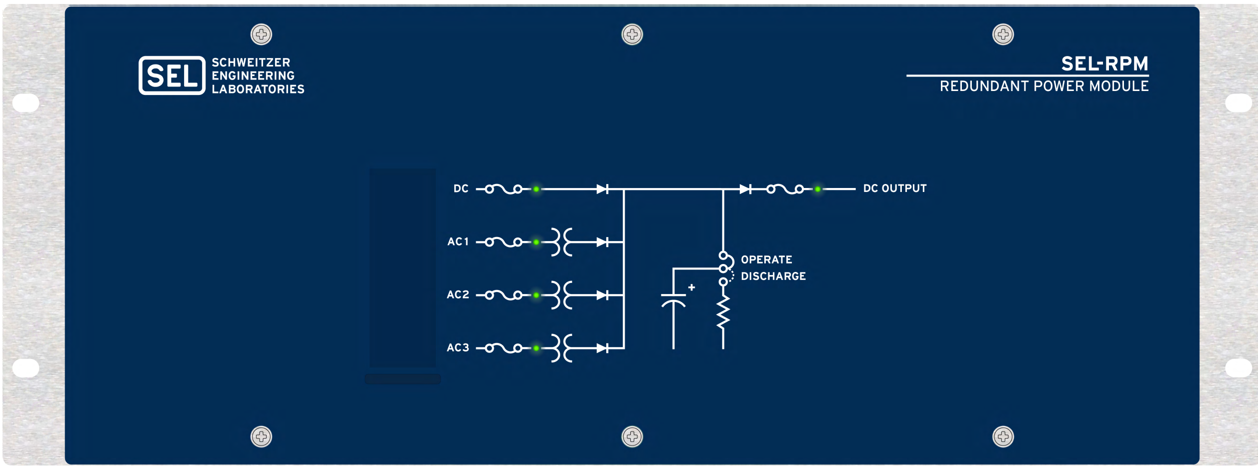
SEL-RPM Data Sheet

Redundant Power Module



Features and Benefits

The SEL Redundant Power Module (RPM) combines up to three ac sources and one dc source to provide a single, reliable dc output to power protection, monitoring, and control equipment. Large energy storage capacitors provide ride through and support switch or breaker trip/close applications when all input sources are lost.

Dependable control power and ride through from the SEL-RPM provide the following advantages:

- ➤ Keeps protection, automation, and SCADA running during battery servicing or power interruptions.
- ➤ Reduces device restarts.
- ➤ Increases device availability.
- ➤ Increases the reliability of control power, especially in stations without batteries.
- ➤ Provides many advantages of a dual battery system at a fraction of the cost.
- ➤ Provides energy for 30 A, 200 ms tripping, in accordance with IEEE C37.90 and EN 60255-1.
- ➤ 1/8 farad (F) capacitor stores 1300 watt-seconds nominal of energy to trip breakers.
- ➤ Powers a 6-watt SEL-351 Protection System for 3.5 minutes, a 25-watt load for 50 seconds, and a 100-watt load for 12 seconds, typical.
- ➤ Includes a capacitor output (unregulated) for reliable energy and high surge currents.

Overview

The SEL-RPM provides reliable dc power as well as ride through to improve the availability of critical systems.

125 Vdc Model

DC Input: One (1) 125 Vdc

AC Input: Three (3) 120 Vac

DC Output: One (1) unregulated 125 Vdc, 100 W

Front-Panel Indicators

LEDs indicate the status of the four inputs and one output.

Rear-Panel Control and Indicator

A rear-panel jumper connects the capacitor bank to the output (**OPERATE**) or disconnects the capacitor bank and discharges it (**DISCHARGE**). An LED adjacent to the jumper indicates when the capacitor bank voltage exceeds 30 Vdc.

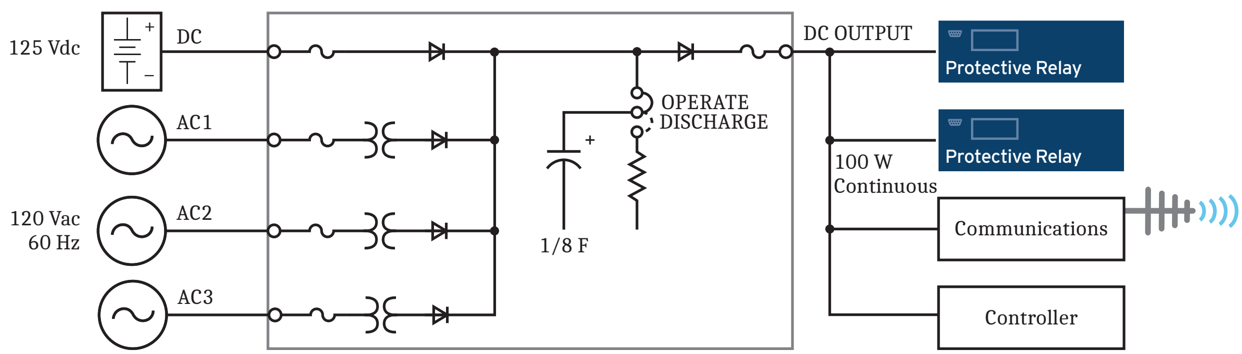


Figure 1 SEL-RPM Typical Application

Principles of Operation

The dc applied to the dc input terminals passes through a full-wave bridge rectifier to provide a polarity-insensitive input and to prevent the internal dc bus from backfeeding the dc input.

With a dc input only, the 126 mF/250 Vdc capacitor bank charges from the internal dc bus through a current-limiting resistor and a blocking diode. The capacitor bank will fully charge from zero in about 3.4 seconds. The SEL-RPM output is protected from backfeed by a blocking diode.

For a dc-only input, the no-load output voltage is the input voltage minus the diode voltage drops (about 2 Vdc). Thus, an input voltage of 125 Vdc produces an output voltage of approximately 123 Vdc.

The three ac inputs are transformer-isolated and full-wave bridge rectified. The rectifier outputs drive the same internal dc bus as the dc input rectifier.

Under no load, the capacitor bank charges to nearly the peak of the ac inputs, multiplied by the isolation transformer turns ratio (120/130), minus the diode drops (about 2 Vdc). With 120 Vac applied to one or more ac inputs, the no-load output voltage reaches approximately $120 \bullet \sqrt{2} \bullet (120/130) - 2 = 154$ Vdc.

A filter reactor smooths the rectified ac and an inrush limiting resistance reduces input current surges upon energization from any source.

Figure 11 shows a plot of the output voltage versus load for various input source configurations.

Fuses on all four inputs protect the SEL-RPM from most internal and external faults. A fuse on the output of the SEL-RPM, in conjunction with a diode across the output, protects the SEL-RPM from accidental reverse polarity voltage being applied to the capacitor bank of the SEL-RPM. The fuses are sized to conservatively handle the surges from energizing the SEL-RPM and from energizing devices connected to the output of the SEL-RPM. The fuses also withstand repeated trip and close operations of circuit breakers.

The SEL-RPM is designed to withstand crowbar short-circuits on the output. One or more fuses will blow under this condition.

Features

Reliable Control Power

DC control power can be a single point of failure. Control power can be interrupted or lost completely because of dc faults, battery charger failures, testing, and maintenance incidents.

When using a single source of control power, any interruption, even as short as 100 ms can cause equipment to restart. Restarts cause a loss of availability. When using the SEL-RPM, in the event of a disturbance of one source, the other sources continue to provide uninterrupted control power. The SEL-RPM provides many of the advantages of a dual dc system at a fraction of the cost. Common sources to combine include the following:

- DC Battery
- Station Service
- Alternate Station Service
- Backup Generator
- Instrument Transformers

Normal Operation

During normal operation, one or more sources are connected to a dc output bus via heavy-duty diodes, as shown in *Figure 1*. AC sources are isolated through transformers. Output combining ensures that the highest voltage source powers the output and maximizes energy storage and ride through. Transition to the next highest voltage source occurs without interruption when any source is lost.

Ride Through Disturbances

The SEL-RPM energy storage capacitors provide ride through during the loss of all input sources. Ride-through time depends on the load and device dropout voltage.

Some ride-through applications include:

- Transfer switch operation, backup generator starting, or automatic reclosing.
- Capacitor-trip the breaker when all sources are lost.
- Trip-on-loss of control power and other safety schemes.
- Power relays long enough to trip breaker and store event record after the loss of control power.

Simple to Use

Simply ensure the devices you intend to connect to the SEL-RPM are properly rated to handle the unregulated capacitor voltage output. See *Table 2* for typical power supply ratings of SEL devices. The SEL-RPM has no settings, and it requires no maintenance because there are no batteries, firmware, or any other components that wear out or need attention.

Parallel Operation

To increase the number of input sources or the ride-through capacity, you can connect SEL-RPM devices in parallel (see *Figure 9*). Isolation diodes block one SEL-RPM from backfeeding the other.

Safety

- Capacitors can be discharged manually to a safe level in less than 10 seconds by using the rear-panel jumper installed in the DISCHARGE position. An LED adjacent to the jumper illuminates when capacitor bank voltage exceeds 30 V.
- Input voltage sources are fuse-protected from indefinite output short circuits.

Five Fuses on Rear Panel

Each ac input is protected by a 6 A slow-blow fuse (Bel Fuse 0654R6000-51). Both the dc input and output are protected by a 10 A fuse (Schurter 8020.5021 or equivalent). Spare fuses for each input and the output are provided on the rear panel.

Rugged and Reliable Design

The SEL-RPM is designed with oversized diodes rated for 80 A and bridge rectifiers rated for 35 A for reliable performance even after repeated short-circuit conditions.

Front- and Rear-Panel Indicators

LEDs show the status of each input, the output, and the capacitor charge, as described in *Table 1*.

Table 1 SEL-RPM Status LEDs

LED	Color	Description
DC	Green	Indicates that the DC SOURCE voltage source is present.
	Off	Indicates that the DC SOURCE voltage source is not present or the source fuse, FDC, is blown.
AC1	Green	Indicates that the AC1 SOURCE voltage source is present.
	Off	Indicates that the AC1 SOURCE voltage source is not present or the source fuse, FAC1, is blown.
AC2	Green	Indicates that the AC2 SOURCE voltage source is present.
	Off	Indicates that the AC2 SOURCE voltage source is not present or the source fuse, FAC2, is blown.
AC3	Green	Indicates that the AC3 SOURCE voltage source is present.
	Off	Indicates that the AC3 SOURCE voltage source is not present or the source fuse, FAC3, is blown.
DC OUTPUT	Green	Indicates that the DC OUTPUT voltage is present.
	Off	Indicates that the DC OUTPUT voltage is not present or the output fuse, FOUT, is blown.[a]
CAPS CHGD (rear panel)	Red	Indicates that the capacitor bank is charged. LED intensity is dependent on the capacitor charge.
	Off	Indicates that the capacitor bank is discharged.

[a] If multiple SEL-RPM devices are connected in parallel, the output LED will remain illuminated if the output of other SEL-RPM devices is present.

Applications

Voltage Ranges of SEL Devices Suitable for Use With the SEL-RPM

The SEL-RPM has an unregulated dc output voltage that may be higher than nominal 125 Vdc systems. Ensure the connected devices, including power supplies and relay binary inputs, are rated for higher output voltages. Refer to *Figure 11* for output voltage based on load and input voltages. SEL devices have a wide operational voltage range. Use *Table 2* for the operational range of the power supplies for several common SEL devices. For devices with multiple power supply options, select the power supply with the lower operating voltage range to provide longer ride-though capabilities. For example, the SEL-300 series relays have a 125–250 Vdc power supply that drops out at 85 Vdc, providing approximately 144 s of ride-through time. The same relay with a 48–125 Vdc power supply that drops out at 38 Vdc will have approximately 204 s of ride-through time.

Table 2 Common SEL Device Power Supply Operational Voltage Range

SEL Device	Nominal Power Supply Voltage (Vdc)	Operational Voltage Range (Vdc)	Typical Power Consumption (W)[a]	TypicalRide-Through Time (s)
SEL-300 Series Relays	48–125[b]	38–200	6	204
	125–250	85–350		144
SEL-400 Series Relays	125–250	85–350	15	58
SEL-700 Series Relays	110–250	85–300	10	86
SEL-3530 Real-Time Automation Controller (RTAC)	48–125	38–200	15	82
	125–250	85–300		58
SEL-2740S Software-Defined Network (SDN) Switch	125–250	85–300	25	35
SEL-3355 Computer	125–250	85–300	75	12
SEL-2488 Satellite-Synchronized Network Clock	125–250	85–300	15	58

[a] Typical power consumption will vary with device configuration and application.

[b] When selecting new relays to use with the SEL-RPM, select the relay power supply with the lower operational range for a longer ride-through time.

Source Diversity

Connect the SEL-RPM to all three phases of control power or to a potential transformer (see *Figure 2*). Only a three-phase fault would remove all ac sources. At least one phase will be healthy for all other faults.

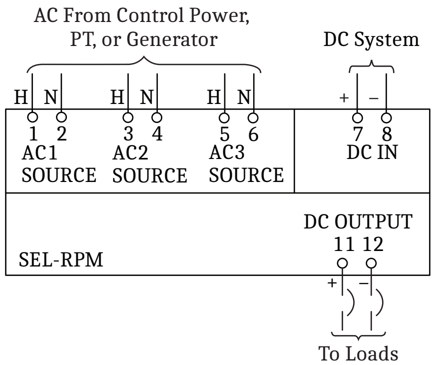


Figure 2 SEL-RPM Connected to Diverse Sources

Powering Protection and Control Devices

In *Figure 3*, the SEL-RPM provides control power to four relays. See *Figure 10* for typical run times.

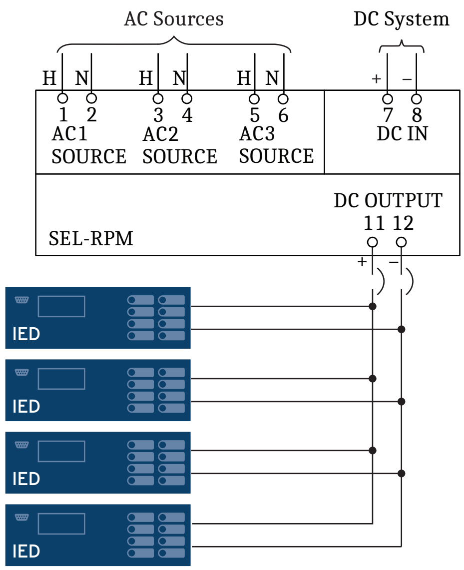


Figure 3 SEL-RPM Providing Control Power to Multiple Relays

Install in Every Panel

Install one SEL-RPM per panel to power multiple relays, as shown in *Figure 4*. You can add a second SEL-RPM device in parallel to provide a longer ride-through time. Alternatively, supply System A protection from one SEL-RPM and System B protection from another SEL-RPM for added redundancy.

Figure 4 SEL-RPM Installed in a Panel

Trip Breakers

An SEL-RPM can trip breakers, even when all sources have been lost. The SEL-RPM stores 1300 watt-seconds nominal of energy. Most trip coils require less than 60 watt-seconds to operate, allowing the SEL-RPM to supply breaker trip coils and power the relay for many seconds after the total loss of all inputs.

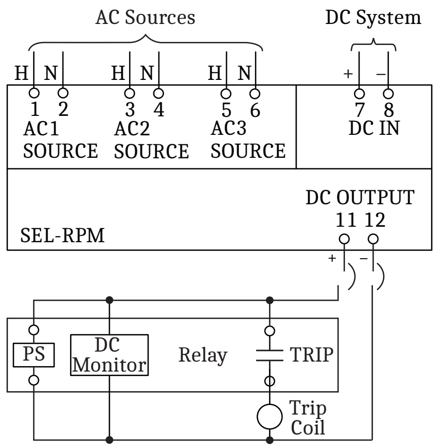


Figure 5 SEL-RPM Providing Control Power to the Relay and the Trip Circuit

Trip-on-Loss of Control Power Safety Scheme

Keep people and equipment safe and protected by designing a safety scheme that trips breakers after the loss of all control power sources. You can use the relay dc monitor, as shown in *Figure 5*, and trip at a low voltage threshold where the SEL-RPM still has energy, as shown in *Figure 6*.

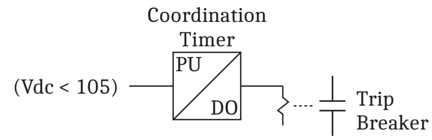


Figure 6 Relay Logic for Low DC Voltage Tripping

Monitoring an SEL-RPM With an SEL Relay or Automation Controller

You can use various SEL relays and automation controllers to monitor the status of an SEL-RPM. Use binary inputs to determine if an input voltage source is present, and use a dc monitor to monitor the SEL-RPM output voltage, if required. Refer to *Figure 7* for typical connections from the SEL-RPM to an SEL relay. When connecting the ac voltage sources to the relay or automation controller, ensure the binary input debounce or voltage type is set to ac. Refer to *Table 3* for summarized application notes for various SEL devices.

NOTE: Refer to the relay instruction manual for settings details when connecting ac to binary inputs.

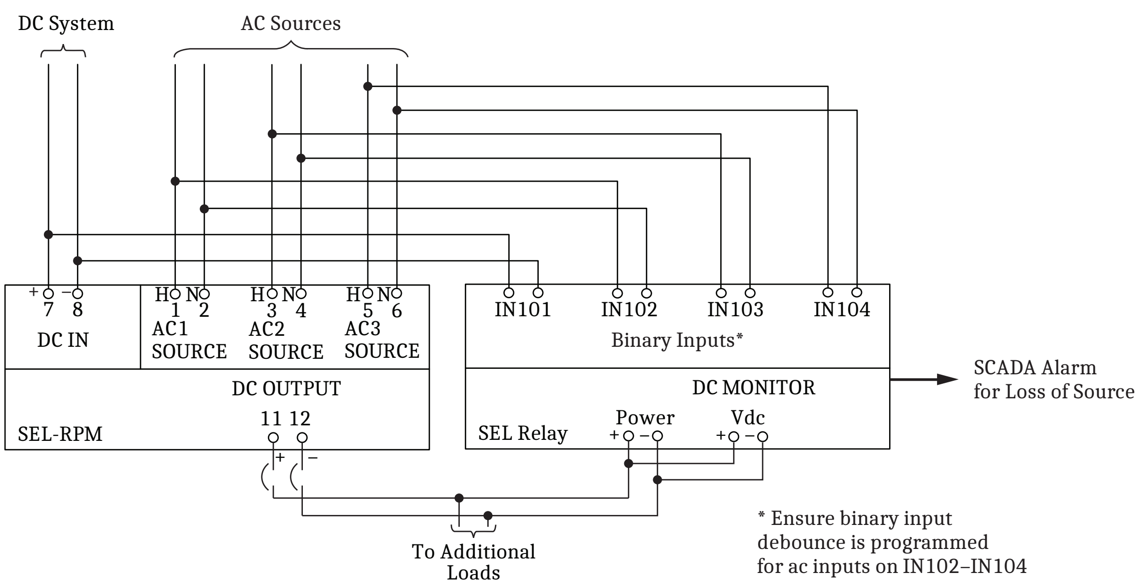


Figure 7 Installation Example for Monitoring the SEL-RPM Input Status and Output Voltage

Table 3 Options for Monitoring the SEL-RPM (Sheet 1 of 2)

Product Line	SEL-RPM DC Input Monitoring	SEL-RPM AC Input Monitoring	SEL-RPM Output Voltage Monitoring[a]	Notes
SEL-300 Series	125 Vdc input	125 Vdc input Set debounce to PU = 0.125 cyc and DO = 1.00 cyc	Vdc monitor	Station battery monitor is integrated with relay power terminals.
SEL-400 Series	125 Vdc input	125 Vdc input Set debounce to PU = 0.125 cyc and DO = 1.00 cyc	Vdc monitor	Main board A with optoisolated inputs are dc only. Main board B can accommodate ac and dc signals.

Table 3 Options for Monitoring the SEL-RPM (Sheet 2 of 2)

Product Line	SEL-RPM DC Input Monitoring	SEL-RPM AC Input Monitoring	SEL-RPM Output Voltage Monitoring[a]	Notes
SEL-500 Series	125 Vdc input	No options	No options	
SEL-700 Series	125 Vdc input	125 Vdc input Set debounce to ac	Vdc monitor	
SEL-2411	125 Vdc input	125 Vdc input Set debounce to ac	Use extended range dc transducer	
SEL-2420 DPAC	125 Vdc input	125 Vdc input Set debounce to ac	No options	
SEL-3530 RTAC	125 Vdc input	125 Vdc input Set voltage type to ac	Requires SEL-2240 Axion® node with dc analog input extended-range module	Requires additional I/O board.
SEL-2240 Axion	125 Vdc module	125 Vdc input module Set voltage type to ac	Use dc analog input extended-range module	Binary input card price is $210 and the ac metering card is $940.

[a] Refer to *Figure 11* for coordinating the unregulated output voltage of the SEL-RPM device with the monitoring port ratings of the relay.

Monitoring the SEL-RPM With the SEL-2652

Use the SEL-2652 Trip Coil Monitor, as shown in *Figure 8*, to monitor the status of the SEL-RPM dc input sources. Connect the SEL-2652 alarm contact to SCADA for remote monitoring.

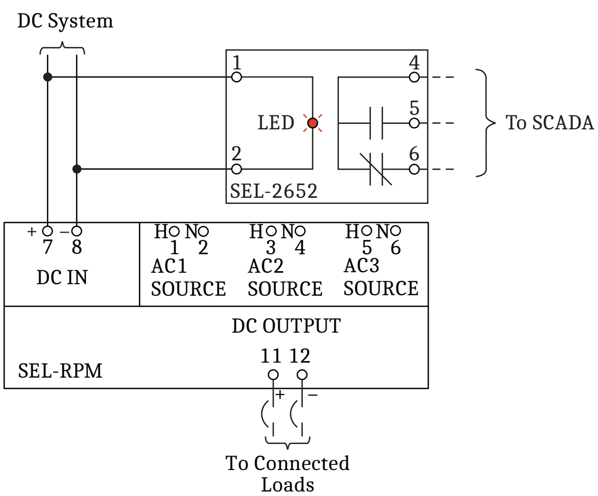


Figure 8 Monitoring the SEL-RPM With the SEL-2652 Trip Coil Monitors

Parallel SEL-RPM Devices for Increased Ride-Through Times

Increase the ride-through times or further improve source diversity by installing two parallel SEL-RPM devices. Isolation diodes block one SEL-RPM from backfeeding the other. Use 12 AWG (4.0 mm^2) wire and comply with National Electric Code Authority Having Jurisdiction (NEC AHJ).

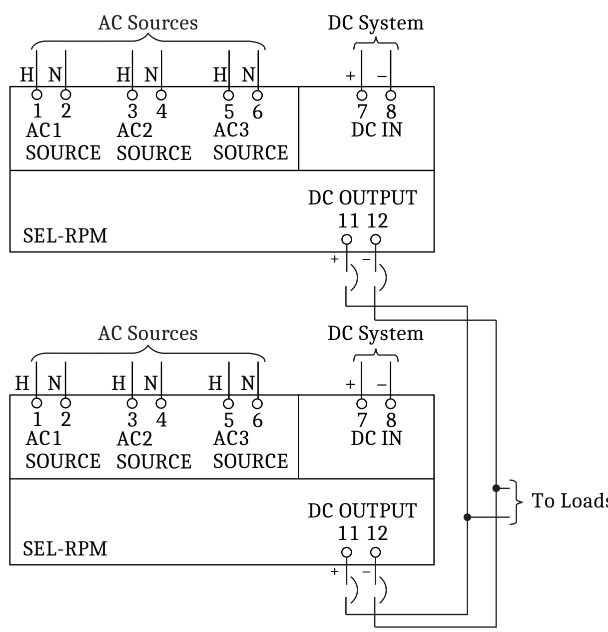


Figure 9 Two SEL-RPM Devices Connected in Parallel

Reliable Power for Computers

The SEL-RPM provides reliable power for computers and automation equipment. Computers take minutes to restart after power interruptions. Files may be corrupted or the computer may fail to restart if power is interrupted. The SEL-RPM provides up to 12 seconds of ride through for an SEL-3355 Computer.

Ride-Through Time

The SEL-RPM stores energy for riding through interruptions of all input sources. The ride-through time depends on the input voltage, the load, and the device dropout voltage. Use *Equation 1* or visit selinc.com/products/RPM to use the online ride-through calculator for estimating ride-through time. *Equation 1* assumes a constant power load, which is an approximation for switching converter loads. Actual ride-through times should be verified through measurement.

$$\text{Ride-through time} = \frac{(V^2_{INITIAL} - V^2_{DROPOUT})}{16 \bullet (P_{LOAD})}$$

Equation 1

where:

$V_{INITIAL}$ is the output voltage at the time of interruption (V).

P_{LOAD} is the connected load in W.

$V_{DROPOUT}$ is the dropout voltage of the connected device (V). For example, for SEL relays with 48/125 Vdc power supplies, the dropout voltage of the relay is approximately 38 V.

Table 4 Typical Ride-Through Times

Initial Output Voltage (Vdc)	Device Dropout Voltage (Vdc)	Load (W)				
		5	25	50	75	100
		Time (s)				
145	38	245	49	24	16	12
	85	173	35	17	12	9
130	38	193	39	19	13	10
	85	121	24	12	8	6

Use *Figure 10* to estimate the dropout time for the given loads and the initial and dropout voltages. The example point shown in *Figure 10* is typical performance with a load of four SEL-351 relays.

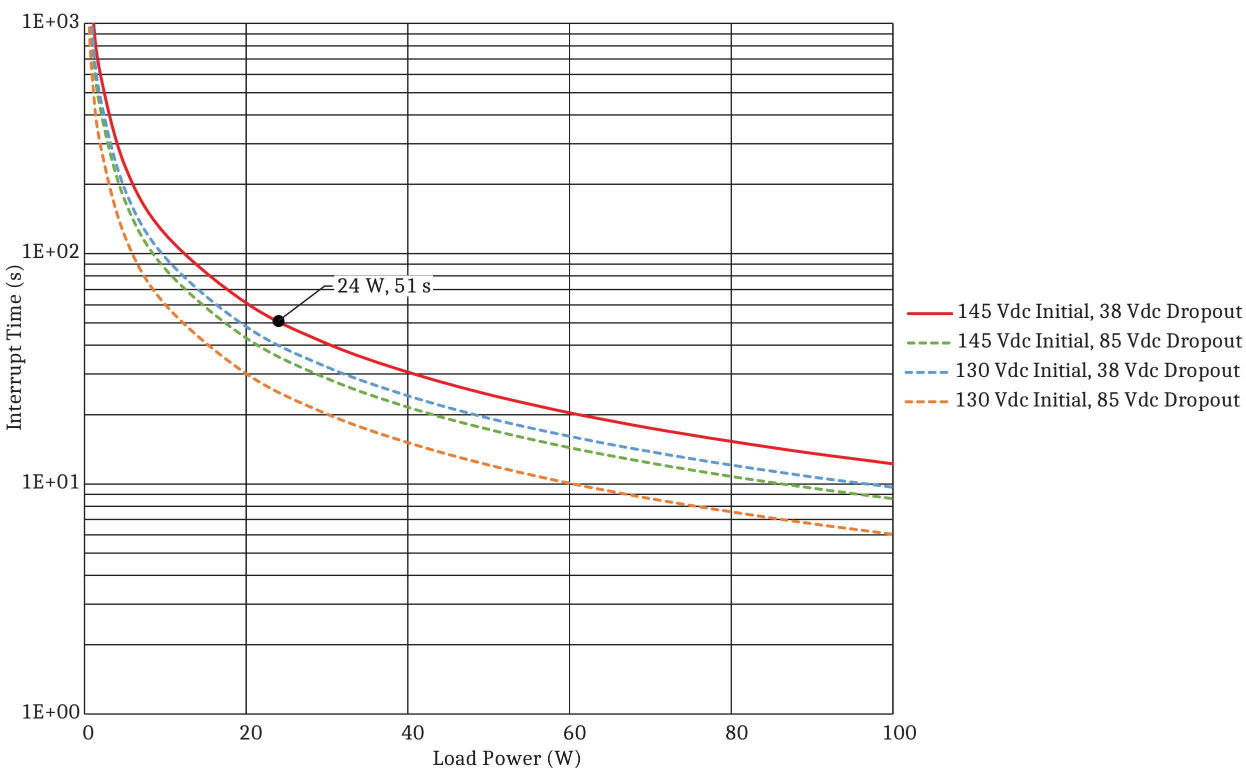


Figure 10 Ride Through Based on Dropout Voltage, Load Power, and 130 or 145 Vdc Initial Voltage

Ride-Through Time Examples

Nominal Ride Through

For a typical installation with 120 Vac three-phase ac connected to the SEL-RPM, the nominal output voltage for a 24 W load is approximately 145 Vdc. At this initial voltage, the ride-through time for four relays measured at 6 watts each, all with dropout voltage ratings of 38 V, is 51 seconds (see *Table 5*).

Example Nominal Ride-Through Time Calculation

$$\text{Ride-through time (s)} = \frac{(V^2_{\text{INITIAL}} - V^2_{\text{DROPOUT}})}{16 \bullet (P_{\text{LOAD}})}$$

$$= \frac{(145^2 - 38^2)}{16 \bullet (24)}$$

$$= 51 \text{ seconds}$$

Table 5 Typical Protection Panel With Four Relays

Device	Measured Power Consumption (W)	Dropout Voltage (V)
Relay 1	6	38
Relay 2	6	38
Relay 3	6	38
Relay 4	6	38
Total	24	38
Ride Through	51 seconds	

Automation Panel

For a typical automation panel with the devices in *Table 6*, the ride-through time is calculated for the measured power consumption during normal operation. The highest dropout voltage is used in the calculation to determine ride-through time based on when the first device would shut down. The initial voltage is based on nominal dc input voltage of 125 Vdc.

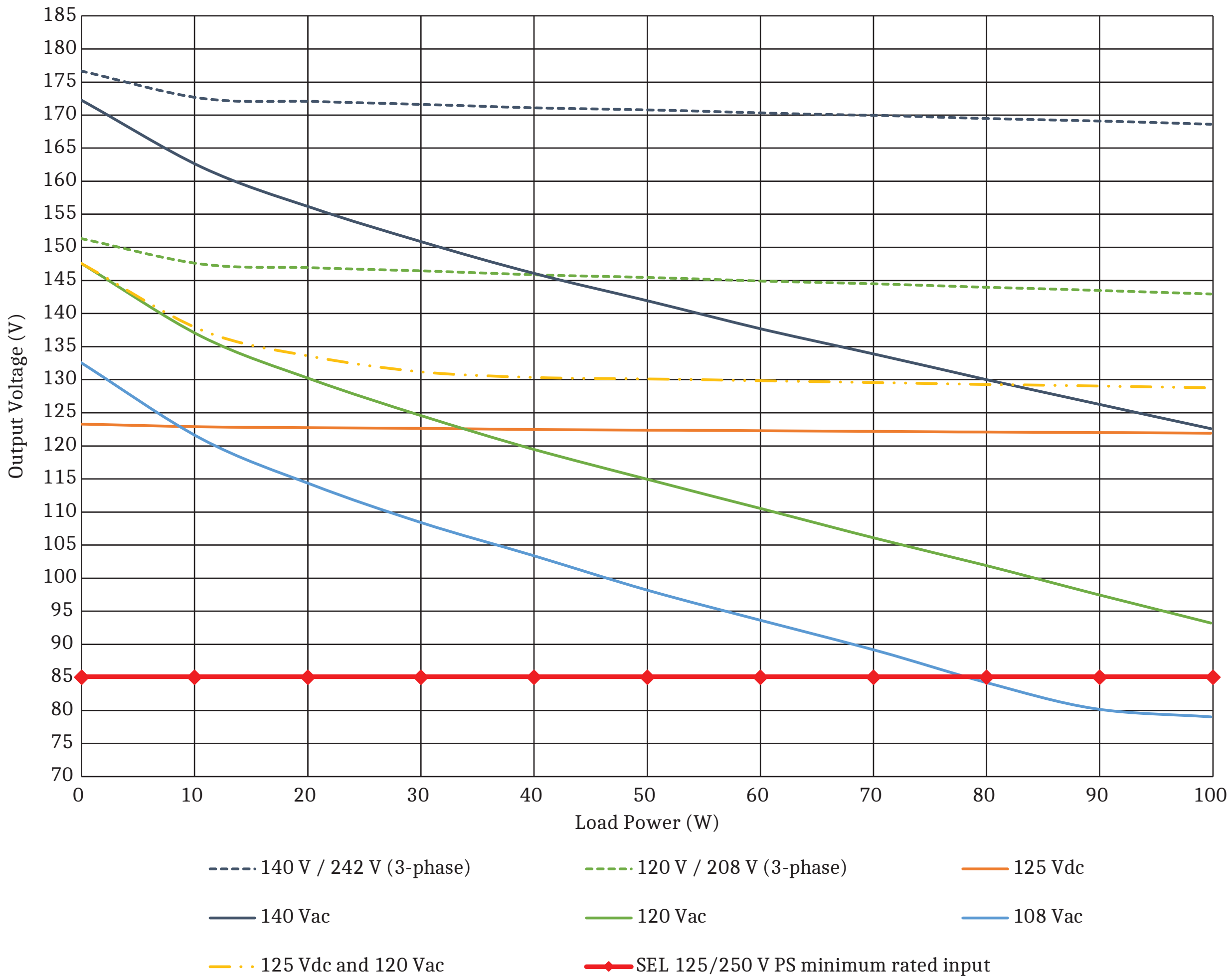
Table 6 Ride Through for a Typical Automation Panel

Device	Measured Power Consumption (W)	Dropout Voltage (Vdc)
Security Gateway	15	40
Automation Controller	15	40
Satellite Clock	5	85
Total	35	85[a]
Ride Through	15 seconds before clock shuts down	

[a] Highest dropout voltage used.

Output Voltage

The output voltage of the SEL-RPM is dependent on the source voltage(s) and load, as shown in *Figure 11*. Ensure the voltage ratings of all devices connected to the SEL-RPM output are appropriately rated for the possible SEL-RPM voltage versus loading, as shown in *Figure 11*.



NOTE: A heavily loaded SEL-RPM, when powered from a single, low-line ac input, produces an output voltage that is below the minimum rated input voltage of SEL devices with the 125/250 V power supply option. Carefully review the load device input voltage specifications in coordination with the SEL-RPM output voltage for the given source and load conditions.

Figure 11 DC Output Voltage Based on Source Voltage(s) and Load

Trip Energy Ride-Through Calculation

When applying an SEL-RPM to power relays and provide energy for trip coils with the stored energy, you can use the following section to assist with determining the maximum ride-through time, t1 (seconds), that ensures enough energy is left to energize connected trip coils.

Inputs Needed for Calculation

- Minimum working voltage of the trip coil (V_f [volts]).
- Resistance of the trip coil (R_{coil} [ohms]).
- Constant power load connected to the SEL-RPM during the ride through (P_{load} [watts])

- ➤ Operate time for the breaker (T [seconds])
- ➤ Initial voltage at the SEL-RPM output at time of power loss of all sources ($V_{INITIAL}$ [volts]).

NOTE: This is dependent on input sources connected and loading on the SEL-RPM output. See *Figure 11* for information on estimating the SEL-RPM output voltage for given source and load combinations.

Figure 12 shows the SEL-RPM output voltage after all sources are lost at t = 0. The output voltage decays because of the connected loads.

- ➤ $V_{INITIAL}$ is the SEL-RPM output voltage at the time of power loss of all sources.
- ➤ V_t is the voltage at the SEL-RPM output just before the trip coil is energized.
- ➤ At t = t1, the trip event is triggered and the trip coil is energized.
- ➤ At t = t2, the trip event is complete and the trip coil is no longer energized.
- ➤ T is the trip coil operate time, typically 3–5 power system cycles.
- ➤ The SEL-RPM output voltage drops immediately from V_t to V'_t after connecting the trip coil to the output.
- ➤ V_f is the minimum SEL-RPM output voltage required for the trip coil (minimum coil operate voltage)

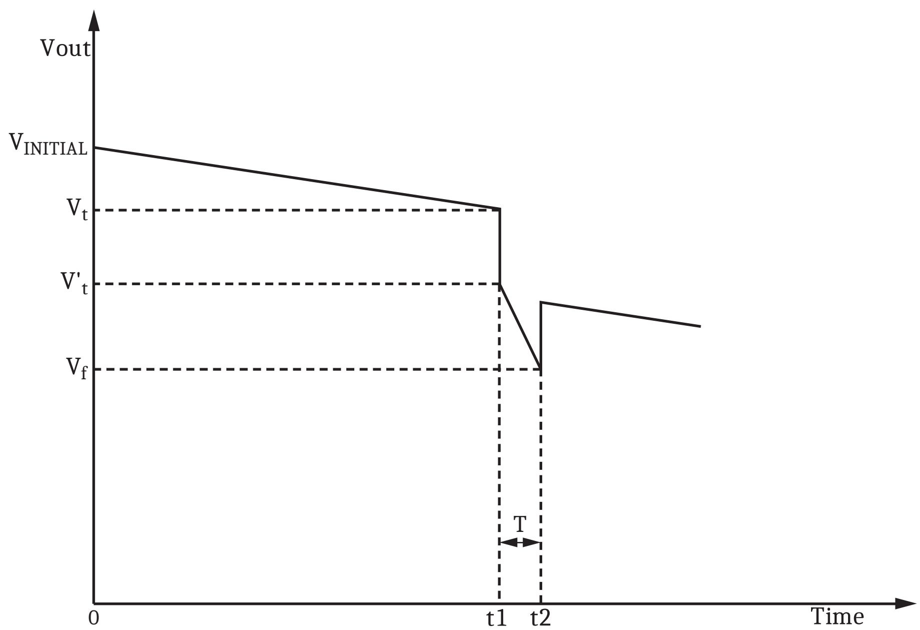


Figure 12 SEL-RPM Output Voltage After Loss of all Sources With Relay Load and Trip Event

Calculation

Use the following procedure to calculate t1, the maximum time following a loss of all SEL-RPM sources before issuing a trip command to ensure a successful trip operation. Note that the dropout voltage of the relay issuing the trip must be less than the minimum operate voltage of the trip coil to ensure the relay does not turn off before successfully issuing a trip.

Step 1. Calculate R.

$$R = 1.1 + \frac{V_f^2 \bullet R_{coil}}{V_f^2 + P_{load} \bullet R_{coil}}$$

Step 2. Calculate V'_t.

$$V'_t = V_f e^{\frac{T}{0.126R}}$$

Step 3. Calculate V_t.

$$V_t = V'_t + \frac{1.1 \bullet V'_t}{R_{coil}}$$

Step 4. Calculate t1.

$$t1 = \frac{0.126 \bullet (V_{INITIAL}^2 - V_t^2)}{2 \bullet P_{load}}$$

Step 5. Derate t1.

t1 should be derated to 70 percent for component tolerance and safety margin.

Example 1 Ride-Through and Trip Calculation

Consider an application with relays connected to the SEL-RPM that amount to a total load of 25 watts. In addition, one trip coil is powered by the SEL-RPM. The trip coil resistance is $R_{coil} = 10\ \Omega$, the trip coil operate time is 100 ms and minimum operating voltage for the trip coil is 60 volts. Assume the SEL-RPM is powered by 125 Vdc and a single 120 Vac source, giving a $V_{INITIAL}$ voltage of approximately 132 V for a 25 W load according to *Figure 11*.

Step 1.

$$R = 1.1 + \frac{60^2 \bullet 10}{60^2 + 25 \bullet 10} = 10.5\ \Omega$$

Step 2.

$$V'_t = 60 \bullet e^{\frac{0.1}{0.126 \bullet 10.5}} = 64.7\ \text{V}$$

Example 1 Ride-Through and Trip Calculation

Step 3.

$$V_t = 64.7 + \frac{1.1 \bullet 64.7}{10} = 71.8\ \text{V}$$

Step 4.

$$t1 = \frac{0.126 \bullet (132^2 - 71.8^2)}{2 \bullet 25} = 30.9\ \text{s}$$

Step 5.

$$t1\ \text{derated} = 30.9 \bullet 0.7 = 21.6\ \text{s}$$

In this example the SEL-RPM provides enough energy to trip the connected trip coil for up to 21 seconds after the loss of all sources.

Alternatively, visit selinc.com/products/RPM to use the online calculator to estimate ride-through times with trip coils.

Safety Information and Precautions

⚠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.

⚠CAUTION
If connecting more than two SEL-RPM devices in parallel, use the appropriate wire gauge and comply with National Electric Code Authority Having Jurisdiction (NEC AHJ).

⚠WARNING
Operator safety may be impaired if the device is used in a manner not specified by SEL.

⚠DANGER
Contact with instrument terminals can cause electrical shock that can result in injury or death.

Capacitor Energy Storage

The SEL-RPM uses large electrolytic capacitors to provide ride through. When installing or maintaining the SEL-RPM, observe the following safety precautions:

- Ensure the output is de-energized and the capacitors have completely discharged prior to installation or maintenance.
- You can manually discharge the capacitors in less than 10 seconds by placing the rear-panel jumper into the **DISCHARGE** position.
- The **CAPS CHGD** LED will extinguish when the capacitor bank has been discharged.
- Do not short circuit **DC OUTPUT** terminals.

Output Protection

Ensure the output has adequate short-circuit protection prior to the distribution of control power. Failure to install protection may result in blowing fuses at the inputs or output.

Parallel Operation

When installing the SEL-RPM in parallel, use caution to ensure the outputs of all SEL-RPM devices have the correct polarity. Connecting SEL-RPM devices in reverse polarity causes the output fuse to blow. Only use two SEL-RPM devices in parallel, connected using 12 AWG (4.0 mm^2) wire.

Output Danger

Prior to working on the output of the SEL-RPM, observe the following process to ensure that the capacitors have been fully discharged, and the output has de-energized safely.

Step 1. Disconnect all input sources.

Step 2. Verify on front of the SEL-RPM that all input LEDs are extinguished.

Step 3. On the rear panel of the SEL-RPM, move the jumper into the **DISCHARGE** position.

Step 4. Verify the **CAPS CHGD** LED is extinguished.

Step 5. Verify the outputs terminals de-energize by using the following live-dead-live process to verify your voltmeter is functioning properly:

a. (Live) Verify the voltmeter is functional on known source.

b. (Dead) Verify the SEL-RPM output is less than 30 volts.

c. (Live) Confirm the voltmeter is still functional on known source.

Installation

The SEL-RPM mounts by its front vertical flanges in a cutout or a 19-inch vertical relay rack. A 1-inch space should be left directly above and below the SEL-RPM to allow for adequate convection cooling.

Connect the dc output to a fuse or a miniature circuit breaker prior to the distribution of control power (see *Figure 13*).

Consider adding a fuse or miniature circuit breaker upstream of the SEL-RPM input sources, depending on system configuration and application requirements. Refer to *Specifications* on page 15 for the SEL-RPM source fuse part numbers to aid fusing coordination.

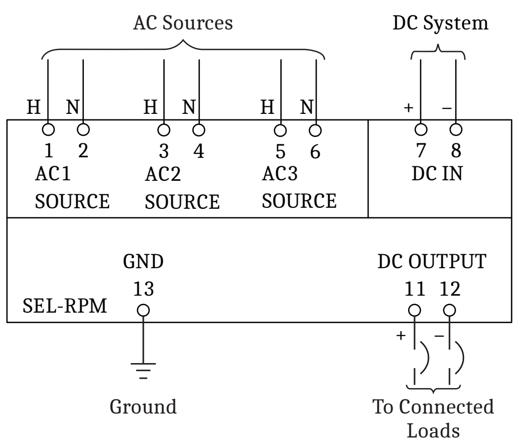


Figure 13 SEL-RPM Connections

Functional Testing

The following steps test the SEL-RPM after installation to verify that each input voltage source can power the load:

Step 1. Connect a dc load to the **DC OUTPUT** terminals, noting the polarity markings on the SEL-RPM and on the load.

Step 2. Connect a rated dc input source to the **DC SOURCE** and the rated ac input sources to **AC1 SOURCE**, **AC2 SOURCE**, and **AC3 SOURCE**.

Step 3. Apply dc power.

Step 4. Verify:

d. **DC** and **DC OUTPUT** LEDs illuminate.

e. DC output voltage is present by using a voltmeter.

Step 5. Disconnect **DC SOURCE** power and apply ac power to **AC1 SOURCE**.

Step 6. Verify:

a. **AC1** and **DC OUTPUT** LEDs illuminate.

b. DC output voltage is present by using a voltmeter.

Step 7. Repeat *Step 5* and *Step 6* for **AC2** and **AC3** source.

Step 8. Remove power from all input sources.

Step 9. Verify:

a. All four input LEDs extinguish.

b. Connected load stays powered for a period of time, estimated using the connected load and voltage dropout.

Testing Ride-Through Time

Ride-through time is based on the connected load, the highest available input voltage, and the dropout voltage of connected loads, as calculated in *Equation 1*.

Perform the following steps to verify approximate ride-through time for the given installation:

Step 1. Apply power.

Step 2. Once all connected loads are powered, disconnect power to the SEL-RPM.

Step 3. Start a timer when all input sources have been disconnected.

Step 4. Stop the timer when the connected load alarm contact asserts or for visual shutdown of connected load.

Dielectric Strength Testing

You can perform high-potential testing on the SEL-RPM ac sources. See *Specifications* on page 15 for dielectric strength rating.

Capacitor Discharge Testing

To verify the proper operation of the capacitor manual discharge, perform the following steps:

Step 1. Disconnect all loads from DC OUTPUT.

Step 2. Disconnect all voltage sources (DC SOURCE, AC1 SOURCE, AC2 SOURCE, and AC3 SOURCE).

Step 3. Use a voltmeter to verify that terminals DC SOURCE, AC1 SOURCE, AC2 SOURCE, and AC3 SOURCE are de-energized.

Step 4. Use a voltmeter to verify the DC OUTPUT terminal has more than 30 volts present and the CAPS CHGD LED is illuminated.

Step 5. Remove the rear-panel jumper from the OPERATE position and install in the DISCHARGE position for 10 seconds. Reinstall the jumper in the OPERATE position.

Verify that the voltage on the DC OUTPUT terminals is less than 30 volts and the CAPS CHGD LED is no longer illuminated.

Diagrams and Dimensions

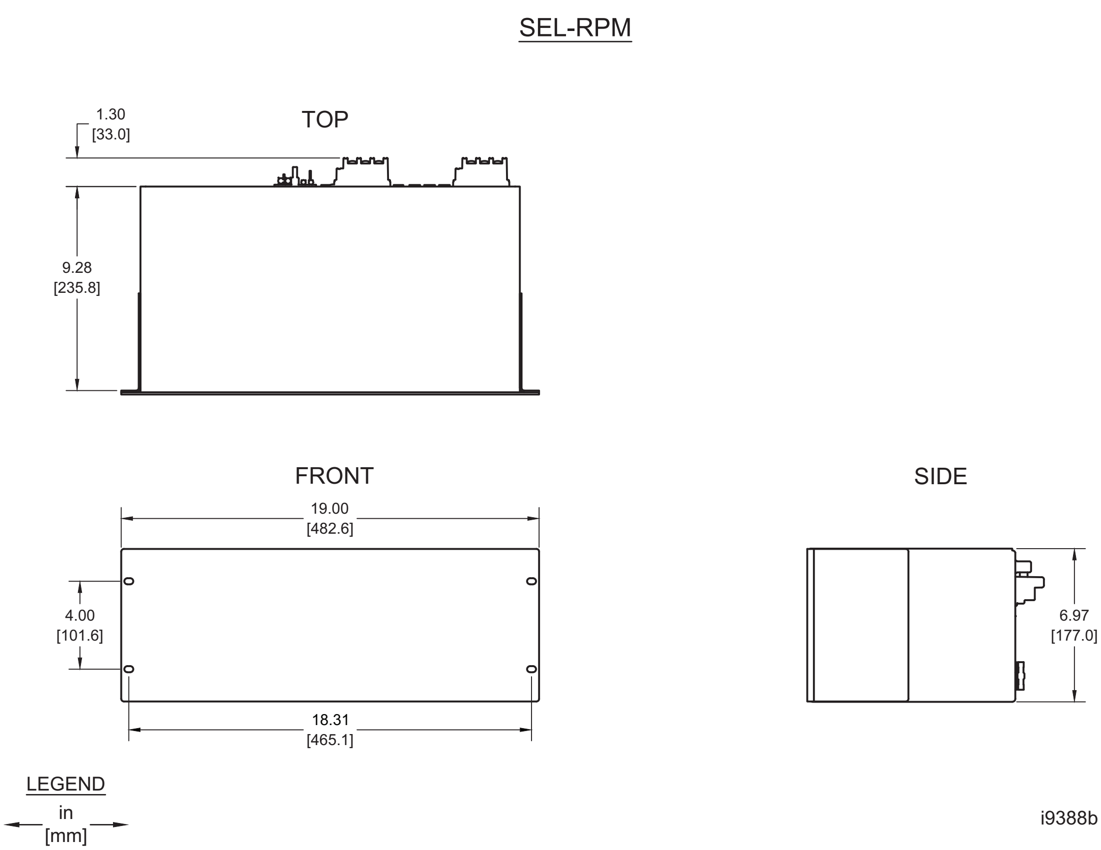


Figure 14 SEL-RPM Front- and Rear-Panel Dimensions

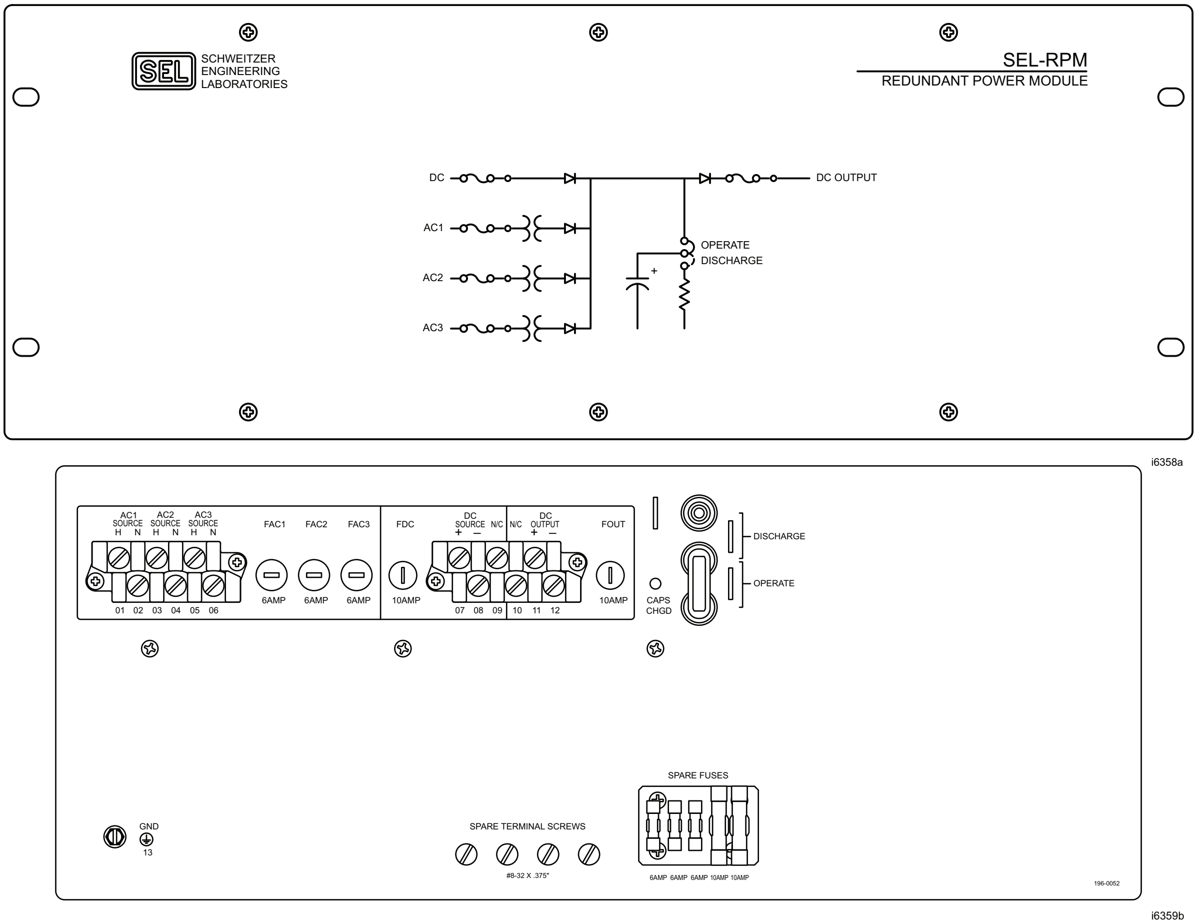


Figure 15 SEL-RPM Rack-Mount Diagrams

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

The SEL-RPM is intended for public utility substations

General

Dimensions

17.7 cm H x 48.3 cm W x 248 cm D (7 in H x 19 in W x 10.58 in D)

Front-Panel LED Indicators

DC:	(Green) dc power input is present
AC1:	(Green) ac power input is present
AC2:	(Green) ac power input is present
AC3:	(Green) ac power input is present
DC OUTPUT:	(Green) dc power output is available

Rear-Panel LED Indicator

CAPS CHGD:	(Red) capacitor bank charged

125 Vdc Model

DC Input	
Rated Voltage:	125 Vdc
Operational Voltage Range[a]:	100–160 Vdc
Peak Inrush Current:	32.5 A
AC Input	
Rated Voltage:	120 Vac
Operational Voltage Range:	108–140 Vac
Peak Inrush Current:	22 A
DC Output	
Rated Voltage:	125 Vdc
Operational Range:	78–181 Vdc
Rated Power[b]:	100 W
Maximum Short Circuit:	183 A
Output Ripple:	<10 Vpp

Stored Energy

Capacitance:	1/8 F
Output Stored Energy:	1300 watt-seconds (J), nominal
Manual Discharge Time:	<10 seconds via rear-panel DISCHARGE jumper to a safe level
Capacitor Life:	>10 years at 55 °C

Fuses

125 Vdc Model

DC Input:	10 A (Schurter 8020.5021 or equivalent)
AC Input:	6 A (Bel Fuse 0654R6000-51 or equivalent)
DC Output:	10 A (Schurter 8020.5021 or equivalent)

Environmental

Operating Temperature:	–40° to +85°C (–40° to +185°F)
Storage Temperature:	–40° to +85°C (–40° to +185°F)
Humidity:	5% to 95% without condensation*
Maximum Altitude:	2,000 m
Pollution Degree:	2

Weight (Maximum)

20.4 kg (45 lb)

Terminal Connections

Rear Screw-Terminal Tightening Torque, #8 Ring Lug, 8-32 Thread Pitch

Minimum:	1.0 Nm (9 in-lb)
Maximum:	2.0 Nm (18 in-lb)

User terminals and stranded copper wire should have a minimum temperature rating of 105°C. Ring terminals are recommended.

Type Tests

Environmental Tests (Exploratory)

Cold:	IEC 60255-27:2013, Section 10.6.1.2 Test Ad:16 hours at –40°C
Damp Heat Cyclic:	IEC 60255-27:2013, Section 10.6.1.6 Test Db: 25° to 55°C, 6 cycles, 95% humidity
Dry Heat:	IEC 60255-27:2013, Section 10.6.1.1 Test Bd:16 hours at +85°C
Vibration:	IEC 60255-27:2013, Section 10.6.2.1 Severity Level: Class 2 (endurance); Class 2 (response) IEC 60255-27:2013, Section 10.6.2.2 Severity Level: Class 1 (shock withstand, bump); Class 2 (shock response) IEC 60255-27:2013, Section 10.6.2.4 Severity Level: Class 2 (quake response)

Safety

Dielectric Strength:	IEC 60255-27:2013, Section 10.6.4.3 3,100 Vdc: ac inputs to chassis, dc input to chassis, dc output to chassis **Note:** DC input is not isolated from the dc output.
Impulse:	IEC 60255-27:2013, Section 10.6.4.2 0.5 J, 5 kV
Object Penetration:	Front: IEC 60255-27:2013, Section 10.6.2.6 Protection Class: IP3X Rear: IEC 60255-27:2013, Section 10.6.2.6 Protection Class: IP2X

[a] **Output Voltage During Permitted Overload Conditions**
Output voltage is further reduced beyond the Operational Range specified and values shown in *Figure 11* for overload conditions beyond 100 W (see [b]). Compatibility with operating ratings of devices powered by the SEL-RPM must be verified by the user.

[b] **Permitted Overload Conditions**
125 W load is permitted for installations with a maximum ambient temperature of 55°C.
150 W load is permitted for installations with three ac connections or two out-of-phase ac connections with a maximum ambient temperature of 55°C.

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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Notes

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