



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

Accurate IRIG-B Over Fiber Optics



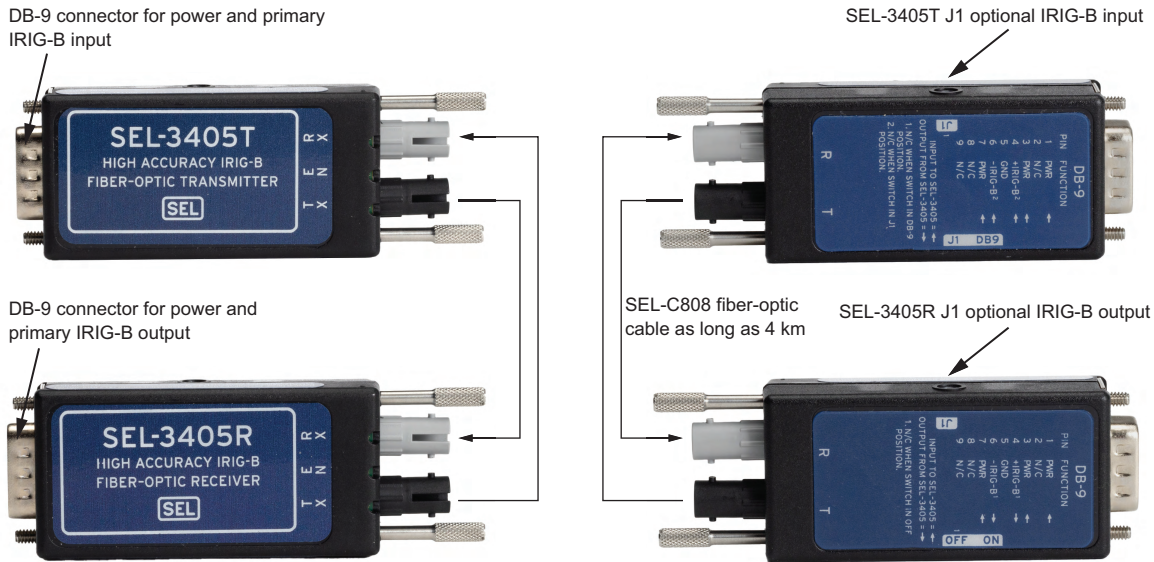
Major Features and Benefits

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 $1\ \mu\text{s}$ 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 the high-accuracy clock must be located long distances away from end devices in order to have a clear view of the sky.

Product Overview

Configuring an SEL-3405 link requires two fiber-optic connections between the SEL-3405T and the SEL-3405R to enable automatic cable delay compensation. 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 return 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 both fiber-optic links to enable automatic cable delay compensation. Pass-through mode will be enabled with only a single fiber-optic connection between an SEL-3405T T port and an SEL-3405R R port.

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 15 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.

The SEL-C941 Cable shown in *Figure 3* includes a female DB-9 connector for connecting the SEL-3405 and provides an in-line, low-voltage +5 Vdc power supply. The cable has a single male BNC connector for IRIG-B

signals. This cable will provide external power when power is unavailable through an IED or a clock serial port.



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



Figure 3 SEL-C941 Cable for an External Power Source

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.

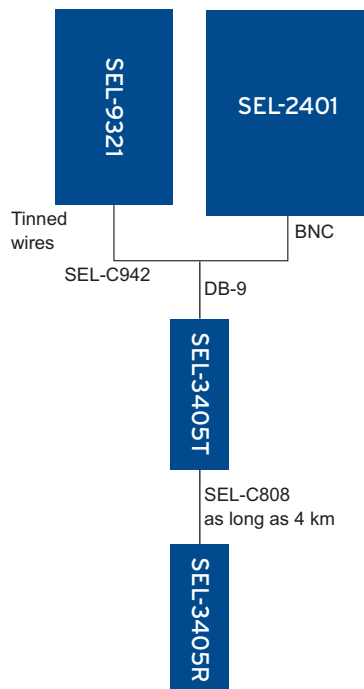


Figure 4 Connecting an SEL-3405T to an SEL-2401

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. 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.

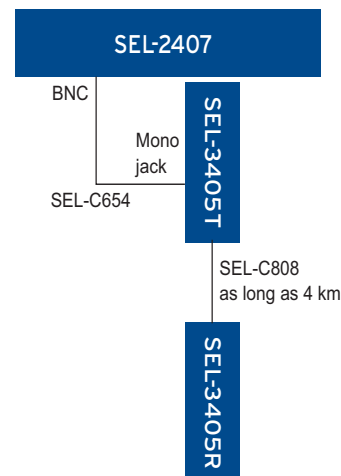


Figure 5 Connecting an SEL-3405T to an SEL-2407

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. 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 the SEL-C654 Cable with an SEL-2407 BNC port.

Connecting the SEL-3405T to the SEL-2488

The SEL-2488 Satellite-Synchronized Network Clock can provide an IRIG-B signal directly from any demodulated output within ± 100 ns peak accuracy. Connect the SEL-3405T to the SEL-2488 using the SEL-C942, as previously discussed with the SEL-2401 and shown in *Figure 4*, to provide remote devices with high-accuracy timing over multimode fiber-optic cable as-long-as 4 km.

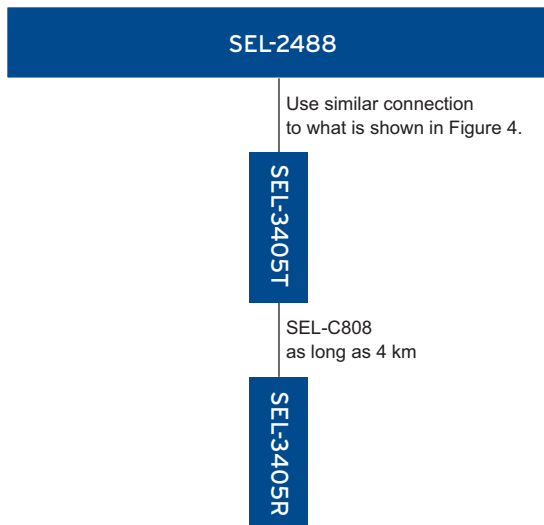


Figure 6 Connecting an SEL-3405T to an SEL-2488

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 7*. 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 8*. 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 9*.

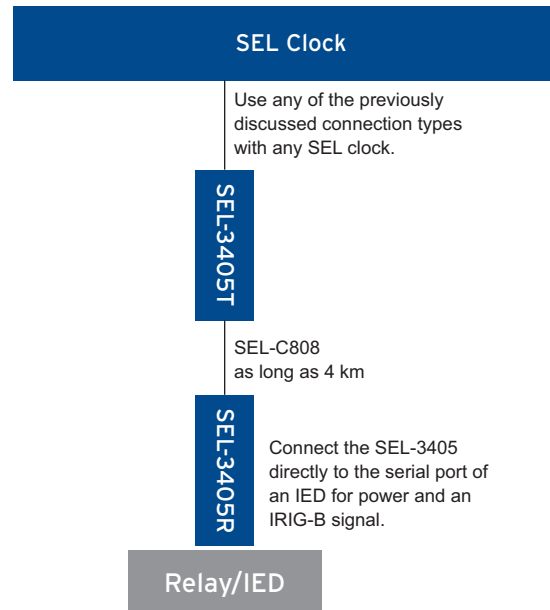


Figure 7 Connecting an SEL-3405R Directly to the DB-9 Port of an IED

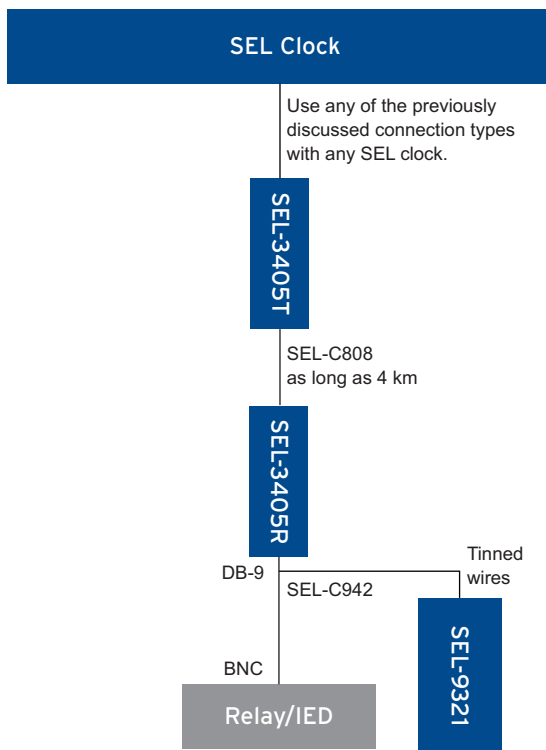


Figure 8 Connecting an SEL-3405R to an IED That Uses an External Power Source

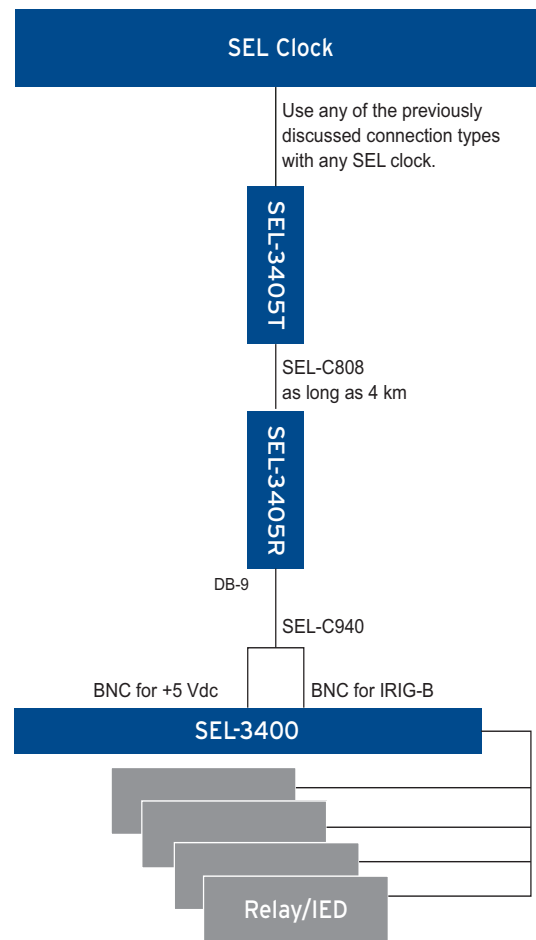


Figure 9 Connecting an SEL-3405R to an SEL-3400

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.

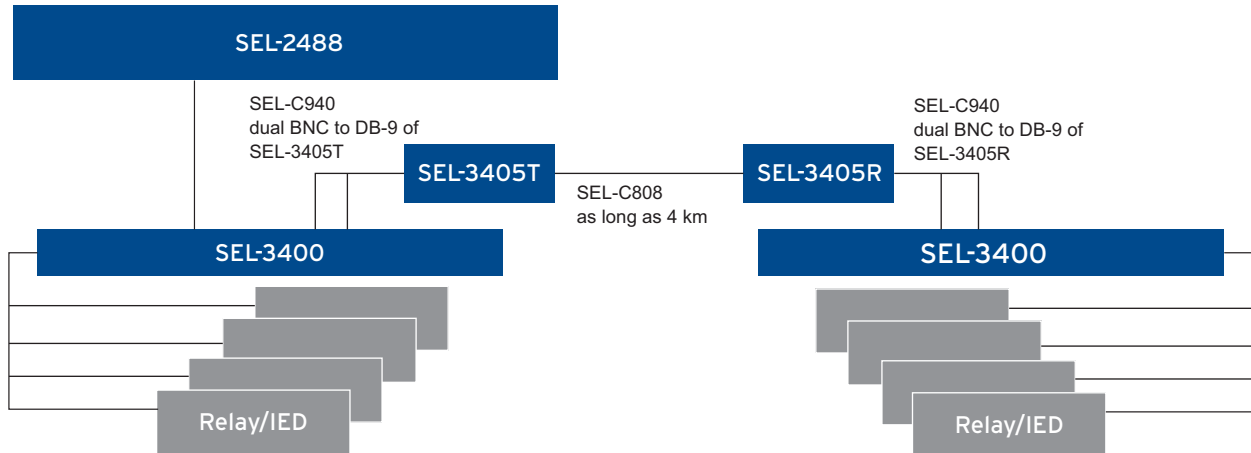


Figure 10 Extend IRIG-B Timing Network

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 μ 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 μ s accuracy. You can extend the ring to hundreds of devices while maintaining an accuracy of 1 ms.

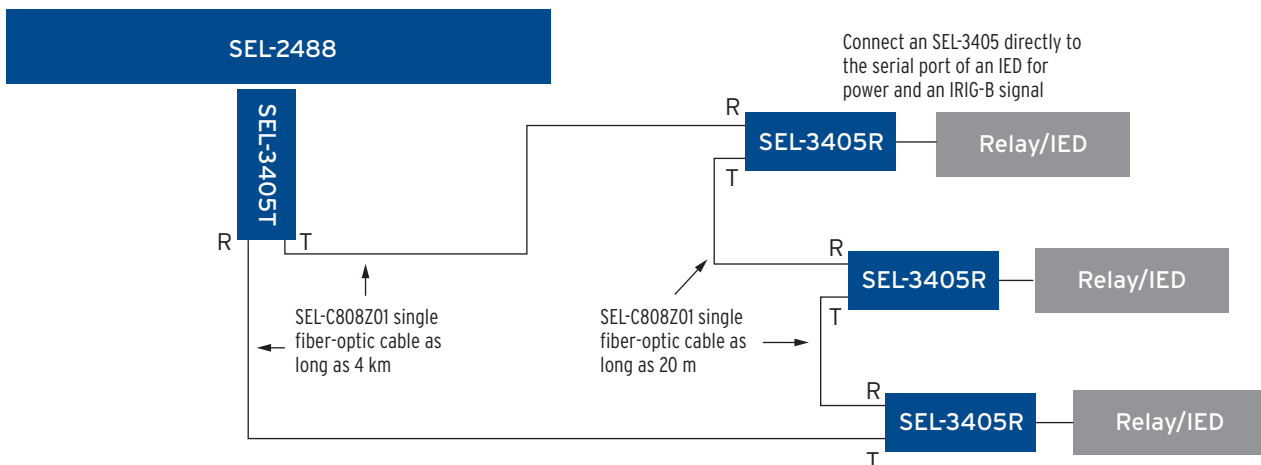


Figure 11 SEL-3405 Timing Ring

Time-Synchronization Pass-Through With the SEL-3405

When only a single fiber-optic connection between an SEL-3405T T port and an SEL-3405R R port is utilized, the SEL-3405T will automatically enable pass-through mode and disable automatic cable delay compensation. With pass-through mode activated, the SEL-3405 can pass-through any demodulated timing signal (e.g., IRIG-B, PPS, etc.) over multimode fiber and maintain a timing accuracy of better than 2 μ s.

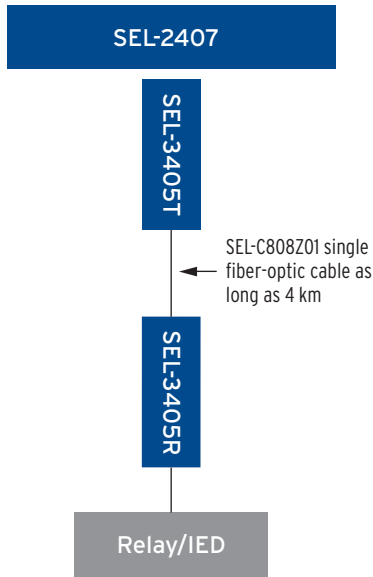


Figure 12 SEL-3405 Pass-Through Mode

Transceiver Dimensions

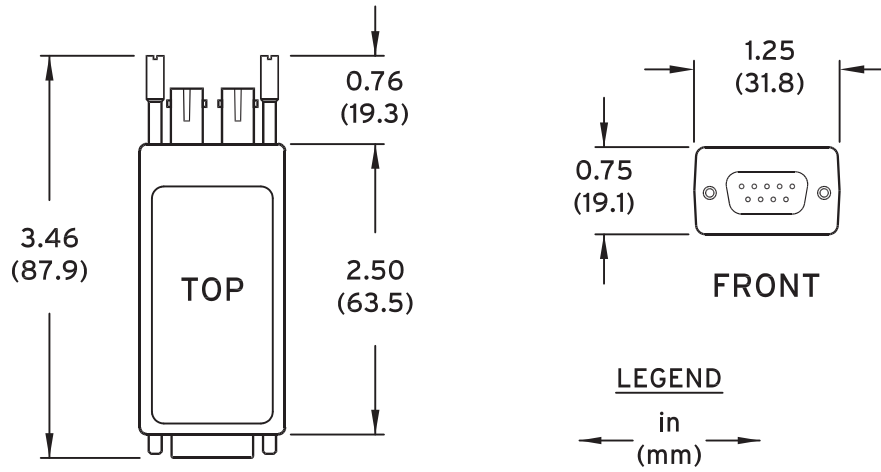


Figure 13 SEL-3405 Dimensions

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

Accuracy

< 200 ns

Optical Source

850 nm (infrared) VCSEL Transmitter

Typical Transmit Level: -13.0 dBm

Minimum Transmit Level: -15.5 dBm

Minimum RX Sensitivity: -27.5 dBm

Fiber-Optic Link Budget: 12.0 dBm

Maximum Output Level: -9.0 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: ±5-10 Vdc

Maximum Current Draw: 15 mA

Fiber-Optic Cable and Connectors

ST Connectors

Multimode Fiber (50-200 μm)

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

Warranty

10 Years

Environmental

Operating Environment

Indoor Use Only

Insulation Class: 3

Pollution Degree: 2

Overtoltage Category: 2

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

Non-Operating Temperature: -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 11:2009 + 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: ± 2, 4, 6, 8 kV contact; ± 2, 4, 8, 15 kV air
IEEE C37.90.3-2001
Discharge Severity Level: ± 2, 4, 8 kV contact; ± 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 °C

Damp Heat, Steady State: IEC 60068-2-78:2012
Severity Level: Test Cab; 10 days, 40°C, 93% RH

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

Notes

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