Introduction

The Basler Electric SMC-250 Synchronous Motor Controller precisely and reliably controls the level of excitation power supplied to the field of a brushless synchronous motor. Field excitation power is delivered and controlled by a DECS-250 Digital Excitation Control System. A dual DECS-250 option provides continued operation in the event of a failure. Motor protection is provided by an ES-55 Power Factor Relay or an optional BE1-11m Motor Protection System. Coordinated programming of the DECS-250 and ES-55 or BE1-11m yields efficient control of the machine and minimizes machine downtime.

The DECS-250, ES-55 or BE1-11m, control relays, and connection terminals are mounted and wired on a single mounting plate or pan chassis intended for installation in a suitable enclosure.

This publication serves as an overview of the functions and capabilities available in the SMC-250. System drawings and product documentation specific to the devices of the SMC-250 accompany this publication.

Safety

Warning!

Personal injury may result if contact is made with system components carrying high voltages. The circuit diagrams, supplied with this document, will disclose hazardous areas.

As with all electrical equipment, appropriate safety measures must be taken whenever dealing with the excitation equipment. High voltages are present at the equipment. The voltage magnitudes depend upon the characteristics of a particular system. Opening the power source connections does not completely remove the threat of high voltages. As long as the machine is physically connected to the system, the possibility of a safety hazard exists.

When working with the excitation control switchgear, every precaution must be taken to ensure that all high voltages are isolated and avoided. In addition to voltage at the PPT, there may be other power sources connected to the equipment. These sources may include the user-supplied dc control power and the ac station power. Consider all connections to be live and dangerous until proven otherwise.

Specifications

Operating Power Input (1- or 3-Phase)

Full-load continuous field voltage:
- 32 Vdc: ..... 56 to 70 Vac
- 63 Vdc: ..... 100 to 139 Vac or 125 Vdc
- 125 Vdc: ..... 190 to 277 Vac or 250 Vdc

Frequency Range: ..... 50 to 420 Hz

Control Power Input

120 Vac nominal, style xxxxx1xxxx:
- Voltage: ..... 82 to 132 Vac
- Frequency:..... 50/60 Hz

24 Vdc nominal, style xxxxx2xxxx:
- Voltage: ..... 16 to 26 Vdc

Sensing Inputs

Voltage (1- or 3-phase)
- 50 Hz: ..... 100 Vac (90 to 110 Vac)
- 60 Hz: ..... 120 Vac (108 to 132 Vac)

Current (1- or 3-phase)
Nominal: ..... 1 or 5 Aac

Excitation Current for Shunt Selection

Style xxxxAxxx: ..... 1 to 4 Adc
Style xxxxBxxx: ..... 4 to 8 Adc
Style xxxxCxxx: ..... 8 to 20 Adc

Contact Outputs (DECS-250)

Make, break, and carry ratings (resistive):
24 Vdc: ..... 7.0 Adc
120 Vdc: ..... 7.0 Adc

Temperature

Operating: ..... 0 to 50°C (32 to 122°F)
Storage: ..... –20 to 60°C (–4 to 140°F)

FCC Requirements

This product complies with FCC 47 CFR Part 15.

Handling and Maintenance

Careful handling and routine maintenance will promote SMC-250 longevity and preserve its performance. Basler Electric publication 9410100990, supplied with this publication, provides guidelines for handling, installing, and maintaining the SMC-250.

Equipment Overview

SMC-250 features and options are defined and specified by a style number derived from the style chart shown in Figure 1.

Standard equipment elements include a DECS-250 Digital Excitation Control System, auxiliary relays, a metering shunt, dc power supply, circuit breakers, and user terminals. Overexcitation and under-excitation protection is provided by an ES-74S DC Millivolt Sensing Relay. Power factor and loss of synchronization is provided by a BE1-11m Motor Protection System or an ES-55 Power Factor Relay.

Mounting Configurations

The variables that affect the size and weight of the SMC-250 are:

- Single or dual DECS-250 controller option,
- ES-55 protection or BE1-11m protection, and
- Mounting plate or pan chassis mounting configuration.

SMC-250 dimensions and weights for each configuration are listed in Table 1.

The SMC-250 mounting plate is constructed from 1.5 millimeter, galvanized steel. The pan chassis is constructed from 11-gauge steel and finished with a light-gray, thermoset polymer coating.

Terminal Configurations

One of two SMC-250 terminal configurations may be specified. User connections to the SMC-250 are made with spring terminals (style xxxxxxxS) or compression (screw) terminals (style xxxxxxxC). Both terminal types accommodate wire sizes over the range of 24 to 12 AWG or 0.2 mm^2 to 2.5 mm^2. When wiring to spring terminals or compression terminals a wire insulation stripping length of 8 to 10 millimeters (0.315 to 0.394 inches) is recommended.

When tightening the connection screws of compression terminals, apply a torque no greater than 0.6 N•m or 5.3 in-lb.

Control and Indication

SMC-250 controls consist of user-supplied switches and contacts which connect to the plate/chassis terminals. Switch and contact inputs are commonly used for start and stop control of the SMC-250, setpoint adjustment, and operating mode control.

System indications are provided through output contacts from the DECS-250, ES-55 or BE1-11*m*, and ES-74S. Output contact connections are made at the plate/chassis terminal blocks.

Optional Equipment

Optional equipment may include a second DECS-250, a BE1-11*m* Motor Protection System, DECS-250 expansion modules, a BE1-11*m* RTD module, and a touchscreen display panel.

Redundant DECS-250

A dual DECS-250 option, specified by style Dxxxxxxx, provides continued operation in the event of a failure. The DECS-250's autotracking capability enables the secondary DECS-250 to track the operating setpoint of the primary DECS-250. This makes for a "bumpless" transfer from the primary DECS-250 to the secondary DECS-250 in the event of a primary DECS-250 failure.

BE1-11*m* Motor Protection Relay

In addition to power factor protection, the BE1-11*m* provides startup coordination and enhances motor reliability. Additional information about the BE1-11*m* is provided in the *Protection Devices* section.

AEM-2020 Analog Expansion Module

DECS-250 inputs and outputs may be augmented with the following analog inputs and outputs of the AEM-2020:

- Eight analog inputs
- Eight RTD (resistance temperature detector) inputs
- Two thermocouple (temperature) inputs
- Four analog outputs

AEM-2020 input and output states are communicated to and from the DECS-250 via CANbus. Input thresholds can be configured and programmed using BESTCOMS*Plus*® and BESTlogic™*Plus*. Outputs are intended to drive external, analog meters and can be configured for indication of motor values and other parameters.

AEM-2020 details and specifications are provided in the DECS-250 instruction manual (Basler publication 9440300990).

CEM-2020 or CEM-125 Contact Expansion Module

The CEM-2020 or CEM-125 can be specified to provide the following additional combinations of DECS-250 contact inputs and outputs:

- Ten contact inputs
- Twenty-four contact outputs

The CEM-125 is rated for 125 Vdc applications, while the CEM-2020 is rated for 12 or 24 Vdc applications.

Contact expansion module input and output contact states are communicated to and from the DECS-250 via CANbus. Input and output functions are assigned using BESTlogic™*Plus*.

RTD Module

In an SMC-250 equipped with a BE1-11*m*, the BE1-11*m* RTD (resistance temperature detector) inputs, analog inputs, and analog outputs can be augmented with the available RTD module. The RTD module provides:

- Twelve RTD inputs,
- Four analog inputs, and
- Four analog outputs.

Each RTD input is configurable to protect against high or low motor temperatures. Programmable over and under thresholds for the analog inputs can be used to trigger a protection element within the BE1-11*m*. The analog outputs can be configured to provide real-time metering of individual motor parameters.

RTD module details and specifications are provided in the BE1-11m instruction manual (Basler publication 9424200996).

Interactive Display Panel

An optional IDP-801 or IDP-1201 display panel can be installed locally or remotely to:

- View analog and digital system parameters,
- Configure motor control, limiter, and protection settings, and
- Download system data recorded by the DECS-250.

The IDP-801 is equipped with a 7.5-inch (19-centimeter) display and the IDP-1201 is equipped with a 12.1-inch (31-centimeter) display. See publication 9437600991 for details about the IDP-801 and publication 9437200992 for details about the IDP-1201.

System Elements

Interconnected SMC-250 system elements work together to supply regulated excitation power to the field and protect the controlled equipment. All excitation system element connections are illustrated on the system interconnection diagrams.

Inputs and Outputs

SMC-250 inputs and outputs consist of power and sensing inputs, control inputs and outputs, the field output, and communication ports. For input and output connections, refer to the appropriate interconnection diagram provided with this publication.

Control Power

Control power is determined by the SMC-250 style number and can be 120 Vac (style xxx1xxxx) or 24 Vdc (style xxx2xxxx).

When 24 Vdc control power is specified, the SMC-250 station power input ranges are as follows:

- 85 to 264 Vac or 90 to 150 Vdc for the 120 Vac Station Power input
- 16 to 26 Vdc for the 24 Vdc Control Power input

When 120 Vac control power is specified, the SMC-250 station power input ranges are as follows:

- 90 to 150 Vdc for the 125 Vdc Control Power input
- 82 to 132 Vac for the 120 Vac Station Power input

Operating Power

SMC-250 operating power is typically supplied by an external power transformer sized for the application.

Sensing Inputs

SMC-250 sensing voltage and sensing current are supplied by external VTs and CTs configured to supply three-phase sensing to the DECS-250 and BE1-11m. The VTs and CTs must be sized appropriately for the application and compatibility with the SMC-250. The CTs may have a secondary rating of 1 Aac (style xxxxx1xx) or 5 Aac (style xxxxx5xx).

Field Output

To obtain optimum metering resolution of the field current, one of three field output ranges may be specified to suit the application requirements, an excitation current range of 1 to 4 Adc is specified by SMC-250 style xxxxAxxx, and excitation current range of 4 to 8 Adc is specified by style xxxxBxx, or an excitation current range of 8 to 20 Adc is specified by style xxxxCxxx.

Control Inputs

SMC-250 control inputs are typically received from remotely-located control switches and contact inputs from external devices. The SMC-250 has preprogrammed control inputs that can be configured at the discretion of the user. Refer to the appropriate interconnection diagram for control input functions and terminal assignments.

Control Outputs

SMC-250 control outputs consist of preprogrammed output contacts and output contacts available for configuration by the user. All control output connections are made at the SMC-250 plate/chassis terminal blocks. Refer to the appropriate inter-connection diagram for control output function and terminal assignments.

Communication Provisions

Optional accessory devices communicate with the SMC-250 via the Ethernet port of the DECS-250 or BE1-11m.

Additional communication capability is provided through an SMC-250 RS-485 communication port which uses the Modbus™ RTU protocol. RS485 connections are made at plate/chassis terminals TB1-54 (A), 55 (B), and 56 (shield).

Digital Excitation Control System DECS-250

The DECS-250 supplies regulated excitation power to the motor field. It also monitors parameters to control and limit the motor from operating beyond its capabilities.

Detailed information about DECS-250 operation can be found in Basler publication 9440300990. The following paragraphs serve as an overview of DECS-250 functions.

Regulation

Digital signal processing and precise regulation algorithms enable the DECS-250 to accurately regulate the level of excitation. Motor parameters are monitored through user-supplied VTs and CTs. Sensing of field voltage and current is obtained directly from the field. Depending upon the regulation mode in use, the DECS-250 compares all or some of these monitored parameters with the operating setpoint and provides regulated excitation power to the field. Two DECS-250 regulation modes are possible: Manual or Auto.

Manual Mode

In Manual mode, the DECS-250 regulates the level of excitation power supplied to the field independently of all motor operating conditions. This makes Manual mode useful as a backup method of excitation control if a loss of motor voltage sensing or current sensing occurs. In an SMC-250 system, Manual mode is configured for field current regulation (FCR). FCR is selected automatically at system startup or manually, by the operator, during normal operation. When operating in FCR mode, the DECS-250 regulates only the level of field current. The operator must manually vary the FCR setpoint in order to achieve the desired motor operating conditions.

Auto Mode

During the motor startup sequence, the DECS-250 is switched from FCR to Auto mode when the BE1-11m determines that the level of ac motor current has reached the nominal level. In Auto mode, the DECS-250 measures the real power into the motor and adjusts the field excitation to obtain the desired level of reactive power (and power factor).

Autotracking

The setpoint of the active regulation mode is automatically tracked (followed) by the inactive control modes. In dual DECS-250 systems, the secondary DECS-250 tracks the setpoint of the primary DECS-250. This feature enables the initiation of “bumpless” transfers between operating modes and DECS-250 controllers. For example, if a loss of sensing occurs while operating in Auto mode, the auto tracking function will minimize the disturbance that the transfer from Auto mode to Manual mode could cause.

Limiters

As implemented in the SMC-250, the following limiter functions are enabled in the DECS-250: under-excitation, overexcitation, reactive power (var), underfrequency/volts per hertz, upper setpoint, and lower setpoint.

Underexcitation Limiter (UEL)

The DECS-250 compares the real power (kW) flowing into the motor with the reactive power (kvar) being supplied. If the reactive power decreases below the UEL setpoint, the DECS-250 will increase field excitation to maintain synchronism and avoid tripping the motor offline. During an underexcitation condition, the DECS-250 closes the SMC-250 General Limiting output contacts at terminals TB1-64 and 65.

If underexcitation persists and is not corrected, the DECS-250 closes the SMC-250 Alarm output contacts at terminals TB1-90 and 91.

Overexcitation Limiter (OEL)

If the level and duration of current applied to the field exceeds the OEL settings, the DECS-250 will retract further increases in field current and lower the current to a safe level for the machine. The OEL operates at three levels to permit short-term var boosting that could be beneficial for the application. During over-excitation limiting, the DECS-250 closes the SMC-250 General Limiting output contacts (TB1-64, 65). If overexcitation persists and is not corrected, the DECS-250 closes the SMC-250 Alarm output contacts (TB1-64, 65).

Reactive Power (Var) Limiter

The DECS-250 compares the level of motor reactive power with the user-established var threshold. A var level outside the established setting initiates var limiting.

During var limiting, the DECS-250 closes the SMC-250 General Limiting output contacts (TB1-64, 65).

Setpoint Limiter

Adjustment of the active DECS-250 setpoint to either the upper or lower limit will result in a General Limiting annunciation at SMC-250 terminals TB1-64 and 65.

Alarms Function

DECS-250 system parameters, communication links, protection functions, and remote inputs/outputs are continuously monitored for alarm conditions. An active alarm triggers closure of the DECS-250 General Protection output contacts.

Communication

The DECS-250 supports simultaneous Modbus™ communication through its copper Ethernet port (Modbus/TCP) and its RS-485 port (Modbus RTU).

Short-term communication with a PC operating BESTCOMS*Plus*®.

Operating Logic

In the SMC-250, the DECS-250 is preconfigured with operating logic that is tailored specifically to synchronous motor applications. If desired, this logic scheme can be customized by using the logic programming capabilities of BESTlogic™*Plus*. The BESTlogic™*Plus* chapter of Basler publication 9440300990 provides information about customizing DECS-250 logic.

Protection Devices

Overexcitation and underexcitation protection is provided by an ES-74S DC Millivolt Sensing Relay. Power factor and loss of synchronization protection is provided by an ES-55 Power Factor Relay or a BE1-11*m* Motor Protection System.

DC Millivolt Sensing Relay (ES-74S)

The ES-74S monitors the level of exciter field current through a metering shunt and functions as an overexcitation/underexcitation relay. The adjustable underexcitation setpoint is preset at 20% of the full-load excitation current rating. The adjustable overexcitation setpoint is preset at 110% of the full-load excitation current rating. A time delay setting of 5 seconds for both setpoints prevents nuisance tripping during transient disturbances. When an underexcitation or overexcitation condition is detected, the ES-74S trips and closes the SMC-250 Alarm output contacts. During motor startup, ES-74S tripping is inhibited by the BE1-11*m* (if equipped).

Details about the ES-74S are provided in Basler publication 9500100994.

Power Factor Relay (ES-55)

The ES-55 protects the motor from damage during increased loading or decreased excitation conditions. A protective trip is initiated when the motor power factor decreases below the ES-55 setpoint for the duration of the prescribed time delay. A power factor trip is annunciated by a front panel LED and two sets of SPDT output contacts.

Details about the ES-55 are provided in Basler publication 9500100892.

Motor Protection System (BE1-11m)

In addition to power factor protection, the optional BE1-11*m* provides startup coordination and enhances motor reliability by providing the following features:

- Comprehensive protection and control functions
- Standard, IEC, or custom thermal curves which adapt to thermal, inertia, and voltage conditions
- Accurate metering of motor parameters
- Extensive reporting capabilities: current demand, watthours, varhours, motor start records, and motor maintenance data
- Oscillography capabilities can be used to evaluate motor characteristics (V curves) and reduce commissioning time

Information about the BE1-11*m* can be found in Basler publication 9424200772 (quick-start guide), 9424200773 (DNP communication protocol manual), 9424200774 (Modbus communication protocol manual), and 9424200996 (device manual).

Startup Coordination

At system startup, a Start contact input is applied to the BE1-11*m* which enables DECS-250 excitation control and prevents an SMC-250 Alarm output from being issued during startup before the motor reaches a nominal operating state.

Protection

The SMC-250 may be supplied with the BE1-11*m* configured for power factor protection. In a synchronous motor application, power factor protection prevents the motor from consuming excessive reactive power (vars). If the var level is permitted to escalate, a loss of synchronism can result. A power factor trip closes the contact of BE1-11*m* output 8.

Other BE1-11*m* protection elements can be enabled and implemented at the user's discretion.

Communication

The BE1-11*m* supports simultaneous Modbus® communication through its copper Ethernet port (Modbus/TCP) and its RS-485 port (Modbus RTU).

Short-term communication with a PC operating BESTCOMS*Plus*® is possible through the front-panel USB port.

Operating Logic

As implemented in the SMC-250, the BE1-11*m* operating logic is preconfigured for basic protection of the synchronous motor and annunciation of preselected motor/SMC-250 conditions. If desired, the BE1-11*m* logic scheme can be customized by using the logic programming capabilities of BESTlogic™*Plus*. The BESTlogic™*Plus* chapter of Basler publication 9424200996 provides information about customizing BE1-11*m* logic.

Startup and Shutdown

SMC-250 startup is initiated through application of a contact input which should coincide with the application of a motor start command. Startup cannot occur if the user-supplied lockout (86) device is tripped.

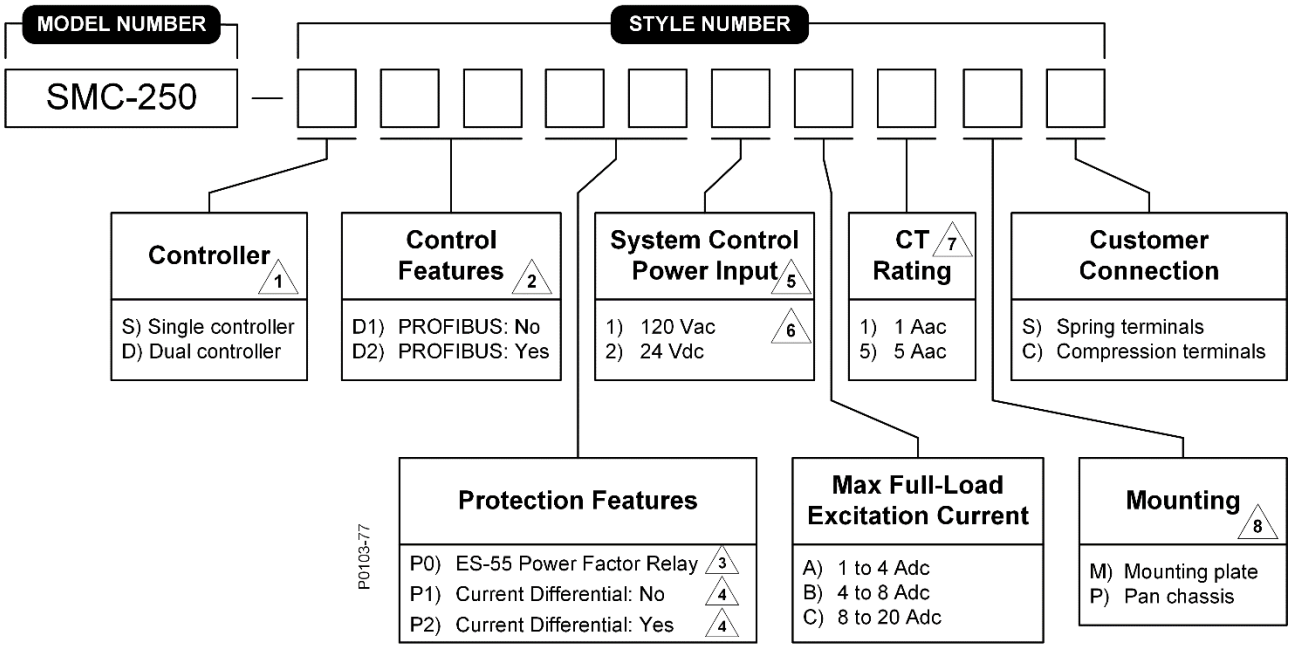
SMC-250 shutdown is initiated by removal of the start contact input. Shutdown also may be initiated by a trip of a user-supplied lockout (86) device.

Spare/Restoration Components

A reasonable stock of spare parts will minimize downtime in the event of an equipment malfunction. A list of recommended spare parts accompanies this publication.

Table 1. SMC-250 Features, Dimensions, and Weights

Style	Controller	Protection	Control Power	Mounting	Dimensions (H x W x D)	Weight
SxxP11xxMx	Single	BE1-11*m*	120 Vac	Mounting plate	28.7 x 27.7 x 10.4 in. 730 x 704 x 264 mm	50 lb. 22.7 kg
SxxP12xxMx	Single	BE1-11*m*	24 Vdc	Mounting plate	28.7 x 27.7 x 10.4 in. 730 x 704 x 264 mm	50 lb. 22.7 kg
SxxP11xxPx	Single	BE1-11*m*	120 Vac	Pan chassis	28.7 x 27.7 x 11.4 in. 730 x 704 x 290 mm	75 lb. 34.0 kg
SxxP12xxPx	Single	BE1-11*m*	24 Vdc	Pan chassis	28.7 x 27.7 x 11.4 in. 730 x 704 x 290 mm	75 lb. 34.0 kg
SxxP21xxPx	Single	BE1-11*m*	120 Vac	Pan chassis	28.7 x 27.7 x 11.4 in. 730 x 704 x 290 mm	75 lb. 34.0 kg
SxxP22xxPx	Single	BE1-11*m*	24 Vdc	Pan chassis	28.7 x 27.7 x 11.4 in. 730 x 704 x 290 mm	75 lb. 34.0 kg
SxxP01xxMx	Single	ES-55	120 Vac	Mounting plate	28.7 x 27.7 x 8.7 in. 730 x 704 x 221 mm	50 lb. 22.7 kg
SxxP02xxMx	Single	ES-55	24 Vdc	Mounting plate	28.7 x 27.7 x 8.7 in. 730 x 704 x 221 mm	50 lb. 22.7 kg
SxxP01xxPx	Single	ES-55	120 Vac	Pan chassis	28.7 x 27.7 x 9.6 in. 730 x 704 x 244 mm	75 lb. 34.0 kg
SxxP02xxPx	Single	ES-55	24 Vdc	Pan chassis	28.7 x 27.7 x 9.6 in. 730 x 704 x 244 mm	75 lb. 34.0 kg
DxxP01xxMx	Dual	ES-55	120 Vac	Mounting plate	37.4 x 29.5 x 8.9 in. 950 x 750 x 225 mm	95 lb. 43.1 kg
DxxP02xxMx	Dual	ES-55	24 Vdc	Mounting plate	37.4 x 29.5 x 8.9 in. 950 x 750 x 225 mm	95 lb. 43.1 kg
DxxP01xxPx	Dual	ES-55	120 Vac	Pan chassis	37.4 x 29.5 x 8.9 in. 950 x 750 x 225 mm	100 lb. 45.4 kg
DxxP02xxPx	Dual	ES-55	24 Vdc	Pan chassis	37.4 x 29.5 x 8.9 in. 950 x 750 x 225 mm	100 lb. 45.4 kg



1 When *Controller* option D is selected, *Control Features* option must be D1 and *Protection Features* option must be P0.

2 DECS-250 Control features:

Control Features	Power Supply	PSS	Autotracking	DECS-250 Terminals	Synchronizer	1st Communication Protocol	2nd Communication Protocol
D1	4	Not included	Autotracking is determined by selection of a single DECS-250 or dual DECS-250 controllers.	Spring terminals	None	100Base-T (Modbus® TCP)	None
D2							PROFIBUS

3 ES-55 style number is ES-551AD1NXN0,

4 BE1-11*m* Protection features:

Protection Features	Phase Current	Ground Current	Power Supply	RS-485 Protocol	Ethernet Protocol	Case	Alarm Contact	Option 1	Network Connection	Language	Option 2	Firmware
P1	6	6	4	Modbus®	Modbus® TCP with BESTnet™*Plus*	Vertical case	Normally closed	None	Copper Ethernet	English	None	Latest Release
P2								Current Differential				

5 Power supply for DECS-250 is determined by option chosen in the SMC-250 style number.

6 If *System Control Power Input* is 1, a 24 Vdc power supply is required when adding the CEM-2020, AEM-2020, or IDP-801 accessories.

7 Phase Current and Ground Current values are determined by options chosen in the SMC-250 style number.

8 A mounting plate is a small, bendable, thin sheet of metal designed to hold all components of the controller. Typically, the mounting plate is designed to fit inside a Rittal enclosure. A pan chassis is made with a larger, more rigid metal panel to hold all system components. Typically, the pan chassis is designed to 1 inch (2.5 centimeters) thick with supporting capabilities to help prevent it from bending or flexing.

Figure 1. SMC-250 Style Chart