Motorpact™
Medium Voltage Motor Controllers

Catalog
03

Class 8198

CONTENTS

a brand of Schneider Electric

SQUARE D

Designed and manufactured by Square D to tackle the toughest power and process control challenges, Motorpact™ Medium Voltage Motor Controllers feature industry-first innovations that provide unmatched performance, high reliability, low maintenance and exclusive technologies that encourage proper operation.

When combined with other electrical distribution and control products from Square D, our medium voltage motor controller can provide a system-wide solution that you know you can trust. Motorpact medium voltage motor controllers feature a one-high design, with drawout contactors and a completely isolated Low Voltage (LV) control compartment.

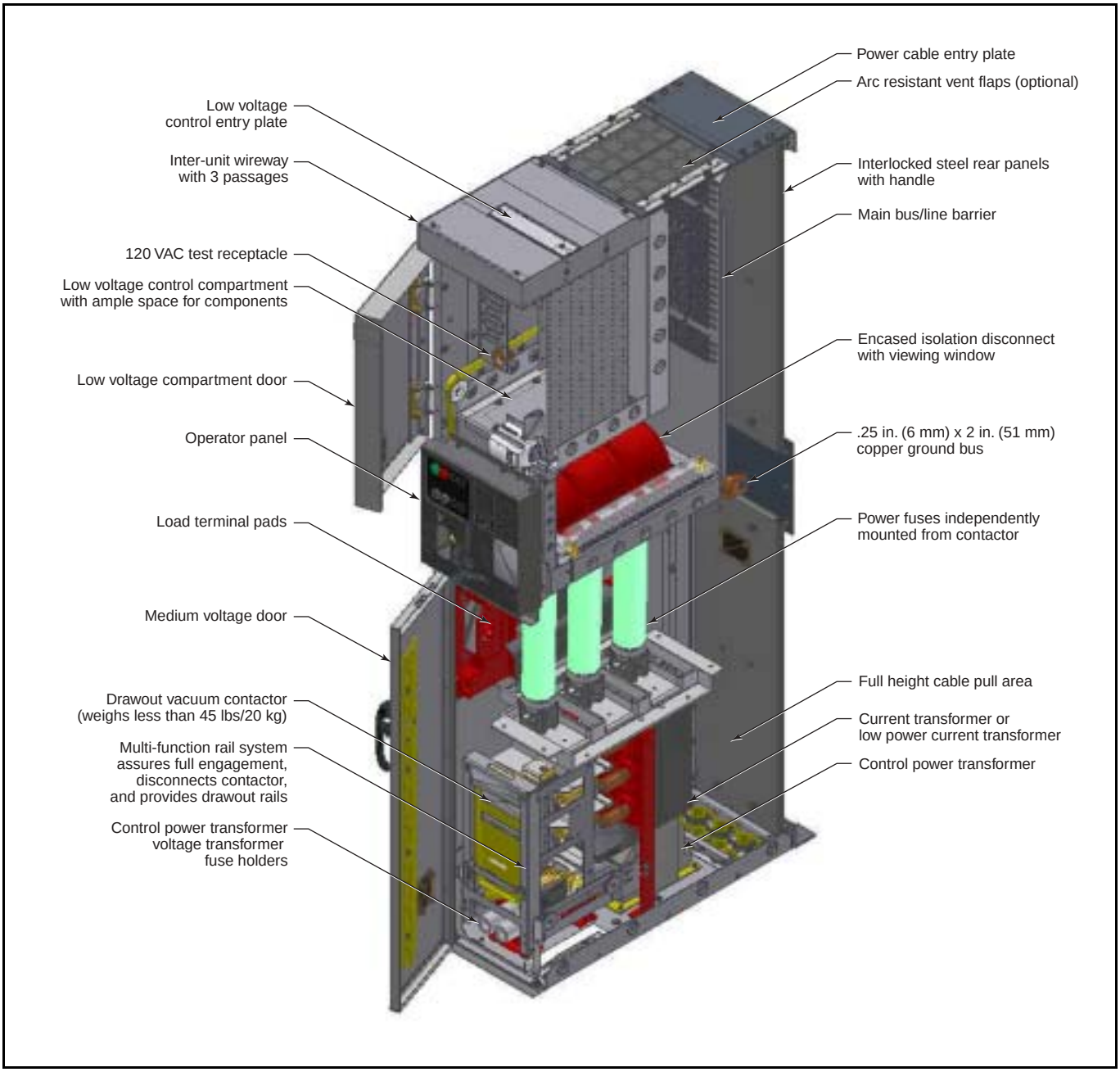
Controller Features

Standard

- Available in single or factory-assembled multiple controller sections
- Compartmentalized design– allows easy front or rear access and encourages proper access to line, load, and control compartments
- Easily expandable modular units, constructed of rugged 11-gauge steel, make extensions and connections to other equipment easy
- Compact footprint – smaller size allows maximum use of available space, reduced installation cost and easy retrofits
- Designed for front access only and with minimum clearance and can be positioned against walls, in small rooms, or in prefabricated buildings
- Highly reliable design — features molds for support of power components, and bus and fuse holder castings improving the overall performance of the power component system
- High operation encased isolation switch eliminates line side shutters
- Self-contained power bus – main horizontal power bus is contained within the standard 90-inch controller height
- Low voltage compartment – the isolated compartment provides adequate space for metering, control or protective devices
- Mechanical and electrical interlocking between contactor and isolation switch
- Drawout contactor rail system that disconnects the contactor when lowered and connects the contactor when raised
- Full Voltage Non-reversing (FVNR) controller section widths and Reduced Voltage Non-reversing (RVNR) main contactor section widths are available as 14.75 in. (375 mm), 20 in. (508 mm), and 29.5 in. (749 mm)
- Finished with high quality electrostatically applied powder coating including a zinc phosphate wash to all parts painted prior to assembly
- 600–3000 A tin-plated main bus mounted directly on isolation switch, when applicable
- Full length ground bus in multiple bay enclosures
- 60 kV BIL rated equipment
- Internal power cable connections feature Swage technology at the terminal ends — Swaging is a cold-fused 360° radial compression connection that is maintenance free (no terminals to torque).

Indoor

- Lifting angles located at the top corners of each shipping section for ease in handling
- Shipping splits up to five sections with full length main bus
- Provisions for expansion



Motorpact Controller Section

Motorpact motor controllers are designed to provide the most efficient means to control and protect a wide range of applications. They may be configured for motor starting, transformer feeders, capacitor feeders, or future spaces. The units also provide a wide range of motor starting applications.

Codes and Standards

- NEMA ICS 3
- UL347
- EEMAC G14-1, Arc Resistant (optional)
- ANSI C19.7
- IEC 60470, 60529, 60694, 60129, 62271-102, 62271-200 (replaces 298)
- ANSI C37.20.7, Arc Resistant (optional)
- IEC 62271-200, Arc Resistant (optional)

Motorpact Medium Voltage Motor Controllers is manufactured to NEMA (National Electrical Manufacturers' Association) Standard ICS 3 standards. Motorpact Medium Voltage Motor Controllers is also manufactured to Underwriters Laboratories Standard 347 and bear the cULus label.

Enclosure Types

- Type 1–Intended for indoor use only. Type 1 enclosures are designed primarily to provide protection against contact with energized equipment inside. They are to be used in locations where normal indoor service conditions exist.
- Type 1 Gasketed (Type 1A)–Intended to restrict the entrance of dust and dirt into Type 1 enclosures.
- Arc Resistant Type B Vented Style
  - — Intended to provide a degree of protection from internal arc faults around the perimeter of the equipment. Exhaust vents are provided on the top of the enclosure to vent hot gasses. A minimum of 2 meters clear above the equipment should be maintained.
- Arc Resistant Type B Plenum Style
  - — Intended to provide a degree of protection from internal arc faults around the perimeter of the equipment. Exhaust ports are provided on the top of the enclosure to vent hot gasses into a plenum box that vents the hot gasses to each end of the equipment. This option may be considered when 2 meters clear above the equipment is not available or when equipment is installed in a PowerZone center house.

*NOTE: Gasketed enclosures are **not** dust-tight.*

Shipping Weights

One, two, three, four, or five vertical sections can be shipped together on a pallet in widths of 14.75 in. (375 mm). Larger motor controllers are split into shipping blocks of three sections maximum. The following table lists typical approximate shipping weights.

Approximate Shipping Weights

Enclosure Type	Weight each (lbs/kg)
NEMA Type 1, 1A FVNR	521/1150

Ratings

Enclosure and Bus Ratings

	450 A Max. Controller
Mimimum line-to-line voltage (kV)	1.0
Maximum line-to-line design voltage (kV)	7.2
BIL (kV) at 3300 ft. (1000 m)	60
Frequency (Hz)	50/60
Continuous amps	200/400/450
Short circuit withstand at rated voltage— (kA peak) main bus to fuse line-side terminal	130
Short time rating (kA) symmetrical: Main bus (2 seconds) (0.25 second – through IM to line-side fuse) Controller (from load) (1 second) Controller (from load) (30 seconds)	 50 50 6.0 2.4
Dielectric withstand (kV 1 minute)	20 kV
Standard maximum altitude rating	1000 m(3300 ft)

The mechanical life of the isolation means is 5000 operations.

The table below lists ratings for the 200/400/450 A vacuum contactor.

Motorpact 200/400/450 V Vacuum Contactor Ratings

Rated voltage	7200 V
Rated operational current	200/400/450 A
Class E1 MVA	25/50 (36/60)
Class E2 MVA	200/400/570
Overcurrent strength (peak value)	85 kA
Interrupting capacity	5000 A rms symmetrical @ 7200 V max.
Permissible switching frequency	1200/hour
Mechanical life	2,500,000 operations
Electrical life	250,000 operations
Impulse withstand	60 kV
Dielectric strength	22 kV–1 minute
Closing time	80 ms or less
Opening time	25 ms or less
Opening time (delayed)[1]	approximately 300 ms
Arcing time	10 ms or less
Pick-up voltage AC or DC	Š85% rated (hot)—70% rated (cold)
Drop-out voltage AC or DC	ð50% rated (hot)—40% rated (cold)
Rated control voltage AC	115/120 or 230/240 V 50/60 Hz
Rated control voltage DC	120/125 or 240/250 V
Coil circuit inrush	670 VA AC (700 W DC)
Coil circuit holding	85 VA AC (85 W DC)
Auxiliary contact arrangement	3 (N.O./N.C.)
Auxiliary contact current	10 A continuous (NEMA Class A600)
Auxiliary contact voltage	48 V (min.)–600 V (max.)
Auxiliary contact AC	720 VA (P.F.0.35)
Auxiliary contact DC	60 W (L/R 150 ms)

[1] Terminals 3 and 4 jumpered.

Ratings for the latched vacuum contactor are the same as in the table above except as listed in the table below.

Motorpact (Latched Type Only) 200/400/450 A Vacuum Contactor Ratings

Permissible switching frequency	300/hour
Mechanical life	250,000 operations
Minimum tripping voltage	40–60% of coil rating DC (cold)
Tripping current	4.8 DC max.

Structures

Each section provides vertical mounting space for one drawout contactor, isolation switch (disconnector), power fuses and a low voltage control compartment. Auxiliary sections are required for units such as reduced voltage starters.

Each vertical section consists of a bolted-formed steel frame, with steel doors, side sheets, top sheets and rear bolted covers. Each section features a bottom cable entry point and a punchable top cover for top entry cables.

Sections are designed for complete front access for locations against walls, or the section may be accessed from the front and the rear allowing greater cable termination and maintenance access.

Sections include a bare copper ground bus that includes mounting provisions for customer supplied ground lug(s).

Structure Options

- 10 in. (254 mm) or 17 in. (432 mm) high cable pull box
- Drip hood
- Strip heater, (240 watts operated at 120 V)
- Thermostat for control of strip heaters (6 heaters maximum)
- Cable entry floor plates
- Contactor status “Open/Close” viewing window in Medium Voltage (MV) door
- Additional nameplates
- Special exterior paint colors

Encased Non Load-break Isolation Switch

- Mechanical and electrical interlocks promote proper access to energized Medium Voltage (MV) compartments
- Provides load side grounding of the MV compartment when in the open position
- Standard viewing window for position indication with optional interior light
- Offers physical isolation between main bus/line compartment and load compartment
- Optional key interlocking
- Maintenance-free contacts capable of 5000 operations

Power Fuses

- DIN style with ANSI R or E-rated characteristics
- Easy removal from the front
- Mounted separate from the vacuum contactor
- Optional FuseLogic blown fuse tripping and remote indication
- Optional fuse Insertion and removal tool accessory

Contactor

- Drawout design
- Control Power Transformer (CPT) and power fuses mounted separately
- Plug style automatic secondary connection
- Drawout rail system inserts and removes contactor from primary stabs
- Contactor truck engages ground bar when connected
- 3 (N.O./ N.C.) auxiliary contacts
- Lightweight at less than 45 lbs (20 kg)
- Optional mechanical operation counter

Control Voltages

- All ANSI ranges

Load Termination Space

- Load terminal pads are front and rear accessible
- Top or bottom cable exit with full height cable pulling area
- Accepts up to (1) - 500 kcmil shielded power cables per phase or (2) - 250 kcmil shielded power cables per phase (Prefabricated stress cones are recommended)
- Optional compression lugs and ground lugs
- Optional cable ground switch mechanically interlocked with the main isolation disconnect

Protection and Control

- Sepam Series 20, 40, or 80 Protective Relay
- Start and Stop pushbutton
- Run and Stop 22 mm LED pilot lights
- Front access low voltage components
- High visibility white interior

Instrument Transformers

- Current transformer – ring style 3-in-1 design
- Optional Low Power Current Transformer (LPCT) – with a linear current range, ring style 3-in-1 design, (mV output to Sepam relay)
- Control power transformer with primary and secondary fusing
- Optional fixed mounted 3-phase open delta voltage transformer with primary and secondary fusing

Horizontal Main Bus

- Standard tin-plated copper bus
- Ratings shown are based on 65°C maximum temperature rise
- Bus bar short circuit withstand rating is 50 kA rms, for 2 seconds
- Optional insulated bus
- 60 kV BIL “standard”
- Optional lightning arrester– Bus bar surge protection

Application

Squirrel Cage Motors

Either applying full line voltage or reduced line voltage to the motor terminals can start a squirrel cage motor. The “typical” squirrel cage motor draws high starting current (inrush) and provides high starting torque when started at full voltage.

Reduced voltage controllers are used to reduce the starting current and the starting torque. When motors are started at reduced voltage, the current at the motor terminals is reduced in direct proportion to the voltage reduction, while the torque is reduced as the square of the voltage reduction therefore, reduced voltage starting provides an effective means of reducing both starting current and starting torque.

If the motor load has a high inertia, or if the motor ratings are marginal for the motor load, reducing starting torque may prevent the motor from reaching full speed before the overload relay trips. Applications that require a high starting torque should be reviewed by the customer to determine if reduced voltage starting is suitable.

There are several different types of reduced voltage controllers available in the marketplace. The soft start controller will handle the vast majority of applications encountered. In addition to soft start controllers, autotransformer types are available. These types provide closed transition starting.

Squirrel Cage Motor Starting Characteristics

Type of Controller	Starting Characteristics in % of Full Load Values				Limitations	Advantages
	Voltage at Motor	Line Current	Motor Current	Starting Torque		
Across the line (Full voltage)	100	600	600	150	Draws highest current from the line during starting which affects: 1. LOAD: High starting torque results in sudden start for drive machine. May cause undue strain. 2. POWER SYSTEM CAPACITY: Limitations may prohibit high inrush current when starting large motor at full voltage. 3. MOTOR LOCATION: Line voltage drop due to inrush current when the motor is located at a considerable distance from power source may cause other controllers on the line to drop out.	1. Simplest. 2. Least expensive and should be used when limitations indicate on left do not apply.
Primary reactor	Taps: 50 65 80	 300 390 480	 300 390 480	 25 42 64 of 150%	1. Uses two contactors and a reactor. Hence, it costs more and requires more space than full voltage controllers. 2. Low power factor during starting.	1. Most economical reduced voltage controller for applications at 2300 V and above. 2. Inherently closed transition type (motor is not disconnected from line during transition from reduced voltage starting to full voltage running). This reduces objectionable switching transients. 3. Voltage taps permit adjustment of starting voltage. 4. Suitable for long starting period.
Auto-transformer	Taps: 50 65 80	 150 253 384	 300 390 480	 25 42 64 of 150%	1. Uses three contactors and an Auto-transformer. Hence, it costs more and requires more space than full voltage controllers. 2. Low power factor during starting.	1. Provides highest torque per ampere of line current. 2. Same for primary reactor 3. Controller. See above. 4. Motor current is greater than line current during starting which produces same starting torque as in primary reactor controller but with reduced line current.
Soft start	Taps: NONE	Voltage 0–100%	Current 0–600%	Torque Up to 150%	1. Uses two contactors and soft start power poles. Cost is slightly higher than RVAT.	1. Provides smooth acceleration and deceleration method for motors. 2. Heavy duty power section can provide 600% current for 30 sec. or 500% for 60 sec. 3. Soft stop programmable. 4. Voltage or Current ramp programmable. 5. Motor protection and monitoring built into control package. 6. Power poles are individually field replacable. 7. NEMA Medium and Heavy duty starting in one package.

Motor Controllers

Medium voltage motor controllers are recommended for motors above 200 horsepower. As compared to 480 volt applications, current is lower allowing for smaller conductors. By reducing the cost of expensive copper wire, generally the overall cost of an installation is reduced. Motorpact medium voltage controllers are available for a conventional single speed, single-winding type, squirrel cage motor. The table above summarizes the differences among the full voltage, the primary reactor, autotransformer controllers and the soft start controllers.

Full Voltage Non-Reversing Controllers

The Full Voltage Non-reversing (FVNR) controller provides full voltage to the motor terminals during starting. The controller provides the maximum starting torque available (up to 150%). FVNR controllers are the most economical type for the control and protection of medium voltage motors.

Reduced Voltage Autotransformer

The autotransformer controller provides reduced voltage to the motor terminals during starting through the use of a tapped, three winding, three-phase, autotransformer. The taps on the autotransformer provide selection of 50%, 65%, or 80% line voltage applied to the motor during staring. Starting torque will be 25%, 42%, or 64% respectively, of full voltage values. However, because of the transformer action, the line current during staring will be less than the motor current, being 28%, 45%, or 67% of full voltage values. Stated another way, the motor current is greater than the line current. This feature allows maximum starting torque with minimum line current, which is the main advantage of the autotransformer controller as compared with the primary reactor controller.

Square D reduced voltage controllers utilize autotransformers that are NEMA/EEMAC medium duty rated. Unless otherwise specified, the controller is shipped with the 65% tap connected. If this tap proves unsuitable, one of the other taps may be easily connected in the field.

Reduced Voltage Soft Start Controllers

Motorpact Reduced Voltage Soft Start (RVSS) Motor Control units provide a pre-engineered, integrated motor control package for reduced voltage starting and soft stopping of three-phase medium voltage induction (squirrel cage) motors. The Motorpact RVSS is a three-phase, microprocessor-based digitally controlled reduced voltage soft starter for medium voltage AC motor applications. The unit controls the motor start-up by delivering an adjustable amount of initial voltage and current to the motor, then slowly increasing the voltage and current to 100 percent. The Motorpact RVSS has a linear voltage versus time ramp, unless setup for current limit or ramp configuration. This adjustable acceleration ramp allows a smooth transition from the point where the motor shaft begins to turn, to full motor speed, regardless of the type of load. The Motorpact RVSS also features a selectable dual adjustment mode that can be programmed for a second load type. The Motorpact RVSS is offered in voltages from 2.3 kV to 7.2 kV, and current ratings from 100 A to 400 A.

The acceleration ramp time for a typical start-up is thirty (30) seconds or less, and is adjustable (0-120's) to allow the motor to smoothly accelerate the load. The current limit is adjustable from 100% to 600% of programmed motor full load amperage (FLA). This adjustment is separate from the acceleration time, to allow greater control of peak power usage. At the end of the start cycle, the unit will switch in a bypass contactor placing the unit across the line with overload protection still present.

Mechanically Latched Controllers

Mechanically latched controllers can be used in place of load interrupter switches or metal-clad circuit breakers in applications where the load remains connected to the power source even during severe undervoltage or power loss conditions or for long periods of time. The controller uses a mechanical latching mechanism that holds the contactor closed. Therefore, the load remains unless the release is activated either electrically or manually.

Transformer Disconnects

Transformer feeders provide a means to control and protect transformers. Mechanically latched controllers are typically used for this purpose and are supplied with E-rated fuses, which are sized for the kVA rating and system voltage rating of the transformer. Additional protection is available using voltage, current, or multi-function protective relays.

Feeder Disconnects

Feeder disconnect applications use E-rated fuses which provide overcurrent protection for the load. Mechanically latched controllers are typically used for this purpose and are supplied with E-rated fuses, which are sized for the kVA rating and system voltage. Additional protection is available using voltage, current, or multi-function protective relays.

Capacitor Bank Disconnects

Motorpact controllers may be used for capacitor bank switching applications. Mechanically latched controllers are typically used for this purpose and are supplied with E-rated fuses, which are sized for the kVA rating and system voltage. Additional protection is available using voltage, current, or multi-function protective relays.

Prepared Spaces

Prepared spaces are available for blank compartments to allow future installation of a complete full voltage non-reversing controller. Both mechanical and electrical packages are available.

Full Voltage Non-Reversing Controllers—Squirrel Cage

Full voltage or across-the-line controllers apply the system line voltage to motor terminals to start a motor. The resulting inrush current can range from 400% to 1000% of full load current. Full voltage starts provide high starting torque (about 150% of full load torque). Full voltage controllers are the most widely used and meet most applications with their simple, cost-effective design.

Full voltage or across-the-line controllers are arranged in one high construction.

Basic Controller Components and Maximum Ratings

Description	Quantity
14.75 in. (375 mm) NEMA/EEMAC Type 1 enclosure	1
Three-pole non-load break isolation disconnector	1
Three-pole vacuum contactor	1
Current limiting power fuse	3
Control Power Transformer (CPT) - 0.3 kVA	1
CPT primary current limiting fuses	2
Current transformers (3 window)	1
Control circuit secondary fuse	1
Low Voltage Controls Include:	
120 VAC test circuit plug	1
Start pushbutton - 22 mm	1
Stop pushbutton - 22 mm	1
Red “RUN” pilot light - 22 mm	1
Green “OFF” pilot light - 22 mm	1
Interposing control relay	2
Auxilary contacts 3 (N.O./N.C.)	1
Class 20 bi-metallic overload	1

Controller Rating (Amperes)	Voltage	Horsepower
200	2300	850
	3300	1225
	4160	1545
	6900	2500
400	2300	1700
	3300	2450
	4160	3000
	6900	5125
450	2300	1925
	3300	2750
	4160	3475
	6900	5750

14.75 in. (375 mm) Standard Width | 20.00 in. (508 mm) Optional Width | 29.50 in. (749 mm) Optional Width

FVNR

Full Voltage Non-Reversing Controllers—Mechanically Latched

Mechanically Latched controllers apply the system line voltage to a load such as a transformer. They provide a simple, cost-effective way of providing control and protection and are arranged in one high construction.

Basic Components and Maximum Ratings

Description	Quantity
NEMA/EEMAC Type 1 enclosure	1
Three-pole non-load break isolation disconnector	1
Three-pole vacuum contactor, mechanically held	1
Current limiting power fuses - E rated	3
Control Power Transformer (CPT) - 0.3 kVA	1
CPT primary current limiting fuses	2
Current transformers (3 window)	1
Control circuit secondary fuse	1
Low Voltage Controls Include:	
120 VAC test circuit plug	1
Close pushbutton - 22 mm	1
Open pushbutton - 22 mm	1
Red “ON” pilot light - 22 mm	1
Green “OFF” pilot light - 22 mm	1
Interposing control relay	2
Auxilary contacts 3 (N.O./N.C.)	1
Manual trip (release) pushbutton	1
Electric release solenoid	1

Controller Rating (Amperes)	Voltage	kVA
200	2300	800
	3300	1145
	4160	1440
	6900	2390
400	2300	1600
	3300	2285
	4160	2880
	6900	4780
450	2300	1800
	3300	2575
	4160	3240
	6900	5375

14.75 in. (375 mm) Standard Width

20.00 in. (508 mm) Optional Width

29.50 in. (749 mm) Optional Width

FVNR Latched

Reduced Voltage Non Reversing Controllers—Autotransformer/Squirrel Cage

Limit the line current draw and voltage drop during full voltage staring on limited power distribution systems.

Basic Components and Maximum Ratings

Description	Quantity
NEMA/EEMAC Type 1 enclosure	1
Three-pole non-load break isolation disconnector	1
Three-pole vacuum contactor (Main/Run)	2
Three-pole vacuum contactor (Start), mechanically interlocked with Run	1
Current limiting power fuses	3
Control Power Transformer (CPT) - 0.3 kVA	1
CPT primary current limiting fuses	2
Current transformers (3 window)	1
Control circuit secondary fuse	1
Three coil autotransformer with 50%, 65%, and 80% voltage taps	1
Low Voltage Controls Include:	
120 VAC test circuit plug	1
Start pushbutton - 22 mm	1
Stop pushbutton - 22 mm	1
Red “RUN” pilot light - 22 mm	1
Green “OFF” pilot light - 22 mm	1
Timing relay	1
Current relay for transition	4
Incomplete sequence relay	2
Auxiliary contacts 3 (N.O./N.C.)	1
Class 20 bi-metallic overload	1

Horsepower Range	Voltage	Figure No.
0–250	2300	1
0–250	3300	
0–250	4160	
0–200	6900	
300–1750	2300	2
300–1750	3300	
300–1750	4160	
250–3750	6900	
1800	2300	3
2250–2750	3300	
2000–3500	4160	
4000–5500	6900	

14.75 in. (375 mm) 29.50 in. (749 mm)
20.00 in. (508 mm)
29.50 in. (749 mm)

14.75 in. (375 mm) 44.25 in. (1124 mm)
20.00 in. (508 mm)
29.50 in. (749 mm)

14.75 in. (375 mm) 59.00 in. (1499 mm)
20.00 in. (508 mm)
29.50 in. (749 mm)

RVAT

Reduced Voltage Non Reversing Controllers—Soft Start/Squirrel Cage

Limit the line current draw and voltage drop during full voltage staring on limited power distribution systems

Motorpact Reduced Voltage Soft Start (RVSS) Motor Control units provide a pre-engineered, integrated motor control package for reduced voltage soft starting and soft stopping of three-phase medium voltage induction motors.

Basic Components and Maximum Ratings

Description	Quantity
NEMA/EEMAC Type 1 enclosure	1
Three-pole non-load break isolation disconnector	1
Three-pole vacuum contactor (Main)	1
Three-pole vacuum contactor (Bypass)	1
Current limiting power fuses	3
Control Power Transformer (CPT) - 0.3 kVA	1
CPT primary current limiting fuses	2
Current transformers (3 window)	1
Control circuit secondary fuse	1
Solid state controller with MPR and metering	1
Low Voltage Controls Include:	
120 VAC test circuit plug	1
Start pushbutton - 22 mm	1
Stop pushbutton - 22 mm	1
Red “RUN” pilot light - 22 mm	1
Green “OFF” pilot light - 22 mm	1
Auxiliary contacts 3 (N.O./N.C.)	2

Controller Type (Amperes)	Voltage (0.8 PF)	Horsepower (1.0 PF)
200	2300	800
	3300	1000
	4160	1250
	6900	2500
400	2300	1500
	3300	2250
	4160	2750
	6900	5000

14.75 in. (375 mm)
20.00 in. (508 mm)
29.50 in. (749 mm)
29.50 in. (749 mm)

RVSS

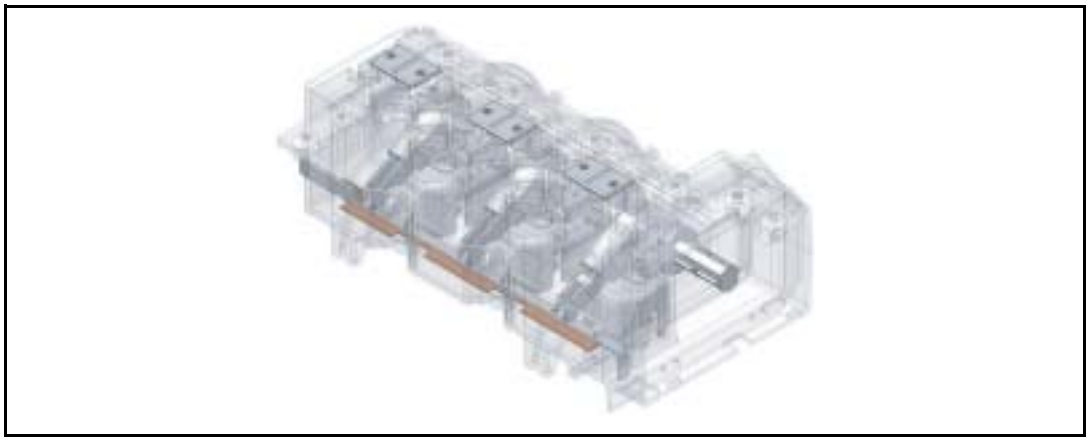
Controller Features

Non-load Break Isolation Switch (Disconnector)

The isolation switch is a means to disconnect a controller from the line or source, and is required to allow for maintenance of the units. Each Motorpact controller is equipped with an isolation switch like the one shown below.

The isolation switch is a medium voltage, three-pole, manually operated device. The disconnect is encased in an arc resistant and flame retarding housing. In the open position, the switch is grounded.

Designed for use on systems up to 7.2 kV, the isolation switches are rated 200 and 450 A. The switches are non-load break devices, which means the devices can not interrupt a power load. Design of the switch allows for interrupting the transformer magnetizing current only. Mechanical and electrical interlocking inhibit opening or closing the switch with the contactor closed.



Isolation Switch

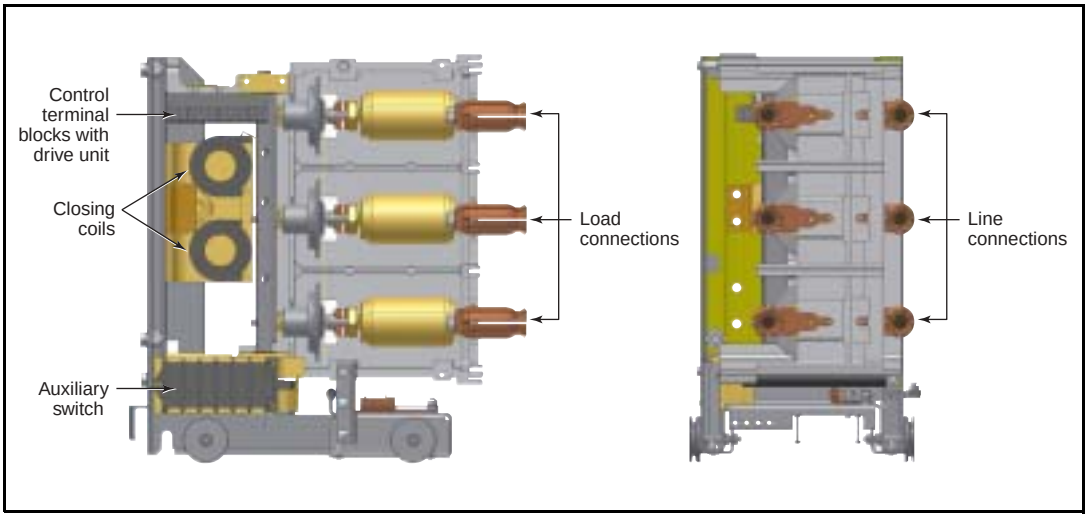
Vacuum Contactor

The Motorpact vacuum contactor utilizes state of the art vacuum technology and is a three-pole device rated 7.2 kV maximum, 60 kV BIL, with an interrupting rating of 5000 A symmetrical. Basic contactors contain three vacuum interrupters, a DC operating coil with a rectifier circuit, and auxiliary contacts. The vacuum contactor incorporates an electronic drive unit to power the operatting coils. This soft start design eliminates economizing resistors and improves the reliability of the coil circuit. The contactor is available in either electrically maintained or latched type versions. This contactor is used as the main (42M) contactor on:

- Full Voltage Non-reversing (FVNR) controllers
- Reduced Voltage Autotransformer (RVAT) controllers
- Reduced Voltage Soft Start (RVSS) controllers

The contactor is also used as the Start (S) and Run (R) contactor on reduced voltage autotransformers and as the bypass contactor for Reduced Voltage Soft Start (RVSS).

A mechanical latching mechanism may be added to a basic contactor to lock the contactor closed. An electrical release is optional. The mechanically latched contactor is used primarily for transformer feeder circuits, transfer schemes, and applications where it is desirable for the contactor to remain closed during voltage dip or loss.



Motorpact 200/400/450 A Vacuum Contactor

Medium Voltage Fuses

Motorpact Medium Voltage Motor Controllers are a fused device (NEMA E2). They may be provided with either "R" rated fuses or "E" rated fuses. R-fuses provide fusing for motor type controllers and E-fuses provide fusing for transformer or distribution feeder type controllers.

R-fuse range is 2R-32R, and E-fuse range is 10E-450 A.

The power fuses have a top mounted trigger (striker pin) that pops up when the fuse element melts. This can activate an optional FuseLogic contact and/or light, indicating a blown fuse.

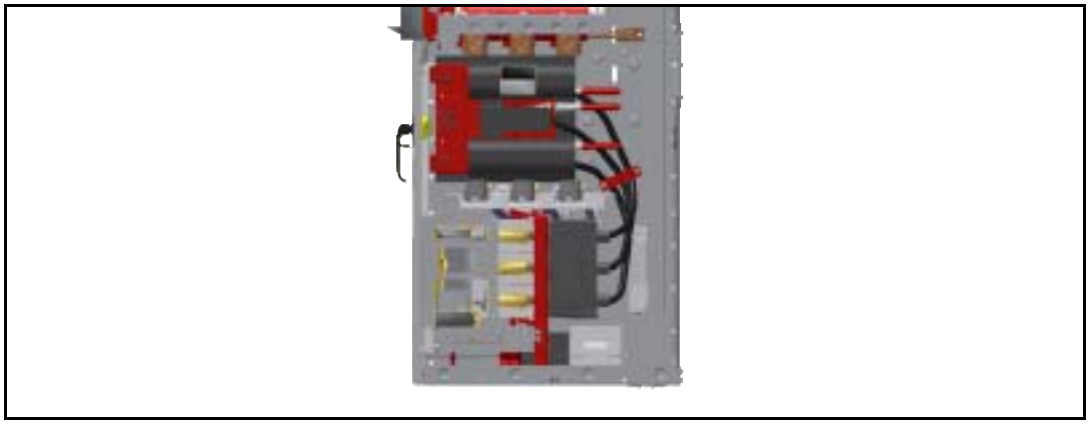
Current Transformers

Motorpact controllers are equipped with current transformers and control power transformers with options available such as potential transformers, power factor correction capacitors, surge arresters, and surge capacitors.

Current Transformers (CTs) are used to provide a current at an acceptable level (typically 0–5 amperes) to metering, protective, and control devices. The figure below shows the three-phase CT and ground fault CT.

MOTORPACT controllers use 0.6 kV voltage class CTs. Use of this lower voltage class is possible since the cable through the toroid is insulated and the cable insulation provides the insulating properties required.

Ground Fault Current Transfomers (GFCT) and a multi-function relay are used to provide protection. Typically, a 50:5 CT is used but both 100:5 and 2000:1 versions are available upon request. The 2000:1 GFCT is typically reserved for high resistance grounded systems requiring greater sensitivity.



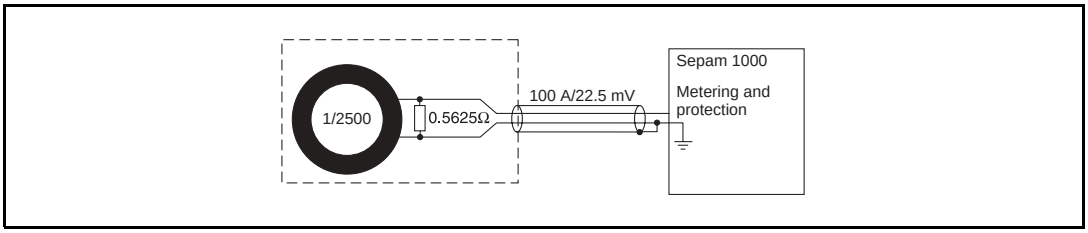
Three-phase Current Transformer, mounted in a Controller with a Ground Fault Current Transformer

Current Transformer Accuracy

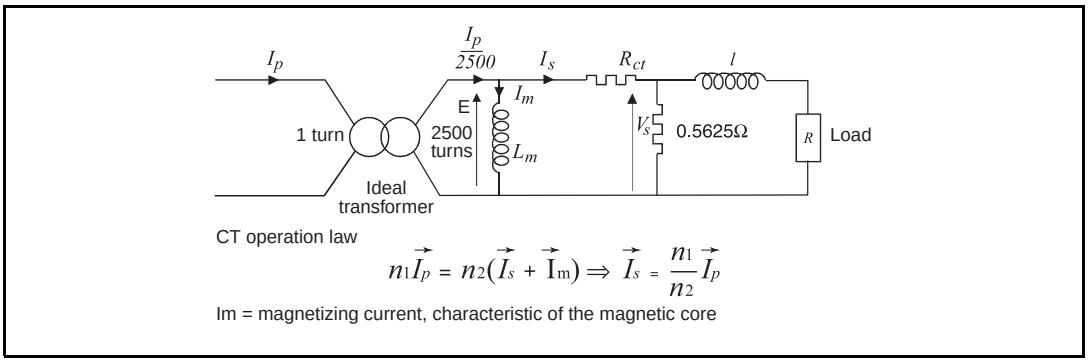
Catalog Number	Current Ratio (Amps)	ANSI Relay Class	ANSI Metering Class at 60 Hz	IEC Relay Class	IEC Metering Class at 60 Hz	Resistance	
			80.1	80.2	80.5	80.9	81.8
3PL55-50C	50:5	–	5.0	–	–	–	–
3PL55-101	100:5	–	2.4	–	–	–	–
3PL55-151	150:5	–	1.2	2.4	–	–	–
3PL55-201	200:5	–	1.2	1.2	2.4	2.4	–
3PL55-251	250:5	–	0.6	0.6	1.2	2.4	–
3PL55-301	300:5	–	0.6	0.6	1.2	1.2	–
3PL55-401	400:5	–	0.3	0.3	0.6	1.2	1.2
3PL55-501	500:5	C10	0.3	0.6	0.6	1.2	–
3PL55-601	600:5	C10	0.3	0.3	0.6	1.2	2.4
3PL55-751	750:5	C10	0.3	0.3	0.3	0.6	1.2
3PL55-801	800:5	C10	0.3	0.3	0.3	0.6	1.2
3PL55-10”	1000:5	C10	0.3	0.3	0.3	0.3	0.6
3PL55-12”	1200:5	C20	0.3	0.3	0.3	0.3	0.6

Low Power Current Transfomers

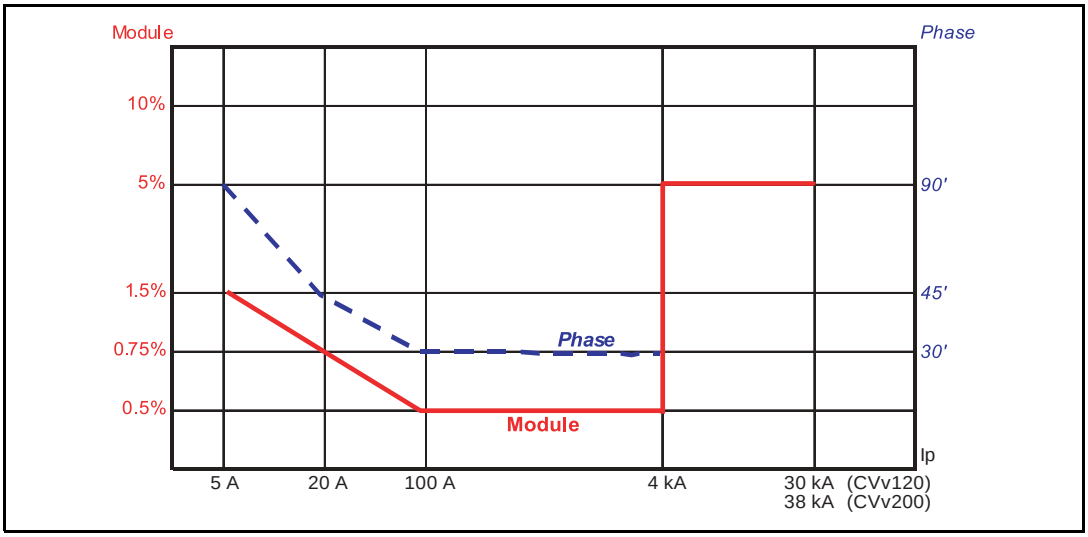
Low Power Current Transformers (LPCTs) provide the ability to have a "one current transformer fits all" ranges application. It is linear across a wide current range. It's rated primary current is 100 A to 4 kA. It's ouput is a millivolt signal rated 22.5 mV. The LPCT is ideal for installations that have future load upgrades that typically would require a new current transformer. It is intended to be used with any Sepam relay. With this type of current transformer it eliminates the danger of loose wires that may cause an open secondary. It requires no maintenance of its secondary connections or leads.



Block Diagram of Low Power Current Transformer



Low Power Current Transformer Equivalent Layout



Low Power Current Transformer Accuracy Template

Control Power Transformers

Control power is supplied to Motorpact controllers via a Control Power Transformer (CPT).

Standard CPT Sizes

Contactor Rating (in Amperes)	Volt-Ampere Rating
200/400/450 A Contactors	300 VA
	500 VA
	750 VA
	2.0 kVA

Optional CPTs

kVA Rating	Section Width (In./mm)
3 kVA	29.50/749
4 kVA	29.50/749

All CPTs are fused with two primary fuses and at least one secondary fuse. Electrical interlocking is also provided in the CPT secondary to de-energize the load on the CPT before opening the non-load break isolation switch. CPTs are epoxy encapsulated to 2.0 kVA. CPTs are typically rated 60 kV BIL.

Control power can be supplied by the end-user. When requested, the CPT is removed from the controller and provisions for an external control power source are provided. Provisions include terminal points to make the control power connection and an appropriately sized control power wire extending through the line-up, if required.

Voltage Transformers

Relays or meters sometimes require a three-phase voltage to operate. This voltage is supplied in one of the following ways:

- 100 VA three-phase controller mounted voltage transformer
- Voltage transformer section
- Three-phase wire bus from external source

The 100 VA three-phase Voltage Transformer (VT) is typically supplied unless a higher burden is required. The voltage transformer is epoxy encapsulated and rated 60 kV BIL.

For higher burden requirements, a VT section may be supplied. A VT section mounts two fixed 700 VA VTs or one 3-phase open delta VT in a section with or without a VT disconnector. It is possible to use a VT disconnect for a line-up and distribute the power via a wire power bus. For some applications, a three-phase wire bus may be advantageous. This method requires mounting the Power Transformers (PT) remotely and feeding the controller or line-up with a potential bus.

Instrument Transformer Primary Fusing

The CPT and VT (when supplied) have (2) or (3), 5.5 kV or 6.9 kV rated primary fuses. The fuses are completely encased in an arc resistant, flame retardant holder. The holder is completely front accessible. The holder has provisions for voltage testing from the front.

CPT Fuse Holder

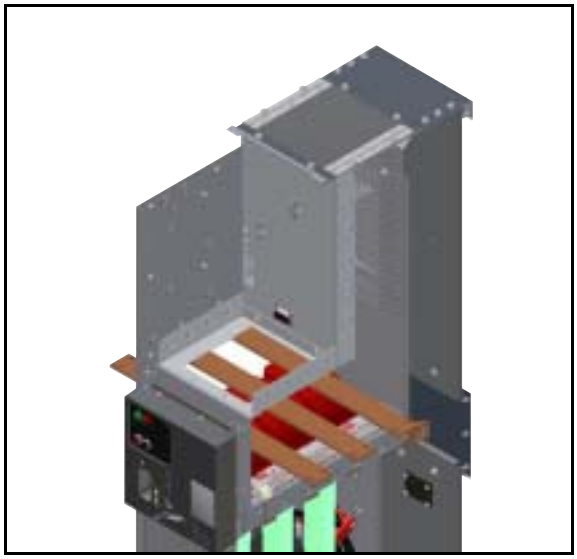
Controller Features and Accessories

Main Bus Amperes and Material

Rating (Amperes)	Material
600	Tin-plated copper
600	Silver-plated copper
1200	Tin-plated copper
1200	Silver-plated copper
2000	Tin-plated copper
2000	Silver-plated copper
3000	Tin-plated copper*
3000	Silver-plated copper*

* Requires a 10 high (min.) top hat/pull box. An optional 17 high box is available.

NOTE: The total current requirements of all the controllers should not exceed the current rating of the horizontal main bus.



Horizontal Main Bus located at the top of the Isolation Switch

Incoming Power Options

- Stand-alone controllers–Motorpact motor controllers can be stand-alone equipment. In this case, provisions are provided for terminating incoming power cables using compression lugs on top of the isolation switch or in an incoming line section. The compression lugs are available as an option. The termination points are configured for NEMA 2-hole drilling with 0.5 in. (5 mm) hardware.
- Lineups–Motorpact medium voltage motor controllers can be part of a lineup that may include other controllers and be fed by incoming line sections, metal-clad switchgear or load-break switches.

NOTE: The total current requirements of all the controllers should not exceed the current rating of the incoming cables or the horizontal main bus.

Terminations

Incoming Cables in Controllers (No Incoming Section)

Equipment Description	Connected To	Top Entry	Bottom Entry	Stress Cones *
200, 400, 450 A controller	Isolation switch	1-500 or 2-250 kcmil	1-500 or 2-250 kcmil	Yes

*Indicates space for 8.0 kV rated stress cones only. Stress cones are not supplied by Square D.

Load Cables

Motorpact controllers provide complete front access to the load termination points. Load termination points provide for either top or bottom entry of the load cables. Like the incoming power cable connections, the load cable connections are designed for compression type lugs. Compression lugs are available as an option. The termination points have NEMA 2-hole drilling with 0.5 in. (5 mm) hardware.

Equipment Description	With Stress Cones *		Without Stress Cones	
	Top Entry	Bottom Entry	Top Exit	Bottom Exit
200, 400, 450 A controllers	1-500 kcmilL or 2-250 kcmil	1-500 kcmil or 2-250 kcmil	1-500 kcmil or 2-250 kcmil	1-500 kcmil or 2-250 kcmil

* Indicates space for 8.0 kV rated prefabricated stress cones only. Stress cones are not supplied by Square D.

Incoming Cable Sections

Incoming cable sections are used to terminate incoming power cables and may contain service metering equipment and/or surge protection equipment. Incoming cable sections are available in two widths and the depth is 37.25 in. (946 mm).

Incoming/Outgoing Cable Sections

Incoming Entry	With Metering CTs	With Lightning Arresters	With Live Line Indicators	Maximum Cables per Phase	Maximum Cable kcmil (Shielded)	Minimum Pull Box (In./mm)	Section Width (In./mm)
Bottom		Y	Y	4	1000	N/A	20.00/508 or 29.50/749
Bottom		Y		4	1000	N/A	20.00/508 or 29.50/749
Bottom			Y	4	1000	N/A	20.00/508 or 29.50/749
Bottom				4	1000	N/A	20.00/508 or 29.50/749
Bottom	Y	Y	Y	6	750	N/A	20.00/508 or 29.50/749
Top	Y	Y	Y	4	500 (note 6)	17.00/432	29.50/749
Top		Y	Y	6	500	10.00/254	29.50/749
Top		Y		6	500	10.00/254	29.50/749
Top			Y	6	500	10.00/254	29.50/749
Top		Y	Y	6	750	17.00/432	29.50/749
Top		Y		6	750	17.00/432	29.50/749
Top			Y	6	750	17.00/432	29.50/749
Top				6	4/0	No	29.50/749

Notes:

1. Sections can be configured for 1200 A, 2000 A or 3000 A main bus.
2. 20 in. (508 mm) wide sections are configured for the left or right end of a controller or lineup only.
3. Top entry/exit is restricted when enclosure is Arc Resistant construction.
4. All 3000 A main bus sections require a 10 in. (254 mm) vent box on top that can be used as a pull box. A 17 in. (432 mm) high pull box may be used for additional cable space.
5. Table is based on shielded cables with 8.0 kV prefabricated stress cones. Larger diameter un-shielded cables may be used in some cases.
6. N1 gasket enclosures require 17 in. (432 mm) high pull box's.
7. 500 kcmil when conduit entry. 750 kcmil when overhead cable tray. (Restriction based on cable bending radius due to currrent transformer.)

Options for Incoming Sections

- Lightning arresters (distribution, intermediate, station class)
- Single phase window type current transformers
- Tin-plating for ground bus
- Compression lugs

Load Break Switches

Controllers can be fed through an incoming fused or unfused load break switch. These switches are available in both 600 and 1200 ampere ratings. The switch can be located on either end of the lineup or in the middle as a tie switch for main-tie-main applications.

NOTE: Use HVL/cc for 40 kA applications and HVL for 61 kA.

HVL Load Interrupter Switch Ratings

Maximim Voltage (kV)	BIL Rating (kV)	Continuous Current (Amperes)	Momentary Current Asymetrical (kA)	Current Symetrical (kA)	Fault Current Closing Asymetrical (kA)	Switch Width (In./mm)
5.5	60	600	40	25	40	38.00/965
5.5	60	1200	61	38	61	38.00/965
7.2	60	600	40	25	40	38.00/965
7.2	60	1200	61	38	61	38.00/965

HVL/cc Load Interrupter Switchgear

Maximum Voltage (kV)	BIL Rating (kV)	Continuous Current (Amperes)	Momentary Current Asymetrical (kA)	Current Symetrical (kA)	Fault Current Closing Asymetrical (kA)	Switch Width (In./mm)
5.5	60	600	40	25	40	14.75/375 20.00/508 29.50/749
5.5	60	1200	40	38	40	29.50/749
7.2	60	600	40	25	40	14.75/375 20.00/508 29.50/749
7.2	60	1200	40	38	40	29.50/749

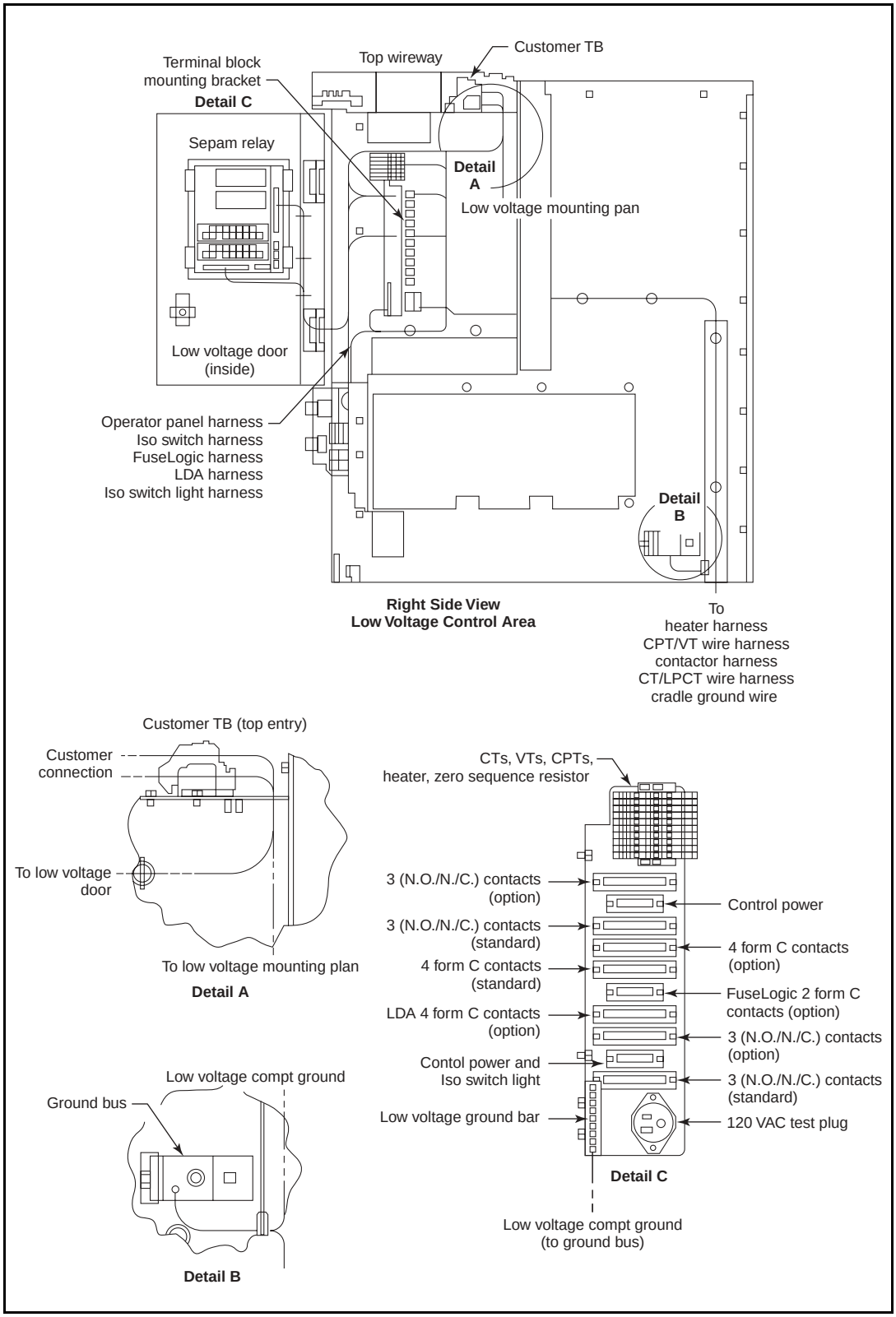
Low Voltage Control Area

Motorpact Controllers are provided with a Low Voltage (LV) control area. The hinged cover is suitable for mounting motor protective relays and meters. Other HMI controls may also be mounted on the cover.

The LV area contains a compartment for the internal wiring controls and the customer controls. The control components are mounted on a LV pan suitable for mounting multiple devices. The LV pan includes the customer terminal block for LV field wiring, when the controller is configured for bottom entry/exit. The pan is painted white for high visibility.

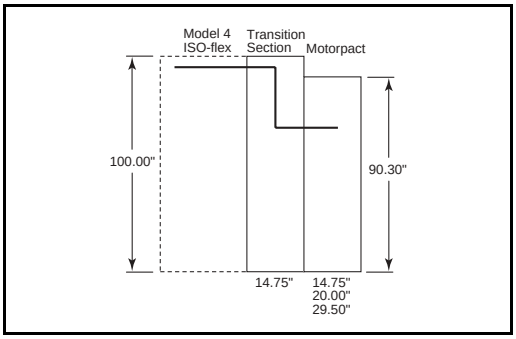
A wireway is also provided as part of the LV area. The wireway is located on top of the controller section and has 3 passages that are barriered from one another. The passage's are intended to separate control power, communications, and interconnect (unit-unit) control wiring. The top wireway includes the customer terminal block for LV field wiring, when the controller is configured for top entry/exit.

Customer terminal blocks for LV field wiring are 2-level screw connection style, rated 32 A and 500 V. Internal connections are made by spring cage clamp style terminals, rated 10 A and 300 V. Optional screw type terminals are available where applicable.

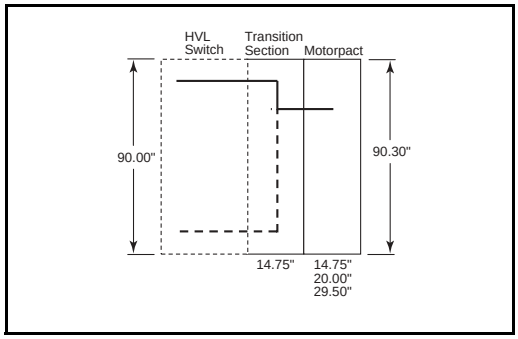


Low Voltage Control Compartment

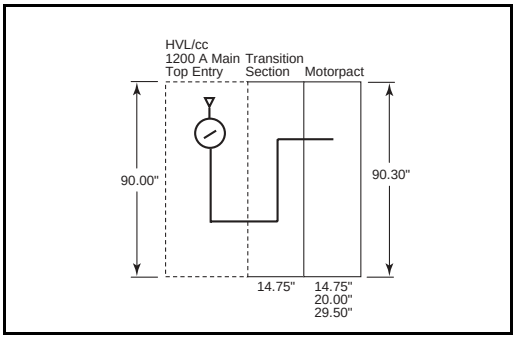
Typical Transition Section Arrangements



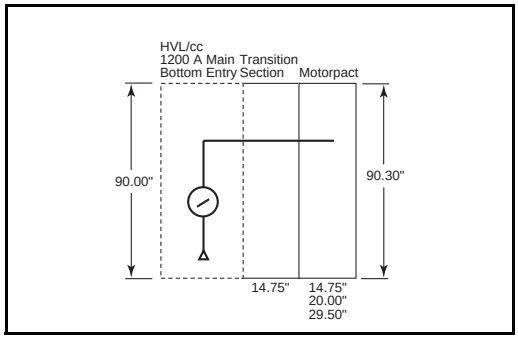
Elevation View — Model 4 ISO-flex



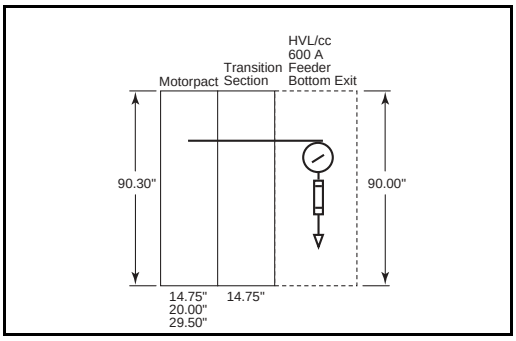
Elevation View — HVL Switch



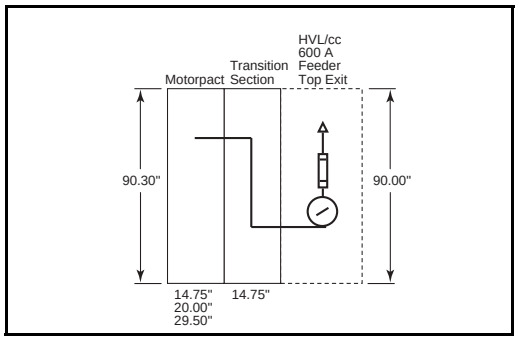
Elevation View — HVL/cc Main — App A



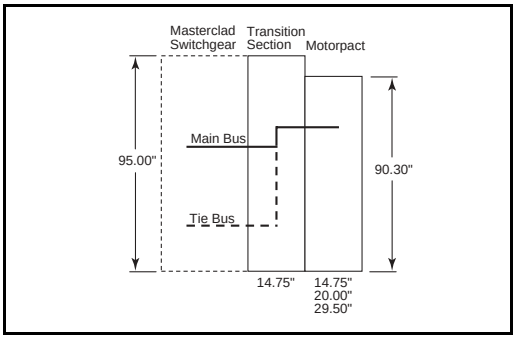
Elevation View — HVL/cc Main — App B



Elevation View — HVL/cc Feeder — App A



Elevation View — HVL/cc Feeder — App B

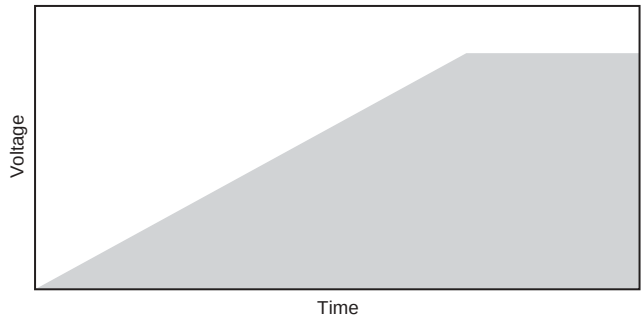


Elevation View — Masterclad

Motorpact Reduced Voltage Soft Start Motor Control

Motorpact Reduced Voltage Soft Start (RVSS) Motor Control units provide a pre-engineered, integrated motor control package for reduced voltage starting and soft stopping of three-phase medium voltage induction motors. Offered as an alternate to traditional reactor or autotransformer type reduced voltage starters, the Motorpact RVSS allows the user to fine tune the starting parameters to meet a wide variety of unique load conditions. The on-board user-friendly microprocessor provides the ability to select the proper combination of initial current, maximum current and ramp time resulting in smooth step-less load acceleration while minimizing mechanical shock to system components.

The Motorpact RVSS is a microprocessor-based controller that provides the benefits of reduced current inrush (and resulting voltage drop) and reduced mechanical shocks that can result from starting a motor across the line.The SCR Power Modules (one for each phase) are used to provide smooth acceleration and deceleration control of a three-phase AC induction motor. Control algorithms are incorporated controlling motor voltage, current, and torque output to ensure smooth rotation throughout the starting ramp without mechanical instability at the end of starting. The Motorpact RVSS uses voltage ramp with current limit to control motor torque performance. The torque control provides accurate and repeatable acceleration and deceleration. This feature allows for linear speed ramp without tachometer feedback and reduces the temperature rise of the motor.



Benefits of Motorpact RVSS

Reduced torque during start, which:

- Aids in startup against damage to material in process
- Can increase the life of machines and reduce down time

Reduced current peaks on the supply during starting, which:

- Reduces plant capacity requirements
- Reduces voltage sag on installations with limited capacity
- Eliminates side effects on other equipment driven from a weak supply

Smooth acceleration and deceleration independent of fluctuations in motor load:

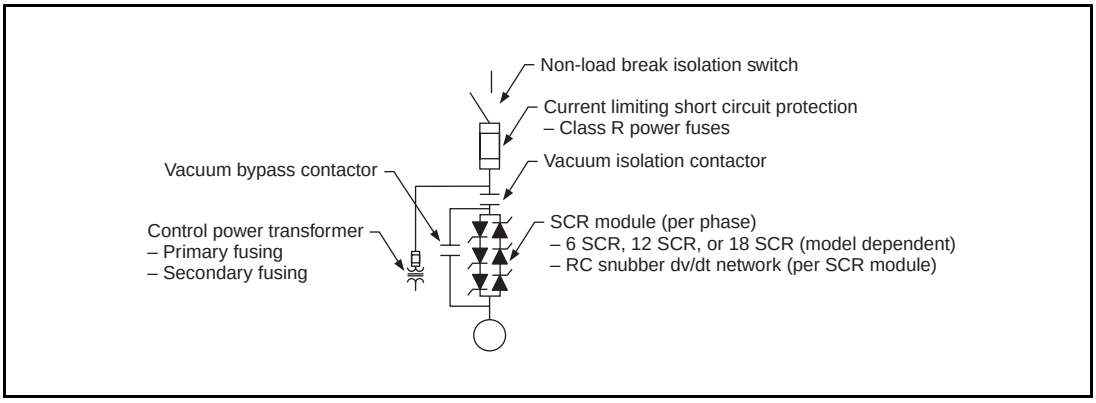
- Ideally suited for most fans, centrifugal pumps or other variable torque loads
- Can eliminate water hammer even on difficult pumping applications

Advanced protection for the motor and the installation, including:

ANSI/IEEE

Number System	Protection Features
19	Reduced voltage soft start
27	Under voltage
37	Under current
46	Current imbalance
47	Phase rotation
48	Locked rotor/incomplete sequence
49	I2t electronic motor overload
50	Instantaneous electronic over current trip
51	Over current
55	Power factor trip
59	Over voltage protection
66	Starts per hour and time between starts
81	Frequency variance
86	Lockout/start inhibit
50N/51G/N	Ground fault detection, instantaneous and current (option)
49/38	Stator and bearing RTD protection (option)
14	Speed switch and tachometer trip (option)

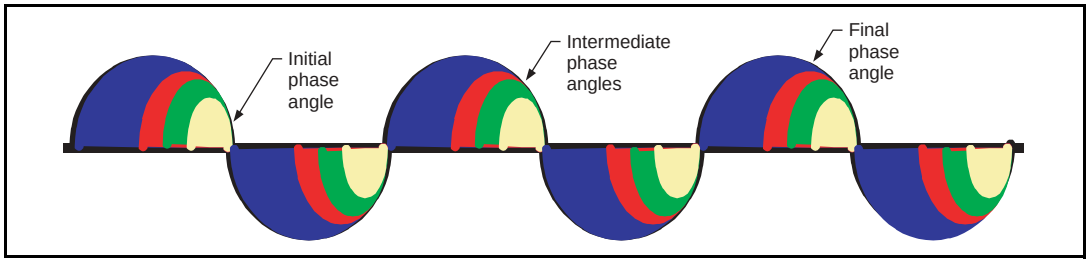
Motorpact Reduced Voltage Soft Start (RVSS) units are available from 2300 through 7200 volts with horsepower ranges to 5000 HP. The RVSS is available as a stand-alone starter or can be incorporated in a lineup with other Motorpact units. The NEMA 1 or NEMA 1 gasketed units are totally enclosed, dead front construction offering a high level of protection.



Basic Features

Control

A Central Processing Unit (CPU) provides the protection and control system for the motor and starter assembly. The CPU controls the phase angle switching of the SCR modules to apply a reduced voltage to the motor, and ramping the voltage and current until the motor accelerates to full speed. Therefore; lowering the inrush current of the motor, reducing the stress on both the electrical and mechanical systems.



The CPU allows the starting method to be adjusted to meet the application, which the unit is controlling. Four types of starting are available:

- Voltage Ramp with Current Limit – Voltage is ramped via the SCR modules over time until the motor reaches full speed/voltage.
- Current Ramp – Provides linear torque increase with closed current feedback PID loop to a maximum current level.
- Constant Current – Current is applied at current limit and held there until the motor is at full speed.
- Tachometer Input – 4-20 mA monitoring signal from the motor is supplied.

Protection

The CPU incorporates a Dynamic Thermal Register system, which simulates the motor thermal state by mathematical representation. The motor and controller temperature is continuously calculated based on the controller nominal current and the current that is actually drawn. Additionally, the cooling curve of the motor is simulated through an electronic circuit that stores the thermal state of the motor even if the supply power is disconnected.

Keypad Interface

Schneider Electric's Motorpact RVSS offers keypad display/programming and serial communications. A 2 line x 20 character LCD display with backlight provides easy readout of multiple motor data points.

Bypass Contactor

A bypass contactor is supplied on all units. This allows the motor current to bypass the SCR modules once the RVSS has ramped to full voltage/speed. The use of the bypass contactor reduces the temperature rise within the enclosure during steady state operation.

Technical Characteristics

Voltage	2300–7200 V
Frequency	50 or 60 Hz
BIL rating	60 kV
Horsepower range	2300 V to 1500 hp
	3300 V to 2250 hp
	4160 V to 2750 hp
	6900 V to 5000 hp
Unit overload capacity	125% - Continuous
	500% - 60 Seconds
	600% - 30 Seconds
Power circuit	6 SCRs, 12 SCRs or 18 SCRs (model dependent)
SCR peak inverse voltage ratings	6500–12000 V (model dependent)
Transient voltage protection	RC snubber dv/dt network (one per module)
Ambient	0° to 40° C
	5–95% relative humidity
	0–3300 ft.
Approvals	UL recognized

Motor Protection Functions

Over current	Trip Level: 100 to 300% of motor FLA
	Trip Delay: 1 to 20 seconds
Under current	Trip Level: 10 to 90% of motor FLA
	Trip Delay: 1 to 60 seconds
Current imbalance	Trip Level: 5 to 30% of phase current
	Trip Delay: 1 to 20 seconds
Two stage overload	Starting: Programmable class 5 through 30
	Run: Programmable class 5 through 30
Reset	Manual
	Automatic
Start-per-hour	Range: 1 through 6 starts per hour
	Time between starts: 1 to 60 minutes

Metering Functions

Motor load	Percent of FLA
Current data	Phase current
	Average current
	Ground fault current
Thermal data	Thermal capacity remaining
	Thermal capacity to start
Start data	Average start time
	Average start current
	Capacity to start
	Elapsed time from last start
RTD data	Up to 12 RTDs
Metering	Kilowatts
	Kilovars
	Power factor
	Kilowatt hours

Serial Communication

Protocol	Modbus RTU
Signal	RS-485
	RS-422
	RS-232

HMI

LCD display	2 x 20 character (backlight)
Keypad	8 function keys with tactile feedback
Status indication	12 LEDs
	Power
	Run
	Alarm
	Trip
	Auxiliary relay indication
Fault display	Shorted SCR
	Phase loss
	Shunt trip
	Phase imbalance
	Overload
	Over temperature
	Overcurrent
	Short circuit
	Load loss
	Undervoltage
Lockout display	Coast down time
	Starts per hour
	Time between starts

Programmable Outputs

Rating	DPDT, 4 A, 240 VAC
Run	Programmable
At speed	Programmable
Acceleration	Voltage ramp (VR) or current ramp (CR)
	Starting torque: 0–100% line voltage (VR) or 0–600% FLA (CR)
	Ramp time: 1–120 seconds
	Current limit: 200–600% (VR or CR)
Deceleration	Begin decel level: 0–100% line voltage
	Stop level: 0–1% less than begin decel level
	Decel time: 1–60 seconds

POWERLOGIC® SEPAM SERIES 20/40/80 PROTECTION UNITS

Whether you are looking for a simple protection relay or a multifunctional, communicating protection unit for remote network management and operation, you will find the right solution in the new POWERLOGIC® Sepam Series 20/40/80 protection devices.

Features and Benefits

Complete line of protective relays	Motor, feeder, generator, transformer and bus protection, all in a common relay family.
Preventative maintenance alerts	Self-diagnostics for protection assurance, and external diagnostics for breaker, CT/VT and trip coils.
Customizable protective settings	Adaptive logic editor in Series 40 and 80 utilizes Boolean logic, allowing users to adapt standard control functions to suit varying needs of a power system.
Intuitive, graphic display	Graphic LCD display features back-light with auto contrast adjustment, and allows user access to operational and diagnostic information, power measurements and alarms, as well as password-protected setup.
Zone selective interlocking	Accelerated coordination between protection devices to minimize equipment damage.
Power monitoring functionality	Series 40 and 80 relays include power monitoring functionality to assist in managing the electrical system.
Global offer	Sepam relays are available and strongly supported by Schneider Electric around the world.

Product Applications

The Sepam family of protection and metering units is designed for the operation of machines and electrical distribution networks. It consists of complete, simple, and reliable solutions, suited to the following applications:

Motor: M Type	For the protection against internal faults, system faults, and load faults
	Monitoring of motor starting conditions
	For the protection of long motor feeders with high capacitance
Substation: S Type	For the protection against phase-to-phase and phase-to-ground short circuits
	Detection of unbalanced power source
	Recloser
	For the protection of systems with parallel mains or closed feeder loops
Generator: G Type	For the protection against internal faults, system faults and abnormal operating conditions
	Monitoring of generator and prime mover
Transformer: T Type	For the protection against internal faults and overloads
	Thermal overload protection suited to cooling modes
	For the protection of systems with transformer mains in parallel
Busbar: B Type	Detection of variations in power system voltage or frequency
	Detection of mains loss with dF/dt (Rate of change of frequency)
	Sepam design integrates the results of an in-depth dependability study for maximum reliability
	Optimized to provide the best possible protection while maintaining secure operation
	Comprehensive self-testing sequence monitors internal health with contact position switching and watchdog relay indication
	Exceptional withstand to environmental electromagnetic disturbances

Advanced UM1 with fixed local graphic LCD display and keypad

MODULAR PLATFORM-S20/40

Sepam may be functionally enhanced at any time by the addition of optional modules to adapt to as many situations as possible and allow for subsequent upgrading of the installation.

- Base unit, with various User/Machine Interface Levels (UMI):
  - — Basic UMI
  - — Advanced UMI with fixed or remote graphic LCD display
- Inputs/outputs extension module (Base 4 out + max 4 out/10 in)
- Connection module for Modbus® communication network
- Temperature acquisition module for transformers or motors
- Analog output module
- Software tools
  - — Sepam parameters and protection settings, control logic customization
  - — Fault recording display

Basic UM1

MODULAR PLATFORM-S80

Sepam may be functionally enhanced at any time by the addition of optional modules to adapt to as many situations as possible and allow for subsequent upgrading of the installation.

- Base unit, with:
  - — No local front Interface with optional remote advanced User/Machine Interface (UMI) with graphic LCD display
  - — Integral advanced UMI with fixed graphic LCD display
- Inputs/outputs extension module (Base 5 out + max 18 out/42 in)
- 2 ports for connection via 2-wire, 4-wire, or fiber optic module for Modbus® communication network
- Temperature acquisition module for transformers or motors
- Analog output module
- Software tools
  - — Sepam parameters and protection settings, control logic customization
  - — Fault recording display

Advanced UM1 with remote graphic LCD display and keypad

Controller Features and Accessories

Protection	ANSI code	S20	S40	S41	S42	S82	T20	T40	T42	T87	M20	M41	M87	G40	G87	G88	B21	B22
Phase overcurrent	50/51	4	4	4	4	8	4	4	4	8	4	4	8	4	8	8		
Ground fault/sensitive ground fault	50N/51N (or G)	4	4	4	4	8	4	4	4	8	4	4	8	4	8	8		
Unbalance/negative sequence	46	1	2	2	2	2	1	2	2	2	1	2	2	2	2	2		
Thermal overload	49 RMS						2	2	2	2	2	2	2	2	2	2		
Thermal overload for cables	49C RMS					2												
Breaker failure	50BF		1	1	1	1		1	1	1		1	1	1	1	1		
Directional real overpower	32P			1	1	2				2		1	2	1	2	2		
Directional ground fault	67N/67NC			2	2	2			2			2	2		2	2		
Directional phase overcurrent	67				2	2			2									
Voltage restrained overcurrent	50 V/51 V													1	2	2		
Directional reactive overpower	32Q/40											1	1	1	1	1		
Phase undercurrent	37										1	1	1					
Locked rotor, excessive start time	48/51/LR/14										1	1	1					
Starts per hour	66										1	1	1					
Restricted earth fault	64REF									2						2		
2-winding transformer differential	87T									1						1		
Machine differential	87M												1		1			
Overfluxing (V/Hz)	24									2					2	2		
Field loss (underimpedance)	40												1		1	1		
Pole slip	78PS												1		1	1		
Overspeed (2 set points) (2)	12												□		□	□		
Underspeed (2 set points) (2)	14												□		□	□		
Underimpedance	21B														1	1		
Inadvertent energization	50/27														1	1		
100% stator earth fault	64G2/27TN														2	2		
Positive sequence undervoltage	27D					2				2		2	2		2	2	2	2
Remanent undervoltage	27R					2				2		1	2		2	2	1	1
Undervoltage	27/27S		2	2	2	4		2	2	4		2	4	2	4	4		
Overvoltage	59		2	2	2	4		2	2	4		2	4	2	4	4		
Neutral voltage displacement	59N		2	2	2	2		2	2	2		2	2	2	2	2	2	2
Negative sequence overvoltage	47		1	1	1	2		1	1	2		1	2	1	2	2		
Overfrequency	81H		2	2	2	2		2	2	2		2	2	2	2	2	1	1
Underfrequency	81L		4	4	4	4		4	4	4		4	4	4	4	4	2	2
Recloser (4 cycles)	79	□	□	□	□	□												
Temperature monitoring (8 or 16 RTDs)	38/49T						□	□	□	□	□	□	□	□	□	□		
Thermostat / Buchholz	26/63						□	□	□	□						□		
Phase-to-phase undervoltage	27																2	2
Phase-to-neutral undervoltage	27S																1	1
Phase-to-neutral overvoltage	59																2	2
Rate of change of frequency	81R																	1

The figures indicate the number of relays available for each protection function

■ Standard

□ According to settings and optional modules

(1) Protection functions with 2 groups of settings.

(2) According to parameter setting and optional MES120 intput/output modules.

(3) With optional MET148-2 temperature input modules.

(4) With ACE949-2 (2-wire RS 485), ACE959 (4-wire RS 485) or ACE937 (fiber optic) communication interface.

Metering/Monitoring		S20	S40	S41	S42	S82	T20	T40	T42	T87	M20	M41	M87	G40	G87	G88	B21	B22
RMS phase and residual currents		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Calculated residual current						■							■		■	■		
Average current I1, I2, I3		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Peak demand current per phase		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Measured residual current						■							■		■	■		
Voltage U21, U32, U13, V1, V2, V3			■	■	■	■		■	■	■		■	■	■	■	■	■	■
Residual voltage Vo			■	■	■	■		■	■	■		■	■	■	■	■	■	■
Positive sequence voltage Vd/rotation direction			■	■	■	■		■	■	■		■	■	■	■	■	■	■
Negative sequence voltage Vi/rotation direction			■	■	■	■		■	■	■		■	■	■	■	■		
Frequency			■	■	■	■		■	■	■		■	■	■	■	■	■	■
Real/reactive/apparent power P, Q, S			■	■	■	■		■	■	■		■	■	■	■	■		
Peak demand real/reactive power PM, QM			■	■	■	■		■	■	■		■	■	■	■	■		
Power factor			■	■	■	■		■	■	■		■	■	■	■	■		
Calculated real/reactive energy (± Wh, ± VARh)			■	■	■	■		■	■	■		■	■	■	■	■		
Real/reactive energy pulse count (± Wh, ± VARh)			□	□	□	□		□	□	□		□	□	□	□	□		
Phase current I'1, I'2, I'3 RMS										■			■		■	■		
Calculated residual current I'0S										■			■		■	■		
Temperature measurement							□	□	□	□	□	□	□	□	□	□		
Rotation speed (2)													□		□	□		
Neutral point voltage Vnt															■	■		

Network and Machine Diagnosis		S20	S40	S41	S42	S82	T20	T40	T42	T87	M20	M41	M87	G40	G87	G88	B21	B22
Tripping current TripI1, TripI2, TripI3, TripIo		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Tripping context			■	■	■	■		■	■	■		■	■	■	■	■		
Phase fault and earth fault trip counters										■			■		■	■		
Unbalance ratio/negative sequence current		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Harmonic distortion (THD), current and voltage Ithd, Uthd										■			■		■	■		
Phase shift Ø0, Ø1, Ø2, Ø3			■	■	■	■		■	■	■		■	■	■	■	■		
Disturbance recording		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Thermal capacity used						■	■	■	■	■	■	■	■	■	■	■		
Remaining operate time before overload tripping						■	■	■	■	■	■	■	■	■	■	■		
Waiting time after overload tripping						■	■	■	■	■	■	■	■	■	■	■		
Running hours counter/operating time							■	■	■	■	■	■	■	■	■	■		
Starting current and time											■	■	■					
Start inhibit delay, number starts before inhibit											■	■	■					
Unbalance ration/negative sequence current I'i										■			■		■	■		
Differential current Idiff1, Idiff2, Idiff3										■			■		■	■		
Through current It1, It2, It3										■			■		■	■		
Current phase displacement										■			■		■	■		
Apparent positive sequence impedance Zd						■				■			■		■	■		
Apparent phase-to-phase impedance Z21, Z32, Z13						■				■			■		■	■		
Third harmonic voltage, neutral point or residual															■	■		

The figures indicate the number of relays available for each protection function

■ Standard

□ According to settings and optional modules

(1) Protection functions with 2 groups of settings.

(2) According to parameter setting and optional MES120 intput/output modules.

(3) With optional MET148-2 temperature input modules.

(4) With ACE949-2 (2-wire RS 485), ACE959 (4-wire RS 485) or ACE937 (fiber optic) communication interface.

Controller Features and Accessories

Switchgear Diagnosis	ANSI code	S20	S40	S41	S42	S82	T20	T40	T42	T87	M20	M41	M87	G40	G87	G88	B21	B22
Cumulative breaking current		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Trip circuit supervision		□	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
Auxiliary power supply monitoring						■				■			■		■	■		
Number operations, operate time, charge time		□	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
Number of racking out operations (2)						□				□			□		□	□		
CT/VT supervision			■	■	■	■		■	■	■		■	■	■	■	■		

Control and Monitoring	ANSI code	S20	S40	S41	S42	S82	T20	T40	T42	T87	M20	M41	M87	G40	G87	G88	B21	B22
Circuit breaker/contactor control	94/69	□	■	■	■	■	□	■	■	■	□	■	■	■	■	■	□	□
Load shed/auto restart/de-excite/Grp shutdown													■		■	■		
Latching/acknowledgment	86		■	■	■	■		■	■	■		■	■	■	■	■		
Logic discrimination	68	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□		
Switching of group of settings			■	■	■	■		■	■	■		■	■	■	■	■		
Logical equation editor			■	■	■	■		■	■	■		■	■	■	■	■		

Modbus Communication	ANSI code	S20	S40	S41	S42	S82	T20	T40	T42	T87	M20	M41	M87	G40	G87	G88	B21	B22
Measurement readout			□	□	□	□		□	□	□		□	□	□	□	□		
Remote indication and time tagging of event			□	□	□	□		□	□	□		□	□	□	□	□		
Remote control orders			□	□	□	□		□	□	□		□	□	□	□	□		
Remote setting of protections			□	□	□	□		□	□	□		□	□	□	□	□		
Transfer of disturbance recording data			□	□	□	□		□	□	□		□	□	□	□	□		

Self-diagnosis		S20	S40	S41	S42	S82	T20	T40	T42	T87	M20	M41	M87	G40	G87	G88	B21	B22
Watchdog		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Output relay test		□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□

The figures indicate the number of relays available for each protection function

■ Standard

□ According to settings and optional modules

(1) Protection functions with 2 groups of settings.

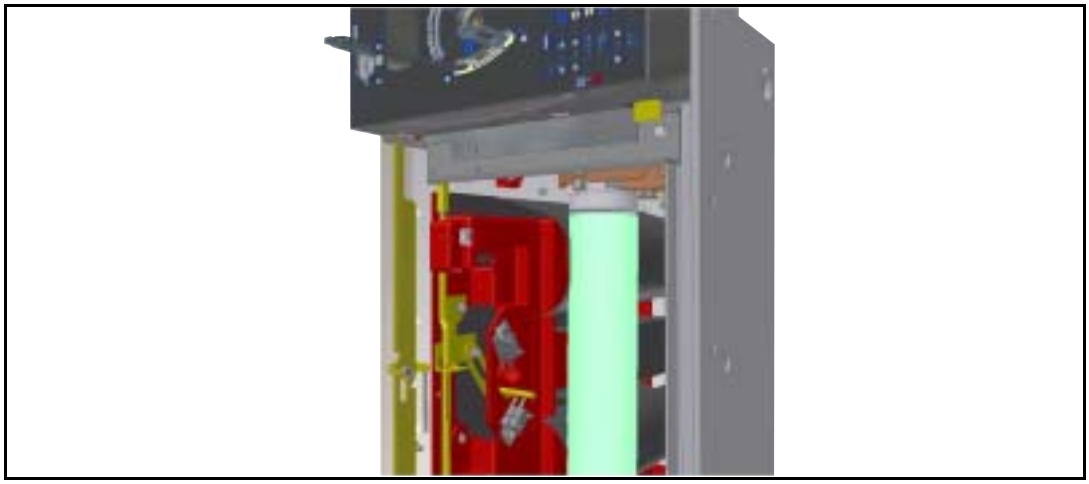
(2) According to parameter setting and optional MES120 intput/output modules.

(3) With optional MET148-2 temperature input modules.

(4) With ACE949-2 (2-wire RS 485), ACE959 (4-wire RS 485) or ACE937 (fiber optic) communication interface.

Load Discharge Assembly

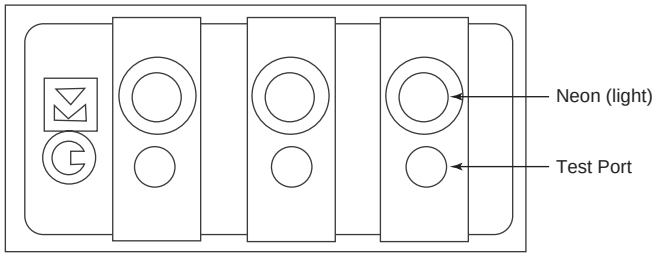
An optional Load Discharge Assembly (LDA) is available with Motorpact controllers. The LDA is used to ground the load cables. It is mechanically interlocked with the isolation switch (disconnector) and is operated using the same handle. The LDA is a spring operated quick make device capable of making 5 kA sym. current at 7.2 kV up to five times. The LDA is not a system grounding switch. It is not capable of closing in on the full fault current that could be available on a system. The LDA is mounted in the load box at the motor lead terminals. The LDA is a maintenance free device.



Load Discharge Assembly

Live Line Indicators

Live Line Indicator (LLI) lights are connected by a capacitive circuit to the the line or load side of main bus bars. LLI lights will indicate voltage when the equpment is energized. Test ports on the LLIs are suitable for testing voltage with a properly rated voltage sensing device. LLIs are not a replacement for voltage indication when working on or inside the equipment. Use properly rated test equipment to ensure no voltage is present before performing any maintenance procedures.



Note: As soon as the circuits have been energized the voltage indicator lamps should illuminate.

Live Line Indicator

Power Factor Correction Capacitors

A majority of the total load connected to industrial power systems is inductive and has a low operating power factor. This type of load results in poor electrical efficiency, higher electrical costs, and extra burden on the power system. Properly selected and installed Power Factor Correction Capacitors (PFCCs) provide an economical means of improving system power factor. The table below provides an estimated PFCC size in kVAR for a motor based on horsepower and speed. Capacitors must be carefully sized when switched with a motor since overvoltages and transients may occur if the capacitor kVAR exceeds the motor magnetizing current.

NOTE: The motor manufacturer determines maximum kVAR value for the motor. Appropriate kVAR size is dependent on system parameters.

Square D can only supply estimated kVAR size based on the motor horsepower unless a system study is performed.

Estimated PFCC Selection (based on horsepower and motor speed)

	Nominal Motor Speed (RPM)											
	3600		1800		1200		900		720		600	
HP	kVAR	% AR	kVAR	% AR	kVAR	% AR	kVAR	% AR	kVAR	% AR	kVAR	% AR
100	25	7	25	10	25	10	25	11	25	12	25	17
150	25	7	25	9	25	9	25	10	50	11	50	15
200	25	7	25	8	50	8	50	9	50	11	50	15
250	50	7	50	6	50	8	50	9	75	10	75	14
300	50	7	50	5	75	5	75	9	75	10	100	14
350	50	6	50	5	75	5	75	9	75	9	100	12
400	50	5	50	5	75	5	100	9	100	9	100	11
450	75	5	50	5	75	5	100	8	100	9	100	10
500	75	5	75	5	100	5	125	8	125	8	125	8
600	75	5	100	5	100	5	125	7	125	8	125	8
700	100	5	100	5	100	5	125	7	150	8	150	8
800	100	5	125	5	125	5	150	7	150	8	150	8
900	125	5	200	5	200	5	200	6	250	7	250	7
1000	150	5	250	5	250	5	250	6	250	7	250	7
1250	200	5	250	5	250	5	300	6	300	6	300	6

The percentage AR value shown in the table above is the percent ampere reduction required for the overload setting when PFCCs are connected after the overload protective device such as at the motor. PFCCs in Motorpact controllers are connected ahead of the overload so this reduction is not required.

NOTE: PFCCs should always be connected to the line side of autotransformers and soft starts.

Surge Protection

Lightning or switching may cause surge voltages on a system that may result in damage to a motor. The surge can be limited by using two methods either individually or together.

A Surge Arrester (SA) is a protective device that limits surge voltages by diverting the surge current. SAs are only operational when a predetermined voltage level is reached. At that time, the device activates and diverts the current to ground through a resistance, therefore, clamping the voltage at a predetermined level. Two classes of surge arrester are available in Motorpact line-ups:

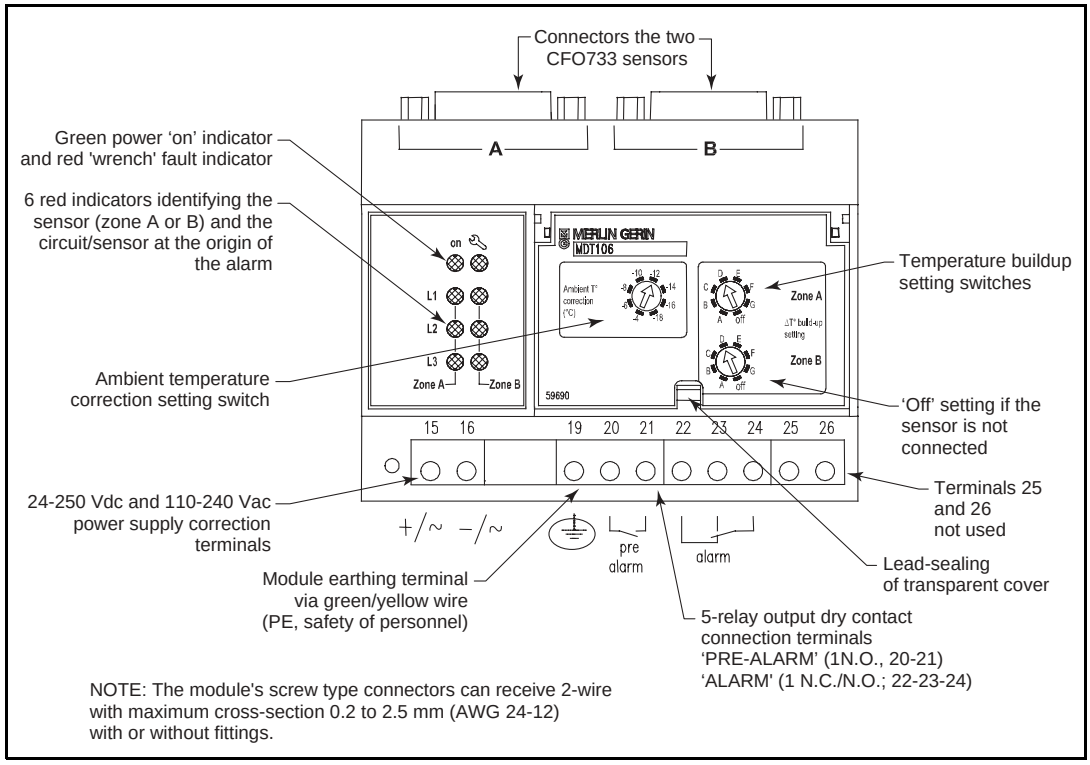
Distribution, intermediate and station class designs are available.

Incoming sections and controllers have mounting provisions for line and load side locations.

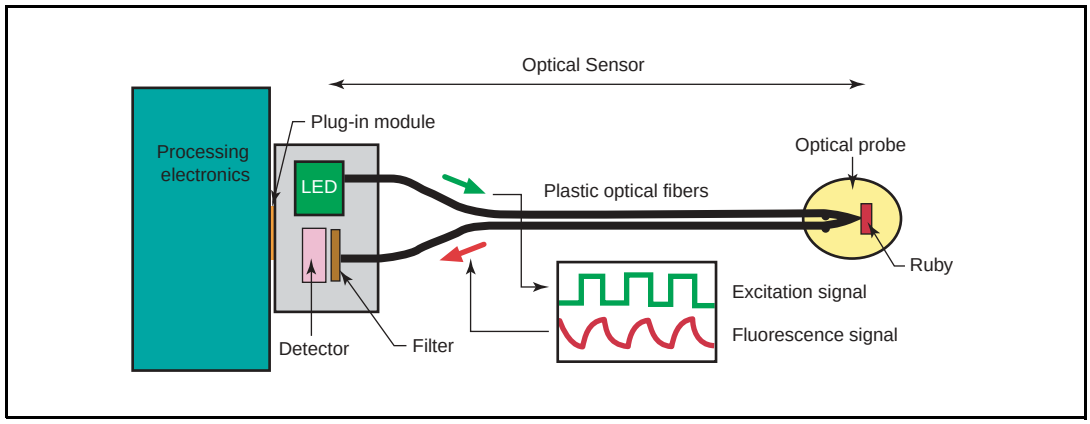
DT1 Temperature Monitoring Module

The DT1 module continuously monitors power circuit temperature build-up, measuring it in relation to the ambient temperature. When overheating occurs, indicating the presence of an abnormal resistance in the power circuit, the module triggers an alarm.

The DT1 module monitors conductor temperature in two 3-point zones. Each zone provides sensor inputs to the low voltage module. These inputs are optically isolated. Sensors are located at the top fuse holders and optionally may be located at the load terminals. These are factory determined positions. Two alarm levels are available on the module.



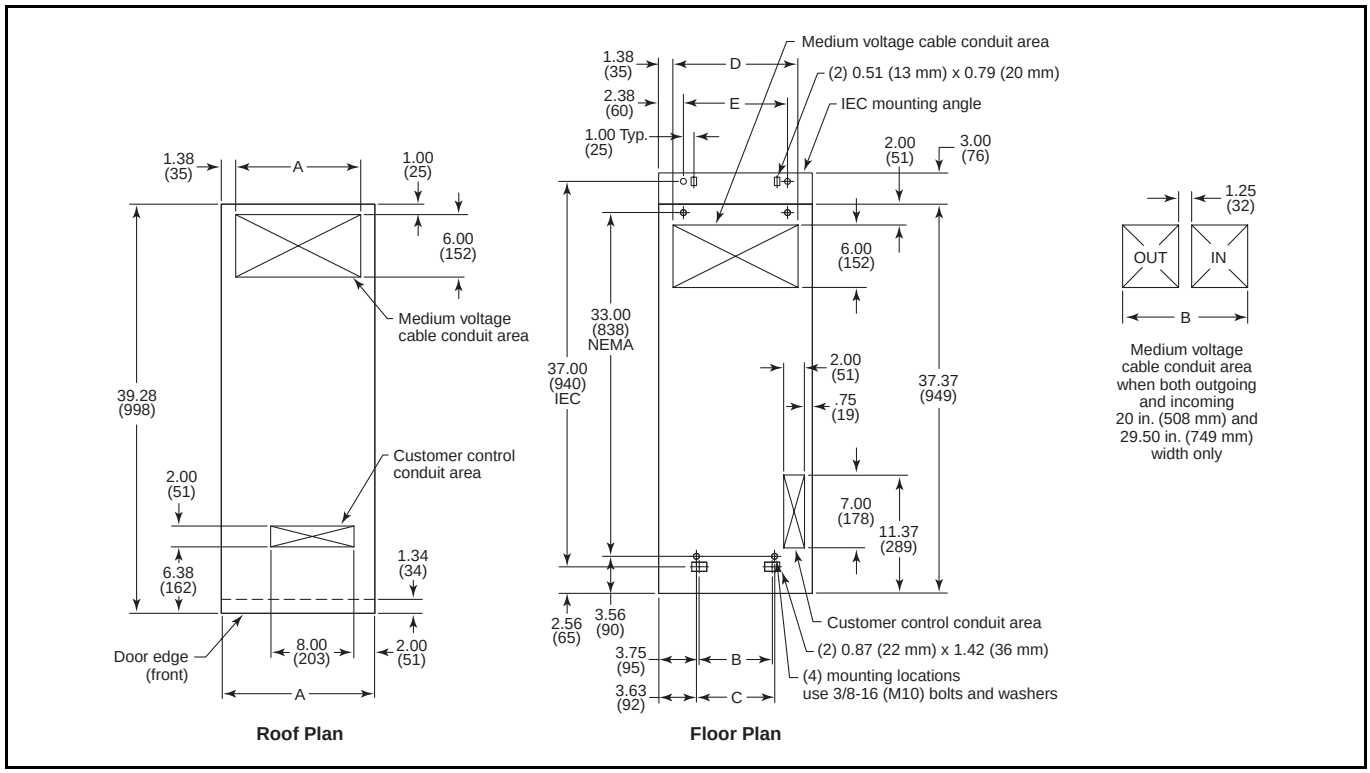
DT1 Temparture Monitoring Module



DT1 Module Operation

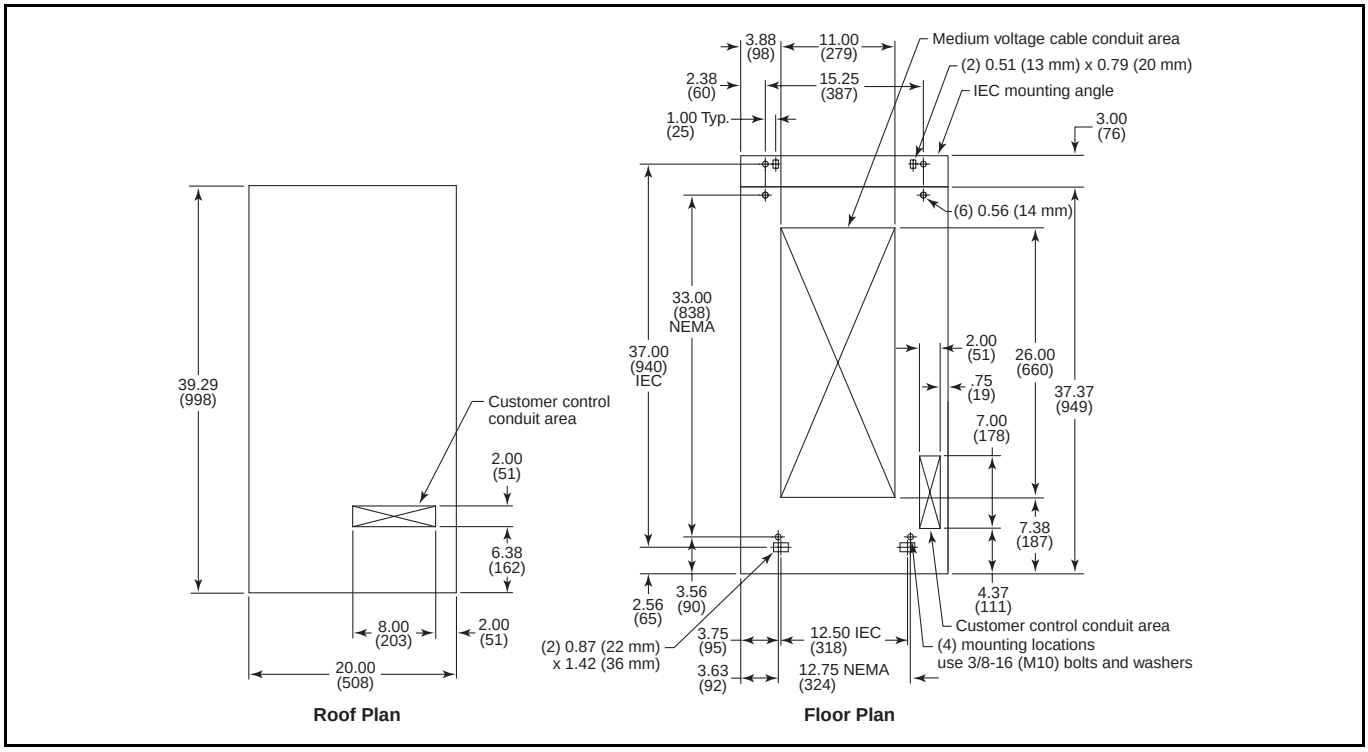
TOP AND FLOOR PLAN DRAWINGS

All dimensions in this section are given in inches (millimeters).

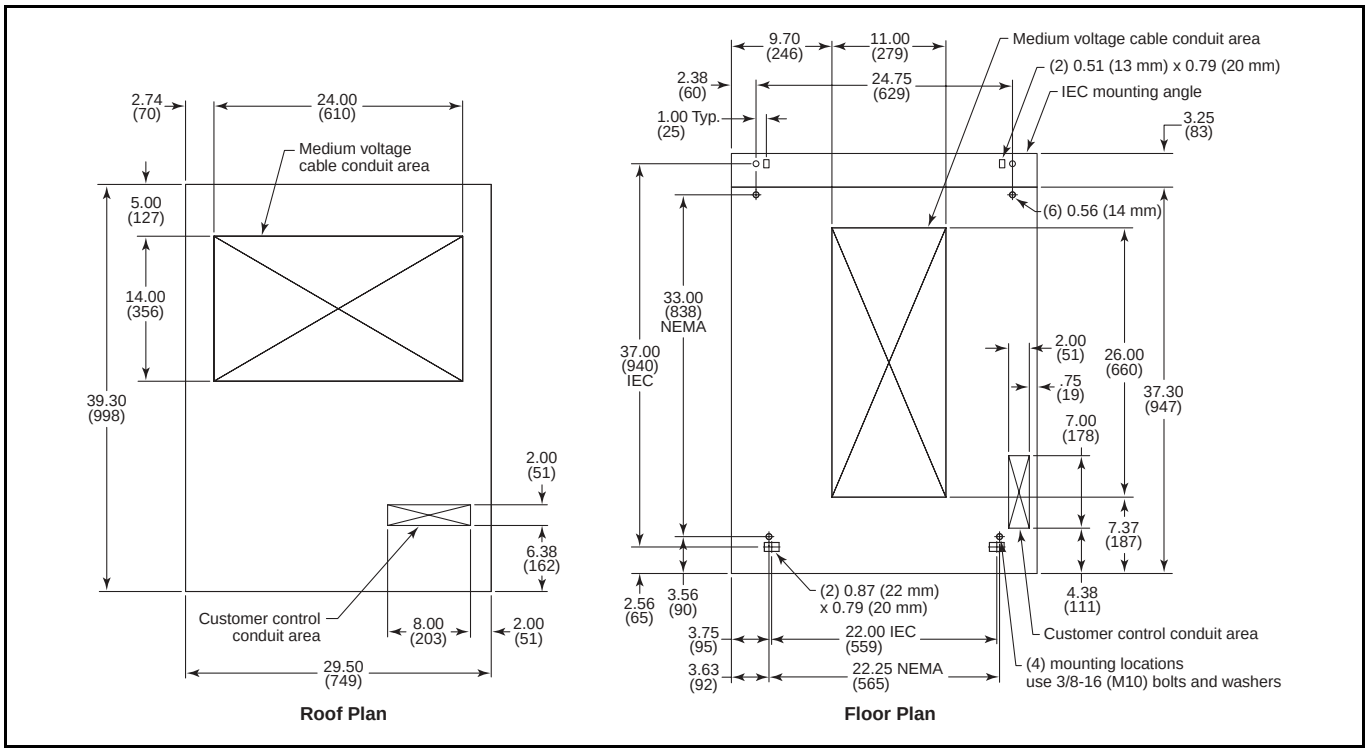


Full Voltage Non-Reversing Controller, 14.75 in. (375 mm) Wide

A Cabinet Width (In./mm)	B IEC (In./mm)	C NEMA (In./mm)	D (In./mm)	E (In./mm)
14.75/375	7.25/184	7.50/191	12.00/305	10.00/254
20.00/500	12.50/318	12.75/324	17.25/438	15.25/387
29.50/749	22.00/559	22.25/565	26.75/679	24.75/629



Incoming Section, 20.00 In. (508 mm) Wide



Incoming Section, 29.50 In. (749 mm) Wide

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