



SEL-3405 High-Accuracy IRIG-B Fiber-Optic Transceiver

Accurate IRIG-B Over Fiber Optics



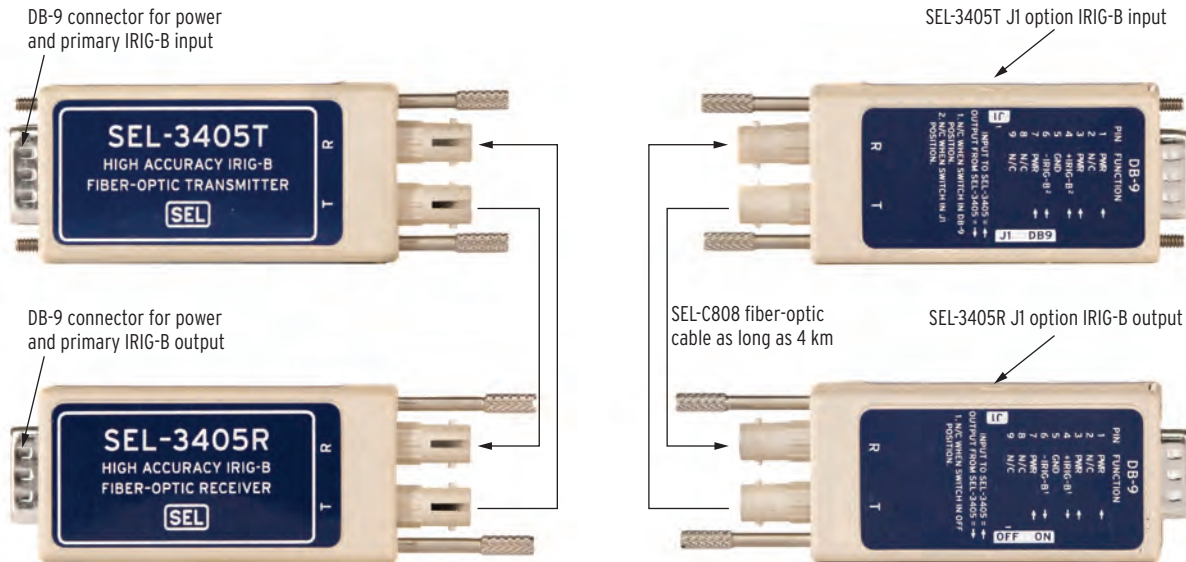
Major Features and Benefits

The SEL-3405 High-Accuracy IRIG-B Fiber-Optic Transceiver can send high-accuracy demodulated IRIG-B timing signals to hard-to-reach locations. The SEL-3405T receives a demodulated IRIG-B signal from a high-accuracy clock and sends the signal over multimode fiber-optic cable as long as 4 km to an SEL-3405R that receives the IRIG-B signal and converts it into an electrical signal for the end device. The SEL-3405 automatically compensates for the signal delay of the fiber-optic link to maintain better than 200 ns of accuracy from the time source to the end device. The SEL-3405 provides a solution when accurate time is required, but installing a satellite-synchronized clock is not feasible because a clear view of the sky is unavailable.

- ▶ **Send IRIG-B Signals Over Fiber-Optic Cables Without Compromising Accuracy.** The SEL-3405 transfers IRIG-B time code over fiber-optic cabling and compensates for signal-propagation delays through the device and fiber-optic cables.
- ▶ **Apply Easily.** This device requires no settings. Simply plug the SEL-3405 into the DB-9 port of a high-accuracy clock to send time to a downstream device.
- ▶ **Increase Reliability.** This device can be applied in harsh environments. The SEL-3405 has an operating range of -40° to $+85^{\circ}\text{C}$ and is hardened to provide isolation in extra-high-voltage (EHV) environments. The SEL-3405 provides additional resistance to electromagnetic interference near disconnect switches.
- ▶ **Provide Isolation to Timing Signals.** The SEL-3405 sends IRIG-B over fiber-optic cables instead of copper to provide isolation against electrical interference.
- ▶ **Support Multiple Devices.** The SEL-3405 provides precise time of better than 1 μs accuracy in a ring configuration for as many as three devices. You can support additional devices for sub-millisecond timing applications.
- ▶ **Receive Accurate Time Where Unobstructed Access to a GPS Satellite Is Unavailable.** A clear and unobstructed view of the sky is required to receive satellite signals that allow a satellite-synchronized clock to provide accurate time. Apply the SEL-3405 Transceiver when a clear view of the sky is not available.

Product Overview

Configuring an SEL-3405 link requires two fiber-optic connections between the SEL-3405T and the SEL-3405R. For the first link, the transmit port, T, of the SEL-3405T sends IRIG-B to the receive port, R, of the SEL-3405R. The second link calculates propagation time for cable delay compensation and runs from the SEL-3405R T port to the SEL-3405T R port.



IMPORTANT: The SEL-3405 requires the second link for proper operation and will not operate without this link.

Standard Features

- Support for demodulated IRIG-B formats B000 and B004
- Input-to-output accuracy of better than 200 ns per link

- Reliable operation for EHV environments
- Automatic cable delay compensation

Powering Options

The SEL-3405 can receive power through Pins 1, 3, or 7 of its DB-9 connector. The maximum current draw is 14 mA.

The SEL-C942 Cable shown in *Figure 1* includes a female DB-9 connector for connecting to the SEL-3405. This cable has tinned wires for connecting the SEL-3405 to an external power source and a BNC male connector for the IRIG-B signal. This cable works in conjunction with the SEL-9321 Low-Voltage DC Power Supply to provide external power when power is unavailable through an intelligent electronic device (IED) or a clock serial port.



Figure 1 SEL-C942 Cable for an External Power Source

The SEL-3405 will work in conjunction with the SEL-3400 IRIG-B Distribution Module to send IRIG-B signals to multiple devices. The SEL-C940 Cable shown in *Figure 2* includes a female DB-9 connector for connecting to the SEL-3405. The cable provides two male BNC connectors for power and IRIG-B signals. Connect one BNC connector to **OUT 1** of the SEL-3400, set DIP SW 16 of the SEL-3400 to the **ON** position, and connect the other BNC connector to one of the IRIG-B ports on the SEL-3400. The SEL-3405R will send time to the

IRIG-B input of the SEL-3400, and the SEL-3405T will receive time from an IRIG-B output of the SEL-3400.



Figure 2 SEL-C940 Cable for Use With an SEL-3400

Applications

Connecting the SEL-3405T to the SEL-2401

When connecting to the SEL-2401 Satellite-Synchronized Clock, use the SEL-9321 Power Supply to power the SEL-3405T. Provide IRIG-B input and power to the SEL-3405T with an SEL-C942 Cable. Connect the SEL-2401 Clock's BNC port to the BNC connector of the SEL-C942 Cable to send an IRIG-B signal to an SEL-3405T. The SEL-3405R provides IRIG-B out on Pins 4 and 6 of the DB-9 port.

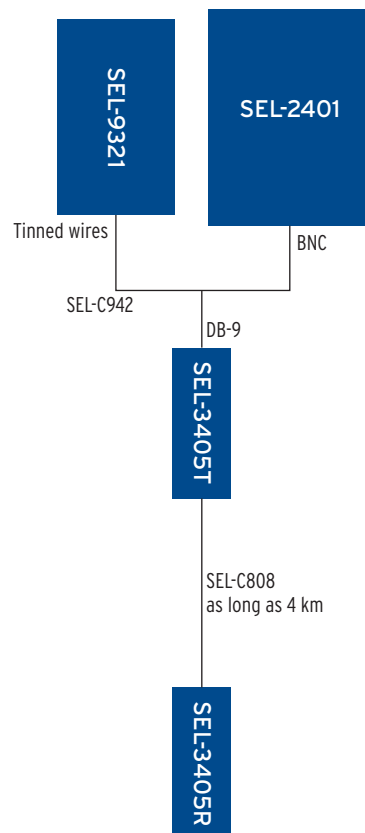


Figure 3 Connecting an SEL-3405T to an SEL-2401

Connecting the SEL-3405T to the SEL-2407

Use the SEL-2407[®] Satellite-Synchronized Clock serial port to power the SEL-3405T as well as provide an IRIG-B signal through an SEL-C654 Cable. The SEL-C654 Cable provides an IRIG-B signal through the use of the **J1** mono jack on the side of the SEL-3405. Use the SEL-2407 Clock's serial port to provide power and an IRIG-B signal to the SEL-3405T. The IRIG-B signal from the SEL-2407 DB-9 port is accurate to within $\pm 1 \mu\text{s}$ peak. If higher accuracy is required, use an SEL-2407 BNC port. Use the SEL-C654 Cable to connect the **J1** port of the SEL-3405T to a BNC port of the SEL-2407. Set the side switch on the SEL-3405T to **J1**.

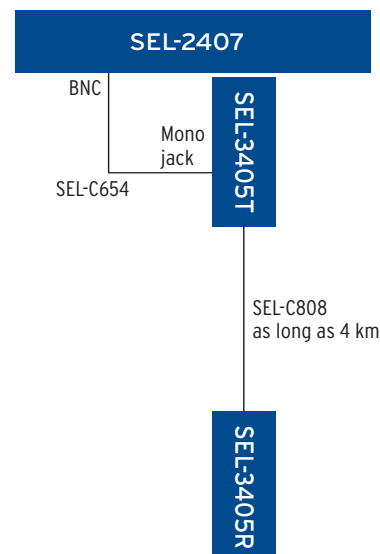


Figure 4 Connecting an SEL-3405T to an SEL-2407

The SEL-3405T can connect directly to an SEL-2407 without an SEL-C654 Cable. In such a connection, the SEL-3405T will receive both power and IRIG-B from the DB-9 port, but an IRIG-B signal from the SEL-2407 DB-9 port is accurate to within $\pm 1 \mu\text{s}$ peak.

Connecting the SEL-3405T to the SEL-2488

The SEL-2488 Satellite-Synchronized Network Clock can provide power through Pin 1 of its serial port. Connect the SEL-3405T directly to the SEL-2488 serial port to obtain power and IRIG-B input. The IRIG-B signal from the SEL-2488 DB-9 port is accurate to within ± 100 ns peak.

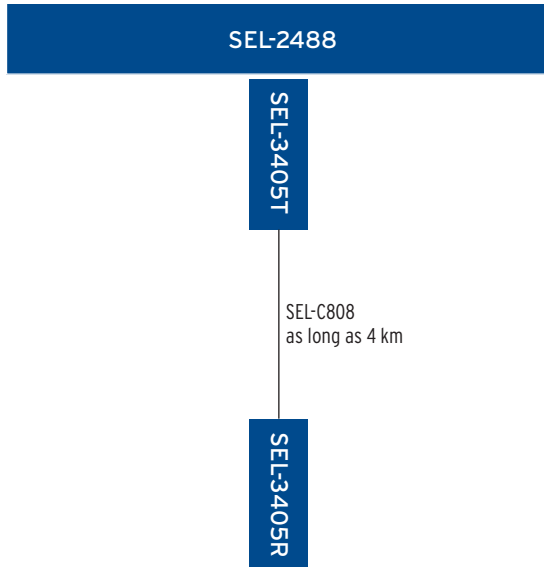


Figure 5 Connecting an SEL-3405T to an SEL-2488

Synchronizing IEDs With SEL-3405R

The SEL-3405 receives an IRIG-B signal from a fiber-optic link and transmits an IRIG-B signal on Pins 4 and 6 of a DB-9 connector. The SEL-3405R can obtain power from Pin 1 of an SEL IED that has +5 Vdc on Pin 1 of its DB-9 connector, as seen in *Figure 6*. If Pin 1 power is unavailable, you can use an SEL-C942 Cable with an SEL-9321 for power and IRIG-B output, as seen in *Figure 7*. The SEL-3405R can also provide an IRIG-B signal to an SEL-3400 and receive power from an SEL-3400 BNC port by using an SEL-C940 Cable, as seen in *Figure 8*.

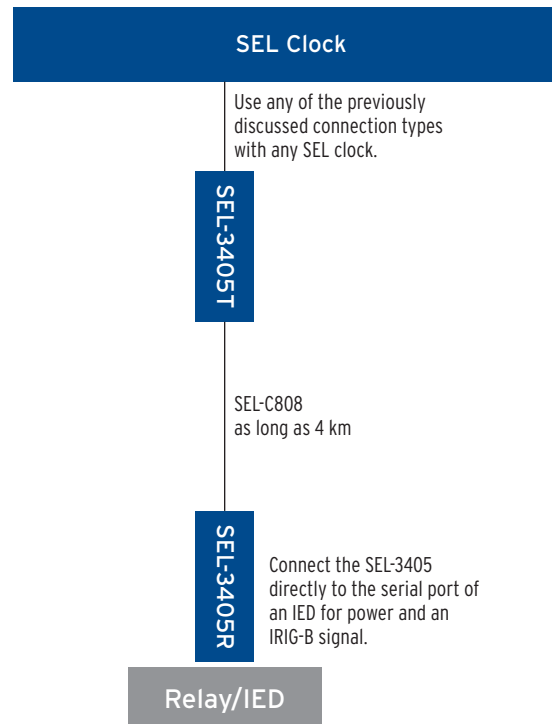


Figure 6 Connecting an SEL-3405R Directly to the DB-9 Port of an IED

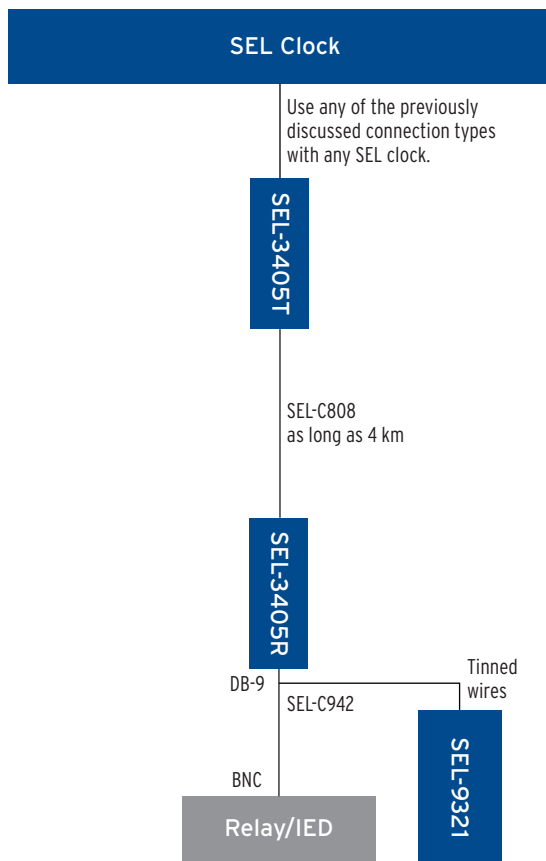


Figure 7 Connecting an SEL-3405R to an IED That Uses an External Power Source

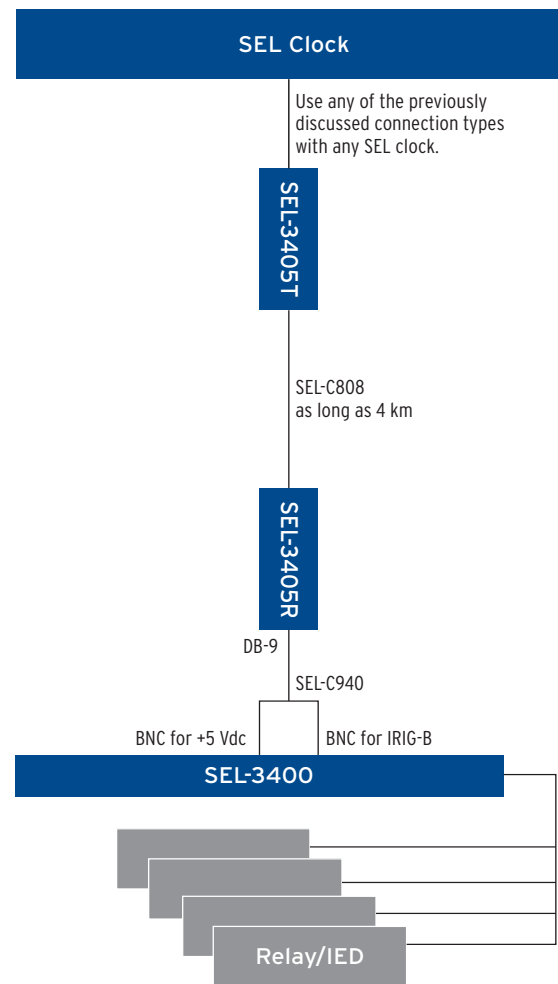


Figure 8 Connecting an SEL-3405R to an SEL-3400

Connecting and Disconnecting Fiber-Optic Cables

For ST[®] connectors not connected to a fiber-optic cable, cover the end with a supplied connector cap to prevent reflected light from appearing as a received message.

Application Examples

Clock and end device locations can vary within a site, and it is sometimes difficult to install a clock in the same physical space as its end devices. Use the SEL-3405 to transfer IRIG-B time code across distances where running coaxial IRIG-B cabling is unrealistic or when installing an antenna is unfeasible because you lack a clear view of the sky. Connect the SEL-3405 to both the clock and the end device and, with no settings, your device will receive a high-accuracy IRIG-B signal.

Extend Your Timing Network

With coaxial cables, IRIG-B time code can be distributed as far as 500 feet. Use the SEL-3405 to connect two SEL-3400 devices and extend your IRIG-B timing signal to locations that traditional coaxial cables cannot reach.

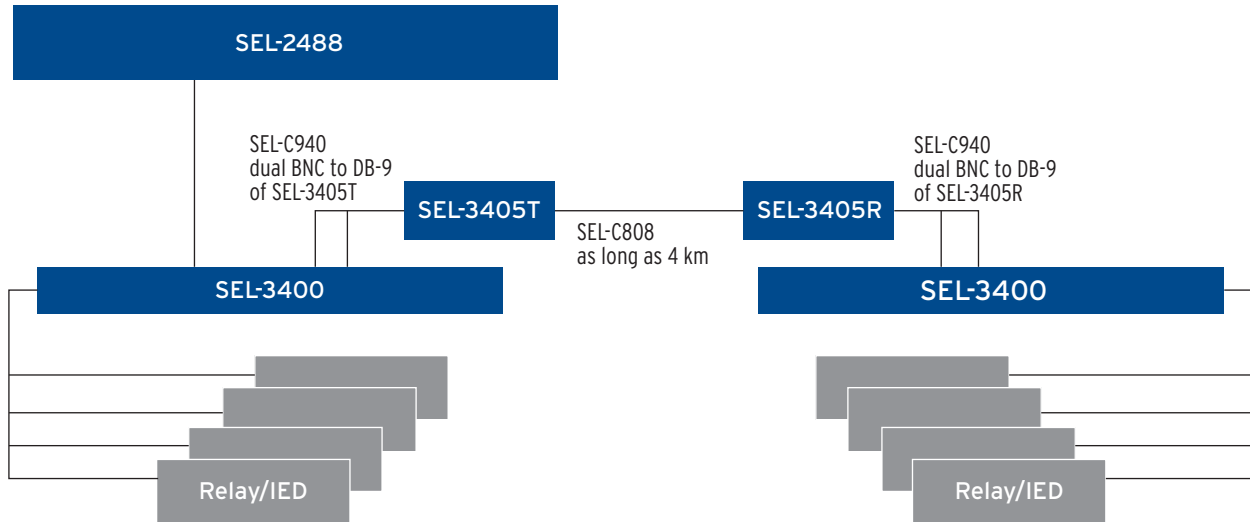


Figure 9 Extend IRIG-B Timing Network

Time-Synchronization Ring With the SEL-3405

Connect the SEL-3405R in a ring of as many as three SEL-3405R transceivers and maintain a timing accuracy of better than $1 \mu\text{s}$. Provide an IRIG-B signal to the first SEL-3405R through a single fiber-optic cable from the SEL-3405T T port to the SEL-3405R R port. Connect the T port of the first SEL-3405R to the R port of the second SEL-3405R. Connect the last SEL-3405R R port to the T port of the second SEL-3405R and connect the T port of the last SEL-3405R to the R port of the SEL-3405T to complete the ring. The end devices must be within 20 m of each other to maintain $1 \mu\text{s}$ accuracy. You can extend the ring to hundreds of devices while maintaining an accuracy of 1 ms.

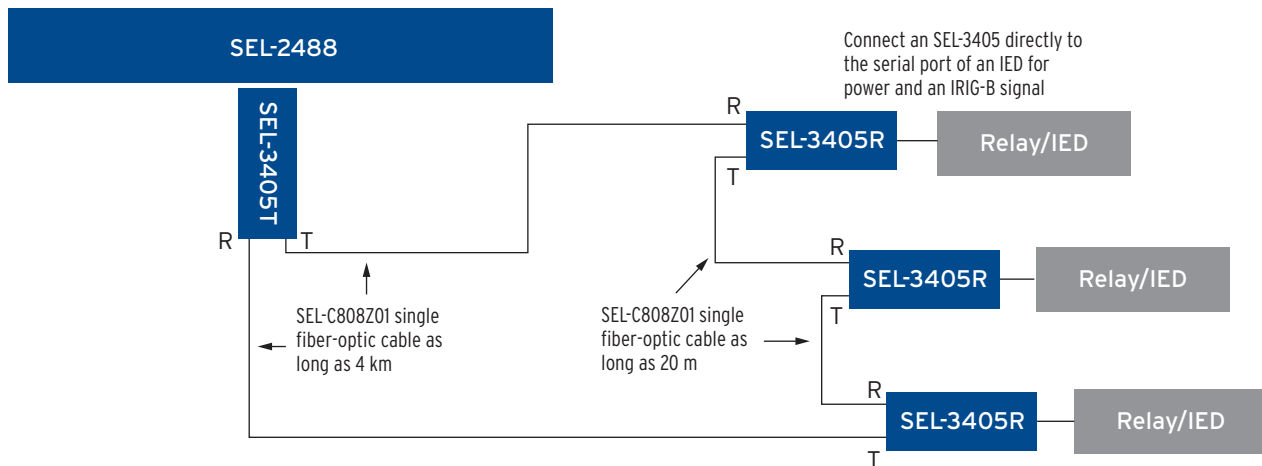


Figure 10 SEL-3405 Timing Ring

Transceiver Dimensions

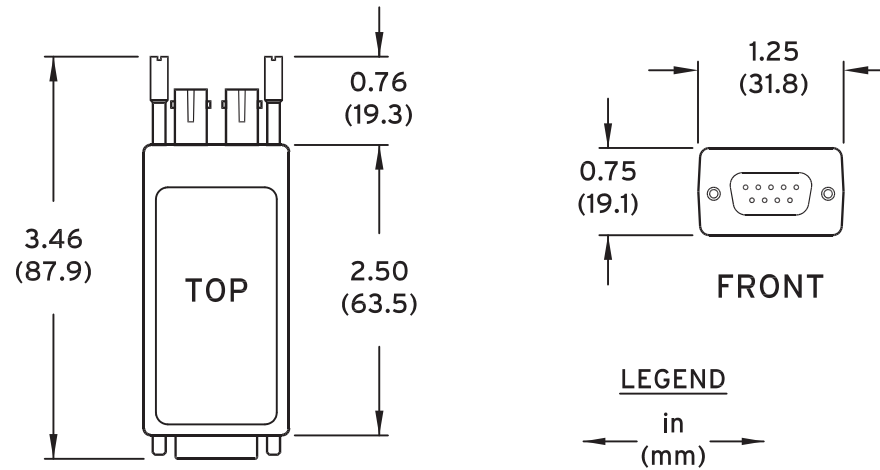


Figure 11 SEL-3405 Dimensions

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

CE Mark

FCC CFR 47 Part 15 Class A

General

Accuracy

< 200 ns

Optical Source

850 nm (infrared) VCSEL Transmitter

Typical Transmit Level: -12.0 dBm

Maximum Output Level: -3.0 dBm

Projection From DB-9 Connector

127 mm (5.0 in) typical, including fiber-optic connector and minimum cable bend radius

Power Requirements

The SEL-3405 can be powered from Pin 1, 3, or 7 of its DB-9 connector.

Pin 1 Power Requirement: + 5–10 Vdc

Pin 3 or 7 Power Requirement: \pm 5–10 Vdc

Maximum Current Draw: 14 mA

Fiber-Optic Cable and Connectors

ST Connectors

Multimode Fiber (50–200 μ m)

SEL provides compatible SEL-C808 Multimode 62.5/125 μ m Core Fiber-Optic Cables.

Warranty

10 Years

Environmental

Temperature

Operating: -40° to +85°C (-40° to +185°F)

Non-Operating: -40° to +85°C (-40° to +185°F)

Relative Humidity: 0 to 95% noncondensing

Altitude: 2000 m

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

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

Power Frequency Magnetic Field Immunity:	IEC 60255-26:2013; Clause 7.2.10 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 Tests

Cold:	IEC 60068-2-1:2007 Severity Level: 16 hours at -40°C
Dry Heat:	IEC 60068-2-2:2007 Severity Level: Test Bd; 16 Hours at $+85^{\circ}\text{C}$
Damp Heat, Cyclic:	IEC 60068-2-30:2005 Severity Level: Test Db; Variant 2; 12 Hr @ 25°C + 12 Hr @ 55°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
Laser Safety:	21 CFR 1040.10 IEC 60825-1

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This product is covered by the standard SEL 10-year warranty. For warranty details, visit www.selinc.com or contact your customer service representative.

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