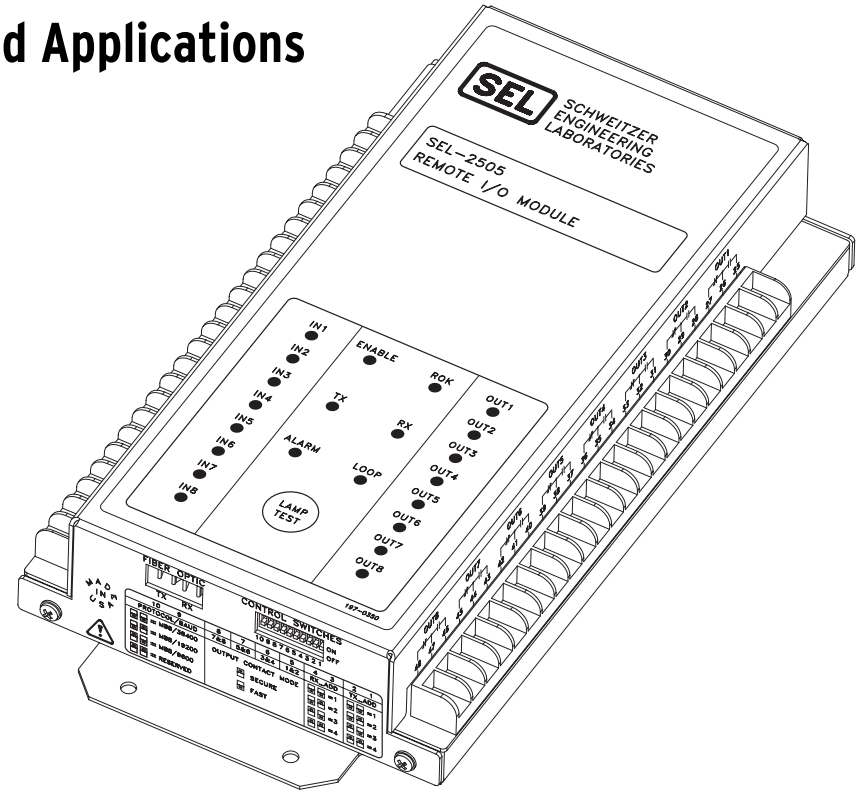
SEL-2505 Remote I/O Module Instruction Manual

Features, Benefits, and Applications



The SEL-2505 is a remote I/O module that has eight contact inputs and eight contact outputs. The status of these inputs and outputs are communicated between the SEL-2505 and host device using MIRRORED BITS™ communications over a dedicated fiber-optic port. Each contact input controls one of the eight MIRRORED BITS transmit bits, while each of the eight received MIRRORED BITS controls a Form C output contact. Use the transmitted contact input status for control and indication of a remote device.

- **Communications Ability** helps you simplify and improve existing or new installations.
  - Add bus protection using existing relay contact inputs and outputs.
  - Add simple pilot communications to existing two- or three-terminal line applications.
  - Isolate relay and breaker dc supplies for breaker failure trip distribution schemes.
  - Replace control wiring to outside cabinets with fiber to reduce dc ground exposure.
  - Add local or remote trip and close coil monitoring capabilities.
- **Compact Size** permits panel-mount replacement of existing auxiliary relays.
- **Self-Testing** increases reliability of auxiliary relay functions.
- **Simple Diagnostics** consisting of 22 LEDs that indicate contact input, output, channel, and device status.
- **Fiber Optics and Channel Monitoring** increase scheme security.
- **Three Models** provide a wide range of applicable communication paths: 650 nm multimode fiber for communications paths ≤500 m, 850 nm multimode fiber for paths ≤15 km, or 1300 nm single-mode fiber for paths ≤80 km.
- **Fast Operating Speed** compares with high-speed auxiliary relays.

Product Overview

Figure 1 shows the functional overview of the SEL-2505.

The SEL-2505 is an excellent auxiliary relay or a simple way of expanding the number of I/O points available in a system of relays. It is superior to hard-wiring relays together through electromechanical or static auxiliary relays, because you can now monitor the performance of the communication channel. In addition, its self-testing ability ensures prompt notification of any device or communication channel problem.

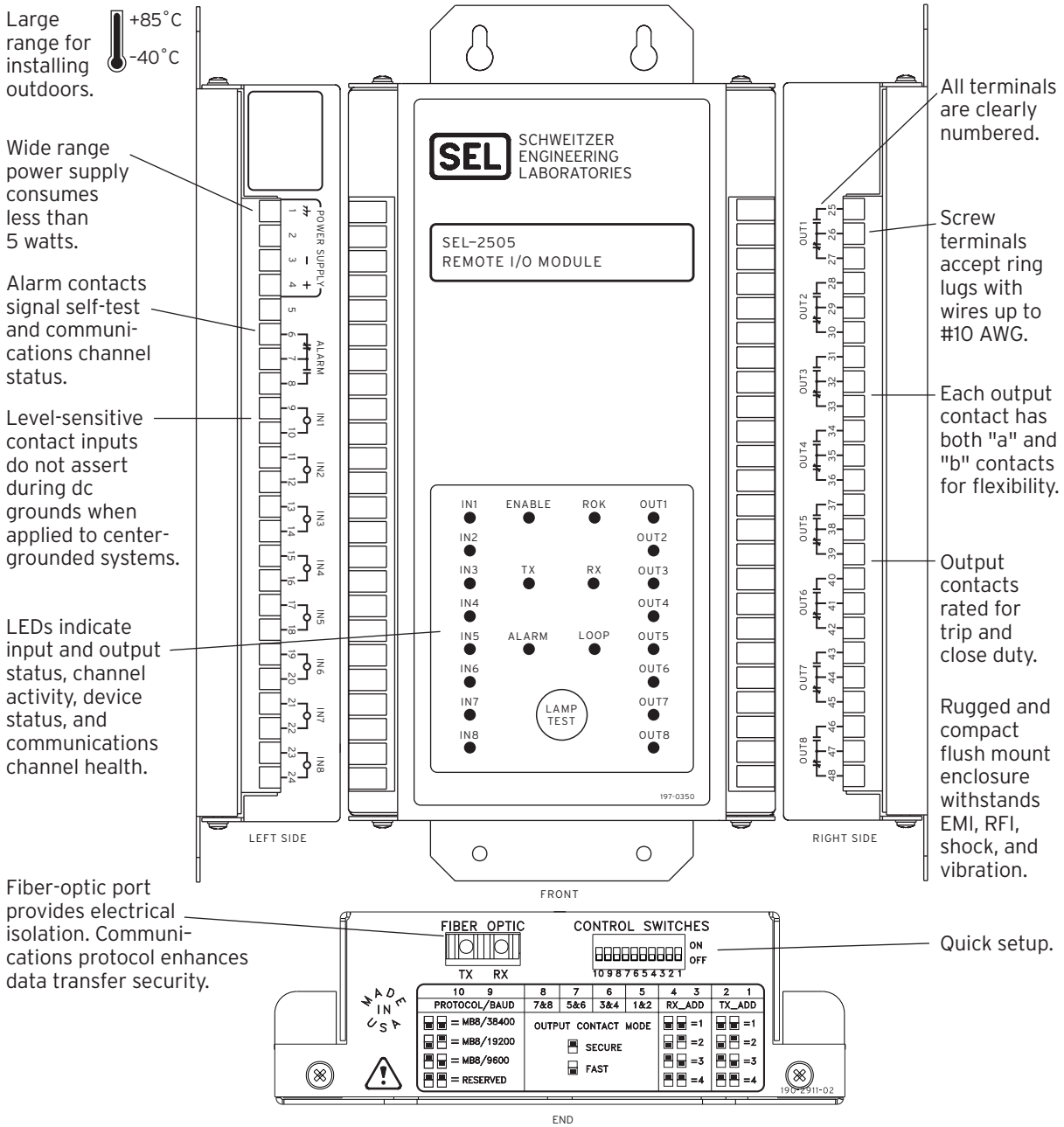


Figure 1 SEL-2505 Functional Overview.

Applications

- Add communications-assisted tripping to existing relays.
- Add alternate communications channel to pilot trip schemes.
- Isolated remote-tripping via fiber-optic links.
- Cross-trigger event reports.
- Perform auxiliary relay functions while adding self-testing capabilities.

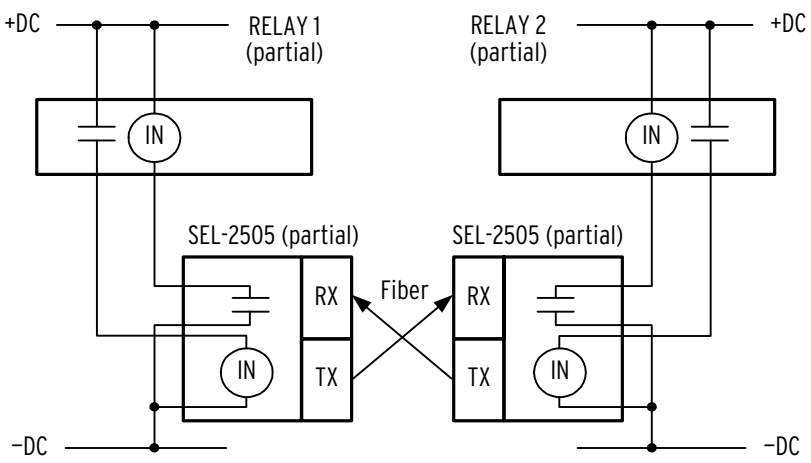


Figure 2 Channel Interface I/O for Relays Without Native MIRRORED BIT Protocol.

- Create bus protection using existing protection relays for simple busses.
- Include an SEL-2100 for bus protection of larger busses.
- Add direct transfer trip to existing cogeneration interconnections.

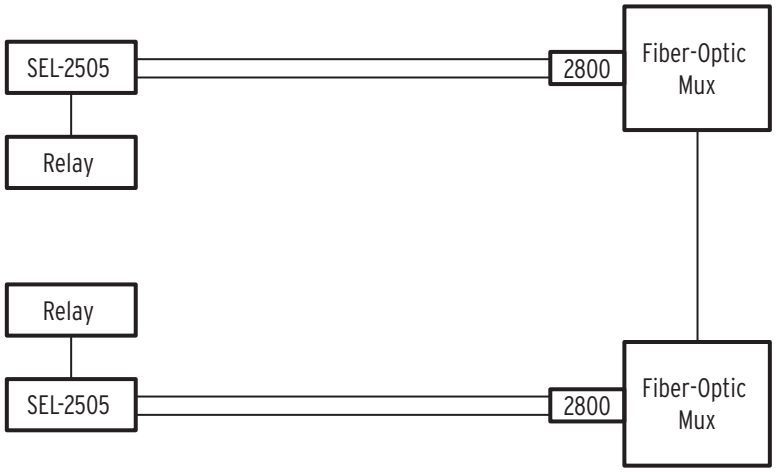


Figure 3 Provide Communications-Assisted Tripping Over Existing Digital Communications Networks.

- Provide low-cost teleprotection over digital multiplexers.
- Provide a migration path from electromechanical relays to MIRRORED BITS relays.

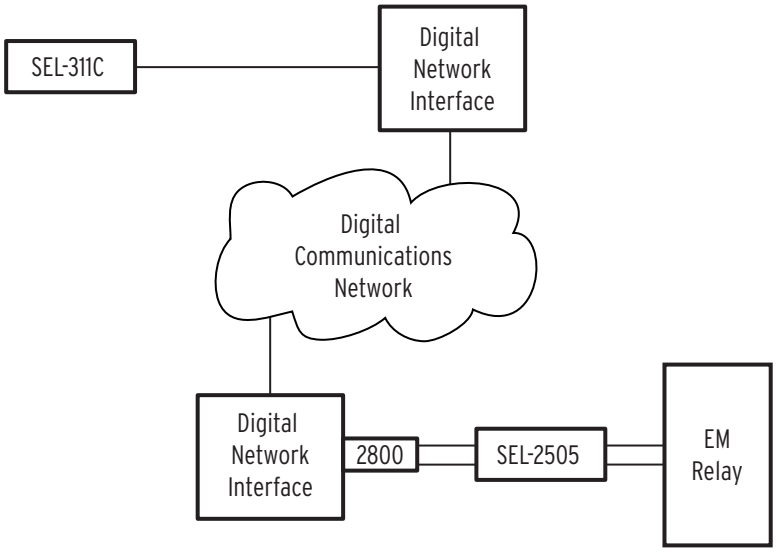


Figure 4 Interface Relays with MIRRORED BITS to Relays Without.

- Eliminate hard-wiring from control room to breaker or motor-operated disconnect switch.
- Reduce dc ground exposure.
- Add trip/close path continuity monitoring.
- Expand I/O capability of relays with MIRRORED BIT communications protocol.

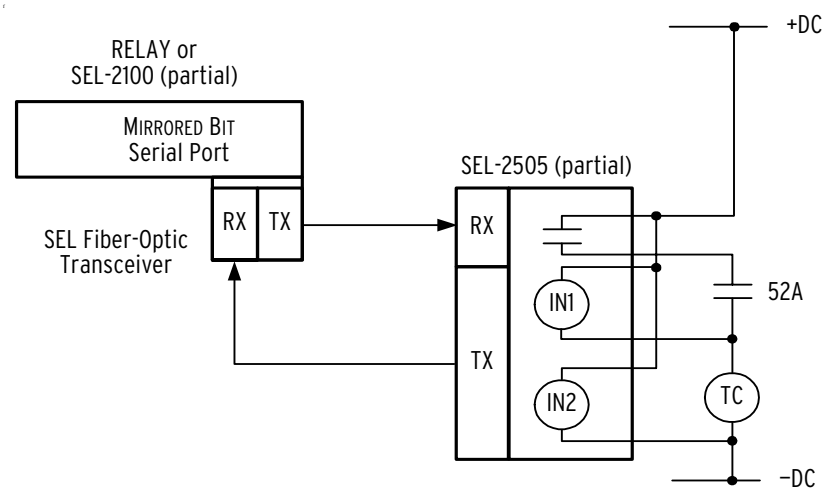


Figure 5 Reduce Wiring From Control House to Outdoor Cabinets.

Example Distribution Bus Protection: Radial Feeders

Figure 6 shows an SEL-2505 application using existing distribution relays and a SEL-2100 Protection Logic Processor to provide bus and line protection for the radial system. When the overcurrent elements of the transformer low-side relay pick-up and the overcurrent elements in the feeder relays do not, the detected fault must be located on the bus. Using relay overcurrent element status transmitted by the SEL-2505 devices, the SEL-2100 uses SELOGIC® control equations to issue a bus trip via a MIRRORED BITS message to the protective relays through the SEL-2505 modules. Unlike conventional schemes, there is no switchboard wiring between relays. Eliminating this wiring reduces dc ground exposure and replacing this wiring with SEL-2505s adds self-testing and automatic communications path checking.

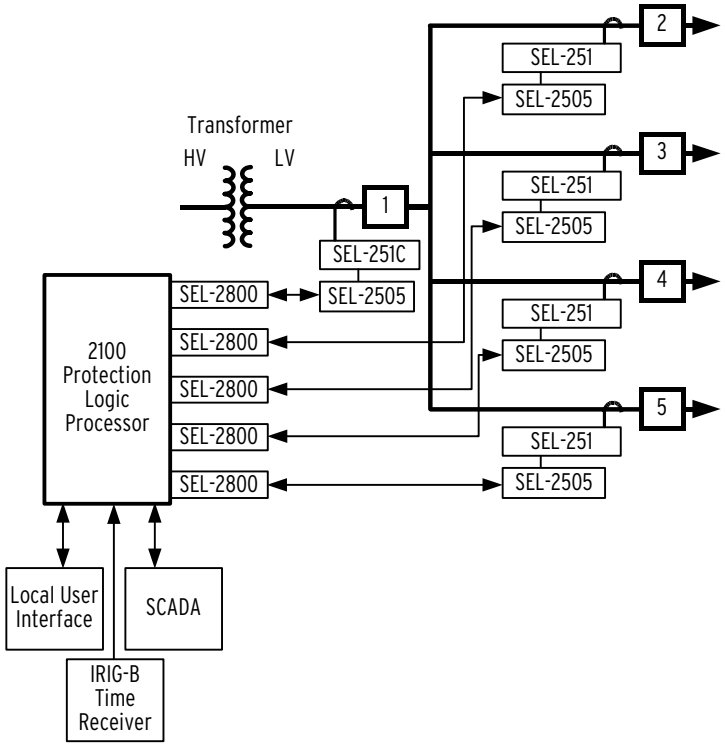


Figure 6 Distribution Bus Protection Application Example.

Functional Description

MIRRORED BITS Decoder/Encoder and I/O Control

Figure 7 shows the functional block diagram of the SEL-2505. There is a MIRRORED BIT decoder associated with the receive (RX) port and an encoder for the transmit (TX) port. The decoder receives MIRRORED BIT messages, checks that the receive address matches that set by SW3 – 4, checks for data message errors, and then decodes each message. If a Receive MIRRORED BIT (RMB) is a logical one for the number of message frames set by SW5 – 8, the SEL-2505 asserts the corresponding output contact.

If an RMB is a logical 0 for the number of message frames set by SW5 – 8, the SEL-2505 deasserts the corresponding output contact. If the communication channel is faulty or power is removed from the device, the contact outputs are deasserted.

The decoder also monitors the received data and channel integrity. Detected errors include: data errors, resynchronization, data over- and under-run, parity, and framing errors. When it detects an error, the SEL-2505 turns off the ROK LED and deenergizes the ALARM relay (closing the alarm contact). If SEL-2505 detects two errors in a row, it begins resynchronizing with the remote device. Once the remote device receives this resynch message, it also deasserts its ROK message to indicate a problem with the communications path.

The encoder converts the eight-contact inputs into the MIRRORED BIT protocol and outputs this data to the transmit fiber port. This protocol is designed to the security requirements outlined by IEC 834-1.

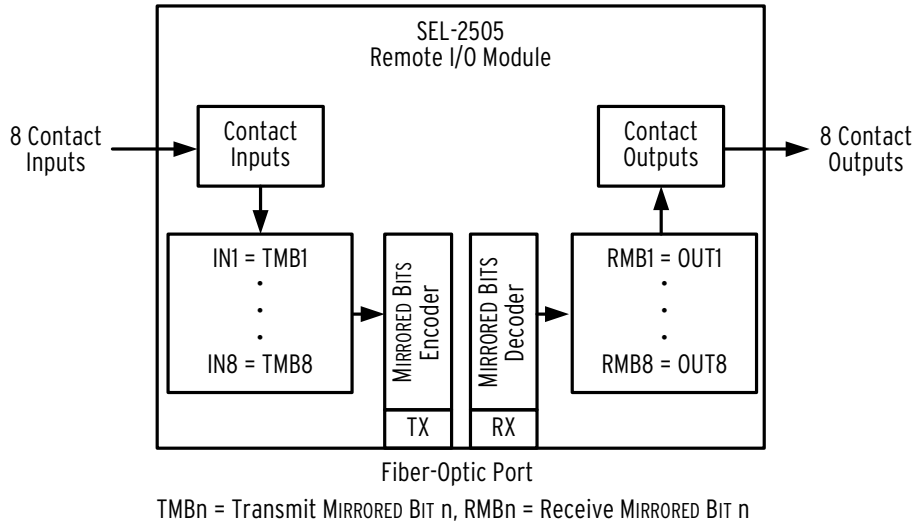
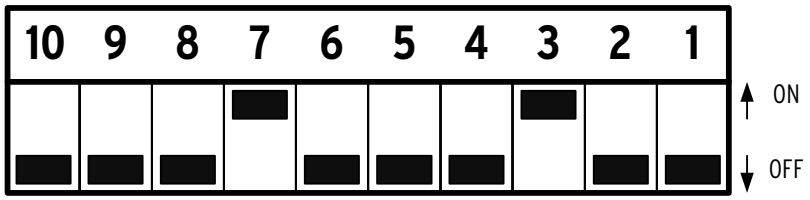


Figure 7 SEL-2505 Functional Block Diagram.

Configuring the SEL-2505

The SEL-2505 uses a ten-position dip switch to set the TX and RX addresses, to determine the number of received correct consecutive messages for output contact control, and to program the baud rate of the MIRRORED BITS communications (see *Table 2 on page 7*). The contact consecutive messages feature is intended to increase the system security for applications requiring higher security like direct transfer tripping.



Switch No.	Function
1,2	Transmit Address (TX)
3,4	Receive Address (RX)
5	OUT1,OUT2 Security Counts
6	OUT3,OUT4 " "
7	OUT5,OUT6 " "
8	OUT7,OUT8 " "
9,10	Baud Rate Setting

Figure 8 SEL-2505 Control Switch Position Identifications.

Setting the Transmit and Receive Addresses

You must set the TX address of each local SEL-2505 to match the receive address of the remote device. Further, the TX and RX addresses of each device should not be set to the same number. The SEL-2505 detects a loop-back condition when it receives its own transmit address in the MIRRORED BIT message. When the SEL-2505 detects loop-back, it illuminates the LOOP LED and extinguishes the ROK LED. The SEL-2505 disables the contact outputs to prevent acting on its own message during loop-back (i.e., output contacts go to their deenergized state).

Table 1 Transmit and Receive Address Settings

Switch 4	Switch 3	RX Address	Switch 2	Switch 1	TX Address
OFF	OFF	1	OFF	OFF	1
OFF	ON	2	OFF	ON	2
ON	OFF	3	ON	OFF	3
ON	ON	4	ON	ON	4

Setting Security Counts for Received Data

Table 2 lists the data security count setting possibilities. When the data security switch is set to "OFF," the contact output follows its associated RMB logical status. When the data security switch is set to "ON," two consecutive RMB messages of the same logical state are required to assert/deassert the associated contact output. Note that each setting switch controls an adjacent pair of contact outputs.

Table 2 Data Security Count Settings

Switch	Message 1	Message 2
Switch 5 (OUT1, OUT2)	OFF	ON
Switch 6 (OUT3, OUT4)	OFF	ON
Switch 7 (OUT5, OUT6)	OFF	ON
Switch 8 (OUT7, OUT8)	OFF	ON

For example, in *Figure 8 on page 6*, SW7 is set to "ON." This requires two consecutive messages to be confirmed before asserting/deasserting OUT5 and OUT6, while all other outputs require only one message.

Setting the Baud Rate

Table 3 lists the settings for the three baud rate options. For applications using fiber connections between SEL devices, baud rate 38400 is recommended. This recommendation is based on operating time. For applications where a multiplexer or other communications device is between the two MIRRORED BITS devices, baud rates 19200 or 9600 are recommended. If the channel is operating intermittently, lowering the baud rate will provide more stable performance in most cases.

Table 3 Protocol/Baud Rate Settings

Switch 10	Switch 9	
OFF	OFF	MB8 Protocol @ 38400 Baud
OFF	ON	MB8 Protocol @ 19200 Baud
ON	OFF	MB8 Protocol @ 9600 Baud
ON	ON	Reserved

Connecting the SEL-2505 to Other SEL Devices

The SEL-2505 uses the MB8 MIRRORED BITS protocol, transmits and receives data at the baud rate set by switches 9 and 10, and is fiber optic. When connecting the SEL-2505 to a MIRRORED BITS port of a relay or the SEL-2100, the following are required:

1. An SEL-2800, SEL-2815, or SEL-2830 fiber modem.
2. The MIRRORED BITS protocol must be set to MB8; the MB protocol is incompatible with the SEL-2505.
3. The SPEED setting must be set to match the setting of the SEL-2505.
4. The transmit address of the local device must match the receive address of the remote device.

If your relay does not have MB8 protocol, contact SEL for a firmware upgrade.

The following examples show how to configure the SEL-351, SEL-321, and the SEL-2100 to operate with the SEL-2505. Only the minimum settings required to configure the communication interface between the relays, SEL-2100, and SEL-2505 are shown. Consult the appropriate instruction manual to ensure proper settings for your particular MIRRORED BITS application.

SEL-2505

TX_ADD = 1 (Switch 1 and 2 = OFF)
RX_ADD = 2 (Switch 3 = ON, Switch 4 = OFF)
PROTO/SPEED = 38400 (Switch 9 = OFF, Switch 10 = OFF)

SEL-351

PROTO = MB8A*
SPEED = 38400
RXID = 1 TXID = 2

* = MB8A or MB8B may be used

SEL-321

PROTO= MB8
SPEED = 38400
TX_ID = 2 RX_ID = 1

SEL-2100

PROTO = MB8
SPEED = 38400
TXID = 1 RXID = 2

Testing the SEL-2505

Testing an SEL-2505 requires another communicating device. Examples include an SEL-2505, SEL-2100, or a relay with MIRRORED BIT protocol and the appropriate fiber-optic transducer. The following test procedure assumes you are using another SEL-2505 as the remote communicating device. The test procedure for other communicating devices is similar:

Step 1. Check the SEL-2505 dip-switch configuration settings. Make certain the transmit address matches the receive address of the remote device and that the baud rate is identical.

Step 2. Connect the chassis ground terminal of the SEL-2505 to ground (Terminal 1).

Step 3. Connect and apply rated voltage to the power supply inputs of the SEL-2505 (positive to Terminal 4, negative to Terminal 3). The ENABLE LED should illuminate. The "b" form of the ALARM contact should remain closed and the ALARM LED illuminates due to no communications.

Step 4. Press the LAMP TEST pushbutton. All LEDs should illuminate. When you release the pushbutton, the LEDs should extinguish.

Step 5. Connect the fiber-optic connections between the SEL-2505s: transmit (TX) on one device to receive (RX) on the other. The ROK, TX, and RX LEDs on both devices should illuminate. In addition, the "b" contacts of the

ALARM contact should open and the ALARM LED should extinguish.

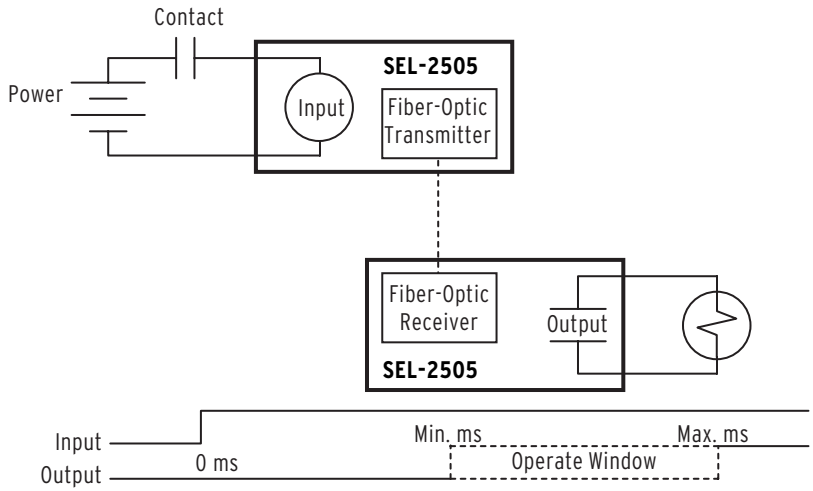
Step 6. Apply rated voltage to IN1 on one device. The IN1 LED should illuminate on this device. On the other SEL-2505, the OUT1 contact should close and OUT1 LED should illuminate.

Step 7. Repeat Step 6 for the remaining contacts.

Step 8. To test the loop-back feature, connect a single fiber between the TX to RX on the same device. The LOOP LED should illuminate and the ROK LED should extinguish. Energize each input. No output contact should assert.

SEL-2505 Operating Time Performance Diagram

Figure 9 shows the time to close an output contact of a remote SEL-2505 given a contact closure on the local SEL-2505.



Baud	Min. ms	Max. ms
38400	5	10
19200	8	13
9600	14	19

Figure 9 SEL-2505 to SEL-2505 End-to-End Operating Time Diagram.

Mechanical Diagram

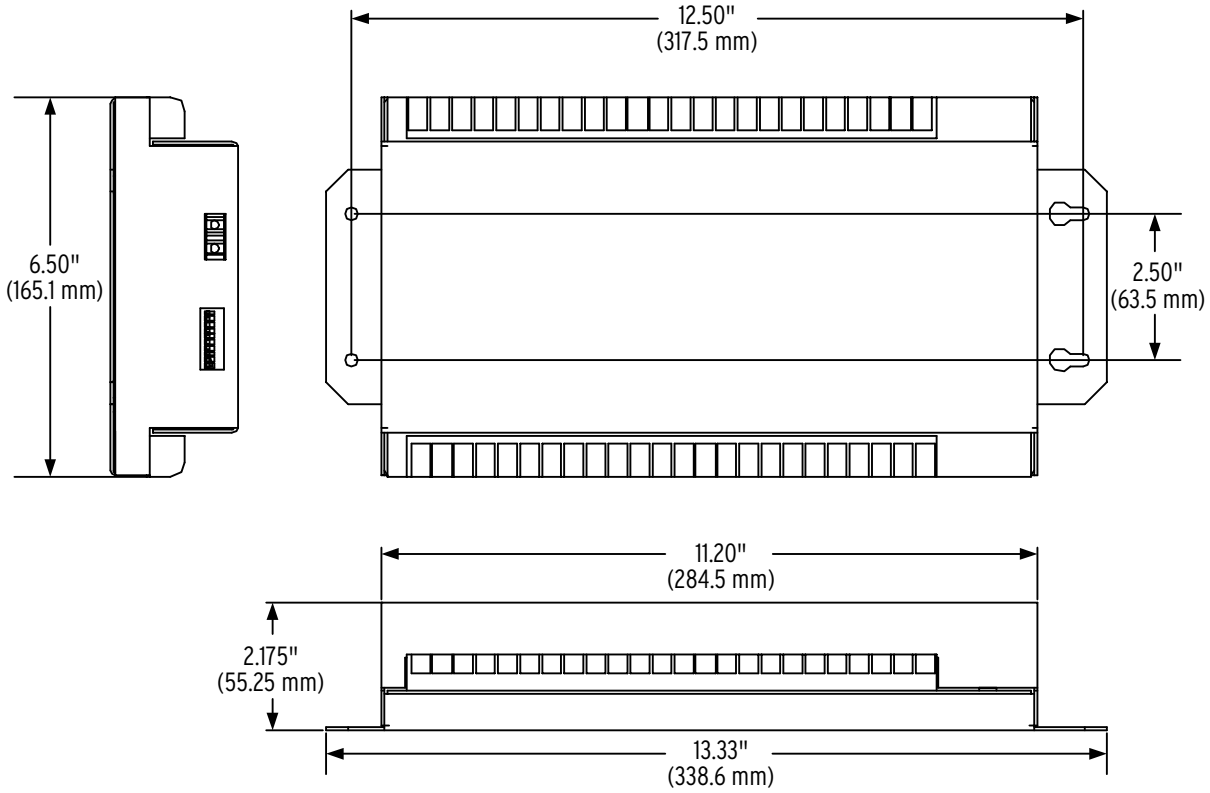


Figure 10 SEL-2505 Dimensions and Drill Diagram.

Specifications

Tightening Torque

Minimum:	7-in-lb (0.8 Nm)
Maximum:	12-in-lb (1.4 Nm)

Terminal Connections

Terminals or stranded copper wire. Ring terminals are recommended. Minimum temperature rating of 90°.

Output Contacts

IEEE C37.90 Tripping Output Performance.

Make:	30 A
Carry:	6 A
MOV protected:	270 Vac rms 360 Vdc continuous

Optoisolated Inputs

250 Vdc:	Pickup 210–300 Vdc Dropout <150 Vdc
125 Vdc:	Pickup 105–150 Vdc Dropout <75 Vdc
110 Vdc:	Pickup 88–132 Vdc Dropout <66 Vdc
48 Vdc:	Pickup 38.4–60 Vdc Dropout <28.8 Vdc
24 Vdc:	Pickup 15–30 Vdc

Note: 24, 48, and 125 Vdc optoisolated inputs draw approx. 4 mA of current.

Power Supply

Rated:	125/250 Vdc or Vac
Range:	85–350 Vdc or 85–264 Vac
Burden:	<5 W
Rated:	48/125 Vdc or 125 Vac
Range:	36–200 Vdc or 85–140 Vac
Burden:	<5 W

Back-to-Back Operate Time

Baud	Min. ms	Max. ms
38400	5	10
19200	8	13
9600	14	19

Mirrored Bits Protocol

MB8 (only)

Port Speed (Data Rate)

38400 baud
19200 baud
9600 baud

Fiber Optic

	V-Pin 650 nm	ST 850 nm	ST 1300 nm
TX PWR	-30 dB	-10 dB	-10 dB
RX Sens.	-39 dB	-51 dB	-50 dB
SYS Gain	9 dB	41 dB	40 dB

Operating Temperature Range

–40° to +85°C
–40° to +185°F

Unit Weight

2.73 kg (3 lb, 0 oz)

Dimensions

338.6 mm x 165.1 mm x 55.2 mm
(13.33" H x 6.5" W x 2.175" D)

Contact Input Update Rate

2 ms

Type Tests

Dielectric:	IEC 255-5: 1977, 2.5 kV rms, 1 min
Environmental:	IEC 68-2-1: 1990 IEC 68-2-2: 1974
Damp Heat Cycle:	IEC 68-2-30:1980
Impulse:	IEC 255-5: 1977, 5 kV 0.5 J
Electrostatic Discharge:	IEC 801-2: 1991, Level 4 IEC 255-22-2: 1989 Level 4
Radio Frequency Immunity:	IEC 801-3: 1984 IEC 255-22-3: 1989
Fast Transient Burst:	IEC 801-4: 1988, Level 4 IEC 255-22-4: 1992, Level 4
Surge Withstand:	IEC 255-22-1: 1988 IEEE C37.90.1: 1989
5 kV Impulse:	IEC 255-5: 1997
Vibration:	IEC 255-21-1: 1988
Endurance:	Class 1
Response:	Class 2
Shock and Bump:	IEC 255-21-2: 1988
Bump:	Class 1
Shock Withstand:	Class 1
Shock Response:	Class 2

Certifications

ISO: Module is designed and manufactured to an ISO-9001 certified quality program.
CE Mark.

Notes

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CAUTION: The module contains devices sensitive to Electrostatic Discharge (ESD). When working on the module with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

CAUTION: Removal of enclosure panels exposes circuitry which may cause electrical shock which can result in injury or death.

DANGER: Contact with instrument terminals may cause electrical shock which can result in injury or death.

DANGER: Contact with this circuitry may cause electrical shock that can result in injury or death.

ATTENTION: Le module contient des pièces sensibles aux décharges électrostatiques. Quand on travaille sur le module avec les panneaux avant ou du dessus enlevés, toutes les surfaces et le personnel doivent être mis à la terre convenablement pour éviter les dommages à l'équipement.

ATTENTION: Le retrait des panneaux du boîtier expose le circuit qui peut causer des chocos électriques pouvant entraîner des blessures ou la mort.

DANGER: Tout contact avec les bornes de raccordement de l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.

DANGER: Tout contact avec ce circuit peut être la cause d'un choc électrique pouvant entraîner des blessuers ou la mort.