



# SEL-351A Protection System

## Optimize Protection, Automation, and Breaker Control



SEL-351A Protection System shown with front-panel USB port and SafeLock® trip/close pushbuttons with high-visibility breaker status LEDs.

## Key Features and Benefits

The SEL-351A Protection System provides an exceptional package of protection, monitoring, control, and fault locating features. The SEL-351A-1 Protection System offers an economical, yet impressive feature subset of the SEL-351A. The SEL-351A-1 offers the same functionality as the SEL-351A, except without directional elements, second-harmonic blocking, synchronism checking, load-encroachment, station battery monitoring, and sensitive earth fault elements.

## Protection Functions

- Second-harmonic blocking secures relay during transformer energization (SEL-351A only).
- Phase, negative-sequence, residual-ground, and neutral-ground overcurrent elements with directional control optimize radial and looped network protection for lines and equipment. Load-encroachment logic provides additional security to distinguish between heavy load and three-phase faults.
- Under- and overfrequency and under- and overvoltage elements and powerful SELOGIC® control equations help implement load shedding and other control schemes.
- SELOGIC control equations permit custom programming for traditional and unique protection and control functions.
- Four levels of rate-of-change-of-frequency elements help detect rapid frequency changes to initiate load shedding or network decoupling.

## Automatic Reclosing and Synchronism Check

- Program as many as four shots of automatic reclosing with two selectable reclose formats.
- Control reclosing schemes for trip saving or fuse saving, and inhibit reclosing for hot-line maintenance.
- Supervise manual or automatic reclosing with synchronism-check and voltage condition logic.

- Available 750 KB of on-board storage space for ACSELERATOR QuickSet® SEL-5030 Software settings file, QuickSet Design Template, or anything else you choose.
- Nominal 5 A or 1 A current inputs: 5 A phase, 5 A neutral; 5 A phase, 1 A neutral; 1 A phase, 1 A neutral; 0.05 A neutral for nondirectional sensitive earth fault (SEF) protection (SEL-351A only); or 0.2 A neutral for directional ground protection on low-impedance grounded, ungrounded, high-impedance grounded, and Petersen Coil grounded systems (SEL-351A only).

**NOTE:** The 0.2 A nominal channel can also provide nondirectional SEF protection. The 0.05 A nominal neutral channel IN option is a legacy nondirectional SEF option.

## Functional Overview

Figure 1 shows the device numbers associated with the protection and control functions available on the SEL-351A Protection System, along with a list of the standard and optional monitoring and communications features.

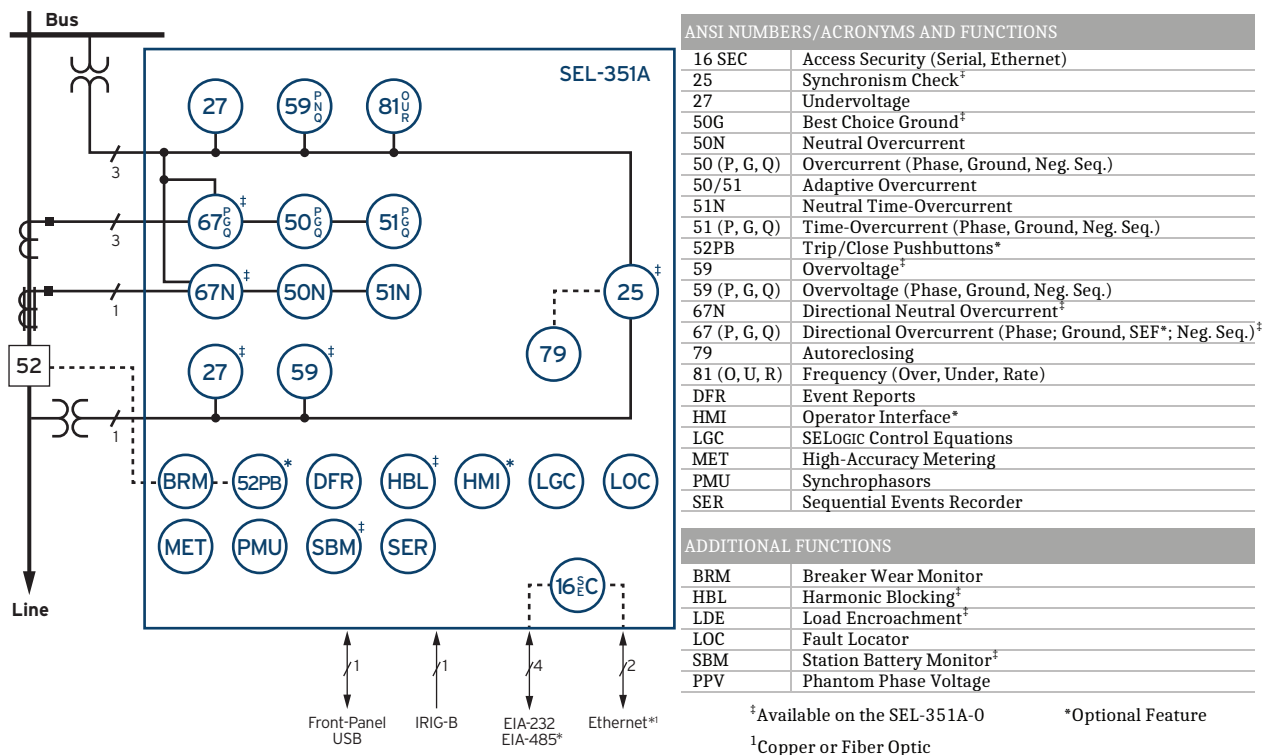


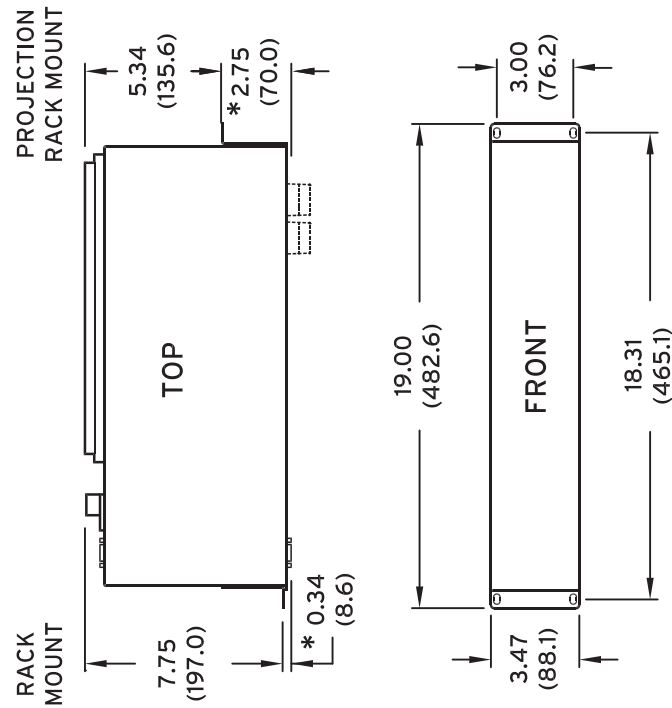
**Figure 1 Functional Diagram**

## Protection Features

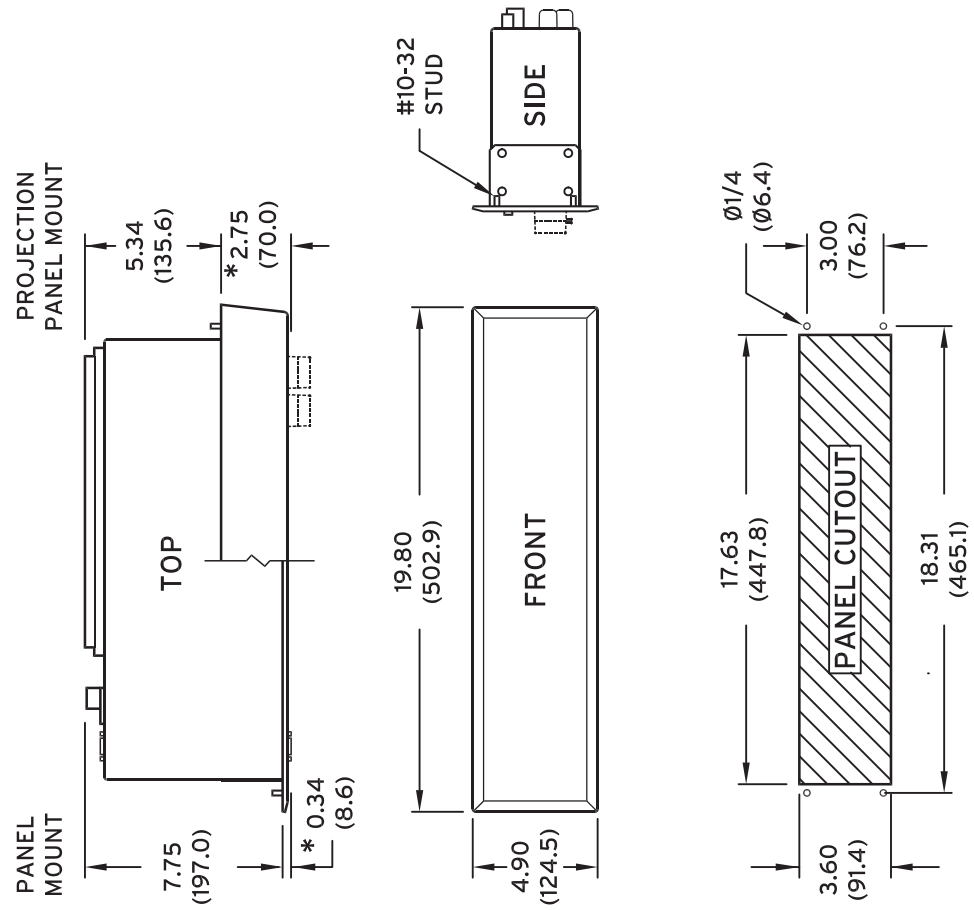
### Overcurrent Elements

The SEL-351A includes numerous phase, negative-sequence, residual-ground, and neutral overcurrent elements, as shown in Table 2.

## RACK-MOUNT CHASSIS



## PANEL-MOUNT CHASSIS



LEGEND  
in  
(mm)

\* ADD 0.75 (19.1) FOR PUSHBUTTON OPTION  
--- OPTIONAL PUSHBUTTON

i9170c

Figure 28 SEL-351A Dimensions and Drill Plan for Rack-Mount and Panel-Mount Models

# Specifications

**Important:** Do not use the following specification information to order an SEL-351A. Refer to the actual ordering information sheets.

## Compliance

Designed and manufactured under an ISO 9001 certified quality management system  
UL Listed to US and Canadian safety standards (File E212775; NRGU, NRGU7)  
CE Mark  
UKCA Mark  
RCM Mark

**Note:** This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

## General

### Terminal Connections

**Note:** Terminals or stranded copper wire. Ring terminals are recommended. Minimum temperature rating of 75°C.

### Tightening Torque

|                                      |                         |
|--------------------------------------|-------------------------|
| Terminals A01–A28                    |                         |
| Terminals B01–B40 (if present):      | 1.1–1.3 Nm (9–12 in-lb) |
| Terminals Z01–Z27:                   | 1.1–1.3 Nm (9–12 in-lb) |
| Serial Port 1 (EIA-485, if present): | 0.6–0.8 Nm (5–7 in-lb)  |

### AC Voltage Inputs

|                            |                                                    |
|----------------------------|----------------------------------------------------|
| Nominal Range              |                                                    |
| Line-to-Neutral:           | 67–120 Vrms                                        |
| Line to Line (open delta): | 115–260 Vrms                                       |
| Continuous:                | 300 Vrms                                           |
| Short-Term Overvoltage:    | 600 Vac for 10 seconds                             |
| Burden:                    | 0.03 VA @ 67 V; 0.06 VA @ 120 V;<br>0.8 VA @ 300 V |

### AC Current Inputs

IA, IB, IC, and Neutral Channel IN

|              |                                                                                                           |
|--------------|-----------------------------------------------------------------------------------------------------------|
| 5 A Nominal: | 15 A continuous (20 A continuous at 55°C), 500 A for 1 s, linear to 100 A symmetrical, 1250 A for 1 cycle |
| Burden:      | 0.27 VA @ 5 A, 2.51 VA @ 15 A                                                                             |
| 1 A Nominal: | 3 A continuous (4 A continuous at 55°C), 100 A for 1 s, linear to 20 A symmetrical, 250 A for 1 cycle     |
| Burden:      | 0.13 VA @ 1 A, 1.31 VA @ 3 A                                                                              |

### Additional Neutral Channel IN Options

|                                                    |                                                                                      |
|----------------------------------------------------|--------------------------------------------------------------------------------------|
| 0.2 A Nominal Neutral Channel (IN) Current Input:  | 15 A continuous, 500 A for 1 second, linear to 6.4 A symmetrical, 1250 A for 1 cycle |
| Burden:                                            | 0.00009 VA @ 0.2 A, 0.54 VA @ 15 A                                                   |
| 0.05 A Nominal Neutral Channel (IN) Current Input: | 15 A continuous, 500 A for 1 second, linear to 6.4 A symmetrical, 1250 A for 1 cycle |
| Burden:                                            | 0.000005 VA @ 0.05 A, 0.0054 VA @ 1.5 A                                              |

**Note:** The 0.2 A nominal neutral channel IN option is used for directional control on low-impedance grounded, Petersen Coil grounded, and ungrounded/ high-impedance grounded systems (see *Table 4.4*). The 0.2 A nominal channel can also provide nondirectional sensitive earth fault (SEF) protection.

The 0.05 A nominal neutral channel IN option is a legacy nondirectional SEF option.

## Power Supply

### High-Voltage Supply

|         |                                            |
|---------|--------------------------------------------|
| Rated:  | 125–250 Vdc nominal or 120–230 Vac nominal |
| Range:  | 85–350 Vdc or 85–264 Vac                   |
| Burden: | <25 W                                      |

### Medium-Voltage Supply

|         |                                       |
|---------|---------------------------------------|
| Rated:  | 48–125 Vdc nominal or 120 Vac nominal |
| Range:  | 38–200 Vdc or 85–140 Vac              |
| Burden: | <25 W                                 |

### Low-Voltage Supply

|         |                              |
|---------|------------------------------|
| Rated:  | 24–48 Vdc nominal            |
| Range:  | 18–60 Vdc polarity dependent |
| Burden: | <25 W                        |

## Fuse Ratings

### High-Voltage Power Supply Fuse

|                        |                                   |
|------------------------|-----------------------------------|
| Rating:                | 2.5 A                             |
| Maximum Rated Voltage: | 125 Vdc, 250 Vac                  |
| Breaking Capacity:     | 200 A at 277 Vac/100 A at 125 Vdc |
| Type:                  | Time-lag T                        |

### Medium-Voltage Power Supply Fuse

|                        |                                   |
|------------------------|-----------------------------------|
| Rating:                | 2.5 A                             |
| Maximum Rated Voltage: | 125 Vdc, 250 Vac                  |
| Breaking Capacity:     | 200 A at 277 Vac/100 A at 125 Vdc |
| Type:                  | Time-lag T                        |

### Low-Voltage Power Supply Fuse

|                        |                                        |
|------------------------|----------------------------------------|
| Rating:                | 7 A                                    |
| Maximum Rated Voltage: | 60 Vdc, 250 Vac                        |
| Breaking Capacity:     | 50 A at 250 Vac, p.f. / 50 A at 60 Vdc |
| Type:                  | Fast-Acting                            |

**Note:** Power supply fuses are non-user-replaceable.

## Frequency and Rotation

**Note:** 60/50 Hz system frequency and ABC/ACB phase rotation are user-settable.

|                           |                                                                                                                                                                  |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Frequency Tracking Range: | 40–65 Hz (Zero-crossing detection method, preferred source: <b>VA-N</b> terminals. Backup source(s) <b>VB-N</b> or <b>VC-N</b> , depending on PT configuration). |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                       |                                                        |
|-----------------------|--------------------------------------------------------|
| Frequency Estimation: | 40–70 Hz<br>Below 40 Hz = 40 Hz<br>Above 70 Hz = 70 Hz |
|-----------------------|--------------------------------------------------------|

|                         |                                                                                                                                                             |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Maximum Rate-of-Change: | ~20 Hz/s (The relay will not measure faster-changing frequencies, and will revert to nominal frequency if the condition is maintained for more than 0.25 s) |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|

## Output Contacts

### Standard

#### DC Output Ratings

|                                        |                                                              |
|----------------------------------------|--------------------------------------------------------------|
| Make:                                  | 30 A                                                         |
| Carry:                                 | 6 A continuous carry at 70°C<br>4 A continuous carry at 85°C |
| 1 s Rating:                            | 50 A                                                         |
| MOV Protected:                         | 270 Vac/360 Vdc/75 J                                         |
| Pickup Time:                           | Less than 5 ms                                               |
| Dropout Time:                          | Less than 5 ms, typical                                      |
| Breaking Capacity (10,000 operations): |                                                              |
| 24 V                                   | 0.75 A L/R = 40 ms                                           |
| 48 V                                   | 0.50 A L/R = 40 ms                                           |
| 125 V                                  | 0.30 A L/R = 40 ms                                           |
| 250 V                                  | 0.20 A L/R = 40 ms                                           |

#### Cyclic Capacity (2.5 cycle/second):

|       |        |             |
|-------|--------|-------------|
| 24 V  | 0.75 A | L/R = 40 ms |
| 48 V  | 0.50 A | L/R = 40 ms |
| 125 V | 0.30 A | L/R = 40 ms |
| 250 V | 0.20 A | L/R = 40 ms |

**Note:** Make per IEEE C37.90-1989.

**Note:** Breaking and Cyclic Capacity per IEC 60255-0-20:1974.

**Note:** EA certified relays do not have MOV protected standard output contacts.

#### AC Output Ratings

|                                                             |                                                  |
|-------------------------------------------------------------|--------------------------------------------------|
| Maximum Operational Voltage ( $U_o$ ) Rating:               | 240 Vac                                          |
| Insulation Voltage ( $U_i$ ) Rating (excluding EN 61010-1): | 300 Vac                                          |
| Utilization Category:                                       | AC-15 (control of electromagnetic loads > 72 VA) |
| Contact Rating Designation:                                 | B300 (B = 5 A, 300 = rated insulation voltage)   |
| Voltage Protection Across Open Contacts:                    | 270 Vac, 40 J                                    |
| Rated Operational Current ( $I_o$ ):                        | 3 A @ 120 Vac<br>1.5 A @ 240 Vac                 |
| Conventional Enclosed Thermal Current ( $I_{the}$ ) Rating: | 5 A                                              |
| Rated Frequency:                                            | 50/60 $\pm$ 5 Hz                                 |
| Electrical Durability Make VA Rating:                       | 3600 VA, $\cos \phi = 0.3$                       |
| Electrical Durability Break VA Rating:                      | 360 VA, $\cos \phi = 0.3$                        |

#### High-Current Interruption for OUT101, OUT102, and Extra I/O Board

|                                        |                                                              |
|----------------------------------------|--------------------------------------------------------------|
| Make:                                  | 30 A                                                         |
| Carry:                                 | 6 A continuous carry at 70°C<br>4 A continuous carry at 85°C |
| 1 s Rating:                            | 50 A                                                         |
| MOV Protection:                        | 330 Vdc/145 J                                                |
| Pickup Time:                           | Less than 5 ms                                               |
| Dropout Time:                          | Less than 8 ms, typical                                      |
| Breaking Capacity (10,000 operations): |                                                              |
| 24 V                                   | 10 A L/R = 40 ms                                             |
| 48 V                                   | 10 A L/R = 40 ms                                             |
| 125 V                                  | 10 A L/R = 40 ms                                             |
| 250 V                                  | 10 A L/R = 20 ms                                             |

Cyclic Capacity (4 cycles in 1 second, followed by 2 minutes idle for thermal dissipation):

|       |      |             |
|-------|------|-------------|
| 24 V  | 10 A | L/R = 40 ms |
| 48 V  | 10 A | L/R = 40 ms |
| 125 V | 10 A | L/R = 40 ms |
| 250 V | 10 A | L/R = 20 ms |

**Note:** Make per IEEE C37.90-1989.

**Note:** Do not use high-current interrupting output contacts to switch ac control signals. These outputs are polarity dependent.

**Note:** Breaking and Cyclic Capacity per IEC 60255-0-20:1974.

## SafeLock Trip/Close Pushbuttons

### Resistive DC or AC Load With Arc Suppression Disabled

|                 |                       |
|-----------------|-----------------------|
| Make:           | 30 A                  |
| Carry:          | 6 A continuous carry  |
| 1 s Rating:     | 50 A                  |
| MOV Protection: | 250 Vac/330 Vdc/130 J |

#### Breaking Capacity (10,000 operations):

|       |        |             |
|-------|--------|-------------|
| 48 V  | 0.50 A | L/R = 40 ms |
| 125 V | 0.30 A | L/R = 40 ms |
| 250 V | 0.20 A | L/R = 40 ms |

**Note:** Make per IEEE C37.90-1989.

### High-Interrupt DC Outputs With Arc Suppression Enabled

|                 |                      |
|-----------------|----------------------|
| Make:           | 30 A                 |
| Carry:          | 6 A continuous carry |
| 1 s Rating:     | 50 A                 |
| MOV Protection: | 330 Vdc/130 J        |

#### Breaking Capacity (10,000 operations):

|       |      |             |
|-------|------|-------------|
| 48 V  | 10 A | L/R = 40 ms |
| 125 V | 10 A | L/R = 40 ms |
| 250 V | 10 A | L/R = 20 ms |

**Note:** Make per IEEE C37.90-1989.

## Breaker Open/Closed LEDs

|          |                     |             |
|----------|---------------------|-------------|
| 250 Vdc: | on for 150–300 Vdc; | 192–288 Vac |
| 125 Vdc: | on for 80–150 Vdc;  | 96–144 Vac  |
| 48 Vdc:  | on for 30–60 Vdc;   |             |
| 24 Vdc:  | on for 15–30 Vdc    |             |

**Note:** With nominal control voltage applied, each LED draws 8 mA (max.). Jumpers may be set to 125 Vdc for 110 Vdc input and set to 250 Vdc for 220 Vdc input.

## Optoisolated Input Ratings

### When Used With DC Control Signals

|          |                     |                    |
|----------|---------------------|--------------------|
| 250 Vdc: | on for 200–300 Vdc; | off below 150 Vdc  |
| 220 Vdc: | on for 176–264 Vdc; | off below 132 Vdc  |
| 125 Vdc: | on for 105–150 Vdc; | off below 75 Vdc   |
| 110 Vdc: | on for 88–132 Vdc;  | off below 66 Vdc   |
| 48 Vdc:  | on for 38.4–60 Vdc; | off below 28.8 Vdc |
| 24 Vdc:  | on for 15–30 Vdc    |                    |

### When Used With AC Control Signals

|          |                         |                     |
|----------|-------------------------|---------------------|
| 250 Vdc: | on for 170.6–300 Vac;   | off below 106.0 Vac |
| 220 Vdc: | on for 150.3–264.0 Vac; | off below 93.2 Vac  |
| 125 Vdc: | on for 89.6–150.0 Vac;  | off below 53.0 Vac  |
| 110 Vdc: | on for 75.1–132.0 Vac;  | off below 46.6 Vac  |
| 48 Vdc:  | on for 32.8–60.0 Vac;   | off below 20.3 Vac  |
| 24 Vdc:  | on for 12.8–30.0 Vac    |                     |

**Note:** AC mode is selectable for each input via Global settings IN101D–IN106D and IN201D–IN216D. AC input recognition delay from time of switching: 0.75 cycles maximum pickup, 1.25 cycles maximum dropout.

**Note:** All optoisolated inputs draw less than 10 mA of current at nominal voltage or ac rms equivalent.

## Time-Code Inputs

Relay accepts demodulated IRIG-B time-code input at Port 2, on the rear-panel BNC input, or through the optional SEL-2812-compatible fiber-optic serial port.

Port 2, Pin 4 Input Current: 1.8 mA typical at 4.5 V (2.5 k $\Omega$  resistive)

|                                                     |                                                                                       |
|-----------------------------------------------------|---------------------------------------------------------------------------------------|
| BNC Input Current:                                  | 4 mA typical at 4.5 V (750 $\Omega$ resistive when input voltage is greater than 2 V) |
| BNC Input Voltage:                                  | 2.2 V minimum                                                                         |
| BNC Nominal Input Impedance:                        | $\geq 1$ k $\Omega$                                                                   |
| Synchronization Accuracy                            |                                                                                       |
| Internal Clock:                                     | $\pm 1$ $\mu$ s                                                                       |
| Synchrophasor Reports (e.g., MET PM, EVE P, CEV P): | $\pm 10$ $\mu$ s                                                                      |
| All Other Reports:                                  | $\pm 5$ ms                                                                            |
| Simple Network Time Protocol (SNTP) Accuracy        |                                                                                       |
| Internal Clock:                                     | $\pm 5$ ms                                                                            |
| Unsynchronized Clock Drift                          |                                                                                       |
| Relay Powered:                                      | 2 minutes per year typical                                                            |

### Communications Ports

|                          |                                             |
|--------------------------|---------------------------------------------|
| EIA-232:                 | 1 front, 2 rear                             |
| EIA-485:                 | 1 rear with 2100 Vdc of isolation, optional |
| Fiber-Optic Serial Port: | SEL-2812-compatible port, optional          |
| Wavelength:              | 820 nm                                      |
| Optical Connector Type:  | ST                                          |
| RX Min. Sensitivity:     | -24 dBm                                     |

**Table 2.1 Link Budget for Fiber-Optic Serial Ports**

| Multimode Fiber Size | Link Budget Typical <sup>a</sup> (Minimum <sup>b</sup> ) | Fiber Loss  | Maximum Distance Typical <sup>a</sup> (Minimum <sup>b</sup> ) |
|----------------------|----------------------------------------------------------|-------------|---------------------------------------------------------------|
| 200 $\mu$ m          | 20 dB (12 dB)                                            | -10.6 dB/km | 1.9 km (1.1 km)                                               |
| 62.5/125 $\mu$ m     | 15 dB (8 dB)                                             | -4 dB/km    | 3.8 km (2.0 km)                                               |
| 50/125 $\mu$ m       | 9.6 dB (4.2 dB)                                          | -4 dB/km    | 2.4 km (1.0 km)                                               |

<sup>a</sup> +26 °C

<sup>b</sup> -40 to +85 °C

|                                |                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Per Port Data Rate Selections: | 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600                                                                                                                                                                                                                                                                                                                      |
| USB:                           | 1 front (Type-B connector, CDC class device)                                                                                                                                                                                                                                                                                                                          |
| Ethernet:                      | 2 standard 10/100BASE-T rear ports (RJ45 connector)<br>1 or 2 100BASE-FX rear ports optional (LC connectors)<br>Wavelength: 1300 nm<br>Optical Connector Type: LC connector<br>Fiber Type: Multimode fiber<br>Typical TX Power: -15.7 dBm<br>RX Min. Sensitivity: -30 dBm<br>Fiber Size: 62.5 $\mu$ m<br>Internal Ethernet switch included with second Ethernet port. |

### Dimensions

Refer to *Figure 2.1*.

### Weight

15 lb (6.8 kg)—3U rack unit height relay

### Operating Temperature

-40° to +185°F (-40° to +85°C)

(LCD contrast impaired for temperatures below -20°C.)

**Note:** Temperature range is not applicable to UL-compliant installations.

### Operating Environment

|                   |   |
|-------------------|---|
| Insulation Class: | 1 |
| Pollution Degree: | 2 |

|                                                                                       |                       |
|---------------------------------------------------------------------------------------|-----------------------|
| Overvoltage Category:                                                                 | II                    |
| Atmospheric Pressure:                                                                 | 80–110 kPa            |
| Relative Humidity:                                                                    | 5%–95%, noncondensing |
| Maximum Altitude Without Derating (Consult the Factory for Higher Altitude Derating): | 2000 m                |

## Type Tests

### Electromagnetic Compatibility Emissions

|            |                                                                 |
|------------|-----------------------------------------------------------------|
| Emissions: | IEC 60255-26:2013, Class A<br>Canada ICES-001 (A) / NMB-001 (A) |
|------------|-----------------------------------------------------------------|

### Electromagnetic Compatibility Immunity

|                                      |                                                                                                                                                                                                                                                                  |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Electromagnetic Compatibility:       | IEC 60255-26:2013                                                                                                                                                                                                                                                |
| Safety Standards:                    | IEC 60255-27:2013                                                                                                                                                                                                                                                |
| Magnetic Field Immunity:             | IEC 60255-26:2013, Section 7.2.10<br>Severity Level:<br>1000 A/m for 3 seconds<br>100 A/m for 1 minute; 50/60 Hz                                                                                                                                                 |
| Conducted RF Immunity:               | IEC 61000-4-6:2014<br>Severity Level: 10 Vrms<br>IEC 60255-26:2013, Section 7.2.8<br>10 Vrms                                                                                                                                                                     |
| Digital Radio Telephone RF Immunity: | ENV 50204:1995<br>Severity Level: 10 V/m at 900 MHz and 1.89 GHz                                                                                                                                                                                                 |
| Electrostatic Discharge Immunity:    | IEC 61000-4-2:2008<br>Severity Level: 2, 4, 6, 8 kV contact;<br>2, 4, 8, and 15 kV air<br>IEC 60255-26:2013, Section 7.2.3<br>IEEE C37.90.3-2001<br>Severity Level: 2, 4, and 8 kV contact;<br>4, 8, and 15 kV air                                               |
| Fast Transient/Burst Immunity:       | IEC 61000-4-4:2012<br>Severity Level: 4 kV, 5 kHz<br>IEC 60255-26:2013, Section 7.2.5                                                                                                                                                                            |
| Power Supply Immunity:               | IEC 61000-4-11:2004/A1:2017<br>IEC 61000-4-29:2000<br>IEC 60255-26:2013, Section 7.2.11<br>IEC 60255-26:2013, Section 7.2.12<br>IEC 60255-26:2013, Section 7.2.13                                                                                                |
| Radiated Radio Frequency Immunity:   | IEC 61000-4-3:2008<br>Severity Level: 10 V/m<br>IEC 60255-26:2013, Section 7.2.4<br>10 V/m<br>IEEE C37.90.2-2004<br>Severity Level: 35 V/m                                                                                                                       |
| Surge Withstand Capability Immunity: | IEC 61004-18:2010<br>Severity Level: 2.5 kV peak common mode, 1.0 kV peak differential mode<br>IEC 60255-26:2013, Section 7.2.7<br>2 kV line-to-line<br>4 kV line-to-earth<br>IEEE C37.90.1-2012<br>Severity Level: 2.5 kV oscillatory;<br>4.0 kV fast transient |
| Surge Immunity:                      | IEC 60255-26:2013, Section 7.2.7<br>2 kV line-to-line<br>4 kV line-to-earth                                                                                                                                                                                      |

### Environmental

|       |                                                                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cold: | IEC 60068-2-1:2007<br>Severity Level: 16 hours at -40°C<br>IEC 60255-27:2013, Section 10.6.1.2<br>IEC 60255-27:2013, Section 10.6.1.4<br>-40°C, 16 hours |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                   |                                                                                                                                                                                                                                                   |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic Temperature With Humidity: | IEC 60068-2-30:2005<br>Severity Level: +25°C to +55°C, 6 cycles, Relative Humidity: 90%<br>IEC 60255-27:2013, Section 10.6.1.6<br>25° to 55°C, 95% relative humidity, 6 cycles                                                                    |
| Damp Heat, Steady State:          | IEC 60068-2-78:2001<br>Severity Level: +40°C<br>Relative Humidity: 90%<br>IEC 60255-27:2013, Section 10.6.1.5<br>40°C, 93% relative humidity, 10 days                                                                                             |
| Dry Heat:                         | IEC 60068-2-2:2007<br>Severity Level: 16 hours at +85°C<br>IEC 60255-27:2013, Section 10.6.1.1<br>IEC 60255-27:2013, Section 10.6.1.3<br>85°C, 16 hours                                                                                           |
| Change of Temperature:            | IEC 60068-2-14:2009<br>Severity Level: -40°C to +85°C                                                                                                                                                                                             |
| Vibration:                        | IEC 60255-21-1:1988<br>Severity Level: Class 1 Endurance, Class 2 Response<br>IEC 60255-21-2:1988<br>Severity Level: Class 1—Shock withstand, Bump, and Class 2—Shock Response<br>IEC 60255-21-3:1993<br>Severity Level: Class 2 (Quake Response) |
| Vibration Resistance:             | IEC 60255-27:2013, Section 10.6.2.1<br>Endurance: Class 2<br>Response: Class 2                                                                                                                                                                    |
| Shock Resistance:                 | IEC 60255-27:2013, Section 10.6.2.2<br>IEC 60255-27:2013, Section 10.6.2.3<br>Withstand: Class 1<br>Response: Class 2<br>Bump: Class 1                                                                                                            |
| Seismic (Quake Response):         | IEC 60255-27:2013, Section 10.6.2.4<br>Response: Class 2                                                                                                                                                                                          |

## Safety

|                                |                                                                                                                                                                                                                                                                                                                     |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Protective Bonding Resistance: | IEC 60255-27:2013                                                                                                                                                                                                                                                                                                   |
| Dielectric:                    | IEC 60255-27:2013<br>Severity Level: 2500 Vac on contact inputs, contact outputs, and analog inputs. 3100 Vdc on power supply. Type Tested for 1 minute.<br>IEEE C37.90-2005<br>Severity Level: 2500 Vac on contact inputs, contact outputs, and analog inputs. 3100 Vdc on power supply. Type Tested for 1 minute. |
| Dielectric (Hi-Pot):           | IEC 60255-27:2013, Section 10.6.4.3                                                                                                                                                                                                                                                                                 |
| Impulse:                       | IEC 60255-27:2013<br>Severity Level: 0.5 Joule, 5 kV<br>IEEE C37.90:2005<br>Severity Level: 0.5 Joule, 5 kV                                                                                                                                                                                                         |
| IP Code:                       | IEC 60529:1989+AMD1:1999+AMD2:2013<br>Severity Level: IP30                                                                                                                                                                                                                                                          |
| Product Safety:                | C22.2 No. 14 - 95<br>Canadian Standards Association, Industrial control equipment, industrial products<br>UL 508<br>Underwriters Laboratories inc., Standard for safety: Industrial control equipment                                                                                                               |

## Processing Specifications and Oscillography

### AC Voltage and Current Inputs

128 samples per power system cycle, 3 dB low-pass filter cut-off frequency of 3 kHz

### Digital Filtering

Digital low-pass filter then decimate to 32 samples per cycle followed by one-cycle cosine filter.  
Net filtering (analog plus digital) rejects dc and all harmonics greater than the fundamental.

### Protection and Control Processing (Processing Interval)

4 times per power system cycle

### Oscillography

|                        |                                                                                                                         |
|------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Length:                | 15, 30, or 60 cycles                                                                                                    |
| Total Storage:         | 11 seconds of analog and binary                                                                                         |
| Sampling Rate:         | 128 samples per cycle unfiltered<br>32 and 16 samples per cycle unfiltered and filtered<br>4 samples per cycle filtered |
| Trigger:               | Programmable with Boolean expression                                                                                    |
| Format:                | ASCII and Compressed ASCII<br>Binary COMTRADE (128 samples per cycle unfiltered)                                        |
| Time-Stamp Resolution: | 1 $\mu$ s with precise time event (EVE P) reports and compressed ASCII event (CEV) reports. 1 ms otherwise.             |
| Time-Stamp Accuracy:   | See <i>Time-Code Inputs</i> on page 27.                                                                                 |

### Sequential Events Recorder

|                                                    |            |
|----------------------------------------------------|------------|
| Time-Stamp Resolution:                             | 1 ms       |
| Time-Stamp Accuracy (with respect to time source): | $\pm 5$ ms |

## Relay Element Pickup Ranges and Accuracies

Accuracy of cycle-based timers is specified for steady-state frequency.

### Instantaneous/Definite-Time Overcurrent Elements

|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pickup Range:                 | 0.25–100.00 A, 0.01 A steps<br>(5 A nominal)<br>1.00–170.00 A, 0.01 A steps<br>(5 A nominal—for phase-to-phase elements)<br>0.050–100.000 A, 0.010 A steps<br>(5 A nominal—for residual-ground elements)<br>0.05–20.00 A, 0.01 A steps<br>(1 A nominal)<br>0.20–34.00 A, 0.01 A steps<br>(1 A nominal—for phase-to-phase elements)<br>0.010–20.000 A, 0.002 A steps<br>(1 A nominal—for residual-ground elements)<br>0.005–2.500 A, 0.001 A steps<br>(0.2 A nominal neutral channel (IN) current input)<br>0.005–1.500 A, 0.001 A steps<br>(0.05 A nominal neutral channel (IN) current input) |
| Steady-State Pickup Accuracy: | $\pm 0.05$ A and $\pm 3\%$ of setting<br>(5 A nominal)<br>$\pm 0.01$ A and $\pm 3\%$ of setting<br>(1 A nominal)<br>$\pm 0.001$ A and $\pm 3\%$ of setting<br>(0.2 A nominal neutral channel (IN) current input)<br>$\pm 0.001$ A and $\pm 5\%$ of setting<br>(0.05 A nominal neutral channel (IN) current input)                                                                                                                                                                                                                                                                              |
| Transient Overreach:          | $\pm 5\%$ of pickup                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Time Delay:                   | 0.00–16,000.00 cycles, 0.25 cycle steps                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Timer Accuracy:               | $\pm 0.25$ cycle and $\pm 0.1\%$ of setting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

**Note:** See pickup and reset time curves in *Figure 3.5* and *Figure 3.6*.

### Breaker Failure Current Detectors and Logic

|                               |                                                                                                            |
|-------------------------------|------------------------------------------------------------------------------------------------------------|
| Pickup Range:                 | 0.5–100.00 A, 0.01 A steps (5 A nominal)<br>0.1–20.00 A, 0.01 A steps (1 A nominal)                        |
| Steady-State Pickup Accuracy: | $\pm 0.05$ A and $\pm 3\%$ of setting (5 A nominal)<br>$\pm 0.01$ A and $\pm 3\%$ of setting (1 A nominal) |
| Transient Overreach:          | $\pm 5\%$ of pickup                                                                                        |
| Reset Time:                   | $\leq 1$ cycle                                                                                             |
| Pickup Time:                  | $\leq 1$ cycle for current greater than 2 multiples of pickup                                              |
| Time Delay:                   | 0.00–16,000.00 cycles, 0.25 cycle steps                                                                    |
| Timer Accuracy:               | $\pm 0.25$ cycle and $\pm 0.1\%$ of setting                                                                |

### Time-Overcurrent Elements

|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pickup Range:                 | 0.25–16.00 A, 0.01 A steps (5 A nominal)<br>0.10–16.00 A, 0.01 A steps (5 A nominal—for residual-ground elements)<br>0.05–3.20 A, 0.01 A steps (1 A nominal)<br>0.02–3.20 A, 0.01 A steps (1 A nominal—for residual-ground elements)<br>0.005–0.640 A, 0.001 A steps (0.2 A nominal neutral channel (IN) current input)<br>0.005–0.160 A, 0.001 A steps (0.05 A nominal neutral channel (IN) current input)                                                                                          |
| Steady-State Pickup Accuracy: | $\pm 0.05$ A and $\pm 3\%$ of setting (5 A nominal)<br>$\pm 0.01$ A and $\pm 3\%$ of setting (1 A nominal)<br>$\pm 0.005$ A and $\pm 3\%$ of setting (0.2 A nominal neutral channel (IN) current input)<br>$\pm 0.001$ A and $\pm 5\%$ of setting (0.05 A nominal neutral channel (IN) current input)                                                                                                                                                                                                |
| Time-Dial Range:              | 0.50–15.00, 0.01 steps (US)<br>0.05–1.00, 0.01 steps (IEC)<br>0.10–2.00, in 0.01 steps (recloser curves)                                                                                                                                                                                                                                                                                                                                                                                             |
| Curve Timing Accuracy:        | $\pm 1.50$ cycles and $\pm 4\%$ of curve time for current between 2 and 30 multiples of pickup<br>$\pm 1.50$ cycles and $\pm 4\%$ of curve time for current less than 1 multiple of pickup<br>$\pm 3.50$ cycles and $\pm 4\%$ of curve time for current between 2 and 30 multiples of pickup for 0.05 A nominal neutral channel (IN) current input<br>$\pm 3.50$ cycles and $\pm 4\%$ of curve time for current less than 1 multiple of pickup for 0.05 A nominal neutral channel (IN) current input |

### Second-Harmonic Blocking Elements

|                               |                                             |
|-------------------------------|---------------------------------------------|
| Pickup Range:                 | 5–100% of fundamental, 1% steps             |
| Steady-State Pickup Accuracy: | 2.5 percentage points                       |
| Pickup/Dropout Time:          | $< 1.25$ cycles                             |
| Time Delay:                   | 0.00–16,000.00 cycles, 0.25 cycle steps     |
| Timer Accuracy:               | $\pm 0.25$ cycle and $\pm 0.1\%$ of setting |

### Under- and Overvoltage Elements

|                                              |                                                                                                                                                                              |
|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pickup Ranges                                |                                                                                                                                                                              |
| Wye-Connected (Global setting PTCONN = WYE): | 0.00–200.00 V, 0.01 V steps (negative-sequence element)<br>0.00–300.00 V, 0.01 V or 0.02 V steps (various elements)<br>0.00–520.00 V, 0.02 V steps (phase-to-phase elements) |

|                                                                          |                                                                                                                                                                                                             |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Open-Delta Connected (when available, by Global setting PTCONN = DELTA): | 0.00–120.00 V, 0.01 V steps (negative-sequence elements)<br>0.00–170.00 V, 0.01 V steps (positive-sequence element)<br>0.00–300.00 V, 0.01 V steps (various elements)                                       |
| Steady-State Pickup Accuracy:                                            | $\pm 0.5$ V plus $\pm 1\%$ for 12.5–300.00 V (phase and synchronizing elements)<br>$\pm 0.5$ V plus $\pm 2\%$ for 12.5–300.00 V (negative-, positive-, and zero-sequence elements, phase-to-phase elements) |
| Transient Overreach:                                                     | $\pm 5\%$ of pickup                                                                                                                                                                                         |

### Synchronism-Check Elements

|                                 |                                                                                                                                     |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Slip Frequency Pickup Range:    | 0.005–1.000 Hz, 0.001 Hz steps                                                                                                      |
| Slip Frequency Pickup Accuracy: | $\pm 0.003$ Hz                                                                                                                      |
| Phase Angle Range:              | 0–80°, 1° steps                                                                                                                     |
| Phase Angle Accuracy:           | $\pm 4^\circ$ when $ \text{slip frequency}  \leq 0.4$ Hz<br>$\pm 10^\circ$ when $0.4 \text{ Hz} <  \text{slip frequency}  < 1.0$ Hz |

### Under- and Overfrequency Elements

|                                               |                                                                    |
|-----------------------------------------------|--------------------------------------------------------------------|
| Pickup Range:                                 | 40.10–65.00 Hz, 0.01 Hz steps                                      |
| Steady-State <i>plus</i> Transient Overshoot: | $\pm 0.01$ Hz                                                      |
| Pickup/Dropout Time:                          | $< 3.0$ cycles                                                     |
| Time Delay:                                   | 2.00–16,000.00 cycles, 0.25-cycle steps                            |
| Timer Accuracy:                               | $\pm 0.25$ cycle and $\pm 0.1\%$ of setting                        |
| Undervoltage Frequency Element Block Range:   | 25.00–300.00 V <sub>LN</sub> (wye) or V <sub>LL</sub> (open delta) |

### Rate-of-Change-of-Frequency Element

|                      |                                            |
|----------------------|--------------------------------------------|
| Pickup Range:        | 0.10–15.00 Hz/sec, 0.01 Hz/sec steps       |
| Dropout:             | 95% of pickup                              |
| Pickup Accuracy:     | $\pm 100$ mHz/s and $\pm 3.33\%$ of pickup |
| Pickup/Dropout Time: | See <i>Equation 3.1</i> .                  |
| Pickup Time Delay:   | 0.10–60.00 seconds, 0.01 second steps      |
| Dropout Time Delay:  | 0.00–60.00 seconds, 0.01 second steps      |
| Timer Accuracy:      | $\pm 6$ ms and $\pm 0.1\%$ of setting      |

### Timers

|                                             |                                                                                                                                                                                 |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pickup Ranges:                              | 0.00–999,999.00 cycles, 0.25-cycle steps (reclosing relay and some programmable timers)<br>0.00–16,000.00 cycles, 0.25-cycle steps (some programmable and other various timers) |
| Pickup and Dropout Accuracy for all Timers: | $\pm 0.25$ cycle and $\pm 0.1\%$ of setting                                                                                                                                     |

### Substation Battery Voltage Monitor

|                  |                                  |
|------------------|----------------------------------|
| Pickup Range:    | 20–300 Vdc, 1 Vdc steps          |
| Pickup accuracy: | $\pm 2\%$ of setting $\pm 2$ Vdc |

### Fundamental Metering Accuracy

Accuracies are specified at 20°C, at nominal system frequency, and voltages 67–250 V unless noted otherwise.

|                                                       |                                                                                               |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| V <sub>A</sub> , V <sub>B</sub> , V <sub>C</sub> :    | $\pm 0.2\%$ (67.0–250 V; wye-connected)<br>$\pm 0.4\%$ typical (250–300 V; wye-connected)     |
| V <sub>AB</sub> , V <sub>BC</sub> , V <sub>CA</sub> : | $\pm 0.4\%$ (67.0–250 V; delta-connected)<br>$\pm 0.8\%$ typical (250–300 V; delta-connected) |
| V <sub>S</sub> :                                      | $\pm 0.2\%$ (67.0–250 V)<br>$\pm 0.4\%$ typical (250–300 V)                                   |

|                                                                             |                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $3V_0, V_1, V_2$<br>( $3V_0$ not available with<br>delta-connected inputs): | $\pm 0.6\%$ (67.0–250 V)<br>$\pm 1.2\%$ typical (250–300 V)                                                                                                                                                                                                                                                                                                          |
| $I_A, I_B, I_C$ :                                                           | $\pm 4$ mA and $\pm 0.1\%$ (1.0–100 A)<br>(5 A nominal)<br>$\pm 6$ mA and $\pm 0.1\%$ (0.25–1.0 A)<br>(5 A nominal)<br>$\pm 1$ mA and $\pm 0.1\%$ (0.2–20 A)<br>(1 A nominal)<br>$\pm 2$ mA and $\pm 0.1\%$ (0.05–0.2 A)<br>(1 A nominal)<br>Temperature coefficient:<br>$\frac{0.0002}{^\circ\text{C}^2} \% \cdot ( \text{ } ^\circ\text{C} - 20^\circ\text{C} )^2$ |
| $I_N$ :                                                                     | $\pm 4$ mA and $\pm 0.1\%$ (1.0–100 A)<br>(5 A nominal)<br>$\pm 6$ mA and $\pm 0.1\%$ (0.25–1.0 A)<br>(5 A nominal)<br>$\pm 1$ mA and $\pm 0.1\%$ (0.2–20 A)<br>(1 A nominal)<br>$\pm 2$ mA and $\pm 0.1\%$ (0.05–0.2 A)<br>(1 A nominal)<br>$\pm 1.6$ mA and $\pm 0.1\%$ (0.005–4.5 A) (0.2 A<br>or 0.05 A nominal channel IN current<br>input)                     |
| $I_1, 3I_0, 3I_2$ :                                                         | $\pm 0.05$ A and $\pm 3\%$ (0.5–100 A)<br>(5 A nominal)<br>$\pm 0.01$ A and $\pm 3\%$ (0.1–20 A)<br>(1 A nominal)                                                                                                                                                                                                                                                    |

### Phase Angle Accuracy

|                   |                                                                                                                                                                               |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_A, I_B, I_C$ : | $\pm 0.5^\circ$ (1.0–100 A) (5 A nominal)<br>$\pm 3^\circ$ (0.25–1.0 A) (5 A nominal)<br>$\pm 0.5^\circ$ (0.2–20 A) (1 A nominal)<br>$\pm 5^\circ$ (0.05–0.2 A) (1 A nominal) |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

$V_A, V_B, V_C, V_S$   
(wye-connected voltages):  $\pm 0.5^\circ$

$V_{AB}, V_{BC}, V_{CA}, V_S$   
(delta-connected voltages):  $\pm 1.0^\circ$

|                                                                              |                                               |
|------------------------------------------------------------------------------|-----------------------------------------------|
| MW/MVAR<br>(A, B, C, and three-phase; wye-connected voltages)                |                                               |
| MW/MVAR<br>(three-phase; open-delta connected voltages; balanced conditions) |                                               |
| Accuracy (MW/MVAR)                                                           | at load angle                                 |
| for phase current $\geq 0.2 \cdot I_{NOM}$ :                                 |                                               |
| 0.35% / –                                                                    | $0^\circ$ or $180^\circ$ (unity power factor) |
| 0.40% / 6.00%                                                                | $\pm 8$ or $\pm 172^\circ$                    |
| 0.75% / 1.50%                                                                | $\pm 30^\circ$ or $\pm 150^\circ$             |
| 1.00% / 1.00%                                                                | $\pm 45^\circ$ or $\pm 135^\circ$             |
| 1.50% / 0.75%                                                                | $\pm 60^\circ$ or $\pm 120^\circ$             |
| 6.00% / 0.40%                                                                | $\pm 82^\circ$ or $\pm 98^\circ$              |
| – / 0.35%                                                                    | $\pm 90^\circ$ (power factor = 0)             |

### Energy Meter

|                          |                                                                                                                                                                                                                                                                                                      |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accumulators:            | Separate IN and OUT accumulators updated once every two seconds, transferred to nonvolatile storage once per day.                                                                                                                                                                                    |
| ASCII Report Resolution: | 0.01 MWh                                                                                                                                                                                                                                                                                             |
| Accuracy:                | The accuracy of the energy meter depends on applied current and power factor as shown in the power metering accuracy table above. The additional error introduced by accumulating power to yield energy is negligible when power changes slowly compared to the processing rate of twice per second. |

## Synchrophasor Accuracy

### Maximum Data Rate in Messages per Second

|                                |                                                                                                                                                                                                                                                                                                                     |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IEEE C37.118 Protocol:         | 60 (nominal 60 Hz system)<br>50 (nominal 50 Hz system)                                                                                                                                                                                                                                                              |
| SEL Fast Message Protocol:     | 1                                                                                                                                                                                                                                                                                                                   |
| IEEE C37.118-2005<br>Accuracy: | Level 1 at maximum message rate when phasor has the same frequency as A-Phase voltage, frequency-based phasor compensation is enabled (PHCOMP = Y), and the narrow-bandwidth filter is selected (PMAPP = N). Out-of-band interfering frequency (Fs) test,<br>$10 \text{ Hz} \leq F_s \leq (2 \cdot \text{NFREQ})$ . |
| Current Range:                 | $(0.1-2) \cdot I_{NOM}$ ( $I_{NOM} = 1 \text{ A or } 5 \text{ A}$ )                                                                                                                                                                                                                                                 |
| Frequency Range:               | $\pm 5$ Hz of nominal (50 or 60 Hz)                                                                                                                                                                                                                                                                                 |
| Voltage Range:                 | 30 V–250 V                                                                                                                                                                                                                                                                                                          |
| Phase Angle Range:             | $-179.99^\circ$ to $180^\circ$                                                                                                                                                                                                                                                                                      |

## Harmonic Metering Accuracy

### Voltages $V_A, V_B, V_C, V_S$ (Wye or Single-Phase); $V_{AB}, V_{BC}, V_S$ (Delta)

|                                                                                 |                           |
|---------------------------------------------------------------------------------|---------------------------|
| Accuracies valid for THD < 100%, 30 V < fundamental < 200 V sec, 50 Hz or 60 Hz |                           |
| RMS and Fundamental<br>Magnitude:                                               | $\pm 5\%$                 |
| THD Percentage:                                                                 | $\pm 5$ percentage points |
| 02 Through 16<br>Harmonic Percentage:                                           | $\pm 5$ percentage points |

### Currents $I_A, I_B, I_C, I_N$

|                                                                              |                                        |
|------------------------------------------------------------------------------|----------------------------------------|
| Accuracies Valid for THD < 100%, fundamental voltage < 200 V, 50 Hz or 60 Hz |                                        |
| 5 A Nominal:                                                                 | 0.25 A < fundamental current < 5 A sec |
| 1 A Nominal:                                                                 | 0.05 A < fundamental current < 1 A sec |
| 0.2 A and 0.05 A Nominal<br>(IN channel only):                               | 0.01 A < fundamental current < 1A sec  |
| RMS and Fundamental<br>Magnitude:                                            | $\pm 5\%$                              |
| THD Percentage:                                                              | $\pm 5$ percentage points              |
| 02 Through 16<br>Harmonic Percentage:                                        | $\pm 5$ percentage points              |

## Power Element Accuracy

### Single-Phase Power Elements

|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pickup Setting<br>0.33–2 VA<br>(5 A nominal),<br>0.07–0.4 VA<br>(1 A nominal):  | $\pm 0.05 \text{ A} \cdot (\text{L-N voltage secondary})$ and<br>$\pm 10\%$ of setting at unity power factor for power elements and zero power factor for reactive power element (5 A nominal)<br>$\pm 0.01 \text{ A} \cdot (\text{L-N voltage secondary})$ and<br>$\pm 10\%$ of setting at unity power factor for power elements and zero power factor for reactive power element (1 A nominal) |
| Pickup Setting<br>2–13000 VA<br>(5 A nominal),<br>0.4–2600 VA<br>(1 A nominal): | $\pm 0.025 \text{ A} \cdot (\text{L-N voltage secondary})$ and<br>$\pm 5\%$ of setting at unity power factor (5 A nominal)<br>$\pm 0.005 \text{ A} \cdot (\text{L-N voltage secondary})$ and<br>$\pm 5\%$ of setting at unity power factor (1 A nominal)                                                                                                                                         |

### Three-Phase Power Elements

|                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pickup Setting<br>1–6 VA<br>(5 A nominal),<br>0.2–1 VA<br>(1 A nominal): | $\pm 0.05 \text{ A} \cdot (\text{L-L voltage secondary})$ and<br>$\pm 10\%$ of setting at unity power factor for power elements and zero power factor for reactive power element (5 A nominal)<br>$\pm 0.01 \text{ A} \cdot (\text{L-L voltage secondary})$ and<br>$\pm 10\%$ of setting at unity power factor for power elements and zero power factor for reactive power element (1 A nominal) |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|