SEL-2600 RTD Module Instruction Manual

Features & Benefits

Transmit 12 RTD-based temperature measurements and a single contact status up to 500 meters using inexpensive fiber-optic cable with the SEL-2600 RTD Module. The SEL-2600 connects directly to the SEL-701 Motor Relay using fiber-optic connectors built into each device and also connects to the SEL-2030 Communications Processor using a single SEL-2800 Fiber-Optic Transceiver. The fiber-optic link eliminates expensive cable pulls and provides electrical noise immunity and ground isolation.

- Measure up to 12 RTD temperatures plus one contact input with zero settings.
  - 100-ohm platinum
  - 100-ohm nickel
  - 120-ohm nickel
  - 10-ohm copper
- LEDs indicate device status, transmit status, and contact input status.
- Power from 120 Vac or 240 Vac.
- Operates in extreme ambient temperatures from –40° to +85° C.

Initial Checkout

Step 1. Connect Terminal 26 to an appropriate ground.

Step 2. Apply line power to the SEL-2600 at Terminals 23 and 24 (120 Vac) or Terminals 23 and 25 (240 Vac).

The SEL-2600 will power up and perform internal diagnostics. The module is ready when the green ENABLE LED illuminates.

Step 3. Verify the red TX LED pulses twice per second. Each pulse corresponds to the transmission of RTD data, device status, and contact input status.

Step 4. Connect Terminal 20 to Terminal 21 to test the contact input. The red INPUT LED illuminates when the contact input is electrically shorted.

Step 5. SEL-701 Motor Relay Application

➢ Connect the SEL-2600 to the SEL-701 Motor Relay as shown in *Figure 1 on page 4*. Set the relay as directed in *SEL-701 Motor Relay Application on page 4*.

NOTE: The SEL-701 front panel may display "RTD Failure" if the correct RTDs are not yet connected. The SEL-701 METER T report displays the RTD temperature as "Comm Fail" if the fiber connection is not operating properly.

SEL-2030 Communications Processor Application

➢ Connect the SEL-2600 to the SEL-2030 Communications Processor as shown in *Figure 2*, *Figure 3*, or *Figure 4 on page 7*. Set the SEL-2030 as directed in *SEL-2030 Communications Processor Applications on page 6*.

Step 6. Follow the wiring diagram in *Figure 5 on page 13* to connect RTDs to the SEL-2600.

NOTE: If RTDs are not available, test the SEL-2600 RTD inputs by connecting all three terminals for each RTD together. For example, using two short wires, connect Terminals 01, 02, and 03 together. The SEL-701 METER T report displays the corresponding temperature as "Short." The SEL-2030 stores the hexidecimal value 8000h in the corresponding data register.

Installation

Step 1. Locate an appropriate mounting panel or enclosure near the protected device.

Step 2. Drill four mounting holes (see *Figure 6 on page 14*).

Step 3. Secure the SEL-2600 using the four bolts and locknuts provided.

Step 4. Ground the SEL-2600 by connecting Terminal 26 to an appropriate electrical ground.

Step 5. Connect as many as 12 RTDs to the SEL-2600 terminal blocks (see *Figure 5 on page 13*).

Step 6. Record the type and location of each RTD in *Table 1 on page 4*.

Step 7. Connect a dry contact to the SEL-2600 contact input Terminals 20 and 21 as appropriate.

CAUTION: Do not connect ac or dc voltage to the contact input.

Step 8. SEL-701 Motor Relay Application

➢ Connect the SEL-2600 to the SEL-701 Motor Relay using a single fiber-optic cable (SEL part number C801FZ or C801FD). Follow the SEL-701 setting instructions in *SEL-701 Motor Relay Application on page 4*.

SEL-2030 Communications Processor Application

➢ Connect the SEL-2600 to the SEL-2030 Communications Processor using a single fiber-optic cable and a fiber-optic transceiver as outlined in *SEL-2030 Communications Processor Applications on page 6*.

Step 9. Connect ac line power to the SEL-2600 through Terminals 23 and 24 (120 Vac) or Terminals 23 and 25 (250 Vac). The green ENABLE LED illuminates when ac power is applied and the internal diagnostics are complete.

Step 10. Verify the SEL-2600 is operating properly.

➢ The green ENABLE LED is illuminated.

➢ The red TX LED pulses twice per second.

➢ The red INPUT LED illuminates when the SEL-2600 contact input is energized.

➢ The SEL-701 or SEL-2030 receives valid RTD measurements.

Table 1 RTD Type and Location Worksheet

RTD Input	RTD Location	RTD Type
RTD1		
RTD2		
RTD3		
RTD4		
RTD5		
RTD6		
RTD7		
RTD8		
RTD9		
RTD10		
RTD11		
RTD12		

SEL-701 Motor Relay Application

The SEL-701 Motor Relay provides comprehensive motor protection, including short circuit, load loss, load jam, and frequent starting protection as well as unbalance current and phase reversal protection. The patented motor thermal protection element used by the SEL-701 Motor Relay accurately tracks the heating effects of overloads and unbalance current.

Combining the SEL-2600 and the SEL-701 Motor Relay enhances this list of protection features by adding remote RTD-based thermal protection.

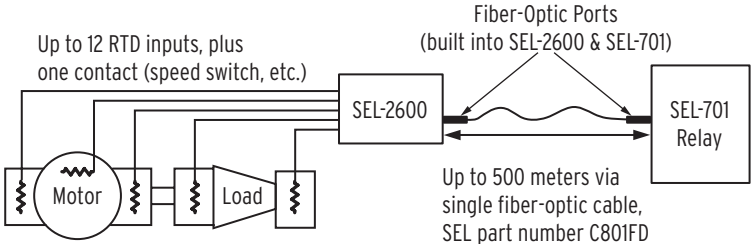

Figure 1 Motor Protection with the SEL-701 Motor Relay.

Step 1. Connect the SEL-2600 to the SEL-701 Motor Relay using fiber-optic cable C801FD. Connect the cable between the SEL-2600 Fiber-Optic TX output and the SEL-701 Motor Relay Fiber-Optic RX input.

Step 2. Set the SEL-701 Motor Relay to accept the RTD temperature data packets (see *Data Packet Definition on page 11*) sent by the SEL-2600. You can use any of the following three methods to enter the settings.

- ➢ Relay front-panel menus: Set Relay\Relay Elements\RTD CONFIGURATION.
- ➢ Personal computer connected to the relay serial port, running SEL-701PC software.
- ➢ Personal computer connected to the relay serial port, using a terminal emulation software package.

In the SEL-701 Relay, set the RTD Input Option setting (RTDOPT) equal to EXT. This enables use of the external module data. Set the RTD Location and RTD Type settings based on the information you recorded in *Table 1 on page 4*. Finally, set the RTD Alarm and Trip Temperature settings as required for your application.

Refer to the *SEL-701 Motor Relay Instruction Manual* for more details regarding calculation and entry of these settings.

Step 3. After accepting the relay settings, verify correct RTD temperature measurement using one of these methods.

- ➢ Relay front-panel menus: Meter Values\Thermal & RTD Data.
- ➢ Personal computer connected to the relay serial port, running SEL-701PC software.
- ➢ Personal computer connected to the relay serial port, using a terminal emulation software package and the METER T command.

The relay will indicate the temperatures of each connected, healthy RTD. If the relay reports that an RTD is open or shorted, or if the temperature reading is wrong, verify the wiring at the SEL-2600. Also verify the RTD type connected to that input matches the RTD type setting.

SEL-2030 Communications Processor Applications

Use the SEL-2600 RTD Module in combination with the SEL-2030 Communications Processor to enhance many protection and monitoring applications. The SEL-2030 monitors temperature data from the SEL-2600, performs threshold comparisons, and sends control commands to a protective relay.

The applications shown in *Figure 2*, *Figure 3*, and *Figure 4 on page 7* represent a few of the possible configurations using the SEL-2600 and the SEL-2030. Contact SEL for help in applying these products in other configurations.

Program the SEL-2030 to perform four automated steps:

Step 1. Receive temperature data from the SEL-2600.

Step 2. Store the temperature data in memory.

Step 3. Perform temperature threshold comparisons.

Step 4. Issue control commands to a protective relay based on the temperature comparisons.

The next few pages describe how to configure the SEL-2030 to perform the four automated steps shown above. It is assumed that the SEL-2600 is connected to Serial Port 4 of the SEL-2030. Refer to the *SEL-2030 Communications Processor Reference Manual* and the *SEL-2030 Communications Processor User's Guide* for further information on programming concepts.

Receive Temperature Data

Connect the SEL-2600 to the SEL-2030 using an SEL-2800 Fiber-Optic Transceiver and fiber-optic cable C801FD. Set the port settings of the SEL-2030 as shown.

```
SET  P 4

DEVICE  = S
CONFIG  = N
PORTID  = SEL-2600 RTD Module
BAUD    = 2400
DATABIT = 8
STOPBIT = 1
PARITY  = N
RTS_CTS = N
XON_XOFF= N
TIMEOUT = OFF
```

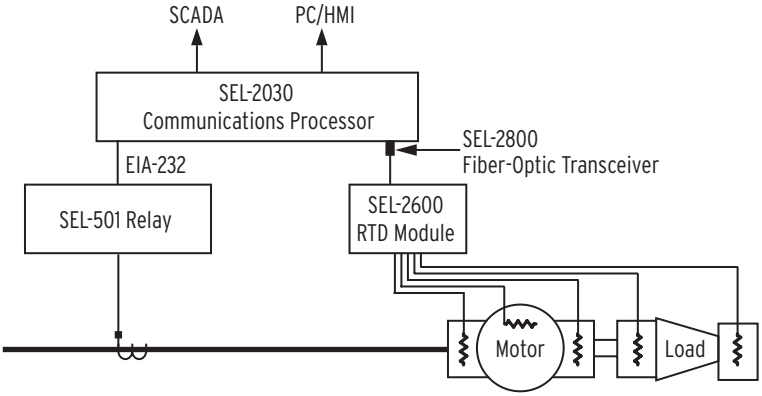

Figure 2 Motor Protection with the SEL-501 Relay.

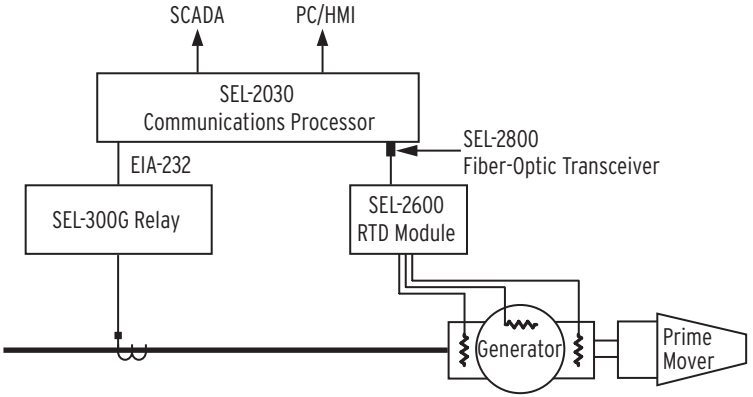

Figure 3 Generator Protection with the SEL-300G Relay.

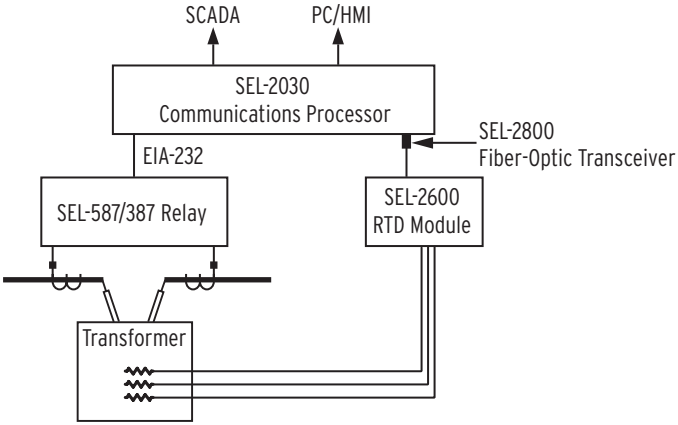

Figure 4 Transformer Protection with the SEL-587 or SEL-387 Relay.

Store Temperature Data in SEL-2030 Memory

Use the SET A command to reserve memory.

```
SET A 4

AUTOBUF = N
STARTUP =""
SEND_OPER= N
REC_SER = N
MSG_CNT = 0
ARCH_EN = N
USER    = 54
```

The USER setting reserves a data region with 54 registers. Each register is 2 bytes for a total length of 108 bytes. This data region holds the received data packet and mathematical equations for threshold comparisons.

The SEL-2030 automatically moves the data section of each received data packet (see *Table 3 on page 11*) into the reserved USER data region at the addresses shown in *Table 2 on page 9*.

The SEL-2600 data packet includes temperature information for each of the four types of RTDs. To access the correct temperature, use the memory map location associated with the correct RTD type.

Data from the USER region can be accessed using an absolute address or in the form “n:USER:offset” where ‘n’ is the port number and ‘offset’ is the value shown in the offset column of *Table 2 on page 9*. For example, access the RTD 2, 10-ohm copper data using the absolute address F80Ah or the offset form: “4:USER:0Ah”. The examples in the remainder of this section use the offset form.

Perform Temperature Threshold Comparisons

The example SEL-2030 settings shown below compare the measured temperature of RTD 2 (10-ohm copper) against a threshold of 28°C. If the measured temperature is valid (i.e., the RTD is not shorted or open) and is above the threshold, Bit 0 of register 035H is set to ‘1’. Serial Port 4 is again assumed.

```
SET M 4
1 033h = 28                   #Store temp threshold
2 034h = 4:USER:033h          #Get the threshold
3 034h -= 4:USER:0Ah          #Subtract the RTD temp
4 035h:0 = 4:USER:034h:15     #Get sign bit of result
5 035h:0 *= !4:USER:0Ah:15    #Test bit 15 of temp
6 035h:0 *= !4:USER:0Ah:14    #Test bit 14 of temp
```

The text following the pound (#) symbols are comments and are not required to set the SEL-2030.

Line 1: Stores the temperature threshold in register 033h.

Line 2: Copies the threshold to register 034h in preparation for Line 3.

Line 3: Subtracts the measured RTD temperature from the threshold and stores the result in register 034h. If the result is negative, the measured RTD temperature is above the threshold and Bit 15 (the sign bit) of 034h is set.

Line 4: Copies the sign bit (Bit 15) of 034h into Bit 0 of 035h.

Line 5: Clears Bit 0 of 35h if RTD is shorted.

Line 6: Clears Bit 0 of 35h if RTD is open.

Table 2 SEL-2030 Communications Processor Memory Map

Address (hex)	Offset	Data Description
F800h–F801h	0–01h	Milliseconds since device power-up
F802h	02h	Device status
F803h	03h	RTD 1, 100-ohm platinum
F804h	04h	RTD 1, 100-ohm nickel
F805h	05h	RTD 1, 120-ohm nickel
F806h	06h	RTD 1, 10-ohm copper
F807h	07h	RTD 2, 100-ohm platinum
F808h	08h	RTD 2, 100-ohm nickel
F809h	09h	RTD 2, 120-ohm nickel
F80Ah	0Ah	RTD 2, 10-ohm copper
•		
•		
(this 4-register sequence is repeated for RTD 3 through RTD11)		
•		
•		
F82Fh	2Fh	RTD 12, 100-ohm platinum
F830h	30h	RTD 12, 100-ohm nickel
F831h	31h	RTD 12, 120-ohm nickel
F832h	32h	RTD 12, 10-ohm copper
F833h–F835h	33h–35h	Storage for mathematical functions

This logic can be expanded to operate on additional RTDs. Use the SET A command to reserve additional registers for mathematical equations.

```
SET A USER 4
USER    = 57
```

Use the SET M command to add the equations. The following settings show how to add RTD 12, 100-ohm platinum (4:USER:02Fh) at a threshold of 31°C.

```
SET M 4
7  036h = 31                   #Store temp threshold
8  037h = 4:USER:036h          #Get the threshold
9  037h -= 4:USER:02Fh         #Subtract the RTD temp
10 038h:0 = 4:USER:037h:15     #Get sign bit of result
11 038h:0 *= !4:USER:02Fh:15   #Test bit 15 of temp
12 038h:0 *= !4:USER:02Fh:14   #Test bit 14 of temp
```

Issue Control Commands to Relay

Connect the SEL-2030 to the protective relay. Establish communications as outlined in the *SEL-2030 Communications Processor Reference Manual* and the protective relay's instruction manual.

Use the SET P command to set AUTO_CONFIG to "Y." This enables automatic control capabilities for the serial port connected to the relay. Use the SET A command to set SEND_OPER to "Y." This enables fast operate commands based on logic bit transitions. Use the SET L command to control four breakers using fast operate commands based on the result of a single temperature comparison.

The following example settings assume the relay is connected to SEL-2030 Serial Port 10, and the SEL-2600 is connected to Serial Port 4.

```
SET L 10
SBR1 = 4:USER:35h:0 #If above threshold open breaker 1
CBR1 = 0
SBR2 = 4:USER:35h:0 #If above threshold open breaker 2
CBR2 = 0
SBR3 = 4:USER:35h:0 #If above threshold open breaker 3
CBR3 = 0
SBR4 = 4:USER:35h:0 #If above threshold open breaker 4
CBR4 = 0
```

The example can be modified to control each breaker based on separate temperature thresholds. The section titled *Perform Temperature Threshold Comparisons on page 8* shows how to program the SEL-2030 for multiple temperature comparisons. The following settings use the results of those comparisons to control Breakers 1 and 2.

```
SBR1 = 4:USER:35h:0 #If RTD 2 > 28 degrees C open breaker 1
CBR1 = 0
SBR2 = 4:USER:38h:0 #If RTD 12 > 31 degrees C open breaker 2
CBR2 = 0
```

Refer to the specific protective relay's instructional manual for more information on fast operate commands, relay wiring, and relay configuration.

Data Packet Definition

The SEL-2600 RTD Module sends a binary data packet every 0.5 seconds. The packet contains data for all four types of supported RTDs so no settings are required in the SEL-2600 (patent pending). Using the SEL-2800 Fiber-Optic Transceiver, any EIA-232 device can be configured to understand the binary data packet contents shown in *Table 3*.

Table 3 SEL-2600 RTD Module Data Packet Definition

Data Value	Data Size	Description
A546h	2 bytes	Beginning of Message Code
74h	1 byte	Message Length (116 bytes)
0000000000h	5 bytes	Routing Value (0)
00h	1 byte	Status Byte
12h	1 byte	Function Code
00h	1 byte	Sequence Byte
00h	1 byte	Pad Byte
xxxxxxx	4 bytes	Milliseconds Since SEL-2600 Power-Up or Clock Rollover (86,400,000 ms/5265C00h)
xx	2 bytes	Device Status (Bitmap) Bit 0: Power Supply Status Bit 1: RTD Circuitry Status (0 = okay; 1 = fail) Bit 2: Watchdog Timer Status (0 = okay; 1 = fail) Bit 3: 8 V Power Supply Status (0 = okay; 1 = fail) Bit 4: 5 V Power Supply Status (0 = okay; 1 = fail) Bit 5: –5 V Power Supply Status (0 = okay; 1 = fail) Bits 6–14: Unused, Zero Bit 15: Contact Input State (0 = deasserted; 1 = asserted)
xxxx	96 bytes[a]	Temperature Data (°C) Word One: PT100 temperature Word Two: NI100 temperature Word Three: NI120 temperature Word Four: CU10 temperature

(Continued)

Table 3 SEL-2600 RTD Module Data Packet Definition *(Continued)*

Data Value	Data Size	Description
		Four words are sent for each of the 12 inputs. Use only the appropriate temperature for the type of RTD connected to each input. If an RTD circuit is open, the error code 7FFFh is sent; if the circuit is shorted, the error code 8000h is sent. For the first four seconds after power is applied to the module, it sends the error code 7FF0h.
yy	2 bytes	CRC-16 Data Block Check Code

[a] 2 bytes per word • 4 words per RTD • 12 RTDs = 96 bytes.

SEL-2600 Guideform Specifications

RTD (Resistive Temperature Device) monitoring shall be provided by a microprocessor-based module with the following characteristics.

- Module shall be capable of acquiring RTD data from as many as 12 RTDs.
- Module shall accept input from any of four different types of three-wire RTDs (100-ohm platinum, 100-ohm nickel, 120-ohm nickel, and 10-ohm copper) on every RTD input terminal.
- Module shall accept a single contact input.
- Module shall require no configuration settings.
- Module shall perform internal self-tests on the power supply and RTD inputs.
- Module shall transmit over fiber optics all measured RTD values, input contact status, and self-test status at 500 ms intervals over a distance of 500 meters.
- Module shall secure data communications using CRC-16 (Cyclical Redundancy Check) error detection.
- Module shall be equipped with a fiber-optic port.
- Module shall use LEDs (Light Emitting Diodes) to indicate device self-test status, input contact status, and fiber port transmit status.
- Module shall be capable of operating within specification over a temperature range of –40° to +85°C.
- Module shall be line powered by 120 Vac or 240 Vac.
- Module shall mount to a flat surface and have package dimensions not exceeding 9.500" x 4.418" x 2.060".

Wiring Diagram

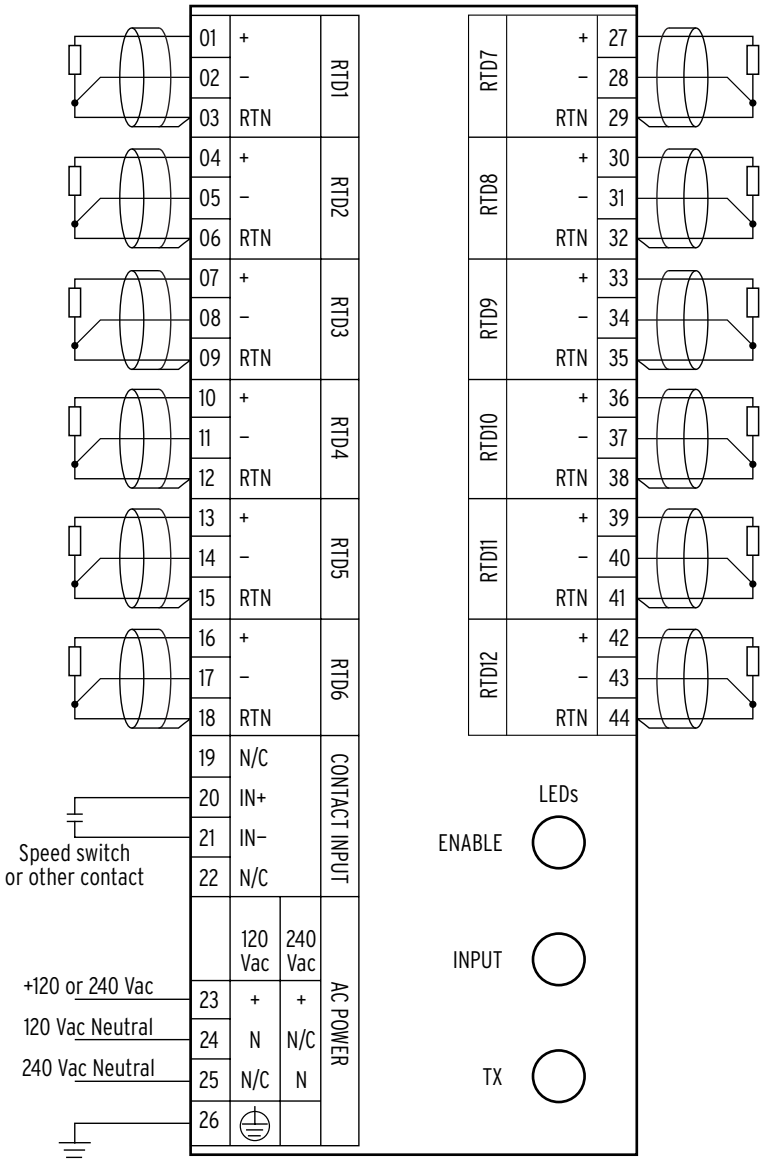

Figure 5 SEL-2600 Wiring Diagram.
N=Neutral, N/C=No Connection, RTN=Return.

Mechanical Diagram

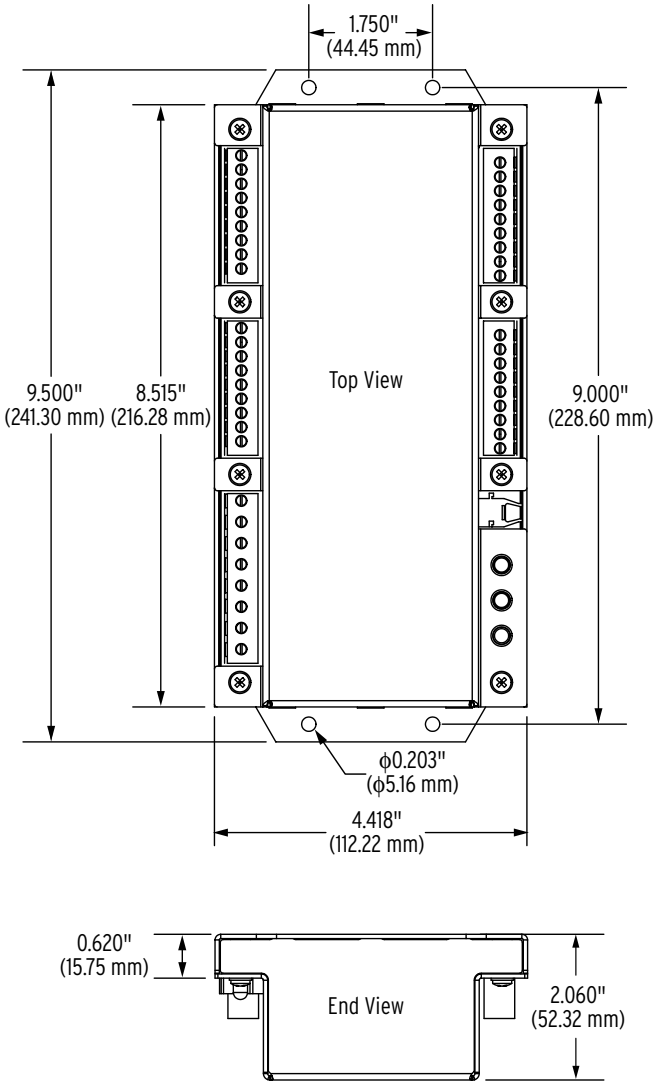

Figure 6 SEL-2600 Mechanical Diagram.

Specifications

12 RTD Inputs

Measuring Range: −50° to +250°C
Error: ±0.5°C, typical
±2°C, maximum
Open and short circuit detection.
PT100, NI100, NI120,
and CU10 RTD-types supported.

Contact Input

One dry contact input.
Use for local speed switch or other monitoring.

Communication

Binary data packet
contains temperatures,
contact status, self-test results.
Sent twice per second at 2400 baud.
CRC-16 data security.
Up to 500 m using fiber-optic cable C801FD.

Power Supply

120 Vac, 50/60 Hz
240 Vac, 50/60 Hz
2 VA total burden

Operating Temperature

−40° to +85°C
−40° to +185°F

Type Tests

Generic Emissions, Light Industrial:	EN 50081-1: 1992,
Generic Immunity, Heavy Industrial:	EN 50082-2: 1995,
Radiated and Conducted Emissions:	EN 55022: 1998, Class B
Conducted Radio Frequency:	EN 61000-4-6: 1996, 10 Vrms
Radiated Radio Frequency (900 MHz with modulation):	ENV 50204: 1996, 10/V/m
Cold:	IEC 60068-2-1: 1990, Test Ad; 16 hr @ −40°C
Dry Heat:	IEC 68-2-2: 1974, Test Bd; 16 hr @ +85°C
Damp Heat, Cyclic:	IEC 60068-2-30: 1980, Test Db, 55°C, 6 cycles, 95% humidity
Dielectric Strength:	IEC 60255-5: 1977, IEEE C37.90: 1989, 3100 Vdc on power supply, 510 Vac on contact input
Impulse:	IEC 60255-5: 1977, 0.5 J, 5000 V
Vibration:	IEC 60255-21-1: 1988, Class 1 Class 2
Shock and Bump:	IEC 60255-21-2: 1988, Class 1 Class 2
Seismic:	IEC 60255-21-3: 1993, Class 2
1MHz Burst Disturbance:	IEC 60255-22-1: 1988, Class 3 (2500 V common and differential mode)
Electrostatic Discharge:	IEC 60255-22-2: 1996, EN 61000-4-2: 1995, Level 4
Radiated Radio Frequency:	IEC 60255-22-3; 1989, IEC 801-3: 1984, ENV 50140: 1994, IEEE C37.90.2: 1995, 10 V/m
Fast Transient Disturbance:	IEC 60255-22-4: 1992, EN 61000-4-4: 1995, Level 4
Surge Withstand:	IEEE C37.90.1: 1989, 3000 V oscillatory 5000 V transient

Certifications

ISO: Device is designed and manufactured to an ISO-9001 certified quality program.
UL/CSA: UL recognized to the requirements of UL-508; CSA C22.2, N.14 for Industrial Control Equipment.
CE: CE Mark.

Notes

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CAUTION: Do not connect ac or dc voltage to the contact input.

ATTENTION: Ne pas raccorder de source de tension CA ou CC sur le contact d'entrée.

DANGER: Disconnect power before removing top cover.

DANGER: Débrancher l'alimentation avant de retirer le couvercle du dessus.