SEL-9331 Power Supply Instruction Manual

Features, Benefits, and Applications

The SEL-9331 is a switched-mode +12 Vdc power supply designed to supply power to SEL's line of industrial automation controllers. The SEL-9331 is flexible enough to provide power for other equipment as well. Additional features include:

- **Reliability.** Meets the same stringent test standards as SEL relays; see *Specifications* for more information.
- **Multiple Mounting Options.** Can be easily mounted to either a panel or DIN rail using optional clips.
- **Redundancy.** Two SEL-9331 Power Supply outputs can be connected in parallel to provide a backup power supply in case one source fails.
- **Power Factor Correction.** Minimizes reactive power and induced harmonics for improved efficiency of ac power systems.
- **Reverse-Polarity Protection.** Protects against damage in the event that input wiring is accidentally reversed.
- **Autorecovery From Undervoltage.** Undervoltage lockout prevents misoperation during brown-out conditions.
- **Short-Circuit Protection.** Prevents damage caused by excessive load.
- **Reverse-Current Protection.** Prevents reverse current flow caused by an overvoltage condition on the output.
- **Power Good Indicator.** The standalone power supply features a power good LED to indicate when the SEL-9331 is operating normally. When installed in an SEL-3355 Automation Controller, the power supply can be monitored by the SEL System Monitor and Microsoft Windows performance counters.
- **Conformal Coating (Optional).** Conformal coating of the circuit board provides an extra level of protection in corrosive environments.

Ordering Options

The following shows a range of ordering options available for the SEL-9331.

Enclosure Options

Figure 1 SEL-3355 Module

Figure 2 Standalone Module

Input Connector Options

Compression Screw Terminal

C14 Coupler

Figure 3 Input Connector Options

Mounting Options (Standalone Only)

Wall/Panel Mount | DIN Rail Horizontal Mount | DIN Rail Vertical Mount

Figure 4 Mounting Options

Safety Information

⚠CAUTION

To ensure proper safety and operation, the equipment ratings, installation instructions, and operating instructions must be checked before commissioning or maintenance of the equipment. The integrity of any protective conductor connection must be checked before carrying out any other actions. 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 manual. If misused, any safety protection provided by the equipment may be impaired.

Dangers, Warnings, and Cautions

This manual uses three kinds of hazard statements, defined as follows:

⚠DANGER
Indicates an imminently hazardous situation that, if not avoided, **will** result in death or serious injury.

⚠WARNING
Indicates a potentially hazardous situation that, if not avoided, **could** result in death or serious injury.

⚠CAUTION
Indicates a potentially hazardous situation that, if not avoided, **may** result in minor or moderate injury or equipment damage.

Safety Symbols

The following symbols are often marked on SEL products.

⚠	**⚠CAUTION** Refer to accompanying documents.	**⚠ATTENTION** Se reporter à la documentation.
⏚	Earth (ground)	Terre
⏚	Protective earth (ground)	Terre de protection
⎓	Direct current	Courant continu
∿	Alternating current	Courant alternatif
≂	Both direct and alternating current	Courant continu et alternatif
📖	Instruction manual	Manuel d'instructions

Safety Marks

The following statements apply to this device.

General Safety Marks

WARNING Dangerous voltage.	**AVERTISSEMENT** Tension dangereuse.
CAUTION Hot surface.	**ATTENTION** Surface très chaude.
For use in Pollution Degree 2 environment.	Pour l'utilisation dans un environnement de Degré de Pollution 2.
Ambient air temperature shall not exceed 40°C (104°F) in locations where touch temperature safety is required.	La température de l'air ambiant ne doit pas dépasser 40 °C (104 °F) dans les endroits où la sécurité relative à la température de surface est requise.
Terminal Ratings Tightening Torque Compression Screw Terminal: 0.6–0.8 Nm (5–7 in-lb) Compression Screw Terminal Mounting Ear: 0.18–0.25 Nm (1.6–2.2 in-lb) Grounding Screw: 0.9–1.4 Nm (8–12 in-lb) Wire Size Ground Wiring: 12 AWG, length <3 m	Spécifications des bornes Couple de serrage Borne à vis à compression : 0,6–0,8 Nm (5–7 livres-pouce) Fiche de montage de la borne à vis à compression : 0,18–0,25 Nm (1,6–2,2 livres-pouce) Vis de terre : 0,9–1,4 Nm (8–12 livres-pouce) Calibre de fil Câblage de mise à la terre : 12 AWG, longueur <3 m

Other Safety Marks

DANGER Contact with instrument terminals can cause electrical shock that can result in injury or death.	**DANGER** Tout contact avec les bornes de l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.
WARNING Do not operate device unless properly grounded.	**AVERTISSEMENT** Ne pas mettre en marche l'appareil sauf s'il est bien mis à la terre.
WARNING Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.	**AVERTISSEMENT** Seules des personnes qualifiées peuvent travailler sur cet appareil. Si vous n'êtes pas qualifiés pour ce travail, vous pourriez vous blesser avec d'autres personnes ou endommager l'équipement.
WARNING Use of this equipment in a manner other than specified in this manual can impair operator safety safeguards provided by this equipment.	**AVERTISSEMENT** L'utilisation de cet appareil suivant des procédures différentes de celles indiquées dans ce manuel peut désarmer les dispositifs de protection d'opérateur normalement actifs sur cet équipement.
CAUTION Failure to ensure proper voltage levels can cause equipment damage.	**ATTENTION** L' application de niveaux de tension inadéquats peut causer des dommages à l'équipement.

Use and Maintenance

Mounting

The SEL-9331 does not require forced air ventilation, but does require open space above and around the power supply for natural heat convection to occur. A minimum of 2.54 cm (1 in) around the power supply is recommended; allow for additional clearance if upward airflow is obstructed or if the power supply is installed inside an enclosure that does not conduct heat well. Ensure that ambient air temperature around the power supply stays within specified limits.

Dimensional drawings of the SEL-9331 are provided in *Figure 7* through *Figure 9*. The mounting hole layout for wall or panel mounting is shown in

NOTE: See the SEL-3355 Automation Controller Instruction Manual for instructions on installing or replacing the SEL-9331 Power Supply in an SEL-3355.

⚠WARNING
Use of this equipment in a manner other than specified in this manual can impair operator safety safeguards provided by this equipment.

⚠WARNING
Do not mount the power supply unit with the input power connector facing up, as doing so creates a risk of electrical shock from falling metal objects, as specified by IEC 60255-27.

⚠WARNING
Mounting the power supply unit in any orientation other than top side up may cause the power supply to exceed 70°C touch temperature as specified by IEC 61010-1.

⚠CAUTION
Hot surface.

Figure 5. DIN-rail clips, if ordered with the SEL-9331, will already be installed on the SEL-9331. If ordered as an accessory kit, the clips are provided with mounting screws. DIN-rail clips are mounted as shown in *Figure 4*.

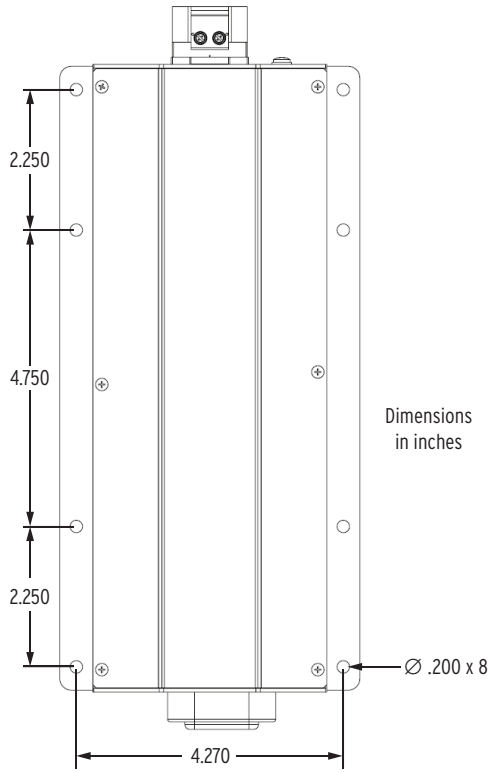


Figure 5 Mounting Hole Layout for Wall/Panel Mount Option

Wiring

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

SEL recommends that you use the supplied output wiring harness because it is sized to handle all specified loads.

When creating a custom harness for the input or output connection, ensure that it is properly sized for the amperage requirements of the load. First, look at the power supply or load device specifications to determine the rated input voltage range. Then, calculate the voltage drop of your harnesses given the wire size, length, and full load current (see *Equation 1*). Finally, subtract the voltage drop from the nominal operating voltage to determine the actual voltage supplied to the power supply or load.

$$(\text{total wire length})(\text{current load})\left(\frac{\text{wire resistance}}{\text{length}}\right) = \text{voltage drop}$$

Equation 1

The following is an example of a voltage drop calculation for a 2 m (6.6 ft) harness drawing an 11 A load. Assuming the use of 14 AWG wire, which has a resistance of 8.28 ohms over 1000 m (3280 ft), and multiplying the length of the harness by 2 to account for the drop in both the power and the return wires, the voltage drop would be 0.36 V, as shown in *Equation 2*. Subtracting 0.36 V from the 12.0 V nominal output of the power supply results in an 11.64 V voltage at the load.

$$(2 \times 2\ \text{m})(11\ \text{A})\left(\frac{8.28\ \text{ohms}}{1000\ \text{m}}\right) = 0.36\ \text{V}$$

Equation 2

⚠WARNING
Do not operate device unless properly grounded.

⚠WARNING
Stranded wire presents a risk of exposing the user to contact with hazardous voltages if not all of the strands are captured in the terminals. Use Crimp Ferrules to safely capture all wire strands.

⚠CAUTION
Failure to ensure proper voltage levels can cause equipment damage.

⚠CAUTION
Input and output wiring must be sized correctly to ensure proper operation.

The wiring steps of the SEL-9331 must proceed in the following order:

Step 1. Connect the protective earth (ground) wire to the SEL-9331. Ensure the grounding wire meets the specifications listed in this manual.

Step 2. Connect the load device to protective earth (ground) per the manufacturer's recommendation.

Step 3. Connect the output terminals of the SEL-9331 to the load device with wires that meet the amperage and voltage requirements of the load device.

Step 4. With the input power source de-energized, connect it to the SEL-9331 with wires that meet the specifications listed in this manual. Input power should be protected by an external overcurrent protection device meeting the specifications of this manual.

Step 5. Energize the input power source

If de-energizing the SEL-9331, ensure the input power source is disconnected before removing earth ground.

An example connection (SEL-9331 to the SEL-3360S) with the supplied wiring harness is shown in *Figure 6*.

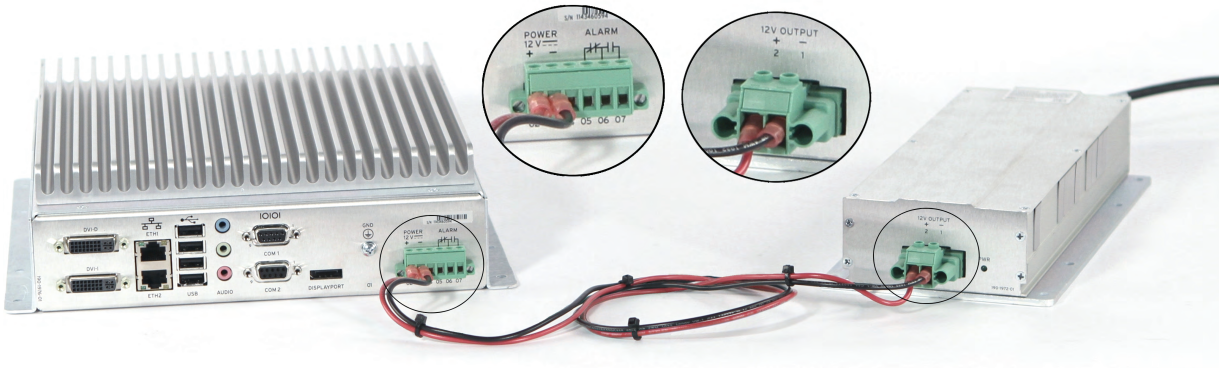


Figure 6 SEL-9331 Connected to SEL-3360S Power Input

Parallel Operation

⚠CAUTION
Using the power supply in parallel with a third-party power supply is not recommended.

Two SEL-9331 power supplies can be wired in parallel for redundancy. In this configuration, the supply with the highest voltage will supply the majority of the current to the load. The second supply will only provide a minimal amount of current until the voltage of the first supply drops below that of the second.

Connecting two SEL-9331 power supplies in parallel should only be done to provide redundancy. Connecting two SEL-9331 power supplies in parallel will not increase current output as one power supply will always provide the majority of the current.

Maintenance and Cleaning

There are no serviceable parts on the SEL-9331. When it is installed correctly, it should operate without any user intervention.

Use care when cleaning the SEL-9331. Disconnect the input and output connections from the SEL-9331. Use a mild soap or detergent solution and a damp cloth to clean the unit chassis. Allow the unit to air dry, or wipe dry with a soft, dry cloth before reapplying power. Do not use abrasive materials, polishing compounds, or other harsh chemical solvents such as xylene or acetone when cleaning these surfaces.

Troubleshooting

⚠WARNING
Do not remove the cover of the power supply unit. There are no user-serviceable parts inside.

The **PWR** LED near the output connector of the standalone SEL-9331 will illuminate when the power supply is energized and able to provide 12 Vdc power to the output. If a fault condition occurs, such as undervoltage or overvoltage on the input, or overcurrent on the output, the **PWR** LED will flash or turn off to indicate a problem, and the output will de-energize. If an external source drives the output voltage above 12 Vdc, the reverse-current protection will prevent the power supply from sinking current, and the **PWR** LED will remain illuminated because the power supply is still able to provide power once the external source is removed or de-energized.

Use the following procedure to diagnose suspected problems with the output voltage of the SEL-9331:

Step 1. Use a voltmeter to measure the voltage at the input connector of the device being powered. If the voltage is not within the specifications indicated in *Specifications on page 9*, continue to *Step 2*.

Step 2. Measure the voltage at the output connector of the SEL-9331. If it is within the specifications, then either the wiring harness is not properly sized or one or more wires in the wiring harness have been damaged. See *Use and Maintenance on page 4* for information on correctly sizing the wiring harness.

If the voltage at the output connector of the SEL-9331 is not within the given specifications, continue to *Step 3*.

Step 3. Disconnect the device being powered by the SEL-9331. Measure the voltage at the output connector of the SEL-9331. If the voltage is now within the given specifications, then the device is drawing more current than the SEL-9331 can supply.

If the powered device is not rated to draw more current than the SEL-9331 can supply, then either the device has become defective and has started to draw excess current, or the SEL-9331 has become defective and is no longer able to supply the rated current.

If the voltage at the output connector of the SEL-9331 is not within the given specifications, continue to *Step 4*.

Step 4. Verify that the input voltage to the SEL-9331 is within specified limits. If the input voltage is within the specifications, return the SEL-9331 for repair.

Dimensions

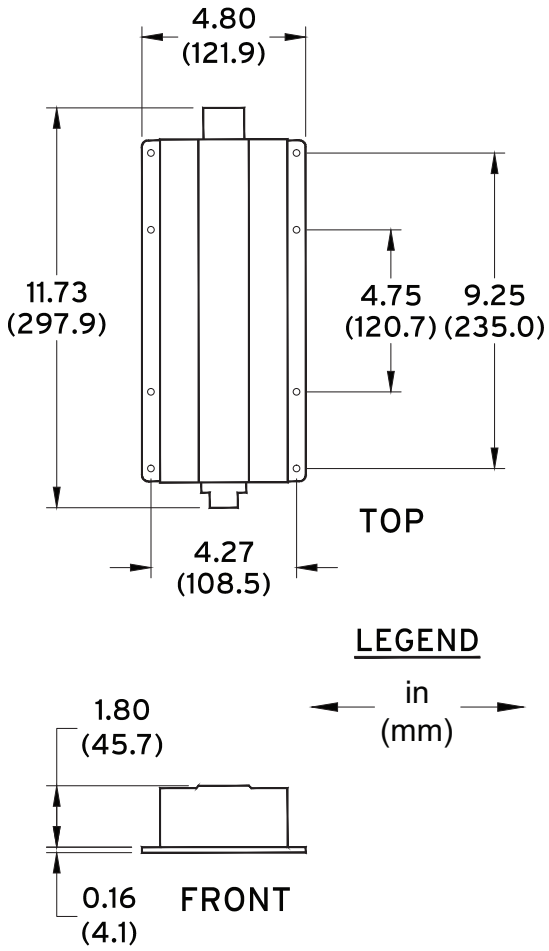


Figure 7 Wall/Panel Mount

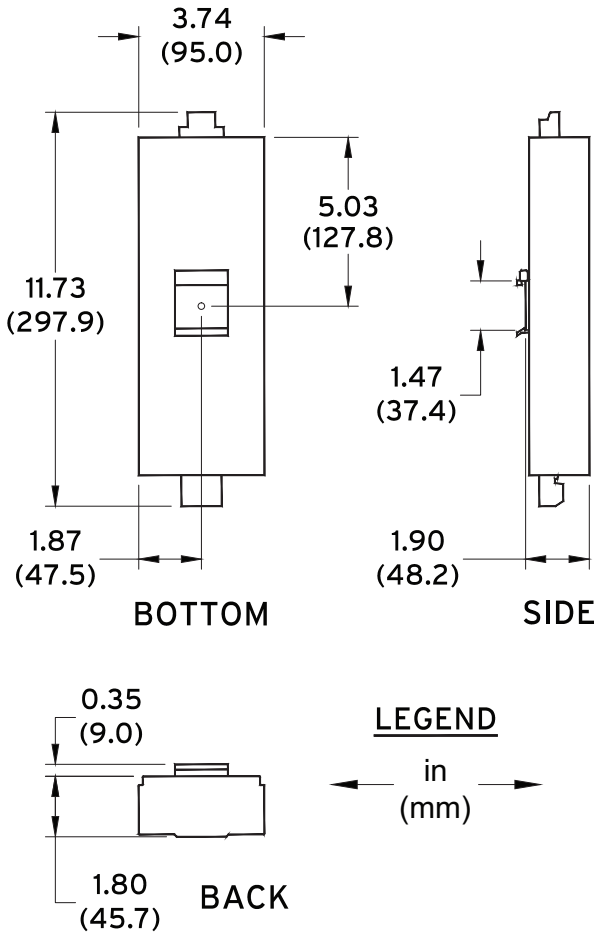


Figure 8 DIN Rail (Vertical Mount)

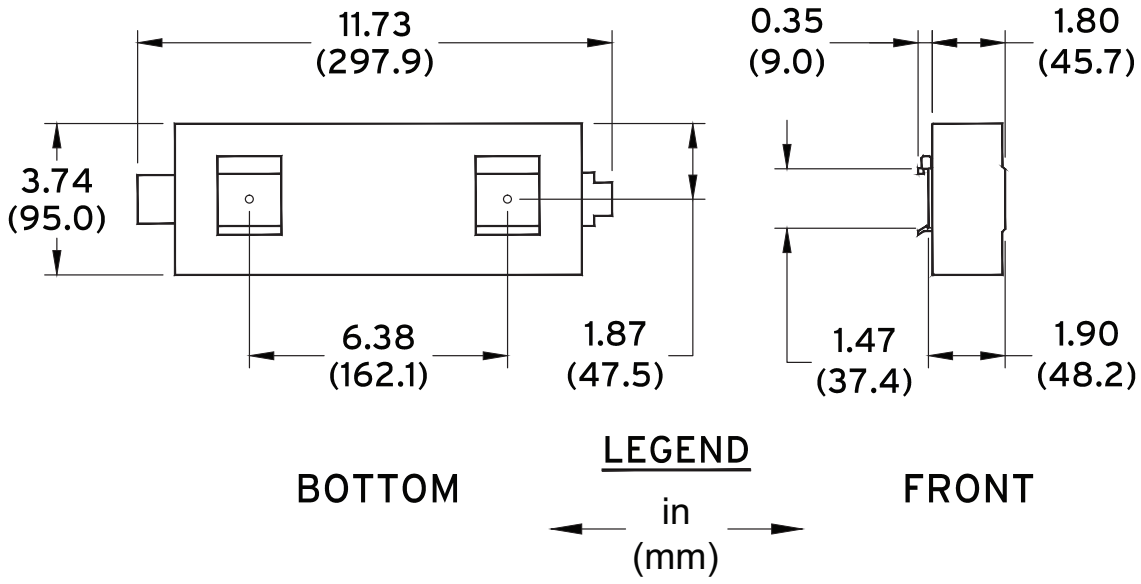


Figure 9 DIN Rail (Horizontal Mount)

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

47 CFR 15B, 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 operated 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 is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

UL Recognized to U.S. and Canadian safety standards (File E220228; NRAQ2, NRAQ8)

CE Mark

UKCA Mark

General

Input Power—High-Voltage Models (SEL-9331A)

Voltage Ratings:	125/250 Vdc 120/220/240 Vac; 50/60 Hz
DC Range:	100–300 Vdc
Maximum DC Dropout:	88 Vdc
AC Range:	85–264 Vac
Frequency Range:	45–65 Hz
Maximum Constant Burden:	155 W, 160 VA
Maximum Peak Burden:	240 W, 248 VA
DC Ripple:	<15% rated voltage
Peak Inrush:	16.6 A peak, 4 ms duration, 240 Vac 12.8 A peak, 9 ms duration, 250 Vdc Measured per IEC 60255-1, Section 6.10. Quiescent current level derived from 75 W input.
Interruption:	200 ms @ 125 Vdc/120 Vac
Insulation:	3100 Vdc
Power Factor:	>0.9 (at full load)
Isolated From Chassis Ground:	Yes

Internal Fuse (Non-Serviceable)

Rating:	5 A
Maximum Rated Voltage:	250 Vdc, 277 Vac
Breaking Capacity:	1500 A at 277 Vac
Type:	Time-lag T

Input Power—Low-Voltage Models (SEL-9331B)

Voltage Ratings:	48 Vdc
DC Range:	38–58 Vdc
Maximum Constant Burden:	149 W
Maximum Peak Burden:	225 W
DC Ripple:	<15% rated voltage
Peak Inrush:	15.5 A peak, 48 ms duration Measured per IEC 60255-1, Section 6.10. Quiescent current level derived from 40 W input.
Interruption:	100 ms @ 48 Vdc
Insulation:	3100 Vdc
Isolated From Chassis Ground:	Yes

Internal Fuse (Non-Serviceable)

Rating:	15 A
Maximum Rated Voltage:	500 Vdc, 500 Vac
Breaking Capacity:	20 kA at 500 Vdc
Type:	Time-lag T

Recommended External Overcurrent Protection

Breaker Type:	Standard
Breaker Rating:	20 A at 250 Vdc
Breaking Capacity:	10 kA
Grounded Neutral Systems:	Device in series with the HOT or energized conductor
DC and Isolated Systems:	Device in series with both conductors

Input Terminal Connections

Wire

Insulation:	300 V min.
Size:	12–18 AWG

Tightening Torque

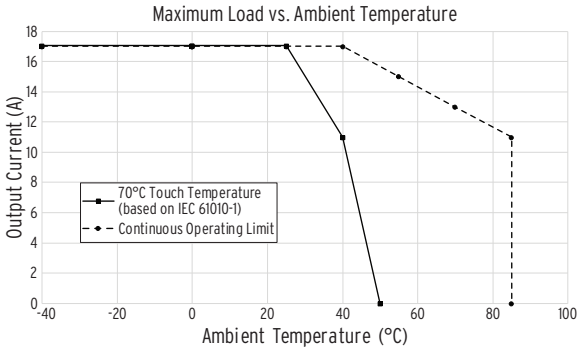
Minimum:	0.6 Nm (5 in-lb)
Maximum:	0.8 Nm (7 in-lb)

Crimp Ferrule Recommended

Output

Nominal Voltage:	12.1 Vdc
Output Voltage Range, Constant Load:	11.5–12.7 V
Output Voltage Range, Step Load:	>10.8 V, 1.5 A to 17 A step <13.6 V, 17 A to 1.5 A step 0.25A/µs step, <4 ms recovery
Maximum Current (Within Stated DC and AC Ranges):	17 A @ –40°C to +40°C (–40°F to +104°F) or as shown in the following graph 11 A continuous @ 40°C (104°F) per IEC 61010-1
Minimum Current:	0 A (no load required)

Note: If mounting the power supply in any orientation other than top side up, de-rate the touch temperature curve in the following graph by shifting it 10°C to the left.



Isolated From Chassis Ground: No

Output Terminal Connections

Wire

Size: 10–14 AWG, length <10 m

Tightening Torque

Minimum: 0.6 Nm (5 in-lb)

Maximum 0.8 Nm (7 in-lb)

Crimp Ferrule Recommended

Protective Grounding (Euro-Style Terminal Block Only)

Grounding Screw

Ground Wire

Insulation: 300 V min.

Size: 12 AWG, length <3 m

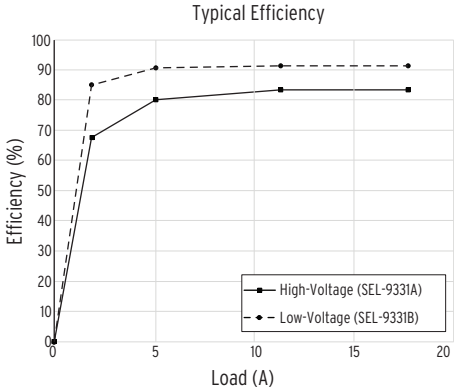
Tightening Torque

Minimum: 0.9 Nm (8 in-lb)

Maximum: 1.4 Nm (12 in-lb)

Ring Terminal Recommended

Efficiency (Typical)



DIN-Rail Clips

Clips are EN 50022 compatible

Operating Temperature Range

–40° to +85°C (–40° to +185°F)

Note: UL ambient 40°C. See *Safety Information* for additional restrictions.

Storage Temperature Range

–40° to +85°C (–40° to +185°F)

Relative Humidity

5%–95% noncondensing

Altitude

5000 m maximum

Atmospheric Pressure

80–110 kPa

Overvoltage Category

Category II

Insulation Class

Class I

Pollution Degree

2

RoHS Compliance

Compliant with the European Union's RoHS directive.

Weight (Maximum)

1.5 kg (3.31 lb)

Product Standards

Industrial Environment:	IEC 61000-6-2:2005 IEC 61000-6-4:2006
Electrical Equipment for Measurement, Control, and Laboratory Use:	IEC 61010-1:2010 UL 61010-1:2016, C22.2 No. 61010-1-12 IEC 61010-2-201:2013
Measuring Relays and Protection Equipment:	IEC 60255-26:2013 IEC 60255-27:2013

Type Tests

Electromagnetic Compatibility Emissions

Conducted and Radiated Emissions:	CISPR 11:2009 + A1:2010 CISPR 22:2008 CISPR 32:2015 IEC 61000-6-4:2006 FCC 15.107:2014 FCC 15.109:2014 Severity Level: Class A Canada ICES-001 (A) / NMB-001 (A)
Harmonic Current:	IEC 61000-3-2:2014 Severity Level: Class A
Voltage Flicker:	IEC 61000-3-3:2013

Electromagnetic Compatibility Immunity

Conducted RF:	IEC 61000-4-6:2013 Severity Level: 10 Vrms
Electrostatic Discharge:	IEC 61000-4-2:2008 IEEE C37.90.3-2001 Severity Level: 2, 4, 6, 8 kV contact discharge; 2, 4, 8, 15 kV air discharge
Fast Transient/Burst:	IEC 61000-4-4:2012 Severity Level: Class A 4 kV, 5 kHz
Magnetic Field:	IEC 61000-4-8:2009 Severity Level: 1000 A/m for 3 s 100 A/m for 1 m
Power Supply:	IEC 61000-4-11:2004 IEC 61000-4-17:1999 + A1:2001 + A2:2008 IEC 61000-4-29:2000

Radiated Radio Frequency:	IEC 61000-4-3:2006 + A1:2007 + A2:2010 Severity Level: 10 V/m IEEE C37.90.2-2004 Severity Level: 20 V/m
Surge Withstand Capability:	IEC 61000-4-18:2006 + A1:2010 Severity Level: 2.5 kV peak common mode 1.0 kV peak differential mode IEEE C37.90.1-2012 Severity Level: 2.5 kV oscillatory 4 kV fast transient
Surge Immunity:	IEC 61000-4-5:2005 0.5, 1 kV line-to-line 0.5, 1, 2 kV line-to-earth

Environmental

Change of Temperature:	IEC 60068-2-14:2009 Severity Level: 5 cycles, 1°C per minute ramp IEC 60255-1:2009 –40°C to +85°C
Cold, Operational:	IEC 60068-2-1:2007 Severity Level: 16 hours at –40°C
Cold, Storage:	IEC 60068-2-1:2007 Severity Level: 16 hours at –40°C IEC 60255-1:2009
Damp Heat, Cyclic:	IEC 60068-2-30:2005 Severity Level: 12 + 12-hour cycle 25°–55°C, 6 cycles, >93% relative humidity
Damp Heat, Steady:	IEC 60068-2-78:2012 Severity Level: 40°C, 240 hours, >93% relative humidity
Dry Heat, Operational:	IEC 60068-2-2:2007 Severity Level: 16 hours at 85°C IEC 60255-1:2009
Dry Heat, Storage:	IEC 60068-2-2:2007 Severity Level: 16 hours at 85°C IEC 60255-1:2009
Free Fall:	IEEE 1613-2009 Severity Level: 100 mm
Vibration:	IEC 60255-21-1:1988 Severity Level: Endurance Class 2 Response Class 2 IEC 60255-21-2:1988 Severity Level: Shock Withstand, Bump Class 1 Shock Response Class 2 IEC 60255-21-3:1993 Severity Level: Quake Response Class 2

Safety

Enclosure Protection:	IEC 60529:1989 + A1:1999 Severity Level: IP30
Dielectric Strength:	IEC 60255-27:2013 IEEE C37.90-2005 Severity Level: 3600 Vdc on power supply inputs Type tested for one minute
Impulse:	IEC 60255-27:2013 IEEE C37.90-2005 Severity Level: 5 kV Common Mode

Instruction Manual

The date code at the bottom of each page of this manual reflects the creation or revision date.

Table 1 lists the product manual release dates and a description of modifications. The most recent product manual revisions are listed at the top.

Table 1 Instruction Manual Revision History

Date Code	Summary of Revisions
20221221	➤ Added UKCA Mark to *Specifications*.
20210720	➤ Updated *Specifications*.
20201210	➤ Updated *Specifications*.
20190109	➤ Updated *Specifications*.
20160908	➤ Updated *Specifications*.
20160505	➤ Updated *Features, Benefits, and Applications*. ➤ Updated *Use and Maintenance*. ➤ Updated *Troubleshooting*. ➤ Updated *Specifications*.
20150803	➤ Updated *Specifications*.
20150721	➤ Updated *Specifications*.
20150428	➤ Updated *Features, Benefits, and Applications*. ➤ Updated *Safety Information*. ➤ Updated *Specifications*. ➤ Updated *Parallel Operation*.
20150313	➤ Initial version.

Technical Support

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

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court
Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.338.3838
Fax: +1.509.332.7990
Internet: selinc.com/support
Email: info@selinc.com

© 2015—2022 by Schweitzer Engineering Laboratories, Inc. All rights reserved.

All brand or product names appearing in this document are the trademark or registered trademark of their respective holders. No SEL trademarks may be used without written permission. SEL products appearing in this document may be covered by U.S. and Foreign patents.

Schweitzer Engineering Laboratories, Inc. reserves all rights and benefits afforded under federal and international copyright and patent laws in its products, including without limitation software, firmware, and documentation.

The information in this document is provided for informational use only and is subject to change without notice. Schweitzer Engineering Laboratories, Inc. has approved only the English language document.

This product is covered by the standard SEL 10-year warranty. For warranty details, visit selinc.com or contact your customer service representative.

SCHWEITZER ENGINEERING LABORATORIES, INC.
2350 NE Hopkins Court • Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.332.1890 • Fax: +1.509.332.7990
selinc.com • info@selinc.com

PM9331-01