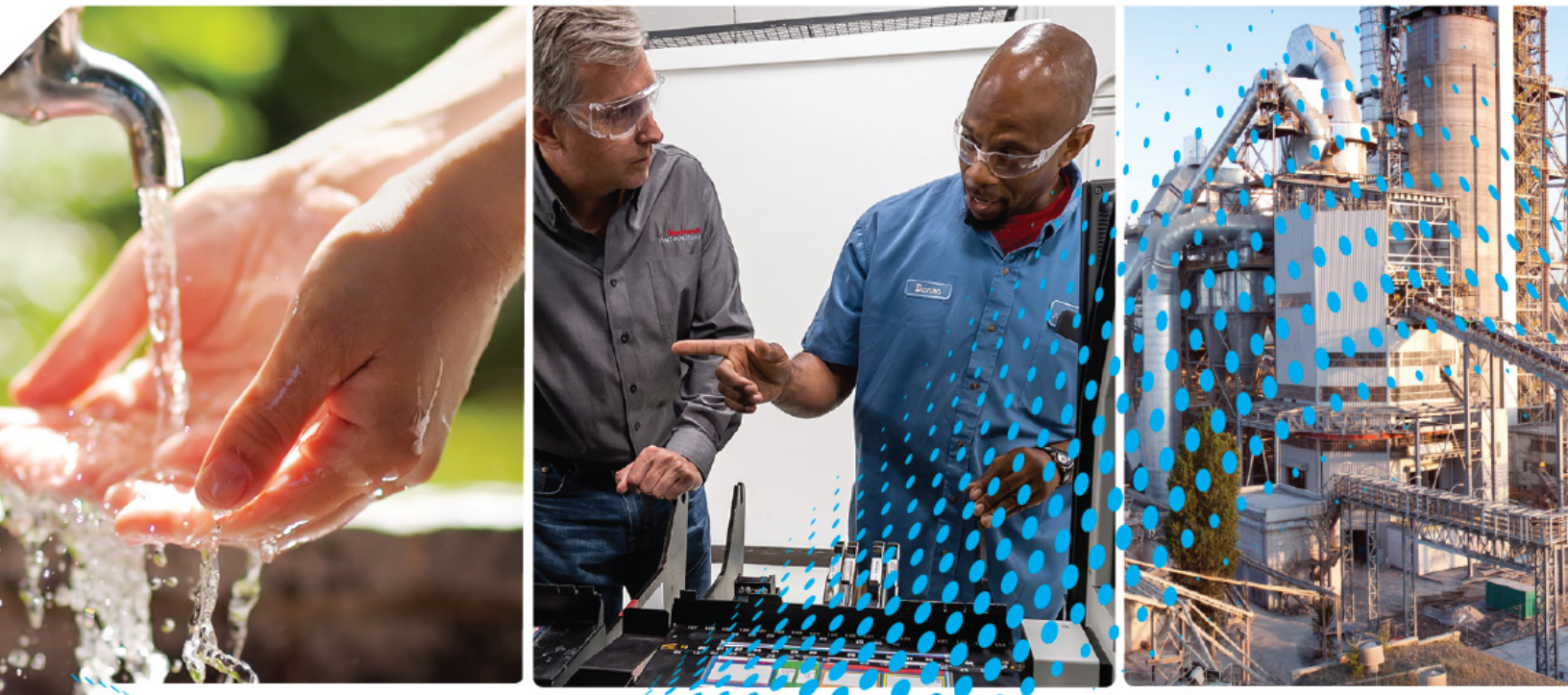

Switched Mode Power Supply

Catalog Number 1606-XLS960F

Allen-Bradley
by ROCKWELL AUTOMATION

Reference Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

These labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

The following icon may appear in the text of this document.

Identifies information that is useful and can help to make a process easier to do or easier to understand.

Table of Contents

Notes:

Terminology and Abbreviations

Terms	Descriptions
PE	The abbreviation for Protective Earth. PE has the same meaning as the symbol.
⏚	The symbol for Protective Earth.
Earth, Ground	This document uses the term “earth”, which is the same as the U.S. term “ground”.
AC 230V	A value that is displayed with the AC or DC before the value represents a nominal voltage with standard tolerances included. For example, DC 12V describes a 12V battery, no matter if it is full (13.7V) or flat (10V).
230V AC	A value with the unit (V AC or V DC) at the end is a momentary value without any additional tolerances included.
50 Hz versus 60 Hz	Unless otherwise stated, AC 230V parameters are valid at 50 Hz mains frequency.
Nom	Indicates a nominal value.
Typ	Indicates a typical value.
–	A dash alone in a table cell indicates that there is no information to be included in that cell.

All values in this document are specified under the following conditions unless otherwise noted:

- 48V, 20 A, 230V AC input voltage
- 25 °C (77 °F) ambient temperature
- After a 5 minutes run-in time

Product Overview

Figure 1 - 1606-XLS960F

The 1606-XLS960F is a high-efficiency DIN rail power supply unit, which uses a synchronous rectification, a bridgeless PFC circuit, and additional design details to achieve a compact size.

Large power reserves of 150% and built-in large sized output capacitors support the starting of heavy loads, such as DC motors or capacitive loads. Therefore, a unit from a lower wattage class can be used.

The 1606-XLS960F power supply unit has a high immunity to transients and power surges, and has low electromagnetic emissions.

The integrated input fuse, near-zero input inrush current, and diagnostic indicators simplify installation and usage.

The 1606-XLS960F power supply unit features a large international approval package for various applications.

Product features include:

- AC 100...240V wide-range input
- Width 125 mm (4.9 in.)
- 95.0% full load and excellent partial load efficiencies
- 50% BonusPower, 1440 W for up to 4 s

- 55 A high peak current for 10 ms, for easy fuse tripping
- Safe Hiccup^{PLUS} overload mode
- Active PFC (Power Factor Correction)
- Negligible low-input inrush current surge
- Full power -25…+60 °C (-13…+140 °F)
- Current sharing feature for parallel use
- Remote control of output voltage
- DC-OK relay contact
- Shut-down input
- ATEX and IECEx approved

Specifications

Attributes	Values	Notes
Output voltage	DC 48V	Nominal
Adjustment range	48…54V DC	–
Output current	20…17.8 A	Continuous
	30…26.7 A	Short term (4 s)
Output power	960 W	Continuous
	1440 W	Short term (4 s)
Output ripple	<150 mVpp	20 Hz…20 MHz
Input voltage	AC 100…240V	-15/+10%
Mains frequency	50…60 Hz	±6%
AC input current	8.6/4.5 A	At 120/230V AC
Power factor	0.99/0.99	At 120/230V AC
AC inrush current	17/11 A peak	At 120/230V AC
Efficiency	93.9/95.0%	At 120/230V AC
Losses	62.4/50.5 W	At 120/230V AC
Temperature range	-25…+70 °C (-13…+158 °F)	Operational
Derating	24 W/1 °C (24 W/1.8 °F) (1)	60…70 °C (140…158 °F)
Hold-up time	27/27 ms	At 120/230V AC
Dimensions	125 x 124 x 127 mm (4.92 x 4.88 x 5 in.)	W x H x D
Weight	1900 g (4.2 lb)	–

(1) Between 85…90V AC. See Environment on page 15.

Catalog Numbers

Cat. No.	Descriptions
1606-XLS960F	Power supply (48…54V standard unit)
1606-XLC	Wall mount bracket
1606-XLSBUFFER48	Buffer unit
1606-XLSRED40HF	Redundancy module

AC Input

Attributes		Values	Notes
Input voltage	Nom	AC 100...240V	Suitable for TN, TT, and IT mains networks
Input voltage range	–	90...264V AC	Continuous operation
	–	85...90V AC	<55 °C (131 °F) ambient temperature continuously allowed >55 °C (131 °F) ambient temperature short term or with output derating, see Figure 27 on page 16
	–	60...85V AC	Full power for up to 200 ms
	–	0...85V AC	No damage to the unit
	–	264...300V AC	<500 ms
Allowed voltage L or N to earth	Max	300V AC	Continuous, IEC 62103
Input frequency	Nom	50...60Hz	±6%
Turn-on voltage	Typ	80V AC	Steady-state value, load independent, see Figure 2
Shut-down voltage	Typ	74V AC	Steady-state value, load independent, see Figure 2
External input protection	–	See External Input Protection on page 24.	

Attributes		Values			Notes
		AC 100V	AC 120V	AC 230V	
Input current	Typ	10.5 A	8.6 A	4.5 A	At 48V, 20 A, see Figure 4
Power factor (1)	Typ	0.99	0.99	0.99	At 48V, 20 A, see Figure 5
Crest factor (2)	Typ	1.47	1.53	1.56	At 48V, 20 A
Startup delay	Typ	800 ms	750 ms	700 ms	See Figure 3
Rise time	Typ	16 ms	16 ms	16 ms	At 48V, 20 A, resistive load, 0 mF, see Figure 3
	Typ	55 ms	55 ms	55 ms	At 48V, 20 A, resistive load, 20 mF, see Figure 3
Turn-on overshoot	Max	100 mV	100 mV	100 mV	See Figure 3

(1) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
(2) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.

Figure 2 - Input Voltage Range

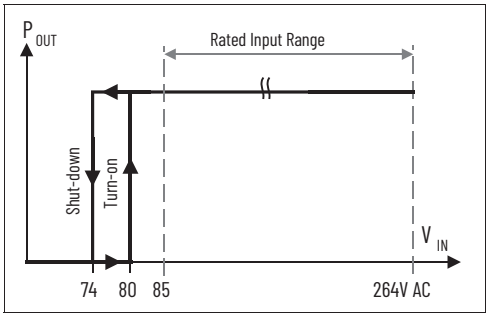


Figure 3 - Turn-on Behavior, Definitions

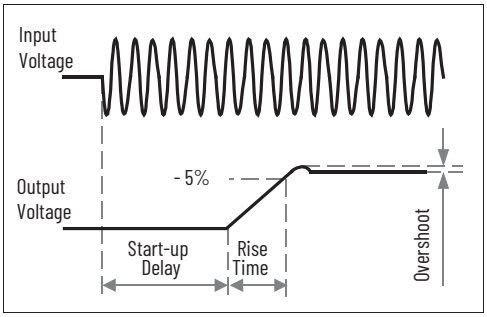


Figure 4 - Input Current Versus Output Load at 48V

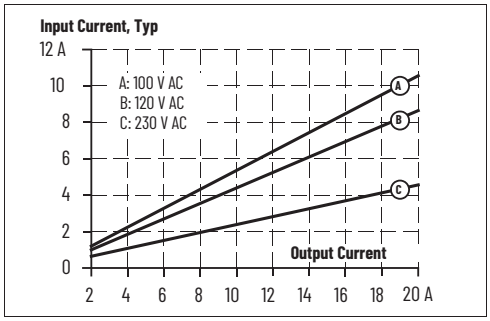
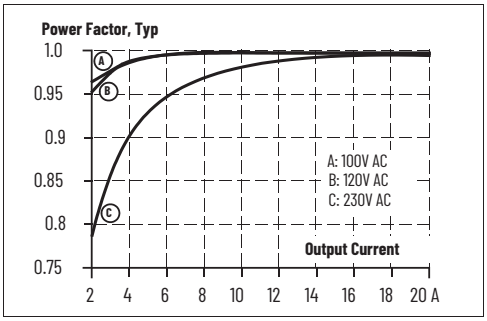


Figure 5 - Power Factor Versus Output Load at 48V



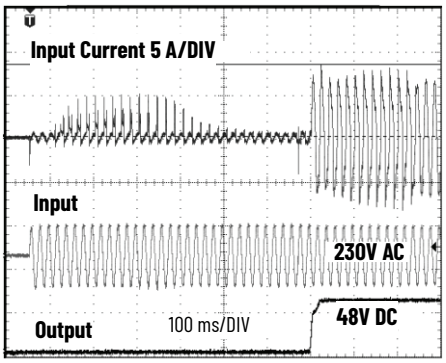
Input Inrush Current

The power supply unit is equipped with an active inrush current limitation circuit, which limits the input inrush current after turn-on to a negligible low value. The input current is smaller than the steady state input current.

Attributes		Values			Notes
		AC 100V	AC 120V	AC 230V	
Inrush current (1)	Max	25 A_{peak}	22 A_{peak}	16 A_{peak}	Over the entire temperature range; mains interruptions >1 s
	Typ	20 A_{peak}	17 A_{peak}	11 A_{peak}	
Inrush energy	Max	5 A^2 s	5 A^2 s	5 A^2 s	

(1) The charging current into EMI suppression capacitors is disregarded in the first microseconds after switch-on.

Figure 6 - Typical Turn-on Behavior at Nominal Load - 25 °C (77 °F) Ambient Temperature



DC Input

Do not operate this power supply unit with DC-input voltage. Use the 1606-XLE480FP-D unit instead. It can be necessary to run two 1606-XLE480EP-D units in parallel.

Output

Attributes		Values	Notes
Output voltage	Nom	DC 48V	–
Adjustment range	–	48...54V DC	Guaranteed
	Max	56V DC (1)	At clockwise end position of potentiometer
Factory setting	Typ	48.0V DC	±0.2%, at full load, cold unit, in Single Use mode
	Typ	46.0V DC	±0.5%, at full load, cold unit, in Parallel Use mode
	Typ	48.0V DC	At no load, cold unit, in Parallel Use mode
Line regulation	Max	10 mV	85...300V AC
Load regulation	Max	50 mV	In Single Use mode: static value, 0 A → 20 A, see Figure 7 on page 7
	Typ	2000 mV	In Parallel Use mode: static value, 0 A → 20 A, see Figure 8 on page 7
Ripple and noise voltage	Max	150 mVpp	20 Hz...20 MHz, 50 Ω
Output current	Nom	20 A	Continuously available at 48V, see Figure 7 on page 7 and Figure 8 on page 7
	Nom	17.8 A	Continuously available at 54V, see Figure 7 on page 7 and Figure 8 on page 7
	Nom	30 A	Short-term available BonusPower (2), at 48V for typical 4 s, see Figure 7 on page 7 and Figure 8 on page 7
	Nom	26.7 A	Short-term available BonusPower (2), at 54V for typical 4 s, see Figure 7 on page 7 and Figure 8 on page 7
	Typ	55 A	Up to 10 ms, output voltage stays above 40V, see Figure 10 on page 7. This peak current is available once every second. See Peak Current Capability on page 22.

Attributes		Values	Notes
Output power	Nom	960 W	Continuously available at 48...54V
	Nom	1440 W (2)	Short-term available BonusPower (2) at 48...54V
BonusPower time	Typ	4 s	Duration until the output voltage dips, see Figure 11 on page 8
BonusPower recovery time	Typ	7 s	Overload free time to reset power manager, see Figure 12 on page 8
Overload behavior	–	Continuous current	Output voltage >40V DC, see Figure 7
	–	Hiccup^{PLUS} mode (3)	Output voltage <40V DC, see Figure 7
Short-circuit current	Min	30 A (4)	Load impedance 50 mΩ, see Figure 9
	Max	35 A (4)	Load impedance 50 mΩ, see Figure 9
	Max	11.5 A	Average (RMS) current, load impedance 50 mΩ, see Figure 9
	Typ	62 A	Up to 10 ms, load impedance <10 mΩ, see Figure 10
Output capacitance	Typ	3700 µF	Included in the power supply

(1) Max output voltage that can occur at the clockwise end position of the potentiometer, due to tolerances. It is not a guaranteed value that can be achieved. The typical value is about 55V.

(2) BonusPower, short-term power capability (up to typ 4 s): The power supply unit is designed to support loads with a higher short-term power requirement without damage or shutdown. The short-term duration is hardware controlled by an output power manager. This BonusPower is repeatedly available. See Repetitive Pulse Loading on page 20. If the power supply unit is loaded longer with the BonusPower than shown in Figure 11 on page 8, the maximum output power is automatically reduced to 960 W. If the power requirement is continuously above 960 W and the voltage falls below approximately 40V (due to the current regulating mode at overload), the unit shuts off and makes periodical restart attempts. This behavior is called Hiccup^{PLUS} mode, see Figure 9. If the voltage is above 40V, the unit continuously delivers current.

(3) For up to 4 s of overloading, the power supply unit delivers continuous output current. After overloading, the output power reduces to nearly zero for approximately 17 s before a new start attempt is automatically performed. If the overload is cleared, the device operates normally. If the overload still exists, the output current is delivered for 2...4 s (depending on the overload) again followed by a 17 s rest time. This cycle repeats as long as the overload exists. During the off-period, a small rest voltage and a rest current are present on the output.

(4) Discharge current of output capacitors is not included.

Figure 7 - Output Voltage Versus Output Current in Single Use Mode, Typ

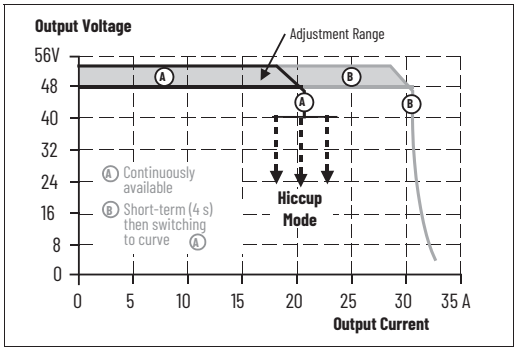


Figure 8 - Output Voltage Versus Output Current in Parallel Use Mode, Typ

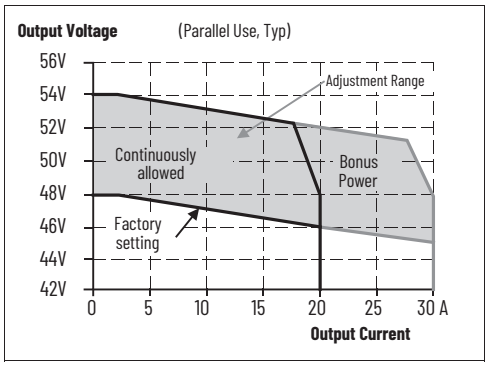


Figure 9 - Short-circuit on Output, Hiccup^{PLUS} Mode, Typ

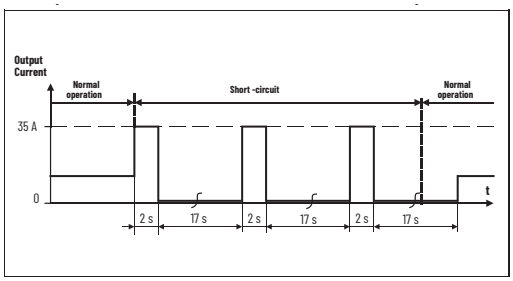


Figure 10 - Dynamic Overcurrent Capability, Typ

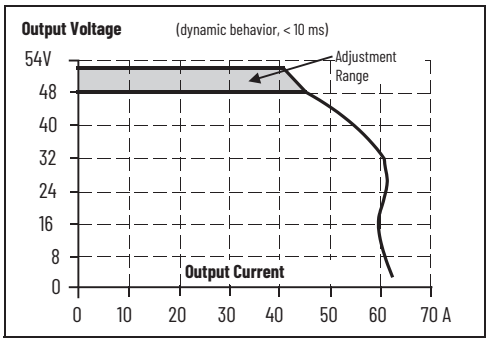


Figure 11 - Bonus Time Versus Output Power

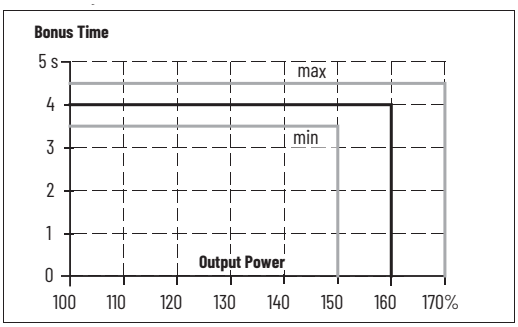
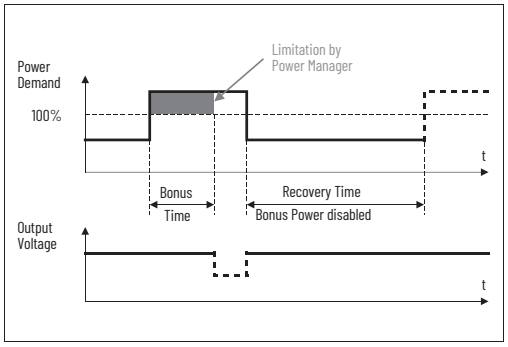


Figure 12 - BonusPower Recovery Time



The BonusPower is available when power comes on and after the end of an output short circuit or output overload.

Figure 13 - BonusPower After Input Turn-on

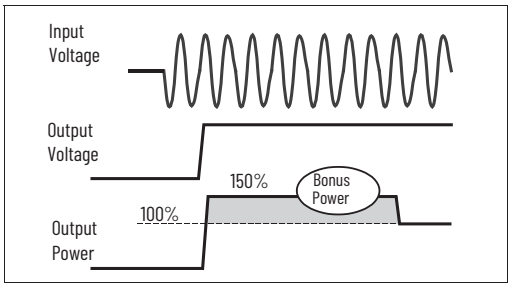
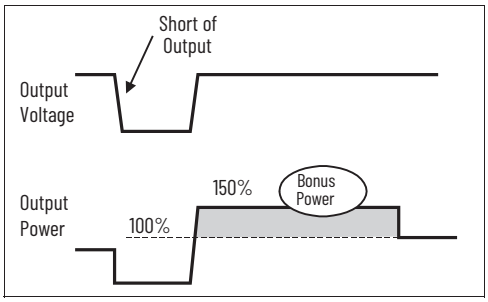


Figure 14 - BonusPower After Output Short



Hold-up Time

Attributes		Values			Notes
		AC 100V	AC 120V	AC 230V	
Hold-up Time	Typ	54 ms	54 ms	54 ms	At 48V, 10 A, see Figure 15
	Min	45 ms	45 ms	45 ms	
	Typ	27 ms	27 ms	27 ms	At 48V, 20 A, see Figure 15
	Min	23 ms	23 ms	23 ms	

Figure 15 - Hold-up Time Versus Input Voltage

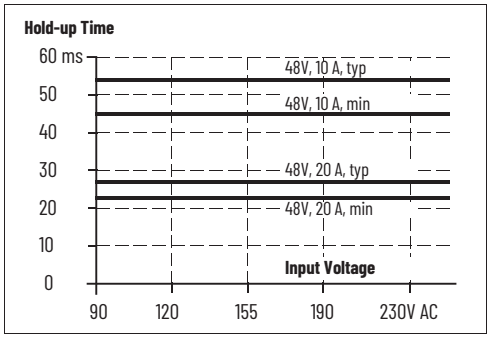
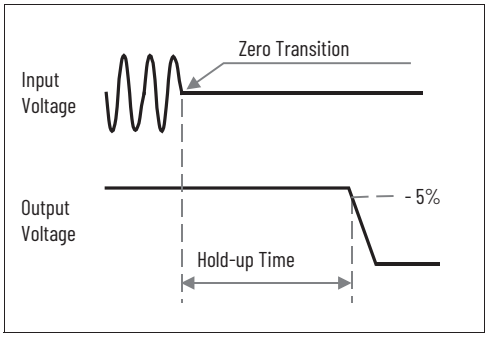


Figure 16 - Shutdown Behavior Definitions

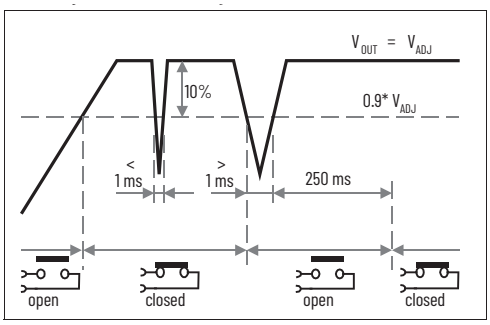


DC-OK Relay Contact

This feature monitors the output voltage that the power supply unit produces. It is independent of any back-fed voltage from a unit that is connected in parallel to the power supply unit output.

Action	Notes		
Contact closes	Once the output voltage reaches 90% of the adjusted output voltage		
Contact opens	Once the output voltage dips more than 10% below the adjusted output voltage. Short dips are extended to a signal length of 250 ms. Dips shorter than 1 ms are ignored.		
Contact recloses	Once the output voltage exceeds 90% of the adjusted voltage		
Contact ratings	Max	60V DC at 0.3 A, 30V DC at 1 A, 30V AC at 0.5 A	Resistive load
	Min	1 mA at 5V DC	Min permissible load
Isolation voltage	See Dielectric Strength on page 16.		

Figure 17 - DC-OK Relay Contact Behavior



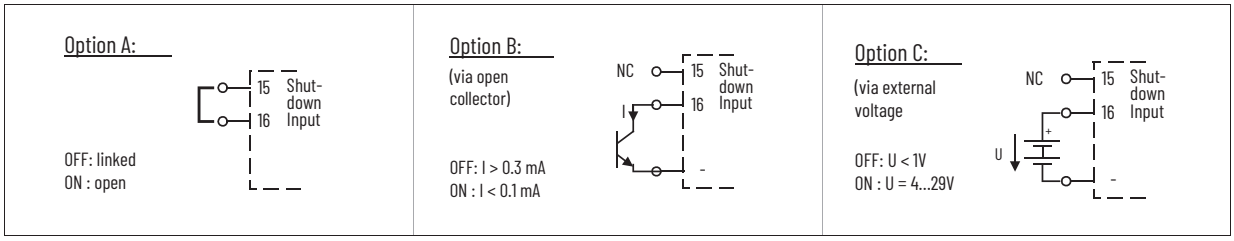
Shutdown Input

This feature allows a switch-off of the output of the power supply unit with a signal switch or an external voltage. The shutdown occurs immediately, while the turn-on is delayed up to 350 ms. In a shut-down condition, the output voltage is <4V and the output power is <0.5 W.

The voltage between different minus pole output terminals must be below 1V when units are connected in parallel. In a series operation of multiple power supply units, only wiring option A with individual signal switches is allowed.

IMPORTANT Option C requires a current sink capability of the voltage source. Do not use a blocking diode.
The shut-down function has no safety feature included.

Figure 18 - Activation of the Shut-down Input



Remote Control of Output Voltage

You can use the shut-down input to adjust the output voltage remotely, typically between 44...54V DC. All other functions of the shut-down input remain the same.

The control voltage is referenced to the main ground (negative output voltage).

Figure 19 - Remote Control of the Output Voltage

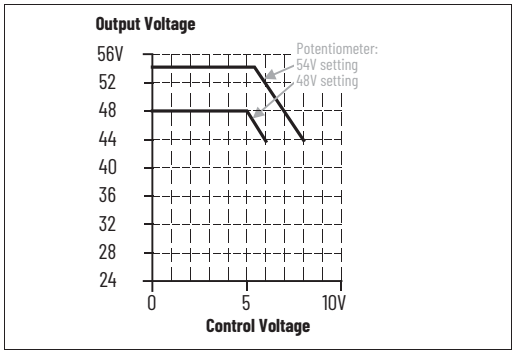
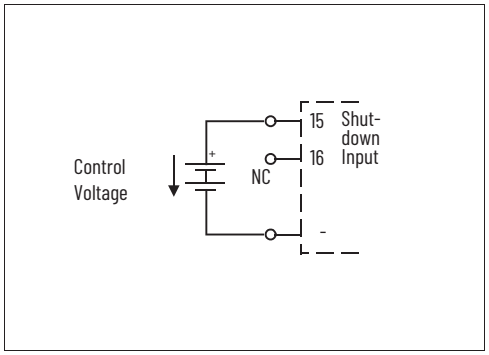


Figure 20 - Applying the Control Voltage



To set the shutdown input to adjust the output voltage remotely:

1. Set the unit into Single Use mode.
2. Set the output voltage adjustment (48...54V) to the maximum desired voltage.
3. Apply a control voltage to reduce the output voltage.

Efficiency and Power Losses

Attributes		Values			Notes
		AC 100V	AC 120V	AC 230V	
Efficiency	Typ	93.5%	93.9%	95.0%	At 48V, 20 A
Average efficiency (1)	Typ	92.9%	93.3%	93.9%	25% at 5 A, 25% at 10 A, 25% at 15 A, 25% at 20 A
Power losses	Typ	3.6 W	3.5 W	3.3 W	With activated shut-down
	Typ	13.5 W	12.8 W	12.8 W	At 48V, 0 A (no load)
	Typ	35.6 W	34.0 W	30.1 W	At 48V, 10 A (half load)
	Typ	66.7 W	62.4 W	50.5 W	At 48V, 20 A (full load)

(1) An assumption for a typical application where the power supply unit is loaded with 25% of the nominal load for 25% of the time, 50% of the nominal load for another 25% of the time, 75% of the nominal load for another 25% of the time, and with 100% of the nominal load for the rest of the time.

Figure 21 - Efficiency Versus Output Current at 48V, Typ

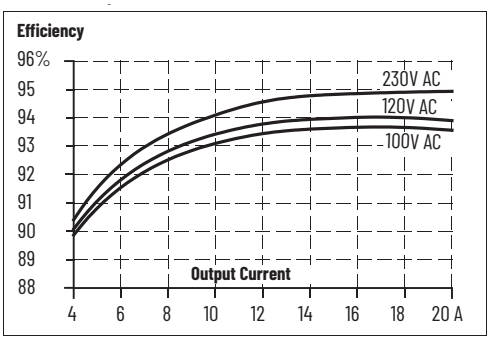


Figure 22 - Losses Versus Output Current at 48V, Typ

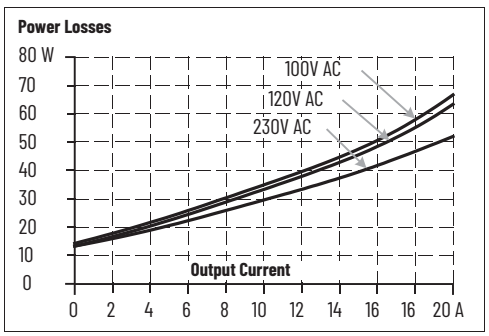


Figure 23 - Efficiency Versus Input Voltage at 48V, 20 A, Typ

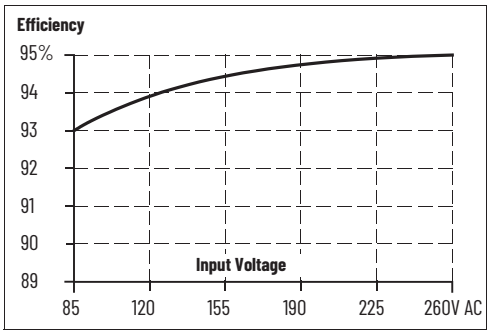
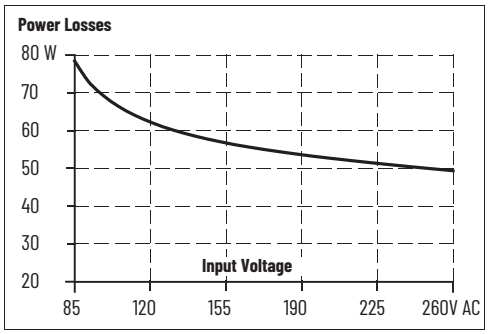
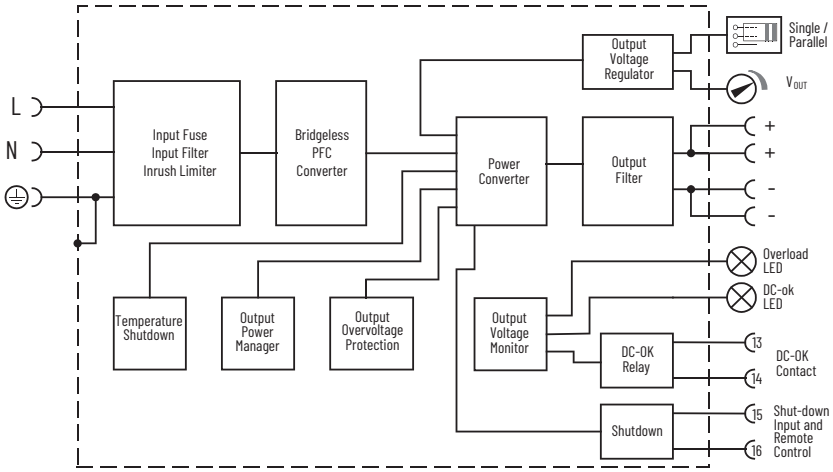


Figure 24 - Losses Versus Input Voltage at 48V, 20 A, Typ



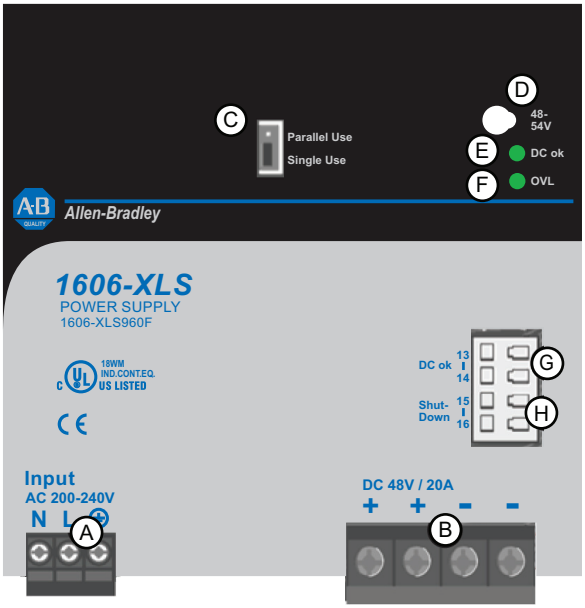
Functional Diagram

Figure 25 - Functional Diagram



Front Side and User Elements

Figure 26 - Front Side



User Elements	
A	**Input terminals** (screw terminals) N, L Line input ⏚ ...PE (protective earth) input
B	**Output terminals** (screw terminals, two pins per pole) + Positive output - Negative (return) output
C	**Parallel Use/Single Use selector** Set the jumper to Parallel Use when the power supply units are connected in parallel to increase the output power. To achieve a sharing of the load current between the individual units, the Parallel Use regulates the output voltage in such a manner that the voltage at no load is approximately 4% higher than at nominal load. See Parallel Use to Increase Output Power on page 24. A missing jumper is equal to a Single Use mode.
D	**Output voltage potentiometer** Multi-turn potentiometer; open the flap to set the output voltage. Factory setting is 48V at full output current, Single Use mode.
E	**DC-OK status indicator** (green) Shows on when the voltage on the output terminals is >90% of the adjusted output voltage.
F	**Overload status indicator** (red) • Shows on when the voltage on the output terminals is <90% of the adjusted output voltage, or if there is a short circuit in the output. • Flashes when the shutdown is activated or the unit is switched off due to over-temperature. • Input voltage is required.
G	**DC-OK relay contact** The DC-OK relay contact is synchronized with the DC-OK status indicator. See DC-OK Relay Contact on page 9.
H	**Shutdown and Remote Control input** Allows the power supply unit to be shut down; can be activated with a switch contact or an external voltage. The remote control input allows for adjustment of the output voltage between 44...54V. See Shutdown Input on page 9 and Remote Control of Output Voltage on page 10.

Indicators (LEDs)	Overload LED	DC-OK LED	DC-OK Contact
Normal mode	OFF	ON	Closed
During BonusPower	OFF	ON	Closed
Overload (Hiccup mode)	Flashing	OFF	Open
Output short circuit	Flashing	OFF	Open
Temperature shut-down	Flashing	OFF	Open
Active shut-down input	Flashing	OFF	Open
No input power	OFF	OFF	Open

Terminals and Wiring

The terminals are IP20 fingersafe constructed and suitable for field and factory wiring.

Attributes	Values		
	Input	Output	DC-OK, Shutdown
Type	Screw termination	Screw termination	Spring clamp termination
Solid wire	0.5...6 mm^2	0.5...16 mm^2	0.15...1.5 mm^2
Stranded wire	0.5...4 mm^2	0.5...10 mm^2	0.15...1.5 mm^2
American Wire Gauge	20...10 AWG	22...8 AWG	26...14 AWG
Max wire diameter	2.8 mm (0.11 in.) (1)	5.2 mm (0.2 in.) (1)	1.5 mm (0.06 in.) (1)
Wire stripping length	7 mm (0.28 in.)	12 mm (0.5 in.)	7 mm (0.28 in.)
Screwdriver	3.5 mm (0.138 in.), slotted or cross-head, No 2	3.5 mm (0.138 in.) or 5 mm (0.2 in.), slotted or cross-head, No 2	3 mm (0.12 in.), to open the spring
Recommended torque	1 N•m (9 lb•in)	2.3 N•m (20.5 lb•in)	–

(1) Includes ferrules.

Wiring instructions:

- Use the appropriate copper cables that are designed for the minimum operating temperatures:
  - 60 °C (140 °F) for an ambient temperature up to 45 °C (113 °F).
  - 75 °C (167 °F) for an ambient temperature up to 60 °C (140 °F).
  - 90 °C (194 °F) for an ambient temperature up to 70 °C (158 °F).
- Follow national installation codes and installation regulations.
- Confirm that all strands of a stranded wire enter the terminal connection.
- Do not use the unit without PE connection.
- Unused terminal compartments must be securely tightened.
- Ferrules are allowed.

Lifetime Expectancy

Attribute	Values			Notes
	AC 100V	AC 120V	AC 230V	
Calculated lifetime expectancy (1)	299,000 hr (1)	305,000 hr (1)	327,000 hr (1)	At 48V, 10 A and 25 °C (77 °F)
	106,000 hr	108,000 hr	116,000 hr	At 48V, 10 A and 40 °C (104 °F)
	180,000 hr (1)	193,000 hr (1)	253,000 hr (1)	At 48V, 20 A and 25 °C (77 °F)
	64,000 hr	68,000 hr	90,000 hr	At 48V, 20 A and 40 °C (104 °F)

(1) The minimum operating hours (service life). The lifetime expectancy of the built-in electrolytic capacitors determines the service life. Lifetime expectancy is specified in operational hours and is calculated according to the manufacturer specification of the capacitor. The manufacturer of the electrolytic capacitors lists a maximum life of up to 15 years (131,400 hr). Any number that exceeds this value is a calculated theoretical lifetime, which can be used to compare devices.

Mean Time Between Failure (MTBF)

MTBF is calculated according to statistical device failures, and indicates the reliability of a device. It is the statistical representation of the likelihood of a unit to fail; it does not necessarily represent the life of a product. An MTBF value of, for example, 1,000,000 hr means that statistically one unit fails every 100 hours if 10,000 units are installed in the field. However, the running time of individual failed units cannot be determined.

Attribute	Values			Notes
	AC 100V	AC 120V	AC 230V	
MTBF SN 29500, IEC 61709	491,000 hr	481,000 hr	537,000 hr	At 48V, 20 A and 25 °C (77 °F)
	274,000 hr	269,000 hr	300,000 hr	At 48V, 20 A and 40 °C (104 °F)
MTBF MIL HDBK 217F Ground Benign	170,000 hr	171,000 hr	183,000 hr	At 48V, 20 A and 25 °C (77 °F); Ground Benign GB25
	126,000 hr	127,000 hr	137,000 hr	At 48V, 20 A and 40 °C (104 °F); Ground Benign GB40
MTBF MIL HDBK 217F Ground Fixed	36,000 hr	36,000 hr	39,000 hr	At 48V, 20 A and 25 °C (77 °F); Ground Fixed GF25
	27,000 hr	27,000 hr	30,000 hr	At 48V, 20 A and 40 °C (104 °F); Ground Fixed GF40

Electromagnetic Compatibility

The power supply unit is suitable for applications in an industrial environment and in a residential, commercial, and light industry environment without any restrictions.

EMC Immunity According to Generic Standards EN 61000-6-1 and EN 61000-6-2

Attributes	Standards	Values		Criteria (1)
Electrostatic discharge	EN 61000-4-2	Contact discharge	8 kV	Criterion A
		Air discharge	15 kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80 MHz...2.7 GHz	20V/m	Criterion A
Fast transients (burst)	EN 61000-4-4	Input lines	4 kV	Criterion A
		Output lines	2 kV	Criterion A
		Signal lines (coupling clamp)	2 kV	Criterion A
Surge voltage on input	EN 61000-4-5	L → N	2 kV	Criterion A
		L → PE, N → PE	4 kV	Criterion A
Surge voltage on output	EN 61000-4-5	+ → -	1 kV	Criterion A
		+ / - → PE	1 kV	Criterion A
Surge voltage on signal lines	EN 61000-4-5	DC-OK signal → PE	1 kV	Criterion A
		Shut-down input → PE	Not relevant due to wire length (2)	
Conducted disturbance	EN 61000-4-6	0.15...80 MHz	20V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100V AC	0V AC, 20 ms	Criterion A
		40% of 100V AC	40V AC, 200 ms	Criterion C
		70% of 100V AC	70V AC, 500 ms	Criterion A
		0% of 200V AC	0V AC, 20 ms	Criterion A
		40% of 200V AC	80V AC, 200 ms	Criterion A
		70% of 200V AC	140V AC, 500 ms	Criterion A
Voltage interruptions	EN 61000-4-11	0% of 200V AC (=0V)	5000 ms	Criterion C
Voltage sags	SEMI F47	Dips on the input voltage according to SEMI F47 standard		
		80% of 120V AC (96V AC)	1000 ms	Criterion A
		70% of 120V AC (84V AC)	500 ms	Criterion A
		50% of 120V AC (60V AC)	200 ms	Criterion A
Powerful transients	VDE 0160	Over entire load range	750V, 1.3 ms	Criterion B (3)

(1) Criterion A: Power supply shows normal operation behavior within the defined limits.
Criterion B: Output voltage dips between 48...42V for 5 ms.
Criterion C: Temporary loss of function is possible. The power supply unit can automatically shut down and restart without damage or hazards to itself.
(2) Do not use longer wires than 30 m (98.42 ft) for the shutdown input or use an additional protection.
(3) Criterion A is fulfilled for output current up to 15 A.

EMC Emission According to Generic Standards EN 61000-6-3 and EN 61000-6-4

Attributes	Standards	Notes
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR 32	Class B
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	10 dB higher than average limits for DC power port according to EN 61000-6-3 (1)
Radiated emission	EN 55011, EN 55032	Class B
Harmonic input current	EN 61000-3-2	Fulfilled for class A equipment
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled (2)

This device complies with FCC Part 15 rules.
Operation is subjected to following conditions:
- This device must not cause harmful interference.
- This device must accept any interference received, including interference that can cause undesired operation.

(1) Restrictions apply for applications in residential, commercial, and light-industrial environments where local DC power networks, according to EN 61000-6-3, are involved. No restrictions for all kinds of industrial applications.
(2) Tested with constant current loads, non-pulsing.

The power supply unit has four converters with four different switching frequencies, which are included. One frequency is nearly constant; others are input voltage and load dependent.

Switching Frequency

Switching Frequency	Values	Notes
1	105 kHz	Resonant converter, nearly constant
2	1...150 kHz	Boost converter, input voltage, and load dependent
3	1...100 kHz	PFC converter, input voltage, and load dependent
4	25...45 kHz	Auxiliary converter, input voltage, and load dependent

Environment

Attributes	Values	Notes
Operational temperature (1)	-25...+70 °C (-13...+158 °F)	Reduce output power according to Figure 27 on page 16
Storage temperature	-40...+85 °C (-40...+185 °F)	For storage and transportation
Output derating	24 W/1 °C (24 W/1.8 °F)	Between 60...70 °C (140...158 °F)
Humidity (2)	5...95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2...17.8 Hz: ±1.6 mm (0.063 in.) (3) 17.8...500 Hz: 1 g (0.04 oz) 2 hours/axis	IEC 60068-2-6
Shock	15 g (0.53 oz) 6 ms, 10 g (0.35 oz) 11 ms (3) 3 bumps/direction, 18 bumps in total	IEC 60068-2-27
Altitude	0...2000 m (0...6560 ft)	Without any restrictions
	2000...6000 m (6560...20,000 ft)	Reduce output power or ambient temperature, see Figure 28 on page 16 IEC 62103, EN 50178, overvoltage category II
Altitude derating	60 W/1000 m (7.5 W/3280 ft), or 5 °C/1000 m (9 °F/3280 ft)	>2000 m (6500 ft), see Figure 28 on page 16
Overvoltage category	III	IEC 62103, EN 50178, altitudes up to 2000 m (6500 ft)
	II	Altitudes from 2000...6000 m (6500...20,000 ft)
Degree of pollution	2	IEC 62103, EN 50178, not conductive

(1) The same as the ambient temperature and is defined as the air temperature 20 mm (0.79 in.) below the unit.
(2) Do not energize while condensation is present.
(3) Higher levels are allowed when using the 1606-XLC wall mounting bracket.

Figure 27 - Output Current Versus Ambient Temperature

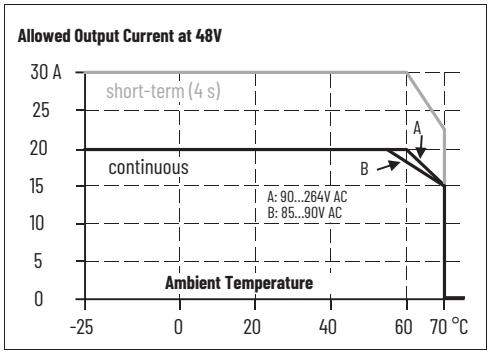
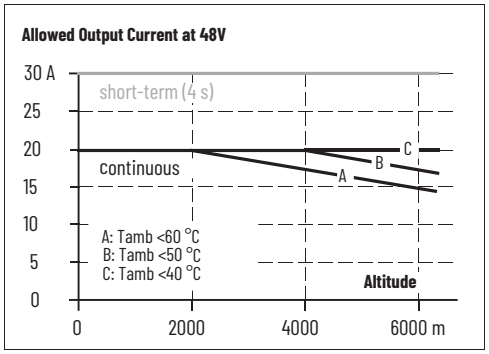


Figure 28 - Output Current Versus Altitude



Protection Features

Attributes	Values	Notes
Output protection	Electronically protected against overload, no-load, and short-circuits (1)	
Output overvoltage protection	58.8V DC typ	If there is an internal power supply anomaly, a redundant circuit limits the maximum output voltage. The output shuts down and automatically attempts to restart.
	60V DC max	
Degree of protection	IP 20	EN/IEC 60529 (2)
Penetration protection	>5 mm (0.2 in.)	For example, screws and small parts
Over-temperature protection	Yes	Output shutdown with automatic restart
Input transient protection	MOV	Metal Oxide Varistor
Internal input fuse	Included	Not user-replaceable

(1) An audible noise occurs if there is a protection event.
(2) For use in a controlled environment according to CSA 22.2 No 107.1-01.

Safety Features

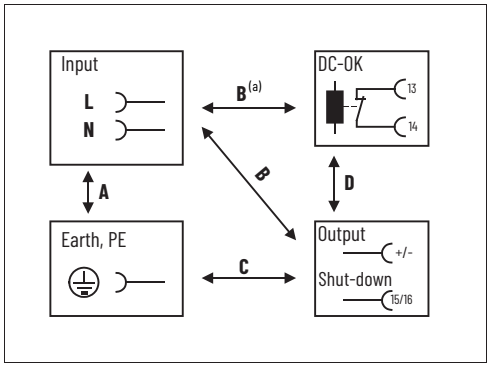
Attributes	Values		Notes
Input/output separation (1)	SELV		IEC/EN 60950-1
	PELV		IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I		PE connection not required.
Isolation resistance	>100 MΩ		Input to output, 500V DC
PE resistance	<0.1 Ω		–
Touch current (leakage current)	Typ	0.39 mA/1.0 mA	100V AC, 50 Hz, TN-, TT-mains/IT-mains
	Typ	0.56 mA/1.43 mA	120V AC, 60 Hz, TN-, TT-mains/IT-mains
	Typ	0.90 mA/2.25 mA	230V AC, 50 Hz, TN-, TT-mains/IT-mains
	Max	0.50 mA/1.21 mA	110V AC, 50 Hz, TN-, TT-mains/IT-mains
	Max	0.71 mA/1.73 mA	132V AC, 60 Hz, TN-, TT-mains/IT-mains
	Max	1.18 mA/2.28 mA	264V AC, 50 Hz, TN-, TT-mains/IT-mains

(1) Double or reinforced insulation.

Dielectric Strength

The output voltage is floating and has no ohmic connection to the ground. The manufacturer conducts type and factory tests. Field tests can be conducted with the appropriate test equipment, which applies the voltage with a slow ramp (2 s up and 2 s down). Connect all input terminals together and connect all output poles before conducting the test. When testing, set the cutoff current settings to the values in the following table.

Figure 29 - Dielectric Strength



(a) When input to DC-OK is tested, confirm that the max voltage between DC-OK and the output is not exceeded (column D). We recommend connecting DC-OK pins and the output pins together when performing the test.

Test or Setting	Time	A	B	C	D
Type test	60 s	2500V AC	3000V AC	500V AC	500V AC
Factory test	5 s	2500V AC	2500V AC	500V AC	500V AC
Field test	5 s	2000V AC	2000V AC	500V AC	500V AC
Cutoff current setting	–	>20 mA	>20 mA	>40 mA	>1 mA

To fulfill the PELV requirements according to EN60204-1 § 6.4.1, we recommend that you connect the protective earth system to the + pole, the – pole, or any other part of the output circuit. This connection helps to avoid situations in which a load starts unexpectedly or cannot be switched off when unnoticed earth faults occur.

Certifications and Standards Compliance

Names	Symbols	Notes (1)
UL 508	c UL US LISTED IND. CONT. EQ.	UL Certificate Listed equipment for category NMTR - Industrial Control Equipment Applicable for US and Canada
UL 60950-1	c US	UL Certificate Recognized component for category QQGQ - Information Technology Equipment Applicable for US and Canada
ATEX	Ex	Agency Certificate (Bureau Veritas) (1) EN 60079-0 Explosive atmospheres - General requirements EN 60079-7, EN 60079-15 Equipment protection by type of protection "e" and "n" Temperature Code: T3 Type of Protection: nA nC
IECEx	IECEx	IECEx Certificate (1) IEC 60079-0 Explosive atmospheres - General requirements IEC 60079-7, IEC 60079-15 Equipment protection by type of protection "e" and "n" Temperature Code: T3 Type of Protection: nA nC
Class I Div 2	SP C US	CSA Certificate Power Supplies for Hazardous Location Applicable for Canada and US CSA Class: 5318-01 (Canada), 5318-81 (US) Temperature Code: T3 Groups: A, B, C, and D
Marine (DNV GL)	DNV·GL dnvgl.com/af	DNV-GL Certificate DNV-GL Type approved product Temperature: Class D Humidity: Class B Vibration: Class C EMC: Class A Enclosure: Class A

Names	Symbols	Notes (1)
EC Declaration of Conformity	CE	The CE marking indicates conformance with the following: – EMC Directive – Low Voltage Directive (LVD) – RoHS directive
REACH Directive	REACH ✓	Manufacturer's Statement EU-Directive regarding the Registration, Evaluation, Authorization, and Restriction of Chemicals
EAC TR Registration	EAC	Registration for the Eurasian Customs Union market (Russia, Kazakhstan, Belarus)

(1) Product certification information (including Certificates and Declarations of Conformity) can be found at rok.auto/certifications.

Approximate Dimensions and Weight

Attributes	Values and Descriptions
Width	125 mm (4.92 in.)
Height	124 mm (4.88 in.)
Depth	127 mm (0.5 in.) (1)
Weight	1900 g (4.2 lb)
DIN rail	Use 35 mm (1.38 in.) DIN rails according to EN 60715 or EN 50022 with a height of 7.5 mm (0.30 in.) or 15 mm (0.59 in.).
Housing material	Aluminum body, steel cover
Installation clearances	Top: 40 mm (1.57 in.) Bottom: 20 mm (0.79 in.) Left/right: 5 mm (0.2 in.) (2)

(1) Add the DIN rail height to the unit depth to calculate the total required installation depth.
(2) Increase the 5 mm (0.2 in.) to 15 mm (0.59 in.) in case the adjacent device is a heat source. When the device is permanently loaded with less than 50%, the 5 mm (0.2 in.) can be reduced to zero.

Figure 30 - Front View [mm (in.)]

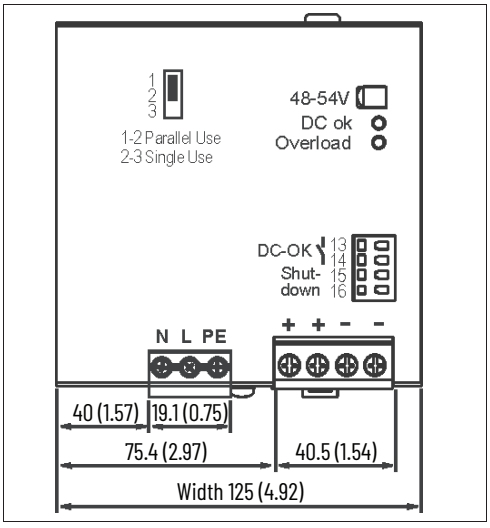
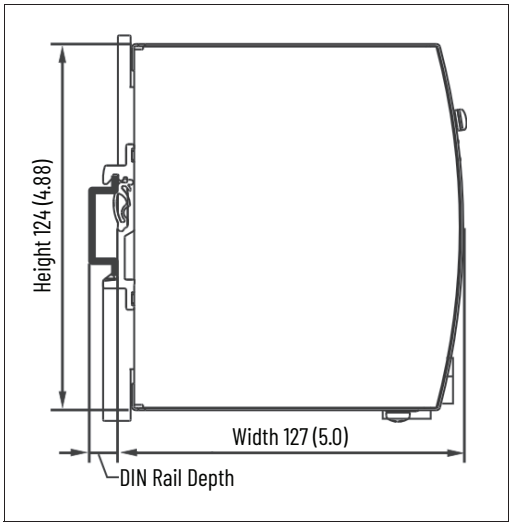


Figure 31 - Side View [mm (in.)]



1606-XLC Wall Mounting Bracket

This bracket is used to mount specific units onto a flat surface without using a DIN rail.

Figure 32 - Wall Mounting Bracket Attached to Unit

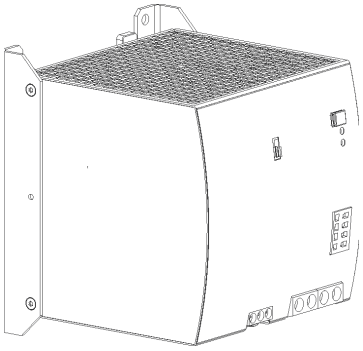
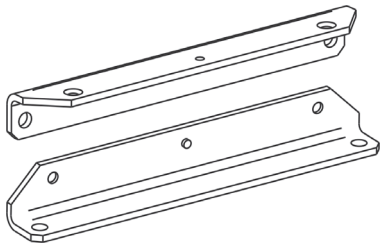


Figure 33 - Wall Mounting Bracket



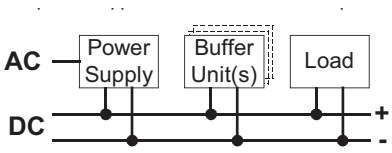
1606-XLSBUFFER48 Buffer Module

This buffer module is a supplementary device for DC 48V power supply units. The module delivers power to bridge typical mains failures or extends the hold-up time after turn-off of the AC power. In times when the power supply unit provides sufficient voltages, the buffer module stores energy in integrated electrolytic capacitors. If there is a mains voltage fault, this energy is released again in a regulated process.

The buffer module does not require any control wiring. It can be added in parallel to the load circuit at any given point. Buffer modules can be added in parallel to increase the output ampacity or the hold-up time.

Figure 34 - Buffer Module

Figure 35 - Buffer Module in Parallel



1606-XLSRED40HF Redundancy Module

The 1606-XLSRED40HF redundancy module is equipped with two input channels of 20 A each, which are individually decoupled by using mosfet technology. The output current is up to 40 A.

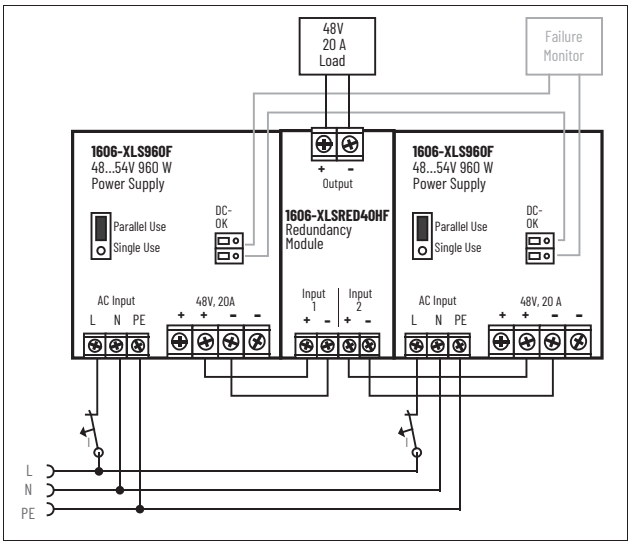
Mosfets are used instead of diodes to reduce the heat generation and voltage drop between input and output.

The 1606-XLSRED40HF redundancy module does not require an additional auxiliary voltage and is self-powered, even if there is a short circuit across the output.

Due to the low-power losses, the module is slender and only requires a 46 mm (1.81 in.) wide DIN rail.

Figure 36 - Redundancy Module

Figure 37 - Typical 1+1 Redundant Configuration for 20 A with a Dual Redundancy Module



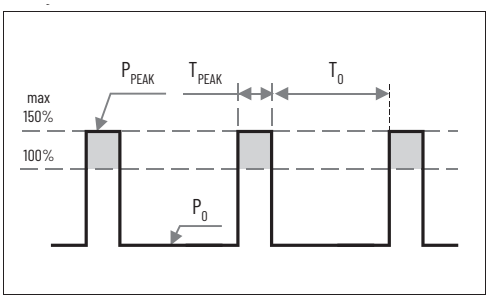
Repetitive Pulse Loading

A load current is not typically constant and varies over time. The power supply unit is designed to support loads with a higher short-term power requirement without damage or shutdown, or BonusPower. An output power manager controls the short-term duration. BonusPower is repeatedly available. If the BonusPower load lasts longer than the hardware controller allows, the output voltage will dip and the next BonusPower is available after the BonusPower recovery time has elapsed (see Output on page 6).

To avoid voltage dips, follow the following rules:

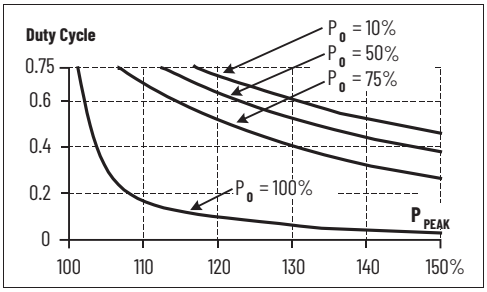
- The power demand of the pulse must be below 150% of the nominal output power.
- The duration of the pulse power must be shorter than the allowed BonusPower time (see Output on page 6).
- The average (RMS) output current must be below the specified continuous output current. If the RMS current is higher, the unit responds with a thermal shutdown after a time. Use the maximum duty cycle curve in Figure 39 on page 21 to check if the average output current is below the nominal current.
- The duty cycle must be below 0.75.

Figure 38 - Repetitive Pulse Loads, Definitions



P_0	Base load (W)
P_{PEAK}	Pulse load (above 100%)
T_0	Duration between pulses (s)
T_{PEAK}	Pulse duration (s)

Figure 39 - Maximum Duty Cycle Curve



$$DutyCycle = \frac{T_{peak}}{T_{peak} + T_0}$$

$$T_0 = \frac{T_{peak} - (DutyCycle \times T_{peak})}{DutyCycle}$$

Example Repetitive Pulse Calculation

A load is powered continuously with 480 W (= 50% of the rated output load). Occasionally a peak power of 1440 W (= 150% of the rated output load) is needed for 1 second.

How often can this pulse be supplied without overloading the power supply?

1. Make a vertical line at P_{PEAK} = 150% and a horizontal line where the vertical line crosses the P_o = 50% curve. Read the maximum duty cycle from the duty cycle-axis (= 0.37)
2. Calculate the required pause (base load) length T_o
3. The result is the required pause length = 1.7 s
4. Max repetition rate = pulse + pause length = <u>2.7 s</u>

$$T_o = \frac{T_{peak} - (DutyCycle \times T_{peak})}{DutyCycle} = \frac{1\ s - (0.37 \times 1\ s)}{0.37} = \underline{1.7\ s}$$

Additional Examples for Pulse Load Compatibility

P_{PEAK}	P_0	T_{PEAK}	T_0
1440 W	960 W	1 s	>25 s
1440 W	0 W	1 s	>1.3 s
1200 W	480 W	1 s	>0.75 s
1440 W	480 W	0.1 s	>0.16 s
1440 W	480 W	1 s	>1.6 s
1440 W	480 W	3 s	>4.9 s

Peak Current Capability

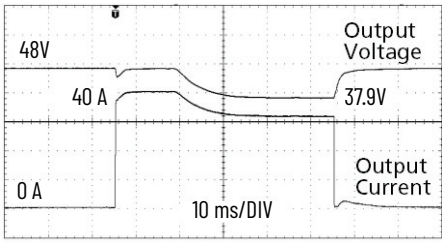
The power supply unit can deliver peak currents (up to several milliseconds) which are higher than the specified short-term currents.

Peak current capability helps to start current-demanding loads. Solenoids, contactors, and pneumatic modules often have a steady state coil and a pick-up coil. The inrush current demand of the pick-up coil is several times higher than the steady-state current and usually exceeds the nominal output current (including the BonusPower). The same situation applies when starting a capacitive load.

The peak current capability also achieves the safe operation of subsequent circuit breakers of load circuits. The load branches are often individually protected with circuit breakers or fuses. If there is a short or an overload in one branch circuit, the fuse or circuit breaker needs a certain amount of overcurrent to open in a timely manner. This safety avoids voltage loss in adjacent circuits.

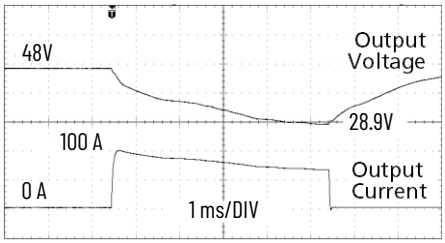
The extra current (peak current) is supplied by the power converter and the built-in large-sized output capacitors of the power supply unit. The capacitors get discharged during such an event, which causes a voltage dip on the output. Figure 40 and Figure 41 show typical voltage dips.

Figure 40 - Peak Loading with 2x the Nominal Current for 50 ms, Typ



Peak load 40 A (resistive load) for 50 ms. Output voltage: 48V dips to 37.9V

Figure 41 - Peak Loading with 5x the Nominal Current for 5 ms, Typ



Peak load 100 A (resistive load) for 5 ms. Output voltage: 48V dips to 28.9V

IMPORTANT The DC-OK relay triggers when the voltage dips more than 10% for longer than 1 ms.

Peak Current Voltage Dips

Attributes	Values	Notes
Typ	48...37.9V	At 40 A for 50 ms, resistive load
Typ	48...34.9V	At 100 A for 2 ms, resistive load
Typ	48...28.9V	At 100 A for 5 ms, resistive load

Back-feeding Loads

Loads such as decelerating motors and inductors can feed voltage back to the power supply unit. This feature is also called return voltage immunity, or resistance against Back Electromagnetic Force (Back EMF).

This power supply unit is resistant and does not show malfunctions when a load feeds back voltage to the unit, regardless of whether the unit is on or off.

The maximum allowed feed back voltage is 63V DC. The absorbing energy can be calculated according to the built-in large-sized output capacitor, which is specified in Output on page 6.

Inductive and Capacitive Loads

The unit is designed to supply any kind of loads, including unlimited capacitive and inductive loads. If extreme large capacitors, such as EDLCs (electric double layer capacitors or UltraCaps) with a capacitance of >1F are connected to the output, the unit can charge the capacitor in the Hiccup^{PLUS} mode (see Output on page 6).

Charging of Batteries

This power supply unit is not recommended to charge lead-acid or maintenance free batteries. The recommended end-of-charge voltage of 55V at 20 °C (68 °F) for four 12V VRLA lead-acid batteries in series cannot be supplied from the 1606-XLS960F power supply unit.

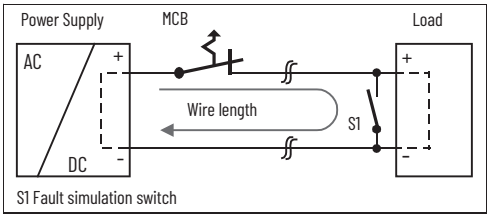
Output Circuit Breakers

Standard miniature circuit breakers, such as MCB or UL1077, are commonly used for AC-supply systems and can be used on DC branches.

MCB circuit breakers are designed to protect wires and circuits. If the ampere value and the characteristics of the MCB circuit breaker are adapted to the wire size that is used, the wiring is considered thermally safe, regardless of whether the MCB opens.

To avoid voltage dips and undervoltage situations in adjacent 48V branches that are supplied by the same source, a fast magnetic tripping of the MCB circuit breaker is desired. A shutdown within 10 ms is necessary, which corresponds roughly to the ride-through time of the PLC. A quick shutdown requires power supply units with high current reserves and large output capacitors. Furthermore, the impedance of the faulty branch must be sufficiently small for the current to flow. The following table contains typical test results that show which B- and C-characteristic MCB circuit breakers magnetically trip, depending on the wire cross section and wire length.

Figure 42 - Test Circuit



Maximal Wire Length for a Fast Magnetic Tripping [m (ft)] (1)

MCB	Wire Length by Gauge			
	0.75 mm² (18 AWG)	1.0 mm² (17 AWG)	1.5 mm² (16 AWG)	2.5 mm² (14 AWG)
C-2A	68 (223.1)	89 (292)	>100 (328.1)	>100 (328.1)
C-3A	53 (173.9)	75 (246.1)	>100 (328.1)	>100 (328.1)
C-4A	44 (144.4)	57 (187)	88 (288.7)	>100 (328.1)
C-6A	18 (5901)	25 (82)	38 (124.7)	58 (190.3)
C-8A	9 (29.5)	12 (39.4)	18 (59.1)	24 (78.7)
C-10A	8 (26.2)	11 (36.1)	16 (52.5)	23 (75.5)
C-13A	4 (13.1)	5 (16.4)	8 (26.2)	12 (39.4)
B-6A	39 (128)	50 (164.0)	74 (242.8)	>100 (328.1)
B-10A	21 (68.9)	29 (95.1)	44 (144.4)	68 (223.1)
B-13A	13 (42.7)	21 (68.9)	34 (111.5)	52 (170.6)
B-16A	7 (23)	9 (29.5)	13 (42.7)	17 (55.8)
B-20A	2 (6.6)	3 (9.8)	4 (13.1)	5 (16.4)

(1) Consider twice the distance to the load or cable length when calculating the total wire length (+ and – wire).

External Input Protection

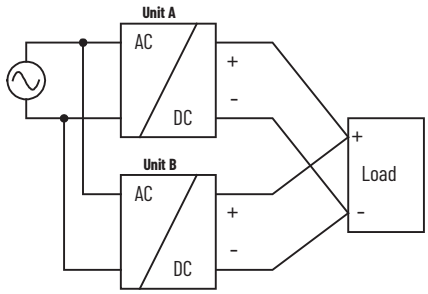
The unit is tested and approved for branch circuits up to 30 A (US) and 32 A (IEC). An external protection is required only if the supplying branch has an ampacity greater than the approved circuit amperage. Check local codes and local requirements. In some countries, local regulations might apply.

If an external fuse is used, minimum requirements must be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 16 A B- or C-characteristic breaker must be used, when the unit is used at AC 100V and AC 120V mains voltages (including AC 230V). If the unit is used only at AC 230V mains, a 10 A B- or C-characteristic breaker is sufficient.

Parallel Use to Increase Output Power

Power supply units from the same series can be paralleled to increase the output power. The output voltage must be adjusted to the same value (±100 mV) in Single Use mode with the same load conditions on all units, or the units can be left with the factory settings. After the adjustments, move the jumper on the front of the unit from Single Use to Parallel Use to achieve load sharing. The Parallel Use mode regulates the output voltage so that the voltage at no load is approximately 4% higher than at nominal load. See Output on page 6. If no jumper is plugged in, the unit is in Single Use mode. The factory setting is also Single Use mode.

Figure 43 - Parallel Use to Increase Output Power



If more than three units are connected in parallel, a fuse or circuit breaker with a rating of 30 A or 32 A is required on each output. Alternatively, use a diode or redundancy module.

Energize all units simultaneously to avoid the overload Hiccup^{PLUS} mode. If the output was in Hiccup^{PLUS} mode due to overload or short circuits and the required output current is higher than the current of one unit, turn off the power for at least 5 seconds.

Keep a left and right installation clearance of 15 mm (0.59 in.) between the two power supply units and avoid installing the units on top of each other. Do not use power supply units in parallel in mounting orientations other than in the standard mounting orientation (terminals on the bottom of the unit). Do not use the power supply units in parallel in any other condition where a derating of the output current is required, such as in altitudes above 60 °C (140 °F).

Understand that leakage current, EMI, inrush current, and harmonics increase when using multiple power supply units.

Parallel Use for Redundancy

Power supplies can be paralleled for redundancy to gain higher system availability. Redundant systems require a certain amount of extra power to support the load in case one power supply unit fails. The simplest way is to put two power supply units in parallel. This type of redundancy is called a 1+1 redundancy. In case one power supply unit fails, the other unit automatically supports the load current without any interruption. Redundant systems for a higher power demand are built in an N+1 method. For example, five power supply units, each rated for 20 A, are paralleled to build an 80 A redundant system. For N+1 redundancy, the same restrictions apply as for increasing the output power, see Parallel Use to Increase Output Power on page 24.

IMPORTANT This redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply unit. In such a case, the defective unit becomes a load for the other power supply units and the output voltage cannot be maintained. This defective unit load can only be avoided by using redundancy modules that include decoupling devices, such as diodes or mosfets. See 1606-XLSRED40HF Redundancy Module on page 19.

Recommendations for building redundant power systems:

- Use separate input fuses for each power supply unit to increase the reliability of the redundant system.
- Set the unit into Parallel Use mode.
- Monitor the individual units. Use the DC-OK relay contact of the 1606-XLS960F power supply unit.
- Set the output voltages of all units to the same value (±100 mV) or leave output voltages at the factory setting.

Daisy Chain

A daisy chain (a jump from one power supply unit output to the next) is allowed as long as the average output current through one terminal pin does not exceed 54 A. If the current is higher, use a separate distribution terminal block as shown in Figure 45.

Figure 44 - Daisy Chain of Outputs

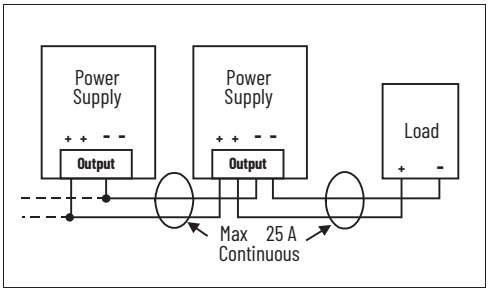
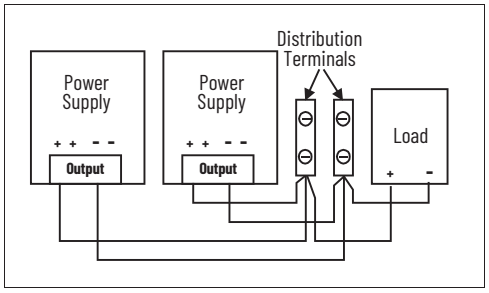
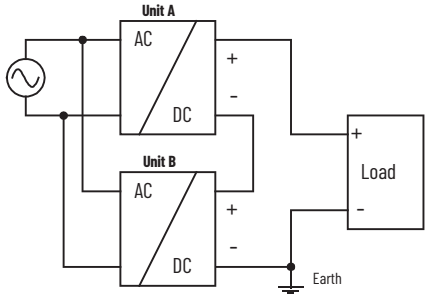


Figure 45 - Using Distribution Terminals



Series Operation

Figure 46 - Series Operation



Power supplies of the same type can be connected in series for higher output voltages. Connect as many units in series as needed, providing the sum of the output voltage does not exceed 150V DC. Voltages with a potential above 60V DC can be dangerous and are no longer SELV. Such voltages must be installed with a protection against being touched.

Earthing of the output is required when the sum of the output voltage is above 60V DC.

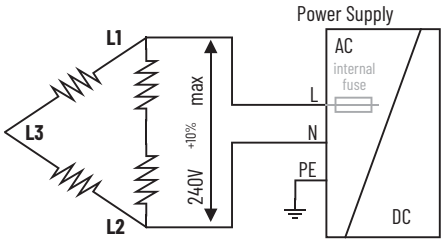
Avoid return voltage (for example, from a decelerating motor or battery) which is applied to the output terminals.

Keep a left and right installation clearance of 15 mm (0.59 in.) between two power supply units and avoid installing the units on top of each other. Do not use power supply units in series in mounting orientations other than the standard mounting orientation (terminals on the bottom of the unit).

Understand that leakage current, EMI, inrush current, and harmonics increase when using multiple power supply units.

Operation on Two Phases

Figure 47 - Operation on Two Phases



The power supply unit can be used on two phases of a three-phase system, as long as the supplying voltage is below $240V^{+10\%}$.

Use in a Tightly Sealed Enclosure

When the power supply unit is installed in a tightly sealed enclosure, the temperature inside the enclosure is higher than outside of the enclosure. In such situations, the inside temperature defines the ambient temperature for the power supply unit.

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure. These measurements are taken with the power supply unit in the middle of the enclosure, with no other heat-producing items inside the enclosure.

Attributes	Values
Enclosure size	254 x 180 x 165 mm (4.88 x 7.09 x 6.50 in.) Rittal Typ IP66 Box PK 9522 100, plastic
Input voltage	230V AC
Load	48V, 16 A; (=80%) (1)
Temperature inside enclosure	65.6 °C (150.08 °F) (2)
Temperature outside enclosure	24.1 °C (75.38 °F)
Temperature rise	41.5K

(1) The load is placed outside the box.
(2) Temperature in the middle of the right side of the power supply unit with a distance of 20 mm (0.79 in.).

Mounting Orientations

Mounting orientations, other than all terminals on the bottom, require a reduction in continuous output power or a limitation in the maximum allowed ambient temperature. The amount of reduction influences the lifetime expectancy of the power supply unit.

Figure 48...Figure 52 on page 28 show two derating curves for continuous operation.

- Curve A1: Recommended output current.
- Curve A2: Max allowed output current (results in approximately half the lifetime expectancy of A1).

Figure 48 - Mounting Orientation A: Standard Orientation

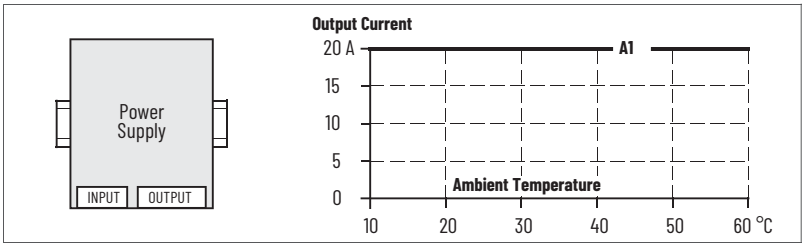


Figure 49 - Mounting Orientation B: Upside Down

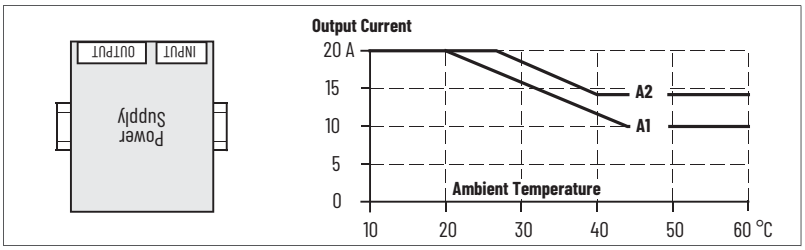


Figure 50 - Mounting Orientation C: Table-top Mounting

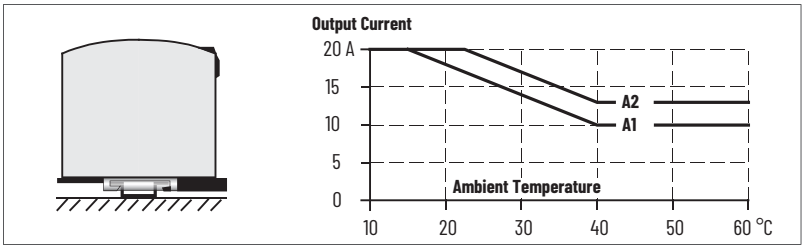


Figure 51 - Mounting Orientation D: Horizontal CW

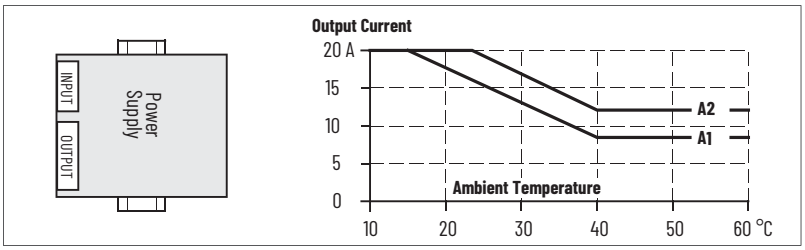
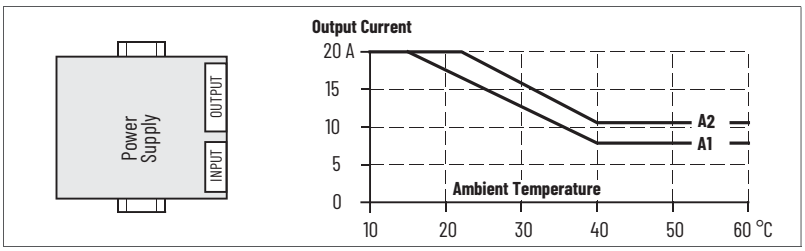


Figure 52 - Mounting Orientation E: Horizontal CCW



Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
Switched Mode Power Supply Specifications Technical Data, publication 1606-TD002	Provides specifications for Bulletin 1606 products and applications.
1606-XLS960F Installation Instructions, publication 1606-IN029	Provides basic specifications and installation instructions.
System Security Design Guidelines Reference Manual, SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley® industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

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Waste Electrical and Electronic Equipment (WEEE)

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