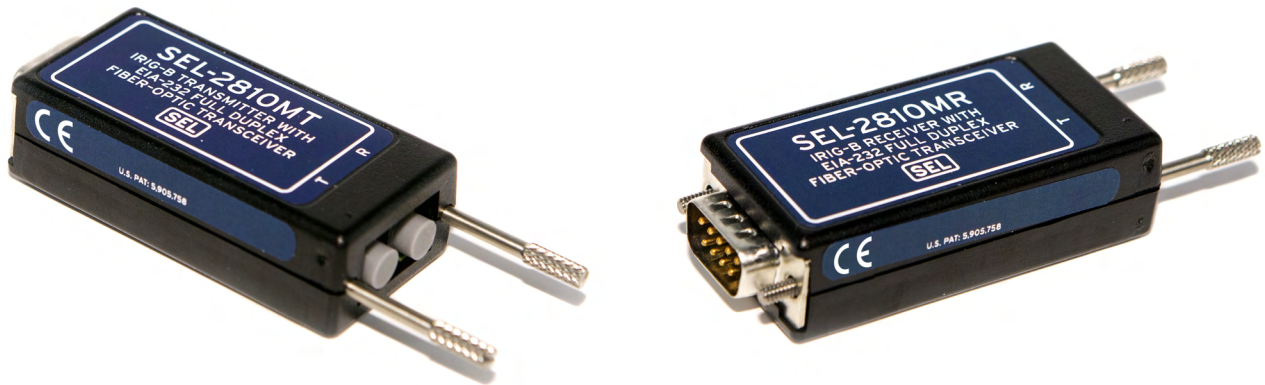




# SEL-2810 Fiber-Optic Transceivers With IRIG-B

## Fiber-Optic Transceivers for Serial Data and IRIG-B Time Signals



## Major Features and Benefits

The SEL-2810 Fiber-Optic Transceivers provide isolation from dangerous ground potential rise, prevent induced electrical noise, and eliminate signal ground loops. The elimination of electrical interfaces made possible by this product increases safety, robustness, and reliability. These transceivers are suitable for use in the harsh environment of electrical substations.

- ▶ **Easy Application.** SEL fiber-optic products are simple to install. Plug an SEL-2810 Transceiver into a standard 9-pin serial connector (DB-9). No special mounting is required.
- ▶ **Port Powered.** The SEL-2810 Transceivers are powered from the host device via the connector. They do not require a separate power supply or wiring.
- ▶ **Improved Safety.** SEL fiber-optic products provide isolation from induced voltages resulting from ground potential rise and electromagnetic induction commonly caused by control cables.
- ▶ **Increased Data and IRIG-B Time-Code Transfer Reliability.** SEL-2810 Transceivers are far less susceptible than copper links to EMI/RFI and can therefore be applied in harsh electrical and physical environments.

# Product Overview

Configuring an SEL-2810 link requires a duplex fiber-optic connection between the SEL-2810MT and the SEL-2810MR. The transmit port, T, of an SEL-2810MT sends serial communication and IRIG-B time synchroni-

zation signals to the receive port, R, of the SEL-2810MR. The transmit port, T, of the SEL-2810MR sends serial communication to the receive port, R, of the SEL-2810MT.

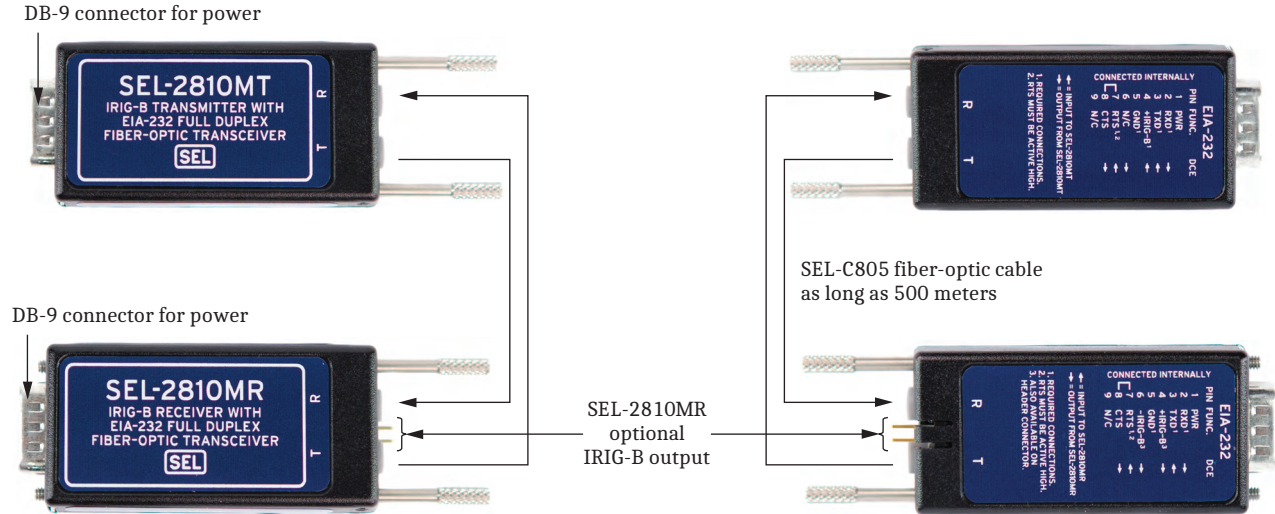


Figure 1 SEL-2810 Product Overview

## Power, Transmit, and Receive LED Indicators

The Power LED illuminates green when the minimum required power is applied to any of Pins 1, 3, 7, or 8 of the DB-9 serial port.

The Transmit and Receive LEDs flash green whenever the transmit or receive signals of the SEL-2810 fiber-optic transceiver are high to help verify the function of the transceiver product.

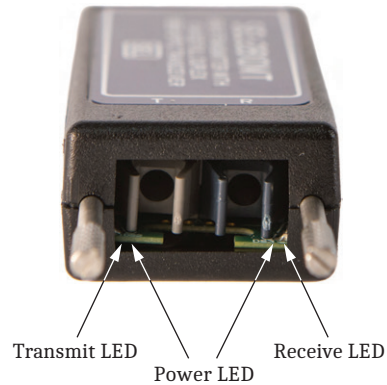


Figure 2 Power, Transmit, and Receive LEDs

## Application Examples

### SEL Information Processors and Relays

You can use an SEL-2810MT/SEL-2810MR pair to connect an SEL information processor to a relay, lower-tier communications processor, or logic processor by mounting the SEL-2810MT on the information processor, mounting the SEL-2810MR on the other device, and connecting the two transceivers with a duplex fiber-optic

cable. In addition, you can connect an adapter cable between the IRIG-B output of the SEL-2810MR and the IRIG-B input of the remote device. The SEL information processors communicate with connected devices via interleaved ASCII and binary messages over the full-duplex serial link through use of the same fibers that are also synchronizing the device clocks with simplex IRIG-B signals.

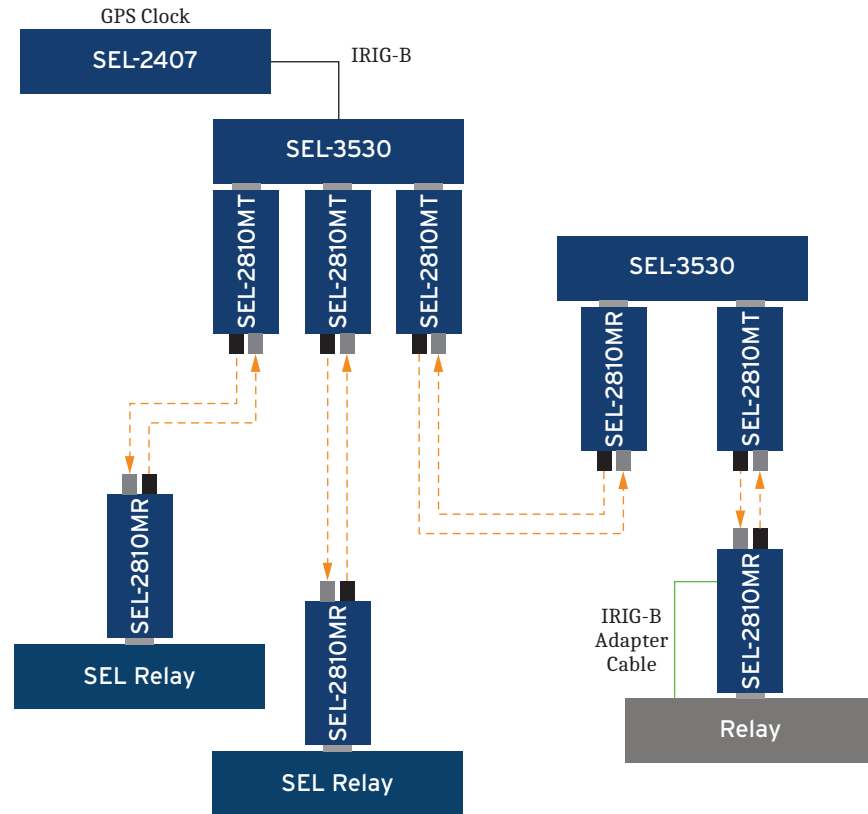


Figure 3 Information Processor to IED Example

## SEL Logic Processors and Relays

Connect SEL-2810MT Fiber-Optic Transceivers to the serial ports of a relay and an SEL-3530 Real-Time Automation Controller (RTAC) or an SEL-2100 Logic Processor to provide the framework for the following tasks:

- Use SEL MIRRORING BITS<sup>®</sup> communications for high-speed exchange of protection information
- Coordinate protection between generating plants and associated switchyards or among multiple control houses or enclosures in the same station
- Transfer to backup protection based on loss of potential or failures detected by diagnostic tests
- Keep dc circuits segregated between cabinets
- Provide directional element-based bus protection

## Application Information

### Determining Maximum Cable Length

You must use 200  $\mu\text{m}$  diameter cable with the SEL-2810. The maximum cable length for an application is based on the optical power budget and the typical fiber loss. The power budget includes the transmit and receive connector coupling loss, so you can determine the maximum cable length by dividing the total optical power budget by the typical fiber loss/km specification.

$$\text{Maximum Cable Length} = \frac{\text{Power Budget}}{\text{Fiber Loss}}$$

To calculate the maximum cable length for your application, first ask your fiber cable supplier for fiber loss/km and connector/splice loss specifications (over the expected temperature range) based on a 650 nm wavelength optical source. Calculate the available optical power budget by subtracting the total connector/splice attenuation from 9 dB (the power budget specification for the SEL-2810). Divide the available optical power budget by the fiber loss/km specification to determine the maximum cable length.

## Example

Fiber Type:	200 $\mu$ m
Splice Loss (Mechanical):	0.4 dB/splice
Fiber Loss @ 650 nm	12 dB/km
SEL-2810 Optical Budget:	9 dB
Less Splice Loss (4 • 0.4 dB):	1.6 dB
Available Power:	7.4 dB
Maximum Cable Length:	7.4 dB / 12 dB/km = 0.62 km

## Intrastation Example

Intrastation applications are typically very simple and consist of two fiber-optic devices connected by a patch cord. The primary benefit of an intrastation application is

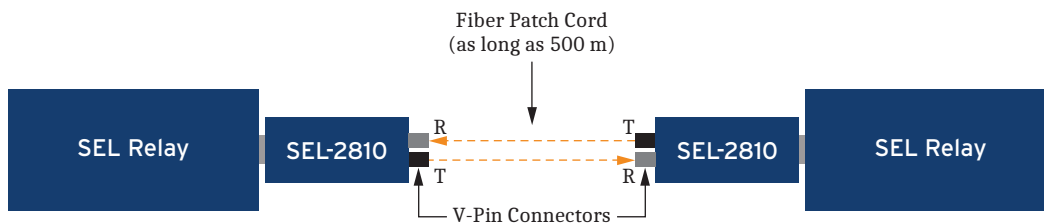


Figure 4 Intrastation Communications Using SEL-2810 Transceivers

## Connecting to Serial Ports

Plug the SEL-2810 directly onto a standard 9-pin serial connector (DB-9). No special mounting is required and the transceiver requires no jumpers or settings. Power is received from the host device via the connector—no separate power supply or wiring is needed. A single pair of fibers handles a full-duplex serial data link.

## IRIG-B Adapter Cables

The SEL-2810MR and SEL-2810FR include a two-pin Molex connector for IRIG-B connections to IEDs that do not accept the IRIG-B signal from Pins 4 and 6 of the DB-9 connector. Use SEL adapter cables SEL-C651 and SEL-C652, which are configured as follows.

- SEL-C651: 2-pin (Molex) to BNC
- SEL-C652: 2-pin (Molex) to DB-9

the replacement of metallic cables between two EIA-232 devices. Fiber-optic transceivers also allow application of EIA-232 connections and IRIG-B time distribution longer than the specified 50-foot limitation. The SEL-2810 is a simple, inexpensive solution for these applications.

To calculate the viability of an intrastation system that is 0.5 km (1640 ft) long and configured as shown in Figure 4, perform the following steps:

Step 1. Calculate the fiber attenuation:

$$\begin{aligned} \text{Cable attenuation for 650 nm} &= 12 \text{ dB/km} \\ 0.5 \text{ km} \cdot 12 \text{ dB/km} &= 6 \text{ dB} \end{aligned}$$

Step 2. Subtract the total losses from the system gain:

$$\begin{aligned} 9 \text{ dB} - 6 \text{ dB} &= 3 \text{ dB} \\ [\text{system gain} - \text{fiber loss} &= \text{system margin}] \end{aligned}$$

If the fiber loss adds as much as 9 dB or higher, then the system is not viable.

## Depth-Restricted Adapter Cables

When mounting depth is an issue, such as in switchgear applications, use an SEL-C780, SEL-C641, or SEL-C641R adapter cable. The SEL-C780 is a 6-inch ribbon cable that allows the fiber transceiver to be mounted at a 90-degree angle to the mating DB-9 host connector. The SEL-C641 (shielded) and SEL-C641R (double-shielded with metal connector housings) cables are configurable in length and allow for mounting of the SEL-2810 Transceiver as far as 1.8 m (6.0 ft) away from the DB-9 host connector.

- SEL-C780: 15.24 cm (6.00 in), low-profile adapter cable, DB-9 male to DB-9 female
- SEL-C641: 0.3 to 1.8 m (1.0 to 6.0 ft) shielded adapter cable, DB-9 male to DB-9 female
- SEL-C641R: 0.3 to 1.8 m (1.0 to 6.0 ft) double-shielded adapter cable, DB-9 male to DB-9 female

# Transceiver Mounting Options

Use an SEL Transceiver Mounting Kit and adapter cable when connecting the SEL-2810 to IEDs with an RJ45 male serial connector or when the mounting depth is an issue (e.g., in switchgear applications). These kits provide a simple and secure way to remotely mount the transceiver away from the host connector.

- 915900573: Mounting kit for SEL transceiver; includes mount only
- 915900574: Mounting kit for SEL transceiver; includes mount and SEL-C478A cable (6 ft, DB-9 female to RJ45 male)
- 915900575: Mounting kit for SEL transceiver; includes mount and SEL-C641 cable (6 ft, DB-9 female to DB-9 male)



Figure 5 Transceiver Mount

# Safety Information

## CAUTION

To ensure proper safety and operation, the equipment ratings and installation instructions must be checked before commissioning or maintenance of the equipment. It is the responsibility of the user to ensure that the equipment is installed, operated, and used for its intended function in the manner specified in this data sheet. If misused, any safety protection provided by the equipment may be impaired.

## Fiber-Optic Port

The SEL-2810 uses a fiber-optic transmitter. When working with this device, observe the following safety precautions:

- Do not perform any procedures or adjustments that this data sheet does not describe.
- Do not use controls or adjustments, or perform procedures, other than those specified in this data sheet.
- Incorporated components, such as transceivers and laser emitters, are not user serviceable. Return units to SEL for repair or replacement.

# Power Requirements

## CAUTION

SEL fiber-optic transceivers have combinations of input/output pins jumpered or shorted together. Ensure that these connections will not harm the device to which you want to attach the transceiver.

The SEL-2810 has the following power specifications:

- Operating Voltage: 5–10 Vdc
- Typical Current Draw: <15 mA

The transceiver draws power from the EIA-232 data as shown in *Table 1*

Table 1 Transmit Data Power Input

Pin	Signal
3	DCE

The transceiver additionally draws power per *Table 2*.

Table 2 Other Power Input

Pin	Voltage (Vdc)
1	+5 to +10
7	±5 to ±10

Figure 6 shows the transceiver rear label, which indicates the internally jumpered pins, pinouts, and signal names.

EIA-232			
CONNECTED INTERNALLY	PIN	FUNC.	DCE
	1	PWR	
	2	RXD <sup>1</sup>	→
	3	TXD <sup>1</sup>	←
	4	+IRIG-B <sup>3</sup>	→
	5	GND <sup>1</sup>	
	6	-IRIG-B <sup>3</sup>	→
	7	RTS <sup>1,2</sup>	←
	8	CTS	→
	9	N/C	

← = INPUT TO SEL-2810MR  
→ = OUTPUT FROM SEL-2810MR

1. REQUIRED CONNECTIONS.  
2. RTS MUST BE ACTIVE HIGH.  
3. ALSO AVAILABLE ON HEADER CONNECTOR.

R T

Figure 6 SEL-2810 Signal Flow

## Troubleshooting

Problem	Possible Cause	Solution
The transceiver LEDs are dark.	Input power is not present	Verify that connected IED device is powered on.
The transceiver does not communicate data.	Wiring error	Verify fiber connections. Verify connecting port is DTE-compliant.

# Dimensions

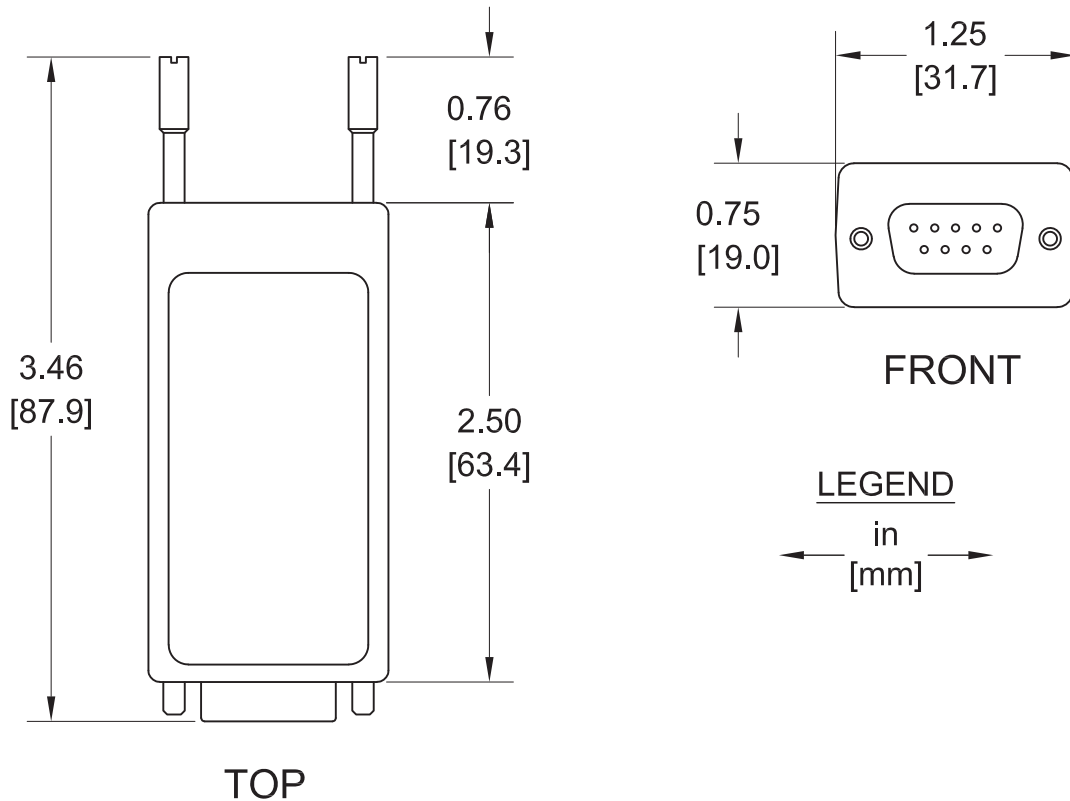


Figure 7 SEL-2810 Dimensions

# Specifications

## Compliance

Designed and manufactured under an ISO 9001 certified quality management system

CE Mark

UKCA Mark

CFR 47 Part 15 Class A

**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 operating 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 may be likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. Any changes or modifications not expressly approved by the manufacturer can void the user's authority to operate the equipment.

## General

### Data Rate

As high as 20 kbps, full duplex, no jumpers or settings

### Link Data Delay

Serial Data: 50  $\mu$ s + 5  $\mu$ s/km of fiber

IRIG-B Time Code: 80  $\mu$ s + 5  $\mu$ s/km of fiber

**Note:** Link includes two transceivers and fibers.

## Optical Source

650 nm (visible red) LED

Typical Transmit Level: -24 dBm

Maximum Output Level: -10 dBm

## IRIG-B Connections

Two-position Molex connector on rear of transceiver

## Projection From DB-9 Connector

127 mm (5 in) typical, including fiber-optic connector and minimum cable bend radius

## Power Requirements

The SEL-2810 can be powered from Pin 1, 3, or 7 of its DB-9 connector

Pin 1 Power: +5 to +10 Vdc

Pin 3, 7 Power:  $\pm$ 5 to  $\pm$ 10 Vdc

Maximum Current Draw: 15 mA

## Fiber-Optic Cables and Connectors

V-Pin connectors

Multimode fiber (200  $\mu$ m)

SEL offers compatible SEL-C805 multimode 200  $\mu$ m core fiber-optic cables as orderable accessories.

## Environmental

### Operating Environment

Indoor Use Only

Insulation Class 3

Pollution Degree 2

Overvoltage Category 2

Operating Temperature:  $-40^{\circ}$  to  $+85^{\circ}\text{C}$  ( $-40^{\circ}$  to  $+185^{\circ}\text{F}$ )

Non-Operating Temperature:  $-40^{\circ}$  to  $+85^{\circ}\text{C}$  ( $-40^{\circ}$  to  $+185^{\circ}\text{F}$ )

Relative Humidity: 0%–95%, noncondensing

Altitude: 2000 m (6562 ft)

## Type Tests

### Electromagnetic Compatibility General

#### Measuring Relays and

Protection Equipment: IEC 60255-26:2013

### Electromagnetic Compatibility Emissions

Radiated and Conducted Emissions: IEC 60255-26:2013, Clause 7.1  
EN 60255-26:2013, Clause 7.1  
CISPR 22:2008  
EN 55022:2010  
CISPR 11:2009 + A1:2010  
EN 55011:2009 + A1:2010  
Canada ICES-001 (A) / NMB-001 (A)

### Electromagnetic Compatibility Immunity

Conducted RF Immunity: IEC 60255-26:2013, Clause 7.2.8  
EN 60255-26:2013, Clause 7.2.8  
IEC 61000-4-6:2008  
Severity Level: 10 V unmodulated, open circuit equivalent

Radiated RF Immunity: IEC 60255-26:2013, Clause 7.2.4  
EN 60255-26:2013, Clause 7.2.4  
IEC 61000-4-3:2006 + A1:2007 + A2:2010  
Severity Level: 10 V/m  
IEEE C37.90.2-2004  
Severity Level: 20 V/m

### Power Frequency

Magnetic Field Immunity: EN 60255-26:2013, Clause 7.2.10  
IEC 61000-4-8:2009  
Severity Level 5: 100 A/m >60 seconds;  
1000 A/m 1 to 3 seconds; 50/60 Hz

### Electrostatic Discharge

Immunity: IEC 60255-26:2013, Clause 7.2.3  
EN 60255-26:2013, Clause 7.2.3  
IEC 61000-4-2:2008  
Discharge Severity Level:  
 $\pm 2, 4, 6, 8$  kV contact;  
 $\pm 2, 4, 8, 15$  kV air  
IEEE C37.90.3-2001  
Discharge Severity Level:  
 $\pm 2, 4, 8$  kV contact;  
 $\pm 4, 8, 15$  kV air

## Environmental

Cold: IEC 60068-2-1:2007  
Severity: 16 hours at  $-40^{\circ}\text{C}$

Dry Heat: IEC 60068-2-2:2007  
Severity Level: Test Bd; 16 hours at  $+85^{\circ}\text{C}$

Damp Heat, Steady State: IEC 60068-2-78:2012  
Severity Level: Test Cab; 10 days,  $40^{\circ}\text{C}$ , 93% RH

Damp Heat, Cyclic: IEC 60068-2-30:2005  
Severity Level: Test Db, Variant 2; 12 hr at  $25^{\circ}\text{C}$  + 12 hr at  $55^{\circ}\text{C}$ , 95% RH, 6 cycles

Vibration: IEC 60255-21-1:1988  
Severity Level: Class 1 Endurance; Class 2 Response

Shock and Bump: IEC 60255-21-2:1988  
Severity Level: Class 1 Shock Withstand, Bump; Class 2 Shock Response

Seismic: IEC 60255-21-3:1993  
Severity Level: Class 2 Quake Response

## Safety

Measuring Relays and Protection Equipment: IEC 60255-27:2014

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**SCHWEITZER ENGINEERING LABORATORIES, INC.**

2350 NE Hopkins Court • Pullman, WA 99163-5603 U.S.A.

Tel: +1.509.332.1890 • Fax: +1.509.332.7990

selinc.com • info@selinc.com

