SEL-2814 Fiber-Optic Transceivers With Hardware Flow Control

Fiber-Optic Transceivers for Serial Data and Hardware Flow Control

Major Features and Benefits

The SEL-2814 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-2814 Transceiver into a standard 9-pin serial connector (DB-9). No special mounting is required.
- **Port Powered.** The SEL-2814 Transceivers are powered from the host device via the connector.
- **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 Transfer Reliability.** SEL-2814 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-2814 link requires a duplex fiber-optic connection between SEL-2814 Transceivers. The transmit port, **TX**, of the SEL-2814 sends serial communication and hardware flow-control signals to the receive port, **RX**, of another SEL-2814.

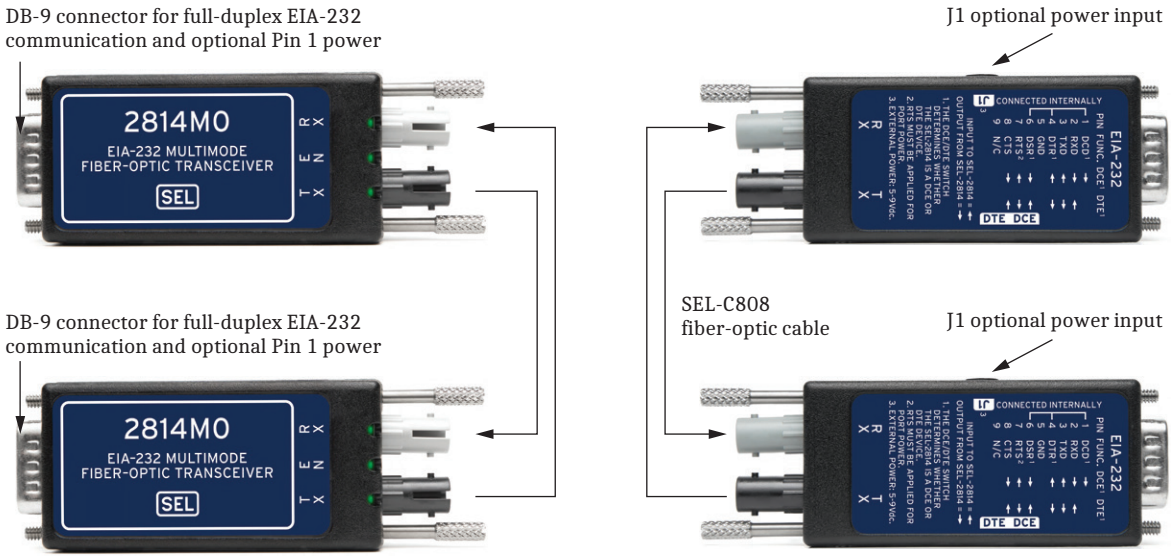

Figure 1 SEL-2814 Product Overview

Power, Transmit, and Receive LED Indicators

The **EN** LED illuminates green when the minimum required power is applied to the DB-9 serial port.

The **TX** and **RX** LEDs illuminate green whenever the transmit or receive signals of the SEL-2814 fiber-optic transceiver are high to help verify the function of the transceiver product.

Application Examples

Instrumentation and Control Links With Hardware Flow Control

Use an SEL-2814 on the EIA-232 ports of SEL communications processors, plant instrumentation and control systems, and intelligent electronic devices (IEDs) that use hardware flow control. Use multimode optical fiber terminated with ST connectors to connect SEL-2814 Transceivers together. Apply high-reliability, low-cost SEL transceivers in harsh electrical and physical environments for the safety and signal integrity advantages that optical fiber offers compared to wire.

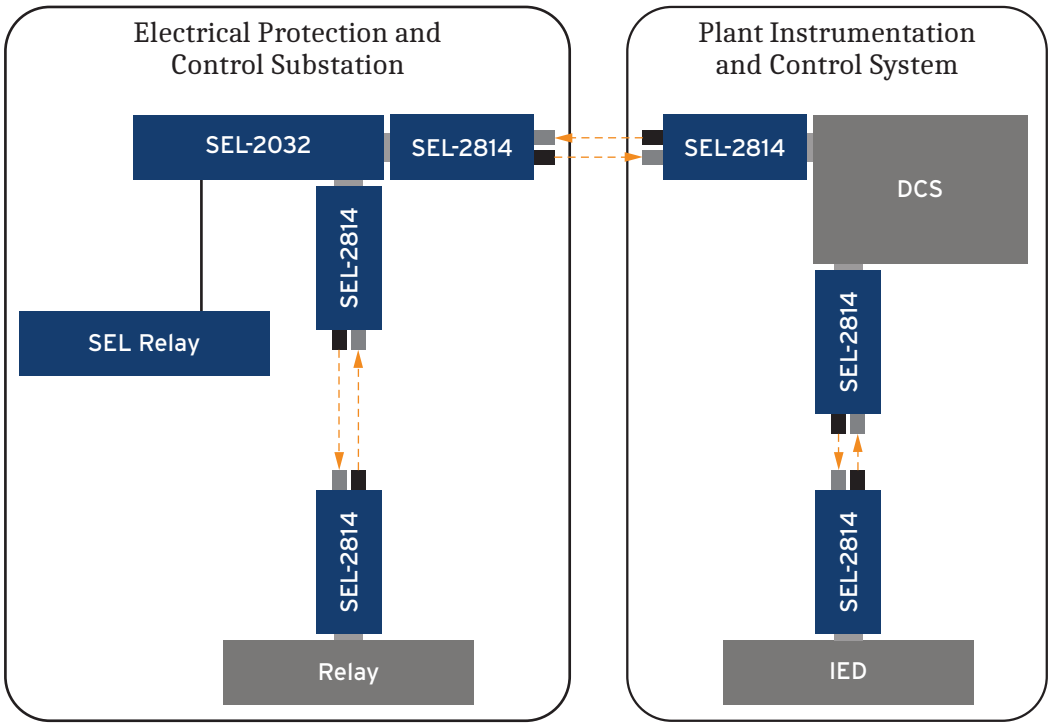

Figure 2 Hardware Flow Control Example

SEL Relays and MIRRORED BITS Protection

Connect SEL-2814 Transceivers to the serial ports of a relay. Use SEL MIRRORED BITS® communications for high-speed exchange of protection information. Coordinate protection between generating plants and associated switchyards or among multiple control houses in the same station. Transfer to backup protection based on loss of potential or failures detected by diagnostic tests. Keep the dc circuits segregated between cabinets. Provide directional element-based bus protection.

Figure 3 MIRRORED BITS Communications Example

Application Information

Determining Maximum Cable Length

The optical power budget includes transmit and receive connector coupling loss, so you can determine the maximum cable length by dividing the total optical power budget (12 dB) by the typical fiber loss/km specification (shown in *Table 1*). 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 an 850 nm wavelength optical source. Calculate the available optical power budget by subtracting the total connector/splice attenuation from the power budget specification shown in *Table 1*. Divide the available optical power budget by the fiber loss/km specification to determine the maximum cable length.

Table 1 Typical Cable Length

Fiber Diameter (µm)	Power Budget (−40° to +85°C) (dB)	Typical Fiber Loss at 25°C (dB/km)	Maximum Cable Length (km)
50	12	2.7	4.44
62.5	12	3.2	3.75
200	12	6.5	1.85

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 the replacement of metallic cables between two EIA-232 devices. Fiber-optic transceivers also allow application of EIA-232 connections longer than the specified 50-foot limitation.

To calculate the viability of an example 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:

Cable attenuation for 850 nm = 3.2 dB/km
0.5 km • 3.2 dB = 1.6 dB

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

12 dB – 1.6 dB = 10.4 dB
(system gain – fiber loss = system margin)

If the fiber loss adds as much as 12 dB or greater, the system is not viable.

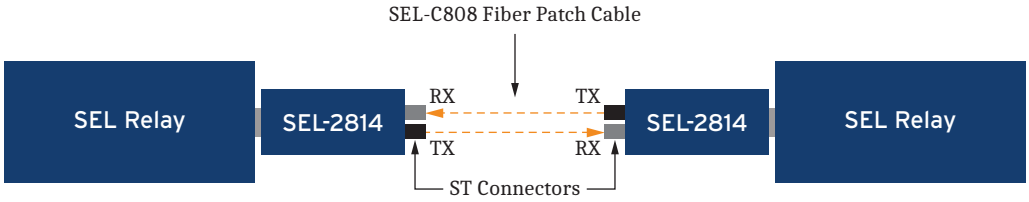

Figure 4 Intrastation Communication Using SEL-2814 Transceivers

Interstation Example

Interstation configurations are more complex than those for intrastation applications. The extra equipment and cables are associated with the termination of the interstation fiber cable. These cables typically contain as many as 24 separate fibers. These separate fibers are not suitable for use as patch cords or for direct termination to the fiber transceiver. A cable termination shelf is used to splice the fibers from the cable to a fiber pigtail. A fiber pigtail is a simplex fiber with a bare fiber on one end and a connector on the other end (the example shown in *Figure 5* uses ST connectors). The fiber pigtail connects to one side of a bulkhead connector that attaches to a patch panel or distribution panel. The SEL transceiver is terminated to the fiber cable at the patch panel through use of a fiber patch cord of suitable length. The additional components in an interstation configuration beyond what exists in an intrastation application complicate calculation of system loss. All of these extra components have additional associated losses.

To calculate the viability of an interstation system that is 3 km (1.9 mi) long and configured as shown in *Figure 5*, perform the following steps:

Step 1. Calculate the fiber attenuation (refer to the typical values shown in *Table 2*):

Cable attenuation for 850 nm = 2.75 dB/km
3 km • 2.75 dB/km = 8.25 dB

Table 2 Typical Attenuation Values

Type	Loss for Multimode Fiber (50 µm)	Loss for Multimode Fiber (62.5 µm)	Loss for Multimode Fiber (200 µm)
Fusion Splice	0.2 dB	0.2 dB	0.2 dB
Mechanical Splice	0.4 dB	0.4 dB	0.4 dB
Connector Loss	0.75 dB	0.75 dB	0.75 dB
Per km @ 850 nm	2.5–3.0 dB	3.0–4.0 dB	7.4 dB

Step 2. Add the splice losses.

Splice attenuation (fusion)
3 splices • 0.2 dB = 0.6 dB

Step 3. Add the connector losses (connectors on the transceiver are included in the system gain).

Connector loss = 0.75 dB per connector
2 connectors • 0.75 dB = 1.5 dB

Step 4. Sum the losses.

8.25 dB + 0.6 dB + 1.75 dB = 10.6 dB
(fiber + splices + connectors = system loss)

Step 5. Subtract the total losses from the system gain.

12 dB – 10.6 dB = 1.4 dB
(system gain – system loss = system margin)

The system margin is positive, so the system is viable.

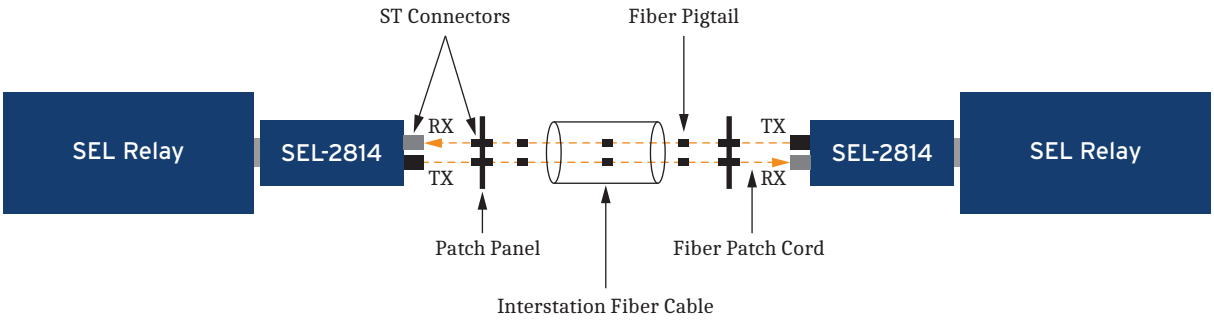

Figure 5 Interstation Communication Using SEL-2814 Transceivers

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 for mounting of the fiber transceiver 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-2814 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-2814 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 6 Transceiver Mount

Conformal Coating Option

Order the SEL-2814 with optional conformal coating for additional protection against environmental and chemical contaminants.

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-2814 uses an 850 nm vertical cavity surface emitting laser (VCSEL) transmitter. When working with this device, observe the following safety precautions:

- Do not look into the fiber (laser) ports/connectors.
- Do not look into the end of an optical cable connected to an optical output.

- ➤ Do not perform any procedures or adjustments that this data sheet does not describe.
- ➤ During installation, maintenance, or testing of the optical ports, use only test equipment qualified for Class 1 laser products.
- ➤ 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-2814 draws power from the data and control lines of the 9-pin subminiature D connector (DB-9) as shown in *Table 3*. Total current draw is less than 15 mA. Upon connecting power, you will see the green TX LED illuminate.

Table 3 Data and Control Line Power Inputs

Pin	Switch Position
2, 8	DTE
3, 7	DCE
4[a], 6	DTE or DCE

[a] A positive voltage on Pin 4 will supply a DCD output on Pin 1.

The transceiver additionally draws power per *Table 4*.

Table 4 Other Power Input

Pin	Voltage (Vdc)
1, J1	+5 to +10

Power input is also available via the J1 connector on the side of the SEL-2814. Use a 0.7 mm coaxial dc plug, with the center pin as positive. SEL provides a coaxial dc plug/cable (part number 240-1525; with a length of 1.82 m [6.0 ft]) to connect J1 to tinned leads. You can connect this cable with the SEL-9321 Low-Voltage DC Power Supply for ac/dc and dc/dc applications. For ac-only input, you can use the AC Power Supply (SEL part number 230-0601).

Figure 7 shows the transceiver rear label, which indicates the internally jumpered pins, pinouts, and signal names.

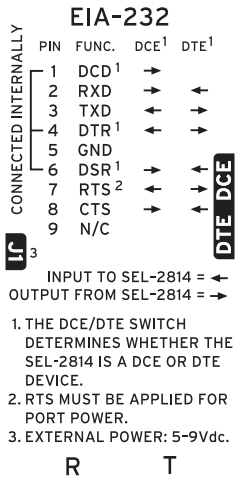

Figure 7 SEL-2814 Signal Flow

Dimensions

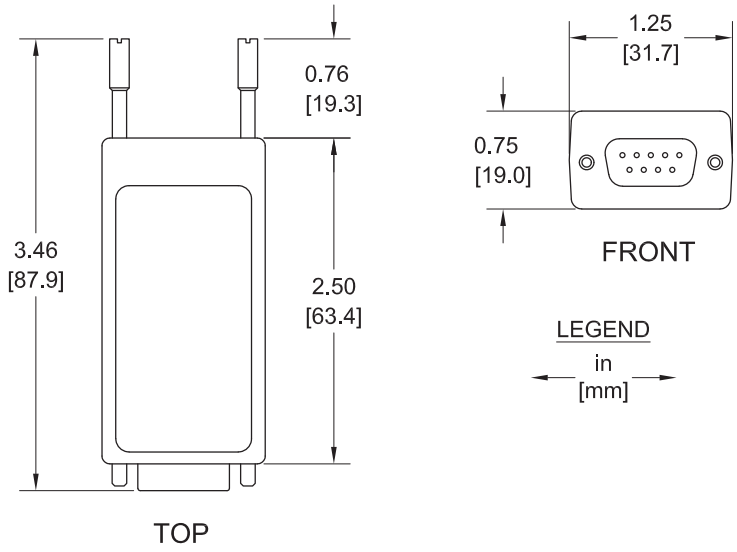

Figure 8 SEL-2814 Dimensions

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 115.2 kbps, full duplex, no jumpers or settings

Link Data Delay

Serial Data:	6 µs + 5 µs/km of fiber

Note: Link includes two transceivers and fibers.

Fiber-Optic Port

Optical Interface

Connector:	ST
Fiber:	Multimode fiber (50 to 200 µm)
Optical Source:	850 nm VCSEL transmitter
Maximum Transmit Level:	–9 dBm
Typical Transmit Level:	–13 dBm
Minimum Transmit Level:	–15.5 dBm
Minimum RX Sensitivity:	–27.5 dBm
Fiber-Optic Link Budget:	12 dB

Projection From DB-9 Connector

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

Power Requirements

The SEL-2814 can be powered from Pin 3 (Pin 2 in DTE mode) and Pin 1 or Pin 7 (Pin 8 in DTE Mode) of its DB-9 connector or from the J1 connector on the side.

Pin 1 or Connector J1:	+5 to +10 Vdc
Pin 2, 3, 4, 6, 7, or 8:	Parasitic Power
Maximum Current Draw:	15 mA

Environmental

Operating Environment

Indoor Use Only

Insulation Class 3

Pollution Degree 2

Overvoltage 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%–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: 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

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 at 25°C + 12 hr at 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

Technical Support

We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

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