Reference Manual

Original Instructions

Allen-Bradley

Power Supply - 24V, 10 A, 240 W, Three-phase Input

Catalog Number 1606-XLE240E-3

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.

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).

Table of Contents

Additional Resources

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

Resource	Description
1606-XL Power Supply Technical Data, publication 1606-TD001	Provides specifications and certifications for the 1606-XL240E-3 power supply.
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.

You can view or download publications at http://www.rockwellautomation.com/global/literature-library/overview.page. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Terminology and Abbreviations

Term	Definition
PE and symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol.
Earth, Ground	This document uses the term 'earth' which is the same as the U.S. term 'ground.'
4000V AC	A figure with the unit (V AC) at the end is a momentary figure without any additional tolerances included.
50 Hz vs. 60 Hz	As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50 Hz mains frequency. AC 120V parameters are valid for 60 Hz mains frequency.

Product Overview

The 1606 Essential line are cost optimized power supplies without compromising quality, reliability, and performance. The most outstanding features of 1606-XLE240E-3 are the high-efficiency, electronic inrush-current limitation, active input-transient filter, and wide-operational temperature range. The small size is achieved by a synchronous rectification and further technological design details.

The 1606-XLE240E-3 is equipped with conformal coated circuit-boards that are preferred for applications in harsh areas.

The 1606 Essential line includes all essential basic functions. The devices have a power reserve of 20% included, which may even be used continuously at temperatures up to 45 °C (113 °F). Additionally, the 1606-XLE240E-3 can deliver three times the nominal output current for 10 ms which helps to trip fuses on faulty output branches.

The power supply features:

- 3x 380…480V AC wide-range input
- 2 or 3-phase operation possible
- Width only 62 mm (0.039 in.)
- Efficiency up to 92.9% due to synchronous rectifier
- Excellent partial load efficiency
- 20% output power reserves
- Easy fuse tripping due to high overload current
- Input-transient blanking circuit included
- Minimal inrush current surge
- Three input fuses included
- Current sharing feature for parallel use
- Full power between -25 °C...+60 °C (-13 °F...+140 °F)

Attribute	Description	
Output voltage Adjustment range	24V DC 24…28V	Nominal Factory setting 24.1V
Output current	12.0…10.3 A 10.0…8.6 A 7.5…6.5 A	Below 45 °C (113 °F) ambient 60 °C(140 °F) ambient 70 °C(158 °F) ambient Derate linearly between 45…70 °C (113…158 °F)
Input voltage AC Mains frequency Input current AC Power factor	3x 380…480V AC 50…60 Hz 0.7/0.6 A 0.53/0.52 A	-15%/+20% ±6% 3x 400/480V 3x 400/480V
AC inrush current	4/4 Apk	3x 400/480V
Efficiency Losses	92.8/92.9% 18.6/18.3 W	3x 400/480V 3x 400/480V
Hold-up time	34/54 ms	3x 400/480V
Temperature range	-25…+70 °C(-13…+158 °F)	–
Size (W x H x D)	62 x 124 x 117 mm (2.44 x 4.88 x 4.60 in.)	Without DIN rail
Weight	750 g (1.65 lb)	Without DIN rail

Figure 1 - Main Approvals

See page 20 for a complete list of approvals.

Installation Notes

ATTENTION: Risk of electrical shock, fire, personal injury, or death.
- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.
- Turn power off before working on the device. Protect against inadvertent repowering.
- Do not modify or repair the unit.
- Do not open the unit as high voltages are present inside.
- Use caution to prevent any foreign objects from entering into the housing.
- Do not use in wet locations or in areas where moisture or condensation can be expected.

BURN HAZARD: Do not touch while applying power, and immediately after turning off the power. Hot surfaces may cause burns.

WARNING: Substitution of components may impair suitability for this environment.

Do not disconnect the device or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

- This device may only be installed and put into operation by qualified personnel.
- This device does not contain serviceable parts. If damage or malfunction should occur during installation or operation, immediately turn power off and send unit to the factory for inspection. The tripping of an internal fuse is caused by an internal defect.
- Install the device in an enclosure providing protection against electrical, mechanical, and fire hazards.
- Install the device onto a DIN rail according to EN60715 with the input terminals on the bottom of the device. Other mounting orientations require a reduction in output current.
- Make sure that the wiring is correct by following all local and national codes.
- Use appropriate copper cables that are designed for a minimum operating temperature of:
  - 60 °C (140 °F) for ambient temperatures up to 45 °C (113 °F),
  - 75 °C (167 °F) for ambient temperatures up to 60 °C (140 °F),
  - and 90 °C (194 °F) for ambient temperatures up to 70 °C (158 °F).
- Verify that all strands of a stranded wire enter the terminal connection.
- Unused screw terminals should be securely tightened.
- The device is designed for pollution degree to areas in controlled environments. No condensation or frost allowed. The enclosure of the device provides a degree of protection of IP20.
- The isolation of the device is designed to withstand impulse voltages of overvoltage category 3 according to IEC 60664-1 for corner grounded delta systems, the overvoltage category level is reduced to level 2.

- The device is designed as Class of Protection I equipment according to IEC 61140.
- Do not use without a proper PE (Protective Earth) connection.
- The device is suitable to be supplied from TN-, TT-, and IT mains networks. The voltage between the L terminals and the PE terminal must not exceed 500V AC continuously.
- A disconnecting means shall be provided for the input of the device.
- The device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid.
- The device is designed for altitudes up to 6000 m (19,685 ft). See Environment for use above 2000 m (6560 ft).
- Keep the following minimum installation clearances:
  - 40 mm (1.57 in.) on top
  - 20 mm (0.78 in.) on the bottom
  - 5 mm (0.19 in.) left and right side
- Increase the 5 mm (0.19 in.)...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 (0.19 in.) can be reduced to zero.
- The device is designed, tested, and approved for branch circuits up to 32 A (IEC) and 30 A (UL) without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6 A B- or C-Characteristic to avoid a nuisance tripping of the circuit breaker.
- The maximum surrounding air temperature is 70 °C (158 °F). The operational temperature is the same as the ambient or surrounding air temperature and is defined 2 cm (7.87 in.) below the device.
- The device is designed to operate in areas between 5% and 95% relative humidity.

AC Input

Attribute		1606-XLE240E-3	
AC input	Nom	3V AC/380…480V AC	–
AC input range	Min	3x 323…576V AC	Continuous operation
	Min	3x 576…700V AC	Max 1 s (occasional)
Allowed voltage L or N to earth	Max	500V AC	Continuous, IEC 62477-1
Input frequency	Nom	50…60 Hz	±6%
Turn-on voltage	Typ	3x 260V AC	Steady-state value, see Figure 2.
Shut-down voltage	Typ	3x 185V AC	Steady-state value, see Figure 2.
External input protection		See recommendations in Installation Notes.	

Attribute		3x 400V AC	3x 480V AC	Description
Input current	Typ	0.7 A	0.6 A	At 24V, 10 A, per phase, see Figure 4.
Power factor(1)	Typ	0.53	0.52	At 24V, 10 A, see Figure 5.
Start-up delay	Typ	90 ms	90 ms	See Figure 3.
Rise time	Typ	40 ms	40 ms	At 24V, 10 A const. current load, 0mF load capacitance, see Figure 3.
	Typ	85 ms	85 ms	At 24V, 10 A const. current load, 10mF load capacitance, see Figure 3.
Turn-on overshoot	Max	200 mV	200 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.

Figure 2 - Input Voltage Range

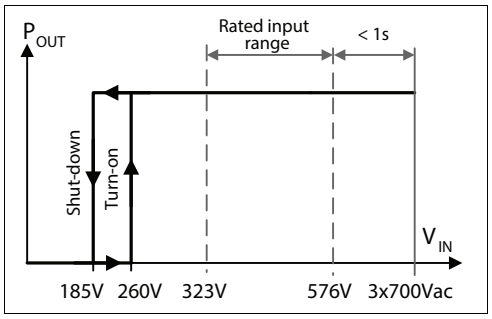


Figure 3 - Turn-on Behavior, Definitions

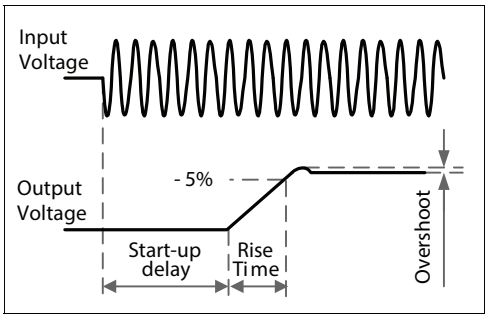


Figure 4 - Input Current versus Output Load at 24V

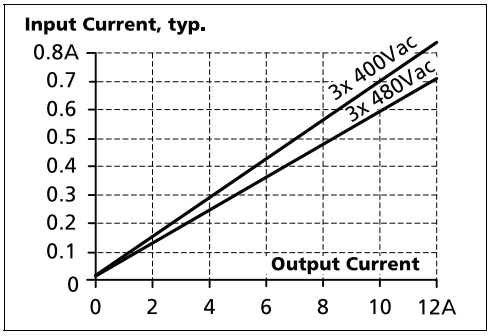
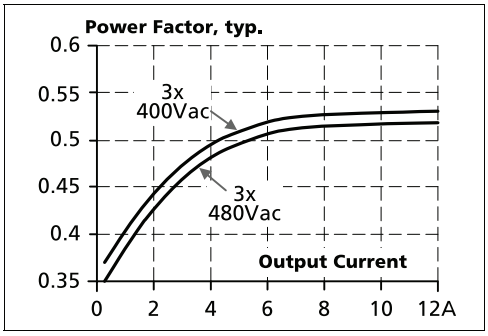


Figure 5 - Power Factor versus Output Load



DC Input

Do not operate the power supply with DC input voltage.

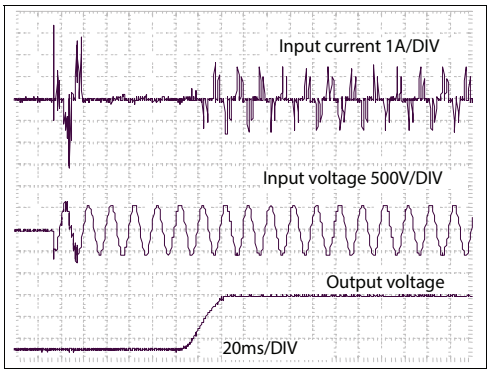
Input Inrush Current

An active inrush limitation circuit limits the input inrush current after turn-on of the input voltage and after short input voltage interruptions.

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

Attribute		3x 400V AC	3x 480V AC	Description
Inrush current	Max	10 A peak	10 A peak	Temperature independent
	Typ	4 A peak	4 A peak	
Inrush energy	Max	0.5 A^2s	1.5 A^2s	

Figure 6 - Typical Input Inrush Current Behavior at Nominal Load and 25 °C (77 °F) Ambient Temperature



DC Output

The output provides a SELV/PELV rated voltage, which is galvanically isolated from the input voltage.

The device is designed to supply any kind of loads, including unlimited capacitive and inductive loads.

The output is electronically protected against overload, no-load, and short-circuits. In case of a protection event, audible noise may occur.

Attribute		Description	
Output voltage	Nom	24V DC	–
Adjustment range	Min	24…28V AC	Guaranteed
	Max	30V	At clockwise end position of potentiometer.
Factory settings	Typ	24.1V	±0.2%, in single use at full load, cold unit
	Typ	24.1V	±0.2%, in parallel use at full load, cold unit (results to 23.9V ±0.7% at 12 A and 25V ±0.2% at no load)
Line regulation	Max	10 mV	3 x 323…3 x 576V AC input voltage change
Load regulation	Max	100 mV	Static value, 0 A…10 A single use mode, static value
	Typ	1000 mV	Static value, 0 A…10 A parallel use mode, static value, see Figure 8.
Ripple and noise voltage	Max	50 mVpp	20 Hz…20 MHz, 50 Ohms
Output current	Nom	12 A(1)	At 24V, below 45 °C (113 °F) ambient temperature.
		10 A	At 24V, below 60 °C (140 °F) ambient temperature.
		7.5 A	At 24V, at 70 °C (158 °F) ambient temperature.
		10.3 A(1)	At 8V, and an ambient temperature below 45 °C (113 °F).
		8.6 A	At 28V, at 60 °C (140 °F) ambient temperature.
		6.5 A	At 28V, at 70 °C (158 °F) ambient temperature.
	–	Reduce output current linearly between 45 °C…70 °C (113 °F…158 °F).	
Fuse breaking current	Typ	23 A	Up to 20 ms once every 5 seconds, see Figure 7. The fuse breaking is an enhanced transient current, which helps to trip fuses on faulty output branches. The output voltage stays above 40V.
Overload behavior	–	Continuous current	See Figure 7.
Overload/Short Circuit current	Max	23 A	Continuous current. See Figure 7.
Output capacitance	Typ	6500 µF	Included inside the power supply.
Back-feeding loads	Max	35V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the power supply. It does not matter whether the power supply is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

(1) This current is also available for temperatures up to 70 °C (158 °F) with a duty cycle of 10% and/or not longer than 1 minute every 10 minutes.

Figure 7 - Output Voltage versus Output Current, typ.

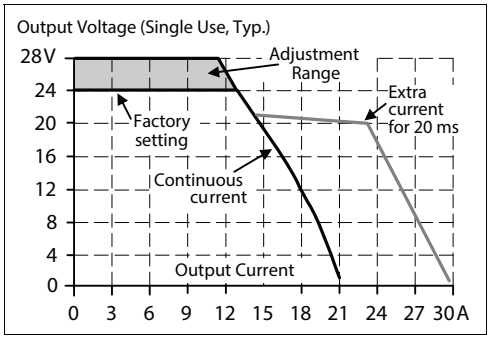
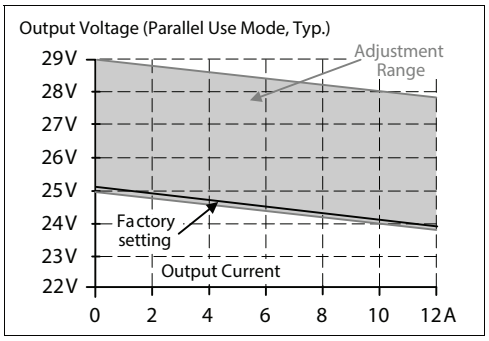


Figure 8 - Output Voltage in Parallel Use Mode, typ.



Hold-up Time

Attribute	3x 400V AC	3x 480V AC	Description
Typ	34 ms	54 ms	At 24V, 10 A, see Figure 9.
Typ	68 ms	108 ms	At 24V, 5 A, see Figure 9.
Min	28 ms	44 ms	At 24V, 10 A, see Figure 9.
Min	56 ms	87 ms	At 24V, 5 A, see Figure 9.

Figure 9 - Hold-up Time versus Input Voltage

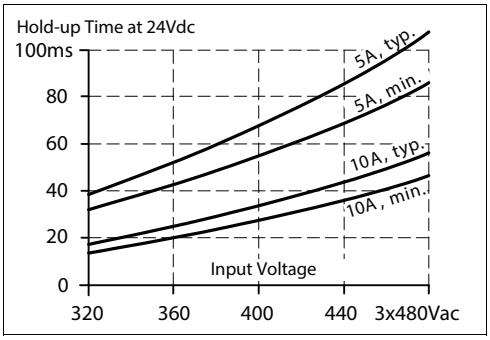
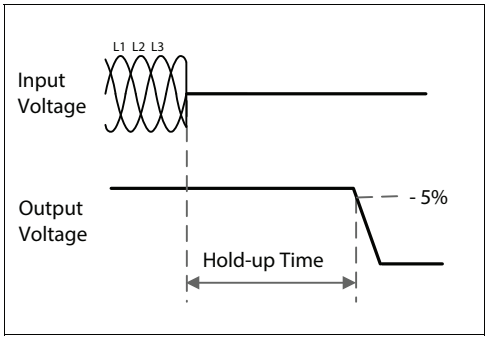


Figure 10 - Shut-down Behavior, Definitions



Efficiency and Power Loss

Attribute		AC 100V	3 AC 480V	Description
Efficiency	Typ	92.8%	92.9%	At 24V, 10 A, 3-phase operation.
	Typ	92.4%	92.6%	At 24V, 10 A, when using only two legs of a 3-phase system.
Average efficiency(1)	Typ	92.2%	92.0%	25% at 2.5 A, 25% at 5 A, 25% at 7.55 A, at 10 A, 3-phase operation
Power losses	Typ	2.3 W	2.6 W	At 0 A, 3-phase operation.
	Typ	11.8 W	11.8 W	At 24V, 5 A, 3-phase operation.
	Typ	18.6 W	18.3 W	At 24V, 10 A, 3-phase operation.
	Typ	12.3 W	11.6 W	At 24V, 12 A, 3-phase operation.

(1) The average efficiency is an assumption for a typical application where the power supply 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 11 - Efficiency versus Output Current at 24V, typ., 3-phase Operation

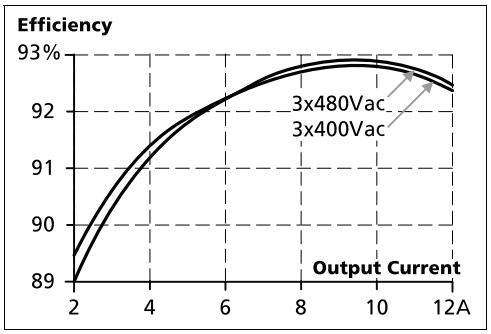


Figure 12 - Losses versus Output Current at 24V, typ., 3-phase Operation

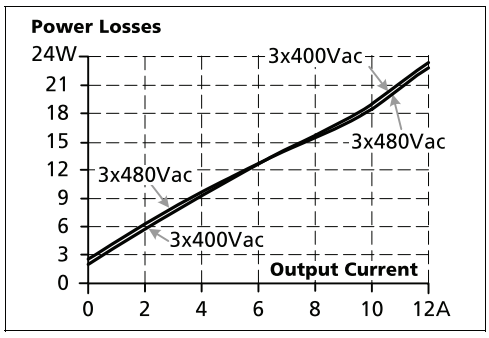
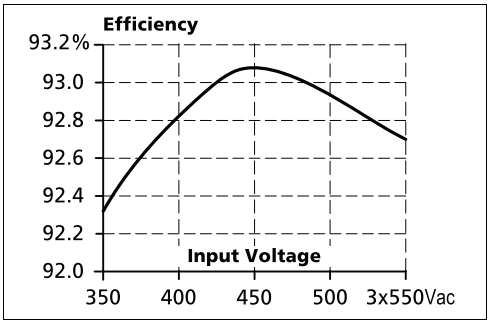
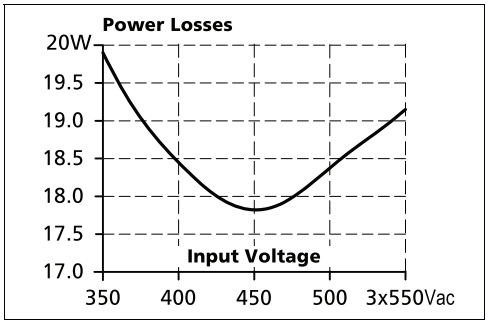


Figure 13 - Efficiency versus Input Voltage at 24V, 10 A, typ., 3-phase Operation

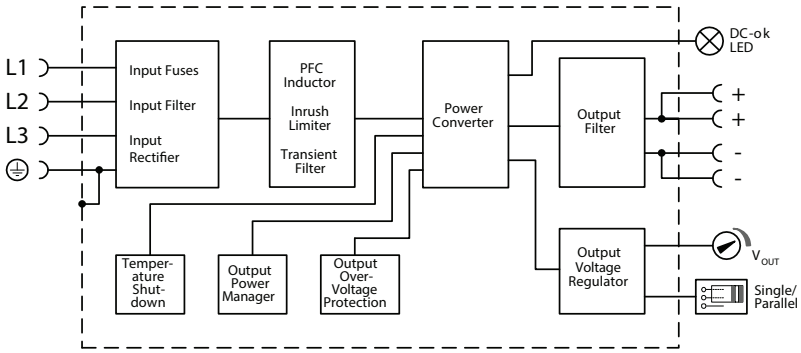


Losses versus Input Voltage at 24V, 10 A, typ., 3-phase Operation



Functional Diagram

Figure 14 - Functional Diagram



Front Side and User Elements

Letter	Definition
A	**Output terminals** - (screw terminals, two pins per pole) + Positive output – Negative (return) output
B	**Input terminals - (**screw terminals) N, L - Line input PE - Protective earth input
C	**Output voltage potentiometer -** Guaranteed adjustment range: 24…28V Factory set: 24.1V
D	**Jumper for Parallel Use, Single Use**
E	**DC-OK Relay Contact** (push-in terminals)

Connection Terminals

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

Attribute	Input and Output
Type	Screw termination
Solid wire	Max 6 mm^2
Stranded wire	Max 4 mm^2
American wire gauge	AWG 20…10
Wire diameter, max (including ferrules)	2.8 mm (0.11 in.)
Tightening torque, recommended	1 Nm, 9 lb-in
Wiring stripping length	7 mm (0.28 in.)
Screwdriver	3.5 mm slotted or Phillips no. 1

Daisy Chaining

Daisy chaining (jumping from one power supply output to the next) is allowed as long as the average output current through one terminal pin does not exceed 25 A. If the current is higher, use a separate distribution terminal block. See Figure 16.

Figure 15 - Daisy Chaining of Outputs

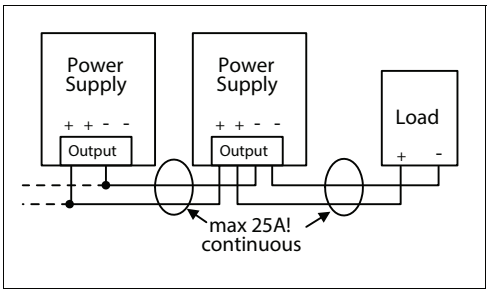
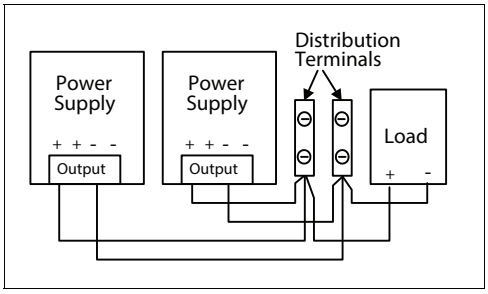


Figure 16 - Using Distribution Terminals



Lifetime Expectancy and Mean Time between Failure

Attribute		100V AC	120V AC	Description
Lifetime expectancy[1]		54,000 h	62,000 h	At 24V, 10 A and 40 °C (104 °F), 3-phase operation.
		133,000 h	134,000 h	At 24V, 5 A and 40 °C (104 °F), 3-phase operation.
		41,000 h	47,000 h	At 24V, 12 A and 40 °C (104 °F), 3-phase operation.
		151,000 h	176,000 h	At 24V, 10 A and 25 °C (77 °F), 3-phase operation.
		376,000 h	379,000 h	At 24V, 5 A and 25 °C (77 °F), 3-phase operation.
		116,000 h	133,000 h	At 24V, 12 A and 25 °C (77 °F), 3-phase operation.
		48,000 h	58,000 h	At 24V, 10 A and 40 °C (104 °F), 2-phase operation.
		134,000 h	145,000 h	At 24V, 5 A and 40 °C (104 °F), 2-phase operation.
		36,000 h	42,000 h	At 24V, 12 A and 40 °C (104 °F), 2-phase operation.
		135,000 h	164,000 h	At 24V, 10 A and 25 °C (77 °F), 2-phase operation.
		379,000 h	410,000 h	At 24V, 5 A and 25 °C (77 °F), 2-phase operation.
		102,000 h	119,000 h	At 24V, 12 A and 25 °C (77 °F), 2-phase operation.
MTBF[2]	SN 29500, IEC 61709	975,000 h	985,000 h	At 24V, 10 A and 40 °C (104 °F), 3-phase operation.
		1,706,000 h	1,723,000 h	At 24V, 10 A and 25 °C (77 °F), 3-phase operation.
		925,000 h	939,000 h	At 24V, 10 A and 40 °C (104 °F), 3-phase operation.
		1,633,000 h	1,656,000 h	At 24V, 10 A and 25 °C (77 °F), 3-phase operation.
	MIL HDBK 217 F	444,000 h	428,000 h	At 24V, 10 A and 40 °C (104 °F), 3-phase; Ground Benign GB40.
		584,000 h	563,000 h	At 24V, 10 A and 25 °C (77 °F), 3-phase; Ground Benign GB25.
		100,000 h	100,000 h	At 24V, 10 A and 40 °C(104 °F), 3-phase; Ground Fixed GF40.
		132,000 h	132,000 h	At 24V, 10 A and 25 °C (77 °F), 3-phase; Ground Benign GB25.
		436,000 h	423,000 h	At 24V, 10 A and 40 °C(104 °F), 2-phase; Ground Fixed GF40.
		555,000 h	572,000 h	At 24V, 10 A and 25 °C (77 °F), 2-phase; Ground Fixed GF25.
		98,000 h	98,000 h	At 24V, 10 A and 25 °C (77 °F), 2-phase; Ground Fixed GF25.
		129,000 h	129,000 h	At 24V, 10 A and 25 °C (77 °F), 2-phase; Ground Fixed GF25.

(1) The Lifetime expectancy that is shown in the table indicates the minimum operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors. Lifetime expectancy is specified in operational hours and is calculated according to the capacitor's manufacturer specification. The manufacturer of the electrolytic capacitors only guarantees a maximum life of up to 15 years (131,400 h). Any number exceeding this value is a calculated theoretical lifetime, which can be used to compare devices.

(2) MTBF stands for Mean Time Between Failure, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.

The MTBF figure is a statistical representation of the likelihood of a device to fail. A MTBF figure of for example, 1,000,000 h means that statistically one unit fails every 100 hours if 10,000 units are installed in the field. However, it cannot be determined if the failed unit has been running for 50,000 h or only for 100 h.
For these types of units the MTTF (Mean Time To Failure) value is the same value as the MTBF value.

EMC

EMC Immunity	According to Generic Standards EN 61000-6-1 and EN 61000-6-2			Criterion[1]
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8 kV 15 kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80 MHz-2.7 GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4 kV 2 kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L1 ->L2, L2 ->L3, L1 ->L3, L1/L2/L3->PE	2 kV 4 kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ ->- +/- ->PE	500V 1 kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15…80 M Hz	10V	Criterion A
Mains voltage dips (Dips on 3 phases)	EN 61000-4-11	0% of 380V AC 0% of 480V AC	0V AC, 20 ms 0V AC, 20 ms	Criterion A Criterion A
Mains voltage dips (Dips on 2 phases)	EN 61000-4-11	40% of 380V AC 40% of 480V AC 70% of 380V AC 70% of 480V AC	200 ms 200 ms 500 ms 500 ms	Criterion A Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11	–	5 s	Criterion C
Powerful transients	VDE 0160	Over entire load range	1550V, 1.3 ms	Criterion A

(1) Criterion A: Power supply shows normal operation behavior within the defined limits.
Criterion C: Temporary loss of function is possible. Power supply can shut down and restart by itself. No damage or hazard for the power supply occurs.

EMC Emission	According to Generic Standards: EN 61000-6-3, EN 610000-6-4	
Conducted emission input lines	EN 55011, EN 55022 FCC Part 15 CISPR 11, CISPR 22	Class B
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	Fulfilled for class A equipment
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled[1]
This device complies with FCC Part 15 rules. Operation is subjected to following two conditions: (1) this device cannot cause harmful interference, and (2) this device must accept any interference received, including interference that can cause undesired operation.		

(1) Tested with constant current loads, non-pulsing.

Switching Frequency	Description	
Main converter	60k Hz…140k Hz	Output load and input voltage dependent

Environment

Attribute	Description	
Operational temperature(1)	-10…+70 °C (+14…+158 °F)	The operational temperature is the ambient or surrounding temperature and is defined as the air temperature 2 cm (0.78 in.) below the device.
Storage temperature	-40…+85 °C (-40…+185 °F)	For storage and transportation.
Output derating(2)	3.2W/°C 6W/°C 15 W/1000 m or 5°C/1000m 9 W/-05 kPa or 3°C/-5 kPa	Range 55…70 °C (131…158 °F) range 50…70 °C (122…158 °F) Altitudes up to 2000 m (6560 ft), see Figure 18. Atmosphere pressures under 80 kPa, see Figure 18.
Humidity	5...95% r.h.	IEC 60068-2-30
Atmospheric pressure	110147 kPa	See Figure 18.
Altitude	0…6000 m (0…20,000 ft.)	See Figure 18.
Overvoltage category	III	IEC 60664-1, altitudes up to 2000 m (6560 ft)
	II	IEC 60664-1, altitudes 2000...6000 m (6560 ft...19685 ft) and atmosphere pressures 80...47 kPa
Degree of pollution	2	IEC 62477-1, non conductive
Vibration sinusoidal(3)	2-17.8Hz: ±1.6 mm; 17.8-500Hz: 2 g 2 hours/axis	IEC 60068-2-6
Shock(4)	30 g 6 ms, 20 g 11 ms 3 bumps/direction, 18 bumps in total	IEC 60068-2-27
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	
Corrosive gases	Tested according to ISA-71.04-1985, Severity Level G3 for a service life of minimum 10 years in these environments.	
Audible noise	Some audible noise may be emitted from the power supply during a no load, overload, or short circuit condition.	

(1) Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 2 cm (0.78 in.) below the unit.
(2) The de-rating is not hardware controlled. You must stay below the de-rated current limits in order not to overload the unit.
(3) Tested on a DIN Rail according to IEC 60715 with a height of 15 mm (0.59 in.) and thickness of 1.3 mm (0.05 in.).
(4) Tested on a DIN Rail according to IEC 60715 with a height of 15 mm (0.50 in.) and thickness of 1.3 mm (0.05 in.).

Figure 17 - Output Current versus Ambient Temperature

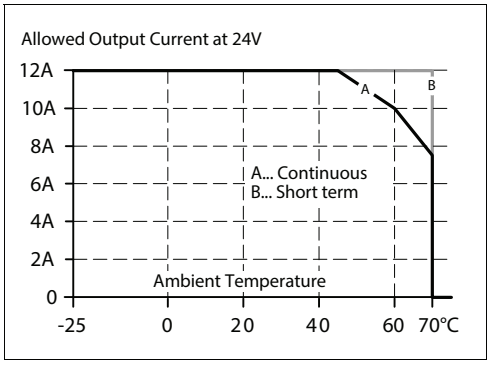
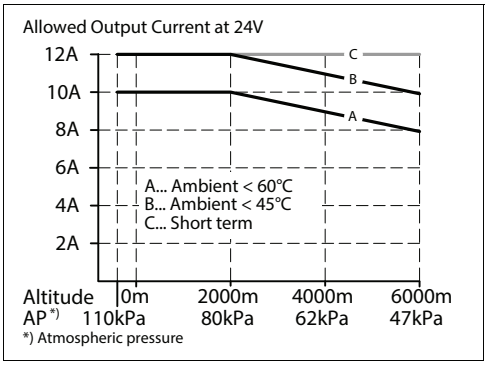


Figure 18 - Output Current versus Altitude at 24V



Protection Features

Attribute	Description	
Output overvoltage protection	Typ 30.5V DC Max 32V DC	In case of an internal power supply anomaly, a redundant circuit limits the maximum output voltage. In such a case, the output shuts down and automatically attempts to restart.
Degree of protection	IP 20	EN/IEC 60529
Over-temperature protection(1)	Included	
Input transient protection	MOV (Metal Oxide Varistor)	
Internal input fuse	Included	Not user replaceable.

(1) Output shuts down with automatic restart. Temperature sensors are installed on critical components inside the unit and turn off the unit in safety critical situations such as when the ambient temperature is too high, ventilation is obstructed, or the de-rating requirements are not followed. There is no correlation between the operating temperature and turn-off temperature since this is dependent on input voltage, load, and installation methods.

Safety Features

Attribute	Description	
Class of protection	I	IEC 61140. A PE (Protective Earth) connection is required.
Isolation resistance	Min 500 MOhm	At delivered condition between input and output, measured with 500V DC.
		At delivered condition between input and PE, measured with 500V DC.
		At delivered condition between output and PE, measured with 500V DC.
		At delivered condition between output and DC-OK contacts, measured with 500V DC.
PE resistance	Max 0.1 Ohm	Resistance between PE terminal and the housing in the area of the DIN rail mounting bracket.
Touch current (leakage current)	Typ 0.17 mA	3x 400V AC, 50 Hz, TN-,TT-mains
	Typ 0.24 mA	3x 480V AC, 60 Hz, TN-,TT-mains
	Max 0.22 mA	3x 440V AC, 60 Hz, TN-,TT-mains
	Max 0.31 mA	3x 528V AC, 50 Hz, TN-,TT-mains

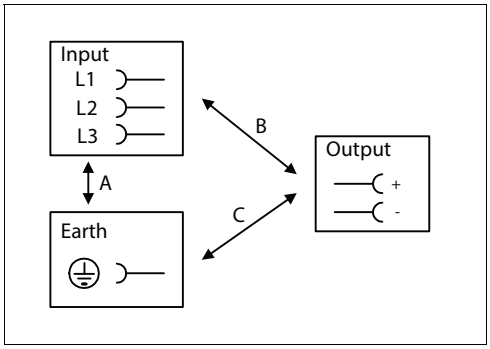
Dielectric Strength

The output voltage is floating and has no ohmic connection to the ground. The output is insulated to the input by a double or reinforced insulation.

Type and routine tests are conducted by the manufacturer. Field tests may be conducted in the field using 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 all output poles before conducting the test. When testing, set the cut-off current settings to the value in the table below.

Attribute		A	B	C
Type test	60 s	2500V AC	3000V AC	500V AC
Factory test	5 s	2500V AC	2500V AC	500V AC
Field test	5 s	2000V AC	2000V AC	500V AC
Cutoff current setting		> 10 mA	> 10 mA	> 30 mA

Figure 19 - Dielectric Strength



It is recommended that either the + pole, - pole, or any other part of the output circuit shall be connected to the earth/ground system. This helps to avoid situations in which a load starts unexpectedly or can be turned off when unnoticed earth faults occur.

Standards Compliance and Approvals

EC Declaration of Conformity	CE	The CE Marking indicates conformance with the RoHS Directive, low voltage directive (LVD), and EMC Directive. EN 60950-1, EN 61000-6
ISA 12.12.01 and CSA C22.2, No. 213	C SP US	RECOGNIZED E244404recognized for use in U.S.A. ISA 12.12.01 and Canada (C22.2 No. 213) Hazardous Location Class I Div 2 T4 Groups A,B,C,D and Class I Zone 2 Groups IIA, IIB and IIC The unit is suitable for use in Class I Division 2 Groups A, B, C, D locations as well as for Class I Zone 2 Groups IIA, IIB and IIC locations. Substitution of components may impair suitability for Class I Division 2 environment. Do not disconnect equipment unless power has been switched off. Wiring must be in accordance with Class I, Division 2 wiring methods of the National Electrical Code, NFPA 70, and in accordance with other local or national codes.
UL 508	c UL US LISTED IND. CONT. EQ.	Listed for use as Industrial Control Equipment; U.S.A. (UL 508) and Canada (C22.2 No. 107-1-01); E-File: E56639
UL 60950-1 2nd edition	c RU US	Recognized for use as Information Technology Equipment, Level 5; U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); File: E168663 Applicable for altitudes up to 2000 m.
Marine	GL	GL (Germanischer Lloyd) classified PDA Environmental category: C, EMC2 Marine and offshore applications
EAC TR Registration	EAC	Registration for the Eurasian Customs Union Market (Russia, Kazakhstan, and Belarus)
RoHS Directive	RoHS ✓	Directive 2011/65/EU of the European Parliament and the Council of June 8th, 2011, on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
REACH Directive	REACH ✓	Directive 1907/2006/EU of the European Parliament and the Council of June 1st, 2007, regarding the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH).

Approximate Dimensions and Weight

Attribute	Description
Width	62 mm (2.44 in.)
Height	124 mm (4.88 in.)
Depth[1]	117 mm (4.61 in.)
Weight	750 g (1.65 lb)
DIN Rail	Use 35 mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15 mm (0.29 or 0.59 in.).
Plastic Material of Housing	Body - aluminum alloy Cover - zinc-plated steel
Installation Clearances	Keep the following installation clearances: 40 mm (1.57 in.) on top, 20 mm (0.78 in.) on the bottom, 5 mm (0.19 in.) on the left and right sides are recommended when the device is loaded permanently with more than 50% of the rated power. Increase this clearance to 15 mm (0.59 in.) in case the adjacent device is a heat source (for example, another power supply).
Penetration protection	Small parts like screws and nuts with a diameter greater than 3.5 mm (0.13 in.).

(1) The DIN rail height must be added to the unit depth to calculate the total required installation depth.

Dimensions are in millimeters.

Figure 20 - Front View

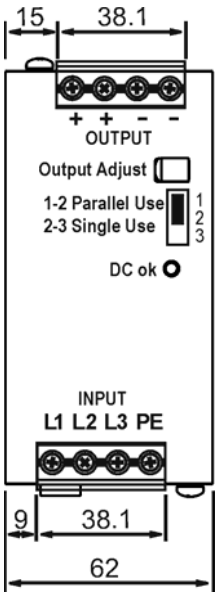
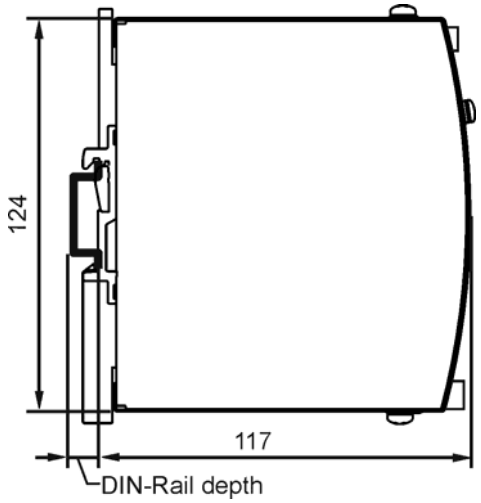


Figure 21 - Side View



Accessories

Wall-Wall/Panel Mount Bracket

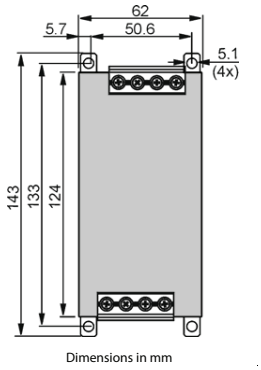
These brackets are used to mount the device on a flat surface or panel without using a DIN rail.

The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the steel brackets can be mounted in the holes of the aluminum brackets.

The order number contains two brackets that are needed for one device.

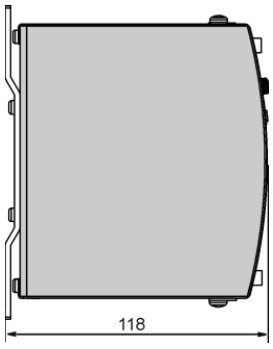
Figure 22 - 1606-XLB Wall Bracket

Figure 23 - Hole Pattern



Dimensions in mm

Figure 24 - Side View



Dimensions in mm

Figure 25 - Isometric View

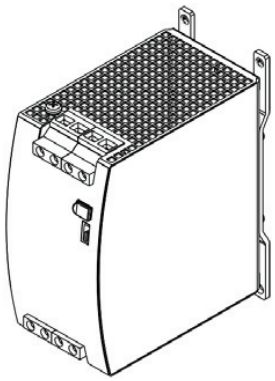


Figure 26 - Isometric View

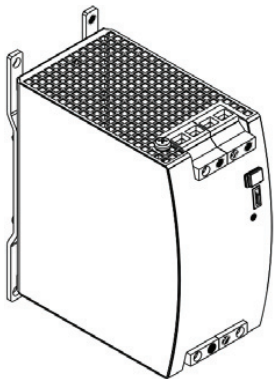
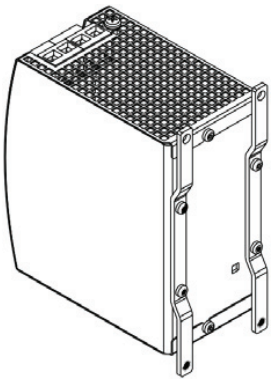


Figure 27 - Isometric View



Diode Redundancy Module

The 1606-XLERED dual redundancy module can be used to build 1+1 or N+1 redundant systems.

The device is equipped with two input channels each 10 A nominal, which are individually decoupled by using diode technology. The output can be loaded with nominal 20 A.

The device does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output.

The device has a monitoring circuit that is included and is the perfect choice when the power supply has no DC-OK function. Two LEDs and two relay contacts signal when one of the two input voltages is not in range due to a non-functioning or disconnected power supply.

The unit requires 32 mm (1.25 in.) width on the DIN rail. See Parallel Use for Redundancy for wiring information.

Figure 28 - 1606-XLERED Diode Redundancy Module

Application Notes

Peak Current Capability

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

This 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 PowerBoost). The same situation applies when starting a capacitive load.

The peak current capability also verifies 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 need a certain amount of overcurrent to open in a timely manner. This 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. The capacitors get discharged during such an event, which causes a voltage dip on the output. The following two examples show typical voltage dips for resistive loads.

Figure 29 - 20 A Peak Current for 50 ms, typ. (2x the nominal current)

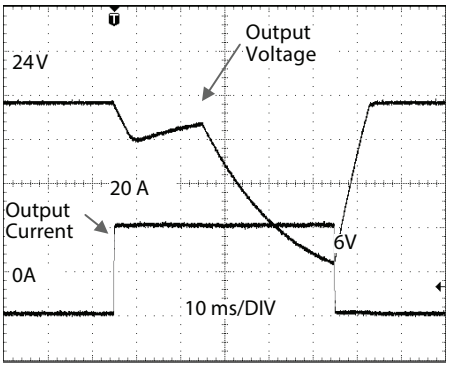
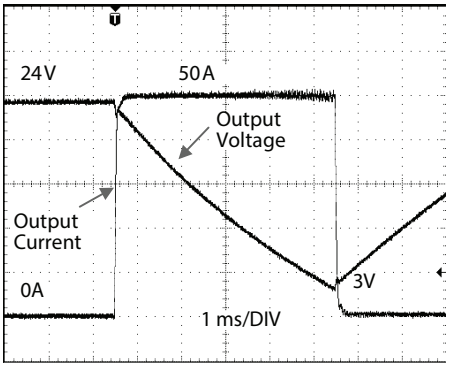


Figure 30 - 50 A Peak Current for 5 ms, typ. (5x the nominal current)



Peak Current Capability		Voltage Dip	Peak Load
Peak current voltage dips	Typ	24…6V	At 20 A for 50 ms, resistive load.
	Typ	24…12V	At 50 A for 2 ms, resistive load.
	Typ	24…3V	At 50 A for 5 ms, resistive load.

Output Circuit Breakers

Standard miniature circuit breakers (MCBs or UL 1077 circuit breakers) are commonly used for AC-supply systems and may also be used on 24V branches.

MCBs are designed to protect wires and circuits. If the ampere value and the characteristics of the MCB are adapted to the wire size that is used, the wiring is considered as thermally safe regardless of whether the MCB opens or not.

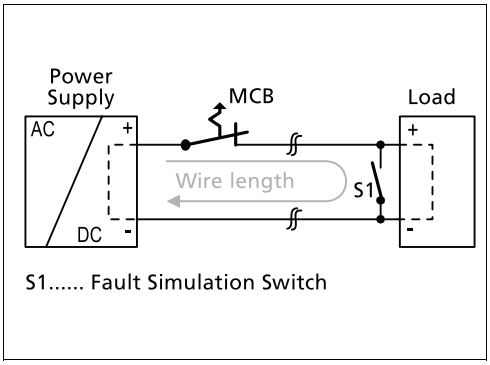
To avoid voltage dips and under-voltage situations in adjacent 24V branches, which are supplied by the same source, a fast (magnetic) tripping of the MCB is desired. A quick shutdown within 10 ms is necessary corresponding roughly to the ride-through time of PLCs. This requires power supplies with high current reserves and large output capacitors.

Furthermore, the impedance of the faulty branch must be sufficiently small in order for the current to actually flow. The best current reserve in the power supply does not help if Ohms law does not permit current flow. The following table has typical test results showing which B- and C-Characteristic MCBs magnetically trip depending on the wire cross section and wire length.

The following test results indicate the maximal wire length for a magnetic (fast) tripping. The wire length is always two times the distance to the load (+ and – wire).

Attribute	0.75 mm^2	1.0 mm^2	1.5 mm^2	2.5 mm^2
C-2A	23 m (75.4 ft)	28 m (91.8 ft)	43 m (141 ft)	69 m (226.3 ft)
C-3A	18 m (59 ft)	23 m (75.4 ft)	34 m (111.5 ft)	54 m (177.1 ft)
C-4A	6 m (19.6 ft)	12 m (39.3 ft)	18 m (59 ft)	28 m (91.8 ft)
C-6A	3 m (9.8 ft)	4 m (13.1 ft)	6 m (19.6 ft)	7 m (22.9 ft)
C-8A	2 m (6.5 ft)	3 m (9.8 ft)	4 m(13.1 ft)	5 m (16.4 ft)
C-10A	1 m (3.2 ft)	2 m (6.5 ft)	3 m (9.8 ft)	4 m (13.1 ft)
B-6A	9 m (29.5 ft)	14 m (45.9 ft)	19 m (62.3 ft)	33 m (108.2 ft)
B-10A	4 m (13.1 ft)	5 m (16.4 ft)	6 m (19.6 ft)	9 m (29.5 ft)
B-13A	3 m (9.3 ft)	4 m (13.1 ft)	5 m (16.4 ft)	8 m (26.2 ft)

Figure 31 - Test Circuit for Maximum Wire Length



Charging Batteries

The power supply can be used to charge lead-acid or maintenance free batteries. Two 12V SLA or VRLA batteries are wired in series. To charge the batteries:

1. Verify that the ambient temperature of the power supply remains below 45 °C (113 °F).
2. Set the output voltage, measured at no load and at the battery end of the cable, precisely to the end-of-charge voltage.

Attribute	Value			
End-of-charge voltage	27.8V	27.5V	27.15V	26.8V
Battery temperature	10 °C (50 °F)	20 °C (68 °F)	30 °C (86 °F)	40 °C (104 °F)

3. Use a 16 A circuit breaker or a blocking diode between the power supply and the battery.
4. Verify that the output current of the power supply is below the allowed charging current of the battery.
5. Use only matched batteries when placing 12V types in series.

The return current to the power supply is typically 8 mA. This return current can discharge the battery when the power supply is switched off except when you use a blocking diode.

Series Operation

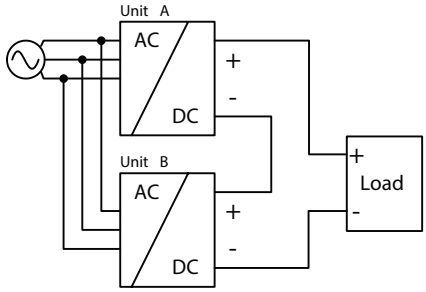
Devices of the same type can be connected in series for higher output voltages. It is possible to connect as many units in series as needed, providing the sum of the output voltage does not exceed 150V DC. Voltages with a potential above 60V DC must be installed with a protection against touching.

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

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

Verify that the leakage current, EMI, inrush current, and harmonics increase when using multiple devices.

Figure 32 - Series Operation



Parallel Use to Increase Output Power

Devices can be paralleled to increase the output power. The output voltage of all devices shall 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, set the unit to Parallel Use mode, to achieve load sharing. The Parallel Use mode regulates the output voltage in such a manner that the voltage at no load is approximately 4% higher than at nominal load.

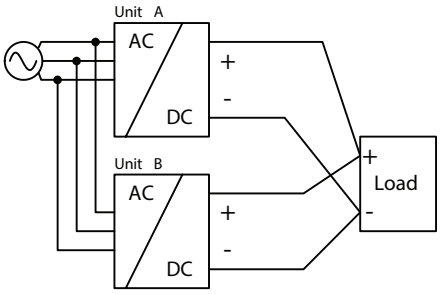
Do not exceed 60 °C (140 °F) or the ambient temperature.

If more than three units are connected in parallel, a fuse or circuit breaker with a rating of 15 A or 16 A is required on each output. Alternatively, a diode or redundancy module can also be used.

Keep an installation clearance of 15 mm (0.59 in.) (left and right) between two devices and avoid installing devices on top of each other. Do not use devices in parallel in mounting orientations other than the standard mounting orientation or in any other condition where a reduction of the output current is required (for example, altitude).

Verify that the leakage current, EMI, inrush current, and harmonics increase when using multiple devices.

Figure 33 - Parallel Use



Parallel Use for Redundancy

1+1 Redundancy

Devices 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 device fails. The simplest way is to put two devices in parallel. This is called a 1+1 redundancy. In case one device fails, the other one is automatically able to support the load current without any interruption. It is essential to use a redundancy module to decouple devices from each other. This prevents that the defective unit becomes a load for the other device and the output voltage cannot be maintained any more.

For 1+1 redundancy the ambient temperature is not allowed to exceed 70 °C (158 °F).

Recommendations for building redundant power systems:

- Use separate input fuses for each device.
- Use separate mains systems for each device whenever it is possible.
- Monitor the outputs of the individual devices. Use the DC-OK contact, which is included in the redundancy module.
- It is desirable to set the output voltages of all devices to the same value (± 100 mV) or leave it at the factory setting.
- Set the devices into Parallel Use mode.

Verify that the leakage current, EMI, inrush current, and harmonics increase when using multiple devices.

N+1 Redundancy

Redundant systems for a higher power demand are usually built in a N+1 method. For example, four devices, each rated for 10 A are paralleled to build a 30 A redundant system.

Verify that the leakage current, EMI, inrush current, harmonics increase when using multiple devices.

Keep an installation clearance of 15 mm (0.59 in.) (left and right) between two devices and avoid installing the devices on top of each other.

Do not use devices in parallel in mounting orientations other than the standard mounting orientation or in any other condition, where a reduction of the output current is required.

For 1+1 redundancy the ambient temperature is not allowed to exceed 60 °C (140 °F).

Figure 34 - 1 + 1 Redundant Configuration for 10 A Load Current and Redundancy Modules

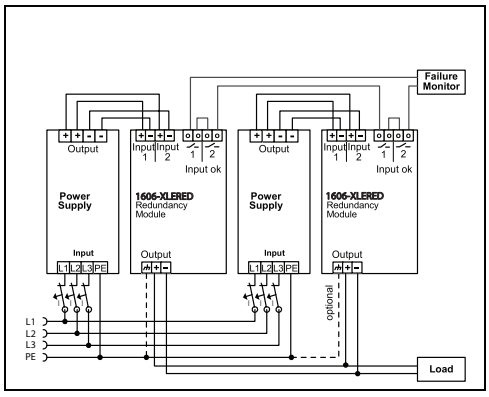
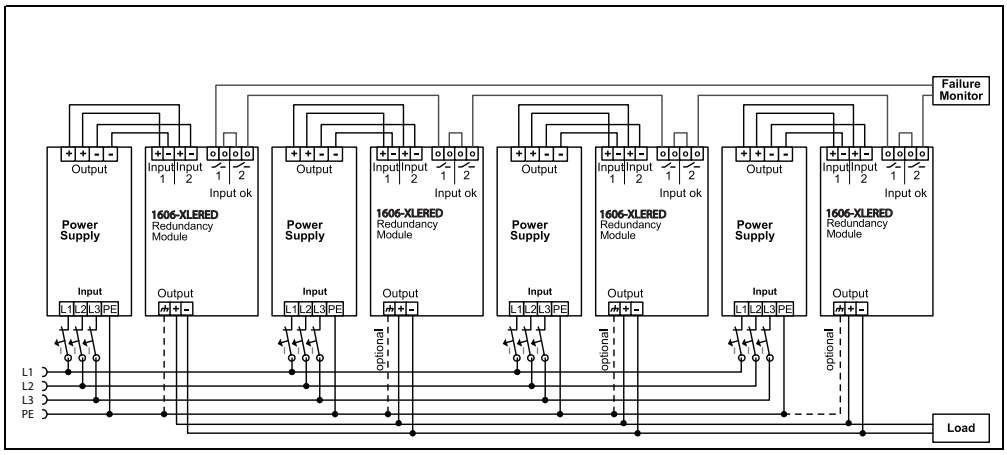


Figure 35 - N + 1 Redundant Configuration for 30 A Load Current with Multiple Power Supplies and Redundancy Modules



Operation on Two Phases

No external protection device is required to protect against a phase-loss failure.

The power supply is allowed to run permanently on only two legs of a 3-phase system, when the output power is reduced according to the curves below. A long term exceeding of these limits will result in a thermal shut-down of the device.

Verify that the EMC performance, hold-up time, and losses differ from a 3-phase operation. Check the suitability of your application.

Using two legs of a 3-phase system is not included in the agency approval. Therefore, additional investigation might be necessary during the approval process of the final system.

Figure 36 - Operation on Two Phases

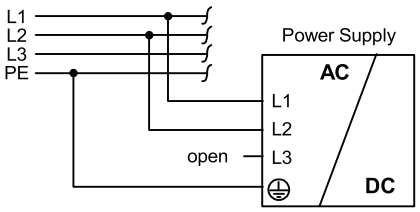


Figure 37 - Allowed Output Current for Use on Only Two Legs of a 3-phase System

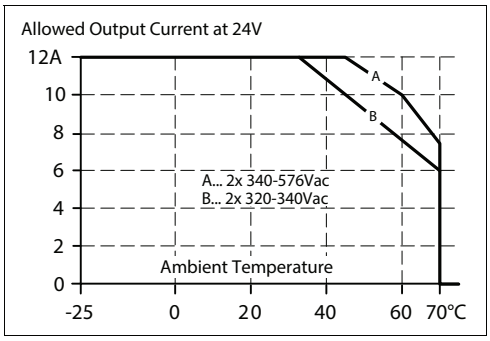


Figure 38 - Hold-up Time for Use on Only Two Legs of a 3-phase System

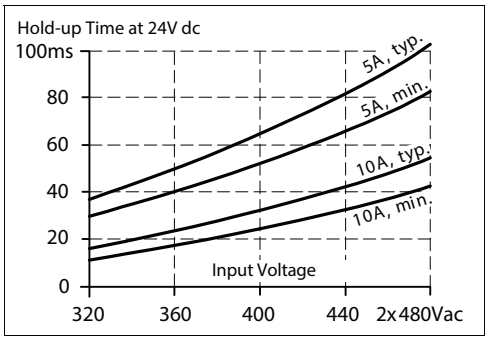


Figure 39 - Efficiency Versus Output Current at 24V for Use on a Only Two Legs of a 3-phase System

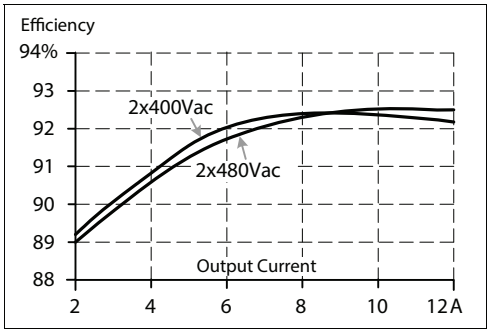
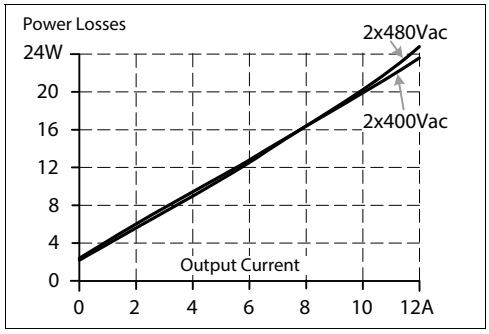


Figure 40 - Losses Versus Output Current at 24V for Use on Only Two Legs of a 3-phase System



Use in a Tightly Sealed Container

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

In the following test setup, the device is placed in the middle of the box, no other heat producing items are inside the box. The load is placed outside the box.

The temperature sensor inside the box is placed in the middle of the right side of the power supply with a distance of 1 cm (0.39 in.).

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

Attribute	Case A	Case B
Enclosure size	180 x 180 x 165 mm (7.08 x 7.08 x 6.49 in.) Rittal Typ IP66 Box, PK 9519 100, plastic	
Input voltage	3x 400V AC	
Load	24V, 8 A (=80%)	24V, 10 A (=100%)
Temperature inside the box	48.4 °C (119.1 °F)	54.7 °C (130.4 °F)
Temperature outside the box	24.5 °C (76.1 °F)	24.9 °C (76.8 °F)
Temperature rise	23.9 K	29.8 K

Mounting Orientations

Mounting orientations other than input terminals on the bottom and output on the top require a reduction in continuous output power or a limitation in the maximum allowed ambient temperature.

The listed lifetime and MTBF values from this document apply only for the standard mounting orientation.

The following curves give an indication for allowed output currents for altitudes up to 2000 m (6560 ft).

Figure 41 - Mounting Orientation A (Standard Orientation)

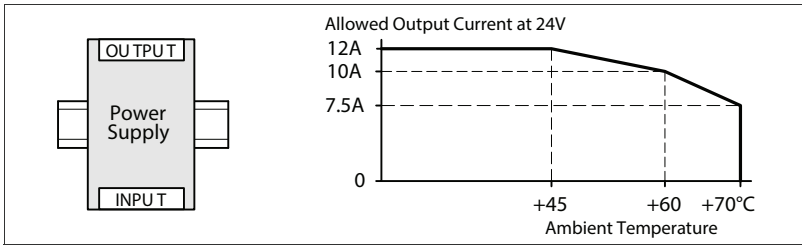


Figure 42 - Mounting Orientation B (Upside Down)

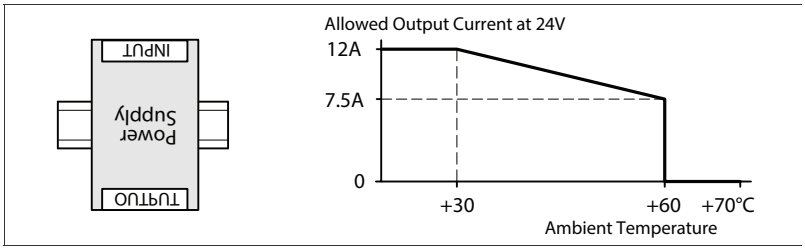


Figure 43 - Mounting Orientation C (Table-top Mounting)

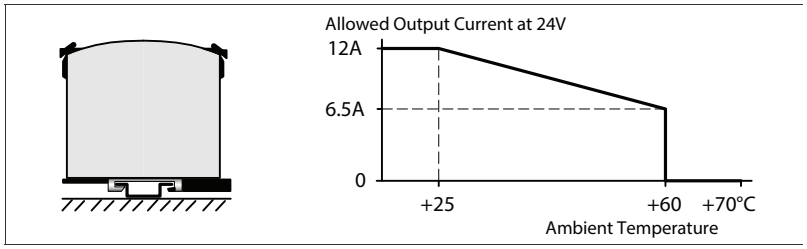


Figure 44 - Mounting Orientation D (Horizontal cw)

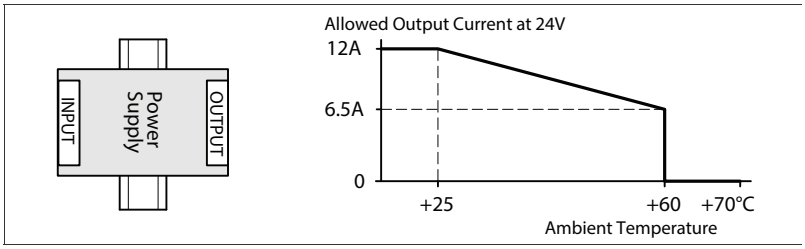
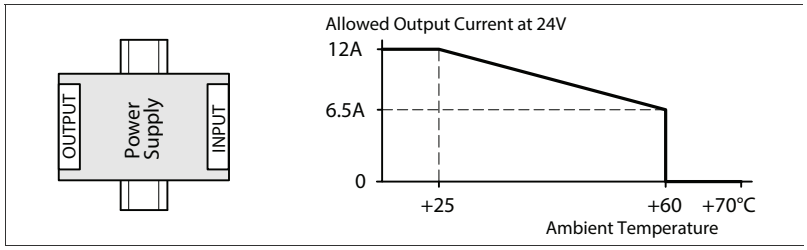


Figure 45 - Mounting Orientation D (Horizontal ccw)



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Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	https://rockwellautomation.custhelp.com/
Local Technical Support Phone Numbers	Locate the phone number for your country.	http://www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	http://www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	http://www.rockwellautomation.com/global/literature-library/overview.page
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	http://www.rockwellautomation.com/global/support/pcdc.page

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Publication 1606-RM002A-EN-P - March 2019