible PVC for outstanding performance in a wide range of corrosive environments. Each float senses the movement of the liquid level past its mounting point on a rising or falling level. Single floats are used for alarm actuation. Two floats are used for differential control of pumps. Floats contain a Form C-type contact mercury switch, which provides normally-open or normally-closed operation. Model LS floats are furnished with clamp-mounting hardware for installation on a vertical 1" pipe. Accessory hardware is available for Suspended or Cable/Weight mounting.

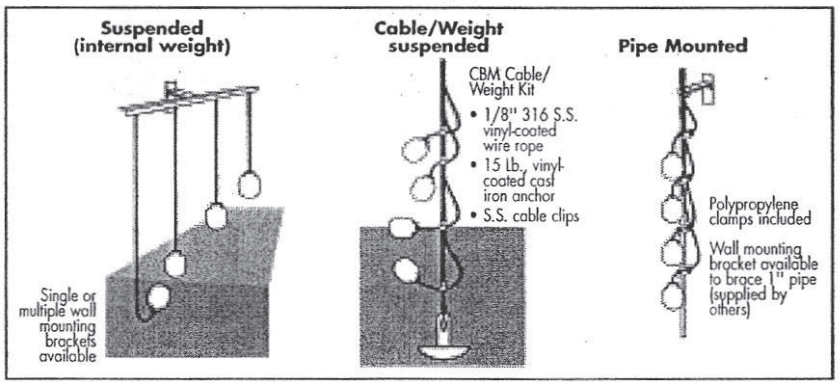
Specifications



USFilter

DATA SHEET

DESCRIPTION	PART NUMBER
LSC Float Switch	
P30NONC LSC Float switch (1-N.O., 1-N.C.) w/30' cable, 3-wire	803138-30
S30NONC LSC Float switch (1-N.O., 1-N.C.) w/30' cable, 3-wire	803138-31
P60NONC LSC Float switch (1-N.O., 1-N.C.) w/60' cable, 3-wire	803138-60
S60NONC LSC Float switch (1-N.O., 1-N.C.) w/60' cable, 3-wire	803138-61
Mounting Hardware & Accessories	
TCB junction box (with terminal blocks for 4 switches and ground lug)	601102-01
IS6 intrinsic safety barrier (requires 12-24 VDC@50mA power source)	601312-02
LS float switch pipe mount clamp (ordered as replacement)	601176-01
LS float switch cable mount clamp (ordered as replacement)	601211-01
CBM 15# anchor mounting kit (does not include SS cable; see next item)	803360-ANC
CBM stainless steel cable; 20'	601440-20
CBM stainless steel cable; each additional 10' (XX=length)	601440-XX
Wall mounting bracket	803134-01
Type W bracket	803213-01



COMPLETE CONTROL CAPABILITIES

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Installation Instructions for Grille Type Weatherproof Adaptahorns

Description

The 876 and 877 series are UL listed, FM approved, vibrating horns in NEMA 4X enclosures. They are low current, high decibel horns designed for heavy-duty use either indoors or outdoors. The die-cast weatherproof box has a durable, corrosion resistant, electrostatic heat flowed powder epoxy gray finish. The horns are intended for general signaling applications.

Cat. No.	Voltage	Current
876-E5	12V 50/60 Hz	1.25A
876-G5	24V 50/60 Hz	0.63A
876-N5	120V 50/60 Hz	0.13A
876-R5	240V 50/60 Hz	0.06A
877-E1	12V DC	0.27A
877-G1	24V DC	0.16A
877-J1	32V DC	0.13A
877-K1	48V DC	0.07A
877-P1	125V DC	0.025A

Installation

1. Using a 5/64" allen wrench (supplied), loosen both set screws (located on either side of backbox) and remove horn from backbox.
2. Fasten backbox to wall or partition as follows:
   a. Remove the screw hole knockouts in the backbox.
   b. Insert caplugs (supplied) in screw holes in backbox.
   c. Drive #8 wood screws (supplied) through caplugs into mounting surface.
   d. Secure conduit at entrance hole.
3. Connect one wire to each terminal in backbox.
4. Ground the unit by connecting the green/yellow striped ground lead to earty ground using the terminal screw in the box or by other appropriate means.
5. Plug horn on backbox with "E" at top and tighten set screws.
6. The volume is factory set at the maximum level. To reduce volume level, turn set screw (located on grille front) clockwise using a 1/16" allen wrench (supplied).

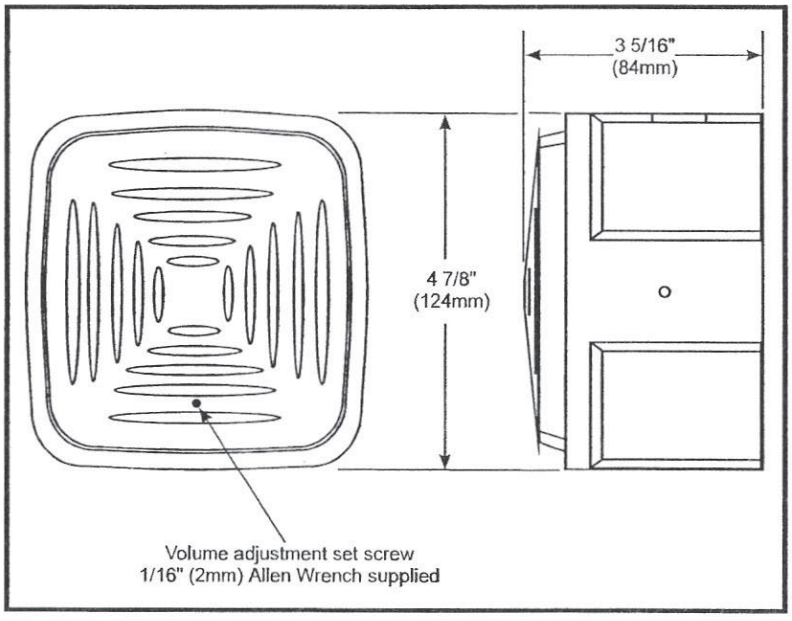


Figure 1. Dimensions

P-047550-1851 ISSUE 1 © 1997

PUBLICATION DIVIDER

General Accessories
Corrosion Inhibitors; Epoxy Patch Kit



Industrial Corrosion Inhibitors

Hoffman corrosion inhibitors protect

- Interior components of electrical enclosures, boxes, consoles, and wireways
- Interior components of electronic enclosures
- Electrical and electronic equipment and controls
- Parts and components that are packaged in crates during shipping and storage
- Switch gear and relay cabinets
- Interiors of pipes, conduits, and fuse boxes
- Process control computers, instruments, and recording devices
- Tool chest interiors and contents
- Equipment stored at construction sites

Chief Advantages

- Protects against salt and high humidity
- Eliminates the need of oiling, plating, or dipping metal
- Puts protected equipment to use immediately without degreasing or coating removal
- Provides durable protection for up to 12 months

How It Works

Each inhibitor contains a special chemical combination that vaporizes and condenses on all surfaces in an enclosed area. Vapors will redeposit as needed in the event of condensation of moisture on surfaces. These vapors reach every part of an enclosure, protecting all interior components. Spraying, wiping, or greasing are not required. This eliminates precoating, special wraps, and drying agents. Protection is effective even in salt water atmospheres. The A-HCI5E and A-HCI10E emitters have additional red metal inhibitors for further protection. Enclosures containing corrosion inhibitors must be reasonably sealed.

Life Expectancy and Usage

The normal useful life-span of Hoffman corrosion inhibitors is in excess of one year. However, inhibitor life expectancy is shortened by approximately 25% when exposed to temperatures above 104° F (40°C). This product is not recommended for use where temperature exceeds 199°F. Ventilated enclosures or enclosures not sealed properly as well as frequent door openings also shorten the product life. Additional inhibitors should be used if these conditions exist. Since Hoffman corrosion inhibitors are vapor phase protective, all surfaces to be protected should be accessible to the vapors. The maximum distance the vapors can travel is approximately 1.50 feet (.46 meters). Protection of long narrow enclosures can be achieved with tape or multiple inhibitors.

Storage and Handling

Each Hoffman corrosion inhibitor is individually packaged in a resealable bag for maximum effectiveness at time of usage. Corrosion inhibitors should be stored at temperatures not exceeding 120°F (45°C). Recommended shelf life under normal conditions is one year. Hoffman corrosion inhibitors are not returnable.

When determining the proper corrosion inhibitor for your application, assume that the enclosure volume to be protected is greater than calculated if (1) cabinet doors are opened frequently, (2) cabinet is located in an extremely corrosive area, and/or (3) cabinet length divided by depth is greater than four.

A-HCI1DV Foam device protects one cubic foot (28 liters) of enclosure volume for approximately one year.

Size: .25" x 1.25" x 3.00" (6mm x 32mm x 76mm)

A-HCI60R Tape protects sixty cubic feet of enclosure volume per roll. Use approximately 2.50" (6.3cm) of tape per cubic foot (28 liters) of enclosure volume to be protected. Each roll of tape is packaged individually in a resealable bag.

Size: .25" x .75" x 12.00' (6mm x 19mm x 3.6m)

A-HCI240R Tape protects 240 cubic feet of enclosure volume per roll. Use approximately 1.00" (2.5cm) of tape per cubic foot (28 liters) of enclosure volume to be protected. Each roll of tape is packaged individually in a resealable bag.

Size: .25" x 2.00" x 20.00' (6mm x 51mm x 6.1m)

A-HCI5E Emitter protects five cubic feet (142 liters) of enclosure volume for approximately one year. Emitters contain additional red metal (non-ferrous) inhibitors.

Size: 2.50" (diameter) x 1.50" (high) (63mm x 38mm)

A-HCI10E Emitter protects ten cubic feet (283 liters) of enclosure volume for approximately one year. Emitters contain additional red metal (non-ferrous) inhibitors.

Size: 2.50" (diameter) x 2.00" (high) (63mm x 51mm)

A-HCI236S Spray is a non-conductive, nonflammable, vapor phase film and is non-toxic. It has essentially neutral pH value. Application provides instant protection against corrosion. Spray is water soluble and can be easily flushed away with water if desired. This product should be kept from freezing, and has a shelf life of 2+ years in normal warehouse conditions.

Metal	Protected by Chemical	Unprotected by Chemical
Aluminum	Marked reduction of surface attack; no pitting	Severe surface attack; tarnish; pitting
* Brass	Decreased tarnish; very minor surface attack	Surface discoloration; pitting
Steel, Iron	No change	Severe corrosion
* Copper	Slight staining	Heavy corrosive attack
Zinc Plate	Slight discoloration	Severe corrosion
Tin Plate	Slight discoloration	Moderate corrosive attack

* A-HCI5E and A-HCI10E emitters are recommended for these materials.

Catalog Number	Enclosure Volume Protected
A-HCI1DV	1 cu. ft. (28.32 liters)
A-HCI5E	5 cu. ft. (141.6 liters)
A-HCI10E	10 cu. ft. (283.2 liters)
A-HCI60R	60 cu. ft. pr. roll (1699 liters)
A-HCI240R	240 cu. ft. pr. roll (6797 liters)
A-HCI236S	(Corrosion Inhibitor Spray)

Data subject to change without notice PH 763 422 2211 FAX 763 422 2600 ©2000 Hoffman Enclosures Inc.
USFCS PDF No. 1058 Rev.: 00



Epoxy Patch Kit

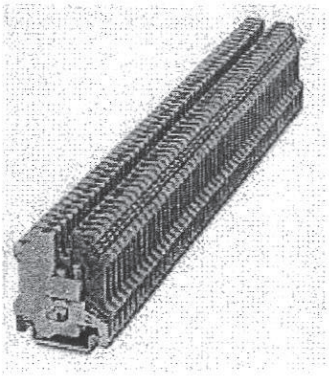
Each kit has two tubes of material, application instructions, and a mixing stick. When the resin and hardener are mixed, a gray epoxy is formed which cures at room temperature, has high adhesion, and will not sag. It is resistant to oils, acids, and chemicals. Other applications include sealing rivets, bolts, metal joints, seams and welds, cement cracks, pipe couplings, joints, and tees.

Catalog Number
A-307

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USLKG 5



Terminal width 6.2

	(IEC)	rigid	flexible	
	[mm²]	solid	stranded	AWG
IEC 947-7-2		0.2-4	0.2-4	24-12
EN 50 019 *		0.2-4	0.2-4	–

* Certificate no.: KEMA Ex-94.C.7133U

KEMA/RMRS

Current carrying capacity of mounting rails see product-line info

Description	Type	Order No.	Pcs. / Pkt.
Ground terminal block[1]), with green-yellow insulation housing, for mounting on ⊏, ⊐ or ⊔	**USLKG 5**	**04 41 50 4**	50
Ground terminal block[1]), with green-yellow insulation housing, for mounting on ⊔	**USLKG 5-1**	**04 41 51 7**	50

Accessories			
(1) **Zack strip,** 10-section, white	**ZB 6** (see info)		
(2) **Screwdriver**	**SZS 0,6 x 3,5**	**12 05 05 3**	10

Technical data

Dimensions		
Width / length	[mm]	6.2 / 42.5
Height (NS 35:7,5 / NS 35:15 / NS 32)	[mm]	47 / 54.5 / 52
Technical data in accordance with IEC / DIN VDE		
Rated surge voltage / contamination class	[kV] / –	8/ 3[3])
Surge voltage category / insulation material group	– / –	III / I
Connection capacity		
stranded with ferrule without / with plastic sleeve	[mm²]	0.25 - 4 / 0.25 - 2.5
Multi-conductor connection (2 conductors with same cross section)		
solid / stranded	[mm²]	0.2 - 1.5 / 0.2 - 1.5

stranded with ferrule without plastic sleeve	[mm^2]	0.25 - 1.5
stranded with TWIN ferrule with plastic sleeve	[mm^2]	0.5 - 2.5
Stripping length	[mm]	9
Internal cylindrical gage (IEC 947-1:1988)		A 4
Fastening: thread / torque	– / [Nm]	M 3 / 0.6 - 0.8
Disconnect slide: thread / torque	– / [Nm]	M 3 / 0.6 - 0.8
Insulation material		PA
Inflammability class acc. to UL 94		V0
Temperature indices RTI / Ti		130 / 120
Approval data (UL and CSA)		
Conductor sizes	UL: AWG	26 - 10
	CSA: AWG	28 - 10

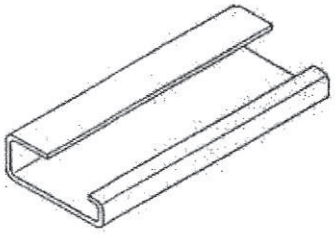
[1]) White labels printed with are included for mounting rail identification.

[3]) With insulation voltages of >690 V, a cover should be inserted when aligning with feed-through terminal blocks with the same profile.

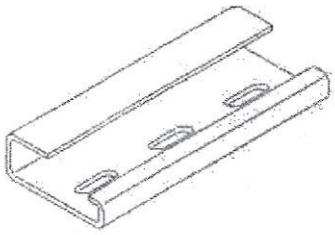
Ground Terminal Blocks USLKG...-1

This USLKG version has been specially developed for the NS 35/15-2,3 mounting rail.

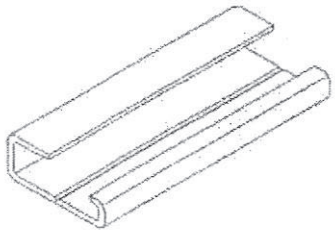
USLKG



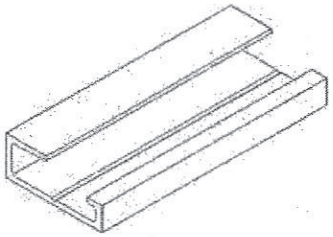
NS 32 UNPERFORATED
acc. to EN 50 035
NS 32-CU/35 QMM
UNPERFORATED
dimensions acc. to
EN 50 035



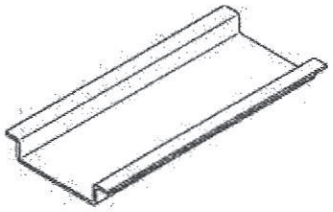
NS 32 PERFORATED
acc. to EN 50 035



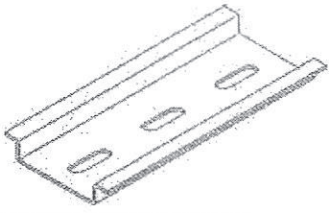
NS 32-AL
UNPERFORATED
similar to EN 50 035



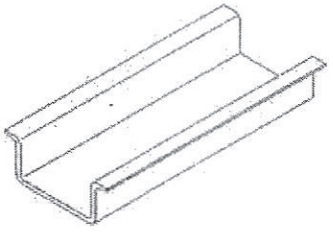
NS 32-CU/120 QMM
UNPERFORATED
similar to EN 50 035



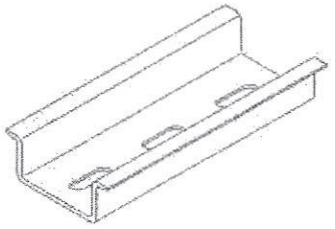
NS 35/7,5
UNPERFORATED
acc. to EN 50 022
NS 35/7,5-CU
UNPERFORATED
dimensions acc. to
EN 50 022



NS 35/7,5 PERFORATED
acc. to EN 50 022

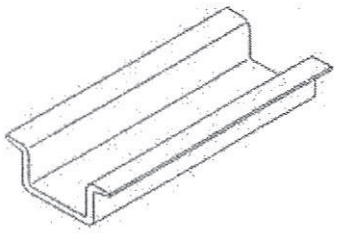


NS 35/15
UNPERFORATED
similar to EN 50 035
NS 35/15-CU
UNPERFORATED
similar to EN 50 035

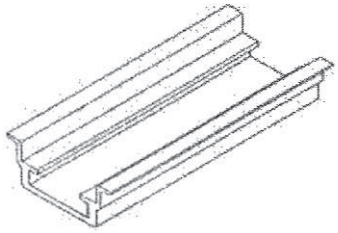


NS 35/15 PERFOR.
similar to EN 50 035

USLKG...-1

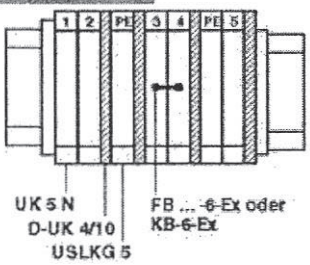


NS 35/15-2,3
UNPERFORATED
acc. to EN 50 022



NS 35/15-AL
UNPERFORATED
similar to EN 50 035

Block diagram



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Allen-Bradley

Application Note

1606-XLP50B
with DC 12...15V/50W



- Mounted and connected in record time, no tools required
- World-wide approvals (CE cULus CB) for industry
- Tiny: WxHxD = 45 x 75 x 91mm DC 15V (with jumper)
- Adjustable output voltage: DC 12...15V(without jumper) resp. DC 15V (with jumper)
- 100...240V Wide Range Input

• Input

Input voltage	AC 100...240V (Wide Range), 47...63Hz Admiss. limits: AC 85...264V (DC 85...375V)
Input current	<1.0A (@ AC 100V, 50W P_{out}) <0.6A (@ AC 196V, 50W P_{out})
External fusing	Unit has internal (not accessible) input fuse. No other protection required. In order to meet local requirements, please consult local codes and regulations for proper installation.
Transient immunity	Transient resistance acc. to VDE 0160 / W2 (750V / 1.3ms), over entire load range
Hold-up time (see diagram below)	>170ms @ AC 230V, 12V / 4.2A >97ms @ AC 196V, 12V / 4.2A >17ms @ AC 100V, 12V / 4.2A

• Efficiency, Reliability

Efficiency	typ. 90% (AC 230V, 12V / 4.2A) (see also diagram below)
Losses	typ. 6W (AC 230V, 12V / 4.2A)
MTBF (Reliability)	appr. 600.000h acc. to Siemensnorm SN29500 (12V / 4.2A, AC 230V, T_{amb} = +40°C)

Prior to shipment, *every* unit undergoes the following tests in order to isolate any defective units which might suffer an early failure:

- Run-in / burn-in (Full load, T_{amb} = +60°C, on/off cycle)
- Functional test (100%)

• Construction, Mechanics, Installation

Robust plastic housing (US Patent No. D442, 923S), fine ventilation grid on three housing sides to keep out small parts (e.g. screws), IP20

Dimensions and weight	
• W x H x D	45mm x 75mm x 91mm (+ DIN Rail))
• Weight	260g
Mounting orientation	, or (cf. 'Output')
Ventilation/Cooling	Normal convection, no fan required
• Free space f. cooling	recommended: 25mm on sides with ventilation grid

Easy snap-on mounting onto the DIN-rail (TS35/7,5 or TS35/15).
Unit sits safely and firmly on the rail; no tools required even to remove

Connection	by Spring Clamp terminals; uniformly firm hold, vibration-resistant and maintenance-free.
• Wire strip length	6mm (0.24in) recommended
• Wire Size Input/Output	Stranded 28...12 AWG (0.3...2.5 mm²), Solid 28...12 AWG (0.3...4 mm²)

Design details – for your advantage:

- All terminals are easy to reach as mounted on the front panel.
- Input and output are strictly apart from each other (input below, output above) and so cannot be mixed up.
- **Mounting *and* connection do not require any screwdriver**

→ Easy, quick, durable and reliable installation.

- A jumper (output terminal) serves to adjust the output voltage (12V resp. 15V).

Rockwell Automation

Publication 1606-AP005A-EN-E March 2003
USFCS PDF No. 567 Rev.: 2003

• Output

Output voltage	without jumper: DC 12...15V (adj. by front panel potentiometer, adj. range guaranteed);
• preset	with jumper: 15V ± 3.5%, without jumper: 12V ± 0.5%
Voltage regulation	static <1% @ V_{out} = 12V static < 1.5% @ V_{out} = 15V, dynamic ±3% V_{out} over all
Ripple/Noise	<100mV_{PP} (20MHz bandwidth, 50 Ω measurement)
Overvoltage prot. (OVP)	<20V
Output noise suppression	Radiated EMI values below EN50081-1, even when using long (>2m), unscreened output cables
Rated continuous loading	at convection cooling: max. I_{out} = 4.2A @ V_{out} = 12V, max. I_{out} = 3.4A @ V_{out} = 15V, details see derating diagram below
• power reserve	max. 10%(depending on V_{in}); details see diagram 'output characteristic' below
Overload behavior	Straight V/I characteristic (depending on V_{in}); details see diagram 'output characteristic' below
Protection	Unit is protected against (also permanent) short-circuit, overload and open-circuit.
Derating	depending on built-in orientation; see diagram below
Power back immunity	22V
Operating indicator	Green LED (DC ON)

• Environmental Data, EMC, Safety

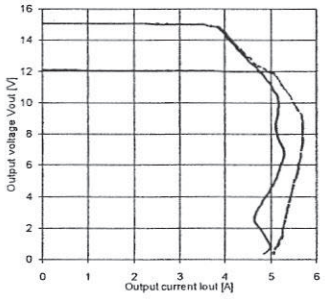
Ambient temperature range (measured 25 mm below unit)	
• storage/transport	-25°C ... +85°C
• operation	-10°C ... +70°C (for derating see diagram below)
Humidity	max. 95% (without condensation)
Electromagnetic emissions (EME)	EN 50081-1 (includes EN 50081-2) Class B (EN 55011, EN 55022) incl. Annex A thanks to noise suppression
Electromagnetic immunity (EMI)	EN 61000-6-2 (includes EN 55024)
Safe low voltage:	SELV (EN 60950, VDE0100/T.410), PELV (EN 50178)
Prot. class/degree:	Class I (EN 60950) / IP20 (EN 60529)

The PSU complies with all major **safety approvals** for EU (EN 60 950, EN 60204-1, EN 50178), USA (UL 60950, E137006, UL508 LISTED, E198865), Canada (CAN/CSA-C22.2 No 60950 [CUR],CAN/CSA-C22.2 No. 14 [CUL]).

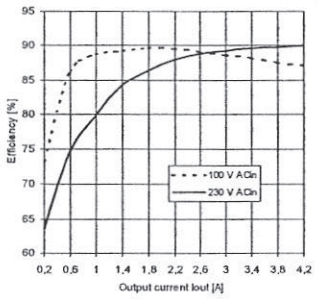
Operation on IT networks: The unit is designed to operate on IT networks. The unit may still deliver a hazardous voltage after the fuses are tripped.

• Diagrams

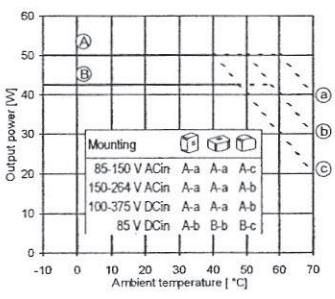
Output characteristic V_{out}/I_{out} (typ.)



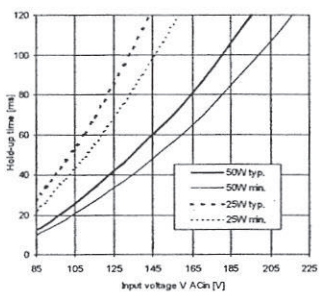
Efficiency (@ V_{out} = 12V, typ.)



Derating of output power



Hold-up time with ACin (at V_{out} = 12V, typ. and min.)



Specifications valid for 230V AC input voltage, +25°C ambient temperature, and 5 min run-in time, unless otherwise stated. They are subject to change without prior notice.

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PUBLICATION DIVIDER

Universal PLC INTERFACE With SPDT Relay
PLC-RSC.../21 – With Screw Connection

The universal PLC-RSC...21 relay series comprises 6.2 mm (0.244 in.) basic terminal blocks and plug-in miniature relays with SPDT contact and screw connection.

Costly wiring is considerably reduced through the use of plug-in bridges. In addition, wiring errors and troubleshooting are minimized.

SPDT Contact = A High Degree of Flexibility

The universal PLC-RSC...21 SPDT contact series is used whenever a high degree of flexibility is required, depending on the application. This series can be used
– as an input or output interface or
– in N/C, N/O or SPDT contact applications

Advantage: Fewer items to order and store. The PLC interfaces are supplied as standard with the relay (or miniature optocoupler with electronic N/O contact function) included.

Input Voltages From 12 V to 230 V

The PLC-RSC...21 is available on the coil side in all popular industrial voltages from 12 V to 230 V. Another advantage is the integrated input wiring, which comprises status indicators, free-wheeling diode and protection against polarity reversal. It also ensures that the operating state is clearly indicated, electromagnetic interference is safely suppressed at the coil, and no damage is caused by accidental polarity reversal.

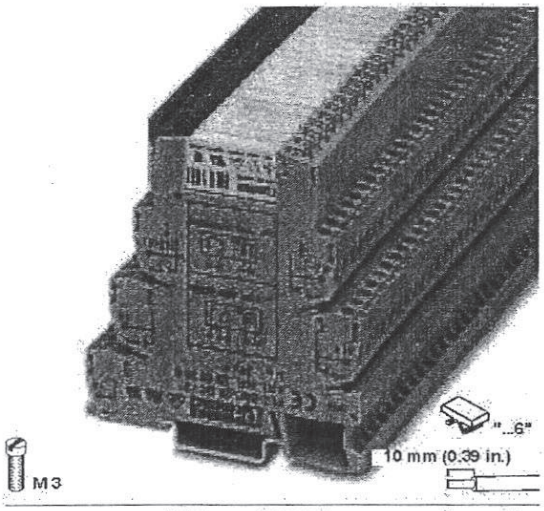
Rugged Miniature Relay

The main component in the SPDT contact series is a rugged miniature relay of the latest generation, equipped with features, which are not normally found in standard plug-in relays:
– Operational safety ensured by mechanics with IP67 protection
– Environmentally friendly, cadmium-free power contact material for loads up to 250 V AC/6 A
– Available with gold coating for low levels of power (mA) as an option
– Safe isolation according to DIN VDE 0106-101
– 4 kV_{rms} electrical isolation between coil and contact

The relay is safely secured in place using an engagement lever. In the event of wear, the relay can be released and replaced quickly and cost-effectively without having to disconnect the wiring.

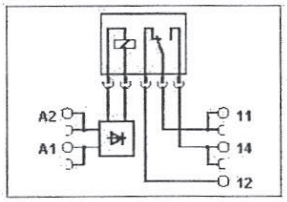
Plug-In Bridges Reduce Wiring

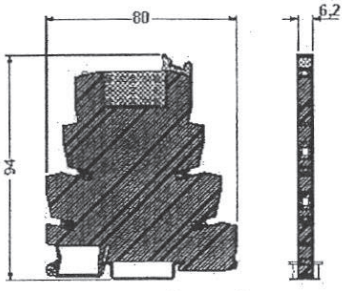
A big advantage for wiring experts is the user-friendly FBST plug-in bridge system. Whether for A1/A2 connection on the coil side or grouped power supply at connection 11 on the contact side, the cut to site plug-in bridge or the 2-pos. bridge connector ensure fast, cost-effective, and error-free plug-in wiring with excellent system clarity. Cumbersome, time-consuming daisy chains are finally a thing of the past.



	Solid [mm²]	Stranded [mm²]	AWG	I [A]	U [V]
Connection data	0.14 - 2.5	0.14 - 2.5	26 - 14	*	*

* The electrical data is determined by the relay.





Universal PLC INTERFACE With PLC-RSC.../21 SPDT Relay

Description	Input voltage U_N [1])	Type	Order No.	Pcs. Pkt.
PLC interface, comprising PLC-BSC.../21 basic terminal block and plug-in miniature relay (see INTERFACE catalog), for mounting on ⊓	24 V DC	Includes gold plated contact relay **PLC-RSC- 24DC/21AU**	29 66 26 5	10
	24 V AC/DC	**PLC-RSC- 24UC/21AU**	29 66 27 8	10
Additional input voltages available on request.	120 V AC/110 V DC	**PLC-RSC-120UC/21AU**	29 66 28 1	10
	230 V AC/220 V DC [2])	**PLC-RSC-230UC/21AU**	29 66 29 4	10
PLC interface, comprising PLC-BSC.../21 basic terminal block and plug-in miniature relay (see INTERFACE catalog), for mounting on ⊓	24 V DC	Includes power contact relay **PLC-RSC- 24DC/21**	29 66 17 1	10
	24 V AC/DC	**PLC-RSC- 24UC/21**	29 66 18 4	10
Additional input voltages available on request.	120 V AC/110 V DC	**PLC-RSC-120UC/21**	29 66 19 7	10
	230 V AC/220 V DC [2])	**PLC-RSC-230UC/21**	29 66 20 7	10

Technical Data

Input Data				
Nominal input voltage U_N	24 V DC	24 V AC/DC	120 V AC/ 110 V DC	230 V AC/ 220 V DC [2])
Permissible range with reference to U_N	See diagram in the INTERFACE catalog			
Typical input current at U_N	9 mA	11/8.5 mA	3.5/3 mA	3 mA
Typical response time at U_N	4 ms	6 ms	6 ms	7 ms
Typical release time at U_N	8 ms	15 ms	15 ms	15 ms
Input wiring:	24, 120, 230 V AC/DC	Operating indicator, polarity protection diode, free-wheeling diode Operating indicator, bridge rectifier		

Output Data		**PLC-R.../21**	**PLC-R.../21AU**
Contact type		Single contact, SPDT contact	Single contact, SPDT contact
Contact material		AgSnO	AgSnO + 5 µ Au [3])
Maximum switching voltage		250 V AC/DC [2])	30 V AC/36 V DC
Minimum switching voltage		12 V AC/DC	100 mV
Limiting continuous current		6 A	50 mA
Maximum inrush current		30 A at AC 15 operation	50 mA
Minimum switching current		10 mA	1 mA
Maximum shutdown power, ohmic load:	24 V DC	140 W	1.2 W
	48 V DC	20 W	–
	60 V DC	18 W	–
	110 V DC	23 W	–
	220 V DC	40 W	–
	250 V AC	1500 VA	–
Minimum switching power		120 mW	10 µW

General Data	
Test voltage input/contact; contact/contact	4 kV, 50 Hz, 1 minute
Ambient operating temperature range	-20°C to +55°C (-4°F to +131°F) (24 V types up to +60°C [+140°F])
Nominal operating mode	100% operating factor
Inflammability class	V0 according to UL 94
Mechanical service life	2×10^7 cycles
Standards/specifications	IEC 664/IEC 664 A/DIN VDE 0110, degree of pollution 3, Surge Voltage Category III, DIN VDE 0160 (in relev. parts), IEC 255/DIN VDE 0435 (in relev. parts), DIN VDE 0106-101:1986-11, reinforced insulation for I/O [4])
Mounting position/mounting	Any/can be mounted without spacing
Connection method	Screw connection

[1]) Input wiring depends on the type.

[2]) For voltages greater than 250 V (L1, L2, L3) between the same terminal blocks on adjacent modules, the PLC-ATP separating plate (see Accessories) should be used.

[3]) If the specified maximum values are exceeded, the gold coating will be damaged. In subsequent operation, the values of the AgNi contact will apply.

[4]) The PLC-ATP separating plate (see Accessories) should be used between adjacent modules for safe isolation.

Insulating Housing Version

Polyamide PA, not reinforced — **See INTERFACE catalog**
Color: green

For torque of terminal block screws, see INTERFACE catalog.

For marking systems and assembly material, see CLIPLINE catalog.

The dimensioning cross section (see INTERFACE catalog) refers to simple wires without ferrules.

Inductive loads must be attenuated with an effective protective circuit to protect inputs and outputs.

For 120 V and 230 V modules, a REL-MR-60DC/... 60 V relay must always be used due to the integrated input wiring in the basic terminal block.

Universal PLC INTERFACE With Optocoupler PLC-OSC...

The universal PLC-OSC... optocoupler series, comprises plug-in miniature optocouplers and the same 6.2 mm (0.244 in.) basic terminal blocks as the SPDT relay series with screw connection.

Costly wiring is considerably reduced through the use of plug-in bridges. In addition, wiring errors and troubleshooting are minimized.

The standard PLC-OSC... series can be used as either an input or output interface. This also simplifies ordering and reduces storage and servicing costs. The unit is complete, which means that the optocoupler does not have to be inserted separately. For increased flexibility, all individual components (basic terminal block, optocoupler or alternatively relay) can also be ordered separately and combined individually.

Input Voltages From 24 V to 230 V

The PLC-OSC... is available on the control side in all popular industrial voltages from 24 V to 230 V. Another advantage is the integrated input wiring, which comprises status indicators and protection against polarity reversal. It also ensures that the operating state is clearly indicated by an LED and no damage is caused to the optoelectronics by accidental polarity reversal.

Powerful Miniature Optocoupler

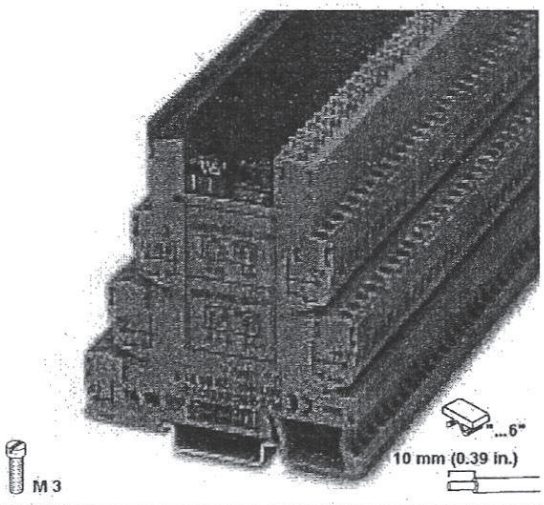
Despite its compact dimensions, the PLC miniature optocoupler is exceptionally powerful, very rugged (as is typical of optocouplers), and the ideal choice for high switching frequencies:

- Switching power up to 24 V DC/3 A, depending on the type
- Fully encapsulated optoelectronics with IP67 protection
- 2.5 kV_{rms} electrical isolation between input/output
- Available with input optocoupler or power optocoupler as an option
- Wear-resistant switching
- Resistant to vibrations and shocks

The optocoupler is safely secured in place using an engagement lever. In the unlikely event that the optocoupler requires servicing, it can be released and replaced quickly and cost-effectively without having to disconnect the wiring.

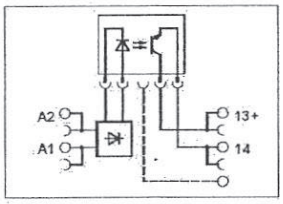
Plug-In Bridges Reduce Wiring

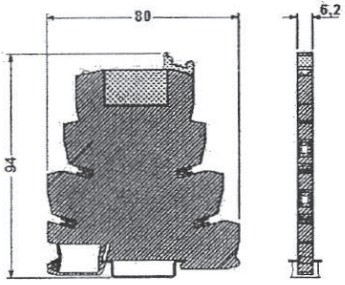
A big advantage for wiring experts is the user-friendly FBST plug-in bridge system. Whether for A1/A2 connection on the control side or grouped power supply at connection 13 on the load side, the cut to site plug-in bridge or the 2-pos. bridge connector ensure fast, cost-effective, and error-free plug-in wiring with excellent system clarity. Cumbersome, time-consuming daisy chains are finally a thing of the past.



	Solid [mm²]	Stranded [mm²]	AWG	I [A]	U [V]
Connection data	0.14 - 2.5	0.14 - 2.5	26 - 14	*	*

* The electrical data is determined by the optocoupler.





Universal PLC INTERFACE With PLC-OSC... Optocoupler

Description	Input voltage U_N [1]	Type	Order No.	Pcs. / Pkt.
PLC interface, comprising PLC-BSC... basic terminal block and plug-in miniature optocoupler (see INTERFACE catalog), for mounting on ⊓	24 V DC 120 V AC/110 V DC	Includes input optocoupler **PLC-OSC- 24DC/48DC/100** **PLC-OSC-120UC/48DC/100**	**29 66 72 8** **29 66 74 4**	10 10
Additional input voltages available on request.	230 V AC/220 V DC [2]	**PLC-OSC-230UC/48DC/100**	**29 66 75 7**	10
PLC interface, comprising PLC-BSC... basic terminal block and plug-in miniature optocoupler (see INTERFACE catalog), for mounting on ⊓	24 V DC 120 V AC/110 V DC	Includes power optocoupler **PLC-OSC- 24DC/24DC/2** **PLC-OSC-120UC/24DC/2**	**29 66 63 4** **29 66 65 0**	10 10
Additional input voltages available on request.	230 V AC/220 V DC [2]	**PLC-OSC-230UC/24DC/2**	**29 66 66 3**	10

Technical Data	Input Optocoupler		Power Optocoupler	
Input Data				
Nominal input voltage U_N	24 V DC	120 V AC/ 110 V DC 230 V AC/ 220 V DC [2]	24 V DC	120 V AC/ 110 V DC 230 V AC/ 220 V DC [2]
Permissible range (with reference to U_N)	0.8 - 1.2	0.8 - 1.1	0.8 - 1.2	0.8 - 1.1
Switching level 1 signal ("H")	0.8 x U_N	0.8 x U_N	0.8 x U_N	0.8 x U_N
0 signal ("L")	0.4 x U_N	0.3 x U_N	0.4 x U_N	0.25 x U_N
Typical input current at U_N	8 mA	4 mA	9 mA	4 mA
Typical switch-on time at U_N	20 µs	6 ms	20 µs	6 ms
Typical switch-off time at U_N	300 µs	10 ms	500 µs	10 ms
Transmission frequency f_{limit}	300 Hz	10 Hz	300 Hz	10 Hz
Input wiring [1]: 24 V DC	Operating indicator, polarity protection diode, free-wheeling diode			
24, 120, 230 V AC/DC	Operating indicator, bridge rectifier			
Output Data	**PLC-O.../48DC/100**		**PLC-O.../24DC/2**	
Maximum switching voltage	48 V DC		33 V DC	
Minimum switching voltage	3 V DC		3 V DC	
Limiting continuous current	100 mA		3 A (see derating curve in IF catalog)	
Maximum inrush current	–		15 A (10 ms)	
Minimum switching current	–	–		
Output switching	2-wire floating ground		2-wire floating ground	
Output wiring	Protection against polarity reversal, surge protection			
Voltage drop on maximum limiting continuous current	≤ 1 V		≤ 200 mV	
General Data				
Test voltage I/O	2.5 kV, 50 Hz, 1 minute			
Ambient operating temperature range	-20°C to +60°C (-4°F to +140°F)			
Nominal operating mode	100% operating factor			
Inflammability class	V0 according to UL 94			
Standards/specifications [3]	IEC 664/IEC 664 A/DIN VDE 0110, degree of pollution 2, Surge Voltage Category III			
Mounting position/mounting	Any/can be mounted without spacing			
Connection method	Screw connection			

[1] Input wiring depends on the type.

[2] For voltages greater than 250 V (L1, L2, L3) between the same terminal blocks on adjacent modules, the PLC-ATP separating plate (see Accessories) should be used.

[3] The PLC-ATP separating plate (see Accessories) should be used between adjacent modules for safe isolation.

Insulating Housing Version

Polyamide PA, not reinforced See INTERFACE catalog
Color: green

For torque of terminal block screws, see INTERFACE catalog.

For marking systems and assembly material, see CLIPLINE catalog.

The dimensioning cross section (see INTERFACE catalog) refers to simple wires without ferrules.

Inductive loads must be attenuated with an effective protective circuit to protect inputs and outputs.

For 120 V and 230 V modules, an OPT-60DC/... 60 V optocoupler must always be used due to the integrated input wiring in the basic terminal block.

PLC Actuator INTERFACE With Relay, "The Output Specialist" PLC-RSC...ACT

In applications as the interface between the PLC and actuators, such as motors, contactors or solenoid valves, usually only one N/O contact is required. The PLC-RSC...ACT output interface, comprising a 6.2 mm (0.244 in.) basic terminal block and plug-in miniature relay with screw connection, is designed specifically for these applications.

Costly wiring is considerably reduced through the use of plug-in bridges. In addition, wiring errors and troubleshooting are minimized.

No Output Terminal Blocks

In contrast to previous coupling relays, all actuator connections, including the load return line, are connected directly to the PLC actuator interface. The PLC-RSC...ACT can therefore be used directly as an output terminal strip with an integrated interface function for the outgoing actuator cables, without the need for additional modular terminal blocks (see also main diagram in the INTERFACE catalog).

Potential savings:

- Cost saving of two output terminal blocks for switching and load return lines
- Space saving of approximately 80%
- Time saving of approximately 60%
- Wiring is reduced through the use of plug-in bridges

Optimum Use of Plug-In Bridges

The actuator interface only achieves maximum efficiency through the user-friendly FBST plug-in bridge system. The PLC-RSC...ACT optimally uses the bridging options for the A1/A2 connection on the coil side, for the load supply at connection 13 on the contact side, and for the load return line. The colored, insulated continuous plug-in bridges, which measure 500 mm (19.685 in.) in length, are a particularly efficient solution. They can be shortened to the required length and inserted quickly and easily in the bridge shafts. There is no need to strip wires, insert ferrules or connect them together. Cumbersome daisy chains are finally a thing of the past.

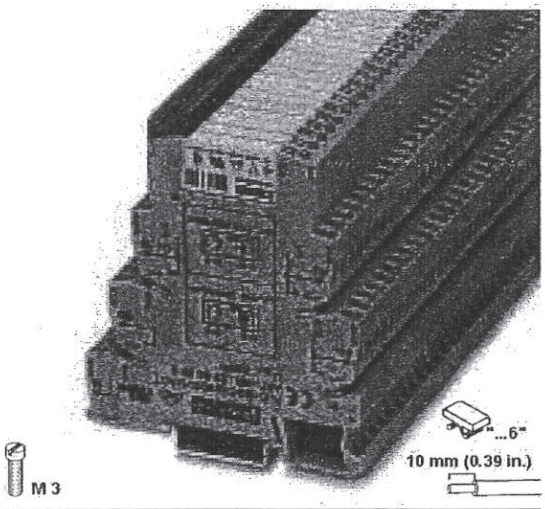
Potential savings:

- Wiring is reduced through the minimum use of modular terminal blocks and the maximum use of all bridging options: approximately 60%.

Additional Advantages

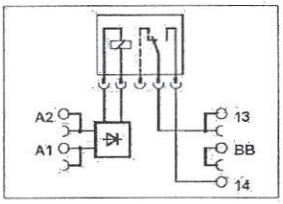
The PLC-RSC...ACT offers the same advantages as the other PLC series with relays:

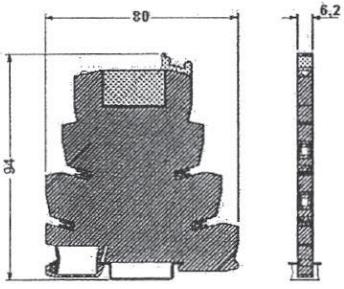
- Available with gold or power contact relay as an option
- Integrated input wiring
- Switching power up to 250 V AC/6 A
- Relay can be replaced using an engagement lever



	Solid [mm²]	Stranded [mm²]	AWG	I [A]	U [V]
Connection data	0.14 - 2.5	0.14 - 2.5	26 - 14	*	*

* The electrical data is determined by the relay.





- Operational safety ensured by relay with IP67 protection
- Safe isolation according to DIN VDE 0106-101
- User-friendly labeling
- Inflammability class V0 according to UL94

PLC Actuator INTERFACE With Relay, "The Output Specialist" PLC-RSC...ACT

Description	Input voltage U_N [1])	Type	Order No.	Pcs. / Pkt.
PLC interface, comprising PLC-BSC...ACT basic terminal block and plug-in miniature relay (see INTERFACE catalog), for mounting on ⊓	24 V DC	Includes power contact relay **PLC-RSC-24DC/1/ACT**	**29 66 21 0**	**10**

Technical Data

Input Data		
Nominal input voltage U_N		24 V DC
Permissible range (with reference to U_N)		See diagram in the INTERFACE catalog
Typical input current at U_N		9 mA
Typical response time/switch-on time at U_N		4 ms
Typical release time/switch-off time at U_N		8 ms
Input wiring [1])		Operating indicator, polarity protection diode, free-wheeling diode
Output Data		
Contact type		Single contact, SPDT contact
Contact material		AgSnO
Maximum switching voltage		250 V AC/DC [2])
Minimum switching voltage		12 V AC/DC
Limiting continuous current		6 A
Maximum inrush current		30 A at AC 15 operation
Minimum switching current		10 mA
Maximum shutdown power, ohmic load:	24 V DC	140 W
	48 V DC	20 W
	60 V DC	18 W
	110 V DC	23 W
	220 V DC	40 W
	250 V AC	1500 VA
Minimum switching power		120 mW
General Data		
Test voltage I/O		4 kV, 50 Hz, 1 minute
Ambient operating temperature range		-20°C to +60°C (-4°F to +140°F)
Nominal operating mode		100% operating factor
Inflammability class		V0 according to UL 94
Mechanical service life		2×10^7 cycles
Standards/specifications		IEC 664/IEC 664 A/DIN VDE 0110, degree of pollution 3, Surge Voltage Category III, DIN VDE 0160 (in relev. parts), IEC 255/DIN VDE 0435 (in relev. parts), DIN VDE 0106-101: 1986-11, reinforced insulation for I/O [3])
Mounting position/mounting		Any/can be mounted without spacing
Connection method		Screw connection

[1]) Input wiring depends on the type.

[2]) For voltages greater than 250 V (L1, L2, L3) between the same terminal blocks on adjacent modules, the PLC-ATP separating plate (see Accessories) should be used.

[3]) The PLC-ATP separating plate (see Accessories) should be used between adjacent modules for safe isolation.

Insulating Housing Version

Polyamide PA, not reinforced — See INTERFACE catalog
Color: green

For torque of terminal block screws, see INTERFACE catalog.

For marking systems and assembly material, see CLIPLINE catalog.

The dimensioning cross section (see INTERFACE catalog) refers to simple wires without ferrules.

Inductive loads must be attenuated with an effective protective circuit to protect inputs and outputs.

For 120 V and 230 V modules, a REL-MR-60DC/... 60 V relay must always be used due to the integrated input wiring in the basic terminal block.

PLC Actuator INTERFACE With Optocoupler, "The Output Specialist" PLC-OSC...ACT

In applications as the interface between the PLC and actuators, such as motors, contactors or solenoid valves, usually only one N/O contact function is required. The PLC-OSC...ACT output interface, comprising a 6.2 mm (0.244 in.) basic terminal block and plug-in miniature optocoupler with screw connection, is designed specifically for these applications.

Costly wiring is considerably reduced through the use of plug-in bridges. In addition, wiring errors and troubleshooting are minimized.

The actuator interface can also be supplied with a miniature relay as an option.

No Output Terminal Blocks

In contrast to previous coupling relays, all actuator connections, including the load return line, are connected directly to the PLC actuator interface. The PLC-OSC...ACT can be used as an output terminal strip with an integrated interface function for the outgoing actuator cables, without the need for additional modular terminal blocks (see also main diagram in the INTERFACE catalog).

Potential savings:

- Cost saving of two output terminal blocks for switching and load return lines
- Space saving of approximately 80%
- Time saving of approximately 60%
- Wiring is reduced through the use of plug-in bridges

Optimum Use of Plug-In Bridges

The actuator interface only achieves maximum efficiency through the user-friendly FBST plug-in bridge system. The PLC-OSC...ACT optimally uses the bridging options for the A1/A2 connection on the coil side, for the load supply at connection 13 on the contact side, and for the load return line. The colored, insulated continuous plug-in bridges, which measure 500 mm (19.685 in.) in length, are a particularly efficient solution. They can be shortened to the required length and inserted quickly and easily in the bridge shafts. There is no need to strip wires, insert ferrules or connect them together. Cumbersome daisy chains are finally a thing of the past.

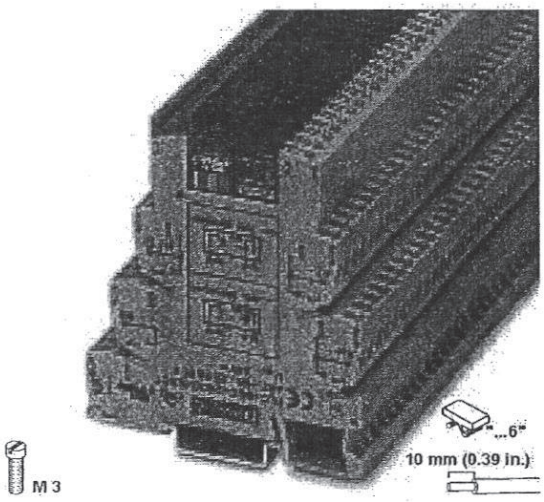
Potential savings:

- Wiring is reduced through the minimum use of modular terminal blocks and the maximum use of all bridging options: approximately 60%.

Additional Advantages

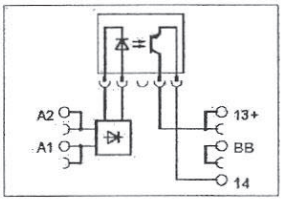
The PLC-OSC...ACT offers the same advantages as the other PLC series with optocouplers:

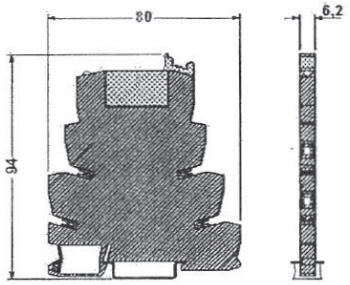
- Switching power up to 24 V DC/3 A, depending on the type
- Wear-resistant switching
- Integrated input wiring
- Available with input or power optocoupler



	Solid [mm²]	Stranded [mm²]	AWG	I [A]	U [V]
Connection data	0.14 - 2.5	0.14 - 2.5	26 - 14	*	*

* The electrical data is determined by the optocoupler.





- Optocoupler can be replaced using an engagement lever
- Fully encapsulated optoelectronics with IP67 protection
- Resistant to vibrations and shocks
- User-friendly labeling
- Inflammability class V0 according to UL94

Phoenix Contact GmbH & Co. KG • 32823 Blomberg, Germany
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Local Contact: www.phoenixcontact.com/salesnetwork

PLC Actuator INTERFACE With Optocoupler, "The Output Specialist" PLC-OSC...ACT

Description	Input voltage U_N [1]	Type	Order No.	Pcs./Pkt.
PLC Interface, comprising PLC-BSC...ACT basic terminal block and plug-in miniature relay (see INTERFACE catalog) for mounting on ⊓ Additional input voltages available on request.	24 V DC	Includes power optocoupler **PLC-OSC-24DC/24DC/2/ACT**	29 66 67 6	10

Technical Data

Input Data	
Nominal input voltage U_N	24 V DC
Permissible range (with reference to U_N)	0.8 - 1.2
Switching level 1 signal ("H")	0.8 x U_N
0 signal ("L")	0.4 x U_N
Typical input current at U_N	9 mA
Typical response time/switch-on time at U_N	20 µs
Typical release time/switch-off time at U_N	500 µs
Transmission frequency f_{limit}	300 Hz
Input wiring [1]	Operating indicator, polarity protection diode, free-wheeling diode
Output Data	
Maximum switching voltage	33 V DC
Minimum switching voltage	3 V DC
Limiting continuous current	3 A (see derating curve in INTERFACE catalog)
Maximum inrush current	15 A (10 ms)
Output switching	2-wire floating ground
Output wiring	Protection against polarity reversal, surge protection
Voltage drop on limiting continuous current	≤ 200 mV
General Data	
Test voltage I/O	2.5 kV, 50 Hz, 1 minute
Ambient operating temperature range	-20°C to +60°C (-4°F to +140°F)
Nominal operating mode	100% operating factor
Inflammability class	V0 according to UL 94
Standards/specifications [2]	IEC 664/IEC 664 A/DIN VDE 0110, degree of pollution 2, Surge Voltage Category III
Mounting position/mounting	Any/can be mounted without spacing
Connection method	Screw connection

[1] Input wiring depends on the type.

[2] The PLC-ATP separating plate (see Accessories) should be used between adjacent modules for safe isolation.

Insulating Housing Version

Polyamide PA, not reinforced See INTERFACE catalog
Color: green

For torque of terminal block screws, see INTERFACE catalog.

For marking systems and assembly material, see CLIPLINE catalog.

The dimensioning cross section (see INTERFACE catalog) refers to simple wires without ferrules.

Inductive loads must be attenuated with an effective protective circuit to protect inputs and outputs.

For 120 V and 230 V modules, a REL-MR-60DC/... 60 V relay must always be used due to the integrated input wiring in the basic terminal block.

PLC Sensor INTERFACE With Relay, "The Input Specialist" PLC-RSC...SEN

In applications as the interface between the PLC and sensors, such as proximity switches, limit switches or auxiliary contacts, often only one N/O contact is required. The PLC-RSC...SEN input interface, comprising a 6.2 mm (0.244 in.) basic terminal block and plug-in miniature relay with screw connection, is designed specifically for these applications.

Costly wiring is considerably reduced through the use of plug-in bridges. In addition, wiring errors and troubleshooting are minimized.

No Power Terminal Blocks

In contrast to previous input relays, all sensor connections, including the supply voltage for sensors/switches, are connected directly to the PLC sensor interface. The PLC-RSC...SEN can be used as a terminal strip with an integrated interface function for the incoming sensor cables, without the need for additional modular terminal blocks (see also main diagram in the INTERFACE catalog).

Potential savings:

- Cost saving of two (or three) modular terminal blocks for sensor/switch supply, signals, and sensor ground (for 3-wire initiators)
- Space saving of approximately 80%
- Time saving of approximately 60%
- Wiring is reduced through the use of plug-in bridges

Optimum Use of Plug-In Bridges

The sensor interface only achieves maximum efficiency through the user-friendly FBST plug-in bridge system. The PLC-RSC...SEN optimally uses the bridging options for the voltage supply of sensors/switches, for the supply/sensor ground at the A2 connection, and for the common supply potential of the PLC at connection 13. The colored, insulated continuous plug-in bridges, which measure 500 mm (19.685 in.) in length, are a particularly efficient solution. They can be shortened to the required length and inserted quickly and easily in the bridge shafts. There is no need to strip wires, insert ferrules or connect them together. Cumbersome daisy chains are finally a thing of the past.

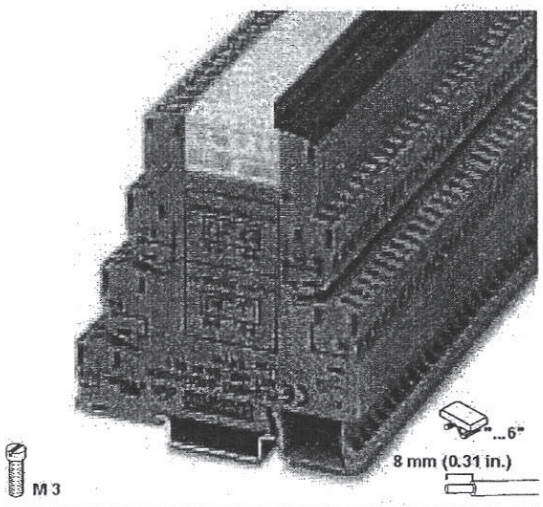
Potential savings:

- Wiring is reduced through the minimum use of modular terminal blocks and the maximum use of all bridging options: approximately 60%.

Additional Advantages

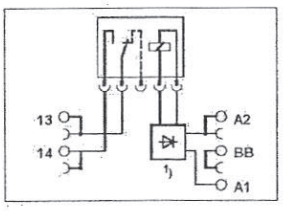
The PLC-RSC...SEN offers the same advantages as the other PLC series with relays:

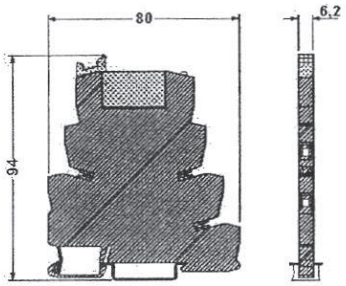
- Switching power up to 250 V AC/6 A
- Integrated input wiring
- Available with gold or power contact relay as an option
- Relay can be replaced using an engagement lever



	Solid [mm²]	Stranded [mm²]	AWG	I [A]	U [V]
Connection data	0.14 - 2.5	0.14 - 2.5	26 - 14	*	*

* The electrical data is determined by the relay.





- Operational safety ensured by relay with IP67 protection
- Safe isolation according to DIN VDE 0106-101
- User-friendly labeling
- Inflammability class V0 according to UL94

PLC Sensor INTERFACE With Relay, "The Input Specialist" PLC-RSC...SEN

Description	Input voltage U_N [1])	Type	Order No.	Pcs. / Pkt.
PLC interface, comprising PLC-BSC.../SEN basic terminal block and plug-in miniature relay (see INTERFACE catalog), for mounting on ⊓	24 V DC 120 V AC/110 V DC 230 V AC/220 V DC [2])	Includes gold plated contact relay **PLC-RSC- 24DC/21AU SEN** **PLC-RSC-120UC/21AU SEN** **PLC-RSC-230UC/21AU SEN**	 **29 66 26 5** **29 66 28 1** **29 66 29 4**	 10 10 10
PLC interface, comprising PLC-BSC.../SEN basic terminal block and plug-in miniature relay (see INTERFACE catalog), for mounting on ⊓	24 V DC 120 V AC/110 V DC 230 V AC/220 V DC [2])	Includes power contact relay **PLC-RSC- 24DC/21 SEN** **PLC-RSC-120UC/21 SEN** **PLC-RSC-230UC/21 SEN**	 **29 66 17 1** **29 66 19 7** **29 66 20 7**	 10 10 10

Technical Data

Input Data				
Nominal input voltage U_N	24 V DC	24 V AC/DC	120 V AC/ 110 V DC	230 V AC/ 220 V DC [2])
Permissible range with reference to U_N	See diagram in the INTERFACE catalog			
Typical input current at U_N	9 mA	11/8.5 mA	3.5/3 mA	3 mA
Typical response time at U_N	4 ms	6 ms	6 ms	7 ms
Typical release time at U_N	8 ms	15 ms	15 ms	15 ms
Input wiring:	Operating indicator, polarity protection diode, free-wheeling diode			
24 V DC 24, 120, 230 V AC/DC	Operating indicator, bridge rectifier			

Output Data	**PLC-R.../21**	**PLC-R.../21AU**
Contact type	Single contact, SPDT contact	Single contact, SPDT contact
Contact material	AgSnO	AgSnO + 5 µ Au [3])
Maximum switching voltage	250 V AC/DC [2])	30 V AC/36 V DC
Minimum switching voltage	12 V AC/DC	100 mV
Limiting continuous current	6 A	50 mA
Maximum inrush current	30 A at AC 15 operation	50 mA
Minimum switching current	10 mA	1 mA
Maximum shutdown power, ohmic load:		
24 V DC	140 W	1.2 W
48 V DC	20 W	–
60 V DC	18 W	–
110 V DC	23 W	–
220 V DC	40 W	–
250 V AC	1500 VA	–
Minimum switching power	120 mW	10 µW

General Data	
Test voltage input/contact; contact/contact	4 kV, 50 Hz, 1 minute
Ambient operating temperature range	-20°C to +55°C (-4°F to +131°F) (24 V types up to +60°C [+140°F])
Nominal operating mode	100% operating factor
Inflammability class	V0 according to UL 94
Mechanical service life	2×10^7 cycles
Standards/specifications	IEC 664/IEC 664 A/DIN VDE 0110, degree of pollution 3, Surge Voltage Category III, DIN VDE 0160 (in relev. parts), IEC 255/DIN VDE 0435 (in relev. parts), DIN VDE 0106-101: 1986-11, reinforced insulation for I/O [4])
Mounting position/mounting	Any/can be mounted without spacing
Connection method	Screw connection

[1]) Input wiring depends on the type.

[2]) For voltages greater than 250 V (L1, L2, L3) between the same terminal blocks on adjacent modules, the PLC-ATP separating plate (see Accessories) should be used.

[3]) If the specified maximum values are exceeded, the gold coating will be damaged. In subsequent operation, the values of the AgNi contact will apply.

[4]) The PLC-ATP separating plate (see Accessories) should be used between adjacent modules for safe isolation.

Insulating Housing Version

Polyamide PA, not reinforced — See INTERFACE catalog
Color: green

For torque of terminal block screws, see INTERFACE catalog.

For marking systems and assembly material, see CLIPLINE catalog.

The dimensioning cross section (see INTERFACE catalog) refers to simple wires without ferrules.

Inductive loads must be attenuated with an effective protective circuit to protect inputs and outputs.

For 120 V and 230 V modules, a REL-MR-60DC/... 60 V relay must always be used due to the integrated input wiring in the basic terminal block.

PLC Sensor INTERFACE With Optocoupler, "The Input Specialist" PLC-OSC...SEN

In applications as the interface between the PLC and sensors, such as proximity switches, limit switches or auxiliary contacts, often only one N/O contact function is required. The PLC-OSC...SEN input interface, comprising a 6.2 mm (0.244 in.) basic terminal block and plug-in miniature optocoupler with screw connection, is designed specifically for these applications.

Costly wiring is considerably reduced through the use of plug-in bridges. In addition, wiring errors and troubleshooting are minimized.

No Power Terminal Blocks

In contrast to previous input optocouplers, all sensor connections, including the supply voltage for sensors/switches, are connected directly to the PLC sensor interface. The PLC-OSC...SEN can be used as a terminal strip with an integrated interface function for the incoming sensor cables, without the need for additional modular terminal blocks (see also main diagram in the INTERFACE catalog).

Potential savings:

- Cost saving of two (or three) modular terminal blocks for sensor/switch supply, signals, and sensor ground (for 3-wire initiators)
- Space saving of approximately 80%
- Time saving of approximately 60%
- Wiring is reduced through the use of plug-in bridges

Optimum Use of Plug-In Bridges

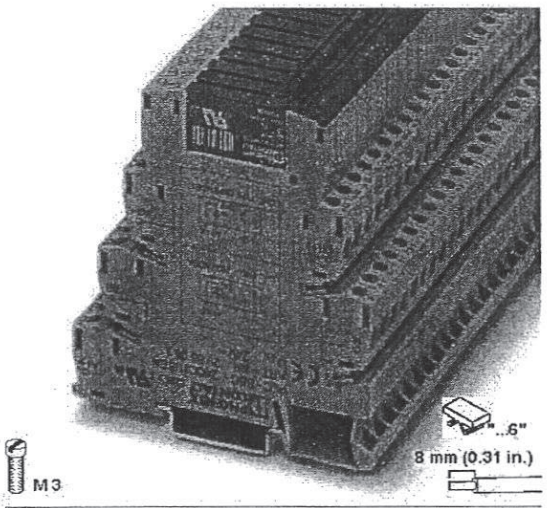
The sensor interface only achieves maximum efficiency through the user-friendly FBST plug-in bridge system. The PLC-OSC...SEN optimally uses the bridging options for the voltage supply of sensors/switches, for the supply/sensor ground at the A2 connection, and for the common supply potential of the PLC at connection 13. The colored, insulated continuous plug-in bridges, which measure 500 mm (19.685 in.) in length, are a particularly efficient solution. They can be shortened to the required length and inserted quickly and easily in the bridge shafts. There is no need to strip wires, insert ferrules or connect them together. Cumbersome daisy chains are finally a thing of the past. Potential savings:

- Wiring is reduced through the minimum use of modular terminal blocks and the maximum use of all bridging options: approximately 60%.

Additional Advantages

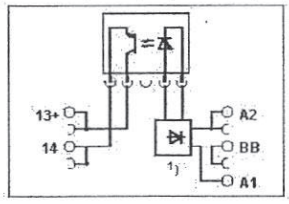
The PLC-OSC...SEN offers the same advantages as the other PLC series with an optocoupler:

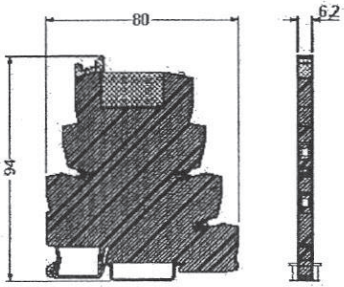
- Switching power up to 24 V DC/3 A, depending on the type
- Wear-resistant switching
- Integrated input wiring



	Solid [mm²]	Stranded [mm²]	AWG	I [A]	U [V]
Connection data	0.14 - 2.5	0.14 - 2.5	26 - 14	*	*

* The electrical data is determined by the optocoupler.





- Available with input or power optocoupler
- Fully encapsulated optoelectronics with IP67 protection
- Resistant to vibrations and shocks
- User-friendly labeling
- Inflammability class V0 according to UL94

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Local Contact: www.phoenixcontact.com/salesnetwork

PLC Sensor INTERFACE With Optocoupler, "The Input Specialist"
PLC-OSC...SEN

Description	Input voltage U_N [1]	Type	Order No.	Pcs. Pkt.
PLC interface, comprising PLC-BSC...SEN basic terminal block and plug-in optocoupler (see INTERFACE catalog), for mounting on ⊓	24 V AC/DC	Includes input optocoupler **PLC-OSC- 24DC/48DC/100/SEN**	29 66 77 3	10
	120 V AC/110 V DC	**PLC-OSC-120UC/48DC/100/SEN**	29 66 79 9	10
	230 V AC/220 V DC [2]	**PLC-OSC-230UC/48DC/100/SEN**	29 66 80 9	10
PLC interface, comprising PLC-BSC...SEN basic terminal block and plug-in optocoupler (see INTERFACE catalog), for mounting on ⊓	24 V AC/DC	Includes power optocoupler **PLC-OSC- 24DC/24DC/2/SEN**	29 66 68 9	10
	120 V AC/110 V DC	**PLC-OSC-120UC/24DC/2/SEN**	29 66 70 2	10
	230 V AC/220 V DC [2]	**PLC-OSC-230UC/24DC/2/SEN**	29 66 71 5	10

Technical Data	Input Optocoupler		Power Optocoupler	
Input Data				
Nominal input voltage U_N	24 V DC	120 V AC/ 110 V DC 230 V AC/ 220 V DC [2]	24 V DC	120 V AC/ 110 V DC 230 V AC/ 220 V DC [2]
Permissible range (with reference to U_N)	0.8 - 1.2	0.8 - 1.1	0.8 - 1.2	0.8 - 1.1
Switching level 1 signal ("H")	0.8 x U_N	0.8 x U_N	0.8 x U_N	0.8 x U_N
Switching level 0 signal ("L")	0.4 x U_N	0.3 x U_N	0.4 x U_N	0.25 x U_N
Typical input current at U_N	8 mA	4 mA	9 mA	4 mA
Typical response time/switch-on time at U_N	20 µs	6 ms	20 µs	6 ms
Typical release time/switch-off time at U_N	300 µs	10 ms	500 µs	10 ms
Transmission frequency f_{limit}	300 Hz	10 Hz	300 Hz	10 Hz
Input wiring: 24 V DC	Operating indicator, polarity protection diode, free-wheeling diode			
120, 230 V AC/DC	Operating indicator, bridge rectifier			
Output Data	**PLC-O.../48DC/100/SEN**		**PLC-O.../24DC/2/SEN**	
Maximum switching voltage	48 V DC		33 V DC	
Minimum switching voltage	3 V DC		3 V DC	
Limiting continuous current	100 mA		3 A (see derating curve in IF catalog)	
Maximum inrush current	–		15 A (10 ms)	
Output switching	2-wire floating ground		2-wire floating ground	
Output wiring	Protection against polarity reversal, surge protection			
Voltage drop on limiting continuous current	≤ 1 V		≤ 200 mV	
General Data				
Test voltage I/O	2.5 kV, 50 Hz, 1 minute			
Ambient operating temperature range	-20°C to +60°C (-4°F to +140°F)			
Nominal operating mode	100% operating factor			
Inflammability class	V0 according to UL 94			
Standards/specifications [3]	IEC 664/IEC 664 A/DIN VDE 0110, degree of pollution 2, Surge Voltage Category III			
Mounting position/mounting	Any/can be mounted without spacing			
Connection method	Screw connection			

[1] For voltages greater than 250 V (L1, L2, L3) between the same terminal blocks on adjacent modules, the PLC-ATP separating plate (see Accessories) should be used.

[2] If the specified maximum values are exceeded, the gold coating will be damaged. In subsequent operation, the values of the AgNi contact will apply.

[3] The PLC-ATP separating plate (see Accessories) should be used between adjacent modules for safe isolation.

Insulating Housing Version

Polyamide PA, not reinforced See INTERFACE catalog
Color: green

For torque of terminal block screws, see INTERFACE catalog.

For marking systems and assembly material, see CLIPLINE catalog.

The dimensioning cross section (see INTERFACE catalog) refers to simple wires without ferrules.

Inductive loads must be attenuated with an effective protective circuit to protect inputs and outputs.

For 120 V and 230 V modules, a REL-MR-60DC/... 60 V relay must always be used due to the integrated input wiring in the basic terminal block.

PLC Accessories

PLC-ESK Power Terminal Block

The 9 mm (0.354 in.) wide PLC-ESK power terminal block has the same structure as the PLC interface terminal blocks. It is used to supply the bridging potentials. Its nominal current is 32 A. For currents ≤ 6 A, the supply can be provided directly at the terminal blocks on one of the PLC interfaces.

FBST Plug-In Bridges

The advantages of PLC interfaces can be optimized through the use of colored, insulated FBST plug-in bridges. FBST 6 2-pos. single plug-in bridges are suitable for bridging a small number of modules and total currents ≤ 6 A. They offer the advantage that when the system is supplied from both sides, the circuit can be isolated at any point and all the other modules will still be supplied.

The 500 mm (19.685 in.) long FBST 500 continuous plug-in bridge is far easier to use. The cut to site plug-in bridges can be used to quickly and easily bridge up to 80 modules at a time. All bridges are fitted with a keyway, which can be removed using a screwdriver.

If adjacent function blocks have bridges with different potentials, the PLC-ATP separating plate should be used inbetween them.

PLC-ATP Separating Plate

The PLC-ATP separating plate should always be used at the start and end of each terminal strip.

In addition to the dedicated optical isolation of function blocks, in some cases the separating plate may also be required between two adjacent PLC interface terminal blocks, e.g., when using 3 phases (L1, L2, L3) on the contact side of the PLC relay terminal blocks.

The PLC-ATP has pre-punched outlets at the bridging positions so that individual bridges can be fed through, if necessary.

Description		Type	Order No.	Pcs. / Pkt.
Power terminal block, for supplying up to four potentials for mounting on 3 **Technical Data** Conductor cross section: Solid 0.2 - 4 mm²; Stranded 0.2 - 4 mm²; 24 - 12 AWG Maximum current: 32 A Maximum voltage: 250 V AC [1] Terminal block dimensions: Same structure as the PLC standard series, terminal block width 9 mm (0.354 in.) Color: Gray		**PLC-ESK GY** [1] For voltages greater than 250 V (L1, L2, L3) between the same terminal blocks on adjacent modules, the PLC-ATP separating plate should be used.	**29 66 50 8**	5
Continuous plug-in bridge, 500 mm (19.685 in.) long, insulated, freely extendable, for potential distribution at PLC...	Color: Red / Blue / Gray	I_{max}: 32 A **FBST 500-PLC RD** **FBST 500-PLC BU** **FBST 500-PLC GY**	 **29 66 78 6** **29 66 69 2** **29 66 83 8**	 20 20 20
2-pos. plug-in bridge, 6 mm (0.236 in.) long, insulated, for potential distribution at PLC	Color: Red / Blue / Gray	I_{max}: 6 A **FBST 6-PLC RD** **FBST 6-PLC BU** **FBST 6-PLC GY**	 **29 66 23 6** **29 66 81 2** **29 66 82 5**	 50 50 50
Separating plate, 2 mm (0.079 in.) thick, should be used at the start and end of each PLC terminal strip. It can also be used for: – Optical isolation of groups – Safe isolation of different voltages in adjacent PLC interfaces according to DIN VDE 0106-101 – Isolation of adjacent bridges with different potentials – Isolation of PLC interfaces at voltages > 250 V Color: Black		**PLC-ATP BK**	**29 66 84 1**	25

ZB 6 PLC Labeling

ZB 6 Zack Marker Strips

This labeling system has both the advantage of easy handling and the appeal of a low price. A Zack marker strip consists of 10 individual labels, which are joined together and can be easily separated at every position. The labels can be placed directly in the label keyway of the engagement lever for "Zack" device identification.

Advantages for your system: cost-effective, extremely fast, optimum look.

In addition to the standard white version, Zack marker strips are also available in other colors (see CLIPLINE catalog). The labels can be written by hand using a marker pen or created using the Computer Marking System (CMS). Alternatively, the labels can also be ordered already printed with numbers, symbols, and PLC input and output numbers.

Description		Type	Order No.	Pcs. Pkt.
Zack marker strip, unprinted: 10 labels, for labeling with marker pen or CMS system, suitable for device identification of up to 100 PLC interface terminal blocks		**ZB 6: UNBEDRUCKT**	**10 51 00 3**	10
As above, but large pack, suitable for device identification of up to 1000 PLC interface terminal blocks		**ZB 6/WH-100: UNBEDRUCKT**	**50 60 93 5**	100
Zack marker strip, printed horizontally: [3] 10 labels, numbered consecutively		**ZB 6, LGS: FORTL. ZAHLEN**	**10 51 01 6**	10
	1 - 10	**ZB 6, LGS: 1-10**		
	11 - 20	**ZB 6, LGS: 11-20**		
	etc. up to	etc. up to		
	991 - 1000	**ZB 6, LGS: 991-1000**		
Zack marker strip, printed horizontally: [2] 9 labels, numbered	1 - 9	**ZB 6, LGS: 1-9**	**10 51 12 6**	10
Zack marker strip, printed horizontally: [3] 10 labels, numbered identically		**ZB 6, LGS: GLEICHE ZAHLEN**	**10 51 03 2**	10
	1/1/1	**ZB 6, LGS: 1**		
	2/2/2	**ZB 6, LGS: 2**		
	etc. up to	etc. up to		
	100/100/100	**ZB 6, LGS: 100**		
Zack marker strip, printed horizontally: [2] 10 labels	L1, L2, L3, N, PE, L1, L2, L3, N, PE	**ZB 6, LGS: L1-N, PE**	**10 51 41 4**	10
	U, V, W, N, 6, U, V, W, N, 6	**ZB 6, LGS: U-N**	**10 51 43 0**	10
Zack marker strip, printed vertically: [2] 10 labels, numbered consecutively		**ZB 6, QR: FORTL. ZAHLEN**	**10 51 02 9**	10
	1 - 10	**ZB 6, QR: 1-10**		
	11 - 20	**ZB 6, QR: 11-20**		
	etc. up to	etc. up to		
	991 - 1000	**ZB 6, QR: 991-1000**		
Zack marker strip, printed vertically: [2] 10 labels, numbered identically		**ZB 6, QR: GLEICHE ZAHLEN**	**10 51 04 5**	10
	1/1/1	**ZB 6, QR: 1**		
	2/2/2	**ZB 6, QR: 2**		
	etc. up to	etc. up to		
	100/100/100	**ZB 6, QR: 100**		
Zack marker strip, printed vertically: [2] 10 labels, with PLC input numbers E.g. I 0.0 to I 0.7 (up to I 127.7, maximum)		**ZB 6, QR: SPS EINGANG...** [1]	**10 51 45 6**	10
Zack marker strip, printed vertically: [2] 10 labels, with PLC output numbers E.g. Q 0.0 to Q 0.7 (up to Q 127.7, maximum)		**ZB 6, QR: SPS AUSGANG...** [1]	**10 51 44 3**	10
Special labeling Zack marker strip, 10 labels, can be separated, labeled according to customer requirements		**ZB 6: SO/CMS...** [3]	**10 50 49 9**	1

[1])Please specify desired labeling when placing an order.

[2])10 strips with identical labeling are packed together in one unit pack.

[3])Please specify desired labeling and color when placing an order.

1	2	3	4	5	6	7	8	9	10

Labeling direction: Horizontally oriented "LGS"

1	2	3	4	5	6	7	8	9	10

Labeling direction: Vertically oriented "QR"

TNR: 5156535-00 05/30/03 © Phoenix Contact

PUBLICATION DIVIDER

Designation:
PLC-RSC- 12DC/21

Long description:
PLC relay, consisting of base terminal block PLC-BSC.../21 with screw connection and pluggable miniature relay with power contact, for assembly on mounting rail NS 35/7.5, 1 PDT, input voltage 12 V DC

Technical data:

Coil side:

Nominal input voltage Un:	12 V DC
Nominal input current at Un:	15.3 mA
Typical response time:	5 ms
Typical release time:	8 ms
Operating voltage display:	Yes

Protective circuit/component:
Damping diode, polarity protection diode

Contact side:

Contact type:	Single contact, 1 PDT
Contact material:	AgSnO

Maximum switching voltage:
250 V AC/DC (The separating plate PLC-ATP should be installed for voltages larger than 250 V (L1, L2, L3) between identical terminal blocks in adjacent modules. Potential bridging is then carried out with FBST 8-PLC... or ...FBST 500...)

Maximum switching voltage:	250 V AC
Maximum switching voltage:	250 V DC
Minimum switching voltage:	12 V AC/DC
Minimum switching voltage:	12 V AC
Minimum switching voltage:	12 V DC
Maximum inrush current:	(on request)
Min. switching current:	10 mA
Limiting continuous current:	6 A

Power rating (ohmic load) max.:
140 W (For 24 V DC)
Power rating (ohmic load) max.: 20 W (For 48 V DC)
Power rating (ohmic load) max.: 18 W (For 60 V DC)
Power rating (ohmic load) max.:
23 W (For 110 V DC)
Power rating (ohmic load) max.:
40 W (For 220 V DC)
Power rating (ohmic load) max.:
1500 VA (for 250 V AC)
Switching capacity min.: 120 mW

General data:

Length:	80 mm
Height:	94 mm
Width:	6.2 mm
Test voltage relay winding/relay contact:	4 kV AC
Ambient temperature (operation):	-20 °C ... 60 °C
Operating mode:	100% operating factor
Service life mechanical:	2 x 10^7 cycles
Inflammability class acc. to UL 94:	V0

Standards/regulations:
IEC 60 664/IEC 60 664 A/DIN VDE 0110, contamination class 2, surge voltage category

III, DIN VDE 0106-101: 1986-11, increased isolation I/O

Standards/regulations:
DIN EN 50 178/VDE 0160/VDE 0160, IEC 60 255/DIN VDE 0435 (in relevant parts)

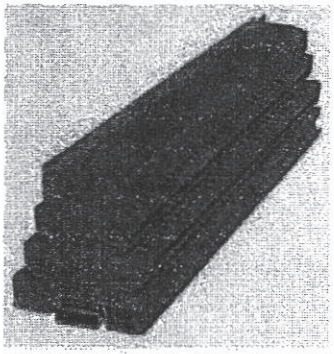
Standards/regulations:
IEC 60 255/DIN VDE 0435 (in relev. parts)

Connection data:	
Type of connection:	Screw connection
Min. conductor cross section, rigid:	0.14 mm²
Conductor cross section, rigid max.:	2.5 mm²
Conductor cross section flexible min.:	0.14 mm²
Max. conductor cross section, flexible:	2.5 mm²
Min. conductor cross section AWG/kcmil:	26
Conductor cross section AWG/kcmil max:	14
Stripping length:	8 mm
Screw thread:	M 3

Order data:	
Manufacturer:	Phoenix Contact
Type:	PLC-RSC- 12DC/21
Order number:	29 66 90 6

PUBLICATION DIVIDER

PLC-R.../21-21



Equipped with pluggable multi-layer contact relay 2 PDT (21-21)



M 3



8



"...10"

Terminal width 14

c UL us

	(IEC) [mm²]	rigid solid	flexible stranded	AWG	I [A]	U [V]
Connection data	0.14-2.5	0.14-2.5	26-14	*	*	

* The electrical data is determined by the relay.

protective separation acc. to DIN VDE 0106-101

Description	Input voltage U_N	Type	Order No.	Pcs. Pkt.
PLC relay, with **screw connection,** consisting of base terminal block PLC-BSC../21 and pluggable miniature relay, for mounting on ⊥	12 V DC	**PLC-RSC- 12DC/21-21**	29 67 23 5	10
	24 V DC	**PLC-RSC-24DC/21-21**	29 67 06 0	10
	24 V AC/DC	**PLC-RSC-24UC/21-21**	29 67 07 3	10
	48 V DC	**PLC-RSC- 48DC/21-21**	29 67 24 8	10
	60 V DC	**PLC-RSC- 60DC/21-21**	29 67 29 3	10
	120 V AC/110 V DC	**PLC-RSC-120UC/21-21**	29 67 08 6	10
	230 V AC/220 V DC[2])	**PLC-RSC-230UC/21-21**	29 67 09 9	10

Technical data

Input data

Nominal input voltage U_N	12 VDC	24 VDC	24 VAC/ DC	48 VDC	60 VDC	120 VAC/ 110 VCD	230 VAC/ 220 VDC[2])
Typ. input current at U_N	33 mA	18 mA	17,5mA	20 mA	10 mA	4.5/ 4.2mA	4.5/ 4.3mA
Typ. operate time at U_N	8 ms	8 ms	8 ms	8 ms	8 ms	7 ms	7 ms

Typ. operate time at U_N		8 ms	8 ms	8 ms	8 ms	8 ms	7 ms	7 ms
Typ. release time at U_N		10 ms	10 ms	10 ms	10 ms	10 ms	10 ms	10 ms
Input circuit::	24 24, 48, 60 V DC	operation indicator, polarity protection diode, damping diode						
	24, 120, 230 V AC/DC	operation indicator, bridge rectifier						

Output data

Contact type		single contact, 2 PDT
Contact material		AgNi
Max. switching voltage		250 V AC/DC [2])
Min. switching voltage		5 V
Limiting continuous current		6 A
Max. inrush current		8 A
Min. switching current		10 mA
Max. power rating, ohmic load:	24 V DC	140 W
	48 V DC	100 W
	60 V DC	60 W
	110 V DC	44 W
	220 V DC	60 W
	250 V DC	1500 VA
Min. switching power		50 mW

General data

Test voltage: input-contact / contact-contact	4 kV, 50 Hz, 1 min./2.5 kV, 50 Hz, 1 min. (between the PDT)
Ambient temperature range	– 20 °C to + 60 °C (230 V-types to + 55 °C)
Nominal operating mode	100 % ED
Inflammability class	V0 acc. to
Mechanical service life	3 x 10^7 cycles
Standards/regulations	IEC 60 664/IEC 60 664 A/DIN VDE 0110, contamination class 3, surge voltage category III, DIN EN 50 178/VDE 0160 (in relev. parts), IEC 60 255/DIN VDE 0435 (in relev. parts), DIN VDE 0106-101: 1986-11, increased insulation I/O [4])
Installation position	any
Mounting	in rows with zero spacing

[1]) The input circuit depends on the type.

[2]) The separating plate PLC-ATP (see info) should be installed for voltages larger than 250 V (L1, L2, L3) between identical terminal blocks in adjacent modules. Potential bridging is then carried out with FBST 8-PLC... or FBST 500....

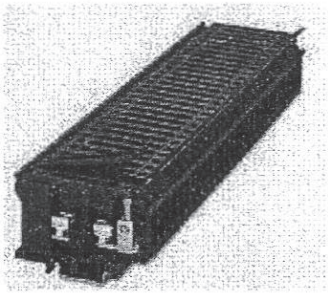
[3]) If the maximum values indicated are exceeded, the gold layer is destroyed. The values in parentheses then apply for further operation.

[4]) The separating plate PLC-ATP (see info) should be installed for protective separation between adjacent modules. Potential bridging is then carried out with FBST 8-PLC... or FBST 500....

Note:
Type of housing Polyamide PA non-reinforced
see info
color: green
Torque value of terminals, (see info) :
For marking systems and mounting material.
The rated cross section (see info) refers to untreated conductors without ferrules.
For the protection of input and output, inductive loads must be dampened with an effective protection circuit.
The PLC-ATP separating plate must always be installed at the beginning and end of a PLC terminal strip.
For matching screwdrivers, please refer to page .

PUBLICATION DIVIDER

UK 6,3-HESI



for 6.3 x 32 mm fuse inserts
with or without light indicator
Terminal width 10.2

	(IEC)	rigid	flexible		I	U
	[mm²]	solid	stranded	AWG	[A]	[V]
DIN VDE 0611						
as disconnect terminal		0.5-16	0.5-16	20-6	6.3	800
with fuse		0.5-16	0.5-16	20-6	1)	1)

LR/BV

Description	Light indicator Voltage [V AC/DC]	Current [mA]	Type	Order No.	Pcs. Pkt.
Fuse terminal block, for mounting on ⊏⎯⊐ or ⊐⎯⊏, for cartridge fuse inserts 6.3 x 32 mm (1 /4 " x 1 1 /4 ") USA standard			**UK 6,3-HESI**	**30 04 17 1**	50
Fuse terminal block, as above, however with light indicator for:	15-30	3.5 - 8.1	**UK 6,3-HESILED 24**	**30 04 26 5**	50
Fuse terminal block, as above, however with light indicator for:	110-250	0.5-1	**UK 6,3-HESILA 250**	**30 04 24 9**	50

Accessories					
(1) **Insertion bridge,** divisible, insulated spine, 10-pos.	fully insulated, 2-pos.		**EB 2-10**	I_{max}.: 63 A **02 03 15 3**	100
	fully insulated, 3-pos.		**EB 10-10**	63 A **02 03 13 7**	10
(2) **Connection pin,** for connecting fuse disconnect levers, plastic, length supplied: 1 m			**VS**	**30 04 20 7**	1
(3) **Zack strip,** 10-section, white			**ZB 10** (see info)		
(4) **Screwdriver**			**SZS 1,0 x 4,0**	**12 05 06 6**	10

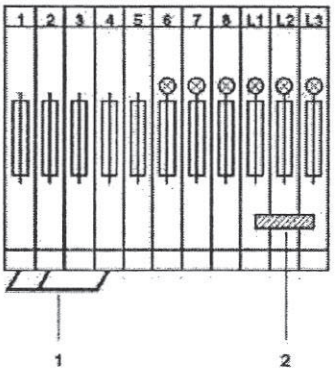
Technical data		
Dimensions		
Width / length	[mm]	10.2 / 79
Height (NS 35:7.5 / NS 35:15 / NS 32)	[mm]	60.5 / 68 / 65
Technical data in accordance with IEC/ DIN VDE		
Fuse type / fuse dimensions	– / [mm]	G / 6.3 x 32

Max. power dissipation		
at 23 °C acc. to E DIN VDE 0611-6: 1995-05	[W]	see info
Max. cross section with insertion bridge (solid / stranded)	[mm^2]	10 / 10
Rated surge voltage / contamination class	[kV] / –	6 / 3
Surge voltage category / insulation material group	– / –	III / I
Connection capacity		
stranded with ferrule without / with plastic sleeve		0.5 - 10 / 0.5 - 10
Multi-conductor connection (2 conductors with same cross section)		
solid / stranded	[mm^2]	0.5 - 4 / 0.5 - 4
stranded with ferrule without plastic sleeve	[mm^2]	0.5 - 4
stranded with TWIN ferrule with plastic sleeve	[mm^2]	0.5 - 6
Stripping length	[mm]	12
Internal cylindrical gage (IEC 947-1:1988)		B 6
Thread / torque		M 4 / 1.5 - 1.8
Insulation material	– / [Nm]	PA
Inflammability class acc. to UL 94		V2
Temperature indices RTI / Ti		130 / 120
Approval data (UL and CSA)		
Nom. voltage / nom. current / conduc. sizes	UL: [V] / [A] / AWG	600 / 25 / 26 - 8
	CSA: [V] / [A] / AWG	600 / 25 / 26 - 8

Note:
Further fuse terminal blocks for other voltage ranges are available on request!

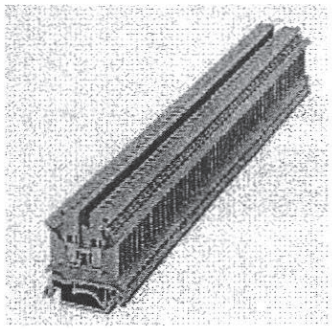
[1]) see table (the current is determined by the fuse, the voltage by the light indicator).

Block diagram



PUBLICATION DIVIDER

UK 5 N



Terminal width 6.2

	(IEC) [mm²]	rigid solid	flexible stranded	AWG	I [A]	U [V]
IEC 947-7-1	0.2-6	0.2-4	24-10	41	800
EN 50 019 *	0.2-6	0.2-4	–	38/30	726[1)]

* Certificate no.: KEMA Ex-94.C.7133U

HCA I FELg KEMA/BV/LR/NV/RMRS/NK

Description	color	Type		Order No.	Pcs. Pkt.
Terminal block, with universal foot for mounting on [, 3 or 2	gray	**UK 5 N**		**30 04 36 2**	50
	blue	**UK 5 N BU**		**30 04 38 8**	50
Accessories					
(1) **End cover**	gray	**D-UK 4/10**		**30 03 02 0**	50
	blue	**D-UK 4/10 BU**		**30 03 10 1**	50
(2) **Fixed bridge,** for cross connections in the terminal center, screw heads with insulating collar, 10-position, divisible, with 10 screws		**FBI 10-6**	I_{max}.: 41 A	**02 03 25 0**	10
(3) **Insertion bridge,** fully insulated, 2-pos.		**EB 2-6**	I_{max}.: 32 A	**02 01 15 5**	100
fully insulated, 3-pos.		**EB 3-6**	32 A	**02 01 14 2**	100
divisible, fully insulated, 10-pos.		**EB 10-6**	32 A	**02 01 13 9**	10
(4) **Isolator bridge bar,** 10-position, divisible, with 10 screws, for switchable branches with		**ISSBI 10-6**	I_{max}.: 30 A	**03 01 50 5**	10
(5) **Bridge bar isolator** IS-K 4 as distance piece		**IS-K 4**		**13 02 33 8**	100
(6) **Switch bar for 2 terminal blocks,** complete, to increase insulation an end cover must be interposed		**USBR 2-7**	I_{max}.: 34 A	**23 03 23 9**	1
(7) **Separating plate,** for electrical separation of neighboring bridges, can be inserted later, no loss of pitch		**TS-K**		**13 02 21 5**	100
(8) **Partition plate,** for visual and electrical separation of terminal groups, 1.5 mm thick		**ATP-UK**		**30 03 22 4**	50
(9) **Test plug socket,** for test connection with test plug MPS or reducing plug RPS		**PSB 3/10/4**		**06 01 29 2**	100

reducing plug RPS

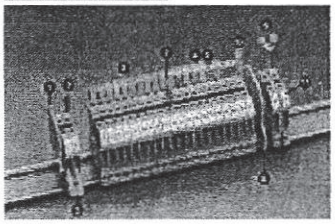
(10) **Test plug socket, insulated,** only to be used with FBI, ISSBI, for test connection with test plug MPS or RPS	**PSBJ 3/13/4**	**02 01 30 4**	100
(11) **Zack strip,** 10-section, white	**ZB 6** (see info)		
(12) **Screwdriver**	**SZS 0,6 x 3,5**	**12 05 05 3**	10

Technical data

Dimensions		
Width / length / end cover width	[mm]	6.2 / 42.5 / 1.8
Height (NS 35:7.5 / NS 35:15 / NS 32)	[mm]	47 / 54.5 / 52
Technical data in accordance with IEC/ DIN VDE		
Maximum load current / cross section	[A] / [mm^2]	41 / 6
Max. cross section with insertion bridge (solid / stranded)	[mm^2]	4 / 4
Rated surge voltage / contamination class	[kV] / –	8 / 3
Surge voltage category / insulation material group	– / –	III / I
Connection capacity		
stranded with ferrule without / with plastic sleeve	[mm^2]	0.25 - 4 / 0.25 - 2.5
Multi-conductor connection (2 conductors with same cross section)		
solid / stranded	[mm^2]	0.2 - 1.5 / 0.2 - 1.5
stranded with ferrule without plastic sleeve	[mm^2]	0.25 - 1.5
stranded with TWIN ferrule with plastic sleeve	[mm^2]	0.5 - 2.5
Stripping length	[mm]	8
Internal cylindrical gage (IEC 947-1:1988)		A 4
Thread		M 3
Torque	[Nm]	0.6 - 0.8
Insulation material		PA
Inflammability class acc. to UL 94		V0
Temperature indices RTI / Ti		130 / 120
Approval data (UL and CSA)		
Nom. voltage / nom. current / conduc. sizes	UL: [V] / [A] / AWG	600 / 30 / 30 - 10
	CSA: [V] / [A] / AWG	600 / 40 / 28 - 10

[1]) The max. nominal voltage is determined by the mounting rail, with [550 V.

Block diagram



PUBLICATION DIVIDER

MAINS-PLUGTRAB PT Series

Overvoltage Protection for Single Phase Equipment

Data Sheet 1298C

May 2002

Features

- Replaceable protection plugs
- 26 amp load current capability
- Visual indication of plug status
- Dry contact for remote indication of plug status
- 10 kA (8/20 µs) maximum surge current
- DIN-rail ground connection
- 24, 60, 120 and 230 V ac plugs available
- UL 1449 2nd edition

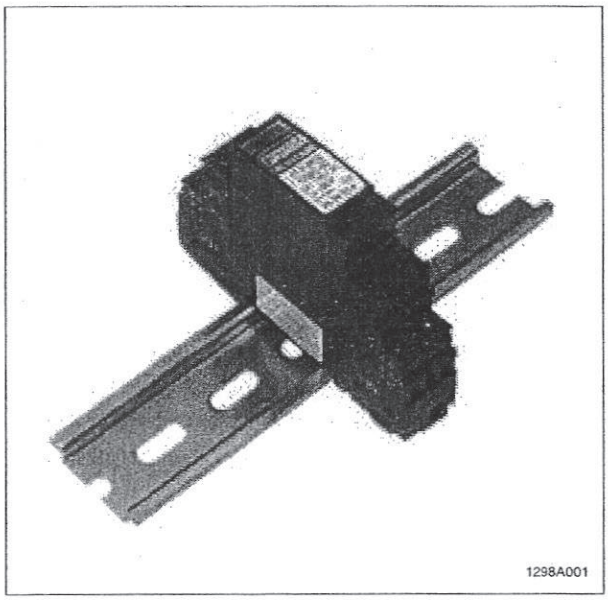


Figure 1. MAINS-PLUGTRAB PT 2-PE/S

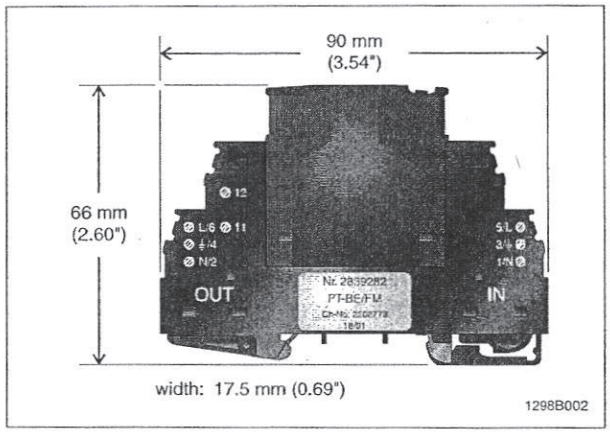


Figure 2. MAINS-PLUGTRAB PT 2-PE/S Dimensions

General Description

The MAINS-PLUGTRAB provides overvoltage protection from electrical transients caused by lightning, switching operations, utility actions, and de-energized inductive loads. It provides protection to power supplies, PLCs, PCs, controllers and other electrical equipment.

The MAINS-PLUGTRAB consists of two pieces: a hard-wired base and a removable plug. The base accepts wire sizes from 24 to 12 AWG. The metal mounting foot allows secure connection to the rail and provides a short path to ground for surge current, increasing the performance of protection for the equipment. The base is a feed-through terminal block. Power is not interrupted to the equipment regardless of plug status (or presence).

The plugs are available in several ratings from 24 to 230 V ac. Two-stage design provides both normal mode and common mode protection with metal oxide varistors (MOVs) and a gas tube. The plug contains a thermal disconnect which monitors the status of the MOV. When the MOV is removed from the circuit, a red lamp indicator illuminates to provide local indication that the plug should be replaced. A normally closed contact opens at the same time and can be used for remote indication of plug status.

The MAINS-PLUGTRAB is rated IP20 which generally is regarded as "finger-safe" or "touch-safe".

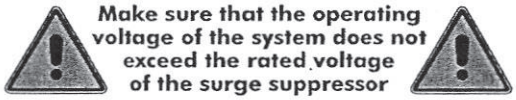
Table 1. MAINS-PLUGTRAB Product Specifications

PT 2-PE/S-	...24 AC	...60 AC	...120 AC	...230 AC
IEC category/VDE requirement class	III/D	III/D	III/D	III/D
Nominal voltage V_N: (Vac)	24	60	120	230
Max. continuous operating voltage (Vac)	34	100	150	250
Max. nominal current (A)	26	26	26	26
Max. nominal current (UL 1449)(A)	20	20	20	20
Leakage current @ mcov (L-N)(mA)	≤2.5	≤1.5	≤1.1	≤1.1
Leakage current to GND (µA)	≤1	≤1.5	≤1.5	≤1.5
Max. discharge surge current (8/20 µS)(KA)	10	10	10	10
Protection level:				
UL 1449 SVR (6 kV, 500 A)(L-N)(V)	330	330	500	900
Response time (ηS)(L-N)	≤25	≤25	≤25	≤25
Response time (component) (ηS)(L-N)	≤1ηS	≤1ηS	≤1ηS	≤1ηS
Temperature range: (°C)	–25 up to +85	–25 up to +85	–25 up to +85	–25 up to +85
Protection type in acc. with IEC 529/EN 60 529	IP 20	IP 20	IP 20	IP 20
Insulation housing	PA	PA	PA	PA
Stripping length	8 mm	8 mm	8 mm	8 mm
Thread/torque	M3/0.8 Nm	M3/0.8 Nm	M3/0.8 Nm	M3/0.8 Nm
Test standards	IEC 61643-1:1998-02, E DIN VDE 0675 part 6: 1989-11/A1: 1996-03/A2: 1996-10 UL 1449, 2nd edition, UL Class 1, Div. 2 (Groups A, B, C, D)(UL 1604)(not...230)			

1298B005

Installation Basics

Overvoltage surge suppressors should be installed by electricians or technicians familiar with and authorized to work with such devices. The relevant safety regulations and guidelines for installation must be observed.



1298A003

Mounting and Grounding

Mounting is accomplished by snapping the device on a NS35 "DIN" rail. The mounting foot of the MAINS-PLUGTRAB provides a grounding path. A ground connection must be made to the DIN-rail using a grounding terminal block or directly to the ground connection on the base (Terminal 3). In order to ensure that the MAINS-PLUGTRAB functions correctly, equipotential bonding is necessary in accordance with the relevant specifications. In general, avoid the use of "daisy–chained" grounds. Note that each removable plug contains a coding pin that ensures only the correct voltage plug can be inserted into a wired base.

Cables and Routing

Protected and non-protected cables, including the conductors used for equipotential bonding, should not be close to or parallel to each other. They must be separated and/or shielded so that surge voltages cannot be coupled into the protected conductors. If cable crossing can not be avoided, they should be laid at right angles to each other.

Equipment Connection - Series

The preferred connection of the MAINS-PLUGTRAB is to be wired in series with the protected equipment as shown in Figure 4. In this case, the cable providing electrical power should be connected to the base on the "IN" side. The cables leading to the protected equipment should be similarly connected to the terminal blocks on the "OUT" side of the base. It is important that the equipment ground is wired to terminal 4 of the base! (See Figure 3).

Equipment Connection - Parallel

Parallel connection of the MAINS-PLUGTRAB is possible in cases where the load current of the protected equipment exceeds the maximum load current capability of the base (26 amps). The wiring is shown in Figure 2. The MAINS-PLUGTRAB is wired via a stub connection on the "IN" side. For best results, minimize the length of wires supplying both the MAINS-PLUGTRAB and the protected equipment. (See Figure 5).

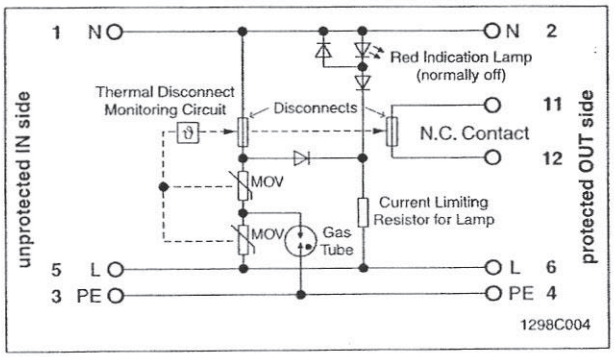


Figure 3. MAINS-PLUGTRAB PT 2-PE/S Circuit Diagram

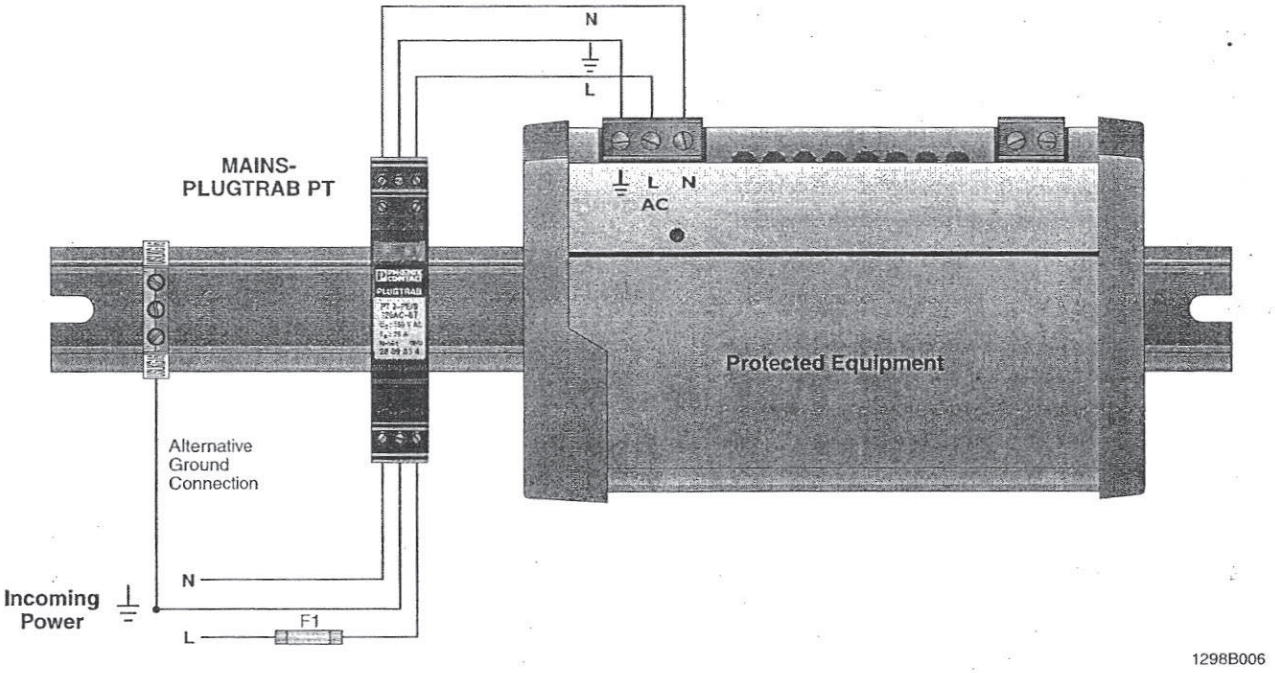


Figure 4. MAINS-PLUGTRAB PT2-PE/S Equipment Connection Series

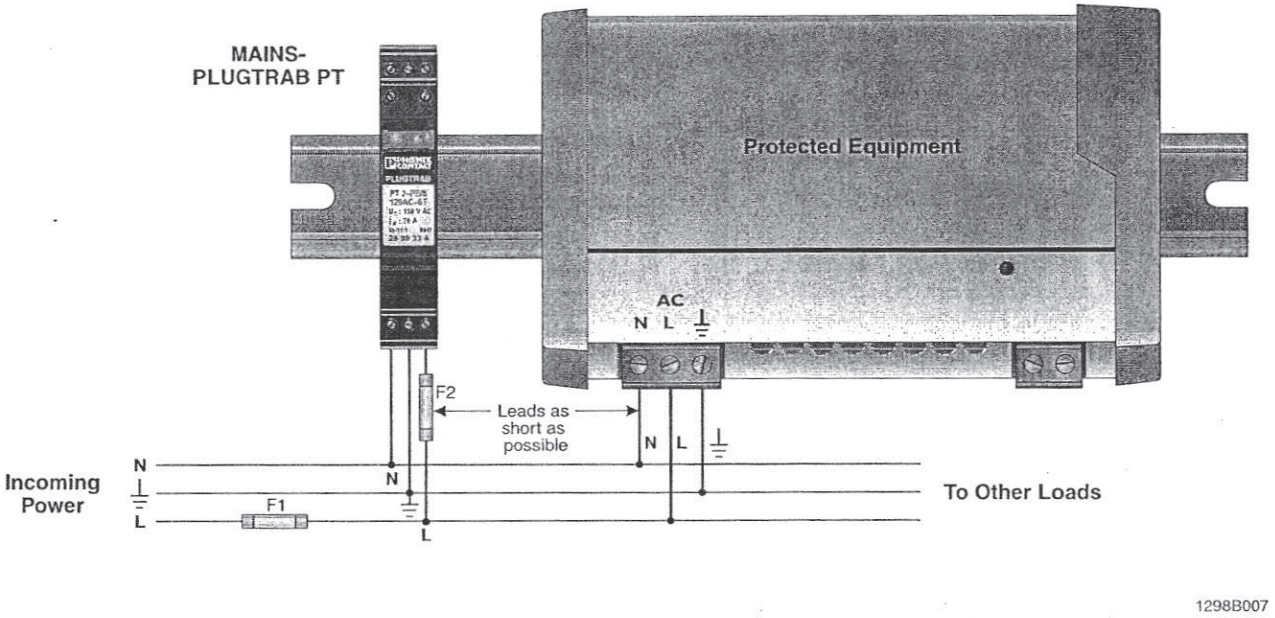


Figure 5. MAINS-PLUGTRAB PT2-PE/S Equipment Connection Parallel

Fusing

In a series installation, F1 in Figure 4 should not exceed the maximum operating current of the MAINS-PLUGTRAB (26 amps, 20 amps UL 1449). In a parallel installation, where the main fuse F1 is greater than the maximum operating current of the MAINS-PLUGTRAB, a back-up fuse F2 should be used which is no greater than 26 amps.

Remote Contact

The "dry", normally closed alarm contact can be connected to a remote warning device. Do not exceed the maximum current and voltage rating of the contact . . . 1 amp and 250 Volts AC. Terminals 11 and 12 are for the NC contacts.

Red Indication Lamp and Plug Replacement

When the red lamp illuminates, it indicates that the protection plug should be replaced as soon as possible. Operating current will continue to be supplied to the protected equipment even when the lamp is lit although no surge protection is being provided. To replace the plug, pull it straight out from the base. Confirm that the replacement plug is of the proper voltage and push the new plug into the base. If the plug does not fit into the base, double check the orientation. Also, verify the plug is the correct voltage for the applications (120 or 230 Volts ac).

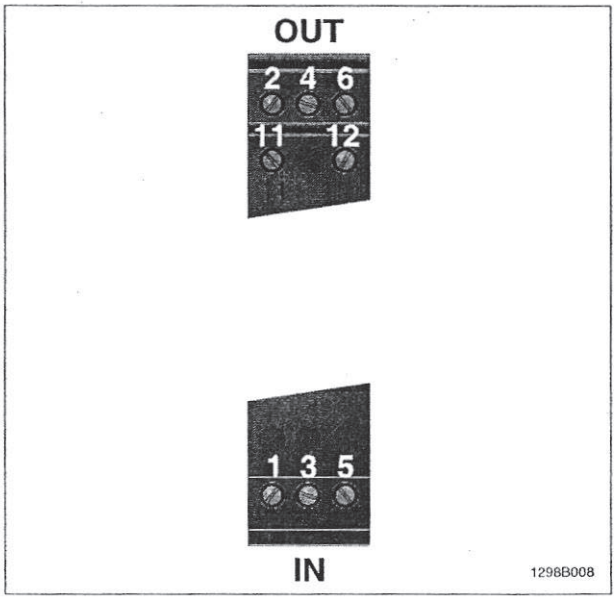


Figure 6. MAINS-PLUGTRAB PT2-PE/S Connections Diagram

Ordering Information

PT-BE/FM (Base)	**28 39 28 2**
PT 2-PE/S-24AC-ST (24 VAC plug)	**28 39 31 8**
PT 2-PE/S-60AC-ST (60 VAC plug)	**28 39 32 1**
PT 2-PE/S-120AC-ST (120 VAC plug)	**28 39 33 4**
PT 2-PE/S-230AC-ST (230 VAC plug)	**28 39 34 7**
PT-BE/FM LABELS ZBN 18 (for marking L, N, GND)	**56 03 23 5**

Related Products

MCR-PLUGTRAB - the best I/O surge protection (see TRABTECH catalog)

Multistage TERMITRAB - the smallest I/O surge protection (Data Sheet 1114B)

NEF Filters - provide CE compliance for power filtering (see TRABTECH catalog)

SYSTEMTRAB - electrical distribution surge suppression for single, split-single and all three phase power (Data Sheet 1097D)

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PUBLICATION DIVIDER

IS6 INTRINSIC SAFETY BARRIER

NEC DEFINITION OF HAZARDOUS LOCATIONS

The NEC Handbook defines hazardous locations by Class, Division and Group as follows:

Class I Locations – Are those in which flammable gasses or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

Class II Locations – Are those which are hazardous because of the presence of combustible dust.

Class III Locations – Are those which are hazardous because of the presence of easily ignitable fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitable mixtures.

Division 1 – Locations in which hazardous concentrations in the air exist continuously, intermittently, or periodically under normal operating conditions.

Division 2 – Locations in which hazardous concentrations are handled, processed, or used but are normally confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown.

Group A – Atmospheres containing acetylene.

Group B – Atmospheres containing hydrogen, or gasses or vapors of equivalent hazard, such as manufactured gas.

Group C – Atmospheres containing ethyl-ether vapors, ethylene, or cyclopropane.

Group D – Atmospheres containing gasoline, hexane, naphtha, benzine, butane, propane, alcohol, acetone, benzol, lacquer solvent vapors, or natural gas.

Group E – Atmospheres containing metal dust, including aluminum, magnesium, and their commercial alloys, and other metals of similarly hazardous characteristics.

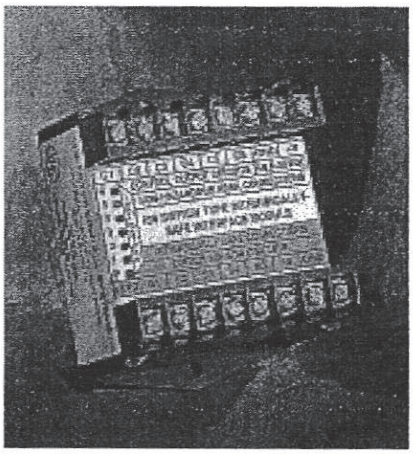
Group F – Atmospheres containing carbon black, coal, or coke dust.

Group G – Atmospheres containing flour, starch, or grain dusts.

The IS6 Intrinsic Safety Barrier is a six-circuit, shunt-diode barrier ON/OFF switch circuit interface that is used between Monitoring and Pump/Alarm Controller Equipment and its level sensor float switch circuitry to render such circuitry "intrinsically safe" and thus suited for installation in a hazardous location such as a sewage or freeway stormwater-handling pump station collection sump.

Powered by the associated Monitor/Controller, the IS6 Barrier has open-collector drivers that provide input sensor signals to the controller in response to the operation of level-sensing float switches in the hazardous location. The IS6 Barrier is most commonly used with our LS and 9G Float Switches, but it can be used with any general purpose simple switch device with N.O. or N.C. non-powered contacts within its application parameters.

The IS6 module is designed to make its associated switches and circuitry suited



for Class I, Division 1 or 2, Groups A, B, C and D, and Class II, Division 1 or 2, Groups E, F, and G hazardous locations as defined by the NEC (National Electrical Code).

The IS6 is ideally suited for applications requiring compliance with UL 913 procedures pertaining to electrical control panels with intrinsically safe extensions to hazardous areas. It includes LED indicators for power and circuit activation.

IS6 PRODUCT SPECIFICATIONS

Cable Lengths: Cable lengths from the module to the switches are to be limited to 300 feet each, or a maximum of 18,000 pF and 60 uH per circuit.

Hazardous Area Connections: Entity parameters (per channel):

- Maximum voltage: 12.6 volts
- Maximum output current: 1.3 mA
- Maximum allowable capacitance: 0.018 uF
- Maximum allowable inductance: 0.06 mH

IS6 Power: The IS6 Module is typically powered by +10.5 to 25 VDC and requires a maximum of 50 mA from an associated monitor/controller, such as our CB1T, CMC15, CB2D, CB23, CB234 or DC power supply. The outputs of the IS6 are open-collectors capable of sinking up to 150 mA and withstanding up to 50 VDC.

Operating Temperature Ranges: -29° to +149° F (-20° to +65° C)

Outside Dimensions: 4" high x 3" wide x 2-1/4" deep

IS6 TYPICAL SPECIFICATIONS

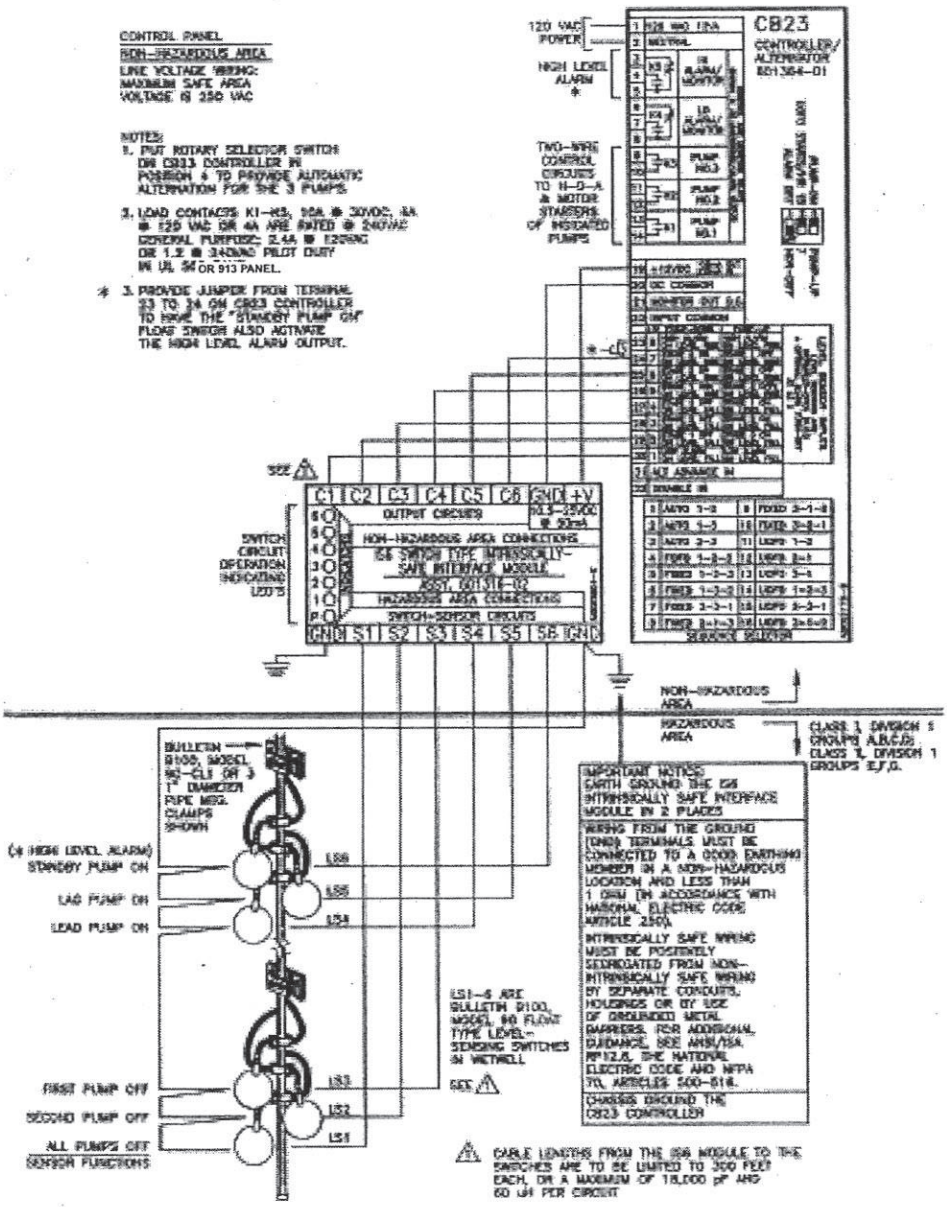
The float switch level sensors shall interface to the control circuitry via an intrinsic safety barrier. The barrier shall provide an intrinsically safe interface for up to six sensors located in a hazardous area rated Class 1, Division 1 or 2, Group A, B, C, and D, and Class II, Division 1 or 2, Groups E, F, and G. The barrier shall contain an LED indicator for each of up to six sensor inputs, providing visible indication of sensor actuation as well as an LED to indicate barrier "Power On" status. The intrinsic safety barrier shall be UL-listed for use in hazardous locations.

DESCRIPTION	PART NO.
Model IS6 six circuit intrinsically safe (switch circuit) barrier, 12/24 VDC powered	601316-02

USFilter

DATA SHEET

IS6 INTRINSIC SAFETY BARRIER



Interconnection Diagram of IS6 Intrinsic Safety Barrier with CB23 Pump Controller/ Alternator showing Intrinsically Safe Level Sensor Float Switch Circuitry

COMPLETE CONTROL CAPABILITIES

USFilter Control Systems offers a single, high-quality source for everything from simple level sensors to telemetry systems to complex system control engineering and software. Based in St. Paul, Minnesota, USFilter Control Systems is part of United States Filter Corporation, the leading global provider of industrial, municipal and residential water and wastewater treatment systems, products and services. As a major manufacturer/integrator with an extensive selection of specialized product lines in the areas of SCADA and telemetry, power equipment integration, automation and measurement, USFilter Control Systems is uniquely positioned to provide cost-effective, comprehensive solutions for water, wastewater, and process control and telemetry applications.

USFilter

Control Systems
1239 Willow Lake Boulevard
Vadnais Heights, MN 55110
800.224.9474 *phone*
651.766.2700 *phone*
651.766.2701 *fax*

www.controlsystems.usfilter.com

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NOTES:

1. THE IS6 INTRINSIC SAFETY BARRIER SHALL NOT BE CONNECTED TO ANY EQUIPMENT WHICH USES OR GENERATES GREATER THAN 250 V.

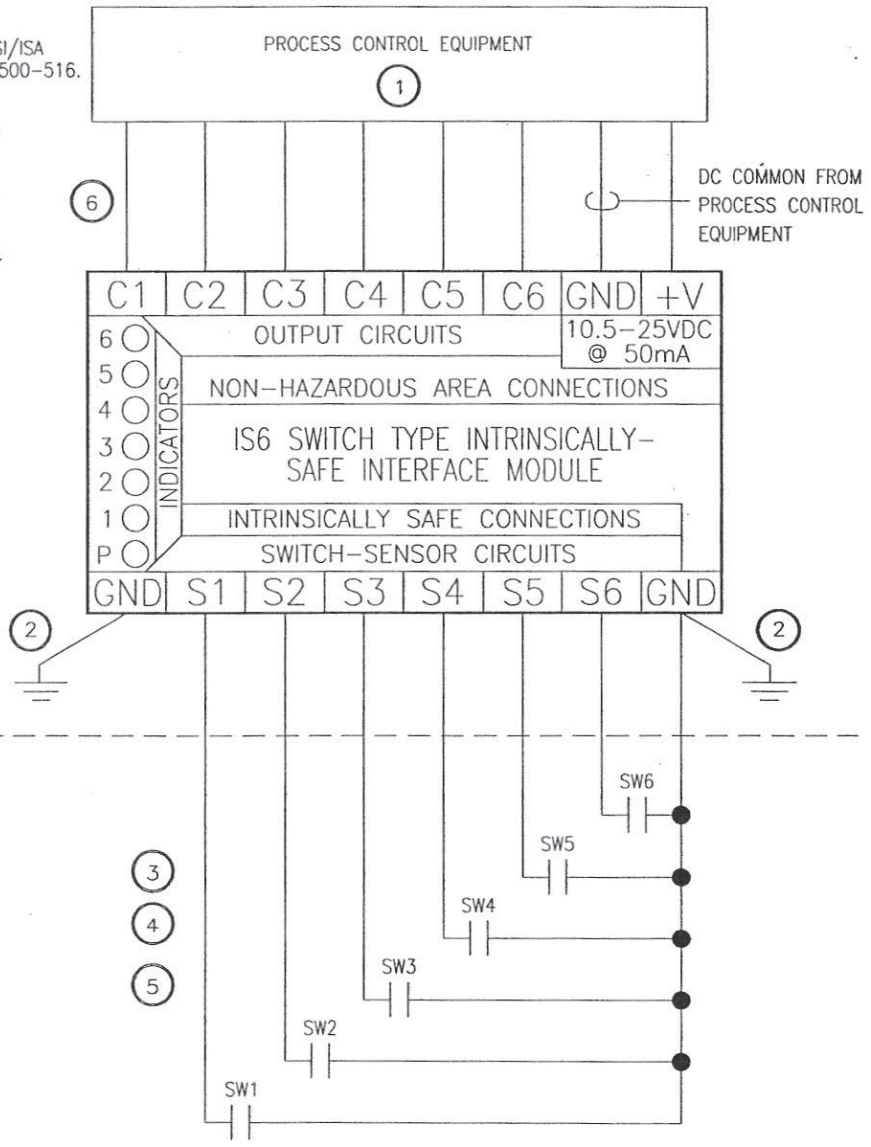
2. BOTH GROUND TERMINALS SHALL BE CONNECTED TO A SUITABLE EARTH GROUND MEMBER IN A NON-HAZARDOUS AREA. THE DC RESISTANCE BETWEEN THE GROUND TERMINAL AND EARTH GROUND SHALL BE LESS THAN 1 OHM. REFERENCE NFPA 70, NEC ARTICLES 250 AND 504 FOR PROPER GROUNDING AND INTRINSIC SAFETY BARRIER INSTALLATION INFORMATION.

3. INTRINSICALLY SAFE WIRING MUST BE POSITIVELY SEGREGATED FROM NON-INTRINSICALY SAFE WIRING BY SEPARATE CONDUITS, HOUSINGS AND GROUNDED METAL BARRIERS. PER ANSI/ISA RP12.6, AND NFPA 70, NEC ARTICLES 500-516.

4. INTRINSICALLY SAFE WIRING FROM THE IS6 TO THE SWITCHES (SW1-SW6) LOCATED IN THE HAZARDOUS AREA MUST BE THROUGH SEALED CONDUITS WHICH ONLY CONTAIN THE IS6 CIRCUIT EXTENSIONS. PER ANSI/ISA RP12.6, AND NFPA 70, NEC ARTICLES 500-516.

5. THE MAXIMUM LENGTH OF EACH CABLE MUST NOT EXCEED 300 FEET OR A MAXIMUM OF 18,000 pF CAPACITANCE AND 60 uH INDUCTANCE.

6. THE IS6 OUTPUTS (C1-C6) ARE TRANSISTOR OPEN-COLLECTORS WHICH ARE CAPABLE OF SINKING 150mA EACH AT UP TO 50 VDC.



REV	C.O. NO.	DATE	DESCRIPTION	CHK	APR
C	11040	11/8/01	UPDATED NOTES	MRB	
B	11026	2/13/01	PER ECO	TP	
A	10024		RELEASED	REW	

TITLE: INSTALLATION INSTRUCTIONS – IS6

DSGN	DWN	CHK	DATE
REW	MG		6/28/94

JOB NAME: STANDARD

SHOP ORDER | DWG. NO. AIM08916 | REV C

ASD00304-A

USFilter CONTROL SYSTEMS
1239 WILLOW LAKE BLVD., VADNAIS HEIGHTS, MN 55110

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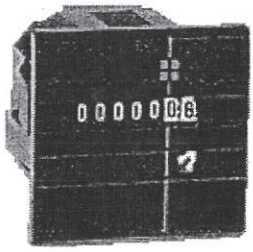
PUBLICATION DIVIDER

Hourmeters

Back Home Features Specifications Models Dimensions Index Next Custom Request

Model 711/731





Features

These 7 figure, AC or DC hourmeters with running indicators, offer crisp, distinctive styling for many panel applications. Available in square and round bezel, flush mount, or three-hole round panel mount. Each is light-weight, low power, and carry UL, CSA and CE approvals.

Top

Specifications

Figures	7 figures, .14" high 99,999.99 hours
Reset	Non-reset
Voltage	24, 115, or 230VAC (+/-10%), 50 or 60Hz., 10-80 V
Power	3 watts (AC), 1.2 watt maximum (DC)
Mounting	Panel (mounting hardware included)
Terminations	1/4" spade terminals, with removable screws, or 8" wire leads
Temp. Range	-22°F to +158°F
Approvals	UL Recognized and CSA Certified (AC only), CE Compliant
Weight	2 oz.
Options	Din Rail

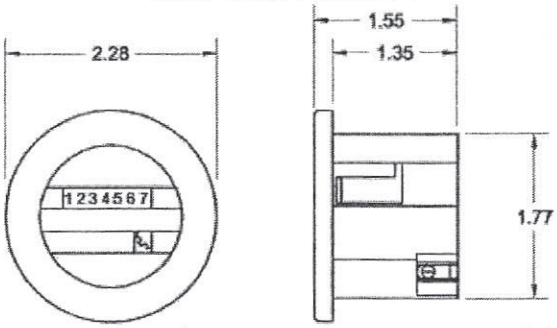
Top

Models Description

711-0150	115VAC/60Hz., 2.28" Dia., Flush mount, screw termination
711-0152	230VAC/60Hz., 2.28" Dia., Flush mount, screw termination
711-0160	115VAC/60Hz., 2.93" Dia., 3-hole round, screw termination
711-0161	115VAC/50Hz., 2.93" Dia., 3-hole round, screw termination

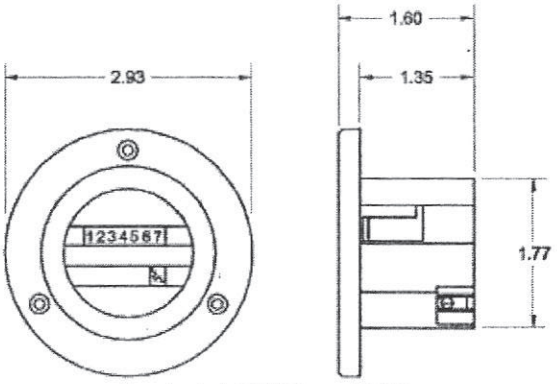
Dimensions

2.28" Dia. FLUSH



Panel cutout: 1.99" Dia. or 1.81" Sq.

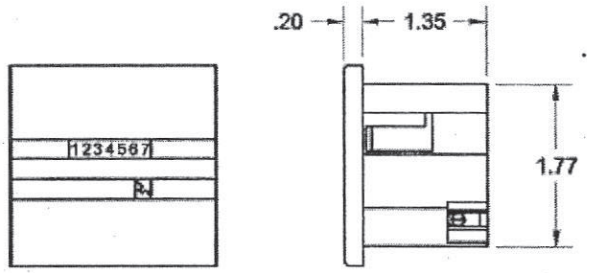
3-HOLE ROUND



Panel cutout: 1.99" Dia. or 1.81" Sq.
Screws provided: 4-40 X 5/8"
Bolt hole circle: 2.44"

1.89", 2.05", or 2.20" Sq FLUSH

711-0162	230VAC/60Hz., 2.93" Dia., 3-hole round, screw termination
711-0163	230VAC/50Hz., 2.93" Dia., 3-hole round, screw termination
711-0164	24VAC/60Hz., 2.93" Dia., 3-hole round, screw termination
711-0170	230VAC/60Hz., 2.93" Dia., 3-hole round, 8" wire leads
711-0171	115VAC/60Hz., 2.93" Dia., 3-hole round, 8" wire leads
711-0180	115VAC/60Hz., 1.89" Sq., Flush mount, screw termination
711-0182	24VAC/60Hz., 1.89" Sq., Flush mount, screw termination
711-0190	115VAC/60Hz., 2.05" Sq., Flush mount, screw termination
711-0191	230VAC/60Hz., 2.05" Sq., Flush mount, screw termination
711-0192	24VAC/60Hz., 2.05" Sq., Flush mount, screw termination
711-0193	115VAC/50Hz., 2.05" Sq., Flush mount, screw termination
711-0194	230VAC/50Hz., 2.05" Sq., Flush mount, screw termination
711-0195	24VAC/50Hz., 2.05" Sq., Flush mount, screw termination
711-0200	115VAC/60Hz., 2.20" Sq., Flush mount, screw termination
711-0201	115VAC/50Hz., 2.20" Sq., Flush mount, screw termination
731-0046	10-80VDC, 2.93" Dia., 3-hole round, screw termination



Panel cutout: 1.99" Dia. or 1.81" Sq.

Top

P.O. Box 608,130 Addison Road, Windsor CT 06095, USA
Phone (860)688-6205 Fax (860) 688-1591 Email:info@redingtoncounters.com

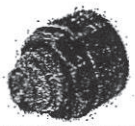
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PUBLICATION DIVIDER

Push Buttons—Class 9001 Type SK—30 mm
Corrosion Resistant Pilot Lights

Pilot Lights—UL Types 4, 4X, 13/NEMA 4, 4X, 13

For use in hazardous locations—See page 17-79.
Legend plate not included.

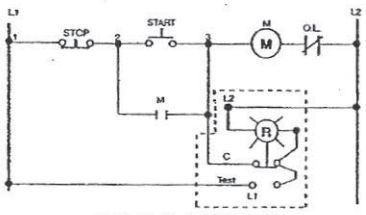
Description		Voltage	Style	With Red Fresnel Color Cap	With Green Fresnel Color Cap	With Other Color Cap	Price	Without Color Cap
 9001SKP1	Standard Pilot Light (Non-metallic fresnel color cap shown)	110–120 V, 50–60 Hz	Transformer	SKP1R31	SKP1G31	SKP1■	$102.	SKP1
		220–240 V, 50–60 Hz	Transformer	SKP7R31	SKP7G31	SKP7■	102.	SKP7
		24–28 Vac/dc	Full Voltage	SKP35R31	SKP35G31	SKP35■	83.	SKP35
		For other voltages see Table ▲	Transformer, Flashing or LED♦	SKP▲R31	SKP▲G31	SKP▲■	102.	SKP▲
			Full Voltage, Neon or Resistor★	SKP▲R31	SKP▲G31	SKP▲■	83.	SKP▲
 9001SKT1	Push-To-Test Pilot Light (Non-metallic fresnel color cap shown)	110–120 V, 50–60 Hz	Transformer	SKT1R31	SKT1G31	SKT1■	131.	SKT1
		220–240 V, 50–60 Hz	Transformer	SKT7R31	SKT7G31	SKT7■	131.	SKT7
		24–28 Vac/dc	Full Voltage	SKT35R31	SKT35G31	SKT35■	111.	SKT35
		For other voltages see Table ▲	Transformer, Flashing or LED♦	SKT▲R31	SKT▲G31	SKT▲■	131.	SKT▲
			Full Voltage, Neon or Resistor★	SKT▲R31	SKT▲G31	SKT▲■	111.	SKT▲
 9001SKTR38	Remote Test Pilot Light (Non-metallic fresnel color cap shown)	120 Vac Only	Resistor	SKTR38R31	SKTR38G31	SKTR38■	131.	SKTR38
		24–28 Vac Only	Full Voltage	SKTR35R31	SKTR35G31	SKTR35■	131.	SKTR35
		For other voltages see Tables ▲■▼	Full Voltage or Resistor ▼	SKTR▲R31	SKTR▲G31	SKTR▲■	131.	SKTR▲
 Pilot Light For Intrinsically Safe Circuits (NEMA 4X)	Intrinsically safe equipment must not release electrical or thermal energy capable of igniting certain explosive or combustible hazardous atmospheres, for which the equipment has been tested. These pilot lights are intrinsically safe when used with suitable approved barrier or barrier relay. These pilot lights are Factory Mutual (FM) approved. Consult your local Square D sales office for further details. These pilot lights are fully encapsulated—there are no replaceable parts—except for the SK40 ring nut. Use KN100 series plastic legend plates as shown on Pages 17-81 and 17-82.			KP44R	KP44G	KP44Y (Yellow Color Cap)	119.	...	...
	Operating Voltage Range: 20–30 Vac/dc	Nominal Current: 25 mA	V max = 32 V, I max = 165 mA					

▲ Add the voltage assembly code as chosen from table, page 17-77.
EXAMPLE: SKT▲R31 with 60 Vac red LED voltage = SKT37LRR31.
■ Add the color code as chosen from the color cap table below.
EXAMPLE: SKP1■ with a blue fresnel cap = SKP1L31.
♦ The cap must be the same color as the LED light module chosen, e.g., for green LED, use green color cap.
★ On neon light modules, use clear color caps only.
▼ Use only full voltage or resistor voltage assembly codes on remote test pilot lights. Do not choose LED, neon or transformer codes. For AC use only.

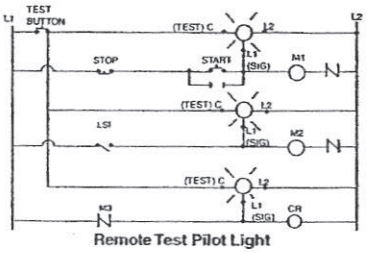
Color Caps

Color	■ Plastic Fresnel 	■ Plastic Domed 
Amber	A31	A9
Blue	L31	L9
Clear	C31	C9
Green	G31	G9
Red	R31	R9
White	W31	W9
Yellow	Y31	Y9

Typical Wiring Diagram



Push-To-Test Pilot Light



Remote Test Pilot Light

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Standard Light Modules for Types K, SK, and KX Control Units ★

For use in hazardous locations—See page 17-79.

- Neon type light modules—use CLEAR color caps only.
- LED light modules require that the color cap and the LED be the same color, or use a clear color cap.



Voltage	Description	For Use With Single Lamp Ill. Operators as Indicated ▲	Light Module Type♦	Voltage Assembly Code	Rating	Replacement Lamp Part Number ♦▼
6 Vac/dc	Full Voltage	All	KM31	31	.9 VA	2550101020
12–14 Vac/dc	Full Voltage	All	KM32	32	1.2 VA	2550101037
18 Vac/dc	Resistor	All	KM33	33	1.4 VA	2550101037
24–28 Vac/dc	Full Voltage	All	KM35	35	1.2 VA	2550101002
24–28 Vac/dc	LED Red	All Except■	KM35LR	35LR	.28 VA	6508805210
24–28 Vac/dc	LED Green	All Except■	KM35LG	35LG	.28 VA	6508805212
24–28 Vac/dc	LED Yellow	All Except■	KM35LY	35LY	.28 VA	6508805211
24–28 Vac/dc	LED White	All Except■	KM35LW	35LW	.28 VA	6508805214
24–28 Vac/dc	LED Blue	All Except■	KM35LL	35LL	.28 VA	6508805213
48 Vac/dc	Full Voltage	All	KM36	36	2.6 VA	2550101025
110–120 V, 50–60 Hz	Transformer	All Except■	KM1	1	2.4 VA	2550101020
110–120 V, 50–60 Hz	Flashing	All Except■	KMF1	F1	.85 VA	2550101036
120 Vac/dc	Resistor	All	KM38	38	3.0 VA	2550101027
120 Vac/dc	Full Voltage	All	KM38	38	3.0 VA	2550101027
120 Vac/dc	Neon	All Except■	KM11	11	0.2 VA	2550101013
120 Vac/dc	LED Red	All Except■	KM38LR	38LR	1.4 VA	6508805210
120 Vac/dc	LED Green	All Except■	KM38LG	38LG	1.4 VA	6508805212
120 Vac/dc	LED Yellow	All Except■	KM38LY	38LY	1.4 VA	6508805211
120 Vac/dc	LED White	All Except■	KM38LW	38LW	1.4 VA	6508805214
120 Vac/dc	LED Blue	All Except■	KM38LL	38LL	1.4 VA	6508805213
208–220 V, 50–60 Hz	Transformer	All Except■	KM3	3	2.5 VA	2550101020
220–240 V, 50–60 Hz	Transformer	All Except■	KM7	7	2.0 VA	2550101020
240 Vac/dc	Resistor	All Except■	KM25	25	6.0 VA	2550101027
240 Vac/dc	Neon	All Except■ and KX	KM12	12	0.3 VA	2550101013
277 V, 50–60 Hz	Transformer	All Except■	KM8	8	2.4 VA	2550101020
380–480 V, 50–60 Hz	Transformer	All Except■	KM5	5	2.8 VA	2550101020
480 Vac/dc	Neon	All Except■ and KX	KM14	14	0.5 VA	2550101013
550–600 V, 50–60 Hz	Transformer	All Except■	KM6	6	2.5 VA	2550101020

Shallow Depth Light Modules For Types K and SK Control Units ★

For use in hazardous locations—See page 17-79. Reduces the depth of illuminated push buttons with contact blocks by over 33%.



Voltage	Description	Light Module Type♦	Voltage Assembly Code	Rating	Replacement Lamp Part Number ♦
24–28 Vac/dc	Full Voltage	KM55	55	1.2 VA	2550101002
110–120 Vac/dc	Full Voltage	KM58	58	3.0 VA	2550101027

▲ 9001K, SK, KX.
■ Do not use on any remote test version pilot light.
♦ All light modules with an LED above 12 V use a 14 V bipolar LED.
★ For use with all operators except KX and remote test pilot.
▼ Check light module label for series and replacement number.

UL File E42259
CCN NKCR

CSA File LR25490
Class 3211 03

CE marked

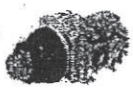
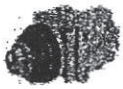
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9/8/03

PUBLICATION DIVIDER

Push Buttons—Class 9001 Type SK—30 mm
Corrosion Resistant Pilot Lights

Pilot Lights—UL Types 4, 4X, 13/NEMA 4, 4X, 13

For use in hazardous locations—See page 17-79.
Legend plate not included.

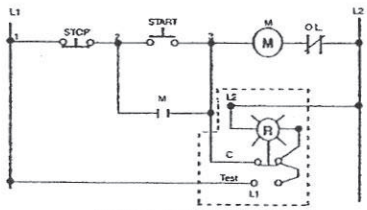
Description		Voltage	Style	With Red Fresnel Color Cap	With Green Fresnel Color Cap	With Other Color Cap	Without Color Cap
 9001SKP1	Standard Pilot Light (Non-metallic fresnel color cap shown)	110–120 V, 50–60 Hz	Transformer	SKP1R31	SKP1G31	SKP1■	SKP1
		220–240 V, 50–60 Hz	Transformer	SKP7R31	SKP7G31	SKP7■	SKP7
		24–28 Vac/dc	Full Voltage	SKP35R31	SKP35G31	SKP35■	SKP35
		For other voltages see Table ▲	Transformer, Flashing or LED♦	SKP▲R31	SKP▲G31	SKP▲■	SKP▲
			Full Voltage, Neon or Resistor★	SKP▲R31	SKP▲G31	SKP▲■	SKP▲
 9001SKT1	Push-To-Test Pilot Light (Non-metallic fresnel color cap shown)	110–120 V, 50–60 Hz	Transformer	SKT1R31	SKT1G31	SKT1■	SKT1
		220–240 V, 50–60 Hz	Transformer	SKT7R31	SKT7G31	SKT7■	SKT7
		24–28 Vac/dc	Full Voltage	SKT35R31	SKT35G31	SKT35■	SKT35
		For other voltages see Table ▲	Transformer, Flashing or LED♦	SKT▲R31	SKT▲G31	SKT▲■	SKT▲
			Full Voltage, Neon or Resistor★	SKT▲R31	SKT▲G31	SKT▲■	SKT▲
 9001SKTR38	Remote Test Pilot Light (Non-metallic fresnel color cap shown)	120 Vac Only	Resistor	SKTR38R31	SKTR38G31	SKTR38■	SKTR38
		24–28 Vac Only	Full Voltage	SKTR35R31	SKTR35G31	SKTR35■	SKTR35
		For other voltages see Tables ▲■▼	Full Voltage or Resistor ▼	SKTR▲R31	SKTR▲G31	SKTR▲■	SKTR▲
 Pilot Light For Intrinsically Safe Circuits (NEMA 4X)	Intrinsically safe equipment must not release electrical or thermal energy capable of igniting certain explosive or combustible hazardous atmospheres, for which the equipment has been tested. These pilot lights are intrinsically safe when used with suitable approved barrier or barrier relay. These pilot lights are Factory Mutual (FM) approved. Consult your local Square D sales office for further details. These pilot lights are fully encapsulated—there are no replaceable parts—except for the SK40 ring nut. Use KN100 series plastic legend plates as shown on Pages 17-81 and 17-82.			KP44R	KP44G	KP44Y (Yellow Color Cap)	
	Operating Voltage Range: 20–30 Vac/dc	Nominal Current: 25 mA	V max = 32 V, I max = 165 mA				

▲ Add the voltage assembly code as chosen from table, page 17-77.
EXAMPLE: SKT▲R31 with 60 Vac red LED voltage = SKT37LRR31.
■ Add the color code as chosen from the color cap table below.
EXAMPLE: SKP1■ with a blue fresnel cap = SKP1L31.
♦ The cap must be the same color as the LED light module chosen, e.g., for green LED, use green color cap.
★ On neon light modules, use clear color caps only.
▼ Use only full voltage or resistor voltage assembly codes on remote test pilot lights. Do not choose LED, neon or transformer codes. For AC use only.

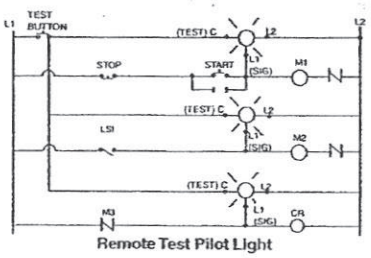
Color Caps

Color	■ Plastic Fresnel 	■ Plastic Domed 
Amber	A31	A9
Blue	L31	L9
Clear	C31	C9
Green	G31	G9
Red	R31	R9
White	W31	W9
Yellow	Y31	Y9

Typical Wiring Diagram



Push-To-Test Pilot Light



Remote Test Pilot Light

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Standard Light Modules for Types K, SK, and KX Control Units ★

For use in hazardous locations—See page 17-79.

- Neon type light modules—use CLEAR color caps only.
- LED light modules require that the color cap and the LED be the same color, or use a clear color cap.



Voltage	Description	For Use With Single Lamp Ill. Operators as Indicated ▲	Light Module Type♦	Voltage Assembly Code	Rating	Replacement Lamp Part Number ♦▼
6 Vac/dc	Full Voltage	All	KM31	31	.9 VA	2550101020
12–14 Vac/dc	Full Voltage	All	KM32	32	1.2 VA	2550101037
18 Vac/dc	Resistor	All	KM33	33	1.4 VA	2550101037
24–28 Vac/dc	Full Voltage	All	KM35	35	1.2 VA	2550101002
24–28 Vac/dc	LED Red	All Except■	KM35LR	35LR	.28 VA	6508805210
24–28 Vac/dc	LED Green	All Except■	KM35LG	35LG	.28 VA	6508805212
24–28 Vac/dc	LED Yellow	All Except■	KM35LY	35LY	.28 VA	6508805211
24–28 Vac/dc	LED White	All Except■	KM35LW	35LW	.28 VA	6508805214
24–28 Vac/dc	LED Blue	All Except■	KM35LL	35LL	.28 VA	6508805213
48 Vac/dc	Full Voltage	All	KM36	36	2.6 VA	2550101025
110–120 V, 50–60 Hz	Transformer	All Except■	KM1	1	2.4 VA	2550101020
110–120 V, 50–60 Hz	Flashing	All Except■	KMF1	F1	.85 VA	2550101036
120 Vac/dc	Resistor	All	KM38	38	3.0 VA	2550101027
120 Vac/dc	Full Voltage	All	KM38	38	3.0 VA	2550101027
120 Vac/dc	Neon	All Except■	KM11	11	0.2 VA	2550101013
120 Vac/dc	LED Red	All Except■	KM38LR	38LR	1.4 VA	6508805210
120 Vac/dc	LED Green	All Except■	KM38LG	38LG	1.4 VA	6508805212
120 Vac/dc	LED Yellow	All Except■	KM38LY	38LY	1.4 VA	6508805211
120 Vac/dc	LED White	All Except■	KM38LW	38LW	1.4 VA	6508805214
120 Vac/dc	LED Blue	All Except■	KM38LL	38LL	1.4 VA	6508805213
208–220 V, 50–60 Hz	Transformer	All Except■	KM3	3	2.5 VA	2550101020
220–240 V, 50–60 Hz	Transformer	All Except■	KM7	7	2.0 VA	2550101020
240 Vac/dc	Resistor	All Except■	KM25	25	6.0 VA	2550101027
240 Vac/dc	Neon	All Except■ and KX	KM12	12	0.3 VA	2550101013
277 V, 50–60 Hz	Transformer	All Except■	KM8	8	2.4 VA	2550101020
380–480 V, 50–60 Hz	Transformer	All Except■	KM5	5	2.8 VA	2550101020
480 Vac/dc	Neon	All Except■ and KX	KM14	14	0.5 VA	2550101013
550–600 V, 50–60 Hz	Transformer	All Except■	KM6	6	2.5 VA	2550101020

Note: Standard light modules are available in other voltages. Contact your nearest Square D/Schneider Electric sales office for details.

Shallow Depth Light Modules For Types K and SK Control Units ★

For use in hazardous locations—See page 17-79. Reduces the depth of illuminated push buttons with contact blocks by over 33%.



Voltage	Description	Light Module Type♦	Price of Light Module	Voltage Assembly Code	Rating	Replacement Lamp Part Number ♦
24–28 Vac/dc	Full Voltage	KM55	$57.	55	1.2 VA	2550101002
110–120 Vac/dc	Full Voltage	KM58	57.	58	3.0 VA	2550101027

▲ 9001K, SK, KX.
■ Do not use on any remote test version pilot light.
♦ All light modules with an LED above 12 V use a 14 V bipolar LED.
★ For use with all operators except KX and remote test pilot.
▼ Check light module label for series and replacement number.

UL File E42259 CCN NKCR

CSA File LR25490 Class 3211 03

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Push Buttons—Class 9001 Type K and SK—30 mm
Replacement Parts

Ring Nuts

Used On	Type	Used On	Type
K1L	K44	SK1L	SK44
K30-K37	K45	...	...
K70-K73	K45	...	...
K20, K21, K22, K23	K45	SK20, SK21, SK22, SK23	SK45
K20, K21, K22, K23 ♦	SK46	SK20, SK21, SK22, SK23 ♦	SK46
K2L	K49	SK2L	SK49
K3L	K111	...	...
KP, KTR	K41	SKP, SKTR	SK41
KR1	K41	SKR1	SK41
KR11	K42	SKR11	SK42
KR12 ▲	K42	SKR12 ▲	SK42
KR12 ■	K41	SKR12 ■	SK41
KR13, 14, 15	K55	...	...
KR2	K42	SKR2	SK42
KR20	K49	...	...
KR24	K49	...	...
KR25	K49	...	...
KR3	K40	SKR3	SK40
KR4	K41	SKR4	SK41
KR5	K41	SKR5	SK41
KR6	K47	...	...
KR67	K47	...	...
KR7	K47	...	...
KR8	K58	SKR8	6509704401
KR9	K41	SKR9	SK41
KS	K45	SKS	SK45
KS ♦	SK46	SKS ♦ SKRU11 SKRU1,2,3,4,5,10	SK46 SK41 SK40
KT	K49	SKT	SK49

▲ Maintained button of two button operator.
■ Momentary button of two button operator.
♦ Secondary ring nut (holds knob on selector switch or potentiometer).

Replacement Lamps For Series A–F (black) Light Modules

Light Module Type	Lamp Number (ANSI)	Square D Replacement Lamps Part Number
KM1	GE44★	...
KM2	GE1490	2550101003
KM3	GE44★	...
KM4	GE1490	2550101003
KM5	GE44★	...
KM6	GE44★	...
KM7	GE44★	...
KM8	GE44★	...
KM9	GE755	2550101020
KM11	CMDK1A5	2550105014
KM12	CMDK1A5	2550105014
KM13	CMDK1A5	2550105014
KM14	CMDK1A5	2550105014
KM15	CMDK1A5	2550105014
KM21	SYL12PSB	2550105003
KM22	SYL12PSB	2550105003
KM23	SYL28PSB	2550105008
KM25	SYL120PSB	2550105005
KM31	SYL6PSB	2550105007
KM32	SYL12PSB	2550105003
KM34	SYL24PSB	2550105004
KM35	SYL28PSB	2550105008
KM36	SYL48PSB	2550105009
KM37	SYL60PSB	2550105010
KM38	SYL120PSB	2550105005

★ GE44 and GE755 are interchangeable (GE755 gives longer life). If a GE44 lamp is ordered, a GE755 (2550101020) will be substituted. For a replacement lamp in a current series light module see the light module listing on page 17-77.

Repair Parts

Description	Part Number
E10 Key	2941101100
Gray cap for KR11, KR12, SKR11, or SKR12	3105217001
Clear plastic top (only) for 9001K44 & SK44 Ring Nut	4487D63X1
Gasket for Type K and SK Push-Pull Knob	6509701801
Gasket for Plastic Illuminated Lens	6509701901
Gasket for Type K and SK selector switch knob	3105406401
Black Compensating Gasket (Type K and SK Operators)	6509702001
Liner for Non-Illuminated Operators	6509704901
Locking Thrust Washer	6512231201
Nylon Spacer	6509705001
Locking Thrust Washer (Std. Type SK Operator)	6512240601
Push-Pull Mushroom Adapter ▼	K54
Rubber Boot for Joystick	6512243201
Knob on Joysticks without latch	4458D20X3

▼ Allows Type -20 and -21 mushroom color caps to be used on push-pull operators. Use of 9001K54 voids Type 6 rating.

KU Replacement Ring Nuts (Threaded Inside and Out)

Used On	Part Number
KU1 through KU8, KU27, KU37, KU47	3105204101
KU17, KU18	3105205901

Interlock



For mechanically interlocking two push buttons so that only one button can be depressed at a time. A Type K3 attachment is furnished with the **9001 KR11, KR12, SKR11, SKR12, SKRU1** and **SKRU11** operators. However, these are maintained operators and the K3 interlock serves to release one of the buttons when the other is depressed. When used with momentary contact buttons, the K3 interlock does not hold the buttons in the depressed position. It simply prevents pushing both buttons at the same time.
The Type K3 interlock is mounted behind the operators. Operators not included.

Type
K3

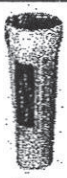
Screwdriver



Used to tighten mounting screws on contact blocks and light modules.

Type
K69

Wrenches



K95



K1

Where Used	Type
For tightening ring nuts on Types K, KX, SK and J control units	K95
For protective cap kits	K1

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PUBLICATION DIVIDER

Push Buttons and Operator Interface Specifiers Guide
Class 9001, Type K, SK — 30 mm
Common Operators

For use in hazardous locations – See page 150.

"START" Push Buttons

Operator Style	Description	Contact Block	Button Color	Type	Legend Plate
30.5 mm Industrial (Metal)			Black	KR1BH13	KN201SP
30.5 mm Corrosion Resistant (Non Metallic)			Black	SKR1BH13	KN101SP

"STOP" Push Buttons

Operator Style	Description	Contact Block	Button Color	Type	Legend Plate
30.5 mm Industrial (Metal)			Red	KR1RH13	KN202RP
30.5 mm Corrosion Resistant (Non Metallic)			Red	SKR1RH13	KN102RP

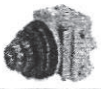
"OFF – ON" Selector Switch

Operator Style	Description	Contact Sequence / Contact Block Included	Knob Color	Type	Legend Plate
30.5 mm Industrial (Metal)			Black	KS11BH13	KN244SP
30.5 mm Corrosion Resistant (Non Metallic)			Black	SKS11BH13	KN144SP

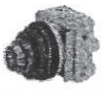
"HAND – OFF – AUTO" Selector Switch

Operator Style	Description	Contact Sequence / Contact Block Included	Knob Color	Type	Legend Plate
30.5 mm Industrial (Metal)			Black	KS43BH13	KN260SP
30.5 mm Corrosion Resistant (Non Metallic)			Black	SKS43BH13	KN160SP

RED – 120 Vac – "ON" Pilot Light

Operator Style	Description	Type	Legend Plate
30.5 mm Industrial (Metal)		KP1R31	KN203SP
30.5 mm Corrosion Resistant (Non Metallic)		SKP1R31	KN103SP

GREEN – 120 Vac – "OFF" Pilot Light

Operator Style	Description	Type	Legend Plate
30.5 mm Industrial (Metal)		KP1G31	KN204SP
30.5 mm Corrosion Resistant (Non Metallic)		SKP1G31	KN104SP

RED – 120 Vac – "ON" Push-To-Test Pilot Light

Operator Style	Description	Type	Legend Plate
30.5 mm Industrial (Metal)		KT1R31	KN203SP
30.5 mm Corrosion Resistant (Non Metallic)		SKT1R31	KN103SP

GREEN – 120 Vac –"OFF" Push-To-Test Pilot Light

Operator Style	Description	Type	Legend Plate
30.5 mm Industrial (Metal)		KT1G31	KN204RP
30.5 mm Corrosion Resistant (Non Metallic)		SKT1G31	KN104RP

UL File E42259
CCN NKCR

CSA File LR 25490
Class 3211 03

CE Marking

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Non-Illuminated Momentary Push Button Operators – UL Types 4, 13/NEMA Types 4, 13

For use in hazardous locations – See page 150.
Contact blocks and legend plate not included unless otherwise noted.

Description	Color	Operator With 1 N.O. and 1 N.C. Contact (KA1)	Operator With 1 N.O. Contact (KA2)	Operator With 1 N.C. Contact (KA3)	Operator Only With No Contacts ⑤
 Full Guard	Black	KR1BH13	KR1BH5	KR1BH6	KR1B
	Red	KR1RH13	KR1RH5	KR1RH6	KR1R
	Green	KR1GH13	KR1GH5	KR1GH6	KR1G
	Universal ①	KR1UH13	KR1UH5	KR1UH6	KR1U
	Other ②	KR1②H13	KR1②H5	KR1②H6	KR1②
 No Guard	Black	KR3BH13	KR3BH5	KR3BH6	KR3B
	Red	KR3RH13	KR3RH5	KR3RH6	KR3R
	Green	KR3GH13	KR3GH5	KR3GH6	KR3G
	Universal ①	KR3UH13	KR3UH5	KR3UH6	KR3U
	Other ②	KR3②H13	KR3②H5	KR3②H6	KR3②
 Extended Guard	Black	KR2BH13	KR2BH5	KR2BH6	KR2B
	Red	KR2RH13	KR2RH5	KR2RH6	KR2R
	Green	KR2GH13	KR2GH5	KR2GH6	KR2G
	Universal ①	KR2UH13	KR2UH5	KR2UH6	KR2U
	Other ②	KR2②H13	KR2②H5	KR2②H6	KR2②
 $1\frac{3}{8}$" Diameter Mushroom Button	**Snap-In Mushroom Button**				
	Black	KR4BH13	KR4BH5	KR4BH6	KR4B
	Red	KR4RH13	KR4RH5	KR4RH6	KR4R
	Red ③	KR4R05H13	KR4R05H5	KR4R05H6	KR4R05
	Green	KR4GH13	KR4GH5	KR4GH6	KR4G
	Other ④	KR4④H13	KR4④H5	KR4④H6	KR4④
	Screw-On Mushroom Button With Set Screw Security				
	Black	KR24BH13	KR24BH5	KR24BH6	KR24B
	Red	KR24RH13	KR24RH5	KR24RH6	KR24R
	Green	KR24GH13	KR24GH5	KR24GH6	KR24G
	Other ④	KR24④H13	KR24④H5	KR24④H6	KR24④
 $2\frac{1}{4}$" Diameter Mushroom Button	**Snap-In Mushroom Button**				
	Black	KR5BH13	KR5BH5	KR5BH6	KR5B
	Red	KR5RH13	KR5RH5	KR5RH6	KR5R
	Red ③	KR5R05H13	KR5R05H5	KR5R05H6	KR5R05
	Green	KR5GH13	KR5GH5	KR5GH6	KR5G
	Other ④	KR5④H13	KR5④H5	KR5④H6	KR5④
	Screw-On Mushroom Button With Set Screw Security				
	Black	KR25BH13	KR25BH5	KR25BH6	KR25B
	Red	KR25RH13	KR25RH5	KR25RH6	KR25R
	Green	KR25GH13	KR25GH5	KR25GH6	KR25G
	Other ④	KR25④H13	KR25④H5	KR25④H6	KR25④

① The universal push button operators contain one each of the following color inserts: black, red, green, yellow, orange, blue and white.
② See table below.
③ Knob has the words "Emergency Stop" in raised letters highlighted in white for readability. Available in red snap-in mushroom buttons only.
④ See table below.
⑤ These operators can be ordered complete with contact blocks – for maximum block usage – see page 155. Add the "H" number chosen from page 151 to the end of the operator type number.
EXAMPLE: KR24B + H2(2 - KA1) = KR24BH2

Color	② For KR1, 2, 3 Choose Color and Place Code in Type Number	④ For KR4, 5, 24, 25 Choose Color and Place Color Code in Type Number
Blue	L	L
Yellow	Y	Y
White	W	–
Orange	S	S
Gray	E	–

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Non-Illuminated Momentary Push Button Operators – UL Types 4, 4X, 13/NEMA Types 4, 4X, 13

For use in hazardous locations – See page 150.
Contact Blocks And Legend Plate Not Included Unless Otherwise Noted

Description	Color	Operator With 1 N.O. and 1 N.C. Contact (KA1)	Operator With (KA2)	Operator With 1 N.C. Contact (KA3)	Operator Only With No Contacts ⑤
 Full Guard	Black	SKR1BH13	SKR1BH5	SKR1BH6	SKR1B
	Red	SKR1RH13	SKR1RH5	SKR1RH6	SKR1R
	Green	SKR1GH13	SKR1GH5	SKR1GH6	SKR1G
	Universal ①	SKR1UH13	SKR1UH5	SKR1UH6	SKR1U
	Other ②	SKR1②H13	SKR1②H5	SKR1②H6	SKR1②
 No Guard	Black	SKR3BH13	SKR3BH5	SKR3BH6	SKR3B
	Red	SKR3RH13	SKR3RH5	SKR3RH6	SKR3R
	Green	SKR3GH13	SKR3GH5	SKR3GH6	SKR3G
	Universal ①	SKR3UH13	SKR3UH5	SKR3UH6	SKR3U
	Other ②	SKR3②H13	SKR3②H5	SKR3②H6	SKR3②
 Extended Guard	Black	SKR2BH13	SKR2BH5	SKR2BH6	SKR2B
	Red	SKR2RH13	SKR2RH5	SKR2RH6	SKR2R
	Green	SKR2GH13	SKR2GH5	SKR2GH6	SKR2G
	Universal ①	SKR2UH13	SKR2UH5	SKR2UH6	SKR2U
	Other ②	SKR2②	SKR2②H5	SKR2②H6	SKR2②
 $1^{3}/_{8}$ Mushroom Button	**Snap In Mushroom Button**				
	Black	SKR4BH13	SKR4BH5	SKR4BH6	SKR4B
	Red	SKR4RH13	SKR4RH5	SKR4RH6	SKR4R
	Red ③	SKR4R05H13	SKR4R05H5	SKR4R05H6	SKR4R05
	Green	SKR4GH13	SKR4GH5	SKR4GH6	SKR4G
	Other ④	SKR4④H13	SKR4④H5	SKR4④H6	SKR4④
	Screw-On Mushroom Button With Set Screw Security				
	Black	SKR24BH13	SKR24BH5	SKR24BH6	SKR24B
	Red	SKR24RH13	SKR24RH5	SKR24RH6	SKR24R
	Green	SKR24GH13	SKR24GH5	SKR24GH6	SKR24G
	Other ④	SKR24④H13	SKR24④H5	SKR24④H6	SKR24④
 $2^{1}/_{4}$ Mushroom Button	**Snap-In Mushroom Button**				
	Black	SKR5BH13	SKR5BH5	SKR5BH6	SKR5B
	Red	SKR5RH13	SKR5RH5	SKR5RH6	SKR5R
	Red ③	SKR5R05H13	SKR5R05H5	SKR5R05H6	SKR5R05
	Green	SKR5GH13	SKR5GH5	SKR5GH6	SKR5G
	Other ④	SKR5④H13	SKR5④H5	SKR5④H6	SKR5④
	Screw-On Mushroom Button With Set Screw Security				
	Black	SKR25BH13	SKR25BH5	SKR25BH6	SKR25B
	Red	SKR25RH13	SKR25RH5	SKR25RH6	SKR25R
	Green	SKR25GH13	SKR25GH5	SKR25GH6	SKR25G
	Other ④	SKR25④H13	SKR25④H5	SKR25④H6	SKR25④

① The universal push button operators include one each of the following color inserts: black, red, green, yellow, orange, blue and white.
② See table below.
③ Knob has the words "Emergency Stop" in raised letters highlighted in white for readability. Available in red snap-in mushroom buttons only.
④ See table below.
⑤ These operators can be ordered complete with contact blocks, for maximum block usage – see page 155. Add the "H" number chosen from page 151 to the end of the operator type number. **EXAMPLE: SKR24B + H2(2-KA1) = SKR24BH2**

Color	② For SKR1,2,3 Choose Color and Place Color Code in Type Number	④ For SKR4,5,24,25 Choose Color and Place Color Code in Type Number
Blue	L	L
Yellow	Y	Y
White	W	–
Orange	S	S
Gray	E	–

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PUBLICATION DIVIDER

Illuminated and Non-Illuminated, Maintained and Spring-Return Selector Switches
Interruptores selectores de contacto sostenido o de retorno por resorte iluminados o no iluminados
Sélecteurs maintenus ou à rappel par ressort lumineux ou non lumineux

CE

Class Clase Classe	Type Tipo Type	Application Aplicación Application	Operators / Operadores / Opérateurs Non-Illuminated No iluminados Non lumineux	Illuminated Iluminados Lumineux	Keyed Con llave À clé	UL Listed for use on a flat surface of enclosure types: Registrado por UL para utilizar sobre una superficie plana de gabinetes tipo: Homologué par UL pour utilisation sur une surface plate des armoires de type :	
9001	KS	Heavy Duty Uso pesado Fort calibre	X		X	1, 2, 3, 3R, 4, 6, 12 & 13	The lens gasket (P) must be installed to retain enclosure Type 4 and 6 ratings. El empaque del lente (P) deberá ser instalado para conservar los valores nominales del gabinete tipo 4 y 6. Le joint de la lentille (P) doit être installé pour préserver les valeurs nominales de l'armoire type 4 et 6.
	K••J			X			
	SKS	Corrosion Resistant Resistente a la corrosión Résistant à la corrosion	X			1, 2, 3, 3R, 4, 4X, 6, 12 & 13	
	SK••J			X			

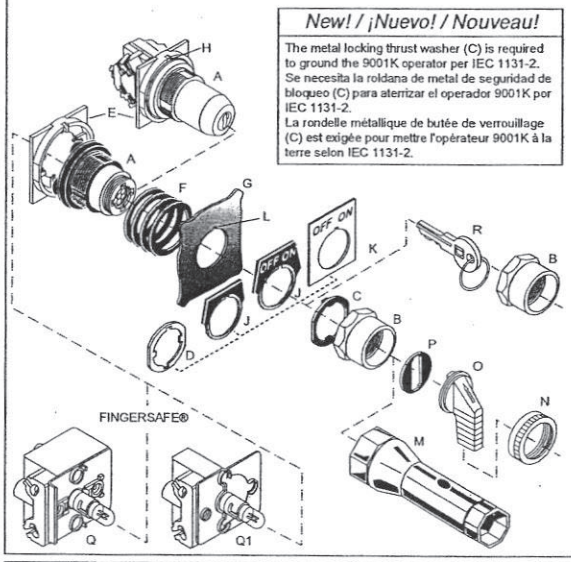
⚠ DANGER / PELIGRO / DANGER

HAZARDOUS VOLTAGE
Disconnect all power before servicing.
Electric shock will result in death or serious injury.

TENSION PELIGROSA
Desconecte todas las alimentaciones antes de efectuar el servicio.
Una descarga eléctrica podrá causar la muerte o lesiones serias.

TENSION DANGEREUSE
Coupez toutes les alimentations avant l'entretien.
L'électrocution entraînera la mort ou des blessures graves.

Full View / Vista completa / Vue complète



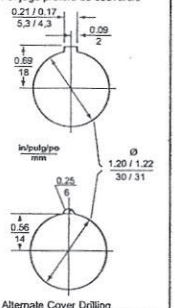
New! / ¡Nuevo! / Nouveau!

The metal locking thrust washer (C) is required to ground the 9001K operator per IEC 1131-2.
Se necesita la roldana de metal de seguridad de bloqueo (C) para aterrizar el operador 9001K por IEC 1131-2.
La rondelle métallique de butée de verrouillage (C) est exigée pour mettre l'opérateur 9001K à la terre selon IEC 1131-2.

Mounting / Montaje / Montage

Dim.: in. / pulg / po (mm)

Preferred Cover Drilling
Perforación sugerida de la cubierta
Perçage préféré du couvercle



Hole & Notch Punch
Ø 31 mm: Greenlee knockout punch 60242
Push buttons also mount in 1.20 (30.5) hole.

Punzonado y Muesca
Ø 31 mm: Punzonado de discos removibles 60242
Estos operadores también se pueden montar en un agujero de 1,20 (30,25).

Poinçon et Encoche
Ø 31 mm : Emporte-pièce Greenlee 60242
Ces opérateurs se montent aussi dans un trou de 1,20 (30,5).

Alternate Cover Drilling
Perforación alterna de la cubierta
Perçage alternatif du couvercle

Min. Centerline Spacing / Espacio mín. al eje / Espacement mín. à l'axe

	Vertical	Horizontal
Without legend plate	1.56 (40)	2.25 (57)
Sin placa leyenda	1,56 (40)	2,25 (57)
Sans plaque à légende	1,56 (40)	2,25 (57)
With legend plate	*Consult the Square D Digest*	
Con placa leyenda	*Consultar el Compendiado Square D*	
Avec plaque à légende	*Consulter le Digest Square D*	

Legend
A. operator
B. ring nut
C. locking thrust washer
D. trim washer
E. liner (KS & SKS)
F. compensating gaskets
G. panel
H. locating mark
J. metal legend plate
K. plastic legend plate
L. alignment tab
M. ring nut wrench (K95)
N. secondary (knob) ring nut
O. knob
P. lens gasket
Q. standard light module (K••J, SK••J)
Q1. shallow depth light module (K••J, SK••J)
R. key

Leyenda
A. operador
B. tuerca arillo
C. roldana de seguridad de bloqueo
D. roldana del marco
E. revestimiento protector (KS & SKS)
F. empaques de compensación
G. panel
H. indicador
J. placa leyenda metálica
K. placa leyenda de plástico
L. muesca de alineamiento
M. llave para tuercas (K95)
N. tuerca arillo secundaria (perilla)
O. perilla
P. empaque del lente
Q. módulo de luz estándar (K••J, SK••J)
Q1. módulo de luz de poca profundidad (K••J, SK••J)
R. llave

Légende
A. opérateur
B. écrou de blocage
C. rondelle de butée de verrouillage
D. rondelle de garniture
E. revêtement (KS & SKS)
F. joints de compensation
G. panneau
H. repère
J. plaque à légende en métal
K. plaque à légende en plastique
L. languette d'alignement
M. clé pour écrou de blocage (K95)
N. écrou de blocage (de bouton) secondaire
O. bouton
P. joint de la lentille
Q. module lumineux standard (K••J, SK••J)
Q1. module lumineux de faible profondeur (K••J, SK••J)
R. clé

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SQUARE D | Telemecanique

USFCS PDF No. 513 Rev.: 02-00

Installation / Instalación / Installation

① - Install the contact blocks.
- Instalar los bloques de contacto.
- Installer les blocs des contact.

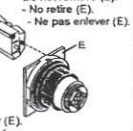
5–8 lb-in / lbs-pulg / lb-po (0,6–0,9 N-m)

SKS & KS
- Do not remove (E).
- No retire (E).
- Ne pas enlever (E).

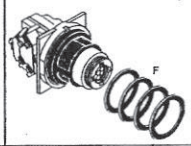
Maintained / Contacto sostenido / Maintenu
MAX : TANDEM–2, TOTAL–4

Spring Return / Retorno por resorte / Rappel par ressort
MAX : TANDEM–1, TOTAL–2

K–J & SK–J
- Remove liner (E) if light module is used.
- Si utiliza el módulo de luz, retire el revestimiento protector (E).
- Enlever le revêtement (E) si le module lumineux est utilisé.

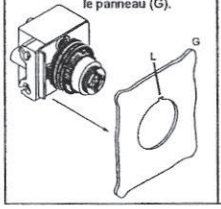


② - Select the number of gaskets (F).
- Seleccionar el número de empaques (F).
- Choisir le nombre de joints (F).

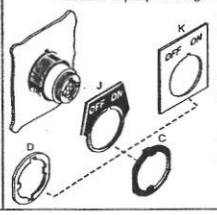


Panel thickness Espesor del panel Épaisseur du panneau in. / pulg / po (mm)	No. gaskets No. de empaques Nombre de joints
1/16 (1,6)	4
1/8 (3,2)	3
3/16 (4,8)	2
1/4 (6,4)	1

③ - Mount onto the panel (G)
- Montar sobre el panel (G).
- Monter sur le panneau (G).

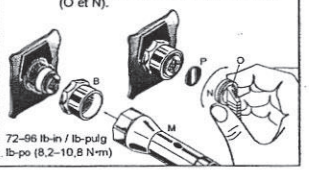


④ - Install the legend plate and washer (see table).
- Instalar la placa y roldana (vea la tabla).
- Installer la plaque de légende et rondelle (voir le tableau).



Legend Plate	Washer
Metal (J) Plastic (K) None	C only C only D and C
Placa leyenda	**Roldana**
De metal (J) De plástico (K) Ninguna	C solamente C solamente D y C
Plaque à légende	**Rondelle**
En métal (J) En plastique (K) Aucune	C seulement C seulement D et C

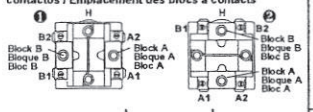
⑤ - Install the ring nut (B), lens gasket (P), and knob assembly (O & N).
- Instalar la tuerca arillo (B), el empaque del lente (P) y el ensamble de la perilla (O y N).
- Installer l'écrou de blocage (B), le joint de la lentille (P) et l'assemblage du bouton (O et N).



72–96 lb-in / lb-pulg
lb-po (8,2–10,8 N-m)

Contact Sequence Selection Table / Tabla de selección de las secuencias de contactos / Tableau de séquence de contact

Contact Block Location / Ubicación de los bloques de contactos / Emplacement des blocs à contacts



CONTACT(S)	Non-Illuminated Operator, Type: / Operador no luminoso, tipo: / Operateurs non lumineux, type :													
	KS11	KS12	KS25	KS34	KS42	KS43	KS44	KS45	KS46	KS47	KS49	KS401	KS402	KS88
	Cam / Leva / Came													
	E	D	E	D	B	C	D	E	F	G*	J	L*	M	H*
	Knob Position / Posición de la perilla / Position du bouton													
	↖ ↗	↖ ↗	↖ ↗	↖ ↗	↖ | ↗	↖ | ↗	↖ | ↗	↖ | ↗	↖ | ↗	↖ | ↗	↖ | ↗	↖ | ↗	↖ | ↗	↖ | ↗
Block A Only Bloque A solamente Bloc A seulement — A1 O|O, A2 O O														
A1	X O	O X	X O	O X	X O O	X O O	O O X	X O O	X O O	X O O	X O O	O X O	X X O	X O O O
A2	O X	X O	O X	X O	O X X	O O X	O X O	O X O	O O X	O X X	O X X	O O X	O O X	O X O O
Block B Only Bloque B solamente Bloc B seulement — B1 O|O, B2 O O														
B1	X O	O X	X O	O X	O O X	X O O	O O X	X O O	O X O	O O X	X O X	O O X	O X X	O O O X
B2	O X	X O	O X	X O	X X O	O O X	O X O	O X O	O O X	X O O	O X O	O X O	O O X	O X O O
Block A and B Bloques A y B Blocs A et B — B1 O|O, B2 O O; A1 O|O, A2 O O														
A1	X O	O X	X O	O X	X O O	X O O	O O X	X O O	X O O	X O O	X O O	O X O	X X O	X O O O
A2	O X	X O	O X	X O	O X X	O O X	O X O	O X O	O O X	O X X	O X X	O O X	O O X	O X O O
B1	X O	O X	X O	O X	O O X	X O O	O O X	X O O	O X O	O O X	X O X	O O X	O X X	O O O X
B2	O X	X O	O X	X O	X X O	O O X	O X O	O X O	O O X	X O O	O X O	O X O	O O X	O X O O

Note: Contacts Closed = X; Open = O
* *An intermediate contact state can exist while changing the switch position.*

Nota: Contactos Cerrados = X; Abiertos = O
* *Es posible que el contacto se encuentre en un estado intermedio al cambiar la posición del interruptor.*

Remarque : Contacts Fermés = X; Ouverts = O
* *C'est possible que un état de contact intermédiaire peut exister en changeant la position de l'interrupteur.*

CAM REPLACEMENT ❶ (wire channels on side) 1. Rotate the knob to the switch position shown in **X**, **Y**, and **Z** as required. 2. Snap the cam into position with the cam key inserted into keyway A1.

CAM REPLACEMENT ❷ (wire channels on top & bottom) Follow steps 1 & 2 above and snap the cam into keyway A2.

Note: The left-most knob position is position #1 for Type KS25.

REEMPLAZO DE LA LEVA ❶ (canales para conductores laterales) 1. Haga girar la perilla a la posición del interruptor mostrada en **X**, **Y** y **Z** según sea necesario. 2. Fije la leva en su posición con la llave insertada en la muesca posicionadora no. A1.

REEMPLAZO DE LA LEVA ❷ (canales para conductores en las partes superior e inferior) Siga los pasos descritos en 1 y 2, y fije la leva en la muesca posicionadora no. A2.

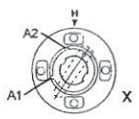
Nota: La posición de la perilla de la extrema izquierda es la posición no. 1 para el tipo KS25.

REMPLACEMENT DE LA CAME ❶ (caniveaux de fil sur le côté) 1. Tourner le bouton sur la position d'interrupteur indiquée sur **X**, **Y**, et **Z** selon les besoins. 2. Encliqueter la came en position, avec la clé de came insérée dans la cannelure n° A1.

REMPLACEMENT DE LA CAME ❷ (caniveaux de fil en haut et en bas) Suivre les étapes 1 et 2 ci-dessus et mettre en place la came avec un déclic dans la cannelure n° A2.

Remarque : La position du bouton qui est le plus à gauche est le n° 1 pour le type KS25.

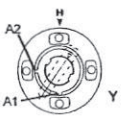




2 Position, spring return to right
2 or 4 Position, maintained

Retorno por resorte hacia la derecha, 2 posiciones
Sostenido, 2 o 4 posiciones

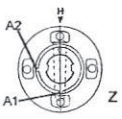
Rappel par ressort vers la droite, 2 positions
Maintenu, 2 ou 4 positions



2 Position, spring return to left

Retorno por resorte hacia la izquierda, 2 posiciones

Rappel par ressort vers la gauche, 2 positions



3 Position, maintained or spring return

Sostenido o retorno por resorte, 3 posiciones

Maintenu ou rappel par ressort, 3 positions

Electrical equipment should be serviced only by qualified electrical maintenance personnel. No responsibility is assumed by Square D for any consequences arising out of the use of this material.

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PUBLICATION DIVIDER

Push Buttons—Class 9001 Type SK—30 mm
Corrosion Resistant Non-Illuminated Operators

Non-Illuminated Momentary Push Button Operators—UL Types 4, 4X, 13/NEMA 4, 4X, 13

For use in hazardous locations—See page 17-79.
Contact blocks and legend plate not included unless otherwise noted.

Description	Color	Operator with 1 N.O. and 1 N.C. Contact (KA1)	Operator with 1 N.O. Contact (KA2)	Operator with 1 N.C. Contact (KA3)	Operator Only No Contacts ▼
 9001SKR1B Full Guard	Black	SKR1BH13	SKR1BH5	SKR1BH6	SKR1B
	Red	SKR1RH13	SKR1RH5	SKR1RH6	SKR1R
	Green	SKR1GH13	SKR1GH5	SKR1GH6	SKR1G
	Universal ▲	SKR1UH13	SKR1UH5	SKR1UH6	SKR1U
	Other ■	SKR1■H13	SKR1■H5	SKR1■H6	SKR1■
 9001SKR3B No Guard	Black	SKR3BH13	SKR3BH5	SKR3BH6	SKR3B
	Red	SKR3RH13	SKR3RH5	SKR3RH6	SKR3R
	Green	SKR3GH13	SKR3GH5	SKR3GH6	SKR3G
	Universal ▲	SKR3UH13	SKR3UH5	SKR3UH6	SKR3U
	Other ■	SKR3■H13	SKR3■H5	SKR3■H6	SKR3■
 9001SKR2B Extended Guard	Black	SKR2BH13	SKR2BH5	SKR2BH6	SKR2B
	Red	SKR2RH13	SKR2RH5	SKR2RH6	SKR2R
	Green	SKR2GH13	SKR2GH5	SKR2GH6	SKR2G
	Universal ▲	SKR2UH13	SKR2UH5	SKR2UH6	SKR2U
	Other ■	SKR2■	SKR2■H5	SKR2■H6	SKR2■

▲ The universal push button operators include one each of the following color inserts: black, red, green, yellow, orange, blue and white.
■ See table below.

Description	Color	Operator with 1 N.O. and 1 N.C. Contact (KA1)	Operator with 1 N.O. Contact (KA2)	Operator with 1 N.C. Contact (KA3)	Operator Only No Contacts ▼
 9001SKR4B 1 3/8 Mushroom Button	**Snap-In Mushroom Button**				
	Black	SKR4BH13	SKR4BH5	SKR4BH6	SKR4B
	Red	SKR4RH13	SKR4RH5	SKR4RH6	SKR4R
	Red ♦	SKR4R05H13	SKR4R05H5	SKR4R05H6	SKR4R05
	Green	SKR4GH13	SKR4GH5	SKR4GH6	SKR4G
	Other ★	SKR4★H13	SKR4★H5	SKR4★H6	SKR4★
	Screw-On Mushroom Button with Set Screw Security				
	Black	SKR24BH13	SKR24BH5	SKR24BH6	SKR24B
	Red	SKR24RH13	SKR24RH5	SKR24RH6	SKR24R
	Green	SKR24GH13	SKR24GH5	SKR24GH6	SKR24G
	Other ★	SKR24★H13	SKR24★H5	SKR24★H6	SKR24★
 9001SKR5B 2 1/4 Mushroom Button	**Snap-In Mushroom Button**				
	Black	SKR5BH13	SKR5BH5	SKR5BH6	SKR5B
	Red	SKR5RH13	SKR5RH5	SKR5RH6	SKR5R
	Red ♦	SKR5R05H13	SKR5R05H5	SKR5R05H6	SKR5R05
	Green	SKR5GH13	SKR5GH5	SKR5GH6	SKR5G
	Other ★	SKR5★H13	SKR5★H5	SKR5★H6	SKR5★
	Screw-On Mushroom Button with Set Screw Security				
	Black	SKR25BH13	SKR25BH5	SKR25BH6	SKR25B
	Red	SKR25RH13	SKR25RH5	SKR25RH6	SKR25R
	Green	SKR25GH13	SKR25GH5	SKR25GH6	SKR25G
	Other ★	SKR25★H13	SKR25★H5	SKR25★H6	SKR25★

♦ Knob has the words "Emergency Stop" in raised letters highlighted in white for readability.
★ See table below.
▼ These operators can be ordered complete with contact blocks. For maximum block usage, see page 17-85. Add the "H" number chosen from page 17-80 to the end of the operator type number and add the cost of the "H" number to the operator cost.

Color	■ SKR1, 2, 3 Place Color Code In Type Number	★ SKR4, 5, 24, 25 Place Color Code In Type Number
Blue	L	L
Yellow	Y	Y
White	W	...
Orange	S	S
Gray	E	...

For additional information, reference Catalog #9001CT0301.

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9/8/03

Push Buttons—Class 9001 Type K, SK and KX—30 mm

Type K, SK and KX—30 mm
Class 9001

The Class 9001 Type KA contact blocks are FINGERSAFE® contact blocks (meeting VDE 0106 Part 100). They have one screw mounting and captive (backed out) plus/minus terminal screws. These contact blocks are double-break, direct-acting contacts. Because of the wiping action of these contacts, they are suitable for use with programmable controllers. All contact blocks listed below accept up to 2 #12–#24 AWG solid or stranded wires. Recommended tightening torque for screw terminals is 7 in-lbs.

Standard Contact Blocks

Description	Symbol	Type
 (Clear Cover)	Direct-Acting	KA1
 (Green Cover)		KA2
 (Red Cover)	Direct-Acting	KA3
 (Clear Cover)	N.O. Contact Early Closing	KA4
 (Red Cover)	N.C. Contact Late Opening	KA5
 (Green Cover)	N.O. Contact Early Closing	KA6

Additional Circuit Arrangements Available

Sequencing ▲ N.O. Contact of KA4 closes before N.O. Contact on KA1	KA4 KA1	Order One Type KA4 and One Type KA1
Overlapping ▲ N.O. Contact of KA4 closes before N.C. Contact of KA5 Opens	KA4 KA5	Order One Type KA4 and One Type KA5

▲ For push buttons or two-position selector switches only. For sequencing or overlapping contacts on other operators, consult your nearest Square D/Schneider Electric sales office.

Symbol	Contact Blocks with Binder Head Screws (not FINGERSAFE)		Gold Flashed Contacts with Standard Pressure Wire Terminals
	Type	Quantity ■	Type
	KA21	25–Up	KA31
	KA22	25–Up	KA32
	KA23	25–Up	KA33
N.O. Early Closing	KA24	25–Up	KA34
N.C. Contact Late Opening	KA25	25–Up	KA35

■ Minimum order quantity is 25. The price represents one individual contact block.

Contact blocks listed below are not FINGERSAFE, but provide:

- Terminals that accept ring tongue/fork tongue connectors
- Short single circuit contact blocks (0.75" deep vs. 0.97" deep on the FINGERSAFE)
- Same as old style Series G product available prior to March, 1989.
- Use form Y238 (add to catalog # as suffix—Example: 9001KRU1H13Y238)



Symbol	Type	Symbol	Type
	KA1G	N.O. Contact Early Closing	KA4G
	KA2G	N.C. Contact Late Opening	KA5G
	KA3G	N.O. Contact Early Closing	KA6G

Contact blocks listed below are not FINGERSAFE, but have Quick-Connect terminals.

Symbol	Type
	KA12
	KA13

Dimensions.....Catalog 9001CT0301

Maximum Current Ratings For Control Circuit Contacts—Types KA1–KA6, KA21–25, KA31–35, KA1G–KA6G

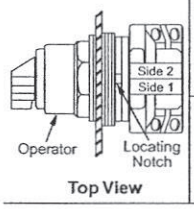
Volts	AC						Volts	DC				
	Inductive (NEMA / UL Type A600) 35% Power Factor					Resistive 75% Power Factor Make, Break and Continuous Amperes		Inductive and Resistive (NEMA Q600)				
	Make		Break		Continuous Carrying Amperes			Make and Break				Continuous Carrying Amperes
	Amperes	VA	Amperes	VA				KA1	KA2 KA3	KA4	KA5 KA6	
120	60	7200	6.0	720	10	10	125	0.55	0.55	...	...	2.5
240	30	7200	3.0	720	10	10	250	0.27	0.27	...	...	2.5
480	15	7200	1.5	720	10	10	600	0.10	0.10	...	...	2.5
600	12	7200	1.2	720	10	10						

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PUBLICATION DIVIDER

Push Buttons and Operator Interface Specifiers Guide
Class 9001, Type SK — 30 mm
Corrosion Resistant Selector Switches

Non-Illuminated 3 Position Selector Switch Operators – UL Types 4, 4X, 13/NEMA Types 4, 4X, 13
For use in hazardous locations – See page 150. Legend Plate and Contact Block Not Included Unless Noted

CONTACT BLOCK REQUIRED			1 — Contact Closed 0 — Contact Open								
Contact Block Position	Quantity and Type	Mount on Side	Center ↖↑↗ Left	Center ↖↑↗ Right	Center ↖↑↗ Left	Center ↖↑↗ Right	Center ↖↑↗ Left	Center ↖↑↗ Right	Center ↖↑↗ Left	Center ↖↑↗ Right	Center ↖↑↗ Left	Center ↖↑↗ Right	Center ↖↑↗ Left	Center ↖↑↗ Right	Center ↖↑↗ Left	Center ↖↑↗ Right
	KA1 OR KA3 / KA2	KA1 #2 OR KA3 #2	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	1	0
			KA2 #2		0	1	1	0	0	1	0	1	0	0	1	0	0	1	0	1	1	1	0	0	0	0	1
	KA1 OR KA3 / KA2	KA1 #1 OR KA3 #1	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	1	0	1	0	0	1	0	1	1
			KA2 #1		1	1	0	0	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0
CAM			B		C		D		E		F		G		J		L		M							
Non-Illuminated Operators			Type		Type		Type		Type		Type		Type		Type		Type		Type							
Manual Return	Operator Only①	Without Knob With Standard Black Knob With Other Color Knob (See Table)②	SKS42 SKS42B SKS42②		SKS43 SKS43B SKS43②		SKS44 SKS44B SKS44②		SKS45 SKS45B SKS45②		SKS46 SKS46B SKS46②		SKS47 SKS47B SKS47②		SKS49 SKS49B SKS49②		SKS401 SKS401B SKS401②		SKS402 SKS402B SKS402②							
	With Contact Block(s)	With Standard Black Knob (See Table for Other Colors, Replace B in Type No. with Color Code) With 1 KA1 on side #2 (H13) With 1 KA1 on side #1 (H1) With 1 KA1 on side #1 and 1 KA1 on side #2 (H2)	SKS42BH13 SKS42BH1 SKS42BH2		SKS43BH13 SKS43BH1 SKS43BH2		SKS44BH13 SKS44BH1 SKS44BH2		SKS45BH13 SKS45BH1 SKS45BH2		SKS46BH13 SKS46BH1 SKS46BH2		SKS47BH13 SKS47BH1 SKS47BH2		SKS49BH13 SKS49BH1 SKS49BH2		SKS401BH13 SKS401BH1 SKS401BH2		SKS402BH13 SKS402BH1 SKS402BH2							
Spring Return from Left to Center	Operator Only①	Without Knob With Standard Black Knob With Other Color Knob (See Table)②	SKS62 SKS62B SKS62②		SKS63 SKS63B SKS63②		SKS64 SKS64B SKS64②		SKS65 SKS65B SKS65②		SKS66 SKS66B SKS66②		SKS67 SKS67B SKS67②		SKS69 SKS69B SKS69②		SKS601 SKS601B SKS601②		SKS602 SKS602B SKS602②							
Spring Return From Right to Center	Operator Only①	Without Knob With Standard Black Knob With Other Color Knob (See Table)②	SKS72 SKS72B SKS72②		SKS73 SKS73B SKS73②		SKS74 SKS74B SKS74②		SKS75 SKS75B SKS75②		SKS76 SKS76B SKS76②		SKS77 SKS77B SKS77②		SKS79 SKS79B SKS79②		SKS701 SKS701B SKS701②		SKS702 SKS702B SKS702②							
Spring Return Both Sides to Center	Operator Only①	Without Knob With Standard Black Knob With Other Color Knob (See Table)②	SKS52 SKS52B SKS52②		SKS53 SKS53B SKS53②		SKS54 SKS54B SKS54②		SKS55 SKS55B SKS55②		SKS56 SKS56B SKS56②		SKS57 SKS57B SKS57②		SKS59 SKS59B SKS59②		SKS501 SKS501B SKS501②		SKS502 SKS502B SKS502②							

① These operators can be ordered complete with contact blocks, for maximum block usage – see page 155. Add the "H" number chosen from page 151 to the end of the operator type number.
EXAMPLE: SKS43FB+H13(KA1-POS 2) = SKS43FBH13.
② Add the color code as chosen from knob color table below.
EXAMPLE: SKS43② with a green gloved hand knob = SKS43FG.

Selector Switch Knobs

Color	Standard Knob		Gloved Hand Knob		Coin Operated	
	② Knob Code	Type	② Knob Code	Type	② Knob Code	Type
Black	B	B11	FB	B25	TB	B18
Red	R	R8	FR	R24	TR	R16
Green	G	G8	FG	G24	TG	G16
Yellow	Y	Y8	FY	Y24	TY	Y16
Orange	S	S11	FS	S25	–	–
Blue	L	L8	FL	L24	TL	L16
White	W	W8	FW	W24	–	–
Amber	A	A8	FA	A24	–	–
Clear	C	C8	FC	C24	TC	C16

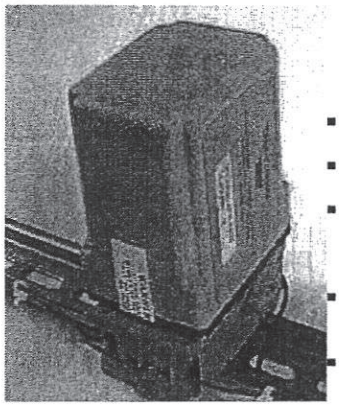
Basic Operators ..... Page 155
Boots ..... Page 154
Contact Blocks ..... Pages 149-150
"H" Numbers ..... Page 151
Legend Plates ..... Pages 152-153
Lockouts ..... Page 154
Outline Dimensions ..... Pages 159-160
Ratings ..... Pages 149-150
Replacement Parts ..... Page 158
Ring Nuts ..... Page 158
Cams ..... Page 157

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Transtronics Battery Voltage UPS™ (BVUPS™)

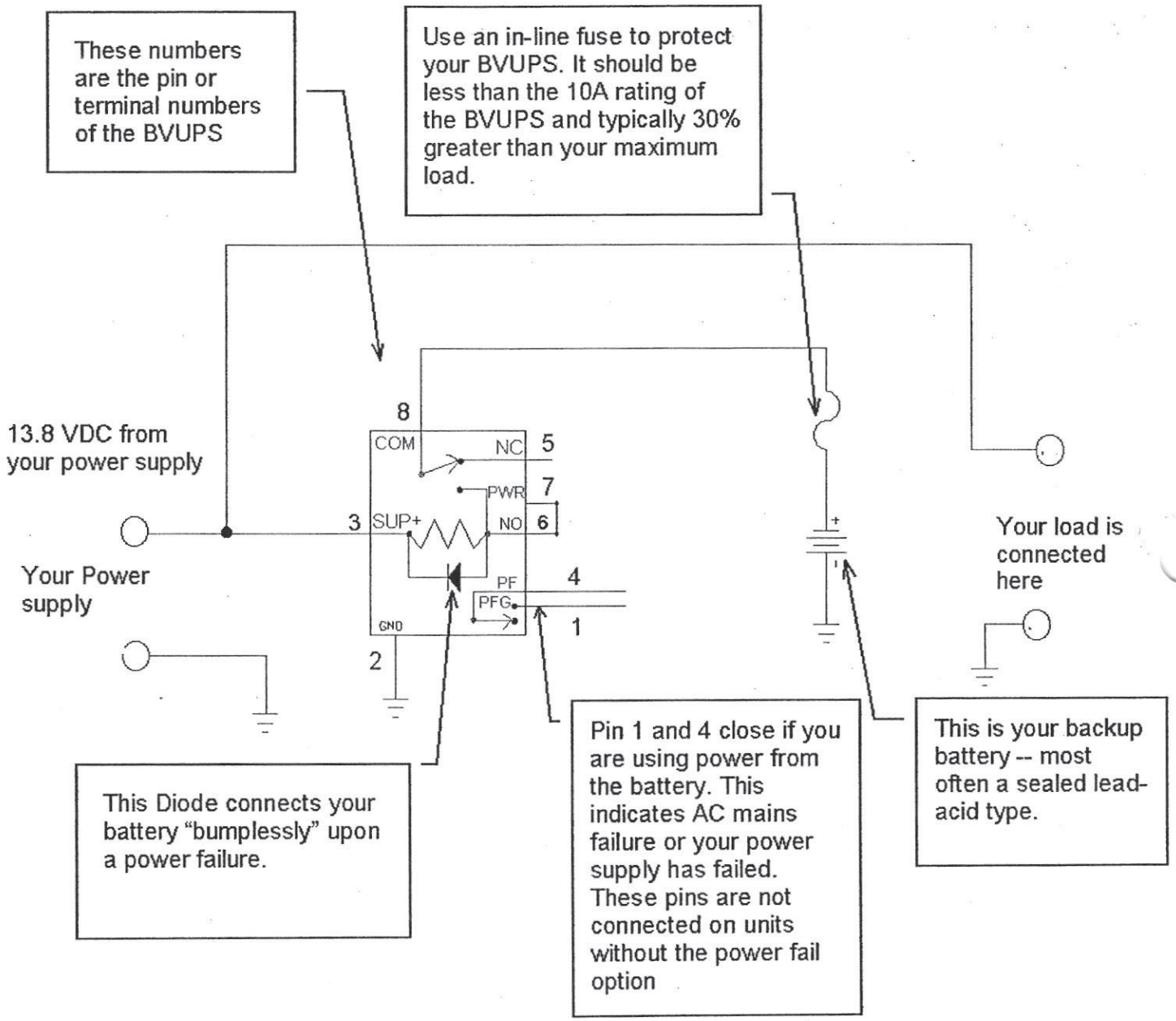
The Transtronics™ BVUPS™ protects your investment in batteries



- Are your lead-acid batteries prematurely dying a ***deep discharge death?***
- Does it seem silly to have a 12 or 24 volt battery powered UPS powering a 12 or 24 volt power supply?
- Upon loss of DC power from your power supply, the ***BVUPS™*** "bumplessly" transfers your load to battery current. If the duration of the power failure drains the battery to its ***Use End Voltage*** (**UEV**), it will disconnect the load from the battery to protect the battery from over discharge stress.
- Upon restoration of power, the ***BVUPS™*** recharges your batteries at a controlled rate with power supplied by your regulated power supply. It then maintains your batteries in a fully charged state.
- Versions of the ***BVUPS™*** with the *Power Fail* (**PF**) option can sense the use of battery current to conditionally close a set of contacts.

Specifications wiring diagram

Maximum ratings	
ıput voltage	30 Vdc
Load current	10 amperes at 28 Vdc
Contact Ratings (battery and power fail)	Conservatively rated for 10 amps resistive at 240 Vac or 28 Vdc and are UL recognized to 15 amps at 240 Vac or 28 Vdc (UL FILE 39006, guide NRNT2)
Dielectric strength	1000 Vac, 60 Hz for one second
Physical	
Ambient Operating Temperature	0 C to 60 C
Octal Case Size	2.75 X 1.75 X 2.375 inches (excluding octal pins)
Electrical	
Protection	Diode protected for reverse and over voltage conditions
Power consumption	500 milliwatts MAX 24 mA @ 13.6 Vdc 17 mA @ 10.0 Vdc
Supplied voltage	10-14 (20-28) VDC (your equipment must be able to operate in these ranges. Most 12 volt equipment is designed to work from 9 to 15 V)
Drop out threshold	10 V +/-200 mV (20V +/-500 mV)
Drop out delay	10 seconds of continuous low voltage
Initial charge rate	1.5 A (Can be programmed to higher values with external charge rate module)
Power fail minimum current	400 mA (Special 125mA versions available)


These numbers are the pin or terminal numbers of the BVUPS
Use an in-line fuse to protect your BVUPS. It should be less than the 10A rating of the BVUPS and typically 30% greater than your maximum load.
13.8 VDC from your power supply
Your Power supply
8
COM
NC
5
PWR
7
3
SUP+
NO
6
PF
4
PFG
1
GND
2
+
-
Your load is connected here
This Diode connects your battery "bumplessly" upon a power failure.
Pin 1 and 4 close if you are using power from the battery. This indicates AC mains failure or your power supply has failed. These pins are not connected on units without the power fail option
This is your backup battery -- most often a sealed lead-acid type.

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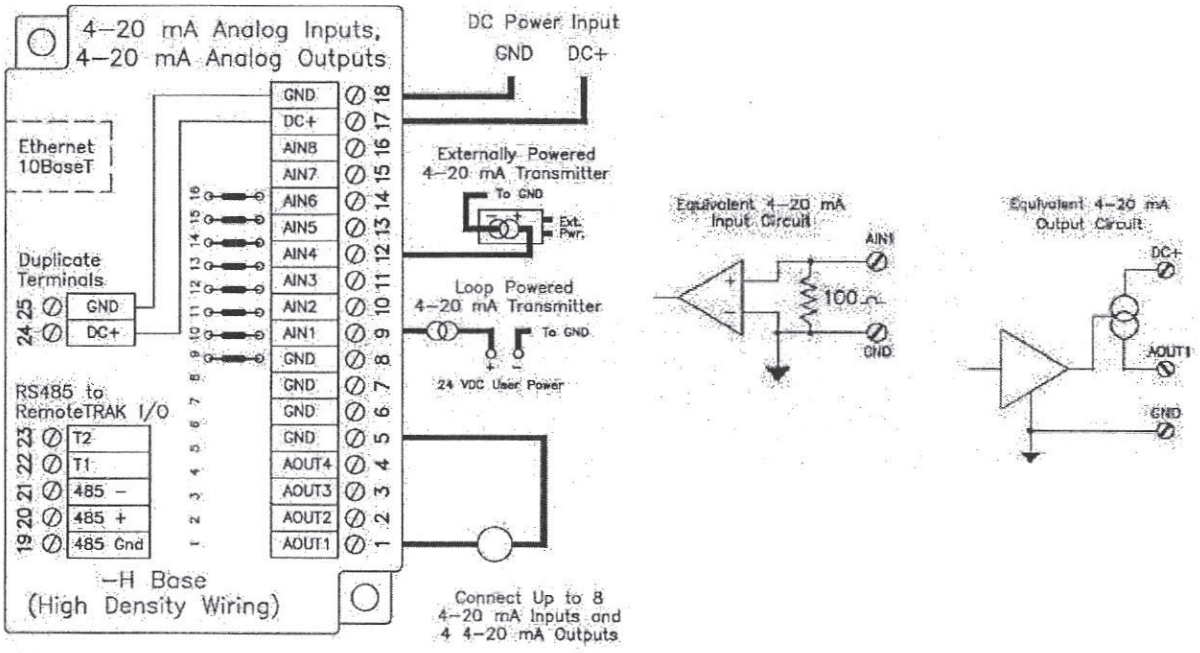
USFilter
CONTROL SYSTEMS
1239 WILLOW LAKE BOULEVARD
VADNAIS HEIGHTS, MINNESOTA 55110
651 - 766 - 2700 Fax: 651 - 766 - 2701
www.control systems.usfilter.com

Product Specification-1262

IntraLink Ethernet I/O
Analog Inputs and Outputs

- When you need a mix of 4-20 mA analog inputs and outputs at the same location
- Single compact solution for small stations
- Lowest cost for small analog applications
- Input/output combination is ideal for control
- May be expanded with Remote RS485 I/O

Part Number	Description	Application
ILK-AI8AO4-BE	Analog Inputs and Outputs	IntraLink Ethernet I/O



Electrical Specifications

Number of analog inputs	8
Analog input range	4-20 mA
Analog input resolution	14 bits (0.01%)
Analog input characteristics	Same as ILK-AI-16-BE
Number of analog outputs	4
Output range	4-20 mA
D/A resolution	16 bits (less than 1μA)
Full scale accuracy (@20°C)	+/- 0.02%
Span and offset temp. coefficient	+/- 50 ppm per °C typical
Max. output settling time (to 0.05%)	5 mS
Required user supplied voltage	10-30 VDC
Load resistance range (@ +24 VDC supply)	0-750 Ohms
Short circuit protection	Current limiting
Fastest scan rate (all channels)	5 mS
Required supply voltage	10-30 VDC (0.75 watt typical)

Number of Ethernet I/O nodes	16,000
Ethernet port on each module	10BaseT at 10 Mbps
Protocols supported	TCP/IP and UDP/IP with Modbus or USFilter Open
Number of I/O per node	512 with RS485 expansion

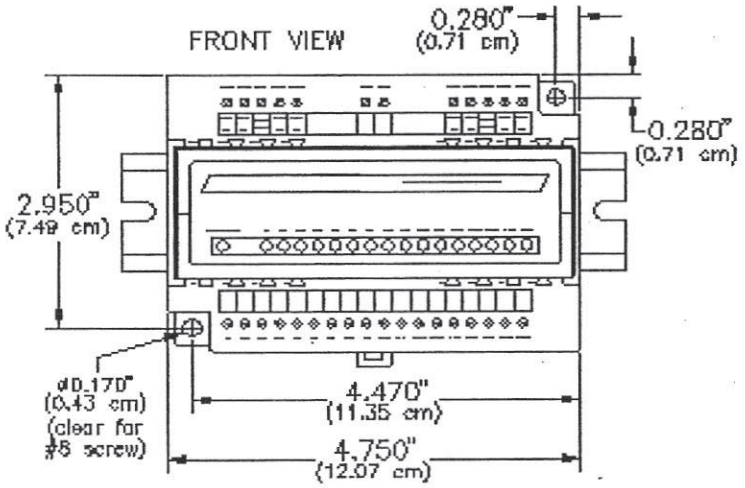
USFilter

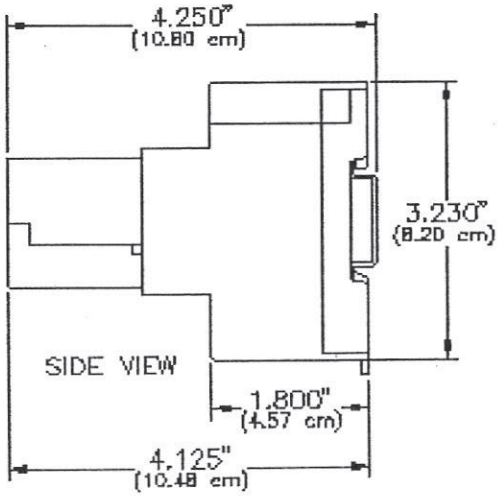
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ILKAI8AO8BE.qxd

Environmental Specifications

Operating temperature range	-30 to 70°C
Storage temperature range	-40 to 85°C
Humidity (non-condensing)	5 to 95%
Flammability (module plastic)	UL 94V-0 materials
Electrical safety	UL 508, CSA C22.2/14; EN61010-1 (IEC1010)
EMI emissions	FCC part 15, ICES-003, Class A; EN55022
EMC immunity	EN50082-1 (IEC801-2, 3, 4)
Surge withstand	IEEE-472 (ANSI C37.90)
Vibration	IEC68-2-6
Hazardous Locations	UL 1604, CSA C22.2/213-M1987 (Class I, Div. 2, Groups A, B, C, D)

Physical Specifications





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USFilter

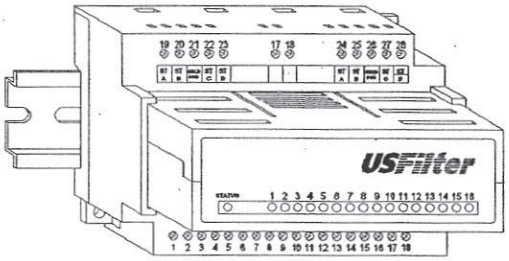
PUBLICATION DIVIDER

USFilter

Ethernet & RTU I/O

Distributed I/O

Installation and Maintenance



Contents at a Glance:

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c UL us
LISTED
Class I, Division 2,
Groups A, B, C, and D
Hazardous Locations

CE

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+1 (651) 766-2700 • FAX +1 (651) 766 2701

USFCS PDF No. 2343 Rev.: ver2

STATEMENT OF LIMITED WARRANTY

The limited warranty applicable to the Ethernet I/O products is set forth in USFilter Control Systems standard terms of sale, that are made applicable to the purchase of these products.

INSTALLATION AND HAZARDOUS AREA WARNINGS

These products should not be used to replace proper safety interlocking. No software-based device (or any other solid-state device) should ever be designed to be responsible for the maintenance of consequential equipment or personnel safety. In particular, USFilter disclaims any responsibility for damages, either direct or consequential, that result from the use of this equipment in any application.

All power, input and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

WARNING – EXPLOSION HAZARD – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIVISION 2.

WARNING – EXPLOSION HAZARD – WHEN IN HAZARDOUS LOCATIONS, DISCONNECT POWER BEFORE REPLACING OR WIRING MODULES.

WARNING – EXPLOSION HAZARD – DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NONHAZARDOUS.

Note: All information in this document applies to Ethernet I/O modules, except where otherwise noted. Refer to the USFilter Toolbox software online help systems for detailed product specifications and configuration settings.

Section 1 General Information

Overview

This manual will help you install and maintain Ethernet I/O and RTU I/O modules. In summary, wiring for power, communications and I/O is connected to each module's base. Then, setup choices are entered using the USFilter Toolbox software and the system will be ready to run.

General Specifications

These general specifications apply to all Ethernet I/O modules. More detailed product specifications may be found in the online help system of the USFilter Toolbox configuration utility.

Supply Voltage	10 - 30 VDC, 1.2 Watt typical per module (48 mA @ 24 VDC – varies by module and load).
RS485 Expansion	Connect up to 32 RTU I/O modules, Ethernet I/O modules or Modbus devices using RS485
Ethernet Isolation	1200 Volts RMS (for 1 minute)
Operating Temperature	-30 to 70 °C
Storage Temperature	-40 to 85 °C
Humidity	5 to 95% (non-condensing)
Protocols Supported	Modbus /TCP, USFilter Open

DC Power Overview

Ethernet modules can be powered from the same DC source that is used to power your I/O devices. No separate power supply is required. Typically, 10 to 30 VDC power is applied to terminals 24 and 25 on the base of each module.

Section 2 Configuring Ethernet I/O

Overview

Ethernet I/O modules must be properly configured. The modules are configured with USFilter Toolbox and then downloaded. The configuration information is stored in non-volatile memory in the module's base. There are two ways to download the configuration information; directly via Ethernet or via an Ethernet I/O Setup module.

Ethernet Download

An Ethernet I/O module can be downloaded by directly connecting the Ethernet I/O module to the Ethernet port on your PC. You must use a crossover cable when direct connecting. The module is configured via USFilter Toolbox and then downloaded using Toolbox. See USFilter Toolbox on-line Help for more details. Note that you may encounter difficulties when using the Ethernet download method to initially configure a module. If you cannot download the module using this method, use the RS232 Setup Module.

RS232 Setup Module Download

The RS232 Setup Module (ILK-232-SETUP-R) is recommended to initially configure each Ethernet I/O module. To use the setup module, simply unplug the Ethernet module from its base and insert the setup module into the base.

Note: Ethernet and Remote I/O "smart bases" allow hot swap of live modules -- an exclusive feature that makes it permissible to configure Ethernet and Remote I/O modules in live systems.

The Ethernet I/O module configuration you created using the USFilter Toolobox program will be written into permanent memory in the module's base. When the Ethernet module is reinserted into its base, the module will find and upload the configuration information, instantly configure itself and begin scanning I/O.

Once an Ethernet I/O module has been configured with an appropriate station address and IP address (Ethernet only), modified configuration data can be downloaded through the Ethernet port or RS485 port into the module base.
More information on the Remote I/O Setup Module can be found in the online help system of the USFilter Toolbox.

RS232 Wiring

Connect the setup module to your Windows PC using a standard null modem cable. Only the transmit (TD), receive (RD) and common return (GND) signals are actively used. The RS232 port on this configuration tool is electrically isolated to protect your computer in the event of field wiring errors. The setup module runs on the DC power connected to terminals 17 and 18 of the module base it is plugged into. No other connections are required. (I/O wiring can be left undisturbed.)

RS232 Mode Selection

This module always communicates to the host PC at 9600 baud, with no parity and eight data bits. Be sure to select "Use Setup Module's Settings" as the communication device selection in the USFilter Toolbox program.

Ethernet LEDs

Every Ethernet I/O module has a number of LEDs. These LEDs can be useful for system diagnostics. These LEDs can be observed in the following states:

I/O Module Status LED

On, with a quick "OFF" BLINK (1.9 seconds ON, .1 seconds OFF) - The module is configured and fully operational, but has not received a valid request from the host for a time longer than the specified time out period. A communication time out has occurred.

Full ON - The module is configured, fully operational, and has received communication from the host device before the timeout period expired. **This is the desired LED indication during system operation.**

HALF BLINK (1 second ON, 1 second OFF) - The module is not adequately configured and requires a download from the USFilter Toolbox program.

Full OFF - There is no power to the module, or the status LED is being turned off intentionally by the USFilter Toolbox program during the module loading operation.

Off, with a quick "ON" BLINK (1.9 seconds OFF, .1 seconds ON) - The module failed self-test at initialization. It will not attempt communication and should be replaced.

Status LED Wink Feature

The "Status" LED of an I/O module can be intentionally winked (10 blinks/ second) by the USFilter Toolbox program to visually identify the module when other modules are present.

ACT / LNK LEDs

The activity (ACT) LED on an Ethernet I/O module will flicker anytime there is traffic on the Ethernet network, regardless of whom the network messages are intended for. The link (LNK) LED will be ON whenever a valid link to another Ethernet device is detected.
The best troubleshooting tools for Ethernet I/O modules are the Status, ACT, and LNK LEDs on each module. Each Ethernet Status LED indicates the health of the module and also the status of communication from the host device. Note that an Ethernet I/O module does not send a reply in response to a Wink command.

Section 3 Discrete I/O Modules

ILK-DI8DO8-BE **8 Discrete Inputs and 8 Discrete Outputs**
ILK-DI-16-BE **16 Discrete Inputs**

ILK-DI8DO8 Overview

This module provides one terminal for each input or output channel. All inputs may be wired as sourcing or sinking. Outputs are wired in a sourcing (power switching) configuration only. An input count feature uses analog input registers to accumulate the positive transitions of each input. More information can be found in the on-line help in the USFilter Toolbox program.

Number of Channels	**8 discrete inputs, 8 discrete outputs (ILK-DI8DO8 only)**
Input Voltage Range	**12/24 VDC/VAC**
Input Current @ 24 VDC	**6.7 mA**
Output Voltage Range	**10 – 30 VDC**
Maximum Count Rate	**100 Hz (6000 / minute) each input, plus selectable 2KHz (120,000 / minute) mode for input 1 only**

Wiring and Jumpers

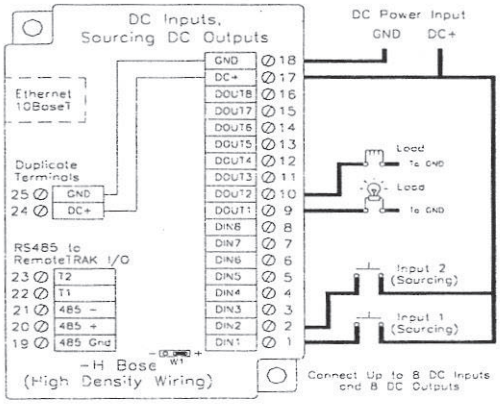
One wire from each sourcing field input should be bussed together and connected to terminal 17 (DC +). One wire from each sourcing field output and/or or sinking field input should be bussed together and connected to terminal 18 (DC GND). Refer to the wiring diagram below. Set jumper W1 to match the wiring configuration of the inputs.

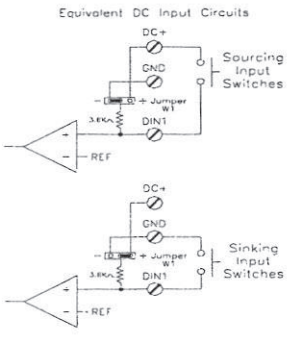
TPO Feature

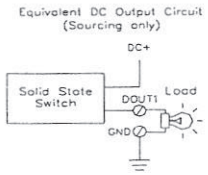
Time proportioned outputs pulse ON and OFF with a duty cycle proportional to an analog value stored in an analog output register. TPO outputs are a low cost way to get smooth proportional control of heaters and other process variables. Typically, TPO analog output registers are assigned to the output of PID or other control logic in an ISaGRAF or other program. Use the USFilter Toolbox software to set pulse cycling as fast as 10 mS or as slow (many minutes) as your system dynamics require. Each output may be configured as a TPO or ordinary discrete output.

I/O Registers

Function	USFilter Open Registers	Modbus Registers
Discrete Inputs	X0 – X7	10001 – 10008
Discrete Outputs	Y0 – Y7	00001 – 00008
TPO Values	AY0 – AY7	40001 – 40008
Counter Inputs	AX0 – AX7	30001 – 30008







ILK-DI-16-BE High Density Discrete Input Module

ILK-DI-16 Overview

This module provides sixteen input channels. Inputs may be wired as all sourcing or sinking. An input count feature uses analog input registers to accumulate the positive transitions of each input. More information on this and other features can be found in the on-line help supplied with the USFilter Toolbox program.

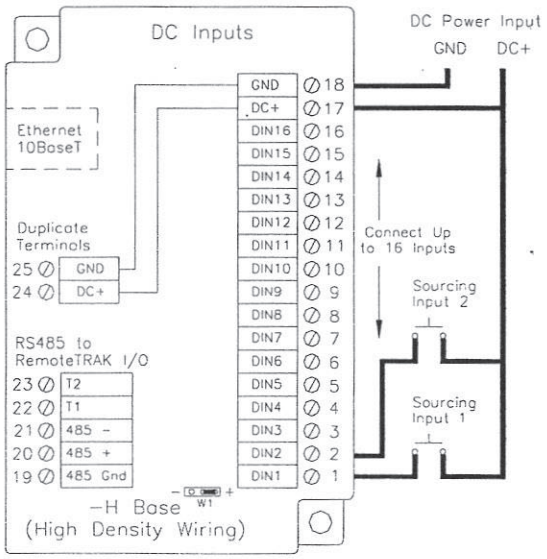
Number of Channels	**16 discrete inputs (connected to a common source)**
Input Voltage Range	**12/24 VDC/VAC**
Input Current @ 24 VDC	**6.7 mA**

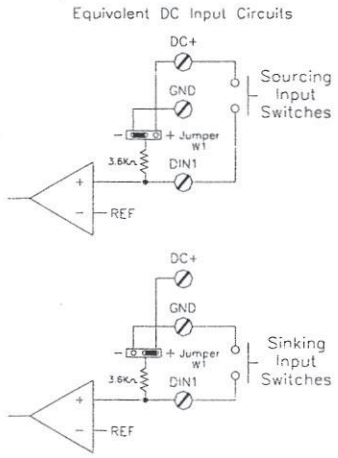
Wiring and Jumpers

Positive DC or AC voltage must be applied to an input to indicate an ON condition. All channels are referenced to a common return or supply, which is connected to the negative side (ground) or positive side (DC+) of the DC power source. One wire from each sourcing field input should be bussed together and connected to terminal 17 (DC +). One wire from each sinking field input should be bussed together and connected to terminal 18 (DC GND). Refer to the wiring diagram below. Set jumper W1 to match the wiring configuration of the inputs.

I/O Registers

Function	USFilter Open Registers	Modbus Registers
Discrete Inputs	X0 – X15	10001 – 10016
Counter Inputs	AX0 – AX15	30001 – 30016





Section 4 Discrete Output Modules

ILK-DO-16-BE High Density Discrete Output Module

ILK-DO-16 Overview

Sixteen discrete output channels each provide up to 1 Amp DC to motor contactors, valves, and other loads. Inductive surge protection is provided. Each of the sixteen outputs may optionally be configured as Time Proportioned Outputs that pulse ON at a duty cycle proportional to an analog output register value. Typically these TPO outputs are controlled by a PID loop or other process algorithm in a control program. More information can be found in the on-line help supplied with the USFilter Toolbox program.

Number of Channels	**16 discrete outputs connected to a common DC source**
Output Voltage Range	**10 - 30 VDC**
Max. Load per Output	**1 Amp**
Max. Load per Module	**8 Amps**
Max. Inrush Current	**5 Amps (for 100 mS)**

Wiring

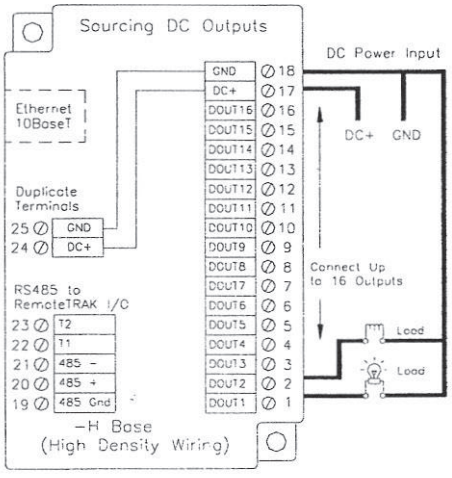
A single terminal is provided for each output channel. All outputs are powered from the DC power terminal. All channels are referenced to a common return, which is connected to the negative side (ground) of the DC power source.

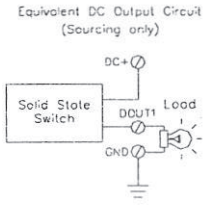
TPO Feature

Time proportioned outputs pulse ON and OFF with a duty cycle proportional to an analog value stored in an analog output register. TPO outputs are a low cost way to get smooth proportional control of heaters and other process variables. Typically, TPO analog output registers are assigned to the output of PID or other control logic in an ISaGRAF or other program. Use the USFilter Toolbox software to set pulse cycling as fast as 10 mS or as slow (many minutes) as your system dynamics require. Each output may be configured as a TPO or ordinary discrete output.

I/O Registers

Function	USFilter Open Registers	Modbus Registers
Discrete Outputs	Y0 – Y15	00001 – 00016
TPO Values	AY0 – AY15	40001 – 40016





Section 5 Discrete / Analog Modules

ILK-A18DI8 Overview

ILK-A18D18-BE 8 Discrete Inputs and 8 4-20 mA Inputs

Eight 4-20 mA inputs provide 14 bit analog measurements. Discrete inputs may be wired as all sourcing or sinking. An input count feature uses analog input registers to accumulate the positive transitions of each input. More information on this and other features can be found in the on-line help supplied with the USFilter Toolbox program.

Number of Channels	**8 analog inputs (14 bit resolution), 8 discrete inputs**
Input Range	**4 - 20 mA (analog), 12/24 VDC/VAC (discrete)**
Analog Input Impedance	**100 ohms Note:** input voltage drop = 2 volts at 20 mA
Discrete Input Voltage Range	**12/24 VDC/VAC**
Input Current @ 24 VDC	**6.7 mA**

Wiring and Jumpers

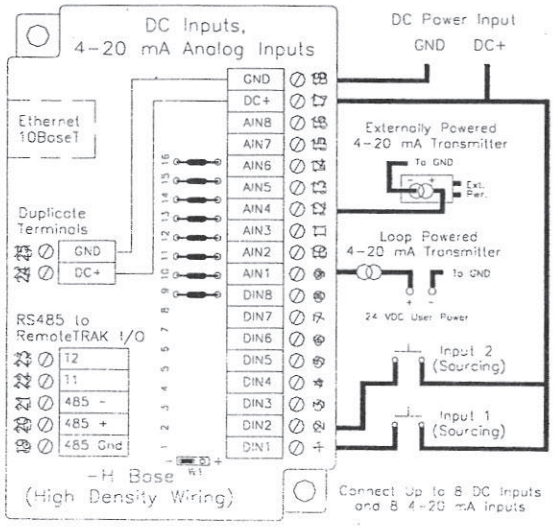
Positive DC or AC voltage must be applied to an input to indicate an ON condition. All channels are referenced to a common return or supply, which is connected to the negative side (ground) or positive side (DC+) of the DC power source. One wire from each sourcing field input should be bussed together and connected to terminal 17 (DC +). One wire from each sinking field input should be bussed together and connected to terminal 18 (DC GND). Refer to the wiring diagram below. Set jumper W1 to match the wiring configuration of the discrete inputs. A single input terminal is provided for each analog input channel. Care must be taken to externally provide a suitable instrumentation ground for these single ended input circuits.

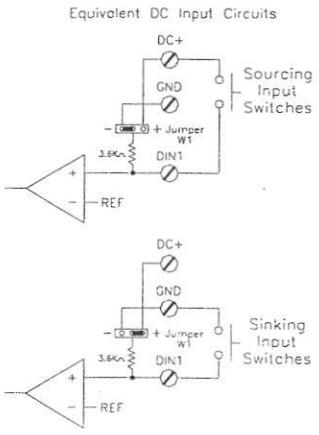
Current Shunts

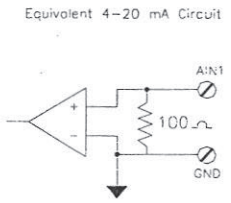
Precision 100 ohm current shunts, beneath the hinged access door in the wiring base, pass current and maintain loop integrity even if the module is unplugged. A spare shunt is provided and may be simply inserted in place of any shunt that open circuits as a result of a current overload.

I/O Registers

Function	USFilter Open Registers	Modbus Registers
Analog Inputs	AX0 – AX7	30001 – 30008
Discrete Inputs	X0 – X7	10001 – 10008
Counter Inputs	AX8 – AX15	30009 – 30016







Section 6 Analog Input Modules

ILK-AI-16-BE High Density 4-20 mA Analog Input Module

ILK-AI-16 Overview

Sixteen 4-20 mA inputs provide 14 bit high resolution analog measurements. More information can be found in the on-line help supplied with the USFilter Toolbox program.

Number of Channels	**16 (14 bit resolution)**
Input Range	**4 - 20 mA**
Input Impedance	**100 ohms** **Note:** input voltage drop = 2 volts at 20 mA

Wiring

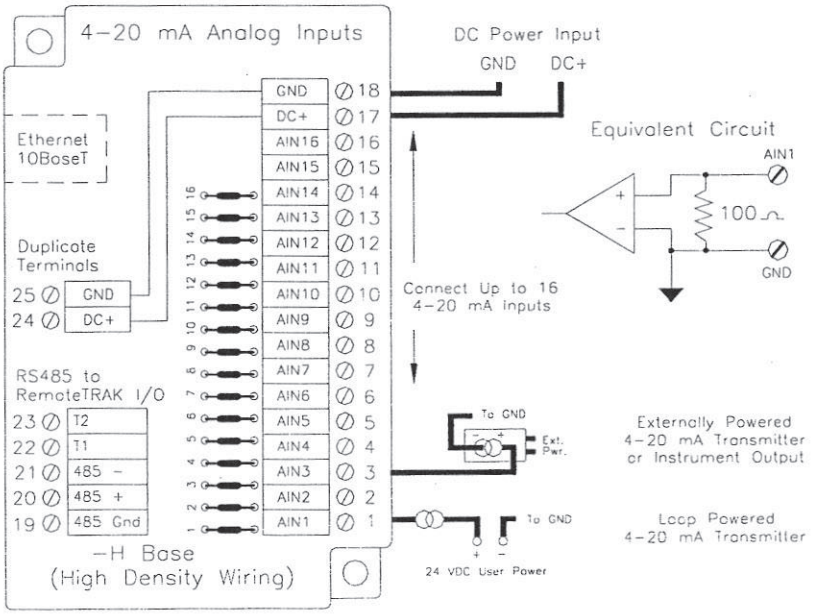
A single input terminal is provided for each measurement channel. Care must be taken to externally provide a suitable instrumentation ground for these single ended input circuits.

Current Shunts

Precision 100 ohm current shunts, beneath the hinged access door in the wiring base, pass current and maintain loop integrity even if the module is unplugged. A spare shunt is provided and may be simply inserted in place of any shunt that open-circuits as a result of a current overload.

I/O Registers

Function	USFilter Open Registers	Modbus Registers
Analog Inputs	AX0 – AX15	30001 – 30016



ILK-INS-08-BE Instrumentation Analog Input Module

ILK-INS-08 Overview

Eight configurable inputs provide 16 bit high resolution analog measurements. More information can be found in the on-line help supplied with the USFilter Toolbox program.

Number of Channels	**8 (16 bit resolution)**
Input Range	**0/4 - 20 mA, 62 mV to 10V, JKERTBCNS thermocouples**
Input Impedance (current)	**100 ohms** **Note:** input voltage drop = 2 volts at 20 mA
Input Impedance (other ranges)	**200K Ohms**

ILK-INS-08 Wiring

Two input terminals are provided for each measurement channel. Channel to channel isolation is provided.

4-20 mA Input Jumpers

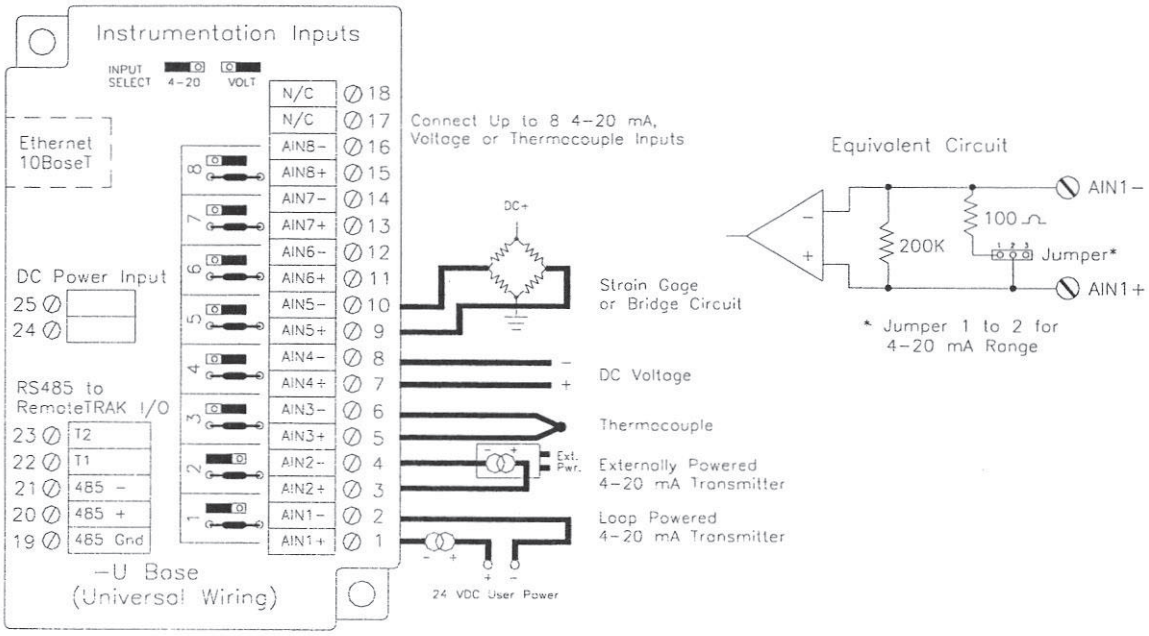
This module has a 4-20 mA input enable jumper for each channel. Set each jumper to match the desired input as shown in the diagram below. The jumper setting must match the range selection in the USFilter Toolbox software.

Current Shunts

Precision 100 ohm current shunts, beneath the hinged access door in the wiring base, pass current and maintain loop integrity even if the module is unplugged. A spare shunt is provided and may be simply inserted in place of any shunt that open-circuits as a result of a current overload.

I/O Registers

Function	USFilter Open Registers	Modbus Registers
Analog Inputs	AX0 – AX7	30001 – 30008



Section 7 Analog I/O Module

ILK-AI8AO4-BE Combined Analog Input and Output Module

ILK-AI8AO4 Overview

This module combines eight 4-20 mA analog inputs and four 4-20 mA outputs. More information can be found in the on-line help supplied with the USFilter Toolbox program.

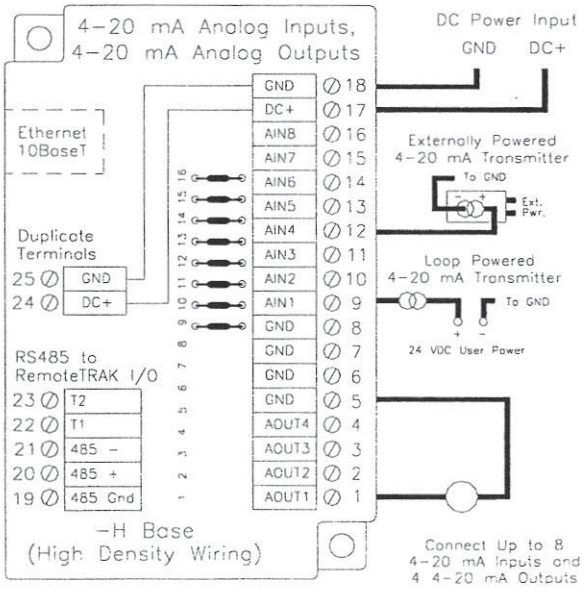
Number of Analog Inputs	**8 (14 bit resolution)**
Input Range	**4 - 20 mA**
Input Impedance	**100 ohms** **Note:** input voltage drop = 2 volts at 20 mA
Number of Analog Outputs	**4 (16 bit resolution)**
Output Range	**4 - 20 mA**

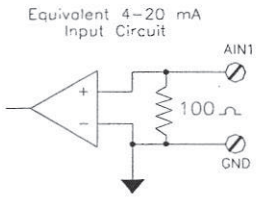
Wiring

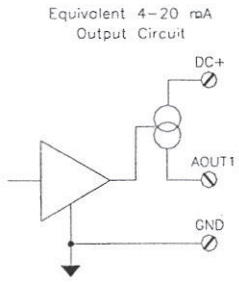
A single input terminal is provided for each input and output channel. Care must be taken to externally provide a suitable instrumentation ground for these input and output circuits.

I/O Registers

Function	USFilter Open Registers	Modbus Registers
Analog Inputs	AX0 – AX7	30001 – 30008
Analog Outputs	AY0 – AY3	40001 – 40004







Section 8 RTU I/O Module

ILK-8440-BR RTU & Combination I/O Module

Overview

This I/O module / RTU combines eight discrete inputs, four discrete outputs and 4 analog inputs. This module is different from the Ethernet I/O modules (xxx-BE part numbers) described in this manual because it features an RS232 port instead of an Ethernet port. The RS232 port is configured as a half-duplex modem port with an RTS line making it suitable for use with leased line modems (like the CMM202) as well as radios.

Number of Discrete Inputs	**8**
Input Voltage Range	**10- 30 Vdc**
Number of Discrete Outputs	**4**
Max Load per Output	**1 A**
Max Inrush Current of Outputs	**5 A (for 100 ms)**
Number of Analog Inputs	**4 (16 bit resolution)**
Input Range	**4 - 20 mA (Inputs 1-3)**
	0 – 5 Vdc (Input 4)
	Inputs have an internal, self resetting fuse protection

Discrete Inputs

The eight discrete inputs of this module are jumper selectable to be sourcing (ON when positive voltage is applied) or sinking (ON when contact closes to ground). The selection jumper is located in the modules base and is easily accessible by unplugging the logic module and opening the hinged door. You must set this jumper to match the way the inputs are wired.

Discrete Input Counter Features

The eight discrete inputs can be configured as counters with a flexible choice of modes. The counters report their values in corresponding 16 bit analog input registers. The first two inputs may be configured as high speed (10 Khz) counters. All of the discrete inputs may be configured as count-up, run-time (time the input is true) in seconds, run-time in minutes and other pulse accumulation modes. See USFilter Toolbox help for more details on these modes. These counters initialize to zero each time power is cycled and they cannot be reset under software control.

Discrete Outputs

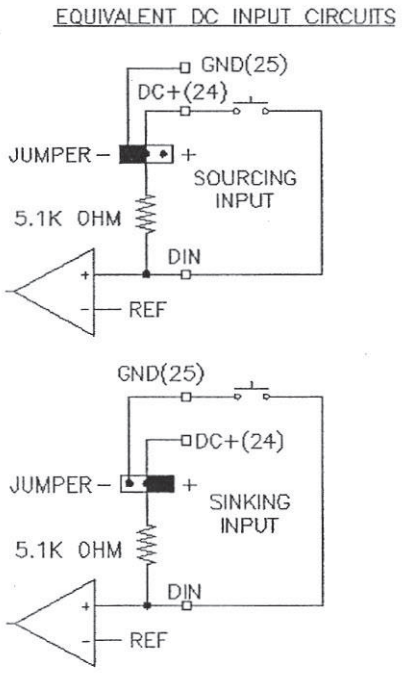
The four discrete outputs can source 10-30 Vdc to each load. All of the outputs return to a common ground.

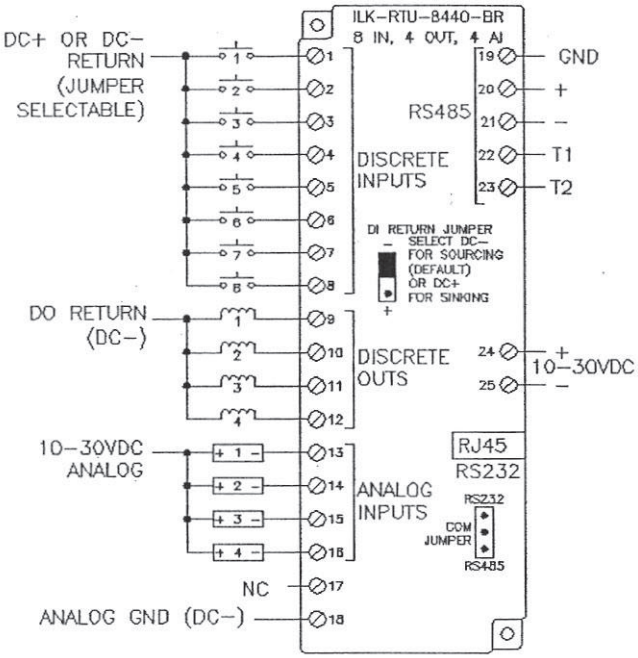
Analog Inputs

Analog inputs 1-3 accept a 4-20 mA signal from field devices. Analog input 4 was designed to read a 0-5 volt signal, in order to directly read A1000 submersible level sensor signals. All inputs are signal ended, returning to a common ground (terminal 18). An appropriate excitation voltage must be provided for the analog inputs. Inputs 1-3 have a 100 ohm precision shunt across the input. Input 4 has a 100k ohm shunt. All inputs are protected from excessive voltage by a self-resetting fuse. Inputs are reported as an un-scaled value from 0 – 32767. Refer to USFilter Toolbox help for more information on calibrating and scaling analog inputs.

I/O Registers

Function	USFilter Open Registers	Modbus Registers
Discrete Inputs	X0 – X7	10001 – 10008
Discrete Outputs	Y0 – Y3	00001 – 00004
Counter Inputs	AX0 – AX7	30001 – 30008 (Unsigned values 0 –65,535)
Analog Inputs	AX8 – AX11	30009 – 30012





Serial Port Connections

The RTU I/O Module has one communication port that is jumper selectable between and RS232 interface and an RS485 interface. The RS232/RS485 jumper is located behind the access door in the module base. The door is accessed by unplugging the logic module from the base. The RS232 interface is made through the RJ45 connector on the topside of the base. Signals supported include RX, TX, RTS and GND. Communication is half-duplex. The RS485 connections are made on terminals 19 through 23 on the base. The default baud rate for the serial port is 9600 baud, 8 data bits, 1 stop bit, and no parity. The serial port is used to download the setup parameters to the module. See USFilter Toolbox help for more information.

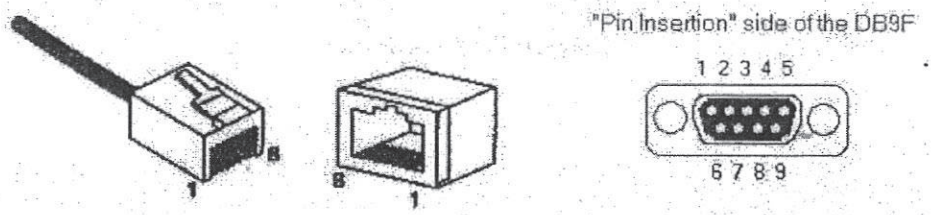
RS232 Port Interface

A female RJ45 connector on the base of the module provides the RS232 interface. The pin-outs follow the EIA/TIA-561 standard. See figure below. Use DB9 adaptor and a Ethernet straight thru patch cable to connect the RTU I/O module to your PC or other communications equipement.

RJ45 to DB9F Adapter pinout (Typical PC Adapter)

LC3000 RJ45F	ADAPTER WIRE COLOR	DB9F
Pin1: NA	Blue	Pin 4: DTR (out)
Pin 2: NA	Orange	N/C
Pin 3: NA	Black	Pin 6: DSR (in)
Pin 4: GND	Red	Pin 5: GND
Pin 5: RXD (in)	Green	Pin 3: TXD (out)
Pin 6: TXD (out)	Yellow	Pin 2: RXD (in)
Pin 7: NA	Brown	Pin 7: RTS (out)
Pin 8: RTS (out)	White	Pin 8: CTS (in)

RJ45 & DB9 connector pinouts



RS485 Port Interface

RS485 connections are made to screw terminals on the base assembly. These terminations provide a RS485 (2-wire, half duplex only) connection to an LC2000/3000 controller, other Ethernet I/O modules, or other equipment. Four terminals (signal ground, RS485+, RS485-, termination) are provided. Generally you connect + to + and – to – . Since there is no standard designation for RS485 terminals, this may vary when connecting to other manufacturers equipment. It is highly recommended that the signal ground be tied to an appropriate ground between all RS485 units. Use good quality cable with three conductors (twisted) plus a shield. Connect the shield to chassis ground on only one end of any cable run.

RS485 Termination: The RTU I/O module has termination components (150 ohm resistor, 0.1 µF capacitor connected in series) already inside. To terminate an RS485 network connect the T terminal to the RS485 – terminal using the same type and size of wire already being used for the – connection. It is recommended that only two stations (one at the beginning of the network and one at the end of the network) be terminated.

Section 9 Product Support

Product Support

To obtain technical support or service for **USFilter Control System** products, contact your local representative. For factory support call **USFCS** and ask for Technical Support. Our phone numbers are:

+1 800-224-9474
+1 (651)-766-2700 (local)
+1 (651)-766-2754 (Fax)

E-mail: cs.technical.support@usfilter.com

Our mailing address:

USFilter Control Systems
1239 Willow Lake Blvd
Vadnais Heights, MN 55110

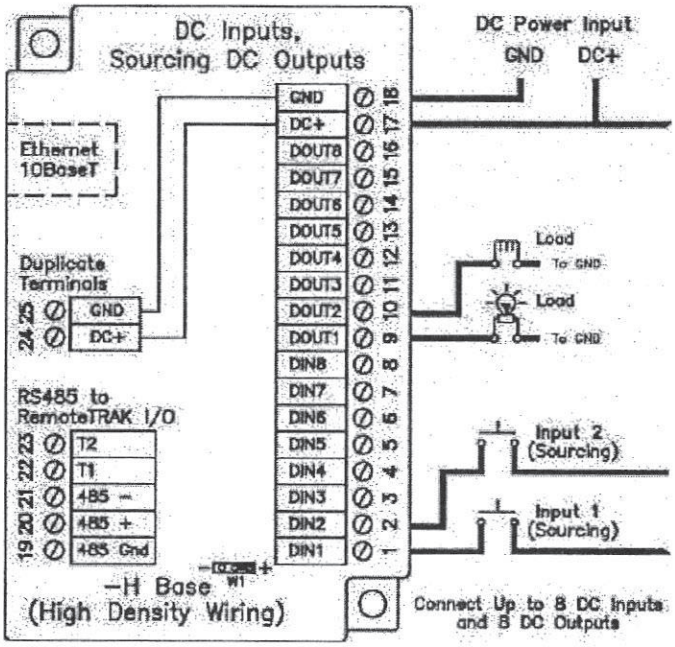
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CONTROL SYSTEMS
1239 WILLOW LAKE BOULEVARD
VADNAIS HEIGHTS, MINNESOTA 55110
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www.control systems.usfilter.com

Product Specification-2237
IntraLink Ethernet I/O
Combination I/O Module

- When you need a mix of discrete inputs and outputs for control at a remote location
- Single module compact solutions for small stations
- Lowest cost solution when mixed I/O is needed
- Can be expanded with Remote RS485 I/O

Part Number	Description	Application
ILK-DI8DO8-BE	Combination I/O Module	IntraLink Ethernet I/O



Electrical Specifications

Number of discrete inputs	8
Nominal discrete input range	12/24 VDC/VAC
Discrete input characteristics	Same as ILK-DI-16-BE
Number of discrete outputs	8
Max. output current per channel	1 Amp
Discrete output characteristics	Same as ILK-DO-16-BE
Required supply voltage	10-30 VDC (0.75 watt typical)

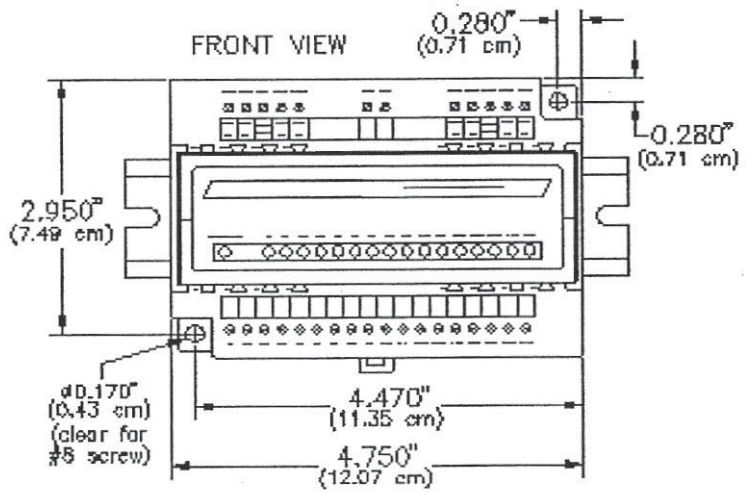
Number of Ethernet I/O nodes	16,000
Ethernet port on each module	10BaseT at 10 Mbps
Protocols supported	TCP/IP and UDP/IP with Modbus or USFilter Open
Number of I/O per node	512 with RS485 expansion

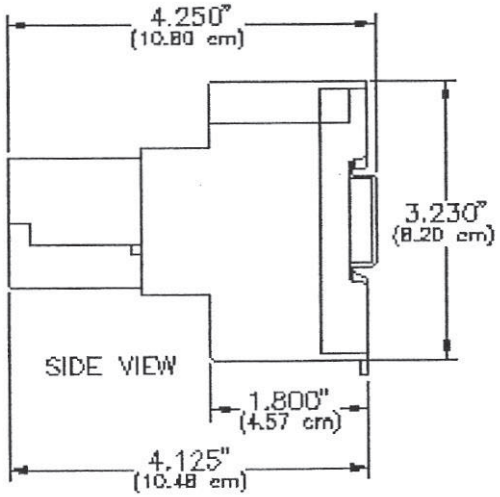
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ILKDI8DO8BE.qxd

Environmental Specifications

Operating temperature range	-30 to 70°C
Storage temperature range	-40 to 85°C
Humidity (non-condensing)	5 to 95%
Flammability (module plastic)	UL 94V-0 materials
Electrical safety	UL 508, CSA C22.2/14; EN61010-1 (IEC1010)
EMI emissions	FCC part 15, ICES-003, Class A; EN55022
EMC immunity	EN50082-1 (IEC801-2, 3, 4)
Surge withstand	IEEE-472 (ANSI C37.90)
Vibration	IEC68-2-6
Hazardous Locations	UL 1604, CSA C22.2/213-M1987 (Class I, Div. 2, Groups A, B, C, D)

Physical Specifications





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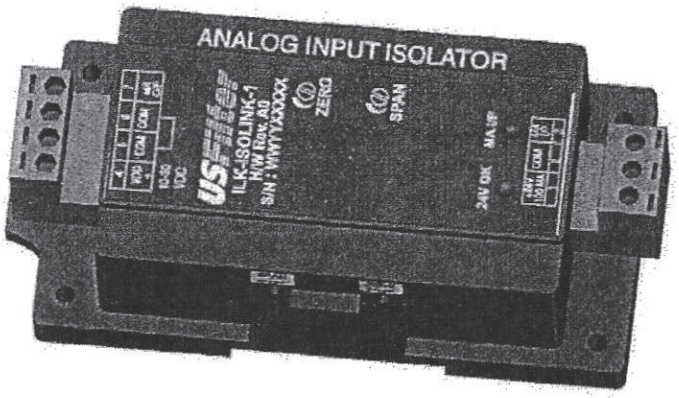
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Product Specification
IsoLink – Analog Loop Power Supply And Isolator

The IsoLink analog loop power supply/isolator is a DIN rail mounted device, which accepts a 4-20 ma input and provides an isolated 4-20 ma output. The unit provides a regulated 24 VDC loop power supply and 1500 volts of isolation between the input and output. The unit can be powered from an input supply of 10-30 VDC making it ideal for use in battery backed, 12 VDC systems. The device can be applied one per loop to provide loop-loop isolation or it can power up to 4 analog loops (no isolation) on a common power supply.



Part Number	Description
ILK-ISOLINK-1	Analog Loop Power Supply/Isolator

Specifications

Input Power	10 – 30 VDC
Loop current supply	24 VDC @ 100 ma
Input to Output isolation	1500 VDC
Fusing	Automatically resetting fuse
Output load – maximum	400 Ohms
Accuracy	¼% of full scale
Linearity	0.04 %
Mounting configuration	DIN rail or panel mount
Terminal blocks	De-pluggable terminal blocks, accepts two 16 gauge wires

Terminal Description

Input Side

Terminal 1	24 VDC loop excitation voltage
Terminal 2	Analog Loop common
Terminal 3	Analog loop signal input (from field device)

Output Side

Terminal 4	Input power supply, 10-30 VDC
Terminal 5	Common
Terminal 6	Common
Terminal 7	Isolated 4-20 ma output signal (to PLC)

Adjustments

Span	5% range, clockwise increases output
Offset	5% range, clockwise increases output

LED Indicators

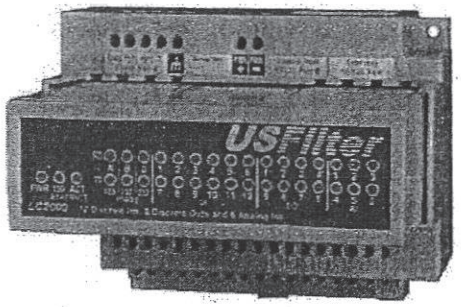
24V OK	LED "ON" indicates proper operation of the power supply
MA I/P	LED "ON" indicates analog loop signal between 4 and 20 ma

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USFilter

Contents at a Glance:



LC2000
Controller/RTU Installation and Maintenance

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Section 5	Communications	10
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Applicable standards and certifications:

c UL us LISTED — Hazardous Locations

c RU us — Standard Locations

CE — European Directives

DNV — Marine & Offshore

FC — US Emissions

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+1 (651) 766-2700 • FAX +1 (651) 766-2701

USFCS PDF No. 386 Rev.: rev1

STATEMENT OF LIMITED WARRANTY

The limited warranty applicable to the IntraLink products is set forth in USFilter Control Systems standard terms of sale, that are made applicable to the purchase of these products.

INSTALLATION AND HAZARDOUS AREA WARNINGS

These products should not be used to replace proper safety interlocking. No software-based device (or any other solid-state device) should be designed to be responsible for the maintenance of consequential equipment or personnel safety. In particular, USFilter disclaims any responsibility for damages, either direct or consequential, that result from the use of this equipment in any application.

All power, input and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

WARNING – EXPLOSION HAZARD – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIVISION 2.

WARNING – EXPLOSION HAZARD – WHEN IN HAZARDOUS LOCATIONS, DISCONNECT POWER BEFORE REPLACING OR WIRING MODULES.

WARNING – EXPLOSION HAZARD – DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

Note: All information in this document applies to the **LC2000**, except where otherwise noted. Refer to the USFilter Toolbox software online help system for detailed product specifications and configuration settings.

Last Revision: May 2005

Section 1 Overview

The LC2000 combines on-board I/O with a state of the art logic controller. The LC2000 was developed specifically for smaller remote applications in the water and wastewater industry. This innovative controller combines robust technologies and an open architecture to produce a cost competitive, feature rich solution that is ideal for use in remote control applications. The LC2000 includes a high performance CPU, multiple RS232 ports, an RS485 port, an Ethernet port, and 26 points of on-board I/O (both discrete and analog). An optional, user-friendly operator interface may be added to provide a window into the process. The local operator interface uses both text and graphics to allow an operator to view process data, change setpoints, view/acknowledge alarms, view alarm history and view historical trends

I/O overview

The LC2000's on-board I/O includes 12 discrete inputs, 8 discrete outputs, and 6 analog inputs. I/O can be expanded up to 250 points using the Ethernet I/O family of modules. The Ethernet I/O modules can be connected to the LC2000 via its Ethernet port or via its RS485 port.

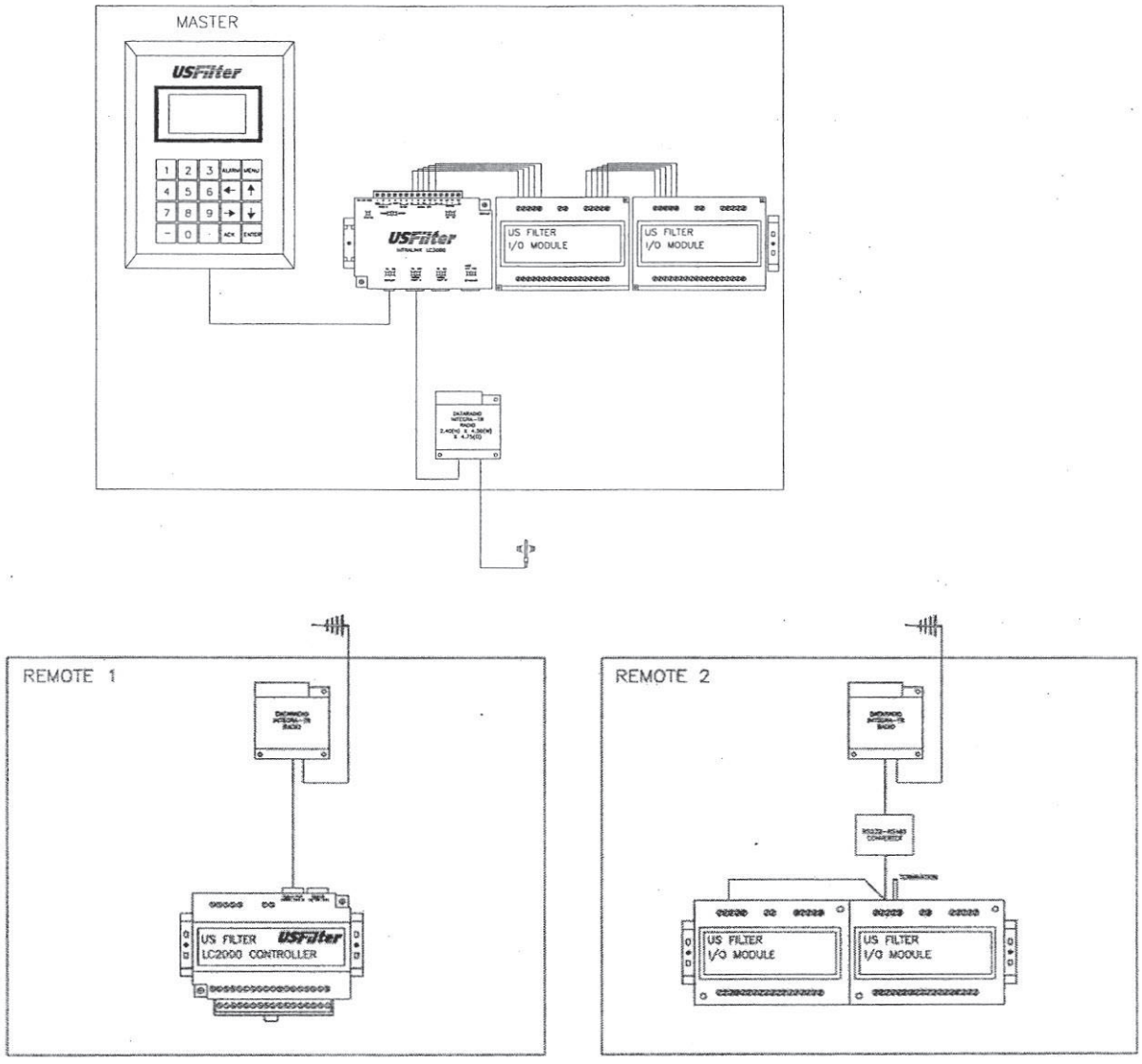
Operator Interface Overview

The OI3000 (optional) is 128 x 64 pixel, backlit, graphical display coupled with an ergonomic 20 key keypad. The operator interface allows the user to view process data, change setpoints, view/acknowledge alarms, view alarm history and view historical trends. Together with a door switch, the OI3000/LC2000 can provide an effective intrusion detection system. The OI3000 is connected to the LC2000 through a dedicated, powered, serial port. The operator interface is configured using USFilter Toolbox software. Please refer to the OI3000 Users Manual and USFilter Toolbox On-line Help for more details.

USFilter Toolbox Overview

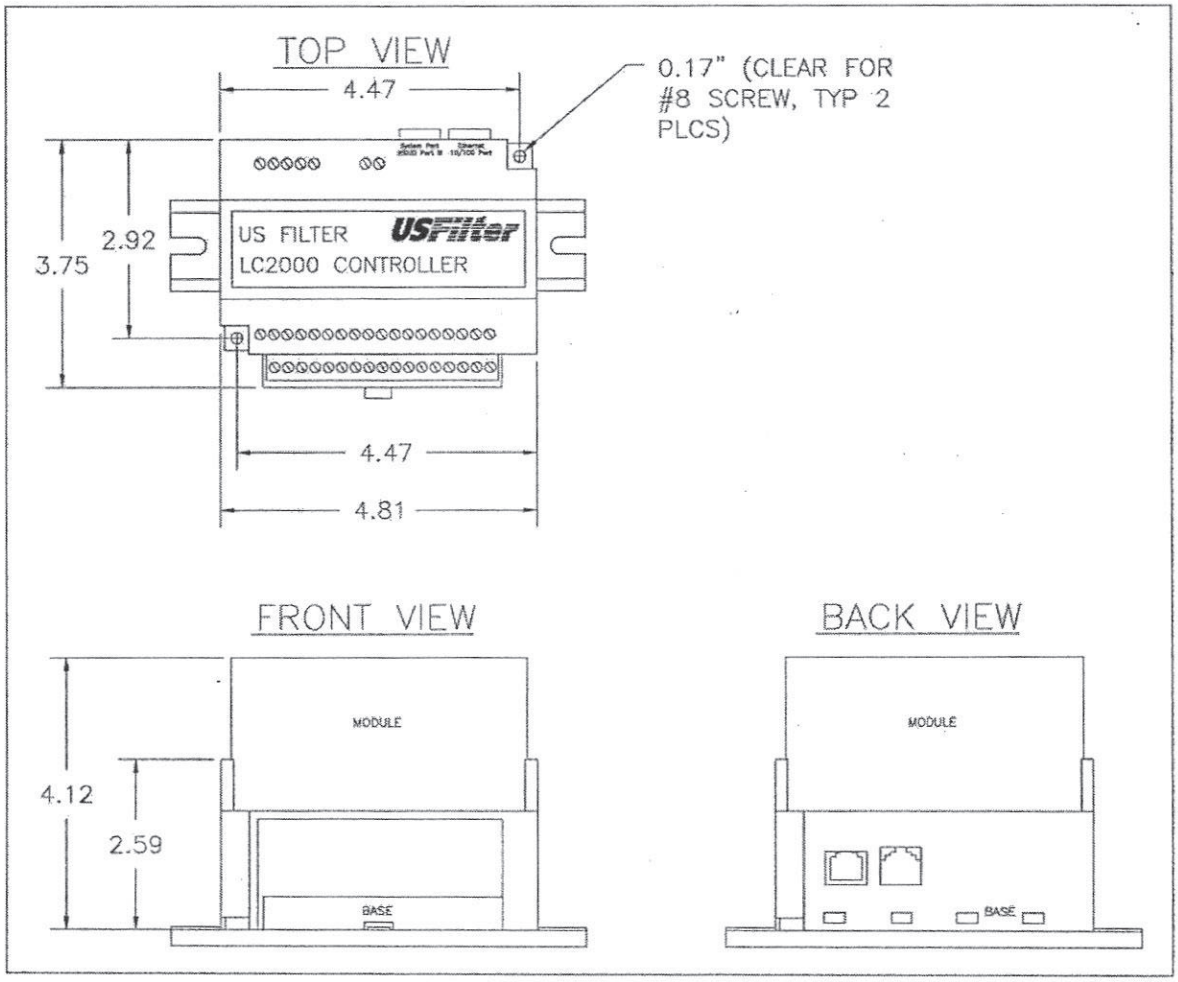
USFilter Toolbox software is used to program, configure, and troubleshoot LC2000 and LC3000 systems. The software runs a PC with current Windows operating systems. USFilter Toolbox allows the users to create stations, configure I/O (both Panel I/O and Ethernet I/O), setup communications, configure the OI3000 display, configure alarms, configure trends, and program a control strategy. ISaGRAF is an industry standard IEC 61131-3 compliant programming language used to implement control algorithms in the LC2000. ISaGRAF supports all five IEC 61131-3 languages including ladder logic and function blocks. USFilter Toolbox contains specialized water and wastewater function blocks enabling consistently implemented, advanced control strategies. USFilter Toolbox supports local connections to the LC2000 via the Ethernet or RS232 ports or remote connections via dial-up modem or network.

Typical system diagram



Section 2 Installation

The LC2000 controller is normally snapped onto DIN rails fastened to a sub-panel. However the LC2000 can also be surface mounted using the mounting holes located on two corners of the case.



Section 3 Power

The LC2000 controller accepts power from an external DC power source of 10–30 VDC. Unlike the LC3000, the LC2000 does not have internal battery handling circuitry. An external battery handling device must be used to charge the battery and provide seamless transfer when line power fails.

Section 4 On-board I/O

The LC2000 comes with integrated discrete and analog I/O on board. Wiring for the on-board I/O should be based on the wiring diagram shown in Figure 4.1. A hardware summary for each type of I/O is described below. Further details on the features available when using the on-board I/O can be found in the on-line Help system found in USFilter Toolbox software.

Discrete Inputs

There are twelve discrete inputs on the LC2000. These inputs may be wired for sourcing or sinking by setting the DI return jumper in the module's base. An input counting feature uses analog input registers to accumulate the number of positive transitions of each input. Positive DC voltage must be applied to an input to indicate an ON condition. All channels are referenced to a common return or supply, which is connected to the negative side (ground) or positive side (DC+) of the DC power source. One wire from each sourcing field input should be bussed together and connected to terminal 17 (DC+). One wire from each sinking field input should be bussed together and connected to terminal 18 (DC GND). Refer to the wiring diagram, Figure 4.1. Set the DI return jumper inside the wiring base to match the wiring configuration of the inputs (sinking or sourcing).

Discrete Outputs

There are 8 discrete outputs integrated on the LC2000. The discrete output channels each provide up to 1 Amp DC to power the relay or other loads. A single terminal is provided for each output channel. All outputs are powered from the DC power terminal. All channels are referenced to a common return, which is connected to the negative side (ground) of the DC power source.

Analog Inputs

There are six 4-20 mA analog inputs on the LC2000. The inputs provide 16 bits of resolution for precision analog measurements. A single input terminal is provided for each measurement channel. Care must be taken to provide a suitable ground and/or isolation for these single ended input circuits. Precision 100 ohm current shunts, beneath the hinged access door in the wiring base, pass current and maintain loop integrity, even if the plug-in logic module is removed. Each analog channel has built in current protection circuitry, such that each channel open circuits before any circuit damage will occur.

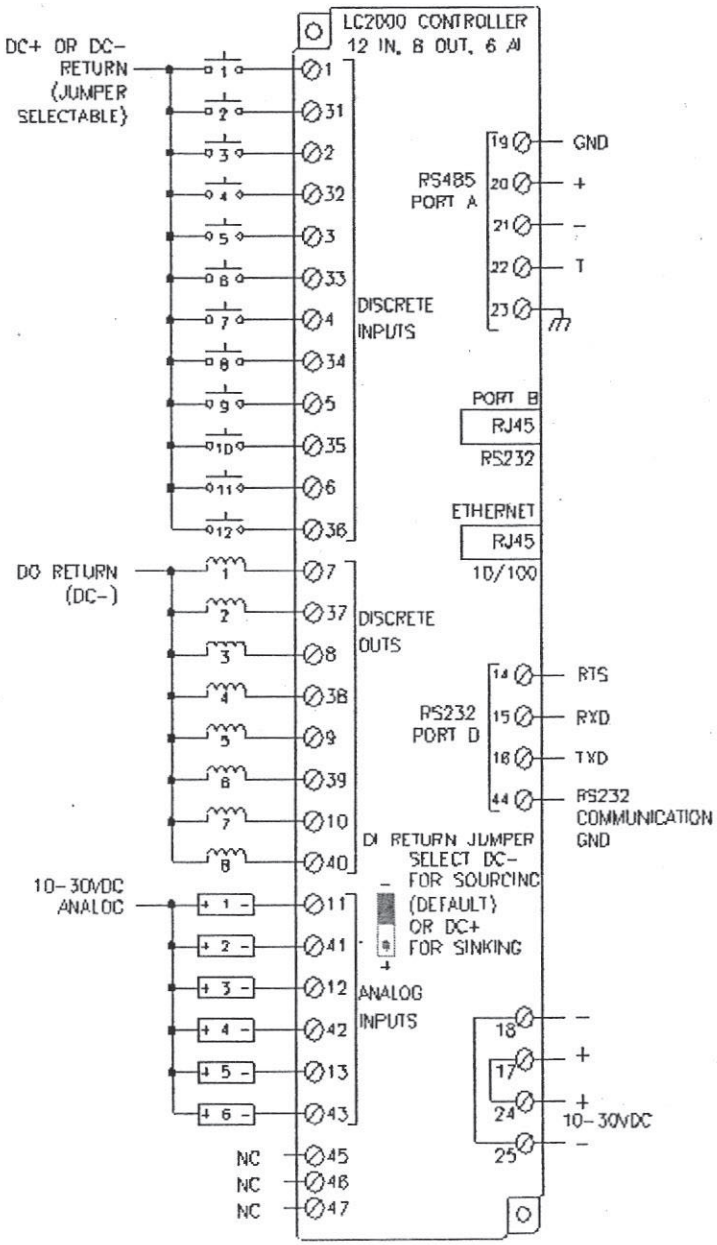


Figure 4.1 – LC2000 Wiring Diagram

Section 5 Communications

The LC2000 controller has 4 communication ports:

- RS485 Port
- RS232 Port D (Display port)
- RS232 Port A
- Ethernet Port

RS485 Port

This port provides an RS485 (2-wire, half duplex) connection to Ethernet I/O modules, RTU I/O modules, and other equipment. Four terminals (signal GND, 485+, 485-, termination) are provided. Generally + is connected to + and – to – between units. However, since there are no standards for RS485 terminal designations, + may need to be connected to – and – to + in some cases. No damage will result if you connect incorrectly. It is highly recommended that signal ground be connected to an appropriate ground (if available) between all RS485 units. Make sure to use a good quality communication cable with three conductors (twisted is preferred) plus a shield. To prevent ground loops, the shield should be connected to chassis ground on only one end of any cable run.

> Note: If you have existing wiring that has only two conductors and a shield, you can use the shield to connect the signal grounds between stations. This is not optimal (especially for long cable runs) but should work in most situations.

The LC2000 has RS485 termination components (150 ohm resistor and 0.1 uF capacitor connected in series) already inside. To terminate your RS485 network tie the "T" terminal to the RS485- terminal. Use the same type and size conductor as that used for the RS485 – connection. It is recommended that both end stations of your RS485 network be terminated. Avoid terminating more than two stations.

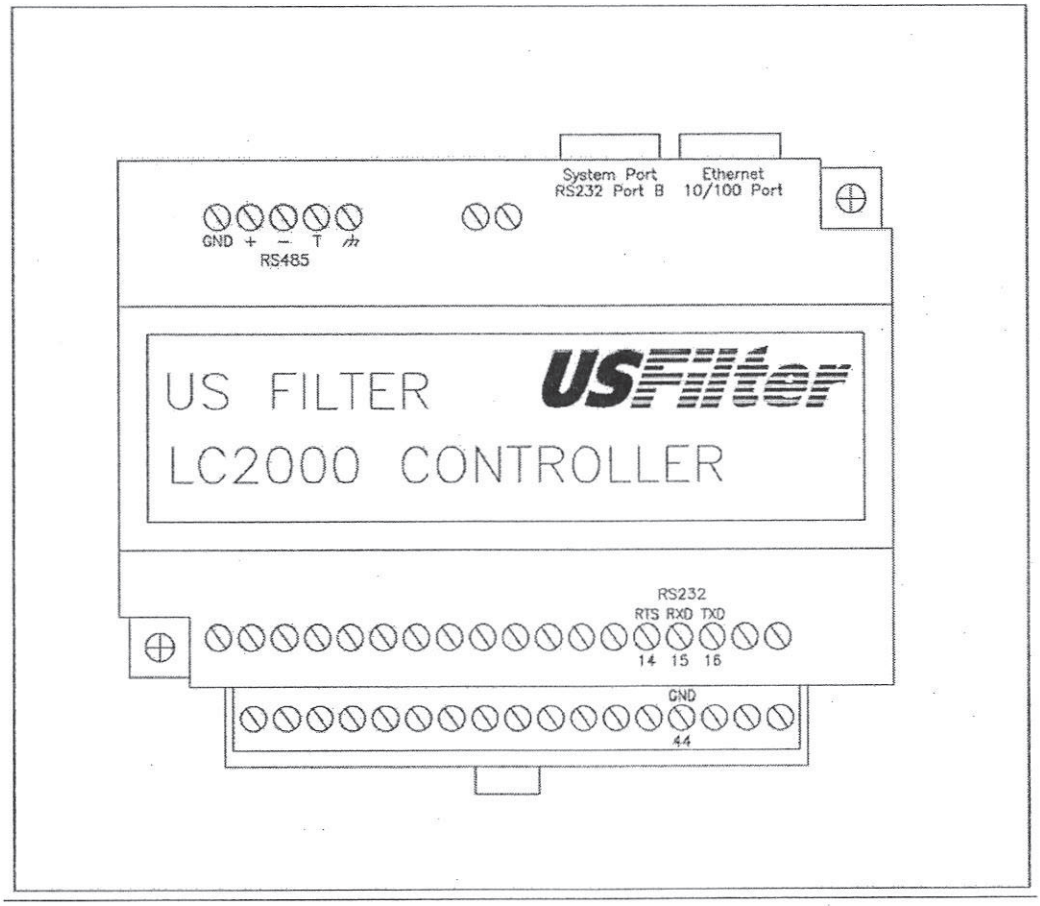
On a RS485 2-wire network, a pair of bias resistors (1K ohm typically) acting upon the transmit/receive wire may be required. If bias resistors are not present, the receive inputs on some RS485 devices may react to noise on the floating wires. The bias resistors will force the transmit/receive to a known (non-floating) state when none of the RS485 devices are transmitting data. Some RS485 devices have bias resistors built in, which can be enabled through DIP-switches or jumper settings. Make sure there is only one pair of bias resistors acting upon the network. If your network is entirely made up of IntraLink family of devices, then bias resistors are not necessary.

Display Port (Port D)
The display port on the LC2000 is normally used to connect to the OI3000 Operator Interface. However, if an OI3000 is not used, this port may be used as a general communications port. This port is a four wire RS232 port providing RTS, RX, TX, and GND. If the port is being used to connect an OI3000, DC+ (terminal 17) is used and RTS (terminal 14) is not used. Refer to the Communications Port Diagram on the following page for exact pin out details. Refer to the OI3000 Users Manual for more details on the operator interface.

RS232 Port B
RS232 port B interface is a RJ45 female connector. This port may be used as a programming port or as a means to connect to a radio or modem. The pin-outs follow the EIA/TIA 561 standard (See Communications Port Details Diagram for pin outs). The ports are generally used in conjunction with a DB9 (or DB25) to RJ-45F adaptor and an RJ-45 male to RJ-45 male straight-through wired patch cable to make a connection between the LC2000 and another communication device.

Ethernet Port
The Ethernet port is a 10/100BaseT, auto-detecting and auto-crossover Ethernet port. This means the port will auto-detect speed and will work with either a straight-through or cross-wired Ethernet cable. A standard shielded RJ-45 female connector is provided. Refer to the Communications Port Diagram on the following page for pin-out details. The port has a fixed, unique MAC address. The port's IP address is viewable through the OI3000 Operator Interface and can be set with USFilter Toolbox software. Refer to USFilter Toolbox software on-line help for details.

Communication Port Details



Port B, RJ45 Female (RS232 DTE):

Pin 1: RI/DSR (in)
Pin 2: DCD (in)
Pin 3: DTR (out)
Pin 4: GND
Pin 5: RXD (in)
Pin 6: TXD (out)
Pin 7: CTS (in)
Pin 8: RTS (out)

Ethernet, RJ45 Female (10T/100T Auto uplink):

Pin 1: TX+
Pin 2: TX-
Pin 3: RX+
Pin 6: RX-

Section 6 Technical Specifications

Here are the technical specifications for the LC3000 controller.

General Details	
Microprocessor	Industrial PowerPC (32 bit data bus)
Operating System	Embedded Linux
Number of unique stations addresses	16,000 (USFilter Open) or 247 (Modbus)
Dynamic memory (for program execution, dynamic variables, dynamic file system etc)	16 Megabytes
Flash memory (Linux OS, program storage, file system)	16 Megabytes
Non-volatile RAM (datalogging)	512K bytes (battery backed, rechargeable Lithium)
Battery backup time/life	1 year/10 years
Real time clock resolution	10 ms
Real time clock accuracy	+/- 15 seconds per month
On board I/O	26 (12 DI, 8 DO, 6 AI)
I/O Expansion	Ethernet I/O, RTU I/O up to 256 points
Maximum virtual I/O registers	256 of each type
Datalogging	Internal datalogging
Programming Language	ISaGRAF (IEC 61131-3 compliant)
Languages supported	Ladder logic, SFC, function block, instruction list, structured text
Communication capabilities	Master, slave, peer-to-peer, report on exception, store and forward
Communication media supported	Ethernet, dial-up telephone, leased line, UHF/VHF radio, spread spectrum radio, wireless Ethernet, fiber optic and more
CPU Watchdog	CPU automatically resets if error is detected; status LED flashed error code
Communication watchdog	Settable timeout and output action (freeze or force off)
Heartbeat watchdog	Settable timeout and output action (freeze or force off)
Ethernet Details	
Ethernet media	10/100BaseT (auto-detecting)
Connection	RJ-45 Female (auto cross-over)
Isolation	1500 Volts RMS 1 minute (60 Hz)
Message response time (typical)	5 ms
Diagnostic LEDs	Link activity and speed
Protocols supported	TCP/IP, ARP, UDP, ICMP, DHCP, Modbus/TCP, USFilter Open
Address	Unique MAC with static or DHCP assigned IP address

Serial Port Details	
Port speed	300 to 115,000 baud
RS232 Port B	RJ-45 (TD, RD, CTS, RTS, CD, DTR, DSR/RI, GND)
RS232 Port D (display port)	Screws (TD, RD, RTS, GND)
RS485 Port	Screw terminals (GND, 485+, 485-, termination) (2-wire half-duplex)
RS485 network	Up to 32 stations
RS485 distance	Up to .5 miles
Protocols (Master & Slave)	Modbus (RTU & ASCII), USFilter Open, Microcat (9500 & 9700), PLTU, DF1, CECO
Diagnostics LED (each port)	Transmit data, Receive Data
Flow control	Hardware (RTS), software (XON/XOFF)
Discrete Inputs	
Guaranteed ON Voltage	9 VDC
Maximum Voltage	30 VDC
Guaranteed OFF voltage	5.0 VDC & 1.5 mA
Input Resistance	10K ohms
Input Current @ 24 V	3 mA
Filtered ON/OFF delay	25 ms (20 Hz max counting rate)
Fast ON/OFF delay	4 ms (100 Hz max counting rate)
Count rate	10 kHz on channel 1 (see above for others)
Discrete Outputs	
Maximum Output per Channel	1 A
Maximum Output per Module	8 A
Maximum Off-state leakage	0.05 mA
Minimum Load	1 mA
Inrush Current	5 A (100 ms surge)
Typical ON resistance	0.3 ohms
Typical ON voltage (@ 1A)	0.3 VDC
Analog Inputs	
A/D Resolution	16 bits
Full scale accuracy	+/- 0.1% (@ 20° C)
Span and Offset temp coefficient	+/- 50 ppm/degree C
Input impedance	100 ohm
Current protection	Self resetting fuse
DMRR	66 dB @ 50/60 Hz
Environmental Details	
Temperature	-40 to 70 C (-40 to 85 C storage)
Humidity	5% to 95% RH (non-condensing)
Flammability	UL 94V-0 materials
Electrical Safety	UL 508, CSA C22.2/14, EN61010-1 (IEC1010), CE
EMI emissions	FCC par 15, ICES-003, Class A; EN55022; EN61326-1; CE

EMC Immunity	EN61326-1 (EN6100-4-2,3,4,6); CE
Surge Withstand	IEEE-472 (ANSI C37.90), EN61000-4-2,4
Vibration	IEC68-2-6
Hazardous locations (Class 1, Div 2, Groups A, B, C, D)	UL 1604, CSA C22.2/213, Cenelec EN50021 Zone 2
Packaging	Lexan packaging
Mounting	DIN rail (EN50022) or direct to panel
Size	4.75"L x 3.83"W x 4.13"H
Weight	.73 lbs.

Section 7 Troubleshooting and Service Information

Local Diagnostics
Local diagnostics can be performed through either RS232 serial port or Ethernet, even while the LC2000 is responding to messages on other ports. USFilter Toolbox software can be used to access internal diagnostics and display the status of I/O registers. Refer to the software's on-line help for details. The OI3000 can display a limited set of controller diagnostics. Refer to the OI3000 Users Manual for details.

Status LED
The status LED on the LC2000 indicates its operational status

ON:	The LC2000 is operating properly
OFF:	There is no power to the LC2000 or service is required
Fast Blink:	This may occur when the LC2000 is being reset, or firmware is being downloaded from USFilter Toolbox software.
Slow or periodic blink:	This indicates that the internal watchdog has detected a problem. Try clearing memory and reloading the project using USFilter Toolbox software.

LC2000 Memory
The LC2000 has non-volatile (battery free) memory for storing configuration data from USFilter Toolbox.

The LC2000 also has battery-backed memory for storing program variables and logged data. The battery is a re-chargeable lithium cell that is kept fresh by the power circuitry on the controller. The memory retention period for an un-powered controller is at least 6 months at room temperature. The retention time will be shorter at high temperatures. The life expectancy of the lithium battery is at least 10 years.

Product Support

To obtain technical support or service for USFilter Control Systems products, contact your local USFCS representative. For factory support contact USFilter Control Systems and ask for technical support. Our phone numbers are:

Phone: 1 (800) 224-9474
Local: (651) 766-2700
Fax: (651) 766-2754
Email: cs.technical.support@usfilter.com

Our mailing address is:

USFilter Control Systems
1239 Willow Lake Blvd
Vadnais Heights, MN 55110

Product Service

The warranty for this product was stated previously in this manual, on page 1.

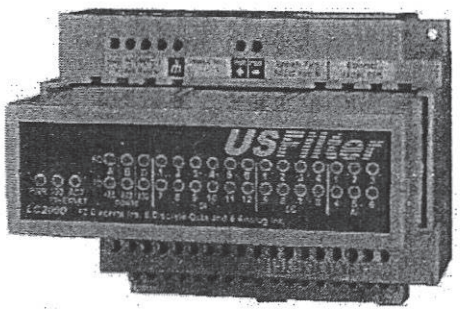
For product service outside the warranty, contact your local USFCS representative. For more information on USFCS parts replacement, contact the factory directly at 1-800-224-9474 and ask to speak with a customer service representative.

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Product Specification
LC2000 Controller
12 Discrete Inputs,
8 Discrete Outputs,
and 6 Analog Inputs

The LC2000 controller combines 26 points of on-board I/O with powerful programming, processing and communications capabilities. The controller incorporates 12 discrete inputs, 8 discrete outputs, and 6 analog inputs in a DIN rail mountable module. The LC2000 uses an Ethernet port, an RS485 port and two RS232 ports (one port can support the OI3000 operator interface) for communications. The LC2000 supports datalogging, alarming, IsaGraf programming and expandable I/O. USFilter legacy protocols, Modbus, and USFilter Open protocols are included.



Part Number	Description
ILK-LC2000-131	Intralink LC2000 Controller with 12 discrete inputs, (sourcing or sinking), 8 sourcing discrete outputs, and 6 analog inputs (4 –20mA)

Specifications

General	Industrial PowerPC (32 bit data bus)
Operating system	Embedded Linux
Number of unique stations addresses	16,000 (USFilter Open) or 247 (Modbus)
Dynamic memory RAM (For program execution, dynamic variables, dynamic file system etc)	32bit, 0 wait states 16 Megabytes
Program (flash) memory (Linux OS, program storage, file system)	16 Megabytes
Non-volatile RAM	512K bytes (battery backed)
Inputs and Outputs	26 (12 Inputs, 8 Outputs, 6 Analog Inputs)
I/O expansion	RS485 or Ethernet
Maximum distributed I/O	256
Real time clock accuracy	±15 seconds per month
Datalogging	Internal datalogging 400Kbytes storage available
Programming language	IsaGraf IEC 61131-3 compliant
Supports programming languages	Ladder, SFC, function block, instruction list, structured text
Communications capabilities	Master, slave, peer-to-peer, report on exception, store and forward
Communications media supported	Ethernet, dial-up telephone, leased line, UHF/VHF radio, spread spectrum radio, wireless Ethernet, fiber optic and more

Watchdogs and Monitors	For run-time diagnostics
CPU watchdog	CPU automatically resets if error is detected; status LED flashed error code
Communications watchdog	Settable timeout and output action (freeze or force off)
Heartbeat watchdog	Settable timeout and output action (freeze or force off)

Ethernet Port	10/100BaseTx (autodetecting)
Connection	RJ45 Female (auto-crossover)
Protocols supported	TCP/IP, ARP, UDP, ICMP, DHCP, Modbus/TCP, USFilter Open
Isolation	1500 Volts RMS 1 minute (60 Hz)
Message response time (typical)	5 mS
Diagnostic LEDs	Link activity and speed
Address	Static or DHCP assigned IP address
Serial Ports	300 to 115,200 baud
RS485 Port A	Screw terminals (GND, 485+, 485-, termination) (2-wire half-duplex)
RS232 Port B	RJ45 (TD, RD, CST, RST, CD, DTR, DSR/RI, GND)
RS232 Port D (OI port)	Screw (TD, RD, RST, GND)
Protocols (Master & Slave)	Modbus (RTU & ASCII), USFilter Open, Microcat and PLTU
Flow control	Hardware (RTS), software (XON/XOFF)
RS485 network	Up to 32 stations
RS485 distance	Up to .5 miles

Physical	
Packaging	Lexan Packaging
Mounting	DIN rail (EN50022) or direct to panel
Size	4.75"L x 3.83"W x 4.13"H

Environmental	
Temperature	-40 to 70 C (-40 to 85 C storage)
Humidity	5% to 95% RH (non-condensing)
Flammability	UL 94V-0 materials
Vibration	IEC 68-2-6
Electrical Safety	UL508, CSA C22.2/14; EN61010; (IEC1010); CE
EMI Emissions	FCC part 15, ICES-003, CLASS A; EN55022; EN61326-1 CE;
EMC Immunity	EN61326-1, (EN61000-4-2, 3,4,6)
Surge withstand	IEEE-472 (ANSI C37.90)
Hazardous locations (Class 1, Div 2 Groups A, B, C, D)	UL1604, CSA C22.2/213, Cenelec EN50021 Zone 2

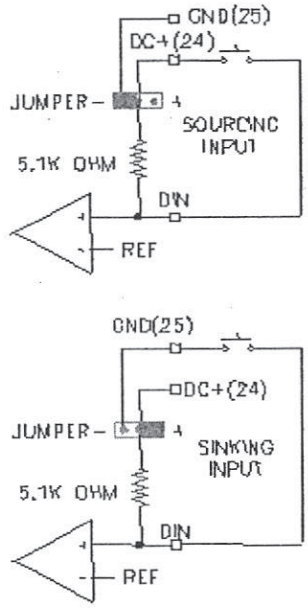
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Electrical	
Input Power (@ 24 VDC) (+/- 10%)	2.4 W (100 mA) – typical (no communications)

Note: Power consumption varies with the number of Ethernet and serial connections.

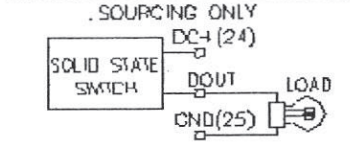
Discrete Inputs	**12 channels** (sink or source)
Guaranteed On voltage	9 VDC
Maximum voltage	30 VDC
Guaranteed Off voltage Guaranteed Off current	5.0 VDC 1.5 mA DC
Input resistance	10K Ohms
Input Current @ 24 VDC	3mA
Channel 1-8 Count rate filtered ON/OFF delay fast ON/OFF delay count rate channel 1	 25mS (20 Hz maximum. counting) 4mS(100 Hz maximum counting) 10kHz

EQUIVALENT DC INPUT CIRCUITS



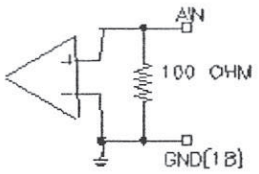
Discrete Outputs	**8 channels**
Voltage range	10-30 VDC
Maximum output per channel	1 Amp
Maximum output per module	8 Amps
Maximum OFF state leakage	0.05 mA
Min. load	1mA
Inrush current	5 Amps (100 mS surge)
Typical ON resistance	0.3 Ohms
Typical ON voltage (@1A)	0.3 VDC

EQUIVALENT DC OUTPUT CIRCUITS



Analog Inputs	**6 Channels**
A/D resolution	16 bits (0.003%)
Full scale accuracy	±0.1%(@20°C)
Span and offset temp. coefficient	±50ppm per degree C
Input impedance	100 Ohm
Current protection	Self-resetting fuses
DMRR (differential mode rejection)	66 dB at 50/60 Hz

EQUIVALENT ANALOG INPUT CIRCUITS



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Terminal Description

Discrete Input Terminals

Terminals 1 - 6	Discrete Inputs (Sourcing or Sinking) DI1, DI3, DI5, DI7, DI9, DI11
Terminals 31 - 36	Discrete Inputs (Sourcing or Sinking) DI2, DI4, DI6, DI8, DI10, DI12

Select Sinking or Sourcing Inputs by setting the DI (Discrete Input) Return Jumper to either DC- for sourcing (default) or DC+ for Sinking Inputs. The DI Jumper is located in the Controller Base.

Discrete Output Terminals

Terminals 7 - 10	Sourcing Discrete Outputs DO1, DO3, DO5, DO7
Terminals 37 - 40	Sourcing Discrete Outputs DO2, DO4, DO6, DO8

Analog Inputs Terminals

Terminals 11, 12, 13	AI1, AI3, AI5	4 -20mA Analog Inputs
Terminals 41, 42, 43	AI2, AI4, AI6	4 -20mA Analog Inputs

Power Terminals

Terminal 17, 24	DC power (+) 10-30VDC
Terminal 18, 25	DC power common (-)

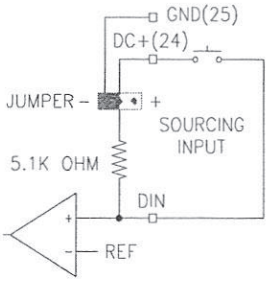
Communication Port Terminals

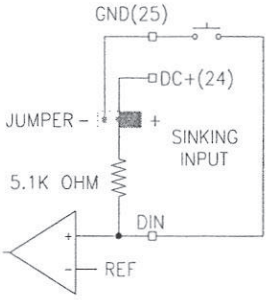
Port A	Terminal 19	RS485 ground
	Terminal 20	RS485 (+)
	Terminal 21	RS485 (-)
	Terminal 22	RS485 termination resistor (tie to RS485 -)
	Terminal 23	RS485 chassis ground
Port D	Terminal 14	RS232 RTS
	Terminal 15	RS232 RXD
	Terminal 16	RS232 TXD
	Terminal 44	RS232 communication ground

Terminals 45, 46, 47 No connection

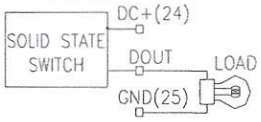
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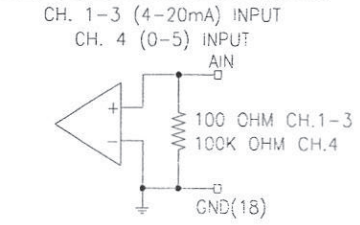


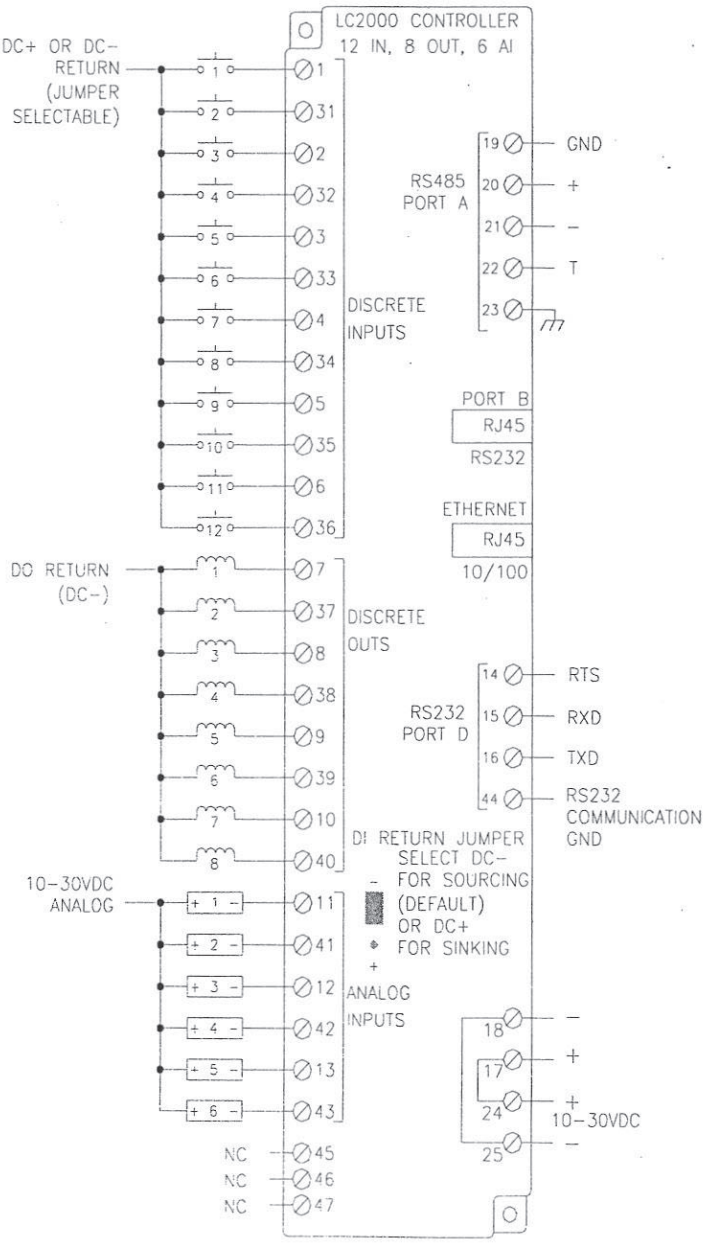


EQUIVALENT DC OUTPUT CIRCUITS



EQUIVALENT ANALOG INPUT CIRCUITS





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Product Specification-2317

ILK-OI3000 LCD Display/Keypad Operator Interface

The ILK-OI3000 is an LCD display and keypad assembly providing an operator interface for the LC3000 controller. The 128x64 pixel backlit display, using text and graphics, shows process and alarm information to the operator and allows setpoint entry. Data and power are carried by a standard RJ-11 phone cable between the OI3000 and a dedicated port on the LC3000. The display is tightly integrated with the LC3000 controller for automatic access to system and tag data, and it is configured with USFilter Toolbox to show job-specific process and alarm data

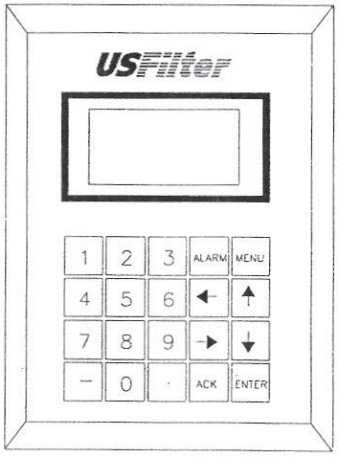
Part Number	Description	Application	Notes
ILK-OI3000	128x64 pixel LCD backlit display and keypad assembly for LC3000	provides operator interface for LC3000	

Specifications

Environmental

Temperature Range
Storage: -20 to 70 C (-4 to 158 degrees F)
Operation: 0 to 50 C (32 to 122 degrees F)

Properly installed, with a foam gasket between the mounting bezel and the panel, the OI3000 is rated NEMA 4.



Physical

Dimensions:	Panel cutout	4.75 x 6.00 in.
	Front bezel	5.88 x 8.125 in.
	Case depth	2.00 in.
Mounting:	mounting clamps supplied	

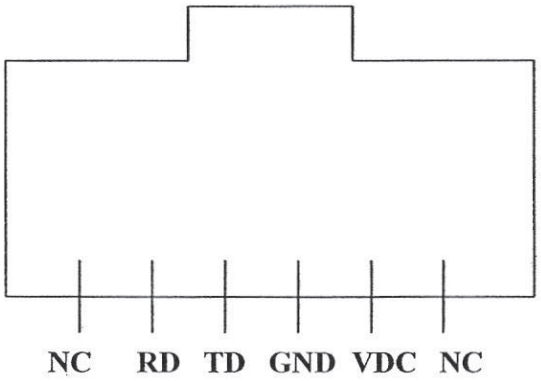
Electrical

Power Requirements: 10 to 30 VDC

Terminal Description and Normal Operation

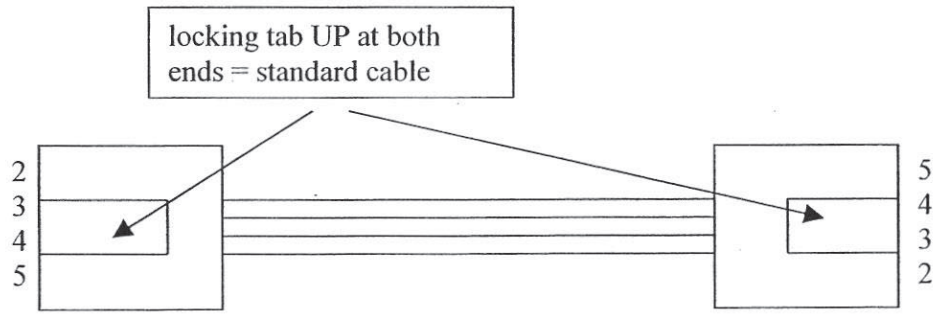
Cable pinout

Looking into RJ-11 connector socket on OI3000:



RJ-11 pinout on OI3000

The cable that runs between the OI3000 and the LC3000 is a straight-through standard IDC modular cable assembly, with no signals crossed inside the cable.



Straight-through cable

USFilter P/N
Conforming commercial cables:
Digi-Key Straight Cable Assembly P/N H1641-07-ND
Radio Shack Modular Line Cord P/N 279-339

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Normal Behavior at Power Up

At power up, the OI3000 display should beep twice, clear the screen, turn the backlight on, then display the USFilter banner logo. The logo remains in place for approximately half a minute while the LC3000 progresses through its bootup sequence. Then the LC3000 should send commands to paint a default display on the OI3000. The default display is the topmost screen in the list of Process screens configured by the project engineer, often a graphic tank or well level.

Pressing a key on the OI3000 should produce a momentary flash (indicating receipt of a serial character) on the RD line of the Display port on the LC3000.

Calibration/Testing Procedures

LCD Contrast Adjustment

On the right-hand side of the case as viewed from in back there is an LCD contrast adjustment that can be made with a small screwdriver. LCD contrast is set at the factory and should require no further adjustment.

Version Numbers

The version number for the software running the microprocessor onboard the OI3000 is found by holding down the MENU key at power up. The version number will be displayed for several seconds before the display reverts to normal behavior.

The version number for the software creating display screens on the OI3000 from the LC3000 controller is shown on the Config screen, reachable through the System submenu.

User's Manual

The OI3000 Operation & Maintenance Manual describes OI3000 operation in detail.

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USFilter

OI3000
Operator Interface
Operation and Maintenance Manual



Contents at a Glance:

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Section 2	Display Operation	7
Section 3	Alarms	15
Section 4	Hardware and Technical Specifications	20
Section 5	Troubleshooting	23

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USFCS PDF No. 2342 Rev.: Rev3

STATEMENT OF LIMITED WARRANTY

The limited warranty applicable to the Panel I/O products is set forth in USFilter Control Systems standard terms of sale, that are made applicable to the purchase of these products.

Note: All information in this document applies to the **OI3000**, except where otherwise noted. Refer to the USFilter Toolbox software online help system for detailed product specifications and configuration settings.

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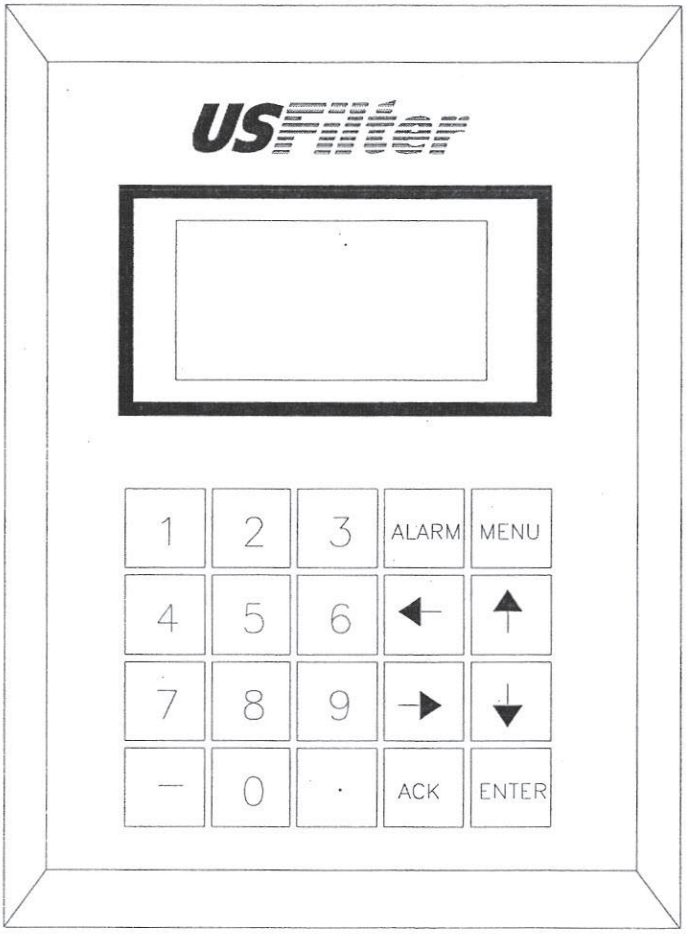


Figure 1 OI3000 operator interface and keypad assembly

Section 1 Quick Start

This section of the manual is designed to give the operator directions for accomplishing typical tasks presented by the operator interface, without having to read the whole document. Topic headings below are first tasks an operator is likely to face.

ACKing Alarms

Press the ACK key or the ALARM key to take a shortcut to the Alarm List. Once there, press the ACK key to acknowledge alarms. As each alarm is acknowledged, the cursor jumps ahead to the

next unacknowledged alarm. If the next unacknowledged alarm is not on the current screen, the screens advance automatically to find the next unacknowledged alarm and place the cursor on it.

Acknowledge all alarms by repeated ACK key presses. When there are no more unacknowledged alarms, the cursor disappears, the alarm warning message stops flashing and the built-in audible alarm stops beeping.

Viewing Alarms and Events

Press the ALARM key to take a shortcut to the Alarm List. Use the Up Arrow and Down Arrow keys to navigate through the Alarm List. Items are on the alarm list because the alarm condition is true or the alarm is unacknowledged or both. The alarm list must be displayed before alarms can be acknowledged.

The Event List is a history of alarms and events. There is little or no urgency associated with the Event List. It is a means to review system behavior and reconstruct the chronology of alarms and events.

To get to the Event List from the Alarm List, press the MENU key once to move up one level to the Alarms submenu. The cursor will be on Alarms. Press the Down Arrow key to move the cursor to Events. Then press the ENTER key to go to the Event List. Use the Up Arrow and Down Arrow keys to navigate through the Event List.

Alarms and events are presented in reverse chronological order, with the most recent alarm or event shown first. The alarms and events appear with up to three on a screen. Press the Down Arrow key to advance the display to the next set of alarms and events.

Logging In

At the Main Menu, look for Login at the bottom of Main Menu items. If no Login item is shown on Main Menu, then security for the system has been disabled. There is no need to log in.

If Login is showing, use the Down Arrow key to move the cursor to Login. Press the ENTER key to go to the Login Screen. Assuming the operator has not already logged in, he will be prompted to enter a login code. Key in a 4-digit login code and press the ENTER key.

The default login code for level 1 is 1111. The default for level 2 is 2222 and the default for level 3 is 3333.

Logging in at level 1 prevents the intrusion program block from considering the operator an intruder. Logging in at level 2 allows changing setpoints. Level 3 allows changing passwords, setting time, clearing the alarm and event lists and changing the alarm configuration.

Changing Setpoints

Setpoint screens are the major place to view/change setpoints and some Process screens may also show the important setpoints or those who need to be changed frequently. To access the Setpoint screen or Process screen, go to main menu by pressing the MENU key and select the corresponding sub-menu by pressing the Up/Down Arrow and ENTER key. Press the Up Arrow

or Down Arrow keys to move through the list of Setpoint/Process screens after entering the screen group.

Floating point values, analog (integer) values and discrete values all may be settable.

If a screen has one or more setpoints on it and the operator has logged in at level 2 or higher, then the cursor will appear on the topmost setpoint. The cursor may be moved from one setpoint to the next using the Left Arrow key or the Right Arrow key.

To set floats and analogs, key in the new value and press the ENTER key. The new value takes effect. If a mistake is made while keying in the new number or to leave the old value intact after an entry is started, press the MENU key to abort the number entry process and return the screen to its former state. Nothing is final until the ENTER key is pressed.

To set discretes, just press the ENTER key to toggle the value. If a discrete value is off, pressing ENTER turns it on. If a discrete value is on, pressing ENTER turns it off.
The On and Off text messages for the discrete are configured in the LC3000 Advanced Utilities.

Setting HOA's and other Switches

Process/Setpoint screens may include HOA (Hand-Off-Auto) screens and other types of switch screens.

The first Process screen is found by pressing the MENU key repeatedly, until the first Process screen alternates with Main Menu. Press the Up Arrow or Down Arrow keys to move through the list of Process screens.

An HOA screen is intended as the software equivalent of a three-position switch knob.

On an HOA screen or any other type of switch screen, the text with the cursor on it shows the current position of the switch. If the operator is logged in at level 2 or higher, he can manipulate the position of the switch knob with the Right Arrow and Left Arrow keys, then he can press the ENTER key to set a new switch position. The cursor will move to the new set position.

A new switch position is not set until the ENTER key is pressed, so the operator may move the switch knob any which way without consequence using the Left Arrow or Right Arrow keys -- until the ENTER key is pressed.

Viewing Trends

The trend data displayed by the OI3000 may be shifted backward in time by pressing the left arrow key, shifting the display two samples per key press. To go backwards quickly, one half screen per press. press the "6" key, just to the left of the Left Arrow. The OI3000 beeps when there is no older data available.

Pressing Right Arrow shifts trend data forward in time, two sample per key press. Pressing the "9" key shifts the data forward one half screen per key press. The OI3000 beeps when there is no newer data available.

Note: If there are setpoints on a trending screen, left/right arrow keys are used to switch among setpoints, not to shift trend time setting.

Silencing the Audible alarm

Acknowledging all alarms silences the audible alarm.

Getting Back to the Beginning

At any time, the operator may return to the default (first) Process screen by pressing the MENU key repeatedly. The deepest menu structure is three levels deep, so no more than three MENU key presses are required to return the display to the default Process screen.

Once the display is showing its default Process screen, continued MENU key presses will toggle the display back and forth between Main Menu and the default Process screen.

Section 2 Display Operation

Overview

The OI3000 is 128 x 64 pixel, backlit, graphical display coupled with a 20-key keypad. The OI3000 operator interface is usually mounted on the front door of the LC3000 controller's enclosure or in some other accessible location. It is connected by serial cable to a dedicated port on the LC3000 controller. The operator interface is a window into the operation of the controller and the state of the controlled process. Through the operator interface, an operator can view process data, change setpoints, view and acknowledge alarms, view alarm history and view historical trends.

The OI3000 operator interface is configured using LC3000 Advanced Utilities of USFilter Toolbox package. Please refer to the LC3000 Users Manual and LC3000 Advanced Utilities On-line Help for more details.

Key functions

Screen navigation keys

The operator interface is organized as a tree hierarchy of menus and lists. Main Menu is at the top of the hierarchy. Menu picks move the operator down a chosen path or branch to the end. At the end of any given menu path there is a list. It may be a one-screen list or a multi-screen list.

The MENU key moves the operator up on the menu hierarchy and the ENTER key moves him down. On a menu or sub-menu screen, the Up Arrow and Down Arrow keys move the cursor from one menu item to the next.

When the operator arrives at a list, the Up Arrow and Down Arrow keys show new screens in the list. Lists are arranged like a ring, so if the operator keeps pressing the Down Arrow key to see the next screen in a list, he will go through all of them, roll over to the first screen, and keep on going.

The up Arrow key can be a handy shortcut to the last or second-to-last screen on a list.

Once the operator is on a list screen, the Left Arrow and Right Arrow keys are used to move the cursor from one item to the next on that screen.

Menu hierarchy illustrated

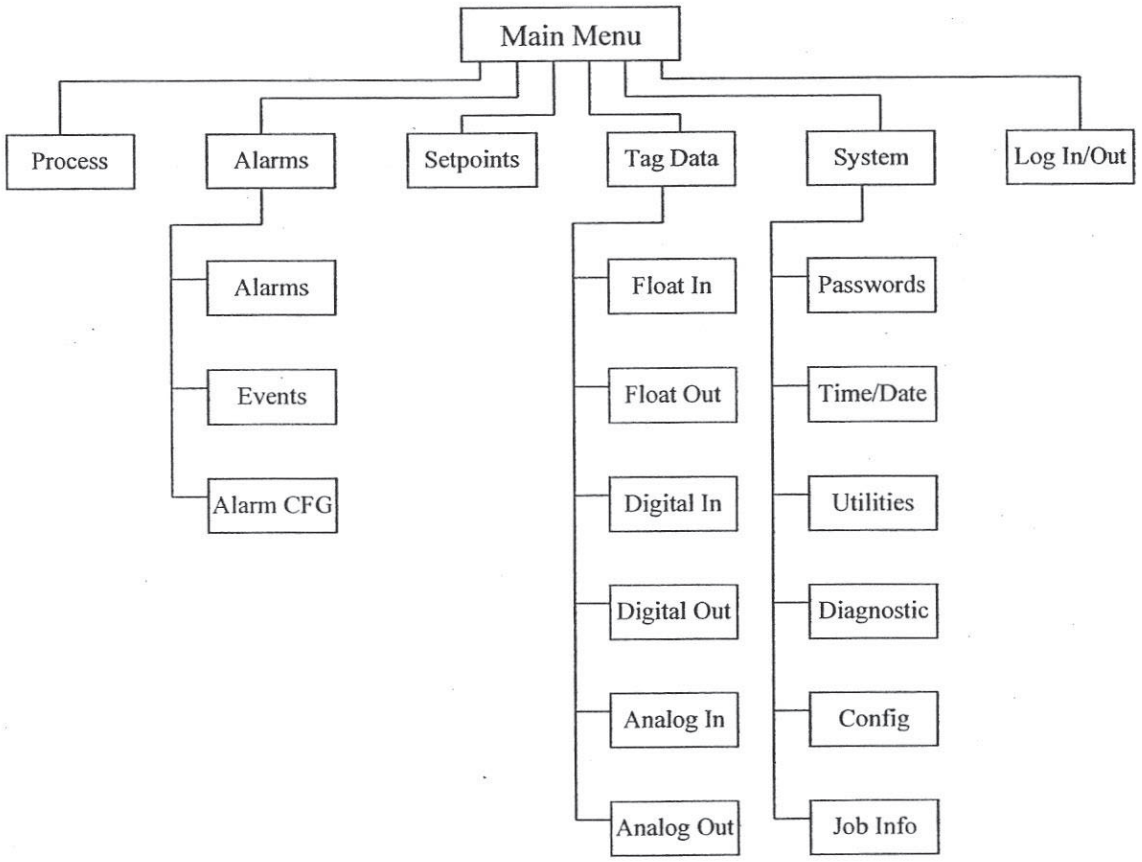


Figure 2 Menu hierarchy with lists at the end of every menu branch.

ALARM and ACK keys

Both the ALARM key and the ACK key provide a shortcut to the Alarm List. No matter where the operator is on the display, even if he is in the midst of entering a number on some other screen, pressing the ALARM key or the ACK key brings him immediately to the Alarm List.

If there are no alarms, then pressing the ALARM key or the ACK key brings the operator to the Alarms sub-menu.

Numeric entry keys

The twelve keys on the left-hand side of the keypad are for numeric entry. They become active when the display is in a state where numeric entry is possible.

If, for example, the display is showing a Process screen with setpoints on it and the operator is logged in at level 2 or higher, then there is a cursor at the topmost setpoint. When a number has the cursor on it, the number is settable. Numeric entry is possible.

The operator does not have to enter a number. But if he presses any numeric entry key, the display pops up a special screen to accept the number. Pressing the MENU key aborts the entry. Pressing the ENTER key finalizes the entry and writes the new value for the setpoint to the controller. There is no range checking so care needs to be taken to enter valid setpoints.

Configured Screens

Process Screens & Setpoints Screens

Process screens display process information with text and graphics. The first Process screen, intended to show the most important data for the process supervised by the controller, is the default display for the OI3000. It is shown when the controller and display are powered up. It is shown when the display times out after ten minutes without any keypad activity.

Setpoints screens provide a place to view/change setpoints.

Process & Setpoints screens are created using the LC3000 Advanced Utilities in USFilter Toolbox. Some OI3000 display screens are created automatically, but all Process & Setpoints screens are created uniquely and are peculiar to the individual site and job.

Process/Setpoints screens are a list. The operator moves from one Process/Setpoints screen to the next using the Up Arrow and Down Arrow keys. There is no hierarchy within Process/Setpoints screens or organization by topic or function. There is only one list of Process/Setpoints screens.

When a Process/Setpoints screen has one or more settable values and the operator is logged in at level 2 or higher, then there will be a cursor on the topmost settable value. The cursor may be moved to the next settable value on the screen, if there is one, by pressing the Left Arrow or Right Arrow keys. When the cursor has reached the last settable value on a screen, it wraps around and starts again.

The Left Arrow and Right Arrow keys do not advance screens, they move the cursor around on a single given screen. The Up Arrow and Down Arrow keys change screens.

Alarm Screens

If alarm points have been configured and if there are active alarms, then there will be one or more alarm screens showing the alarms in reverse chronological order, with the most recent alarms shown first.

Alarm screens are a list. So the Up Arrow and Down Arrow keys are used to move from one alarm screen to the next.

There are three alarm records shown per screen. The On Message or Off Message for the alarm is shown on the top line. The left-hand part of the second line shows the date and time associated with the displayed message. The right-hand field of the second line shows the ack status of the alarm.

For example, if the tag PUMP1_HITEMP is configured as an alarm point, with Pump1 High Temp as the On Message and Pump 1 Temp Normal as the Off Message, then the alarm screen will show "Pump 1 High Temp" if the tag goes true, along with the time the tag went true. The alarm screen will show "Pump 1 Temp Normal" if the tag goes false, along with the time the tag went false. The right-hand field of the second line will show whether or not the alarm has been acknowledged.

For auto reset alarms, the ack status may be "UNACKD" or "ACKD." For manual reset alarms, ack status may be "UNACKD" or "ACKD" or "RSTREQ."

There are various outputs associated with alarms. There is more about alarm operation in Section 3 of this manual.

Event Screens
Even if no alarms or events have been configured, there will be at least one item on the event list, and hence there will always be at least one event screen.

When the controller is powered up, the alarming application automatically records startup as an event. It also automatically records login and logout.

Changes in the status of alarm points are automatically recorded as events. For example, when an alarm input tag goes true, when it goes false, and when the alarm is acknowledged -- each of these occurrences changes the status of an alarm point. The alarm list is updated accordingly, and the occurrence is also recorded as an event. There is more about alarms and events in Section 3 of this manual.

Default Screens
Default screens appear on the display whether or not screens have been configured using the LC3000 Advanced Utilities in USFilter Toolbox. Default screens are hard-coded into the display. They are produced automatically.

Tagdata Screens
From Main Menu, use the Down Arrow key to get to the Tagdata selection, then press the ENTER key to go to the Tagdata submenu. The six Tagdata types are shown, along with the quantity of each type in the tag database.

Since the Tagdata submenu is a type of menu, the Up Arrow and Down Arrow keys are used to move the cursor to the next Tagdata type. Press the ENTER key to look at the chosen Tagdata list.

There are four Tagdata items on each screen. For each entry, the first line shows the tag name and the second line shows its value.

The tagdata lists are intended as a window into the raw data of the control system, making them a powerful troubleshooting tool. At any time, an operator may go to the tagdata lists and check the value held in a tag.

Tagdata screens are dynamically updated. If a value changes while the display is showing that particular value, the new value is written to the screen.

For Float In and Float Out tagdata lists, the number format is fixed at 6 places to the left of the decimal point and one place to the right. Digital In and Digital Out values are shown as 1's or 0's. Analog In and Analog Out are shown as integers.

For each data type, the data are shown in the same order as they are listed in the IO tag database file in the LC3000. No attempt is made to organize data by function or otherwise. Tagdata screens mirror the data in the tag database file.

System Screens

From Main Menu, use the Down Arrow key to get to the System selection, then use the ENTER key to go to the System submenu.

Passwords

When the operator first arrives at the System submenu, the cursor is at Passwords. If he has logged in at level 1 or level 2, pressing the ENTER key does nothing. If the operator has logged in at level 3, then pressing the ENTER key produces the Passwords setting screen, a one-screen list.

The operator can use Left Arrow and Right Arrow keys to shift the cursor from one password level to the next. The display is ready to accept numeric input. To set a password, the operator keys in a 4-digit code and presses the ENTER key.

If all three passwords are "0000," then security is disabled. No login is required to change setpoints or change passwords or set time or erase alarm and event lists or change the alarm configuration. The system behaves the same as it would if security was enabled and the operator had logged in at level 3.

Time/Date

Arrow down once from Passwords, then press the ENTER key to get to the Time/Date screen, a one-screen list. If the operator has logged in at level 3, then there is a cursor on the Time/Date screen, meaning time may be set.

The cursor moves between hours, minutes, AM/PM, month, day of the month, year and time zone. Values at the cursor are adjusted using Up Arrow and Down Arrow keys.

The Time/Date screen is the only screen where the Up Arrow and Down Arrow keys are used to adjust values. On all other screens, any new value is keyed in using the 12 numeric entry keys on the left-hand side of the keypad.

Each field on the Time/Date screen has to be manipulated as necessary. If, for example, the display says 11:35 AM and the operator wants to set the clock ahead one hour, he would position the cursor over the "11" in "11:35" and press the Up Arrow key. Then he would move the cursor over to "AM" and press either the Up Arrow or Down Arrow keys to toggle

the value to "PM." Finally, he would press the ENTER key to write the new value to the system clock and to the battery-backed hardware clock.

The time zone field shows the local time offset relative to Universal Time, formerly called Greenwich Mean Time. For the four time zones in the continental United States, the regional names are given in parentheses after the numeric value.

The clock is not automatically updated for daylight savings time. This update must be done manually using the procedure described above.

Utilities

The Utilities screen is a one-screen list. When it first appears, the cursor is resting on the status field for the audible alarm. No login is required to disable the audible alarm. Pressing the ENTER key toggles the audible alarm enable or disable status.

If the operator has logged in at level 3, then two more items appear on the Utilities screen underneath the audible alarm line. The operator has the option to clear the Alarm Record and to clear the Event Record.

The cursor may be moved from one location to the next by pressing the Left Arrow and Right Arrow keys. If the cursor is at CLEAR for Alarm Records or Event Records, then pressing the ENTER key clears the respective record. The text underneath the cursor does not change.

Clearing the alarm record should be reserved for times of startup of field devices or when known problems with field devices are creating cycling alarms. In normal operation, the alarm record should clear itself as alarm conditions are corrected and alarms are acknowledged. It is best to let the alarm record clear itself by this normal method.

The event record can become quite lengthy. The system stores up to 1000 events. After that, as new events occur, the oldest events are discarded to make room for the newest ones.

Diagnostics

With the cursor resting on Diagnostics on the System submenu, the operator presses the ENTER key to see the contents of the /usr/local/bin directory in the Linux file system in the LC3000. Missing files are a very likely source of trouble, especially at startup. The Diagnostics screen affords the opportunity to check for missing files in /usr/local/bin.

Required files include the following:

tags.6tg	IO tag database file
[station name].cfg	screen and alarm configuration file
timeZone.txt	time zone value
usfMakepipes1	communication between display and alarming
usfMakepipes2	communication between display and alarming
usfMonitor	small application for monitoring power
usfAlarm	alarming application

usfDisplay	display application

No matter what the operator's login level, there is never a cursor on the diagnostics screen. There is nothing to change, only information to view.

Config

The Config screen, a one-screen list, shows the IP address of the LC3000, its serial number, the version number of the display software, and the version number of the LC3000 firmware. The IP address and serial number of the LC3000 are needed when establishing communication between the LC3000 and a computer running USFilter Toolbox.

There is never a cursor on the Config screen. There is nothing to change, only information to view.

Job Info

The Job Info screen, a one-screen list, shows the job name, the shop order number and the station name. The first two items are entered using the LC3000 Advanced Utilities in USFilter Toolbox. The station name is found automatically by the display software and is an important system parameter.

In a system with more than one RTU, the station name distinguishes one particular RTU and its local data from the other RTUs in the system. The display software goes to /usr/local/bin and finds its station name by examing the _tags_.6tg file. Then, having found its station name, the software looks for a file with that exact station name and a .cfg extension in order to read in its display and alarm configurations.

For example, if the Job Info screen shows the station name as KNOB_HILL_LS1, then it is worthwhile to verify the presence in the /usr/local/bin directory of a KNOB_HILL_LS1.cfg file.

There is never a cursor on the Job Info screen. There is nothing to change, only information to view.

Login Screen

Login is the last of the Main Menu items. If no Login item is shown on Main Menu, then security for the system has been disabled. All three passwords have been set to "0000." There is no need to log in.

If Login is showing, then one or more of the passwords has been set to a non-zero value. Security is enabled. Pressing the ENTER key with the cursor on the Login menu item brings up the Login page, a one-screen list.

Assuming the operator has not already logged in, he will be prompted to enter a login code. The operator should key in a 4-digit login code and press the ENTER key. When in doubt, try the

defaults. The default code for level 1 is 1111. The default for level 2 is 2222 and the default for level 3 is 3333.

Logging in at level 1 prevents the intrusion program block from considering the operator an intruder. Logging in at level 2 prevents the intrusion program block from considering the operator an intruder and it allows the operator to change setpoints. On Process screens with settable values, an operator logged in at level 2 sees the cursor on settable values.

In addition to retaining the privileges of level 1 and level 2, level 3 authorizes the operator to view and change passwords, set the time, clear alarm and event logs and change the alarm configuration.

If Login is showing on Main Menu and the operator presses the ENTER key but he is already logged in, then he is presented with the Logout screen, another one-screen list. The choices are shown on the screen. The operator may log out, log in again or go back to the Main Menu.

Implied Decimals

If an analog (integer) value displays not as a whole number but as a float, with places to the right of the decimal point, it is not an error. The value has been configured for an implied decimal in the LC3000 Advanced Utilities.

For example, if an analog value is 1234 but the analog screen element has been configured for 2 places to the right of the decimal, then "12.34" will be displayed on the operator interface. If the value has been configured to be settable and the operator keys in "13.56," then the code multiplies the keyed-in value by 100 and writes 1356 to the tag database. If the operator browses to see the value in the Tagdata list -- it would be an analog in or an analog out -- he will see the actual value of 1234 or 1356. The decimal is shifted only for display.

From the operator's standpoint, the value behaves exactly like a float. The only exception to this perspective is the presence of the actual whole number value in the tag database.

Timeout

If there has been no keypad activity for approximately ten minutes, the display assumes the operator has left. It turns off the backlight and returns the display to the default Process screen. It also checks the login level. If the login level is greater than 1, then it resets the login level to 1.

It is the responsibility of the operator to log out when he leaves the display, thereby re-arming the intrusion program block.

Making Changes to the Configuration File

Both OI and alarm configuration data are contained in the [station_name].cfg file, but the file includes a system for tracking changes to the two applications, allowing the display and alarming applications to react to a new file independently.

For example, if a change is made to the OI configuration using the LC3000 Advanced Utilities in USFilter toolbox and the new [station_name].cfg file is downloaded to the LC3000, the display application will restart, but the alarm application will not.

Section 3 Alarms

Overview
USFilter's alarming application affords a method for tracking critical system variables and signaling when they are out of range.

Alarm points are configured using the LC3000 Advanced Utilities in USFilter Toolbox. Treatment of alarm points varies from their definition as simple events up to their definition as manual reset alarms, requiring an increasing level of operator involvement according to the point definition.

Each transition in the state of an alarm point is recorded as an event. The LC3000 controller stores up to 1000 events in non-volatile memory, providing a history of controller operation.

Alarm and event records are held in man-readable text files in the LC3000. The alarm and event files conform to a CSV (Comma Separated Variable) file format, a venerable file format supported by all spreadsheet programs.

The alarm record file is called alarmRecords.txt. The event record file is called eventRecords.txt. Both are located in the /nvram directory in the LC3000 Linux file system.

Active alarms
All alarms points, whether they are simple events, auto reset alarms or manual reset alarms, have an input tag. The input tag is a discrete value signaling the alarm condition. The alarming application scans the input tags of configured alarm points looking for a transition from false to true. The scan cycle time is not greater than two seconds.

When the input tag of an alarm point transitions from false to true, the alarm is added to the active alarm list. Once an alarm has been added to the active alarm list, it stays there until all the conditions for its removal from the list have been met.

If the alarm point has been configured as an auto reset alarm, then the conditions for its removal from the list are return of the input tag to a normal state and alarm acknowledgement. If the alarm point has been configured as a manual reset alarm, then the conditions for its removal from the list are return of the input tag to a normal state, alarm acknowledgement, and alarm reset.

Because an alarm stays on the active alarm list until all conditions for its removal have been met, it is completely possible for an alarm that has returned to normal to be on the list -- because it has not been acknowledged.

The active alarm list is what the operator sees when he presses the ALARM shortcut key.

Acknowledged and unacknowledged alarms
When any alarm on the alarm list is unacknowledged, the alarming application attempts to draw the attention of the operator by beeping the audible alarm and flashing a message on the display screen.

In addition, group output tags may be active. If alarms have been organized into groups and group output tags defined, these may be used to sound an external horn or turn on a flashing light.

Alarms may be acknowledged by repeated presses of the ACK key. The first press of the ACK key is a shortcut to the Alarm List. The display will show the most recent alarms, with the cursor on the most recent unacknowledged alarm. As the operator continues to hit the ACK key to acknowledge alarms, the cursor jumps forward to the next unacknowledged alarm. When all the unacknowledged alarms on a screen have been acknowledged, the alarming application finds the next screen with unacknowledged alarms and advances to it, putting the cursor on the topmost unacknowledged alarm. The process continues until all alarms have been acknowledged.

When there are no more unacknowledged alarms, the cursor disappears, the audible alarm stops beeping, the alarm message stops flashing and group unacknowledged tags are cleared.

Audible alarm
The audible alarm may be silenced through System\Utilities if the operator wants to quiet the system down without acknowledging all alarms.

How alarms are removed from the alarm list
Just as the alarming application scans alarm point input tags to see if any alarms should be added to the alarm list, it scans the alarm list to see if conditions have been met to remove items from the list.

The most common type of alarm is an auto reset alarm. When an auto reset alarm input tag goes true, the alarm is written to the alarm list with the On Message, the time the input tag went true and "UNACKD" in the ack status field.

When the input tag goes false, the alarm application removes from the alarm list the alarm entry with the On Message and replaces it with a new entry showing the Off Message and the time the transition to off occurred.

When the alarm is acknowledged, the alarming application writes "ACKD" to the ack status field in place of "UNACKD." When the alarm has been acknowledged and the input tag has been cleared, the entry is removed entirely from the alarm list.

Manual reset alarms follow the same sequence except they require an additional key press, an explicit manual reset. After the alarm has been acknowledged and the alarm input has been cleared, the ack status field for a manual reset alarm shows 'RSTREQ." An ENTER key press is required for the manual reset, completing the conditions required for removal of the manual reset alarm from the alarm list.

Alarm screens are dynamically updated. If an alarm changes state while it is being displayed, then the alarm screen refreshes and the new state of the alarm is shown. The alarm input tag may have transitioned from true to false, or perhaps the alarm was remotely acknowledged. The alarm

screen will show the most recent state of the alarm. It is also entirely possible for the alarm to disappear because all conditions for its removal from the alarm list have been met.

Alarm groups, group outputs
Alarms may have been configured as members of an alarm group. Up to five alarm groups may be configured. Each group has two outputs. One output is true if any alarm in the group is unacknowledged. The other output is true if any alarm in the group is on the alarm list.

Manual reset alarm outputs
A manual reset alarm has an output tag. The output tag is true as soon as the alarm goes onto the active alarm list. The output tag stays true until all three conditions for removal of the alarm from the alarm list have been met.

There is no method for determining through the OI3000 display what output tag is associated with a manual reset alarm. If the tag has an accurate and descriptive name, however, it probably can be found by paging through the Digital Out list in Tagdata.

Event Records
An alarm point defined as an event (sometimes called a pure event) creates an entry to the event list whenever its input tag transitions from false to true or from true to false. A pure event is the type of alarm that requires no operator involvement. A pure event does not appear on the Alarm list. Pure events appear only on the Event list.

For example, if the operator wanted to keep track of pump starts over a given period, the pump run signal could be defined as an event. A record would be created showing each time the pump turned on and each time it turned off.

In addition to defined pure events, other entries to the event list are generated automatically. When the LC3000 controller is powered up and the alarming application starts up, it automatically creates an event. Whenever the operator logs in or logs out, it is recorded as an event. Whenever there is a change in the state of an alarm point, the change is recorded as an event. For example, when an alarm input tag first goes true and the alarm is written to the alarm list, an event entry is generated. When the input tag goes false, an event entry is generated. When the alarm is acknowledged, an event entry is generated.

Unlike the alarm list, there is no set of circumstances where event list entries are deleted (except when the list fills to capacity). The event list is always growing.

The high limit for entries to the event list is 1000 events. After there are 1000 events on the event list, the oldest entries are discarded to make room for newer ones as they occur.

Clearing alarm and event logs
The option to clear the alarm and event lists is available through System\Utilities for an operator logged in at level 3.

It promotes efficient operation of the LC3000 to clear the event list periodically. If a PC is available for archiving data and the procedure is reasonably convenient, it would be sensible to upload the eventRecords.txt file to the PC periodically, then clear event records through System\Utilities at the controller.

USFilter Toolbox is used to upload files from the LC3000. In Toolbox, choose Operations, then File Operations. A dialogue box pops up showing the Linux file structure in the LC3000. Double click on the nvram directory, and the dialogue box will show eventRecords.txt among the directory contents. Highlight eventRecords.txt, then click on Read File.

The alarm list does not accumulate entries endlessly the way the event list does. In a well-maintained system, the alarm list should be empty. If it has entries, some action should be in progress to acknowledge the alarms and clear the alarm conditions. The whole point of the alarm list is to draw attention to, then resolve, transitory events.

Viewing and Changing Alarm Configuration

The alarm configuration is viewable through the display by picking "ALARM CFG," the third item on the Alarms submenu. Alarm cfg is a list, usually a multi-screen list, akin to the tagdata lists. The alarm cfg list shows the alarm configuration in the same order as it is given in the [station_name].cfg file. The total number of configured alarm points is shown to the right of the alarm cfg menu pick.

Each alarm point entry shows the input tag name, the type of alarm, the group assignment and the enable/disable status.

If an operator is logged in at level 3, the cursor appears on the enable/disable field of the topmost alarm point on the screen. As is the case on other screens with settable values, Up Arrow and Down Arrow shift the display to the next screen, while Left Arrow and Right Arrow shift the cursor on a single screen.

Pressing the ENTER key toggles the enable/disable value. If an alarm point is enabled, pressing the ENTER key disables it. If an alarm point is disabled, pressing the ENTER key enables it. When the enable/disable status of an alarm point is changed, the change is communicated to the alarming application and it is also written to the [station_name].cfg file, so the change will remain intact if power is cycled.

When an alarm is disabled, any alarm list entry or entries it has generated are removed from the alarm list, whether they have been acknowledged or not. Outputs dependent on the contents of the alarm list are adjusted accordingly.

Alarm behavior when power is interrupted

The alarming application assumes at startup there are no alarms on the alarm list and alarm input tags are off. When it starts up, the alarming application examines the input tag values for each alarm point. If an input tag is on, the alarming application sees a transition from off (its starting

assumption) to on (the actual tag value). The alarming application adds the alarm to the alarm list, the audible alarm sounds and the alarm warning box flashes on the display.

For example, at a site there are three alarm points whose input tags are on. The audible alarm has sounded, the alarm warning box has flashed on the display. The operator has heard the warnings and acknowledged alarms. The display is quiet. The operator goes about his business seeing what he can do to clear alarm conditions. Then power is lost for 30 seconds There is no battery backup. When power returns, because their input tags are on, the same three alarms go active all over again.

At power up, the alarm list is rebuilt from scratch. The previous file containing the alarm list is thrown away. By contrast, the event list is maintained. It is not discarded at power up. In the power outage example above, the event list would have recorded the first three alarms and their acknowledgement. Then it would have recorded the alarming application startup when power returned, and it would have recorded the return of the three alarms.

Section 4 Hardware and Technical Specifications

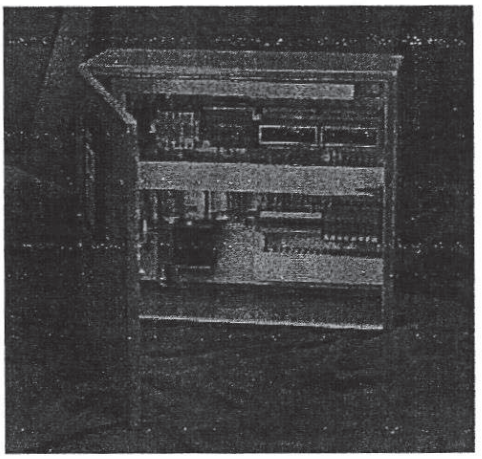
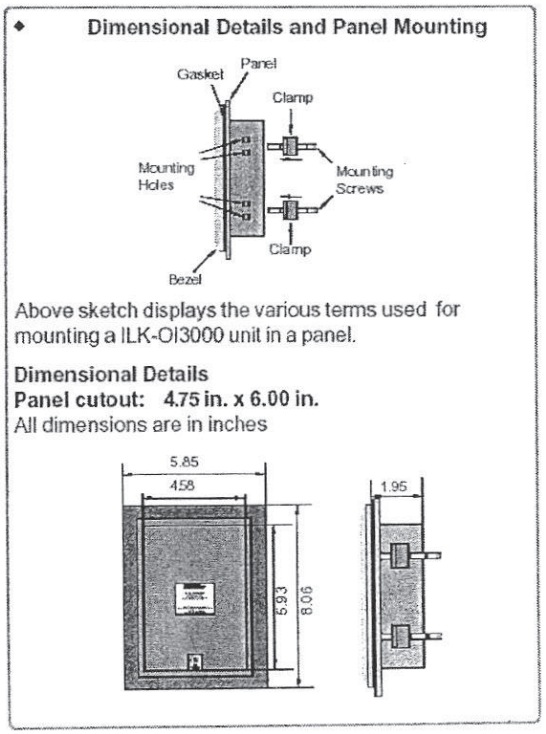


Figure 3 A typical control enclosure.
The OI3000 is mounted on door of the enclosure facing out. The LC3000 controller and other components are mounted on the back panel inside the enclosure.



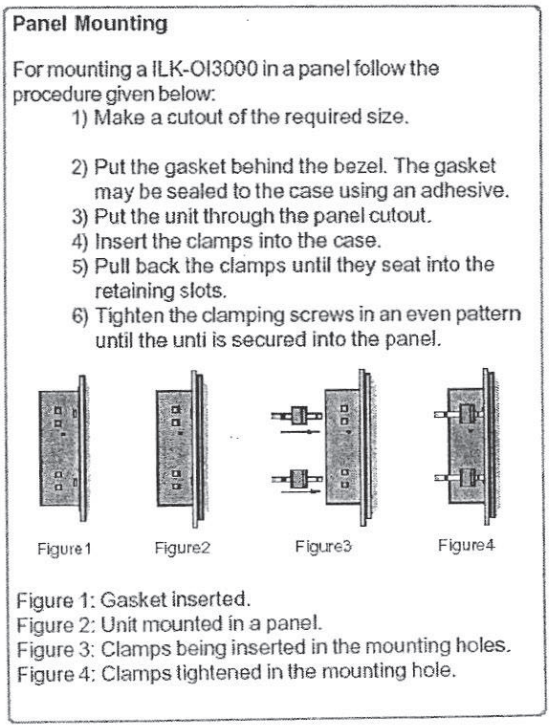


Figure 4 Dimensional Detail and Panel Mounting

Cable pinouts

Looking into the RJ-11 connector socket on the OI3000:

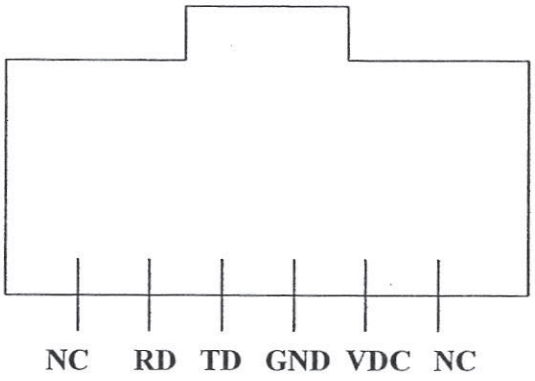


Figure 5 RJ-11 pinout on the OI3000

Looking into the RJ-11 Display port connector socket on the LC3000:

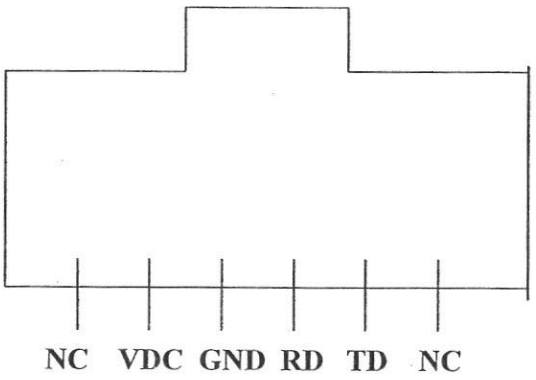


Figure 6 RJ-11 Display port pinout on the LC3000

Please note that the RJ-11 ports provide the signal crossing required for a straight cable connection between them. The cable that runs between the OI3000 and the LC3000 is a straight-through standard IDC modular cable assembly, with no signals crossed inside the cable.

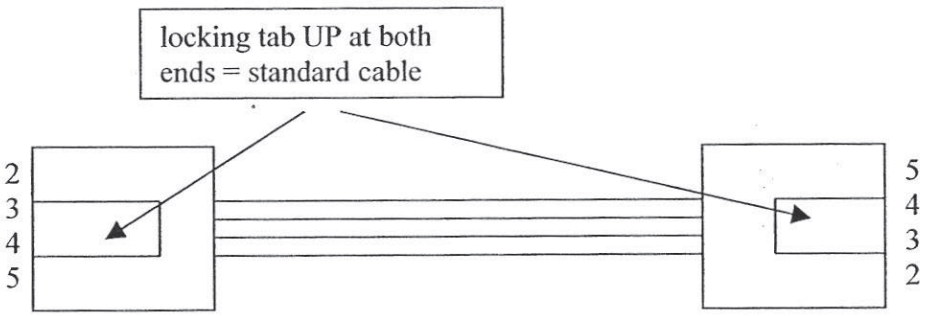


Figure 7 Straight-through cable

USFilter P/N = "LC3000 Reverse Style Adapter"
Conforming commercial cables:
Digi-Key Straight Cable Assembly P/N H1641-07-ND
Radio Shack Modular Line Cord P/N 279-339

Power requirement

10 - 30 VDC.
With the backlight on, the display draws approximately 100 mA at 12VDC.

RS-232 parameters

19200 baud at 8-N-1
These parameters are not settable.

Environmental specification

The OI3000 is rated NEMA 4.
Operating temperature: 0 to 50 degree C.
Storage temperature: -20 to 70 degrees C.

Section 5 Troubleshooting and Support

Behavior at power-up

When the OI3000 display is powered up, the backlight comes on and the display shows a USFilter banner logo. The display remains in that state until it receives instructions from the LC3000 controller, generally 30 seconds to a minute after power up.

From a troubleshooting perspective, appearance of the backlight and logo indicate the OI3000 hardware is okay. If the display remains dark at power up, the most probable problem is lack of power, usually because the cable is disconnected or broken.

Holding down the MENU key at power-up forces the OI3000 to show the firmware version number for the display microprocessor.

There are no other diagnostic tools for the display itself.

Error messages

When the display software in the LC3000 is starting up, it looks for certain files it requires for operation. It looks for a configuration file called [station_name].cfg If it cannot find the file or fails to open it, the display driver clears the screen and puts up a "cfg file not found" message. The display driver looks for a _tags_.6tg file in order to fill its tagdata tables and display raw tagdata values to the operator. If the display driver cannot find the _tags_.6tg file, it clears the screen and puts up a "tag file not found" message.

Without the cfg file the display will show no Process screens. Job information will be missing on the System\Job Info screen and passwords will default to "0000".

Without the _tags_.6tg file, all tag data will be unavailable. There will be no entries in the Tagdata submenu. Process screens will produce a variety of "tag not found" error messages. Not only will the display not work, the controller itself will probably do very little, because tag definitions and manipulation of tag data are the heart of the LC3000 control system.

The alarming application also looks for the [station_name].cfg file. If it is missing, no alarms will be written to the alarm list because the alarming application does not know what tags to scan.

System\Diagnostics or USFilter Toolbox may be used to review the contents of the /usr/local/bin directory in the LC3000 to see if the necessary files are in the directory.

If necessary files are missing, the best troubleshooting procedure is to find the files, load them into /usr/local/bin, and restart the controller. Files are loaded to the LC3000 using USFilter Toolbox. Choose Operations, then File Operations. A dialogue box pops up showing the Linux file structure in the LC3000. Double click on usr, then on local, then on bin to indicate the destination of the file to be loaded. Then click on Load File.

Checking for communication between LC3000 and OI3000
The LC3000 has red LEDs to indicate activity on its ports, including LEDs for the TD (Transmit Data) and RD (Receive Data) lines on the dedicated Display port. The leftmost port on the bottom of the LC3000 is the display port.

When a key is pressed on the OI3000 display, the LED on the RD line of the LC3000 Display port should light momentarily, indicating receipt of a character. This simple diagnostic reveals much. It shows the display hardware is behaving correctly as a subsystem. It is detecting key hits and generating a character to send to the LC3000. The momentary LED flicker at the LC3000 confirms the cable is good. Strictly speaking, it is possible the display is generating the wrong character to reflect the keyhit or it is generating a character at the wrong baud rate, but these possibilities are remote. If the RD light on the LC3000 is showing key hits, the display and the cable are probably good.

When the display driver is running, a key hit from the display usually generates a burst of traffic on the TD line from the LC3000 as the display software issues commands for moving the cursor or creating a new screen. Sometimes, in the midst of the traffic burst on the TD line, there will be a flicker of lights on the RD line. These are flow control commands from the display regulating the data flow from the LC3000.

These are qualitative descriptions of how the LC3000 and OI3000 interact when things are working correctly. A substantial deviation from this behavior indicates error.

Garbled screen ... trash characters
If, at any point, the screen display becomes garbled or is showing what look like trash characters, the easiest fix is to press the MENU key to move up one level in the menu hierarchy and then press the ENTER key to go back down.

If the display is unplugged, then plugged in again, the display driver goes about its business updating some screen elements and leaving others alone. The result is a mosaic. Usually there are remnants of the USFilter banner logo on the display along with some updated values and some garbage characters.

The fix is to press the MENU key and then the ENTER key (or sometime Up Arrow then Down Arrow keys) to go away from the present screen, then come back. In the process of coming back, the display driver erases everything, then recreates the screen from scratch, giving a complete and clean outcome.

Resetting the display
It is possible, given very rare circumstance, to confuse and lock up the microprocessor on the display. If keyhits are generating no data on the RD line, or if commands from the LC3000 (visible on the TD line) produce no action in the display, then the display microprocessor is not working correctly.

Clear the condition by cycling power to the display. Unplug the cable, wait a few seconds, then plug it back in. Press the MENU key and the ENTER key, or Up Arrow and Down Arrow keys, to

refresh the display. If this does not work, verify correct operation of the LC3000. It may be necessary to reset the LC3000.

Contacting Tech Support

Please call your local support representative for technical support or replacement parts, or call USFilter at 1-800-224-9474 for more information.

PUBLICATION DIVIDER

BUSSMANN electronic fuses

COOPER Electronic Technologies

1/4" x 1-1/4" Fuses

MDL Series, Time Delay, Glass Tube

Description

- Time delay, glass tube
- Optional leaded version available
- 1/4 x 1-1/4 (6.3mm x 32mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

ELECTRICAL CHARACTERISTICS		
Rated Current	**Amp Rating**	**Opening Time**
1/16 - 30A	100%	None
	135%	60 minutes max.
	200%	120 seconds max.
1/16 - 3A	200%	5 seconds min.
3-2/10 - 8A	200%	12 seconds min.

Agency Information

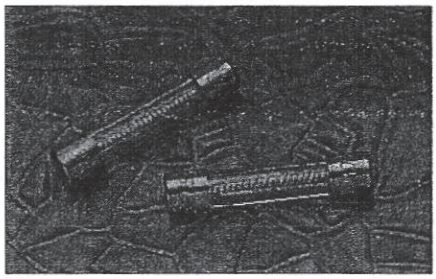
- UL Listed Card: MDL 1/16 - 8A (Guide JDYX, File E19180)
- UL Recognized Card: MDL 9 - 30A (Guide JDYX2, File E19180)
- CSA Certification Card: MDA 2/10 - 15 (Class No. 1422-01)

Environmental Data

- Shock: 1/100A and 8/10A – MIL-STD-202, Method 213, Test Condition I; 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/100A and 8/10A – MIL-STD-202, Method 201; 1/4A thru 30A – MIL-STD-202, Method 204, Test Condition C (Except 5g, 500HZ)

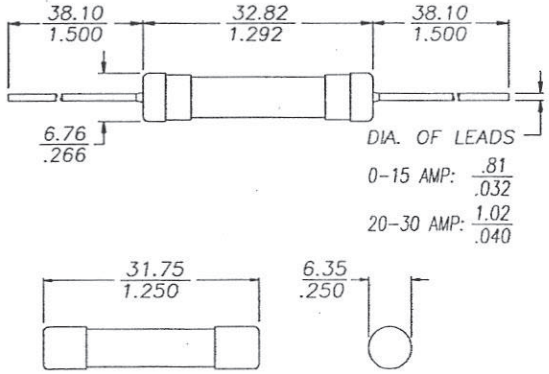
Ordering

- Specify product code, option code and packaging code



Dimensions (mm/in)

Drawing Not to Scale



SPECIFICATIONS							
Product Code	**Voltage Rating AC**	**AC Interrupting Rating* 250V**	**125V**	**32V**	**Typical DC Cold Resistance** (ohms)**	**Typical Melting I²t† AC**	**Typical Voltage Drop‡**
MDL-1/16	250V	35A	10000A	-	38.000	0.0046	2.79
MDL-1/10	250V	35A	10000A	-	15.900	0.0420	1.95
MDL-1/8	250V	35A	10000A	-	9.850	0.0422	1.52
MDL-3/16	250V	35A	10000A	-	4.680	0.116	N/A
MDL-2/10	250V	35A	10000A	-	4.115	0.314	0.972
MDL-1/4	250V	35A	10000A	-	0.320	0.447	0.965
MDL-3/10	250V	35A	10000A	-	2.300	0.412	0.808
MDL-3/8	250V	35A	10000A	-	2.800	0.982	1.46
MDL-1/2	250V	35A	10000A	-	1.725	1.656	1.27
MDL-3/4	250V	35A	10000A	-	0.822	4.343	1.01
MDL-1	250V	35A	10000A	-	0.525	11.498	0.995
MDL-1-1/4	250V	100A	10000A	-	0.320	86.2	0.722
MDL-1-1/2	250V	100A	10000A	-	0.250	22.7	0.721
MDL-2	250V	100A	10000A	-	0.173	62.3	0.644
MDL-2-1/4	250V	100A	10000A	-	0.068	49.6	0.535
MDL-2-1/2	250V	100A	10000A	-	0.096	63.1	0.410
MDL-3	250V	100A	10000A	-	0.067	67.5	0.345
MDL-4	250V	200A	10000A	-	0.035	19.3	0.187
MDL-5	250V	200A	10000A	-	0.023	32.0	0.160
MDL-6	250V	200A	10000A	-	0.018	37.4	0.155
MDL-6-1/4	250V	200A	10000A	-	0.018	38.7	0.152
MDL-7	250V	200A	10000A	-	0.018	42.7	0.140
MDL-8	250V	200A	10000A	-	0.011	47.8	0.119
MDL-9	32V	-	-	1000A	0.009	51.5	0.124
MDL-10	32V	-	-	1000A	0.008	64.4	0.114
MDL-15	32V	-	-	1000A	0.006	354.0	0.130
MDL-20	32V	-	-	1000A	0.002	2914.0	0.530
MDL-25	32V	-	-	1000A	0.001	15221.0	0.30
MDL-30	32V	-	-	1000A	0.001	15581.0	0.40

* Interrupting Ratings (Interrupting ratings were measured at 70% - 80% power factor on AC)

** DC Cold Resistance (Measured at ≤10% of rated current)

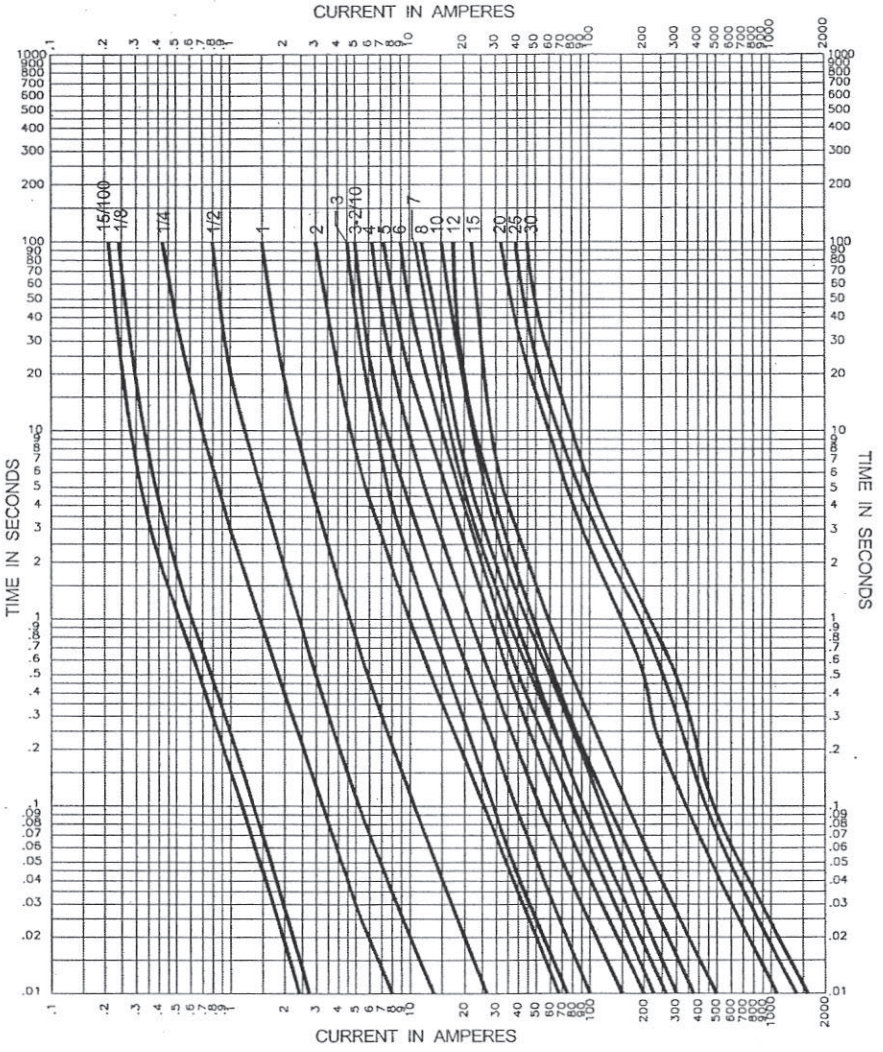
† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)

‡ Typical Voltage Drop (Voltage drop was measured at 25°C±3°C ambient temperature at rated current)

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MDL Series, Time Delay, Glass Tube

TIME CURRENT CURVE



OPTION CODE	
Option Code	**Description**
B	Board Washable - Hermetically sealed to withstand aqueous cleaning
V	Axial leads - brass overcaps with copper and nickel flash, plated in tin lead

PACKAGING CODE	
Packaging Code	**Description**
BK	100 pieces of fuses packed into a cardboard carton with flaps folded
BK1	1,000 pieces of fuses packed into a cardboard carton with flaps folded
BK8	8,000 pieces of fuses packed into a cardboard carton with flaps folded

OC-2546 5/02

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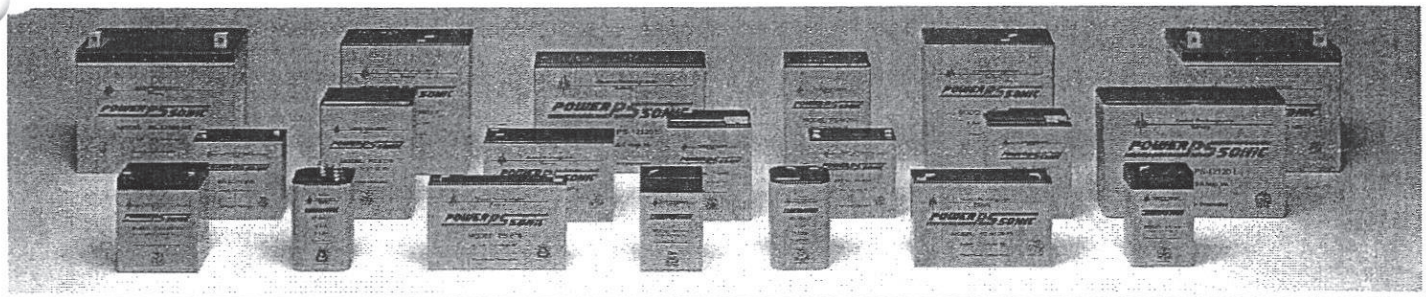
MODEL	FINAL VOLTAGE	WATTS PER CELL @ 25 C						
		5 Min	10 Min	15Min	20 Min	30 Min	45 Min	60Min
PSH-1255	1.75	38	27	22	17	12	9.5	6.4
	1.70	39	28	23	17.5	12.5	9.6	6.5
	1.67	40	29	24	18	13	9.8	6.7
PS-1270	1.75	50	33	25	20	15	11	9
	1.70	51	34	26	21	16	12	9
	1.67	52	35	27	22	16	12	10
PSH-1280	1.75	65	43	35	24	18	14	12.8
	1.70	66	44	36	24.3	19	15.3	12.9
	1.67	67	45	37	24.7	20	15.8	13
PS-6100	1.75	84	56	43	35	26	19	14
	1.70	86	58	44	36	27	20	15
	1.67	87	60	45	37	28	21	16
PS-12120	1.75	85	57	43	35	26	20	15
	1.70	86	58	44	36	27	20	16
	1.67	87	59	45	37	28	21	17
PS-12180	1.75	121	82	62	51	38	28	21
	1.70	124	84	64	52	39	29	22
	1.67	126	85	65	53	40	30	23
PS-12260	1.75	172	118	90	74	54	39	32
	1.70	175	120	92	75	55	40	33
	1.67	177	122	93	76	56	41	34
PS-12280	1.75	176	124	94	77	56	41	34
	1.70	180	126	96	78	58	42	35
	1.67	184	128	98	80	60	43	35
PS-12330	1.75	245	170	133	108	80	60	45
	1.7	251	174	136	110	82	61	47
	1.67	258	176	139	113	83	62	48
PS-12400	1.75	270	183	140	115	86	64	49
	1.70	278	187	143	116	87	65	50
	167	280	189	145	118	88	66	52
PS-12550	1.75	320	210	184	153	115	87	72
	1.70	342	225	190	158	118	89	73
	1.67	354	230	194	160	120	90	74
PS-12700	1.75	462	312	238	195	145	108	84
	1.70	473	319	243	198	148	110	85
	1.65	478	325	246	201	150	112	86
PS-12750	1.75	480	339	270	220	168	126	102
	1.70	509	356	278	231	171	128	103
	1.67	518	360	282	233	173	130	106
PS-121000	1.75	550	395	312	267	207	152	128
	1.70	586	413	324	277	212	155	129
	1.67	605	421	330	283	215	158	130
PS-121100	1.75	655	470	365	304	225	164	133
	1.70	692	490	375	312	231	168	134
	1.67	706	500	380	315	233	170	135
PS-121400	1.75	680	510	432	366	302	220	176
	1.70	720	550	462	376	304	225	180
	1.67	740	560	480	381	306	228	182

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Model	Nominal Voltage V	Nominal Capacity@ A.H.	Current @ 20 hr. rate mA	Length		Width		Height		Ht. Over Terminal		Weight		Standard Terminals
				in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kgs.	
PS-260	2	6.0	300	1.97	50	1.34	34	3.94	100	4.13	105	0.90	0.41	F1
PS-445	4	4.5	225	1.89	48	2.09	53	3.70	94	3.86	98	1.40	0.64	F2
PS-490	4	9.0	450	3.97	101	1.73	44	3.74	95	4.02	102	2.80	1.27	F2
PS-4100	4	10.0	500	4.02	102	1.97	50	3.72	94	3.92	100	3.10	1.41	F1
PS-605	6	0.5	25	2.24	57	0.55	14	1.97	50	1.97	50	0.20	0.09	WL
PS-610	6	1.0	50	2.00	51	1.65	42	2.00	51	2.20	56	0.60	0.27	F1
PS-612	6	1.3	65	3.82	97	0.98	24	2.03	51.5	2.25	57	0.70	0.30	F1
PS-628	6	2.8	140	2.60	66	1.30	33	3.86	98	4.06	103	1.25	0.57	F1
PS-630	6	3.4	170	5.28	134	1.34	34	2.35	60	2.56	65	1.50	0.68	F1
PS-632	6	3.2	160	2.60	66	1.30	33	4.65	118	4.92	125	1.50	0.68	F1
PS-640	6	4.5	225	2.76	70	1.89	48	4.02	102	4.25	108	1.95	0.89	F1
PS-650L	6	5.0	250	2.63	67	2.63	67	3.78	96	4.28	109	2.00	0.91	SP
PS-665	6	6.5	325	3.86	98	2.20	56	4.05	103	4.05	103	3.00	1.36	FP
PS-670	6	7.0	350	5.95	151	1.34	34	3.70	94	3.86	98	3.00	1.36	F1
PS-682	6	8.0	400	3.86	98	2.20	56	4.65	118	4.65	118	3.30	1.50	F1
PS-6100	6	12.0	600	5.95	151	2.00	51	3.70	94	3.86	98	4.60	2.09	F1 or F2
PS-6120	6	12.0	600	4.26	108	2.75	70	5.54	141	5.54	141	5.20	2.36	FP
PS-6120Toy	6	12.0	600	4.26	108	2.75	70	5.54	141	5.54	141	5.20	2.36	TS or TH
PS-6200	6	20.0	1000	6.18	157	3.27	83	4.92	125	4.92	125	8.20	3.73	NB
PS-6360	6	36.0	1800	6.25	159	3.35	85	6.50	165	6.95	177	13.80	6.27	F2 or NB
PS-832	8	3.2	160	5.28	134	1.42	36	2.49	63	2.70	69	1.90	0.86	F1
PS-1208	12	0.8	40	3.78	96	0.98	25	2.42	62	2.42	62	0.80	0.36	WL
PS-1212	12	1.2	60	3.82	97	1.69	43	2.00	51	2.13	54	1.30	0.59	F1
PS-1220	12	2.2	110	7.01	178	1.34	34	2.38	60.5	2.56	65	2.10	0.95	F1
PS-1223	12	2.3	115	7.17	182	0.94	24	2.42	62	2.42	62	1.76	0.80	PC
PS-1228	12	2.8	140	5.24	133	1.30	33	3.82	97	4.09	104	2.55	1.16	F1
PS-1229	12	2.9	145	7.01	178	1.34	34	2.36	60	2.56	65	2.20	1.00	F1
PS-1230	12	3.4	170	5.28	134	2.64	67	2.36	60	2.60	66	2.60	1.18	F1
PS-1250	12	5.0	250	3.54	90	2.75	70	3.98	101	4.17	106	3.75	1.70	F1 or F2
PSH-1255	12	5.5	24 Watts/Cell*	3.54	90	2.75	70	3.98	101	4.17	106	4.00	1.80	F2
PS-1270	12	7.0	350	5.95	151	2.56	65	3.70	94	3.86	98	5.70	2.59	F1 or F2
PSH-1280	12	8.0	37 Watts/Cell*	5.95	151	2.56	65	3.70	94	3.86	98	5.95	2.70	F2
PS-1282	12	8.0	400	3.86	98	4.40	112	4.65	118	4.65	118	6.70	3.05	F1
PS-12100	12	12.0	600	5.95	151	4.00	102	3.70	94	3.86	98	9.20	4.18	F1
PS-12120	12	12.0	600	5.95	151	3.86	98	3.70	94	3.94	100	9.00	4.09	F2
PS-12180	12	18.0	900	7.13	181	2.99	76	6.57	167	6.57	167	13.10	5.95	F2 or NB
PS-12260	12	26.0	1300	6.54	166	6.88	175	4.95	126	4.95	126	20.80	9.45	F2 or NB
PS-12280	12	28.0	1400	6.54	166	4.95	126	6.89	175	6.89	175	21.40	9.70	NB
PS-12330	12	35.0	1750	7.80	198	5.20	132	6.22	158	7.07	180	26.50	12.00	NB
PS-12400	12	40.0	2000	7.75	197	6.50	165	6.75	172	6.75	172	32.25	14.70	NB
PS-12550	12	55.0	2750	9.04	230	5.45	138	8.15	207	8.98	228	39.20	17.80	NB
PS-12750	12	75.0	3750	10.25	260	6.60	168	8.15	207	8.98	228	58.00	26.40	NB
PS-121000	12	100.0	5000	12.00	305	6.60	168	8.15	207	8.98	228	67.80	30.80	NB
PS-121100	12	110.0	5500	13.00	330	6.76	172	8.40	213	8.70	221	77.70	35.30	B
PS-121400	12	140.0	7000	13.60	345	6.82	173	11.28	287	11.34	288	104.50	47.50	B

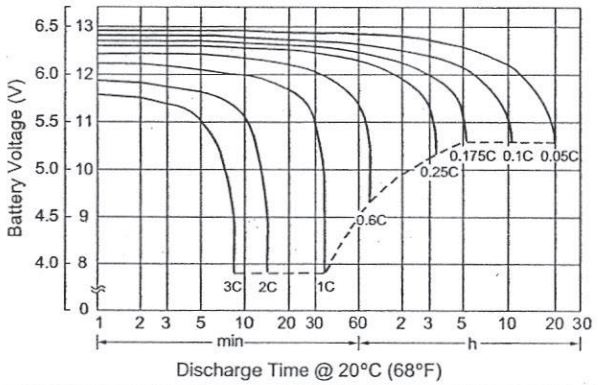
* Watts/cell @ 15 min.rate to 1.67V

ıe **PSG Series** of batteries correspond in size to Hawker models of the same voltage and capacity.

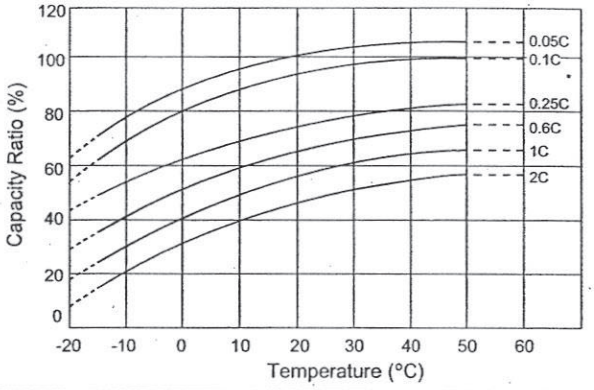
3G-450	4	5.0	250	3.54	90	1.94	49	2.87	73	2.87	73	1.70	0.77	F2
PSG-480	4	8.0	400	3.54	90	1.94	49	4.00	102	4.00	102	2.50	1.14	F2
PSG-625	6	2.5	125	4.15	105	1.63	41	2.70	69	2.70	69	1.50	0.68	F1
PSG-650	6	5.0	250	5.28	134	1.94	49	3.00	76	3.00	76	2.50	1.14	F2
PSG-680	6	8.0	400	5.28	134	1.94	49	3.99	101	3.99	101	3.70	1.68	F2

DISCHARGE CHARACTERISTICS

Characteristic Discharge Curves



Effect of Temperature on Capacity



CHARGING

Cycle Applications: Limit initial current to 0.30C (C is the nominal A.H. capacity of the battery). Charge until battery voltage (under charge) reaches 2.45 volts per cell at 68˚F (20˚C). Hold at 2.45 volts per cell until current drops to approximately 0.01C amperes. Battery is fully charged under these conditions, and charger should be disconnected or switched to "float" voltage.

"Float" or "Stand-by" Service: Hold battery across constant voltage source of 2.25 to 2.30 volts per cell continuously. When held at this voltage, the battery will seek its own current level and maintain itself in a fully charged condition.

APPLICATION NOTES

Continuous over or undercharging is the single worst enemy of a lead-acid battery. Caution should be exercised to insure that the charger is disconnected after cycle charging, or that the float voltage is set correctly.

Because there is a chance of off-gassing hydrogen and oxygen if the battery is overcharged, it is important to provide adequate air circulation.

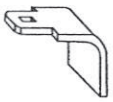
Batteries should not be stored in a discharged state (or in a hot place). If a battery has been discharged for some time it may not readily take a charge. To overcome this, leave the charger connected and the battery will eventually begin to accept a charge.

Due to the self-discharge characteristics of this type of battery, it is imperative that they be charged after 6 months of storage at 20-25ºC, otherwise permanent loss of capacity might occur as a result of sulfation. To prolong shelf life without charging, store batteries at 50˚F (10˚C) or less.

TERMINALS

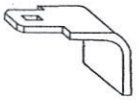
"F1" FASTON

0.187" x 0.032" quick disconnect tabs.



"F2" FASTON

0.250" x 0.032" quick disconnect tabs.



"FP" FASTON Polarized

Positive: "F2" Negative: "F1"

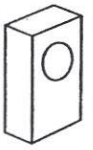
"PC" Pressure Contacts

On PS-1223 battery.



Spring **"SP"**

Fully collapsible spring terminals for positive and negative contacts.



Nut & Bolt **"NB"**

Terminal post (lead alloy or tin-plated brass)



Button **"B"**

Threaded copper insert terminals

"WL" Insulated, stranded wire leads terminated with:

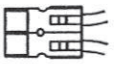
- Molex Housing 5264-02 & 5263-PBT plug on PS-605
- AMP Housing 1-480318-0 & 8116-1 on 1208

"TS/TH" Toy battery connectors:

- S-connector 6120 TS



- H-connector 6120 TH



All data subject to change without notice.

POWER-SONIC

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Jan. 2003 - 2.5M

PUBLICATION DIVIDER

POWER-SONIC

MATERIAL SAFETY DATA SHEET

Product Name: Sealed Maintenance Free Lead-Acid Batteries	

DATE:	9/23/2002	ISSUED BY	ENGINEERING	TELEPHONE NO.	(619) 661-2030

HAZARDOUS COMPONENTS

COMPONENTS	WEIGHT %	TLV	LD50	LC50	LC50
			ORAL	INHALATION	CONTACT
Lead (Pb, $Pb0_2$, $PBSO_4$)	about 70%	N/A	(500) mg/kg	N/A	N/A
Sulfuric Acid	about 20%	1mg/m³	(2,140) mg/kg	N/A	N/A
Fiberglass Separator	about 5%	N/A	N/A	N/A	N/A
ABS Plastic	about 5%	N/A	N/A	N/A	N/A

PHYSICAL DATA

COMPONENTS	DENSITY	MELTING POINTS	SOLLUBILITY (H_2O)	ODOR	APPEARANCE
Lead	11.34	327.4° C (Boiling)	None	None	Silver-Gray Metal
Lead Sulfate	6.2	1070° C (Boiling)	40 mg/l(15° C)	None	White Powder
Lead Dioxide	9.4	290° C (Boiling)	None	None	Brown Powder
Sulfuric Acid	about 1.3	about 114° C (Boiling)	100%	Acidic	Clear Colorless Liquid
Fiberglass Separator	N/A	N/A	Slight	Toxic	White Fibrous Glass
ABS Plastic	N/A	N/A	None	No Odor	Solid

FLAMMABILITY DATA

COMPONENTS	FLASHPOINT	EXPLOSIVE LIMIT	COMMENTS
Lead	None	None	
Sulfuric Acid	None	None	
Hydrogen		4% - 72.4%	Sealed batteries can emit hydrogen if over charged (float voltage > 2.40 VPC).
Fiberglass Separator	N/A	N/A	Toxic vapors may be released. In case of fire, wear self-contained breathing apparatus.
ABS Plastic	None	N/A	Temp. over 300° C (572° F) may release combustible gases. In case of fire: wear positive pressure self-contained breathing apparatus.

FIRST AID

SULFURIC ACID PRECAUTIONS	
Skin Contact:	Flush with water, see physician if contact area is large or if blisters form.
Eye Contact:	Call physician immediately and flush with water until physician arrives.
Ingestion:	Call physician. If patient is conscious, flush mouth with water, have patient drink milk or sodium bicarbonate solution.

Continued on Page 2

POWER-SONIC

MATERIAL SAFETY DATA SHEET

(PAGE 2 OF 2)

REACTIVITY DATA

COMPONENT	Sulfuric Acid
STABILITY	Stable at all temperatures
COLYMERIZATION	Will not polymerize
INCOMPATIBILITY	Reactive metals, strong bases, most organic compounds
DECOMPOSITION PRODUCTS	Sulfuric dioxide, trioxide, hydrogen sulfide, hydrogen
CONDITIONS TO AVOID	Prohibit smoking, sparks, etc. from battery charging area. Avoid mixing acid with other chemicals

SPILL OR LEAK PROCEDURES

Steps to take in case of leak or spill:	If sulfuric acid is spilled from a battery, neutrilize acid with bicarbonate (baking soda), sodium carbon (soda ash), or calcium oxide (lime). Flush area with water and discard to the sewage system. Do not allow unneutralized acid into sewage system.
Waste disposal method:	Neutrilized acid may be flushed down the sewer. Spent batteries must be treated as hazardous waste and disposed of according to local, state, and federal guidelines. A copy of this MSDS must be supplied to any scrap dealer or secondary lead smelter with battery.

PROTECTION

EXPOSURE SITE	PROTECTION	COMMENTS
SKIN	Rubber gloves, Apron	Protective equipment must be worn if the battery is cracked or otherwise damaged. A respirator should be worn during reclaim operations if the TLV is exceeded.
RESPIRATORY	Respirator (for lead)	
EYES	Safety goggles, Face Shield	

ELECTRICAL SAFETY

Due to the battery's low internal resistance and high power density, high levels of short circuit current can be developed across the battery terminals. Do not rest tools or cables on the battery. Use insulated tools only. Follow all installation instructions and diagrams when installing or maintaining battery systems.

HEALTH HAZARD DATA

LEAD: The toxic effects of lead are accumulative and slow to appear. It affects the kidneys, reproductive, and central nervous systems. The symptoms of lead overexposure are anemia, vomiting, headache, stomach pain (lead colic), dizziness, loss of appetite, and muscle and joint pain. Exposure to lead from a battery most oftern occurs during lead reclaim operations through the breathing or ingestion of lead dust or fumes.

SULFURIC ACID: Sulfuric acid is a strong corrosive. Contact with acid can casue severe burns on the skin and in eyes. Ingestion of sulfuric acid will cause GI tract burns. Acid can be released if the battery case is damaged or if vents are tampered with.

FIBERGLASS SEPARATOR: Fibrour glass is an irritant of the upper repiratory tract, skin and eyes. For exposure up to 10F/CC use MSA Comfoll with type H filter. Above 10F/CC up to 50F/CC use Ultra-Twin with type H filter. This product is not considered carcinogenic by NTP or OSHA.

ALL DATA MUST BE PASSED TO ANY SCRAP DEALER OR SMELTER WHEN BATTERY IS RESOLD.

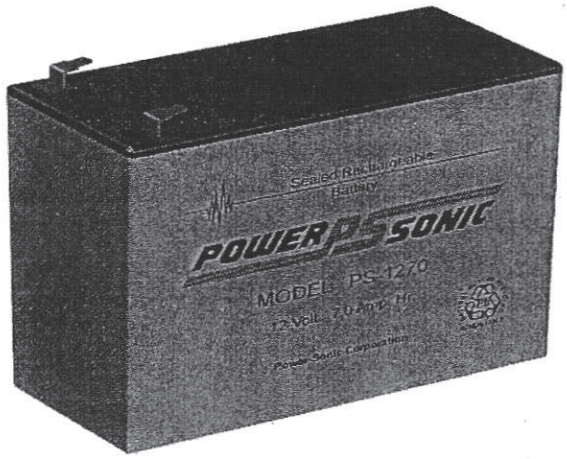
Power-Sonic Corporation
9163 Siempre Viva Road, San Diego, CA 92154 Tel (619) 661-2020 Fax (619) 661-3650
Website: www.power-sonic.com E-Mail: battery@power-sonic.com

PUBLICATION DIVIDER

POWER-SONIC

Rechargeable Sealed Lead-Acid Battery

PS-1270



Power-Sonic rechargeable batteries are lead-lead dioxide systems. The dilute sulphuric acid electrolyte is suspended and thus immobilized. Should the battery be accidently overcharged producing hydrogen and oxygen, special one-way valves allow the gases to escape thus avoiding excessive pressure build-up. Otherwise, the battery is completely sealed and is, therefore, maintenance-free and leak proof.

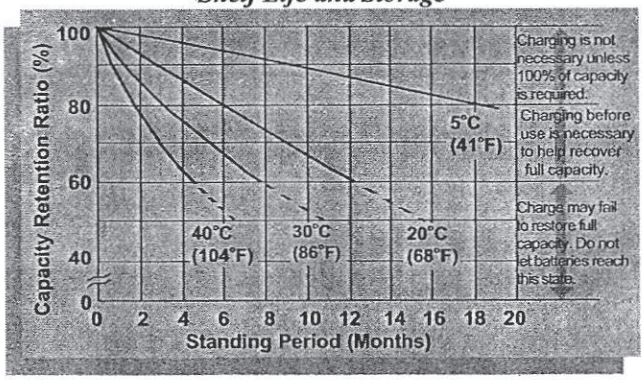
PS-1270 is air transport approved, and meets all current requirements set forth by the C.A.B., F.A.A., I.A.T.A. and D.O.T.

U.L. recognizes model PS-1270 under file number MH 14328.

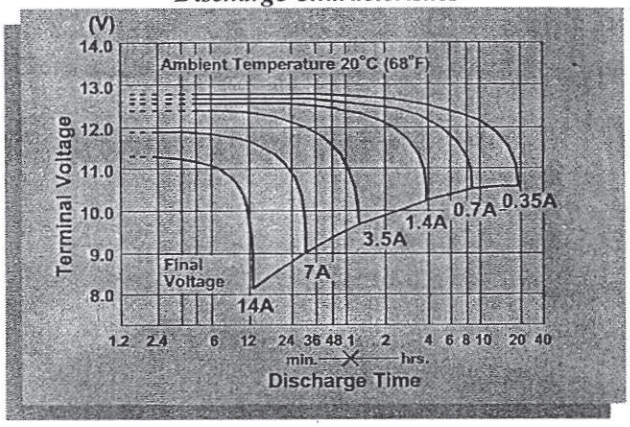
PERFORMANCE SPECIFICATIONS

Nominal Voltage	12 volts (6 cells in series)
Nominal Capacity	
20 hour rate (350mA to 10.50 volts)	7.0 A.H.
10 hour rate (650mA to 10.50 volts)	6.5 A.H.
5 hour rate (1100mA to 10.20 volts)	5.5 A.H.
1 hour rate (4200mA to 9.00 volts)	4.2 A.H.
Approximate Weight	5.75 pounds (2.6 kg)
Energy Density (20 hour rate)	1.49 Watt-hours/cubic inch (91.0 Watt-hours/l)
Specific Energy (20 hour rate)	14.6 Watt-hours/pound (32.2 Watt-hours/kg)
Internal Resistance (Fully Charged Battery)	22 milliohms (approximately)
Maximum Discharge Current (≤ 7 Min.)	21 amperes
Maximum Short-Duration Discharge Current (≤ 10 Sec.)	70 amperes
Terminals	Quick disconnect tabs, 0.187" x 0.032" Mate with AMP, INC. FASTON "187" series.
Vibration Test (2000 cycles/minute, 0.10 inch excursion, 2 hours)	No loss in capacity or performance
Shelf Life — % of nominal capacity at 68° F (20° C)	
1 Month	97%
3 Months	91%
6 Months	83%
Operating Temperature Range	
Charge	-4°F (-20°C) to 122°F (50°C)
Discharge	-4°F (-20°C) to 140°F (60°C)
Case/Cover (Meets UL94V-O flammability rating)	ABS Plastic

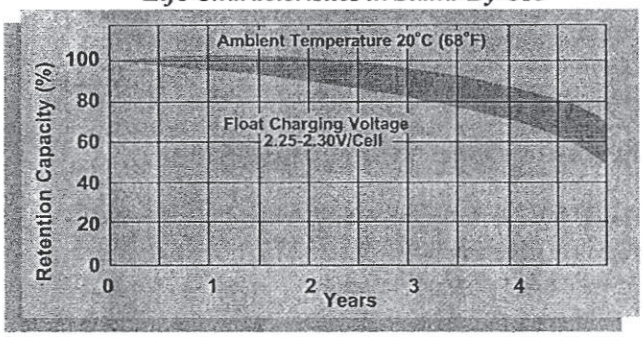
Shelf Life and Storage



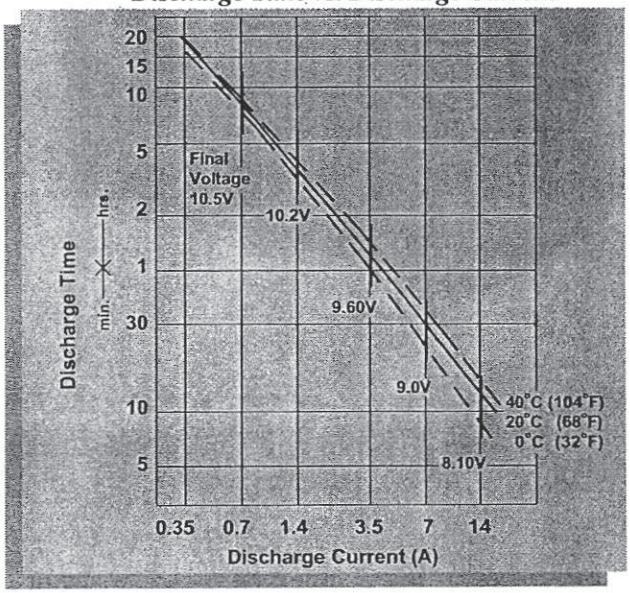
Discharge Characteristics



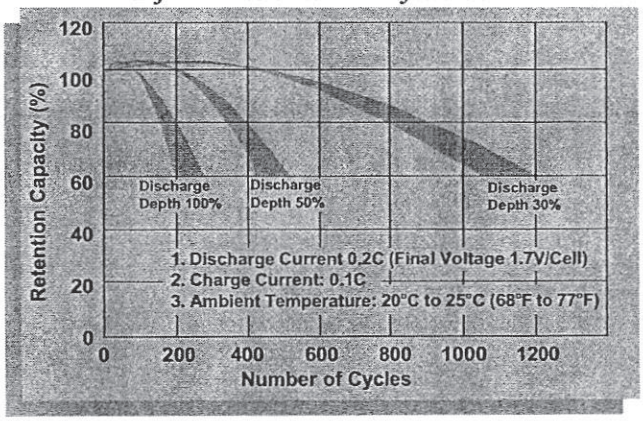
Life Characteristics in Stand-By Use



Discharge Time vs. Discharge Current



Life Characteristics in Cyclic Use



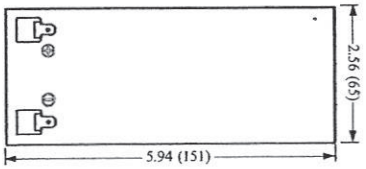
CHARGING

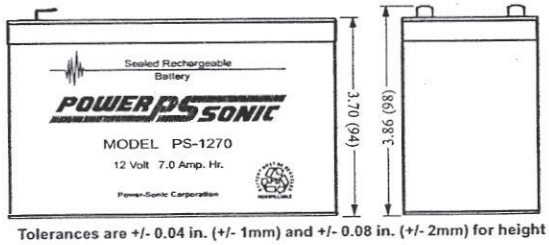
Cycle Applications: Limit initial current to 1500mA. Charge until battery voltage (under charge) reaches 14.40 to 14.70 volts at 68°F (20°C). Hold at 14.40 to 14.70 volts until current drops to approximately 70mA. Battery is fully charged under these conditions, and charger should either be disconnected or switched to "float" voltage.

"Float" or "Stand-By" Service: Hold battery across constant voltage source of 13.50 to 13.80 volts continuously. When held at this voltage, the battery will seek its own current level and maintain itself in a fully charged condition.

NOTE: Due to the self-discharge characteristics of this type of battery, it is imperative that they be charged after 6-9 months of storage, otherwise permanent loss of capacity might occur as a result of sulfation.

Physical Dimensions: in. (mm)





Tolerances are +/- 0.04 in. (+/- 1mm) and +/- 0.08 in. (+/- 2mm) for height dimensions.

POWER SONIC

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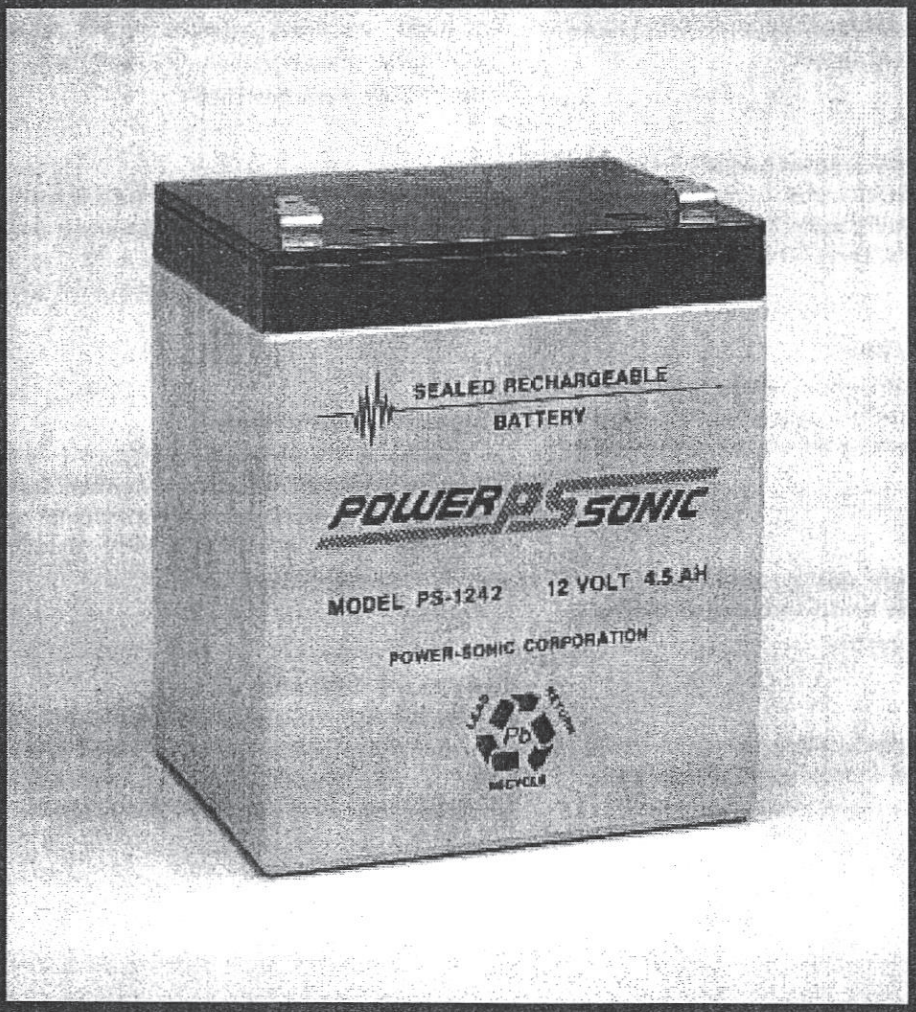
CUSTOMER SERVICE
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PRINTED IN U.S.A.

MAS010 REV 1.0 (effective 9/5/97) 7/98 1.5M

PUBLICATION DIVIDER

POWER SONIC



SEALED LEAD-ACID BATTERIES

TECHNICAL HANDBOOK

USRCS PDF No. 1624

FEATURES

Sealed/Maintenance-Free
The valve regulated, spill-proof construction of the Power-Sonic battery allows trouble-free, safe operation in any position. There is no need to add electrolyte, as gases generated during over-charge are recombined in a unique "oxygen cycle."

Long Shelf Life
A low self-discharge rate permits storage of fully charged batteries for up to a year at room temperature before charging is required. Lower storage temperatures enhance shelf life characteristics even further.

Design Flexibility
Batteries may be used in series and/or parallel to obtain choice of voltage and capacity. Due to recent design breakthroughs, the same battery may be used in either cyclic or standby applications. Over 50 models are available to choose from.

Deep Discharge Recovery
Special separators, advanced plate composition, and a carefully balanced electrolyte system have greatly improved the ability of recovering from excessively deep discharge.

Economical
The high watt-hour per dollar value is made possible by the materials used in a sealed lead-acid battery: they are readily available and low in cost.

Easy Handling
No special handling precautions or shipping containers — surface or air — are required due to the leak-proof construction. Classified as non-hazardous commodity.

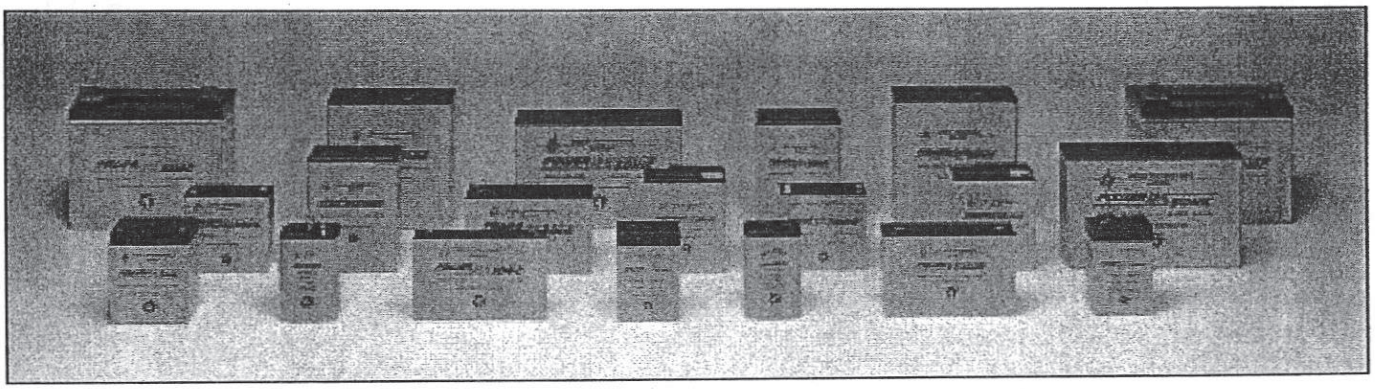
Compact
Power-Sonic batteries use state of the art design, high grade materials, and a carefully controlled plate-making process to provide excellent output per cell. The high energy density results in superior power/volume and power/weight ratios.

High Discharge Rate
Low internal resistance allows discharge currents of up to ten times the rated capacity of the battery. Relatively small batteries may thus be specified in applications requiring high peak currents.

Wide Operating Temperature Range
Power-Sonic batteries may be discharged over a temperature range of -40°C to +60°C (-40°F to +140°F) and charged at temperatures ranging from -20°C to +50°C (4°F to +122°F).

Rugged Construction
The high impact resistant battery case is made either of non-conductive ABS plastic or styrene. Large capacity batteries frequently have polypropylene cases. All of these case materials impart great resistance to shock, vibration, chemicals and heat.

Long Service Life
Under normal operating conditions, four or five years of dependable service life can be expected in stand-by applications, or between 200-1000 charge/discharge cycles depending on average depth of discharge.



CONSTRUCTION

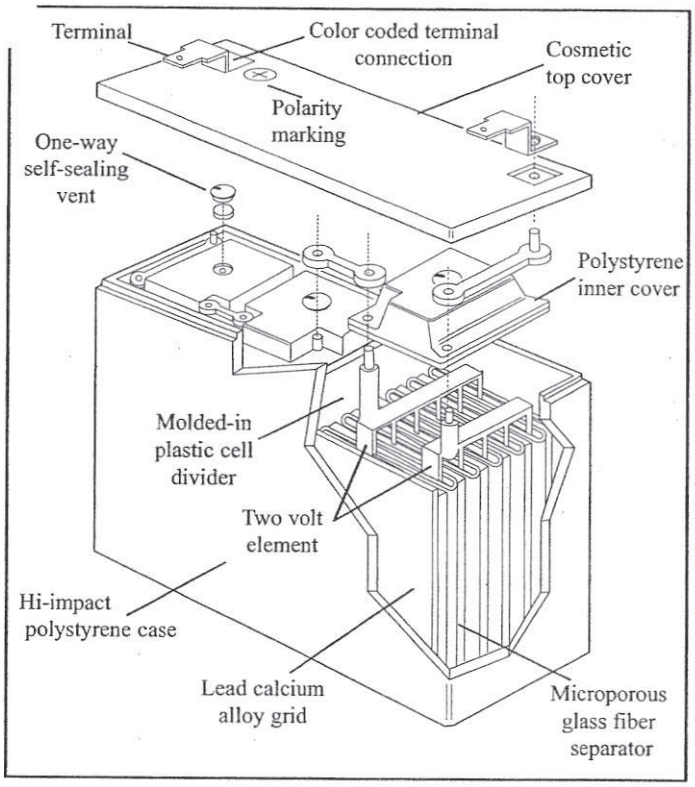


Figure 1

Plates (Electrodes)

Plate construction is the key to producing a good battery. Recognizing this, Power-Sonic utilizes the latest technology and equipment to cast grids from a lead-calcium alloy free of antimony. The small amount of calcium and tin in the grid alloy imparts strength to the plate and guarantees durability even in extensive cycle service. Lead oxide paste is added to the grid to form the electrically active material. In the charged state, the negative plate paste is pure lead and that of the positive lead oxide. Both of these are in a porous or spongy form to optimize surface area and thereby maximize capacity.

Separators

Power-Sonic separators are made of woven glass fiber cloth with high heat and oxidation resistance. The material further offers superior electrolyte absorption and retaining ability, as well as excellent ion conductivity.

Electrolyte

Immobilized dilute sulfuric acid: H_2SO_4.

Container

Case material is either ABS, a high-impact proof plastic resin, styrene, or a polypropylene-polyethylene copolymer with resistance to chemicals and flammability.

Leakproof Design & Operational Safety

Power-Sonic batteries have been approved for shipment by air, both by D.O.T. and I.A.T.A.. U.L.'s component recognition program for emergency lighting and power batteries lists Power-Sonic under file numbers MH14328 and MH14838.

Terminals

Depending on the model, batteries come either with AMP Faston type terminals made of tin plated brass, post type terminals of the same composition with threaded nut and bolt hardware, or heavy duty flag terminals made of lead alloy. A special epoxy is used as sealing material surrounding the terminals.

Relief Valve

In case of excessive gas pressure build-up inside the battery (usually caused by abnormal charging) the relief valve will open and relieve the pressure. The one-way valve not only ensures that no air gets into the battery where the oxygen would react with the plates causing internal discharge, but also represents an important safety device in the event of excessive overcharge. Vent release pressure is between 2-6 psi; the seal ring material is neoprene rubber.

Case Sealing

Depending on model, the case sealing is tongue and groove with polyurethane, epoxy, or heat seal.

THEORY OF OPERATION

The basic electrochemical reaction equation in a lead-acid battery can be written as follows:

Pb	$2H_2SO_4$	PbO_2	Discharging ⇘ Charging	$PbSO_4$	$2H_2O$	$PbSO_4$
(porous lead) active material of negative plate	(sulfuric acid) electrolyte	(porous lead dioxide) active material of positive plate		(lead sulfate) active material of negative plate	(water) electrolyte	(lead sulfate) active material of positive plate

Discharge

During the discharge portion of the reaction, lead dioxide (positive plate) and lead (negative plate) react with sulfuric acid to create lead sulfate, water and energy.

Charge

During the recharge phase of the reaction, the cycle is reversed: the lead sulfate and water are electro-chemically converted to lead, lead oxide and sulfuric acid by an external electrical charging source.

Oxygen Recombination

To produce a truly maintenance-free battery, it is necessary that gases generated during overcharge are recombined in a so-called "oxygen cycle". Should oxygen and hydrogen escape, a gradual drying out would occur, eventually affecting capacity and battery life. During charge, oxygen is generated at the positive and reacts with and partially discharges the sponge lead of the negative. As charging continues, this oxygen recombines with the hydrogen being generated by the negative, forming water. The water content of the electrolyte thus remains unchanged unless the charging rate is too high.

In case of rapid generation of oxygen gas exceeding the absorbing capacity of the negative plate, the pressure relief valve will open to release excessive gas.

Deep Discharge

The Power-Sonic battery is protected against cell shorting by the addition of a buffering agent that insures the presence of acid ions even in a fully discharged state. The need for expensive circuitry in the design of a system to prevent deep discharge and possible cell shorting is thereby reduced considerably.

Power-Sonic defines "deep discharge" as one that allows the battery voltage under load to go below the cut-off (or "final") voltage of a full discharge. The recommended cutoff voltage varies with the discharge rate for a 6 volt battery, for example, it is 5.25V at the 20-hour (0.05C) rate, 5.10V at the 4-hour (0.2C) rate, and 4.5V at the 1/2- hour(1.0C) rate.

It is important to note that deep discharging a battery at high rates for short periods is not nearly as severe as discharging a battery at low rates for long periods of time. To clarify, let's, analyze two examples:

- Battery A is discharged at the 1C rate to zero volts. "C" for a 4 AH battery, for example, is 4 amps. Full discharge is reached after about 30 minutes when the battery voltage drops to 1.5V/cell. At this point, only 50% of rated capacity has been discharged (1C amps x 0.5 hrs = 0.5C Amp. Hrs.) Continuing the discharge to zero volts will bring the total amount of discharged ampere-hours to approximately 75% because the rapidly declining voltage quickly reduces current flow to a trickle. The battery will recover easily from this type of deep discharge.

- Battery B is discharged at the 0.01C rate to zero volts. 0.01C for a 4 AH battery is 40mA. Full discharge is reached after 100+ hours when the terminal voltage drops to 1.75 V/cell. At this point, the battery has already delivered 100% of its rated capacity (0.01 x 100 hrs = 1C Amp. Hrs.). Continuing the discharge to zero volts will keep the battery under load for another 4-5 days(!), squeezing out every bit of stored energy.

This type of "deep" discharge is severe and is likely to damage the battery. The sooner a severely discharged battery is recharged, the better its chances to fully recover.

CAPACITY

The capacity of a battery is the total amount of electrical energy available from a fully charged cell or cells. Its value depends on the discharge current, the temperature during discharge, the final (cut-off) voltage and the general history of the battery.

Capacity, expressed in ampere-hours (AH) is the product of the current discharged and the length of discharge time. The rated capacity (C) of a Power-Sonic battery is measured by its performance over 20 hours of constant current discharge at a temperature of 68°F (20°C) to a cutoff voltage of 1.75 volts.

As an example, Model PS-610, with a rated capacity of 1AH will deliver 50 mA (1/20 of 1AH, or 0.05C) for 20 hours before the voltage drops from 6.45 to 5.25 volts.

By cycling the battery a few times or float charging it for a month or two, the highest level of capacity development is achieved. Power-Sonic batteries are fully charged before leaving the factory, but full capacity is realized only after the battery has been cycled a few times or been on float charge for some time.

The table in *Figure 2* shows capacities for various multiples of the 20-hour discharge current.

Rated Capacity	@ 0.05C rate (20 Hr. Rate.)		@0.1C rate (9 Hr. Rate)		@0.2C rate (4 Hr. Rate)		@0.5C rate (1.3 Hr. Rate)		@1C rate (33 Min. Rate)		@2C rate (12 Min. Rate)		@3C rate (7.2 Min. Rate)	
	Current Amps.	Capacity Amp. Hrs.	Current Amps.	Capacity Amp. hrs.	Current Amps.	Capacity Amp.Hrs.	Current Amps.	Capacity Amp. Hrs.	Current Amps.	Capacity Amp. hrs.	Current Amps.	Capacity Amp. Hrs.	Current Amps.	Capacity Amp. Hrs.
0.5AH	0.025	0.50	0.05	0.45	0.10	0.40	0.25	0.325	0.50	0.28	1.00	0.20	1.50	0.18
0.8AH	0.04	0.80	0.08	0.72	0.16	0.64	0.40	0.52	0.80	0.44	1.60	0.32	2.40	0.29
1.0AH	0.05	1.00	0.10	0.90	0.20	0.80	0.50	0.65	1.00	0.56	2.00	0.40	3.00	0.36
1.3AH	0.065	1.30	0.13	1.17	0.26	1.04	0.65	0.845	1.30	0.715	2.60	0.52	3.90	0.47
2.3AH	0.115	2.30	0.23	2.07	0.46	1.84	1.15	1.495	2.30	1.288	4.60	0.92	6.90	0.83
3.0AH	0.15	3.00	0.30	2.70	0.60	2.40	1.50	1.95	3.00	1.65	6.00	1.20	9.00	1.08
3.2AH	0.16	3.20	0.32	2.88	0.64	2.56	1.60	2.08	3.20	1.76	6.40	1.28	9.60	1.15
4.5AH	0.22	4.40	0.45	4.05	0.90	3.60	2.25	2.92	4.5	2.47	9.00	1.80	13.50	1.62
5.0AH	0.25	5.00	0.50	4.50	1.00	4.00	2.50	3.25	5.00	2.80	10.00	2.00	15.00	1.80
6.5AH	0.325	6.50	0.65	5.85	1.30	5.20	3.25	4.23	6.50	3.64	13.00	2.60	19.50	2.34
7.0AH	0.35	7.00	0.70	6.30	1.40	5.60	3.50	4.55	7.00	3.85	14.00	2.80	21.00	2.52
8.0AH	0.40	8.00	0.80	7.20	1.60	6.40	4.00	5.20	8.00	4.48	16.00	3.20	24.00	2.88
9.0AH	0.45	9.00	0.90	8.10	1.80	7.20	4.50	5.85	9.00	5.04	18.00	3.60	27.00	3.24
10.0AH	0.50	10.00	1.00	9.00	2.00	8.00	5.00	6.50	10.00	5.60	20.00	4.00	30.00	3.60
12.0AH	0.60	12.00	1.20	10.80	2.40	9.60	6.00	7.80	12.00	6.72	24.00	4.80	36.00	4.32
18.0AH	0.90	18.00	1.80	16.20	3.06	14.40	9.00	11.70	18.00	9.90	36.00	7.20	54.00	6.48
20.0AH	1.00	20.00	2.00	18.00	4.00	16.00	10.00	13.00	20.00	11.20	40.00	8.00	60.00	7.20
26.0AH	1.30	26.00	2.60	23.40	5.20	20.80	13.00	16.90	26.00	14.30	52.00	10.40	78.00	9.36
28.0AH	1.40	28.00	2.80	25.20	5.40	21.60	14.00	18.20	28.00	15.40	54.00	10.88	84.00	10.08
33.0AH	1.65	33.00	3.30	29.70	6.60	26.40	16.50	21.45	33.00	18.15	66.00	13.20	99.00	11.88
40.0AH	2.00	40.00	4.00	36.00	8.00	32.00	20.00	26.00	40.00	22.40	80.00	16.00	120.00	14.40
55.0AH	2.75	55.00	5.50	49.50	11.00	44.00	27.50	35.75	55.00	30.25	110.00	22.00	165.00	19.80
60.0AH	3.00	60.00	6.00	54.00	12.00	48.00	30.00	39.00	60.00	33.60	120.00	24.00	180.00	21.60
75.0AH	3.75	75.00	7.50	67.50	15.00	60.00	37.50	48.75	75.00	41.25	150.00	30.00	225.00	27.00
80.0AH	4.00	80.00	8.00	72.00	16.00	64.00	40.00	52.00	80.00	44.80	160.00	32.00	240.00	28.80
100.0 AH	5.00	100.00	10.00	90.00	20.00	80.00	50.00	65.00	100.00	55.00	200.00	40.00	300.00	36.00

Figure 2

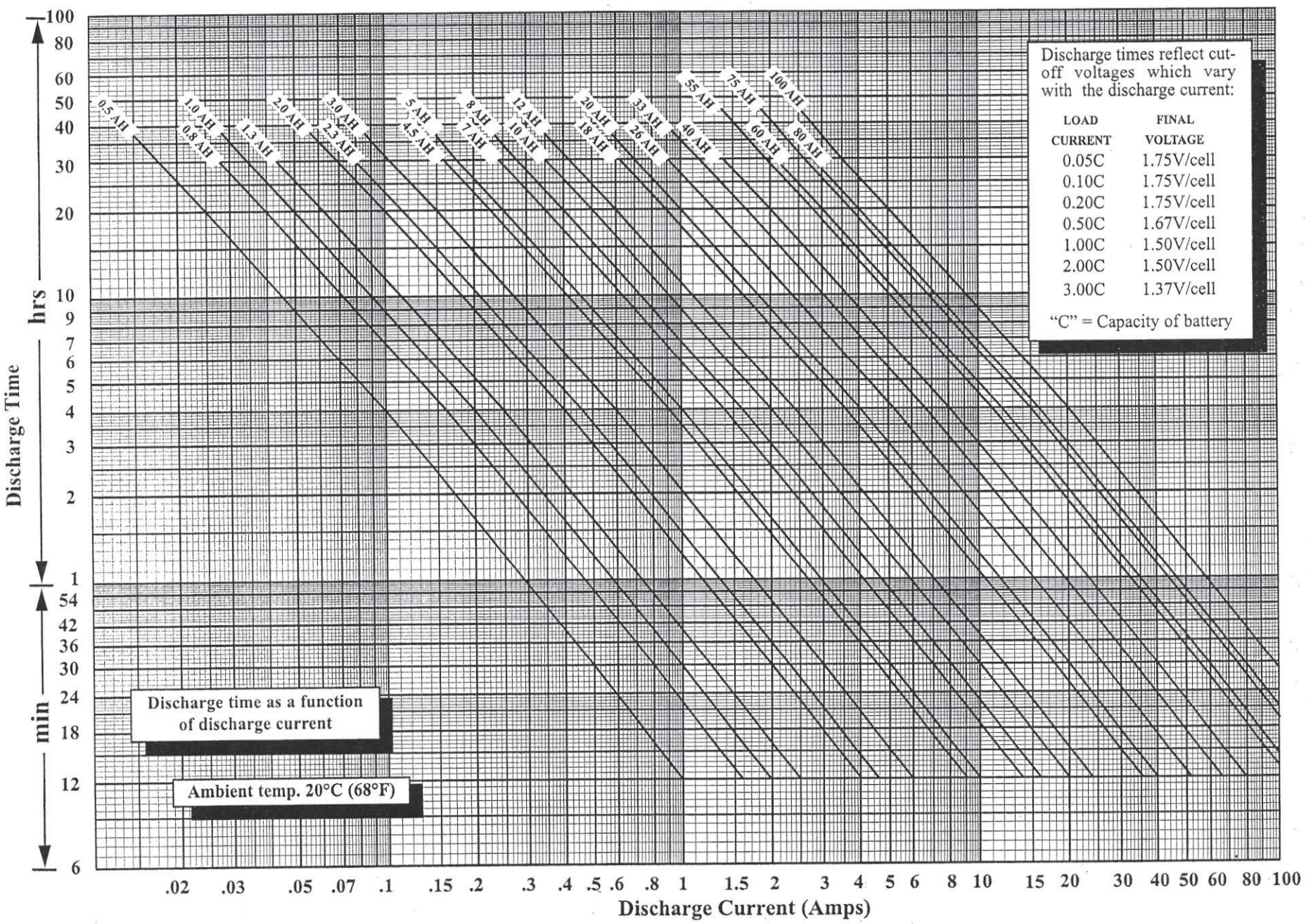
When a battery discharges at a constant rate, its capacity changes according to the amperage load. Capacity increases when the discharge current is less than the 20-hour rate and decreases when the current is higher.

Figure 3 shows capacity curves for major Power-Sonic battery models with different ampere-hour ratings. Amperage is on the horizontal scale and the time elapsed is on the vertical scale; the product of these values is the capacity.

Proper battery selection for a specific application can be made from this graph if the required time and current are known. For example, to determine the proper capacity of a battery providing 3 amps for 20 minutes, locate the intersection of these values on the graph. The curve immediately above that point represents the battery which will meet the requirement.

CAPACITY VARIATION BY CURRENT LOAD

Figure 3



PERFORMANCE DATA

Discharge

During discharge the voltage will decrease. The graphs in *Figure 4* illustrate this for different discharge rates and ambient temperatures. "C" is the rated capacity of a battery: "C" for Model PS-610 (6V - 1AH) is 1AH. By convention, rating of nearly all sealed-lead acid batteries, including Power-Sonic, is based on a 20-hour (0.05C) discharge rate .

An important feature of Power-Sonic batteries is shown in the discharge curves; namely, the voltage tends to remain high and almost constant for a relatively long period before declining to an end voltage.

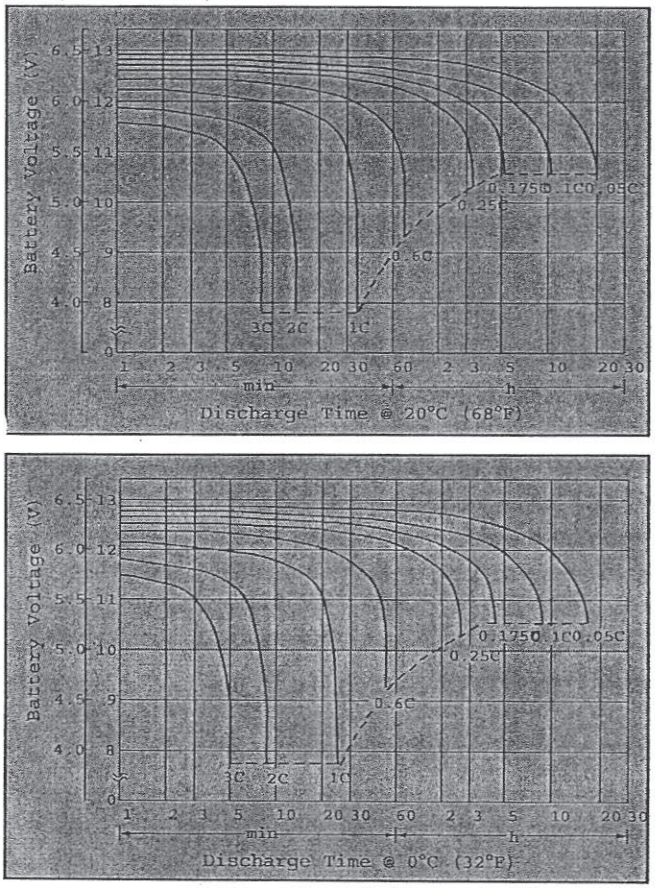


Figure 4: Characteristic Discharge Curves

Open-Circuit Voltage

Open circuit voltage varies according to ambient temperature and the remaining capacity of the battery. Generally, open circuit voltage is determined by the specific gravity of the electrolyte. Discharging a battery lowers the specific gravity. Consequently, it is possible to determine the approximate remaining capacity of a battery from the terminal voltage.

The open circuit voltage of a Power-Sonic battery is 2.15 V/cell when fully charged and 1.94 V/cell when completely discharged.

As seen in *Figure 4,* under load, the battery can deliver useful energy at less than 1.94 V/cell, but after the load is removed the open circuit voltage will "bounce back" to voltages shown in *Figure 5*, dependent upon residual capacity.

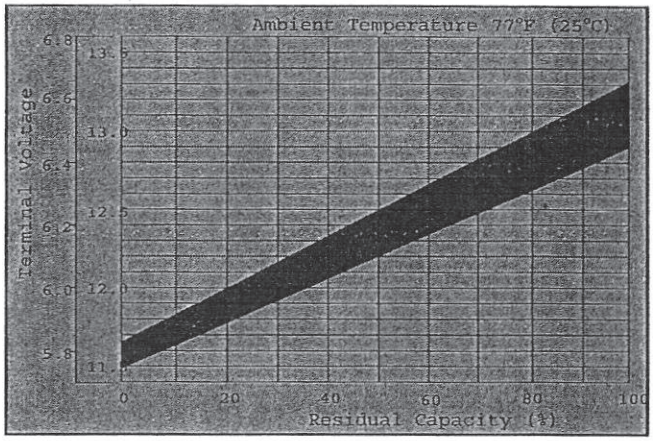


Figure 5: Open-Circuit Voltage Characteristics

Temperature

Actual capacity is a function of ambient temperature and rate of discharge. At 68°F (20°C) rated capacity is 100%. The capacity increases slowly above this temperature and decreases as the temperature falls. Even at -40°F (-40°C), however , the Power-Sonic battery will still function at better than 30% of its rated capacity when discharged at the 20-hour rate (0.05C). At any ambient temperature, the higher the rate of discharge, the lower the available capacity. This relationship is shown in *Figure 6.*

Power-Sonic batteries may be discharged at temperatures ranging from -40°F to 140°F (-40°C to 60°C) and charged at temperatures from -4°F to 122°F (-20°C to 50°C).

While raising ambient temperature increases capacity, it also decreases useful service life. It is estimated that battery life is halved for each 10°C above normal room temperature.

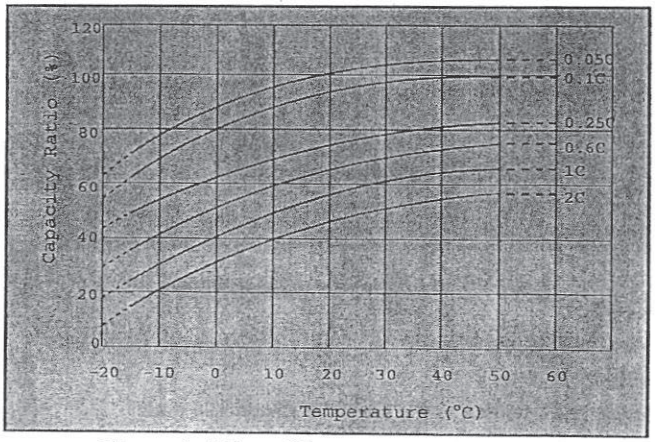


Figure 6: Effect of Temperature on Capacity

Figure 7 shows the relationship between current and discharge time for different ambient temperatures.

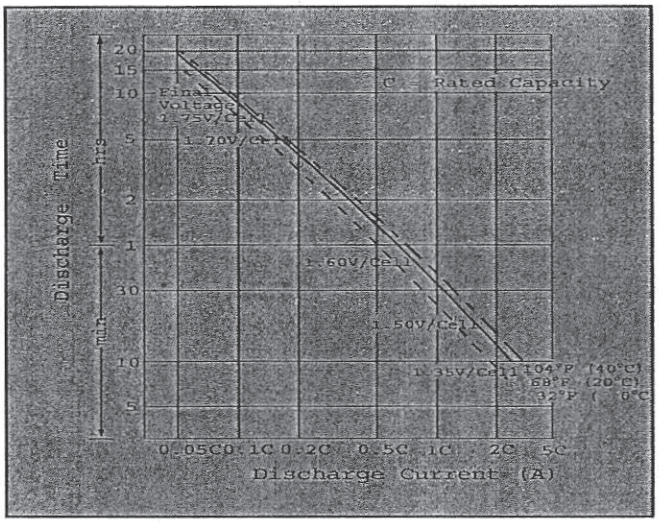


Figure 7: Discharge Time vs. Discharge Current

Shelf Life & Storage

Low internal resistance and special alloys in the electrodes assure a low self discharge rate and, consequently, a long shelf life. If kept at 68°F (20°C), about 60-70% of the nominal capacity remains after one year of storage. One recharge per year is sufficient to maintain the original capacity of a battery not in use.

The rate of self discharge varies with the ambient temperature. At room temperature it is about 3% per month. At low temperatures it is nearly negligible, at higher ambient temperatures self discharge increases.

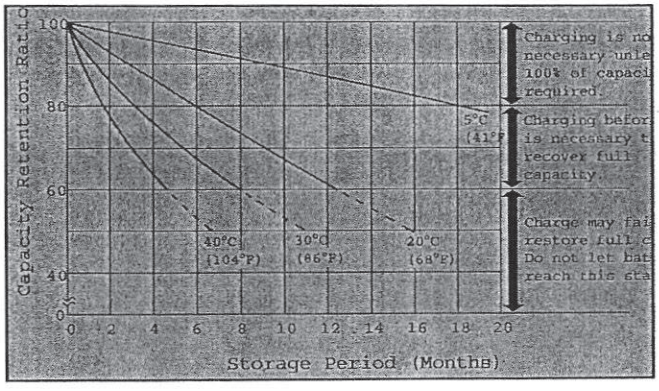


Figure 8: Self Discharge Characteristics

To obtain maximum battery life and performance, batteries should be:

- recharged as soon as possible after each use and not stored in a discharged state;
- stored at 68°F (20°C) or lower, if possible, and
- recharged annually when not used.

Battery Life

Cyclic Use: The number of charge/discharge cycles depends on the capacity taken from the battery (a function of discharge rate and depth of discharge), operating temperature and the charging method.

Figure 9 shows the relationship between depth of discharge and number of cycles as well as increases of capacity during the early cycles.

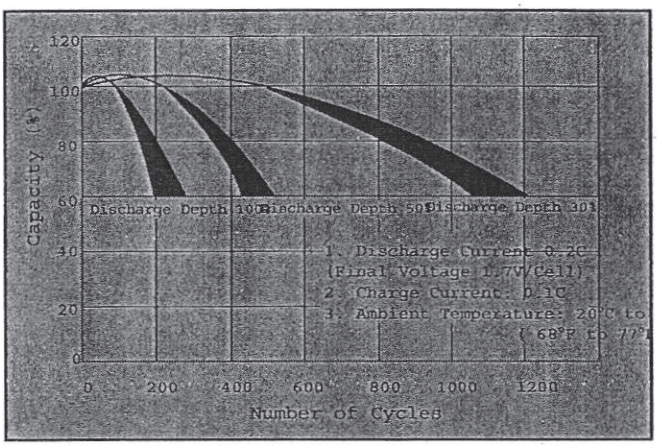


Figure 9: Depth of Discharge vs. Number of Cycles

Standby Use: The float service life, or life expectancy under continuous charge, depends on the frequency and depth of discharge, the charge voltage, and the ambient temperature. At a float voltage of 2.25V to 2.30V/cell and an ambient temperature of 60°F to 77°F (20°C to 25°C) Power-Sonic batteries should last four to five years before the capacity drops to 60% of its original rating.

Figure 10 indicates how capacity changes over time.

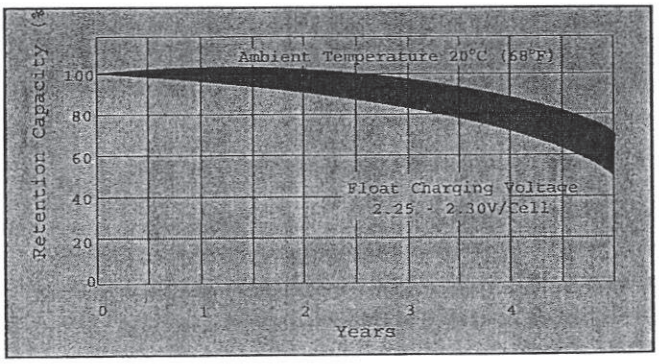


Figure 10: Life Characteristics in Standby Use

PERFORMANCE DATA

The graph in *Figure 11* shows life characteristics in float (standby) service for ambient temperatures ranging from 15°C to 55°C

If prevailing ambient temperatures are well above 20-25°C the life expectancy of this type of battery in float service depends greatly on temperature compensated charging. The typical temperature coefficient is -2mV/cell/°C. The graph shown along side is based on temperature compensated charging.

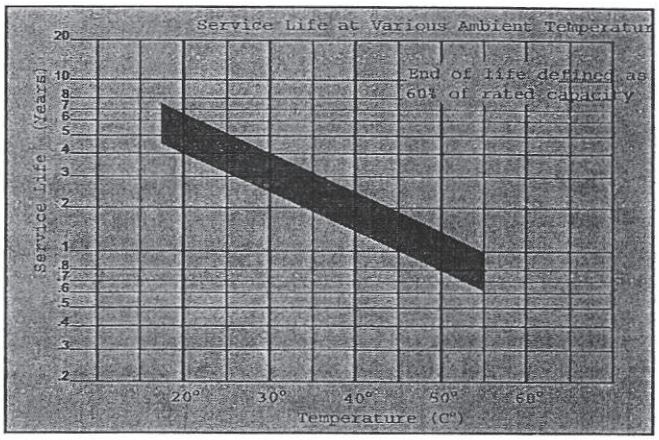


Figure 11: Service Life at Various Ambient Temperatures

OVER-DISCHARGE PROTEC-

To optimize battery life, it is recommended that the battery be disconnected from the load when the end voltage – a function of the discharge rate – is reached. It is the voltage point at which 100% of the usable capacity of the battery has been consumed or continuation of the discharge is useless because of the voltage dropping below useful levels. (see section on Deep Discharge on page 3)

Discharging a sealed lead-acid battery below this voltage or leaving a battery connected to a load will impair the battery's ability to accept a charge. To prevent potential over-discharge problems, voltage cut-off circuits as shown in *Figure 12* may be used.

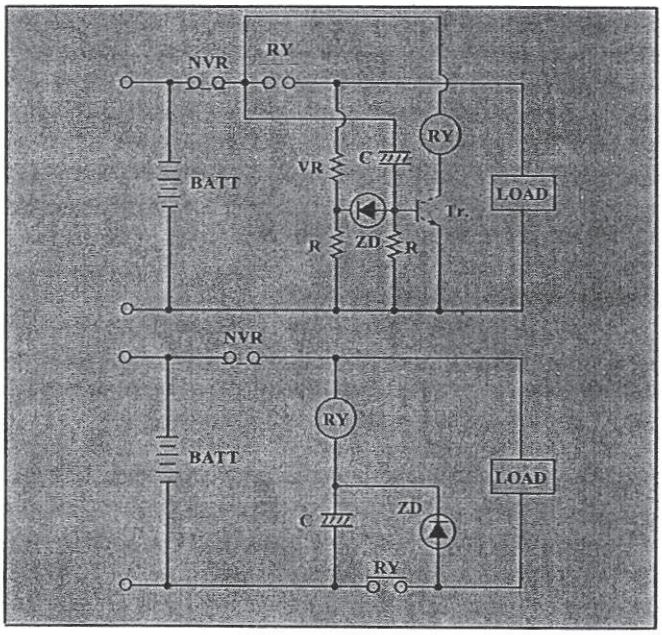


Figure 12: Circuits of Over-Discharge Preventive Device

CHARGING

Dependable performance and long service life depend upon correct charging. Faulty procedures or inadequate charging equipment result in decreased battery life and/or unsatisfactory performance. The selection of suitable charging circuits and methods is as important as choosing the right battery for the application.

General

To charge a Power-Sonic battery, a DC voltage higher than the open-circuit voltage of 2.15 is applied to the terminals of the battery. Depending on the state of charge, the cell may temporarily be lower (after discharge) or higher (right after charging) than 2.15 volts. After some time, however, it should level off at about 2.15 volts per cell.

Power-Sonic batteries may be charged by using any of the conventional charging techniques. To obtain maximum service life and capacity, along with acceptable recharge time and economy, constant voltage-current limited charging is recommended.

During charge, the lead sulfate of the positive plate becomes lead dioxide. As the battery reaches full charge, the positive plate begins generating dioxide causing a sudden rise in voltage. A constant voltage charge, therefore, allows detection of this voltage increase and thus control of the charge amount.

Overcharging: As a result of too high a charge voltage excessive current will flow into the battery after reaching full charge causing decomposition of water in the electrolyte and, hence, premature aging.

At high rates of overcharge a battery will progressively heat up. As it gets hotter, it will accept more current, heating up even further. This is called thermal runaway, and can destroy a battery in as little as a few hours.

Undercharging: If too low a charge voltage is applied, the current flow will essentially stop before the battery is fully charged. This allows some of the lead sulfate to remain on the electrodes which will eventually reduce capacity.

Batteries which are stored in a discharged state, or left on the shelf for too long, may initially appear to be "open circuited" or will accept far less current than normal. This is caused by a phenomenon called "sulfation". When this occurs, leave the charger connected to the battery. Usually, the battery will start to accept increasing amounts of current until a normal current level is reached. If there is no response, even to charge voltages above recommended levels, the battery may have been in a discharged state for too long to recover.

Charging Characteristics

During constant voltage or taper charging, the battery's current acceptance decreases as voltage and state of charge increase. The battery is fully charged once the current stabilizes at a low level for a few hours.

Caution: Never charge or discharge a battery in a hermetically sealed enclosure. Batteries generate a mixture of gases internally. Given the right set of circumstances, such as extreme overcharging or shorting of the battery, these gases might vent into the enclosure and create the potential for an explosion when ignited by a spark.

If in doubt, or concepts of proper use and care are unclear, contact Power-Sonic's department for application engineering at 619-661-2020.

Please note that there are two criteria for determining when a battery is fully charged: (1) the final current level and (2) the peak charging voltage while this current flows.

Figure 13 depicts an example of typical charge characteristics for cycle service where charging is non-continuous and peak voltage can, therefore, be higher.

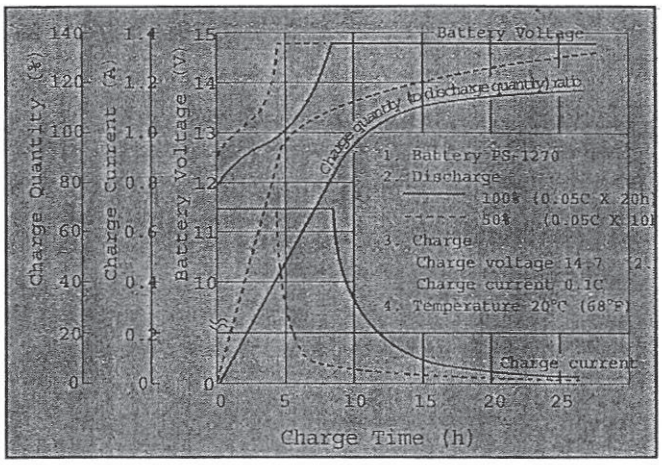


Figure 13: Charge characteristics for 14.7V Constant Voltage

Figure 14 illustrates typical characteristics for standby service type charge. Here, charging is continuous and the peak charge voltage must, therefore, be lower.

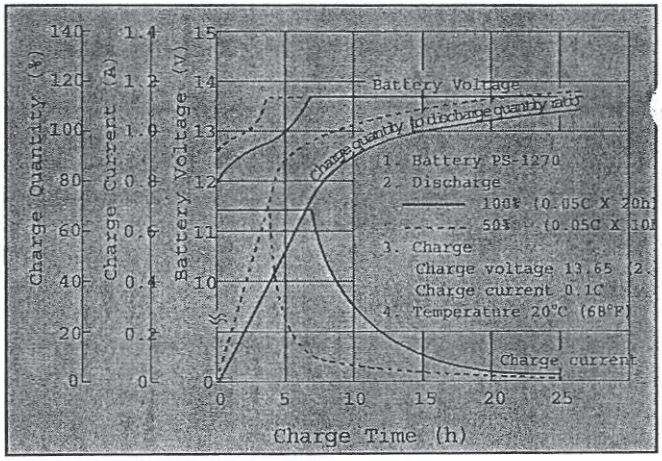


Figure 14: Charge Characteristics for 13.65V Constant Voltage

Charging Methods

Selecting the appropriate charging method depends on the intended use (cyclic or float service), economic considerations, recharge time, anticipated frequency and depth of discharge, and expected service life. The key goal of any charging method is to control the charge current at the end of the charge.

Taper Charging: This is the simplest, least expensive charging method. Either quasi-constant voltage or quasi-constant current characteristics can be built into the charger through combination of transformer, diode and resistance. Of the two, constant potential charging is preferable.

Typical taper chargers are comprised of small transformer-rectifier circuits wherein the transformer is so designed that the current is limited to the maximum initial charge current for the battery. This current is held constant until the terminal voltage and resultant current demand reach a point at which the charge current begins to fall. Although this type of charger can provide a relatively fast recharge, it is basically a constant current device and the charge voltage may be driven too high. Therefore, it must be disconnected, usually within 12-24 hours, or after 100-120% of the preceding discharge has been returned. It is also sensitive to line voltage variations which can cause over- or under-charging. Consequently, this charging method can only be used in cyclic applications

Figure 15 shows an example of a typical diagram and *Figure 16* the resultant charge characteristics for this type of basically unregulated charger.

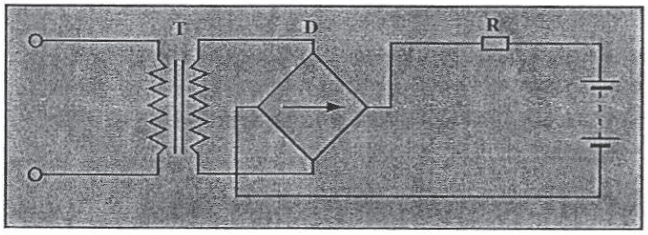


Figure 15: Semi-Constant Current Charging Circuit

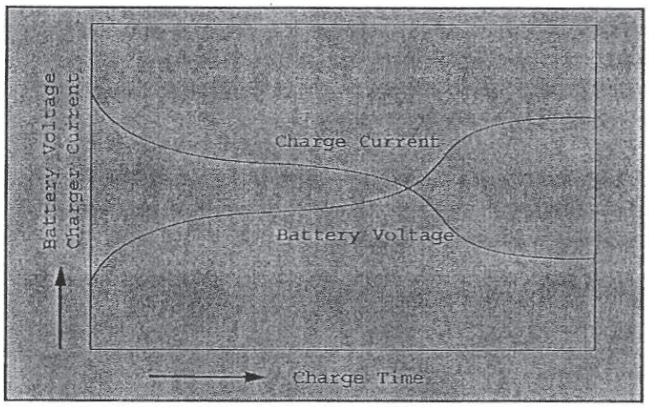


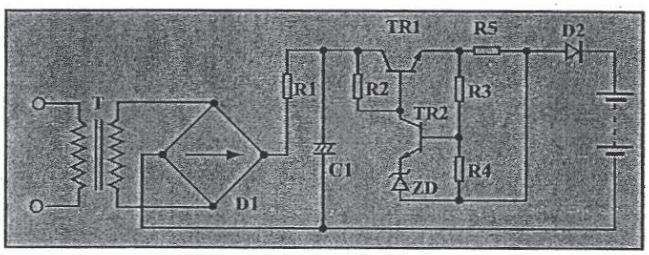
Figure 16: Semi-Constant Current Charge Characteristics

Constant Current Charging: Constant current charging is suited for applications where discharged ampere-hours of the preceding discharge cycle are known. Charge time and charge quantity can easily be calculated, however an expensive circuit is necessary to obtain a highly accurate constant current. Monitoring of charge voltage or limiting of charge time is necessary to avoid excessive overcharge.

While this charging method is very effective for recovering the capacity of a battery that has been stored for an extended period of time, or for occasional overcharging to equalize cell capacities, it lacks specific properties required in today's electronic environment.

An example of a constant current charge circuit is shown in *Figure 17* and the charge characteristics for this type of charger in *Figure 18.*

Figure 17: Constant Current Charging Circuit



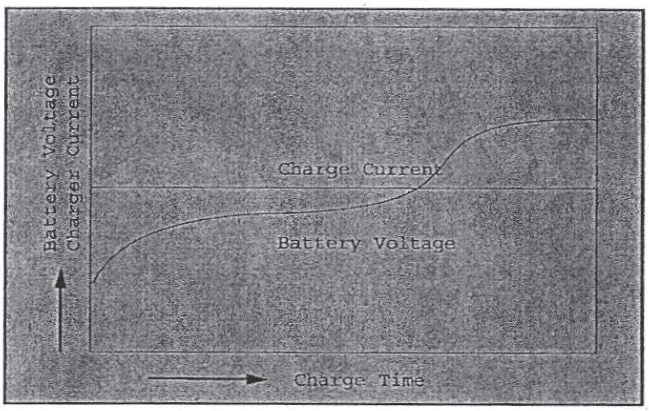


Figure 18: Constant Current Charge Characteristics

Constant Voltage Charging: Constant current/constant voltage charging is the best method to charge Power-Sonic batteries. Depending on the application, batteries may be charged either on a continuous or non-continuous basis. In applications where standby power is required to operate when the AC power has been interrupted, continuous float charging is recommended. Non-continuous cyclic charging is used primarily with portable equipment where charging on an intermittent basis is appropriate.

The constant current/constant voltage charge method applies a constant voltage to the battery and limits the initial charge current. It is necessary to set the charge voltage according to specified charge and temperature characteristics. Inaccurate voltage settings cause over- or under-charge. This charging method can be used for both cyclic and standby applications.

Figures 19 and *20* illustrate examples of a constant current/constant voltage charging circuit and charging characteristics, respectively. The circuit diagram includes a temperature compensation feature for charge voltage to ensure optimum charging conditions regardless of changes in ambient temperature.

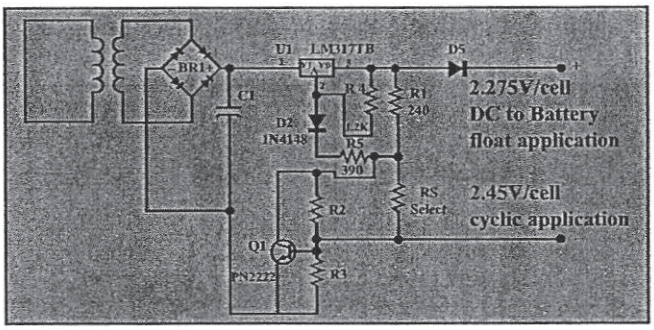


Figure 19: Constant Current/Constant Voltage Charge Circuit

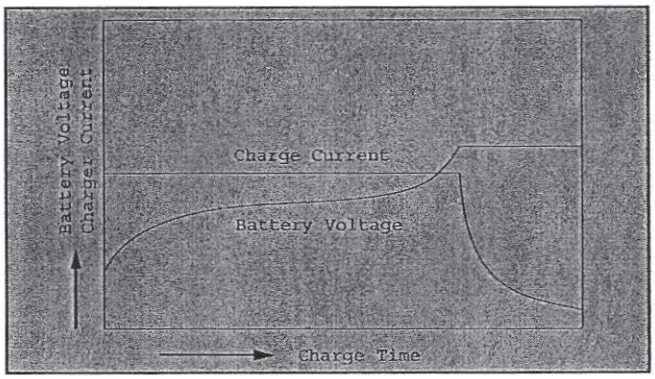


Figure 20: Constant Current/Constant Voltage Charge Characteristics

Charging for Cycle Operation

Cyclic applications generally require that recharging be done in a relatively short time. The initial charge current, however, must not exceed 0.20 x C amps. Just as battery voltage drops during discharge, it slowly rises during charge. Full charge is determined by voltage and inflowing current. When, at a charge voltage of 2.45 ±0.05 volts/cell, the current accepted by the battery drops to less than 0.01 x C amps (1% of rated capacity), the battery is fully charged and the charger should be disconnected or switched to a float voltage of 2.25 to 2.30 volts/cell. The voltage should not be allowed to rise above 2.45 ±0.05 volts/cell.

Charging for Standby Operation

Standby applications generally do not require that the battery be charged as fast or as frequently as in cycle operation. However, the battery must be kept constantly charged to replace the energy that is expended due to internal loss and deterioration of the battery itself. Although these losses are very low in Power-Sonic batteries, they must be replaced at the rate the battery self-discharges; at the same time the battery must not be given more than these losses or it will be overcharged. To accomplish this, a constant voltage method of charging called "float charging" is used.

The recommended constant float voltage is 2.25-2.30 volts per cell. Maintaining this float voltage will allow the battery to define its own current level and remain fully charged without having to disconnect the charger from the battery. The trickle current for a fully charged battery floating at the recommended charge voltage will typically hover around the 0.001C rate (10mA for a 10AH battery, for example.)

The float charger is basically a constant voltage power supply. As in cycle chargers, however, care must be exercised not to exceed the initial charge current of 0.20 x C amperes.

Two-Step Constant Voltage Charging

This method uses two constant voltage devices. In the initial charge phase the high voltage setting is used. When charging is nearly complete and the charge voltage has risen to a specified value (with the charge current decreased), the charger switches the voltage to the lower setting. This method allows rapid charging in cycle or float service without the possibility of overcharging even after extended charging periods.

The graph in *Figure 21* shows charging characteristics, and the diagram in *Figure 22* an example of a charging circuit for this type of charger.

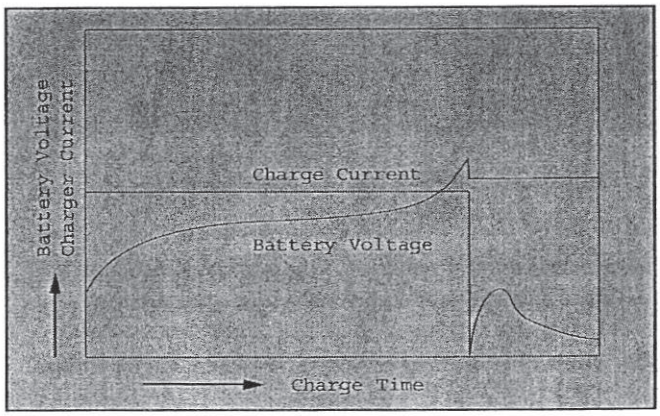


Figure 21: Two-Step Constant Voltage Charge Characteristics

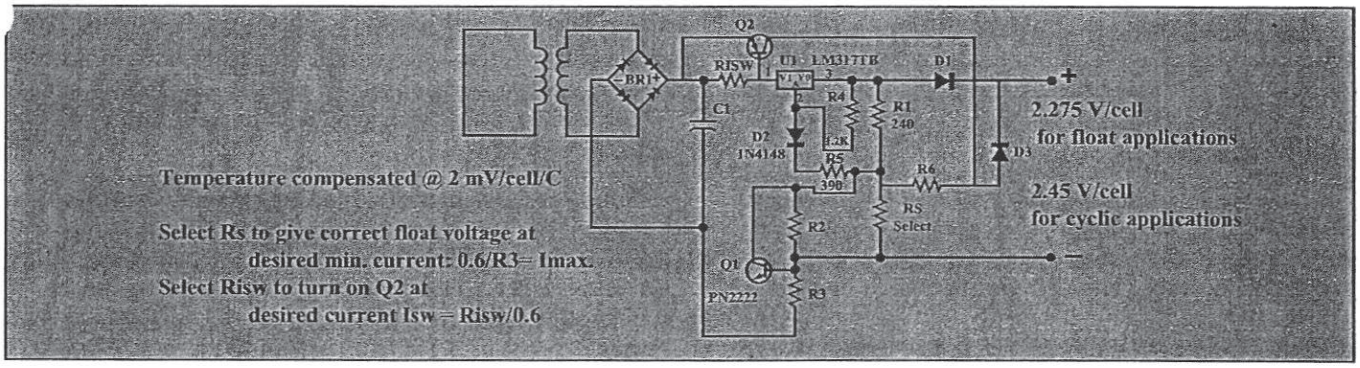


Figure 22: Dual Stage Current Limited Battery Charger

Charging in Series: Lead-acid batteries are strings of 2 volt cells connected in series, commonly 2, 3 ,4 or 6 cells per battery. Strings of Power-Sonic batteries up to 48 volts and higher may be charged in series safely and efficiently. However, as the number of batteries in series increases, so does the possibility of slight differences in capacity. These differences can result from age, storage history, temperature variations or abuse.

When a single constant voltage charger is connected across an entire high voltage string, the same current flows through all cells in the string. Depending on the characteristics of the individual batteries, some may overcharge while others remain in a slightly undercharged condition. When charging high voltage strings this way for extended periods it is generally recommended to use a low input voltage inverter to enhance service life and simplify charging requirements.

If one cell is lower in capacity than the others when discharging a long string in series, it may actually reverse polarity even though the total voltage of the string is at or above the cut-off voltage.

To minimize the effects of individual battery differences, use batteries of the same age and history and, if possible, charge in strings of no greater than 24 or 48 volts.

Charging in Parallel: Power-Sonic batteries may be used in parallel with one or more batteries of equal voltage.

When connected in parallel, the current from a charger will tend to divide almost equally between the batteries. No special matching of batteries is required. If the batteries of unequal capacity are connected in parallel, the current will tend to divide between the batteries in the ratio of capacities (actually, internal resistances).

When charging batteries in parallel, where different ratios of charge are to be expected, it is best to make provisions to assure that the currents will not vary too much between batteries. Holding a small resistance in series with each battery is all that is needed

Temperature Compensation

Power-Sonic batteries perform well both at low and high temperatures. At low temperatures, however, charge efficiency is reduced; at temperatures above 45°C, charge efficiency increases so rapidly that there is a danger of thermal runaway if temperature compensation is not precise.

The effect of temperature on charge voltage is less critical in float applications, than in cyclic use where relatively high charge currents are applied for the purpose of short recharge times.

Temperature effects should definitely be considered when designing or selecting a charging system. As a rule of thumb, temperature compensation is desirable in the charging circuit when operating outside the range of 41°F to 95°F (5°C to 35°C) prevailing ambient. The temperature coefficient is -2mV/cell/°C below 20°C in standby service and -6mV/cell/°C below 20°C in cyclic use. For higher temperatures the charge voltage should be correspondingly decreased.

The table in *Figure 23* lists recommended charge voltages for different temperatures.

AMBIENT TEMPERATURE	CHARGE VOLTAGE PER CELL	
	Cyclic use	Float Use
4 °F(-20 °C)	2.67-2.77V	2.34-2.39V
14 °F(-10 °C)	2.61-2.71V	2.32-2.37V
32 °F(0 °C)	2.55-2.65V	2.30-2.35V
50 °F(+10 °C)	2.49-2.59V	2.28-2.33V
68 °F(+20 °C)	2.43-2.53V	2.26-2.31V
77 °F(+25 °C)	2.40-2.50V	2.25-2.30V
86 °F(+30 °C)	2.37-2.47V	2.24-2.29V
104 °F(+40 °C)	2.31-2.41V	2.22-2.27V
122 °F(+50 °C)	2.25-2.35V	2.20-2.25V

Figure 23: Temperature Compensated Charge Voltage

APPLICATION NOTES

Power-Sonic rechargeable sealed lead-acid batteries are designed to provide years of dependable service. Adherence to the following guidelines in system design will ensure that battery life is maximized and operation is trouble-free.

• Continuous over-or undercharging is the single worst enemy of a lead-acid battery. Caution should be exercised to ensure that the charger is disconnected after cycle charging, or that the float voltage is set correctly.

• Batteries should not be stored in a discharged state or at elevated temperatures. If a battery has been discharged for some time or the load was left on indefinitely, it may not readily take a charge. To overcome this, leave the charger connected and the battery should eventually begin to accept charge.

• Avoid exposing batteries to heat! Care should be taken to place batteries away from heat-emitting components. If close proximity is unavoidable, provide ventilation. Service life is shortened considerably at ambients above 30°C.

• Although Power-Sonic batteries have a low self-discharge rate which permits storage of a fully charged battery for up to a year, it is recommended that a battery be charged 6-9 months after receipt to account for storage from the date of manufacture to the date of purchase. Otherwise, permanent loss of capacity might occur as a result of sulfation. To prolong shelf life without charging, store batteries at 50°F (10°C) or less.

• Fasten batteries tightly and make provisions for shock absorption if exposure to shock or vibration is likely.

• Although it is possible to charge Power-Sonic batteries rapidly, i.e. in 6-7 hrs., it is not normally recommended. Unlimited current charging can cause increased off-gassing and premature drying. It can also produce internal heating and hot spots resulting in shortened service life. Too high a charge current will cause a battery to get progressively hotter. This can lead to "thermal runaway" and can destroy a battery in as little as a few hours.

• Caution: Never charge or discharge a battery in an airtight enclosure. Batteries generate a mixture of gases internally. Given the right set of circumstances such as extreme overcharging or shorting of the battery, these gases might vent into the enclosure and create the potential for an explosion when ignited by a spark. Generally, ventilation inherent in most enclosures is sufficient to avoid problems.

• Do not place batteries in close proximity to objects which can produce sparks or flames, and do not charge batteries in an inverted position.

• When charging batteries in series (positive terminal of one battery is connected to the negative terminal of another), all batteries in the string will receive the same amount of charge current, though individual battery voltages may vary.

• When charging batteries in parallel (positive terminals are connected to the positive terminal and negative terminals to the negative), all batteries in the string will receive the same charge voltage but the charge current each battery receives will vary until equalization is reached.

• High voltage strings of batteries in series should be limited to twenty 6 volt or ten 12 volt batteries when a single constant voltage charger is connected across the entire string . Differences in capacity can cause some batteries to overcharge while others remain undercharged thus causing premature aging of batteries. It is, therefore, not advisable to mix batteries of different capacities, make, or age in a series string.

To minimize the effects of cell or battery differences, charge the string in 24 volt battery groups through a constant current source with zener diode regulation across individual batteries or battery groups.

• To prevent problems arising from heat exchange between batteries connected in series or parallel, it is advisable to provide air space of at least 0.4" (10mm) between batteries.

• Battery containers, made of ABS plastic or styrene, can sustain damage if exposed to organic solvents or adhesives.

• Recharge time depends on the depth of the preceding discharge and the output current of the charger. To determine the approximate recharge time of a fully discharged battery, divide the battery's capacity (amp. hrs.) by the rated output of the charger (amps.) and multiply the resulting number of hours by a factor of 1.75 to compensate for the declining output current during charge. If the amount of amp. hrs. discharged from the battery is known, use it instead of the battery's capacity to make the calculation.

• For best results and generally acceptable performance and longevity, keep operating temperature range between -20°C and +40°C.

• Do not attempt to disassemble batteries. Contact with sulfuric acid may cause harm. Should it occur, wash skin or clothes with liberal amounts of water. Do not throw batteries into fire; batteries so disposed may rupture or explode. Disassembled batteries are hazardous waste and must be treated accordingly. It is unlawful to dispose of batteries except through a recycling center.

GLOSSARY

Ambient Temperature
The prevailing surface temperature to which a battery is exposed.

Ampere
Unit of measurement for electric current.

Ampere-Hour
The product of current (amperes) multiplied by time (hours). Used to indicate the capacity of a battery. Also Amp.Hr. or A.H.

Battery
Two or more cells connected together, most typically in series.

Capacity
The electrical energy available from a cell or battery expressed in ampere-hours.
Available capacity refers to ampere-hours that can be discharged from a battery based on its state of charge, rate of discharge, ambient temperature, and specified cut-off voltage.
Rated capacity ("C") is the discharge capacity the manufacturer says may be obtained at a given discharge rate and temperature.

Cell
The basic building block of a battery. The nominal voltage of a lead-acid battery is 2 volts.
Cell reversal – the act of driving a cell into reverse polarity by excessive discharge.
Primary cell – cell or battery that can be discharged only once.
Secondary cell – the process is reversible so that charging and discharging may be repeated over and over.

Charge
The conversion of electrical energy to chemical energy; the process which restores electrical energy to a cell or battery.
Charge retention refers to a battery's ability to hold a charge. It diminishes during storage.
Charge acceptance quantifies the amount of electric charge which accumulates in a battery.
Float charge maintains the capacity of a cell or battery by applying a constant voltage.
Trickle charge maintains the capacity of a cell or battery by applying a small constant current.
Charge equalization brings all of the cells in a battery or string to the same state of charge.

Discharge
The process of drawing current from a battery.
Deep Discharge – the discharge of a cell or battery to between 80% and 100% of rated capacity.
Depth of Discharge – the mount of capacity – typically expressed as a percentage – removed during discharge.
Self Discharge – the loss of capacity while stored or not in use.
Self Discharge Rate – the percent of capacity lost on open circuit over a specified period of time.

Electrode
Positive or negative plate containing materials capable of reacting with electrolyte to produce or accept current.

Energy Density
Ratio of battery energy to volume or weight expressed in watt-hours per cubic inch or pound.

Gas Recombination
The process by which oxygen gas generated from the positive plate during the final stage of charge is absorbed into the negative plate, preventing loss of water.

Impedance
The resistive value of a battery to an AC current expressed in ohms (Ω). Generally measured at 1000 Hz at full charge.

Internal Resistance
The resistance inside a battery which creates a voltage drop in proportion to the current draw.

Nominal Voltage / Nominal Capacity
The nominal value of rated voltage / the nominal value of rated capacity. The nominal voltage of a lead-acid battery is 2 volts per cell.

Open Circuit Voltage
The voltage of a battery or cell when measured in a no load condition.

Parallel Connection
Connecting a group of batteries or cells by linking all terminals of the same polarity. This increases the capacity of the battery group.

Series Connection
The connection of a group of cells or batteries by linking terminals of opposite polarity. This increases the voltage of the battery group.

Separator
Material isolating positive from negative plates. In sealed lead-acid batteries it normally is absorbent glass fiber to hold the electrolyte in suspension.

SLA Battery
Sealed lead-acid battery, generally having the following characteristics: Maintenance-free, leak-proof, position-insensitive. Batteries of this type have a safety vent to release gas in case of excessive internal pressure build-up. Hence also the term: Valve regulated battery.
"Gel Cells" are SLA batteries whose dilute sulfuric acid electrolyte is immobilized by way of additives which turn the electrolyte into a gel.

Standby Service
An application in which the battery is maintained in a fully charged condition by trickle of float charging.

State of Charge
The available capacity of a battery at a given time expressed as a percentage of rated capacity.

Thermal Runaway
A condition in which a cell or battery on constant potential charge can destroy itself through internal heat generation.



Primary Power

- Portable Tools & Instruments
- Hand-held Lights
- Cordless & Portable Cellular Phones
- Power Packs
- Remote or Portable Data Gathering Devices
- Medical Apparatus
- Battery Powered Wheelchairs, Ride-on Toys
- Engine Starting Devices
- Robotics
- Consumer Electronics
- Hobby Craft

Standby Power

- UPS Systems
- Emergency Lighting
- Fire & Burglar Alarm Systems
- Access Control Devices
- Telecommunications Equipment
- Electronic Equipment Requiring Memory Protection
- Solar Powered Systems
- Automotive Electronics

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San Diego, CA 92173
Telephone: (619) 661-2020
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Fax: (1268) 560902

http://www.power-sonic.com
E-mail: battery@power-sonic.com

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PUBLICATION DIVIDER

Series 3 QOU® Circuit Breakers and QYU® Supplementary Protectors
Interruptores automáticos QOU® serie 3 y protectores suplementarios QYU®
Disjoncteurs QOU® série 3 et protecteurs supplémentaires QYU®

Retain for future use. / Conservar para uso futuro. / À conserver pour usage ultérieur.

⚠ DANGER / PELIGRO / DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

- Utilice equipo de protección personal (EPP) apropiado y siga las prácticas de seguridad eléctrica establecidas por su Compañía (consulte la norma NFPA 70E).
- Solamente el personal eléctrico especializado deberá instalar y prestar servicio de mantenimiento a este equipo.
- Desenergice el equipo antes de realizar cualquier trabajo en él.
- Siempre utilice un dispositivo detector de tensión nominal adecuado para confirmar la desenergización del equipo.
- Vuelva a colocar todos los dispositivos, las puertas y las cubiertas antes de energizar el equipo.

El incumplimiento de estas instrucciones podrá causar la muerte o lesiones serias.

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ÉCLAIR D'ARC

- Portez un équipement de protection personnel (ÉPP) approprié et observez les méthodes de travail électrique sécuritaire. Voir NFPA 70E.
- Seul un personnel qualifié doit effectuer l'installation et l'entretien de cet appareil.
- Coupez toute alimentation de cet appareil avant d'y travailler.
- Utilisez toujours un dispositif de détection de tension à valeur nominale appropriée pour s'assurer que l'alimentation est coupée.
- Replacez tous les dispositifs, les portes et les couvercles avant de mettre l'appareil sous tension.

Si ces précautions ne sont pas respectées, cela entraînera la mort ou des blessures graves.

INSTALLATION

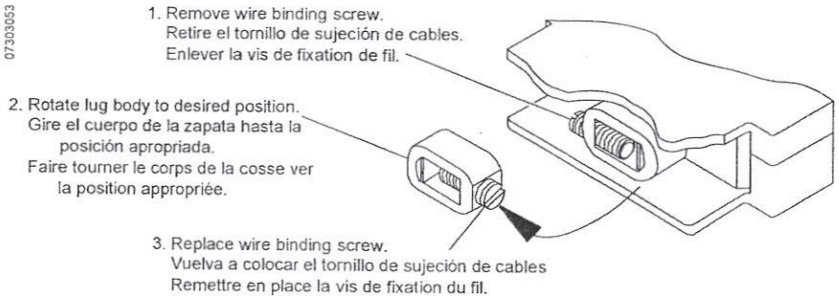
1. Turn off all power supplying this equipment before working on or inside equipment.
2. Circuit breaker lugs can be rotated to allow access to wire binding screw from top or bottom of circuit breaker.

INSTALACIÓN

1. Desenergice el equipo antes de realizar cualquier trabajo en él.
2. Las zapatas de los interruptores automáticos se pueden girar para permitir el acceso al tornillo de sujeción de cables por arriba o por abajo del interruptor.

INSTALLATION

1. Coupez l'alimentation de l'appareil avant d'y travailler.
2. Les cosses des disjoncteurs peuvent être tournées pour permettre l'accès à la vis de fixation du fil par le haut ou par le bas du disjoncteur.



MOUNTING FEET

NOTE: If circuit breaker was purchased in a bulk pack, mounting feet must be ordered separately.

1. Install mounting feet (A) on each end of circuit breaker.

BASES DE MONTAJE

NOTA: Si el interruptor automático se compró como parte de un paquete, las bases de montaje se deben solicitar por separado.

1. Instale las bases de montaje (A) en cada extremo del interruptor automático.

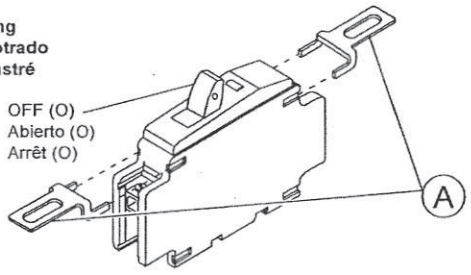
PIEDS DE MONTAGE

REMARQUE : Si le disjoncteur a été acheté dans un paquet économique, les pieds de montage doivent être commandés séparément.

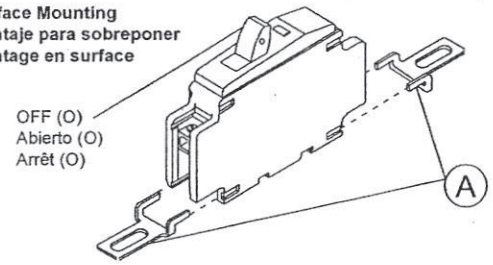
1. Installer les pieds de montage (A) à chaque extrémité du disjoncteur.

07303055 07303054

Flush Mounting
Montaje empotrado
Montage encastré



Surface Mounting
Montaje para sobreponer
Montage en surface



2. Use a screw through each mounting foot to fasten circuit breaker inside enclosure.

2. Coloque un tornillo a través de cada base de montaje para fijar el interruptor automático al interior del gabinete.

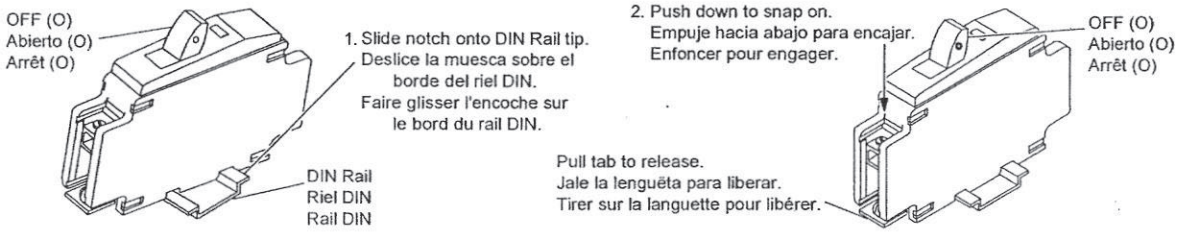
2. Utiliser une vis à travers chaque pied de montage pour fixer le disjoncteur à l'intérieur du coffret.

DIN RAIL MOUNTING

MONTAJE EN RIEL DIN

MONTAGE SUR RAIL DIN

07303057 07303056

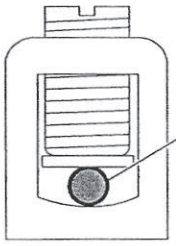


CONNECTING WIRES

CONEXIÓN DE LOS CABLES

RACCORDEMENT DES FILS

07303058



See circuit breaker for lug wire range and tightening torque.
Consulte la etiqueta del interruptor automático para obtener el calibre del cable y el par de apriete.
Voir l'étiquette du disjoncteur pour obtener le calibre des fils et le couple de serrage.

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

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1-888-SquareD (1-888-778-2733)
www.SquareD.com

Solamente el personal especializado deberá instalar, hacer funcionar y prestar servicios de mantenimiento al equipo eléctrico. Schneider Electric no asume responsabilidad alguna por las consecuencias emergentes de la utilización de este material.

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Seul un personnel qualifié doit effectuer l'installation, l'utilisation, l'entretien et la maintenance du matériel électrique. Schneider Electric n'assume aucune responsabilité des conséquences éventuelles découlant de l'utilisation de cette documentation.

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PUBLICATION DIVIDER



Low Ampere QOU Miniature Circuit Breakers

General Specifications Common to All Low Ampere QOU Circuit Breakers

- For convenient flush mount, surface mount or DIN mount (symmetrical rail 35 x 7.5 DIN/EN 50 022)
- Single handle with internal common trip
- Terminal lug wire size (1) #14–#2 AWG Cu or Al
- Reversible line and load lugs
- Field-installable quick connectors
- UL Listed 48 Vdc (5,000 AIR)
- UL Listed as HACR Type—10–70 A



High Ampere QOU Circuit Breakers

General Specifications Common to All High Ampere QOU Circuit Breakers

- Flush mount, surface mount, and DIN rail mount
- Internal common trip
- Lugs supplied in standard position only
- Terminal lug wire size (1) #12–#2/0 AWG Cu or Al
- UL Listed 60 Vdc per pole (5000 AIR)—**Note:** except switches
- UL Listed as HACR type—80–125 A

Special Ordering Instructions:

For Bulk-packed QOU Circuit Breakers and Accessories

QOU circuit breakers and accessories must be ordered in multiples of the quantities listed. Bulk-packed circuit breakers do not include mounting feet.

EXAMPLE:

Individual pack—small quantity orders: To receive five QOU220 circuit breakers, order five individual QOU220 circuit breakers at **$58.00** each. Product will be individually packaged, and will include necessary mounting feet.

Bulk pack—large quantity order. To order 440 QOU220 circuit breakers using bulk packaging, order 440 QOU220B at **$56.00** each. Product will be packaged in 22 packages of 20 pieces each. Product will not include mounting feet. To order mounting feet, order 880 pieces of QOUMF2B. Product will be packaged in 22 packages of 40 pieces each.

Interrupting Ratings . . . . . page 6-3
Accessories . . . . . pages 6-12, 6-15
Dimensions . . . . . page 6-49

Low Ampere QOU Series 3 Circuit Breaker (10,000 AIR)

No. of Poles	Voltage Rating	Ampere Rating	Catalog No.	Catalog No.
1	120/240 Vac	10	QOU110	QOU110B
		15	QOU115	QOU115B
		15	QOU115HM▲	QOU115HMB▲
		20	QOU120	QOU120B
		20	QOU120HM▲	QOU120HMB▲
		25	QOU125	QOU125B
		30	QOU130	QOU130B
		35	QOU135	QOU135B
		40	QOU140	QOU140B
		45	QOU145	QOU145B
		50	QOU150	QOU150B
		60	QOU160	QOU160B
		70	QOU170	QOU170B
2	120/240 Vac	10	QOU210	QOU210B
		15	QOU215	QOU215B
		20	QOU220	QOU220B
		25	QOU225	QQOU225B
		30	QOU230	QOU230B
		35	QOU235	QOU235B
		40	QOU240	QOU240B
		45	QOU245	QOU245B
		50	QOU250	QOU250B
		60	QOU260	QOU260B
		70	QOU270	QOU270B
	240 Vac	15	QOU215H■	QOU215HB
		20	QOU220H■	QOU220HB
		25	QOU225H■	QOU225HB
		30	QOU230H■	QOU230HB
3	240 Vac	10	QOU310	QOU310B
		15	QOU315	QOU315B
		20	QOU320	QOU320B
		25	QOU325	QOU325B
		30	QOU330	QOU330B
		35	QOU335	QOU335B
		40	QOU340	QOU340B
		45	QOU345	QOU345B
		50	QOU350	QOU350B
		60	QOU360	QOU360B

High Ampere QOU Series 3 Circuit Breaker (10,000 AIR)

No. of Poles	Voltage Rating	Ampere Rating	Catalog No.	Catalog No.	Unit Price
1	120/240Vac	80	QOU180	QOU180B	
		90	QOU190	QOU190B	
		100	QOU1100	QOU1100B	
2	120/240 Vac	80	QOU280	QOU280B	
		90	QOU290	QOU290B	
		100	QOU2100	QOU2100B	
		125	QOU2125	QOU2125B	
3	240 Vac	70	QOU370	QOU370B	
		80	QOU380	QOU380B	
		90	QOU390	QOU390B	
		100	QOU3100	QOU3100B	

QYU UL Recognized Component, Supplementary Protectors (5,000 AIR)

No. of Poles	Voltage Rating	Ampere Rating	Catalog No.	Catalog No.
1	277 Vac	10	QYU110	QYU110B
		15	QYU115	QYU115B
		20	QYU120	QYU120B
		25	QYU125	QYU125B
		30	QYU130	QYU130B

QOU Non-Automatic Switch

No. of Poles	Voltage Rating	Ampere Rating	Catalog No.	Catalog No.
2	240 Vac	60	QOU200	QOU200B
		100	QOU2000	QOU2000B
		125	QOU20001	QOU20001B
3		60	QOU300	QOU300B
		100	QOU3000	QOU3000B
		125	QOU30001	QOU30001B

▲ HM High magnetic trip circuit breakers are recommended for applications where high initial inrush may occur and for individual dimmer applications.
■ QOU-H interrupting rating is 5 kA at 240 Vac.

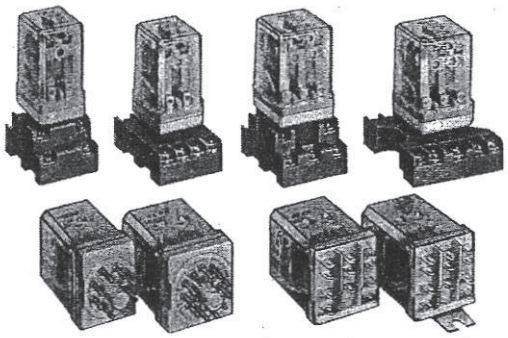
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9/8/03

PUBLICATION DIVIDER

RR Series — General Purpose Power Relays

Key features of the RR series include:

- **High reliability and long service life**
- **Available in octal (8- and 11-pin) or square (11-blade) base**
- **Options include check button for test operation, indicator light, and side flange**
- **DIN rail, surface and panel type sockets available for a wide range of mounting applications**



UL Recognized
File Nos. E67770

CSA Certified
File No. LR35144

TÜV PRODUCT SERVICE
File No. BL951113332319*
* Pin Style Only
(does not apply to blade style)

CE*
* Pin Style Only

Specifications

Contact Material	Silver
Contact Resistance	30mΩ maximum (initial value)
Minimum Applicable Load	24V DC/10mA, 5V DC/20mA (reference value)
Operating Time	25ms maximum
Release Time	25ms maximum
Maximum Continuous Applied Voltage (AC/DC) at 20°C	110% of the rated voltage
Minimum Operating Voltage (AC/DC) at 20°C	80% of the rated voltage
Drop-Out Voltage (AC) at 20°C	30% of the rated voltage
Drop-Out Voltage (DC) at 20°C	15% of the rated voltage
Power Consumption	AC: approximately 3VA (50Hz), 2.5VA (60Hz) DC: approximately 1.5W
Insulation Resistance	100MΩ minimum (measured with 500V DC megger)
Dielectric Strength	**Pin** (RR2P, RR3PA) Between live and dead parts: 1,500V AC, 1 minute Between contact circuit and operating coil: 1,500V AC, 1 minute Between contact circuits: 1,500V AC, 1 minute (1,000V AC between NO-NC contacts)
	Blade (RR1BA, RR2BA, RR3B) Between live and dead parts: 2,000V AC, 1 minute Between contact circuit and operating coil: 2,000V AC, 1 minute Between contact circuits: 2,000V AC, 1 minute Between contacts of same polarity: 1,000V AC, 1 minute
Frequency Response	1,800 operations/hour
Temperature Rise	Coil: 85°C maximum Contact: 65°C maximum
Vibration Resistance	0 to 6G (55Hz maximum)
Shock Resistance	100N (approximately 10G)
Life Expectancy	Electrical: over 500,000 operations (120V, 50/60Hz, 10A) Mechanical: over 10,000,000 operations
Operating Temperature	–30 to +70°C
Weight	RR2P: 90g, RR3P/RR3PA: 96g (approximately) RR1BA/RR2BA/RR3B: 82g (approximately)

Ordering Information

Order standard voltages for fastest delivery. Allow extra delivery time for non-standard voltages.

Basic Part No.		*Coil Voltage:*
RR3PA-U	–	*AC120V*

Part Numbers

Part Numbers: RR Series with Options

Termination	Contact Configuration	Basic Part No.	Indicator Light	Check Button	Light and Check Button	Side Flange
P, PA (pin)	DPDT	RR2P-U	RR2P-UL	RR2P-UC	RR2P-ULC	—
	3PDT	RR3PA-U	RR3PA-UL	RR3PA-UC	RR3PA-ULC	—
B, BA (blade)	SPDT	RR1BA-U	RR1BA-UL	RR1BA-UC	RR1BA-ULC	RR1BA-US
	DPDT	RR2BA-U	RR2BA-UL	RR2BA-UC	RR2BA-ULC	RR2BA-US
	3PDT	RR3B-U	RR3B-UL	RR3B-UC	RR3B-ULC	RR3B-US

1. RR1BA, RR2BA, and RR3PA are U.S. standard terminal arrangements.
2. For diode option on DC coils please consult factory.

Ratings

Coil Ratings

Rated Voltage		Rated Current ±15% at 20°C		Coil Resistance ±10% at 20°C	Inrush Current	Inductance	
		60Hz	50Hz			Energizing	De-Energizing
AC	6V	420mA	490mA	4.9Ω	720mA	0.04H	0.02H
	12V	210mA	245mA	18Ω	365mA	0.15H	0.08H
	24V	105mA	121mA	79Ω	182mA	0.57H	0.32H
	120V	20.5mA	24mA	2100Ω	35mA	15H	8.2H
	240V	10.5mA	12.1mA	8330Ω	18mA	57H	32H
DC	6V	240mA		25Ω	N/A		
	12V	120mA		100Ω			
	24V	60mA		400Ω			
	48V	30mA		1600Ω			
	110V	13mA		8460Ω			

Contact Ratings

	Resistive			Inductive			Motor Load
Voltage	Nominal	UL	CSA	Nominal	UL	CSA	UL
30V DC	10A	10A	10A	7.5A	7A	7.5A	—
110V DC	0.5A	—	—	0.3A	—	0.5A	—
120V AC	10A	10A	10A	7.5A	7.5A	7.5A	1/4 hp
240V AC	7.5A	10A	10A	5A	7A	7A	1/3 hp

Inductive load: cos ø = 0.3, L/R = 7ms.

Applicable Sockets

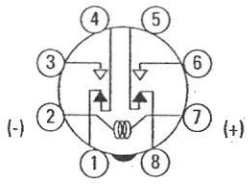
Part Numbers: Sockets

Relays	Standard DIN Rail Mount	Finger-Safe DIN Rail Mount	Panel Mount
RR2P	SR2P-05 SR2P-06	SR2P-05C	SR2P-51
RR3PA	SR3P-05 SR3P-06	SR3P-05C	SR3P-51
RR1BA RR2BA RR3B	SR3B-05	—	SR3B-51

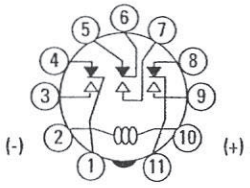
Springs & Clips (optional)	
Part Numbers	Use With
SR2B-02F1	SR2P-05, -05C, -06
SR3P-01F1	SR2P-51
SR3B-02F1	SR3P-05, -05C, -06
SR3P-01F1	SR3P-51
SR3B-02F1	SR3B-05 SR3B-51

See Section F for details on sockets. All DIN rail mount sockets listed can be mounted using DIN rail BNDN1000.

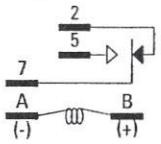
Internal Circuit



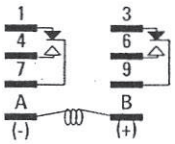
RR2P



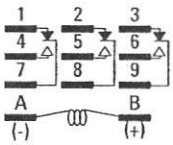
RR3PA



RR1BA



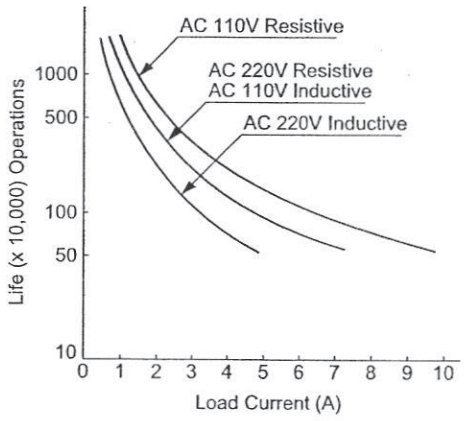
RR2BA

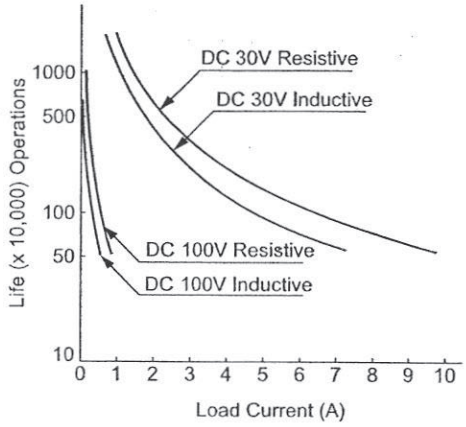


RR3B

E

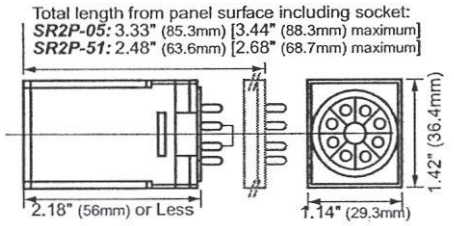
Electrical Life Curves



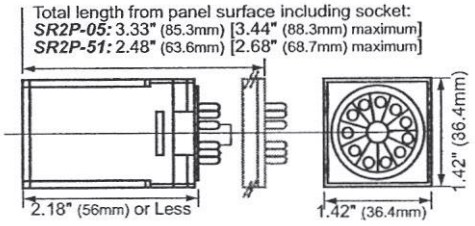


Dimensions

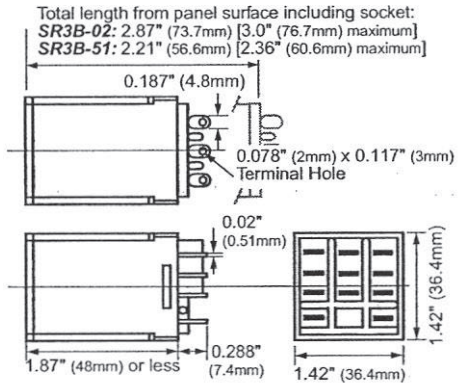
8-Pin
RR2P



11-Pin
RR3PA

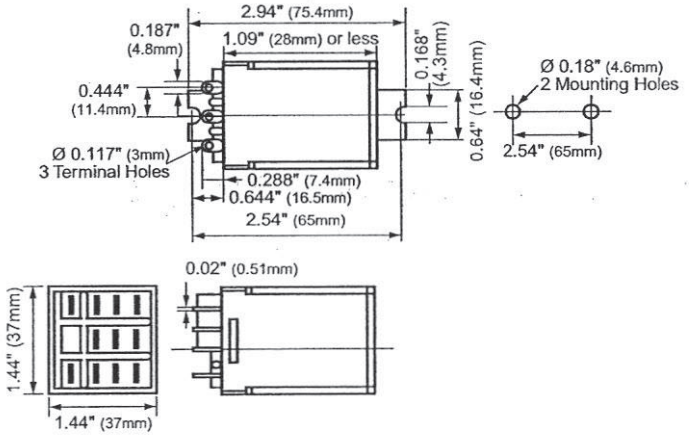


Blade
RR1BA, RR2BA, RR3B



Note: *Dimensions in [ ] include hold-down spring.*

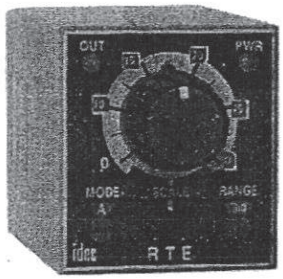
Side Flange
RR1BA-US, RR2BA-US, RR3B-US



E

PUBLICATION DIVIDER

RTE Series — Analog Timers



NEW DESIGN!

Key features of the RTE series include:

- 20 time ranges and 10 timing functions
- Time delays up to 600 hours
- Space-saving package
- High repeat accuracy of ± 0.2%
- ON and timing OUT LED indicators
- Standard 8- or 11-pin and 11-blade termination
- 2 form C delayed output contacts
- 10A Contact Rating

TÜV PRODUCT SERVICE Cert. No. E9950913332316 (EMC, RTE)
cert. No. BL960813332355 (LVD, RTE)

c UL us UL Listed
File No. E66043

CE

General Specifications

Operation System		Solid state CMOS Circuit
Operation Type		Multi-Mode
Time Range		0.1sec to 600hours
Pollution Degree		2 (IE60664-1)
Over voltage category		III (IE60664-1)
Rated Operational Voltage	AF20	100-240V AC(50/60Hz)
	AD24	24V AC(50/60Hz)/24V DC
	D12	12V DC
Voltage Tolerance	AF20	85-264V AC(50/60Hz)
	AD24	20.4-26.4V AC(50/60Hz)/21.6-26.4V DC
	D12	10.8-13.2V DC
Input off Voltage		Rated Voltage x10% minimum
Ambient Operating Temperature		-20 to +65ºC (without freezing)
Ambient Storage and Transport Temperature		-30 to +75ºC (without freezing)
Relative Humidity		35 to 85%RH (without condensation)
Atmospheric Pressure		80kPa to 110kPa (Operating), 70kPa to 110kPa (Transport)
Reset Time		100msec maximum
Repeat Error		±0.2%, ±20msec*
Voltage Error		±0.2%, ±20msec*
Temperature Error		±0.5%, ±20msec*
Setting Error		±10% maximum
Insulation Resistance		100MΩ minimum (500V DC)
Dielectric Strength		Between power and output terminals: 2000V AC, 1 minute Between contacts of different poles: 2000V AC, 1 minute Between contacts of the same pole:1000V AC, 1 minute
Vibration Resistance		10 to 55Hz amplitude 0.5mm2 hours in each of 3 axes
Shock Resistance		Operating extremes: 98m/sec² (10G) Damage limits: 490m/sec² (50G) 3 times in each of 3 axes
Degree of Protection		IP40 (enclosure) (IEC60529)

Power Consumption (Approx.)				
TYPE		RTE-P1, -B1	RTE-P2, -B2	
AF20	120V AC/60Hz	6.5VA	6.6VA	
	240V AC/60Hz	11.6VA	11.6VA	
24V AC 60Hz/DC		3.4VA/1.7W	3.5VA/1.7W	
D12		1.6W	1.6W	

Mounting Position		Free		
Dimensions	RTE-P1, P2	40Hx 36W x 77.9D mm		
	RTE-B1, B2	40Hx 36W x 74.9D mm		
Weight (Approx.)		RTE-P1	RTE-P2	RTE-B1, -B2
		87g	89g	85g

For the value of the error against a preset time, whichever the largest.

Contact Ratings

Contact Configuration		2 Form C, DPDT (Delay output)
Allowable Voltage / Allowable Current		240V AC, 30V DC / 10A
Maximum Permissible Operating Frequency		1800 cycles per hour
Rated Load	Resistive	10A 240V AC, 30V DC
	Inductive	7A 240V AC, 30V DC
	Horse Power Rating	1/6 HP 120V AC, 1/3 HP 240V AC
Life	Electrical	500,000 op. minimum (Resistive)
	Mechanical	50,000,000 op. minimum

RTE Table of Contents

Specifications —G-8
Part Number Guide — G-9
Part Number List — G-9
RTE Timing Diagrams — G-10
RTE Accessories — G-11
Instructions: Setting Timer — G-13
RTE Dimensions — G-14
General Timing Diagrams — G-4

Part Numbering Guide

RTE series part numbers are composed of 4 part number codes. When ordering a RTE series part, select one code from each category.
Example: RTE-P1AF20

RTE	—	P	1	—	AF20
① Series		② Terminal Style	③ Function Group		④ Input Voltage

Part Numbers: RTE Series

	Description	Part Number Code	Remarks
① Series	RTE series	RTE	For internal circuits, see next page.
② Terminal Style	Pin	P	Select one only.
	Blade	B	
③ Function Group	ON-delay, interval, cycle OFF, cycle ON	1	Each function group has different timing functions. See page G-4.
	ON-delay, cycle OFF, cycle ON, signal ON/OFF delay, OFF-delay, one-shot	2	
④ Input Voltage	100 to 240V AC(50/60Hz)	AF20	
	24V AC(50/60Hz)/24V DC	AD24	
	12V DC	D12	

Part Number List

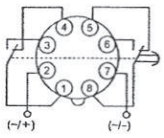
Part Numbers

New Part Number	Voltage	Terminals	Obsolete Part Number
RTE-B1AD24	24V AC/DC	Blade	RTE-B11-24V RTE-B12-24V
RTE-B1AF20	100 - 240V AC	Blade	RTE-B11-AC120V RTE-B12-AC120V
RTE-B1D12	12V DC	Blade	RTE-B11-12V RTE-B12-12V
RTE-B2AD24	24V AC/DC	Blade	RTE-B21-24V RTE-B22-24V
RTE-B2AF20	100 - 240V AC	Blade	RTE-B21-AC120V RTE-B22-AC120V
RTE-B2D12	12V DC	Blade	RTE-B21-12V RTE-B22-12V
RTE-P1AD24	24V AC/DC	8 Pin	RTE-P11-24V RTE-P12-24V
RTE-P1AF20	100 - 240V AC	8 Pin	RTE-P11-AC120V RTE-P12-AC120V
RTE-P1D12	12V DC	8 Pin	RTE-P11-12V RTE-P12-12V
RTE-P2AD24	24V AC/DC	11 Pin	RTE-P21-24V RTE-P22-24V
RTE-P2AF20	100 - 240V AC	11 Pin	RTE-P21-AC120V RTE-P22-AC120V
RTE-P2D12	12V DC	11 Pin	RTE-P21-12V RTE-P22-12V

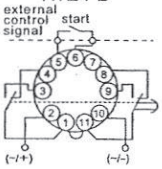
1. *For schematics, see page G-10.*
2. *For timing diagrams, see page G-10.*
3. *All timers have multiple time ranges. For a list of ranges, see page G-13.*
4. *For socket and accessory information, see page G-11.*

Timing Diagrams

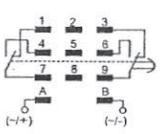
RTE-P1



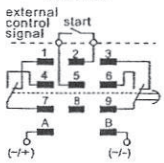
RTE-P2



RTE-B1



RTE-B2

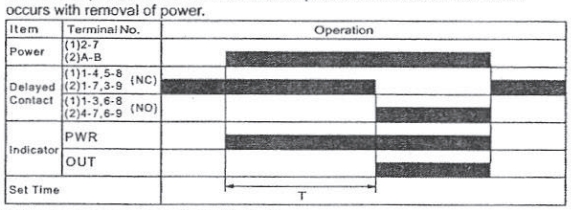


1. *RTE-P2: Do not apply voltage to terminals #5, #6 & #7.*
2. *RTE-B1, -B2: Do not apply voltage to terminals #2, #5 & #8.*
3. *IDEC sockets are as follows: RTE-P1: SR2P-06* pin type socket, RTE-P2: SR3P-05* pin type socket, RTE-B1, -B2: SR3B-05* blade type socket, (*-may be followed by suffix letter A,B,C or U).*

RTE-P1, -B1

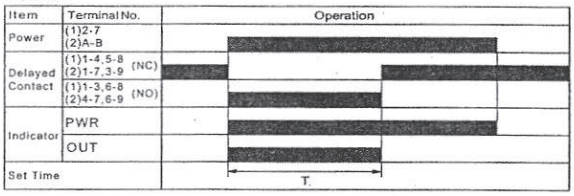
A: ON-Delay 1 (power start)

Set timer for desired delay, apply power to coil. Contacts transfer after preset time has elapsed, and remain in transferred position until timer is reset. Reset occurs with removal of power.



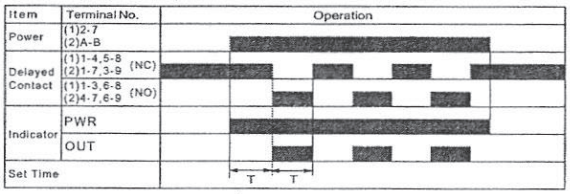
B: Interval (power start)

Set timer for desired delay, apply power to coil. Contacts transfer immediately, and return to original position after preset time has elapsed. Reset occurs with removal of power.



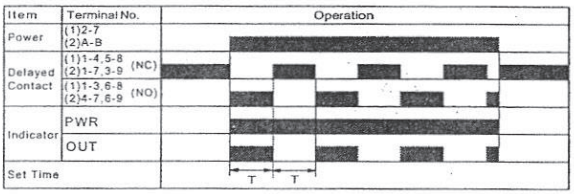
C: Cycle 1 (power start, OFF first)

Set timer for desired delay, apply power to coil. First transfer of contacts occurs after preset delay has elapsed, after the next elapse of preset delay contacts return to original position. The timer now cycles between on and off as long as power is applied (duty ratio 1:1).



D: Cycle 3 (power start, ON first)

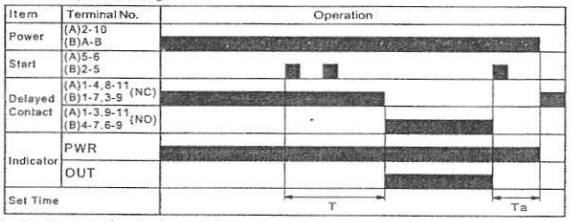
Functions in same manner as Mode C, with the exception that first transfer of contacts occurs as soon as power is applied. The ratio is 1:1. Time On = Time Off



RTE-P2, -B2

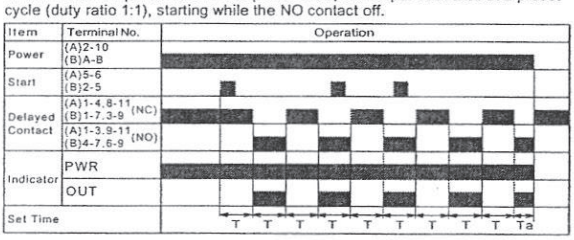
A: ON-Delay 2 (signal start)

When a preset time has elapsed after the start input turned on while power is on, the NO output contact goes on.



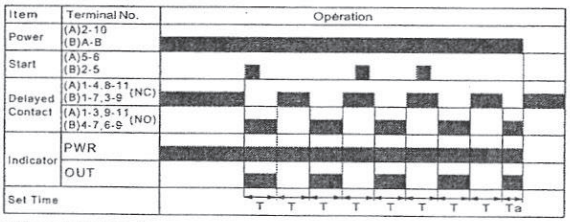
B: Cycle 2 (signal start, OFF first)

When the start input turns on while power is on, the output oscillates at a preset cycle (duty ratio 1:1), starting while the NO contact off.



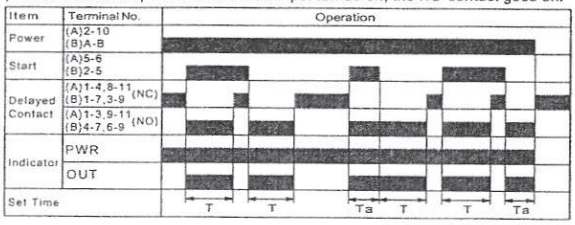
C: Cycle 4 (signal start, ON first)

When the start input turns on while power is on, the NO contact goes on. The output oscillates at a preset cycle (duty ratio 1:1).



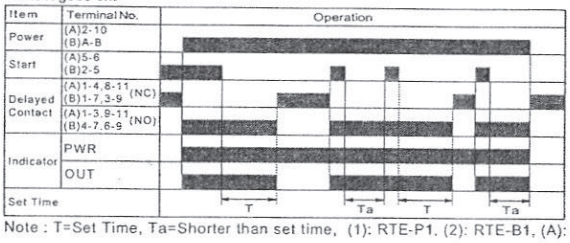
D: Signal ON/OFF-Delay

When the start input turns on while power is on, the NO output contact goes on. When a preset time has elapsed while the start input remains on, the output contact goes off. When the start input turns off, the NO contact goes on again. When a preset time has elapsed after the start input turned off, the NO contact goes off.



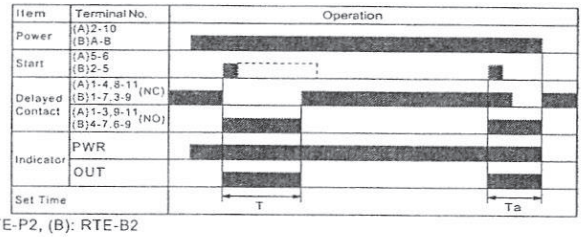
E: Signal OFF-Delay

When power is turned on while the start input is on, the NO output contact goes on. When a preset time has elapsed after the start input turned off, the NO output contact goes off.



F: One-Shot (signal start)

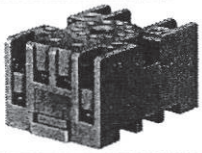
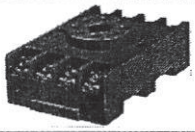
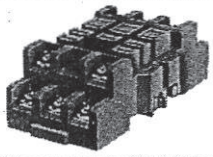
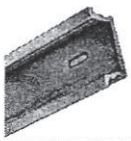
When the start input turns on while power is on, the NO output contact goes on. When a preset time has elapsed, the NO output contact goes off.



Note : T=Set Time, Ta=Shorter than set time, (1): RTE-P1, (2): RTE-B1, (A): RTE-P2, (B): RTE-B2

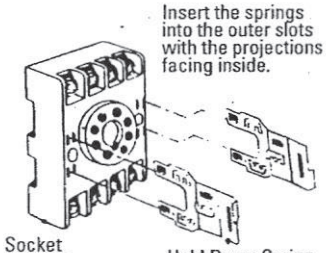
DIN Rail Mounting Accessories

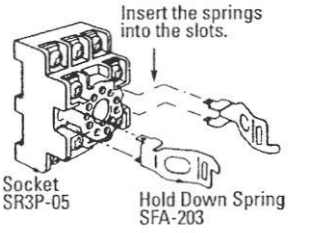
Part Numbers: DIN Rail/Surface Mount Sockets and Hold-Down Springs

DIN Rail Mount Socket				Applicable Hold-Down Springs	
Style	Appearance	Use with Timers	Part No.	Appearance	Part No.
11-Pin Screw Terminal (dual tier)		RTE-P2	SR3P-05		SFA-203
11-Pin FingerSafe Socket		RTE-P2	SR3P-05C		
8-Pin Screw Terminal		RTE-P1	SR2P-06		SFA-202
11-Blade Screw Terminal		RTE-B1 RTE-B2	SR3B-05		
DIN Mounting Rail Length 1000mm		—	BNDN1000		

Installation of Hold-Down Springs

DIN Rail Mount Socket

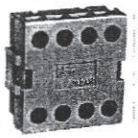




Once installed into the sockets, the hold-down springs cannot be removed.

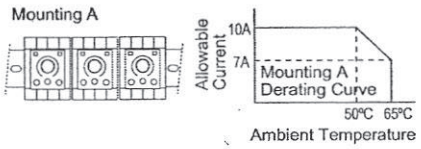
Panel Mounting Accessories

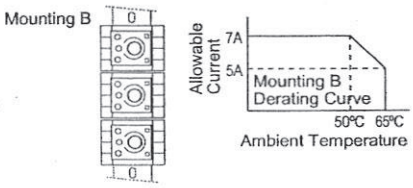
Part Numbers: Flush Panel Mount Adapter and Sockets that use an Adapter

Accessory	Description	Appearance	Use with	Part No.
Panel Mount Adapter	Adaptor for flush panel mounting RTE timers		All RTE timers	RTB-G01
Sockets for use with Panel Mount Adapter	8-pin screw terminal	 (Shown: SR6P-M08G for Wiring Socket Adapter)	RTE-P1	SR6P-M08G
	11-pin screw terminal		RTE-P2	SR6P-M11G
	8-pin solder terminal		RTE-P1	SR6P-S08
	11-pin solder terminal		RTE-P2	SR6P-S11

No hold down clips are available for flush panel mounting applications.

Temperature Derating Curves





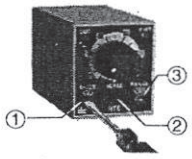
Instructions

Types

RTE-P1AF20

- Power Voltage: AF20: 100 to 240V AC(50/60Hz); AD24: 24V AC(50/60Hz)/24V DC; D12: 12V DC
- Connection type: P: Pin; B: Blade
- Operation Mode: 1: No Control Signal (A: ON-Delay 1; B: Interval; C: Cycle 1; D: Cycle 3); 2: Control Signal (A: ON-Delay 2; B: Cycle 2; C: Cycle 4; D: Signal ON/OFF-Delay; E: Signal OFF-Delay; F: One-Shot)

Switch Settings



① Operation Mode Selector
② Scale Selector
③ Time Range Selector

1. Turn the selectors securely using a flat screwdriver 4mm wide (maximum). Note that incorrect setting may cause malfunction. Do not turn the selectors beyond their limits.
2. Since changing the setting during timer operation may cause malfunction, turn power off before changing.

Safety Precautions

Special expertise is required to use Electronic Timers.

- All Electronic Timers are manufactured under IDEC's rigorous quality control system, but users must add a backup or fail safe provision to the control system when using the Electronic Timer in applications where heavy damage or personal injury may occur should the Electronic Timer fail.
- Install the Electronic Timer according to instructions described in this catalog.
- Make sure that the operating conditions are as described in the specifications. If you are uncertain about the specifications, contact IDEC in advance.
- In these directions, safety precautions are categorized in order of importance under Warning and Caution.

Warnings

Warning notices are used to emphasize that improper operation may cause severe personal injury or death.

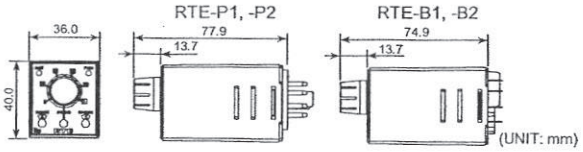
- Turn power off to the Electronic timer before starting installation, removal, wiring, maintenance, and inspection on the Electronic Timer.
- Failure to turn power off may cause electrical shocks or fire hazard.
- Do not use the Electronic Timer for an **emergency stop circuit** or **interlocking circuit**. If the Electronic Timer should fail, a machine malfunction, breakdown, or accident may occur.

Caution

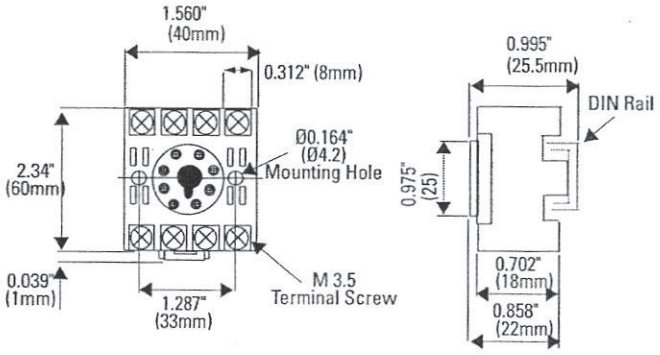
Caution notices are used where inattention might cause personal injury or damage to equipment.

- The Electronic Timer is designed for installation in equipment. Do not install the Electronic Timer outside equipment.
- Install the Electronic Timer in environments described in the specifications. If the Electronic Timer is used in places where it will be subjected to high-temperature, high-humidity, condensation, corrosive gases, excessive vibrations, or excessive shocks, then electrical shocks, fire hazard, or malfunction could result.
- Use an IEC60127-approved fuse and circuit breaker on the power and output line outside the Electronic Timer.
- Do not disassemble, repair, or modify the Electronic Timer.
- When disposing of the Electronic Timer, do so as industrial waste.

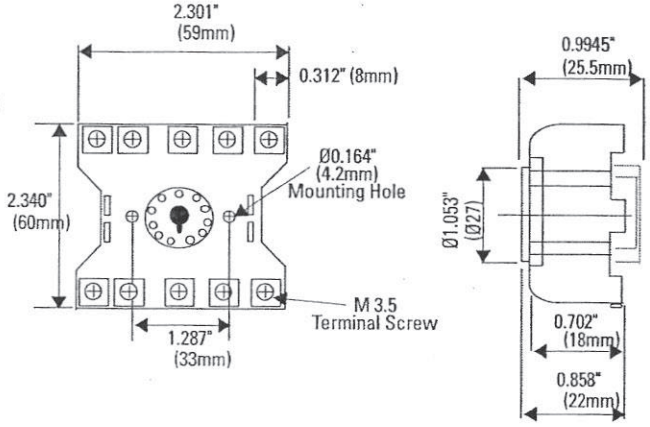
Dimensions



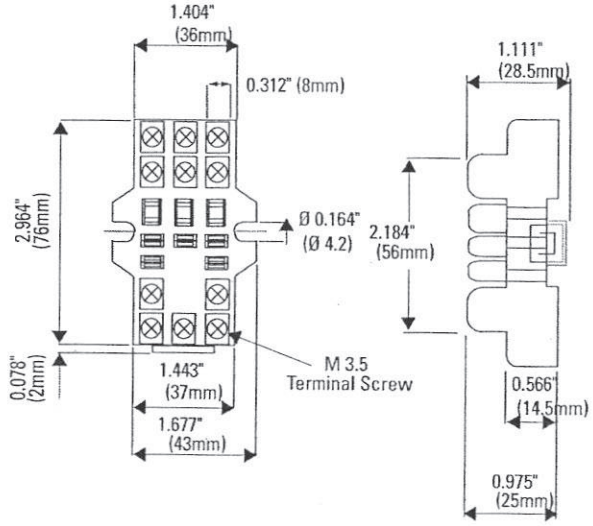
SR2P-06 Socket



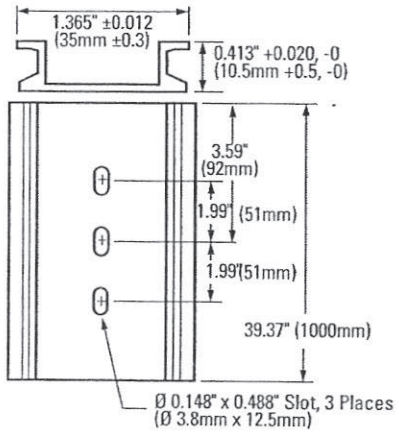
SR3P-06 Socket



SR3B-05 Socket



BNDN1000 DIN Rail



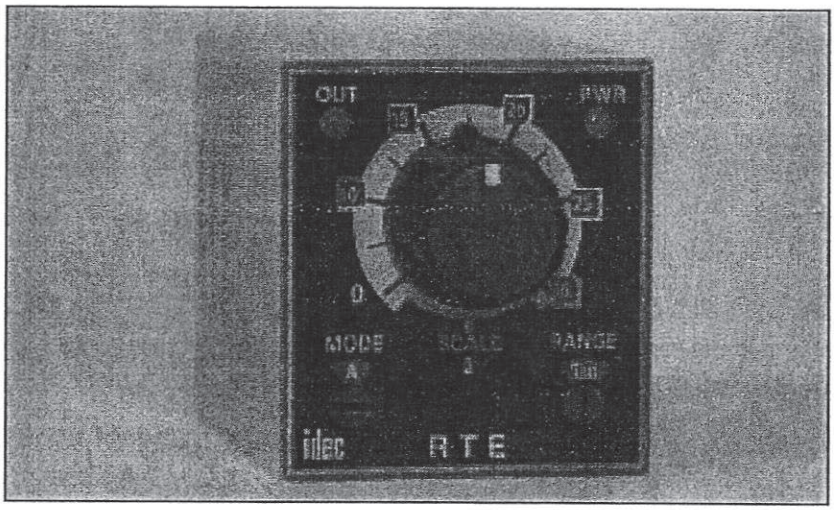
PUBLICATION DIVIDER

Product Upgrade

No.112 Directly from IDEC Corporation Sept. 22, 2003

NOTE: *See reverse for replacement information on discontinued models.*

- *Changes effective immediately.*
- *No change to list prices.*
- *New part numbers (see reverse).*
- *For any questions or concerns, please call Technical Support at 1-800-262-IDEC (press 2) or email: support@idec.com.*



RTE Series – Multi-Function Timers

IDEC Corporation hereby announces a part number replacement, enhancement and consolidation for the RTE series of multi-function timers.

The new RTE timers have improved functions and are much easier to use. They now have 20 selectable time ranges from 0.1 second to 600 hours, allowing for a wide range of timing requirements. Input voltage ranges have also been expanded to provide more flexibility. The new timers are now rated for 100 to 240V AC, 24V AC/DC, or 12V DC depending upon the model.

The color of the LED lamp indicating when power is "on" has been changed from red to green and the LED light indicating when output is "on" is now orange, instead of red. The mode setting and time range setting switches, as well as the visual scale, are now rotary switches making them easier and simpler to set.

The new RTE timers are UL-listed, c-UL-listed, and CE marked.

The updated RTE timers are still available in two models (the power triggered and signal triggered), but with expanded operation modes now being offered:

Power Triggered: (Group 1)	Signal Triggered: (Group 2)
A: On Delay	A: On Delay
B: Interval	B: Cycle (off first)
C: Cycle (off first)	C: Cycle (on first)
D: Cycle (on first)	D: Signal On/OFF Delay
	E: OFF Delay
	F: One-Shot

Along with the new features, the RTE timers are available with the same tubular pin or .187" solder/quick connect plug-in terminals and can be mounted in plug-in sockets or with the optional panel mount adaptor.

On the reverse is a list of the old part numbers and their replacements.

For further information, please call IDEC Technical Support at 1-800-262-IDEC (press 2).

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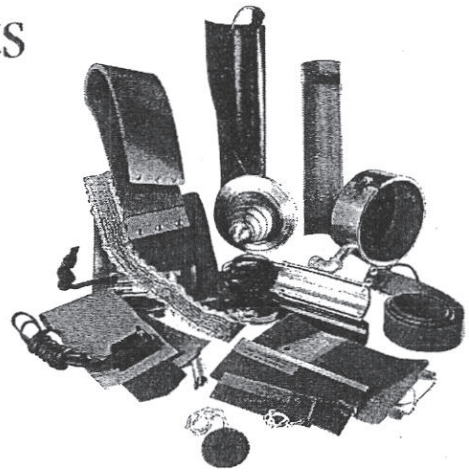
RTE Series — Multi-Function Timers

New Part Number	Obsolete Part Number
RTE-B1AD24	RTE-B11-24V
	RTE-B12-24V
RTE-B1AF20	RTE-B11-AC120V
	RTE-B12-AC120V
RTE-B1D12	RTE-B11-12V
	RTE-B12-12V
RTE-B2AD24	RTE-B21-24V
	RTE-B22-24V
RTE-B2AF20	RTE-B21-AC120V
	RTE-B22-AC120V
RTE-B2D12	RTE-B21-12V
	RTE-B22-12V
RTE-P1AD24	RTE-P11-24V
	RTE-P12-24V
RTE-P1AF20	RTE-P11-AC120V
	RTE-P12-AC120V
RTE-P1D12	RTE-P11-12V
	RTE-P12-12V
RTE-P2AD24	RTE-P21-24V
	RTE-P22-24V
RTE-P2AF20	RTE-P21-AC120V
	RTE-P22-AC120V
RTE-P2D12	RTE-P21-12V
	RTE-P22-12V

PUBLICATION DIVIDER

Flexible Heater Products

Overview



- **Flexible Heaters, Insulation Blankets, Insulation Covers.**
- **Two Different Element Types: Wire Wound or Etched Foil**
- **Silicone Rubber Standard and Stock Products**
- **Drum Heaters**
- **Enclosure and General Purpose Air Heaters**
- **Flexible and Molded Thermal Insulation Products**
- **Up to 600 Volt**
- **Extensive Stock Program**

Description

Flexible Heaters and Thermal Insulation Products are flexible in design and application to fit your specific needs. Chromalox provides dedicated engineering support to customize our Flexible heaters per your requirements. Most size, shape or contour can be used to apply direct and efficient heat without sacrificing dependability.

Various insulating materials are available to suit your application environment. Temperature controlling devices can be molded directly to the elements to provide precise system operation. Power requirements can be minimized and heat-up time optimized by applying heat directly to the part. Cool-down time is shortened and distributed wattages or multiple heater circuit designs are possible with Chromalox flexible heating elements.

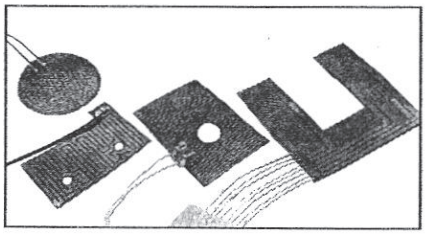
Features

- Flexible Heaters can be made to meet electrical and contour specifications.
- Holes and Slots can be incorporated for positioning on complex surfaces,
- Fast heat-up and cooling with accurate temperature control is possible.
- Wide choice of electrical terminations including solderless connectors, terminals, stranded wire leads, cords and plugs.
- Thin profile depending on choice of construction and insulation barrier.
- Distributed wattage multiple circuits and designs are available.
- Complete system development available which includes heater, sensor and temperature controller.

Applications

Flexible/Molded Products are suited for application environments in a wide-range of industries:

- Medical
- Semiconductor
- Power Systems/Motors
- Communications
- Food Service
- Laminating/Forming
- Chromatography
- Printing/Copying
- Vending
- Transportation & Aerospace
- Manufacturing
- Military
- Tank/Vessel Heating



Flexible Heaters

Ordering Guidelines

Ordering Information

To Order — *Complete the Model Number using the Matrix provided.*

Model	Flexible Heating Elements
SL-N	General Purpose Heater
SL-B	Enclosure and Air Heater

Code	Special Mounting Features				
N[a]	None	V[d]	Velcro®	a.	SL
A[b]	Adhesive (PSA)	S[d]	Spring	b.	SL
B[c]	Vulcanized	SC[d]	Spring Clasp	c.	SL
F[c]	Foil Backing	H[d]	Hooks	d.	SL
I[c]	Insulation	C[c]	Preformed		
E[d]	Eyelets/Mounting Holes				

Code	Physical Dimensions (In.)[1]
xx.xx	Smallest Dimensions (for circular shaped heaters use designator "xx" only)
xx.xx	Largest Dimensions (for circular shaped heaters, add "OD" to the indicated outside diameter, i.e., 8.250D)

Code	Control Options
0	None
P	Preset Thermostat specify temperature (300°F max.)
A	Adjustable Thermostat; range 70-140°F, 70-190°F or 70-425°F
J	Type J Thermocouple
K	Type K Thermocouple
R	RTD: specify rating
D	TFD: specify rating
TF	Thermal Fuse: specify high limit
T	Thermistor: specify rating

Code	
xx	Lead Length (In.): 10" Standard Power Cord Length (Ft.): 6´ Standard

Code	Lead Type
	Silicone Rubber Insulated Leads
T	Teflon® Insulated Leads
CGM	Power Cord w/o Plug, w/ Mesh Grid
CPGM	Power Cord w/ Plug, w/ Mesh Grid
CG	Power Cord with Integral Grounding, w/o Plug
CPG	Power Cord with Integral Grounding, w/ Plug

Code	Electrical Specifications
V	- Voltage
W	- Wattage
	- Single Phase is Standard (use "3P" for three phase)

SL-	N	5	25	0	10	120V	100W	Typical Model Number
SL-	Al	25	25	40P/120P	6CPG	480V	400W	Typical Model Number

1. Cutouts, notches, etc., must be indicated with accompanying detail drawings to show angle of curvature.
2. If adding abrasion protection, add designator. "F" for silicone rubber coated Fiberglas® Sleeving or "A" for Armor Braiding.
3. Consult your Local Chromalox Sales office for recommended grounding methods.

PUBLICATION DIVIDER

Specifications		
	Rated Insulation Voltage	300V; except SH1B and SY4S-62: 250V
	Rated Current	SR/SH: 10A, SY: 7A (SH1B coil terminal 7A)
	Insulation Resistance	100MΩ minimum
	Dielectric Strength	2,000V AC, 1 minute
	Material Grade	UL94V-0

UL Recognized
File No. E62437

CSA Certified
File No.LR35144

TÜV PRODUCT SERVICE
File No. BL950813332307 *

CE *

1. * *Applicable to DIN rail sockets only.*

Relay Socket Part Numbering Guide

Relay socket part numbers are composed of 5 part number codes. When ordering a relay socket, select one code from each category.
Example: SR2P-05C

SR	2	P	—	05	C
① Socket Series	② No. of Poles	③ Termination		④ Mounting Style	⑤ Fingersafe Option

F

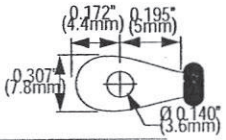
Part Numbers: Relay Sockets

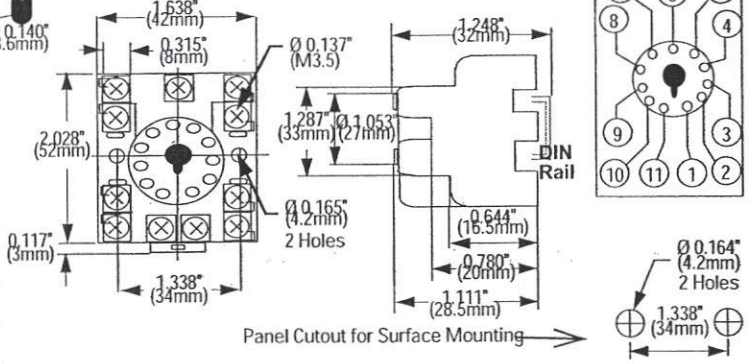
	Description	Part Number Code	Remarks
① Socket Series	SR	SR	For use with RR series relays
② No. of Poles			
	3-pole	3	SR, and SH series
③ Termination	Tubular pin	P	SR series
	Blade	B	SH series
④ Mounting Styles	DIN rail snap-mount	05	To decide between configuration 05 and 06, see pictures and schematics beginning on page F-5
⑤ Fingersafe Option			

2. *For hold-down springs and clips for DIN rail snap-mount, panel mount, and PC board mount, see page F-4.*
3. *For socket accessories, see page F-22.*

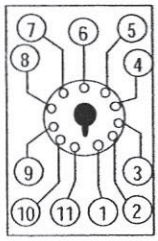
SR3P Sockets





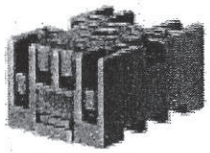


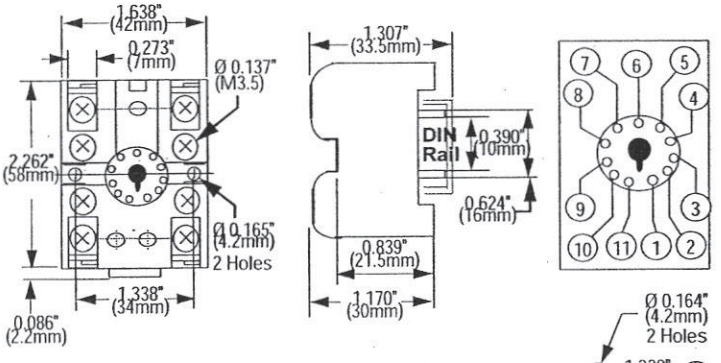
Terminal Arrangements (top view)



SR3P-05

Style	11-pin octal, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp
Wire Size	Maximum up to 2–#12AWG
Electrical Rating	300V, 10A
Compatible Relay	RR3PA, *RR2KP (*latching relay)
Compatible Timer	GT3 (11-pin), RTE-P2
Hold-Down Spring	SR3B-02F1, *SR3P-06F3 (*RR2KP relay)
Hold-Down Clip	SFA-203



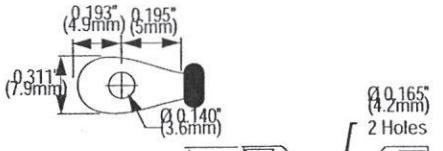


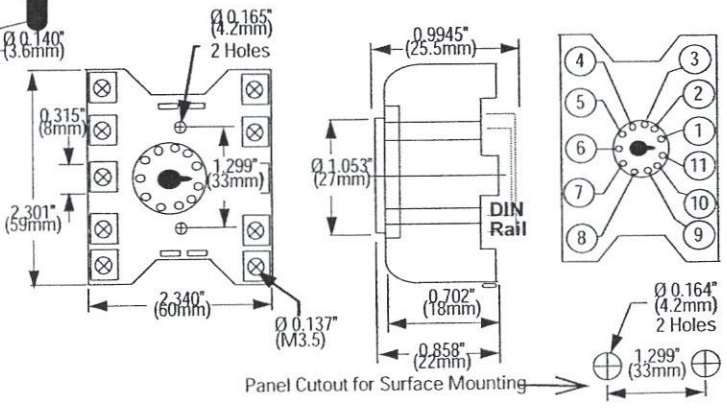
F

SR3P-05C Fingersafe

Style	11-pin octal, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp, fingersafe
Wire Size	Maximum up to 2–#12AWG
Electrical Rating	300V, 10A
Compatible Relay	RR3PA, *RR2KP (*latching relay)
Compatible Timer	GT3 (11-pin), RTE-P2
Hold-Down Spring	SR3B-02F1, *SR3P-06F3 (*RR2KP relay)
Hold-Down Clip	SFA-203





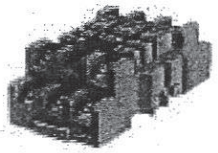


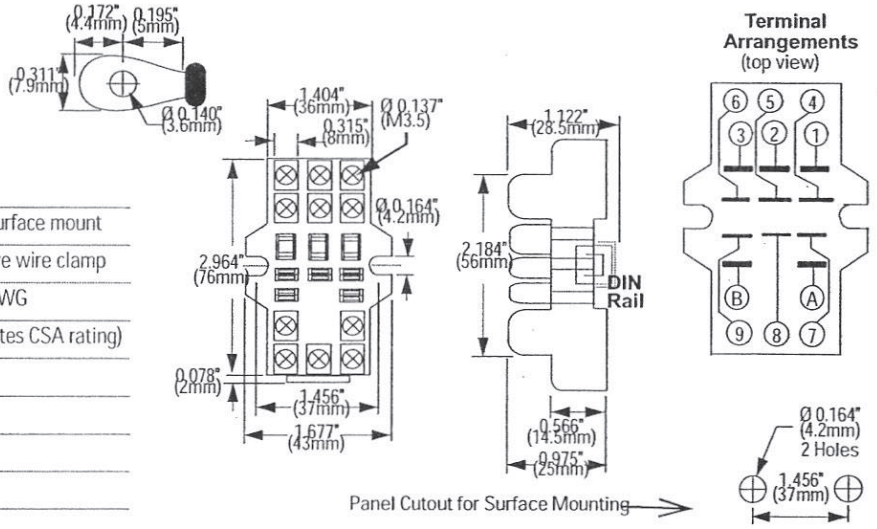
SR3P-06

Style	11-pin octal, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp
Wire Size	Maximum up to 2–#12AWG
Electrical Rating	300V, 10A
Compatible Relay	RR3PA, *RR2KP (*latching relay)
Compatible Timer	GT3 (11-pin), RTE-P2
Hold-Down Spring	SR3B-02F1, *SR3P-06F3 (*RR2KP relay)
Hold-Down Clip	SFA-202

1. For socket mounting accessories, see page F-22.
2. For hold-down clip/spring selections, see page F-4.

SR3B Sockets





SR3B-05

Style	11-blade, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp
Wire Size	Maximum up to 2–#12AWG
Electrical Rating	300V, 15A (10A)* (*denotes CSA rating)
Compatible Relay	RR1BA, RR2BA, RR3B
Compatible Timer	RTE-B
Hold-Down Spring	SR3B-02F1
Hold-Down Clip	SFA-202

F

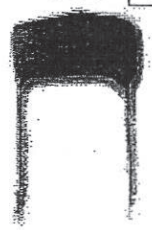
1. *For socket mounting accessories, see page F-22.*
2. *For hold-down clip/spring selections, see page F-4.*

PUBLICATION DIVIDER

Arc Suppressor
Snubber Network

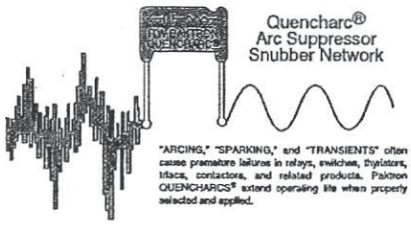
Q/QRL

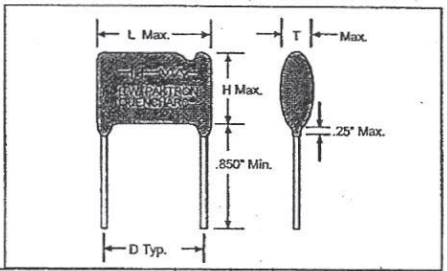
UL/CSA version



QUENCHARC®

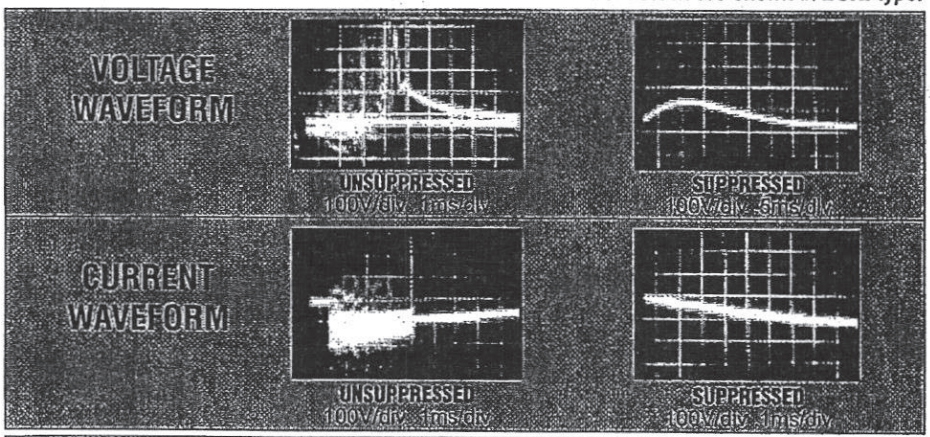
- **Relay contact protection • Noise reduction on controllers/drivers**
- **dv/dt suppression on thyristor and triacs • EMI/RFI reduction**
- **No lag time in suppression • Available voltages: 125 VAC - 660 VAC**
- **Type QRL – UL/CSA version**





PF CODE	µF ± 20%	VOLTAGE	TYPE	OHMS ±10%	WATT	T	H	L	D
104	.1	600 VDC/250 VAC	QC	**22, 47, 100**, 150, 220, 330	1/2	.39	.66	1.08	.82
104	.1	1200 VDC/480VAC	QH	**39**	2	.64	1.04	1.60	1.29
104	.1	1600 VDC/660VAC	QV	**39**	2	.54	1.00	2.18	1.80
254	.25	600 VDC/250 VAC	QD	22, 47, 100, 150	1/2	.42	.75	1.45	1.20
504	.5	600 VDC/250 VAC	QE	22, 47, 100, 150	1/2	.59	.92	1.45	1.20
504	.5	200 VDC/125 VAC	QA	22, 47, **100, 220**	1/2	.37	.64	1.08	.82
105	1.0	200 VDC/125 VAC	QB	22, **47**	1/2	.39	.66	1.45	1.20
UL/CSA Recognized Across-the-Line Application				NOTE: Type QRL complies with UL1414/CSA-C22.2 No. 1					
104	.1	125 VAC	QRL	**150**, 680	1/2	.44	.66	1.08	.82

Preferred values available from stock are shown in **bold** type.



HOW TO ORDER

QA QB QC QD QE QH QV

EXAMPLE: .1 µF ± 20% 600 VDC 100 Ohms =

104	M	06	QC	100
PF CODE	**TOLERANCE**	**VOLTAGE**	**TYPE**	**RESISTOR**
	M = ± 20%	02 = 200 VDC/125 VAC	QA QD	22 150
		06 = 600 VDC/250 VAC	QB QE	39 220
		48 = 1200 VDC/480 VAC	QC QV	47 330
		66 = 1600 VDC/660 VAC	QH	100

QRL

EXAMPLE: .1 µF ± 20% 125 VAC 150 Ohms =

104	M	AC	QRL	150
PF CODE	**TOLERANCE**	**VOLTAGE**	**TYPE**	**RESISTOR**
104	M = ± 20%	AC = 125 VAC	QRL	150 680

Type QRL: UL Recognized for 125 VAC across-the-line. UL File No. E33628.
CSA Certified for 125 VAC across-the-line. CSA File No. LR32208

ITW Paktron • P.O. Box 4539, 1205 McConville Road, Lynchburg, Virginia 24502 • Phone 804-239-6941 • FAX 804-239-4730 • www.paktron.com

HOW QUENCHARC® WORKS

The most popular and commonly used method of arc suppression is to connect a resistor-capacitor network as shown in Figures A and B. The preferred method of connection is across the contacts it wants to protect. However, the network can be hooked across the load, as is shown by the dashed line, when all inductance of the load circuit is considered lumped together.

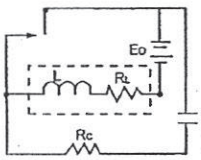


Figure A

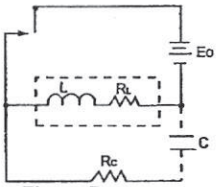


Figure B

When the contacts open, the voltage across the uncharged capacitor is zero and the transient voltage starts charging the capacitor. In the meantime, the gap of the contact is steadily widened, and by the time the capacitor is charged to its full potential, the contact gap is widened well beyond the minimum breakdown potential of air, thus preventing the arcing. When the contact closes, the inrush current from the capacitor may damage the contact, and here resistance is needed to limit the maximum current to Eo/Rc during the contact closure.

The induced voltage on opening the contact is

$$V = IRc = \frac{Rc}{RL} E_o \qquad (1)$$

and, as can be seen, the larger the value of a series resistor, the higher the induced voltage. On the other hand, the lower series resistance makes the current on contact closure higher. The time dependence of the voltage is given by:

$$V(t) = L\frac{di}{dt} + (RL + Rc)i + E_o + \frac{1}{C}\int_o^t i\,dt$$

and the rate of voltage change, which is important in transient suppression of triac switching, is:

$$\frac{dv}{dt} = L\frac{d^2i}{dt^2} + (RL + Rc)\frac{di}{dt} + \frac{i}{C}$$

Equation (3) tells us that by knowing the circuit conditions with given values of L and coil resistance that limit the current prior to contact opening, the rate of voltage rise is inversely proportional to capacitance. In other words, the larger the capacitance, the greater is the transient suppression. However, when the contact closes, the additional energy stored in the capacitor has to be discharged through the contact. Hence, a compromise has to be made in the selection of both resistance and capacitance.

In an effort to provide a simple answer to designers' requests for proper values of resistance and capacitance, some relay manufacturers came out with empirical formulas and nomographs. For instance, C.C. Bates[1] gives the equations

$$C = \frac{I^2}{10} \qquad R = \frac{E_o}{10I(1 + \frac{50}{E_o})}$$

where
C = capacitance in μF
I = load current in amperes prior to contact opening
R = resistance in ohms in series with capacitor
E_o = source voltage

The choice of resistance and capacitance value however, is quite flexible. In fact, the choice is so simple that one does not need a nomograph at all. Besides, a nomograph published by a certain relay manufacturer may be for the particular relays the firm manufactures, not necessarily universal.

[1]Bates, C.C., "Contact Protection of Electromagnetic Relays." Electro-mechanical Design, August, 1966.

CHOOSING A QUENCHARC®

In choosing a Quencharc®, first of all, check the maximum switching current rating of the contacts to be protected. This value differs for different types of contact materials and different types of relays. The maximum current during the contact closure with an RC network is E_o/R_c, where E_o is the source voltage and R_c is the resistance value of the network. The quantity E_o/R_c must be lower than the maximum switching current for obvious reasons. Next, the selection of capacitance is best done with an oscilloscope.

Connect the oscilloscope probe to the relay wiper and ground the other plate of the contact. Without an RC network across the contacts, check the amplitude of the transient voltage on contact break and the amplitude of the current on contact make. If the voltage is less than 300V and the current less than the maximum switching current rating of the relay, and if you don't see any arcing, you may not need the contact protection at all. If you spot arcing, connect a .1 μF + 100 ohm, 250 VAC, QC100 (our most widely used Quencharc®), across the contacts, and observe the levels of suppression, voltage on break and current on make. The suppressed voltage should be below 250V, which provides 70 volts of safety margin from the breakdown potential of air. If the voltage is still above 250V, try a .25 μF + 220 ohms or a .5 μF + 330 ohms range. If you need a higher capacitance than 1.0 μF, you may be better off with a Zener or a varistor in terms of cost and space. For most relays and triacs .1 μF + 100 ohms provides a satisfactory suppression.

When protecting contacts in AC circuits, the same general guidelines as for DC circuits can be used, but the wattage of the resistor must be considered if current flow is sustained for a long enough period of time to heat the component. Compute the impedance of the RC unit to obtain a current value, then use I^2R and time considerations to determine whether the standard network resistor is adequate.

OPERATING

TEMPERATURE RANGE –55°C to +85°C at full rated voltage

DISSIPATION FACTOR
The nominal dissipation factor is determined from the following equation:
DF = 2πfCR × 100
where
f = test frequency in hertz
C = nominal capacitance value in farads
R = nominal value of series resistance in ohms

DIELECTRIC WITHSTANDING VOLTAGE
Unit shall withstand a DC potential of 1.6 times the DC voltage rating. Testing is conducted at 25°C.

DC LIFE TEST
Unit shall withstand a test potential of 125% of the rated voltage for a period of 500 hours at a temperature of 85°C. At all times shall consist of:
Capacitance change greater than 5%.
Dissipation factor greater than original limits.

LONG TERM STABILITY
The capacitance shall not change more than 2% when stored at ambient temperature and humidity for a period of 2 years or less.

PHYSICAL

TOLERANCE
Capacitor ± 20%. Resistor ± 10%.

CONSTRUCTION
Metallized polyester capacitor in series with a carbon composition resistor.

CASE
Coated with a UL 94 V-0 flame retardant epoxy.

WIRE LEADS
#20 AWG (.032") capacitor lead. #18 AWG (.040") for QF & QV styles. Resistor lead .025" to .040".

MARKING
"ITW Quencharc" capacitance, resistance, voltage.

Ceramic resistors are power wirewound.

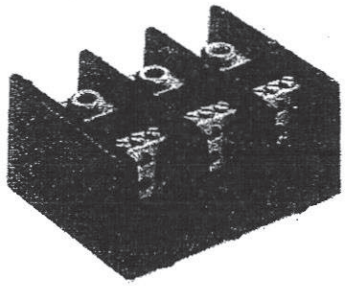
PUBLICATION DIVIDER

Power Distribution & Terminal Blocks

PDB

Power Distribution Blocks

600 Volt AC or DC



Catalog Symbol: Power Distribution Blocks
Voltage Rating: 600 Volts AC or DC maximum
Agency Information:
UL Recognized, Guide XCFR2, File E84923
CSA Certified, Class 6228-01, File 15364

Example: A 3-pole, 16023 series is 16023-3. It has 1 line opening per section that accepts 350MCM - #6. 3 openings total. This block has 6 load openings per section. Each opening accepts #6 - #14 wire. A total of 18 openings are on the 3-pole block.
Picture shown:
3-Pole - 1 opening on line per pole
6 opening on load per pole

Power Distribution Blocks (600V) Catalog Data

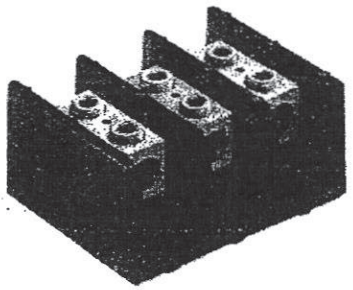
Catalog Number	1-Pole	2-Pole	3-Pole	4-Pole	Connection Line	Load	Connector Material and Ampacity	UL	CSA
16021	NA	-2	-3	-4	2/0 - #14CU, 2/0 - #8AL	(6) #4 - #14CU, #4 - #8AL	AL-175A	•	•
16023	NA	-2	-3	-4	350kcmil - #6CU-AL	(6) #4 - #14CU, #4 - #12AL	AL-310A	•	•
16220	-1	-2	-3	NA	2/0 - #14CU, 2/0 - #8AL	(4) #4 - #14CU, #4 - #8AL	AL-175A	•	•
16321	-1	-2	-3	NA	2/0 - #14CU, 2/0 - #8AL	(6) #4 - #14CU, #4 - #8AL	AL-175A	•	•
16323	-1	-2	-3	NA	350kcmil - #6CU-AL	(6) #4 - #14CU, #4 - #12AL	AL-310A	•	•
16325	-1	-2	-3	NA	(2) 2/0 - #14CU, 2/0 - #8AL	(6) #4 - #14CU, #4 - #8AL	AL-350A	•	•
16330	-1	-2	-3	NA	500kcmil - #6CU-AL	(6)#2 - #14CU, #2 - #12AL	AL-380A	•	•
16332	-1	-2	-3	NA	350kcmil - #6CU-AL	(3) #2 - #14CU, #2 - #8AL (2) 1/0 - #14CU, 1/0 - #8AL	AL-310A	•	•
16335	-1	-2	-3	NA	500kcmil - #6CU-AL	(3) #2 - #14 CU, #2 - #8AL (2) 1/0 - #14CU, 1/0 - #8AL	AL-380A	• •	• —
16370	-1	-2	-3	NA	350kcmil - #6CU-AL	(12) #4 - #14CU, #4 - #12AL	AL-310A	•	•
16371	-1	-2	-3	NA	350kcmil - #6CU-AL	(6) #2 - #14CU, #2 - #8AL (3) 1/0 - #14CU, 1/0 - #8AL	AL-310A	•	•
16372	-1	-2	-3	NA	350kcmil - #6CU-AL	(21) #10 - #14CU, #10AL	AL-310A	•	•
16373	-1	-2	-3	NA	350kcmil - #6CU-AL	(3) 1/0 - #14CU-AL (14) #10 - #14CU, #10AL	AL-310A	•	•
16375	-1	-2	-3	NA	600kcmil - #2CU-AL	(12) #4 - #14CU, #4 - #12AL	AL-420A	•	•
16376	-1	-2	-3	NA	600kcmil - #2CU-AL	(6) #2 - #14CU, #2 -8AL (3) 1/0 - #14CU, 1/0 - #8AL	AL-420A	•	•
16377	-1	-2	-3	NA	(2)300kcmil - #4CU-AL	(12) #4 - #14CU, #4 - #12AL	AL-570A	•	—
16528	-1	-2	-3	NA	(2) 600kcmil - #2CU-AL	(4) 3/0 - #6CU-AL (4) #4 - #14CU-AL	AL-840A	•	—
16530	-1	-2	-3	NA	(2) 500kcmil - #6CU-AL	(12) #4 - #14CU-AL	AL-760A	•	•
16541	-1	-2	-3	NA	500kcmil - #6CU-AL	(21) #6 - #14CU-AL	AL-380A	•	—

How To Order: Catalog Number + # of Poles
Example: 16021-3 (complete part number)

Power Distribution & Terminal Blocks

PDB

Splicer Terminal Blocks
600 Volt AC or DC



Catalog Symbol: Splicer Terminal Blocks
Voltage Rating: 600 Volts AC or DC maximum
Agency Information:
UL Recognized, Guide XCFR2, File E84923
CSA Certified, Class 6228-01, File 15364

Picture shown:
3-Pole - 1 opening on line per phase
1 opening on load per phase

Power Distribution Blocks (600V) Catalog Data

Catalog Number	1-Pole	2-Pole	3-Pole	4-Pole	Connection		Connector Material and Ampacity	U.R.	CSA
					Line	Load			
16000	NA	-2	-3	-4	2/0 - #8CU-AL	2/0 - #8CU-AL	AL-175A	•	—
16003	NA	-2	-3	-4	250kcmil - #6CU Only	250kcmil - #6CU Only	CU-255A	•	—
16005	NA	-2	-3	-4	350kcmil - #6CU-AL	350kcmil - #6CU-AL	AL-310A	•	—
16200	-1	-2	-3	NA	#2 - #14CU, #2 - #8AL	#2 - #14CU, #2 - #8AL	AL-115A	•	•
16201	-1	-2	-3	NA	1/0 - #14CU Only	1/0 - #14CU Only	CU-150A	•	•
16204	-1	-2	-3	NA	2/0 - #8CU-AL	2/0 - #8CU-AL	AL-175A	•	•
16301	-1	-2	-3	NA	250kcmil - #6CU Only	250kcmil - #6CU Only	CU-255A	•	•
16303	-1	-2	-3	NA	350kcmil - #6CU-AL	350kcmil - #6CU-AL	AL-310A	•	•
16500	-1	-2	-3	NA	(2) 350kcmil - #4CU-AL	(2) 350kcmil - #4CU-AL	AL-620A	•	•
16504	-1	-2	-3	NA	(2) 500kcmil - #6CU-AL	(2) 500kcmil - #6CU-AL	AL-760A	•	•

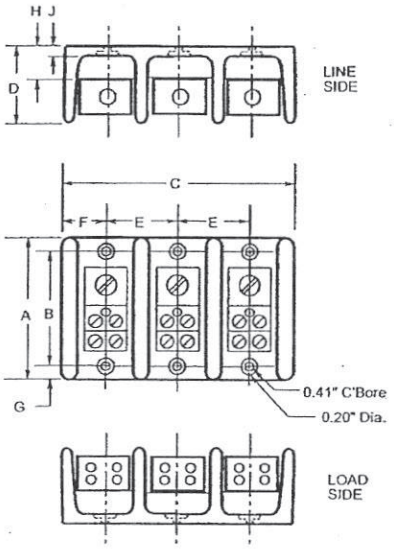
Power Distribution & Terminal Blocks

Connector-Stud and Stud-Stud Blocks
600 Volt AC or DC

PDB

Catalog Symbol: Connector–Stud Block
Voltage Rating: 600 Volts AC or DC maximum
Agency Information:
UL Recognized, Guide XCFR2, File E84923
CSA Certified, Class 6228-01, File 15364

Series 162, 163, 164, and 165 Dimensional Data (Available 1, 2, and 3 pole)



Dimensions for Series 162, 163, 164, and 165

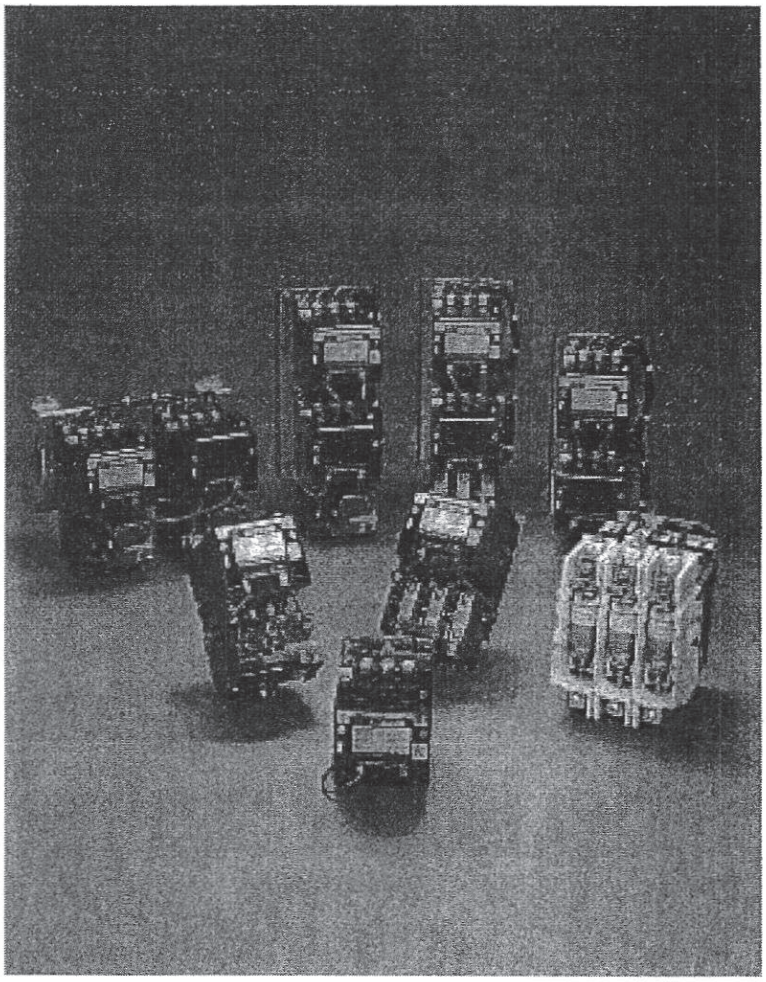
Cat. No.	A	B	C1	C2	C3	D	E	F	G	H	J	K	L
162	2.88	2.25	1.06	1.88	2.69	1.75	0.81	0.53	0.31	0.84	0.31	0.20	0.41
163	4.0	3.38	1.98	3.60	5.21	3.32	1.62	0.97	0.31	0.87	0.35	0.20	0.41
165	5.5	4.75	3.12	5.81	8.5	3.13	2.69	1.56	0.38	1.38	0.63	0.20	0.41

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PUBLICATION DIVIDER

Type S Contactors and Starters

Class 8536/8502/8736/8702/8810/8811/8812



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SQUARE D
GROUPE SCHNEIDER

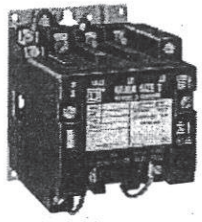
USFCS PDF No. 2306 Rev.: 05-98

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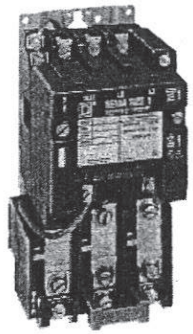
SECTION 1 – MAGNETIC CONTACTORS AND STARTERS

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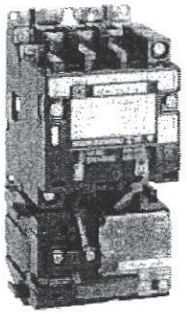
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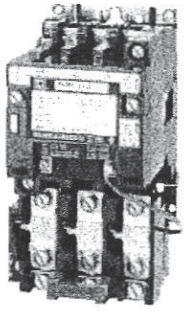
Type SCO2
Size 1, 3-Pole Contactor



Type SCO3
Size 1, 3-Pole Starter



Starter with MOTOR LOGIC



Starter with Melting Alloy

AC MAGNETIC CONTACTORS CLASS 8502

General Information

Class 8502 Type S magnetic contactors are used to switch heating loads, capacitors, transformers, and electric motors where overload protection is separately provided. Class 8502 contactors are available in NEMA Sizes 00-7. Type S contactors are designed for operation at 600 Volts, AC 50-60 Hertz.

Holding Circuit Contact

A normally open holding circuit contact for three wire control is provided on all contactors as standard. Sizes 00-2 contactors use a Class 9999 SX11 auxiliary contact as the holding circuit contact. Sizes 3-7 contactors use a Class 9999 SX6 auxiliary contact as the holding circuit contact. See Class 9999 for the holding circuit contact electrical ratings. On Size 00-1 single phase contactors, a power pole is used as the holding circuit contact and therefore has the same rating as the power contacts.

Enclosures

Class 8502 magnetic contactors are available in the following enclosures:

- NEMA Type 1 General Purpose
- NEMA Type 4 & 4X Watertight and Dusttight Stainless Steel
- NEMA Type 4X Watertight, Dusttight, and Corrosion Resistant Glass — Polyester
- NEMA Type 7 & 9 Bolted and Spin-Top for Hazardous Locations
- NEMA Type 12 Dusttight and Driptight for Industrial Use

The NEMA Type 4 & 4X stainless steel enclosure (Sizes 0-5) has a brushed finish. For an electropolished finish, specify Form G16 and add 15% to the price of the standard device.

Also, NEMA Type 12 devices are available UL Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G21, no additional charge.

Separate enclosures are available, see Class 9991.

AC MAGNETIC STARTERS CLASS 8536

General Information

Class 8536 Type S magnetic starters are used for full voltage starting and stopping AC squirrel cage motors. Motor overload protection is provided by melting alloy type thermal overload relays. Class 8536 starters are available in NEMA Sizes 00-7. Type S starters are designed for operation at 600 Volts AC, 50-60 Hertz.

Holding Circuit Contact

A normally open holding circuit contact for three wire control is provided on all contactors as standard. Sizes 00-2 contactors use a Class 9999 SX11 auxiliary contact as the holding circuit contact. Sizes 3-7 contactors use a Class 9999 SX6 auxiliary contact as the holding circuit contact. See Class 9999 for the holding circuit contact electrical ratings.

Overload Relays with Melting Alloys

Class 8536 Type S Sizes 00-6 starters are provided with a melting alloy thermal overload relay as standard. Interchangeable thermal units are available in standard trip (Class 20) Sizes 00-6, quick trip (Class 10) Sizes 00-4, and slow trip (Class 30) Sizes 00-3. Single-phase starters use one thermal unit, 3-phase starters use three thermal units.

Class 8536 Size 7 starters are provided with solid state Motor Logic which has selectable trip Class10/20, Ground fault detection, and Communication capabilities for future enhancement. The solid state overload relay is ambient insensitive and features phase loss, phase unbalance and over-current protection.

MOTOR LOGIC™ Solid State Overload Relay (SSOLR)

Solid state overload relays are available for Sizes 00 – 7 starters. These ambient insensitive overload relays provide phase loss protection, phase unbalance protection and a LED power indicator. For additional information, see the Class 9065 catalog section. To order Type S starters with solid state overload relays, see Factory Modification (FORMS).

Bimetallic overload relays are also available for Sizes 0-6. Ambient Compensated and Non-compensated versions are supplied with manual

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and automatic reset, trip current adjustment, and an alarm contact on Sizes 0-2. For additional information, see the Class 9065 catalog section. To order Type S starters with bimetallic overload relays, see Factory Modifications (FORMS).

Enclosures

Class 8536 magnetic starters are available in the following enclosures.

- NEMA Type 1 General Purpose Enclosure
- NEMA Type 3R Rainproof, Sleet Resistant for Outdoor Use
- NEMA Type 4 & 4X Watertight and Dusttight
- NEMA Type 4X Watertight, Dusttight, and Corrosion Resistant Glass – Polyester
- NEMA Type 7 & 9 Bolted and Spin-Top for Hazardous Locations
- NEMA Type 9 Bolted for Hazardous Locations
- NEMA Type 12 Dusttight and Driptight for Industrial Use

The NEMA Type 4 & 4X stainless steel enclosure (Sizes 0-5) has a brushed finish. For an electropolished finish, specify Form G16 and add 15% to the price of the standard device. Sizes 6 & 7 are painted sheet steel and are rated NEMA 4 ONLY.

Also NEMA Type 12 devices are available UL Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Specify Form G21, no additional charge.

Separate enclosures are available, see Class 9991.

Coil Voltages

AC coils are available for application on 50-60 Hertz. NEMA Sizes 00-5 are supplied with coils that are designed to operate satisfactorily on line voltages of 85% – 110% of rated voltage. NEMA Size 6 and 7 contactors are supplied with a DC coil operated by a solid state rectifier circuit that is powered by an AC source.

Please note that **Voltage Codes** have been added to the Type designations in order to improve customer service. It is necessary to include the Voltage Code when ordering contactors and starters. Also, 120 Volt Polyphase contactors and starters will be wired for separate control.

Auxiliary Contacts

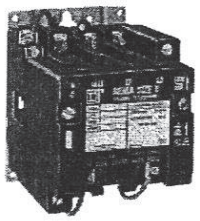
Additional auxiliary contacts may be added to Type S contactors. See Page 15 for maximum number of auxiliary units and Form designations for factory installed auxiliary contacts.

Type S Accessories

Additional accessories such as power poles, pneumatic timer attachments, and cover mounted control stations are available as factory or field modifications.

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Full Voltage Contactors — NEMA
Selection – Class 8502



Type SC02
Size 1, 3-Pole Contactor

3-Pole Polyphase — 600 Volts AC Maximum — 50-60 Hertz

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	Open Type	NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure (Size 0-5)♦
					Type	Type	Type
00	9	Separate Control†		120	SAO12V02S	SAG12V02S	USE Size 0
		200	1½	208	SAO12V08	SAG12V08	
		230	1½	240	SAO12V03	SAG12V03	
		460	2	480	SAO12V06	SAG12V06	
		575	2	600	SAO12V07	SAG12V07	
0	18	Separate Control†		120	SBO2V02S	SBG2V02S	SBW12V02S
		200	3	208	SBO2V08	SBG2V08	SBW12V08
		230	3	240	SBO2V03	SBG2V03	SBW12V03
		460	5	480	SBO2V06	SBG2V06	SBW12V06
		575	5	600	SBO2V07	SBG2V07	SBW12V07
1	27	Separate Control†		120	SCO2V02S	SCG2V02S	SCW12V02S
		200	7½	208	SCO2V08	SCG2V08	SCW12V08
		230	7½	240	SCO2V03	SCG2V03	SCW12V03
		460	10	480	SCO2V06	SCG2V06	SCW12V06
		575	10	600	SCO2V07	SCG2V07	SCW12V07
2	45	Separate Control†		120	SDO2V02S	SDG2V02S	SDW12V02S
		200	10	208	SDO2V08	SDG2V08	SDW12V08
		230	15	240	SDO2V03	SDG2V03	SDW12V03
		460	25	480	SDO2V06	SDG2V06	SDW12V06
		575	25	600	SDO2V07	SDG2V07	SDW12V07
3	90	Separate Control†		120	SEO2V02S	SEG2V02S	SEW12V02S
		200	25	208	SEO2V08	SEG2V08	SEW12V08
		230	30	240	SEO2V03	SEG2V03	SEW12V03
		460	50	480	SEO2V06	SEG2V06	SEW12V06
		575	50	600	SEO2V07	SEG2V07	SEW12V07
4	135	Separate Control†		120	SFO2V02S	SFG2V02S	SFW12V02S
		200	40	208	SFO2V08	SFG2V08	SFW12V08
		230	50	240	SFO2V03	SFG2V03	SFW12V03
		460	100	480	SFO2V06	SFG2V06	SFW12V06
		575	100	600	SFO2V07	SFG2V07	SFW12V07
5	270	Separate Control†		120	SGO2V02S	SGG2V02S	SGW12V02S
		200	75	208	SGO2V08	SGG2V08	SGW12V08
		230	100	240	SGO2V03	SGG2V03	SGW12V03
		460	200	480	SGO2V06	SGG2V06	SGW12V06
		575	200	600	SGO2V07	SGG2V07	SGW12V07
6	540	Separate Control†		120	SHO2V02S	SHG2V02S	SHW12V02S
		200	150	208	SHO2V08	SHG2V08	SHW12V08
		230	200	240	SHO2V03	SHG2V03	SHW12V03
		460	400	480	SHO2V06	SHG2V06	SHW12V06
		575	400	600	SHO2V07	SHG2V07	SHW12V07
7	810	Separate Control†		120	SJO2V02S	SJG2V02S	SJW12V02S
		200	...	208	SJO2V08	SJG2V08	SJW12V08
		230	300	240	SJO2V03	SJG2V03	SJW12V03
		460	600	480	SJO2V06	SJG2V06	SJW12V06
		575	600	600	SJO2V07	SJG2V07	SJW12V07

♦ Size 6 and 7 are painted sheet steel rated NEMA Type 4 only.
† 120 Volt Polyphase contactors are wired for separate control.
* Coil voltage code must be specified to order this product. Refer to standard voltage codes listed below and insert as shown in How to Order.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	VO1
120	110	VO2
208	...	VO8
240	220	VO3
480	440	VO6
600	550	VO7
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

How to Order:

To Order Specify:	Catalog Number			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8502	SBG2	VO2	P1S

Factory Modifications (FORMS) .....Refer to Catalog 9999CT9701
Application Data ..... Pages 13-16
Dimensions ..... Pages 17-20
Separate Enclosures (Class 9991) .....Refer to Catalog 9999CT9701
Replacement Parts (Class 9998) .....Refer to Catalog 9999CT9701
Type S Accessories (Class 9999) .....Refer to Catalog 9999CT9701

File E78351
CCN NLDX

File LR12751
Class 3211-04

File 60905
Class 3211-04

IEC 947-4-1
Sizes 00-5 only

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3-Pole Polyphase — 600 Volts AC Maximum — 50-60 Hertz

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	NEMA Type 4X Watertight, Dusttight, Corrosion-Resistant Glass-Polyester Enclosure	NEMA Type 7 & 9 Hazardous Locations Class I, Groups C & D Class II, Groups E, F, & G			NEMA Type 12 Dusttight & Driptight Industrial Use Enclosure
					Type	Bolted Type		SPIN TOP® Type	Type
						Cast Iron■	Cast Aluminum		
00	9	Separate Control†		120 208 240 480 600	Use Size 0	Use Size 0		Use Size 0	Use Size 0
		200	1½						
		230	1½						
		460	2						
		575	2						
0	18	Separate Control†		120 208 240 480 600	SBW22V02S SBW22V08 SBW22V03 SBW22V06 SBW22V07	SBT2V02S SBT2V08 SBT2V03 SBT2V06 SBT2V07	SBT42V02S SBT42V08 SBT42V03 SBT42V06 SBT42V07	SBR2V02S SBR2V08 SBR2V03 SBR2V06 SBR2V07	SBA2V02S SBA2V08 SBA2V03 SBA2V06 SBA2V07
		200	3						
		230	3						
		460	5						
		575	5						
1	27	Separate Control†		120 208 240 480 600	SCW22V02S SCW22V08 SCW22V03 SCW22V06 SCW22V07	SCT2V02S SCT2V08 SCT2V03 SCT2V06 SCT2V07	SCT42V02S SCT42V08 SCT42V03 SCT42V06 SCT42V07	SCR2V02S SCR2V08 SCR2V03 SCR2V06 SCR2V07	SCA2V02S SCA2V08 SCA2V03 SCA2V06 SCA2V07
		200	7½						
		230	7½						
		460	10						
		575	10						
2	45	Separate Control†		120 208 240 480 600	SDW22V02S SDW22V08 SDW22V03 SDW22V06 SDW22V07	SDT2V02S SDT2V08 SDT2V03 SDT2V06 SDT2V07	SDT42V02S SDT42V08 SDT42V03 SDT42V06 SDT42V07	SDR2V02S SDR2V08 SDR2V03 SDR2V06 SDR2V07	SDA2V02S SDA2V08 SDA2V03 SDA2V06 SDA2V07
		200	10						
		230	15						
		460	25						
		575	25						
3	90	Separate Control†		120 208 240 480 600	SEW22V02S SEW22V08 SEW22V03 SEW22V06 SEW22V07	...	SET42V02S SET42V08 SET42V03 SET42V06 SET42V07	SER2V02S SER2V08 SER2V03 SER2V06 SER2V07	SEA2V02S SEA2V08 SEA2V03 SEA2V06 SEA2V07
		200	25						
		230	30						
		460	50						
		575	50						
4	135	Separate Control†		120 208 240 480 600	SFW22V02S SFW22V08 SFW22V03 SFW22V06 SFW22V07	...	SFT42V02S SFT42V08 SFT42V03 SFT42V06 SFT42V07	SFR2V02S SFR2V08 SFR2V03 SFR2V06 SFR2V07	SFA2V02S SFA2V08 SFA2V03 SFA2V06 SFA2V07
		200	40						
		230	50						
		460	100						
		575	100						
5	270	Separate Control†		120 208 240 480 600	...	...	...	SGR2V02S SGR2V08 SGR2V03 SGR2V06 SGR2V07	SGA2V02S SGA2V08 SGA2V03 SGA2V06 SGA2V07
		200	75						
		230	100						
		460	200						
		575	200						
6	540	Separate Control†		120 208 240 480 600	...	...	...	...	SHA2V02S SHA2V08 SHA2V03 SHA2V06 SHA2V07
		200	150						
		230	200						
		460	400						
		575	400						
7	810	Separate Control†		208 240 480 600	...	...	...	...	SJA2V02S SJA2V08 SJA2V03 SJA2V06 SJA2V07
		200	—						
		230	300						
		460	600						
		575	600						

† 120 Volt Polyphase contactors are wired for separate control.

■ Limited to one Pilot Light and a Selector Switch or Start-Stop Push Button.

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	VO1
120	110	VO2
208	...	VO8
240	220	VO3
480	440	VO6
600	550	VO7
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

Explosion Proof Units

File E78503
CCN NPKR

File LR60905
Class 3218-03

How to Order:

To Order Specify:	*Catalog Number*			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8502	SBA2	VO2	P1S

Factory Modifications (FORMS)..... Refer to Catalog 9999CT9701
Application Data..... Pages 13-16
Dimensions..... Pages 17-20
Separate Enclosures (Class 9991)..... Refer to Catalog 9999CT9701
Replacement Parts (Class 9998)..... Refer to Catalog 9999CT9701
Type S Accessories (Class 9999)..... Refer to Catalog 9999CT9701

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Full Voltage Contactors — NEMA
Selection – Class 8502

600 Volts AC Maximum — 50-60 Hertz

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	Open Type	NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure (Size 0-5)♦
					Type	Type	Type
1-Pole Single Phase							
0	18	115 230	1 2	120 240	SBO5V02 SBO5V03	SBG5V02 SBG5V03	SBW15V02 SBW15V03
1	27	115 230	2 3	120 240	SCO5V02 SCO5V03	SCG5V02 SCG5V03	SCW15V02 SCW15V03
2-Pole Single Phase							
00	9	115 230	⅓ 1	120 240	SAO11V02 SAO11V03	SAG11V02 SAG11V03	Use Size 0
0	18	115 230	1 2	120 240	SBO1V02 SBO1V03	SBG1V02 SBG1V03	SBW11V02 SBW11V03
1	27	115 230	2 3	120 240	SCO1V02 SCO1V03	SCG1V02 SCG1V03	SCW11V02 SCW11V03
2	45	115 230	3 7½	120 240	SDO1V02 SDO1V03	SDG1V02 SDG1V03	SDW11V02 SDW11V03
3	90	...	...	120 240	SEO1V02 SEO1V03	SEG1V02 SEG1V03	SEW11V02 SEW11V03
4	135	...	...	120 240	SFO1V02 SFO1V03	SFG1V02 SFG1V03	SFW11V02 SFW11V03
5	270	...	...	120 240	SGO1V02 SGO1V03	SGG1V02 SGG1V03	SGW11V02 SGW11V03
6	540	...	...	120 240	SHO1V02 SHO1V03	SHG1V02 SHG1V03	SHW1V02 SHW1V03
7	810	...	...	120 240	SJO1V02 SJO1V03	SJG1V02 SJG1V03	SJW1V02 SJW1V03
4-Pole Polyphase							
0	18	Separate Control† 200 230 460 575	 3 3 5 5	120 208 240 480 600	SBO3V02S SBO3V08 SBO3V03 SBO3V06 SBO3V07	SBG3V02S SBG3V08 SBG3V03 SBG3V06 SBG3V07	SBW13V02S SBW13V08 SBW13V03 SBW13V06 SBW13V07
1	27	Separate Control† 200 230 460 575	 7½ 7½ 10 10	120 208 240 480 600	SCO3V02S SCO3V08 SCO3V03 SCO3V06 SCO3V07	SCG3V02S SCG3V08 SCG3V03 SCG3V06 SCG3V07	SCW13V02S SCW13V08 SCW13V03 SCW13V06 SCW13V07
2	45	Separate Control† 200 230 460 575	 10 15 25 25	120 208 240 480 600	SDO3V02S SDO3V08 SDO3V03 SDO3V06 SDO3V07	SDG3V02S SDG3V08 SDG3V03 SDG3V06 SDG3V07	SDW13V02S SDW13V08 SDW13V03 SDW13V06 SDW13V07
3	90	Separate Control† 200 230 460 575	 25 30 50 50	120 208 240 480 600	SEO3V02S SEO3V08 SEO3V03 SEO3V06 SEO3V07	SEG3V02S SEG3V08 SEG3V03 SEG3V06 SEG3V07	SEW13V02S SEW13V08 SEW13V03 SEW13V06 SEW13V07
4	135	Separate Control† 200 230 460 575	 40 50 100 100	120 208 240 480 600	SFO3V02S SFO3V08 SFO3V03 SFO3V06 SFO3V07	SFG3V02S SFG3V08 SFG3V03 SFG3V06 SFG3V07	SFW13V02S SFW13V08 SFW13V03 SFW13V06 SFW13V07
5-Pole Polyphase							
0	18	Separate Control† 200 230 460 575	 3 3 5 5	120 208 240 480 600	SBO4V02S SBO4V08 SBO4V03 SBO4V06 SBO4V07	SBG4V02S SBG4V08 SBG4V03 SBG4V06 SBG4V07	SBW14V02S SBW14V08 SBW14V03 SBW14V06 SBW14V07
1	27	Separate Control† 200 230 460 575	 7½ 7½ 10 10	120 208 240 480 600	SCO4V02S SCO4V08 SCO4V03 SCO4V06 SCO4V07	SCG4V02S SCG4V08 SCG4V03 SCG4V06 SCG4V07	SCW14V02S SCW14V08 SCW14V03 SCW14V06 SCW14V07
2	45	Separate Control† 200 230 460 575	 10 15 25 25	120 208 240 480 600	SDO4V02S SDO4V08 SDO4V03 SDO4V06 SDO4V07	SDG4V02S SDG4V08 SDG4V03 SDG4V06 SDG4V07	SDW14V02S SDW14V08 SDW14V03 SDW14V06 SDW14V07
3	90	Separate Control† 200 230 460 575	 25 30 50 50	120 208 240 480 600	SEO4V02S SEO4V08 SEO4V03 SEO4V06 SEO4V07	SEG4V02S SEG4V08 SEG4V03 SEG4V06 SEG4V07	SEW14V02S SEW14V08 SEW14V03 SEW14V06 SEW14V07
4	135	Separate Control† 200 230 460 575	 40 50 100 100	120 208 240 480 600	SFO4V02S SFO4V08 SFO4V03 SFO4V06 SFO4V07	SFG4V02S SFG4V08 SFG4V03 SFG4V06 SFG4V07	SFW14V02S SFW14V08 SFW14V03 SFW14V06 SFW14V07

♦ Size 6 and 7 are painted sheet steel rated NEMA Type 4 only.

† 120 Volt Polyphase contactors are wired for separate control.

* Coil voltage code must be specified to order this product. Refer to standard voltage codes listed in selection table above or additional standard voltage codes and insert as shown in the HOW TO ORDER block on Page 5.

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600 Volts AC Maximum — 50-60 Hertz

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	NEMA Type 4X Watertight, Dusttight, Corrosion-Resistant Glass-Polyester Enclosure	NEMA Type 7 & 9 Hazardous Locations Class I, Groups C & D Class II, Groups E, F, & G			NEMA Type 12 Dusttight & Driptight Industrial Use Enclosure
					Type	Bolted Type		SPIN TOP® Type	Type
						Cast Iron■	Cast Aluminum		
1-Pole Single Phase									
0	18	115 230	1 2	120 240	...	SBT5V02 SBT5V03	SBT45V02 SBT45V03	SBR5V02 SBR5V03	SBA5V02 SBA5V03
1	27	115 230	2 3	120 240	...	SCT5V02 SCT5V03	SCT5V02 SCT5V03	SCR5V02 SCR5V03	SCA5V02 SCA5V03
2-Pole Single Phase									
00	9	115 230	1/3 1	120 240	Use Size 0	Use Size 0		Use Size 0	Use Size 0
0	18	115 230	1 2	120 240	SBW21V02 SBW21V03	SBT1V02 SBT1V03	SBT41V02 SBT41V03	SBR1V02 SBR1V03	SBA1V02 SBA1V03
1	27	115 230	2 3	120 240	SCW21V02 SCW21V03	SCT1V02 SCT1V03	SCT41V02 SCT41V03	SCR1V02 SCR1V03	SCA1V02 SCA1V03
2	45	115 230	3 7½	120 240	SDW21V02 SDW21V03	SDT1V02 SDT1V03	SDT41V02 SDT41V03	SDR1V02 SDR1V03	SDA1V02 SDA1V03
3	90	...	...	120 240	Consult Local Square D Field Office	...	SET41V02 SET41V03	SER1V02 SER1V03	SEA1V02 SEA1V03
4	135	...	...	120 240	Consult Local Square D Field Office	...	SFT41V02 SFT41V03	SFR1V02 SFR1V03	SFA1V02 SFA1V03
5	270	...	...	120 240	...	...	...	SGR1V02 SGR1V03	SGA1V02 SGA1V03
6	540	...	...	120 240	...	...	...	...	SHA1V02 SHA1V03
7	810	...	...	120 240	...	...	...	...	SJA1V02 SJA1V03
4-Pole Polyphase									
0	18	Separate Control† 200 | 3 230 | 3 460 | 5 575 | 5		120 208 240 480 600	SBW33V02S SBW33V08 SBW33V03 SBW33V06 SBW33V07	SBT3V02S SBT3V08 SBT3V03 SBT3V06 SBT3V07	Consult Local Square D Field Office	SBR3V02S SBR3V08 SBR3V03 SBR3V06 SBR3V07	SBA3V02S SBA3V08 SBA3V03 SBA3V06 SBA3V07
1	27	Separate Control† 200 | 7½ 230 | 7½ 460 | 10 575 | 19		120 208 240 480 600	SCW23V02S SCW23V08 SCW23V03 SCW23V06 SCW23V07	SCT3V02S SCT3V08 SCT3V03 SCT3V06 SCT3V07	Consult Local Square D Field Office	SCR3V02S SCR3V08 SCR3V03 SCR3V06 SCR3V07	SCA3V02S SCA3V08 SCA3V03 SCA3V06 SCA3V07
2	45	Separate Control† 200 | 10 230 | 15 460 | 25 575 | 25		120 208 240 480 600	SDW23V02S SDW23V08 SDW23V03 SDW23V06 SDW23V07	SDT3V02S SDT3V08 SDT3V03 SDT3V06 SDT3V07	Consult Local Square D Field Office	SDR3V02S SDR3V08 SDR3V03 SDR3V06 SDR3V07	SDA3V02S SDA3V08 SDA3V03 SDA3V06 SDA3V07
3	90	Separate Control† 200 | 25 230 | 30 460 | 50 575 | 50		120 208 240 480 600	Consult Local Square D Field Office	Consult Local Square D Field Office	Consult Local Square D Field Office	SER3V02S SER3V08 SER3V03 SER3V06 SER3V07	SEA3V02S SEA3V08 SEA3V03 SEA3V06 SEA3V07
4	135	Separate Control† 200 | 40 230 | 50 460 | 100 575 | 100		120 208 240 480 600	Consult Local Square D Field Office	Consult Local Square D Field Office	Consult Local Square D Field Office	SFR3V02S SFR3V08 SFR3V03 SFR3V06 SFR3V07	SFA3V02S SFA3V08 SFA3V03 SFA3V06 SFA3V07
5-Pole Polyphase									
0	18	Separate Control† 200 | 3 230 | 3 460 | 5 575 | 5		120 208 240 480 600	Consult Local Square D Field Office	...	...	...	SBA4V02S SBA4V08 SBA4V03 SBA4V06 SBA4V07
1	27	Separate Control† 200 | 7½ 230 | 7½ 460 | 10 575 | 10		120 208 240 480 600	Consult Local Square D Field Office	...	...	...	SCA4V02S SCA4V08 SCA4V03 SCA4V06 SCA4V07
2	45	Separate Control† 200 | 10 230 | 15 460 | 25 575 | 25		120 208 240 480 600	Consult Local Square D Field Office	...	...	...	SDA4V02S SDA4V08 SDA4V03 SDA4V06 SDA4V07
3	90	Separate Control† 200 | 25 230 | 30 460 | 50 575 | 50		120 208 240 480 600	Consult Local Square D Field Office	...	...	...	SEA4V02S SEA4V08 SEA4V03 SEA4V06 SEA4V07
4	135	Separate Control† 200 | 40 230 | 50 460 | 100 575 | 100		120 208 240 480 600	Consult Local Square D Field Office	...	...	...	SFA4V02S SFA4V08 SFA4V03 SFA4V06 SFA4V07

† 120 Volt Polyphase contactors are wired for separate control.

■ Limited to one Pilot Light and a Selector Switch or Start-Stop Push Button.

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes and insert as shown in the HOW TO ORDER block on Page 5.

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3-Pole Polyphase—600 Volt AC Max. 50/60 Hz—Three Thermal Units Required

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	Open Type	NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure (Size 0-5)♦	NEMA Type 4X Watertight, Dusttight, Corrosion-Resistant Glass-Polyester Enclosure
					Type	Type	Type	Type
00	9	Separate Control†		120	SAO12V02S	SAG12V02S	Use Size 0	Use Size 0
		200	1½	208	SAO12V08	SAG12V08		
		230	1½	240	SAO12V03	SAG12V03		
		460	2	480	SAO12V06	SAG12V06		
		575	2	600	SAO12V07	SAG12V07		
0	18	Separate Control†		120	SBO2V02S	SBG2V02S	SBW12V02S	SBW22V02S
		200	3	208	SBO2V08	SBG2V08	SBW12V08	SBW22V08
		230	3	240	SBO2V03	SBG2V03	SBW12V03	SBW22V03
		460	5	480	SBO2V06	SBG2V06	SBW12V06	SBW22V06
		575	5	600	SBO2V07	SBG2V07	SBW12V07	SBW22V07
1	27	Separate Control†		120	SCO3V02S	SCG3V02S	SCW13V02S	SCW23V02S
		200	7½	208	SCO3V08	SCG3V08	SCW13V08	SCW23V08
		230	7½	240	SCO3V03	SCG3V03	SCW13V03	SCW23V03
		460	10	480	SCO3V06	SCG3V06	SCW13V06	SCW23V06
		575	10	600	SCO3V07	SCG3V07	SCW13V07	SCW23V07
2	45	Separate Control†		120	SDO1V02S	SDG1V02S	SDW11V02S	SDW21V02S
		200	10	208	SDO1V08	SDG1V08	SDW11V08	SDW21V08
		230	15	240	SDO1V03	SDG1V03	SDW11V03	SDW21V03
		460	25	480	SDO1V06	SDG1V06	SDW11V06	SDW21V06
		575	25	600	SDO1V07	SDG1V07	SDW11V07	SDW21V07
3	90	Separate Control†		120	SEO1V02S	SEG1V02S	SEW11V02S	SEW21V02S
		200	25	208	SEO1V08	SEG1V08	SEW11V08	SEW21V08
		230	30	240	SEO1V03	SEG1V03	SEW11V03	SEW21V03
		460	50	480	SEO1V06	SEG1V06	SEW11V06	SEW21V06
		575	50	600	SEO1V07	SEG1V07	SEW11V07	SEW21V07
4	135	Separate Control†		120	SFO1V02S	SFG1V02S	SFW11V02S	SFW21V02S
		200	40	208	SFO1V08	SFG1V08	SFW11V08	SFW21V08
		230	50	240	SFO1V03	SFG1V03	SFW11V03	SFW21V03
		460	100	480	SFO1V06	SFG1V06	SFW11V06	SFW21V06
		575	100	600	SFO1V07	SFG1V07	SFW11V07	SFW21V07
5	270	Separate Control†		120	SGO1V02S	SGG1V02S	SGW11V02S	...
		200	75	208	SGO1V08	SGG1V08	SGW11V08	
		230	100	240	SGO1V03	SGG1V03	SGW11V03	
		460	200	480	SGO1V06	SGG1V06	SGW11V06	
		575	200	600	SGO1V07	SGG1V07	SGW11V07	
6	540	Separate Control†		120	SHO2V02S	SHG2V02S	SHW2V02S	...
		200	150	208	SHO2V08	SHG2V08	SHW2V08	
		230	200	240	SHO2V03	SHG2V03	SHW2V03	
		460	400	480	SHO2V06	SHG2V06	SHW2V06	
		575	400	600	SHO2V07	SHG2V07	SHW2V07	
7	810	Separate Control†		120	SJO2V02S	SJG2V02S	SJW2V02S	...
		200	—	208	SJO2V08	SJG2V08	SJW2V08	
		230	300	240	SJO2V03	SJG2V03	SJW2V03	
		460	600	480	SJO2V06	SJG2V06	SJW2V06	
		575	600	600	SJO2V07	SJG2V07	SJW2V07	

♦ Size 6 and 7 are rated NEMA Type 4 only.

† 120 Volt Polyphase starters are wired for separate control.

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	VO1
120	110	VO2
208	...	VO8
240	220	VO3
480	440	VO6
600	550	VO7
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

File E78351
CCN NLDX

File LR60905
Class 3211-04

IEC 947-4-1
Sizes 00-5 only

How to Order:

To Order Specify:	Catalog Number			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8536	SBA2	VO2	P1S

Factory Modifications (FORMS) ..... Refer to Catalog 9999CT9701
Application Data ..... Pages 13-16
Dimensions ..... Pages 17-20
Separate Enclosures (Class 9991) ..... Refer to Catalog 9999CT9701
Replacement Parts (Class 9998) ..... Refer to Catalog 9999CT9701
Type S Accessories (Class 9999) ..... Refer to Catalog 9999CT9701

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3-Pole Polyphase — 600 Volts AC Maximum — 50-60 Hertz—Three Thermal Units Required

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	NEMA Type 7 & 9 Hazardous Locations Class I, Groups C & D Class II, Class E, F, & G			NEMA Type 9 Hazardous Locations Class II, Groups E, F, & G	NEMA Type 12/3R● Dusttight & Driptight Industrial Use Enclosure
					Bolted Type		SPIN TOP® Type	Type	Type
					Cast Iron■	Cast Aluminum			
00	9	Separate Control†		120	USE Size 0		USE Size 0	USE Size 0	Use Size 0
		200	1½	208					
		230	1½	240					
		460	2	480					
		575	2	600					
0	18	Separate Control†		120	SBT2V02S	SBT42V02S	SBR2V02S	SBE2V02S	SBA2V02S
		200	3	208	SBT2V08	SBT42V08	SBR2V08	SBE2V08	SBA2V08
		230	3	240	SBT2V03	SBT42V03	SBR2V03	SBE2V03	SBA2V03
		460	5	480	SBT2V06	SBT42V06	SBR2V06	SBE2V06	SBA2V06
		575	5	600	SBT2V07	SBT42V07	SBR2V07	SBE2V07	SBA2V07
1	27	Separate Control†		120	SCT3V02S	SCT43V02S	SCR3V02S	SCE3V02S	SCA3V02S
		200	7½	208	SCT3V08	SCT43V08	SCR3V08	SCE3V08	SCA3V08
		230	7½	240	SCT3V03	SCT43V03	SCR3V03	SCE3V03	SCA3V03
		460	10	480	SCT3V06	SCT43V06	SCR3V06	SCE3V06	SCA3V06
		575	10	600	SCT3V07	SCT43V07	SCR3V07	SCE3V07	SCA3V07
2	45	Separate Control†		120	SDT1V02S	SDT41V02S	SDR1V02S	SDE1V02S	SDA1V02S
		200	10	208	SDT1V08	SDT41V08	SDR1V08	SDE1V08	SDA1V08
		230	15	240	SDT1V03	SDT41V03	SDR1V03	SDE1V03	SDA1V03
		460	25	480	SDT1V06	SDT41V06	SDR1V06	SDE1V06	SDA1V06
		575	25	600	SDT1V07	SDT41V07	SDR1V07	SDE1V07	SDA1V07
3	90	Separate Control†		120	...	SET43V02S	SER3V02S	SEE1V02S	SEA1V02S
		200	25	208		SET43V08	SER3V08	SEE1V08	SEA1V08
		230	30	240		SET43V03	SER3V03	SEE1V03	SEA1V03
		460	50	480		SET43V06	SER3V06	SEE1V06	SEA1V06
		575	50	600		SET43V07	SER3V07	SEE1V07	SEA1V07
4	135	Separate Control†		120	...	SFT41V02S	SFR1V02S	SFE1V02S	SFA1V02S
		200	40	208		SFT41V08	SFR1V08	SFE1V08	SFA1V08
		230	50	240		SFT41V03	SFR1V03	SFE1V03	SFA1V03
		460	100	480		SFT41V06	SFR1V06	SFE1V06	SFA1V06
		575	100	600		SFT41V07	SFR1V07	SFE1V07	SFA1V07
5	270	Separate Control†		120	...	SGT41V02S	SGR1V02S	SGE1V02S	SGA1V02S
		200	75	208		SGT41V08	SGR1V08	SGE1V08	SGA1V08
		230	100	240		SGT41V03	SGR1V03	SGE1V03	SGA1V03
		460	200	480		SGT41V06	SGR1V06	SGE1V06	SGA1V06
		575	200	600		SGT41V07	SGR1V07	SGE1V07	SGA1V07
6	540	Separate Control†		120	...	...	...	...	SHA2V02S
		200	150	208					SHA2V08
		230	200	240					SHA2V03
		460	400	480					SHA2V06
		575	400	600					SHA2V07
7	810	Separate Control†		120	...	...	...	...	SJA2V02S
		200	—	208					SJA2V08
		230	300	240					SJA2V03
		460	600	480					SJA2V06
		575	600	600					SJA2V07

● For NEMA Type 3R enclosed devices (Sizes 0-4 only), change "A" in Type designation to "H", no additional charge. Consult Factory for restrictions on available Forms in NEMA Type 3R enclosures.

† 120 Volt Polyphase starters are wired for separate control.

■ Limited to one Pilot Light and a Selector Switch or Start-Stop Push Button.

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes in table below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	VO1
120	110	VO2
208	...	VO8
240	220	VO3
480	440	VO6
600	550	VO7
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

Factory Modifications (FORMS)..... Refer to Catalog 9999CT9701
Application Data..... Pages 13-16
Dimensions..... Pages 17-20
Separate Enclosures (Class 9991)..... Refer to Catalog 9999CT9701
Replacement Parts (Class 9998)..... Refer to Catalog 9999CT9701
Type S Accessories (Class 9999)..... Refer to Catalog 9999CT9701

How to Order:

To Order Specify:	*Catalog Number*			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8536	SBA2	VO2	H3O

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Full Voltage Starters — NEMA
Selection – Class 8536

2-Pole Single Phase — 600 Volts AC Maximum — 50-60 Hertz Thermal Units — One Thermal Unit Required

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	Open Type	NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure	NEMA Type 4X Watertight, Dusttight, Corrosion-Resistant Glass-Polyester Enclosure
					Type	Type	Type	Type
00	9	115 230	⅓ 1	120 240	SAO11V02 SAO11V03	SAG11V02 SAG11V03	Use Size 0	Use Size 0
0	18	115 230	1 2	120 240	SBO1V02 SBO1V03	SBG1V02 SBG1V03	SBW11V02 SBW11V03	SBW21V02 SBW21V03
1	27	115 230	2 3	120 240	SCO1V02 SCO1V03	SCG1V02 SCG1V03	SCW11V02 SCW11V03	SCW21V02 SCW21V03
1P	36	115 230	3 5	120 240	SCO2V02 SCO2V03	SCG2V02 SCG2V03	SCW12V02 SCW12V03	SCW22V02 SCW22V03
2	45	115 230	3 7½	120 240	SDO6V02 SDO6V03	SDG6V02 SDG6V03	SDW16V02 SDW16V03	SDW26V02 SDW26V03

4-Pole, 2-Phase — 600 Volts AC Maximum — 50-60 Hertz — Two Thermal Units Required

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	Open Type	NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure	NEMA Type 4X Watertight, Dusttight, Corrosion-Resistant Glass-Polyester Enclosure
					Type	Type	Type	Type
0	18	Separate Control†		120	SBO3V02S	SBG3V02S	SBW13V02S	SBW23V02S
		200	3	208	SBO3V08	SBG3V08	SBW13V08	SBW23V08
		230	3	240	SBO3V03	SBG3V03	SBW13V03	SBW23V03
		460	10	480	SBO3V06	SBG3V06	SBW13V06	SBW23V06
		575	10	600	SBO3V07	SBG3V07	SBW13V07	SBW23V07
1	27	Separate Control†		120	SCO4V02S	SCG4V02S	SCW14V02S	SCW24V02S
		200	7½	208	SCO4V08	SCG4V08	SCW14V08	SCW24V08
		230	7½	240	SCO4V03	SCG4V03	SCW14V03	SCW24V03
		460	10	480	SCO4V06	SCG4V06	SCW14V06	SCW24V06
		575	10	600	SCO4V07	SCG4V07	SCW14V07	SCW24V07
2	45	Separate Control†		120	SDO2V02S	SDG2V02S	SDW12V02S	SDW22V02S
		200	10	208	SDO2V08	SDG2V08	SDW12V08	SDW22V08
		230	15	240	SDO2V03	SDG2V03	SDW12V03	SDW22V03
		460	25	480	SDO2V06	SDG2V06	SDW12V06	SDW22V06
		575	25	600	SDO2V07	SDG2V07	SDW12V07	SDW22V07
3	90	Separate Control†		120	SEO2V02S	SEG2V02S	SEW12V02S	Consult Local Square D Field Office
		200	15	208	SEO2V08	SEG2V08	SEW12V08	
		230	30	240	SEO2V03	SEG2V03	SEW12V03	
		460	50	480	SEO2V06	SEG2V06	SEW12V06	
		575	50	600	SEO2V07	SEG2V07	SEW12V07	
4	135	Separate Control†		120	SFO2V02S	SFG2V02S	SFW12V02S	
		200	40	208	SFO2V08	SFG2V08	SFW12V08	
		230	50	240	SFO2V03	SFG2V03	SFW12V03	
		460	100	480	SFO2V06	SFG2V06	SFW12V06	
		575	100	600	SFO2V07	SFG2V07	SFW12V07	

† 120 Volt Polyphase starters are wired for separate control.

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	VO1
120	110	VO2
208	...	VO8
240	220	VO3
480	440	VO6
600	550	VO7
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

File E78351
CCN NLDX

File LR60905
Class 3211-04

IEC 947-4-1

How to Order:

To Order Specify:	Catalog Number			
• Class Number • Type Number • Coil Voltage Code • Form(s)	Class	Type	Coil Voltage Code	Form(s)
	8536	SCG1	VO2	P1

Factory Modifications (FORMS) ..... Refer to Catalog 9999CT9701
Application Data ..... Pages 13-16
Dimensions ..... Pages 17-20
Separate Enclosures (Class 9991) ..... Refer to Catalog 9999CT9701
Replacement Parts (Class 9998) ..... Refer to Catalog 9999CT9701
Type S Accessories (Class 9999) ..... Refer to Catalog 9999CT9701

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2-Pole Single Phase — 600 Volts AC Maximum — 50-60 Hertz — One Thermal Unit Required

Devices require 1 thermal unit

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	NEMA Type 7 & 9 Hazardous Locations Class I, Groups C & D Class II, Groups E, F, & G			NEMA Type 9 Hazardous Locations Class II, Groups E, F, & G	NEMA Type 12/3R♦ Dusttight & Driptight Industrial Use Enclosure
					Bolted Type		SPIN TOP® Type	Type	Type
					Cast Iron■	Cast Aluminum			
00	9	115 230	⅓ 1	120 240	USE Size 0		USE Size 0	USE Size 0	Use Size 0
0	18	115 230	1 2	120 240	SBT1V02 SBT1V03	SBT1V02 SBT1V03	SBR1V02 SBR1V03	SBE1V02 SBE1V03	SBA1V02 SBA1V03
1	27	115 230	2 3	120 240	SCT1V02 SCT1V03	SCT1V02 SCT1V03	SCR1V02 SCR1V03	SCE1V02 SCE1V03	SCA1V02 SCA1V03
1P	36	115 230	3 5	120 240	SCT2V02 SCT2V03	SCT2V02 SCT2V03	SCR2V02 SCR2V03	SCE2V02 SCE2V03	SCA2V02 SCA2V03
2	45	115 230	3 7½	120 240	SDT6V02 SDT6V03	SDT6V02 SDT6V03	SDR6V02 SDR6V03	SDE6V02 SDE6V03	SDA6V02 SDA6V03

4-Pole 2-Phase — 600 Volts AC Maximum — 50-60 Hertz —Two Thermal Units Required

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	NEMA Type 7 & 9 Hazardous Locations Class I, Groups C & D Class II, Groups E, F, & G			NEMA Type 9 Hazardous Locations Class II, Groups E, F, & G	NEMA Type 12 Dusttight & Driptight Industrial Use Enclosure
					Bolted Type		SPIN TOP® Type	Type	Type
					Cast Iron■	Cast Aluminum			
0	18	Separate Control† 200 230 460 575	 3 3 5 5	120 208 240 480 600	SBT3V02S SBT3V08 SBT3V03 SBT3V06 SBT3V07	Consult Local Square D Field Office	SBR3V02S SBR3V08 SBR3V03 SBR3V06 SBR3V07	...	SBA3V02S SBA3V08 SBA3V03 SBA3V06 SBA3V07
1	27	Separate Control† 200 230 460 575	 7½ 7½ 10 10	120 208 240 480 600	SCT4V02S SCT4V08 SCT4V03 SCT4V06 SCT4V07	Consult Local Square D Field Office	SCR4V02S SCR4V08 SCR4V03 SCR4V06 SCR4V07	...	SCA4V02S SCA4V08 SCA4V03 SCA4V06 SCA4V07
2	45	Separate Control† 200 230 460 575	 10 15 25 25	120 208 240 480 600	SDT2V02S SDT2V08 SDT2V03 SDT2V06 SDT2V07	Consult Local Square D Field Office	SDR2V02S SDR2V08 SDR2V03 SDR2V06 SDR2V07	...	SDA2V02S SDA2V08 SDA2V03 SDA2V06 SDA2V07
3	90	Separate Control† 200 230 460 575	 25 30 50 50	120 208 240 480 600	Consult Local Square D Field Office	Consult Local Square D Field Office	SER2V02S SER2V08 SER2V03 SER2V06 SER2V07	...	SEA2V02S SEA2V08 SEA2V03 SEA2V06 SEA2V07
4	135	Separate Control† 200 230 460 575	 40 50 100 100	120 208 240 480 600	Consult Local Square D Field Office	Consult Local Square D Field Office	...	...	SFA2V02S SFA2V08 SFA2V03 SFA2V06 SFA2V07

† 120 Volt Polyphase contactors are wired for separate control.

♦ For NEMA Type 3R enclosed devices (2-Pole only), change 'A' in Type designation to 'H', no additional charge.

■ Limited to one Pilot Light and Selector Switch or Start-Stop Push Button.

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	VO1
120	110	VO2
208	...	VO8
240	220	VO3
480	440	VO6
600	550	VO7
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

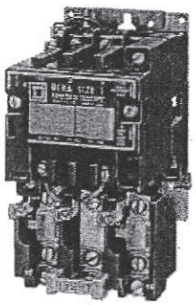
Factory Modifications (FORMS)..... Refer to Catalog 9999CT9701
Application Data..... Pages 13-16
Dimensions..... Pages 17-20
Separate Enclosures (Class 9991)..... Refer to Catalog 9999CT9701
Replacement Parts (Class 9998)..... Refer to Catalog 9999CT9701
Type S Accessories (Class 9999)..... Refer to Catalog 9999CT9701

How to Order:

To Order Specify:	*Catalog Number*			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8536	SCA1	VO3	P1

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Full Voltage Starters
Selection – Class 8536



Types SB-SD with Auxiliary Load Terminals – Class 8536
3-Pole Polyphase — Three Thermal Units Required

It is sometimes desirable to use the capacitors in motor branch circuits to improve power factor. The Size 0-2 Type SB-SD starters listed included three auxiliary terminals to allow easy connection of power factor correction capacitors. When capacitors are connected using these terminals, no adjustment on the selection of thermal units is necessary.

These terminals are also available as a kit Class 9999 Type PFL for Type S NEMA Size 0, 1 and 2 Starters with Motor Logic overload relays. These terminals are available for connection of power factor (PF) correction capacitors. These kits are sold separately and are not factory installed.

NEMA Size	Motor Volts	Maximum HP	Coil Voltage	Open Type
0	Separate Control†		120	SBTO2V02S
	200	3	208	SBTO2V08
	230	3	240	SBTO2V03
	460	5	480	SBTO2V06
	575	5	600	SBTO2V07
1	Separate Control†		120	SBTO3V02S
	200	7½	208	SBTO3V08
	230	7½	240	SBTO3V03
	460	10	480	SBTO3V06
	575	10	600	SBTO3V07
2	Separate Control†		120	SDTO1V02S
	200	10	208	SDTO1V08
	230	15	240	SDTO1V03
	460	25	480	SDTO1V06
	575	25	600	SDTO1V07

† 120 Volt polyphase starters are wired for separate control.

Extra Capacity Single Phase Starters
2-Pole Single Phase — 250 Volts AC Maximum — 50-60 Hertz
Thermal Units — Devices require 1 thermal unit. Standard trip.

Motor Volts	Max. HP	* Coil Voltage	Open Type	NEMA Type 1 General Purpose Enclosure	NEMA Type 3R Rainproof, Sleet Resistant, Outdoor Use Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure (Sizes 0-5)	NEMA Type 4X Watertight Corrosion Resistant Class-Polyester Enclosure	NEMA Type 12 Dusttight & Driptight Industrial Use Enclosure
				Type	Type	Type	Type	Type
115	5	120	SDO8V02	...	SDH8V02	...	...	...
230	10	240	SDO8V03		SDH8V03			
115	7½	120	SEO6V02	SEG6V02	SEH6V02	SEW16V02	SEW26V02	SEA6V02
230	15	240	SEO6V03	SEG6V03	SEH6V03	SEW16V03	SEW26V03	SEA6V03

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection tables above or additional standard voltage codes below and insert as shown in the HOW TO ORDER bolck.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24	...	VO1
120	110	VO2
208	...	VO8
240	220	VO3
480	440	VO6
600	550	VO7
Specify	Specify	V99

How to Order:

To Order Specify:	*Catalog Number*			
• Class Number • Type Number • Coil Voltage Code • Form(s)	Class	Type	Coil Voltage Code	Form(s)
	8536	SEG6	VO3	P1

Factory Modifications (FORMS) ..... Refer to Catalog 9999CT9701
Application Data ..... Pages 13-16
Dimensions ..... Pages 17-20
Separate Enclosures (Class 9991) ..... Refer to Catalog 9999CT9701
Replacement Parts (Class 9998) ..... Refer to Catalog 9999CT9701
Type S Accessories (Class 9999) ..... Refer to Catalog 9999CT9701

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NEMA Size	Load Volts	Maximum Horsepower Rating – Nonplugging and Nonjogging Duty		Maximum Horsepower Rating – Plugging and Jogging Duty †		Continuous Current Rating, Amperes – 600 Volt Max.	Service – Limit Current Rating, Amperes *	Tungsten and Infrared Lamp Load, Amperes – 250 Volts Max. ★	Resistance Heating Loads, KW – Other Than Infrared Lamp Loads ‡		KVA Rating for Switching Transformer Primaries at 50 or 60 Cycles				3 Phase Rating for Switching Capacitors •
											Transformers Having Inrush Currents (Worst Case Peak) of Not More Than 20 Times Peak of Continuous Current Rating		Transformers Having Inrush Currents (Worst Case Peak) of Over 20 Through 40 Times Peak of Continuous Current Rating		
		Single Phase	Poly-Phase	Single Phase	Poly-Phase				Single Phase	Poly-Phase	Single Phase	Poly-Phase	Single Phase	Poly-Phase	KVAR
00	115	½	...	...	...	9	11	5	...	...	...	...	...	...	...
	200	...	1½	...	...	9	11	5	...	...	...	...	...	...	...
	230	1	1½	...	...	9	11	5	...	...	...	...	...	...	...
	380	...	1½	...	...	9	11	...	...	...	...	...	...	...	...
	460	...	2	...	...	9	11	...	...	...	...	...	...	...	...
	575	...	2	...	...	9	11	...	...	...	...	...	...	...	...
0	115	1	...	½	...	18	21	10	...	...	0.6	...	0.3	...	...
	200	...	3	...	1½	18	21	10	...	...	...	1.8	...	0.9	...
	230	2	3	1	1½	18	21	10	...	...	1.2	2.1	0.6	1.0	...
	380	...	5	...	1½	18	21	...	...	...	...	...	...	...	...
	460	...	5	...	2	18	21	...	...	...	2.4	4.2	1.2	2.1	...
	575	...	5	...	2	18	21	...	...	...	3.0	5.2	1.5	2.6	...
1	115	2	...	1	...	27	32	15	3	5	1.2	...	0.6	...	...
	200	...	7½	...	3	27	32	15	...	9.1	...	3.6	...	1.8	...
	230	3	7½	2	3	27	32	15	6	10	2.4	4.3	1.2	2.1	...
	380	...	10	...	5	27	32	...	...	16.5	...	...	...	...	...
	460	...	10	...	5	27	32	...	12	20	4.9	8.5	2.5	4.3	...
	575	...	10	...	5	27	32	...	15	25	6.2	11.0	3.1	5.3	...
1P	115	3	...	1½	...	36	42	24	...	...	...	...	...	...	...
	230	5	...	3	...	36	42	24	...	...	...	...	...	...	...
2	115	3	...	2	...	45	52	30	5	8.5	2.1	...	1.0	...	...
	200	...	10	...	7½	45	52	30	...	15.4	...	6.3	...	3.1	...
	230	7½	15	5	10	45	52	30	10	17	4.1	7.2	2.1	3.6	8
	380	...	25	...	15	45	52	...	...	28	...	...	...	...	...
	460	...	25	...	15	45	52	...	20	34	8.3	14	4.2	7.2	16
	575	...	25	...	15	45	52	...	25	43	10.0	18	5.2	8.9	20
3	115	...	...	...	...	90	104	60	10	17	4.1	...	2.0	...	...
	200	...	25	...	15	90	104	60	...	31	...	12	...	6.1	...
	230	...	30	...	20	90	104	60	20	34	8.1	14	4.1	7.0	27
	380	...	50	...	30	90	104	...	...	56	...	...	...	...	...
	460	...	50	...	30	90	104	...	40	68	16	28	8.1	14	53
	575	...	50	...	30	90	104	...	50	86	20	35	10	18	67
4	200	...	40	...	25	135	156	120	...	45	...	20	...	10	...
	230	...	50	...	30	135	156	120	30	52	14	23	6.8	12	40
	380	...	75	...	50	135	156	...	...	86.7	...	...	...	...	...
	460	...	100	...	60	135	156	...	60	105	27	47	14	23	80
	575	...	100	...	60	135	156	...	75	130	34	59	17	29	100
5	200	...	75	...	60	270	311	240	...	91	...	41	...	20	...
	230	...	100	...	75	270	311	240	60	105	27	47	14	24	80
	380	...	150	...	125	270	311	...	...	173	...	...	...	...	...
	460	...	200	...	150	270	311	...	120	210	54	94	27	47	160
	575	...	200	...	150	270	311	...	150	260	68	117	34	59	200
6♦	200	...	150	...	125	540	621	480	...	182	...	81	...	41	...
	230	...	200	...	150	540	621	480	120	210	54	94	27	47	160
	380	...	300	...	250	540	621	...	...	342	...	...	...	...	...
	460	...	400	...	300	540	621	...	240	415	108	188	54	94	320
	575	...	400	...	300	540	621	...	300	515	135	234	68	117	400
7♦	230	...	300	...	...	810	932	...	180	315	...	...	...	...	240
	460	...	600	...	...	810	932	...	360	625	...	...	...	...	480
	575	...	600	...	...	810	932	...	450	775	...	...	...	...	600

Tables and footnotes are taken from NEMA Standards.

† Ratings shown are for applications requiring repeated interruptions of stalled motor current or repeated closing of high transient currents encountered in rapid motor reversal, involving more than five openings or closings per minute and more than ten in a ten-minute period, such as plug-stop, plug-reverse or jogging duty. Ratings apply to single speed and multi-speed controllers.

* Per NEMA Standards paragraph ICS 2-321.20, the service-limit current represents the maximum ms current, in amperes, which the controller may be expected to carry for protracted periods in normal service. At service-limit current ratings, temperature rises may exceed those obtained by testing the controller at its continuous current rating. The ultimate trip current of over-current (overload) relays or other motor protective devices shall not exceed the service-limit current ratings of the controller.

★ FLUORESCENT LAMP LOADS – 300 VOLTS AND LESS – The characteristics of fluorescent lamps are such that it is not necessary to derate Class 8502 contactors below their normal continuous current rating. Class 8903 contactors may also be used with fluorescent lamp loads. For controlling tungsten and infrared lamp loads, and resistance heating loads, Class 8903 ac lighting contactors are recommended. These contactors are specifically designed for such loads and are applied at their full rating as listed in the Class 8903 Section.

‡ Ratings apply to contactors which are employed to switch the load at the utilization voltage of the heat producing element with a duty which requires continuous operation of not more than five openings per minute. Class 8903 Types L and S lighting contactors are rated for resistance heating loads.

• When discharged, a capacitor has essentially zero impedance. For repetitive switching by contactor, sufficient impedance should be connected in series to limit inrush current to not more than 6 times the contactor rated continuous current. In many installations, the impedance of connecting conductors may be sufficient for this purpose. When switching to connect additional banks, the banks already on the line may be charged and can supply additional available short-circuit current which should be considered when selecting the impedance to limit the current. The ratings for capacitor switching above assume the following maximum available fault currents: NEMA Size 2-3: 5,000 A RMS Sym.; NEMA Size 4-5: 10,000 A RMS Sym.; NEMA Size 6-7: 18,000 A RMS Sym. If available fault current is greater than these values, connect sufficient impedance in series as noted in the previous paragraph.

♦ See Page 16 regarding operation rates for Size 6 & 7.

The motor ratings in the above table are NEMA standard ratings and apply only when the code letter of the motor is the same as or occurs earlier in the alphabet than is shown in the table below. Motors having code letters occurring later in the alphabet may require a larger controller. Consult local Square D field office.

Motor HP Rating	Maximum Allowable Motor Code Letter
1½-2	L
3-5	K
7½ & above	H

5/98

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CLASS 8502 AND 8536 APPLICATION DATA

Power Contact Ratings

All contactors and starters are rated in accordance with NEMA standards. The ratings shown in the price tables are for normal service. For complete data on power contact ratings, refer to Page 13.

Short Circuit Protection

According to the National Electrical Code branch circuit overcurrent protection must be provided for each contactor or starter. For starters refer to instructions furnished with the thermal unit selection table. For contactors (Class 8502 or 8702) provide branch circuit overcurrent protection in accordance with the National Electrical Code, except do not exceed the maximum protective device ratings in table below.

NEMA Size	Maximum Voltage	Class K5, RK5 or RK1 Fuse (Ampere)	Class J or T Fuse (Ampere)	Inverse-Time Circuit Breaker (Ampere)
00	600 250	10 12	15	15
0	600 250	20 25	30	20 35
1	600 250	30 40	60	40 60
2	600 250	60	100	80 90
3	600 250	100 125	200	125 150
4	600	200	400	225
5	600	400	600	400
6	600	600	1200*	800
7	600	600	1600*	1200

* Class L Fuse only.

Capacitor Switching

The kilovar ratings of enclosed, three phase contactors used as switches for capacitor loads, when only one load appears on the secondary of a distribution system are shown in the table on Page 13.

Coil Burden▲

NEMA Size	No. of Poles	Inrush VA		Sealed VA		Sealed Watts	
		50 Hertz	60 Hertz	50 Hertz	60 Hertz	50 Hertz	60 Hertz
00	2-3	...	165	...	33	...	6
0 & 1	1-5	232	245	26	27	7.7	7.8
2	2 & 3	296	311	36	37	12	14
	4 & 5	429	438	37	38		
3	2-3	676	700	47	46	15	14
	4-5	1260	1185	89	85	23.4	22
4	2-5	...	973	...	81	...	25
5	2-3	2970	2970	250	212	42	39
6★	2-3	1495	1780	56	48	27	32
7★	2-3	...	1960	...	59	...	36

▲ Mean values.
★ Size 6 and 7 have a DC coil. The values shown are for the AC input to the DC power supply that provides power to the coil.

Maintenance of Equipment

Class 9998 Repair Parts Kits are available for all Class 8502 contactors and Class 8536 starters. Service bulletins with a complete list of replaceable parts are supplied with all enclosed devices. Separate bulletins can be ordered and are listed along with the appropriate contact parts kit.

Device				Service Bulletin	Replacement Contacts Class 9998 Type
NEMA Type	Type	Series	No. of Poles		
00	SA	A	2-3	362AS	SL2
		B	2-3	556AS	SJ1
0	SB	A & B	1-3 4 5	277AS 277AS & 250AS 277AS & 250AS	SL2 SL12 (1)SL12 & (1)SL22 or (1)SL2 & (2)SL22
1	SC	A & B	1-3 4 5	278AS 278AS & 250AS 278AS & 250AS	SL3 SL13 (1)SL13 & (1)SL22 or (1)SL3 & (2)SL22
1P	SC	A	2	278AS	SL3
2	SD	A	2-3 4 5	279AS 279AS & 293AS 279AS & 293AS	SL4 SL14 (1)SL14 & (1)SL24 or (1)SL4 & (2)SL24
3	SE	A	2 3 4 5	305AS 305AS 326AS 326AS	SL6 SL7 (2)SL6 (1)SL6 & (1)SL7
4	SF	A	2 3 4 5	306AS 306AS 326AS 326AS	SL8 SL9 (2)SL8 (1)SL8 & (1)SL9
5	SG	A	2 3	328AS 328AS	SL10 SL11
6	SH	A	2 3	342AS 342AS	SL25 SL26
		B	2 3	370AS 370AS	SL25 SL26
7	SJ	A	2 3	397AS	SL30 SL31

Terminals

NEMA Size	Type	Power Terminals		Control Terminals	
		Type of Lug	Wire Sizes* Min.-Max.	Type of Lug	Wire Sizes* Min.-Max.
00, 0 & 1	SA, SB & SC	Pressure Wire	#14-#8	Pressure Wire	#16-#12
2	SD	Box Lug	#14-#4	Pressure Wire	#16-#12
3	SE	Box Lug	#14-1/0	Pressure Wire	#16-#12
4	SF	Box Lug	#8-250 kcmil	Pressure Wire	#16-#12
5	SG	Box Lug	#4-500 kcmil	Pressure Wire	#16-#12
6	SH	Parallel Groove	One or two 250-500 kcmil per phase	Pressure Wire	#16-#12
7	SJ	Parallel Groove	One to four 250-500 kcmil per phase	Pressure Wire	#16-#12

* Solid or stranded copper wire.

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Auxiliary Units

Auxiliary contacts, power poles, and timer attachments can be added by the factory or in the field on all Type S starters and contactors. The table below shows the maximum number of auxiliary units **(in addition to the holding circuit contact)** that can be added to a given size starter or contactor. In addition, it is possible to add a second internal contact on NEMA Size 0, 1, and 2 contactors and starters.

NEMA Size	Type	No. of Poles of Basic Contactor	Maximum Number of External Auxiliary Units (In addition to holding circuit contact)
00	SA	2-3	4 single circuit auxiliary contacts (N.O. or N.C.) if second internal auxiliary contact is not used.
0, 1 & 2	SB SC SD	1, 2 or 3	4 single circuit auxiliary contacts (N.O. or N.C.)
			3 single circuit auxiliary contacts (N.O. or N.C.) plus 1 attached timer (ON or OFF delay).
			2 single circuit auxiliary contacts (N.O. or N.C.) plus 1 power pole adder (1 or 2 poles, N.O. or N.C.).
			1 attached timer (ON or OFF delay) plus 1 power pole adder (1 or 2 poles, N.O. or N.C.) plus 1 auxiliary contact.
		4 or 5	2 single circuit auxiliary contacts (N.O. or N.C.) 1 timer attachment plus 1 auxiliary contact.
3, 4 & 5	SE SF SG	2-5 (Size 3 & 4)	4 single circuit auxiliary contacts (N.O. or N.C.)
			2 single circuit (Sizes 3 & 4) or 3 single circuit (Size 5) auxiliary contacts plus 1 attached timer (ON or OFF delay).
		2-3 (Size 5)	2 single circuit auxiliary contacts (N.O. or N.C.) plus 1 NEMA Size 0-1 or Size 2 power pole adder (1 or 2 poles, N.O. or N.C.)
6 & 7	SH SJ	2-3	4 single circuit auxiliary contacts (N.O. or N.C.)
			3 single circuit auxiliary contacts (N.O. or N.C.) plus 1 attached timer (ON or OFF delay).
			2 single circuit auxiliary contacts (N.O. or N.C.) plus 1 NEMA Size 0-1 or Size 2 power pole adder (1 or 2 poles, N.O. or N.C.)

Factory Installed Auxiliary Contacts

Additional auxiliary contacts may be factory or field added to any Type S contactor or starter. See table above for maximum number of auxiliary units. The table below lists the Form designations for factory installed electrical contacts.

See Class 9999 for field modification kits.

Form Number of Additional Auxiliary Contacts

When ordering factory installed auxiliary contacts, the Form designations listed should be used.

Number of N.O. Contacts	Number of N.C. Contacts	Form Number
0	1	X01
	2	X02
	3	X03
	4	X04
1	0	X10
	1	X11
	2	X12
	3	X13
2	0	X20
	1	X21
	2	X22
3	0	X30
3	1	X31
4	0	X40

Control Circuit Transformers

Class 9070 Type T machine tool control transformers are normally used when it is necessary to provide a lower voltage to the control circuit. This transformer with fused protection may be ordered from the factory by specifying Form F4T. The addition of a transformer often requires the use of a larger enclosure. The table below shows the transformer selection for given sized starters and contactors with or without auxiliary units.

NEMA Size	Type	No. of Poles	Auxiliary Units	Transformer Class 9070 Type
0 & 1	SB SC	1-3	With max. of 2 auxiliary contacts	T50
			With timer and maximum of 1 auxiliary contact	
			With 3 or 4 auxiliary contacts with timer and 2 or 3 auxiliary contacts	T100
0 & 1	SB SC	4 & 5	With or without auxiliary contacts or timer	T100
0 & 1 Mechanically Interlocked Devices	SB SC	1-5	With or without attachments	T100
2	SD	2-5	With or without attachments	T100
3	SE	2-3	With or without attachments	GO3†
3	SE	4 & 5	With or without attachments	T300
4	SF	2-5	With or without attachments	T300
5	SG	2-3	Any	T500
6, 7	SH, SJ	2-3	Any	‡

† Class 8502 & 8536 Type S, Size 3 standard NEMA Type 1, 4 and 12 enclosures have space for field mounting a fused control circuit transformer. A Class **9070 Type GFT3** transformer and fuse block kit is available for Form F4T requirements in a NEMA Type 1 enclosure. NEMA Type 4 and 12 enclosures utilize a Class 9070 T150 transformer and a Class 9999 SF4 fuse block.

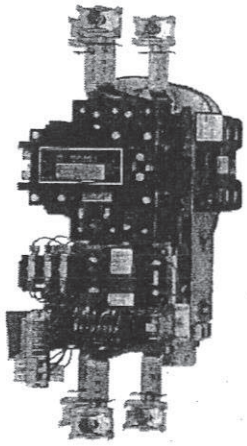
‡ A Class 9070 transformer is an integral part of the Size 6 and Size 7 control circuit providing 120 volt control circuit voltage as standard.

Power Poles

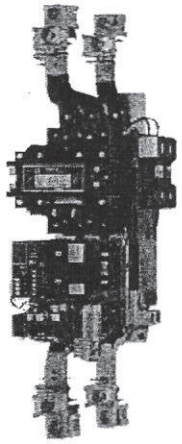
Single or double circuit power pole adders may be factory or field installed on 2 and 3 pole Type S contactors and starters. The table below lists the Form designation for factory installed power pole adders. Only one power pole adder may be installed per contactor.

Type	NEMA Size	Class 9999 Type	Form Designation
1 N.O.	0, 1	SB6	Y428
	2	SB11	Y436
1 N.C.	0, 1	SB7	Y429
	2	SB12	Y437
1 N.O., 1 N.C.	0, 1	SB8	Y435
	2	SB13	Y440
2 N.O.	0, 1	SB9	Y430
	2	SB14	Y438
2 N.C.	0, 1	SB10	Y434
	2	SB15	Y439

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Size 6 Starter 8536 SH



Size 7 Starter 8536 SJ

Size 6 Type SH and Size 7 Type SJ Contactors and Starters

Size 6 Type SH and Size 7 Type SJ contactors and starters have a DC coil operated by a solid state rectifier circuit mounted on the device and powered from an ac source. The Size 6 and 7 are equipped as standard with a fused control circuit transformer (Form F4T) rated 240/480-120 volts 60 hertz, 220/440-110 volts 50 hertz. The purpose of this transformer is to provide an isolated 120 volts 60 hertz, 110 volts 50 hertz, supply for the control circuit. Size 6 and 7 devices may be ordered for other system voltages by specifying the voltage and frequency desired.

Operation Rates

Continuous operation rate: 3 operations/minute maximum. Jogging or Plugging Duty: 15 operations/minute – 3 minutes maximum.

Field conversion for other system voltages is accomplished by one of the following methods, NOT BY THE USUAL PRACTICE OF CHANGING THE COIL:

1. If the factory wiring is indicated as being for 480 volts 60 hertz, 440 volts 50 hertz, conversion to 240 volts 60 hertz, 220 volts 50 hertz, can be accomplished by reconnecting the control transformer as illustrated on instruction sheet supplied with the controller. This is the same method that would be used on Class 9070 control circuit transformers.

   Conversion to any other voltage requires replacement of the control transformer. For other system voltages: i.e. 208, 277, 380, 600 volts, a new transformer with single voltage primary must be selected from table at right. Control transformer connections are illustrated on the instruction sheet supplied with the controller.
2. If the factory wiring is indicated as being for any voltage other than 480 volts 60 hertz, 440 volts 50 hertz, conversion to any other voltage requires replacement of the control transformer. Refer to table at right.
3. The standard transformer supplied may be used to power a maximum of five Class 9001 Type K illuminated operators powered with transformer type light modules. When extra capacity to power control relays or other inductive loads is required, a second transformer must be added. Extra capacity can be purchased as Form F4T with additions in 100 VA increments.
4. Standard controllers are wired for common control and are not convertible for operation of the control circuit from a separate source of supply voltage. Controllers designated Form S have special wiring designed for separate control. They are furnished with an isolating transformer, usually having a 120 volt primary and 120 volt secondary, that must not be bypassed. Form S controllers are not convertible for operation on common control.

The tables below give the replacement transformers for Type S Sizes 6 and 7 contactors and starters. To change voltages on these devices, coils are not changed, instead transformers with the desired voltage are changed.

Replacement Control Transformers for Type S Size 6

Voltage		Class 9070 Type
60 Hertz	50 Hertz	
240/480-120	220/440-110	EO3S2A
208-120	...	EO3S2B
277-120	...	EO3S2C
...	380-110	EO3S2D
600-120	550-110	EO3S2E
120-120	110-110	EO3S2F
240-120	220-110	EO3S2G

Replacement Control Transformers for Type S Size 7

Voltage		Class 9070 Type
60 Hertz	50 Hertz	
240/480-120	220/440-110	EO19S2A
208-120	...	EO19S2B
277-120	...	EO19S2C
...	380-110	EO19S2D
600-120	550-110	EO19S2E
120-120	110-110	EO19S2F
240-120	220-110	EO19S2G

Auxiliary Contacts

A N.O. holding circuit contact and a N.C. auxiliary contact are provided as standard. The holding circuit contact may or may not be required for either 3-wire or 2-wire control. Size 6 and 7 devices have an additional N.C. auxiliary contact which is wired in the coil control circuit. **DO NOT USE THIS N.C. CONTACT FOR ANY OTHER PURPOSE.**

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Approximate Dimensions, Shipping Weights – Class 8502, 8536

Class 8502 Open Type

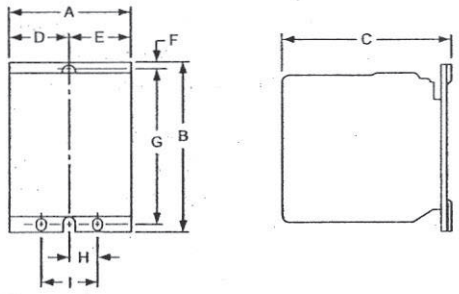


Figure 1

Class 8536 Open Type

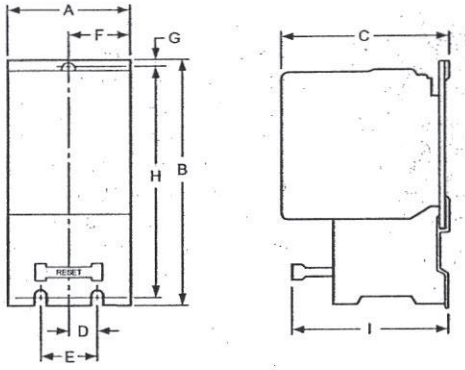


Figure 2

Class	NEMA Size	Type	No. of Poles	Fig. No.	Mtg. Screws	Dimensions – Inches/mm (Refer to Appropriate Figure)																		Wt (Lbs)
						A		B		C		D		E		F		G		H		I		
						IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	
8502	00	SAO	2-3	1	(2) #10	3.22	82	4.34	110	4.22	107	1.63	41	1.63	41	.22	6	3.94	100	...	...	...	...	4
	0 1	SBO SCO	1-3 4-5	1	(2) #10	3.22 4.25	82 108	4.34 4.34	110 110	4.22 4.22	107 107	1.63 1.63	41 41	1.63 2.63	41 67	.22 .22	6 6	3.94 3.94	100 100	... ...	... ...	... ...	... ...	4 4½
	2	SDO	2-3 4-5	1	(3) #10	4.94 5.63	125 143	5.13 5.13	130 130	4.94 4.94	125 125	2.16 2.16	55 55	2.16 3.47	55 88	.22 .22	6 6	4.59 4.59	117 117	.53 .53	13 13	1.06 1.06	27 27	6¾ 8¼
	3	SEO	2-3 4-5	1	(3) ¼" (3) 5⁄16"	5.47 9.75	139 248	7.09 7.88	180 200	6.50 6.50	165 165	1.88 3.94	48 100	3.59 5.81	91 148	.31 .31	8 8	6.03 7.00	153 178	3.25 4.53	83 115	4.75 9.06	121 230	14 22
	4	SFO	2-3 4-5	1	(3) 5⁄16" (3) 5⁄16"	6.00 9.75	152 248	8.19 8.19	208 208	6.50 6.50	165 165	2.06 3.94	52 100	3.94 5.81	100 148	.31 .31	8 8	7.00 7.00	178 178	3.59 4.53	91 115	5.31 9.06	135 230	18 22
	5	SGO	2-3	1	(3) ½"	8.66	220	12.31	313	8.75	222	3.25	83	5.81	148	.63	16	11.13	283	4.75	121	7.25	184	45
	6	SHO	2-3	1	(3) ½"	12.34	313	28.06	713	9.00	229	3.53	90	5.78	147	5.06	129	18.56	471	4.75	121	7.25	184	80
	7	SJO	2-3	1	(3) ½"	12.34	313	37.25	946	10.88	276	3.53	90	5.78	147	7.22	183	22.38	568	4.75	121	7.25	184	135
8536	00, 0, 1, 1P	SAO-SCO	2-3	2	(3) #10	3.50	89	6.77	172	4.22	107	.50	13	1.00	25	1.61	41	.20	5	6.25	159	3.97	101	5
	0, 1	SBO-SCO	4	2	(3) #10	4.53	115	6.77	172	4.22	107	.50	13	1.00	25	2.66	68	.20	5	6.25	159	3.97	101	5½
	2	SDO	2-3 4	2	(3) #10	4.31 5.63	109 143	7.81 7.81	198 198	4.94 4.94	125 125	.50 .50	13 13	1.00 1.00	25 25	2.16 3.47	55 88	.20 .20	5 5	7.34 7.34	186 186	4.06 4.06	103 103	7¾ 9¼
	3	SEO	2-3 4	2	(3) ¼" (3) 5⁄16"	5.47 9.75	139 248	11.09 12.13	282 308	6.50 6.50	165 165	.88 1.81	22 46	1.75 1.75	44 44	3.59 5.81	91 148	.31 .31	8 8	10.19 11.19	259 284	5.75 5.75	146 146	17 25
	4	SFO	3 4	2	(3) 5⁄16" (3) 5⁄16"	6.00 9.75	152 248	12.88 12.88	327 327	6.50 6.50	165 165	1.81 1.81	46 46	1.75 1.75	44 44	3.94 5.91	100 150	.31 .31	8 8	11.19 11.19	284 284	5.75 5.75	146 146	22 25
	5	SGO	3	2	(3) ½"	8.56	217	17.56	446	8.75	222	4.75	121	7.25	184	5.38	137	.63	16	16.38	416	6.00	152	62
	6	SHO	3	2	(3) ½"	12.34	313	28.06	713	9.00	229	4.75	121	7.25	184	5.78	147	5.06	129	18.56	471	8.69	221	85
	7	SJO	3	2	(3) ½"	12.34	313	37.25	946	10.88	276	4.75	121	7.25	184	5.78	147	7.22	183	22.38	568	9.00	229	140

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Full Voltage Contactors and Starters — NEMA
Approximate Dimensions, Shipping Weights – Class 8502, 8536

NEMA Type 1 — General Purpose Enclosure

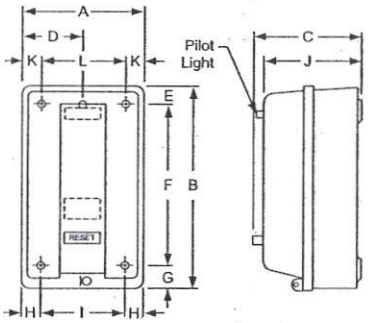


Figure 3

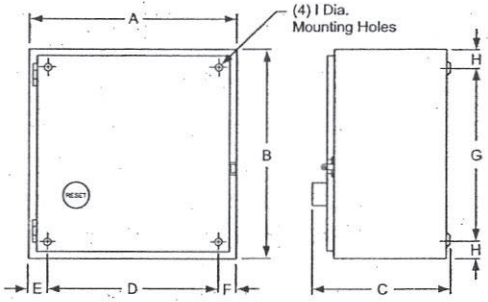


Figure 4

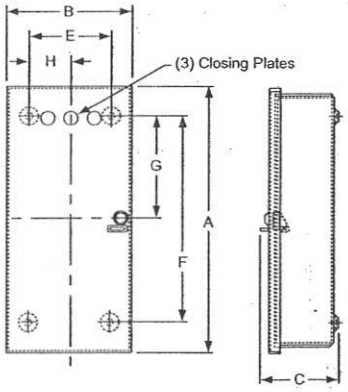


Figure 5

NEMA Size	Class	Type	No. of Poles	Fig. No.	Mtg. Screws	Dimensions – Inches/mm (Refer to Appropriate Figure)												Wt (Lbs)	
						A	B	C		D	E	F	G	H	I	J	K	L	Class 8502	Class 8536
								8502	8536											
00 0 1	8502 & 8536	SAG SBG SCG	All	3	(3) #10	6.00 152	10.00 254	5.28 134	5.56 141	3.00 76	.88 22	8.13 207	1.00 25	.94 24	4.13 105	5.00 127	...	...	7½	8
2	8502 & 8536	SDG	All	3	(4) ¼"	7.81 198	12.69 322	6.03 153	6.31 160	...	1.09 28	10.50 267	1.09 28	1.09 28	5.63 143	5.75 146	1.09 28	5.63 143	14½	15½
3	8502 & 8536	SEG	All	3	(4) ⅜"	11.44 291	21.81 554	8.00 203	8.38 213	...	1.53 39	18.75 476	1.53 39	1.53 39	8.38 213	7.75 197	1.53 39	8.38 213	34	37
4	8502 & 8536	SFG	All	4	(4) 7⁄16"	11.25 286	25.16 639	9.00 229	9.00 229	8.59 218	1.25 32	1.25 32	22.31 567	1.44 37	.44 11	...	...	...	52	56
5	8502 & 8536	SGG	All	4	(4) 9⁄16"	17.22 437	44.22 1123	12.81 325	12.94 329	13.00 330	2.13 54	2.13 54	40.00 1016	2.13 54	.56 14	...	...	....	143	160
6	8502 & 8536	SHG	All	5	(4) 11⁄16"	65.75 1670	20.22 514	13.13 334	13.13 334	...	11.00 279	64.50 1638	2.31 59	5.50 140	...	...	...	....	226	231
7	8502 & 8536	SJG	All	5	...	93.00 2362	34.50 876	23.50 597	23.50 597	Floor Mounting									...	...

NEMA Type 1 — General Purpose Enclosure with Form F4T

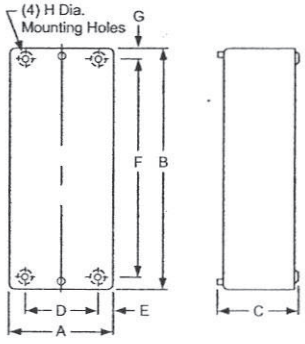


Figure 3

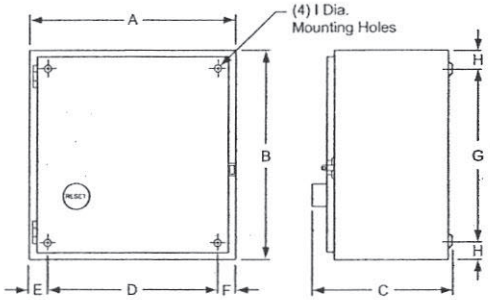


Figure 3

NEMA Size	Class	Type	No. of Poles	Fig. No.	Mtg. Screws	Dimensions – Inches/mm (Refer to Appropriate Figure)																	
						A		B		C				D		E		F		G		H		I	
										8502		8536													
						IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
0	8502 & 8536	SBG	All	6	(4) 9⁄32	6.34	161	15.88	403	5.00	127	5.19	132	4.66	118	.84	21	14.38	365	.75	19	.28	7	...	...
1	8502 & 8536	SCG	All	6	(4) 9⁄32																				
2	8502 & 8536	SDG	All	7	(4) 5⁄16	14.88	378	14.13	359	7.56	192	7.66	195	12.75	324	1.06	27	1.06	27	12.00	305	1.06	27	.31	8
3	8502 & 8536	SEG	2–3	3	(4) ⅜	Same as Standard NEMA 1 Dimensions, see above.																			
4	8502 & 8536	SFG	2–3	7	(4) ⅜	18.16	461	29.16	741	9.25	235	9.25	235	15.50	394	1.33	34	1.33	34	26.50	673	1.33	34	.44	11
5	8502 & 8536	SGG	All	7	(4) 9⁄16	Same as Standard NEMA 1 Dimensions, see above.																			
6	8502 & 8536	SHG	All	5	(4) 11⁄16	Form F4T is supplied as standard. Refer to Page 16.																			
7	8502 & 8536	SJG	All	5	...																				

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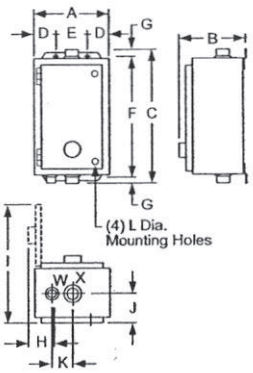


Figure 8
NEMA Type 4 & 4X
Watertight Enclosure

NEMA Type 4 & 4X — Stainless Steel Watertight Enclosures▲

NEMA Size	Class	Type	No. of Poles	Dimensions – Inches/mm (Figure 8) A	B	C	D	E	F	G	H	I	J	K	L	W. Bot. Only	X Top & Bot.	Weight (Lbs) Class 8502	Class 8536
0 & 1	8502	SBW SCW	All	6.38 162	7.13 181	13.19 335	1.56 40	3.25 83	12.00 305	.59 15	1.19 30	11.78 299	1.63 41	2.31 59	.31 8	¾" Dia. Hub	1" Dia. Hub	17	...
	8536	SBW SCW	All	6.38 162	7.81 198	13.19 335	1.56 40	3.25 83	12.00 305	.59 15	1.88 48	11.78 299	1.63 41	2.31 59	.31 8			...	18
2	8502	SDW	All	8.13 207	7.88 200	16.19 411	1.56 40	5.00 127	15.00 381	1.09 28	1.94 49	14.75 375	2.00 51	2.63 67	.31 8	¾" Dia. Hub	1½" Dia. Hub	24	...
	8536			8.13 207	8.56 217	16.19 411	1.56 40	5.00 127	15.00 381	1.09 28	2.88 73	14.75 375	2.00 51	2.63 67	.31 8			...	25
3 & 4	8502	SEW	All	18.16 461	8.75 222	32.22 818	3.08 78	12.00 305	30.50 775	.88 22	3.69 94	26.72 679	2.56 65	3.19 81	.44 11	¾" Dia. Hub	2½" Dia. Hub	65	...
		SFW																69	...
	8536	SEW	All	18.16 461	9.56 243	32.22 818	3.08 78	12.00 305	30.50 775	.88 22	4.50 114	26.72 679	2.56 65	3.19 81	.44 11	¾" Dia. Hub	2½" Dia. Hub	...	68
		SFW																...	73
5	8502 & 8536	SGW	All	17.22 437	12.63 321	47.22 1199	4.13 105	9.00 229	46.00 1168	.63 16	4.59 117	28.31 719	3.13 80	5.75 146	.56 14	¾" Dia. Hub	3½" Dia. Hub	159	176
6▲	8502 & 8536	SHW	All	20.22 514	12.13 308	65.22 1657	4.13 105	12.00 305	64.00 1626	.63 16	4.59 117	30.81 783	2.69 68	4.50 114	.56 14	¾" Dia. Hub	(2) 3" Dia. Hub	227	232
7▲	8502 & 8536	SJW	All	34.50 876	23.50 597	101.00 2565	Floor Mounting											...	...

▲ Size 6 and 7 are sheet steel enclosures and are rated NEMA Type 4 only.

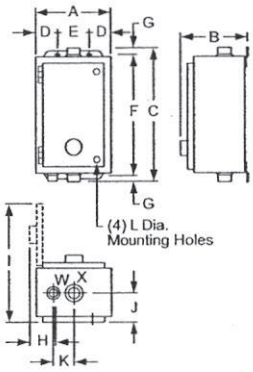


Figure 9
NEMA Type 4 & 4X
Watertight Enclosure

NEMA Type 4 & 4X — Stainless Steel Watertight Enclosures with Form F4T▲

NEMA Size	Class	Type	No. of Poles	Dimensions – Inches/mm (Figure 9) A	B	C	D	E	F	G	H	I	J	K	L	W Bot. Only	X Top & Bot.
0 & 1	8502	SBW	All	12.63 321	7.13 181	4.69 119	2.56 65	7.50 191	13.50 343	.59 15	3.19 81	18.41 468	1.66 42	2.31 59	.31 8	¾	1
		SCW															
	8536	SBW	All	12.63 321	7.81 198	14.69 373	2.56 65	7.50 191	13.50 343	.59 15	3.88 99	18.41 468	1.66 42	2.31 59	.31 8	¾	1
		SCW															
2	8502	SDW	All	14.88 378	7.56 192	16.31 414	2.56 65	9.75 248	15.00 381	.66 17	3.19 81	20.88 530	2.00 51	2.63 67	.31 8	¾	1½
	8536			14.88 378	8.25 210	16.31 414	2.56 65	9.75 248	15.00 381	.66 17	3.88 99	20.88 530	2.00 51	2.63 67	.31 8	¾	1½
3 & 4	8502	SEW	2-3	Same as Standard NEMA Type 4 dimensions, see above.													
		SFW															
	8536	SEW	2-3	See as Standard NEMA Type 4 dimensions, see above.													
		SFW															
5	8502 & 8536	SGW	All	Same as Standard NEMA Type 4 dimensions, see above.													
6▲	8502 & 8536	SHW	All	Form F4T is supplied as standard. Refer to Page 16.													
7▲	8502 & 8536	SJW	All														

▲ Size 6 and 7 are sheet steel enclosures and are rated NEMA Type 4 only.

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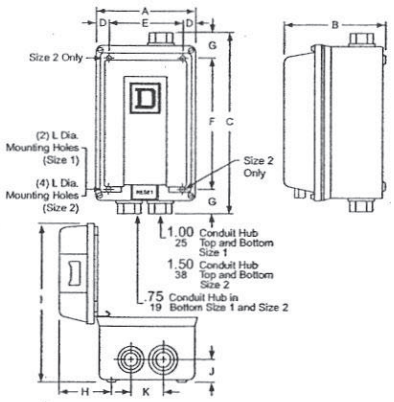


Figure 10A

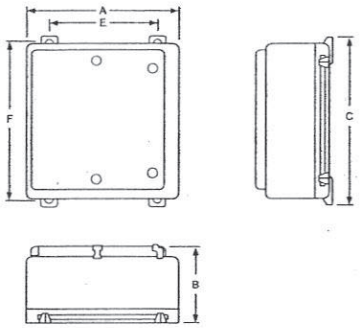


Figure 10B

NEMA Type 4X — Watertight and Corrosion Resistant Glass Polyester Enclosures

NEMA Size	Class	Type	No. of Poles	Fig.	Dimensions — Inches/mm (Figure 11)																								Bot. Hub Only	Top & Bot. Hub	Wt (Lbs)
					A		B		C		D		E		F		G		H		I		J		K		L		W	X	
					IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm			
0, 1	8502 & 8536	SBW SCW	All	10A	6.50	165	6.44	164	12.13	308	.75	19	5.00	127	8.75	222	1.69	43	3.34	85	10.06	256	1.31	33	2.13	54	.31	8	¾	1	17
2	8502 & 8536	SDW	All	10B	8.50	216	7.06	179	13.88	353	.75	19	7.00	179	10.50	267	1.69	43	3.91	99	11.94	303	1.63	41	2.38	60	.31	8	¾	1½	22
0-2*	8502 & 8536	SBW SCW SDW	All	10B	16.88	429	9.78	248	22.75	578	...	...	10.13	257	21.50	546	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3-4†	8502 & 8536	SEW SFW	All	10B	25.81	656	11.94	303	33.50	851	...	...	18.50	470	32.25	819	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

* With control power transformer (Form F4T).
† Dimensions also for Form F4T.

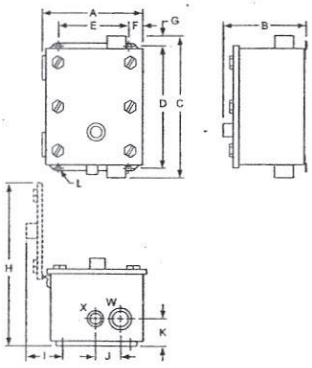


Figure 11

NEMA Type 9 Enclosures for Hazardous Locations — Sheet Steel

NEMA Size	Type	No. of Poles	Dimensions — Inches/mm (Figure 11)																						X Bot. Only	W Top & Bot.	Wt (Lbs)
			A		B		C		D		E		F		G		H		I		J		K				
			IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm			
0	SBE	2-4	8.84	225	8.22	209	13.00	330	12.00	305	6.00	152	1.38	35	.50	13	14.69	373	3.91	99	2.13	54	2.00	51	¾" Dia. Hub	1" Dia. Hub	24½
1	SCE																										
2	SDE	2-4	10.34	263	8.97	228	16.13	410	15.00	381	7.50	191	1.38	35	.56	14	16.94	430	3.91	99	2.75	70	2.38	60	¾" Dia. Hub	1½" Dia. Hub	31¼
3	SEE	2-4	12.84	326	9.72	247	24.16	614	22.25	565	9.00	229	1.88	48	.97	25	20.56	522	4.41	112	3.25	83	2.88	73	¾" Dia. Hub	2" Dia. Hub	54
4	SFE	2-4	15.84	402	9.72	247	34.16	868	32.25	819	12.00	305	1.88	48	.97	25	23.56	598	4.41	112	3.25	83	2.88	73	¾" Dia. Hub	2½" Dia. Hub	74

NOTE: Devices with Form F4T may use larger enclosure. Consult local Square D Field Office for dimensions.

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NEMA Type 7 & 9 Enclosures for Hazardous Locations
Sizes 0-2, Bolted Cover, Cast Iron, Sizes 0-5, Bolted Cover, Cast Aluminum, Sizes 0-5, SPIN TOP®, Cast Aluminum

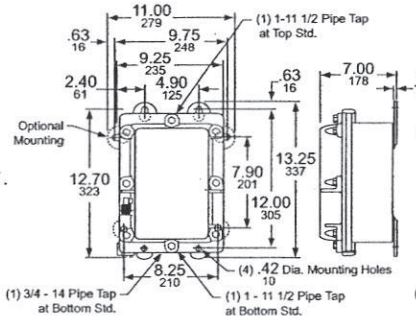


Figure 12 Size 0 and 1

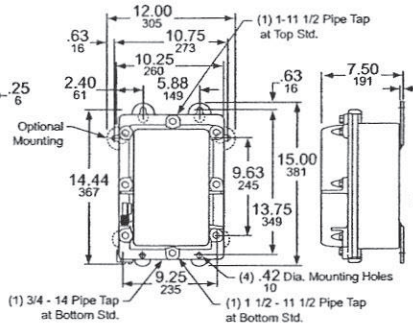


Figure 13 Size 2

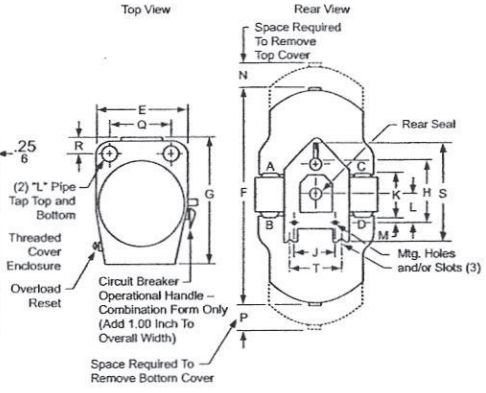


Figure 14 Size 0-5

NEMA 7 & 9 Bolted Cover, Cast Iron

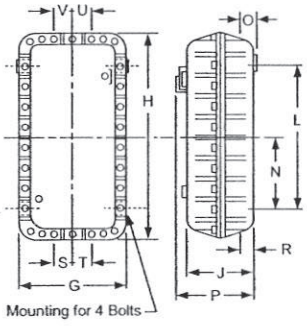
NEMA Size	Type	Dimensions — Inches/mm														Wt (Lbs)
		A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	
0, 1	SBT SCT	See Figure 12															59
2	SDT	See Figure 13															75

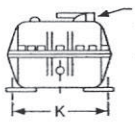
NEMA 7 & 9 SPIN TOP® Enclosure – Figure 14

NEMA Size	Type	Dimensions — Inches/mm																		Wt (Lbs)
		A	B*	B†	C*	C†	D	E*	E†	F	G	H*	H†	J	K	L	M	N	P	R	
0-1	SBR SCR	**10.63** 270	**25.06** 637	**30.06** 764	**34.69** 881	**47.69** 1211	**14.69** 373	**6.25** 159	**11.25** 286	**7.69** 195	**11.13** 283	**2.00** 51	**9.00** 229	**7.63** 194	**7.38** 187	**2.06** 52	**9.38** 238	**5.25** 133	**1.25** 32	**.38** 10	70
2	SDR	**12.00** 305	**29.31** 744	**34.31** 871	**42.81** 1087	**54.81** 1392	**16.75** 425	**6.75** 171	**11.75** 298	**7.69** 195	**14.75** 375	**3.00** 76	**9.00** 229	**11.50** 292	**8.50** 216	**2.06** 52	**9.38** 238	**5.25** 133	**1.50** 38	**.38** 10	100
3-4	SER SFR	**16.13** 410	**37.50** 953	**40.50** 1029	**60.00** 1524	**66.50** 1689	**20.25** 514	**8.63** 219	**11.63** 295	**8.63** 219	**20.25** 514	**4.50** 114	**8.00** 203	**18.00** 457	**12.00** 305	**2.63** 67	**11.00** 279	**5.50** 140	**2.50** 64	**.50** 13	165 195
5	SGR	**20.75** 527	**62.13** 1578	**62.13** 1578	**103.63** 2632	**103.63** 2632	**25.75** 654	**24.13** 613	**24.13** 613	**13.88** 353	**24.13** 613	**20.00** 508	**20.00** 508	**21.50** 546	**14.38** 365	**4.75** 121	**17.00** 432	**8.00** 203	**4.00** 102	**.63** 16	375

* Without control transformer.
† With control transformer (Form F4T)

NEMA 7 & 9 Bolted Cover, Cast Aluminum





Circuit Breaker Handle not supplied on Class 8502 or 8536

1/2" NPT for Breather and Drain

Figure 15

NEMA Size	Type	Dimensions — Inches/mm																		Wt (Lbs)
		G		H		J		K		L		N		P		Q, R		S, T, U, V		
		IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	
0-1	SBT SCT	14.25	362	17.25	438	9.50	241	12.25	311	8.88	226	4.50	114	11.00	279	2.38	60	3.13	80	75
2	SDT	13.63	346	27.63	702	9.50	241	12.25	311	19.25	489	9.63	245	11.00	279	2.38	60	3.13	80	115
3-4	SET	18.13	461	13.63	346	10.00	254	16.25	413	19.25	489	9.63	245	12.63	321	2.38	60	3.75	95	180
	SFT																			
5	SGT	24.50	622	45.63	1159	13.75	349	22.50	572	27.50	699	13.75	349	15.38	391	3.44	87	4.00	102	500

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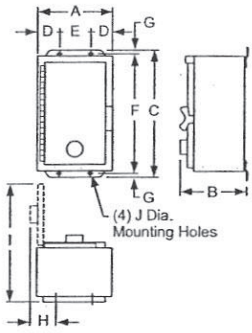


Figure 16
NEMA Type 12
Industrial Use
Enclosure

NEMA Type 12 — Dusttight Enclosure

NEMA Size	Class	Type	No. of Poles	Dimensions – Inches/mm (Figure 16)										Weight (Lbs)	
				A	B	C	D	E	F	G	H	I	J	Class 8502	Class 8536
0	8502 & 8536	SBA	All	6.38 162	8.53 217	12.75 324	1.56 40	3.25 83	12.00 305	.38 10	3.56 90	12.25 311	.31 8	15	16
1		SCA													
2	8502 & 8536	SDA	All	8.13 207	9.28 236	16.00 406	1.56 40	5.00 127	15.00 381	.50 13	3.56 90	15.38 391	.31 8	22	23
3	8502 & 8536	SEA	All	18.16 461	9.56 243	31.50 800	3.08 78	12.00 305	30.50 775	.50 13	4.50 114	26.72 679	.44 11	65	68
4		SFA												69	73
5	8502 & 8536	SGA	All	17.22 437	13.44 341	47.00 1194	4.13 105	9.00 229	46.00 1168	.50 13	5.41 137	28.31 719	.56 14	160	177
6	8502 & 8536	SHA	All	20.22 514	13.00 330	65.00 1651	4.13 105	12.00 305	64.00 1626	.50 13	6.44 164	30.88 784	.69 18	228	233
7	8502 & 8536	SJA	All	34.50 876	23.50 597	93.00 2362	Floor Mounting							...	...

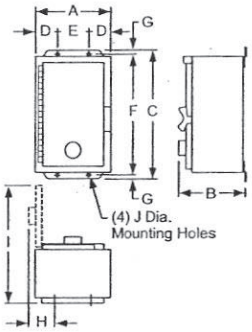


Figure 17
NEMA Type 12
Industrial Use
Enclosure

NEMA Type 12 — Dusttight Enclosure with Form F4T

NEMA Size	Class	Type	No. of Poles	Dimensions – Inches/mm (Figure 17)																	
				A		B		C		D		E		F		G		H		I		J	
				IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
0	8502 & 8536	SBA	All	11.88	302	8.00	203	13.50	343	2.81	71	6.75	171	12.75	324	.38	10	3.91	99	18.38	467	.31	8
1		SCA																					
2	8502 & 8536	SDA	All	14.88	378	8.13	207	16.00	406	2.56	65	9.75	248	15.00	381	.38	10	3.66	93	21.50	546	.31	8
3	8502 & 8536	SEA	2–3	Same as Standard NEMA Type 12 dimensions, see above.																			
4		SFA																					
5	8502 & 8536	SGA	All																				
6	8502 & 8536	SHA	All	Form F4T is supplied as standard. Refer to Page 16.																			
7	8502 & 8536	SJA	All																				

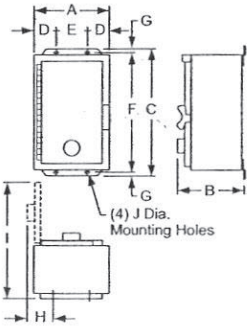
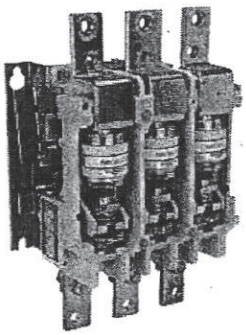


Figure 18
NEMA Type 3R
Outdoor Use
Enclosure

NEMA Type 3R — Rainproof and Sleet Resistant Enclosures

NEMA Size	Class	Type	No. of Poles	Dimensions — Inches/mm (Figure 17)																	
				A	B	C	D1	D2	E	F	G1	G2	H1	H2	J	K	L	M	N	P	K.O. X	K.O. Y
0 & 1	8502 & 8536	SBH, SCH	All	8.84 225	12.28 312	7.13 181	1.38 35	1.44 37	6.00 152	7.50 191	2.59 66	2.19 56	2.06 52	2.63 67	14.28 363	1.38 35	1.38 35	1.88 48	4.38 111	1.84 47	½ ¾ 1	½ ¾ 1
2	8502 & 8536	SDH	All	9.84 250	16.28 414	8.63 219	1.38 35	1.44 37	7.00 178	11.50 292	2.59 66	2.19 56	2.06 52	2.63 67	16.78 426	1.31 33	1.75 44	2.13 54	4.88 124	1.84 47	1 1¼ 1½	½ ¾
3	8502 & 8536	SEH	All	12.84 326	25.28 642	8.63 219	1.38 35	1.44 37	10.00 254	20.50 521	2.59 66	2.19 56	2.06 52	2.63 67	19.78 502	1.31 33	1.94 49	2.44 62	6.38 162	1.84 47	1 1¼ 2 2½	½ ¾
4	8502 & 8536	SFH	All	12.84 326	40.28 1023	9.13 232	1.38 35	1.44 37	10.00 254	35.50 902	2.59 66	2.19 56	2.06 52	2.63 67	20.28 515	1.31 33	2.31 59	2.69 68	6.38 162	1.84 47	1 1¼ 2 2½	½ ¾

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Class 8502 Type WF
Vacuum Contactor

Electrical Ratings

Characteristic	Size 4	Size 5	Size 6
Maximum Motor HP at:			
200 V	40	75	150
230 V	50	100	200
380 V	75	150	300
460 V	100	200	400
575 V	100	200	400
3 Phase Capacitor Switching – KVAR			
230 V	40	80	160
460 V	80	160	320
575 V	100	200	400
Transformer Switching – KVA 3 Phase, 3-Pole			
240 V	23	47	94
480 V	47	94	188
600 V	59	117	234
Coil Data			
Inrush VA	300	600	1450
Sealed VA	30	20	32
Sealed Watts	6	20	30
Pick-up Volts	70% of rated coil voltage		
Drop-out Volts	50% of rated coil voltage		
Pick-up Time (ms)	18-22	24-32	24-32
Drop-out Time (ms)	90-120	96-100	96-100
Additional Electrical Characteristics			
Number of Poles	3	3	3
Max. Voltage Rating	600	600	600
Enclosed Ampere Rating	135	270	540
Max. Closing Current	1600	3000	6000
Max. Interrupting Current	1600	3000	6000
Short Time Current (RMS):			
1 second	2400	4500	9000
2 seconds	1600	3000	6000
Dielectric Strength, volts	5375	5375	5375
Max. Allowable Interrupting	1200/hr	1200/hr	1200/hr
Impulse Voltage, VA (1 x 40ms)	15000	15000	15000

General Information

Class 8502 Type W non-reversing vacuum contactors are a new addition to the Square D line of contactors. These contactors are used to switch capacitors, transformers and electric motors where overload protection is separately provided. Type W vacuum contactors are designed for operation at 600 Volts, 50/60 Hertz.

By design, these contactors are well suited to heavy-duty applications in harsh environments. The power contacts are sealed in ceramic tubes, called vacuum interrupters or vacuum bottles, where the air has been evacuated. Arc quenchers are not required because any arc formed between opening contacts is not sustained due to the presence of the vacuum. The arc is extinguished when the current crosses zero after the contacts are opened, therefore the arc typically does not survive more than one half cycle. There is one vacuum interrupter or bottle per pole, therefore a three pole contactor has three vacuum interrupters or bottles. The power contacts are not affected by ambient conditions or contamination. This provides for long life and reliable operation in harsh applications.

File E78351
CCN NLDX2

LR75167, 75168
Class 3211-04

Altitude

The vacuum contactor is designed to tolerate normal barometric pressure variances up to 6600 feet above sea level. If the contactor is to be used above 6600 feet above sea level, please consult the factory.

Termination Means

The Size 4 vacuum contactor is supplied with line and load side lugs*. The Size 5 and 6 vacuum contactors are supplied without line and load side lugs. Class 9999 Type LUW5 and LUW6 lug kits are available for the Size 5 and 6 contactors. These kits include six lugs and the necessary mounting hardware.

Auxiliary Contacts

An auxiliary contact block, Class 9999 Type WX11, with one normally-open contact and normally-closed contact is used with the Size 4, 5 and 6 vacuum contactors.

Auxiliary Contact Units

Auxiliary contact units may be added in the field. the table below shows the maximum number of units that may be added to a given size contactor (in addition to the coil auxiliary contact).

Class 8502	
Size 4	3
Size 5	4
Size 6	4

Terminals

Size	Power Terminals Wire Size▲ Min. – Max.	Control Terminals Wire Size▲ Min. – Max.
4	#12-4/0	#16-12
5■	One #0-500 kcmil per phase	#16-12
6■	Two #0-500 kcmil per phase	#16-12

■ Power terminal lugs are not supplied on Size 5 and 6 contactors. Values in table reflect those for the Size 5 and 6 lug kits, Class 9999 Type LUW5 and LUW6 respectively.

▲ Solid or stranded copper wire.

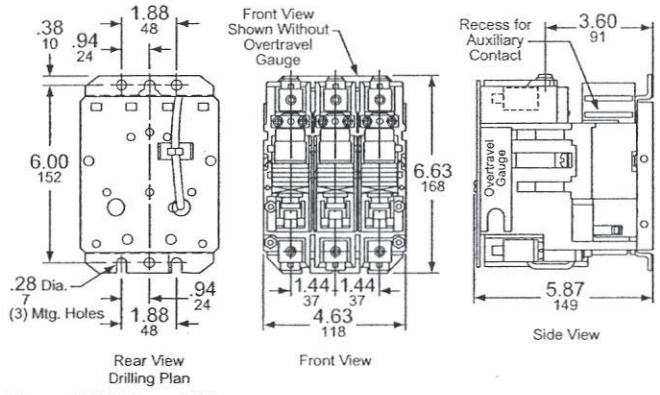
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Full Voltage Contactors — NEMA
Selection – Class 8502

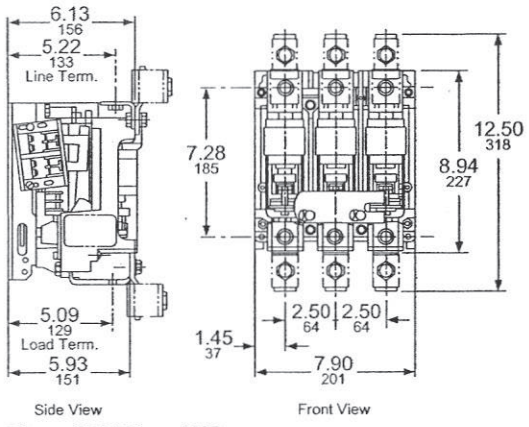
Class 8502 – Full Voltage Vacuum Contactors

NEMA Size	Enclosed Ampere Rating	Locked Rotor Current (Amps)	Motor Volts	Max. HP	* Coil Voltage	Open Type	NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure (Size 4 & 5 only)	NEMA Type 12 Dusttight & Driptight Industrial Use Enclosure
						Type	Type	Type	Type
4	135	1080	200	40	120	WFO3V02S	WFG3V02S	WFW3V02S	WFA3V02S
			230	50	240	WFO3V03	WFG3V03	WFW3V03	WFA3V03
			380	75	120	WFO3V02S	WFG3V002S	WFW3V02S	WFA3V02S
			460	100	480	WFO3V06	WFG3V06	WFW3V06	WFA3V06
			575	100	600	WFO3V07	WFG3V07	WFW3V07	WFA3V07
5	270	2160	200	75	120	WGO3V02S	WGG3V02S	WGW3V02S	WGA3V02S
			230	100	240	WGO3V03	WGG3V03	WGW3V03	WGA3V03
			380	150	120	WGO3V02S	WGG3V002S	WGW3V02S	WGA3V02S
			460	200	480	WGO3V06	WGG3V06	WGW3V06	WGA3V06
			575	200	600	WGO3V07	WGG3V07	WGW3V07	WGA3V07
6	540	4320	200	150	120	WHO3V02S	WHG3V02S	WHW3V02S	WHA3V02S
			230	200	240	WHO3V03	WHG3V03	WHW3V03	WHA3V03
			380	300	120	WHO3V02S	WHG3V002S	WHW3V02S	WHA3V02S
			460	400	480	WHO3V06	WHG3V06	WHW3V06	WHA3V06
			575	400	600	WHO3V07	WHG3V07	WHW3V07	WHA3V07

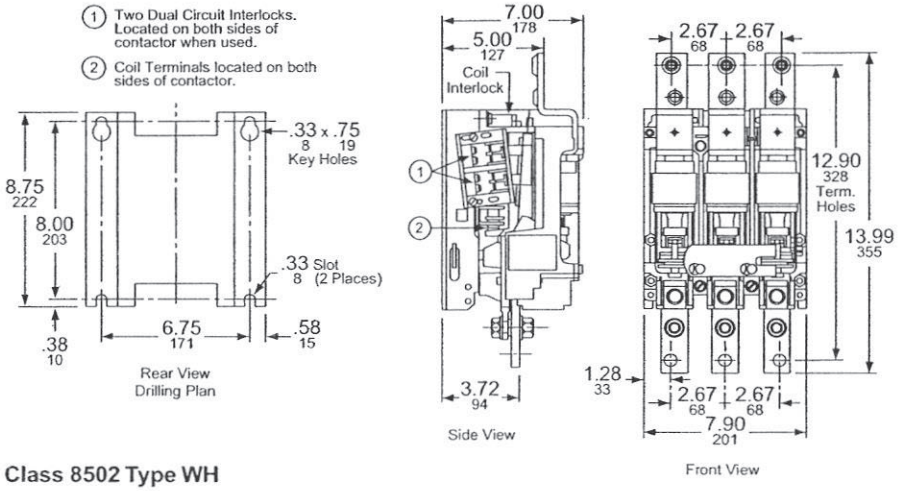
* Consult factory for availability of enclosed devices.



Class 8502 Type WF



Class 8502 Type WG



Class 8502 Type WH

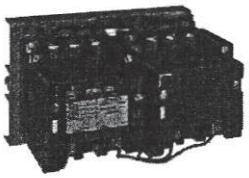
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SECTION 2 – REVERSING MAGNETIC STARTERS AND CONTACTORS

Application Data – Class 8702, 8736 27-28
Selection – Class 8702 29-30
Selection – Class 8736 31-32
Application Data – Class 8702, 8736 33
Approximate Dimensions – Class 8702, 8736 34-36
Application Data, Selection – Class 8702 Vacuum Contactor 37
Selection – Class 8702 38

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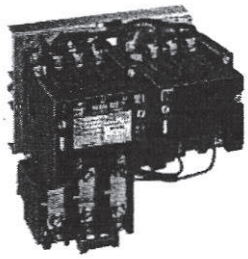


Size 00, 0, 1
Reversing Contactor

AC MAGNETIC REVERSING CONTACTORS CLASS 8702

General Information

Class 8702 Type S reversing magnetic contactors are used for starting, stopping, and reversing AC motors where overload protection is separately provided. Class 8702 reversing contactors are available in NEMA Sizes 00-7. Class 8702 reversing contactors consist of two Class 8502 contactors mechanically and electrically interlocked. Open type devices, Sizes 0-5 are available in either horizontal or vertical arrangements. Sizes 00, 6, and 7 are available as horizontal only. Enclosed devices, Size 00-7 use horizontally arranged components. Type S reversing contactors are designed for operation at 600 Volts AC, 50-60 Hertz.



Size 00, 0, 1
Reversing Starter

AC MAGNETIC REVERSING STARTERS CLASS 8736

General Information

Class 8736 Type S reversing magnetic starters are used for full voltage starting, stopping, and reversing AC squirrel cage motors. Class 8736 reversing starters are available in NEMA Sizes 00-7. Class 8736 reversing starters consist of one Class 8502 contactor and one Class 8536 starter mechanically and electrically interlocked. Open type devices, Sizes 0-5 are available in either horizontal or vertical arrangements. Sizes 00, 6, and 7 are available as horizontal only. Enclosed devices use horizontally arranged components. Motor overload protection is provided by melting alloy type thermal overload relays. Type S starters are designed for operation at 600 Volts AC, 50-60 Hertz.

Overload Relays

Class 8736 Type S Size 00-6 reversing starters are provided with melting alloy thermal overload relay as standard. Interchangeable thermal units are available in standard trip Sizes 00-6, quick trip Sizes 00-4, and slow trip Sizes 00-3. Single phase starters use one thermal unit, three phase starters use three thermal units.

Class 8736 Size 7 starters are provided with solid state overload Motor Logic, which has selectable trip Class 10/20, Ground Fault Detection, and Communication capabilities for future enhancements. The solid state overload relay is ambient insensitive and features phase loss, phase unbalance and over-current protection.

MOTOR LOGIC™ Solid State Overload Relay (SSOLR)

Solid state overload relays are available for Sizes 00-7 starters. These ambient insensitive overload relays provide phase loss protection, phase unbalance protection and LED power indicator. For additional information see the Class 9065 catalog section. To order Type S starters with solid state overload relays, see Factory Modification (FORMS).

Bimetallic overload relays are also available for Sizes 0-6. Ambient Compensated and Non-compensated versions are supplied with manual and automatic reset, trip current adjustment, and an alarm contact on Sizes 0-2. For additional information, see the Class 9065 catalog section. To order Type S starters with bimetallic overload relays, see Factory Modifications (FORMS).

Enclosures

Class 8702 and 8736 reversing magnetic contactors and starters are available in the following enclosures:

- NEMA Type 1 General Purpose Enclosure
- NEMA Type 4 & 4X Watertight and Dusttight
- NEMA Type 7 & 9 Bolted and Spin-Top for Hazardous Locations
- NEMA Type 12 Dusttight and Driptight for Industrial Use

The NEMA Type 4 and 4X stainless steel enclosure (Sizes 0-5) has a brushed finish. For an electropolished finish, specify Form G16 and add 15% to the price of the standard device. Sizes 6 and 7 are painted sheet steel and are rated NEMA Type 4 only.

Also, NEMA Type 12 devices are available UL Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G21, no additional charge.

Separate enclosures are available, see Class 9991.

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Holding Circuit Contact

Two normally open holding circuit contacts are provided on all reversing contactors and starters as standard. Sizes 00-2 contactors use a Class 9999 SX11 auxiliary contact as the holding circuit contact. Sizes 3-7 contactors use a Class 9999 SX6 auxiliary contact as the holding circuit contact. Additionally, two normally closed auxiliary contacts are provided as standard and wired to prevent energization of both coils at the same time. Sizes 00-2 use a Class 9999 SX12 auxiliary contact while Sizes 3-7 use a Class 9999 SX7 auxiliary contact for this purpose. See Class 9999, for the holding circuit contact electrical ratings.

Coil Voltages

AC coils are available for application on 50-60 Hertz. NEMA Sizes 00-5 are supplied with coils that are designed to operate satisfactorily on line voltages of 85%-110% of rated voltage. NEMA Size 6 and 7 contactors are supplied with a DC coil operated by a solid state rectifier circuit that is powered by an AC source.

Please note that **Voltage Codes** have been added to the Type designations in order to improve customer service. It is necessary to include the Voltage Code when ordering contactors and starters. Also, 120 Volt Polyphase reversing contactors and starters will be wired for separate control.

Mechanical Interlocks

Mechanical interlocks are available for replacement or field assembly of Type S reversing contactors and starters (Sizes 00-4 ONLY). See Class 9999 for additional information.

Auxiliary Contacts

Additional auxiliary contacts may be added to Type S reversing contactors and starters. See Page 33 for maximum number of auxiliary units and Form designations for factory installed auxiliary contacts. See Class 9999 for auxiliary contact kits for field installation.

Type S Accessories

Additional accessories such as power poles, pneumatic timer attachments, and cover mounted control stations are available as factory or field modifications.

File E78351
CCN NLDX

File LR60905
Class 3211-04

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3-Pole Polyphase — 600 Volts AC Maximum — 50-60 Hertz

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	Open Type		NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure (Sizes 0-5)♦	NEMA Type 7 & 9 Hazardous Locations Class I, Groups C & D Class II, Groups E, F & G		NEMA Type 12 Dusttight & Driptight Industrial Use Enclosure
					Vertical Type	Horizontal Type	Type	Type	Bolted Type Aluminum	SPIN TOP® Type	Type
00	9	Separate Control†		120	...	SAO4V02S	SAG4V02S	Use Size 0	Use Size 0	Use Size 0	Use Size 0
		200	1½	208	...	SAO4V08	SAG4V08				
		230	1½	240	...	SAO4V03	SAG4V03				
		460	2	480	...	SAO4V06	SAG4V06				
		575	2	600	...	SAO4V07	SAG4V07				
0	18	Separate Control†		120	SBO12V02S	SBO4V02S	SBG4V02S	SBW14V02S	SBT49V02S	SBR9V02S	SBA4V02S
		200	3	208	SBO12V08	SBO4V08	SBG4V08	SBW14V08	SBT49V08	SBR9V08	SBA4V08
		230	3	240	SBO12V03	SBO4V03	SBG4V03	SBW14V03	SBT49V03	SBR9V03	SBA4V03
		460	5	480	SBO12V06	SBO4V06	SBG4V06	SBW14V06	SBT49V06	SBR9V06	SBA4V06
		575	5	600	SBO12V07	SBO4V07	SBG4V07	SBW14V07	SBT49V07	SBR9V07	SBA4V07
1	27	Separate Control†		120	SCO7V02S	SCO8V02S	SCG8V02S	SCW14V02S	SCT49V02S	SCR9V02S	SCA4V02S
		200	7½	208	SCO7V08	SCO8V08	SCG8V08	SCW14V08	SCT49V08	SCR9V08	SCA4V08
		230	7½	240	SCO7V03	SCO8V03	SCG8V03	SCW14V03	SCT49V03	SCR9V03	SCA4V03
		460	10	480	SCO7V06	SCO8V06	SCG8V06	SCW14V06	SCT49V06	SCR9V06	SCA4V06
		575	10	600	SCO7V07	SCO8V07	SCG8V07	SCW14V07	SCT49V07	SCR9V07	SCA4V07
2	45	Separate Control†		120	SDO1V02S	SDO2V02S	SDG2V02S	SDW11V02S	SDT43V02S	SDR3V02S	SDA1V02S
		200	10	208	SDO1V08	SDO2V08	SDG2V08	SDW11V08	SDT43V08	SDR3V08	SDA1V08
		230	15	240	SDO1V03	SDO2V03	SDG2V03	SDW11V03	SDT43V03	SDR3V03	SDA1V03
		460	25	480	SDO1V06	SDO2V06	SDG2V06	SDW11V06	SDT43V06	SDR3V06	SDA1V06
		575	25	600	SDO1V07	SDO2V07	SDG2V07	SDW11V07	SDT43V07	SDR3V07	SDA1V07
3	90	Separate Control†		120	SEO1V02S	SEO2V02S	SEG2V02S	SEW11V02S	SET43V02S	SER3V02S	SEA1V02S
		200	25	208	SEO1V08	SEO2V08	SEG2V08	SEW11V08	SET43V08	SER3V08	SEA1V08
		230	30	240	SEO1V03	SEO2V03	SEG2V03	SEW11V03	SET43V03	SER3V03	SEA1V03
		460	50	480	SEO1V06	SEO2V06	SEG2V06	SEW11V06	SET43V06	SER3V06	SEA1V06
		575	540	600	SEO1V07	SEO2V07	SEG2V07	SEW11V07	SET43V07	SER3V07	SEA1V07
4	135	Separate Control†		120	SFO1V02S	SFO3V02S	SFG3V02S	SFW11V02S			SFA1V02S
		200	40	208	SFO1V08	SFO3V08	SFG3V08	SFW11V08			SFA1V08
		230	50	240	SFO1V03	SFO3V03	SFG3V03	SFW11V03	...	...	SFA1V03
		460	100	480	SFO1V06	SFO3V06	SFG3V06	SFW11V06			SFA1V06
		575	100	600	SFO1V07	SFO3V07	SFG3V07	SFW11V07			SFA1V07
5	270	Separate Control†		120	SGO1V02S	SGO3V02S	SGG3V02S	SGW11V02S			SGA1V02S
		200	75	208	SGO1V08	SGO3V08	SGG3V08	SGW11V08			SGA1V08
		230	100	240	SGO1V03	SGO3V03	SGG3V03	SGW11V03	...	...	SGA1V03
		460	200	480	SGO1V06	SGO3V06	SGG3V06	SGW11V06			SGA1V06
		575	200	600	SGO1V07	SGO3V07	SGG3V07	SGW11V07			SGA1V07
6	540	Separate Control†		120		SHO1V02S	SHG1V02S	SHW1V02S			SHA1V02S
		200	150	208		SHO1V08	SHG1V08	SHW1V08			SHA1V08
		230	200	240	...	SHO1V03	SHG1V03	SHW1V03	...	...	SHA1V03
		460	400	480		SHO1V06	SHG1V06	SHW1V06			SHA1V06
		575	400	600		SHO1V07	SHG1V07	SHW1V07			SHA1V07
7	810	Separate Control†		120		SJO1V02S	SJG1V02S	SJW1V02S			SJA1V02S
		200	—	208		SJO1V08	SJG1V08	SJW1V08			SJA1V08
		230	300	240	...	SJO1V03	SJG1V03	SJW1V03	...	...	SJA1V03
		460	600	480		SJO1V06	SJG1V06	SJW1V06			SJA1V06
		575	600	600		SJO1V07	SJG1V07	SJW1V07			SJA1V07

♦ Size 6 and 7 are rated NEMA Type 4 only.

† 120 Volt Polyphase contactors are wired for separate control.

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	V01†▲
120	110	V02†
208	...	V08
240	220	V03
480	440	V06
600	550	V07
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

† These voltage codes must include Form S (supplied at N.C.).

How to Order:

To Order Specify:	Catalog Number			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8702	SCG8	VO2	P1S

Factory Modifications (FORMS)..... Refer to Catalog 9999CT9701
Application Data.....Page 33, 37
Dimensions.....Pages 34-36
Separate Enclosures (Class 9991)..... Refer to Catalog 9999CT9701
Replacement Parts (Class 9998)..... Refer to Catalog 9999CT9701
Type S Accessories (Class 9999)..... Refer to Catalog 9999CT9701

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Full Voltage Reversing Contactors — NEMA
Selection – Class 8702

600 Volts AC Maximum — 50-60 Hertz

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	Type of Motor	* Coil Voltage	Open Type		NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure	NEMA Type 7 & 9 Hazardous Locations Class I, Groups C & D Class II, Groups E, F & G		NEMA Type 12 Dusttight & Driptight Industrial Use Enclosure
						Vertical Type	Horizontal Type	Type	Type	Bolted Type	SPIN TOP® Type	Type
2-Pole Single Phase												
00	9	115 230	⅓ 1	Single Phase 3-Wire	120 240	... ...	SAO1V02 SAO1V03	SAG1V02 SAG1V03	Use Size 0	Use Size 0	Use Size 0	Use Size 0
0	18	115 230	1 2		120 240	SBO9V02 SBO9V03	SBO1V02 SBO1V03	SBG1V02 SBG1V03	SBW11V02 SBW11V03	SBT46V02 SBT46V03	SBR6V02 SBR6V03	SBA1V02 SBA1V03
1	27	115 230	2 3		120 240	SCO1V02 SCO1V03	SCO2V02 SCO2V03	SCG2V02 SCG2V03	SCW11V02 SCW11V03	SCT46V02 SCT46V03	SCR6V02 SCR6V03	SCA1V02 SCA1V03
3-Pole Single Phase												
00	9	115 230	⅓ 1	4-Wire Rep.-Ind.	120 240	... ...	SAO2V02 SAO2V03	SAG2V02 SAG2V03	Use Size 0	Use Size 0	Use Size 0	Use Size 0
		115 230	⅓ 1	4-Wire Split Ph.	120 240	... ...	SAO3V02 SAO3V03	SAG3V02 SAG3V03	Use Size 0	Use Size 0	Use Size 0	Use Size 0
0	18	115 230	1 2	4-Wire Rep.-Ind.	120 240	SBO10V02 SBO10V03	SBO2V02 SBO2V03	SBG2V02 SBG2V03	SBW12V02 SBW12V03	SBT47V02 SBT47V03	SBR7V02 SBR7V03	SBA2V02 SBA2V03
		115 230	1 2	4-Wire Split Ph.	120 240	SBO11V02 SBO11V03	SBO3V02 SBO3V03	SBG3V02 SBG3V03	SBW13V02 SBW13V03	SBT48V02 SBT48V03	SBR8V02 SBR8V03	SBA3V02 SBA3V03
1	27	115 230	2 3	4-Wire Rep.-Ind.	120 240	SCO3V02 SCO3V03	SCO4V02 SCO4V03	SCG4V02 SCG4V03	SCW12V02 SCW12V03	SCT47V02 SCT47V03	SCR7V02 SCR7V03	SCA2V02 SCA2V03
		115 230	2 3	4-Wire Split Ph.	120 240	SCO5V02 SCO5V03	SCO6V02 SCO6V03	SCG6V02 SCG6V03	SCW13V02 SCW13V03	SCT48V02 SCT48V03	SCR8V02 SCR8V03	SCA3V02 SCA3V03
4-Pole Polyphase												
0	18	Separate Control 200 230 460 575	 3 3 5 5	2 Phase 2 Wire	120 208 240 480 600	SBO13V02S SBO13V08 SBO13V03 SBO13V06 SBO13V07	SBO5V02S SBO5V08 SBO5V03 SBO5V06 SBO5V07	SBG5V02S SBG5V08 SBG5V03 SBG5V06 SBG5V07	SBW15V02S SBW15V08 SBW15V03 SBW15V06 SBW15V07	Consult Local Square D Field Office	SBR10V02S SBR10V08 SBR10V03 SBR10V06 SBR10V07	SBA5V02S SBA5V08 SBA5V03 SBA5V06 SBA5V07
1	27	Separate Control 200 230 460 575	 7½ 7½ 10 10		120 208 240 480 600	SCO9V02S SCO9V08 SCO9V03 SCO9V06 SCO9V07	SCO10V02S SCO10V08 SCO10V03 SCO10V06 SCO10V07	SCG10V02S SCG10V08 SCG10V03 SCG10V06 SCG10V07	SCW15V02S SCW15V08 SCW15V03 SCW15V06 SCW15V07	Consult Local Square D Field Office	SCR10V02S SCR10V08 SCR10V03 SCR10V06 SCR10V07	SCA5V02S SCA5V08 SCA5V03 SCA5V06 SCA5V07
2	45	Separate Control 200 230 460 575	 10 15 25 25		120 208 240 480 600	 ... 	SDO4V02S SDO4V08 SDO4V03 SDO4V06 SDO4V07	SDG4V02S SDG4V08 SDG4V03 SDG4V06 SDG4V07	SDW12V02S SDW12V08 SDW12V03 SDW12V06 SDW12V07	Consult Local Square D Field Office	SDR4V02S SDR4V08 SDR4V03 SDR4V06 SDR4V07	SDA2V02S SDA2V08 SDA2V03 SDA2V06 SDA2V07
3	90	Separate Control 200 230 460 575	 25 30 50 50		120 208 240 480 600	 ... 	SEO4V02S SEO4V08 SEO4V03 SEO4V06 SEO4V07	SEG4V02S SEG4V08 SEG4V03 SEG4V06 SEG4V07	SEW12V02S SEW12V08 SEW12V03 SEW12V06 SEW12V07	 ... 	 ... 	SEA2V02S SEA2V08 SEA2V03 SEA2V06 SEA2V07
4	135	Separate Control 200 230 460 575	 40 50 100 100		120 208 240 480 600	 ... 	SFO4V02S SFO4V08 SFO4V03 SFO4V06 SFO4V07	SFG4V02S SFG4V08 SFG4V03 SFG4V06 SFG4V07	SFW12V02S SFW12V08 SFW12V03 SFW12V06 SFW12V07	 ... 	 ... 	SFA2V02S SFA2V08 SFA2V03 SFA2V06 SFA2V07

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	V01†
120	110	V02†
208	...	V08
240	220	V03
480	440	V06
600	550	V07
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

† These voltage codes must include Form S (supplied at N.C.).

File E78351
CCN NLDX

File LR60905
Class 3211-04

How to Order:

To Order Specify:	*Catalog Number*			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8702	SCG2	VO2	P1S

Factory Modifications (FORMS) ..... Refer to Catalog 9999CT9701
Application Data ..... Page 33, 37
Dimensions ..... Pages 34-36
Separate Enclosures (Class 9991) ..... Refer to Catalog 9999CT9701
Replacement Parts (Class 9998) ..... Refer to Catalog 9999CT9701
Type S Accessories (Class 9999) ..... Refer to Catalog 9999CT9701

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3-Pole Polyphase—Three Thermal Units Required

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	Open Type		NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure (Size 0-5)♦	NEMA Type 7 & 9 Hazardous Locations Class I, Groups C & D Class II, Groups E, F & G		NEMA Type 12 Dusttight & Driptight Industrial Use Enclosure
					Vertical Type	Horizontal Type	Type	Type	Bolted Type	SPIN TOP® Type	Type
00	9	Separate Control†		120		SAO16V02S	SAG16V02S				
		200	1½	208		SAO16V08	SAG16V08				
		230	1½	240	...	SAO16V03	SAG16V03	Use Size 0	Use Size 0	Use Size 0	Use Size 0
		460	2	480		SAO16V06	SAG16V06				
		575	2	600		SAO16V07	SAG16V07				
0	18	Separate Control†		120	SBO10V02S	SBO4V02S	SBG4V02S	SBW14V02S	SBT49V02S	SBR9V02S	SBA4V02S
		200	3	208	SBO10V08	SBO4V08	SBG4V08	SBW14V08	SBT49V08	SBR9V08	SBA4V08
		230	3	240	SBO10V03	SBO4V03	SBG4V03	SBW14V03	SBT49V03	SBR9V03	SBA4V03
		460	5	480	SBO10V06	SBO4V06	SBG4V06	SBW14V06	SBT49V06	SBR9V06	SBA4V06
		575	5	600	SBO10V07	SBO4V07	SBG4V07	SBW14V07	SBT49V07	SBR9V07	SBA4V07
1	27	Separate Control†		120	SCO7V02S	SCO8V02S	SCG8V02S	SCW14V02S	SCT49V02S	SCR9V02S	SCA4V02S
		200	7½	208	SCO7V08	SCO8V08	SCG8V08	SCW14V08	SCT49V08	SCR9V08	SCA4V08
		230	7½	240	SCO7V03	SCO8V03	SCG8V03	SCW14V03	SCT49V03	SCR9V03	SCA4V03
		460	10	480	SCO7V06	SCO8V06	SCG8V06	SCW14V06	SCT49V06	SCR9V06	SCA4V06
		575	10	600	SCO7V07	SCO8V07	SCG8V07	SCW14V07	SCT49V07	SCR9V07	SCA4V07
2	45	Separate Control†		120	SDO1V02S	SDO2V02S	SDG2V02S	SDW11V02S	SDT43V02S	SDR3V02S	SDA1V02S
		200	10	208	SDO1V08	SDO2V08	SDG2V08	SDW11V08	SDT43V08	SDR3V08	SDA1V08
		230	15	240	SDO1V03	SDO2V03	SDG2V03	SDW11V03	SDT43V03	SDR3V03	SDA1V03
		460	25	480	SDO1V06	SDO2V06	SDG2V06	SDW11V06	SDT43V06	SDR3V06	SDA1V06
		575	25	600	SDO1V07	SDO2V07	SDG2V07	SDW11V07	SDT43V07	SDR3V07	SDA1V07
3	90	Separate Control†		120	SEO1V02S	SEO2V02S	SEG2V02S	SEW11V02S	SET43V02S	SER3V02S	SEA1V02S
		200	25	208	SEO1V08	SEO2V08	SEG2V08	SEW11V08	SET43V08	SER3V08	SEA1V08
		230	30	240	SEO1V03	SEO2V03	SEG2V03	SEW11V03	SET43V03	SER3V03	SEA1V03
		460	50	480	SEO1V06	SEO2V06	SEG2V06	SEW11V06	SET43V06	SER3V06	SEA1V06
		575	50	600	SEO1V07	SEO2V07	SEG2V07	SEW11V07	SET43V07	SER3V07	SEA1V07
4	135	Separate Control†		120	SFO1V02S	SFO3V02S	SFG3V02S	SFW11V02S			SFA1V02S
		200	40	208	SFO1V08	SFO3V08	SFG3V08	SFW11V08			SFA1V08
		230	50	240	SFO1V03	SFO3V03	SFG3V03	SFW11V03	...	...	SFA1V03
		460	100	480	SFO1V06	SFO3V06	SFG3V06	SFW11V06			SFA1V06
		575	100	600	SFO1V07	SFO3V07	SFG3V07	SFW11V07			SFA1V07
5	270	Separate Control†		120	SGO1V02S	SGO3V02S	SGG3V02S	SGW11V02S			SGA1V02S
		200	75	208	SGO1V08	SGO3V08	SGG3V08	SGW11V08			SGA1V08
		230	100	240	SGO1V03	SGO3V03	SGG3V03	SGW11V03	...	...	SGA1V03
		460	200	480	SGO1V06	SGO3V06	SGG3V06	SGW11V06			SGA1V06
		575	200	600	SGO1V07	SGO3V07	SGG3V07	SGW11V07			SGA1V07
6	540	Separate Control†		120		SHO1V02S	SHG1V02S	SHW1V02S			SHA1V02S
		200	150	208		SHO1V08	SHG1V08	SHW1V08			SHA1V08
		230	200	240	...	SHO1V03	SHG1V03	SHW1V03	...	...	SHA1V03
		460	400	480		SHO1V06	SHG1V06	SHW1V06			SHA1V06
		575	400	600		SHO1V07	SHG1V07	SHW1V07			SHA1V07
7	810	Separate Control†		120		SJO1V02S	SJG1V02S	SJW1V02S			SJA1V02S
		200	—	208		SJO1V08	SJG1V08	SJW1V08			SJA1V08
		230	300	240	...	SJO1V03	SJG1V03	SJW1V03	...	...	SJA1V03
		460	600	480		SJO1V06	SJG1V06	SJW1V06			SJA1V06
		575	600	600		SJO1V07	SJG1V07	SJW1V07			SJA1V07

♦ Size 6 and 7 are sheet steel rated NEMA Type 4 only.

† 120 Volt Polyphase starters are wired for separate control.

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	V01
120	110	V02
208	...	V08
240	220	V03
480	440	V06
600	550	V07
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

How to Order:

To Order Specify:	Catalog Number			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8736	SCG8	VO2	P1S

Factory Modifications (FORMS)..... Refer to Catalog 9999CT9701
Application Data.....Page 33, 37
Dimensions.....Pages 34-36
Separate Enclosures (Class 9991)..... Refer to Catalog 9999CT9701
Replacement Parts (Class 9998)..... Refer to Catalog 9999CT9701
Type S Accessories (Class 9999)..... Refer to Catalog 9999CT9701

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Full Voltage Reversing Starters — NEMA
Selection – Class 8736

600 Volts AC Maximum — 50-60 Hertz

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	Type of Motor	* Coil Voltage	Open Type		NEMA Type 1 General Purpose Enclosure	NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure	NEMA Type 7 & 9 Hazardous Locations Class I, Groups C & D Class II, Groups E, F & G		NEMA Type 12 Dusttight & Driptight Industrial Use Enclosure
						Vertical Type	Horizontal Type	Type	Type	Bolted Type	SPIN TOP® Type	Type
2-Pole Single Phase — 1 Thermal Unit Required												
00	9	115 230	⅓ 1	Single Phase 3-Wire	120 240	... ...	SAO13V02 SAO13V08	SAG13V02 SAG13V08	Use Size 0	Use Size 0	Use Size 0	Use Size 0
0	18	115 230	1 2		120 240	SBO7V02 SBO7V08	SBO1V02 SBO1V08	SBG1V02 SBG1V08	SBW11V02 SBW11V08	SBT46V02 SBT46V08	SBR6V02 SBR6V08	SBA1V02 SBA1V08
1	27	115 230	2 3		120 240	SCO1V02 SCO1V08	SCO2V02 SCO2V08	SCG2V02 SCG2V08	SCW11V02 SCW11V08	SCT46V02 SCT46V08	SCR6V02 SCR6V08	SCA1V02 SCA1V08
3-Pole Single Phase — 1 Thermal Unit Required												
00	9	115 230	⅓ 1	4-Wire Rep.-Ind.	120 240	... ...	SAO14V02 SAO14V08	SAG14V02 SAG14V08	Use Size 0	Use Size 0	Use Size 0	Use Size 0
		115 230	⅓ 1	4-Wire Split Ph.	120 240	... ...	SAO15V02 SAO15V08	SAG15V02 SAG15V08	Use Size 0	Use Size 0	Use Size 0	Use Size 0
0	18	115 230	1 2	4-Wire Rep.-Ind.	120 240	SBO80V02 SBO8V08	SBO2V02 SBO2V08	SBG2V02 SBG2V08	SBW12V02 SBW12V08	SBT47V02 SBT47V08	SBR7V02 SBR7V08	SBA2V02 SBA2V08
		115 230	1 2	4-Wire Split Ph.	120 240	SBO9V02 SBO9V08	SBO3V02 SBO3V08	SBG3V02 SBG3V08	SBW13V02 SBW13V08	SBT48V02 SBT48V08	SBR8V02 SBR8V08	SBA3V02 SBA3V08
1	27	115 230	2 3	4-Wire Rep.-Ind.	120 240	SCO3V02 SCO3V08	SCO4V02 SCO4V08	SCG4V02 SCG4V08	SCW12V02 SCW12V08	SCT47V02 SCT47V08	SCR7V02 SCR7V08	SCA2V02 SCA2V08
		115 230	2 3	4-Wire Split Ph.	120 240	SCO5V02 SCO5V08	SCO6V02 SCO6V08	SCG6V02 SCG6V08	SCW13V02 SCW13V08	SCT48V02 SCT48V08	SCR8V02 SCR8V08	SCA3V02 SCA3V08
4-Pole Polyphase — 2 Thermal Units Required												
0	18	Separate Control†		2 Phase 2 Wire	120 208 240 480 600	SBO11V02S SBO11V08 SBO11V03 SBO11V06 SBO11V07	SBO5V02S SBO5V08 SBO5V03 SBO5V06 SBO5V07	SBG5V02S SBG5V08 SBG5V03 SBG5V06 SBG5V07	SBW15V02S SBW15V08 SBW15V03 SBW15V06 SBW15V07	Consult Local Square D Field Office	SBR10V02S SBR10V08 SBR10V03 SBR10V06 SBR10V07	SBA5V02S SBA5V08 SBA5V03 SBA5V06 SBA5V07
		200 230 460 575	3 3 5 5									
1	27	Separate Control†			120 208 240 480 600	SCO9V02S SCO9V08 SCO9V03 SCO9V06 SCO9V07	SCO10V02S SCO10V08 SCO10V03 SCO10V06 SCO10V07	SCG10V02S SCG10V08 SCG10V03 SCG10V06 SCG10V07	SCW15V02S SCW15V08 SCW15V03 SCW15V06 SCW15V07	Consult Local Square D Field Office	SCR10V02S SCR10V08 SCR10V03 SCR10V06 SCR10V07	SCA5V02S SCA5V08 SCA5V03 SCA5V06 SCA5V07
		200 230 460 575	7½ 7½ 10 10									
2	45	Separate Control†			120 208 240 480 600	...	SDO4V02S SDO4V08 SDO4V03 SDO4V06 SDO4V07	SDG4V02S SDG4V08 SDG4V03 SDG4V06 SDG4V07	SDW12V02S SDW12V08 SDW12V03 SDW12V06 SDW12V07	Consult Local Square D Field Office	SDR4V02S SDR4V08 SDR4V03 SDR4V06 SDR4V07	SDA2V02S SDA2V08 SDA2V03 SDA2V06 SDA2V07
		200 230 460 575	10 15 25 25									
3	90	Separate Control†			120 208 240 480 600	...	SEO4V02S SEO4V08 SEO4V03 SEO4V06 SEO4V07	SEG4V02S SEG4V08 SEG4V03 SEG4V06 SEG4V07	SEW12V02S SEW12V08 SEW12V03 SEW12V06 SEW12V07	...	...	SEA2V02S SEA2V08 SEA2V03 SEA2V06 SEA2V07
		200 230 460 575	25 30 50 50									
4	135	Separate Control†			120 208 240 480 600	...	SFO4V02S SFO4V08 SFO4V03 SFO4V06 SFO4V07	SFG4V02S SFG4V08 SFG4V03 SFG4V06 SFG4V07	SFW12V02S SFW12V08 SFW12V03 SFW12V06 SFW12V07	...	...	SFA2V02S SFA2V08 SFA2V03 SFA2V06 SFA2V07
		200 230 460 575	40 50 100 100									

† 120 Volt starters are wired for separate control.

* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24▲	...	V01
120	110	V02
208	...	V08
240	220	V03
480	440	V06
600	550	V07
Specify	Specify	V99

▲ 24 V coils are not available on Sizes 4-7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified.

File E78351
CCN NLDX

File LR60905
Class 3211-04

How to Order:

To Order Specify:	*Catalog Number*			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8736	SCG8	VO2	P1S

Factory Modifications (FORMS).....Refer to Catalog 9999CT9701
Application Data..... Page 33, 37
Dimensions..... Pages 34-36
Separate Enclosures (Class 9991).....Refer to Catalog 9999CT9701
Replacement Parts (Class 9998).....Refer to Catalog 9999CT9701
Type S Accessories (Class 9999).....Refer to Catalog 9999CT9701

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Power Contact Ratings

All contactors are rated in accordance with NEMA standards. The ratings shown in the tables on Pages 29-32 are for normal service. For complete data on power contact ratings, refer to Class 8536 Section.

Maintenance of Equipment

Class 9998 repair parts kits are available for all Class 8702 contactors and Class 8736 starters. Service bulletins with a complete list of replaceable parts are supplied with all devices. See Page 15.

Control Transformer Selection

The following table gives the proper size control transformer to be used with a given reversing device, with or without additional auxiliary contacts or timer. For factory addition of control transformers, see Factory Modifications (Forms) section.

NEMA Size	Type	No. of Poles	Transformers Class 9070 Type
0, 1 & 2	SB, SC & SD	Any	T100 or GO2
3	SE	3	T1500 or GO3
		4 & 5	T300
4	SF	Any	T300
5	SG	Any	T500
6 & 7	SH & SJ	Any	See Page 16

Auxiliary Units

The table below shows the maximum number of auxiliary units **(in addition to the holding circuit and interlocking contacts)** that can be added to either the forward or reverse contactor or starter.

NEMA Size (Type)	No. of Poles of Basic Contactor	Maximum number of auxiliary units on each contactor, forward or reverse, (in addition to internal holding circuit and interlocking contacts).
00 (SA)	2 or 3	2 single circuit auxiliary contacts (N.O. or N.C.)
0, 1 & 2 (SB, SC & SD)	2 or 3	4 single circuit auxiliary contacts▲ (N.O. or N.C.)
		1 single circuit auxiliary contact (N.O. or N.C.) plus 1 attached timer (ON or OFF delay).
	4	2 single circuit auxiliary contacts (N.O. or N.C.)
3, 4, 5, 6, & 7 (SE, SF, SG, SH, & SJ)	Any	2 single circuit auxiliary contacts (N.O. or N.C.)
		1 single circuit auxiliary contact plus 1 attached timer (ON or OFF delay).

▲ When adding 4 external auxiliary contacts to one Size 0 or 1 contactor, remove one of the return springs.

Factory Installed Auxiliary Contacts

Additional auxiliary contacts may be factory or field added to any Type 3 contactor or starter. See table above for maximum number of auxiliary units. The table below lists the Form designations for factory installed auxiliary contacts. See Class 9999 for field modification kits.

Example: X 1 O 1 O

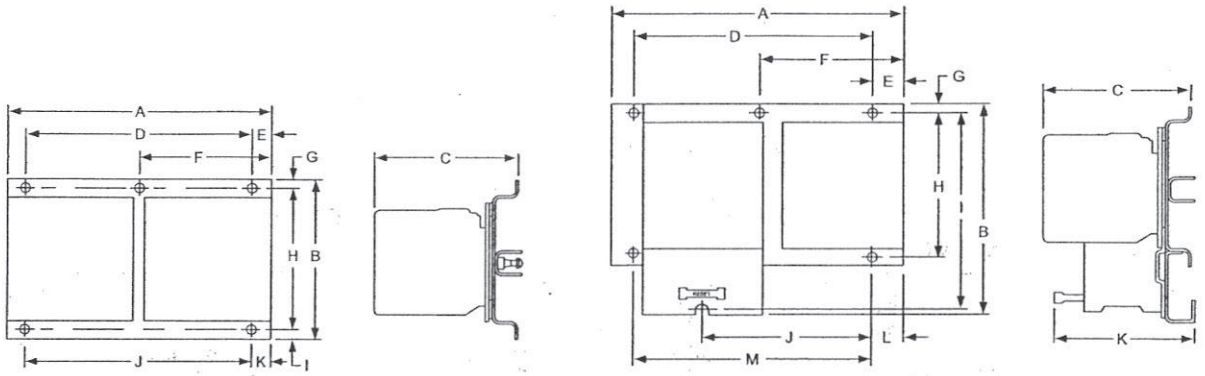
- X — Basic Form Designation.
- 1 — Number of N.O. auxiliary contacts on left hand (Forward) contactor.
- O — Number of N.C. auxiliary contacts on left hand (Forward) contactor.
- 1 — Number of N.O. auxiliary contacts on right hand (Reverse) contactor.
- O — Number of N.C. auxiliary contacts on right hand (Reverse) contactor.

		Additional Auxiliary Contacts on R.H. Contactor (Reverse Contactor)					
		Standard (No Additional Auxiliary Contacts)	1 N.O.	1 N.C.	2 N.O.	1 N.O.-1 N.C.	2 N.C.
Additional Auxiliary Contacts on L.H. Contactor (Forward Contactor)	Standard (No Additional Auxiliary Contacts)		X0010	X0001	X0020	X0011	X0002
	1 N.O.	X1000	X1010	X1001	X1020	X1011	X1002
	1 N.C.	X0100	X0110	X0101	X0120	X0111	X0102
	2 N.O.	X2000	X2010	X2001	X2020	X2011	X2002
	1 N.O.-1 N.C.	X1100	X1110	X1101	X1120	X1111	X1102
	2 N.C.	X0200	X0210	X0201	X0220	X0211	X0202

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Full Voltage Reversing Contactors and Starters — NEMA
Approximate Dimensions – Class 8702, 8736

Open Type — 2 or 3-Pole Only



Class	NEMA Size	Type	Mounting	Figure Number	Dimensions — Inches/mm													Weight (Lbs)
					A	B	C	D	E	F	G	H	I	J	K	L	M	
8702	00	SAO	Horizontal	1	7.13 181	5.00 127	5.31 135	...	...	3.41 87	.47 12	4.34 110	.19 5	5.50 140	.91 23	...	...	12
	0	SBO	Horizontal	1	7.13 181	5.00 127	5.31 135	...	...	3.41 87	.47 12	4.34 110	.19 5	5.50 140	.91 23	...	...	12
	1	SCO	Vertical	1*	5.41 137	9.22 234	5.31 135	5.03 128	.22 6	...	.61 15	8.00 203	.61 15	5.03 128	.22 6	...	...	12
	2	SDO	Horizontal	1	9.00 229	6.88 175	6.03 153	...	...	4.50 114	.38 10	5.63 143	.25 6	6.00 152	1.50 38	...	...	16
			Vertical	1*	6.75 171	11.38 289	6.03 153	6.25 159	.25 6	...	.50 13	10.38 264	.50 13	6.25 159	.25 6	...	...	16
	3	SEO	Horizontal	1	12.72 323	7.97 202	7.00 178	11.75 298	.48 12	...	.48 12	7.00 178	.48 12	11.75 298	.48 12	...	...	35
			Vertical	1*	7.20 183	19.00 483	7.00 178	6.25 159	.48 12	...	1.02 26	17.00 432	.98 25	6.25 159	.48 12	...	...	35
	4	SFO	Horizontal	1	14.25 362	11.69 297	7.00 178	13.25 337	.50 13	...	.50 13	8.00 203	1.84 47	13.25 337	.50 13	...	...	45
			Vertical	1*	7.97 202	23.91 607	7.00 178	7.00 178	.48 12	...	1.81 46	20.25 514	1.19 30	7.00 178	.48 12	...	...	45
	5	SGO	Horizontal	1	19.31 490	16.19 411	9.38 238	18.00 457	.66 17	...	1.03 26	14.00 356	1.16 29	18.00 457	.66 17	...	...	98
			Vertical	1*	10.75 273	34.41 874	9.38 238	9.50 241	.63 16	...	1.25 32	32.00 813	1.16 29	9.50 241	.63 16	...	...	98
	6	SHO	Horizontal	1	22.38 568	28.05 712	9.52 242	18.00 457	.77 20	...	3.83 97	21.19 538	3.03 77	18.00 457	.77 20	...	...	195
	7	SJO	Horizontal	1	24.25 616	37.25 946	13.81 351	19.75 502	1.52 39	...	...	30.00 762	...	...	...	...	...	310
8736	00	SAO	Horizontal	2	7.13 181	6.91 176	5.31 135	...	...	3.41 87	.47 12	4.34 110	6.22 158	4.53 115	5.06 129	.66 17	...	13
	0	SBO	Horizontal	2	7.13 181	6.91 176	5.31 135	...	...	3.41 87	.47 12	4.34 110	6.22 158	4.53 115	5.06 129	.66 17	...	13
	1	SCO	Vertical	2*	5.41 137	11.52 293	5.31 135	5.03 128	.22 6	...	.61 15	8.00 203	10.70 272	2.52 64	5.06 129	.22 6	5.03 128	13
	2	SDO	Horizontal	2	9.00 229	8.50 216	6.03 153	...	...	4.50 114	.38 10	5.63 143	7.50 191	5.00 127	5.16 131	1.50 38	...	18
			Vertical	2*	6.75 171	13.48 342	6.03 153	6.25 159	.25 6	...	.78 20	10.38 264	12.97 329	3.13 80	5.16 131	.25 6	6.00 152	18
	3	SEO	Horizontal	2	12.72 323	11.72 298	7.00 178	11.75 298	.48 12	...	.48 12	10.75 273	10.75 273	11.75 298	6.25 159	.48 12	11.75 298	38
			Vertical	2*	7.31 186	22.25 565	7.00 178	6.25 159	.48 12	...	1.02 26	20.75 527	...	6.25 159	6.25 159	.48 12	6.25 159	38
	4	SFO	Horizontal	2	14.25 362	14.59 371	7.00 178	13.25 337	.50 13	...	1.84 47	12.25 311	12.25 311	13.25 337	6.25 159	.50 13	13.25 337	48
			Vertical	2*	7.97 202	26.81 681	7.00 178	7.00 178	.48 12	...	1.84 47	24.50 622	...	4.05 103	6.25 159	.48 12	7.00 178	48
	5	SGO	Horizontal	2	19.31 490	20.91 531	9.38 238	18.00 457	.66 17	...	1.28 33	19.00 483	19.00 483	18.00 457	6.63 168	.63 16	18.00 457	115
			Vertical	2*	10.75 273	39.16 995	9.38 238	9.50 241	.66 17	...	1.28 33	37.25 946	37.25 946	9.50 241	6.63 168	.63 16	9.50 241	115
	6	SHO	Horizontal	2	22.38 568	28.05 712	9.52 242	18.00 457	.77 20	...	3.83 97	21.19 538	3.03 77	18.00 457	.77 20	...	...	200
	7	SJO	Horizontal	1	24.25 616	37.25 946	13.81 351	19.75 502	1.52 39	...	...	30.00 762	...	...	...	...	...	315

* Vertical type design differs from that shown on the corresponding NEMA size horizontal figure, but dimensions listed apply to that figure.

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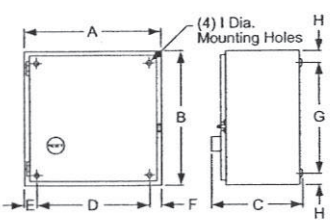


Figure 4

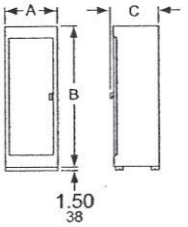


Figure 5

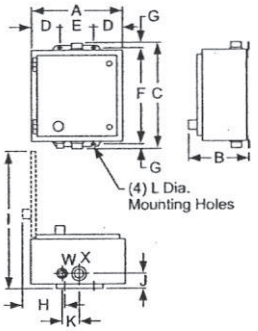


Figure 6

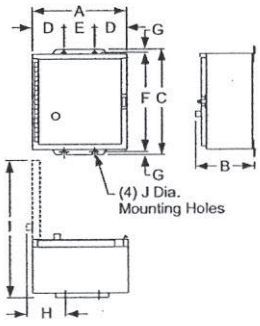


Figure 7

NEMA Type 1

NEMA Size	Class No.	Fig. No.	Dimensions — Inches/mm																				Wt (Lbs)	
			A		B		C 8702		C 8736		D		E		F		G		H		I		8702	8736
			IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm		
00, 0† 1†	8702 & 8736	4	11.88	302	11.88	302	7.41	188	7.53	191	9.75	248	1.06	27	1.06	27	9.75	248	1.06	27	.31	8	16	17
2†	8702 & 8736	4	14.88	378	14.13	359	7.56	192	7.66	195	12.75	324	1.06	27	1.06	27	12.00	305	1.06	27	.31	8	24	25
3* 4*	8702 & 8736	4	18.16	461	29.16	741	9.25	235	9.25	235	15.50	394	1.33	34	1.33	34	26.50	673	1.33	34	.44	11	95	98
5	8702 & 8736	4	35.22	895	46.22	1174	12.81	325	12.93	328	31.00	787	2.11	54	2.11	54	42.00	1067	2.11	54	.56	14	298	315
6	8702 & 8736	5	36.22	920	62.22	1580	19.47	495	19.47	495	Floor Mounting												400	405
7	8702 & 8736	5	34.50	876	93.00	2362	23.50	597	23.50	597													...	...

† Standard enclosure has space for a fused control transformer, Form F4T, on Sizes 0-2, except for Size 0 & 1 4-Pole.
* 3-Pole only.

NEMA Type 4 & 4X – Stainless Steel▲

NEMA Size	Class Number	Fig. No.	Dimensions — Inches/mm												Hub Dia.		Weight (Lbs)	
			A	B	C	D	E	F	G	H	I	J	K	L	W Bot. Only	X Top & Bot.	8702	8736
0† 1†	8702 & 8736	6	12.63 321	7.81 198	14.69 373	2.56 65	7.50 191	13.50 343	.59 15	3.88 99	18.41 468	1.66 42	2.31 59	.31 8	¾	1	25	26
2†	8702 & 8736	6	14.88 378	8.25 210	15.75 400	12.56 319	9.75 248	15.00 381	.38 10	3.88 99	20.88 530	1.72 44	2.63 67	.31 8	¾	1½	33	35
3* 4*	8702	6	18.16 461	8.75 222	32.22 818	3.08 78	12.00 305	30.50 775	.88 22	3.69 94	26.72 679	2.56 65	3.19 81	.44 11	¾	2½	96	...
	8736	6	18.16 461	9.56 243	32.22 818	3.08 78	12.00 305	30.50 775	.88 22	4.50 114	26.72 679	2.56 65	3.19 81	.44 11	¾	2½	...	99
5	8702	6	35.22 895	12.13 308	49.22 1250	4.11 104	27.00 686	48.00 1219	.63 16	4.59 117	45.81 1164	2.97 75	3.50 89	.56 14	¾	3½	300	...
	8736	6	35.22 895	12.94 329	49.22 1250	4.11 104	27.00 686	48.00 1219	.63 16	5.41 137	45.81 1164	2.97 75	3.50 89	.56 14	¾	3½	...	317
6	8702 & 8736	5	36.22 920	70.13 1781	19.47 495	Floor Mounting											500	505
7	8702 & 8736	5	34.50 876	101.00 2565	23.50 597												...	...

† Standard enclosure has space for a fused control transformer, Form F4T, on Sizes 0-2, except for Size 0 & 1 4-Pole devices.
* 3-Pole only.
▲ Size 6 & 7 are sheet steel enclosures and are rated NEMA Type 4 only.

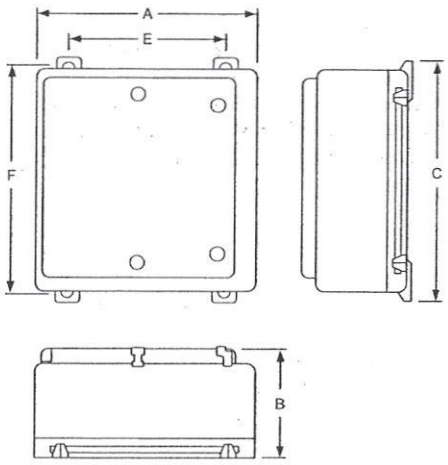
NEMA Type 12

NEMA Size	Class Number	Fig. No.	Dimensions — Inches/mm																		Wt (Lbs)	
			A		B		C		D		E		F		G		H		I		J		8702	8736
			IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm		
0† 1†	8702 & 8736	7	11.88	302	7.75	197	13.75	349	2.56	65	6.75	171	12.75	324	.50	13	3.66	93	18.13	461	.31	8	23	24
2†	8702 & 8736	7	14.88	378	7.88	200	16.00	406	2.56	65	9.75	248	15.00	381	.50	13	3.66	93	21.25	540	.31	8	31	32
3*	8702	7	18.16	461	9.25	235	31.50	800	3.08	78	12.00	305	30.50	775	.50	13	3.69	93	26.72	679	.44	11	96	...
4*	8736	7	18.16	461	9.56	243	31.50	800	3.08	78	12.00	305	30.50	775	.50	13	4.50	114	26.72	679	.44	11	...	99
5	8702	7	35.22	895	13.13	334	49.00	1245	4.13	105	27.00	686	48.00	1219	.50	13	5.31	135	45.88	1165	.56	14	302	...
	8736	7	35.22	895	13.94	354	49.00	1245	4.13	105	27.00	686	48.00	1219	.50	13	6.13	156	45.88	1165	.56	14	...	319
6	8702 & 8736	5	36.22	920	62.22	1580	19.47	495	Floor Mounting														490	495
7	8702 & 8736	5	34.50	876	93.00	2362	23.50	597															...	...

† Standard enclosure has space for a fused control transformer, Form F4T, on Sizes 0-2, except for Size 0 & 1 4-Pole devices.
* 3-Pole only.

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Full Voltage Reversing Contactors and Starters — NEMA
Approximate Dimensions – Class 8702, 8736



NEMA Type 4X — Watertight and Corrosion Resistant Glass Polyester Enclosure

NEMA Size	Class	Type	No. of Poles	Fig.	A		B		C		E		F	
					IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
0-2	8702/36	SBW SCW SDW	All		16.88	429	9.78	248	22.75	578	10.13	257	21.50	546
0-2*	8702/36	SBW SCW SDW	All		24.63	626	11.94	303	27.00	686	17.88	454	25.75	654
3-4	8702/36	SEW SPW	All		25.81	656	11.94	303	33.50	851	18.50	470	32.25	819
3-4*	8702/36	SEW SPW	All		32.00	813	12.13	308	39.31	998	23.88	607	38.13	969

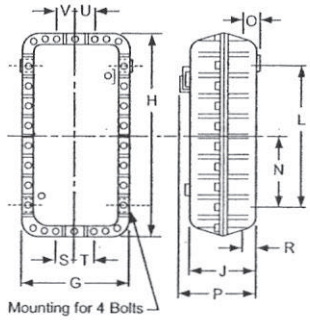
* With control power transformer (Form F4T)

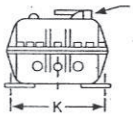
Figure 7

NEMA Type 7 & 9 Bolted Enclosure — Figure 8

NEMA Size	Type	Dimensions — Inches/mm■																	Wt (Lbs)
		G		H		J		K		L		N		P		Q, R		S, T, U, V	
		IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	
0-2	SBT SCT SDT	14.25	362	27.63	702	9.50	241	12.25	311	19.25	489	9.63	245	11.50	292	2.38	60	3.13	80	115
3-4*	SET SFT	24.50	622	45.63	1159	13.75	349	22.50	572	27.50	699	13.75	349	15.38	391	3.44	87	4.00	102	180

■ Dimensions shown for 2 or 3-Pole devices only.





Circuit Breaker Handle not supplied on Class 8502 or 8536

1/2" NPT for Breather and Drain

Figure 8

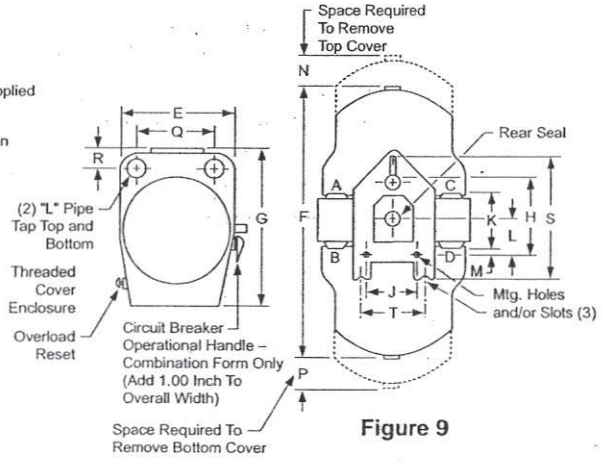


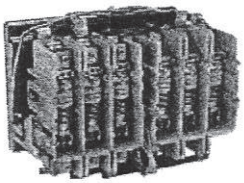
Figure 9

NEMA 7 & 9 SPIN TOP® Enclosure — Figure 9

NEMA Size	Type	Dimensions — Inches/mm																			Wt (Lbs)
		A	B*	B†	C*	C†	D	E*	E†	F	G*	G†	H*	H†	J*	J†	K	L	M	N	P	R	
0-1	SBR SCR	12.00 305	41.06 1043	46.13 1172	68.06 1729	79.13 2010	16.75 425	7.25 184	12.25 311	7.69 195	26.13 664	26.13 664	3.00 76	9.00 229	24.00 610	24.00 610	8.50 216	2.06 52	9.38 238	5.25 133	1.50 38	.38 10	70
2	SDR	16.13 410	48.50 1232	50.50 1283	81.50 2070	85.00 2159	20.25 514	12.13 308	9.13 232	8.63 219	27.75 705	32.75 832	8.00 203	4.50 114	25.00 635	30.00 762	12.00 305	12.63 321	11.00 279	5.50 140	2.50 64	.38 10	100
3	SER	Consult Local Square D Field Office																					

* Without control transformer.
† With control transformer (Form F4T).

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Class 8702 Type WF Reversing Vacuum Contactor

Auxiliary Contact Units

Additional auxiliary contact units may be added to the Size 4 and 5 reversing contactors in the field. A maximum of 2 units may be added to the Size 4; a maximum of 1 unit may be added to the Size 5. No additional units may be added to the Size 6, however, 1 N.O. and 1 N.C. circuit are available on each forward and reverse contactor for customer use.

GENERAL INFORMATION

Class 8702 Type W reversing vacuum contactors are a new addition to the Square D line of contactors. These reversing contactors are used to switch capacitors, transformers and electric motors where overload protection is separately provided. Type W reversing vacuum contactors are designed for operation at 600 Volts, 50/60 Hertz.

By design, these contactors are well suited to heavy-duty applications in harsh environments. The power contacts are sealed in ceramic tubes, called vacuum interrupters or vacuum bottles, where the air has been evacuated. Arc quenchers are not required because any arc formed between opening contacts is not sustained due to the presence of the vacuum. The arc is extinguished when the current crosses zero after the contacts are opened, therefore the arc typically does not survive more than one half cycle. There is one vacuum interrupter or bottle per pole, therefore a three pole contactor has three vacuum interrupters or bottles. The power contacts are not affected by ambient conditions or contamination. This provides for long life and reliable operation in harsh applications.

Altitude

The reversing vacuum contactor is designed to tolerate normal barometric pressure variances up to 6600 feet above sea level. If the contactor is to be used above 6600 feet above sea level, please consult the factory.

Termination Means

The Size 4 reversing vacuum contactor is supplied with line and load side lugs. The Size 5 and 6 reversing vacuum contactors are supplied without line and load side lugs. Class 9999 Type LUW5 and LUW6 lug kits are available for the Size 5 and 6 contactors. These kits include six lugs and the necessary mounting hardware.

Auxiliary Contacts

An auxiliary contact block, Class 9999 Type WX11, with one normally-open contact and normally-closed contact is used with Size 4, 5 and 6 vacuum contactors.

Class 8702 – Full Voltage Reversing Vacuum Contactors (Horizontal Only)
3-Pole Polyphase – 600 Volts AC Maximum (50-60 Hertz)

NEMA Size	Enclosed Ampere Rating	Locked Rotor Current (Amps)	Motor Volts	Max. HP	* Coil Voltage	Open Type
						Type
4	135	1080	200 230 380 460 575	40 50 75 100 100	120 240 120 480 600	WFO3V02S WFO3V03 WFO3V02S WFO3V06 WFO3V07
5	270	2160	200 230 380 460 575	75 100 150 200 200	120 240 120 480 600	WGO3V02S WGO3V03 WGO3V02S WGO3V06 WGO3V07
6	540	4320	200 230 380 460 575	150 200 300 400 400	120 240 120 480 600	WHO3V02S WHO3V03 WHO3V02S WHO3V06 WHO3V07

File E78351
CCN NLDX2

File LR60905
Class 3211-04

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Class 9998 – Replacement Coils for Class 8502 and 8702 Vacuum Contactors

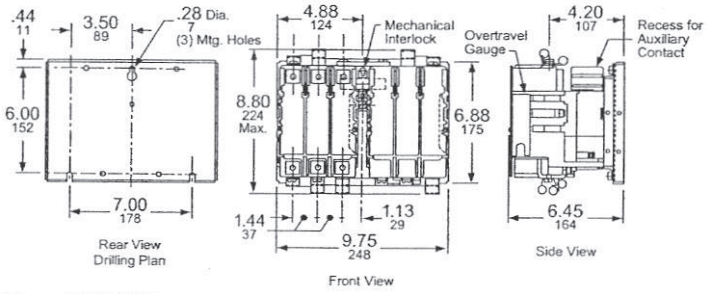
Size	Type	Poles	Class & Type	Hertz	Suffix Number (Complete Coil Number Consists of Class and Type Followed by Suffix Number)			
				50 60	120 Volts 110 Volts	240 Volts 220 Volts	480 Volts 440 Volts	600 Volts 550 Volts
4 5 6	WF WG WH	All	9998WF 9998WG 9998WH		120	240	480	600

Class 9999 – Vacuum Contactor Kits

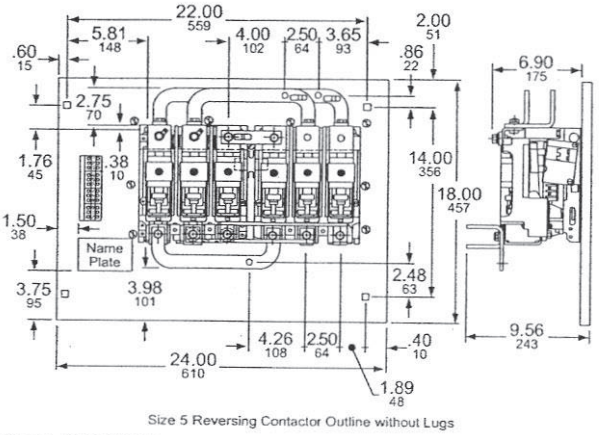
For Use With		Kit Description	Class 9999 Type
Type	Size		
WF-WH	4-6	**Auxiliary Contacts, Non-Convertible** **1-N.O. & 1-N.C. Isolated Contacts**	9999WX11
WF WG-WH	4 5-6	**Coil Circuit Auxiliary Contacts** 1-N.O. & 1-N.C. Isolated Contacts, Delayed Break 1-N.C. Isolated Contact	9999WCX11 9999WLX01
WG WH	5 6	**Lug Kits** (6) lugs included (6) lugs included	9999LUW5 9999LUW6

Auxiliary Contact Ratings — NEMA A600, R300

Description	Voltage	Make	Break
Class 9999 Type WX11 and WXO1	120-600 Vac 72-120 Vac 28-72 Vac 28-300 Vac	7200 VA 60 A 60 A 28 A	720 VA 720 VA 10 A 28 VA

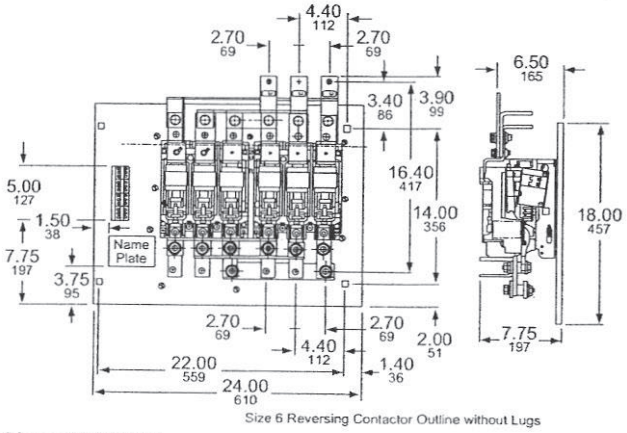


Class 8702 WF



Size 5 Reversing Contactor Outline without Lugs

Class 8702 WG



Size 6 Reversing Contactor Outline without Lugs

Class 8702 WH

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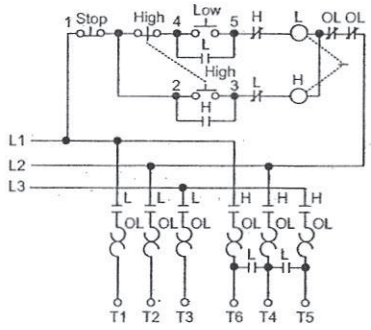
SECTION 3 – MOTOR STARTERS MULTI-SPEED

Application Data – Class 8810, 8811, 8812 40-41
Line Voltage — with Melting Alloy Overload Relays – Class 8810 42
Reversing Line Voltage Type — with Melting Alloy Overload Relays – Class 8810 43
Line Voltage — with Melting Alloy Overload Relays or Solid State Overload Relays – Class 8810 44-45
Line Voltage — with Melting Alloy Overload Relays – Class 8811, 8812 . . 48
Application Data – Class 8810, 8811, 8812 47
Application Data for Types SB-SJ – Class 8810, 8811, 8812 48
Dimensions – Class 8810, 8811, 8812 49
Application Data – Class 8810, 8811, 8812 50-51
Disconnect Switch or Circuit Breaker Type – Class 8810, 8811, 8812 . . . 52

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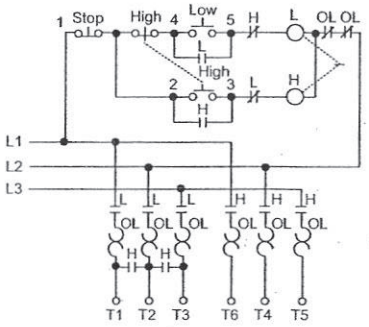
AC Multispeed Magnetic Starters
Application Data – Class 8810, 8811, 8812

Typical Schematic Diagrams

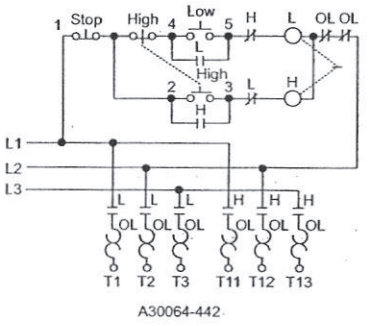


A30064-446

2-Speed Consequent Pole Constant Horsepower
NEMA Size 0-4
Sizes 5, 6 & 7 Use Special Circuitry



2-Speed Consequent Pole Constant or Variable Torque
NEMA Size 0-4
Sizes 5, 6 & 7 Use Special Circuitry



A30064-442

2-Speed Separate Winding Constant HP, Constant Torque and Variable Torque NEMA Size 0-4
Sizes 5, 6 & 7 Use Special Circuitry

Multispeed motors are available in two basic versions:

- Consequent pole
- Separate winding

A separate winding motor has a winding for each speed while a consequent pole motor has a winding for every two speeds (three speed motors have two windings). The motor connections (and thus the types of controllers) for two speed starters are exemplified by the schematic diagrams shown to the left. Note that consequent pole two speed controllers involve a 5-pole and a 3-pole starter while separate winding controllers have two 3-pole starters.

Separate winding motors are usually chosen when flexibility is important, since the speeds of a consequent pole motor are usually limited to a 2/1 ratio; a broad range of speeds can be obtained on a separate winding motor.

Both consequent pole and separate winding motors are available in three types:

- Constant horsepower
- Constant torque
- Variable torque

Typical applications for these different types of motors are shown below.

NOTE: For detailed information involving the technical aspects of flexibility of the starters used in the multispeed controllers, see Classes 8702, 8736 and 8810 application data.

Typical Applications

Constant H.P.

- Spindles
- Cutting Tools
  - — Lathes
  - — Saws

Constant Torque

- Conveyors
- Mills
- Dough Mixers
- Reciprocating Pumps

Variable Torque

- Fans
- Centrifugal Pumps

Speed Selection

The speed of a squirrel cage motor is directly proportional to the power supply frequency and inversely proportional to the number of poles in the stator winding. With the frequency constant, motor speed is determined by the number of poles.

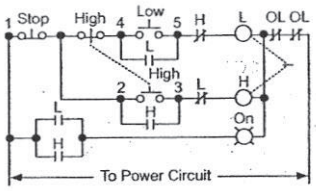
$$\text{(RPM) Speed} = \frac{(120)\,(\text{Frequency})}{\text{No. of Poles}}$$

$$\text{Horsepower} = \frac{T \times S}{5250}$$

Where:
T = Torque in Lb Ft
S = Speed in RPM

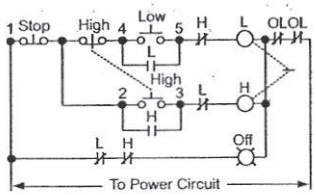
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Special Pilot Lighting



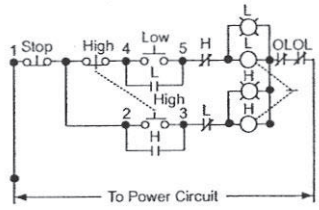
A30080-017

One pilot light "ON"



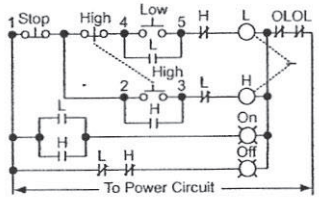
A30080-018

One pilot light "OFF"



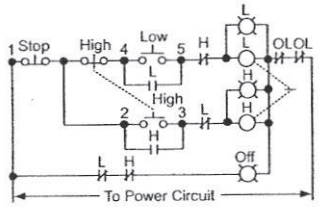
A30080-015

Two pilot lights "L" and "H"



A30080-016

Two pilot lights "ON" and "OFF"



A30080-019

Three pilot lights "L", "H" and "OFF"

ADDITIONAL FEATURES

Special Relays for Non-Reversing and Reversing Multispeed Starters

General

Standard starters are not equipped with any special relays to require starting at lowest speed, progressive acceleration or deceleration through each speed, etc. However, when the type of motor or characteristics of the load involved make certain starting or control sequences necessary, four types of relays/timers are available to accomplish the required function.

Form R1 Compelling Relay

This relay makes it necessary for the motor to be started at low speed before any higher speed can be selected. Pressing any push button except the low speed will not start the motor. This arrangement insures that the motor will always start the load at low speed. The stop button must be pressed before it is possible to change from a higher to a lower speed.

Form R2 Accelerating Relay/Timer

When the starter is equipped with Form R2 accelerating relays, the ultimate speed is determined by the button which is pressed, but the starter will start the motor at low speed and then automatically accelerate it through successive steps until the selected speed is reached. Definite time intervals must elapse between each speed change. Individual timing relays are provided for each interval, and all are adjustable. The stop button must be pressed before it is possible to change from a higher to a lower speed.

Form R3 Decelerating Relay/Timer

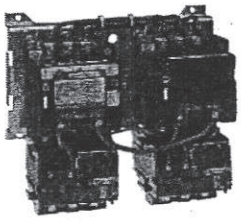
This is similar in action to Form R2 accelerating relays, except that they function to prevent immediate transfer from a higher to a lower speed. A definite time interval, preset on the timer, must elapse between each speed change.

Form R10 Antiplugging Relays/Timers

If it is necessary to have an imposed time delay when transferring from the forward to the reverse direction or reverse to forward, then Form R10 should be included in the form designation of the **reversing** multispeed starters. This provides up to a 60 second delay in the transfer of the direction of the motor, and can help prevent damage which could result from plugging.

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AC Two Speed Magnetic Starters
Line Voltage — with Melting Alloy Overload Relays – Class 8810



Class 8810, Type S
in NEMA Type 1 Enclosure

Line voltage type, ac two speed starters are designed to control reconnectable squirrel cage motors to operate at two different constant speeds, depending upon their construction. The use of an automatic starter and proper control station permits greater operating efficiency and offers protection to both motor and machine against improper sequencing or too rapid speed change. Protection against motor overload in each speed is provided by an overload relay block which accepts three (3) thermal units.

Class 8810 Non-reversing – Two Speed – 50-60 Hertz – 600 Volts Maximum

Type of Motor	NEMA Size	Maximum Polyphase Horsepower Ratings						General Purpose Enclosure NEMA Type 1	Watertight and Dusttight Enclosure (Stainless Steel) (Sizes 0-5 only) Size 6 Sheet Steel■ NEMA Type 4	For Hazardous Locations Class I Groups C & D Class II Groups E, F & G NEMA Types 7 and 9●	Dusttight and Driptight Industrial Use Enclosure NEMA Type 12†	Open Type
		Constant Horsepower Motors			Constant Torque or Variable Torque Motors							
		200 V	230 V	460-575 V	200 V	230 V	460-575 V	Type	Type	Type	Type	Type
Single Winding (Consequent Pole) 5-Pole – 3-Pole												
Constant HP	0	2	2	3	...	...	...	SBG-1	SBW-1▲	...	SBA-1▲	SBO-1
	1	5	5	7½	...	...	...	SCG-1	SCW-1▲	SCR-1●	SCA-1▲	SCO-1
	2	7½	10	20	...	...	...	SDG-1	SDW-1	SDR-1●	SDA-1	SDO-1
	3	20	25	40	...	...	...	SEG-1	SEW-1	SER-1●	SEA-1	SEO-1
	4	30	40	75	...	...	...	SFG-1	SFW-1	...	SFA-1	SFO-1
	5	60	75	150	...	...	...	SGG-1	SGW-1	...	SGA-1	SGO-1
	6	100	150	300	...	...	...	SHG-1	SHW-1	...	SHA-1	SHO-1
Constant Torque or Variable Torque	0	...	...	...	3	3	5	SBG-2	SBW-2▲	...	SBA-2▲	SBO-2
	1	...	...	...	7½	7½	10	SCG-2	SCW-2▲	SCR-2●	SCA-2▲	SCO-2
	2	...	...	...	10	15	25	SDG-2	SDW-2	SDR-2●	SDA-2	SDO-2
	3	...	...	...	25	30	50	SEG-2	SEW-2	SER-2●	SEA-2	SEO-2
	4	...	...	...	40	50	100	SFG-2	SFW-2	...	SFA-2	SFO-2
	5	...	...	...	75	100	200	SGG-2	SGW-2	...	SGA-2	SGO-2
	6	...	...	...	150	200	400	SHG-2	SHW-2	...	SHA-2	SHO-2
Two Winding (Separate Winding) 3-Pole – 3-Pole♦												
Constant HP♦	0	2	2	3	...	...	...	SBG-3	SBW-3▲	...	SBA-3▲	SBO-3
	1	5	5	7½	...	...	...	SCG-3	SCW-3▲	SCR-3●	SCA-3▲	SCO-3
	2	7½	10	20	...	...	...	SDG-3	SDW-3	SDR-3●	SDA-3	SDO-3
	3	20	25	40	...	...	...	SEG-3	SEW-3	SER-3●	SEA-3	SEO-3
	4	30	40	75	...	...	...	SFG-3	SFW-3	...	SFA-3	SFO-3
	5	60	75	150	...	...	...	SGG-3	SGW-3	...	SGA-3	SGO-3
	6	100	150	300	...	...	...	SHG-3	SHW-3	...	SHA-3	SHO-3
	7	...	225	450	...	...	...	SJG-3	...	...	SJA-3	SJO-3
Constant Torque or Variable Torque♦	0	...	...	...	3	3	5	SBG-4	SBW-4▲	...	SBA-4▲	SBO-4
	1	...	...	...	7½	7½	10	SCG-4	SCW-4▲	SCR-4●	SCA-4▲	SCO-4
	2	...	...	...	10	15	25	SDG-4	SDW-4	SDR-4●	SDA-4	SDO-4
	3	...	...	...	25	30	50	SEG-4	SEW-4	SER-4●	SEA-4	SEO-4
	4	...	...	...	40	50	100	SFG-4	SFW-4	...	SFA-4	SFO-4
	5	...	...	...	75	100	200	SGG-4	SGW-4	...	SGA-4	SGO-4
	6	...	...	...	150	200	400	SHG-4	SHW-4	...	SHA-4	SHO-4
	7	...	...	...	...	300	600	SJG-4	...	...	SJA-4	SJO-4

♦ Type numbers shown for three phase separate winding motor starters apply only when motor windings are wye connected. When motor windings are connected open delta use three phase consequent pole motor starters.

▲ Separate NEMA Type 4 and 12 enclosures available.

† NEMA Type 12 enclosures may be field modified for outdoor applications.

■ NEMA Type 4X enclosures available; consult local Square D field office.

● Addition of forms to standard NEMA Type 7 and 9 enclosed devices is limited. Consult local Square D field office.

380 Volts, 50 Hertz – above type numbers will apply to starters for 380 volt, 50 hertz but the selection by NEMA size must be based on the horsepower ratings in the following table:

NEMA Size	0	1	2	3	4	5	6
Constant Horsepower	3	7½	20	40	60	100	200
Constant or Variable Torque Horsepower	5	10	25	50	75	150	300

Thermal Units

Thermal units should be ordered separately. See Thermal Unit Selection Index. **Do not use horsepower rating(s) for thermal unit selection. All three phase two speed magnetic starters require six (6) thermal units, three per speed.** Use nameplate FLC's (Full Load Currents) from motor nameplate.

Special Features — See Factory Modifications and Forms, Catalog 9999CT9701.

Dimensions — See Pages 49-52.

Field Modification Kits — See Catalog 9999CT9701 Section.

Class 8810, 8811 and 8812 multispeed starters, both non-reversing and reversing versions, are available with either circuit breaker or disconnect switch. Refer to Factory Modifications and Forms for Form numbers and price additions.

How to Order:

To Order Specify:	*Catalog Number*			
• Class Number • Type Number • Coil Voltage Code • Form(s)	Class	Type	Coil Voltage Code	Form(s)
	8810	SCO8	VO6	P1S

File E78351
CCN NLDX

File LR60905
Class 3211-04

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AC Reversing Two Speed Magnetic Starters
Line Voltage Type — with Melting Alloy Overload Relays – Class 8810

Class 8810 AC reversing two speed starters combine the functions of reversing and speed selection in one controller. The units are electrically and mechanically interlocked, and include motor running overcurrent protection. Typical applications include conveyors, drilling and tapping machines, and cooling tower fans. Many of these applications also require the special relay features.

Class 8810 – Reversing – 50-60 Hertz – 600 Volts Maximum

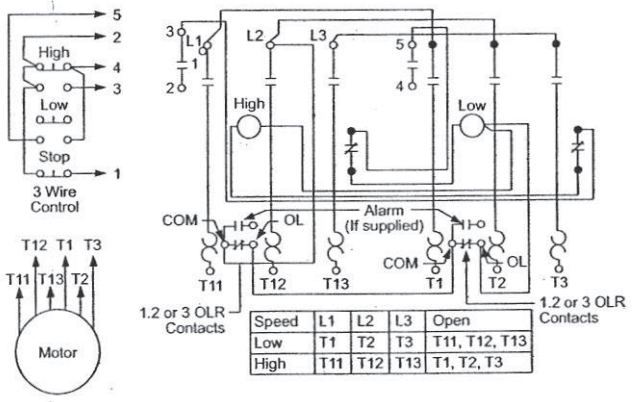
Type of Motor	NEMA Size	Maximum Polyphase Ratings						Reversing In One Speed Only			Reversing In Both Speeds		
		Constant Horsepower Motors			Constant Torque or Variable Torque Motors			General Purpose Enclosure NEMA Type 1	Dusttight and Driptight Industrial Use Enclosure NEMA Type 12 (Type 3 and 3R)♦	Open Type	General Purpose Enclosure NEMA Type 1	Dusttight and Driptight Industrial Use Enclosure NEMA Type 12 (Type 3 and 3R)♦	Open Type
		200 V	230 V	460-575 V	200 V	230 V	460-575 V	Type★	Type★	Type★	Type	Type	Type
Single Winding Constant Horsepower	0	2	2	3	...	...	...	SBG-21	SBA-21	SBO-21	SBG-31	SBA-31	SBO-31
	1	5	5	7½	...	...	...	SCG-21	SCA-21	SCO-21	SCG-31	SCA-31	SCO-31
	2	7½	10	20	...	...	...	SDG-21	SDA-21	SDO-21	SDG-31	SDA-31	SDO-31
	3	20	25	40	...	...	...	SEG-21	SEA-21	SEO-21	SEG-31	SEA-31	SEO-31
	4	30	40	75	...	...	...	SFG-21	SFA-21	SFO-21	SFG-31	SFA-31	SFO-31
	5	60	75	150	...	...	...	SGG-21	SGA-21	SGO-21	SGG-31	SGA-31	SGO-31
Single Winding Constant Torque or Variable Torque	0	...	...	...	3	3	5	SBG-22	SBA-22	SBO-22	SBG-32	SBA-32	SBO-32
	1	...	...	...	7½	7½	10	SCG-22	SCA-22	SCO-22	SCG-32	SCA-32	SCO-32
	2	...	...	...	10	15	25	SDG-22	SDA-22	SDO-22	SDG-32	SDA-32	SDO-32
	3	...	...	...	25	30	50	SEG-22	SEA-22	SEO-22	SEG-32	SEA-32	SEO-32
	4	...	...	...	40	50	100	SFG-22	SFA-22	SFO-22	SFG-32	SFA-32	SFO-32
	5	...	...	...	75	100	200	SGG-22	SGA-22	SGO-22	SGG-32	SGA-32	SGO-32
Constant† Horsepower	0	2	2	3	...	...	...	SBG-23	SBA-23	SBO-23	SBG-33	SBA-33	SBO-33
	1	5	5	7½	...	...	...	SCG-23	SCA-23	SCO-23	SCG-33	SCA-33	SCO-33
	2	7½	10	20	...	...	...	SDG-23	SDA-23	SDO-23	SDG-33	SDA-33	SDO-33
	3	20	25	40	...	...	...	SEG-23	SEA-23	SEO-23	SEG-33	SEA-33	SEO-33
	4	30	40	75	...	...	...	SFG-23	SFA-23	SFO-23	SFG-33	SFA-33	SFO-33
	5	60	75	150	...	...	...	SGG-23	SGA-23	SGO-23	SGG-33	SGA-33	SGO-33
Constant† Torque or Variable Torque	0	...	...	...	3	3	5	SBG-24	SBA-24	SBO-24	SBG-34	SBA-34	SBO-34
	1	...	...	...	7½	7½	10	SCG-24	SCA-24	SCO-24	SCG-34	SCA-34	SCO-34
	2	...	...	...	10	15	25	SDG-24	SDA-24	SDO-24	SDG-34	SDA-34	SDO-34
	3	...	...	...	25	30	50	SEG-24	SEA-24	SEO-24	SEG-34	SEA-34	SEO-34
	4	...	...	...	40	50	100	SFG-24	SFA-24	SFO-24	SFG-34	SFA-34	SFO-34
	5	...	...	...	75	100	200	SGG-24	SGA-24	SGO-24	SGG-34	SGA-34	SGO-34

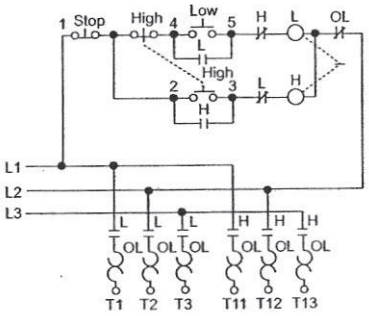
† Prices and Type numbers shown for three phase, separate winding motor starters apply only when motor windings are wye connected. When motor windings are connected open delta use the prices shown for consequent pole motor starters.

▲ Specify the speed which requires reversing by adding an L (low) or an H (high) after the type number, e.g. A Class 8810 Type SBG-21 with reversing in low only would be ordered as a Class 8810 Type SBG-21L.

♦ NEMA Type 12 enclosures may be field modified for outdoor applications. For details refer to Class 9991.

Typical Elementray Diagrams





How to Order:

To Order Specify:	Catalog Number			
• Class Number • Type Number • Coil Voltage Code • Form(s)	Class	Type	Coil Voltage Code	Form(s)
	8810	SCO8	VO6	P1S

Thermal Units

Thermal units should be ordered separately. See Thermal Unit Selection Index. **Do not use horsepower rating(s) for thermal unit selection. All three phase two speed magnetic starters require six (6) thermal units, three per speed.** Use nameplate FLC's (Full Load Currents) from motor nameplate.

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AC Two Speed Magnetic Starters
Line Voltage — with Melting Alloy Overload Relays or Solid State Overload Relays – Class 8810

Class 8810 — Non-Reversing — Horizontally Arranged Starters
▲†Glass Polyester Watertight, Dusttight and Corrosion Resistant Enclosure
50-60 Hertz – 600 Volts Maximum

Type of Motor	NEMA Size	Maximum Horsepower Ratings				For Consequent Pole Motors	For Separate Winding Motors
		200 V	230 V	380 V	460-575 V	Type	Type
Constant Horsepower	0	2	2	3	3	SBW-51	SBW-53
	1	5	5	7½	7½	SCW-51	SCW-53
	2	7½	10	20	20	SDW-51	SDW-53
	3	20	25	40	40	SEW-51	SEW-53
	4	30	40	60	75	...	SFW-53
Constant Torque or Variable Torque	0	3	3	5	5	SBW-52	SBW-54
	1	7½	7½	10	10	SCW-52	SCW-54
	2	10	15	25	25	SDW-52	SDW-54
	3	25	30	50	50	SEW-52	SEW-54
	4	40	50	75	100	...	SFW-54

▲ NEMA Type 4X hubs are included with each starter at no additional cost.
† Combination features available – consult factory.

Vertically Arranged, Open Type, Two Speed Starters

Vertically arranged starters are used where width limitations prevent the use of the conventional horizontally arranged device. Such starters may be used to advantage in threaded NEMA Type 7 explosion-proof enclosures, and in multi-motor panels in which other equipment within the enclosure used limits the available width.

These starters have all the features of the standard horizontally arranged devices, but the two contactors are in a vertical arrangement. These starters are offered in open type construction only.

Class 8810 — Non-Reversing — Vertically Arranged Starters – 50 or 60 Hertz – 600 Volts Maximum

Type of Motor	NEMA Size	Maximum Horsepower Ratings				For Consequent Pole Motors	For Separate Winding Motors
		200 V	230 V	380 V	460-575 V	Type	Type
Constant Horsepower	0	2	2	3	3	SBO-11	SBO-13
	1	5	5	7½	7½	SCO-11	SCO-13
	2	7½	10	20	20	SDO-11	SDO-13
	3	20	25	40	40	SEO-11	SEO-13
	4	30	40	60	75	SFO-11	SFO-13
Constant Torque or Variable Torque	0	3	3	5	5	SBO-12	SBO-14
	1	7½	7½	10	10	SCO-12	SCO-14
	2	10	15	25	25	SDO-12	SDO-14
	3	25	30	50	50	SEO-12	SEO-14
	4	40	50	75	100	SFO-12	SFO-14

How to Order:

To Order Specify:	*Catalog Number*			
	Class	Type	Coil Voltage Code	Form(s)
• Class Number • Type Number • Coil Voltage Code • Form(s)	8810	SCO8	VO6	P1S

Thermal Units

Thermal units should be ordered separately. For selection of thermal units, refer to the Catalog Thermal Unit Selection Index, Digest or Bulletin SM-416, entitled "Application and Selection of Overload Relays." Do not use horsepower rating(s) for thermal unit selection. All three phase two speed magnetic starters require six (6) thermal units, three per speed. Use nameplate FLC's (Full Load Currents) from motor nameplate.

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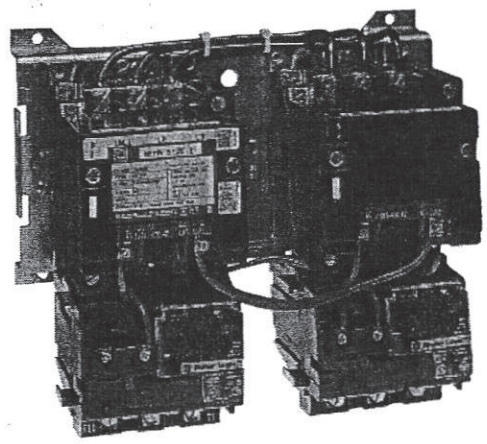
Special Arrangements with Three Devices

Three Type S Contactors can be mechanically interlocked so that only one contactor can be energized at any one time. The mechanical interlock, pictured in Figure 2, is an interference (non-jamming) type locking at the beginning of the stroke of any contactor.

Factory assembled units are listed in the table below. Figures 1 and 2 show factory assembled and wired devices. All contactors are both electrically and mechanically interlocked. The class and type numbers listed only cover the contactor and/or starter mounting arrangement, NEMA size of the devices, and the number of poles. A power and control wiring diagram must accompany each order. Additional electrical interlocks are available factory (or field) installed in the locations shown in Figure No. 2 and Table No. 2, Page 52. 8810 starters are supplied with melting alloy type thermal overload relays.

For customer assembled units, the basic mechanical interlock and base assembly can be purchased separately. Standard Class 8502 contactors and Class 8536 starters are used in the locations and pole arrangement shown. If Class 8536 starters are used, it is necessary to mount a Class 9999 Type SO bracket below the overload block to give the block support.

For electrically interlocking customer assembled units a Class 9999 Type SX-12, normally closed internal interlock and/or a Class 9999 Type SX-7, normally closed external interlock can be used.



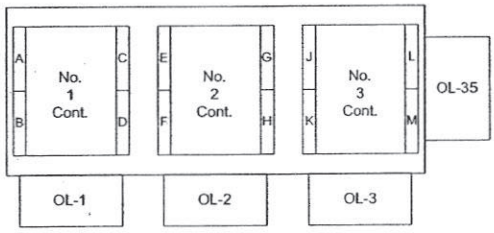


Figure 2
Contactor, overload and external electrical interlock positions

Three Mechanically Interlocked Contactors and Starters — Factory Assembled

Class	Type	Contactor Position — See Figure 2						Overload Relay Position See Fig. 3	Number of Thermal Units Required
		No. 1 Contactor Size and Poles		No. 2 Contactor Size and Poles		No. 3 Contactor Size and Poles			
		NEMA Size 1 No. of Poles	NEMA Size 2 No. of Poles	NEMA Size 1 No. of Poles	NEMA Size 2 No. of Poles	NEMA Size 1 No. of Poles	NEMA Size 2 No. of Poles		
8810	SCO-41	3	...	3	...	3	...	OL-2 & -3	6
	SCO-42	4	...	3	...	3	...		
	SCO-43	...	3	3	...	3	...		
	SCO-44	...	4	3	...	3	...		
	SDO-41	...	3	...	3	...	3		
	SDO-42	...	4	...	3	...	3		
8810	SCO-45	3	...	3	...	5	...	OL-2 & -3	6
	SCO-46	4	...	3	...	5	...		
	SCO-47	...	3	3	...	5	...		
	SCO-48	...	4	3	...	5	...		
	SDO-43	...	3	...	3	...	5		
	SDO-44	...	4	...	3	...	5		

Ordering Information Required

1. Order complete factory assembled devices by class and type number from table above.
2. Supply wiring diagram for power and control connections as catalog number only covers general contactor and starter mounting arrangement.
3. Voltage and frequency of contactor coils.
4. Select additional factory assembled electrical interlocks from table on Page 47 specifying interlock position letter and whether interlock is N.O. or N.C.
5. Example of ordering information required on factory assembled devices:
   (a) Class 8810 Type SCO-45
   (b) Wired per diagram (which must accompany order)
   (c) All coils — 120 volts, 60 hertz
   (d) Additional electrical interlocks: C — N.O., E — N.C., and J — N.O.
6. For customer assembly of three mechanically interlocked devices, order the mechanical interlock and overload relay mounting brackets by class and type numbers.

Thermal Units

Thermal units should be ordered separately. For selection of thermal units, refer to the Catalog Thermal Unit Selection Index R Digest. Use the motor nameplate FLC's (Full Load Currents) to select thermal units.

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Three and Four Speed AC Magnetic Starters
Line Voltage — with Melting Alloy Overload Relays – Class 8811, 8812

Class 881 and 8812 line voltage starters are designed to control 3 and 4 speed motors, respectively. The use of an automatic starter and proper control station permits greater efficiency. The addition of compelling relays to a starter gives protection to both the motor and the machine against an improper sequence or a too rapid change in speed. The motor is protected against excessive operating currents by overload relay blocks (one for each motor speed) each of which accepts three (3) thermal units. While the starters listed are for use with consequent pole motors only, separate winding motor starters are also available upon request.

Class 8811 — Three Speed AC Magnetic Starters — Consequent Pole, 2 Winding 600 Volts Maximum — 50-60 Hertz

Type of Motor	NEMA Size	Maximum Horsepower			General Purpose Enclosure NEMA Type 1	Watertight and Dusttight Enclosure (Stainless Steel) NEMA Type 4	Dusttight and Driptight Industrial Use Enclosure NEMA Type 12 (Type 3 and 3R)†	Open Type
		200 V	230 V	460-575 V	Type	Type	Type	Type
Constant Horsepower	0	2	2	3	SBG-1	SBW-1	SBA-1	SBO-1
	1	5	5	7½	SCG-1	SCW-1	SCA-1	SCO-1
	2	7½	10	20	SDG-1	SDW-1	SDA-1	SDO-1
	3	20	25	40	SEG-1	SEW-1	SEA-1	SEO-1
	4	30	40	75	SFG-1	SFW-1	SFA-1	SFO-1
Constant Torque	0	3	3	5	SBG-2	SBW-2	SBA-2	SBO-2
	1	7½	7½	10	SCG-2	SCW-2	SCA-2	SCO-2
	2	10	15	25	SDG-2	SDW-2	SDA-2	SDO-2
	3	25	30	50	SEG-2	SEW-2	SEA-2	SEO-2
	4	40	50	100	SFG-2	SFW-2	SFA-2	SFO-2
Variable Torque	0	3	3	5	SBG-3	SBW-3	SBA-3	SBO-3
	1	7½	7½	10	SCG-3	SCW-3	SCA-3	SCO-3
	2	10	15	25	SDG-3	SDW-3	SDA-3	SDO-3
	3	25	30	50	SEG-3	SEW-3	SEA-3	SEO-3
	4	40	50	100	SFG-3	SFW-3	SFA-3	SFO-3

Class 8812 — Four Speed AC Magnetic Starters — Consequent Pole, 2 Winding 600 Volts Maximum — 50-60 Hertz

Type of Motor	NEMA Size	Maximum Horsepower			General Purpose Enclosure NEMA Type 1	Watertight and Dusttight Enclosure (Stainless Steel) NEMA Type 4	Dusttight and Driptight Industrial Use Enclosure NEMA Type 12 (Type 3 and 3R)†	Open Type
		200 V	230 V	460-575 V	Type	Type	Type	Type
Constant Horsepower	0	2	2	3	SBG-1	SBW-1	SBA-1	SBO-1
	1	5	5	7½	SCG-1	SCW-1	SCA-1	SCO-1
	2	7½	10	20	SDG-1	SDW-1	SDA-1	SDO-1
	3	20	25	40	SEG-1	SEW-1	SEA-1	SEO-1
	4	30	40	75	SFG-1	SFW-1	SFA-1	SFO-1
Constant Torque	0	3	3	5	SBG-2	SBW-2	SBA-2	SBO-2
	1	7½	7½	10	SCG-2	SCW-2	SCA-2	SCO-2
	2	10	15	25	SDG-2	SDW-2	SDA-2	SDO-2
	3	25	30	50	SEG-2	SEW-2	SEA-2	SEO-2
	4	40	50	100	SFG-2	SFW-2	SFA-2	SFO-2
Variable Torque	0	3	3	5	SBG-3	SBW-3	SBA-3	SBO-3
	1	7½	7½	10	SCG-3	SCW-3	SCA-3	SCO-3
	2	10	15	25	SDG-3	SDW-3	SDA-3	SDO-3
	3	25	30	50	SEG-3	SEW-3	SEA-3	SEO-3
	4	40	50	100	SFG-3	SFW-3	SFA-3	SFO-3

† NEMA Type 12 enclosures may be field modified for outdoor applications.

Thermal Units

Thermal units should be ordered separately. For selection of thermal units, refer to the Catalog Thermal Unit Selection Index R Digest. All starters require the use of three (3) thermal units for each speed of the motor. Do not use the horsepower rating(s) for selection. Use nameplate FLC's (Full Load Currents) from motor nameplate.

How to Order:

To Order Specify:	*Catalog Number*			
• Class Number • Type Number • Coil Voltage Code • Form(s)	Class	Type	Coil Voltage Code	Form(s)
	8810	SCO8	VO6	P1S

File E78351
CCN NLDX

File LR60905
Class 3211-04

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Application Data for Types SB-SH

Form Designations for Factory Installation of Electrical Interlocks

	Additional Electrical Interlocks on High Starter							
		Standard (No Additional Interlocks)	Change N.O. Holding Circuit Interlock to N.C.	1 N.O.	1 N.C.	2 N.O.	1 N.O.-1 N.C.	2 N.C.
Additional Electrical Interlocks on Low Starter	Standard (No Additional Interlocks)		X01	X02	X03	X05	X06	X07
	Change N.O. Holding Circuit Interlock to N.C.	X10	X11	X12	X13	X15	X16	X17
	1 N.O.	X20	X21	X22	X23	X25	X26	X27
	1 N.C.	X30	X31	X32	X33	X35	X36	X37
	2 N.O.	X50	X51	X52	X53	X55	X56	X57
	1 N.O.-1 N.C.	X60	X61	X62	X63	X65	X66	X67
	2 N.C.	X70	X71	X72	X73	X75	X76	X77

Control Transformer Selection

The following table gives the proper size control transformer to be used with a given reversing device, with or without additional electrical interlocks or timer.

NEMA Size	Type	No. of Poles	Transformer* Class 9070 Type
0, 1 & 2	SB, SC & SD	Any	EO-2 or GO-2
3	SE	3	EO-3 or GO-3
		4 & 5	EO-4
4	SF	Any	EO-4
5	SG	Any	▲
6	SH	Any	‡
7	SJ	Any	†

* If a different manufacturer's transformer is to be used, check its suitability for use with coil loads. See inrush and sealed VA ratings of the contactor coil.

▲ Standard engineering practice for Size 5 contactors is to use a Class 9070 Type EO-1 transformer and Class 8501 Type DO-20 control relay.

‡ A Class 9070 Type EO-3S2 transformer is an integral part of the Size 6 control circuit providing 120 volt control circuit voltage as standard on devices wired for common control.

† A Class 9070 Type EO-19-S2 transformer is an integral part of the size 7 control circuit providing 120 volt control circuit voltage as standard on devices wired for common control.

Maximum Number of Auxiliary Units

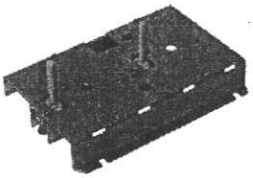
NEMA Size (Type)	No. of Poles of Basic Contactor	Maximum number of auxiliary units on each contactor, forward or reverse, (in addition to internal holding circuit and electrical interlocks).
00, 0, 1 and 2 (SA, SB, SC and SD)	2 or 3	4 single circuit external interlocks (N.O. or N.C.)
		1 single circuit external interlock (N.O. or N.C.) plus 1 attached timer (ON or OFF delay).
	4	2 single circuit external interlocks (N.O. or N.C.)
3, 4, 5 and 6 (SE, SF, SG and SH)	Any	2 single circuit external interlocks (N.O. or N.C.)
		1 single circuit external interlock plus 1 attached timer (ON or OFF delay).
7 (SJ)	Any	Consult local Square D field office

AC Magnet Coils for AC Contactors and Starters

Devices Using Coil			Coil Specification Number	Suffix Numbers (Complete coil part number consists of specification number followed by suffix number as 31041-400-51.)							
NEMA Size	Type	Poles		24 V/60 Hz	120 V/60 Hz 110 V/50 Hz	208 V/60 Hz	220 V/60 Hz	240 V/60 Hz 220 V/50 Hz	277 V/60 Hz	480 V/60 Hz 440 V/50 Hz	600 V/60 Hz 550 V/50 Hz
00	SA	All	31041-400-	20	42	48	‡	51	52	60	62
0	SB	All	31041-400-	20	42	48	‡	51	52	60	62
1	SC	All	31041-400-	20	42	48	‡	51	52	60	62
2	SD	3	31063-409-	16	38	44	‡	47	49	57	60
		4-5	31063-400-	16	38	44	‡	47	49	57	60
3	SE	3	31074-400-	16	38	44	‡	47	49	57	60
		4-5	31091-400-	16	38	44	‡	47	49	57	60
4	SF	All	31091-400-	16	38	44	‡	47	49	57	60
5	SG	3	31096-400-	...	09	15	‡	18	19	24	29
6	SH	3	31104-400-50 (all voltages)								
7	SJ	3	31104-400-50 (all voltages)								

‡ For 220 volt and 230 volt, 60 hertz applications, use 240 volt coil.

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Class 9999 Type SM-1 Mechanical Interlock For Two Contactors Horizontally Mounted



Class 9999 Type SM-12 For Sizes 3 and 4 Horizontally Mounted

MECHANICAL INTERLOCK

General

Type S contactors or starters can be mechanically interlocked so that only one device will be energized at a time. The mechanical interlock is an interference (non-jamming) type, locking at the beginning of the stroke of any starter or contactor.

Overload Relay Mounting Bracket

Mechanical interlock Types SM-1 through SM-10 for Sizes 00-2 devices use overload relay mounting brackets to support the overload relay portion of the starter.

Type S Sizes 00, 0, 1 and 2

The mechanical interlock is mounted on the underside of the reversing baseplate. Two pins extend from the mechanical interlock through openings in the baseplate and engage the contact carrier of each contactor. Two styles of mechanical interlocks are used: one version for three pole contactors, a different version for four or five pole contactors. **When adding a power pole to an existing three pole reversing contactor, a new mechanical interlock must also be installed.**

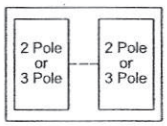
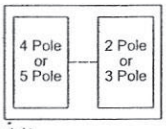
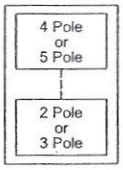
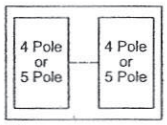
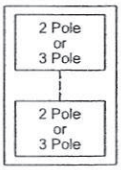
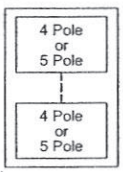
Three unit mechanically interlocked contactors and/or starters are also available for various combinations of Sizes 0, 1 and 2.

Type S Sizes 3, 4, 5 and 6

The mechanical interlock is separate from the mounting pan on Sizes 3-6. Cams on the mechanical interlocks are operated by the contact carrier of each contactor. The mechanical interlock is attached to the underside of the two contactors on Sizes 3 and 4; directly to the mounting pan on sizes 5 and 6. Size 5 and 6 mechanical interlocks are sold only as a factory assembly with the 8810 starter.

The mechanical interlock utilizes a special baseplate and bracket that connects between the armatures. This is sold only as a factory assembly with the 8810 starter.

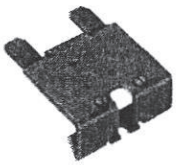
Mechanical Interlock for Two Contactors

Kit Description – The following kits consist of the mechanical interlock and base assembly for interlocking 2-5 pole contactors. Mechanical interlocks for horizontal and vertical mounting are listed for various pole arrangements.			Contactor NEMA Size	Class 9999 Type
 Horizontal Type SM-1 for Size 00†, 0, or 1 Type SM-6 for Size 2 Type SM-12 for Sizes 3 & 4	 Horizontal* Type SM-2 for Size 0 or 1 Type SM-7 for Size 2 Type SM-12 for Sizes 3 & 4	 Vertical* Type SM-2 for Size 0 or 1 Type SM-10 for Size 2 Type SM-11 for Size 3 Type SM-13 for Size 4	00†, 0, 1 0, 1 0, 1 0, 1 0, 1	SM-1 SM-2* SM-3 SM-4 SM-5
 Horizontal Type SM-3 for Size 0 or 1 Type SM-8 for Size 2 Type SM-12 for Sizes 3 & 4	 Vertical Type SM-4 for Size 0 or 1 Type SM-9 for Size 2 Type SM-11 for Size 3 Type SM-13 for Size 4	 Horizontal Type SM-5 for Size 0 or 1 Type SM-11 for Size 3 Type SM-13 for Size 4	2 2 2 2 2 3 3, 4 4	SM-6 SM-7 SM-8 SM-9 SM-10 SM-11▲ SM-12▲ SM-13▲

* The type SM-2 interlock is factory assembled for horizontal mounting but can easily be converted to vertical mounting. Conversion instructions are included.

† For replacement only on the NEMA Size 00, reversing starters and contactors.

▲ Interlocks do not include mounting pan.



Type SO-11 Overload Relay Mounting Bracket

Overload Relay Mounting Bracket

Kit Description	Class 9999 Type
Bracket for one overload relay used with horizontal mechanical interlocks, Types SM-1, SM-2, SM-3, SM-6, SM-7 and SM-8	SO-11
Bracket for two overload relays used with vertical mechanical interlocks, Types SM-2, SM-4, SM-5, SM-9 and SM-10	SO-12

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Non-Reversing — Open Type

Approximate Dimensions

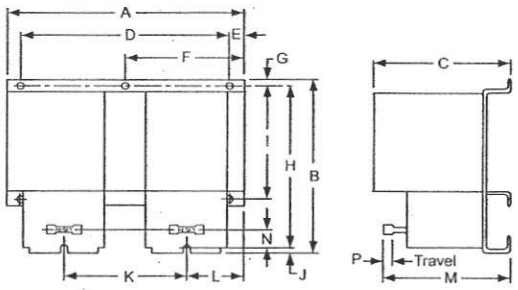


Figure 1
Class 8810, Sizes 0, 1 & 2 Types SBO, SCO & SDO

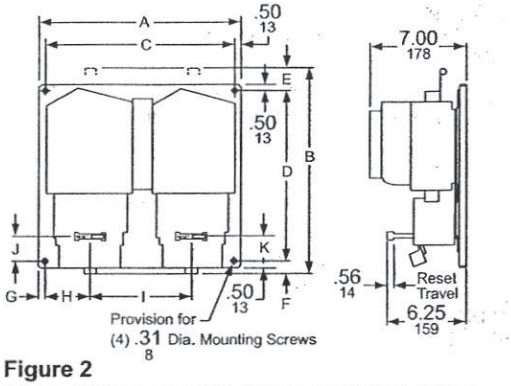


Figure 2
Class 8810, Sizes 3 & 4 Types SEO and SFO

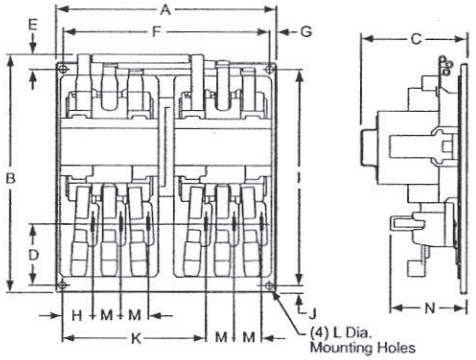


Figure 3
Class 8810, Size 5 Type SGO

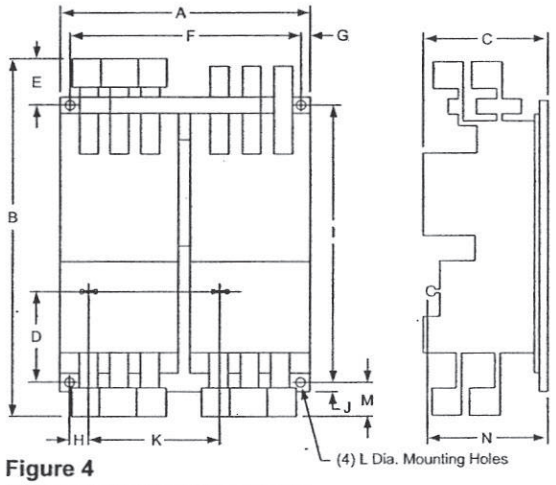


Figure 4
Class 8810, Size 6 Type SHO

Fig. No.	NEMA Size	Type	Mtg. Holes	A		B		C		D		E		F		G		H		I		J		K		L		M		N	
				IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
1	0 and 1	SBO-1, 2 SCO-1, 2	4	9.63	245	7.34	186	5.31	135	8.00	203	.63	16	...	...	.22	6	6.91	176	...	...	.22	6	4.75	121	2.25	57	5.06	129	.59	15
		SBO-3, 4 SCO-3, 4	3	7.13	181	6.91	176	5.31	135	...	...	...	...	3.41	87	.47	12	6.22	158	...	...	.22	6	3.56	90	1.63	41	5.06	129	.59	15
	2	SDO-1, 2	6	12.03	306	8.53	217	6.03	153	10.38	264	.50	13	...	...	.25	6	8.13	207	6.25	159	.16	4	5.75	146	2.81	71	5.16	131	.78	20
		SDO-3, 4	3	9.00	229	8.06	205	6.03	153	...	...	...	...	4.50	114	.38	10	7.50	191	...	...	.19	5	4.34	110	2.16	55	5.16	131	.78	20
2	3	SEO-1, 2	4	18.00	457	14.44	367	17.00	432	12.25	311	1.50	38	.69	18	.50	13	6.44	164	7.38	187	1.66	42	2.16	55	...	...	...	...	...	...
		SEO-3, 4	4	12.75	324	12.28	312	11.75	298	10.75	273	1.03	26	.50	13	.50	13	2.50	64	6.75	171	1.16	29	1.16	29	...	...	...	...	...	...
	4	SFO-1, 2	4	18.63	473	15.59	396	17.00	432	12.25	311	1.84	47	1.50	38	1.13	29	6.44	164	7.66	195	1.66	42	1.66	42	...	...	...	...	...	...
		SFO-3, 4	4	14.25	362	14.59	371	13.25	337	12.25	311	1.84	47	.50	13	.50	13	2.94	75	7.38	187	1.66	42	1.66	42	...	...	...	...	...	...
3	5	SGO-1, 2*	4	29.28	744	20.28	515	9.38	238	5.41	137	1.28	33	28.00	711	.63	16	12.56	319	19.00	483	.63	15	22.53	572	.50	13	2.41	61	6.63	168
		SGO-3, 4	4	19.28	490	20.28	515	9.38	238	5.14	137	1.28	33	18.00	457	.63	16	2.63	67	19.00	483	.63	15	12.53	318	.50	13	2.41	61	6.63	168
4	6▲	SHO-1, 2*	4	29.53	750	22.44	570	9.53	242	6.97	177	3.81	97	28.00	711	.75	19	11.63	295	21.19	538	.63	15	9.88	251	.56	14	3.03	77	9.31	236
		SHO-3, 4	4	19.53	496	22.44	570	9.53	242	6.97	177	3.81	97	18.00	457	.75	19	1.69	43	21.19	538	.63	15	9.88	251	.56	14	3.03	77	9.31	236
—	7♦	SJO-3, 4	Consult Square D																												

* Consequent pole, type starters consist of two 3-pole starters as pictured in Figure 3 and an additional 2-pole shorting contactor (not shown), all on a common base-plate, horizontally mounted.

▲ Current transformers used with Size 1 overload relay blocks.

♦ Solid state overloads and special current transformers.

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Non-Reversing — Non-Combination — Enclosed

Approximate Dimensions

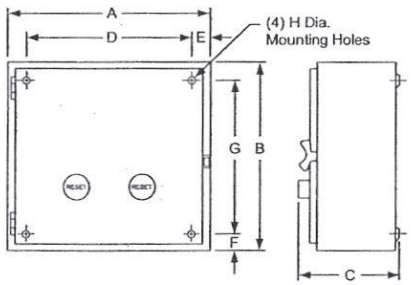


Figure 1

NEMA Type 1 Enclosure – Figure 1

Type	A		B		C		D		E		F		G		H	
	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
SBG and SCG	11.88	302	11.88	302	7.53	191	9.75	248	1.06	27	1.06	27	9.75	248	.31	8
SDG	14.88	378	14.13	359	7.66	195	12.75	324	1.06	27	1.06	27	12.00	305	.31	8
SEG-3 & -4 and SFG-3 & -4	18.16	461	29.16	741	9.23	234	15.50	394	1.34	34	1.34	34	26.50	673	.44	11
SEG-1 & -2 and SFG-1 & -2	22.16	563	39.16	995	10.23	260	19.50	495	1.34	34	1.34	34	36.50	927	.44	11
SGG-1, 2, 3, 4	20.22	514	65.75	1670	6.45	164	31.00	787	2.13	54	2.13	54	42.00	1067	.56	14
SHG-1, 2, 3, 4	36.22	920	62.22	1580	19.47	495	Floor Mount									
SJG-3 & 4	Consult Square D															

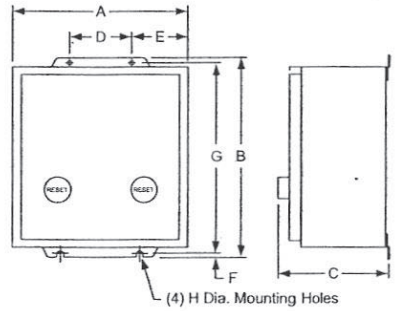


Figure 2

NEMA Type 1 Enclosure – Figure 2

Type	A		B		C		D		E		F		G		H	
	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
SBA and SCA	11.88	302	13.50	343	7.75	197	4.25	108	3.81	97	.38	10	12.75	324	.31	8
SDA	14.88	378	15.75	400	7.88	200	4.25	108	5.31	135	.38	10	15.00	381	.31	8
SEA-3 & -4 and SFA-3 & -4	18.16	461	31.50	800	9.59	244	16.00	406	3.09	78	.50	13	30.50	775	.44	11
SEA-1 & -2 and SFA-1 & -2	22.16	563	41.50	1054	10.59	269	16.00	406	3.09	78	.50	13	40.50	1029	.44	11
SGA-1, 2, 3, 4	35.22	895	49.00	1245	13.11	333	27.00	686	4.11	104	.50	13	48.00	1219	.56	14
SHA-1, 2, 3, 4	36.22	920	62.22	1580	19.47	495	Floor Mount									
SJA-3 & 4	Consult Square D															

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Non-Reversing — Non-Combination — Enclosed

Approximate Dimensions

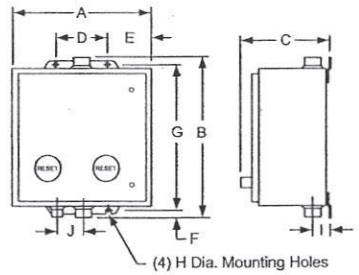


Figure 3

NEMA Type 4 Enclosure – Figure 3

Type	A		B		C		D		E		F		G		H		I		J	
	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
SBW and SCW	12.63	321	14.69	373	7.81	198	4.25	108	4.19	106	.59	15	13.50	343	.31	8	1.66	42	2.31	59
SDW	14.88	378	15.75	400	8.25	210	4.25	108	5.31	135	.38	10	15.00	381	.31	8	2.03	52	2.63	67
SEW-3 & -4 and SFW-3 & -4	18.16	461	32.22	818	8.77	223	12.00	305	3.08	78	.86	22	30.50	775	.44	11	2.58	66	3.19	81
SEW-1 & -2 and SFW-1 & -2	22.16	563	42.22	1072	9.77	248	16.00	406	3.08	78	.86	22	40.50	1029	.44	11	2.33	59	2.89	73
SGW-1, 2, 3, 4	35.22	895	49.22	1250	12.13	308	27.00	686	4.09	104	.61	15	48.00	1219	.56	14	2.98	76	3.50	89

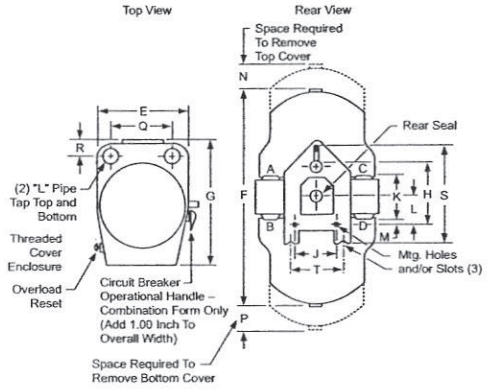


Figure 4

NEMA Type 7 & 9 Enclosure – Figure 4

Type	A		B		C		D		E		F		G		H		J		K		L		M		N		P		R	
	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
SCR-1, 2, 3 & 4 Std. & Form Y79-1	12.00	305	41.06	1043	68.06	1729	16.75	425	7.25	184	7.69	195	26.13	664	3.00	76	24.00	610	8.50	216	2.06	52	9.38	238	5.25	133	1.50	38	.38	10
SCR-1, 2, 3 & 4 Forms T & TY79-1	12.00	305	46.13	1172	79.13	2010	16.75	425	12.25	311	7.69	195	26.13	664	9.00	229	24.00	610	8.50	216	2.06	52	9.38	238	5.25	133	1.50	38	.38	10
SDR-1, 2, 3 & 4 Std. & Form Y79-1	16.13	410	48.50	1232	81.50	2070	20.25	514	12.50	318	8.63	219	27.75	705	8.00	203	25.00	635	12.00	305	2.63	67	11.00	279	5.50	140	2.50	64	.38	10
SCR-1, 2, 3 & 4 Forms T & Y79-1	16.13	410	50.50	1283	85.00	2159	20.25	514	9.13	232	8.63	219	32.75	832	4.50	114	30.00	762	12.00	305	2.63	67	11.00	279	5.50	140	2.50	64	.38	10

For Sizes 3, 4 and 5 consult Square D field office.

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AC Two Speed Combination Starters
Disconnect Switch or Circuit Breaker Type – Class 8810, 8811, 8812

"Quick Ship Only"

Approximate Dimensions

NEMA Type 1 Enclosure – Figure 1

NEMA Size	Class	Type	Dimensions — Inches/mm															Top & Bottom		Sides
			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	W	X	Y
0-1	8810	SBG SCG	13.88 353	23.13 588	8.25 210	10.63 270	21.00 533	19.28 490	1.88 48	1.88 48	3.75 95	2.31 59	1.06 27	3.30 84	2.19 56	1.25 32	.88 22	...	½-¾-1	½-¾-1	½
2	8810	SDG	15.16 385	28.91 734	9.56 243	11.63 295	26.25 667	21.81 554	2.19 56	2.00 51	4.00 102	2.63 67	1.33 34	3.30 84	2.22 56	1.27 32	.91 23	...	1-1¼	½-¾	½

NEMA Type 4 Enclosure – Figure 2

NEMA Size	Class	Type	Dimensions — Inches/mm												Bottom	Top & Bottom
			A	B	C	D	E	F	G	H	I	J	K	L	W	X
0-1	8810	SBW SCW	13.88 353	8.33 212	25.19 640	3.30 84	2.56 65	8.75 222	24.00 610	.59 15	3.95 100	1.63 41	2.31 59	18.53 471	¾ Hub	1 Hub
2	8810	SDW	15.13 389	9.58 243	30.94 786	3.30 84	2.56 65	10.00 254	29.75 756	.59 15	3.95 100	2.00 51	2.63 67	21.03 534	¾ Hub	1½ Hub

NEMA Type 12 Enclosure – Figure 3

NEMA Size	Class	Type	Dimensions — Inches/mm																	
			A		B		C		D		E		F		G		H		I		J	
			IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
0-1	8810	SBA SCA	13.88	353	10.09	256	24.75	629	3.30	84	2.56	65	8.75	222	24.00	610	.38	10	3.95	100	20.28	515
2	8810	SDA	15.16	385	10.97	279	31.25	794	3.30	84	3.08	78	9.00	229	30.25	768	.50	13	4.83	123	23.44	595

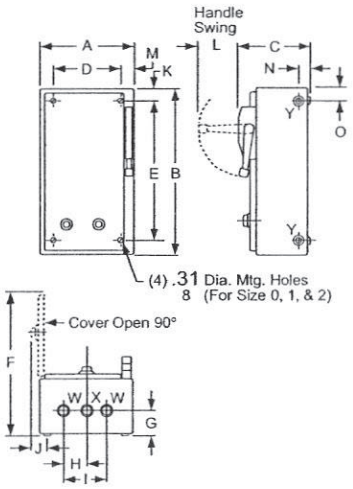


Figure 1
NEMA Type 1 Enclosure

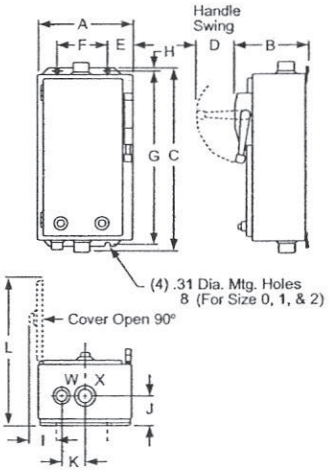


Figure 2
NEMA Type 4 Enclosure

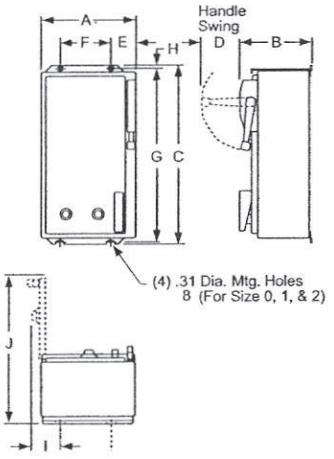


Figure 3
NEMA Type 12 Enclosure

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Square D Company
8001 Highway 64 East
Knightdale, NC 27545-9023
(919) 266-3671

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PUBLICATION DIVIDER

Instruction Bulletin

48049-031-03
Cedar Rapids IA, USA 05/01
ECN K447

English

KA, KC, KH, KI, SKC and SKH Circuit Breakers

Retain for future use.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

NOTE: The following symbols may be used on the circuit breaker faceplate.

V~	Volts ac		Lug/wiring Information
V⎓	Volts dc		Solid Wire
10 - 30	Grounded B Phase		Stranded Wire
	Isolator per IEC947-2		Wire Strip Length
250 V⎓	For 250 V⎓ service use outside poles only	Ii	Magnetic Trip Current

FACTORY-INSTALLED ACCESSORIES

If circuit breaker has factory-installed accessories, refer to label on circuit breaker for electrical specifications and lead colors.

CIRCUIT BREAKER WITH BOLTED CONNECTIONS ONLY

If standard lug is removed and a bolted connection to terminal pad is needed, insert kit AL250KAIN is required. Install inserts according to directions shipped with insert kit.

INDIVIDUALLY-MOUNTED CIRCUIT BREAKER INSTALLATION

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE

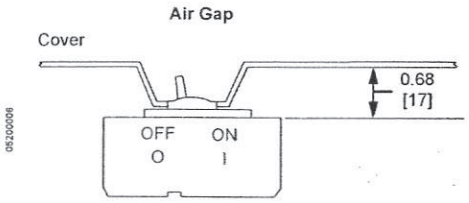
When mounted in a metal box, cover must be insulated as shown.

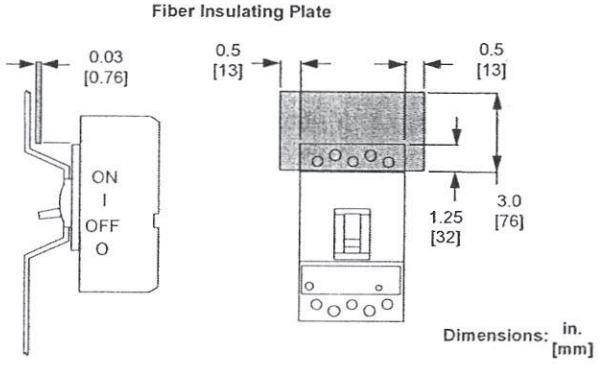
Failure to follow this instruction can result in injury or equipment damage.

1. Turn off all power supplying this equipment before working on or inside equipment.
2. Turn off circuit breaker or trip circuit breaker before installation.
3. See Page 5 for mounting dimensions.

NOTE: For air gap between cover and face of circuit breaker equal to or greater than 0.68 in (17 mm) no additional installation fiber required.

For air gap less than 0.68 (17 mm) attach fiber insulating plate (customer supplied) to enclosure cover.





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SQUARE D
Schneider Electric

English

CLEARANCES FOR KC, KI AND SKC CIRCUIT BREAKERS

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

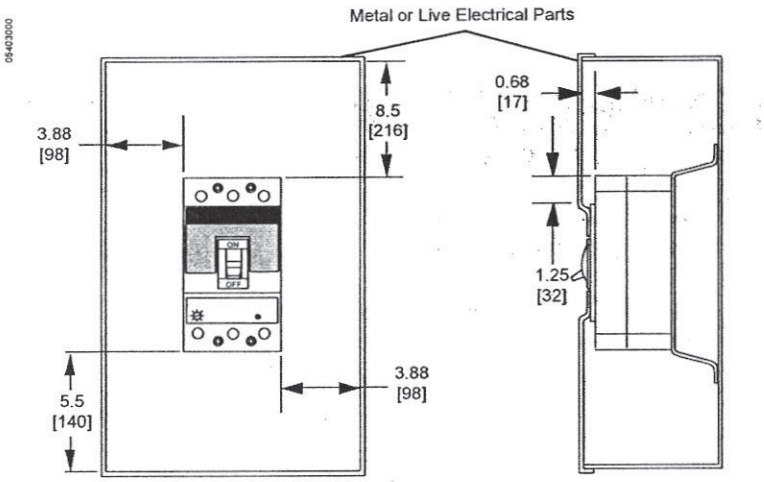
- Mount circuit breaker only in equipment marked to accept it.
- Mount no closer to enclosure metal or live parts than is indicated in drawing.
- All enclosure closing hardware must be installed.

Failure to follow these instructions will result in death or serious injury.

Dimensions for electrical and mechanical clearances to metal or live electrical parts.

Refer to NEC table 373-6(b) for wire bending space requirements.

Dimensions not valid for enclosure volumes less than 4,400 in^3 (72,103 cm^3).



Dimensions: in. [mm]

I-LINE® CIRCUIT BREAKER INSTALLATION

⚠ CAUTION

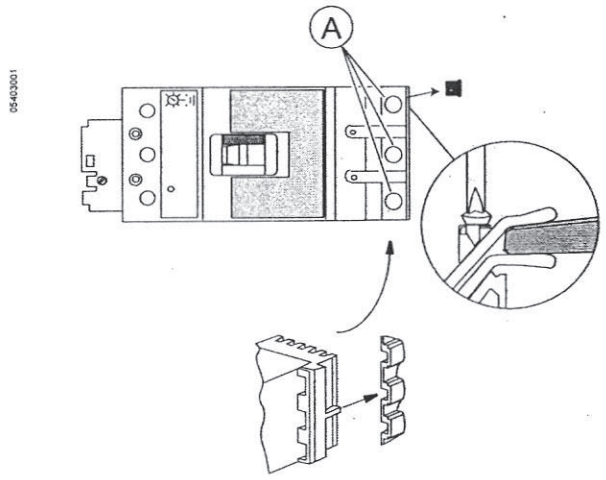
HAZARD OF EQUIPMENT DAMAGE

- Do not adjust jaws.
- Do not remove joint compound.
- If necessary, use Square D joint compound PJC7201.

Failure to follow these instructions can result in injury or equipment damage.

1. Turn off all power supplying this equipment before working on or inside equipment.
2. Turn off circuit breaker or trip circuit breaker before installation.
3. If equipped with bus screws (A), remove plug and loosen screws.
4. Place circuit breaker on I-LINE pan with jaws pushed against bus.

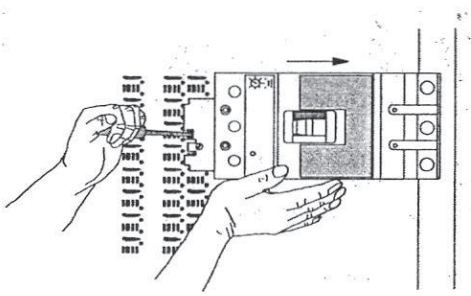
NOTE: Install main circuit breaker adjacent to main lugs.



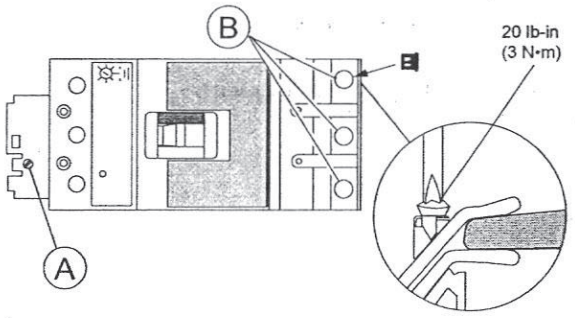
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English

5. Insert long-shanked screwdriver into slot. Rack circuit breaker onto bus.



6. Tighten screw (A) firmly without bending mounting bracket.
7. If equipped with bus screws (B), tighten screws and replace caps.



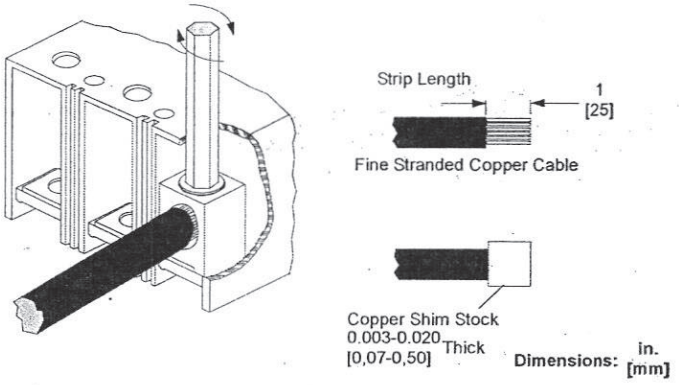
WIRE INSTALLATION—ALL CIRCUIT BREAKERS

CAUTION

HAZARD OF EQUIPMENT DAMAGE

- Do not allow conductor strands to interfere with threads of wire binding screw.
- Wrap stripped portion of fine stranded wire with a sleeve made from copper shim stock.

Failure to follow these instructions can result in equipment damage.



See circuit breaker faceplate label or optional lug instructions for wire size and torque.

CIRCUIT BREAKER REMOVAL

1. Turn off all power supplying this equipment before working on or inside equipment.
2. Turn off circuit breaker or trip circuit breaker before removal.
3. Remove circuit breaker in reverse order of installation.

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English

PADLOCK ACCESSORY

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

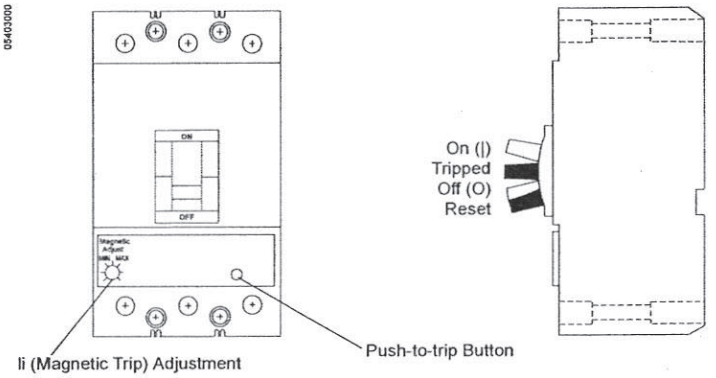
When circuit breaker handle is padlocked off, always use a properly rated voltage sensing device to confirm power is off before working on equipment.

Failure to follow this instruction will result in death or serious injury.

NOTE: With padlock accessory installed, circuit breaker does not comply with IEC 947 positive contact indication requirement for isolation.

CIRCUIT BREAKER OPERATION

Press push-to-trip button once a year to excercise circuit breaker.



TROUBLESHOOTING

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- This equipment must be installed and serviced only by qualified electrical personel.
- Troubleshooting may require energizing auxiliary devices with a test power supply. Make sure that the power supply is off before connecting or disconnecting it to the auxiliary device.
- Do not touch the terminals of the device during the test.

Failure to follow this instruction will result in death or serious injury.

Turn off all power supplying this equipment before working on or inside equipment.

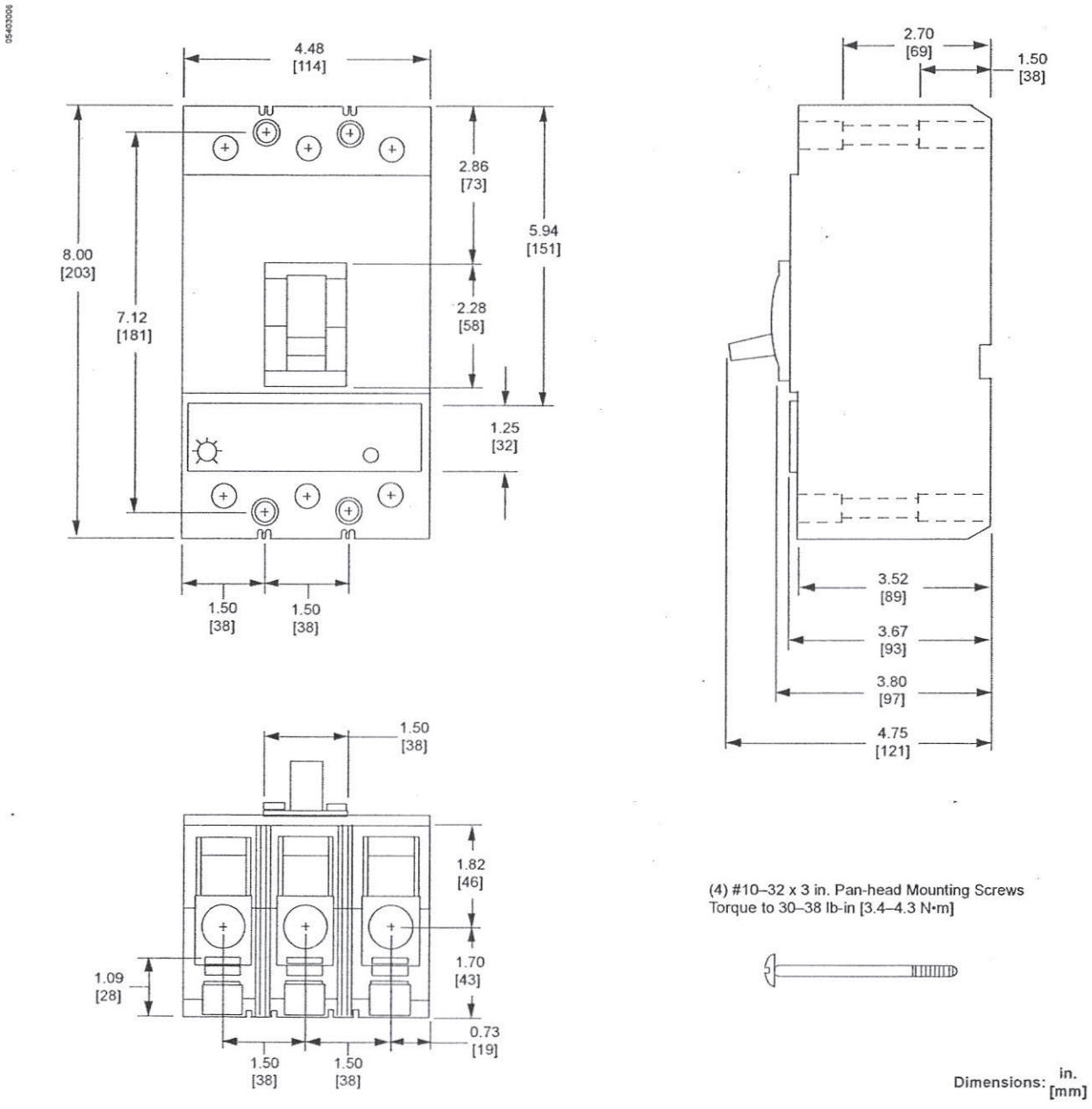
If problems occur during installation, refer to the following guide. If trouble persists, contact the local Square D Field Office.

CONDITION	POSSIBLE CAUSES	SOLUTION
Circuit breaker fails to stay closed.	1. Magnetic trip adjustment too low. 2. Undervoltage trip not energized. 3. Shunt trip energized. 4. Short circuit or overload on system.	1. Adjust magnetic trip adjustment. 2. Energize undervoltage trip. 3. De-energize shunt trip. 4. Check system for short circuit or overload.
Circuit breaker trips, but no short circuit or overload is evident.	1. Magnetic trip adjustment too low. 2. Voltage below undervoltage trip setting.	1. Adjust magnetic trip adjustment. 2. Check system for low voltage.
Push-to-trip button will not trip circuit breaker.	Circuit breaker already tripped or off (O).	Move circuit breaker handle to reset then to on (|).

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English

DIMENSIONS

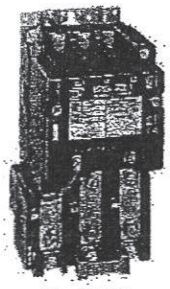


(4) #10–32 x 3 in. Pan-head Mounting Screws
Torque to 30–38 lb-in [3.4–4.3 N•m]

Dimensions: in. [mm]

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PUBLICATION DIVIDER



Type SCO3
Size 1, 3-Pole Starter

General Information

Type S magnetic starters are used for full-voltage starting and stopping of AC squirrel cage motors. Motor overload protection is provided via melting alloy type thermal overload relays. Type S starters are available in NEMA Sizes 00 through 7, and are designed for operation at 600 Vac, 50 to 60 Hz.

Solid State Overload Relay Protection (MOTOR LOGIC®)

These ambient insensitive overload relays are available on Sizes 00 through 6 and standard on size 7. They provide phase loss, phase unbalance protection and a power LED indication.

3-Pole Polyphase—600 Vac Maximum—50–60 Hz

NEMA Size	Continuous Current Ratings	Motor Voltage	Max. Hp	Open Type	NEMA 1 General Purpose Enclosure	NEMA 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure (Size 0-5)▲	NEMA 4X Watertight, Dusttight, Corrosion-Resistant Glass-Polyester Enclosure	
				Type	Type	Type	Type	
00	9	Separate Control■ 200 230 460 575	 1½ 1½ 2 2	SAO12♦	SAG12♦	Use Size 0	Use Size 0	
0	18	Separate Control■ 200 230 460 575	 3 3 5 5	SBO2♦	SBG2♦	SBW12♦	SBW22♦	
1	27	Separate Control■ 200 230 460 575	 7½ 7½ 10 10	SCO3♦	SCG3♦	SCW13♦	SCW23♦	
2	45	Separate Control■ 200 230 460 575	 10 15 25 25	SDO1♦	SDG1♦	SDW11♦	SDW21♦	
3	90	Separate Control■ 200 230 460 575	 25 30 50 50	SEO1♦	SEG1♦	SEW11♦	SEW21♦	
4	135	Separate Control■ 200 230 460 575	 40 50 100 100	SFO1♦	SFG1♦	SFW11♦	SFW21♦	
5	270	Separate Control■ 200 230 460 575	 75 100 200 200	SGO1♦	SGG1♦	SGW11♦	...	...
6	540	Separate Control■ 200 230 460 575	 150 200 400 400	SHO2♦	SHG2♦	SHW2♦	...	...
7	810	Separate Control■ 200 230 460 575	 ... 300 600 600	SJO2♦	SJG2♦	SJW2♦	...	...

▲ Size 6 and 7 are rated NEMA 4 only.
■ 120 Volt Polyphase starters are wired for separate control and must be ordered with Form S (i.e., 8502SCO2V02S).
♦ Coil voltage code must be specified to order this product. Refer to standard coil voltage codes shown below.

Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24★	...	V01
120▼	110	V02
208	...	V08
240	220	V03
480	440	V06
600	550	V07
Specify	Specify	V99

★ 24 V coils are not available on Sizes 4–7. On Sizes 00-3, where 24 V coils are available, Form S (separate control) must be specified (i.e., order as 8502SBO2V01S).
▼ 120 Volt Polyphase contactors are wired for separate control (i.e., order as 8502SCO2V02S).

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MOTOR LOGIC—Class 9999

Isolated Auxiliary Contacts for MOTOR LOGIC Overload Relays

Overload relay auxiliary contacts are available factory installed or in kit form for field installation on MOTOR LOGIC overload relays. These contacts may be used for isolated alarm contact applications.

For Use With		Parts Kit Description	Class 9999 Type
Class & Type	NEMA Size		
8536 SA-SJ	00_B through 7	N.O. or N.C. Auxiliary Contact (Field Convertible)	AC04
9065 SS, SR, SF, ST	00_B through 7		

DIN Adapter

The DIN adapter provides a method to mount the MOTOR LOGIC overload relay to a 35 mm DIN rail.

For Use With		Parts Kit Description	Class 9999 Type
Class & Type	NEMA Size		
9065 SS or SF	00_B, 00_C, 0, and 1	DIN Adapter	DA01

Lug-Lug and Lug-Extender Kits

A Class 9999 LL0 Lug-Lug Kit can be field installed on separately mounted overload relays. The standard NEMA Size 00_B, 00_C, 0, and 1 Class 9065 Type SS and SF overload relays are supplied without lugs. A Class 9999 LB0 Lug-Extender Kit is designed for NEMA Size 00_B, 00_C, 0, and 1 Retrofit Starter Applications. This kit allows the lugs to be in the same location as the Class 9065 melting alloy overload relay, eliminating the need for additional wire length.

For Use With		Parts Kit Description	Class 9999 Type
Class & Type	NEMA Size		
9065 SS or SF	00_B, 00_C, 0, and 1	Lug-Lug Kit for separate mounting	LL0
9065 SS or SF	00_B, 00_C, 0, and 1	Lug-Extender Kit for retrofitting existing NEMA S starters	LB0

Remote Reset Module

The Remote Reset Module can be easily field installed on solid state overload relays. This module will allow the overload relay to be reset from a remote location.

For Use With		Parts Kit Description	Class 9999 Type
Class and Type	NEMA Size		
8536 SA-SJ	00_B through 7	Remote Reset Module	RR04■
9065 SS, SR, SF, ST	00_B through 7		
8536 SE-SF	3 and 4	Top Mounting Bracket	RB34▲■
9065 SS, SR, SF, ST	3 and 4		

▲ To be used to mount the remote reset module on the top of the overload relay.
■ 120 Vac power required.

MOTOR LOGIC Plus—Class 9065

Lug-Lug Kit

This kit can be field installed on separately mounted MOTOR LOGIC Plus overload relays.

For Use With		Parts Kit Description	Class 9999 Type
Class & Type	NEMA Size		
8536 SA-SH	1–6	Lug-Lug Kit	MLPL
9065 SP	1–6		

Software Kit

Solutions software program allows an IBM PC compatible computer (with Windows 95 or greater) to communicate with a MOTOR LOGIC Plus overload relay connected to an RS-485 network using MODBUS protocol.

For Use With		Parts Kit Description	Class 9999 Type
Class & Type	NEMA Size		
8536 SA-SH	1–6	Software Kit	MLPS
9065 SP	1–6		

Communication Module

This module allows the MOTOR LOGIC Plus overload relay to support RS-485 electrical communications standards. Up to 99 MOTOR LOGIC Plus overload relays can be controlled and monitored from one remote personal computer.

For Use With		Parts Kit Description	Class 9999 Type
Class and Type	NEMA Size		
8536 SA-SH	1–6	Communication Module	MB22
9065 SP	1–6		

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Factory Modifications (Forms)
For Full Voltage Contactors & Starters and Solid State Overload Relays

Full Voltage Controllers Only

Classes 8502, 8536, 8538, 8539, 8702, 8736, 8738, 8739, 8810, 8811 and 8812

	Factory Modifications	Enclosure Type	Form	NEMA Size 00	0	1	2	3	4	5	6	7
Overload Relays	**Non-Compensated Bimetallic Overload Relays**											
	Single Phase:											
	Types SB–SD (Sizes 0–2)■	Any	B1	—	●	●	●	—	—	—	—	—
	Polyphase:											
	Two Element—For 2 Phase Only											
	Types SB–SD (Sizes 0–2)	Any	B1	—	●	●	●	—	—	—	—	—
	Three Element											
	Types SB–SD (Sizes 0–2)	Any	B2	—	●	●	●	—	—	—	—	—
	Type SG (Size 5)	Any	B2	—	—	—	—	—	—	●	—	—
	Type SH (Size 6)	Any	B2	—	—	—	—	—	—	—	●	▲
	Ambient Compensated Bimetallic Overload Relays											
	Three Element											
	Types SB–SD (Sizes 0–2)	1, 4, 7, 9, 12	B	—	●	●	●	—	—	—	—	—
	Types SE–SF (Sizes 3 & 4)	Any	Y59	—	—	—	—	●	●	—	—	—
	Type SG (Size 5)	Any	B	—	—	—	—	—	—	●	—	—
	Type SH (Size 6)	Any	B	—	—	—	—	—	—	—	●	▲
	Overload Relays—General											
	Omit overload protection from combination starters. (Classes 8538, 8539, 8738, 8739 only) Do not use with MAG-GARD® Circuit Breakers. Deduct per starter	Any	Y76	—	●	●	●	●	●	●	●	●
	Modify Size 3 Type SE starters with melting alloy overload relays to accept Type FB quick trip or SB slow trip thermal units and Size 4 Type SF starters to accept Type FB quick trip thermal units. (Rejects Type CC standard trip thermal units.)	Any	Y81	—	—	—	—	N/C	N/C	—	—	—
	Substitute 9999 SO4 isolated alarm contact (N.O.) on melting alloy overload relay	Any	Y342	●	●	●	●	●	●	●	●	▲
	Substitute 9999 SO5 isolated alarm contact (N.C.) on melting alloy overload relay	Any	Y344	●	●	●	●	●	●	●	●	▲

▲ Size 7 uses a solid state overload relay as standard. See Class 8536 for complete details.
■ Single phase bimetallic overload relays for Type S Sizes 0–2 require two (2) thermal units per starter.
♦ For Classes 8736, 8738 and 8739 Type SG, consult your nearest Square D/Schneider Electric sales office.

Solid State Overload Relay Factory Modfications (Forms)

The solid state overload relay is available on NEMA Size 00–7.
For Class 8536, 8538, 8539, 8736, 8738, 8739 and 8810 devices.

Form Description

H # # #

Type S Starter with MOTOR LOGIC®
Solid State Overload Relay
- 1—MOTOR LOGIC, Base Unit, Trip Class 10
- 2—MOTOR LOGIC, Base Unit, Trip Class 20
- 3—MOTOR LOGIC, Feature Unit
- 0—No additional modifications
- 1—N.O. Auxiliary Contact (Field Convertible to N.C.)

Special Overload/Contactor Size Combinations (Base Unit & Feature Units):
(Must Be Specified On Size 00 Starter Orders)
- Blank–Overload Matched to Starter Size (i.e., Size 1 contactor & 9-27 A overload)
- 0—A 6–18 A overload on a starter size as indicated by the Starter Catalog Number
- 1—A 9–27 A overload on a starter size as indicated by the Starter Catalog Number
- 2—A 15–45 A overload on a starter size as indicated by the Starter Catalog Number
- 3—A 30–90 A overload on a starter size as indicated by the Starter Catalog Number
- 4—A 45–135 A overload on a starter size as indicated by the Starter Catalog Number
- 8—A 1.5–4.5 A overload on a starter size as indicated by the Starter Catalog Number (only offered on Feature Units)
- 9—A 3–9 A overload on a starter size as indicated by the Starter Catalog Number

SPECIAL NOTE for Class 8810 devices:
You MUST SPECIFY TWO SEPARATE FORM NUMBERS TO GET MOTOR LOGIC OVERLOADS ON TWO SPEED STARTERS. The first form number is for the low speed winding and the second is for the high speed winding.
EXAMPLE: Open Style, Size 4 Two Speed Starter with MOTOR LOGIC Overload Relays Required.
Single Winding, 460 V, Constant Horsepower
High Speed FLA = 96 A
Low Speed FLA = 27 A (use Size 2 Overload)

Catalog Number to Order: 8810 SF01V02 form S H20 H202
Where: Form H20 is a Size 4 Contactor with a 45-135 A MOTOR LOGIC Overload Relay for the High Speed and form H202 is a 15–45 A MOTOR LOGIC Overload Relay on the low speed contactor.

Classes 8536, 8538, 8539, 8736, 8738, 8739 and 8810

	Factory Modifications	Form	NEMA Size (Overload Current Range) 00 3–9 A	0 6–18 A	1 9–27 A	2 15–45 A	3 30–90 A	4 45–135 A	5 90–270 A	6 180–540 A	7 270–810 A
MOTOR LOGIC Solid State Overload Relay	Base Unit, Trip Class 10	H10	●	●	●	●	●	●	●	—	—
	Base Unit, Trip Class 20	H20	●	●	●	●	●	●	●	—	—
	Feature Unit	H30	●	●	●	●	●	●	●	●	●
MOTOR LOGIC Solid State Overload Relay with Auxiliary Contact	Base Unit, Trip Class 10	H11	●	●	●	●	●	●	●	—	—
	Base Unit, Trip Class 20	H21	●	●	●	●	●	●	●	—	—
	Feature Unit	H31	●	●	●	●	●	●	●	●	●

Special Starter Combinations with MOTOR LOGIC Overload Relay Protection

NEMA Contactor Size	Solid State Overload Relay Size 00B	00C	0	1	2	3	4	NEMA Contactor Size	Solid State Overload Relay Size 00B	00C	0	1	2	3	4
00	★	Std						2	★	★	★	★	Std		
0	★	★	Std					3	n/a	n/a	n/a	n/a	n/a	Std	
1	★	★	★	Std				4	n/a	n/a	n/a	n/a	n/a	★	Std

★ Possible factory starter combinations available.

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PUBLICATION DIVIDER

Bulletin No. 30072-013-33A
August 1999
Raleigh, NC, USA

Replaces 30072-013-33 dated 10/94

Instruction Bulletin

Auxiliary Contact Kit
Class 9999 Type AC04

INTRODUCTION

The Class 9999 Type AC04 auxiliary contact kit is used with MOTOR LOGIC™ solid-state overload relays (Class 9065 Types SS, SF, SR, and ST). This auxiliary contact, which can be installed as normally-open (N.O.) or normally-closed (N.C.), is isolated from the solid-state overload relay trip contact.

INSTALLATION

⚠ DANGER

HAZARDOUS VOLTAGE

Disconnect all power before working on equipment.

Electric shock will result in death or serious injury.

To install the auxiliary contact on the solid-state overload relay:

1. Disconnect all power from the overload relay.
2. Remove the wires from terminals 95 and 96.
3. Remove the black label from the overload relay auxiliary contact socket.
4. To install the contact (see Figure 1):

   N.O. operation: Press the overload relay *reset* bar. Slide the contact block into the N.O. position of the overload relay (tabs on the front of the contact block align with the N.O. tab on the overload relay).

   N.C. operation: Trip the overload relay by sliding the white test switch on the bottom of the overload relay. Slide the contact block into the N.C. position of the overload relay (rotate the contact 180° from the N.O. position; tabs on the front of contact block align with the N.C. tab on the overload relay).
5. Tighten the screw in the center of the auxiliary contact block (see Figure 2).

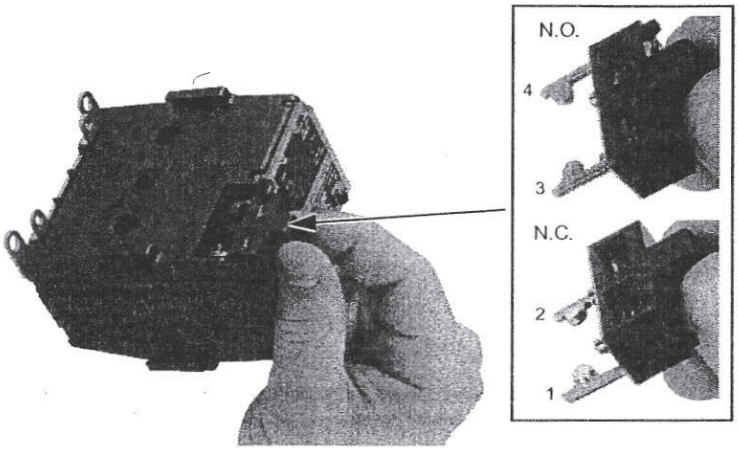


Figure 1: Installing the Auxiliary Contact

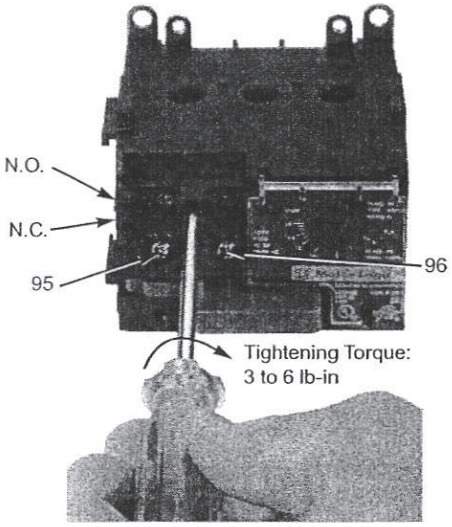


Figure 2: Tightening the Mounting Screw

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SQUARE D

TERMINALS

Use only **copper** wire on auxiliary contact terminals. These terminals are suitable for wire sizes 16 to 12 AWG, solid or stranded, and accept one or two conductors per terminal. Recommended tightening torque is 9 to 12 lb-in.

SPECIFICATIONS

The auxiliary contact is rated A600/P300. Refer to Table 1.

Table 1: Auxiliary Contact Ratings

NEMA Rating	Maximum Voltage	Thermal Continuous Current	Maximum Current		VA Rating	
			Make	Break	Make	Break
A600	600 Vac	10 A	[1, 3]	[1, 3]	7200 VA	720 VA
P300	300 Vdc	5 A	[2]	[2]	138 VA	138 VA

[1] For application voltages between 120 and 600 V: obtain the maximum make and break currents by dividing the VA rating by the application voltage. For application voltages below 120 V: the maximum make current is the same as for 120 V, and the maximum break current is obtained by dividing the break VA by the application voltage; however, the current values must not exceed the thermal unit continuous current.

[2] For application voltages of 300 V or less: obtain the maximum make and break currents by dividing the VA rating by the application voltage; however, the current values must not exceed the thermal unit continuous current.

[3] 35% power factor.

SHORT CIRCUIT PROTECTION

Provide overcurrent protection for control circuits in accordance with the National Electrical Code and/or other applicable electrical codes. For applications requiring compliance with I.E.C. 947-5-1, use only Class CC fuses or better, 30 A maximum.

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Auxiliary Contact Kit
Class 9999 Type AC04

INTRODUCTION

The Class 9999 Type AC04 auxiliary contact kit is used with MOTOR LOGIC™ solid-state overload relays (Class 9065 Types SS, SF, SR, and ST). This auxiliary contact, which can be installed as normally-open (N.O.) or normally-closed (N.C.), is isolated from the solid-state overload relay trip contact.

INSTALLATION

⚠ DANGER

HAZARDOUS VOLTAGE

Disconnect all power before working on equipment.

Electric shock will result in death or serious injury.

To install the auxiliary contact on the solid-state overload relay:

1. Disconnect all power from the overload relay.
2. Remove the wires from terminals 95 and 96.
3. Remove the black label from the overload relay auxiliary contact socket.
4. To install the contact (see Figure 1):

   N.O. operation: Press the overload relay *reset* bar. Slide the contact block into the N.O. position of the overload relay (tabs on the front of the contact block align with the N.O. tab on the overload relay).

   N.C. operation: Trip the overload relay by sliding the white test switch on the bottom of the overload relay. Slide the contact block into the N.C. position of the overload relay (rotate the contact 180° from the N.O. position; tabs on the front of contact block align with the N.C. tab on the overload relay).
5. Tighten the screw in the center of the auxiliary contact block (see Figure 2).

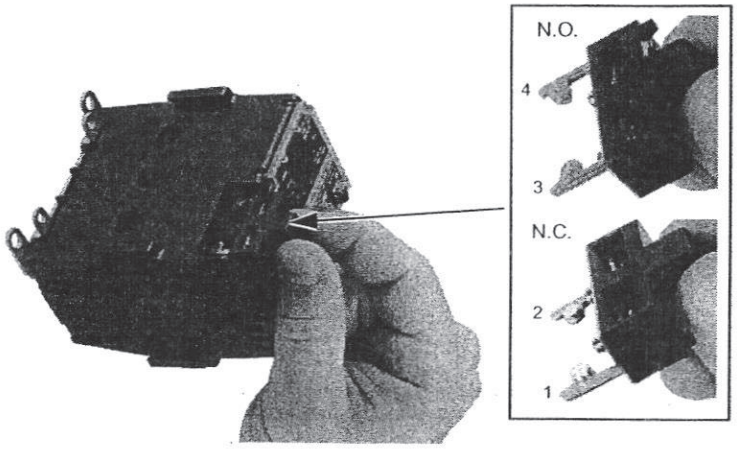


Figure 1: Installing the Auxiliary Contact

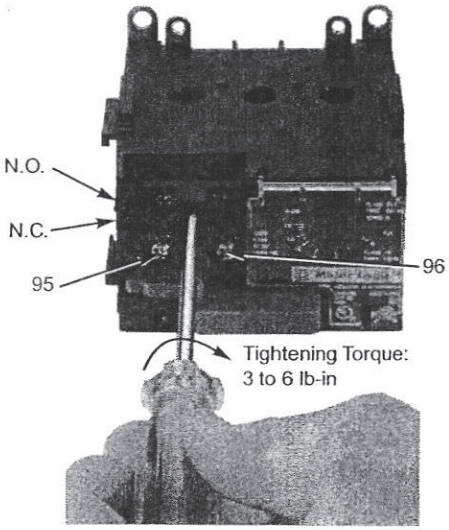


Figure 2: Tightening the Mounting Screw

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TERMINALS

Use only **copper** wire on auxiliary contact terminals. These terminals are suitable for wire sizes 16 to 12 AWG, solid or stranded, and accept one or two conductors per terminal. Recommended tightening torque is 9 to 12 lb-in.

SPECIFICATIONS

The auxiliary contact is rated A600/P300. Refer to Table 1.

Table 1: Auxiliary Contact Ratings

NEMA Rating	Maximum Voltage	Thermal Continuous Current	Maximum Current		VA Rating	
			Make	Break	Make	Break
A600	600 Vac	10 A	[1, 3]	[1, 3]	7200 VA	720 VA
P300	300 Vdc	5 A	[2]	[2]	138 VA	138 VA

[1] For application voltages between 120 and 600 V: obtain the maximum make and break currents by dividing the VA rating by the application voltage. For application voltages below 120 V: the maximum make current is the same as for 120 V, and the maximum break current is obtained by dividing the break VA by the application voltage; however, the current values must not exceed the thermal unit continuous current.

[2] For application voltages of 300 V or less: obtain the maximum make and break currents by dividing the VA rating by the application voltage; however, the current values must not exceed the thermal unit continuous current.

[3] 35% power factor.

SHORT CIRCUIT PROTECTION

Provide overcurrent protection for control circuits in accordance with the National Electrical Code and/or other applicable electrical codes. For applications requiring compliance with I.E.C. 947-5-1, use only Class CC fuses or better, 30 A maximum.

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PUBLICATION DIVIDER

SQUARE D
Instruction Bulletin

Bulletin No. 30072-013-40A
April 1995
Raleigh, NC, USA

Remote Reset Module
for MOTOR LOGIC™ Solid-State Overload Relay
Class 9999 Type RR04

INTRODUCTION

This module is for resetting a MOTOR LOGIC™ solid-state overload relay (Class 9065 Type SS, SF, SR and ST) from a remote location. The remote reset module is energized by a 110/120 VAC 50/60 Hz source through a normally-open (N.O.) push button. It allows a tripped, solid-state overload relay to be reset from a distance of up to 150 ft (46 m).

INSTALLATION

⚠ DANGER

HAZARDOUS VOLTAGE.

Disconnect all power before installing or servicing equipment.

Electrical shock will cause severe injury or death.

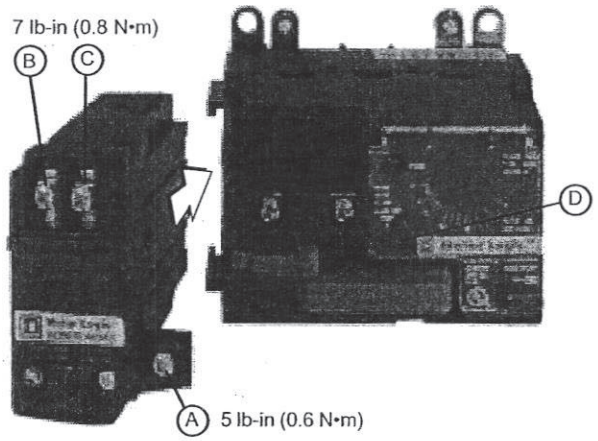


Figure 1 Remote Reset Installation

1. Disconnect all power from the cabinet containing the overload relay.
2. Slide the module onto the overload relay (see Figure 1). The bottom of the module mounting tab must be flush with the housing of the overload relay.
3. Tighten the remote reset mounting screw (A) to 5 lb-in (0.6 N•m). Excessive torque could damage the mounting tab and affect the module's performance.

⚠ CAUTION

INCORRECT MOUNTING HAZARD.

Use the mounting screw provided with the remote reset module.

Incorrect mounting screw can result in equipment damage.

4. Connect a 110/120 VAC separate control source, via a N.O., momentary contact push button, to the remote reset module terminal (B and C). Refer to Typical Control Diagram on page 2.

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Replaces 30072-013-40 dated 3/95

USFCS PDF No. 953 Rev.: 04-95

TERMINALS

Only use copper wire on remote reset terminals. Pressure wire control terminals are suitable for wire sizes AWG 16 to 12 (1.5 to 2.5 mm^2), solid or stranded, and accept one or two conductors per terminal. Tightening torque: 7 lb-in (0.8 N•m).

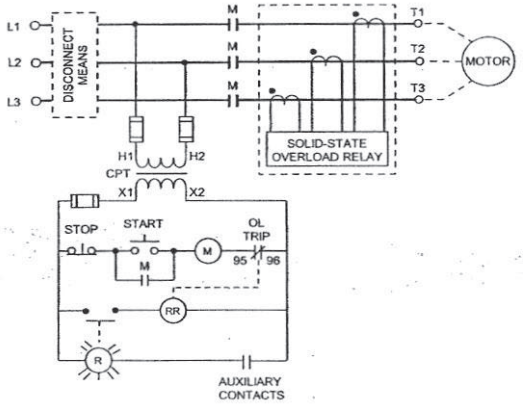


Figure 2 Typical Control Wiring

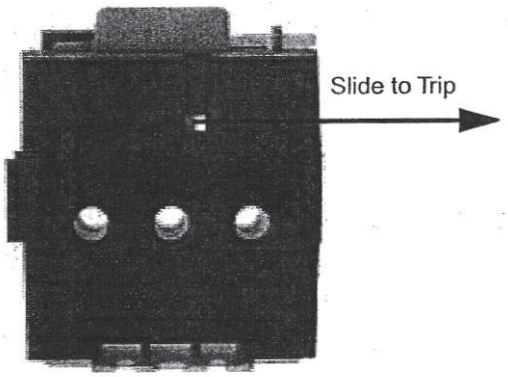


Figure 3 Manually Tripping the Overload Relay

TESTING

1. Verify that all power is disconnected.
2. Manually trip the solid-state overload relay (see Figure 3).
3. Energize control power.
4. Press the remote, momentary-action push button. If the reset module is properly installed, the overload relay will reset when the push button is pressed and the yellow flag in the trip indicator window (Item D in Figure 1) disappears.

OPERATION

The module resets the solid-state relay when the remote push button is actuated for a minimum of 0.25 seconds. The maximum allowable duty cycle for the remote reset module is five repeats of 2 seconds on/ 2 seconds off, followed by a fifteen minute off time. Exceeding this duty cycle impairs the proper function of the remote reset module.

Each time the remote reset module is energized, it draws 270 VA (2.2 A @ 120 VAC) for less than 0.5 s from the control power supply.

The maximum recommended wire run length for the module is 150 ft (46 m) for dry environments. A transient suppression module (Class 9999 Type ST1) should be wired across the remote reset device terminals (B and C Figure 1) to achieve this distance for wet wire environments.

Note: This device is not intended for use with solid-state output contacts.

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Electrical equipment should be serviced only by qualified electrical maintenance personnel, and this document should not be viewed as sufficient instruction for those who are not otherwise qualified to operate, service or maintain the equipment discussed. Although reasonable care has been taken to provide accurate and authoritative information in this document, no responsibility is assumed by Square D for any consequences arising out of the use of this material.

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PUBLICATION DIVIDER

TRANQUELL® Secondary Surge Arresters and Protective Capacitor

120-650 Volt AC

Assures Service Continuity

The GE TRANQUELL® secondary arrester is specifically designed to protect utility, agricultural, and industrial installations and equipment in the 120-650 volt range from overvoltages caused by lightning discharges. It is available for both single- and three-phase application.

Applications which provide ideal installations for this arrester are:

- Exposed secondary circuits
- Watthour meters
- Station auxiliary equipment and circuits
- Motors and control circuits
- Distribution transformer secondaries

TRANQUELL® Secondary Arresters — Indoor or Outdoor Mounting UL & CSA Listed

For Knockout or Bracket Mounting

Circuit Voltage Rating rms	Max. Permissible Line-to-ground Voltage rms	No. of Poles	Model No.	List Price Each, GO-58 ①	Net Weight Lbs	Net Weight Kg	Figure Number
120	175	2	9L15FCB001	$62.50	1.0	0.4	1
650	650	1	9L15ECA001	42.00	1.0	0.4	1
		2	9L15ECB001	55.00	1.0	0.4	1
		3	9L15ECC001	69.00	1.0	0.4	1

Secondary Arrester Protective Characteristics

IR Discharge Voltage kV Crest (8 x 20 Microsecond Current Wave)				Discharge Capabilities 8 x 20 microsecond	Energy Handling Capability
At 1500 Amp	At 5000 Amp	At 10,000 Amp	At 20,000 Amp		
2.2	2.6	2.9	3.5	20,000 Amp	900 joules per pole

(Non-PCB) Secondary Protective Capacitors — Indoor or Outdoor Mounting

0-650	650	3	9L18BBB301	$145.00	4.00	1.8	2

① Quantity break pricing applies; consult factory or your GE sales representative.

Dependable Protection

The unique metal oxide element inside each TRANQUELL® arrester gives you improved overvoltage protection. These tough elements can handle surge after surge with no trouble, no breakdown, no repairs. **Your TRANQUELL® arrester's protective ability will remain UNCHANGED throughout it's service life.**

Fuse Selection—For 9L15E Series (above 120V)

Arrester Location	Maximum Lightning Impulse See Notes ③ & ④	Fuse Rating See Note ⑤
A Long Branch Circuit more than 20 m from Service Entrance with wires # 14-10	200A	30 A; 600 V U.L. Class T 200,000 A Interrupt
B Major Feeders and Short Branch Circuits less than 20 m from Service Entrance	3 kA 8x20 µs	30 A; 600V U.L. Class T 200,000 A Interrupt
C Outside and Service Entrance	10 kA 4x10 µs	60 A; 600 V U.L. Class T 200,000 A Interrupt

Fusing

To minimize the possibility of violent rupture in the unlikely event of electrical failure of the arrester, current limiting fuses are recommended for all applications above 120 volts. A fuse must be installed in series with each pole of the arrester (i.e. each black wire). See Fuse Selection table below. The GEH-4982C instruction book shipped with each arrester also includes fusing guidelines.

NOTES:

③ Maximum impulse expected as described in ANSI/IEEE C62.41 for systems with medium exposure to surges. Arresters have been design tested to impulses as high as 20 kA, 8x20 µs.

④ Design tests for secondary arresters as required by ANSI/IEEE standards are limited to a maximum of 10 kA, 4x10 µs impulses.

⑤ U.L. Class CC (Midget) 30 A fuses are also satisfactory for locations A & B.

Dimensions

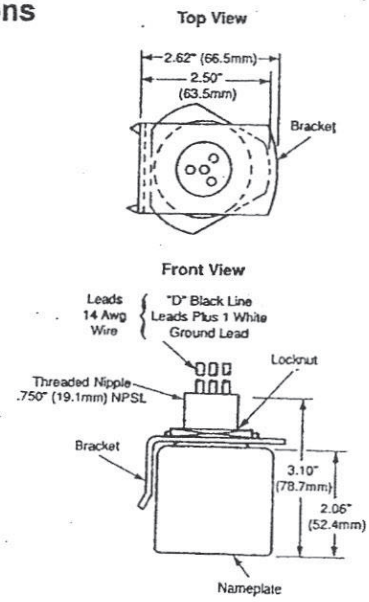


Fig. 1. TRANQUELL® Arrester

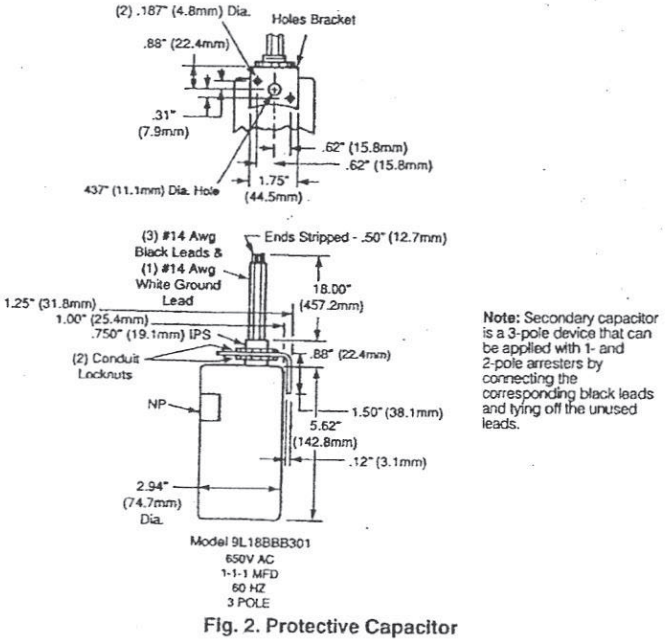


Fig. 2. Protective Capacitor

Note: Secondary capacitor is a 3-pole device that can be applied with 1- and 2-pole arresters by connecting the corresponding black leads and tying off the unused leads.

PUBLICATION DIVIDER

GE Transmission, Distribution & Industrial Systems

Secondary Surge Arresters

GENERAL SAFETY INSTRUCTIONS

WARNING: *ARRESTER CAN FAIL VIOLENTLY AND CAUSE INJURY AND PROPERTY DAMAGE WHEN APPLIED AT VOLTAGES GREATER THAN 120V. FUSING IS RECOMMENDED ABOVE 120V.*

In the unlikely event of an electrical failure, when applied at voltages greater than 120V, this arrester can rupture violently at available 60 Hz fault current levels as low as 1000 A or less. Electrical failures may result from sustained overvoltages or excessive current surges. The failure mode can result in an electrical arc that will propel the cover and internal components within the arrester distances up to 100 feet from the device.

On 120 V systems, no field failures have been reported and the failure modes that could result in violent failure are not expected to occur. On higher voltage systems, failures are very unlikely based upon a total reported field failure rate of .01% since 1983. However, violent failures have been reported and therefore fusing is recommended to minimize risk of injury and property damage unless the arrester is located in an area where a violent failure will be safely contained without hazard to personnel or adjacent property.

FOR APPLICATION AT VOLTAGES ABOVE 120 V SEE SECTION ON FUSE SELECTION GUIDELINES.

CAUTION: *THE EQUIPMENT COVERED BY THESE INSTRUCTIONS SHOULD BE INSTALLED AND SERVICED ONLY BY COMPETENT PERSONNEL FAMILIAR WITH GOOD SAFETY PRACTICES. THIS INSTRUCTION IS WRITTEN FOR SUCH PERSONNEL AND IS NOT INTENDED AS A SUBSTITUTE FOR ADEQUATE TRAINING AND EXPERIENCE IN SAFE PROCEDURES FOR THIS TYPE OF EQUIPMENT.*

NOTE: *AN ARRESTER SHOULD BE INSTALLED IN ACCORDANCE WITH ALL APPLICABLE LOCAL AND NATIONAL ELECTRICAL CODES.*

CAUTION: *FIRST REMOVE ALL SOURCE OF POWER AT THE POINT Of INSTALLATION. INSTALL TEMPORARY GROUND TO THE LINES AT THE POINT OF INSTALLATION. OTHERWISE ELECTRIC SHOCK MAY OCCUR CAUSING SEVERE PERSONAL INJURY.*

INSTALLATION

The TRANQUELL Secondary Surge Arrester is designed to protect an electrical system and equipment from damage due to excessive line surges caused by lightning or other circuit disturbances. The arrester complies with ANSI standard C62.11-1987. It is not a substitute for lightning rods, or other devices intended to protect people and property against a direct or nearby lightning stroke.

The arrester is available in a one-pole, two-pole, or three-pole version, and is suitable for both indoor and outdoor use.

Each arrester is permanently sealed in a LEXAN housing.

Arrester Model	Arrester Rating	No. of Poles	No. of White Ground Leads	No. of Black Line Leads
9L15ECA001	650	1	1	1
9L15ECB001	650	2	1	2
9L15ECC001	650	3	1	3
9L15ECD001	175	2	1	2

The 9L15E series arrester has a maximum continuous operating voltage (MCOV) rating of 650 Volts rms. The permissible line-to-line voltage of the system to which the arrester is applied depends on the circuit configuration, grounding and voltage regulation. Since overvoltages of 10% and greater are common on many systems, the arrester should not be applied at nominal voltages above 480 V. If an arrester is to be applied on higher voltages, e.g. 575 V or 600 V, the user must assure that continuous voltage across the arrester (black-to-white)does not exceed 650 V.

The 9L15FCB001 arrester has a maximum continuous operating voltage (MCOV) rating of 175 Volts rms. Since overvoltages of 10% and greater are common on many systems, the arrester should not be applied at nominal voltages above 120 V.

Typical connections and associated nominal system voltages are shown in Figure 2 for 9L15E series and in Figure 3 for the 9L15FCB001.

These arresters do not require testing, and no test which applies power voltage in excess of maximum arrester voltage rating should be made without consulting the General Electric Company. There is no single field test which will indicate the complete operating characteristics of the arrester.

The arrester may be bracket-mounted (see Figure 1-bracket included with arrester) to a pole, cross arm, wall, panel, or mounted into a connection box having a three quarter of an inch diameter knockout

hole.

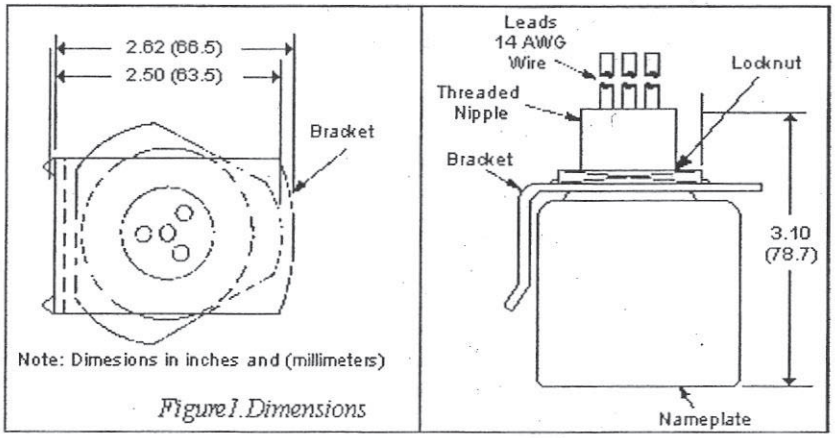


Figure1. Dimensions

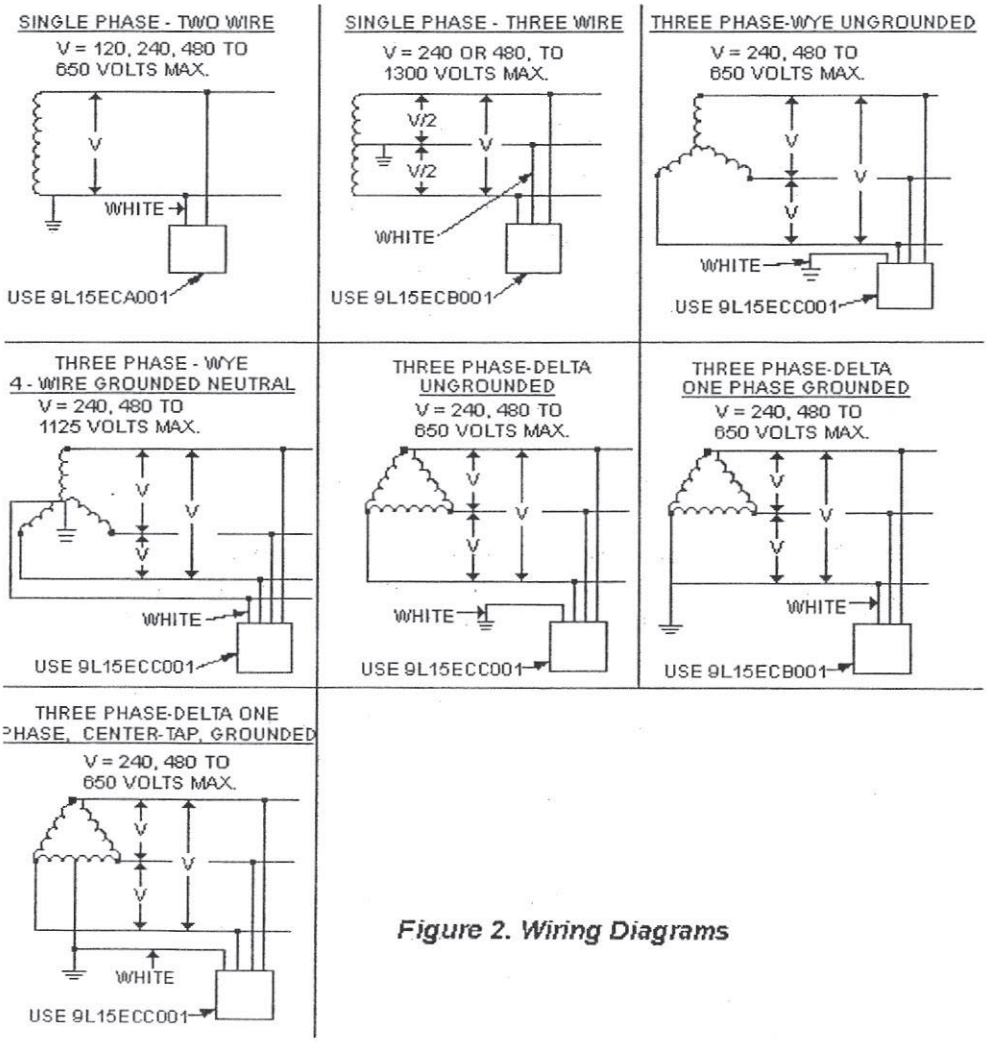


Figure 2. Wiring Diagrams

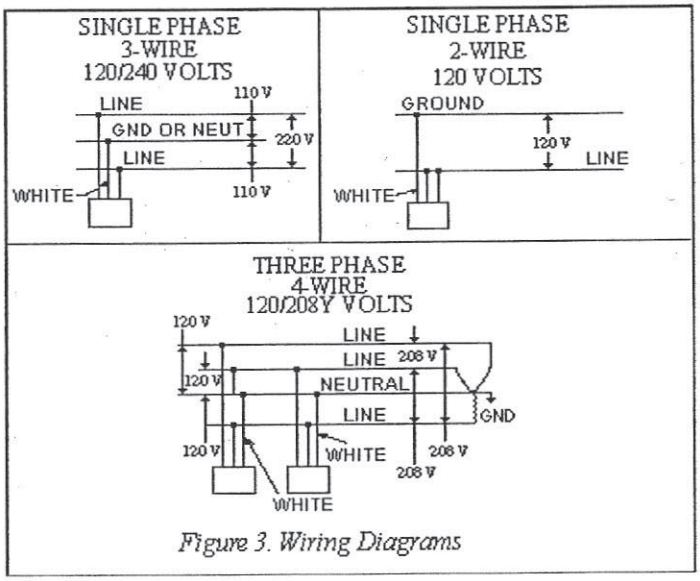


Figure 3. Wiring Diagrams

FUSE SELECTION GUIDELINES

To minimize the possibility of violent rupture in the unlikely event of electrical failure of the arrester, current limiting fuses are recommended for all applications above 120 V. A fuse must be installed in series with each pole of the arrester (i.e. each black wire).

Fault testing has demonstrated that U.L.Class T current limiting fuses of 30 A rating and smaller will minimize risk of rupture. A 60 A fuse did not prevent rupture in all cases but did limit the damage; if 60 A fuses are used the possibility of

rupture should be considered when locating the arrester. Use the smallest fuse that will pass the transient currents expected in service. A list of the current transients tested and the fuses that passed are shown in Table 1.

These fuses are of the non-indication type, so installation of indicating lights or scheduled checks of continuity will be necessary to assure that the arrester has not been disconnected by the fuse as a result of a large surge or in the unlikely event of an arrester failure.

Arrester Location	Maximum Lightning Impulse See Notes (1) & (2)	Fuse Rating See Note (3)
A. Long Branch Circuit more than 20 m from Service Entrance with wires #14-10	200 A	30A; 600 V U.L. Class T 200,000 A Interrupt
B. Major Feeders and Short	3 kA	30A; 600 V

Branch Circuits less than 20 m from Service Entrance	8 x 20 us	U.L. Class T 200,000 A Interrupt
C. Outside Service Entrance	10kA 4x 10 us	60A; 600 V U.L. Class T 200,000 A Interrupt

Notes: (1) Maximum impulse expected as described in ANSI/IEEE C62.41-1980 for systems with Medium Exposure to surges. Arresters have been design tested to impulses as high as 20 kA, 8 x 20 us.

(2) Design Tests for secondary arresters as required by ANSI/IEEE C62.11-1987 are limited to a maximum of 10 kA, 4 x 10 us impulses.

(3) U.L. Class CC (Midget) 30 A fuses are also satisfactory for Locations A & B.

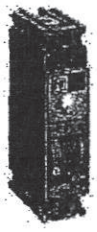
PUBLICATION DIVIDER

Thermal-magnetic Molded Case Circuit Breakers

100 Ampere Frame
Class 650

SQUARE D
www.SquareD.com
For the most up-to-date information

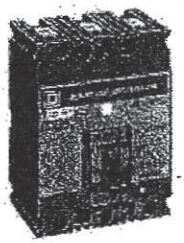
Thermal-magnetic molded case circuit breakers shown on pages 6-20–6-24 are permanent trip UL Listed, CSA Certified, IEC rated, and also meet the requirements of Federal Specification W–C–375B/GEN as indicated on pages 6-4–6-7. For I-LINE® molded case circuit breakers, see listings on pages 8-25–8-28.



FAL
1-pole
15–100 Amperes



FAL/FHL
2-pole
15–100 Amperes



FAL/FHL/FCL
3-pole
15–100 Amperes

Interrupting Ratings (kA)

	FAL240	FAL480	FCL
240 V	10	18 (1P), 25 (2, 3P)	100
480 V	...	18	65
600 V	...	...	...

Circuit Breaker Termination Options

(Third character of catalog number)

F=No Lugs
L=Lugs both ends
M=Lugs "ON" end only
P=Lugs "OFF" end only

F-frame—100 A, Thermal-magnetic (240 Vac)

Continuous Current Rating @ 40° C	AC Magnetic Trip Settings		Standard Interrupting	Terminal Wire Range
	Hold	Trip	Catalog Number	
1-pole, 120 Vac				
15	275	600	FAL12015	AL50FA #14–#4 AWG Cu or #12–#4 AWG Al
20	275	600	FAL12020	
25	275	600	FAL12025	
30	275	600	FAL12030	
35	400	850	FAL12035	AL100FA #14–#1/0 AWG Cu or #12–#1/0 AWG Al
40	400	850	FAL12040	
45	400	850	FAL12045	
50	400	850	FAL12050	
60	800	1450	FAL12060	
70	800	1450	FAL12070	
80	800	1450	FAL12080	
90	900	1700	FAL12090	
100	900	1700	FAL12100	
2-pole, 240 Vac				
15	275	600	FAL22015	AL50FA #14–#4 AWG Cu or #12–#4 AWG Al
20	275	600	FAL22020	
25	275	600	FAL22025	
30	275	600	FAL22030	
35	400	850	FAL22035	AL100FA #14–#1/0 AWG Cu or #12–#1/0 AWG Al
40	400	850	FAL22040	
45	400	850	FAL22045	
50	400	850	FAL22050	
60	800	1450	FAL22060	
70	800	1450	FAL22070	
80	800	1450	FAL22080	
90	900	1700	FAL22090	
100	900	1700	FAL22100	
3-pole, 240 Vac				
15	275	600	FAL32015	AL50FA #14–#4 AWG Cu or #12–#4 AWG Al
20	275	600	FAL32020	
25	275	600	FAL32025	
30	275	600	FAL32030	
35	400	850	FAL32035	AL100FA #14–#1/0 AWG Cu or #12–#1/0 AWG Al
40	400	850	FAL32040	
45	400	850	FAL32045	
50	400	850	FAL32050	
60	800	1450	FAL32060	
70	800	1450	FAL32070	
80	800	1450	FAL32080	
90	900	1700	FAL32090	
100	900	1700	FAL32100	

F-frame—100 A, Thermal-magnetic (480 Vac)

Continuous Current Rating @ 40° C	AC Magnetic Trip Settings		Standard Interrupting	Extra High Interrupting	Terminal Wire Range	
	Hold	Trip	Catalog Number	Catalog Number	FA Lugs	FC Lugs
1-pole, 277 Vac, 125 Vdc						
15	275	600	FAL14015	...	AL50FA #14–#4 AWG Cu or #12–#4 AWG Al	...
20	275	600	FAL14020	...		
25	275	600	FAL14025	...		
30	275	600	FAL14030	...		
35	400	850	FAL14035	...	AL100FA #14–#1/0 AWG Cu or #12–#1/0 AWG Al	...
40	400	850	FAL14040	...		
45	400	850	FAL14045	...		
50	400	850	FAL14050	...		
60	800	1450	FAL14060	...		
70	800	1450	FAL14070	...		
80	800	1450	FAL14080	...		
90	900	1700	FAL14090	...		
100	900	1700	FAL14100	...		
2-pole, 480 Vac, 250 Vdc■▲						
15	275	600	FAL24015	FCL24015	AL50FA #14–#4 AWG Cu or #12–#4 AWG Al	CU30FA4 (1) #14–#10 AWG Cu only
20	275	600	FAL24020	FCL24020		
25	275	600	FAL24025	FCL24025		
30	275	600	FAL24030	FCL24030		
35	400	850	FAL24035	FCL24035	AL100FA #14–#1/0 AWG Cu or #12–#1/0 AWG Al	AL100FA4 (1) #14–#3 AWG Cu or (1) #12–#1 AWG Al
40	400	850	FAL24040	FCL24040		
45	400	850	FAL24045	FCL24045		
50	400	850	FAL24050	FCL24050		
60	800	1450	FAL24060	FCL24060		
70	800	1450	FAL24070	FCL24070		
80	800	1450	FAL24080	FCL24080		
90	900	1700	FAL24090	FCL24090		
100	900	1700	FAL24100	FCL24100		
3-pole, 480 Vac, 250 Vdc■						
15	275	600	FAL34015	FCL34015	AL50FA #14–#4 AWG Cu or #12–#4 AWG Al	CU30FA4 (1) #14–#10 AWG Cu only
20	275	600	FAL34020	FCL34020		
25	275	600	FAL34025	FCL34025		
30	275	600	FAL34030	FCL34030		
35	400	850	FAL34035	FCL34035	AL100FA #14–#1/0 AWG Cu or #12–#1/0 AWG Al	AL100FA4 (1) #14–#3 AWG Cu or (1) #12–#1 AWG Al
40	400	850	FAL34040	FCL34040		
45	400	850	FAL34045	FCL34045		
50	400	850	FAL34050	FCL34050		
60	800	1450	FAL34060	FCL34060		
70	800	1450	FAL34070	FCL34070		
80	800	1450	FAL34080	FCL34080		
90	900	1700	FAL34090	FCL34090		
100	900	1700	FAL34100	FCL34100		

▲ FCL 2-pole circuit breaker built using 3-pole module.
■ FCL circuit breakers are not rated for 250 Vdc.

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9/8/03

PUBLICATION DIVIDER

CC-TRON®

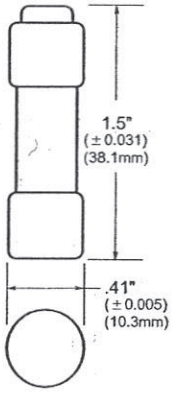
FNQ-R

Time-Delay Fuses

13/32" x 1½", 600 Volt, ¼ to 30 Amps



Dimensional Data



Catalog Symbol: FNQ-R
Time-Delay
Application: Circuit Transformer Protection
Ampere Rating: ¼ to 30 Amperes
Voltage Rating: 600 Volts AC (or less)†
Interrupting Rating: 200,000A RMS Sym. (U.L.)
Agency Approvals:
U.L. Listed, Std. 248-4, Class CC, Guide JDDZ, File E4273
CSA Certified, Class CC CSA, Class 1422-01,
File 53787–HRC-MISC

†12-30 amp is 300 Vdc and 10 KAIC.

General Information:

- The Bussmann CC-TRON® (FNQ-R) was designed to meet the needs of control circuit transformer protection.
- Current-limitation protects down stream components against damaging thermal and magnetic effects of short-circuit currents.
- **Rejection feature.** FNQ-R fuses meet the U.L. 508, paragraph 19.2.4 requirement that control circuit fuses used in equipment listed for use with more than 10,000 ampere available must have an adequate interrupting rating and must be rejection type.
- **High inrush time-delay.** Control circuit transformers can experience inrush currents up to 85 times their full-load current rating. FNQ-R fuses can be sized according to NEC and U.L. requirements and still allow the high inrush currents, with significantly more time-delay than the U.L. minimum value of 12 seconds at 200% for Class CC fuses.
- Melamine tube. Nickel-plated brass endcaps.

Maximum Acceptable Rating of Overcurrent Device*

Rated Primary Current (Amperes)	Maximum Rating of Overcurrent Protective Device Expressed As A Percent of Transformer Primary Current Rating
Less than 2A	500**
2A to less than 9A	167
9A or more	125

*U.L. 508, Table 19.3.
**300% for other than motor control applications.

CE CE logo denotes compliance with European Union Low Voltage Directive (50-1000 Vac, 75-1500 Vdc). Refer to BIF document #8002 or contact Bussmann Application Engineering at 636-527-1270 for more information.

Electrical Ratings (Catalog Symbol and Amperes)

FNQ-R-¼	FNQ-R-1 3/10	FNQ-R-3 2/10	FNQ-R-8
FNQ-R-3/10	FNQ-R-1 1/10	FNQ-R-3½	FNQ-R-9
FNQ-R-4/10	FNQ-R-1½	FNQ-R-4	FNQ-R-10
FNQ-R-½	FNQ-R-1 5/10	FNQ-R-4½	FNQ-R-12
FNQ-R-6/10	FNQ-R-1 8/10	FNQ-R-5	FNQ-R-15
FNQ-R-¾	FNQ-R-2	FNQ-R-5 5/10	FNQ-R-17½
FNQ-R-8/10	FNQ-R-2¼	FNQ-R-6	FNQ-R-20
FNQ-R-1	FNQ-R-2½	FNQ-R-6¼	FNQ-R-25
FNQ-R-1⅛	FNQ-R-2 8/10	FNQ-R-7	FNQ-R-30
FNQ-R-1¼	FNQ-R-3	FNQ-R-7½	—

Carton Quantity and Weight

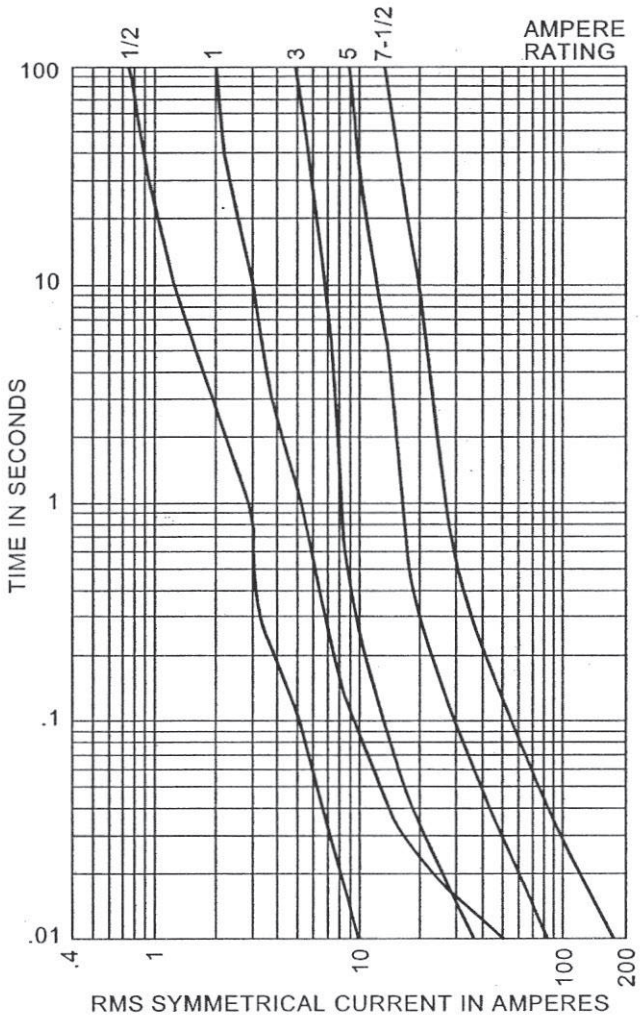
Ampere Ratings	Carton Qty.	Weight* Lbs.	Weight* Kg.
¼-30	10	.200	.091

*Weight per carton

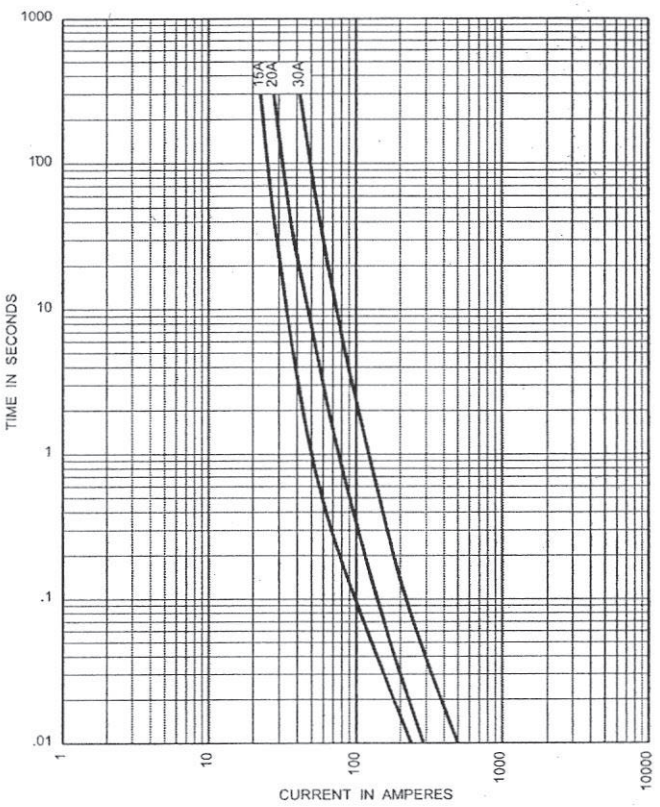
CC-TRON®
Time-Delay Fuses
13/32" x 1½", 600 Volt, ¼ to 30 Amps

FNQ-R

Time-Current Characteristics–Total Clearing



Time-Current Characteristics–Average Melt



Fuseblock Catalog Numbers

No. of Poles	Screw Terminal	Pressure Plate	Box Terminal	Screw Quick-Connect	Pressure Quick-Connect
1	BC6031S	BC6031P	BC6031B	BC6031SQ	BC6031PQ
2	BC6032S	BC6032P	BC6032B	BC6032SQ	BC6032PQ
3	BC6033S	BC6033P	BC6033B	BC6033SQ	BC6033PQ

See Also OPTIMA - Overcurrent Protection Modules

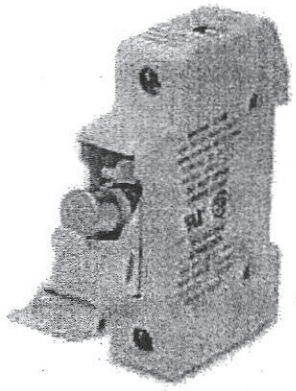
Catalog Number		BIF Document No.
OPM-SW	Fuse Switch with indication	1101
OPM-CC	Fuse Module with indication	1100

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PUBLICATION DIVIDER

Global modular fuse holders

CH Series



Specifications

Description: The 'CH' line of modular fuse holders accommodates many fuses from around the world, including North American Class-CC, Midget, Class gR, aR HSF, and IEC Industrial Ferrule (Class gG and aM) in four physical sizes: 8x32, 10x38, 14x51 and 22x58mm.

Agency Information: Manufactured in accordance with IEC 60269 and IEC 60947-3. UL and CSA Compliance as indicated in the Catalog Numbers table.

Flammability Rating: UL 94V0.

Features/Benefits

- Finger-safe multiple pole configurations
- Optional "open-fuse" indication
- 14x51 & 22x58mm configurations available with optional micro-switches for remote "open-fuse" indication, pre-breaking, and fuse presence
- Multi-phase connections available for ganging poles

Typical Applications

- Industrial Controls
- Process Controls
- Individual Control Circuits

Catalog Numbers

Catalog Numbers W/O Indication	W/Indication	Series/ Size	Max Voltage & Current	IEC	UL	CSA	Phase Configuration	No. of 17.5mm Modules	Box Qty.	Wire Range	Maximum Torque
CH081D	CH081DI	CH08 8X32	IEC 400Vac 25A	•			1-pole	1	12	1-16mm2 (18-8 AWG)	2.5 N•m (22in-lb)
CH081DNX	-			•			1 Neutral Pole	1	12		
CH081DNS	CH081DNSI			•			1-pole + Neutral	1	12	1-10mm2 (18-8 AWG)	2.0 N•m (17.5in-lb)
CH081DN	CH081DNI			•			1-pole + Neutral	2	6	1-16mm2 (18-8 AWG)	2.5 N•m (22in-lb)
CH082D	CH082DI			•			2-pole	2	6		
CH083D	CH083DI			•			3-pole	3	4		
CH083DNS	CH083DNSI			•			3-pole + Neutral	3	4		
CH083DN	CH083DNI			•			3-pole + Neutral	4	3		
CH084D	CH084DI			•			4-pole	4	3		
CHM1D	CHM1DI	CHM 10X38 & Midget	UL/CSA 600Vac/dc, 30A (3 Watt) 690Vac, 32A	•	†	•	1-pole	1	12	1-16mm2 (18-8 AWG)	2.5 N•m (22in-lb)
CHM1DNX	-			•			1 Neutral Pole	1	12		
CHM1DNS	CHM1DNSI			•			1-pole + Neutral	1	12	1-10mm2 (18-8 AWG	2.0 N•m (17.5in-lb)
CHM1DN	CHM1DNI			•			1-pole + Neutral	2	6	1-16mm2 (18-8 AWG)	2.5 N•m (22in-lb)
CHM2D	CHM2DI			•	†	•	2-pole	2	6		
CHM3D	CHM3DI			•	†	•	3-pole	3	4		
CHM3DNS	CHM3DNSI			•			3-pole + Neutral	3	4		
CHM3DN	CHM3DNI			•			3-pole + Neutral	4	3		
CHM4D	CHM4DI			•			4-pole	4	3		
CHCC1D	CHCC1DI	CHCC Class CC	UL/CSA 600Vac/dc, 30A		††	•	1-pole	1	12	1-16mm2 (18-8 AWG)	2.5 N•m (22in-lb)
CHCC2D	CHCC2DI				††	•	2-pole	2	6		
CHCC3D	CHCC3DI				††	•	3-pole	3	4		
CH141D	CH141DI	CH14 14X51	UL 600Vac/dc, 40A (5 Watt) IEC 690Vac, 50A	•	†		1-pole	1.5	6	2.5-16mm2 (14-6 AWG)	3.0 N•m (26in-lb)
CH141DMS	-			•			1-pole + Microswitch	1.5	6		
CH141DNX	-			•			1 Neutral Pole	1.5	6		
CH141DN	CH141DNI			•			1-pole + Neutral	3	3		
CH142D	CH142DI			•	†		2-pole	3	3		
CH143D	CH143DI			•	†		3-pole	4.5	2		
CH143DMS	-			•			3-pole + Microswitch	4.5	2		
CH143DN	CH143DNI			•			3-pole + Neutral	6	1		
CH143DNMS	-			•			3-pole + Neutral + Microswitch	6	1		
CH144D	CH144DI			•			4-pole	6	1		
CH221D	Not	CH22 22X58	UL 600Vac/dc, 100A (9.5 Watt) IEC 690Vac, 125A	•	†		1-pole	2	6	2.5-50mm2 (14-1 AWG)	4.0 N•m (35in-lb)
CH221DMS	Available			•			1-pole + Microswitch	2	6		
CH221DNX	with			•			1 Neutral Pole	2	6		
CH221DN	local			•			1-pole + Neutral	4	3		
CH222D	neon			•	†		2-pole	4	3		
CH223D	indication			•	†		3-pole	6	2		
CH223DMS	(remote			•			3-pole + Microswitch	6	2		
CH223DN	microswitch			•	†		3-pole + Neutral	8	1		
CH223DNMS	only)			•			3-pole + Neutral + Microswitch	8	1		
CH224D				•			4-pole	8	1		

† UL Recognized †† UL Listed
*Holder width as compared to standard 17.5mm module.
i.e. 1 = 17.5mm 2 = 35mm.

Data Sheet: 2143

Global modular fuse holders

Recommended Cooper Bussmann Fuse Types

— 8x32 IEC ferrule - C08 Series

— 10x38 North American Class CC Fuses - LP-CC, FNQ-R, KTK-R

Fuses - FNQ, KTK, AGU, KM, BAF, BAN, GNM, FWA, FWC, C10 Series

— 14x51 Fuses - FWX, FWH, FWP & NON, C14 Series

— 22x58 Fuses - FWP, C22 Series

High Speed Fuses For Semiconductor Protection

The 'CH' range of modular fuse holders may be used in conjunction with Class gR and aR high-speed fuses, offering a touch-safe design with no exposed contacts. See Data Sheet 2143 for details. Contact Cooper Bussmann Application Engineering for more information regarding high-speed fuse application.

Accessories for CH Series

Catalog Numbers	Accessory	For Use with Fuse Holders	No. of Poles	Box Qty.
AL-D	Multi-Phase Connection Links	CH08, CHM,	-	12
		CHCC, AND	-	12
		CH14 Series	-	12
CH810-HP	Multi-Phase Handle Pins	CH08, CHM,&	-	12
		CHCC Series	-	12
CH14-HP	Neutral Links	CH14 Series	-	12
C08NL		CH08 Series	-	10
C10NL, NNB		CHM Series	-	10
NNB-R		CHCC Series	-	10
C14NL		CH14 Series	-	10
C22NL		CH22 Series	-	10
CH14MS-1D	Operated-Fuse Micro-Switches	CH141 Series	1	5
CH14MS-3D		CH143 Series	3	2

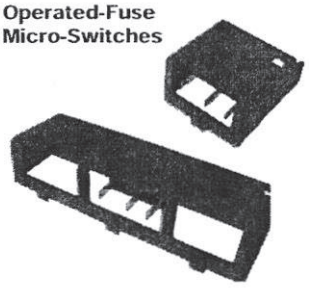
Multi-Phase Connection Links



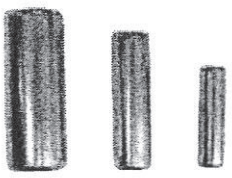
Multi-Phase Handle Pins



Operated-Fuse Micro-Switches



Neutral Links



Did You Know?

Cooper Bussmann Optima® OPM-NG Wins Product of the Year Award

As voted by the readers of Plant Engineering Magazine, the Cooper Bussmann Optima® OPM-NG modular fuseholder won a Product of the Year Award (Silver) in the power products category. This prestigious honor recognizes innovative products used by electrical, engineering and maintenance professionals to improve safety and increase productivity.

The OPM-NG fuseholder's design incorporates IP-20 finger-safe construction with integral DIN rail spring mounting — requiring no tools – so installation is fast and easy. When the OPM-NG is used in motor starter applications, wiring time in group installations can be reduced by up to 80 percent.

The compact 45 mm width matches the OPM-NG with 32A/45 mm IEC motor starter requirements. The low profile handle is integral with the fuse carrier and acts as a built-in fuse puller. This eliminates the inconvenience of needing an extra tool to remove the fuses.

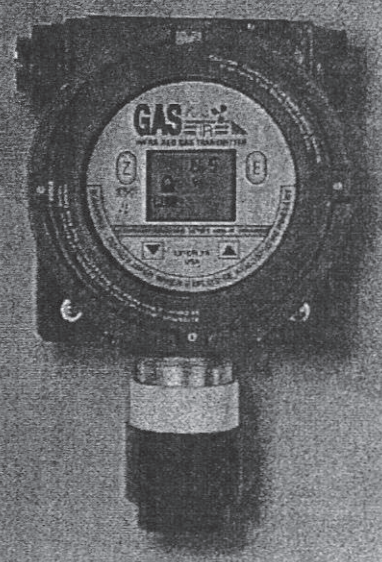
PUBLICATION DIVIDER

GasPlus®-IR

Model 4688-IR Combustible Gas Transmitter

SCOTT INSTRUMENTS

www.ScottGasPlusIR.com



COMBUSTIBLES

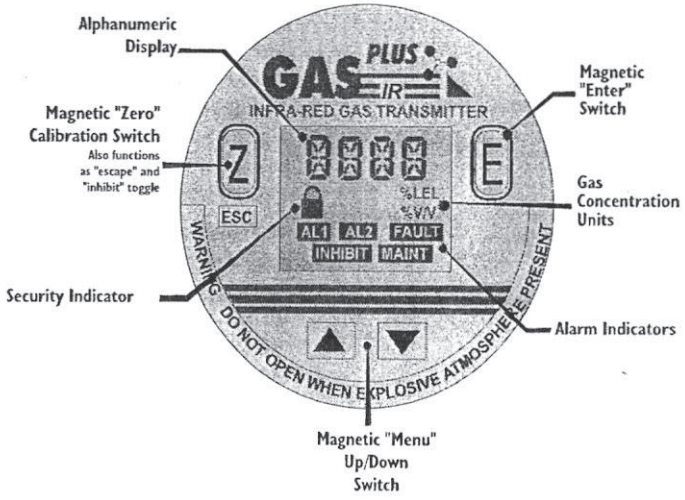
The Model 4688 IR is a rugged, reliable solution for hydrocarbon gas detection. Designed with extensive user input, the instrument is extremely flexible, easy to use, and easy to maintain. The **GAS^{PLUS} IR** is suitable for most applications where catalytic bead detectors are currently used – as well as some applications where catalytic sensors won't work.

Principle of Operation

An infrared source emits pulses of radiation into the instrument's "optical bench", which contains a known volume of gas. This radiation is reflected onto two detectors, one tuned to measure a wavelength absorbed by organics and the other tuned to a reference band that is not absorbed. The outputs of the detectors are compared and used to compute gas concentration. Fault conditions are detected by the sensors when radiation intensity falls below a threshold level for a set period of time.

(continued...)

Easy, Intuitive Operation...



Features...

Low Maintenance
No span calibration required. Zero adjustment a quick, non-intrusive procedure.

Flexible
Many parameters are user-adjustable, including gas to be detected, decimal precision, damping, and engineering units.

Rugged Design
Conformally coated electronics, nickel plated optics protects components against corrosion, and harsh industrial environments.

Extensive Self Diagnostics
Instrument compensates for detector contamination and aging. Optics are heated to prevent moisture formation. Detailed fault codes aid in troubleshooting.

Multiple Output Choices
4-20mA and RS/485 (Modbus protocol) outputs are standard features. Relays with user adjustable set/reset points, and time delays are available as an option.

User-Friendly Display
Large LCD display shows gas concentration, engineering units (%LEL or %v/v), alarm relay status, alarm inhibit, and more.

Low Cost of Ownership
An excellent price/performance ratio and low long-term cost of ownership.

Use and Maintenance

Operation of the 4688IR is simple and intuitive. All settings and adjustments, such as alarm setpoints, gas measured, etc., are non-intrusive, performed at the instrument with a magnetic screwdriver – or remotely through the instrument's RS/485 interface. Password protection prevents unauthorized personnel from tampering with the settings.

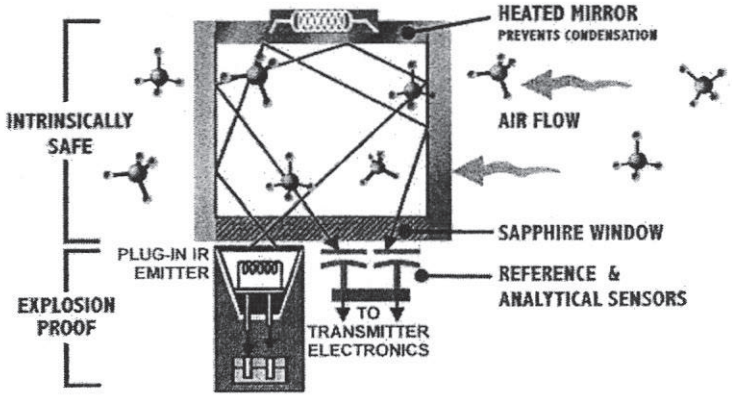
Minimal maintenance is necessary. All span information is preset at the factory, and never needs to be adjusted. Zero adjustment is a quick, non-intrusive procedure. On-board diagnostics continuously check transmitter electronics, optics, and software for faults and indicate corrective action should a fault be detected. The field serviceable infrared emitter is replaced with a simple plug-in connection .

4688-IR Infrared Technology

Why IR?

IR technology provides numerous advantages that may be benificial for your application's conditions

- Reduced maintenance (no span calibration required).
- No saturation from high gas concentrations
- No oxygen required for operation
- Continuous sensor fault monitoring
- Sensor lifetime not reduced by exposure to gas
- Rapid speed of response
- Minimal temperature and humidity effects



Typical Specifications

1. **General.** Transmitter shall be approved by a nationally recognized testing laboratory for Class 1, Division 1 Group B, C, and D hazardous locations. All parameter settings shall be password protectable. A large integral display shall provide visual indication of gas concentration, engineering units, alarm relay and inhibit status.
2. **Temperature and Power.** Transmitter shall operate over an input range of 18-28VDC in ambient conditions of -40 C to 60°C and shall consume no more than 4.0 W maximum.
3. **Output.** Transmitter shall provide an isolated, 4-20mA signal, and shall be digitally addressable using MODBUS protocol with RS/485 or RS/232 data transmission. Two SPST alarm relays shall be available as an option. User shall be able to separately adjust alarm set points, reset points, set delays, and reset delays. All alarm parameters shall be password protected and be non-intrusively adjustable through transmitter's front panel via a manufacturer supplied magnet.
4. **Diagnostics.** Transmitter shall conduct self-diagnostics of electronics, software, and sensor at least twice per second. Fault conditions shall be indicated with a specific fault code on the instrument display and with a user-adjustable analog signal. One SPST fault relay shall be available as an option. User shall be capable of testing the alarm and fault relays from the instrument's front panel or remotely via RS-232 / RS-485 communications interface.
5. **Calibration.** All span calibration data shall be preset, with no additional span calibration required by user. Non-intrusive zero calibration shall be performed via magnet. Transmitter shall provide the ability to inhibit its output. A time-out feature shall automatically return the unit to normal operation mode after a preset amount of time. The calibration curve for the gas being monitored shall be user selectable in the field through the transmitter's front panel via a manufacturer supplied magnet.
6. **Sensor.** Sensor shall be non-dispersive infrared type using no moving mechanical parts. Linearity and repeatability shall be ±2%LEL below 40% of full scale, and ±5%LEL at or above 40% of full scale. Infrared emitter shall be field replacable.

Ordering Information

Model 4688IR - A - B - C- D - E - F - G

Includes Rainshield

A: Gas Type

1 - Standard Gases (built-in)
- *Butane* 0-100% LEL or 0-1.9% v/v Note 1
- *Ethane* 0-100% LEL or 0-3.0% v/v
- *Hexane* 0-100% LEL or 0-1.1% v/v
- *Methane* 0-100% LEL or 0-5.0% v/v
- *Pentane* 0-100% LEL or 0-1.5% v/v
- *Propane* 0-100% LEL or 0-2.1% v/v
- *Propylene* 0-100% LEL or 0-2.0% v/v

2 - Extended Gas Set 1 Specify gas(es) *(includes standard gases but not extended gas set 2)*
- *Acetone* 0-100% LEL or 0-2.5% v/vv
- *MEK* 0-100% LEL or 0-1.5% v/v
- *Isopropyl Alcohol* (IPA) 0-100% or 0-2.0%v/v
- *Pure Methane* 0-100% v/v
- *Methanol* 0 - 100% or 0 - 6% v/v
- *Toluene* 0-100% LEL or 1.1%v/v

3 - Extended Gas Set 2 Specify gas(es)
(includes standard gases but not extended gas set 1)
- *Butadiene* 0-100%LEL or 0-2% v/v
- *Ethylene* 0-100% LEL or 2.7% v/v
- *Ethanol* 0-100% or 3.3% v/v
- *Isobutanol* 0-100% LEL or 1.7% v/v
- *Hexane* 0-20% v/v NOTE 2
- *Benzene* 0-100% LEL or 1.2 % v/v
- *Xylene* 0-100% LEL or 1.1v/v

4 - Other Gases (contact factory)

B: Remote Display/User Interface

1 -Display integral with transmitter
2 -Remote display/user interface
*th junction box - 50' (15.2 meters) max
aration

C: Digital Protocol

1 - RS-485 Note 3
2 - RS-232

D: Relays *(non-failsafe mode of operation)*

1 - None
2 - All Normally Open (NO)
3 - All Normally Closed (NC)
4 - Alarm NO, Fault NC
5 - Alarm NC, Fault NO

E: Optics Material

1 - Nickel Plated aluminum
2 - Stainless Steel

F: Rating NOTE 4

1 - Non CENELEC approved transmitter
2 - CENELEC approved transmitter

G: Rainshields

1 - Standard
2 - Flowcell (Nitrile O-ring)
3 - Flowcell (Viton O-ring)
4 - Flowcell (ethylene propylene)

Ordering Notes

- *Not available for acetylene or H_2*
1. *%v/v is in air*
2. *Not for %LEL applications*
3. *RS/485 includes 120Ω termination resistor which is user removable.*
4. *"CENELEC approved" covers transmitter only. CENELEC approved enclosure includes metric conduit seal fitting; non-CENELEC approved enclosure includes NPT conduit seal fitting.*

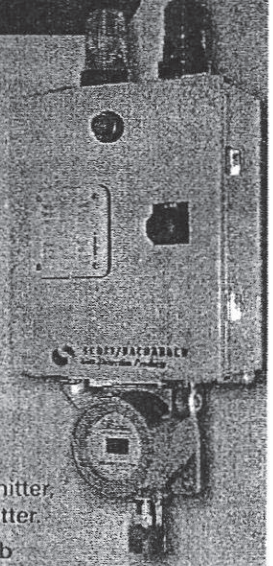
Accessories

Part #	Description
077-0120	magnetic screwdriver
096-2201	RS-485 Termination Board
096-2191	1/4 turn flowcell Note 2 (Requires Gas Test Adaptor,#096-2192)
074-0321	Rainshield
096-2192	Gas Test Adaptor
096-2289	Bump Test Adaptor
096-2187	Zero Adjustment Kit (includes regulator, tubing, and carrying case - does NOT include methane "bump gas")
096-2190	Gas test kit (2 ft tubing, zero air and methane "bump" gas", cal adaptor, regulator, and carrying case)
096-2215	Porex dust filter (for rainshield) pack of 5
096-2214	Porex dust filter (for sensor) pack of 5
077-0161	Emitter replacement tool
096-2193	IR Emitter (plug-in, includes emitter replacement tool)

Optical Bench Assembly



GasPlus Alarm System



Engineered to handle difficult industrial enviroments yet incredibly easy to operate and maintain, the Gas Plus Alarm System provides visual and audible local alarm annunciation in a rugged steel enclosure.

Designed for easy use and maintenance, the Gas Plus Alarm System can be equipped with either the Scott Instruments Model 4600 Gas Plus Universal Toxic Gas Transmitter, the Model 4688IR Infrared Combustible Gas Transmitter, or the Model 4679IR CO_2 transmitter.

Built-in strobe lights and an 80 db horn respond to two levels of alarm to quickly alert personnel of dangerous, build-ups of toxic or combustible gas. Three 10 amp relays provide additional response support for your facility, and a front panel light provides continuous visual indication of system status.

The built-in 110 Vac power supply provides simple plug-in electrical connection. Since all system adjustments are non-intrusive, the rugged painted or stainless steel enclosure never needs to be opened after installation.

See the Alarm System datasheet for more information.

Technical Specifications

GENERAL

Sensor Type	Non-dispersive infrared
Detection Range	See "Ordering Information"
Linearity	± 2% below 40% full scale ± 5% from 40% to 110% full scale
Repeatability	± 2% below 40% full scale ± 5% from 40% to 110% full scale
Response Time	T90 < 5 seconds (without rainshield)
Start Up Time	30 seconds
Self-Diagnostic Test	2x per second
Calibration	Span: none (factory set) Zero: every 3 to 6 months
User Interface	Non-intrusive via magnet
Display	4 digit LCD with user-adjustable contrast. Numeric display of gas concentration and faults; icons for alarms, lock, and inhibit
Weight	6.5 lbs (3.0 kg)
Warranty	2 years

OUTPUTS

Analog	Isolated, 4-20mA, max loop load 900ohms at 24 VDC (current source or sink)
Programmable Fault	2.4 to 4.0mA
Programmable Inhibit	1.5 to 20.0mA
Programmable Loop Test	1.0 to 20.0mA
Digital	RS/485 or RS/232 using Modbus RTU or Modbus ASCII protocol
Relay (optional)	3 SPST relays (2 concentration, 1 fault), 5A at 250 VAC. User-selectable latching/nonlatching, energized/de-energized, set/reset delay, and set/reset point

ELECTRICAL

Input Voltage	18-27VDC
Power Consumption	3.1W, nominal / 6.0W, max
Connections	3 wires or 4 wires (with RS/485 or RS/232 configuration); 18-22 AWG nominal
RFI/EMI	certified to EN50082-1

ENVIRONMENTAL

Operating Temp	-40°F to 140°F (-40°C to 60°C)
Operating Humidity	0 to 100% RH

ENCLOSURE

Enclosure Material	Copper-free cast aluminum, baked epoxy finish
Optical Bench Material	Stainless steel or electroplated aluminum

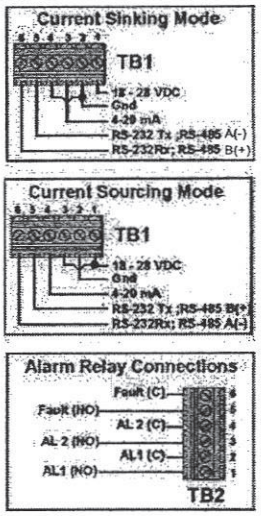
APPROVALS

Enclosure	Explosion proof; UL/FM/CSA, Class 1 Group B,C,D / Class 2, Group E, F / Class 3, NEMA-4X, NEMA-7B, C,D; NEMA-9 E,F,G; IP66
System	ETL listed to UL2279 and UL3111-1 (Class 1, Div 1, Group B,C,D), CE Marked CSA approved to Class 1, Zone 1,Groups IIB+H2;Class I, Groups E,F,&G; Class III CENELEC approved to EExd[ib] IIc T6

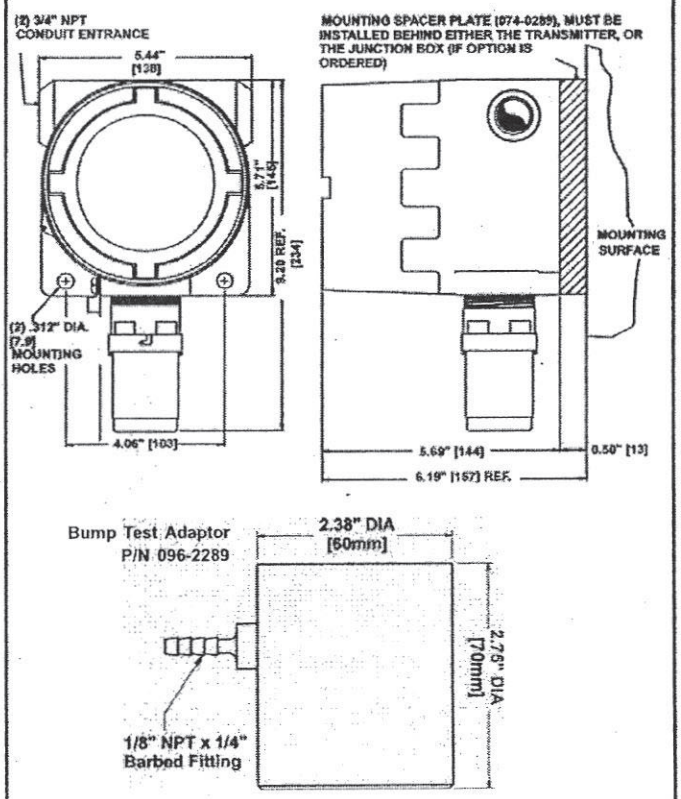
tyco
Scott Technologies, Inc.
SCOTT INSTRUMENTS

Installation Drawings

Electrical



Dimensions



Represented by:

DS-4688-IR 08-02

Toll Free US and Canada
1-800-872-8008

251 Welsh Pool Rd., Exton, PA 19341
(PH) 610-363-5450 • (FAX) 610-363-0167
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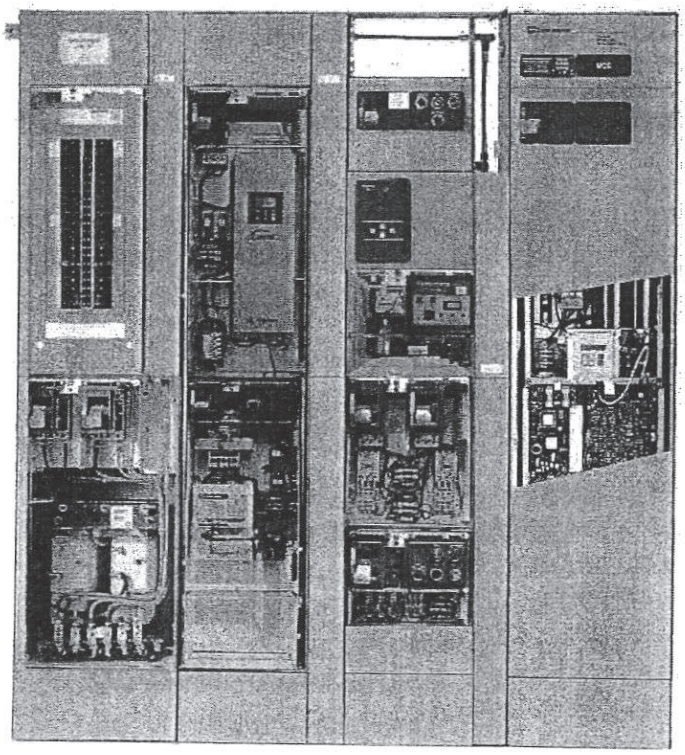
EATON | Cutler-Hammer

Low Voltage Motor Control Centers (ac/dc)

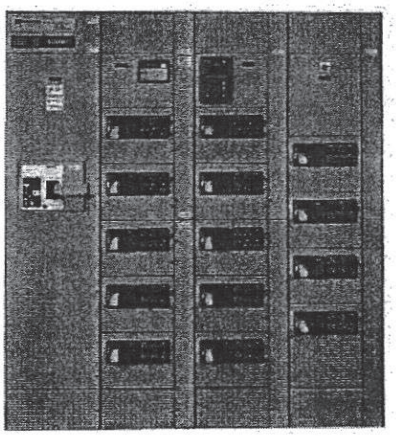
Technical Data

Supersedes TD.03A.01B.T.E
pages 1-48, dated June 2001

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2100 Series Motor Control Center



2100 Series Motor Control Center

General Description

Introduction

Eaton Corporation currently produces two Cutler-Hammer motor control center designs; Freedom™ and Advantage™. Each MCC type provides quality group motor control for a wide variety of applications. Freedom MCCs offer the best motor control for traditional electromechanical starter applications. The Advantage motor starter brings enhanced solid-state technology to the electromechanical motor starter industry. Each MCC model utilizes the same rugged enclosure and plug-in cell design.

Refer to Table 80 for feature highlights of each MCC design.

Features

- UL® label.
- 42,000, 65,000, 100,000 AIC ratings.
- Molded Case, Insulated Case and Air Circuit Breakers.
- 3200 A maximum horizontal bus.
- Optional labyrinth barrier system for bus.
- Pull apart latching terminal blocks.
- Front only or front and rear unit mounting.
- Solid-state motor control.
- DeviceNet™ Communications for control and monitoring.
- PowerNet™ Communications for energy management and monitoring.

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Description

Eaton's Cutler-Hammer Motor Control Centers (MCCs) provide the best method for grouping motor control as well as associated distribution equipment. The Freedom and Advantage 2100 Series Control Centers are specially designed to operate machinery, industrial processes and commercial building systems.

The MCC enclosure consists of a strong and rigid steel channel framework assembled into standardized vertical sections and bolted together to form a complete shipping section of up to 80-inch (2032.0 mm) maximum, four structures each. Structures include horizontal and vertical bus, insulation and isolation barriers, horizontal and vertical isolated wiring troughs, cable entrance areas and space for inserting starter and control equipment.

All control units, removable or fixed mounted, are assembled with Cutler-Hammer components of proven safety, quality and reliability. All components are wired in accordance with NEC® and UL standards. Specifically designed bus stabs, insertion guides, handle mechanisms and safety interlocks are added to form a standardized plug-in unit which meets the highest safety standards.

Both Freedom and Advantage 2100 Series MCCs may be applied on electrical systems up to 600 V, 50 or 60 Hz having available fault currents of up to 100,000 A rms. Freedom dc Motor Control Centers are available up to 250 Vdc, having available fault currents up to 22,000 A rms. Enclosure designs include NEMA® 1 Gasketed, 2, 12 and 3R. An ongoing temperature and short circuit design test program, as required by UL 845, ensures a quality product that meets the latest safety codes.

Replacement MCC Units

In addition to fully assembled, free-standing MCC lineups, replacement MCC plug-in units are available for:

- Westinghouse 11-300, built from 1950.
- Westinghouse Type W, built from 1965.
- Westinghouse 5 Star, built from 1975.
- Westinghouse Series 2100, built since 1986.
- Westinghouse Advantage, built since 1991.
- Cutler-Hammer 9800, built from 1956.
- Cutler-Hammer F10, built from 1972.
- Cutler-Hammer Freedom, built since 1988.
- Cutler-Hammer Freedom Series 2100, built since 1995.

A complete plug-in unit for adding to an existing MCC includes the plug-in unit, hinged door, isolating divider pan, and all necessary installation hardware.

Note: Mounting hardware for an old Cutler-Hammer MCC is sold separately. Since MCC UL 845 standard was established in 1975, most standard replacement plug-in units will have UL labels.

Ordering Information

Replacement plug-in units should be ordered by description indicating:

- Old General Order number/factory order number.
- MCC model.
- Type of plug-in unit.
- Required features.
- Circuit breaker or fuse rating.
- Schematic reference, if any.
- Motor data.

NEMA Classifications (ICS 3, Part 1)

Class I Control Centers

A mechanical grouping of combination motor control, feeder tap and/or other units arranged in a convenient assembly. Connections from the common horizontal power bus to the units are included. Interwiring or interlocking between units or to remotely mounted devices is not included. Only diagrams of the individual units are supplied.

When master terminal blocks are specified, a sketch showing general location of terminals is provided.

Class II Control Centers

The same as Class I, but designed to form a complete control system. They include the necessary electrical interlocking and interwiring between units and interlocking provisions to remotely mounted devices. A suitable diagram illustrating operation of the control associated with the motor control center will be provided.

When master terminal blocks are specified, the terminal arrangement and required wiring connections are shown on the diagram.

NEMA Types of Wiring

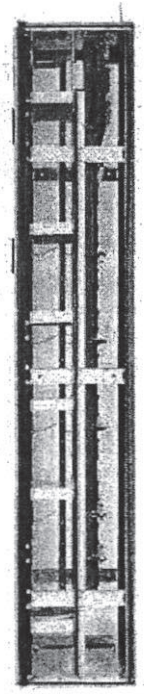
Type A includes no terminal blocks. Combination line starters are factory wired and assembled in the structure in the most efficient arrangement. Auxiliary devices can be supplied, but no wiring external to the unit will be furnished. All feeder circuit breaker or fusible disconnect units are in this classification.

Type B duplicates Type A except that all control wires terminate at blocks on the side or near the bottom of each unit. Load terminals are all conveniently located adjacent to the control terminal blocks on size 1 units only. Plug-in type terminal blocks are standard for all control wiring.

Type C-S all factory supplied control terminals and load terminals for size 1 and 2 starters are brought to a master terminal block located in the structure.

Type C-M all factory supplied control terminals and load terminals for size 1 and 2 starters are brought to a master terminal block located in a separate marshaling structure.

Structures



Standard Structure — Side View

Construction

The standard vertical structure is 90 inches (2286.0 mm) high and 20 inches (508.0 mm) wide. Front mounted only structures can be either 16 inches (406.4 mm) or 21 inches (533.4 mm) deep. Back-to-back unit mounting is 21 inches (533.4 mm) deep.

The structure framework is made of 12-gauge formed steel channels. The subframes for the front and rear of each structure are welded. These subframes are then bolted to longitudinal members to form the complete frame which is rigid and self-supporting. Side, back and roof covers of 14-gauge steel are mounted with screw fasteners for quick and easy removal. All doors are 14-gauge steel with a 1/2-inch (12.7 mm) flange to provide a rigid, secure closure for all openings. Doors mounted on removable pin hinges are provided on all unit compartments. Vertical wireways, top horizontal wireways and bottom horizontal wireways are standard.

The unit pan forms the top barrier of each unit space. In conjunction with the unit wrapper, this provides isolation between adjacent units and wireways. The guide rails are an integral part of this pan and provide precise alignment of the unit stabs on the vertical bus.

Standard Structure Arrangements

Standard structural height is 90 inches (2286.0 mm) with 9-inch (228.6 mm) horizontal wireways available at top and bottom for wiring. The balance of vertical compartments, 72 inches (1828.8 mm), is available for mounting of control units. This space can provide up to 12 6-inch (152.4 mm) high (X spaces) or any combination thereof.

Note: In the rear of back-to-back structures, the top horizontal wireway is 15 inches (381.0 mm) high and the bottom wireway is 9 inches (228.6 mm). This means that back-to-back structures have only 66 inches (1676.4 mm) 11X of usable space in the rear. 72-inch (1828.8 mm) 12X of mounting space is available with a 3-inch (76.2 mm) bottom wireway.

Special Structures

In addition to the standard 20-inch (508.0 mm) wide structure, extra wide structures are available in 4-inch (101.6 mm) increments up to 40 inches (1016.0) wide.

Reduced height structures, in increments of 6 inches (152.4 mm) 1X from 90 to 54 inches (2286.0 to 1371.6 mm), are available for applications with limited access.

Another special structure is a transition section between Type W and the Freedom 2100 Series. This structure is 10 inches (254.0 mm) wide to provide for horizontal bus splicing.

Paint

All enclosure parts are thoroughly cleaned and given a phosphatizing treatment to inhibit rust and to prime the metal for the finish coating. A 2 mil thick electrostatic powder paint coat is applied to all surfaces. The paint type and process meets UL 1332 for electrical equipment steel enclosures. All exterior enclosure covers and doors are painted ANSI 61 gray (Munsel No. 8.3G/6.10/0.54). For improved interior visibility, the interior of the enclosure and plug-in units are painted white (Munsel No. N9.43/0.21B, 0.23).

Enclosures

The standard enclosure type is NEMA Type 1 Gasketed General Purpose — Indoor. This enclosure is appropriate for installations with normal atmospheric conditions.

The NEMA Type 2 Dripproof — Indoor employs a special roof panel with a drip shield and water channels. This prevents liquid from dripping onto the front of the control center.

The NEMA Type 3R Rainproof and Sleet Resistant — Outdoor consists of a NEMA 1 gasketed enclosure mounted on a special base with an outdoor house erected around and over it. Non-walk-in, walk-in aisle and tunnel types are available.

The NEMA Type 12 Dust-tight and Driptight — Indoor has gasketed material around all doors, door cutouts, cover plates, side, top, and back sheets. A gasketed bottom plate is provided with this enclosure. This construction provides maximum protection against airborne matter and dripping liquids.

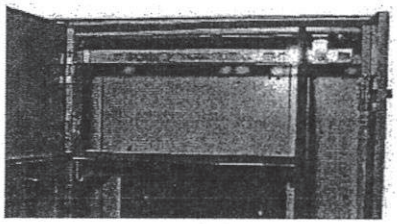
Indoor enclosures comply with NEC UL 845's "Two Meter Rule" when the bottom of the MCC is at the same level as the operator's platform. MCC elevated on a raised pad or installed on unembedded channel sills may require operator handle extensions for the uppermost operators. Handle extensions are optionally available and may be installed on-site.

Vertical Wireway

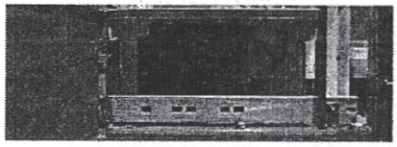
A vertical wireway is provided in each structure. Located on the right side, it extends the full 90-inch (2286.0 mm) height of the structure. The width of the wireway is 4-5/8 inches (117.5 mm) at the rear of the vertical frame members. Overall depth of the wireway is 8 inches (203.2 mm) providing a cross-sectional area of nearly 35 square inches (889 square mm) to easily accommodate control and load wiring. Supports are provided at suitable intervals to secure all wiring and cables.

The doors swing open 115° and opposite to the unit doors for maximum accessibility. The doors are mounted on concealed removable pin hinges for quick detachment and are secured in the closed position by spring-loaded quarter-turn indicating type fastener.

Horizontal Wireways



Top Horizontal Wireway



Bottom Horizontal Wireway

The top front horizontal wireway is 9 inches (228.6 mm) high and 8 inches (203.2 mm) deep in front mounted only structures and in the front of back-to-back mounted structures. It extends the full width of each structure and is totally isolated from the main horizontal bus. The bottom horizontal wireway is 9 inches (228.6 mm) high and extends the full depth of the structure. The entire floor area under the control center is open for unrestricted conduit entry. For top entry, the top wireway can be increased to 15 inches (381.0 mm) high, reducing the bottom wireway height to 3 inches (76.2 mm).

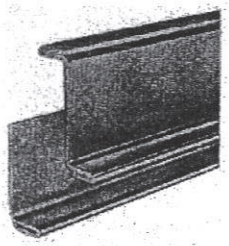
For back-to-back unit mounted, the rear top horizontal wireway is 15 inches (381.0 mm) high and 5 inches (127.0 mm) deep.

All horizontal wireway openings are covered by doors for increased accessibility. Each door is mounted with removable pin hinges to allow quick detachment.

Bus System

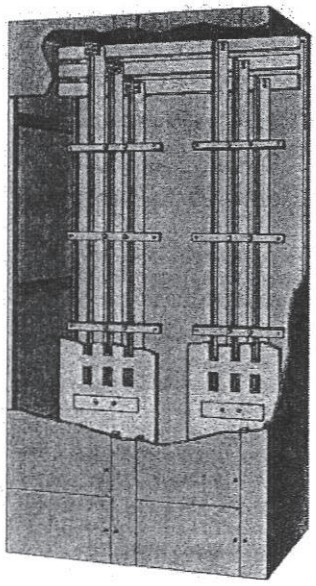
The bus system is designed to efficiently distribute power throughout the MCC and provides inherent mechanical strength in the event of faults.

Vertical Bus



Vertical Bus Configuration

The vertical bus provides 3-phase power distribution from the main horizontal bus into the vertical compartments. The bus is a unique angular configuration with an "L" shape for front mounted only structures and a "Z" shape for back-to-back. These shapes have the inherent mechanical strength to withstand fault stresses. They also provide a smooth stabbing surface for unit connection.

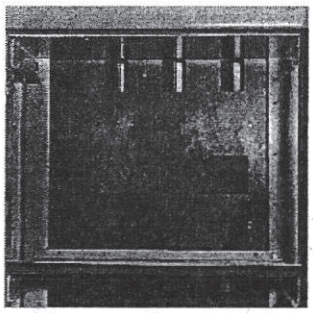


MCC Bus Layout

Due to the high strength capability of the bus bars, bus bracing at 65,000 rms symmetrical amperes is standard. Optional bracing is available at 42,000 A and 100,000 A rms. Bus braces are molded from a glass-reinforced polyester material which is non-tracking and impervious to moisture and other adverse atmospheric operating conditions.

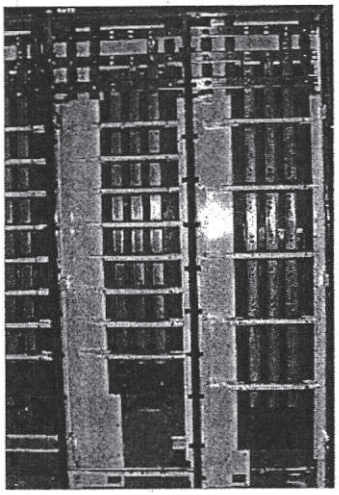
The vertical bus is available in ratings of 300, 600, 800 and 1200 A for front mounted only, and 600, 800 and 1200 A for back-to-back mounted. **Vertical bus bars are tin-plated copper only.** Vertical bus of the incoming section will match the horizontal bus when applicable.

Isolation of the Freedom Series 2100 vertical bus compartment from the unit compartment is accomplished by a full height barrier. This is a single sheet of glass-reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus. Snap-in covers are available for the cutout openings to provide total isolation during maintenance procedures.



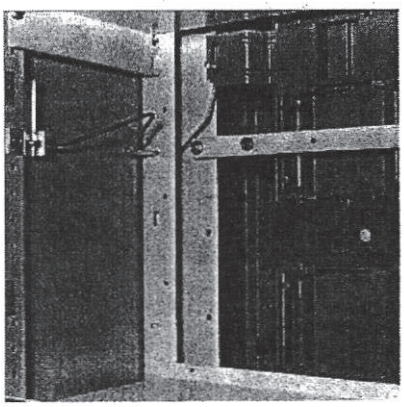
Standard Isolation Barrier

When insulation and isolation of the vertical bus is required, a **labyrinth design barrier,** as shown on the next page, is available. This barrier is molded glass-reinforced polyester and forms a labyrinth around the bus bars to prevent fault propagation. This design provides maximum protection against phase-to-phase insulation breakdown. Thermal efficiency is maintained by a close tolerance fit between the bus bars and the barrier which minimizes air pockets. The labyrinth barrier is standard for Advantage MCCs.



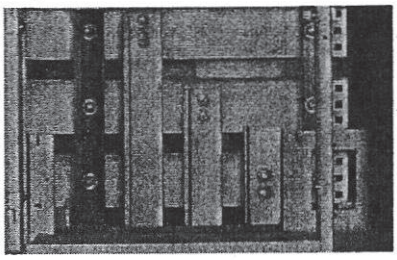
Standard Isolation Barrier Rear View

An automatic shutter mechanism is standard with the labyrinth barrier to provide complete isolation of the vertical bus. The shutter moves automatically to cover the stab openings when a unit is removed. This provides maintenance personnel with maximum protection since the vertical bus is never exposed. As the unit is reinserted in the compartment, the shutter moves sideways to uncover the stab openings in the barrier.



Labyrinth Barrier with Automatic Shutter Mechanism

Horizontal Bus



Horizontal Bus

The main horizontal bus provides 3-phase power distribution from the incoming line or primary disconnect device to each vertical structure in the motor control center. The bus bars are mounted in a vertical plane, edge to edge. This mounting produces an exceptionally strong assembly, able to withstand high fault current stresses.

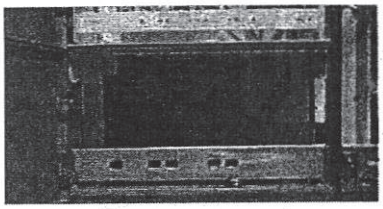
Standard horizontal bus bracing is 65,000 A rms symmetrical amperes. Optional bracing is available at 100,000 A rms. Bus braces are molded from high strength glass-reinforced polyester material which is non-tracking and impervious to moisture and other adverse atmospheric operating conditions.

The main horizontal bus is rated at 600 A as standard with ratings of 800, 1200, 1400, 1600, 2000, 2500 and 3200 A optionally available. Tin-plated copper bus bars are supplied as standard. Silver-plated copper is also available.

Note: 3200 A horizontal bus available in NEMA 1A enclosure only and 65°C rise above 40°C ambient only.

The horizontal main bus is isolated from the top horizontal wireway compartment by an isolation barrier. This two-piece steel barrier extends to the full width of each vertical structure. The two-piece design allows access to bus connections without the removal of the entire barrier, for added maintenance convenience. The bus bar layout permits front access to all bus connections. This allows maintenance personnel to make splices and check splice bolt torques from the front of the structure.

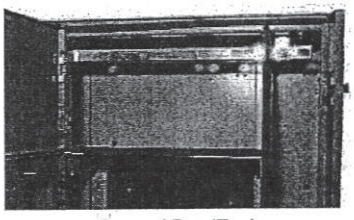
Neutral Assemblies



Neutral Bus (Bottom)

For 3-phase 4-wire applications, a neutral landing pad is provided as standard. This is a 100% rated neutral. As an option, half or fully rated neutral bus can be supplied in the bottom of the entire MCC.

Ground Bus



Ground Bus (Top)

Copper ground bus, rated 300 A 1/4-inch by 1-inch (6.4 mm by 25.4 mm) is supplied as standard. Mounting is across the top of each vertical structure in the horizontal wireway. The bus can also be mounted across the bottom when the bottom 9 inches (228.6 mm) are not occupied by units or master terminal blocks. A 1/4-inch by 2-inch (6.4 mm by 50.8 mm) copper ground bus rated 600 A is optional.

An optional 300 A vertical tin-plated only copper ground bus is available. Located in the vertical wireway, it provides direct starter unit grounding.

Units

General

Motor starter units are combination type employing a linestarter and a disconnect device of proven capability. The disconnect device can be a motor circuit protector, circuit breaker or fusible switch. The Cutler-Hammer Type HMCP motor circuit protector is furnished as standard.

All starters through NEMA Size 5 are a drawout design except Size 5 electromechanical reduced voltage.

All dimensions and ratings in the following tables are based on NEMA B, 1800 RPM motors.

The HMCP and starter combination has a 65,000 rms symmetrical ampere short circuit current rating as standard at 480 V. Starter units are available with optional 100,000 A short circuit current rating. Series C thermal-magnetic circuit breakers (65 kAIC, or optional 100 kAIC) for starter units are also available.

Freedom and Advantage starters meet or exceed IEC 947-4 Type II testing with R and J fuses. Additionally, Advantage is Type II listed with Cutler-Hammer motor circuit protector disconnects.

The fusible switch disconnect device is the Type K. It is a quick-make, quick-break, visible blade switch with fuse clips for use with current-limiting or dual element, rejection type, NEMA Class J or R fuses. Rejection fuse clips for Class RK-5 fuses are standard. Fuses are not included as standard.

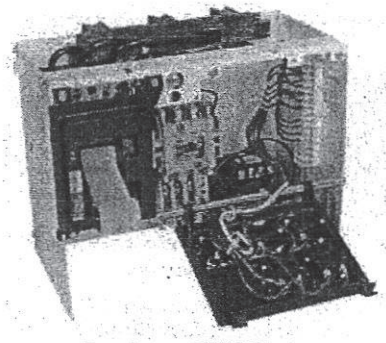
Both breaker and fuse selection must take into consideration the total short circuit capacity of the system to which the control center is connected.

Typical starter units available include the following:

- Full voltage, non-reversing.
- Full voltage, reversing.
- Two-speed, single winding and two winding.
- Reduced voltage, autotransformer, closed transition.
- Reduced voltage, wye delta.
- Reduced voltage, part winding.
- Reduced voltage, solid state.
- Adjustable frequency drives.

Each starter includes a stainless steel corrosion-resistant safety ground clip that makes connection before the power stabs engage the vertical bus.

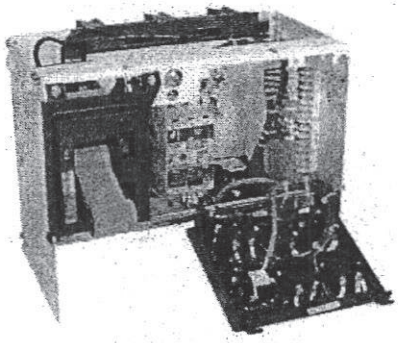
Units — Freedom Starter



Freedom — FVNR Starter

Freedom Series 2100 starter units are equipped with Cutler-Hammer Freedom starters and contactors NEMA sizes 1 through 5. Size 6 and 7 starters are A200 type. These contactors have been successfully applied in thousands of the most demanding industrial applications. Overload protection is provided by a 3-pole adjustable ambient compensated, bi-metallic thermal overload relay. The overload relay also provides single-phase sensitivity and isolated alarm contact. An insulated hand reset button extends through the compartment door.

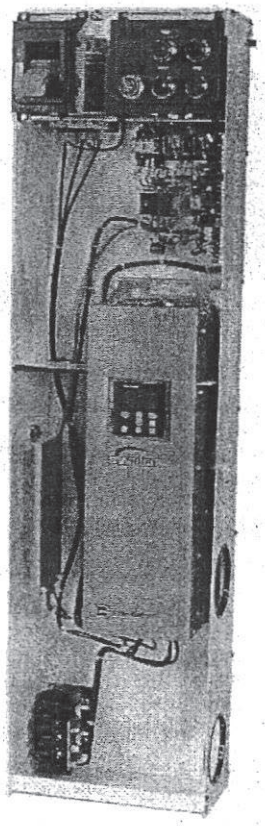
Units — Advantage Starter



Advantage — FVNR Starter

Advantage starter units are equipped with Cutler-Hammer Advantage starters NEMA sizes 1 through 6. Introduced in 1991, the Advantage starter has been successfully applied in the most demanding industrial applications. Utilizing microprocessor control, the Advantage starter affords phase unbalance protection, ground fault protection, more accurate motor overload protection, discrete pickup and dropout voltages and inherent coil surge protection. Additionally, motor running data and starter status are available through PowerNet and DeviceNet communications systems.

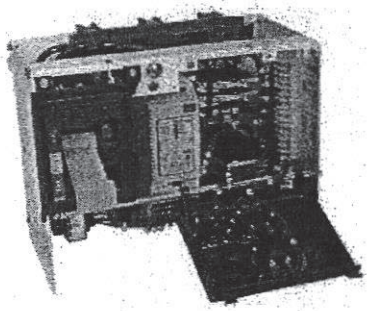
Units — ac Drives



Adjustable Frequency Drive

Adjustable Frequency Drives are available from .5 hp to 1100 hp for control of standard ac motors in processes that benefit from the ability to change motor speed. Use of Inverter Duty motors is recommended. Controllers are available to handle constant torque applications, such as conveyors and crushers, and variable torque applications, such as fans and pumps. Control schemes are available for volts/Hz, open loop vector and closed loop vector models. SV9000 drive units include as standard: line reactors and a door mounted keypad. Units up to 150 hp VT have a standard output reactor for V/dT filtering. AF91 drive units include as standard: a line reactor, viewing window for drive display, and an output filter. All drive structures are bus connected which allows for expansion of the MCC on both sides of the structure. A wide range of AFD features and options are available to meet the requirements of most applications. AFDs are available in NEMA 1A.

Units — Solid-State Reduced Voltage Starters



IT. SSRV Starter Unit

IT. SSRV Starters are designed to reduce the inrush current to a motor during starting and limit the amount of available starting torque, thus reducing mechanical wear and utility demand requirements. The amount of starting current is field adjustable to match the specific requirements of all applications.

Cutler-Hammer *IT.* SSRV Controllers are available with a wide variety of standard features: Kick start, soft stop, phase loss and stall protection. *IT.* Solid-State Reduced Voltage Starters are 30 – 70% smaller than competitive designs.

Typical applications include conveyors, compressors, machine tools, pumps and fans.

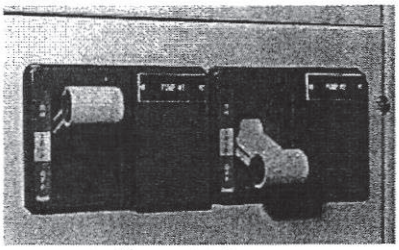
Units — dc Starters



dc Starter Unit

UL listed dc MCCs use combination circuit breaker dc starters suitable for motor starting duty only. Using Cutler-Hammer Type ME dc definite purpose contactors, all dc starters are suitable for up to 250 Vdc and have a 22 kA withstand rating. Class 135 starting resistors for reduced voltage starters are sized for 200% starting current. Typical applications include emergency lube oil pumps, emergency seal oil pumps and emergency turning gear motors.

Feeder Tap Units



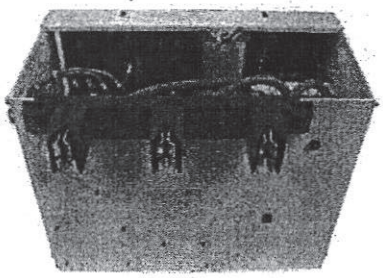
Dual Feeder Tap Unit

Feeder tap units may contain either circuit breakers or fusible switches. Drawout breaker units include the fixed trip Type HFD, single or dual mounted in ratings through 150 A and the interchangeable trip Types HJD and HKD single mounted through 250 A and 400 A respectively. Larger Series C® circuit breakers with ratings to 2500 A are fixed mounted.

Fusible feeder tap units utilize the Cutler-Hammer Type K visible blade disconnect switch. Fused switches are mounted in drawout units through 400 A with 30 and 60 A ratings available in dual mountings. Fixed mounted switch ratings of 600 A and 800 A are also available.

All switches are supplied with fuse clips for use with current-limiting or dual-element rejection type. Types of fuses include Class J, R or L.

Stab Assembly

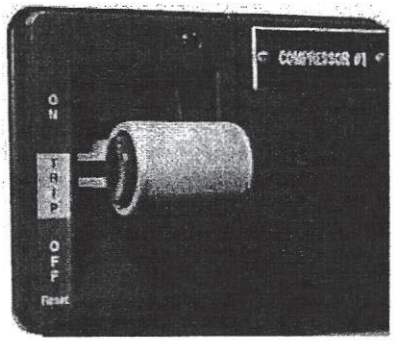


Plug-in Unit Bus Stabs

A tin-plated copper alloy stab incorporates the ultimate in mechanical simplicity to provide precise control of contact pressure on the bus. This ensures a positive connection yet permits easy unit insertion and withdrawal. Self-aligning stabs are mounted in a glass-reinforced plastic insulation block which totally shrouds each stab and absolutely ensures positive alignment of the stabs with the vertical bus. The insulation block is also an integral part of the phase-to-phase isolation system. Power wiring is welded to the stabs and is totally contained within the unit enclosure. This means the vertical bus compartment is completely free of wiring for maximum safety and reliability.

Stab assemblies are accurately matched to the electrical requirements of each individual unit and are provided in 60, 150, 300 or 400 A ratings.

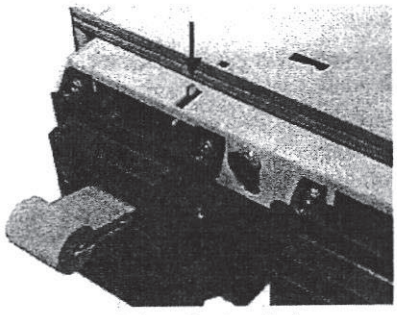
Handle Mechanism



Circuit Breaker Handle Mechanism

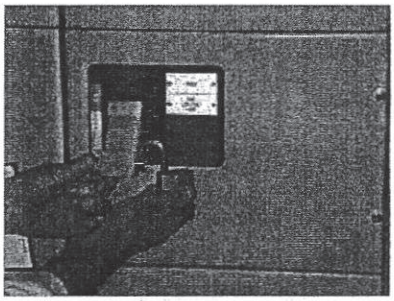
The handle mechanism is designed to provide a high mechanical leverage so that little effort is required to operate any device.

The standard handle mechanism is a vertical motion type device with four positions; ON, OFF, TRIPPED and RESET. Only circuit breaker types have tripped and reset positions. It is securely mounted to the front of the unit and mechanically connected to the breaker or fusible switch, eliminating alignment problems. It provides a positive indication of the breaker or switch position, even with the door open.



Unit Insertion Interlock

The handle and exterior front panel are molded from the same plastic material as the device panel. A textured surface preserves the appearance. The ON position indicator is at the top and is a bright red. The OFF/RESET position is at the bottom and is bright green. The TRIP position, a bright yellow, is in the middle, between the ON and OFF position. All position indicator colors contrast with the black background and are highly visible even at considerable distances. The operating handle is designed for rugged duty and solid operator feel.

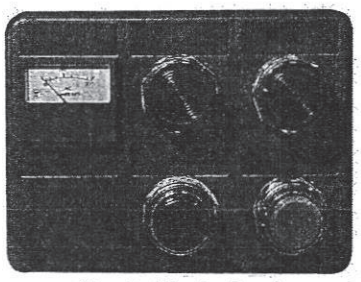


Padlocking Bar

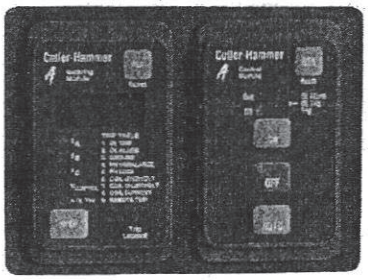
The handle mechanism provides several safety features:

- In the ON position, an interlock prevents the unit door from being opened. A door interlock defeater screw located above the handle is provided to enable authorized maintenance personnel access to the units when required.
- With the unit door open and the operating handle in the ON position, an interlock slides into a slot in the divider pan above and prevents removal of the unit. This same interlock prevents insertion of the unit unless the handle mechanism is in the OFF position. The interlock also prevents the operating handle from being turned on with the unit door open.
- To ensure that units are not energized accidentally or by unauthorized personnel, the handle mechanism can be padlocked in the OFF position. Sufficient space is available for a maximum of three padlocks. Where critical processes are involved and to prevent unauthorized shutdown, the handle mechanism can be modified to enable padlocking in the ON position.

Device Panel



Standard Device Panel



Advantage Device Panel with ACM and Metering Module

The device panel can accommodate up to six 1-3/16-inch (30.2 mm) Cutler-Hammer 10250T type pilot devices such as oiltight pushbuttons, indicating lights, selector switches and miniature meters.

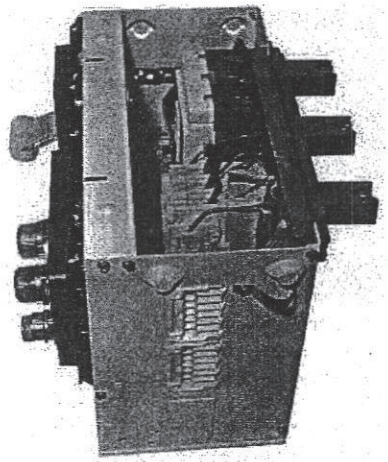
Molded into the panel is a knockout for each device location. This facilitates the future addition of devices to the panel.

The device panel is hinged on a horizontal pivot tube extending across the front of the unit. With the unit door open, loosening two captive retaining screws at the top of the panel and sliding it 1/2-inch (12.7 mm) left, permits it to swing down. This provides ready access to the rear of the panel and increased accessibility to the unit interior.

Nameplates

Unit nameplates are engraved with 3/16-inch (4.8 mm) high white lettering on a black background. They are heat and crack resistant to eliminate the need for replacement. Nameplates are mounted with stainless steel self-tapping screws.

Unit Wrapper



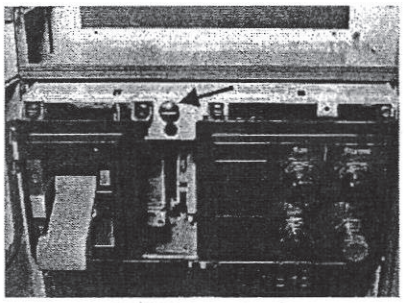
Plug-in Unit Wrapper

The unit wrapper is fabricated of 14-gauge steel. After fabrication, it is cleaned and given a rust inhibiting phosphatizing treatment. The finish on a unit wrapper is a baked Munsel No. N9.43/0.21B, 0.23 white. This is highly durable finish, gloss-white in color to increase visibility within the unit and facilitate wiring and maintenance procedures.

The unit wrapper consists of a three-sided rugged steel shell including the mounting base for the unit components. The smallest unit measures 13-3/4 inches (349.3 mm) wide, 8 inches (203.2 mm) deep and 6 inches (152.4 mm) high. Units increase in 6-inch (152.4 mm) increments to a maximum height of 72 inches (1828.8 mm).

The unit wrapper is designed to provide ample space for cable entry from the wireway to the unit.

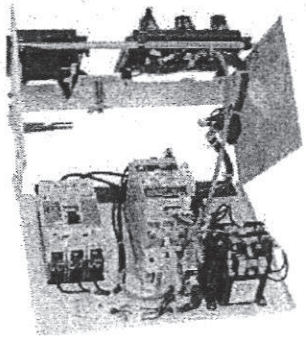
The unit wrapper has four mounting points, two on each side, which support the unit in the structure. They engage guide rails located near the top of each unit space. This mounting point guide rail system produces minimum friction and allows units to be inserted and withdrawn easily. The guide rails also give precise alignment to the unit for accurate stabbing on the vertical bus.



Unit Wrapper Latch

At the top center of the unit wrapper is a quarter-turn latch which securely holds the unit in the compartment. The latch can only be engaged when the stabs are fully mated with the vertical bus. Upon release of the latch, the unit can be partially withdrawn such that the stabs disengage from the vertical bus. In this position, the latch can be re-engaged to prevent the unit from being returned to the fully stabbed position or from being removed from the structure. The latch can be padlocked in this position to ensure that the stabs remain disengaged during maintenance.

Unit Maintenance



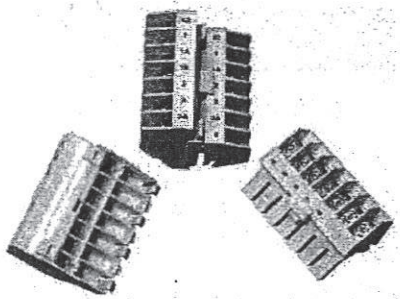
Plug-in Unit Maintenance

The three-piece unit wrapper design facilitates easy work bench maintenance. When removed from the MCC, the unit top/side barrier assembly can easily be swiveled up and back for complete access to components and wiring.

Terminal Blocks

A side mounted, seven-circuit, latching pull-apart terminal block is standard on units with NEMA Type B or C wiring. This industrial grade Cutler-Hammer MCC terminal block provides solid electrical connections while conserving space and making installation and maintenance easier.

Terminal blocks are mounted in knockouts on the vertical wireway side of the unit housing affording greater access to the unit compartment and interior components. The two-piece terminal block snap-locks together to ensure permanent circuit continuity. To aid installation and wiring checks, the terminal marking strips for both sides of the terminal block are fully visible from the front of the starter compartment.



Side Mounted — Latched Pull-Apart Terminal Block

Heavy-duty saddle wire terminals are of the resilient collar design which eliminates loose connections caused by expansion and contracting of the conductor as the current is switched on and off. This unique design maintains constant pressure as the wire expands and contracts. This 600 V, 30 A rated terminal block will accept 12 AWG stripped wires as well as ring or spade wire lugs. All terminal block conductors are fully shielded for added safety and cleanliness.

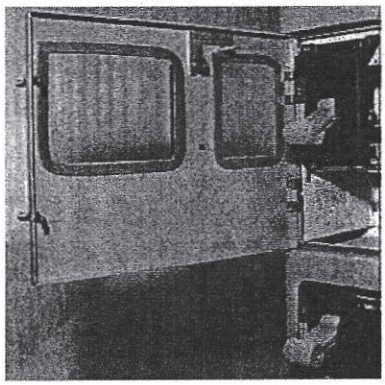
A 12-inch (304.8 mm) high (2X-space) starter unit accommodates up to three side-mounted terminal blocks providing a maximum of 21 points. Larger units accommodate two additional 7-point terminal blocks for every additional 6 inches (152.4 mm) 1X-space of unit height. The 6-inch (152.4 mm) compact starter unit uses a 9-point pull-apart terminal block which is installed along the top front of the starter unit.

Control wiring within each starter compartment consists of 16 AWG control wire for Freedom 2100 Series MCCs and 14 AWG wire for Advantage 2100 Series MCCs. Rated 105°C, the flame-retardant, thermoplastic insulated wire is red. Power wiring is black and sized to carry the maximum full load current of the starter unit.

Front Rail Mounted Terminal Blocks

For special applications, other types of rail mounted terminal blocks are also available. They are installed horizontally at the bottom front of the starter unit. Refer to the Cutler-Hammer business for terminal block types available and space restrictions.

Unit Doors

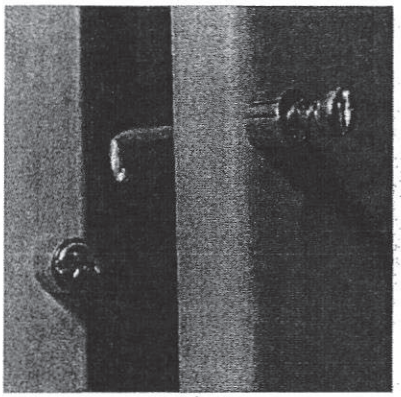


12-inch (304.8 mm) Unit Door

Unit doors are formed of 14-gauge steel with a 1/2-inch (12.7 mm) flange on all four sides. The flange adds rigidity to the door and provides a surface to contain door gasketing. Cutouts are made in the door as required to accommodate the operating handle and device panel. The doors are cleaned, phosphatized and given a finish of gray, baked on enamel ANSI 61.

The doors will open 115° opposite to the wireway doors permitting optimum access to the unit compartment. The doors are mounted on removable concealed pin hinges. This permits quick removal of any door in a vertical structure without disturbing adjacent doors.

Doors 2X and larger are held closed with a minimum of two quarter-turn indicating type fasteners. They securely hold the door in the closed position, yet allow quick and easy access to the unit when required. The fasteners provide a visual indication of the latched position. The head slot of the fastener is designed to prevent screwdriver slippage.



Spring-Loaded Unit Door 1/4 Turn Latch

Options

Starter and feeder tap units can be modified to meet a variety of specification requirements. Some typical components which can be added include: control power transformers with two primary and one secondary control fuses, control relays, CEP7 or IQ 500 (solid-state overload) relays, ground fault relays, current transformers, extra electrical interlocks, push-buttons, selector switches, indicating lights, circuit breaker shunt trip or undervoltage release and auxiliary switches. In most cases, one of these modifications does not increase starter unit size.

Additional Equipment

In addition to motor starter and feeder units, additional equipment can be supplied including the following:

- Single-phase dry-type distribution transformers in ratings of .5, .75, 1, 1.5, 2, 3, 5, 7.5, 10, 15, 20, 25, 30 and 45 kVA.
- 3-phase dry-type distribution transformers in ratings of 9, 15, 25, 30 and 45 kVA.
- Lighting panelboards with up to 42 circuits with either plug-in branch breakers or bolt-on branch breakers, 120/240 V, 120/208 V or 480 V, single- or 3-phase.
- Current limiting reactors with ohmic values of .01, .015, .02 and .025, and ampere ratings of 600, 800, 1000 and 1200.
- Metering equipment including the IQ family of solid-state power monitors, voltmeters and ammeters.
- PLC and DCS I/O racks.
- *IT.* family of solid-state reduced voltage starters.
- AF91 and SV9000 adjustable frequency controllers.
- Active Harmonic Correction Units.
- Transient Voltage Surge Suppression (TVSS) units.
- Size 4, 5 and 6 vacuum starters and contactors.
- Power factor correction capacitors.
- Automatic transfer switches.
- DeviceNet Communications.
- PowerNet Communications.
- PanelMate industrial Operator Interface.
- Industrial PCs.

Control and Load Terminations

For NEMA Type A wiring each unit is assembled and devices interwired. Terminal blocks are not supplied and control and load wiring is internal to the unit.

For NEMA Type B wiring, control wires are terminated at blocks within the unit. Refer to the discussion of units for types of terminal blocks available.

For NEMA Type C-S wiring, control, and size 1 and 2 starter load wires are extended from the unit terminal blocks to master terminal blocks located at the top or bottom of each vertical structure.

The mounting location of the master terminal block in front mounted only structures is in the existing horizontal wireway space at the top or at the bottom as shown above. When mounting is made in an incoming line section, 12 inches (304.8 mm) of unit space must be used. When mounting is made in the rear of back-to-back mounted structures, 6 inches (152.4 mm) of unit space must be used at the bottom and 12 inches (304.8 mm) at the top.

Master terminal blocks are rack mounted to permit removal of entire assembly for ease of wiring during installation and maintenance.

For NEMA Type C-M wiring control and size 1 and 2 starter load wires are extended from the unit terminal blocks to master terminal blocks located in a separate marshaling structure.

Incoming Line

Incoming line cables entering the MCC from either the top or bottom can be easily terminated onto main lugs or connected to a main disconnect. All incoming line sections comply with NEC wiring bending requirements as adopted by UL.

Main Lugs Only (MLO)

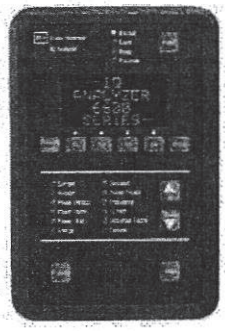
Up to 1200 A rated horizontal bus, cables, up to four per phase, are terminated on crimp or screw lugs mounted on adapters solidly bolted to fully rated vertical bus. Top entry cables are terminated at the top of the MCC and bottom entry cables are conveniently terminated near the bottom. **Table 77** shows spacing requirements for various cable configurations. MLO termination for 1600, 2000, 2500 and 3200 A requires a full vertical section.

Note: 3200 A main lugs only available in NEMA 1A enclosure only and 65°C rise above 40°C ambient only.

Main Disconnects

Incoming cables may also be easily terminated on a main circuit breaker or fused switch. A variety of molded case or encased circuit breakers are available. **Tables 55** through **60** show spacing requirements for various main devices.

Metering



IQ Analyzer

The Cutler-Hammer IQ family of metering and power monitors includes:

IQ 100 cost-effective electronic power meter provides 3-phase display for L-L, L-N voltage, current.

IQ 320 microprocessor-based 3-phase power monitor displays phase currents, voltage, L-L, L-N, power-real and apparent, power factor, frequency, energy: watthours, VAR hours, VA hours.

IQ 200 includes all of the functions of the IQ 320 Meter. The door mounted display is smaller, making the IQ 200 ideal for use on individual starter and drive units.

IQ DP-4000 includes all of the functions of the IQ 320 plus THD readings for voltage and current. Additionally, the IQ 4130 includes contact inputs and outputs. This device is ideal for incoming line monitoring.

IQ Analyzer provides extensive metering, power quality analysis, remote input monitoring, control relaying, analog input/outputs, and is communications capable. A display provides the flexibility of exhibiting large characters with high visibility and small characters for detailed descriptions.

These IQ power monitors each contain their own voltage power pack for systems up to 600 V. Therefore, separate potential transformers are not required. Either two or three separate current transformers must be used. All IQ power monitors are communications capable. Refer to **Section 3** of the *Cutler-Hammer Consulting Application Guide, 13th Edition* for further details.

Communications — PowerNet



Central Monitoring Unit

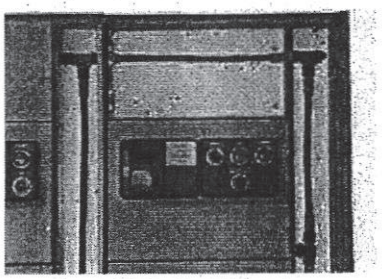
The Advantage MCC is available with the PowerNet communications network. PowerNet network capable devices, such as Advantage starters, the IQ family of metering devices, addressable relays, energy sentinels and many others, can be connected together with one twisted pair PowerNet communications network. Advantage starters may be controlled and monitored from remote locations. 3-phase motor running current, control voltage, elapsed time, start count and overload status information is available on the network.

Central Monitoring Unit (CMU) For Advantage MCCs, a Central Monitoring Unit can be installed to provide centralized motor monitoring for an entire MCC. Using a PowerNet communications network, all Advantage starters with WPONI network modules are serially connected to the CMU via one shielded twisted pair network. At the CMU, motor running data as well as start/stop and overload status can be conveniently monitored.

Parameters Displayed

- Monitored values:
  - Device description
  - I_A, I_B, I_C currents
  - Control voltage
  - Present time, date
  - Resettable operation unit
  - Run time, hours
- Trip data — current values and cause of trip.
- Set points:
  - Device size
  - OL trip current setting (FLA setting)
  - OL trip class
  - Ground fault protection — ON/OFF
  - Phase loss/unbalance protection — ON/OFF
  - Reset mode — Auto/Manual Frequency

Communications — DeviceNet



DeviceNet Wiring

Freedom and Advantage MCCs are available with DeviceNet Communications. DeviceNet is a device level open communication network linking DeviceNet capable control products, such as Advantage Starters, Freedom Starters, Adjustable Frequency Drives, PanelMate® 1700 Series and operator interfaces, DN50 I/O blocks, *IT.* soft starters and iPCs. These products are prewired in the MCC with DeviceNet cable. Available control and monitoring features of Advantage Starters and SV9000 drives include:

- ON/OFF control.
- Control voltage.
- Trip reset.
- Trip indication.
- Cause of trip.
- Thermal capacity.
- 3-phase or average motor current.
- Various drive parameters.
- Overload warning.

Available control and monitoring features of Freedom Starters and *IT.* Solid State Reduced Voltage include:

- ON/OFF control.
- Overload trip indication.
- RUN status.
- Disconnect status.

The DeviceNet specification is controlled by the Open Device Vendors Association (ODVA). The DeviceNet system can be controlled from:

- iPC (industrial personal computer) PC-based control software.
- DeviceNet scanner cards designed for leading PLC and DCS systems.

Harmonic Correction

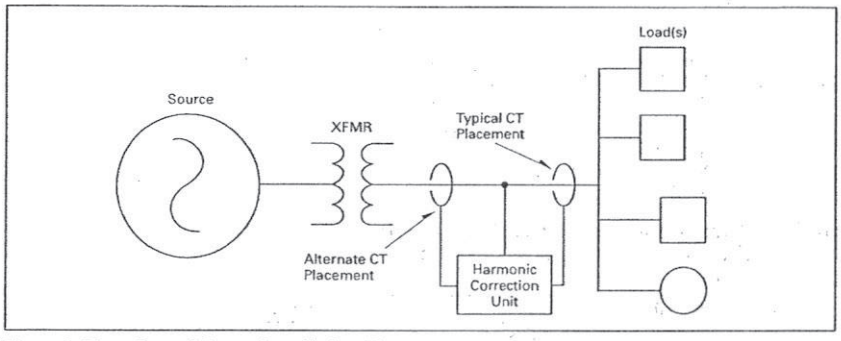


Figure 1. Clean Control Center Installation Diagram

The Clean Control Center utilizes a harmonic correction unit to provide harmonic cancellation directly on the Motor Control Center Horizontal Bus. The harmonic correction unit senses the load current and injects into the ac lines a synthesized waveform that is inverted compared to the remaining signal. The result is a clean waveform as seen by the upstream electrical system. Single or multiple harmonic correction units may be applied within a Clean Control Center providing an economical solution to excessive harmonics due to ac drives or other non-linear loads. Use of the Clean Control Center will provide compliance to the most stringent 5% Total Demand Distortion (TDD) requirements of IEEE 519. Clean Control Center assemblies include a 24-inch (609.6 mm) wide MCC structure, Active Harmonic Correction Unit, Current Transformers and a doormounted digital interface panel.

PLCs

Programmable Controllers can be mounted in Freedom Series 2100 and Advantage MCCs in a wide variety of configurations. Popular mounting configurations include small PLCs unit mounted to replace relays, medium sized PLCs with I/O for control of an MCC lineup, and remote I/O drops mounted in an MCC and connected to the main CPU via coaxial cable. Due to the flexibility of PLCs and the wide variety of applications and configurations, the Freedom Series 2100 and Advantage MCCs are designed to meet the mounting requirements of most applications.

Motor Protection

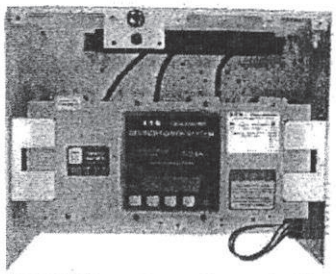
The **CEP7** Solid-State Overload Relay offers improved motor protection due to high repeat accuracy and fast reaction times to phase failures. The state-of-the-art microelectronics design permits the choice of relays with different trip classes (Class 10, 20) to accom-modate motors with a variety of application needs.

The CEP7 Solid-State overload is available on all starter sizes. (Size 5 and up utilize CTs with the overload relay.) Key features include:

- Phase loss
- Phase imbalance
- Wide adjustment range
- Low energy usage
- Reduced heat

The **MP-3000** Motor Overload Relay is a microprocessor-based relay which provides superior motor protection for critical process motors. Standard protective features provided in the MP-3000 include: I^2t with programmable locked rotor protection, instantaneous overcurrent, ground fault, underload, jam, phase loss/unbalance/reversal, limit starts/hr, alarm and trip modes and capability to utilize RTDs for motor protection. Functions are user programmed via a data entry and display panel mounted in the door of the Freedom Series 2100. Alarm and Trip contacts are provided for remote indication. In addition, the MP-3000 will have the capability for remote monitoring via a communications port. The ultimate in motor protection is available in the MP-3000 and the Series 2100 MCC.

TVSS (Clipper Surge Protection)



TVSS (Clipper Power System) with Circuit Breaker Disconnect

Visor Series TVSS Units feature advanced Thermodynamic Fusing Technology and Intelligent Monitor Options in 12, 18-inch space factors. All TVSS units (100 – 500 kA) meet UL 449, 2nd edition and UL 1283. Internal fuse protection is up to 200 kAIC.

Standard MCC offering includes SuperVisor Monitoring Display with power quality meter for volts, sag, swell, outage, transient counter, Form C contact, alarm enable and disable.

Additional Services

Startup Assistance

To ensure complete customer satisfaction and to expedite equipment startup for Motor Control Centers, this service provides a factory-trained representative at the job-site during equipment energization. This service is provided on a fixed price basis. In addition to factory directed startup, the standard equipment warranty is extended for a period of 24 months. This service is especially beneficial when solid-state equipment is incorporated within the MCC due to the flexibility in adjusting solid-state equipment for each application.

Maintenance and Operational Training

A full range of Training and Operational Training programs are available for all types of MCC mounted equipment. In addition, Preventative Maintenance programs are available to ensure years of trouble-free operation.

Seismic Qualification

Seismic testing has been completed for Freedom and Advantage MCCs. Freedom and Advantage MCCs are qualified for UBC® Seismic Zones 1 and 2, IBC and CBC without modification. For Seismic Zones 3 and 4, additional end plates are required.

Note: Contact the Cutler-Hammer business for availability of seismically qualified MCC.

Retrofits

Existing installations can many times benefit from some of the "new" technology equipment available in today's MCCs. The Cutler-Hammer business offers a full range of retrofit capabilities to upgrade existing MCC lineups. Examples include: vacuum contactors, reduced voltage solid-state starters, solid-state metering and solid-state overload protection. Starter retrofit kits for selective competitor MCCs are also available. Consult factory for availability.

Technical Data

Table 1. Short Circuit Ratings for Motor Control (480 Volt)

Short Circuit Protective Device	Combination Starter FV and RV (kA)	Solid-State Reduced Voltage	Adjustable Frequency Drives
HMCP Motor Circuit Protector (Standard Rating)	65	65	65
HMCP Motor Circuit Protector (Optional Rating)	100	100	100
MCCB Molded Case Circuit Breaker (Standard Rating)	65	65	65
MCCB Molded Case Circuit Breaker (Optional Rating)	100	—	100
Fusible Switch	100	100	100

Table 2. Combination Starters with Series C Motor Circuit Protectors or Molded Case Circuit Breakers — Dimensions in Inches (mm)
Motor Circuit Protector Ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP Frame ①	MCCB Frame ②	Freedom Unit Size		Advantage Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space	Inches (mm)	X Space
Full Voltage Non-Reversing								**Type F206**		**Type W206**	
								6 (152.4) ③	1X ③	6 (152.4) ③	1X ③
							HFD/FDC	12 (304.8) ④	2X ④	12 (304.8) ④	2X ④
1	7.5	7.5	10	10	10	150	HFD/FDC	18 (457.2)	3X	18 (457.2)	3X
										6 (152.4) ③	1X ③
							HFD/FDC	12 (304.8) ④	2X ④	12 (304.8) ④	2X ④
2	10	15	25	25	25	150	HFD/FDC	18 (457.2)	3X	18 (457.2)	3X
							HFD/FDC			12 (304.8) ③	2X ③
							HFD/FDC	18 (457.2) ⑤	3X ⑤	18 (457.2) ⑤	3X ⑤
3	25	30	50	50	50	150	HFD/FDC	24 (609.6)	4X	24 (609.6)	4X
							HFD/FDC			12 (304.8) ⑥	2X
							HFD/FDC	18 (457.2) ⑤⑥	3X ⑤	18 (457.2) ⑤⑥	3X ⑤
4	40	50	75	100	100	150	HJD/JDC	24 (609.6) ⑥	4X	24 (609.6) ⑥	4X
	50	60	100	125	150	250	HJD/JDC				
5	75	100	150	200	200	600	HKD/KDC	36 (914.4)	6X	36 (914.4)	6X
	25	100	250	300	400	600	HLD/LDC ⑪	48 (1219.2)	8X	42 (1066.8)	7X ⑩
6	150			350	—						
		200	300	400	—	1200	HND	72 (1828.8) ⑦	12X	60 (1524.0)	10X
7	—	300	—	600	600	1200	HND	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
Full Voltage Non-Reversing — Dual Unit ⑧								**Type F246**		**Type W246**	
1	7.5	7.5	10	10	10	150	HFD/FDC	18 (457.2)	3X	18 (457.2)	3X
2	10	15	25	25	25	150	HFD/FDC	18 (457.2)	3X	18 (457.2)	3X
Full Voltage Reversing								**Type F216**		**Type W216**	
								18 (457.2) ⑤	3X ⑤	18 (457.2) ⑤	3X ⑤
1	7.5	7.5	10	10	10	150	HFD/FDC	24 (609.6)	4X	24 (609.6)	4X
								18 (457.2) ⑤	3X ⑤	18 (457.2) ⑤	3X ⑤
2	10	15	25	25	25	150	HFD/FDC	24 (609.6)	4X	24 (609.6)	4X
3	25	30	50	50	50	150	HFD/FDC	24 (609.6) ⑨	4X	24 (609.6) ⑨	6X
4	40	50	75	100	100	150	HJD/JDC	30 (762.0) ⑨	5X	30 (762.0) ⑨	5X
	50	60	100	125	150	250	HJD/JDC				10X
5	75	100	150	200	200	600	HKD/KDC	60 (1524.0)	10X	60 (1524.0)	
	125	100	250	300	400	600	HLD/LDC	72 (1828.8) ⑦	12X	72 (1828.8)	12X
6	150	200	300	400	—	1200	HND ⑫	72 (1828.8) ⑫	12X ⑫	72 (1828.8) ⑬	12X ⑬

① Standard Combination Starter Units with HMCP Magnetic Only disconnect have short circuit ratings of 65,000 amperes at 480 volts. Optional HMCP combination starter units are available with 100,000 amperes at 480 volts.
② Optional Combination Starter Units with Thermal-Magnetic breaker disconnects are available with either 65,000 amperes or 100,000 amperes at 480 volts.
③ Maximum of (3) pilot devices, (2) auxiliary contacts; 100 VA CPT maximum. Standard lugs only.
④ 12-inch (304.8 mm)/2X unit is standard.
⑤ 18-inch (457.2 mm)/3X unit is standard.
⑥ Minimum 30-inch (762.0 mm) space needed with Thermal-Magnetic Circuit Breaker.
⑦ Requires 28-inch (711.2 mm) wide structure.
⑧ Limited options. Two starter units share common door.
⑨ 30-inch (762.0 mm) space needed for Thermal-Magnetic Circuit Breaker.
⑩ For top entry, 8X space required.
⑪ 1200A HMCP frame available in 11X 66-inch (1676.4 mm).
⑫ Requires 36-inch (914.4 mm) wide structure.
⑬ Requires 28-inch (711.2 mm) wide structure.

Note: For HMCP continuous ampere ratings by Motor hp, see **Table 81** on **Page 39**.

Table 2. Combination Starters with Series C Motor Circuit Protectors or Molded Case Circuit Breakers (Continued)

NEMA Size	Maximum Horsepower					HMCP Frame ①	MCCB Frame ②	Freedom Unit Size		Advantage Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space	Inches (mm)	X Space
Two-Speed One Winding, Constant/Variable Torque								**Type F946**		**Type W946**	
1	7.5	7.5	10	10	10	150	HFD/FDC	24 (609.6) ③	4X	24 (609.6) ③	4X
2	10	15	25	25	25	150	HFD/FDC	24 (609.6) ③	4X	24 (609.6) ③	4X
3	25	30	50	50	50	150	HJD/JDC	36 (914.4) ③④	6X	36 (914.4) ③④	6X
4	40	50	75	100	100	150	HJD/JDC	36 (914.4) ③④	6X	36 (914.4) ③④	6X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72 (1828.8) ⑤	12X	72 (1828.8) ⑤	12X
Two-Speed Two Winding, Constant/Variable Torque								**Type F956**		**Type W956**	
1	7.5	7.5	10	10	10	150	HFD/FDC	24 (609.6)	4X	24 (609.6) ③	4X
2	10	15	25	25	25	150	HFD/FDC	24 (609.6)	4X	24 (609.6) ③	4X
3	25	30	50	50	50	150	HFD/FDC	30 (762.0)	5X	30 (762.0) ③	5X
4	30 40	40 50	60 75	75 100	100 —	150 250	HFD/FDC HJD/JDC	30 (762.0) 30 (762.0) ⑥	5X 5X	30 (762.0) ③ 30 (762.0) ③	5X 5X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72 (1828.8) ⑤	12X	72 (1828.8) ⑤	12X
Reduced Voltage Autotransformer								**Type F606**		**Type W606**	
2	10	15	25	25	25	150	HFD/FDC	36 (914.4)	6X	36 (914.4)	6X
3	25	30	50	50	50	150	HFD/FDC	48 (1219.2)	8X	54 (1371.6)	9X
4	30	50	75	100	100	150	HJD/JDC	54 (1371.6)	9X	54 (1371.6)	9X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72 (1828.8)	12X	72 (1828.8)	12X
6	150	200	300	400	400	600	HLD/LDC	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
7	—	300	—	600	600	1200	HND	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
Reduced Voltage Part Winding								**Type F706**		**Type W706**	
1PW	10	10	15	15	15	150	HFD/FDC	24 (609.6)	4X	24 (609.6) ⑧	4X
2PW	20	25	40	40	40	150	HFD/FDC	24 (609.6)	4X	24 (609.6) ⑧	4X
3PW	40	50	75	75	75	150	HFD/FDC	30 (762.0)	5X	30 (762.0) ⑧	5X
4PW	— 60 75	— 60 75	— 125 150	100 150 —	125 150 —	150 250 400	HFD/FDC HJD/JDC HKD/KDC	36 (914.4) ⑧	6X	36 (914.4) ⑧	6X
5PW	100 150	125 150	— 250	250 350	300 350	400 600	HKD/KDC HLD/LDC	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
Reduced Voltage Wye Delta Open Transition								**Type F806**		**Type W806**	
2YD	20	25	40	40	40	150	HFD/FDC	30 (762.0)	5X	30 (762.0)	5X
3YD	30 40	40 50	75 —	75 —	75 —	150 250	HFD/FDC HJD/JDC	42 (1066.8)	7X	42 (1066.8)	7X
4YD	60 —	75 —	125 150	150 —	150 —	250 400	HJD/JDC HKD/KDC	48 (1219.2)	8X	42 (1066.8)	7X
5YD	100 150	125 150	200 250	250 300	300 —	400 600	HKD/KDC HLD/LDC	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
Reduced Voltage Wye Delta Closed Transition								**Type F896**		**Type W896**	
2YD	20	25	40	40	40	150	HFD/FDC	42 (1066.8)	7X	42 (1066.8)	7X
3YD	40	50	—	—	—	250	HFD/FDC	54 (1371.6)	9X	54 (1371.6)	9X
4YD	60 —	75 —	125 150	150 —	150 —	250 400	HJD/JDC HKD/KDC	60 (1524.0)	10X	60 (1524.0)	10X
5YD	100 150	125 150	200 250	250 300	300 —	400 600	HKD/KDC HLD/LDC	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X

① Standard Combination Starter Units with HMCP Magnetic Only disconnect have short circuit ratings of 65,000 amperes at 480 volts. Optional HMCP combination starter units are available with 100,000 amperes at 480 volts.

② Optional Combination Starter Units with Thermal-Magnetic breaker disconnects are available with either 65,000 amperes or 100,000 amperes at 480 volts.

③ Add 6-inch (152.4 mm) space for low speed disconnect.

④ 42-inch (1066.8 mm) space needed with Thermal-Magnetic Circuit Breaker. 48-inch (1219.2 mm) space needed with Thermal-Magnetic Circuit Breaker.

⑤ Requires 28-inch (711.2 mm) wide structure.

⑥ 36-inch (914.4 mm) space needed for Thermal-Magnetic Circuit Breaker.

⑦ Requires 21-inch (533.4 mm) deep, 28-inch (711.2 mm) wide structure.

⑧ For starting speed disconnect, add 6-inch (152.4 mm) space.

Intelligent Technologies *IT.* Solid-State Reduced Voltage Starter — HMCP

The *IT.* solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The *IT.* solid-state starter has five 24 Vdc inputs and two relay outputs. *IT.* soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

Motor Service Factor (SF) Effect on *IT.* Starter Selection

- A 1.0 service factor motor may draw up to 1.00 x full load amperes.
- A 1.15 service factor motor may draw up to 1.15 x full load amperes. (15% more current.)
- *IT.* starters are current rated devices. In some cases, a larger *IT.* SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below.

Table 3. Standard Duty Ratings — Motor Circuit Protector Disconnect

Ampere Rating	*IT.* Width (mm)	Maximum Horsepower or (kW)										HMCP/ MCCB Frame	Unit Size Inches (mm)
		208 V		240 V		380 V		480 V		600 V			
		1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF		
HMCP ①													
37	65	10	10	10	10	15	18.5	20	25	30	30	100	12
66		15	20	20	20	30	30	40	50	50	60	100	(304.8)
105	110	30	30	30	40	45	55	60	75	75	100	150	18
135		40	40	40	50	—	—	75	100	100	125	150	(457.2)
135		—	—	—	—	55	75	—	—	—	—	250	
180	200	—	—	60	60	—	—	—	—	150	150	250	36
180		50	60	—	—	75	90	125	150	—	—	400	(914.4)
240		60	75	75	75	110	132	150	200	200	200	400	
304		75	100	100	100			200	250	250	300	400	
304		—	—	—	—	132	160	—	—	—	—	600	
360	290	125	125	125	150	160	200	—	—	300	350	600	54
420		150	150	—	—	200	220	300	350	350	450	600	(1371.6)
500		—	—	150	200	250	250	350	400	450	500	600	
650	290	200	200	200	250	315	375	450	500	600	600	1200	72
720		200	250	250	300	—	—	500	600	600	700	1200	(1828.8)
850		—	—	300	350	375	500	600	700	700	900	1200	
1000	290	—	—	350	400	500	560	700	800	900	1000	2000	72 ②③ (1828.8)
Thermal-Magnetic Circuit Breaker Disconnect ①													
37	65	10	10	10	10	15	18.5	20	25	30	30	150	12
66		15	20	20	20	30	30	40	50	50	60	150	(304.8)
105	110	30	30	30	40	45	55	60	75	75	100	150	18
135		40	40	40	50	55	75	75	100	100	125	225	(457.2)
180	200	—	—	—	—	—	—	—	—	150	150	250	36
180		50	60	60	60	75	90	125	150	—	—	250	(914.4)
240		60	75	75	75	110	132	150	200	200	200	400	
304		75	100	100	100	132	160	—	—	—	—	400	
304		—	—	—	—	—	—	200	250	250	300	600	
360	290	125	125	125	150	160	200	—	—	300	350	600	72
420		150	150	—	—	200	220	300	350	350	450	600	(1828.8)
500		—	—	150	200	250	250	350	400	450	500	600	
650	290	200	200	—	—	—	—	450	500	600	600	800	72
650		—	—	200	250	315	375	—	—	—	—	1200	(1828.8)
720		200	250	250	300	—	—	500	600	600	700	1200	
850		—	—	300	350	375	500	600	700	700	900	1200	
1000	290	—	—	350	400	500	560	700	800	900	1000	2000	72 ②③ (1828.8)

① Standard duty ampere rating. See rating chart below.
② 28-inch (711.2 mm) wide structure.
③ Bottom exit only. Top exit unit is 24 inches (609.6 mm) wide (rear is unusable).
Note: Most motors used in industrial applications are 1.15 Service Factor (SF).

Table 4. Option Sizing — Dimensions in Inches (mm)

IT. Width (mm)	Disconnect Type	Starter Size	Option Unit Size ⑤	Structure Width
Isolating Contactor				
65	HMCP, MCCB	1,2,3	24 (609.6)	20 (508.0)
110	HMCP, MCCB	3,4	36 (914.4)	20 (508.0)
110	HMCP, MCCB	5	54 (1371.6)	20 (508.0)
200	HMCP, MCCB	5,6	72 (1828.8)	20 (508.0)
290	HMCP, MCCB	6	72 (1828.8)	32 (812.8)
290	HMCP, MCCB	7	72 (1828.8)	48 (1219.2)
Bypass Starter				
65	HMCP, MCCB	1,2,3	24 (609.6)	20 (508.0)
110	HMCP, MCCB	3,4	36 (914.4)	20 (508.0)
110	HMCP, MCCB	5	54 (1371.6)	20 (508.0)
200	HMCP, MCCB	5,6	72 (1828.8)	24 (609.6)
290	HMCP, MCCB	6	72 (1828.8)	32 (812.8)
290	HMCP, MCCB	7	72 (1828.8)	48 (1219.2)

Note: Unit size includes space for *IT.* starter and option.

Table 5. Control Options

Extra 50 VA Control Power Transformer ④⑤
24 Vdc Control ④
Line or Load MOV Protection ④
Pump Control Option ④
DeviceNet Communications Module ④⑤

④ Option fits in standard unit space.
⑤ Option adds 6 inches (1X) to 37 and 66 ampere units.

Table 6. Standard Duty Ratings

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
300%	30 Seconds	3	Soft Start
500%	10 Seconds	3	Full Voltage
350%	20 Seconds	3	Wye Delta
480%	20 Seconds	2	80% RVAT
390%	20 Seconds	3	65% RVAT
300%	20 Seconds	4	50% RVAT

IT06 — Intelligent Technologies *IT.* Solid-State Reduced Voltage Starter — HMCP

The *IT.* solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The *IT.* solid-state starter has five 24 Vdc inputs and two relay outputs. *IT.* soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

Motor Service Factor (SF) Effect on *IT.* Starter Selection

- A 1.0 service factor motor may draw up to 1.00 x full load amperes.
- A 1.15 service factor motor may draw up to 1.15 x full load amperes. (15% more current.)
- *IT.* starters are current rated devices. In some cases, a larger *IT.* SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below.

Table 7. Severe Duty Ratings — Motor Circuit Protector Disconnect

Ampere Rating	*IT.* Width (mm)	Maximum Horsepower or (kW)										HMCP/ MCCB Frame	Unit Size Inches (mm)
		208 V		240 V		380 V		480 V		600 V			
		1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF		
HMCP ①													
22	65	5	5	5	7.5	7.5	11	10	15	15	20	100	12
42		10	10	10	15	18.5	22	25	30	30	40	100	(304.8)
65	110	15	20	20	20	22	30	40	50	50	60	100	18
80		—	—	—	—	37	37	—	—	—	—	100	(457.2)
80		20	25	25	30	—	—	50	60	60	75	150	
115	200	30	40	30	40	55	55	75	75	100	100	150	36
150		—	—	50	50	—	—	100	100	—	—	150	(914.4)
150		40	50	—	—	55	75	—	—	125	150	250	
192		—	—	—	—	90	90	—	—	—	—	250	
192		50	60	60	75	—	—	125	125	150	200	400	
240	290	60	75	—	—	110	132	150	200	—	—	400	54
305		75	100	100	100	132	160	200	250	250	300	400	(1371.6)
365		100	125	125	150	160	200	250	300	300	350	600	
420		125	150	—	—	200	220	300	350	350	450	600	
480		—	—	150	200	220	250	350	400	450	500	600	
525	290	—	—	—	—	—	—	350	450	—	—	600	72
													(1828.8)
600		—	—	—	—	—	—	450	500	500	600	1200	72 ②③
													(1828.8)
Thermal-Magnetic Circuit Breaker Disconnect ①													
22	65	5	5	5	7.5	7.5	11	10	15	15	20	150	12
42		10	10	10	15	18.5	22	25	30	30	40	150	(304.8)
65	110	15	20	20	20	22	30	40	50	50	60	225	18
80		20	25	25	30	37	37	50	60	60	75	225	(457.2)
115	200	30	40	30	40	55	55	75	75	100	100	400	36
150		40	50	50	50	55	75	100	100	125	150	400	(914.4)
192		50	60	60	75	90	90	125	150	150	200	400	
240	290	60	75	—	—	110	132	150	200	—	—	600	54
305		75	100	100	100	132	160	200	250	250	300	800	(1371.6)
365	290	100	125	125	150	160	200	250	300	300	350	1200	72
420		125	150	—	—	200	220	300	350	350	450	1200	(1828.8)
480		—	—	150	200	220	250	350	400	450	500	1200	
525		—	—	—	—	—	—	350	450	—	—	1200	
600	290	—	—	—	—	—	—	450	500	500	600	1200	72 ②③
													(1828.8)

① Severe duty ampere rating. See rating chart below.
② 28-inch (711.2 mm) wide structure.
③ Bottom exit only. Top exit unit is 24 inches (609.9 mm) wide (rear is unusable).
Note: Most motors used in industrial applications are 1.15 Service Factor (SF).

Table 8. Option Sizing — Dimensions in Inches (mm)

IT. Width (mm)	Disconnect Type	Starter Size	Option Unit Size ⑤	Structure Width
Isolating Contactor				
65	HMCP, MCCB	1,2,3	24 (609.6)	20 (508.0)
110	HMCP, MCCB	3,4	36 (914.4)	20 (508.0)
110	HMCP, MCCB	5	54 (1371.6)	20 (508.0)
200	HMCP, MCCB	5,6	72 (1828.8)	20 (508.0)
290	HMCP, MCCB	6	72 (1828.8)	32 (812.8)
290	HMCP, MCCB	7	72 (1828.8)	48 (1219.2)
Bypass Starter				
65	HMCP, MCCB	1,2,3	24 (609.6)	20 (508.0)
110	HMCP, MCCB	3,4	36 (914.4)	20 (508.0)
110	HMCP, MCCB	5	54 (1371.6)	20 (508.0)
200	HMCP, MCCB	5,6	72 (1828.8)	24 (609.6)
290	HMCP, MCCB	6	72 (1828.8)	32 (812.8)
290	HMCP, MCCB	7	72 (1828.8)	48 (1219.2)

Note: Unit size includes space for *IT.* starter and option.

Table 9. Control Options

Extra 50 VA Control Power Transformer ④⑤
24 Vdc Control ④
Line or Load MOV Protection ④
Pump Control Option ④
DeviceNet Communications Module ④⑤

④ Option fits in standard unit space.
⑤ Option adds 6 inches (1X) to 37 and 66 ampere units.

Table 10. Severe Duty Ratings

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
450%	30 Seconds	4	Soft Start
500%	10 Seconds	10	Full Voltage
350%	65 Seconds	3	Wye Delta
480%	25 Seconds	4	80% RVAT
390%	40 Seconds	4	65% RVAT
300%	60 Seconds	4	50% RVAT

Table 11. Combination Starters with Fusible Switches — Dimensions in Inches (mm)

NEMA Size	Maximum Horsepower					Switch Rating ①	Freedom Unit Size		Advantage Unit Size	
	208 V	240 V	380 V	480 V	600 V		Inches (mm)	X Space	Inches (mm)	X Space
Full Voltage Non-Reversing — Fusible							**Type F204**		**Type W204**	
1	7.5	7.5	10	10	10	30	6 (152.4) ⑪ 12 (304.8) ② 18 (457.2)	1X 2X ② 3X	6 (152.4) ⑪ 12 (304.8) ② 18 (457.2)	1X 2X ② 3X
2	10	15	25	25	25	60	12 (304.8) ② 18 (457.2)	2X ② 3X	12 (304.8) ② 18 (457.2)	2X ② 3X
3	25	30	50	50	50	100	24 (609.6)	4X	24 (609.6)	4X
4	40	50	75	100	100	200	36 (914.4)	6X	36 (914.4)	6X
5	75	100	150	200	200	400 ③	60 (1524.0)	10X	54 (1371.6)	9X
6	150	200	300	400	400	600	66 (1676.4) ④ 72 (1828.0) ⑤	11X 12X	60 (1524.0)	10X
Full Voltage Reversing — Fusible							**Type F214**		**Type W214**	
1	7.5	7.5	10	10	10	30	24 (609.6)	4X	24 (609.6)	4X
2	10	15	25	25	25	60	24 (609.6)	4X	24 (609.6)	4X
3	25	30	50	50	50	100	30 (762.0)	5X	30 (762.0)	5X
4	40	50	75	100	100	200	54 (1371.6)	9X	48 (1219.2)	8X
5	75	100	150	200	200	400	72 (1828.0) ⑥	12X	72 (1828.0) ⑥	12X
6	150	200	300	400	400	600	72 (1828.0) ⑥	12X	72 (1828.0) ⑥	12X
Two-Speed One Winding — Fusible							**Type F944**		**Type W944**	
1	7.5	7.5	10	10	10	30	24 (609.6)	4X	24 (609.6)	4X
2	10	15	25	25	25	60	24 (609.6)	4X	24 (609.6)	4X
3	25 25	30 30	— 50	30 50	50 50	60 100	36 (914.4)	6X	36 (914.4)	6X
4	— 40	— 50	— 75	— 100	60 100	100 200	60 (1524.0)	10X	54 (1371.6)	9X
5	75	100	150	200	200	400	72 (1828.0) ⑥	12X	72 (1828.0) ⑥	12X
Two-Speed Two Winding — Fusible							**Type F954**		**Type W954**	
1	7.5	7.5	10	10	10	30	24 (609.6)	4X	24 (609.6)	4X
2	10	15	25	25	25	60	30 (762.0)	5X	24 (609.6)	4X
3	— 25	— 30	— 50	— 50	30 50	60 100	30 (762.0)	5X	30 (762.0)	5X
	— 25	— 30	— 50	— 50	30 50	60 100	36 (914.4) ⑦	6X	36 (914.4)	6X
4	— 40	— 50	— 75	— 100	60 100	100 200	54 (1371.6) ⑧	9X	48 (1219.2)	8X
5	75	100	150	200	200	400	72 (1828.0) ⑥	12X	72 (1828.0) ⑥	12X
Reduced Voltage Autotransformer — Fusible							**Type F604**		**Type W604**	
2	10	15	25	25	25	60	36 (914.4)	6X	36 (914.4)	6X
3	25	30	50	50	50	100	60 (1524.0)	10X	54 (1371.6)	8X
4	40	50	75	100	100	200	72 (1828.0) ⑨	12X	72 (1828.0) ⑨	12X
5	75	100	150	200	200	400	72 (1828.0) ⑥	12X	72 (1828.0) ⑥	12X
6	150	200	300	400	400	600	72 (1828.0) ⑩	12X	72 (1828.0) ⑩	12X

① Combination fused starter units rated 100 kAIC short circuit current.
② 12-inch (304.8 mm)/2X unit is standard.
③ Certain items in unit option Groups B and C may require additional space. See **Page 27.**
④ For bottom entry of motor cables.
⑤ For top entry of motor cables.
⑥ Requires 28-inch (711.2 mm) wide structure.
⑦ Add 6-inch (152.4 mm) space for low speed fuses.
⑧ Add 12-inch (304.8 mm) space for low speed fuses.
⑨ Bottom 24-inch (609.6 mm) space in rear is unusable.
⑩ Requires 28-inch (711.2 mm) wide and 21-inch (533.4 mm) deep structure.
⑪ Maximum of (3) pilot devices, (2) auxiliary contacts; 100 VA CPT, standard lugs only.

Table 11. Combination Starters with Fusible Switches (Continued)

NEMA Size	Maximum Horsepower					Switch Rating ①	Freedom		Advantage	
							Unit Size		Unit Size	
	208 V	240 V	380 V	480 V	600 V		Inches (mm)	X Space	Inches (mm)	X Space
Reduced Voltage Part Winding — Fusible							**Type F704**		**Type W704**	
1PW	10	10	15	15	15	60	24 (609.6)	4X	24 (609.6)	4X
	—	15	25	30	40	60	24 (609.6)	4X	24 (609.6)	4X
2PW	20	25	40	40	—	100	24 (609.6)	4X	24 (609.6)	4X
	—	—	—	50	60	100	48 (1219.2)	8X	48 (1219.2)	8X
3PW	40	50	75	75	75	200	48 (1219.2)	8X	48 (1219.2)	8X
	50	—	100	100	150	200	54 (1371.6)	9X	48 (1219.2)	8X
4PW	75	75	150	150	—	400	54 (1371.6)	9X	48 (1219.2)	8X
	100	100	200	250	300	400				
5PW	150	150	250	350	350	600	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
Reduced Voltage Wye Delta Open Transition — Fusible							**Type F804**		**Type W804**	
	15	15	30	40	40	60			36 (914.4)	6X
2YD	20	25	40	—	—	100	36 (914.4)	6X	36 (914.4)	6X
	25	30	50	60	75	100				
3YD	40	50	75	75	—	200	54 (1371.6)	9X	54 (1371.6)	9X
	50	60	100	125	150	200			60 (1524.0)	10X
4YD	60	75	150	150	—	400	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
	100	125	200	250	300	400				
5YD	150	150	250	300	—	600	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
	—	—	—	—	350	400				
	—	200	350	400	500	600				
	250	250	400	500	700	800	72 (1828.8) ③	12X ③	72 (1828.8) ③	12X ③
6YD	300	350	500	700	700	1200				
Reduced Voltage Wye Delta Closed Transition — Fusible							**Type F894**		**Type W894**	
	15	15	30	40	40	60			48 (1219.2)	8X
2YD	20	25	40	—	—	100	48 (1219.2)	8X	48 (1219.2)	8X
	25	30	50	60	75	100				
3YD	40	50	75	75	—	200	66 (1676.4)	11X	66 (1676.4)	11X
	50	60	100	125	50	200	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
4YD	60	75	150	150	—	400	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
	100	125	200	250	300	400				
5YD	150	150	250	300	—	600	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
	—	—	—	—	350	400				
	—	200	350	400	500	600				
	250	250	400	500	700	800	72 (1828.8) ③	12X ③	72 (1828.8) ③	12X ③
6YD	300	350	500	700	700	1200				

① Combination fused starter units rated 100 kAIC short circuit current.
② Requires 28-inch (711.2 mm) wide structure.
③ Requires 28-inch (711.2 mm) wide and 21-inch (533.4 mm) deep section.

Intelligent Technologies *IT.* Solid-State Reduced Voltage Starter — Fusible Switch

The *IT.* solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The *IT.* solid-state starter has five 24 Vdc inputs and two relay outputs. *IT.* soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

Motor Service Factor (SF) Effect on *IT.* Starter Selection

- A 1.0 service factor motor may draw up to 1.00 x full load amperes.
- A 1.15 service factor motor may draw up to 1.15 x full load amperes. (15% more current.)
- *IT.* starters are current rated devices. In some cases, a larger *IT.* SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below.

Table 12. Standard Duty Ratings — Fusible Disconnect ①

Ampere Rating	*IT.* Width (mm)	Maximum Horsepower (kW)										Switch Rating	Unit Size Inches (mm)
		208 V		240 V		380 V		480 V		600 V			
		1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF		
37	65	10	10	10	10	15	18.5	20	25	30	30	30/60	18
66		15	20	20	20	30	30	40	50	50	60	100	(457.2)
105	110	30	30	30	40	45	55	60	75	75	100	200	30
135		40	40	40	50	55	75	75	100	100	125	200	(762.0)
180	200	50	60	60	60	75	90	125	150	150	150	400	60
240		60	75	75	75	110	132	150	200	200	200	400	(1524.0)
304		—	—	100	100	—	—	—	—	—	—	400	
304		75	100	—	—	132	160	200	250	250	300	600	
360	290	125	100	125	150	160	200	—	—	300	350	600	72
420		—	—	—	—	200	220	—	—	—	—	600	(1828.8)
420		150	125	—	—	—	—	300	350	350	450	800	
500		—	—	150	200	250	250	350	400	450	500	800	
650	290	200	200	200	250	315	375	450	500	600	600	1200	72
720		200	250	250	300	—	—	500	600	600	700	1200	(1828.8)
850		—	—	300	350	375	500	600	700	700	900	1200	
1000	290	—	—	350	400	500	560	700	800	900	1000	1200	72 ②③ (1828.8)

① Standard duty ampere rating. See rating chart below.
② 28-inch (711.2 mm) wide structure.
③ Bottom exit only. Top exit unit is 24 inches (609.6 mm) wide (rear is unusable).
Note: Most motors used in industrial applications are 1.15 Service Factor (SF).

Table 13. Control Options

Extra 50 VA Control Power Transformer ④
24 Vdc Control ④
Line or Load MOV Protection ④
Pump Control Option ④
DeviceNet Communications Module ④

④ Option fits in standard unit space.

Table 14. Standard Duty Ratings

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
300%	30 Seconds	3	Soft Start
500%	10 Seconds	3	Full Voltage
350%	20 Seconds	3	Wye Delta
480%	20 Seconds	2	80% RVAT
390%	20 Seconds	3	65% RVAT
300%	20 Seconds	4	50% RVAT

Table 15. Option Sizing for Isolating Contactor and Bypass Starter

IT. Width (mm)	Fused Switch Type	Starter Size	Option Unit Size (Inches) ⑤	Structure Width Inches (mm)
65	30/60/100 A	1,2,3	36 (914.4)	20 (508.0)
110	100 A	3	36 (914.4)	20 (508.0)
110	200 A	4	54 (1371.6)	20 (508.0)
200	400/800 A	5,6	72 (1828.8)	32 (812.8)
290	600/800 A	6	72 (1828.8)	36 (914.4)
290	800/1200 A	7	72 (1828.8)	64 (1625.6)

⑤ Unit size includes space for *IT.* starter and option.

Intelligent Technologies *IT.* Solid-State Reduced Voltage Starter — Fusible

The *IT.* solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The *IT.* solid-state starter has five 24 Vdc inputs and two relay outputs. *IT.* soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

Motor Service Factor (SF) Effect on *IT.* Starter Selection

- A 1.0 service factor motor may draw up to 1.00 x full load amperes.
- A 1.15 service factor motor may draw up to 1.15 x full load amperes. (15% more current.)
- *IT.* starters are current rated devices. In some cases, a larger *IT.* SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below.

Table 16. Severe Duty Ratings — Fusible ①

Ampere Rating	*IT.* Width (mm)	Maximum Horsepower (kW)										Switch Rating	Unit Size (Inches)
		208 V		240 V		380 V		480 V		575 V			
		1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF		
22	65	5	5	5	7.5	7.5	11	10	15	15	20	30/60	18
42		10	10	—	—	—	—	—	—	—	—	30/60	(457.2)
42		—	—	10	15	18.5	22	25	30	30	40	100	
65	110	15	20	20	20	22	30	40	50	50	60	200	30
80		20	25	25	30	37	37	50	60	60	75	200	(762.0)
115	200	—	—	—	—	—	—	75	75	100	100	200	60
115		30	40	30	40	55	55	100	100	—	—	400	(1524.0)
150		40	50	50	50	55	75	—	—	125	150	400	
192		50	60	60	75	90	90	125	150	150	200	400	
240	290	60	75	—	—	110	132	150	200	—	—	600	72
305		75	100	100	100	132	160	200	250	250	300	600	(1828.8)
365		100	125	125	150	160	200	250	300	300	350	800	
420		125	150	—	—	200	220	300	350	350	450	800	
480		—	—	—	—	220	250	—	—	—	—	800	
480		—	—	150	200	—	—	350	400	450	500	1200	
525		—	—	—	—	—	—	350	450	—	—	1200	
600	290	—	—	—	—	—	—	450	500	500	600	1200	72 ②③

① Severe duty ampere rating. See rating chart below.
② 28-inch (711.2 mm) wide structure.
③ Bottom exit only. Top exit unit is 24 inches (609.6 mm) wide (rear is unusable).
Note: Most motors used in industrial applications are 1.15 Service factor (SF).

Table 17. Control Options

Extra 50 VA Control Power Transformer ④
24 Vdc Control ④
Line or Load MOV Protection ④
Pump Control Option ④
DeviceNet Communications Module ④

④ Option fits in standard unit space.

Table 18. Severe Duty Ratings

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
450%	30 Seconds	4	Soft Start
500%	10 Seconds	10	Full Voltage
350%	65 Seconds	3	Wye Delta
480%	25 Seconds	4	80% RVAT
390%	40 Seconds	4	65% RVAT
300%	60 Seconds	4	50% RVAT

Table 19. Option Sizing for Isolating Contactor and Bypass Starter

IT. Width (mm)	Fused Switch Type	Starter Size	Option Unit Size (Inches) ⑤	Structure Width (Inches)
65	30/60/100 A	1,2,3	36 (914.4)	20 (508.0)
110	100 A	3	36 (914.4)	20 (508.0)
110	200 A	4	54 (1371.6)	20 (508.0)
200	400/800 A	5,6	72 (1828.8)	32 (812.8)
290	600/800 A	6	72 (1828.8)	36 (914.4)
290	800/1200 A	7	72 (1828.8)	64 (1625.6)

⑤ Unit size includes space for *IT.* starter and option.

AF91 Adjustable Frequency Drives

Maximum motor lead length is 500 feet (152 m). Drives are dual rated CT and VT with 150% Overload for 1 minute. Standard unit includes disconnect, 1% line reactor, 50 VA CPT, a 1.5% output reactor, and provisions for a control relay. Output reactor is not required if using an inverter duty motor.

- All AF91 units are Plug-in for 20-inch (508 mm) wide structures.
- Maximum motor lead length is 500 feet (152 m).
- Firmly connect each drive chassis to an earthed ground. Grounding conduit does not provide adequate grounding.
- Use separate conduit for output power conductors and digital and analog control signals. Within the MCC, care should be taken in routing power and control wiring.

Table 20. AF91 Adjustable Frequency Drives — Dimensions in Inches (mm)

Maximum Hp	Maximum Amperes	CB Type	Standard Unit Space		Typical Option Space		Maximum Option Space	
			Inches (mm)	X Space	Inches (mm)	X Space	Inches (mm)	X Space
460 V Application (+/- 10%)								
.5	1.5	HMCP	18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
1	2.5	or	18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
2	3.8	MCCB	18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
3	5.5		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
5	8.6		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
208/240 V Application								
.25	1.4	HMCP	18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
.5	2.6	or	18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
1	4	MCCB	18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
2	7.1		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
3	10		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
5	15.9		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)

Note: 3% line reactors should be used where Power Factor Correction Capacitors are an integral part of the MCC Line Power.

Table 21. AF91 Options

Description	Units with Space
Viewing Window	①②
Output Contactor	②③
Manual 3 Contactor Bypass	③④
3 or 5% Line Reactors ⑤	②③
Door Mounted Keypad	①②③
Door Mounted Display	③
Oversized CPT	②③
Fusible Disconnect	②③
Line Fuses	③④
Dual Overloads	②③
EMI Filter	③
1 Control Relay	①②③
2 Control Relays	②③
3 Control Relays	③

① Standard unit.
② Typical option unit.
③ Maximum option unit.
④ Only one of these options can fit in the typical option unit.
⑤ Three or 5% line reactors should be used where power factor correction capacitors are an integral part of the MCC lineup.

SV9000 1 – 30 Hp at 480 V Plug-in Adjustable Frequency Drive Units

All standard units include a disconnect, an ac choke, output reactor and a door-mounted keypad. All plug-in units have a built-in Dynamic Braking Circuit, M3 frame Standard unit drives do not include a CPT.

Note: Output reactor not included on 240 V units. Standard on 380 – 500 V drives up to 125 hp (CT rating).

CT: Constant Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute.

VT: Variable Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute.

Table 22. SV9000 Adjustable Frequency Drives — Dimensions in Inches (mm)

CT/VT Amperes	Nominal Hp CT/VT or (kW)	CB Type ①	Standard Unit Space	Standard Unit Space (X)	Typical Options Space ①	Typical Option Unit Space (X)	Maximum Option Unit Space	Maximum Option Unit Space (X)
200V – 230 V								
3.6	.75	HMCP	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
4.7	1	or	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
5.6	1.5	MCCB	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
7	2		18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
10	3		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
16	5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
22	7.5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
30	10		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X
43	15		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X
57	20		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X
380V – 415 V								
2.5	.75	HMCP	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
3.5	1.1	or	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
4.5	1.5	MCCB	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
6.5	2.2		18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
8	3		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
10	4		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
13	5.5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
18	7.5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
24	11		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
32	15		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X
42	18.5		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X
48	22		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X
440V – 500 V								
2.5	1	HMCP	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
3	1.5	or	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
3.5	2	MCCB	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
5	3		18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
8	5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
11	7.5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
15	10		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
21	15		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X
27	20		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X
34	25		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X
40	30		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X

① For fusible disconnect use typical option unit.

Note: Drive units fit into a standard 20-inch (508.0 mm) wide MCC structure.

Table 23. Plug-in Options

Plug-in Options	
Option Boards ②	
I/O Expander	⑨
Encoder Expander	③
Interbus S Communications	③
Modbus®-RTU Communications	③
PROFIBUS® Communications	③
Lonbus Communications	③
SDS™ Communications	③
DeviceNet Communications	④
Metasys® N2 Communications	③
Siemens® Apogee FLN Communications	③
Plug-in Control Relays	
1 Relay	⑤
2 Relays	⑤
3 Relays	⑥
Speed Pot	④
Speed Pot and HOA Selector Switch	④
Other Options	
Automatic Bypass Circuit	⑦
Bypass Drive Test Switch	⑦
7 Relay 120V Control W/CPT	⑤
Isolated Signal Processor	③
3-15 PSIG Interface	③
Dynamic Breaking Resistors	⑧
Graphics Keypad	④
Line Fuses	③⑤
RFI Filter	④
Deduct to Remove Output Filter	⑨
KLC 2000 ft. dV/dT Filter	⑥
Output Contactor	③
Dual Overloads	③⑥
3 Contactor Bypass	③⑥
Solid-State Starter Bypass	⑥
RWT Filter	
NEMA 1	⑩
NEMA 4X, Class 1, Division 2	⑩

② Only one option board per drive can be selected.

③ All options will fit in Typical and maximum option unit.

④ This option will fit in all units.

⑤ One of these options will fit in 5 –30 hp CT at 480 V frame standard units, 1 –30 hp CT at 480 V Typical and maximum option units.

⑥ All options will fit in maximum option unit.

⑦ Use with bypass option.

⑧ DB resistors are to be mounted by the customer external to the MCC.

⑨ Not available for 240 V units.

⑩ RWT is mounted at the motor. See **Section 35** of the *Cutler-Hammer Consulting Application Guide, 13th Edition* for Reflected Wave Trap (RWT).

Note: Output reactor or dV/dT filter not required for motor lead lengths shorter than 100 feet (30.4 m) — 30 feet (9.1 m) for 2 hp and below), or when a RWT filter is used at the motor.

Note: Maximum motor lead length is 160 feet (48.8 m) for 1.5 hp and below, 330 feet (100.6 m) for 2 hp and 400 feet (121.9 m) for 3 hp and larger when using a standard output reactor.

Note: Motor lead lengths up to 2000 feet (609.6 m) can be achieved by using the KLC dV/dT filter.

SV9000 30 – 200 Hp at 480 V Non-Plug-in Adjustable Frequency Drive Units

All standard units include a disconnect, a line reactor, output reactor and a door-mounted keypad. Standard units of 9X unit space must be located in the bottom of the MCC and there is no vertical bus in the lower 48 inches (1219.2 mm). There is no vertical bus for 12X units.

Note: Output reactor not included on 200 – 240 V units. Standard on 380 – 690 V drives up to 125 hp (CT rating).

CT: Constant Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute.

VT: Variable Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute.

Table 24. SV9000 Adjustable Frequency Drives — Dimensions in Inches (mm)

CT Amperes	Nominal Hp or CT (kW)	VT Amps	Nominal Hp or VT (kW)	CB Type ①	Standard Unit Space	Standard Unit Space (X)	Options Space	Drive Options Space (X)
200V – 230 V								
—	—	70	25	HMCP	54 (1371.6)	9X	72 (1828.8)	12X
70	25	83	30	or	54 (1371.6)	9X	72 (1828.8)	12X
83	30	113	40	MCCB	54 (1371.6)	9X	72 (1828.8)	12X
113	40	139	50		72 (1828.8)	12X	72 (1828.8) ③	12X
139	50	165	60		72 (1828.8)	12X	72 (1828.8) ③	12X
165	60	200	75		72 (1828.8)	12X	72 (1828.8) ③	12X
200	75	264	100		72 (1828.8) ②	12X	72 (1828.8) ④	12X
380V – 415 V, 50/60Hz								
—	—	60	30	HMCP	54 (1371.6)	9X	72 (1828.8)	12X
60	30	75	37	or	54 (1371.6)	9X	72 (1828.8)	12X
75	37	90	45	MCCB	54 (1371.6)	9X	72 (1828.8)	12X
90	45	—	—		54 (1371.6)	9X	72 (1828.8)	12X
—	—	110	55		72 (1828.8)	12X	72 (1828.8) ③	12X
110	55	150	75		72 (1828.8)	12X	72 (1828.8) ③	12X
150	75	180	90		72 (1828.8)	12X	72 (1828.8) ③	12X
180	90	—	—		72 (1828.8)	12X	72 (1828.8) ③	12X
—	—	210	110		72 (1828.8) ②	12X	72 (1828.8) ④	12X
210	110	270	132		72 (1828.8) ②	12X	72 (1828.8) ④	12X
270	132	325	160		72 (1828.8) ②	12X	72 (1828.8) ④	12X
325	160	410	200		72 (1828.8) ②	12X	72 (1828.8) ④	12X
440V – 500 V, 50/60 Hz								
—	—	52	40	HMCP	54 (1371.6)	9X	72 (1828.8)	12X
52	40	65	50	or	54 (1371.6)	9X	72 (1828.8)	12X
65	50	77	60	MCCB	54 (1371.6)	9X	72 (1828.8)	12X
77	60	96	75		54 (1371.6)	9X	72 (1828.8)	12X
96	75	125	100		72 (1828.8)	12X	72 (1828.8) ③	12X
125	100	160	125		72 (1828.8)	12X	72 (1828.8) ③	12X
160	125	180	150		72 (1828.8)	12X	72 (1828.8) ③	12X
180	150	—	—		72 (1828.8) ②	12X	72 (1828.8) ④	12X
—	—	250	200		72 (1828.8) ②	12X	72 (1828.8) ④	12X
260	200	320	250		72 (1828.8) ②	12X	72 (1828.8) ④	12X
525V – 690 V, 50/60 Hz								
4.5	3	—	—	HMCP	36 (914.4)	6X	72 (1828.8)	12X
—	—	7.5	5	or	36 (914.4)	6X	72 (1828.8)	12X
7.5	5	10	7.5	MCCB	36 (914.4)	6X	72 (1828.8)	12X
10	7.5	14	10		36 (914.4)	6X	72 (1828.8)	12X
14	10	19	15		36 (914.4)	6X	72 (1828.8)	12X
19	15	23	20		36 (914.4)	6X	72 (1828.8)	12X
23	20	26	25		36 (914.4)	6X	72 (1828.8)	12X
26	25	35	30		36 (914.4)	6X	72 (1828.8)	12X
35	30	42	40		54 (1371.6)	9X	72 (1828.8)	12X
42	40	52	50		54 (1371.6)	9X	72 (1828.8)	12X
52	50	62	60		54 (1371.6)	9X	72 (1828.8)	12X
62	60	—	—		54 (1371.6)	9X	72 (1828.8)	12X
—	—	85	75		72 (1828.8) ②	12X	72 (1828.8) ④	12X
85	75	100	100		72 (1828.8) ②	12X	72 (1828.8) ④	12X
100	100	122	125		72 (1828.8) ②	12X	72 (1828.8) ④	12X
122	125	145	150		72 (1828.8) ②	12X	72 (1828.8) ④	12X
145	150	—	—		72 (1828.8) ②	12X	72 (1828.8) ④	12X

① Drives with Fusible disconnects require drive with option space.
② 28-inch (711.2 mm) wide, 21-inch (533.4 mm) deep enclosure with bolt-in panel.
③ All options will fit in option unit.
④ 40-inch wide (1016.0 mm), 21-inch (533.4 mm) deep enclosure with bolt-in panel.

Table 25. Non Plug-in Options

Non Plug-in Options	
Option Boards ⑤	
I/O Expander	⑧
Encoder Expander	⑧
Interbus S Communications	⑥
Modbus-RTU Communications	⑥
PROFIBUS Communications	⑥
Lonbus Communications	⑥
SDS Communications	⑥
DeviceNet Communications	⑥
Metasys N2 Communications	③
Siemens Apogee FLN Communications	③
Plug-in Control Relays	
1 Relay	⑥
2 Relays	⑥
3 Relays	⑥
Speed Pot	④
Speed Pot and HOA Selector Switch	④
Other Options	
Automatic Bypass Circuit	⑦
Bypass Drive Test Switch	⑦
7 Relay 120 V Control W/CPT	⑥
Isolated Signal Processor	⑧
3-15 PSIG Interface	⑧
Dynamic Breaking Resistors	⑨
Graphics Keypad	⑥
Line Fuses	⑧
RFI Filter	⑧
Deduct to Remove Output Filter	⑩
KLC 1000 ft. dV/dT Filter	⑤
Output Contactor	⑧
Dual Overloads	⑧
3 Contactor Bypass	⑧
Solid-State Starter Bypass	⑤
Dynamic Breaking Circuit	⑤
RWT Filter	
NEMA 1	⑪
NEMA 4X, Class 1, Division 2	⑪

⑤ Only one option board per drive can be selected.
⑥ This option will fit in all units.
⑦ Use with bypass option.
⑧ All options will fit in option unit.
⑨ DB resistors are to be mounted by the customer external to the MCC.
⑩ Not available for 240 V units.
⑪ RWT is mounted at the motor.

Note: Output reactor or dV/dT filter not required for motor lead lengths shorter than 100 feet (30.4 m) — 30 feet (9.1 m) for 2 hp and below), or when a RWT filter is used at the motor.

Note: Maximum motor lead length is 160 feet (48.8 m) for 1.5 hp and below, 330 feet (100.6 m) for 2 hp and 400 feet (121.9 m) for 3 hp and larger when using a standard output reactor.

Note: Motor lead lengths up to 2000 feet (609.6 m) can be achieved by using the KLC dV/dT filter.

Note: Fusible units take option unit space. Not all options will fit in fusible units.

SV9000 200 – 1100 Hp at 480 V Multi-Structure Adjustable Frequency Drive Units

All standard units include a disconnect, a line reactor, and a door-mounted keypad. Disconnect and drive unit are in separate structures, structures are mechanically interlocked. Structures have no vertical bus. These drives are bottom exit only.

CT: Constant Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute.

VT: Variable Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute.

Table 26. SV9000 Adjustable Frequency Drives — Dimensions in Inches (mm)

CT Amperes	Nominal Hp or CT (kW)	VT Amperes	Nominal Hp or VT (kW)	CB Type ①	Standard Unit Space	Standard Unit Space (X)	Options Space	Drive Options Space (X)
380V – 415 V								
410	(200)	510	(250)	MCCB	72 (1828.8) ②	12X	72 (1828.8) ③	12X
510	(250)	580	(315)		72 (1828.8) ②	12X	72 (1828.8) ③	12X
600	(315)	750	(400)		72 (1828.8) ④	12X	⑤	12X
750	(400)	840	(500)		72 (1828.8) ④	12X	⑤	12X
840	(500)	1050	(630)		72 (1828.8) ⑥	12X	⑤	12X
1050	(630)	1270	(710)		72 (1828.8) ⑥	12X	—	—
1270	(710)	1330	(800)		72 (1828.8) ⑥	12X	—	—
1330	(800)	1460	(900)		72 (1828.8) ⑥	12X	—	—
1460	(900)	—	—		72 (1828.8) ⑥	12X	—	—
1600	(1000)	—	—		72 (1828.8) ⑥	12X	—	—
440V – 480 V								
320	250	400	300	MCCB	72 (1828.8) ②	12X	72 (1828.8) ③	12X
400	300	460	400		72 (1828.8) ②	12X	72 (1828.8) ③	12X
480	400	600	500		72 (1828.8) ④	12X	⑤	12X
600	500	672	600		72 (1828.8) ④	12X	⑤	12X
700	600	880	700		72 (1828.8) ⑦	12X	⑤	12X
880	700	1020	800		72 (1828.8) ⑥	12X	—	—
1020	800	1070	900		72 (1828.8) ⑥	12X	—	—
1070	900	1200	1000		72 (1828.8) ⑥	12X	—	—
1200	1000	—	—		72 (1828.8) ⑥	12X	—	—
1300	1100	—	—		72 (1828.8) ⑥	12X	—	—
500 – 575 V								
—	—	222	200	MCCB	72 (1828.8) ②	12X	72 (1828.8) ③	12X
222	200	287	250		72 (1828.8) ②	12X	72 (1828.8) ③	12X
287	250	325	300		72 (1828.8) ④	12X	⑤	12X
325	300	400	400		72 (1828.8) ④	12X	⑤	12X
400	400	490	500		72 (1828.8) ⑦	12X	⑤	12X
490	500	620	600		72 (1828.8) ⑥	12X	—	—
620	600	700	700		72 (1828.8) ⑥	12X	—	—
700	700	—	—		72 (1828.8) ⑥	12X	—	—
780	800	—	—		72 (1828.8) ⑥	12X	—	—

① Drives with fusible disconnects require drive with option space.
② 60-inch (1524.0 mm) wide unit. Drive is in a 40-inch (1016.0 mm) wide structure and disconnect is in a 20-inch (508.0 mm) wide structure.
③ 80-inch (2032.0 mm) wide unit. Drive is in a 40-inch (1016.0 mm) wide structure and disconnect is in a 40-inch (1016.0 mm) wide structure.
④ 68-inch (1727.2 mm) wide unit. Drive is in a 48-inch (1219.2 mm) wide structure and disconnect is in a 20-inch (508.0 mm) wide structure.
⑤ Contact factory for sizing.
⑥ 116-inch (2946.4 mm) wide unit. 96-inch (2438.4 mm) drive is in (2) 48-inch (1219.2 mm) wide structures, disconnect is in a 20-inch (508.0 mm) wide structure.
⑦ 100-inch (2540.0 mm) wide unit. 80-inch (2032.0 mm) drive is in (2) 40-inch (1016.0 mm) wide structures, disconnect is in a 20-inch (508.0 mm) wide structure.

Table 27. Multi-Structure Options

Options	
Option Boards ⑧	
I/O Expander	⑨
Encoder Expander	⑨
Interbus S Communications	⑨
Modbus-RTU Communications	⑨
PROFIBUS Communications	⑨
Lonbus Communications	⑨
SDS Communications	⑨
DeviceNet Communications	⑨
Metasys N2 Communications	③
Siemens Apogee FLN Communications	③
Plug-in Control Relays	
1 Relay	⑨
2 Relays	⑨
3 Relays	⑨
Other Options	
Automatic Bypass Circuit	⑩
Bypass Drive Test Switch	⑩
7 Relay 120 V Interface Board w/CPT	⑩
Isolated Signal Processor	⑪
3-15 PSIG Interface	⑪
Dynamic Breaking Resistors	⑫
Graphics Keypad	⑨
Line Fuses	⑨⑪
RFI Filter	⑪
KLC 1000 ft. dV/dT Filter	⑪⑭
Output Contactor	⑬⑪
3 Contactor Bypass	⑬⑪
Dynamic Breaking Circuit	⑨
RWT Filter	
NEMA 1	⑮
NEMA 4X, Class 1, Division 2	⑮

⑧ Only one option board per drive can be selected.
⑨ This option will fit in all units.
⑩ Use with bypass option.
⑪ All options will fit in Option unit.
⑫ DB resistors are to be mounted by the customer external to the MCC.
⑬ Consult factory for sizing and availability.
⑭ dV/dT filter not available 700 hp and above.
⑮ RWT is mounted at the motor. See **Section 35** of the *Cutler-Hammer Consulting Application Guide, 13th Edition* for Reflected Wave Trap (RWT).

Note: Output reactor or dV/dT filter not required for motor lead lengths shorter than 100 feet (30.4 m) — 30 feet (9.1 m) for 2 hp and below), or when a RWT filter is used at the motor.

Note: Maximum motor lead length is 160 feet (48.8 m) for 1.5 hp and below, 330 feet (100.6 m) for 2 hp and 400 feet (121.9 m) for 3 hp and larger when using a standard output reactor.

Note: Motor lead lengths up to 2000 feet (609.6 m) can be achieved by using the KLC dV/dT filter.

Note: Fusible units take option unit space. Not all options will fit in fusible units.

Unit Options for ac Combination Starters, ac Drives

Option Group A

Table 28. Wiring Class

Description
NEMA Class IA ① NEMA Class IC
NEMA Class IIB NEMA Class IIC NEMA Class IS (Includes 1B wiring and 2B schematics)

① Control Terminal Blocks and Device Panels not included with NEMA 1A wiring.

Table 29. 100 kA Circuit Breaker Starter Interrupting Capacity

Starter Type	Voltage
Starters with HMCPs Starters with Thermal Magnetic Circuit Breakers	480 480
Starters with HMCPs Starters with Thermal Magnetic Circuit Breakers	600 ② 600 ②

② Current Limiter Attachments are used. Add 6 inches (152.4 mm) to all size 3 and 4 starters.

Table 30. Control Circuit Transformers — Typical Sizing ③

Starter Size
1, 2 (100 VA) — Includes extra 50 VA 3, 4 (150 VA) — Includes extra 50 VA 5, 6 (250 VA) — Includes extra 50 VA
Extra 50 VA, Size 1, 2 Extra 100 VA, Size 3, 4 Extra 150 VA, Size 5, 6

③ Refer to **Table 79** for actual ratings.
Note: Price includes 1 secondary and 2 primary fuses.

Table 31. Control Circuit Fusing

Description
Control Fuse and Auxiliary Switch Control Fuse Blown Fuse Indicator

Note: Required in accordance with NEC for all starter units with control wiring external to the MCC. See NEC, General for exceptions.

Table 32. Motor Starter Auxiliary Contacts

Description	
1NO or 1NC (Size 1-4) 1NO or 1NC (Size 5-6)	Maximum of eight on each contactor ④ Maximum of four on each contactor

④ Maximum of 4 per contactor on multi-contactor starters and 6-inch (152.4 mm) units.

Table 33. Interlock for Switch or Breaker Operator

Description
1NO – 1NC 2NO – 2NC

Note: For use when control circuit is fed from an external source.

Table 34. Internal Circuit Breaker Options

Description
Alarm Contact Auxiliary 1NO – 1NC Auxiliary 2NO – 2NC 120 Volts Shunt Trip 50°C (Thermal Magnetic)

Table 35. Terminal Blocks

Description	
Side Mounted (Will accept stripped wire or ring/spade wire lug –14 AWG wire maximum)	
Front Rail – Pressure Connector Front Rail – Pull Apart Front Rail – Utility/Accepts ring wire lug.	Additional 6-inch (152.4 mm) space required for Freedom Starters Size 1 – 4

Table 36. Control Wire Options

Description
#16 AWG (standard) #14 AWG Wire Markers
Spade Wire Terminals Ring Wire Terminals ⑤ Wiring to Common CPT
SIS Power Wire – Substitution SIS Control Wire – Substitution Starter Class 2 Interwiring/Per Wire

⑤ Freedom Starter control terminals only available with spade wire terminals.

Table 37. Miscellaneous Options

Description
Mini Ammeter and CT ⑥ Mini Voltmeter Mini Elapsed Time Meter
Panel Elapsed Time Meter ⑦ Operations Counter Wiring Diagram on Door Coil Surge Suppressor
CT for Remote Metering (Requires additional 6-inch (152.4 mm) space) Heater Packs Installed Device Labels Blank Device Panels

⑥ May add 6 inches (152.4 mm) to unit size. Consult factory.
⑦ May add 6 inches (152.4 mm). Consult factory.

Table 38. Vacuum Contactors in Lieu of Air Break

Starter Type
FVNR FVR, 2S2W, PW RVAT, 2S1W, YD-Open YD-Closed

Table 39. Ground Fault Protection — Instantaneous or Adjustable

Description	
Earth Leakage Breakers Size 1-4 Earth Leakage Breakers Size 5 GRT1 Size 1-4 GRT1 Size 5-6	All require additional 6-inch (152.4 mm) space

Table 40. Power Fuses — R, J Type

Ampere Rating
30 60 100
200 400 600

Table 41. Power Factor Capacitor Options

Description
Blown Power Fuse Indicator (Set of 3-1 Per Phase)

Table 42. Current Limiter Attachment for HMCP

Description	
Size 1-2 Size 3 Size 4	— Requires additional 6-inch (152.4 mm) space Requires additional 6-inch (152.4 mm) space

Option Group B

Devices may require extra unit space.

Table 43. Timing Relays

Type of Relay	Mounting
Solid-State Timer Pneumatic — AGASTAT	Panel Panel On or Off Delay
24 Hour Motor Timer 7 Day Timer Repeat Cycle Timer	Panel Panel Door or Panel

Table 44. Control Relays

Number of Poles	Type
2-Pole 4-Pole	General Purpose Type D7 Socket Relay N300 Fixed Contacts
2-Pole 4-Pole 6-Pole 8-Pole 10-Pole	Type AR Machine Tool Relays N600 Convertible Contacts
2-Pole 3-Pole 4-Pole 6-Pole ① 8-Pole ①	Type M — D26 Relays N600 Convertible Contacts

① The 6- and 8-pole units can be provided with 4 additional non-convertible NO contacts.

Table 45. Alternators

Description	
2-Circuit Alternator 3-Circuit Alternator	Panel (Additional 6-inch (152.4 mm) space required on size 1s and size 2s)

Option Group C

Devices may require extra unit space.

Table 46. Monitoring Relays

Type of Relay		
D60LA Current Sensing Voltage Transducer	— Price Includes 1 PT	Additional 6-inch (152.4 mm) space required
ac Current Sensors with CTs ②	0 – 5 A Thru 0 – 100 A 0 – 50 A Thru 0 – 300 A 0 – 300 A Thru 0 – 600 A	
ac Current Transducer, 4 – 20 mA, Self-powered with CTs ③	All Ratings	
Phase Monitoring Relay — 3-Phase Watt Transducer, 4 – 20 mA, Self-powered CTs ③		

② Loop powered devices — requires 24 Vdc power source which is typically provided in the PLC.

③ Does not require separate 24 Vdc power source. Suitable for powering analog meters.

Table 47. Extra Bi-Metallic Overload Relay — Type C306

Description
Size 1 — 32 Amperes Overload Relay Size 2 — 75 Amperes Overload Relay Size 3 — 100 Amperes Overload Relay Size 4 — 144 Amperes Overload Relay

Option Group D

Devices may require extra unit space.

Table 48. Solid-State Overload Relays

Description
CEP7 Solid-State Overload MP-3000 Motor Protector MP-3000 RTD Module IQ 500 Relay ④ IQ 500M Load Protection ④⑤⑥

④ Requires thermal-magnetic disconnect.

⑤ Includes LAM, JAM, ULM functions with 2 dry contacts.

⑥ Requires a 120 V source.

⑦ Size 4 starters require an additional 6-inch (152.4 mm) (1X) space. When used with CEP7 Solid-State Overload.

Option Group E

Table 49. Oiltight Pushbuttons, Lights, Selector Switches

Device	Device Type
Pushbuttons 1 Unit 2 Unit 3 Unit	10250T ①②
Selector Switches 2 Position 3 Position 4 Position Key Operated Adder	
Pilot Lights Standard XFMR 6 Volt Bulb Standard XFMR LED Bulb Push to Test XFMR 6 Volt Bulb Push to Test LED Bulb	
Pushbuttons 1 Unit 2 Unit 3 Unit	E30 ①②
Selector Switches 2 Position 3 Position 4 Position Key Operated Adder	
Pilot Lights Standard XFMR 6 Volt Bulb Standard XFMR LED Bulb Push to Test XFMR 6 Volt Bulb Push to Test LED Bulb	

① Maximum 2 devices per starter in dual units.
② Maximum of 6 devices without increasing compartment space.

Option Group F

Options for 6-inch Starter Units

- Control terminal blocks are 300 volt rated and are limited to 12 points maximum.
- Standard VA control transformer only.

Table 50. Oiltight Pushbuttons, Lights, Selector Switches

Device	Device Type
Pushbuttons 1 Unit 2 Unit 3 Unit	E22 ③
Selector Switches 2 Position 3 Position 4 Position Key Operated Adder	
Pilot Lights Standard XFMR 6 Volt Bulb Standard XFMR LED Bulb Push to Test XFMR 6 Volt Bulb Push to Test LED Bulb	

③ On 6-inch (152.4 mm) starter units, pilot devices are limited to (3) E22 devices.

Cutler-Hammer dc Motor Control Center

UL listed dc MCCs use combination circuit breaker dc starters suitable for motor starting duty only. Using Cutler-Hammer type ME dc definite purpose contactors, all dc starters are suitable for up to 250 Vdc and have a 22 kA withstand rating. Class 135 starting resistors for reduced voltage starters are sized for 200% starting current. Typical applications include emergency lube oil pumps, emergency seal oil pumps and emergency turning gear motors.

Table 51. Cutler-Hammer dc Motor Control Center — HCMP or Thermal Magnetic Circuit Breaker

dc Starters HMCP or Thermal Magnetic Circuit Breaker	Interr-upting Capacity	Hp		MCCB	Unit Size ① Inches (mm)	X Space
		125 Vdc	250 Vdc			
Full Voltage Non-Reversing Size 1	22 kAIC	3	5	150	30 (762.0)	5X
Full Voltage Reversing Size 1					36 (914.4)	6X
Reduced Voltage Non-Reversing Size 2		5	10		30 (762.0) ②	5X
Reduced Voltage Non-Reversing Size 3		10	20		42 (1066.8) ②	7X
Reduced Voltage Non-Reversing Size 4		20	40	250	48 (1219.2) ②	8X

① Not available in NEMA 3R enclosures.
② 21-inch (533.4 mm) deep structure required. Rear is unusable.

Table 52. Cutler-Hammer dc Motor Control Center — Model K Fused Switch (RK5 Fuses not Included)

dc Starters ③ Model K Fused Switch (RK5 Fuses not Included)	Hp		Switch Size	Unit ④ Size Inches (mm)	X Space
	125 Vdc	250 Vdc			
Full Voltage Non-Reversing Size 1	3	5	30A	36 (914.4)	6X
Full Voltage Reversing Size 1				42 (1066.8)	7X
Reduced Voltage Non-Reversing Size 2	5	10	60A	48 (1219.2) ⑤	8X
Reduced Voltage Non-Reversing Size 3	10	20	100A	60 (1524.0) ⑤	10X
Reduced Voltage Non-Reversing Size 4	20	40	200A	72 (1828.8) ⑤	12X

③ Fused switch units are not UL listed.
④ Not available in NEMA 3R enclosures.
⑤ 21-inch (533.4 mm) deep structure required. Rear is unusable.

Table 53. Options

400% Starting Torque Resistors
Ammeter and dc Shunt. Starter Mounted
Ammeter and dc Shunt. Incoming Line ⑥
Negative Side Line Contactor
Negative Overload Relay
Shunt Field Discharge Resistor

⑥ Add 2X space.

Table 54. Standards

200% Starting Torque Resistors
MME dc Contactors
Positive Side Contactor and Overload Relay Only
Bus Systems for dc Motor Control Centers are 2-phase. The B-phase Bus Bar is Removed
Reduced Voltage Starters include NEMA Class 135 Edgewound Power Resistors
MCC Plug-in Combination dc Starters
UL 845 Listed

Table 55. Incoming Line and Feeder Circuit Breakers — Molded Case Circuit Breakers — Dimensions in Inches (mm)

Frames reflect standard circuit breakers. Unit spacings shown include sufficient space to terminate cables on any standard breaker lug. If cable sizes exceed those listed, add 12-inch (304.8 mm) space for lug adapters.

Frame Size (Amperes)	Circuit Breaker Frame	Interrupting Capacity (kAIC)			Main Unit Size		Maximum Cable Size See circuit breaker terminal data for variations.
		240 V	480 V	575 V	Inches (mm)	X Space	
150	HFD FDC	100 100	65 100	25 35	18 (457.2)	3X	4/0 (1 per Phase)
225	HFD FDC	100 100	100 100	35 35	18 (457.2)	3X	4/0 (1 per Phase)
250	HJD JDC	100 100	65 100	35 35	30 (762.0)	5X	350 kcmil (1 per Phase)
400	HKD KDC CHKD ① CKDC ①	100 100 100 100	65 100 65 100	25 50 25 50	30 (762.0)	5X	250 kcmil (2 per Phase) or 500 kcmil (1 per Phase)
600	HLD LDC	100 100	65 100	35 50	24 (609.6) ②③	4X	500 kcmil (2 per Phase)
	CHLD ①④ CLDC ①④	100 100	65 100	35 50	24 (609.6) ②③	4X	500 kcmil (2 per Phase)
800	HMDL	100	65	35	30 (762.0) ③	5X	750 kcmil (3 per Phase)
	CHMDL ①④	100	65	35	48 (1219.2) ③	8X	750 kcmil (3 per Phase)
	NDC	100	100	50	42 (1066.8) ③	7X	750 kcmil (3 per Phase)
	CHND ① CNDC ①	100 100	65 100	35 50	72 (1828.8)	12X	750 kcmil (3 per Phase)
1200	HND ⑤ NDC ⑤	100 100	65 100	35 50	42 (1066.8) ③	7X	750 kcmil (3 per Phase)
	CHND ①④ CNDC ①④	100 100	65 100	35 50	72 (1828.8)	12X	750 kcmil (3 per Phase)
2000	RD ⑤ RDC ⑤ CRD ① CRDC ①	100 100 100 100	65 100 65 100	50 65 50 65	72 (1828.8) ⑥	12X	750 kcmil (6 per Phase)
2500	RD RDC	100 100	65 100	50 65	72 (1828.8) ⑥⑦	12X	750 kcmil (6 per Phase)

① 100% Rated when 90° cable is applied at 75°C ampacity for 100% rating. RMS310LS is required and included in the price.
② Add 6-inch (152.4 mm) for top entry of incoming cables.
③ Install at top or cable top entry or at bottom for bottom cable entry.
④ NEMA 1 gasketed only.
⑤ Digitrip RMS 310 LS is standard and included in the pricing.
⑥ The main breaker requires the complete vertical section. The rear is unusable.
⑦ 24-inch (609.6 mm) wide.

Table 56. Dual Feeder Units — Molded Case Circuit Breakers — Dimensions in Inches (mm)

Maximum Amperes	Circuit Breaker Frame	Interrupting Ratings (kAIC)			Enclosure Width Inches (mm)	Main Unit Size		Feeder Unit Size		Maximum Cable Size
		240 V	480 V	600 V		Inches (mm)	X Space	Inches (mm)	X Space	
50/50	HFD FDC	100 200	65 100	25 35	Standard 20 (508.0)	N/A		12 (304.8)	2X	See above breaker frame information
50/100	HFD FDC	100 200	65 100	25 35				12 (304.8)	2X	
100/100	HFD FDC	100 200	65 100	25 35				12 (304.8)	2X	
100/100	HFD FDC	100 200	65 100	25 35				12 (304.8)	2X	
150/150	HFD FDC	100 200	65 100	25 35				12 (304.8)	2X	

Table 57. Main Circuit Breakers — Insulated Case Type SPB Stored Energy, Manually or Electrically Operated — Dimensions in Inches (mm)

Frame Size (Amperes)	Circuit Breaker Type	Interrupting Capacity (kAIC)	Mounting	Enclosure Width Inches (mm)	Main Unit Size		Feeder Unit Size		Maximum Cable Size See circuit breaker terminal data for variations.
					Inches (mm)	X Space	Inches (mm)	X Space	
800	SPB	100	Fixed Drawout ①	20 (508.0) 20 (508.0)	72 (1828.8)	12X	N/A		750 kcmil (6 per Phase)
1600			Fixed Drawout ①	20 (508.0) 20 (508.0)					
2000			Fixed Drawout ①	20 (508.0) 24 (609.6)					
3000			Fixed Drawout ①	20 (508.0) 24 (609.6)					

① Drawout circuit breakers require a 42-inch (1066.8 mm) deep structure.

Table 58. Main Circuit Breakers — Magnum DS Air Circuit Breakers, Manually or Electrically Operated — Dimensions in Inches (mm)

Frame Size (Amperes)	Circuit Breaker Type	Interrupting Capacity (kAIC)			Unit Size	Mounting ④	Enclosure Width
		240 V	480 V	575 V			
800	MDS-608 MDS-C08	65 100	65 100	65 100	72 (1828.8) ②	Drawout	24 (609.6) ③
1600	MDS-616 MDS-C16	65 100	65 100	65 100	72 (1828.8) ②	Drawout	24 (609.6) ③
2000	MDS-620 MDS-C20	65 100	65 100	65 100	72 (1828.8) ②	Drawout	24 (609.6) ③
3200	MDS-632 MDS-C32	65 100	65 100	65 100	72 (1828.8) ②	Drawout	24 (609.6) ③

② Structure is 42 inches (1066.8 mm) deep, MCC is rear aligned.
③ A 4-inch (101.6 mm) filler section must be added between the main and the rest of the MCC to allow for door opening.
④ Consult factory for Fixed Mounted Magnum Assemblies.

Table 59. Digitrip Units

Type	Unit Space Inches (mm)
RMS510LSI RMS510LSIG RMS510MLSI	— — —
RMS510MLSI RMS1150LSI RMS1150LSI	— — —
Options	
Tie Breaker ⑤ Electrically Operated	72 (1828.8) or 12X —
Automatic Throwover Main-Main using IQ Transfer Logic Automatic Throwover Main-Tie-Main using PLC/Operator Interface ⑥	 72 (1828.8) 72 (1828.8)
Accessories	
UV Release-Instantaneous Shunt Trip (standard on electrically operated breakers) Key Interlock on breaker	— — —
Auxiliary Switch (3A/3B) Cell Position Switch Operations Counter	— — —
Auxiliary Power Module (to test Digitrip) Portable Lift Truck Manual Close Pushbutton Cover	— — —

⑤ Tie breaker adds an additional 20-inch (508.0 mm) wide bus transition section. Also (2) 4-inch (101.6 mm) filler sections will be added to the MCC if the tie breaker is located in the center of the MCC line up. If the tie breaker is located between the two main structures the (2) 4-inch (101.6 mm) fillers are not needed.
⑥ 24-inch (609.6 mm) wide structure.

Table 60. Incoming Line and Feeder Fusible Switches — Dimensions in Inches (mm)

3-Pole — 250 V or 600 Vac. Fuses not included.

Switch Rating ① Amperes ②	Fuse Clip Size Amperes	Unit Space			
		Incoming Line		Feeder	
		Inches (mm)	X Space	Inches (mm)	X Space
30	30	18 (457.2)	3X	12 (304.8)	2X
60	60	18 (457.2)	3X	12 (304.8)	2X
30/30 Dual	30/30 Dual	—	—	12 (304.8)	2X
30/60 Dual	30/60 Dual	—	—	12 (304.8)	2X
60/60 Dual	60/60 Dual	—	—	12 (304.8)	2X
100	100	18 (457.2)	3X	18 (457.2)	3X
200	200	30 (762.0)	5X	30 (762.0)	5X
400	400	48 (1219.2)	8X	42 (1066.8)	7X
600	600	54 (1371.8) ③	9X ③	48 (1219.2)	8X
800	800	48 (1219.2) ④	8X ④	48 (1219.2) ⑤	8X ⑤
1200 ⑥	1200	60 (1524.0)	10X	60 (1524.0)	10X

① Suitable for 100,000 A interrupting if Class RK fuses are used.
② Type of SW K-SW 30 – 800 A.
③ For bottom cable entry, add 6 inches (152.4 mm) or 1X space.
④ For bottom entry, add 12 inches (304.8 mm) or 2X space.
⑤ For top entry, add 6 inches (152.4 mm) or 1X space.
⑥ High magnetic molded case switch.

Table 61. Lighting Panelboards
120/240 V or 120/208 V Lighting Panelboards Type — PL1A

Fixed mounted, main lug only panelboards can be either 120/240 V, 1-phase, 3-wire; 208Y/120 V, 3-phase, 4-wire.

Number of Circuits	Chassis Rating (Amperes)		Unit Space	
	1-Phase 3-Wire	3-Phase 4-Wire	1-Phase 3-Wire	3-Phase 4-Wire
18	225	100	24 – 4X	24 – 4X
30	225	100	30 – 5X	30 – 5X
42	225	225	36 – 6X	36 – 6X

Note: For MCB, back feed panelboard branch circuit breaker, or select separate feeder unit.

Note: Bolt-on 1-, 2-, 3-pole breakers only.

Table 62. 277/480 V or 480/600 V Lighting Panelboards Type — PRL3A

Fixed mounted, main lug only panelboards can be either 480 V or 600 V, 3-phase, 3-wire or 480Y/277 V, 3-phase, 4-wire. Mounted in bottom portion of structure.

Number of Circuits	Chassis Rating (Amperes)	Unit Space	
		3-Phase 3-Wire	3-Phase 4-Wire
14	100	—	36 – 6X
18	250	36 – 6X	—
24	100	36 – 6X	—
26	250	—	48 – 8X
32	100	—	48 – 8X
36	250	48 – 8X	—
42	100	48 – 8X	60 – 10X
42	250	60 – 10X	60 – 10X
12	400/600	36 – 6X	—
14	400/600	—	48 – 8X
30	400/600	48 – 8X	60 – 10X
42	400/600	60 – 10X	72 – 12X

Note: For MCB, back feed panelboard branch circuit breaker, or select separate feeder unit.

Note: Either plug-in or bolt-on 1-, 2-, 3-pole breakers only.

Table 63. Lighting Panelboard Circuit Breakers

Cutler-Hammer circuit breakers can be either plug-in or bolt-on, 1-, 2- or 3-pole through 240 V. 600 V maximum 1-, 2- or 3-pole circuit breakers are bolt-on.

Poles	Maximum Voltage	Plug-in	Bolt-on	Ampere Interrupting Capacity
1/2/3	240	HQP	BAB	10,000
1/2/3	240	QPHW	QBHW	22,000
1/2/3	600	—	EHD	14,000
1/2/3	600	—	HFD	65,000

Table 64. Automatic Transfer Switches — Dimensions in Inches (mm)

Ampere Rating	Switch ⑦ Type	Interrupting Rating (kA)	Unit Width	Unit Space
100 ⑧	Cutler-Hammer MTVX, NTVS	65	20 (508.0) ⑦	36 (6X)
150 ⑧	Cutler-Hammer MTVX, NTVS	65		
100	Cutler-Hammer ATVI	65		48 (8X)
150	Cutler-Hammer ATVI	65		
225	Cutler-Hammer ATVI	65		
300	Cutler-Hammer ATVI	65		
400	Cutler-Hammer ATVI	65		
600	Cutler-Hammer ATVI	50	24 (609.6) ⑦	72 (12X)
800	Cutler-Hammer ATVI	50		
1000	Cutler-Hammer ATVI	50		
1000	Cutler-Hammer ATVISP	100	44 (1117.6) ⑨	72 (12X)
1200	Cutler-Hammer ATVISP	100		
1600	Cutler-Hammer ATVISP	100		
2000	Cutler-Hammer ATVISP	100		
100	ASCO Type 7000	65	20 (508.0) ⑨	72 (1828.8) or 12X
150	ASCO Type 7000	65		
260	ASCO Type 7000	65	28 (711.2) ⑨	
400	ASCO Type 7000	35		
600	ASCO Type 7000	35	36 (914.4) ⑨	
800	ASCO Type 7000	50		
1000	ASCO Type 7000	50	40 (1016.0) ⑨	
1200	ASCO Type 7000	100		

⑦ ATVI designs include IQ Transfer door mounted microprocessor-based monitoring device for use in open transition transfer switches where rapid, reliable restoration of power in outage situations is essential. The IQ Transfer is a microprocessor-based logic controller to be used with Cutler-Hammer transfer switches. This device provides the operator with an at-a-glance overview of switch status and parameters, as well as key diagnostic data. Real-time values for volts and frequency can be viewed via the front panel LED display, along with an indication of the power source currently in use. The IQ Transfer continuously monitors either single-phase or 3-phase voltages for Source 1, Source 2 and the Load. Depending on the application, the user can customize the IQ Transfer to meet specific application need.
⑧ Manually operated switch: MTVX = Single handle manual operation. NTVS = Electrically operated non-automatic.
⑨ Requires 42-inch (1066.8 mm) deep structure.

Table 65. Dry-Type Distribution Transformers

- Transformer 1.0 – 2.0 kVA will include a CB and fuses in a standard 2X unit.
- Transformers 3.0 kVA and above have taps and electrostatic shields as standard.
- Transformers 3.0 kVA and above will include the primary and secondary circuit breakers housed behind a single door.

kVA Rating	Unit Space	Primary Breaker (included in space factor)		Secondary Breaker (included in space factor)
		230 V	480 V	
Single-Phase				
.5	2X	15	15	—
.75	2X	15	15	—
1	2X	15	15	—
1.5	2X	15	15	—
2	2X	15	15	—
3	4X	15	15	20
5	4X	15	15	30
7.5	4X	20	20	40
10	4X	25	30	60
15	5X	40	40	90
20	5X	50	60	125
25	5X	60	70	150
30	6X	70	80	175
45	7X	100	125	250
Three-Phase				
9	5X	15	15	40
15	5X	20	25	60
25	6X	40	40	90
30	6X	40	50	125
45	6X	60	70	175

Table 66. Power Factor Correction Capacitors

PF capacitors are electrolytic type and are optionally available with external line fuses and blown fuse indicators. Capacitors' sizes must be specified by the customer.

Caution: Capacitors on the main bus of the MCC may affect solid-state equipment. Please consult factory.

kVAR Rating	208 V Unit Space		240 V Unit Space		600V Unit Space	
	Inches (mm)	X Space	Inches (mm)	X Space	Inches (mm)	X Space
2	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
3	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
4	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
5	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
7.5	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
10	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
15	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
20	24 (609.6)	4X	12 (304.8)	2X	12 (304.8)	2X
22.5	24 (609.6)	4X	12 (304.8)	2X	12 (304.8)	2X
25	—	—	24 (609.6)	4X	12 (304.8)	2X
30	—	—	24 (609.6)	4X	12 (304.8)	2X
40	—	—	—	—	12 (304.8)	2X
50	—	—	—	—	24 (609.6)	4X
60	—	—	—	—	24 (609.6)	4X
75	—	—	—	—	24 (609.6)	4X
90	—	—	—	—	24 (609.6)	4X
100	—	—	—	—	36 (914.4)	6X
120	—	—	—	—	36 (914.4)	6X

Table 67. Current Limiting Reactors — Dimensions in Inches (mm)

Structures contain three single-phase 60 Hz reactors which limit available short circuit current from 100,000 rms amperes to 14,000 rms amperes. Reactors available with ohmic values of .01, .015, .02 and .025.

Amperes	Unit Space		Mounting
	Inches (mm)	X Space	
600	72 (1828.8)	12X	21 D x 20 W (533.4 D x 508.0 W)
800	72 (1828.8)	12X	21 D x 20 W (533.4 D x 508.0 W)
1000	72 (1828.8)	12X	26 D x 28 W (660.4 D x 711.2 W)
1200	72 (1828.8)	12X	26 D x 28 W (660.4 D x 711.2 W)

Table 68. TVSS (Clipper Power System) with Circuit Breaker Disconnect

Includes SuperVisor Monitoring Display with power quality meter for volts, sag, swell, outage, transient counter, Form C contact, alarm enable and disable.

Description		Unit Space ①	
		Inches (mm)	X Space
Surge Current Per Phase			
100 kA	CPS-100	18 (457.2)	3X
120 kA	CPS-120 (Recommended Branch Unit)	18 (457.2)	3X
160 kA	CPS-160	18 (457.2)	3X
200 kA	CPS-200	18 (457.2)	3X
250 kA	CPS-250 (Recommended Service Entrance)	18 (457.2)	3X
300 kA	CPS-300	18 (457.2)	3X
400 kA	CPS-400	18 (457.2)	3X
500 kA	CPS-500	18 (457.2)	3X

① Also available in 12-inch (304.8 mm) unit (2X) without circuit breaker disconnect.

Note: Specify 3-phase Delta or 3-phase Wye.

Table 69. DeviceNet Communications

DeviceNet-enabled components in MCCs eliminate up to 90% of the control wiring versus traditional hardwired designs. 24 Vdc DeviceNet is prewired throughout the MCC. Trunk cable is provided in the horizontal wireway. Drop cable is provided for vertical wireways and units.

Part Number	Description	Space Requirements
WPONIDNA	DeviceNet interface for Advantage Starter	No Additional Space
DN65	DeviceNet interface for Freedom Starter	No Additional Space
AF91DNA	AF91 Adjustable Frequency Drives DeviceNet Interface	—
SV9DNA	SV9000 Adjustable Frequency Drives DeviceNet Interface	—
DN50, DN65	Discrete DeviceNet Interface for *IT.* Solid State Starters	②
PS1	Single 5 ampere Power Supply	2X
PS2	Dual 5 ampere Power Supply	2X
PanelMate 1700	Operator interface for DeviceNet System	12-inch (304.8 mm)/2X
DN50	DeviceNet I/O module	12-inch (304.8 mm)/ 2X Minimum

② *IT.* starters up to 66 amperes require additional 6 inches when selecting DN50, DN65 DeviceNet interfaces.

Earth Leakage Breakers

Earth Leakage Breakers offer Class 1 ground fault protection down to the 30 mA level.

- Ground fault pickup setting is adjustable from .03 to 30 A in eight steps.
- Ground fault time delay setting is adjustable from instantaneous to 2.0 seconds in six steps.

Standard Features

- Built-in push-to-trip for functional testing.
- Tripped window indicates red for ground fault trip.
- Alarm contact for remote indication of trip.

Table 70. Earth Leakage Breakers

Frame	HMCP or Thermal-Magnetic	Additional Space Required
F	Yes	1X ①
J	Yes	1X ①
K	Yes	1X ①

① Six-inch (152.4 mm) not required for NEMA size 6 starters.

Table 71. Electronic Metering Specifications ②

Description	IQ 100	IQ 320	IQ DP-4130	IQ Analyzer 6400 and 6600
Volts	L-L, L-N	L-L, L-N	L-L, L-N	L-L, L-N
Current	A, B, C	A, B, C	A, B, C	A, B, C, N, G
Power	—	Watt, VAR, VA	Watt, VAR, VA	Watt, VAR, VA
Power Factor	—	Apparent, Displacement	Apparent, Displacement	Apparent, Displacement
Frequency	—	Hertz	Hertz	Hertz
THD	—	—	Amperes, Volts	Amperes, Volts
Demand Values	—	All	All	All
Trend Analysis	—	③	—	Time, Date ④
Programmable Output Relays	—	—	(3) 10A Form C	(4) 10A Form C
Programmable Analog Outputs	—	—	—	(3) 0-10/4-20 mA
Contact Inputs	—	—	(1) kW Demand	(3) + 30 Vdc Differential
Analog Inputs	—	—	—	(1) 0-20/4-20 mA
Display Type	7 Segment LED	Reverse Mode LCD with LED Backlight	7 Segment LED	Graphic LCD with LED Backlight
Communications	—	Cutler-Hammer PowerNet ⑤	Cutler-Hammer PowerNet ⑤	Cutler-Hammer PowerNet ⑤

② Requires 12-inch (1X) unit space.
③ At computer only.
④ Up to 24 data values may be used for Trend Analysis with Time, Date Stamp.
⑤ Communications to Modbus, Ethernet available via optional Communication Modules.

Table 72. Incoming Line Metering and Bus Protection

Type	Description	Unit Space Inches (mm) ①
Switchboard Meters ③ 1% Accuracy	Ammeter Ammeter with Switch Voltmeter Voltmeter with Switch	12 (304.8) or 2X
	AM/VM AM/VM with Switches	
Instrument Transformers	600/800A CT 1000 A CT 2000 A CT 2500 A CT	Consult Cutler-Hammer
	480/120 PT	6 (152.4) or 1X
Signal Transducers	Current (Add CT) 1-Phase Voltage (Add PT) Watt (Add CT and PT) 1-Phase	6 (152.4) or 1X

Voltage Protection

TVSS (See **Table 68**)	18 (457.2) or 3X ④
Ground Detection Lights — 3-Phase Underground Systems	
System Voltage Monitor Lightning Arrester and Surge Capacitor	6 (152.4) or 1X

Ground Fault Sensing C-HRG "Safe Ground" High Resistance Ground System

Current	Requires 21-inch (533.4 mm) deep, 20-inch (508.0 mm) wide structure without a vertical wireway.	72 (1828.8) or 12X
Voltage		

① Two electronic meters will fit in a single 12-inch (304.8 mm) (2X) unit.
② 3-phase/3-wire systems require 2 CTs. 3-phase/4-wire systems require 3 CTs.
③ Ammeters require 2 CTs for 3-phase/3-wire systems, and 3 CTs for 3-phase/4-wire systems. Voltmeters require 2 PTs for 3-phase/3-wire systems, and 3-PTs for 3-phase/4-wire systems.
④ Without disconnect 12 inches (304.8 mm) or 2X.

Harmonic Correction

Table 73. Clean Control Center

The Cutler-Hammer Clean Control Center is an integrated power correction system that provides harmonic correction directly on the MCC Horizontal Bus. The harmonic correction unit senses the load current and dynamically injects into the Horizontal Bus a synthesized waveform which cancels harmonic content from non-linear loads such as ac drives. The result is a clean waveform. Clean Control Centers are UL 845 listed.

Harmonic Current (Amperes)	Input Voltage	Disconnect Type	Standard Unit Space ⑤ Inches (mm)	Standard Unit Space (X)
50 A Active Harmonic Filter ⑥	Up to 480 V	Molded Case Switch	72 H x 20 W (1828.8 H x 508.0 W)	12X
100 A Active Harmonic Filter ⑥	Up to 480 V	Molded Case Switch	72 H x 20 W (1828.8 H x 508.0 W)	12X

⑤ Clean Control Center model includes 24-inch (609.6 mm) wide MCE structure, current transformers and door-mounted digital interface panel.
⑥ Multiple units can be applied in parallel for additional harmonic correction.

Standard Structures and Structure Options

The Standard Freedom or Advantage 2100 Series MCC structure is NEMA 1, gasketed, 90-inch (2286.0 mm) high, 20-inch (508.0 mm) wide with a depth as shown on Figures 1 – 3 right. Each standard structure has a 9-inch (228.6 mm) high horizontal wireway at the top and at the bottom and a 4-inch (101.6 mm) wide full height vertical wireway at the right. All wireway doors are hinged and secured with 1/4-turn latches. The standard busing is 600 A, UL rated, copper horizontal bus and 300 A, UL rated, copper vertical bus braced for 65,000 symmetrical amperes. Many other bus sizes and types are available. Also included as standard is a vertical bus isolation barrier.

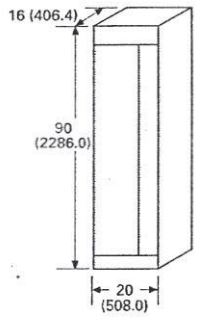
Table 74. Standard Structures and Structure Options — Dimensions in Inches (mm)

Description	
Standard Structures	
16 (406.4) deep structure	Structure 1
21 (533.4) deep structure	
Front mounting only	Structure 2
Front and rear mounting	Structure 3
4 (101.6) of additional structure width, 32 (812.8) maximum	
8 (203.2) vertical wireway in lieu of standard 4-inch (101.6)	
Special Structures	
Single corner section for "L" configuration of MCC	
Transition section	
Series 2100 to Type W	
10 (254.0) wide — front aligned	
Plug-in blank relay mounting space, per 6-inch	Any 6 (152.4) height
Fixed-mounted relay back pan, full depth of structure	
20 (508.0) structure with wireway, 13 (330.2) with usable panel	
24 (609.6) structure with wireway, 17 (431.8) with usable panel	
28 (711.2) structure with wireway, 21 (533.4) with usable panel	
20 (508.0) structure without wireway, 17 (431.8) with usable panel	
24 (609.6) structure without wireway, 21 (533.4) with usable panel	
28 (711.2) structure without wireway, 25 (635.0) with usable panel	
32 (812.8) with double door	
36 (914.4) with double door	
40 (1016.0) with double door	
Programmable controller mounting structure	
(per complete structure with full fixed mounting back pan)	
20 (508.0) structure with wireway	Complete section
24 (609.6) structure with wireway	Complete section
28 (711.2) structure with wireway	Complete section
20 (508.0) structure without wireway	Complete section
24 (609.6) structure without wireway	Complete section
28 (711.2) structure without wireway	Complete section
Plexiglass see-through door insert for PLC structure	6 (152.4) increments
19 (482.6) instrumentation mounting racks installed in PLC structure	Consult Factory

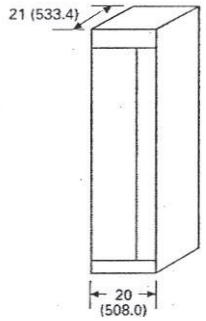
Table 75. Structure Modifications — Dimensions in Inches (mm)

Channel floor sills: 11-gauge, 1 x 3 (25.4 x 76.2)
NEMA 1 gasket
NEMA 12 dust-proof, includes bottom plate
Bottom plate for NEMA 1 gasketed enclosure
150-watt space heater, per structure
Thermostat for space heater control
Pullbox kit for cable and wiring to be field mounted on top structure
12 (304.8) high
18 (457.2) high
24 (609.6) high
Rear hinged structure door, 72 (1828.8) high
NEMA 2 drip shield on top of MCC
NEMA 3R non-walk-in
Front-mounted
Back-to-back
NEMA 3R walk-in aisle-front mounted
NEMA 3R walk-in tunnel type
Special reduced height structures
Seismic certification (earthquake qualification)
UL handle extension ①

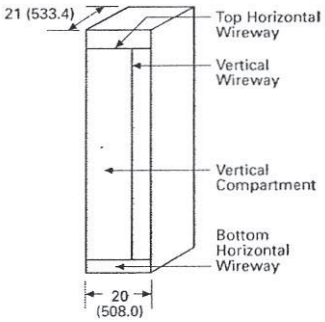
① The standard Freedom Series 2100 and Advantage structure is designed to comply with the UL 2-meter requirement. Disconnect operating handle is not more than 2 meters [78 inches (1981.2 mm)] above the bottom of the MCC. Motor Control Centers elevated on a raised pad or installed on unembedded channel sills may require operator handle extensions for the uppermost operators. UL handle extension optionally available when required.



Structure 1 ①
72-inch (1828.8 mm) Space
Front Mounted Only



Structure 2 ①
72-inch (1828.8 mm) Space
Front Mounted Only



Structure 3
72-inch (1828.8 mm) Space — Front
66-inch (1676.4 mm) Space — Rear
Back-to-Back

Figure 2. Structure — Dimensions in Inches (mm)

Table 76. Bus Modifications — Dimensions in Inches (mm)

Freedom and Advantage 2100 Series MCCs bear the UL label. Service entrance labeling is available.

Description			
Main Bus, Per Vertical Structure			Cu — Tin-Plated (Standard)
Copper Horizontal Bus Ratings Tin-Plated	50°C	65°C	
600 A Size	.25 x 2.00 (6.4 x 50.8) – Bars/Phase 1	.25 x 2.00 (6.4 x 50.8) – Bars/Phase 1	—
800 A Size	.25 x 3.00 (6.4 x 76.2) – Bars/Phase 1	.25 x 2.00 (6.4 x 50.8) – Bars/Phase 1	—
1200 A Size	.25 x 2.50 (6.4 x 63.5) – Bars/Phase 2	.25 x 3.00 (6.4 x 76.2) – Bars/Phase 1	—
1600 A Size	.25 x 3.00 (6.4 x 76.2) – Bars/Phase 4	.25 x 3.00 (6.4 x 76.2) – Bars/Phase 2	21 (533.4) Deep ①
2000 A Size	.25 x 2.50 (6.4 x 63.5) – Bars/Phase 6	.25 x 2.50 (6.4 x 63.5) – Bars/Phase 4	21 (533.4) Deep ①
2500 A Size	.25 x 3.00 (6.4 x 76.2) – Bars/Phase 8	.25 x 3.00 (6.4 x 76.2) – Bars/Phase 6	21 (533.4) Deep ②
3200 A Size	N/A	.25 x 3.00 (6.4 x 76.2) – Bars/Phase 8	21 (533.4) Deep ②③
Silver-Plated Bus			Optional
Insulated main horizontal bus, per vertical structure (taping)			Optional
Vertical bus, per vertical structure: 300 A — copper (tin-plated)			Standard ④
Increased bus capacity: Rated at 600 A (Front mounted only)			Cu Only
Rated at 600 A (Back-to-back) — copper			Standard
Rated at 800 A (Back-to-back and front)			Cu Only
Rated at 1200 A			Cu Only
Increased mechanical bus bracing, per vertical structure:			
42,000 A rms symmetrical short circuit current			Optional
65,000 A rms symmetrical short circuit current			Standard
100,000 A rms symmetrical short circuit current			Optional
Vertical Bus isolation barrier, per vertical structure			Standard
Labyrinth design insulation-isolation vertical bus barrier			Optional Freedom
Ground bus, 300 A standard, per vertical structure			Standard Cu
Increased capacity ground bus only, 600 A, 1/4- x 2-inch (6.4 x 50.8 mm), per vertical structure			Standard Cu
Plug-in Grounding System, includes 300 A vertical ground bus and unit grounding clips, per vertical structure			Cu
Neutral bus, ungrounded for 3-phase, 4-wire power, per vertical structure ⑤			Cu
Splice plates			—

① Requires 21-inch (533.4 mm) deep structure.
② Requires 21-inch (533.4 mm) deep structure. Not available in back-to-back structure.
③ Contact the Cutler-Hammer business for 3200 A dimensions.
④ Vertical bus and unit stabs are tin-plated copper only.
⑤ Neutral is half-rating of horizontal bus.

Table 77. Main Lugs Only — Mechanical Lug Compartment (3-Phase, 3- or 4-wire) — Dimensions in Inches (mm)

Provisions for terminating incoming line cables directly onto the MCC bus system. Up to 1200 A, all lug landings are bolted to a fully rated vertical bus in that section. MLO sections must be put at the top for top entry cables and at the bottom for bottom entry cables. For smaller cable sizes, cable lugs may also be extended into an optional top hat as shown in this table.

Maximum Cable Size (kcmil)	Bus Rating	Maximum Cables per Phase	Cable Entry (Top or Bottom)	Lug Type	Unit Space	X Space ⑥	Enclosure Width
350	600 A	2		Screw	12 (304.8)	2X	
				Crimp	18 (457.2)	3X	
		4	Top	Screw	18 (457.2)	3X	
				Screw	24 (609.6)	4X	
			Bottom	Crimp	36 (914.4)	6X	
			18-inch (457.2 mm) Top Hat	Either	—	—	
600	800 A	2		Screw	18 (457.2)	3X	
				Crimp	24 (609.6)	4X	
		4		Screw	24 (609.6)	4X	
				Crimp	36 (914.4)	6X	
			18-inch (457.2 mm) Top Hat	Either	—	—	20 (508.0)
750	1000 A	2		Screw	24 (609.6)	4X	
				Crimp	36 (914.4)	6X	
		4		Screw	36 (914.4) ⑦	12X	
				Crimp	48 (1219.2) ⑦	12X	
1000	1200 A	2		Screw	30 (762.0)	5X	
				Crimp	36 (914.4)	6X	
1000	2500 A	8		Screw	72 (1828.8) ⑦	12X	
				Crimp	72 (1828.8) ⑦	12X	
	3200 A			Screw	72 (1828.8) ⑦	12X	
				Crimp	72 (1828.8) ⑦	12X	

⑥ Requires 12-inch (304.8 mm) (1X) unit space.
⑦ Lug landings require the complete vertical section. The rear is unusable.

Bus Duct Entry Sandwich Type to Horizontal Bus or Main Disconnect — Pull Box

Pull box and pre-fabricated bus connectors are supplied to match the sandwich type bus duct end flange. Bus duct is assumed to enter the top. Bus duct type and orientation to the MCC must be provided.

Table 78. Bus Duct Entry to Horizontal Bus or Main Disconnect — Pull Box — Dimensions in Inches (mm)

Horizontal Bus Rating	Pull Box Height
600 A – 1600 A	18 (457.2)
2000 A – 2500 A ⑧	24 (609.6)

⑧ Contact the Cutler-Hammer business for 3200 A dimensions.

Note: Consult factory for non-segregated bus requirements.

Table 79. Control Power Transformer Data

All Control Power transformers are encapsulated and will deliver rated secondary voltage at full load. Two primary and one secondary fuses are furnished as standard.

NEMA Size Starter	Starter Type	Freedom		Advantage	
		Standard VA Rating	Maximum ① VA Rating	Standard VA Rating	Maximum ① VA Rating
Size 1	Full Voltage Non-Reversing and Reversing	100 VA	150 VA	100 VA	150 VA
Size 1 – 6-inch (252.4 mm) Unit		100 VA	100 VA	100 VA	100 VA
Size 2		100 VA	150 VA	100 VA	150 VA
Size 2 – 6-inch (252.4 mm) Unit		N/A	N/A	100 VA	100 VA
Size 3		150 VA	250 VA	150 VA	250 VA
Size 4		200 VA	250 VA	150 VA	250 VA
Size 5		200 VA	350 VA	300 VA	350 VA
Size 6		150 VA	250 VA	300 VA	350 VA
Size 2	Autotransformer	100 VA	150 VA	150 VA	250 VA
Size 3		150 VA	250 VA	150 VA	250 VA
Size 4		200 VA	250 VA	150 VA	250 VA
Size 5		250 VA	350 VA	500 VA	500 VA
Size 6		200 VA	350 VA	500 VA	500 VA
Size 1	Two-Speed One Winding	100 VA	200 VA	200 VA	250 VA
Size 2		100 VA	200 VA	200 VA	250 VA
Size 3		200 VA	250 VA	200 VA	250 VA
Size 4		350 VA	500 VA	200 VA	250 VA
Size 5		350 VA	500 VA	500 VA	500 VA
Size 6		200 VA	350 VA	500 VA	500 VA
Size 1	Two-Speed Two Winding	100 VA	150 VA	100 VA	250 VA
Size 2		100 VA	150 VA	100 VA	250 VA
Size 3		150 VA	250 VA	150 VA	250 VA
Size 4		200 VA	250 VA	150 VA	250 VA
Size 5		200 VA	250 VA	300 VA	350 VA
Size 6		200 VA	350 VA	300 VA	350 VA
Size 1	Part Winding	150 VA	150 VA	200 VA	250 VA
Size 2		150 VA	150 VA	200 VA	250 VA
Size 3		200 VA	250 VA	200 VA	250 VA
Size 4		350 VA	500 VA	200 VA	250 VA
Size 5		350 VA	500 VA	200 VA	250 VA
Size 6		200 VA	350 VA	500 VA	500 VA
Size 2	Wye Delta (Open or Closed Transition)	200 VA	200 VA	200 VA	250 VA
Size 3		350 VA	200 VA	200 VA	250 VA
Size 4		350 VA	500 VA	200 VA	250 VA
Size 5		200 VA	500 VA	500 VA	500 VA
Size 6		200 VA	350 VA	500 VA	500 VA

① Maximum size without increasing starter space.

Table 80. Freedom and Advantage MCC Ratings and Highlights

Feature	Freedom	Advantage
Vertical Bus Barrier	Flat Glastic, Labyrinth Available	Labyrinth
Communications from Starter Units	IQ 500 via PowerNet, DN65 via DeviceNet IQ MP-3000 via PowerNet	Advantage WPONI or CMU via PowerNet WPONIDNA via DeviceNet
Bus Bracing	65 kA Standard 42 and 100 kA Available	65 kA Standard 100 kA Available
Control Wire	#16 Standard	#14 Standard ②
Horizontal Bus Material	Copper	Copper
Pilot Devices	10250T	ACM or 10250T
6-inch (152.4 mm) Starter Compartment	F206 Size 1	W206 Sizes 1 and 2
FVNR Sizes 3 and 4	18-inch (457.2 mm) Compartment	12- or 18-inch (304.8 or 457.2 mm) Compartment
FVNR Size 6	54-inch (1371.6 mm) Compartment	36-inch (914.4 mm) Compartment

② 6-inch (152.4 mm) units available with #16 control wire only.

Motor Protection

In line with NEC 430-6(a), circuit breaker, HMCP and fuse rating selections are based on full load currents for induction motors running at speeds normal for belted motors and motors with normal torque characteristics using data taken from NEC Table 430-150 (3-phase). Actual motor nameplate ratings shall be used for selecting motor running overload protection. Motors built special for low speeds, high torque characteristics, special starting conditions and applications will require other considerations as defined in the application section of the NEC.

These additional considerations may require the use of a higher rated HMCP, or at least one with higher magnetic pickup settings.

Circuit breaker, HMCP and fuse ampere rating selections are in line with maximum rules given in NEC 430-52 and Table 430-152. Based on known characteristics of Cutler-Hammer type breakers, specific units are recommended. The current ratings are no more than the maximum limits set by the NEC rules for motors with code letters F to V or without code letters. Motors with lower code letters will require further considerations.

In general, these selections were based on:

1. Ambient — Outside enclosure not more than 40°C (104°F).
2. Motor starting — Infrequent starting, stopping or reversing.
3. Motor accelerating time — 10 seconds or less.
4. Locked rotor — Maximum 6 times motor FLA.

Type HMCP motor circuit protector may not be set at more than 1700% of the motor full-load current, to comply with the NEC, Sec. 430-52. (Except for new E rated motor which can be set up to 1700%.)

Circuit breaker selections are based on types with standard interrupting ratings. Higher interrupting rating types may be required to satisfy specific system application requirements.

For motor full load currents of 208 and 200 volts, increase the corresponding 230-volt motor values by 10 and 15% respectively.

Table 81. Motor Circuit Protector (MCP), Circuit Breaker and Fusible Switch Selection Guide

Hp	Full Load Amperes (NEC) FLA	Fuse Size NEC 430-152 Maximum Amperes		Recommended Cutler-Hammer			
				Circuit Breaker		Motor Circuit Protector Type HMCP	
		Time Delay	Non-Time Delay	Amperes	Type	Amperes	Adj. Range
230 Volts, 3-Phase							
1	3.6	10	15	15	HFD	7	21 – 70
1-1/2	5.2	10	20	15	HFD	15	45 – 150
2	6.8	15	25	15	HFD	15	45 – 150
3	9.6	20	30	20	HFD	30	90 – 300
5	15.2	30	50	30	HFD	30	90 – 300
7-1/2	22	40	70	50	HFD	50	150 – 500
10	28	50	90	60	HFD	50	150 – 500
15	42	80	150	90	HFD	70	210 – 700
20	54	100	175	100	HFD	100	300 – 1000
25	68	125	225	125	HFD	150	450 – 1500
30	80	150	250	150	HFD	150	450 – 1500
40	104	200	350	150	HFD	150	750 – 2500
50	130	250	400	200	HFD	150	750 – 2500
60	154	300	500	225	HFD	250	1250 – 2500
75	192	350	600	300	HKD	400	2000 – 4000
100	248	450	800	400	HKD	400	2000 – 4000
125	312	600	1000	500	HLD	600	1800 – 6000
150	360	700	1200	600	HLD	600	1800 – 6000
200	480	1000	1600	700	HND	600	1800 – 6000
460 Volts, 3-Phase							
1	1.8	6	6	15	HFD	7	21 – 70
1-1/2	2.6	6	10	15	HFD	7	21 – 70
2	3.4	6	15	15	HFD	7	21 – 70
3	4.8	10	15	15	HFD	15	45 – 150
5	7.6	15	25	15	HFD	15	45 – 150
7-1/2	11	20	35	25	HFD	30	90 – 300
10	14	25	45	35	HFD	30	90 – 300
15	21	40	70	45	HFD	50	150 – 500
20	27	50	90	50	HFD	50	150 – 500
25	34	60	110	70	HFD	70	210 – 700
30	40	70	125	70	HFD	100	300 – 1000
40	52	100	175	100	HFD	100	300 – 1000
50	65	125	200	110	HFD	150	450 – 1500
60	77	150	150	250	HFD	150	750 – 2500
75	96	175	300	150	HJD	150	750 – 2500
100	124	225	400	175	HJD	150	750 – 2500
125	156	300	500	225	HJD	250	1250 – 2500
150	180	350	600	250	HJD	400	2000 – 4000
200	240	450	800	350	HKD	400	2000 – 4000
575 Volts, 3-Phase							
1	1.4	3	6	15	HFD	3	9 – 30
1-1/2	2.1	6	10	15	HFD	7	21 – 70
2	2.7	6	10	15	HFD	7	21 – 70
3	3.9	10	15	15	HFD	7	21 – 70
5	6.1	15	20	15	HFD	15	45 – 150
7-1/2	9	20	30	20	HFD	15	45 – 150
10	11	20	35	25	HFD	30	90 – 300
15	17	30	60	40	HFD	30	90 – 300
20	22	40	70	50	HFD	50	150 – 500
25	27	50	90	60	HFD	50	150 – 500
30	32	60	100	60	HFD	50	150 – 500
40	41	80	125	80	HFD	100	300 – 1000
50	52	100	175	100	HFD	100	300 – 1000
60	62	110	200	125	HFD	150	750 – 2500
75	77	150	250	150	HFD	150	750 – 2500
100	99	175	300	175	HJD	150	750 – 2500
125	125	225	400	200	HJD	250	1250 – 2500
150	144	300	450	225	HJD	250	1250 – 2500
200	192	350	600	300	HKD	400	2000 – 4000

Table 82. Starter Sizes Selection Guide

Squirrel-Cage Motor Horsepower	230 V, 3-Phase			460 V, 3-Phase			575 V, 3-Phase		
	Control Center Starter NEMA Size	Full Load ① Current Amperes	Wire Size ② at 75°C Max. at 40°C Amb.	Control Center Starter NEMA Size	Full Load ① Current Amperes	Wire Size ② at 75°C Max. at 40°C Amb.	Control Center Starter NEMA Size	Full Load ① Current Amperes	Wire Size ② at 75°C Max. at 40°C Amb.
1/2	1	2.2	14	1	1.1	14	1	.9	14
3/4	1	3.2	14	1	1.6	14	1	1.3	14
1	1	4.2	14	1	2.1	14	1	1.7	14
1-1/2	1	6.0	14	1	3.0	14	1	2.4	14
2	1	6.8	14	1	3.4	14	1	2.7	14
3	1	9.6	14	1	4.8	14	1	3.9	14
5	1	15.2	12	1	7.6	14	1	6.1	14
7-1/2	1	22	10	1	11	14	1	9	14
10	2	28	10	1	14	14	1	11	14
15	2	42	8	2	21	10	2	17	12
20	3	54	6	2	27	10	2	22	10
25	3	68	4	2	34	8	2	27	10
30	3	80	3	3	40	8	3	32	8
40	4	104	1	3	52	6	3	41	8
50	4	130	1/0	3	65	4	3	52	6
60	5	154	3/0	4	77	3	4	62	4
75	5	192	4/0	4	96	2	4	77	3
100	5	248	300 kcmil	4	124	1/0	4	99	2
125	6	312	500 kcmil	5	156	3/0	5	125	1/0
150	6	360	2 – 4/0	5	180	4/0	5	144	2/0
200	6	480	2 – 300 kcmil	5	240	300 kcmil	5	192	4/0
250	—	—	—	6	302	500 kcmil	6	242	300 kcmil
300	—	—	—	6	361	2 – 4/0	6	289	400 kcmil

① Information is based on Table 430-150 of NEC (1999).
② Information is based on use of copper conductors — Table 310-16 and Tables 1, 4 and 5, Ch. 9 of NEC. If aluminum conductors are used refer to Table 310-16 of NEC (1999).

Dimensions

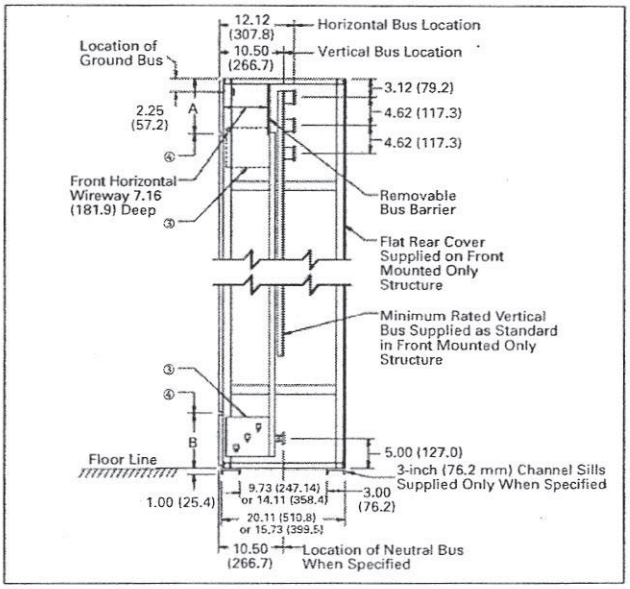


Figure 3. Side View A — Front Mounted Only in Inches (mm)
③ Master terminal block assembly furnished for Type C wiring only. When location not specified, MTB supplied at the bottom.
④ Standard structure arrangement in front
Without MTB; A & B = 9 (228.6)
With MTB at bottom; A & B = 9 (228.6)
With MTB at top; A = 15 (381.0), B = 3 (76.2)

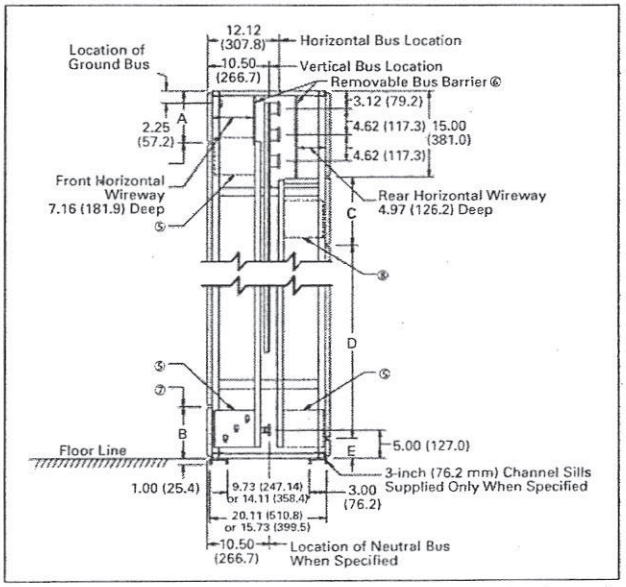


Figure 4. Side View B — Front and Rear Mounted in Inches (mm)
⑤ Master terminal block assembly furnished for Type C wiring only. When location not specified, MTB supplied at the bottom.
⑥ Rear horizontal bus barrier not supplied with front mounted only structure.
⑦ Standard structure arrangement in front
Without MTB; A & B = 9 (228.6)
With MTB at bottom; A & B = 9 (228.6)
With MTB at top; A = 15 (381.0), B = 3 (76.2)
⑧ Standard structure arrangement in rear
Without MTB; C = 9 (228.6), D = 72 (1828.8), E = 3 (76.2)
With MTB at bottom; C = 0, D = 66 (1676.4), E = 9 (228.6)
With MTB at top; C = 12 (304.8), D = 60 (1524.0), E = 3 (76.2)

Not to be used for construction purposes unless approved.

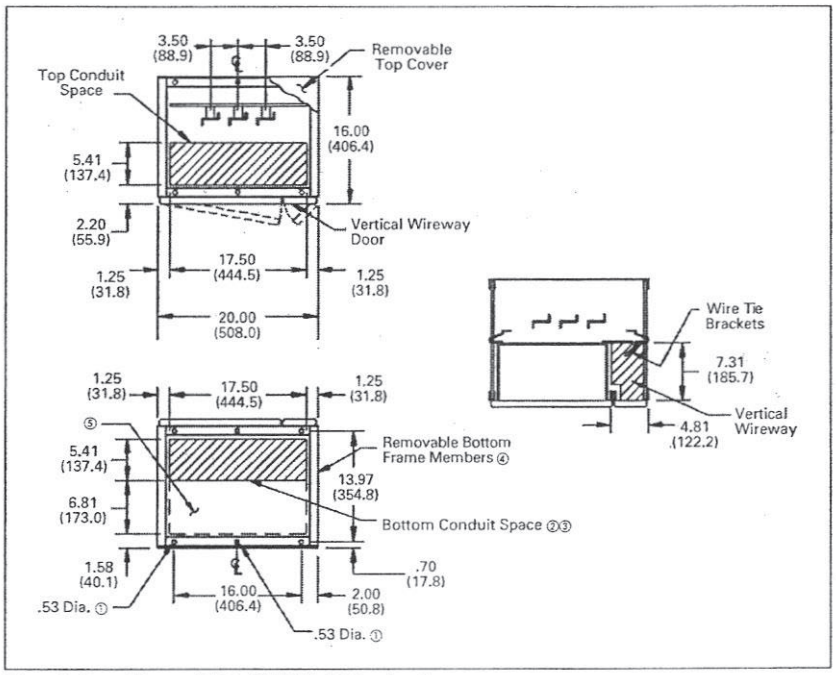


Figure 5. Front Mounted Only (FMO) in Inches (mm)
20 Inches (508.0 mm) Wide, 16 Inches (406.4 mm) Deep

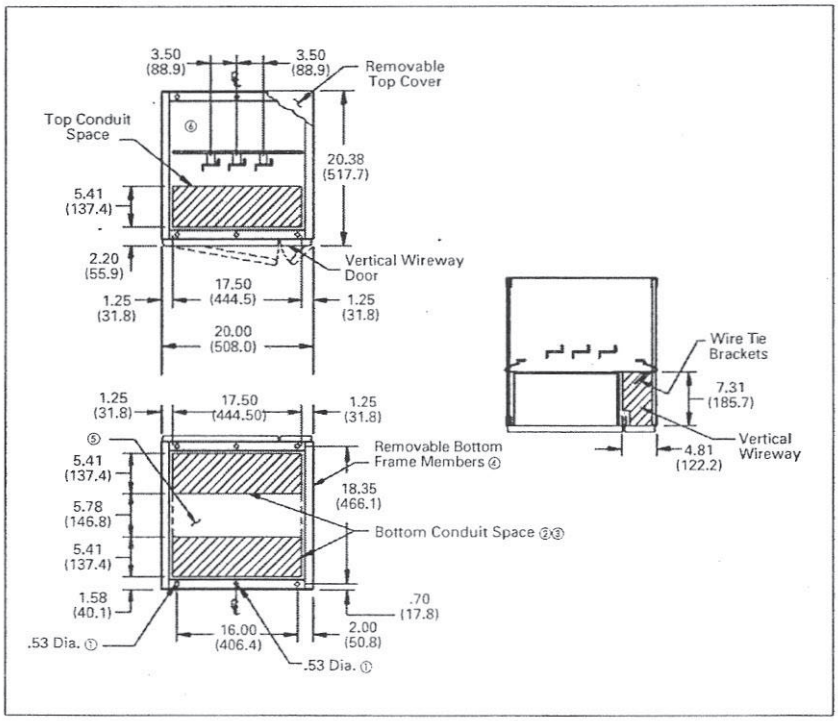


Figure 6. 20 Front Mounted Only (FMO) in Inches (mm)
20 Inches (508.0 mm) Wide, 21 Inches (533.4 mm) Deep

① Minimum length of anchor bolt 2 (50.8) .36 (9.1) — 16 recommended.
② Recommended maximum conduit height above floor line 3.5 (88.9).
③ Maximum conduit space with channel sills 17.5 x 9.73 (444.5 x 247.1).
④ For multiple structure assemblies. Either one or both of these members are removed to provide maximum unrestricted conduit space at bottom. Not to be removed for Seismic.
⑤ This conduit space not recommended when neutral bus required. Otherwise available.
⑥ Top rear conduit space not recommended for conduit entry in FMO structure.

See Side View A **Page 40** for vertical dimensions.

Not to be used for construction purposes unless approved.

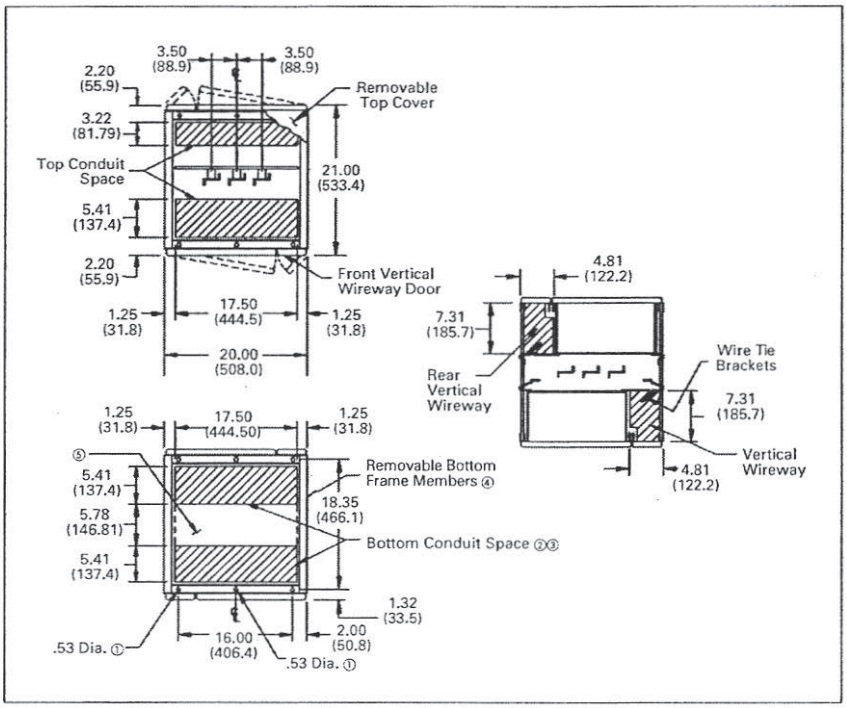


Figure 7. Front Mounted Only (FMO) in Inches (mm)
20 Inches (508.0 mm) Wide, 21 Inches (533.4 mm) Deep

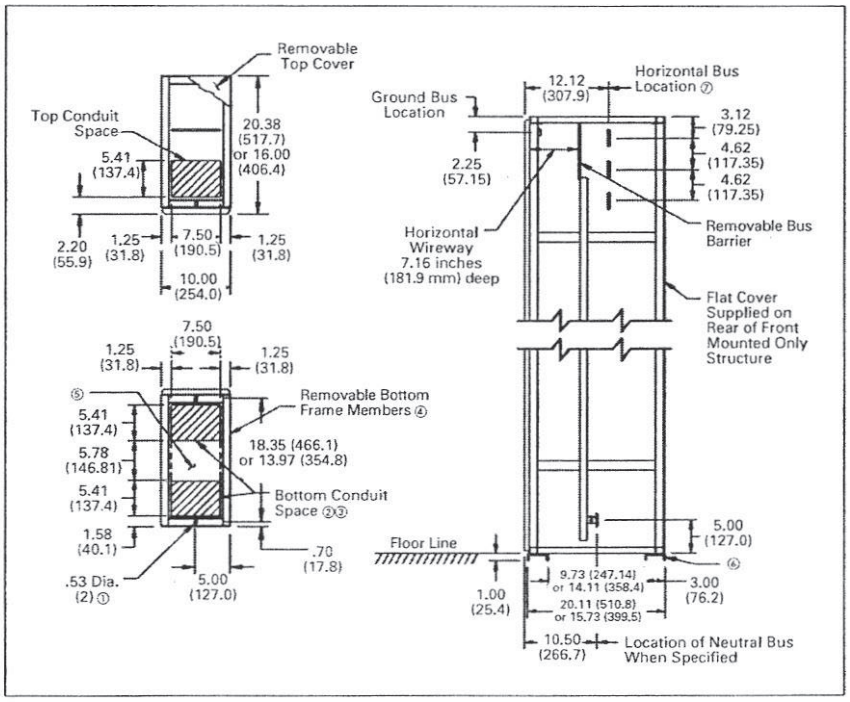


Figure 8. Front Mounted Only (FMO) in Inches (mm)
10 Inches (254.0 mm) Wide, 16 or 21 Inches (406.4 mm or 533.4 mm) Deep

① Minimum length of anchor bolt 2 (50.8) .36 (9.1) — 16 recommended.
② Recommended maximum conduit height above floor line 3.5 (88.9).
③ Maximum conduit space with channel sills 17.5 x 14.11 (444.5 x 358.4) in 21-inch deep structure. 7.5 x 9.73 (190.5 x 247.1) in 16-inch deep structure.
④ For multiple structure assemblies. Either one or both of these members are removed to provide maximum unrestricted conduit space at bottom. Not to be removed for Seismic.
⑤ This conduit space not recommended when neutral bus required. Otherwise available.
⑥ Channel sills supplied only when specified. For seismic loads channel sills if required must be embedded so top of channel sill is still at floor level.

See Side View B **Page 40** for vertical dimensions.

Not to be used for construction purposes unless approved.

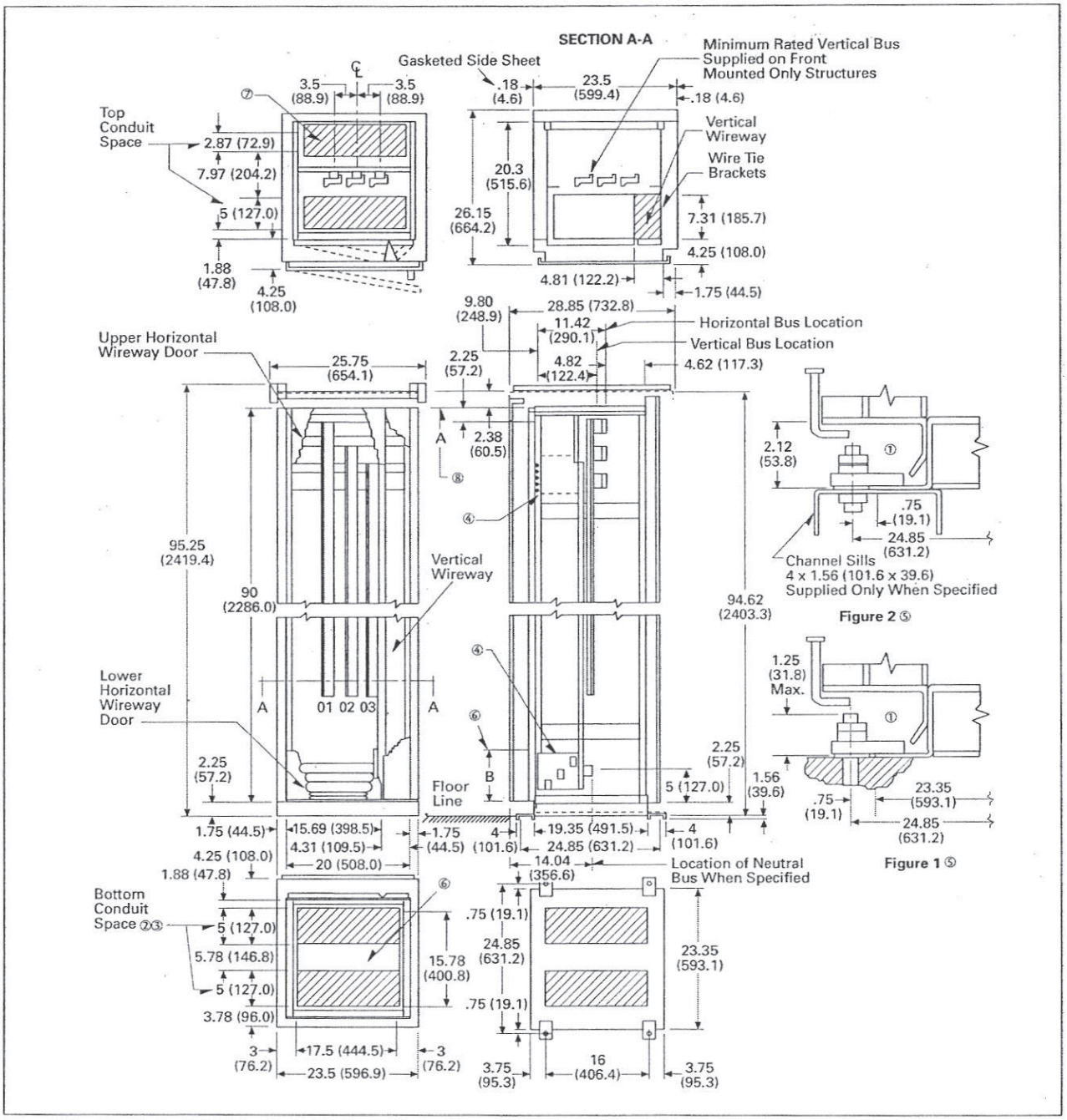
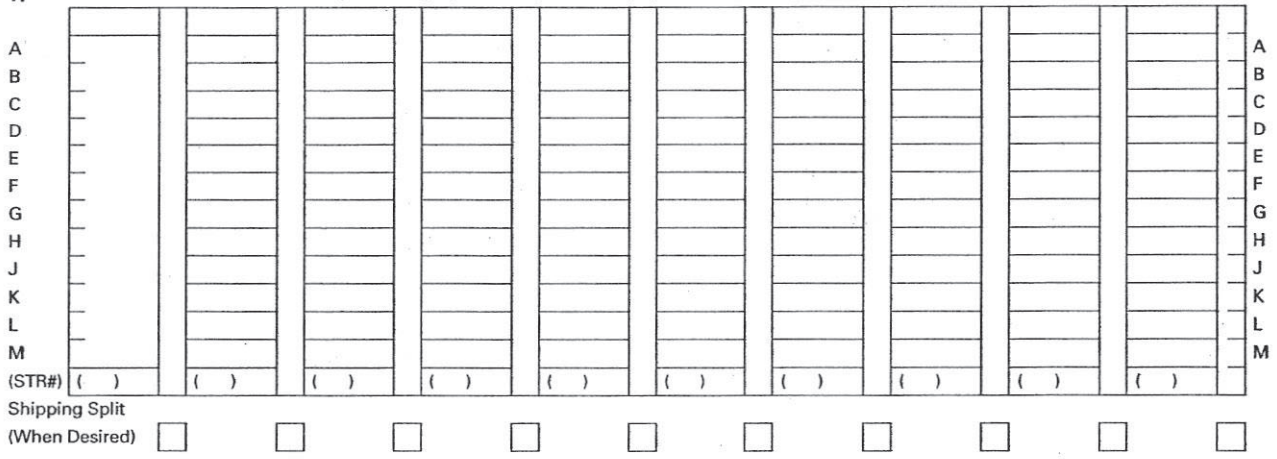


Figure 9. Freedom Series 2100 Motor Control Center Outline and Floor Plan NEMA 3R 20-inch (508.0 mm) Deep Structure — Dimensions in Inches (mm)

① Minimum length of anchor bolt 2 inches (50.8 mm). 38 (9.7 mm) — 16 recommended.
② Recommended maximum conduit height above floor line 3.5 inches (88.9 mm).
③ Maximum conduit space with channel sills 15.78 x 16.6 inches (400.8 x 421.6 mm).
④ Master terminal block assembly furnished for type "C" wiring only. When location not specified MTB supplied at the bottom.
⑤ Recommended standard anchor bolting for Figure 1. When channel sills are used see Figure 2.
⑥ This conduit space not recommended when neutral bus required. Otherwise available.
⑦ Top rear conduit space not recommended for conduit entry in front mounted only structure.
⑧ Standard structure arrangement (In front) without master terminal block, A and B — 9 inches (228.6 mm). With master terminal block at bottom, A and B — 9 inches (228.6 mm). With master terminal block at top: A — 15 inches (381.0 mm), B — 3 inches (76.2 mm).

Note: Rear horizontal bus barrier not supplied with front mounted only structure.

Table 83. Arrangement of Structures (Numbered from Left to Right)
Typical Dimensions: Indoor — 20-inch (508.0 mm) W, 90-inch (2286.0 mm) H; Outdoor 23.5-inch (596.9 mm) W, 95.25-inch (2419.4 mm) H



◇–Future Space Only
Ø–Unusable Space

Unit No.	Starter Class or Description	Size	HMC Feeder Breaker or Switch Amperes	Hp	Extra Intlks.		Control Devices															Nameplate Identifications
							Pushbutton			Selector Switches				Indicating Lights					Meters			
					NO	NC	Start-Stop	Fwd-Rev-Stop	Fast-Slow-Stop	Hand-Off-Auto	On-Off	Fwd-Off-Rev	Fast-Off-Slow	Green (Stopped)	Red (Run, Fwd, Fast)	Amber (Rev, Slow)	Push-To-Test	Transformer Type	Elapsed Time	Ammeter	Extra VA on CPT	

Section 16482 — Motor Control Centers

Part 1 General

1.01 Scope

A. The Contractor shall furnish and install the motor control centers as specified herein and as shown on the contract drawings.

1.02 Related Sections

A. Section 16475 — Circuit Breakers and Fusible Switches.

B. Section 16481 — Par. 2.03 — Freedom Electromechanical Motor Control.

C. Section 16481 — Par. 2.04 — Advantage Microprocessor Motor Control.

D. Section 16481 — Par. 2.05 — Solid-State Reduced Voltage Motor Control.

E. Section 16483 — Adjustable Frequency Drives.

F. Section 16671 — Transient Voltage Surge Suppression.

G. Section 16901 — Microprocessor Metering Equipment.

H. Section 16902 — Electric Control Devices.

I. Section 16903 — Protective Relays.

J. Section 16905 — Programmable. Controllers

K. Section 16911 — Electrical Monitoring and Control Systems.

1.03 References

A. The Motor Control Centers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI and UL 845.

1.04 Submittals — For Review/Approval

A. The following information shall be submitted to the Engineer:

1. Master drawing index.
2. Front view elevation.
3. Floor plan.
4. Top view.
5. Single line.
6. Unit wiring diagrams depicting remote devices.
7. Nameplate schedule.
8. Starter and component schedule.
9. Conduit entry/exit locations.
10. Assembly ratings including:
    a. Short-circuit rating.
    b. Voltage.
    c. Continuous current.
11. Major component ratings including:
    a. Voltage.
    b. Continuous current.
    c. Interrupting ratings.
12. Cable terminal sizes.
13. Product data sheets.

B. Where applicable, the following information shall be submitted to the Engineer:

1. Busway connection.
2. Connection details between close-coupled assemblies.
3. Composite floor plan of close-coupled assemblies.
4. Key interlock scheme drawing and sequence of operations.

1.05 Submittals — For Construction

A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in paragraph 1.04.
2. Unit wiring diagrams.
3. Certified production test reports.
4. Installation information.
5. Seismic certification and equipment anchorage details.

B. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

1.06 Qualifications

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO® 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of Uniform Building Code (UBC) for Zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, UBC: a peak of 2.15g's (3.2–11 Hz), and a ZPA of 0.86g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz.

– OR –

D. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the California Building Code (CBC) through Zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, CBC: a peak of 2.15g's, and a ZPA of 0.86g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz.

– OR –

D. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the BOCA® National Building Code, paragraph 1612.6. This shall include both vertical and lateral required response spectra as specified. Alternatively, the manufacturer's certification may be based on a detailed computer analysis of the entire assembly structure and its components. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. The test response spectra shall meet or exceed the required response spectra peak acceleration of 1.6g's (3.2–11 Hz) and a ZPA of 1.0g as specified in the BOCA National Building Code, for all equipment natural frequencies up to at least 35 Hz.

E. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.

1. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of the equipment.
2. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
3. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.07 Regulatory Requirements

A. The motor control centers shall bear a UL label. (Certified copies of production test reports shall be supplied demonstrating compliance with these standards when requested by the Engineer.)

1.08 Delivery, Storage and Handling

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.09 Operation and Maintenance Manuals

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

Part 2 Products

2.01 Manufacturers

A. The Cutler-Hammer business

B. _____

C. _____

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 Ratings

A. The Motor Control Center(s) shall be 600-volt class suitable for operation on a 3-phase, 60-Hz system. The system operating voltage and number of wires shall be as indicated on the drawings.

2.03 Construction

A. Motor Control Center(s) shall be Cutler-Hammer type [F2100] [Advantage] design.

B. Structures shall be totally enclosed deadfront, free-standing assemblies. They shall be 90 inches high and [16 inches] [21 inches] deep for front-mounted units. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.

C. Compartments for mounting control units shall be incrementally arranged such that not more than [six (6) size 1 starters for front-mounted only] [eleven (11) size 1 starters for back-to-back] can be mounted within each vertical structure. Guide rails shall be provided.

D. A vertical wireway with minimum of 35 square inches of cross-sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain steel rod cable supports.

E. All full voltage starter units through NEMA Size 5 shall be of the drawout type. Drawout provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Drawout units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend into the bus compartment. Interior of all units shall be painted white for increased visibility. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks. In addition, a master terminal block, when Type C wiring is specified, shall be drawout and shall be located in the [top] [bottom] wireway, readily accessible through a hinged cover. All control wire to be [14 gauge] [16 gauge] minimum.

F. F. All drawout units shall be secured by a spring-loaded quarter turn indicating type fastening device located at the top front of the unit. Each unit compartment shall be provided with an individual front door.

G. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access unless the disconnect is in the OFF position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. A second interlock shall be provided to prevent removal or re-insertion of the unit while in the ON position. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one (1) to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

2.04 Bus

A. Each structure shall contain a main horizontal [copper tin-plated] [copper silver-plated] bus, with minimum ampacity of 600 amperes or rated [800] [1200] [1400] [1600] [2000] [2500] [3200] amperes as shown on the drawings. The horizontal bus shall be rated at [65] [50] °C temperature rise over a 40°C ambient in compliance with UL standards. Vertical bus feeding unit compartments shall be copper and shall be securely bolted to the horizontal main bus. All joints shall be front-accessible for ease of maintenance. The vertical bus shall have a minimum rating of 300 amperes for front-mounted units and 600 amperes for back-to-back mounted units or fully rated [600] [800] [1200] amperes.

B. For [F2100] [Advantage] design MCC, the vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical buses to prevent any fault-generated gases to pass from one phase to another. The vertical bus shall include a shutter mechanism to provide complete isolation of the vertical bus when a unit is removed.

– OR –

B. For F2100 design MCC, isolation of the vertical bus compartment from the unit compartment shall be by means of a full height insulating barrier. This barrier shall be a single sheet of glass reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus. Provide snap-in covers for all unused openings.

C. Buses shall be braced for [65,000] [100,000] amperes rms symmetrical.

2.05 Wiring/terminations

A. A. Wiring shall be NEMA Class [I] [II], Type [A] [B] [C].

B. DeviceNet Wiring shall be in accordance with the Open DeviceNet Vendors Association (ODVA) specification. Truck cable shall be provided in the upper wireway, with T connectors for each MCC section. Drop cables and T connectors shall be used in the vertical wireway to connect each DeviceNet device.

2.06 Motor Controllers

Note to Spec. Writer:

Two classes of combination motor starters are outlined below. Select one of the paragraphs 2.06 A. The first paragraph is for circuit breaker type combination starters; the second paragraph is for fusible type starters combination starters. Three types of motor starter (contactor/ overload) are available. Select one of the of paragraphs 2.06 B. The first paragraph is for Advantage Microprocessor Motor Starters; the second paragraph is for DeviceNet Compatible Motor Controllers; the third paragraph is for Freedom Series NEMA Electromechanical Motor Starters for F2100 MCC

A. Combination starter units shall be full-voltage non-reversing, unless otherwise shown, and shall utilize Cutler-Hammer type HMCP Motor Circuit Protectors.

1. Each combination unit shall be rated [65,000] [100,000] AIC symmetrical at 480 V. The HMCP shall provide adjustable magnetic protection and be provided with pin insert to limit magnetic adjustment to a maximum of 1700% motor nameplate full load current to comply with NEC requirements. All HMCP combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the HMCP. Type HMCP motor circuit protectors shall include transient override feature for motor inrush current. [HMCP shall be used to provide IEC 947-4 Type 2 coordination to 100,000 amperes.]

– OR –

A. Combination starter units shall be full-voltage non-reversing, unless shown otherwise utilizing fusible switches.

1. Fusible switches shall be quick-make, quick-break and shall accept class R dimension fuses and the combination shall safely interrupt 100,000 amperes. Fusible combination starters shall provide IEC 947-4 Type 2 coordination to 100,000 amperes.

B. Motor starters shall be Cutler-Hammer type Advantage, electrically operated, electrically held, 3-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) NO or eight (8) NC auxiliary contacts. The overload protection shall consist of one (1) current sensor located in each phase monitored by the microprocessor that yields a time-current curve closely paralleling that of motor heating damage boundary, accurate to 2%. Running overload protection shall be DIP switch selectable for the specific motor full load amperes within the starter range. Provide DIP switch selectable overload trip class of 10, 20 and 30.

1. Motor starters shall monitor current in each phase to provide phase loss and phase unbalance protection, such that if the unbalance on any of two phases is greater than 30% of the DIP switch selected trip rating, a phase loss/ unbalance trip occurs. Provide phase loss/unbalance protection which requires no time delay for reset.

2. Motor starters shall provide ground fault protection. Ground fault protection shall be set at 20% of maximum continuous ampere rating and have a start delay of 20 seconds, and a run delay of 1 second to prevent nuisance trip on starting.

3. Microprocessor shall measure control circuit voltage and prevent closing of the coil on low-voltage (78 Vac) and/or high-voltage (135 Vac) conditions which are outside of the coil ratings.
4. Microprocessor shall apply voltage to the coil such that a guaranteed maximum of two (2) milliseconds of main contact bounce occurs on contactor closure.
5. Microprocessor shall continuously measure coil circuit voltage and current so as to maintain constant coil power at a level to maintain main contact closure and minimize coil power consumption.
6. Provide control modules to perform the indicated input/output control functions shown on the drawings. Module to incorporate faceplates having membrane type pushbuttons and LEDs. All pushbutton and LED functions to be furnished with clearly written identification. Modules to be provided with the ability to replace conventional start, stop, hand, auto, and control functions, and when utilized in starter applications, overload reset function. Modules to be provided with the ability to replace conventional indicating light status of run, off, selector switch pushbutton position, and when utilized in starter applications, overload alarm and overload trip.
7. Provide, where indicated on the drawings, a metering module capable of displaying control voltage, status and where utilized on starter applications, cause of trip, current at time of trip and current in each phase.
8. [Provide] [Make provisions for] an addressable communication card capable of transmitting all data over a compatible two-wire local area network to a central personal computer for storage and/or printout. The network shall also be capable of transmitting data in RS232c format via a translator module.
   a. ON-OFF reset control functions.
   b. Status (ON, OFF, TRIPPED, NO RESPONSE).
   c. Current in each phase.
   d. Percent phase unbalance.
   e. Control voltage.
   f. Overload protection settings.
   g. Cause of trip.
   h. Trip current magnitude.

– OR –

C. Motor starters shall be DeviceNet compatible, Cutler-Hammer type Advantage, electrically operated, electrically held, 3-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) NO or eight (8) NC auxiliary contacts. The overload protection shall consist of one (1) current sensor located in each phase monitored by the microprocessor that yields a time-current curve closely paralleling that of motor heating damage boundary, accurate to 2%. Running overload protection shall be DIP switch selectable for the specific motor full load amperes within the starter range. Provide DIP switch selectable overload trip class of 10, 20 and 30.

1. Motor starters shall monitor current in each phase to provide phase loss and phase unbalance protection, such that if the unbalance on any of two phases is greater than 30% of the DIP switch selected trip rating, a phase loss/unbalance trip occurs. Provide phase loss/unbalance protection which requires no time delay for reset. Phase unbalance protection shall have the capability of being deactivated by use of a hand-held programmer.
2. Motor starters shall provide ground fault protection. Ground fault protection shall be set at 20% of maximum continuous ampere rating and have a start delay of 20 seconds, and a run delay of 1 second to prevent nuisance trip on starting. Ground fault protection shall have the capability of being deactivated by use of a hand-held programmer.
3. Microprocessor shall measure control circuit voltage and prevent closing of the coil on low-voltage (78 Vac) and/or high-voltage (135 Vac) conditions which are outside of the coil ratings.
4. Microprocessor shall apply voltage to the coil such that a guaranteed maximum of two (2) milliseconds of main contact bounce occurs on contactor closure.
5. Microprocessor shall continuously measure coil circuit voltage and current so as to maintain constant coil power at a level to maintain main contact closure and minimize coil power consumption.
6. Provide control modules to perform the indicated input/output control functions shown on the drawings. Module to incorporate faceplates having membrane type pushbuttons and LEDs. All pushbutton and LED functions to be furnished with clearly written identification. Modules to be provided with the ability to replace conventional start, stop, hand, auto, and control functions, and when utilized in starter applications, overload reset function. Modules to be provided with the ability to replace conventional indicating light status of run, off, selector switch pushbutton position, and when utilized in starter applications, overload alarm and overload trip.
7. Provide, where indicated on the drawings, a metering module capable of displaying control voltage, status and where utilized on starter applications, cause of trip, current at time of trip and current in each phase.
8. Each Starter shall have an addressable communication card capable of transmitting control and diagnostic data over an open DeviceNet network to either a personal computer or PLC. The addition of the DeviceNet communication module shall not increase the size of the controller. The starter shall be capable of transmitting the following data.
   a. ON-OFF reset control functions.
   b. Status (ON, OFF, TRIPPED, NO RESPONSE).
   c. Current in each phase.
   d. Percent phase unbalance.
   e. Control voltage.
   f. Overload protection settings.
   g. Trip current magnitude.
   h. Average motor current.

i. Hand/Manual/Local control.

j. Cause of trip indication:

1. Phase loss.

2. Phase unbalance.

3. Ground fault.

4. Thermal trip.

– OR –

B. Motor starters shall be Cutler-Hammer Freedom Series NEMA type electrically operated, electrically held, 3-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) NO or eight (8) NC auxiliary contacts. The overload relay assembly shall be of the thermal bimetallic ambient compensated type. Overload relays shall be reset from outside the enclosure by means of an insulated button. The overload relay shall have a built-in push-to-test button, electrically isolated NO-NC contacts and single-phase sensitivity.

C. Each starter shall be equipped with a fused control power transformer, two (2) indicating lights, HOA selector switch, and two (2) NO contacts, unless otherwise scheduled on the drawings. Device panel to have space to accommodate six (6) oil-tight pilot-control devices or indicating ammeters, voltmeters, or elapsed time meters.

D. Solid-state reduced-voltage starters, Cutler-Hammer type S801 shall be provided where shown on the contract drawings. The solid-state reduced-voltage starter shall be UL and CSA® listed in the motor control center, and consist of an SCR-based power section, logic board and paralleling bypass contactor. The paralleling bypass contactor shall be energized when the motor reaches full speed. Heat sinks shall not be allowed in the MCC structure. Each starter shall have an addressable communication card capable of transmitting control and diagnostic data over an open DeviceNet network to either a personal computer or PLC.

Note to Spec. Writer:

For more detailed specification information refer to section 16481, paragraph 2.05.

E. Adjustable frequency controllers shall be provided in MCC(s) where scheduled. Controllers shall be Cutler-Hammer type AF91 and/or SV9000 for variable torque loads unless otherwise indicated on the drawings. Controllers for variable torque loads shall be rated a minimum of 110% overcurrent for one (1) minute. Drives larger than [1 hp] [10 hp] shall have identical keypads, control terminals and programmable parameters. Drives shall be capable of providing 200% starting torque. Drives over 150 hp shall be located next to the main section to reduce bus loading and heating. All controllers shall be combination type and shall include options as specified. Drives shall have communication cards capable of communication using [DeviceNet] [PROFIBUS] [LonWorks] [Modbus RTU] [Interbus S] [SDS]. Drives shall be capable of using a V/Hz, open loop vector, or closed loop vector control architecture.

Note to Spec. Writer:

For more detailed specification information refer to section 16483, paragraph 2.02.

Note to Spec. Writer:

Select paragraph 2.06 F as optional choice on Advantage MCC only.

F. Advantage Central Monitoring Unit (CMU)

1. Where shown on the drawing, provide a Cutler-Hammer type Advantage Central Monitoring Unit (CMU) or approved equal. The CMU shall be a microprocessor-based, self-contained device (NEMA 3R/12 faceplate) suitable for door mounting and shall perform the following listed functions. Each assembly shall have provisions for a communications module to provide for remote computer monitoring up to 10,000 feet (2540 m).

2. Monitoring and display parameters of up to 99 Cutler-Hammer type Advantage starters or contactors equipped with product operated network interface card (PONI), or Cutler-Hammer type IQ 500 solid-state overload relays. Communications over the local area network shall be 9,600 baud. Parameters locally displayed at the CMU for each starter and overload relay shall also be capable of being communicated via twisted pair to a remote personal computer. Information displayed at the CMU shall include the following:

a. Status – ON, OFF, TRIPPED, NO RESPONSE.

b. Standard address.

c. Three-phase current.

d. Control voltage.

e. Overload condition (alarm).

f. Cause of device trip.

g. Operations count.

h. Run time.

i. Set points.

j. Starter description and identification.

3. When used with the remote communications option, the CMU shall pass data to a computer from Advantage starters, contactors and overload relays (IQ 500). The master or the host network's baud rate (speed of upper network passing data to a computer) shall be independent of the CMU's subnetwork baud rate. The master or host network's baud rate shall be established via the PONI communications module while the CMU's subnetwork baud rate shall be switch selectable on the rear of the CMU.

4. The program directing the functions or the CMU shall be permanently stored in the CMU. There shall be no need to reload data after ac power loss.

5. The addresses, types of devices and descriptions shall be stored in memory during the learn mode and shall also be retained throughout a power loss. Unless there has been a change, it shall not be necessary to re-enter the learn mode after a power loss.

6. The CMU shall have an 8-digit alphanumeric display to monitor active data, trip data or set points which are available from the individual motor control devices. The CMU shall have three (3) LEDs to indicate which group of data is being displayed, as selected through membrane-type alphanumeric pushbuttons by the user. The CMU shall have a 2-digit alphanumeric display to indicate the address of the control device for which data is

being displayed. The CMU shall have membrane type pushbuttons to allow the user to step up or down to select the control device to be displayed. The CMU shall have two (2) additional LEDs at the top of the CMU to indicate that the CMU is operational and when there is an "alarm" status on one of the motor control devices. The CMU shall have an "acknowledge/reset" membrane-type pushbutton to permit the user to reset the CMU following a motor control device trip.

7. The CMU shall be operated from 120-volt, single-phase input.
8. The CMU shall have a "Help" button function, which shall scroll English explanations in the alphanumeric window for any condition or abbreviations.
9. [Provide] [Make provisions for] an addressable communication card capable of transmitting all data, including trip data over a compatible two-wire, local area network to a central personal computer for storage and or printout. Provide data and time-stamping for all starter/contactor operations. Reprogramming of the CMU shall not be required when adding a communication module. The network shall also be capable of transmitting data in RS232c format via a translator module.

2.07 Overcurrent Devices

A. Circuit Breakers

1. Individual feeder breakers shall have a minimum interrupting capacity of [65] [100] kAIC at rated voltage or as scheduled on the drawings.

B. Fusible Switches

1. Individual feeder switches shall be quick-make, quick-break gang-operated type utilizing class R fuse clips. The fused switch shall be rated 100 kAIC at rated voltage.

2.08 DeviceNet Devices

A. Motor Control Center assemblies shall be provided with a factory assembled DeviceNet fieldbus communications network providing direct connectivity between MCC devices and the system controller and/or HMI.

B. The DeviceNet system installed in the MCC shall include a complete and tested cabling system compliant and approved by the ODVA DeviceNet standard. The cabling system shall consist of trunk and drop line cabling including all splice and tap connectors and terminating resistors. The trunk and drop cabling shall be 600V insulation and include electrical shielding as per the standard ODVA DeviceNet specification. Non-standard, non-shielded flat cable will not be accepted.

C. The trunk line shall be installed in the top horizontal wireway of the MCC. The trunk line shall be thick cable as specified by the ODVA standard. Sealed, threaded, and keyed device tap connectors located and mounted in the top horizontal wireway shall "T" off the top wireway to drop cable mounted in each of the vertical wireways. Each DeviceNet device shall have a dedicated drop line connection via T Connector. The drop cable shall be thin cable as specified by the ODVA standard. Each section of motor control shall be connected with sealed, threaded, and keyed device tap connectors located and mounted in the top horizontal wireway All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer's recommendations.

D. DeviceNet communications modules shall be provided at each device interfacing to the DeviceNet fieldbus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the DeviceNet drop cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated DeviceNet device.

E. Port expanders shall be provided where required to permit multiple device communications. The port expander shall be installed in the associated unit device compartment.

F. Motor control centers shall provide required 24 Vdc power to adequately supply power to all the devices in the [MCC] [Total System], and shall be sized as shown in drawings. The power supply shall be installed in an MCC unit with a disconnect switch, supplementary protection and a cable tap box to prevent damage to/from other power supplies on the network.

G. Operator interface unit(s) shall be PanelMate Power Series. Operator interface units shall be able to provide the following. Starter status, 3-phase current, control voltage, overload condition (alarm), cause of device trip, operations count, run time, set points, starter description and identification, system process graphics screens. Operator interface shall have the capability of communicating on the DeviceNet network.

2.09 Miscellaneous Devices

2.10 Incoming Feeder Terminations and Device

A. Incoming [cable] [busway] shall terminate within the control center on a [main lug] [main breaker] termination point. Main lug terminations shall have adequate dedicated space for the type and size of cable used and the lugs shall be [standard mechanical screw] [compression-type] with antiturn feature. Main breakers shall be provided as indicated on the drawings and shall be [molded case] [insulated case, stored energy device] [air power circuit breakers].

2.11 Customer Metering

A. Where indicated on the drawings, provide a separate customer metering compartment with front hinged door.

B. Provide current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.

C. Provide [potential transformers including primary and secondary fuses with disconnecting means] [fused potential taps as the potential source] for metering as shown on the drawings.

Note to Spec. Writer:

Select devices as required for paragraph 2.11 D.

Refer to section 16901 for detailed specification for metering.

IQ Analyzer Series (Section 16901, paragraph 2.02 A.)

IQ DP-4000 Series (Section 16901, paragraph 2.02 B.)

IQ 300 Series (Section 16901, paragraph 2.02 C.)

IQ 200 Series (Section 16901, paragraph 2.02 D.)

IQ Generator (Section 16901, paragraph 2.02 E.)

IQ Data (Section 16901, paragraph 2.02 F.)

D. Microprocessor-Based Metering System.

2.12 Enclosures

A. The type of enclosure shall be in accordance with NEMA standards for [type 1A with gasketed doors] [type 12 dust-tight and drip-proof] [type 3R non-walk-in] [type 3R walk-in]. All enclosing sheet steel, wireways and unit doors shall be gasketed.

2.13 Nameplates

A. Each unit will have a 1.0 x 2.5-inch (25.4 x 63.5 mm) engraved nameplate. The lettering shall be black 3/16-inch (4.78 mm) high, on a white background.

2.14 Finish

A. The control center shall be given a phosphatizing pretreatment. The paint coating shall be a polyester urethane, thermosetting powder paint. Manufacturer's standard color shall be used.

B. The control center finish shall pass 600 hours of corrosion-resistance testing per ASTM B 117.

Part 3 Execution

3.01 Factory Testing

A. The motor control centers shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities.

B. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.

C. A certified test report of all standard production tests shall be available to the Engineer upon request.

D. Factory tests as outlined above shall be witnessed by the owner's representative.

1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.
2. The manufacturer shall include the cost of transportation and lodging for up to three (3) owner's representatives. The cost of meals and incidental expenses shall be the owner's responsibility.

3.02 Field Quality Control

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and startup of the equipment specified under this section for a period of _____ working days. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:

1. Rig the MCC assembly into final location and install on level surface.
2. Check all removable cells and starter units for easy removal and insertion.
3. Perform insulation tests on each phase and verify low-resistance ground connection on ground bus.
4. Connect all power wiring and control wiring and verify basic operation of each starter from control power source.
5. Torque all bolted connections made in the field and verify all factory bolted connections.
6. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on record drawings. Perform startup of any solid-state starters and adjustable frequency drives.

C. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 Manufacturer's Certification

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the generation of any reports.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.04 Training

A. The Contractor shall provide a training session for up to five (5) owner's representatives for ____ normal workdays at the jobsite or other office location chosen by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative.

C. The training program shall consist of the following:

1. Review of the MCC one-line drawings and schedules
2. Review of the factory record shop drawings and placement of the various cells
3. Review of each type of starter cell, components within, control, and power wiring
4. Review contactor coil replacement and contact replacement procedures.
5. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
6. Provide three-ring binders to participants complete with copies of drawings and other course material covered.

3.05 Examination

A. Installing Contractor to fully inspect shipments for damage and report damage to manufacturer and file claim upon shipper, if necessary.

B. Overload relay heater ratings must be properly sized and coordinated for each motor starter unit.

C. Installing Contractor to verify NEC clearances as dictated on the contract drawings prior to installation. Verify UL labeling of the assembly prior to installation.

3.06 Installation

A. Contractor to follow the installation instructions supplied by the manufacturer.

B. Control wiring shall be as shown on the contract drawings except as modified by the approval and submittal process. Interface all local and remote devices into the control wiring and operational systems for each load.

C. As shown on the contract drawing, provide DeviceNet trunk and drop cabling with threaded, sealed and keyed device taps.

3.07 Field Adjustments

A. Follow the manufacturer's instructions and the contract documents concerning any short-circuit device settings, heater selection, timing relays, or startup of components.

3.08 Field Testing

A. Follow the minimum requirements as stipulated in the NETA testing procedure for this type of motor control center assembly.

B. Generate a field report on tests performed, test values experienced, etc., and make available to owner upon request.

UL is a federally registered trademark of Underwriters Laboratories Inc

National Electrical Code and NEC are registered trademarks of the National Fire Protection Association, Quincy, Mass.

NEMA is the registered trademark and service mark of the National Electrical Manufacturers Association

Uniform Building Code (UBC) is a trademark of the International Conference of Building Officials (ICBO).

ISO is the registered trademark and sole property of the International Organization for Standardization

BOCA is a registered trademark of Building Officials and Code Administrators International, Inc

CSA is a registered trademark of the Canadian Standards Association.

Modbus is a registered trademark of Modicon, a division of Schneider Electric Industries SA.

PROFIBUS is a registered trademark of PROFIBUS International.

SDS (Smart Distributed System) is a trademark of Synergistic Micro Systems.

Metasys is a registered trademark of Johnson Controls, Inc.

Siemens is a federally registered trademark of Siemens AG.

For a complete product specification in CSI format, see *Cutler-Hammer Product Specification Guide*, section 16482.

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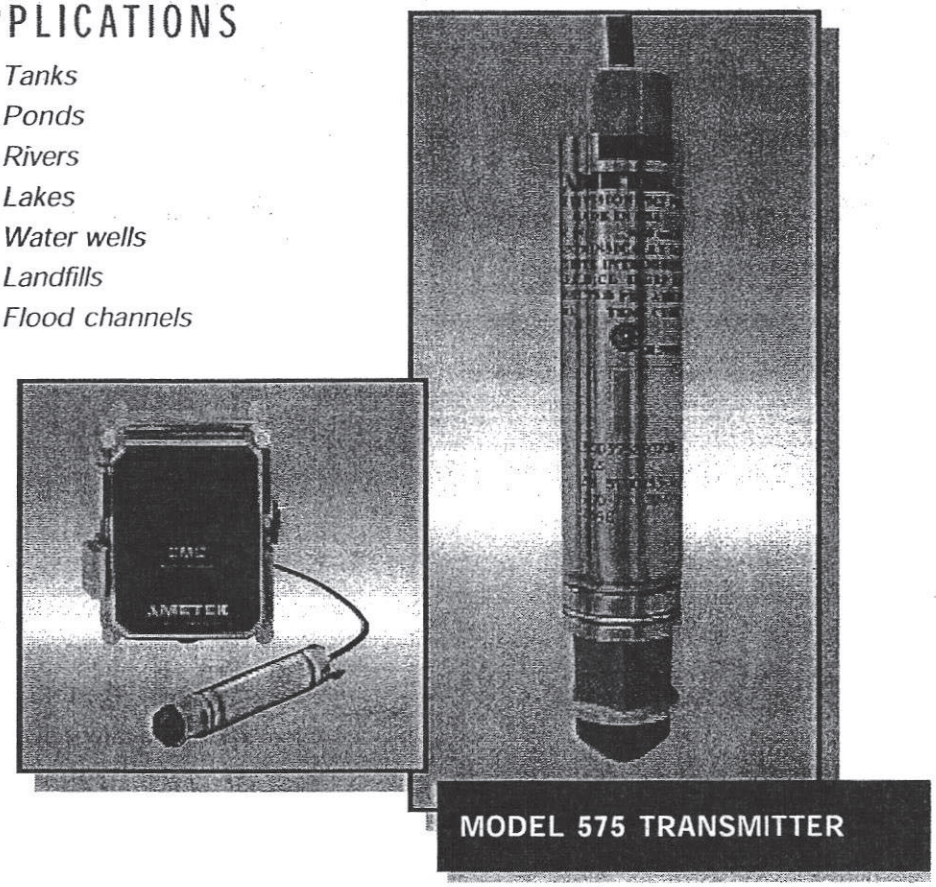
Model 575 Submersible Level Transmitter

FEATURES

- *Solid state semiconductor sensor for accuracy and reliability*
- *Rugged 316 stainless steel housing with excellent environmental protection*
- *Easy to install and use*
- *Removable, nonclogging snub nose end protects sensing elements*
- *2 wire 4-20 mA output*
- *Vented to the atmosphere through the surface end of the cable*
- *Reverse polarity and surge protected*
- *Lightning protectors available*

APPLICATIONS

- *Tanks*
- *Ponds*
- *Rivers*
- *Lakes*
- *Water wells*
- *Landfills*
- *Flood channels*



MODEL 575 TRANSMITTER

DESCRIPTION

The Model 575 Submersible Level Transmitter is specially designed to provide the convenience of direct submergence in many type of liquid for quick, accurate and reliable level measurement. The simple design and rugged construction of this solid state instrument provide long lasting service with virtually no maintenance.

The Model 575 Transmitter indicates the level of liquid by continuously measuring hydrostatic pressure via its sensing element, an ion implanted silicon semiconductor chip with integral Wheatstone Bridge circuit. Once the sensor measures the pressure, the data is transmitted by a 4 to 20 mA output signal. This design provides for excellent linearity and repeatability, low hysteresis and long term stability.

The Model 575 is easy to install, too. Simply lower the transmitter into a vessel or well. It's that easy. All the electronics are mounted in a submersible 316 stainless steel housing. A special cable support bracket is also available. This gives extra stability to the transmitter when used with longer lengths of cable or when used in an agitated liquid.

The transmitter is available calibrated for any span needed, from 0 to 3 psi or 0 to 0.2 bar (0 to 7 feet or 0 to 2.1 meters of water) to 0 to 300 psi or 0 to 20 bar (0 to 690 feet or 0 to 211 meters of water).

To complete your liquid level measurement and control system, use the AMETEK Model DMC Digital Meter/ Controller with the Model 575 Submersible Transmitter.

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Model 575 Submersible Level Transmitter

SPECIFICATIONS

FEET OF WATER: 0/14, 0/35, 0/69, 0/138, 0/230, 0/345, 0/460, 0/690

METERS OF WATER: 0/4, 0/10, 0/21, 0/42, 0/70, 0/105, 0/140, 0/210

BAR: 0/0.4, 0/1, 0/2, 0/4, 0/7, 0/10, 0/14, 0/20

PSI: 0/6, 0/15, 0/30, 0/60, 0/100, 0/150, 0/200, 0/300

OUTPUT: 4-20 mA, 2 wire, current limited to 30 mA DC

POWER SUPPLY: 12 to 40 VDC with reverse polarity surge protection; Limit to 28 VDC for CSA I.S.

LOOP RESISTANCE: 1400 ohms maximum at 40 volts

TEMPERATURE RANGE:
Ambient Operating: CSA intrinsically safe T3C = 32° to 104° F (0° to 40° C)
Storage: -40° to 176° F (-40° to 80° C)

OVERRANGE EFFECT: ±0.15% full scale at 300% of maximum range

ACCURACY: ±0.25% full scale, BFSL (including linearity, hysteresis and repeatability); ±0.50% full scale (6 psi range only)

ZERO OFFSET: ±0.50% full scale set at 25° C

SPAN: ±0.50% full scale set at 25° C

TEMPERATURE EFFECTS:
Compensated: 32° to 122° F (0° to 50° C); Maximum ±1% URL output change for ±25° C temperature change within compensated range when calibrated at 25° C

POWER SUPPLY EFFECT: ±0.005% full scale per volt

CONSTRUCTION:
Diaphragm: Type 316L stainless steel
Housing Type: 316 stainless steel
Nut/Washer Type: 316 stainless steel
Cable Grommet: Viton
Housing O Ring: Viton
Cable Jacket: Polyurethane
Snub Nose: Nylon 6/6, removeable (1/2 inch NPT)

MEDIA COMPATIBILITY: Reference materials of construction

ELECTRICAL CONNECTION: Attached 20 gauge polyurethane shielded cable. Unspliced lengths available up to 5000 ft. (1662 m)

WEIGHT: 1.0 lb. (454 g)

APPROVALS: Meets CSA requirements for intrinsically safe operation in hazardous locations as designated by Class I, Div 1, Groups A, B, C & D and Class II, Groups E, F & G. Temperature Code T3C (when used with approved barrier)

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

ORDERING INFORMATION

MODEL NUMBER
575-S-B-0015-N-L-S (100 Ft. of Cable)

SENSING PORT
S = Snub nose

INPUT/OUTPUT
B = 12-28 VDC/4-20 mA
Consult factory for availability of different input/output options

RANGE
0006 = 0-6 psi/0-0.4 bar (0-14 ft./0-4.2 m water)
0015 = 0-15 psi/0-1 bar (0-35 ft./0-10.5 m water)
0030 = 0-30 psi/0-2 bar (0-69 ft./0-21.1 m water)
0060 = 0-60 psi/0-4 bar (0-138 ft./0-42.2 m water)
0100 = 0-100 psi/0-7 bar (0-230 ft./0-70.3 m water)
0150 = 0-150 psi/0-10 bar (0-345 ft./0-105.4 m water)
0200 = 0-200 psi/0-14 bar (0-460 ft./0-140.5 m water)
0300 = 0-300 psi/0-20 bar (0-690 ft./0-211.0 m water)

Calibrated ranges can be specified after the model code; the specific range should be between the upper and lower ranges in the category selected.

ELECTRICAL CONNECTION
N = Standard nut/cable
R = Cable support with standard nut/cable
C = Conduit adapter

DIAPHRAGM
L = 316L stainless steel

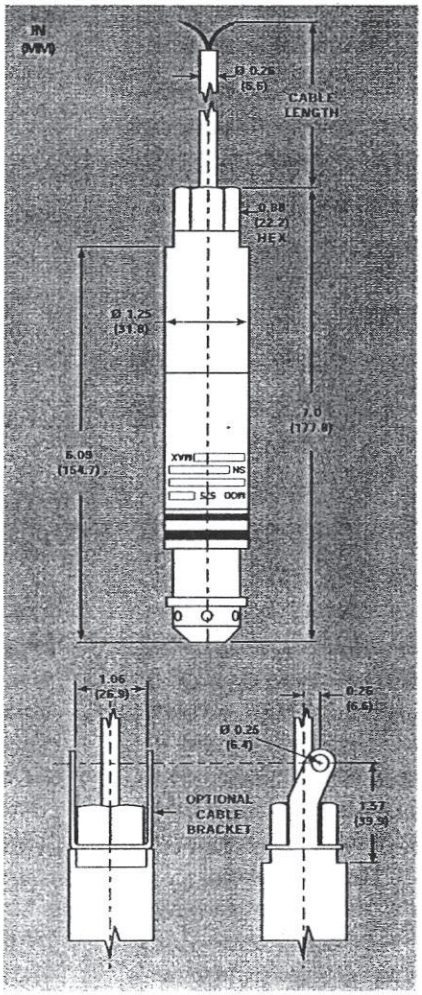
FILL
S = Silicone oil
Others = Consult factory for availability.

CABLE LENGTH
(Specify length in feet)

NOTE: For maximum reliability and long term performance, AMETEK recommends the use of a lightning protector with this level transmitter. For ordering information consult factory.

Example:
575-S-B-0015-N-L-S
(100 Ft. of Cable)
Model 575 snubnose submersible transmitter,12-28 VDC input, 4-20 mA output, to measure 15 psi, standard nut, cable electrical connection, 316L stainless steel diaphragm, silicone fill, 100 ft. of cable

DIMENSIONS



AMETEK®
U.S. GAUGE • PMT PRODUCTS
820 PENNSYLVANIA BLVD., FEASTERVILLE, PENNSYLVANIA 19053 U.S.A.
TEL: (215) 355-6900 • FAX: (215) 355-2937 • www.ametekusg.com

ISO 9001 REGISTERED MANUFACTURER

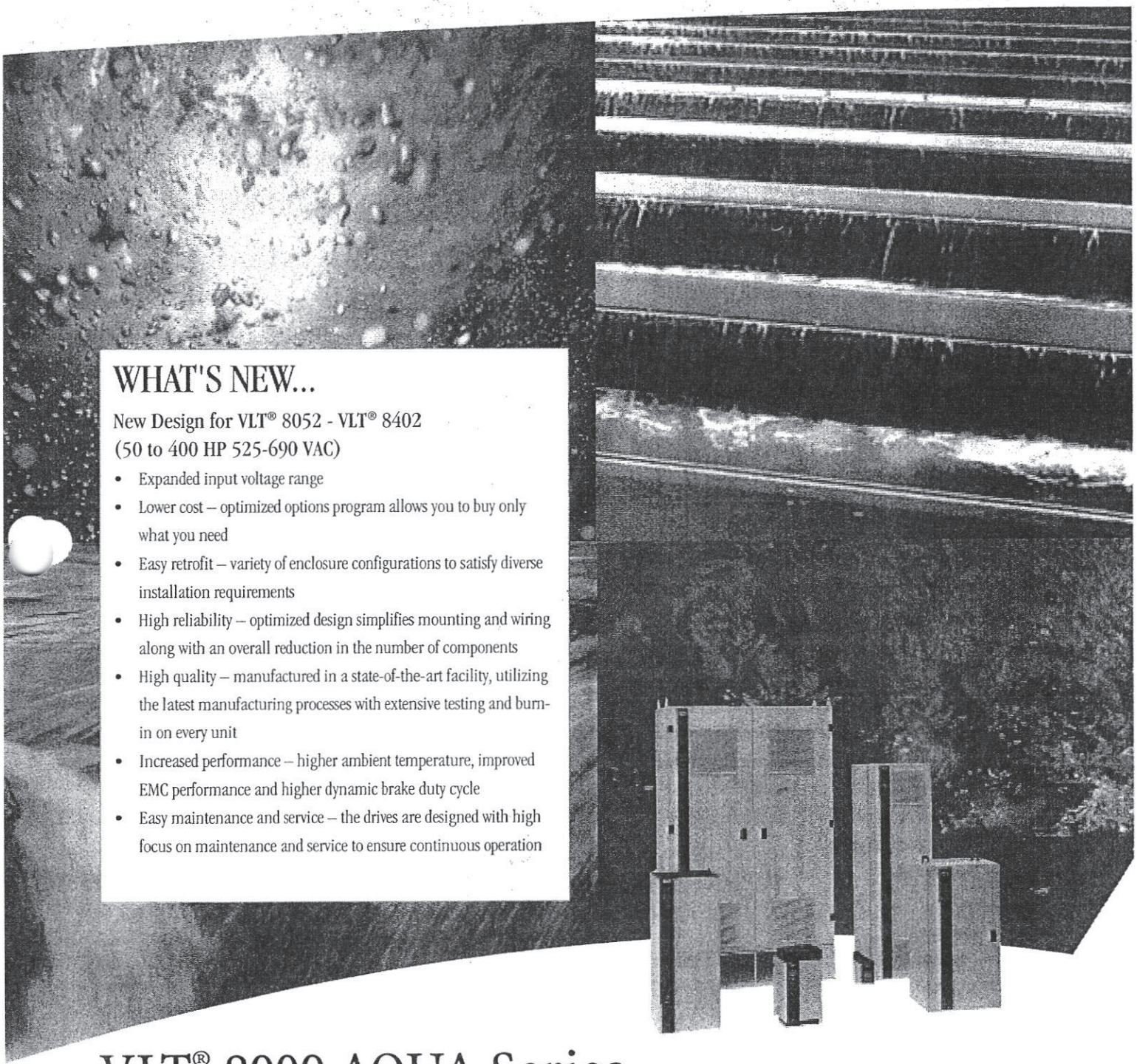
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Danfoss



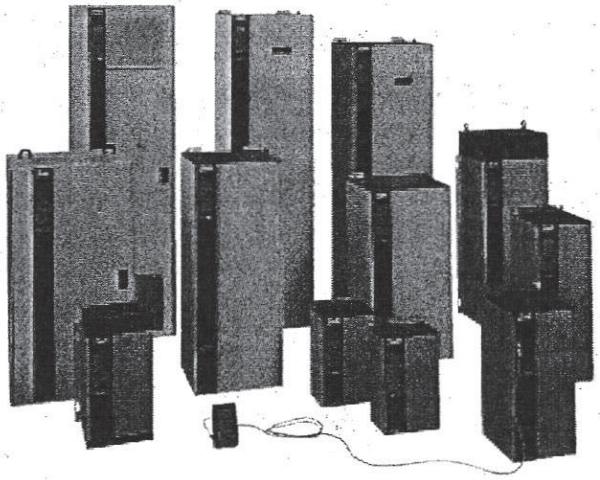
WHAT'S NEW...

New Design for VLT® 8052 - VLT® 8402
(50 to 400 HP 525-690 VAC)

- Expanded input voltage range
- Lower cost – optimized options program allows you to buy only what you need
- Easy retrofit – variety of enclosure configurations to satisfy diverse installation requirements
- High reliability – optimized design simplifies mounting and wiring along with an overall reduction in the number of components
- High quality – manufactured in a state-of-the-art facility, utilizing the latest manufacturing processes with extensive testing and burn-in on every unit
- Increased performance – higher ambient temperature, improved EMC performance and higher dynamic brake duty cycle
- Easy maintenance and service – the drives are designed with high focus on maintenance and service to ensure continuous operation

VLT® 8000 AQUA Series Updates 7.01.05

VLT® 8000 AQUA Overview



VLT 8000 AQUA drives are available in chassis, NEMA 1 or NEMA 12 enclosures; 230 VAC input (5 to 60 HP), 380-480 VAC (5 to 600 HP) or 550-600 VAC (1.5 to 40 HP), or 525-690 VAC (50-400 HP) for CT/VT applications.

VLT® 8000 AQUA Benefits for Water and Wastewater Applications

- Provides and optimizes process control of flow, level and pressure
- Enables use of standard pumps with integral AC motors and can be installed into existing plants using standard AC motors
- Programmable for constant or variable torque operation: constant torque operation for maximum motor torque throughout speed range; variable torque operation optimized for maximum efficiency
- Ideal for controlling multiple parallel-coupled pumps/blowers
- Eliminates control valves and problematic pressure storage tanks
- Harmonic distortion protection built in
- Lower energy consumption
- Less pump noise
- Easy to set up and operate
- Comprehensive protection of drive, motor and process equipment
- Reduced maintenance
- Eliminates current in-rushes on the AC line
- No motor derating required
- Designed to communicate with programmable logic controllers as well as machine operators
- Resistant to extreme voltage and temperature conditions

- 5 to 60 HP, 200-240 VAC
- 5 to 600 HP, 380-480 VAC
- 1.5 to 40 HP, 550-600 VAC
- 50 to 400 HP, 525-690 VAC

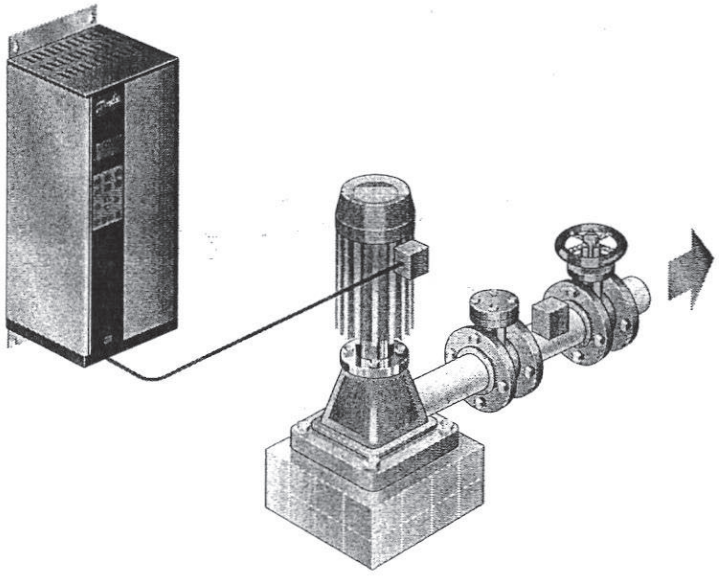
VLT® 8000 AQUA Feature Highlights

Optimized Enclosures

- Ideal for panels
- Side by side flush mounting requires less panel space
- Optimized NEMA 12 enclosures offer stand-alone protection

Designed for Performance

- 1-600 HP constant or variable torque (CT/VT) operation
- Constant torque start and 160% breakaway current for up to 0.5 seconds for high torque loads
- 110% overload (CT/VT)
- Standard protection features include: phase-to-phase short; phase-to-ground short; input and output protection
- Unlimited switching on the drive output to the motor
- Fast response time for control inputs
- Built-in DC link inductors reduce harmonics



VLT® 8000 AQUA Overview

Enhanced Software

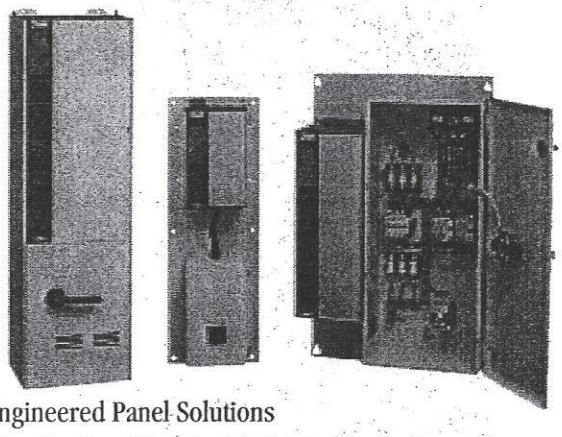
- Quick Menu has 12 primary parameters for quick start-up
- Electronic Thermal Relay provides motor overload protection
- Built-in two setpoint and two feedback PID controller
- AMA (Automatic Motor Adaptation) saves setup time by making most adjustments itself; optimizes operation between the drive and the motor-- without the need to disconnect the motor from the load or spinning the motor
- Autoramping extends ramp up and ramp down time to prevent nuisance tripping
- Initial Ramp fill mode provides initial ramp feature to get pump running -- optimized for the operation of submersible pumps
- AEO (Automatic Energy Optimizer) reduces energy consumption and audible motor noise
- Sleep mode automatically stops and starts the drive as determined by user-programmed levels at low demand-- saves additional energy and reduces wear on drive components
- Run permissive logic circuit ensures system security prior to operation
- Dual pump/motor alternation

Versatile Interfaces

- Programmable I/O selector switches, pushbuttons and indicator lights for manual devices
- Built-in H-O-A (Hand-Off-Auto) switch function on keypad
- Direct thermistor input for motor thermal protection
- Alarm, Warning and On LEDs indicate drive status
- Built-in RS-485 is fully-equipped for serial communication -- up to 31 drives can be connected to one serial bus
- Window-based programming, system monitoring control or diagnostics with VLT Dialog software
- Galvanically-isolated I/O

International Approvals

- UL
- cUL
- CE (230, 460 and 690 V units)



Engineered Panel Solutions
(See Section E for complete information)

The Engineered Panel Solutions program for the VLT 8000 AQUA family provides increased functionality. These enclosures are available in NEMA 1, 3R, 4/4X, 12 and offer a variety of control configurations.

Options (Factory built-in)
(Pages A 38-42)

Enclosures

- Chassis (IP00)
- Protected Chassis (IP20)
- NEMA 1 (IP20)
- NEMA 12 (IP54)

Hardware

- Standard
- Extended with Drive Disconnect

RFI Filter

- Class 1 Group A

Fieldbus Options

- Profibus DP/FMS
- Modbus RTU
- DeviceNet

Application Options

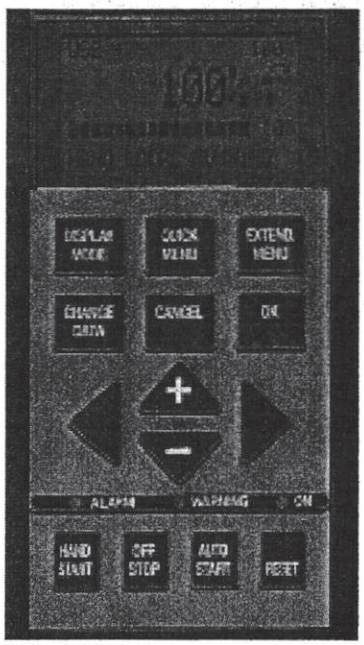
- 4-Relay option card
- Cascade Controller

Conformal Coating

Accessories
(See Section F)

- Remote keypad kit
- EMC/RFI filters
- LC filters
- Line Reactors
- Harmonic traps
- VLT Dialog Software

Keypad and Display Functions



Fast, Simple, Automatic Start-Up

The VLT 8000 AQUA has a two level menu-prompted software structure. The first level, referred to as the Quick Set-Up Menu, contains the twelve most commonly used parameters; the second level offers extended programming capabilities. If the drive and the motor are of the same rated size, programming is not normally necessary – simply connect the AC line, the motor and the control wires, and start the VLT 8000 AQUA.

Versatile Data Display

The VLT 8000 AQUA drive's four line, alphanumeric, backlit LCD display is easy to read from any angle. With three lines of 20 characters and one line of eight double-sized characters. Up to four measurements can be shown continuously on the top two lines of the display. Choose from twenty-five different items to display, including input reference, motor current, hours run, and output frequency, horsepower, kW or kWh, or select from custom units, such as GPM or HP.

H-O-A Manual or Automatic Control

The VLT 8000 AQUA's keypad separates the H-O-A (Hand-Off-Auto) functions for easy, logical control of the drive. Local control is easily accomplished by simply pressing the HAND START key and controlling the drive's speed using the + and - keys. Activating the Remote/Auto button enables remote operation via the control terminals.

Keypad (LCP – Local Control Panel)

All VLT 8000 AQUA drives use the same control panel, menu-driven operating system and cabling connections. Once familiar with one drive, an operator can start-up, program and operate any other drive throughout the HP range.

- Interchangeable LCP keypad contains non-volatile memory for uploading/downloading parameters for single and multiple drive installations.
- LCP keypad may be removed for secure, tamper-proof operation. (The drive's status lights operate independent of keypad). The operational status on the drive include a green "ON", yellow "WARNING", and red "ALARM" LEDs.
- The VLT 8000 AQUA's LCP keypad can be remotely mounted up to 10 feet by using one of the optional NEMA 1 or NEMA 12 remote mounting kits (ideal for panel mounting).

Quick Set-Up Menu



With the direct-access Quick Menu, most installations are commissioned by simply scrolling through the twelve parameter settings to confirm that they match your requirements. Once checked, the values set are automatically stored in non-volatile memory. That's it! After setting up one drive, the removable Keypad/Display can be used to transfer the same settings to all other VLT 8000 AQUA drives.

Quick Set-up Menu items include:

- Language select
- Motor horsepower
- Motor voltage
- Motor frequency
- Motor current
- Motor rated speed
- Low limit output frequency
- High limit output frequency
- Ramp up time
- Ramp down time
- Relay 1 output
- Relay 2 output

Keypad and Display Functions

Control Keys

The control keys on the LCP are divided into functions. The keys between the LCD display and the LEDs are used for parameter setup, including choice of display indication during normal operation.

Keys for local control are found under the LEDs.



[DISPLAY MODE] is used for selecting the mode of display or for changing back to Display mode from either the Quick menu mode or the Menu mode.



[QUICK MENU] is used for programming the VLT unit using the 12 parameters in the Quick menu. It is possible to switch directly between Quick menu mode and Menu mode.



[EXTENDED MENU] provides the access to all parameters for programming. It is possible to switch directly between Menu mode and Quick menu mode.



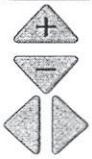
[CHANGE DATA] is used for changing the data value of a parameter when programming.



[CANCEL] is used to cancel the last programming command so it is not carried out.



[OK] is used for confirming that the last programming change is acceptable and should be stored.



[+/–], [<>] provide the user the ability to move the cursor around the LCD display, or sequence through display values. These keys are active during operation as well as programming modes.



[HAND START] is used to start the motor. When Hand Start is activated, signals including Off Stop, Auto Start, Reset, Safety Interlock, Coasting Stop Inverse, Reversing, Setup Select, Jog, Run Permissive, Lock for Data Change, Stop Command from Serial Communication remain active.



[OFF STOP] stops the motor.



[AUTO START] is used if the VLT is to be controlled via the control terminals and/or serial communication. When a start signal is active on the control terminals and/or the bus, the VLT will start.

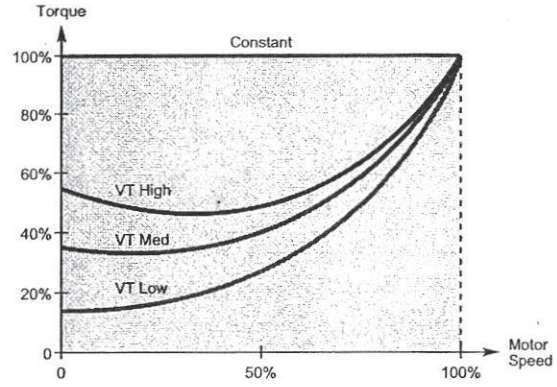


[RESET] is used for resetting the VLT after an alarm (trip).

Operating variable	Unit
Reference	[%]
Reference	[unit]
Frequency	[Hz]
% max. output frequency	[%]
Motor current	[A]
Power	[kW]
Power	[HP]
Output energy	[kWh]
Motor voltage	[V]
DC-link voltage	[V]
Motor thermal load	[%]
VLT thermal load	[%]
Hours run	[hours]
Input status, digital input	[binary code]
Input status, analog terminal 53	[V]
Input status, analog terminal 54	[V]
Input status, analog terminal 60	[mA]
Pulse reference	[Hz]
External reference	[%]
Cooling plate temperature	[°C]
User-defined readout	[unit]
Setpoint 1	[unit]
Setpoint 2	[unit]
Feedback	[unit]
Feedback 1	[unit]
Feedback 2	[unit]
User-defined text	[-]

Functionality to Increase Efficiency

Operating Characteristics



Choice of Torque Modes

The VLT 8000 AQUA can be programmed for efficient operation in Constant Torque or Variable Torque applications.

Constant Torque operation demands that the motor have the ability to produce a constant and consistent amount of torque on its shaft while operating throughout the rated speed range. When the VLT 8000 AQUA is programmed for operation in Constant Torque mode a load-dependant U/f characteristic is obtained in which output voltage and frequency increase with increasing loads to maintain constant energy to the motor.

Typical Constant Torque applications where the torque requirements remain constant throughout the operational speed range are; conveyors, cranes and positive displacement pumps/fans/blowers.

Variable Torque loads create a non-linear relationship between the speed and torque on a motor's shaft. Typically the load increases at the square of the increase in speed; for example if the speed increases by 25% the resulting load on the shaft would increase approximately 50%.

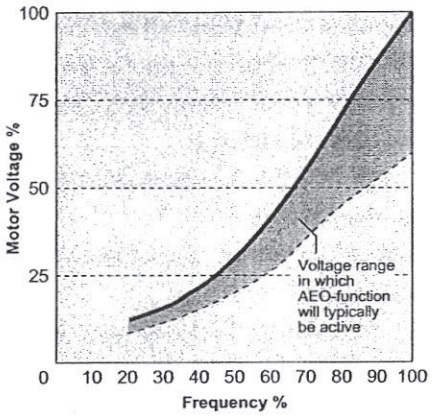
Installations operating under Variable Torque conditions typically involve control of fans or centrifugal pumps. Differences in equipment and applications can result in the variations in the speed-torque curve profile. Matching an adjustable frequency drive's output (U/f ratio) to the speed-torque curve as closely as possible results in improved energy efficiency and overall process control.

The VLT 8000 AQUA Series drive offers the ability to chose between three (3) Variable Torque curve profiles to closely match your application's requirements. Selecting the closest operating curve between the VT High, VT Medium and VT Low will provide the maximum energy efficiency in the application.

Constant Torque Start, Breakaway Current for High Torque Loads

Even when operating in variable torque mode, the VLT 8000 AQUA assumes a constant torque mode of operation during start. This assures that the load accelerates to the commanded speed. Breakaway torque provides up to 160% of rated current for up to 0.5 seconds to ensure that sufficient torque is produced to begin operation.

Specialized Software Functionality



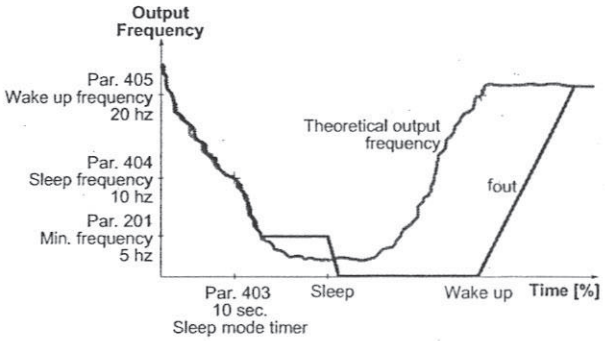
AEO (Automatic Energy Optimization)

- Increased energy savings
- Extends motor life by reducing heat of the motor
- Minimizes audible noise in the motor
- Maintains high system efficiency, even in applications using oversized motors

AEO is a unique control scheme that ensures an optimum relationship between voltage and frequency depending on the actual load. Most PWM drive control schemes allow changes in the V/Hz ratio, but the response is based on an expected load (not actual) at various frequencies. In other words, conventional PWM drives estimate the torque required based on the output frequency and a predetermined torque profile, not on the actual torque requirement. As a result, energy is lost as heat in the motor. Utilizing the AEO function, the VLT 8000 AQUA provides up to 5% energy savings in comparison to other PWM drives.

Sleep Mode with Torque Boost

Sleep Mode monitors the input signal determining the output frequency of the VLT 8000 AQUA, and thus, the system's flow/pressure. When the signal has decreased to the point that the output frequency (motor's speed), has become inefficient and the resulting flow/pressure is negligible, Sleep Mode automatically turns the output off to save energy. Once the unit senses that the system has reached a point where the motor-driven pump will be effective, Sleep Mode "wakes up" the VLT 8000 AQUA and operation resumes.



Pump/Motor Alternation

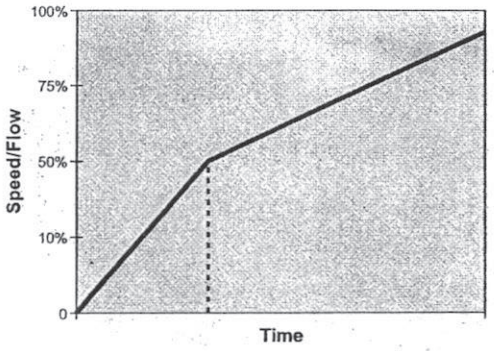
The VLT 8000 AQUA includes a built-in software function to provide an automatic means to alternate between two pump/motors. The pump/motor alternation feature provides a 0.1 to 999 hour crossover between two pump/motors, eliminating the need for an external pump controller and decreases wear and maintenance requirements. A built-in relay is used to signal the motor contactors (customer supplied) to alternate motor operation.

Run Permissive Circuit

This circuit accepts a "system ready" signal to ensure that peripheral equipment is in the proper state before a start command commences drive operation.

Built-in Two Setpoint and Two Feedback PID Controller

The integral, digital PID (Proportional Integral Derivative) control eliminates overcompensation and the need for an additional external regulator, including a low-pass filter. The PID can monitor two feedback signals, compare the two setpoints and make various process control decisions.



Initial Ramp/Empty Pipe Fill Mode

Submersible pumps and other equipment often have a requirement to not operate below a minimum speed any longer than necessary to avoid damage and excessive wear. The initial ramp is used to quickly accelerate the motor/equipment to a minimum speed at which point the normal ramp up rate is activated.

The VLT 8000 AQUA also provides a unique empty pipe fill mode function whereby the drive will operate the pump at a specified rate for a preset time, then automatically follow the PID. The function is typically used for dry start-ups to quickly fill a plumbing system without causing a "water hammer" effect that often occurs under such conditions. Both acceleration rates and times are fully programmable to suit any application.

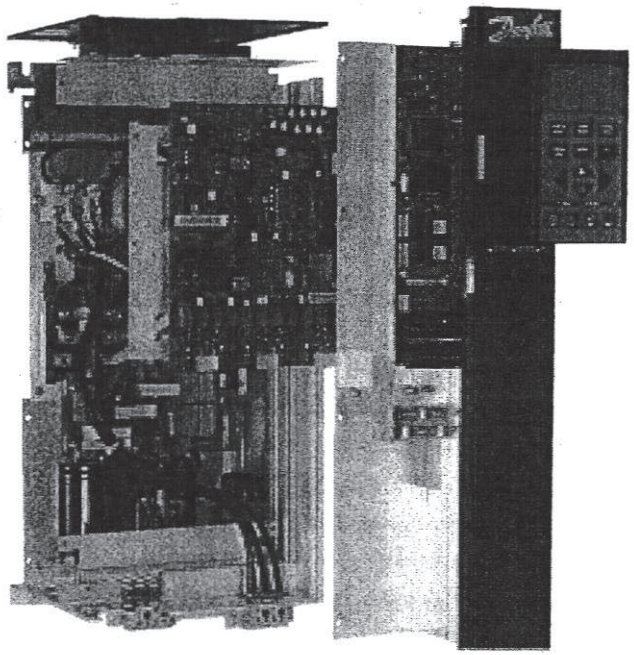
Autoramping

The autoramping function extends ramp up and ramp down time, dependent on load requirements, to prevent nuisance tripping. Autoramping will automatically modify a typical fixed acceleration/deceleration rate and adjust it to suit the system requirements.

AMA (Automatic Motor Adaptation)

The AMA function provides an automatic means to "tune" the VLT 8000 AQUA to its connected motor. AMA automatically optimizes operation between the drive and the motor by reading and checking the values without spinning the motor, so there's no wasted time disconnecting the motor from the load.

Built-in Protection



VLT® 8000 AQUA has Built-in Protection to Maximize System Reliability

- System overloads
- Motor failures
- Motor and drive overheating
- Voltage disturbances
- Power surges
- Loss of phase
- Phase-to-phase and phase-to-ground short circuit
- Ground fault
- Switching on input/output
- Electrical disturbances
- Triple layer galvanic isolation
- Self-testing
- Overvoltage
- Over-current
- Under-voltage
- External fault
- ETR (Electronic Thermal Relay)

Input Line Protection from Extreme Running Conditions

Line Disturbances and Transients

To protect itself from AC line voltage disturbances, the drive monitors all three phases and interrupts drive operation for phase loss or if there is phase imbalance. Transients on the AC line are suppressed by MOV's as well as zener diodes for extreme transients. Danfoss VLT 8000 AQUA drives meet VDE 0160 (European standard – 2.3 x line voltage for 1.3 msec) for transient protection.

Voltage Sags and Surges

The VLT 8000 AQUA is designed for a wide range of operating conditions. The 480 volt drive will operate from 342-528 VAC. The 230 volt drives will operate on 180-264 VAC. 575 volt drives will operate on 495-660 VAC and 690 volt drives will operate on 472-759 VAC. Full rated motor voltage and torque can be delivered down to 10% under nominal AC line voltage. During an AC line drop-out, the VLT 8000 AQUA continues until the intermediate circuit voltage drops below the minimum stop level, which is typically 15% below the VLT 8000 AQUA's lowest rated supply voltage.

Short Circuit

The VLT 8000 AQUA is protected against short circuits by means of current measurement in each of the three motor phases. A short circuit between two output phases will shut down the inverter as soon as the current exceeds the permitted value.

Ground Fault

The VLT 8000 AQUA provides complete protection from potentially damaging ground fault conditions:

- On the supply side
- On the motor side

Optimally Low Motor Noise Through ASFM

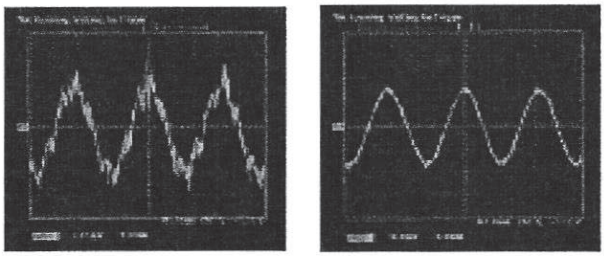
With the ASFM (Adjustable Switching Frequency Modulation) function, the switching frequency is adjusted automatically in relation to the speed of the motor. As speed is reduced, the switching frequency increases to ensure optimally low motor noise.

Built-in Protection

VVC^{PLUS} Output Switching Pattern

Unique digital VVC^{PLUS} voltage vector control provides:

- Nearly perfect output sine wave reduces over and undershooting of voltage and current as generated by standard PWM drives
- Fully rated motor voltage at rated frequency
- High efficiency for both drive and motor
- Full motor performance without derating; no additional heating of motor windings



PWM scope trace (left) compared to smoother VVC^{PLUS} scope trace (right).

Exclusive "Soft Turn On" IGBT Technology

With the patented Danfoss "soft turn on", the IGBT transistors produce one of the lowest dV/dt in the industry.

- Motor cable lengths up to 1,000 feet standard
- Motor output reactors built in as standard on all drives 100 HP and larger
- Unlimited switching on the output

Minimal Harmonic Distortion/Maximum Power Factor

The DC link inductor reduces the harmonic distortion currents that an adjustable frequency drive injects back into the AC line. A properly sized inductor, such as that in a VLT 8000 AQUA can reduce line harmonic currents to 40% or less of the fundamental current. This eliminates the need and cost of additional AC line reactors and their resultant line voltage reduction.

Reduced Installation Cost

The dual DC link inductors reduce the input RMS current to be less than or equal to the output current. This greatly reduces the cable size requirement and the subsequent cost of installation.

Output Protection

VLT 8000 AQUA drives incorporate both DC link inductors and motor output protection as standard design features. This provides short circuit protection and allows unlimited switching on the output without damage to the drive, eliminating the need for additional output reactors or switch interlocks.

The DC link inductor improves overall efficiency by increasing the power factor and lowering the ripple current in the bus voltage for an almost threefold increase in capacitor and drive life. As a result, motor operation is smooth and quiet and longer motor life can be expected.

Hall effect current transducers measure current flowing on all three motor phases. This provides highly responsive and accurate feedback to the VLT control circuit for optimum motor protection and performance.

Thermal Protection for the Drive and Motor

The ETR (Electronic Thermal Relay) is an open loop method built into the VLT 8000 AQUA software to guard against motor overheating – requiring no additional sensors or wiring. This function is UL recognized (Class 20) as an effective guard against motor thermal overload.

The VLT 8000 AQUA has drive thermal protection and also accepts thermistor signal input from the motor to create closed loop thermal protection for the entire system.

Control Inputs and Outputs

Typical VLT® 8000 AQUA Wiring Connections

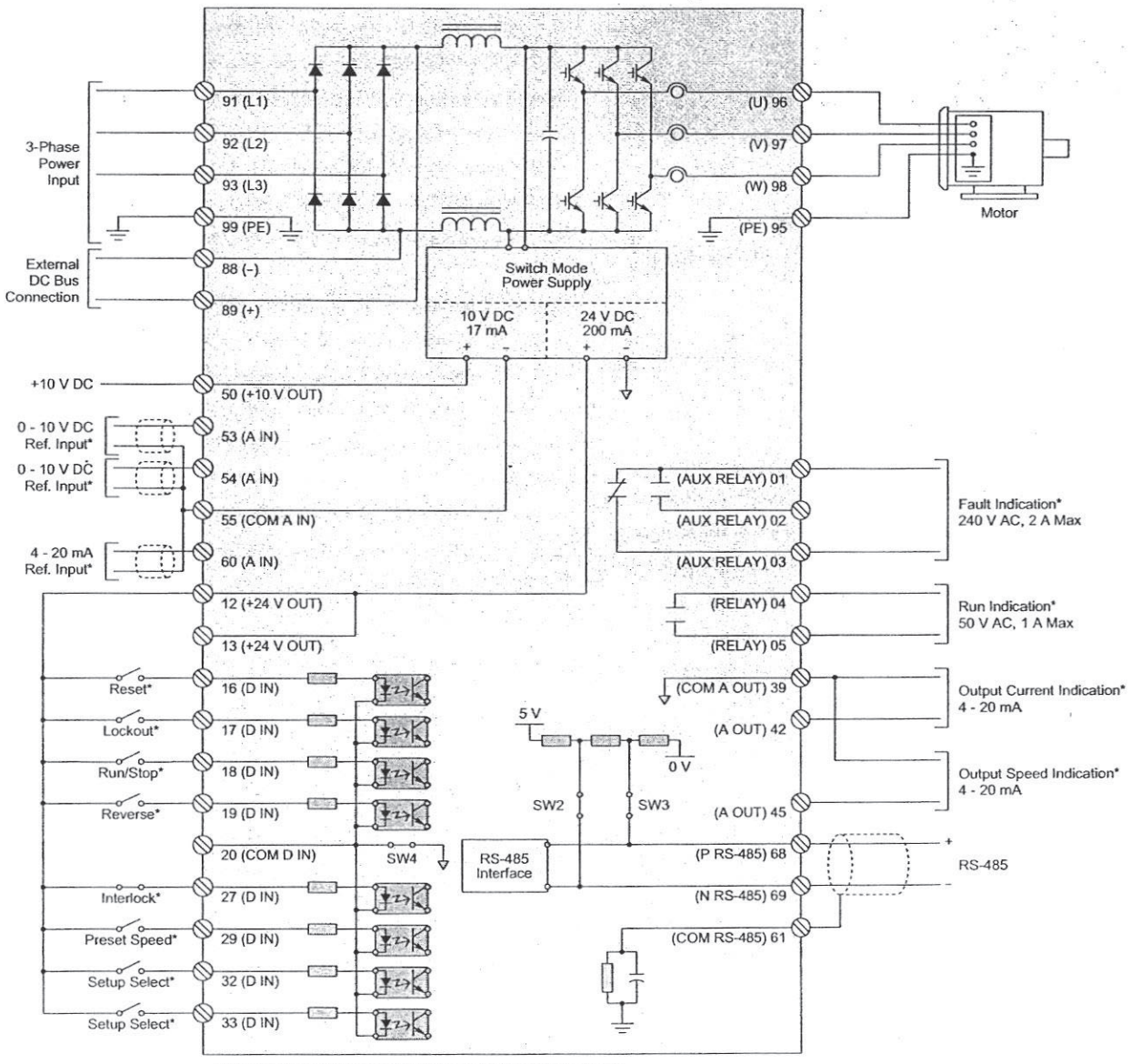
The illustration below shows how a VLT 8000 AQUA typically interfaces with other components in a system. The terminal numbers and functions are identical on all VLT 8000 AQUA drives. The analog, digital and relay terminals are all programmable. The functions shown here are typical, but show only a small portion of the total capability.

Control Card Benefits

The standard I/O supplied on the VLT 8000 AQUA drive is equal to or greater than that supplied by most competitive drives which feature extended I/O options.

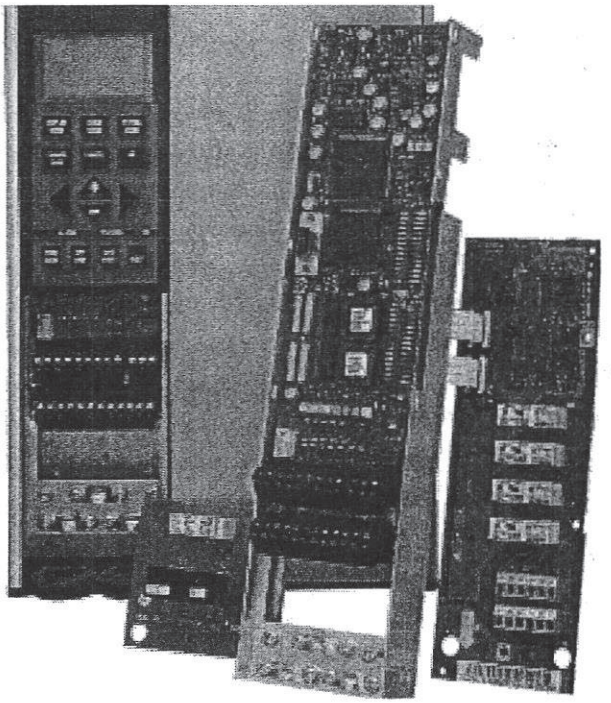
Standard I/O includes:

- 8 digital inputs
- 3 analog inputs
- 2 analog/digital outputs
- 2 relay outputs



* The operation of all control inputs and outputs is programmable. Typical terminal functions are shown.

Control Inputs and Outputs



Isolation

All analog and digital inputs/outputs and the RS-485 serial communication port are galvanically isolated. Because these points do not share a common, the drive can eliminate ground loop problems. In the VLT 8000 AQUA Series, all control terminals, as well as terminals 1-5 (AUX relays), are supplied by or connected to circuits that comply with PELV (high impedance) requirements in relation to the AC line potential.

Digital Inputs

There are eight digital inputs that offer a wide range of programmability. Typical control functions such as Run/Stop, Jog, and Forward/Reverse commands; as well as more dedicated settings such as preset speeds, setup select, interlock, etc. are supported. All digital inputs operate on a nominal 24 VDC level so a wide range of input switching devices may be utilized.

Analog Inputs

Two analog inputs for voltage signals and one input for current signals are provided for reference and feedback signals. A thermistor can also be connected to either voltage input. The two analog voltage inputs can be scaled in the range of 0-10 VDC; the current input in the range of 0/4-20 mA.

Digital/Analog Outputs

The two digital/analog outputs can be programmed to show present drive status or a process value. When used as a digital output, the VLT 8000 AQUA presents status with a 0/4- 24 VDC signal. The drive supports two types of analog signals: 0/4-20 mA. The terminals can also be configured for voltage output (0-10V) with the addition of a pull-down resistor (recommended 500 ohm, 1W).

Relay Outputs

Relay outputs may be selected to indicate thirty different functions such as ready, run, trip, current above a customer preset value, current above current limit, frequency within customer preset limits, frequency above a customer preset value, electronic motor over temperature protection warning, or that remote operation mode has been selected.

General Technical Data

AC Line Supply (L1, L2, L3):

Supply voltage

200-240 VAC	3Ø x 200/208/220/230/240 VAC ±10%
380-480 VAC	3Ø x 380/400/415/440/460/480 VAC ±10%
550-600 VAC	3Ø x 550/575/600 VAC ±10%
525-690 VAC	3Ø x 550/575/600/690 VAC ±10%
Input frequency	50/60 Hz ±2 Hz
Max. imbalance of supply voltage	± 2% of rated line voltage
Undervoltage trip point	150 or 285 or 413 or 446 VAC
Overvoltage trip point	300 or 640 or 689 or 759 VAC
Displacement/true power factor	0.90/1.0
Switching on supply input	1 time/2minutes
Max. short circuit current rating	100,000 A

VLT output data (U, V, W):

Output voltage	0-100% of supply voltage
Output frequency	0-120 Hz
Rated motor voltage,	
200-240 VAC	200/208/220/230/240 VAC
380-480 VAC	380/400/415/440/460/480 VAC
550-600 VAC	550/575 VAC
525-690 VAC	550/575/690 VAC
Rated motor frequency	50/60 Hz
Switching on output	unlimited
Ramp times	0.05-3600 sec.

Torque characteristics:

Starting torque	110% for 1 min.
High breakaway torque (Parameter 110)	130% for 0.5 sec.
Acceleration torque	100%
Overload torque	110%

Control Characteristics:

Frequency range	0 - 120 Hz
Resolution on output frequency	±0.003 Hz
System response time	3 msec.
Speed, control range	1:100 of synchro. speed
Speed, accuracy	< 1800 rpm: max. error ±7.5 rpm; > 1800 rpm: max. error of 0.5% of actual speed

All control characteristics are based on a 4-pole asynchronous motor

Programmable Features

Display languages	English, Spanish, French, German, Italian, Portuguese, Swedish, Dutch, Danish
Lost feedback action	Selectable to go to a preset speed, go to maximum speed, stay at last speed stop, turn off, or stop and trip
Time delay for lost analog reference action	1 to 99 sec.
Output current limit setting	Adjustable to 110% of drive rating
Current limit timer	0 to 60 sec.
Adjustable acceleration time	1 to 3600 sec. to base speed
Adjustable deceleration time	1 to 3600 sec. from base speed
Adjustable auto restart time delay	0 to 600 sec.
Maximum number of preset speeds	16
Maximum number of bypass frequencies	4
Maximum number of accel/decel rates	2 of each
Low frequency and high frequency warnings	0 to 120 Hz
Low current and high current warnings	0 to maximum current
Low reference and high reference warnings	-999,999.999 to 999,999.999
Low feedback and high feedback warnings	-999,999.999 to 999,999.999
Delayed start	0 to 120 sec.
DC braking time	0 to 60 sec.
DC braking start	0 to maximum frequency
DC braking current	0 to 50% of rated motor current
Automatic restart attempts	0 to 20
Automatic restart time delay	0 to 600 sec. between each attempt
Relay ON delay and Relay OFF delay	0 to 600 sec.

Control Card, Digital Inputs:

Number of programmable digital inputs	8
Terminal nos.	16, 17, 18, 19, 27, 29, 32, 33
Voltage level	0-24 VDC (PNP positive logic)
Voltage level, logical "0"	< 5 VDC
Voltage level, logical "1"	> 10 VDC
Maximum voltage on input	28 VDC
Input resistance R_i	approx. 2 kΩ
Scanning time per input	≤ 3 msec.

All digital inputs are galvanically isolated from the supply voltage (PELV). In addition, the digital inputs can be isolated from the other terminals on the control card by connecting an external 24 VDC supply.

Control Card, Analog Inputs:

No. of programmable analog voltage inputs	2
Terminal numbers	53, 54
Voltage level	0 - ±10 VDC (scalable)
Input resistance, R_i	approx. 10 kΩ
No. of programmable analog current inputs	1
Terminal number	60
Current range	0 - 20 mA or inverse (scalable)
Input resistance, R_i	approx. 200 Ω
Resolution	10 bit + sign
Accuracy on input	Max. error 1% of full scale
Scanning time per input	3 msec.

All analog inputs are galvanically isolated from the supply voltage (PELV) as well as other inputs and outputs.

Control Card, Digital/Pulse and Analog Outputs:

Number of programmable analog outputs	2
Terminal numbers	42, 45
Voltage level at digital/pulse output	0-24 VDC
Minimum load to frame (terminal 39) at digital/pulse output	600 Ω
Frequency ranges (digital output used as pulse output)	0-32 kHz
Current range at analog output	0/4 - 20 mA
Maximum load to frame (terminal 39) at analog output	500 Ω
Accuracy of analog output	Max. error: 1.5% of full scale
Resolution on analog output	8 bit
Follower Signal	0 to 5 VDC, 0 to 10 V DC, 0 to 20 mA, 4 to 20 mA, direct and inverse acting

All digital and analog outputs are galvanically isolated from the supply voltage (PELV) as well as other inputs and outputs.

Relay Outputs:

No. of programmable relay outputs	2
Terminal numbers, control card	04-05 (N.O. Form A)
Max. terminal load (DC) on 04-05, control card in UL/cUL applications	30 VAC, 42.5 VDC, 1 A
Max. terminal load (AC) on 04-05, control card in EC applications	50 VAC, 1 A, (60 VA)
Max. terminal load (DC) on 04-05, control card in EC applications	75 VDC, 1 A, 30 W
Terminal numbers, power card	01-03 (N.C.), 01-02 (N.O. Form C)
Max. terminal load (AC) on 01-03, 01-02, power card	240 VAC, 2 A, 60 VA
Min. terminal load on 01-03, 01-02, power card	24 VDC 10 mA, 24 VAC 100 mA

Control Card, 24 VDC Supply:

Terminal numbers	12, 13
Max. load	200 mA

The 24 VDC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog outputs.

Control Card, RS-485 Serial Communication:

Terminal numbers	68 (TX+, RX+), 69 (TX–, RX–)

Full galvanic isolation.

External 24 Volt DC Supply: (for DX Hardware configuration only)

Terminal numbers 35, 36
Voltage range ..... 24 VDC ±15% (max. 37 VDC for 10 sec.)
Max. voltage ripple ..... 2 VDC
Power consumption ..... 15 W - 50 W (50 W for start-up, 20 msec.)
Min. pre-fuse ..... 6 Amp

Full galvanic isolation if the external 24 VDC supply is also of the PELV type.

Cable Lengths and Cross-Sections:

Use 75°C copper wire minimum
Max. motor cable length, shielded cable ..... 500 ft. (150 m)
Max. motor cable length, non-shielded cable ..... 1000 ft. (300 m)
Max. motor cable length, shielded cable VLT 8011 (380-480 V) ..... 330 ft. (100 m)
Max. motor cable length, shielded cable VLT 8008 and 8011 (550-600 V) ..... 165 ft. (50 m)
Max. loadsharing cable length, shielded cable ..... 82.5 ft. (25 m) from adjustable frequency drive to DC bus.
Max. cable cross-section for motor and loadsharing
*Max. cable cross-section for 24 V external DC supply ..... 10 AWG (4.0 mm²)
*Max. cross-section for control cables ..... 16 AWG (1.5 mm²)
*Max. cross-section for serial communication ..... 16 AWG (1.5 mm²)

**See drive specification charts.*

Environment:

Enclosure ..... Chassis (IP00), NEMA 1 (IP20), NEMA 12 (IP54)*
Vibration test ..... 0.7 g

Tested according to a procedure based on the following standards: IEC 68-2-6; Vibration (sinusoidal) - 1970; IEC 68-2-34; Random vibration broadband – general requirements; IEC 68-2-35; Random vibration broadband – high reproducibility IEC 68-2-36; Random vibration broadband – medium reproducibility. VLT 8000 AQUA drives comply with requirements that correspond to conditions when the unit is mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

Max. relative humidity ..... 93% +2% -3% (IEC 68-2-3) for storage/transportation
Max. relative humidity ..... 95% non-condensing (IEC 721-3-3; class 3K3) for operation
Ambient temp. Chassis/NEMA 1/NEMA 12 ..... Max. 104°F/40°C (24-hr. average max. 95°F/35°C)
Min. ambient temperature in full operation ..... 32°F/0°C
Min. ambient temperature at reduced performance ..... 14°F/-10°C
Temperature during storage ..... -13°F/-25°C to 149°F/65°C
Temperature during transportation ..... -13°F/-25°C to 158°F/70°C
Max. altitude above sea level ..... 3,300 feet

**NEMA 12 enclosures on 240 and 480 VAC class only.*

Protection:

- ETR Electronic Thermal Relay protects against motor overload.
- Temperature monitoring of heat-sink ensures that the VLT adjustable frequency drive cuts out if the temperature reaches 90°C for Chassis and NEMA 1. For NEMA 12, the cut-out temperature is 80°C. An overtemperature can be reset when the temperature of the heat-sink has fallen below 60°C.
- The VLT adjustable frequency drive is protected against short circuiting and ground fault on motor terminals U, V, W.
- Monitoring of the intermediate circuit voltage ensures that the VLT adjustable frequency drive cuts out if the intermediate circuit voltage gets too high or too low.
- If a motor phase is missing, the VLT adjustable frequency drive will trip.
- If there is an AC line fault, the VLT adjustable frequency drive is able to carry out a controlled deramping.
- If an AC line phase is missing, the VLT adjustable frequency drive will trip when a load is placed on the motor.

Performance Data – 5 - 20 HP 3Ø 200-240 VAC

VLT Model		8006	8008	8011	8016	8022
Output						
Current						
Continuous	208V [A]	16.7	24.2	30.8	46.2	59.4
Intermittent (60 sec)	208V [A]	18.4	26.6	33.9	50.6	65.3
Continuous KVA	208V [KVA]	6.9	10.1	12.8	19.1	24.7
Typical shaft output (CT/VT)	[HP]	5	7.5	10	15	20
Max. motor cable size	[AWG]	10	6	6	6	2
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded				
Output voltage	[%]	0-100% of the AC line voltage				
Output frequency	[Hz]	0-120				
Rated motor voltage	[V]	200/208/220/230/240				
Rated motor frequency	[Hz]	50/60				
Thermal protection during operation		ETR for motor and VLT trip at 90°C				
Switching on the output		Unlimited				
Ramp times	[sec]	1.0 - 3600				
Input						
Max. current	208V [A]	16.0	23.0	30.0	46.0	59.2
Max. power cable size	[AWG]	10	6	6	6	2
Max. pre-fuses	[A]	30	50	60	60	80
Supply voltage	[V]	3Ø, 200/208/220/230/240 ±10%				
Supply frequency	[Hz]	50/60				
Efficiency		≥ 0.98	≥ 0.98	≥ 0.98	≥ 0.96	≥ 0.96
Switching on input		Approximately 1 time/minute				
Environment						
Estimated power loss at rated max. load	[W]	194	426	545	545	783
Enclosure		Protected Chassis (IP 20), NEMA 1 (IP 20), NEMA 12 (IP 54)				
Weight (estimated)						
Protected Chassis	[lbs]	51	51	51	51	60
NEMA 1	[lbs]	51	51	51	51	60
NEMA 12	[lbs]	77	77	76	76	98

Performance Data – 25 - 60 HP 3Ø 200-240 VAC

VLT Model		8027	8032	8042	8052	8062
Output						
Current						
Continuous	208V [A]	74.8	88.0	115.0	143.0	170.0
Intermittent (60 sec)	208V [A]	82.3	96.8	127.0	158.0	187.0
Continuous KVA	208V [KVA]	31.1	36.6	41.0	52.0	67.0
Typical shaft output (CT/VT)	[HP]	25	30	40	50	60
Max. motor cable size	[AWG]	2	1/0	1/0	3/0	4/0
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded				
Output voltage	[%]	0-100% of the AC line voltage				
Output frequency	[Hz]	0-120				
Rated motor voltage	[V]	200/208/220/230/240				
Rated motor frequency	[Hz]	50/60				
Thermal protection during operation		ETR for motor and VLT trip at 90°C				
Switching on the output		Unlimited				
Ramp times	[sec]	1.0 - 3600				
Input						
Max. current	208V [A]	74.8	88.0	101.3	126.6	149.9
Max. power cable size	[AWG]	2	1/0	1/0	3/0	4/0
Max. pre-fuses	[A]	125	125	150	200	250
Supply voltage	[V]	3Ø, 200/208/220/230/240 ±10%				
Supply frequency	[Hz]	50/60				
Efficiency		≥ 0.96				
Switching on input		Approximately 1 time/minute				
Environment						
Estimated power loss at rated max. load	[W]	1042	1243	1089	1361	1613
Enclosure		Chassis, NEMA 1 (IP20), NEMA 12 (IP54)				
Weight (est.)						
Chassis	[lbs]	60	96	180	180	180
NEMA 1	[lbs]	60	96	202	202	202
NEMA 12	[lbs]	100	110	208	208	208

Performance Data – 5 - 20 HP 3Ø 380-480 VAC

VLT Model		8006	8008	8011	8016	8022
Output						
Current						
Continuous	380-440V [A]	10.0	13.0	16.0	24.0	32.0
	441-480V [A]	8.2	11.0	14.0	21.0	27.0
Intermittent (60 sec)	380-440V [A]	11.0	14.3	17.6	26.4	35.2
	441-480V [A]	9.0	12.1	15.4	23.1	29.7
Continuous KVA	380-440V [KVA]	7.2	9.3	11.5	17.3	23.0
	441-480V [KVA]	6.5	8.8	11.2	16.7	21.5
Typical shaft output (CT/VT)	[HP]	5	7-1/2	10	15	20
Max. motor cable size	[AWG]	10	10	10	6	6
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded				
Output voltage	[%]	0-100% of the AC line voltage				
Output frequency	[Hz]	0-120				
Rated motor voltage	[V]	380/400/415/440/460/480				
Rated motor frequency	[Hz]	50/60				
Thermal protection during operation		ETR for motor and VLT trip at 90°C				
Switching on the output		Unlimited				
Ramp times	[sec]	1.0 - 3600				
Input						
Max. current	380-440V [A]	9.1	12.2	15.0	24.0	32.0
	441-480V [A]	8.3	10.6	14.0	21.0	27.6
Max. power cable size	[AWG]	10	10	10	6	6
Max. pre-fuses	[A]	20	25	30	40	40
Supply voltage	[V]	3Ø, 380/400/415/440/460/480 ±10%				
Supply frequency	[Hz]	50/60				
Efficiency		≥ 0.96				
Switching on input		Approximately 1 time/minute				
Environment						
Estimated power loss at rated max. load (460V)	[W]	198	250	295	419	559
Enclosure		Protected Chassis (IP 20), NEMA 1 (IP 20), NEMA 12 (IP 54)				
Weight (est.)						
Protected Chassis	[lbs]	21	21	21	21	46
NEMA 1	[lbs]	21	21	21	21	46
NEMA 12	[lbs]	28	28	28	28	96

Performance Data – 25 - 75 HP 3Ø 380-480 VAC

VLT Model		8027	8032	8042	8052	8062	8072
Output							
Current							
Continuous	380-440V [A]	37.5	44.0	61.0	73.0	90.0	106.0
	441-480V [A]	34.0	40.0	52.0	65.0	77.0	106.0
Intermittent	380-440V [A]	41.3	48.4	67.1	80.3	99.0	117.0
	441-480V [A]	37.4	44.0	57.2	71.5	84.7	117.0
Continuous KVA	380-440V [KVA]	27.0	31.6	43.8	52.5	64.7	73.4
	441-480V [KVA]	27.1	31.9	41.4	51.8	61.3	84.5
Typical shaft output (CT/VT)	[HP]	25	30	40	50	60	75
Max. motor cable size	[AWG]	6	6	2	2	1/0	1/0
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded					
Output voltage	[%]	0-100% of the AC line voltage					
Output frequency	[Hz]	0-120					
Rated motor voltage	[V]	380/400/415/440/460/480					
Rated motor frequency	[Hz]	50/60					
Thermal protection during operation		ETR for motor and VLT trip at 90°C					
Switching on the output		Unlimited					
Ramp times	[sec]	1.0 - 3600					
Input							
Max. current	380-440V [A]	37.5	44.0	60.0	72.0	89.0	103.0
	441-480V [A]	34.0	41.0	53.0	64.0	77.0	103.0
Max. power cable size	[AWG]	6	6	2	2	1/0	1/0
Max. pre-fuses	[A]	50	60	80	100	125	150
Supply voltage	[V]	3Ø, 380/400/415/440/460/480 ±10%					
Supply frequency	[Hz]	50/60					
Efficiency		≥ 0.96					
Switching on input		Approximately 1 time/minute					
Environment							
Estimated power loss at rated max. load (460V)	[W]	655	768	1065	1275	1571	1851
Enclosure		Protected Chassis (IP 20), NEMA 1 (IP 20), NEMA 12 (IP 54)					
Weight (est.)							
Protected Chassis	[lbs]	46	60	60	96	96	96
NEMA 1	[lbs]	46	60	60	96	96	96
NEMA 12	[lbs]	96	102	122	134	140	140

Performance Data – 100 - 300 HP 3Ø 380-480 VAC

VLT Model		8102	8122	8152	8202	8252	8302
Output							
Current							
Continuous	380-440V [A]	147	177	212	260	315	395
	441-480V [A]	130	160	190	240	302	361
Intermittent	380-440V [A]	162	195	233	286	347	405
	441-480V [A]	143	176	209	264	332	397
Continuous KVA	380-440V [KVA]	102	123	147	180	218	274
	441-480V [KVA]	104	127	151	191	241	288
Typical shaft output (CT/VT)	[HP]	100	125	150	200	250	300
Max. motor cable size	380V [AWG]	3/0	4/0	2x1/0	2x2/0	2x3/0	2x4/0
	460V [AWG]	2/0	3/0	2x1/0	2x1/0	2x3/0	2x4/0
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded					
Output voltage	[%]	0-100% of the AC line voltage					
Output frequency	[Hz]	0-120					
Rated motor voltage	[V]	380/400/415/440/460/480					
Rated motor frequency	[Hz]	50/60					
Thermal protection during operation		ETR for motor and VLT trip at 90°C					
Switching on the output		Unlimited					
Ramp times	[sec]	1.0 - 3600					
Input							
Max. current	380-440V [A]	145	174	206	256	318	363
	441-480V [A]	128	158	185	236	304	356
Max. power cable size	380V [AWG]	3/0	4/0	2x1/0	2x2/0	2x3/0	2x4/0
	460V [AWG]	2/0	3/0	2x1/0	2x2/0	2x3/0	2x4/0
Max. pre-fuses	[A]	220	250	300	350	400	500
Supply voltage	[V]	3Ø, 380/400/415/440/460/480 ±10%					
Supply frequency	[Hz]	50/60					
Efficiency		≥ 0.98					
Switching on input		Approximately 1 time/minute					
Environment							
Estimated power loss at rated max. load (460V)	[W]	1400	1600	2383	3010	3787	4526
Enclosure		Chassis (IP 00), NEMA 1 (IP 20), NEMA 12 (IP 54)					
Weight (est.)							
Chassis	[lbs]	119	119	196	196	295	295
NEMA 1	[lbs]	119	119	212	212	315	315
NEMA 12	[lbs]	154	154	212	212	315	315

Performance Data – 350 - 600 HP 3Ø 380-480 VAC

VLT Model		8352	8450	8500	8600
Output					
Current					
Continuous	380-440V [A]	480	600	658	745
Continuous	441-480V [A]	443	540	590	678
Intermittent	380-440V [A]	528	660	724	820
Intermittent	441-480V [A]	487	594	649	746
Continuous KVA	400V [KVA]	333	431	473	536
Continuous KVA	480V [KVA]	353	430	470	540
Typical shaft output (CT/VT)	[HP]	350	450	500	600
Max. motor cable size					
UL/CSA	[AWG]	2x350MCM	2x500MCM	2x600MCM	2x750MCM
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded			
Output voltage	[%]	0-100% of the AC line voltage			
Output frequency	[Hz]	0-120			
Rated motor voltage	[V]	380/400/415/440/460/480			
Rated motor frequency	[Hz]	50/60			
Thermal protection during operation		ETR for motor and VLT trip at 90°C			
Switching on the output		Unlimited			
Ramp times	[sec]	1.0 - 3600			
Input					
Max. current	400V [A]	467	584	648	734
	480V [A]	431	526	581	668
Max. power cable size					
UL/CSA (75°C copper)	[AWG]	2x350MCM	2x500MCM	2x600MCM	2x750MCM
Max. pre-fuses (Bussmann FWH semiconductor type or exact equivalent)					
	[A]	600	700	800	800
Supply voltage	[V]	3Ø, 380/400/415/440/460/480 ±10%			
Supply frequency	[Hz]	50/60			
Efficiency		≥ 0.98		≥ 0.97	
Switching on input		Approximately 1 time/minute			
Environment					
Estimated power loss at rated max. load (460V)	[W]	5555	9450	10650	12000
Enclosure		Chassis (IP 00), NEMA 1 (IP 20), NEMA 12 (IP 54)*			
Estimated shipping weight					
Chassis	[lbs]	295	1133	1232	1288
NEMA 1	[lbs]	315	1387	1486	1541
NEMA 12	[lbs]	315	1409	1508	1563

** NEMA 1 and NEMA 12 enclosures are designed to be floor mounted.*

Performance Data – 1.5 - 7.5 HP 3Ø 550-600 VAC

VLT Model		8002	8003	8004	8005	8006	8008
Output							
Current							
Continuous	575V [A]	2.4	2.7	3.9	4.9	6.1	9.0
Intermittent (60 sec)	575V [A]	2.6	3.0	4.3	5.4	6.7	9.9
Continuous KVA	575V [KVA]	2.4	2.7	3.9	4.9	6.1	9.0
Typical shaft output (CT/VT)	[HP]	1.5	2	3	4	5	7.5
Max. motor cable size	[AWG]	10	10	10	10	10	10
	[mm²]	4	4	4	4	4	4
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded					
Output voltage	[%]	0-100% of the AC line voltage					
Output frequency	[Hz]	0-120					
Rated motor voltage	[V]	550/575					
Rated motor frequency	[Hz]	50/60					
Thermal protection during operation		ETR for motor and VLT trip at 90°C					
Switching on the output		Unlimited					
Ramp times	[sec]	1.0 - 3600					
Input							
Max. current	575V [A]	2.5	2.8	4.0	5.1	6.2	9.2
Max. power cable size	[AWG]	10	10	10	10	10	10
	[mm²]	4	4	4	4	4	4
Max. pre-fuses	[A]	83	4	5	6	8	10
Supply voltage	[V]	3Ø, 550/575/600 ±10%					
Supply frequency	[Hz]	50/60					
Efficiency		≥ 0.96					
Switching on input		Approximately 1 time/minute					
Environment							
Estimated power loss at rated max. load (575 V)	[W]	65	73	103	131	161	238
Enclosure		Protected Chassis (IP 20)					
		NEMA 1 (IP 20)					
Weight (est.)							
Protected Chassis (IP 20)	[lbs]						
NEMA 1 (IP 20)	[lbs]	23	23	23	23	23	23

Performance Data – 10 - 40 HP 3Ø 550-600 VAC

VLT Model		8011	8016	8022	8027	8032	8042
Output							
Current							
Continuous	575V [A]	11.0	17.0	22.0	27	32	41
Intermittent (60 sec)	575V [A]	12.1	18.7	24.2	30	35	45
Continuous KVA	575V [KVA]	11.0	16.9	22.0	27	32	41
Typical shaft output (CT/VT)	[HP]	10	15	20	25	30	40
Max. motor cable size	[AWG]	10	6	6	6	2	2
	[mm²]	4	16	16	16	35	35
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded					
Output voltage	[%]	0-100% of the AC line voltage					
Output frequency	[Hz]	0-120					
Rated motor voltage	[V]	550/575					
Rated motor frequency	[Hz]	50/60					
Thermal protection during operation		ETR for motor and VLT trip at 90°C					
Switching on the output		Unlimited					
Ramp times	[sec]	1.0 - 3600					
Input							
Max. current	575V [A]	11.2	18.0	22.0	27	33	42
Max. power cable size	[AWG]	10	6	6	6	2	2
	[mm²]	4	16	16	16	35	35
Max. pre-fuses	[A]	15	20	30	35	45	60
Supply voltage	[V]	3Ø, 550/575/600 ±10%					
Supply frequency	[Hz]	50/60					
Efficiency		≥ 0.96					
Switching on input		Approximately 1 time/minute					
Environment							
Estimated power loss at rated max. load	575V [W]	288	451	576	707	852	1077
Enclosure		Protected Chassis (IP 20)					
		NEMA 1 (IP 20)					
Weight (est.)							
Protected Chassis (IP 20)	[lbs]		—	—	—	—	—
NEMA 1 (IP 20)	[lbs]	23	51	51	51	66	66

Performance Data – 50 - 150 HP 3Ø 525-690 VAC

VLT Model		8052	8062	8072	8102	8122	8152
Output							
Current							
Continuous	575/690V [A]	54	73	86	108	131	155
Intermittent	575/690V [A]	59	80	95	119	144	171
Continuous KVA	575V [KVA]	54	73	86	108	130	154
	690V [KVA]	65	87	103	129	157	185
Typical shaft output (CT/VT)	[HP]	50	60	75	100	125	150
Max. motor cable size	[AWG]	2x2/0	2x2/0	2x2/0	2x2/0	2x2/0	2x2/0
	[mm²]	2x70	2x70	2x70	2x70	2x70	2x70
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded					
Output voltage	[%]	0-100% of the AC line voltage					
Output frequency	[Hz]	0-200					
Rated motor voltage	[V]	550/575/690					
Rated motor frequency	[Hz]	50/60					
Thermal protection during operation		ETR for motor and VLT trip at 90°C					
Switching on the output		Unlimited					
Ramp times	[sec]	0.05 - 3600					
Input							
Max. current	575V [A]	58	74	85	106	124	151
	690V [A]	58	77	87	109	128	155
Max. power cable size	[AWG]	2x2/0	2x2/0	2x2/0	2x2/0	2x2/0	2x2/0
	[mm²]	2x70	2x70	2x70	2x70	2x70	2x70
Max. pre-fuses	.[A].	80	90	125	150	175	225
Supply voltage	[V]	3Ø, 525-690 ±10%					
Supply frequency	[Hz]	50/60					
Efficiency		0.98					
Switching on input		Approximately 1 time/minute					
Environment							
Estimated power loss at rated max. load	690V[W]	1458	1717	1913	2262	2662	3114
Enclosure		Chassis (IP 00), NEMA 1 (IP 20)					
Weight (est.)							
Chassis (IP 00)	[lbs]	181	181	181	181	181	181
NEMA 1 (IP 20)	[lbs]	210	210	210	210	210	210
NEMA 12 (IP 54)	[lbs]	210	210	210	210	210	210

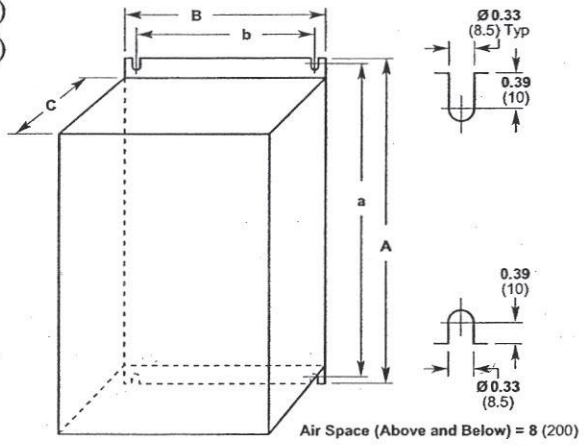
Performance Data – 200 - 400 HP 3Ø 525-690 VAC

VLT Model		8202	8252	8302	8352	8402
Output						
Current						
Continuous	575/690V [A]	192	242	290	344	400
Intermittent	575/690V [A]	211	266	319	378	440
Continuous KVA	575V [KVA]	191	241	289	343	398
	690V [KVA]	229	289	347	411	478
Typical shaft output (CT/VT)	[HP]	200	250	300	350	400
Max. motor cable size	[AWG]	2x2/0	2x350mcm	2x350mcm	2x350mcm	2x350mcm
	[mm²]	2x70	2x185	2x185	2x185	2x185
Max. motor cable length		500 feet (150 m) shielded, 1000 feet (300 m) unshielded				
Output voltage	[%]	0-100% of the AC line voltage				
Output frequency	[Hz]	0-200				
Rated motor voltage	[V]	550/575/690				
Rated motor frequency	[Hz]	50/60				
Thermal protection during operation		ETR for motor and VLT trip at 90°C				
Switching on the output		Unlimited				
Ramp times	[sec]	0.05 - 3600	0.05 - 3600	0.05 - 3600	1.0 - 3600	1.0 - 3600
Input						
Max. current	575V [A]	189	234	286	339	390
	690V [A]	197	240	296	352	400
Max. power cable size	[AWG]	2x2/0	2x350mcm	2x350mcm	2x350mcm	2x350mcm
	[mm²]	2x70	2x185	2x185	2x185	2x185
Max. pre-fuses	[A]	250	350	400	500	600
Supply voltage	[V]	3Ø, 525-690 ± 10%				
Supply frequency	[Hz]	50/60				
Efficiency		0.98				
Switching on input		Approximately 1 time/2 minutes				
Environment						
Estimated power loss at rated max. load	690V [W]	3612	4293	5156	5821	6149
Enclosure		Chassis (IP 00), NEMA 1 (IP 20), NEMA 12 (IP 54)				
Weight (est.)						
Chassis (IP 00)	[lbs]	199	246	271	303	333
NEMA 1 (IP 20)	[lbs]	229	276	300	333	363
NEMA 12 (IP 54)	[lbs]	229	276	300	333	363

Protected Chassis (IP20) Mechanical Dimensions

Protected Chassis (IP 20)
VLT 8006 – VLT 8032 (230 VAC)
VLT 8016 – VLT 8122 (480 VAC)

in (mm)



VLT 8006 – VLT 8032 (230 VAC)

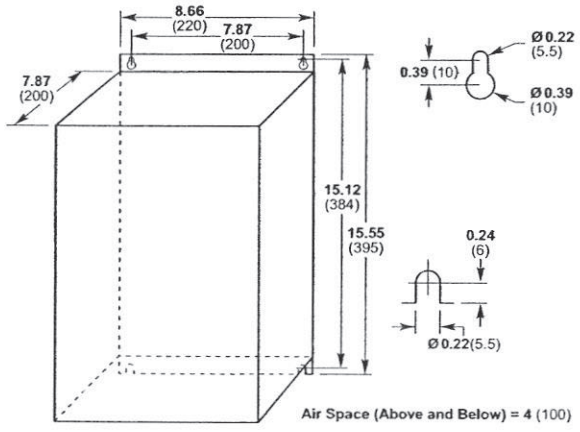
VLT Model	A	B	C	a	b
8006 - 8011	22.05 (560)	9.53 (242)	10.24 (260)	21.26 (540)	7.87 (200)
8016 - 8022	27.56 (700)	9.53 (242)	10.24 (260)	26.77 (680)	7.87 (200)
8027 - 8032	31.50 (800)	12.13 (308)	11.65 (296)	30.71 (780)	10.63 (270)

VLT 8016 – VLT 8122 (480 VAC)

VLT Model	A	B	C	a	b
8016 - 8027	22.05 (560)	9.53 (242)	10.24 (260)	21.26 (540)	7.87 (200)
8032 - 8042	27.56 (700)	9.53 (242)	10.24 (260)	26.77 (680)	7.87 (200)
8052 - 8072	31.50 (800)	12.13 (308)	11.65 (296)	30.71 (780)	10.63 (270)
8102 - 8122	31.50 (800)	14.57 (370)	13.19 (335)	30.71 (780)	13.00 (330)

Protected Chassis (IP 20)
VLT 8006 – VLT 8011 (480 VAC)
VLT 8002 – VLT 8011 (575 VAC)

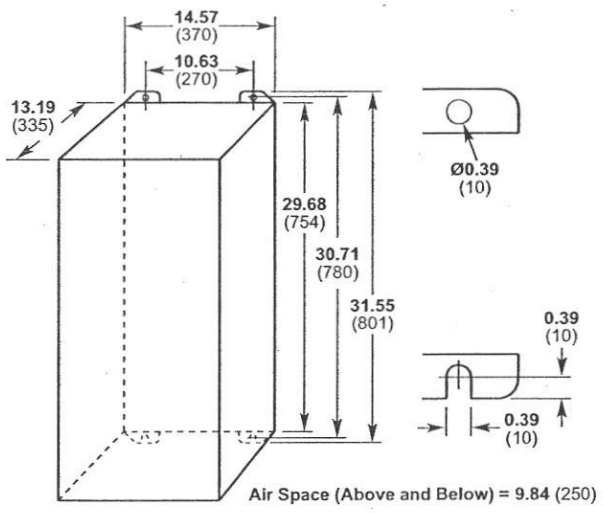
in (mm)



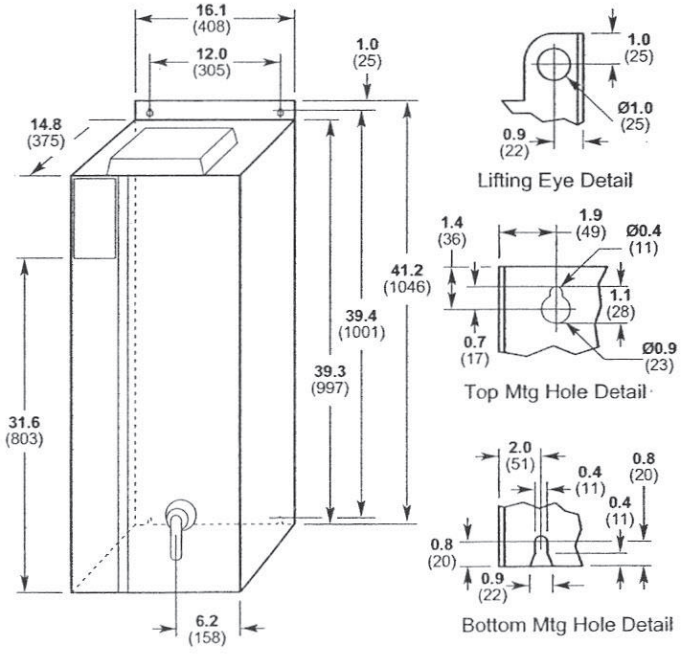
Chassis (IP00) Mechanical Dimensions

VLT 8042 – VLT 8062 (230 VAC)

in (mm)



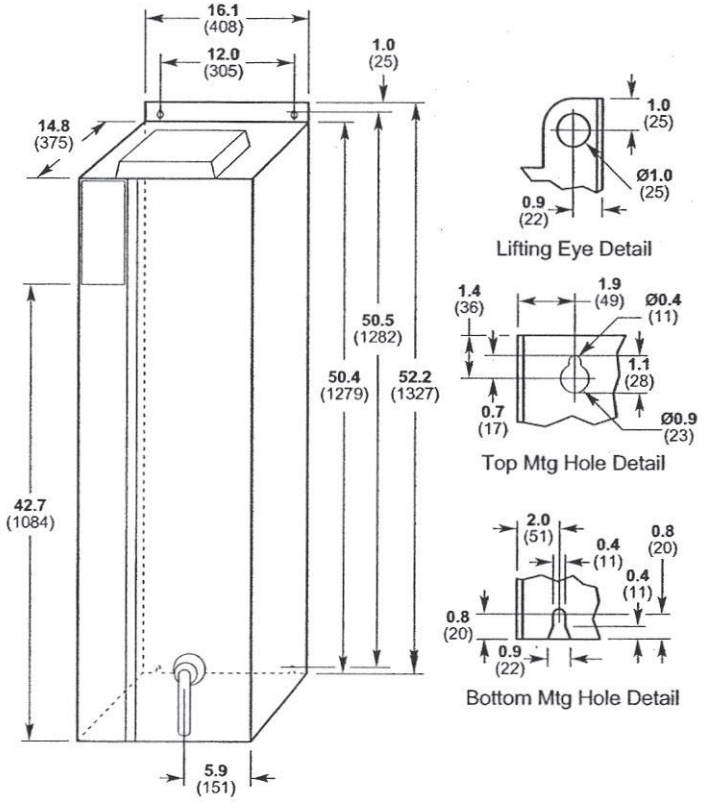
VLT 8152 – VLT 8202 (460 VAC)
VLT 8052 – VLT 8202 (690 VAC)



Chassis/IP00 Mechanical Dimensions

VLT 8252 – VLT 8352 (460 VAC)
VLT 8252 – VLT 8402 (690 VAC)

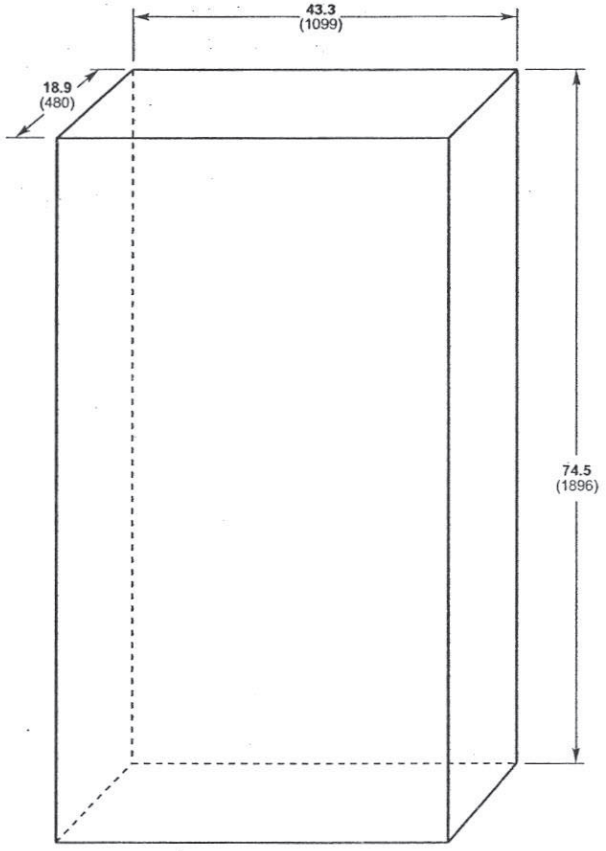
in (mm)



Chassis/IP00 Mechanical Dimensions

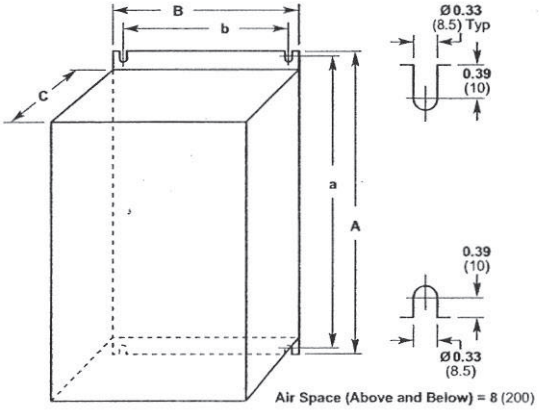
VLT 8450 – VLT 8600 (460 VAC)

in (mm)

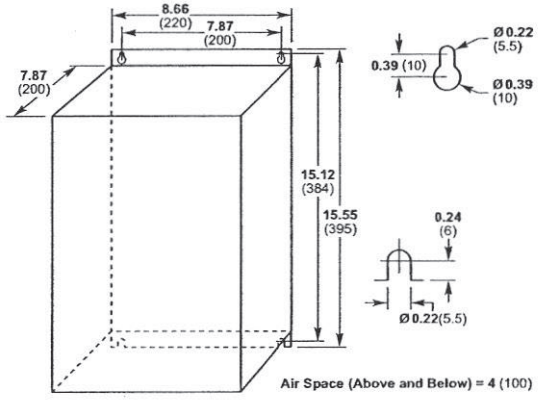


NEMA 1 (IP20) Mechanical Dimensions

NEMA 1 (IP 20) *in (mm)*
VLT 8006 – VLT 8032 (230 VAC)
VLT 8016 – VLT 8122 (480 VAC)
VLT 8016 – VLT 8042 (575 VAC)



NEMA 1 (IP 20) *in (mm)*
VLT 8006 – VLT 8011 (480 VAC)
VLT 8002 – VLT 8011 (575 VAC)



VLT 8006 – VLT 8032 (230 VAC) Without RFI

VLT Model	A	B	C	a	b
8006 - 8011	22.05 (560)	9.53 (242)	10.23 (260)	21.26 (540)	7.87 (200)
8016 - 8022	27.56 (700)	9.53 (242)	10.23 (260)	26.77 (680)	7.87 (200)
8027 - 8032	31.50 (800)	12.13 (308)	11.65 (296)	30.71 (780)	10.63 (270)

VLT 8006 – VLT 8032 (230 VAC) With RFI

VLT Model	A	B	C	a	b
8006 - 8011	26.35 (669)	9.53 (242)	10.23 (260)	21.26 (540)	7.87 (200)
8016 - 8022	31.86 (809	9.53 (242)	10.23 (260)	26.77 (680)	7.87 (200)
8027 - 8032	36.90 (937)	12.13 (308)	11.65 (296)	30.71 (780)	10.63 (270)

VLT 8016 – VLT 8122 (480 VAC), VLT 8016 – VLT 8042 (575 VAC) Without RFI

VLT Model	A	B	C	a	b
8016 - 8027	22.05 (560)	9.53 (242)	10.23 (260)	21.26 (540)	7.87 (200)
8032 - 8042	27.56 (700)	9.53 (242)	10.23 (260)	26.77 (680)	7.87 (200)
8052 - 8072	31.50 (800)	12.13 (308)	11.65 (296)	30.71 (780)	10.63 (270)
8102 - 8122	31.50 (800)	14.57 (370)	13.19 (335)	30.71 (780)	13.00 (330)

VLT 8016 – VLT 8072 (480 VAC) With RFI

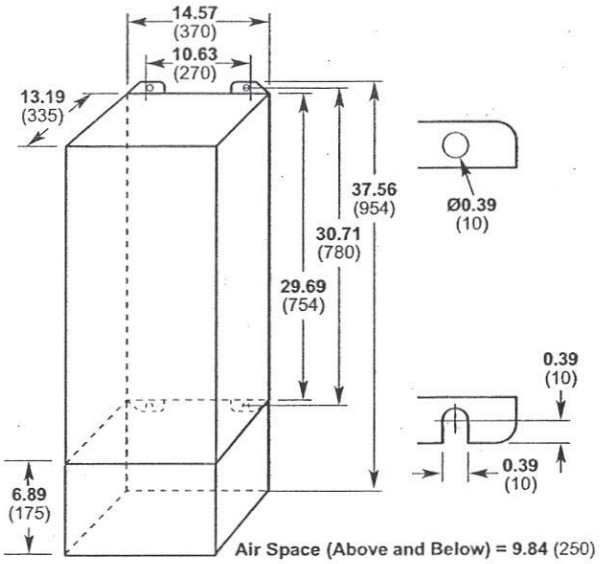
VLT Model	A	B	C	a	b
8016 - 8027	26.35 (669)	9.53 (242)	10.23 (260)	21.26 (540)	7.87 (200)
8032 - 8042	31.86 (809)	9.53 (242)	10.23 (260)	26.77 (680)	7.87 (200)
8052 - 8072	36.90 (937)	12.13 (308)	11.65 (296)	30.71 (780)	10.63 (270)

NEMA 1 (IP20) Mechanical Dimensions

NEMA 1 (IP 20)

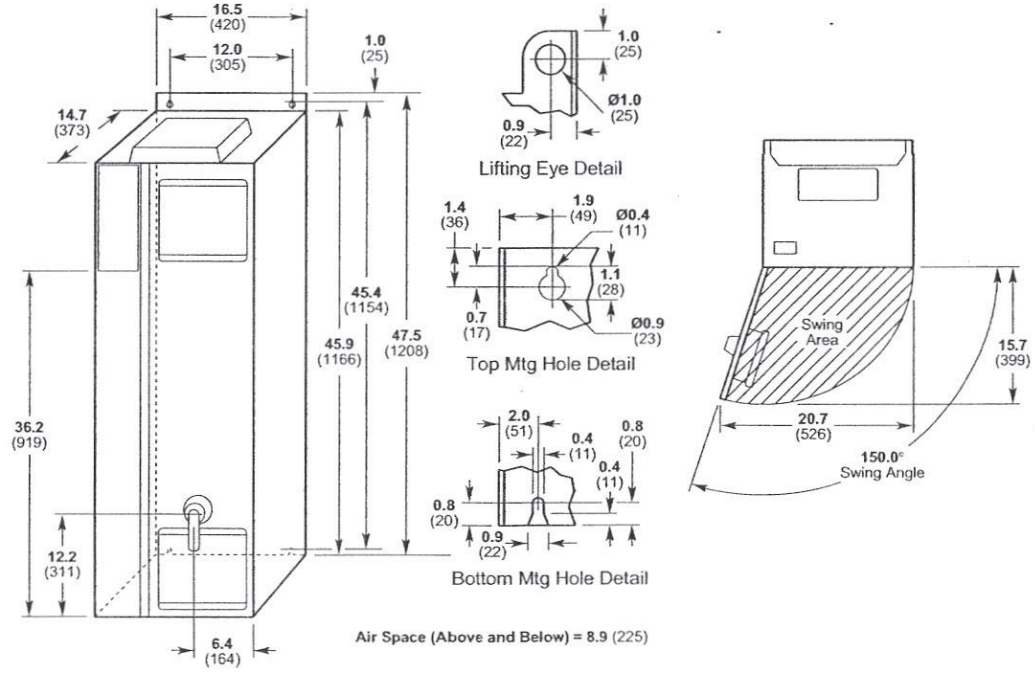
in (mm)

VLT 8042 – VLT 8062 (230 VAC)



VLT 8152 – VLT 8202 (460 VAC)

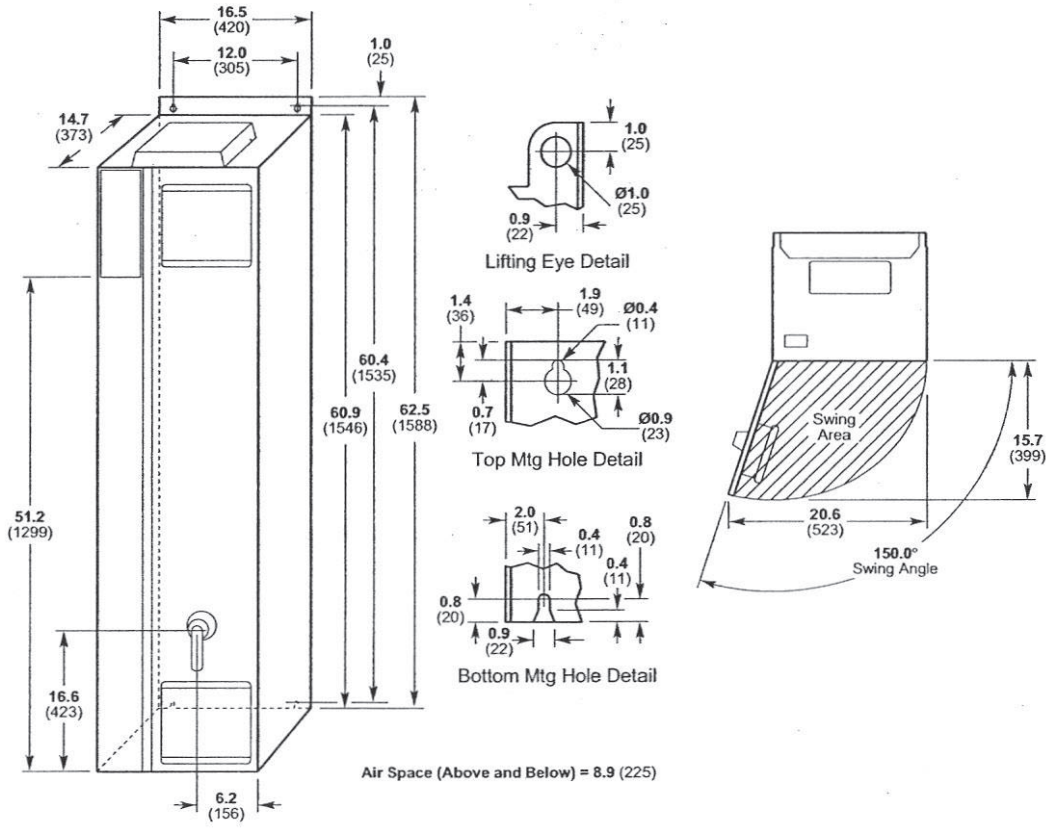
VLT 8052 – VLT 8202 (690 VAC)



NEMA 1 Mechanical Dimensions

VLT 8252 – VLT 8352 (460 VAC)
VLT 8252 – VLT 8402 (690 VAC)

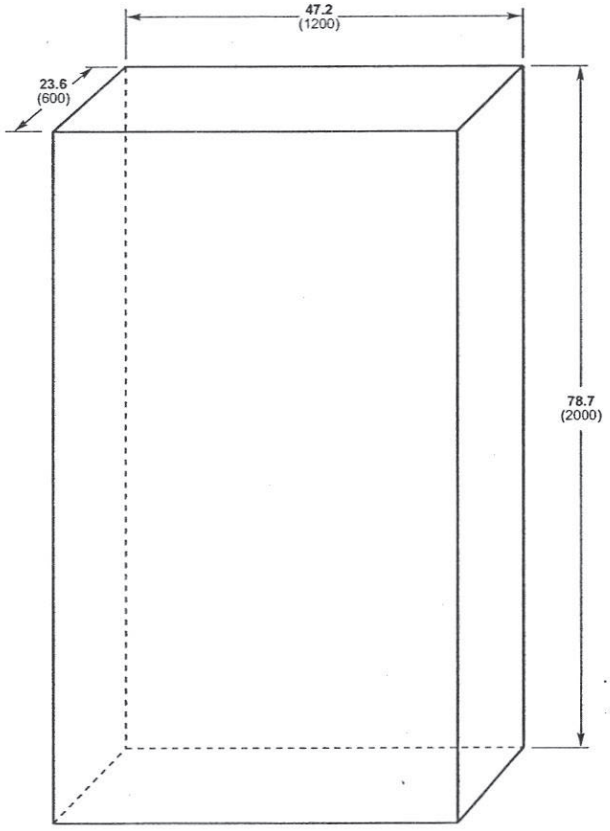
in (mm)



NEMA 1 Mechanical Dimensions

VLT 8450 – VLT 8600 (460 VAC)

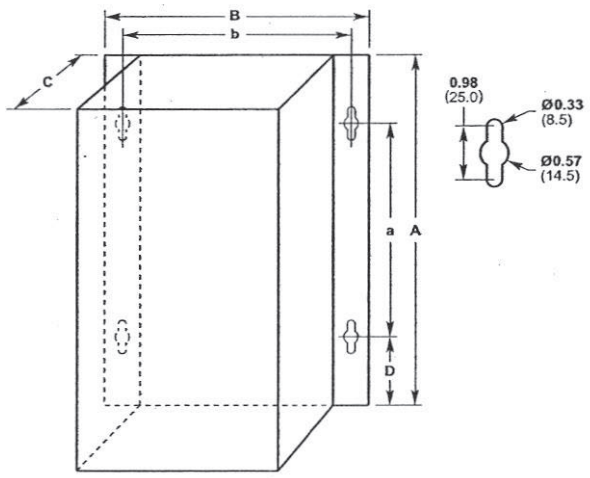
in (mm)



NEMA 12 (IP54) Mechanical Dimensions

NEMA 12 (IP 54)
VLT 8006 – VLT 8032 (230 VAC)
VLT 8006 – VLT 8122 (480 VAC)

in (mm)



VLT 8006 – VLT 8032 (230 VAC)

VLT Model	A	B	C	D	a	b	Air Space*
8006 - 8011	31.89 (810)	13.98 (355)	11.02 (280)	2.76 (70)	22.05 (560)	12.99 (330)	8 (200)
8016 - 8032	37.01 (940)	15.75 (400)	11.02 (280)	2.76 (70)	27.17 (690)	14.76 (375)	8 (200)

VLT 8006 – VLT 8122 (480 VAC)

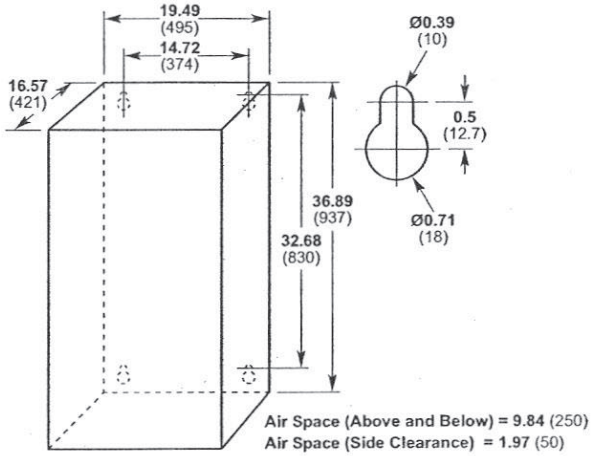
VLT Model	A	B	C	D	a	b	Air Space*
8006 - 8011	20.87 (530)	11.10 (282)	7.68 (195)	3.35 (85)	12.99 (330)	10.16 (258)	4 (100)
8016 - 8032	31.89 (810)	13.98 (355)	11.02 (280)	2.76 (70)	22.05 (560)	12.99 (330)	8 (200)
8042 - 8072	37.01 (940)	15.75 (400)	11.02 (280)	2.76 (70)	27.17 (690)	14.76 (375)	8 (200)
8102 - 8122	37.01 (940)	15.75 (400)	14.17 (360)	2.76 (70)	27.17 (690)	14.76 (375)	8 (200)

* *Minimum air space above and below enclosure.*

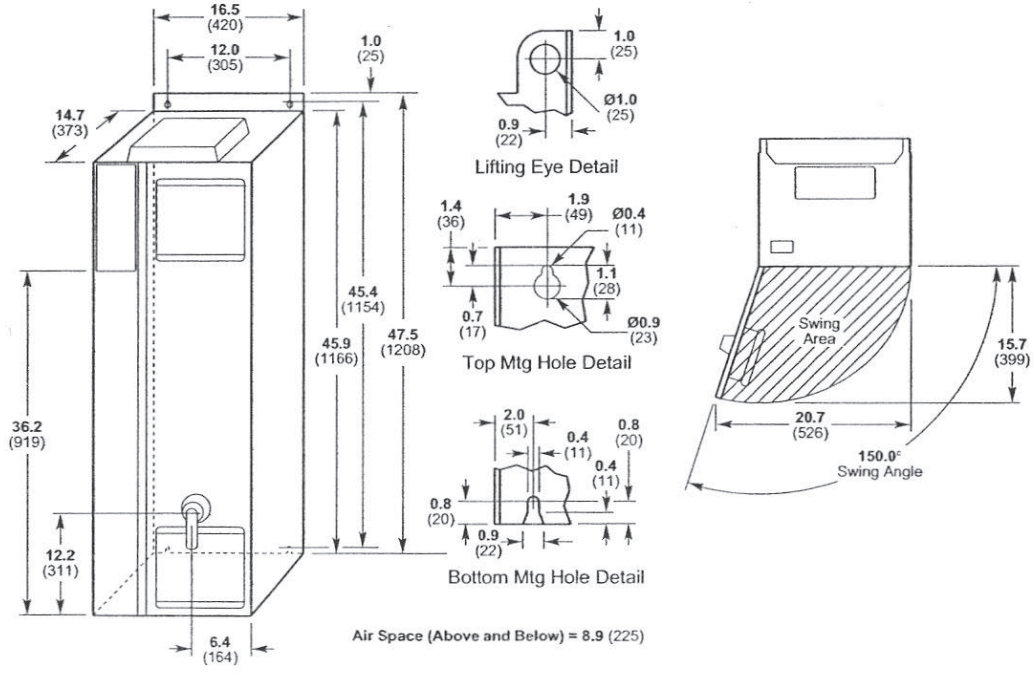
NEMA 12 (IP54) Mechanical Dimensions

VLT 8042 – VLT 8052 (230 VAC)

in (mm)



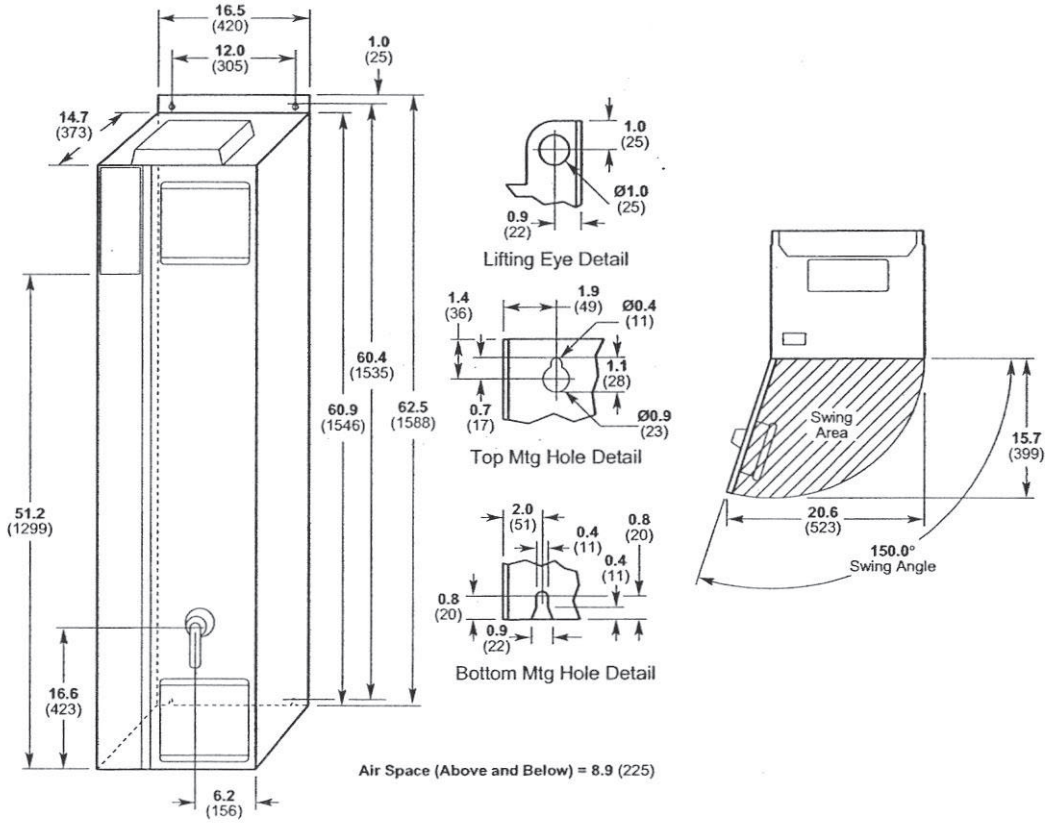
VLT 8152 – VLT 8202 (460 VAC)
VLT 8052 – VLT 8202 (690 VAC)



NEMA 12/IP54 Mechanical Dimensions

VLT 8252 – VLT 8352 (460 VAC)
VLT 8252 – VLT 8402 (690 VAC)

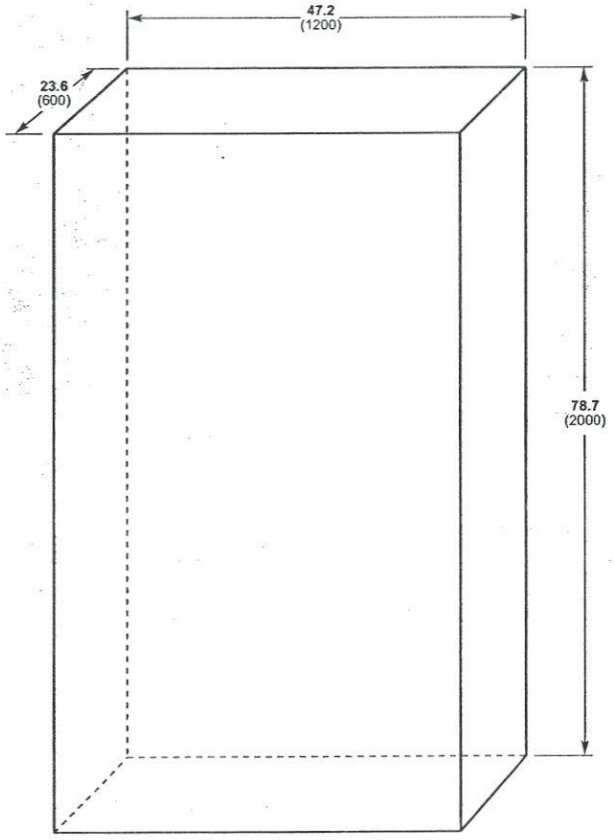
in (mm)



NEMA 12/IP54 Mechanical Dimensions

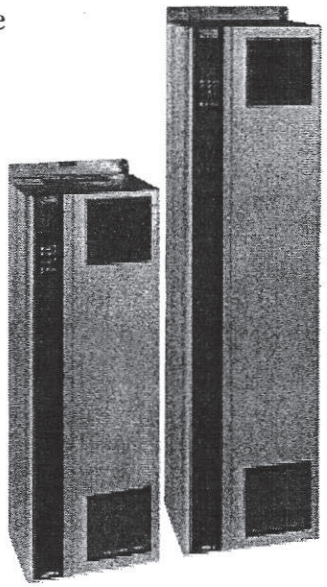
VLT 8450 – VLT 8600 (460 VAC)

in (mm)



Options

Enclosure



The VLT 8000 AQUA is available in Chassis, Protected Chassis, NEMA 1 or NEMA 12 enclosures. All VLT 8000 AQUA drives provide for a vertical wall-mounting arrangement. Most VLT 8000 AQUA drives allow for side-by-side mounting with zero side clearances.

C00: Chassis (IP 00);
C20: Protected Chassis (IP 20)

Chassis and Protected Chassis Enclosures allow easy mounting in panels, quick access to terminals, and greater heat tolerance.

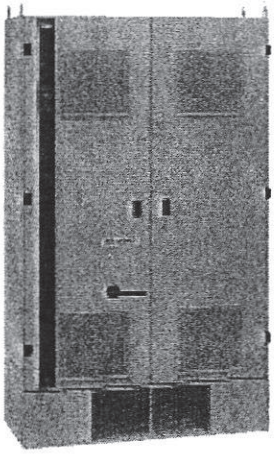
CN1: NEMA 1 (IP 20) Enclosures

All NEMA 1 drives are designed for minimal width, allowing drives to fit into crowded equipment rooms. Multiple drives can be mounted with no side clearance. Conduit entry is provided on the bottom of all drives.

C54: NEMA 12 (IP 54) Enclosures

VLT 8000 AQUA units provide one of the most compact NEMA 12 solutions on the market. Now the increased environmental protection offered by a NEMA 12 enclosure can fit both the equipment room and the budget.

Hardware



ST Standard

Standard configuration available for VLT 8002 AQUA thru VLT 8352 AQUA.

SL Standard with Load Sharing

Standard with Load Sharing configuration available for VLT 8016 AQUA thru VLT 8072 AQUA.

EX Extended

For VLT 8450-8600 units, the EX Extended configuration offers connection terminals for load sharing capabilities between VLT 8000 AQUA units, plus input terminals for a remote 24 VDC supply (user-supplied) to maintain the control card logic during removal of the AC input power.

DX Fuse/Disconnect

For VLT 8152-8600 AQUA (480 VAC) and VLT 8052-8402 (690 VAC) units, hardware configuration DX provides built-in pre-fuses and an AC line disconnect. Pre-fuses are designed for circuit protection up to a maximum of 100,000 Amps rms (symmetrical), 480V, providing critical protection without requiring additional space. The DX configuration also offers connection terminals for load sharing capabilities between VLT 8000 AQUA units, plus input terminals for a remote 24 VDC supply to maintain the control card logic during removal of the AC input power.

New Hardware Variants

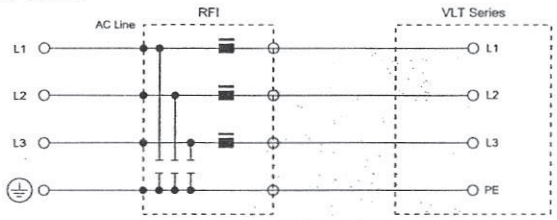
For VLT 8152-8352 (480 VAC units)

PS 24V input for logic supply
PF 24V input for logic supply and mains fuses
PD 24V input for logic supply and mains fuses/disconnect

For VLT 8052-8402 (690 VAC units):

PD 24V input for logic supply and mains fuses/disconnect

RFI Filter*



The switching of an adjustable frequency drive's power components causes voltage and current deviations in the voltage and current of the AC line. These deviations contain elements of high frequencies that may disturb equipment sharing the power line and may radiate to nearby equipment which can be affected. High frequencies in the 150 kHz to 30 MHz range are identified as RFI (Radio Frequency Interference). When properly used, RFI filters prevent interference currents from transmitting back onto the AC power lines. Danfoss RFI Filters are comprised of appropriately sized inductor and capacitor banks placed on the AC line input to the VLT, and meets the latest European Community ratings. The RFI filter option is built into the VLT 8000 AQUA Series drive at time of purchase; it cannot be retrofitted in the field. All RFI options are factory installed and are UL/cUL listed.

R0 Without RFI Filter

No RFI-filter built-in. No EMC specifications fulfilled. All R0 units are 500 feet (150 m shielded); 1,000 feet (300 m) unshielded.

R1 With 1A Filter

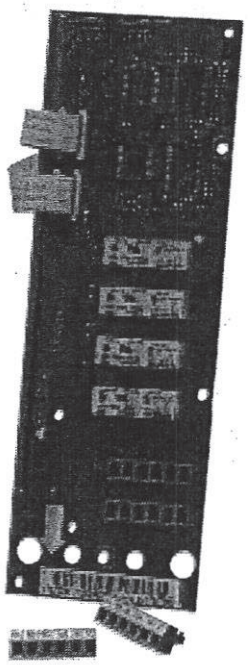
Available for 230, 480 and 690 VAC units only. Fulfillment of EN55011 Class 1A.

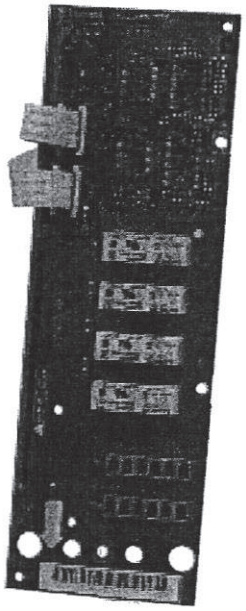
*** NEMA 1 Cover Accessory**
(used in conjunction with RFI option)

For the VLT 8000 AQUA Series models listed below, if both the RFI option and NEMA 1 enclosure option are specified, a separate field-installed, NEMA 1 terminal cover accessory is also required. Overall height of the VLT model increases as indicated.

	NEMA 1 Bottom Cover	Adder to Overall Height	
VLT Model	Part Number	Inches	(mm)
8006-8016 (230 VAC)	175Z4620	4.3	109
8022-8032 (230 VAC)	175Z4621	5.4	137
8016-8042 (480 VAC)	175Z4620	4.3	109
8052-8072 (480 VAC)	175Z4621	5.4	137
8102-8122 (480 VAC)	175Z4280	5.4	137

Application Option Card





A31 4-Relay Option Card

The 4-Relay Option adds four Form C relays to the standard two VLT 8000 AQUA Series relays (1 Form C and 1 Form A) for remote status indication, process monitoring, and regulation. Each relay is equipped with an ON-delay and OFF-delay timer and is programmable for over 30 different functions.

Specifications

- 4 additional relays, Form C (N.O. and N.C. contacts)
- 250 VAC, maximum 2 Amps
- Requires 12 VDC supply, internal to drive
- Mounts internal to drive
- Factory or field installed
- UL/cUL approved and CE

A32 Cascade Controller Option Card

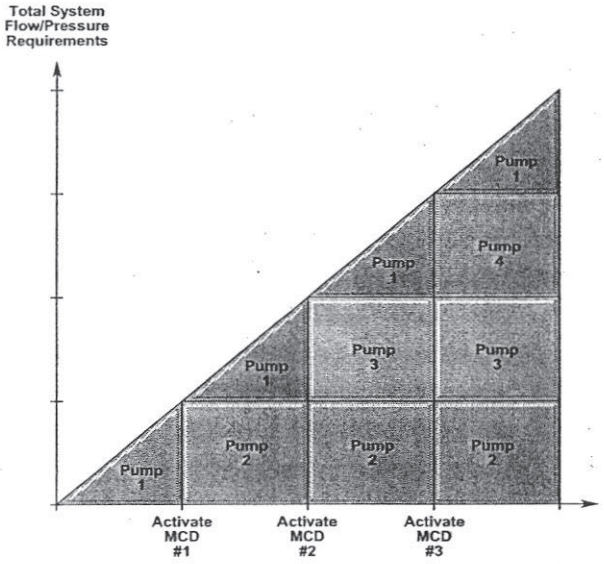
The Cascade Controller Option Card control up to five parallel pumps. The controller provides constant pressure or level control in such systems, and reduces water hammer and energy consumption. The controller also eliminates the need for PLCs and external controllers. The Cascade Controller is designed for a variety of applications including:

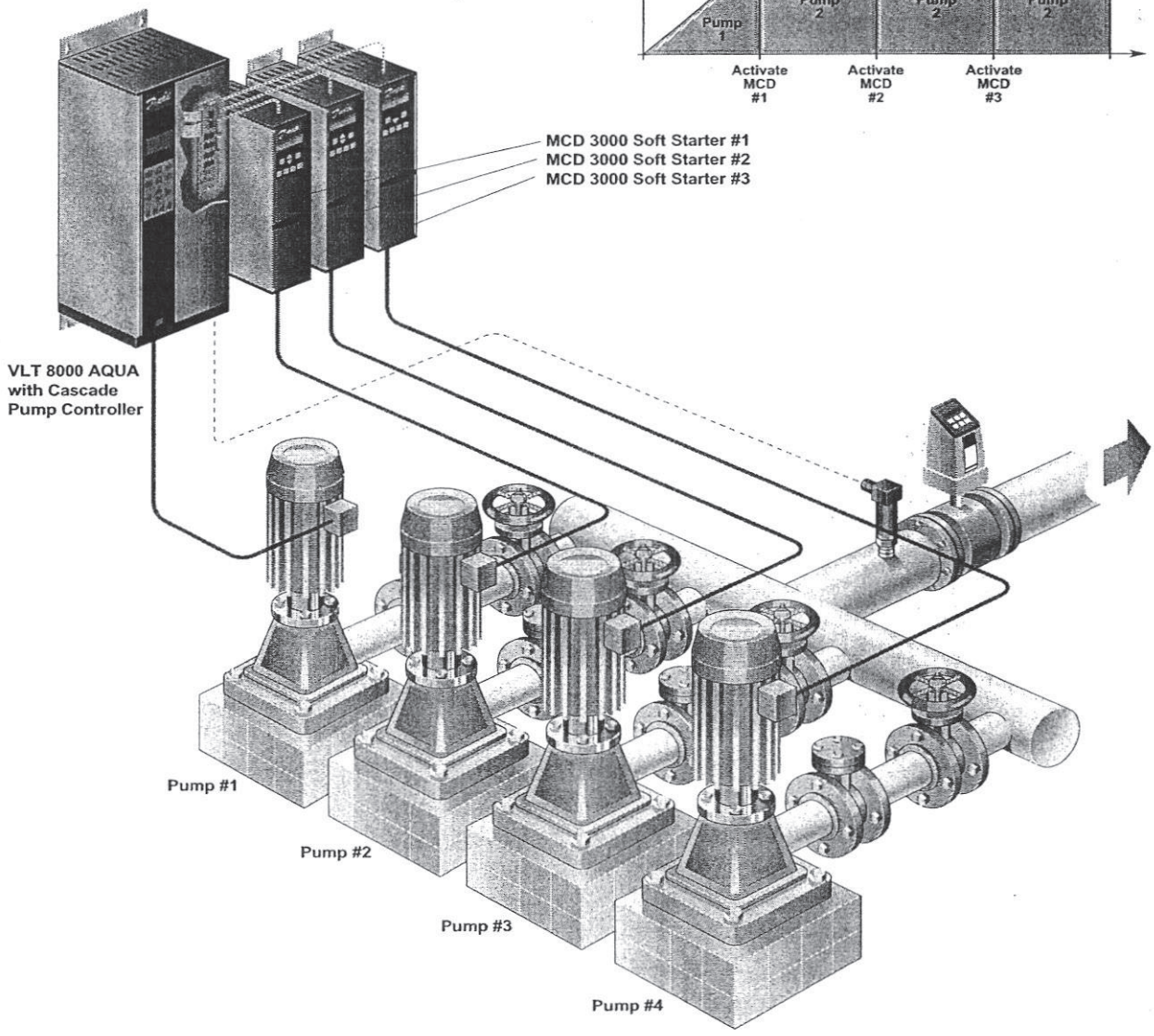
- Pressure booster pump systems
- Tank level control
- Pressure control
- Lift station pump control
- Irrigation and fire pump systems
- Wastewater blower systems

The Cascade Controller works with the MCD Soft Starters (see section D), and adjustable frequency drives such as the VLT 8000 AQUA or simple across the line starters.

Cascade Controller Application

This illustration depicts a typical VLT 8000 AQUA drive installation utilizing the Cascade Controller option. The controller is being used in conjunction with MCD Series Soft Starters (see section D) to operate one to four pumps as demand requires, (plotted in the graph at right). Pump #1 is shown as the variable pump station, with pumps #2-#4 as fixed (on-off) across the line.





Fieldbus Options

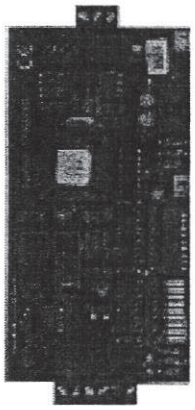
Fieldbus option cards are designed to give unprecedented flexibility and command over an adjustable speed drive controlled system. The options perform as an integrated part of the VLT, giving access to all parameters relevant to the application.

The Danfoss drive always acts as a follower to the master PC or PLC. It exchanges a multitude of information and commands such as "speed reference", "start/stop" of motor, "reverse" operation, etc. The drive acknowledges receipt by transmitting status signals, such as "running", "on reference", "motor stopped" and so on to the PC/PLC. The VLT Series drive may also transmit fault indications, alarms and warnings to the PC/PLC, such as "VLT fault" or "Current overload."

F10 Profibus DP/FMS

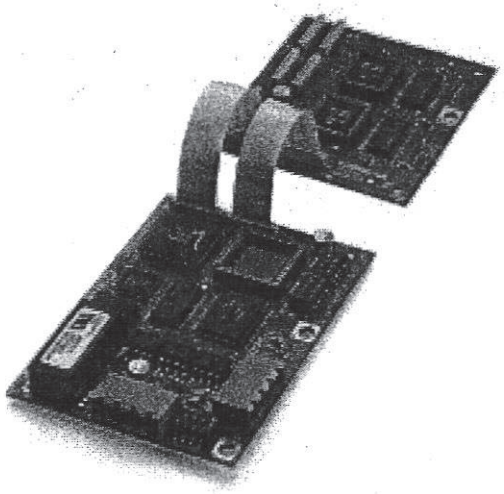
Profibus is an open, non-proprietary fieldbus standard complying with EN 50170.

- Simple 2-wire connection
- Universal product with high global acceptance
- Communication speed up to 12 Mbaud
- Access to drive master file makes planning easy
- Fulfillment of PROFIDRIVE guideline
- Danfoss VLT Series drives with Profibus are certified by the Profibus organization



F21 Modbus RTU

The common language used by all Modicon controllers is the Modbus RTU (Remote Terminal Unit) protocol. This protocol defines a message structure that controllers will recognize and use, regardless of the type of networks over which they communicate. It describes the process a controller uses to request access to another device, how it will respond to requests from the other devices, and how errors will be detected and reported. It establishes a common format for the layout and content of message fields.



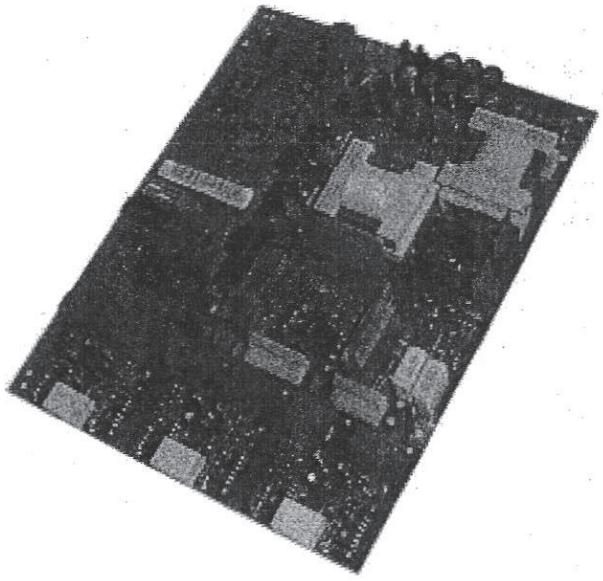
F30 DeviceNet

DeviceNet is a low-cost alternative to expensive hardwire communication links for connecting industrial automation devices to a network. Direct connectivity provides improved communication between devices, as well as enabling device-level diagnostics not typically accessible or available through hardwired I/O interfaces

- Cyclic I/O communication
- Acyclic communication – "explicit messaging"
- UCMM messages are integrated
- EDS-file/easy configuring
- Bus concept provides fieldbus voltage supply
- Fulfillment of DeviceNet AC/DC motor profile
- Protocol defined in accordance with the Open DeviceNet Vendor Association (ODVA)
- Transmission rate of 500 kBaud

Conformal Coating

All VLT 8000 AQUA drives are available with conformal coated circuit boards as an option.



C1 With Conformal Coating

Conformal coating provides additional protection against accelerated corrosion found in installations with high humidity or corrosive airborne contaminants. These corrosive gasses attack components in the drive, in particular, printed circuit assemblies and their components. High humidity and high ambient temperatures exacerbate the situation.

Conformal coating is used to mitigate these corrosive effects. Danfoss has chosen a protective polyurethane coating that has high resistance to chemicals and fungus and meets UL requirements for use in electronic controls. Performance of the coating has been verified by independent laboratory testing of the VLT 8000 AQUA Series using both coated and uncoated printed circuit assemblies in NEMA 1 (IP 20) and NEMA 12 (IP 54) versions.

VLT 8000 AQUA Series Ordering Information

Example:

VLT | 8006 | - A - | T2 | - | C20 | - | ST | - | R0 | - DL - | A00 | - | F00 | - | C0 |

Model

8002	1.5 HP
8003	2 HP
8004	3 HP
8005	4 HP
8006	5 HP
8008	7.5 HP
8011	10 HP
8016	15 HP
8022	20 HP
8027	25 HP
8032	30 HP
8042	40 HP
8052	50 HP
8062	60 HP
8072	75 HP
8102	100 HP
8122	125 HP
8152	150 HP
8202	200 HP
8252	250 HP
8302	300 HP
8352	350 HP
8402*	400 HP
8450	450 HP
8500	500 HP
8600	600 HP

** 525-690 VAC only*

Enclosure

C00 Compact Chassis (IP 00)
T2: 8042-8062; T4: 8150-8600; T7: 8052-8402
C20 Compact Protected Chassis (IP 20)
T2: 8006-8032; T4: 8006-8022; T6: 8002-8011
CN1 Compact NEMA 1 (IP 20): all units
C54 Compact NEMA 12 (IP 54): T2, T4 and T7 only

Hardware

ST Standard
SL Standard with Load Sharing
DX Extended (VLT 8450-8600 only)
DX Integral with fuse/disconnect (VLT 8350-8600 only)
PS 24V input for logic supply*
PF 24V input for logic supply and mains fuses*
PD 24V input for logic supply and mains fuses/disconnect**

** 8152-8352 (480 VAC) only*
*** 8152-8352 (480 VAC); 8042-8402 (690 VAC) only*

RFI Filter (T2 and T4 only)

R0 Without filter (available all models)
R1 With integral 1A filter*

** When a built-in RFI filter is ordered for a NEMA 1 enclosure VLT 8006-8032 (T2) or VLT 8016-8072 (T4), a separate NEMA 1 terminal cover must be ordered (see page A 33).*

Fieldbus Option Cards

F00 No option
F10 Profibus DP/FMS
F21 Modbus RTU
F30 DeviceNet

Application Option Card

A00 No option
A31 4-Relay card option
A32 Cascade controller

AC Line Supply

T2 3Ø 200 - 240 VAC (VLT 8006-8062)
T4 3Ø 380 - 480 VAC (VLT 8006-8600)
T6 3Ø 550 - 600 VAC (VLT 8002-8042)
T7 3Ø 525 - 690 VAC (VLT 8052-8402)

Conformal Coating

C0 No conformal coating
C1 With conformal coating (std on VLT 8450-8600 (480 VAC) and 8052-8402 (690 VAC) units