

Bulletin 1606 Switched Mode Power Supplies

Catalog Number: 1606-XLERED

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Terminology and Abbreviations

- **PE and $\oplus$ symbol**—PE is the abbreviation for **Protective Earth** and has the same meaning as the symbol $\oplus$.
- **Earth, Ground**—This document uses the term “earth” which is the same as the U.S. term “ground”.
- **T.b.d.**—To be defined, value or description will follow later.
- **AC 230V**—A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually $\pm 15\%$) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
- **230Vac**—A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
- **50Hz vs. 60Hz**—As long as not otherwise stated, AC100V and AC230V parameters are valid at 50Hz and AC120V parameters are valid at 60Hz mains frequency.
- **may**—A key word indicating flexibility of choice with no implied preference.
- **shall**—A key word indicating a mandatory requirement.
- **should**—A key word indicating flexibility of choice with a strongly preferred implementation.





Redundancy Module

- Cost Effective Solution to Build Redundant Systems
- Dual Input with Single Output
- Alarm Relay-contacts for each Input Path
- Two Diodes (Common Cathode)
- DC24-48V $\pm 25\%$ (18-60Vdc) Wide-range Input
- Full Power Between -40°C and $+60^{\circ}\text{C}$
- Width only 32mm
- Rugged Metal Housing
- Large Screw Terminals
- Easy Wiring:
Distribution Terminal for Negative Pole Included
- 3 Year Warranty

Description

The 1606-XLERED is a redundancy module specifically designed to build 1+1 and N+1 redundant systems. It is equipped with two input channels which can be connected to 10A power supplies and one output which can carry nominal currents up to 20A.

The 1606-XLERED includes a monitoring circuit and is the perfect solution when the power supply has no DC-OK function. Two LEDs and two relay contacts indicate when one of the two DC input voltages is out of range due to a non-functioning or disconnected power supply.

In addition to the 1606-XLERED is the 1606-XLSRED that does not include monitoring circuitry. It is the perfect fit when the power supply itself is already equipped with a DC-OK signal.

Large screw terminals allow for an easy installation and a huge international approval package for a variety of applications makes this unit suitable for nearly every situation.

Specification Quick Reference

Input voltage	DC 24-48V	$\pm 25\%$
Input voltage range	18-60Vdc	
Input current	2x 0-10A 2x 0-16A	continuous for 5 seconds
Output current	0-20A 20-32A 25A	continuous for 5 seconds at cont. overload/ short circuit
Input to output voltage drop	typ. 0.78V typ. 0.85V typ. 0.85V	input: 2x5A input: 1x10A input: 2x10A
Power losses	typ. 1.0W typ. 8.8W typ. 9.5W typ. 18W	at no load input: 2x5A input: 1x10A input: 2x10A
Temperature range Derating	-40°C to $+70^{\circ}\text{C}$ 0.5A/ $^{\circ}\text{C}$	operational, $+60$ to $+70^{\circ}\text{C}$
Dimensions	32x124x117mm	WxHxD

Catalog Numbers

Redundancy Module	1606-XLERED	24-48V Standard unit
Accessory	1606-XLB	Wall/panel mount bracket

Certifications



All parameters are specified at 24V, 2.5A, 230Vac input, 25°C ambient and after a 5 minutes run-in time unless noted otherwise.

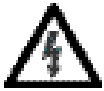
Rockwell Automation Publication 1606-RM033A-EN-P — March 2014

1. Intended Use

- This device is designed for installation in an enclosure and is intended for the general professional use such as in industrial control, office, communication, and instrumentation equipment.
- Do not use this power supply in aircraft, trains, nuclear equipment or similar systems where malfunction may cause severe personal injury or threaten human life.
- This device is designed for use in hazardous, non-hazardous, ordinary or unclassified locations.

2. Installation Requirements

- This device may only be installed and put into operation by qualified personnel.
- This device does not contain serviceable parts. The tripping of an internal fuse is caused by an internal defect.
- If damage or malfunction should occur during installation or operation, immediately turn power off and send unit to the factory for inspection.
- Mount the unit on a DIN rail so that the terminals are located on the bottom of the unit. For other mounting orientations, refer to Mounting.
- This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 15%!
- Keep the following installation clearances: 40mm on top, 20mm on the bottom, 5mm 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 15mm in case the adjacent device is a heat source (e.g. another power supply).



SHOCK HAZARD: 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 re-powering
- Make sure that the wiring is correct by following all local and national codes
- 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 the housing
- Do not use in wet locations or in areas where moisture or condensation can be expected
- Do not touch during power-on, and immediately after power-off. Hot surfaces may cause burns.



WARNING: EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment or S/P jumper unless power has been switched off or the area is known to be non-hazardous.

Notes for use in hazardous location areas:

- The unit is suitable for use in Class I Division 2 Groups A, B, C, D locations

3. Input and Output Characteristics

Number of inputs	-	2	
Number of outputs	-	1	
Input voltage	nom.	DC 24-48V	±25% The input circuitry must meet the SELV requirements stipulated by IEC/EN/UL 60950-1.
Input voltage range	-	18-60Vdc	
Voltage drop, input to output	typ.	0.78V	at 2x5A, see Fig. 3-1
	typ.	0.85V	at 1x10A, see Fig. 3-2
	typ.	0.85V	at 2x10A, see Fig. 3-1
Input current	nom.	2x 0-10A	continuous
	nom.	1x 0-20A	continuous, see note 1
	nom.	2x 10-16A	for up to 5 seconds
Peak input current	max.	150A	for maximal 10ms per input
Output current	nom.	20A	continuous
	nom.	20-32A	for up to 5 seconds
	max.	25A	at continuous overload or short circuit, see note 2
Reverse current	max.	2mA	per input, -40°C to +60°C
Reverse voltage	max.	200Vdc	voltage applied to the output, continuously allowed

Note 1: Each input can be loaded up to 20A. At currents above 10A, the other input should not be loaded. It is preferable to parallel the two inputs in order to minimize the power loss in such cases.

Note 2: Ensure that the continuous output current does not exceed 25A. Check the short-circuit current of the power sources and if the power source can deliver more than 25A together, use an appropriate fuse on the output.

Fig. 3-1 **Input to output voltage drop when both inputs draw current**
(typical 1+1 redundant case, when the output voltages of the two units are equal or set into "parallel use" mode)

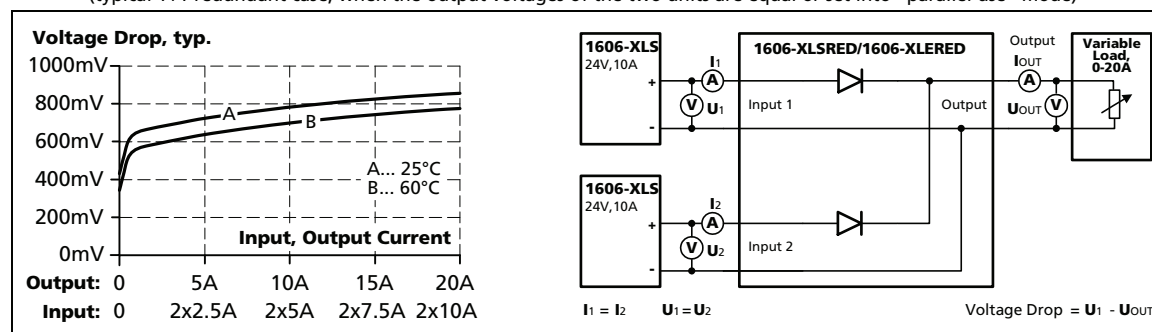
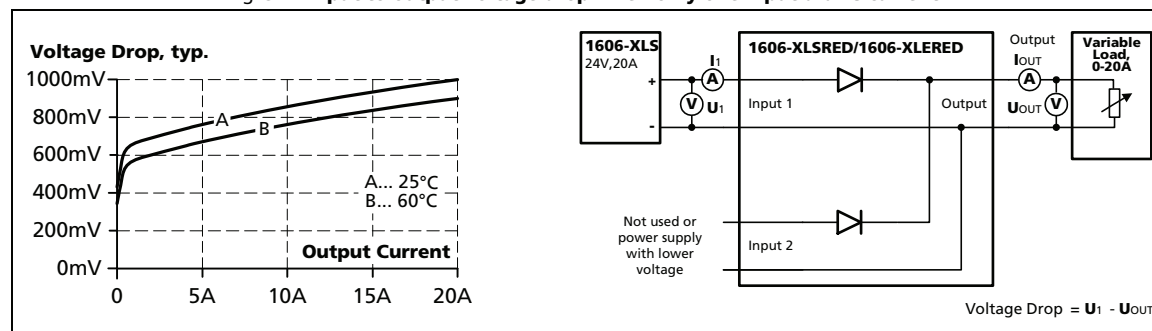


Fig. 3-2 **Input to output voltage drop when only one input draws current**



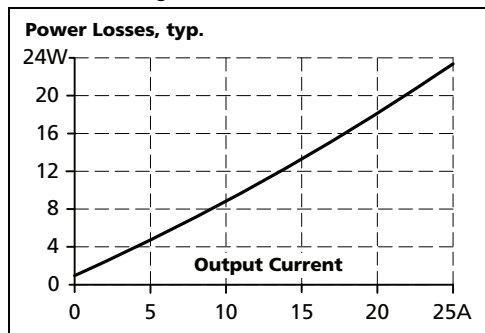
All parameters are specified at 24V, 2.5A, 230Vac input, 25°C ambient and after a 5 minutes run-in time unless noted otherwise.

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4. Power Losses

DC 24V			
Power losses	typ.	8.8W	input: 2x5A
	typ.	9.5W	input: 1x10A
	typ.	18.0W	input: 2x10A
Standby power losses	typ.	1.0W	at no output current

Fig. 4-1 Power losses



5. Alarm Contacts

Both input voltages are monitored individually. If one input voltage is too low or completely lost, it will be indicated by an alarm relay contact.

Each input has its own monitoring circuitry and relay contact.

Alarm threshold	nom.	21.5V ($\pm 0.5V$)	Relay contact opens immediately after the input voltage falls below this value
Contact ratings	min.	60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A	input: 1x10A
	max.	1mA at 5Vdc	input: 2x10A
Isolation voltage	see dielectric strength table in section 14.		

6. Reliability

The redundancy module does not include electrolytic capacitors. Therefore, the lifetime expectancy and MTBF value are extremely high.

Input / output current conditions		Input: 2x10A Output: 20A	Input: 2x5A Output: 10A	
Lifetime expectancy *)	min.	25 years	25 years	at 24V and 40°C
	min.	25 years	25 years	at 24V and 25°C
MTBF **) SN 29500, IEC 61709		9 100 000h	10 900 000h	at 24V 40°C
		15 700 000h	18 800 000h	at 24V 25°C
MTBF **) MIL HDBK 217F		9 200 000h	11 100 000h	at 24V and 40°C (Ground Benign GB40)
		12 600 000h	15 100 000h	at 24V and 25°C (Ground Benign GB25)
		3 380 000h	4 060 000h	at 24V and 40°C (Ground Fixed GF40)
		4 630 000h	5 570 000h	at 24V and 25°C (Ground Fixed GF25)

*) The **Lifetime expectancy** shown in the table indicates the minimum operating hours (service life).

) **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.

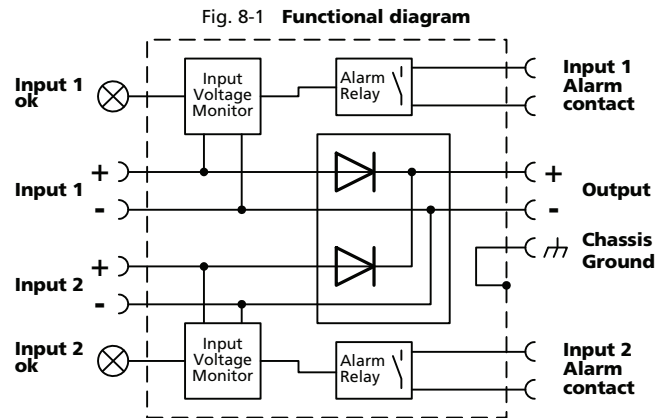
7. Terminals and Wiring

	Input and output terminals	Alarm-signal terminals
Type	Screw terminals IP20 Finger safe construction. Suitable for field installation.	Screw terminals, pluggable IP20 Finger safe construction. Suitable for field installation.
Solid wire	0.5-6mm ²	0.2-1.5mm ²
Stranded wire	0.5-4mm ²	0.2-1.5mm ²
American Wire Gauge	20-10 AWG	22-14 AWG
Wire stripping length	7mm / 0.28inch	6mm / 0.25inch
Screwdriver	3.5mm slotted or Pozidrive No 2	3mm slotted
Recommended tightening torque	0.8Nm / 7lb.in	0.4Nm / 3.5lb.in

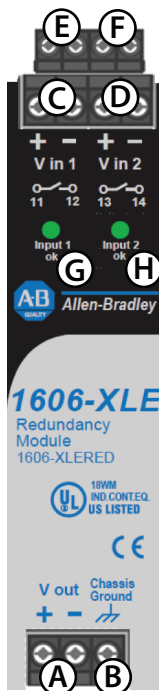
Instructions:

- The external circuitry of all terminals (including signalling contacts) must meet the safety requirements stipulated by IEC/EN/UL 60950-1: SELV.
- Use appropriate copper cables that are designed for minimum operating temperatures of:
60°C for ambient up to 45°C and
75°C for ambient up to 60°C minimum.
- Follow national installation codes and installation regulations!
- Ensure that all strands of a stranded wire enter the terminal connection!
- Up to two stranded wires with the same cross section are permitted in one connection point.
- Screws of unused terminal compartments should be securely tightened.
- Ferrules are allowed, but not required.
- Do not connect or disconnect the wires from the terminals below -25°C (-13°F).

8. Functional Diagram



9. Front Side and User Elements

Fig. 9-1 **Front side**

A Output terminals

B Chassis ground terminal

Connection of the chassis is optional and not required since the unit fulfils the requirements according to protection class III.

C Input terminals for input 1

D Input terminals for input 2

E Alarm-signal terminals for input 1 monitoring (relay contact)

F Alarm-signal terminals for input 2 monitoring (relay contact)

G Green LED for input 1 (LED is on, when input voltage is in range)

H Green LED for input 2 (LED is on, when input voltage is in range)

10. EMC

This redundancy module is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions (e.g. cable length). The CE Mark indicates conformance with EMC directive 2004/108/EC and the low-voltage directive (LVD) 2006/95/EC.

A detailed EMC report is available upon request.

EMC Immunity		According generic standards: EN 61000-6-1 and EN 61000-6-2		
Electrostatic discharge	EN 61000-4-2	Contact discharge	8kV	Criterion A
		Air discharge	15kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	2kV	Criterion A
		Output lines	2kV	Criterion A
		Alarm contacts	2kV	Criterion A
Surge voltage on input lines	EN 61000-4-5	+ → -	200V	Criterion A
		+/- → Chassis ground	1kV	Criterion A
Surge voltage on output lines	EN 61000-4-5	+ → -	200V	Criterion A
		+/- → Chassis ground	1kV	Criterion A
Surge voltage on alarm contacts	EN 61000-4-5	Alarm contact → Chassis ground	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A
Power-frequency magnetic field *)	EN 61000-4-8	50Hz	30A/m	Criterion A

Criteria:

A: Redundancy module shows normal operation behavior within the defined limits.

Notes:

*) A test is not applicable according to EN 61000-6-2, since the device does not contain components susceptible to magnetic fields, e.g. hall elements, electrodynamic microphones, etc.

EMC Emission		According generic standards: EN 61000-6-3 and EN 61000-6-4	
Conducted emission	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Class B, input lines *)	
		Class B, output lines *)	
Radiated emission	EN 55011, EN 55022	Class B	

This device complies with FCC Part 15 rules.

Operation is subjected to following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

*) Provided that power sources connected on the inputs fulfill the class B requirements as well.

11. Environment

Operational temperature *)	-40°C to +70°C (-40°F to 158°F)	Reduce output power above +60°C
Output de-rating	0.5A/°C	60-70°C (140°F to 158°F), see
Storage temperature	-40 to +85°C (-40°F to 185°F)	for storage and transportation
Humidity **)	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: $\pm 1.6\text{mm}$ 17.8-500Hz: 1g 2 hours / axis	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction 18 bumps in total	IEC 60068-2-27
Altitude	0 to 6000m (0 to 6 560ft) 2000 to 6000m (6 560 to 20 000ft)	without any restrictions reduce output power or ambient temperature, see Fig. 11-2
Altitude de-rating	1.25A/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 11-2
Over-voltage category	not applicable	The concept of the overvoltage category is used for equipment energized directly from the low voltage mains (IEC 60664-1 §4.3.3.2.1).
Degree of pollution	2	IEC 62103, EN 50178, not conductive

*) Operational temperature is the same as the ambient temperature and is defined as the air temperature 2cm below the unit.

**) Do not energize in the presence of condensation.

Fig. 11-1 Output current vs. ambient temp.

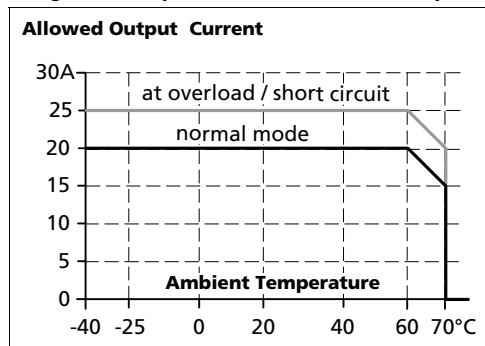
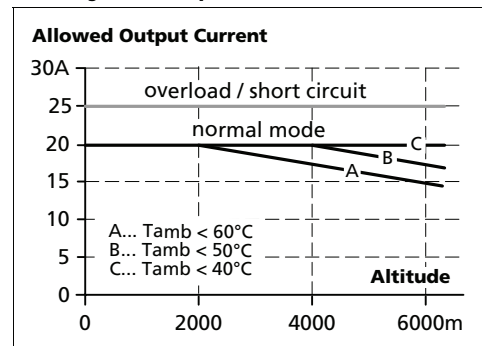


Fig. 11-2 Output current vs. altitude



12. Protection Features

Output over-current protection	not included	
Reverse input polarity protection	included	unit does not start when input voltage is reversed
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 3.6mm	e.g. screws, small parts
Over-temperature protection	not included	
Input transient protection	not included	
Output transient protection	included	see EMC section
Internal input fuse	not included	

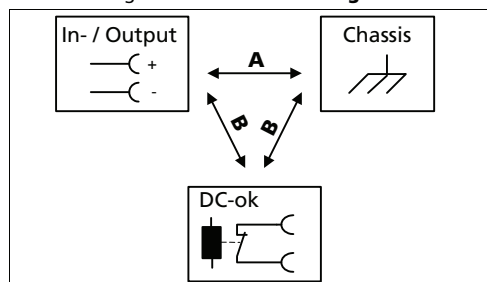
13. Safety Features

Input / output separation	no galvanic separation	200V epitaxial diode between input and output
Safety level of output voltage	The output voltage is regarded to be SELV (EN 60950-1) or PELV (EN 60204-1, EN 50178, IEC 60364-4-41) if the input voltage and the voltage which is applied to the alarm contacts fulfills the requirements for a SELV source or PELV source.	
Class of protection	III	PE (Protective Earth) or chassis connection not required
PE resistance	< 0.1Ohm	between housing and chassis-ground terminal

14. Dielectric Strength

The input and output voltages have the same reference, are floating and have no ohmic connection to ground. Type and factory 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 (2s up and 2s down). Connect input/output/signal terminals together before conducting the test. When testing, set the cut-off current settings to the value in the table below.

Fig. 14-1 **Dielectric strength**



		A	B
Type test	60s	500Vac	500Vac
Factory test	5s	500Vac	500Vac
Field test	5s	500Vac	500Vac
Cut-off current setting		> 2mA	

15. Certifications

EN 60950-1, EN 61204-3		Complies with CE EMC and CE Low Voltage Directives.
UL 508		LISTED E56639 for use in the U.S.A. (UL 508) and Canada (C22.2 No. 14-95) Industrial Control Equipment
UL 60950-1		RECOGNIZED E168663 for use in the U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950) Information Technology Equipment, Level 3
CSA 22.2 No. 213, ISA 12.12.01		CSA certified under File Number 2400020; CERTIFIED for use in the U.S.A. (ISA 12.12.01) and Canada (C22.2 No. 213). Hazardous Location Class I, Div. 2, Groups A, B, C, D
EN 60079-15 ATEX	 II 3G Ex nAC II Tx	II 3G Ex nAC II Tx
Marine GL		GL (Germanischer Lloyd) classified for marine and offshore applications. Environmental category: C, EMC2. See below for link to Certificate.
GOST R		GOST R certification is applicable for products intended for sale and use within Russia. See below for link to Certificate.
Marine RINA		RINA (Registro Italiano Navale) certified. See below for link to Certificate.
C-TICK		C-tick is for products intended for sale and use within the Australian market. See below for the C-Tick Declarations of Conformity.

Product certification information (including Certificates and Declarations of Conformity) can be found at www.ab.com/certifications.

16. Environmental Compliance

The unit does not release any silicone and is suitable for use in paint shops.

The unit conforms to the RoHS directive 2002/96/EC

Plastic housings and other molded plastic materials are free of halogens, wires and cables are not PVC insulated.

The production material within our production does not include following toxic chemicals:

Polychlorized Biphenyl (PCB), Polychlorized Terphenyl (PCT), Pentachlorophenol (PCP), Polychlorinated naphthalene (PCN), Polybrom Biphenyl (PBB), Polybrom Biphenyl-oxyl (PBO), polybrominated Diphenylether (PBDE), Polychlorinated Diphenylether (PCDE), Polydibromophenyl Oxyl (PBDO), Cadmium, Asbestos, Mercury, Silica

17. Physical Dimensions and Weight

Weight	350g / 0.77lb
DIN Rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN rail height must be added to the unit depth (117mm) to calculate the total required installation depth.
Installation clearances	See section 2.

Fig. 18-1 Front view

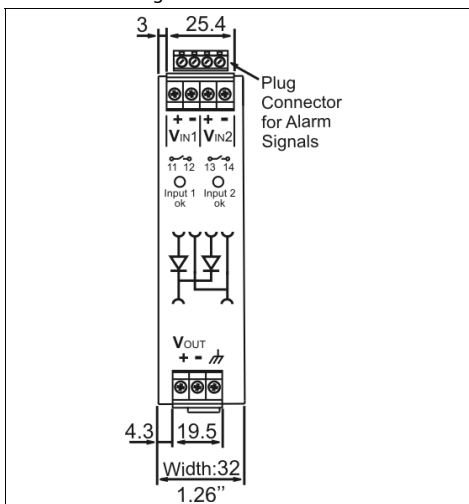
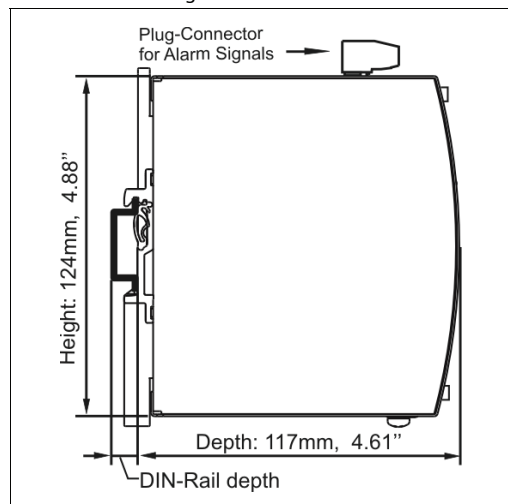


Fig. 18-2 Side view



18. Accessory

1606-XLB Wall mounting bracket

This standard bracket is used to mount the 1606-XLERED redundancy module onto a flat surface without a DIN rail.

Fig. 18-1 1606-XLB Wall mounting bracket

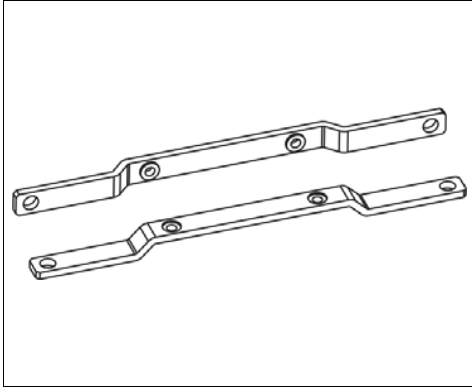
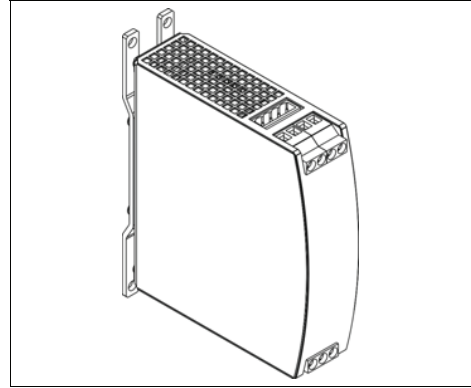


Fig. 18-2 Assembled wall mounting bracket



19. Application Notes

19.1. Recommendations for Redundancy

Recommendations for the configuration of redundant power systems:

- Use separate input fuses for each power supply.
- Use three-phase power supplies to gain functional safety if one phase fails.
- When single-phase power supplies are utilized connect them to different phases or mains circuits if possible.
- Set the power supply in "Parallel-Use" mode if this feature is available.
- It is desirable to set the output voltages of all power supplies to the same value.

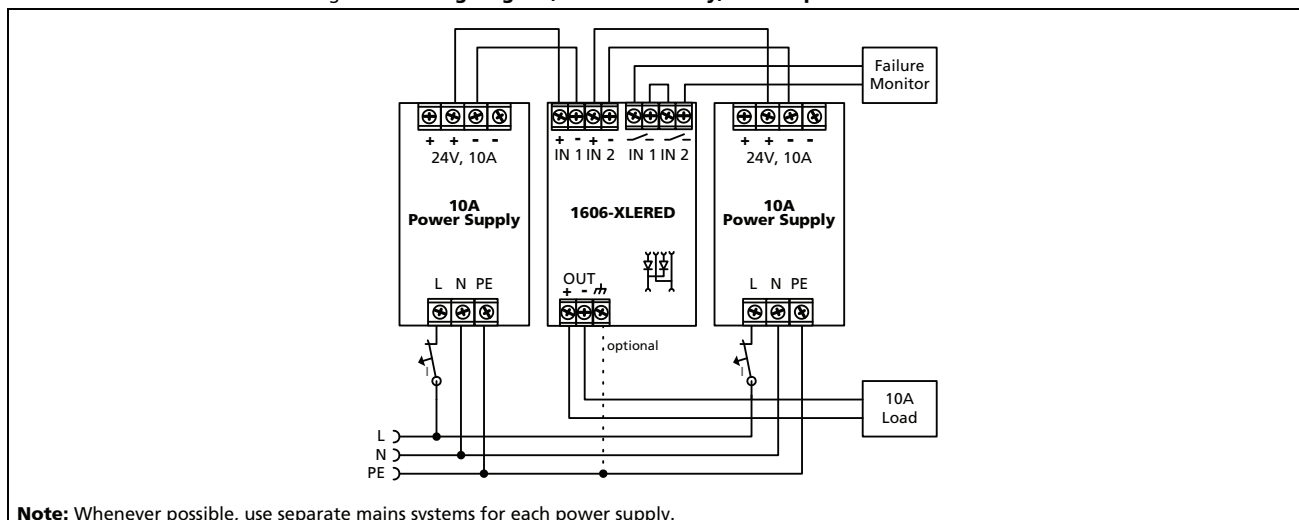
19.2. Inductive and Capacitive Loads

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

19.3. Example: 1+1 Redundancy up to 10A

1+1 Redundancy up to 10A requires two 10A power supplies and one 1606-XLERED redundancy module.

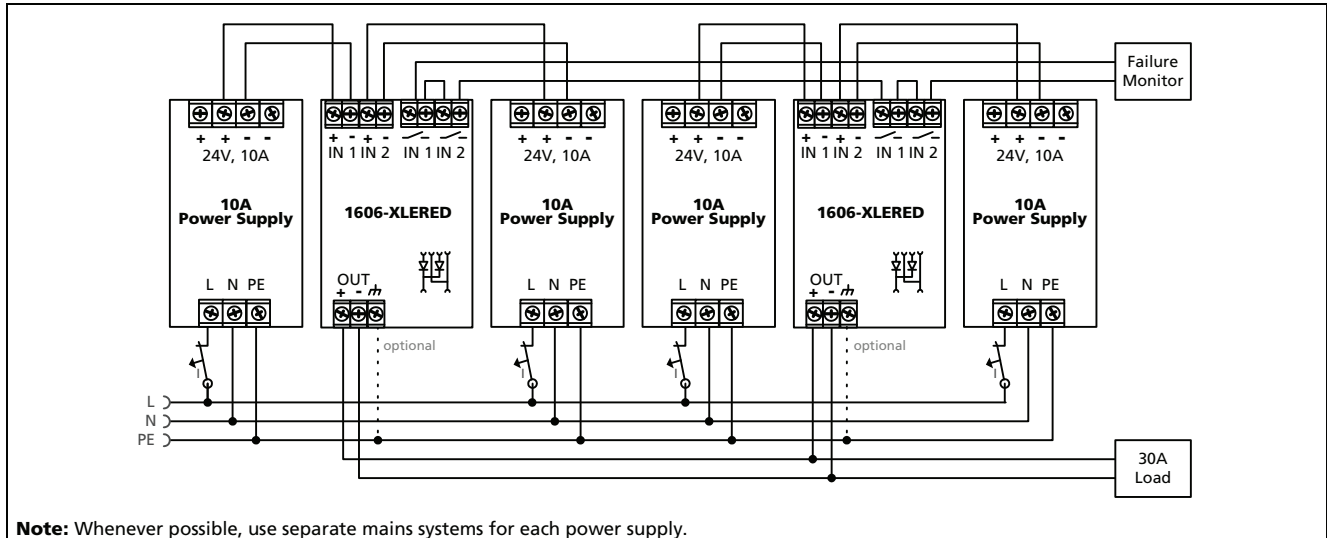
Fig. 20-1 **Wiring diagram, 1+1 Redundancy, 10A output current**



19.4. Example: N+1 Redundancy up to 30A

N+1 Redundancy up to 30A requires four 10A power supplies and two 1606-XLERED redundancy modules.

Fig. 19-2 Wiring diagram, n+1 Redundancy, 30A output current



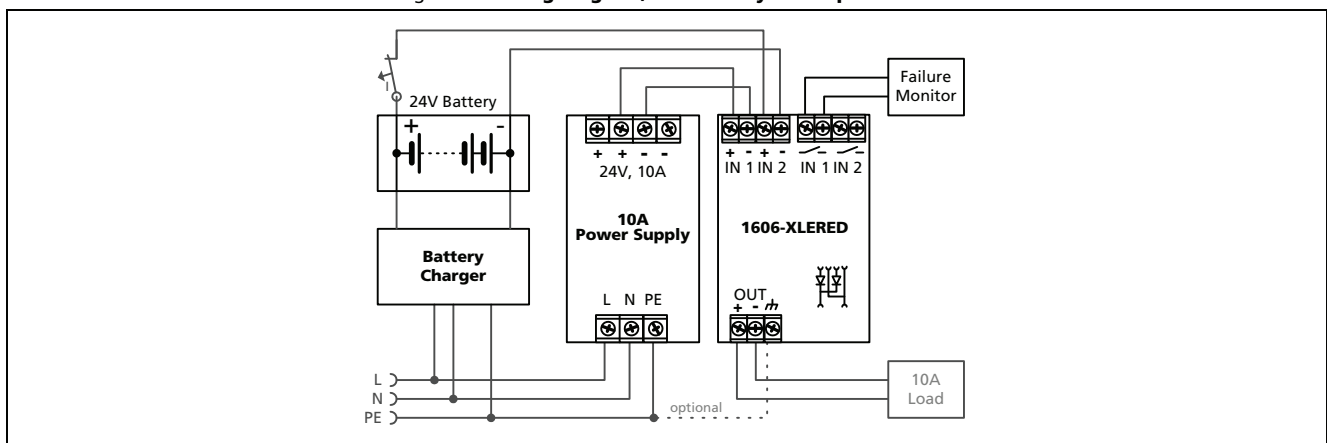
19.5. Example: Battery Back-up

A battery back-up with 10A requires one 10A power supply and one 1606-XLERED redundancy module.

Please note:

Set output voltage of power supply to 26.5Vdc minimum to ensure that the load current is delivered from the power supply and not from the charger (battery). Use a fuse between the battery and the 1606-XLERED module!

Fig. 19-3 Wiring diagram, 10A Battery back-up

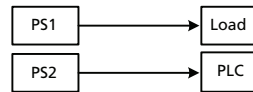


19.6. Example: Redundancy for Controls

The example shows a cost effective solution to get redundant power for a PLC or controller system.

In many cases, two power supplies are used; one for the demanding loads and the second for the controls and sensitive loads. The power supply for the demanding loads can be used as a redundant source to supply the controls.

Traditional approach:



Improved approach:

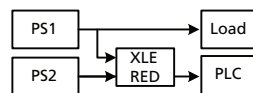
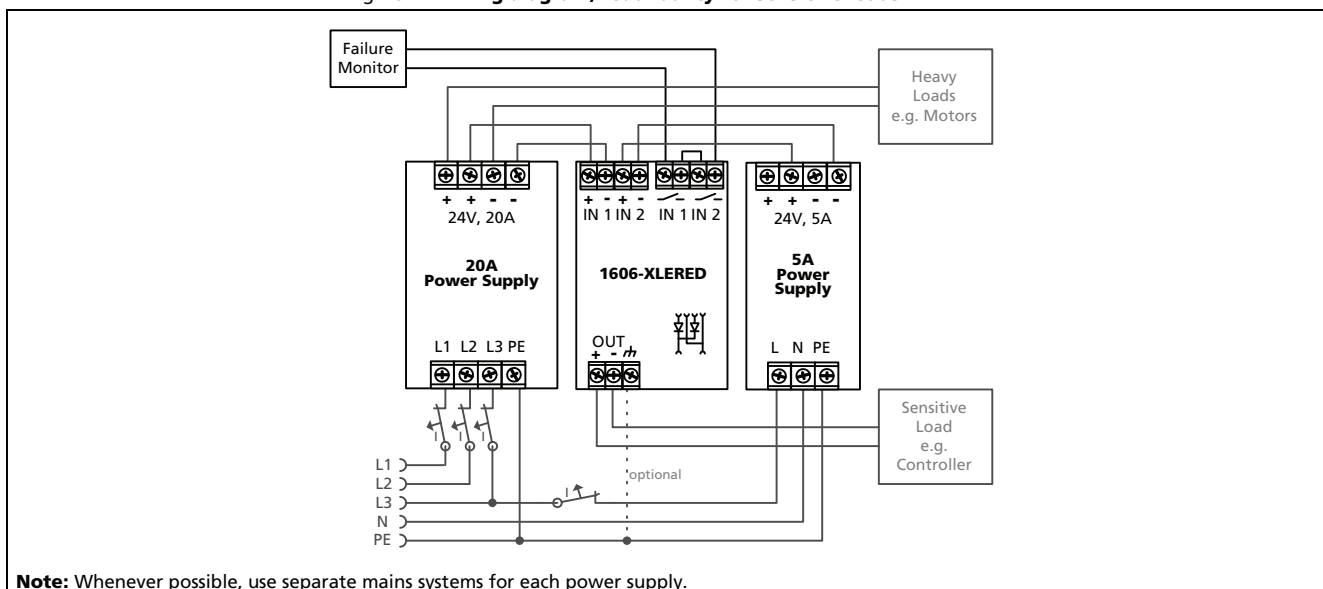


Fig. 19-4 Wiring diagram, redundancy for sensitive loads



Note: Whenever possible, use separate mains systems for each power supply.

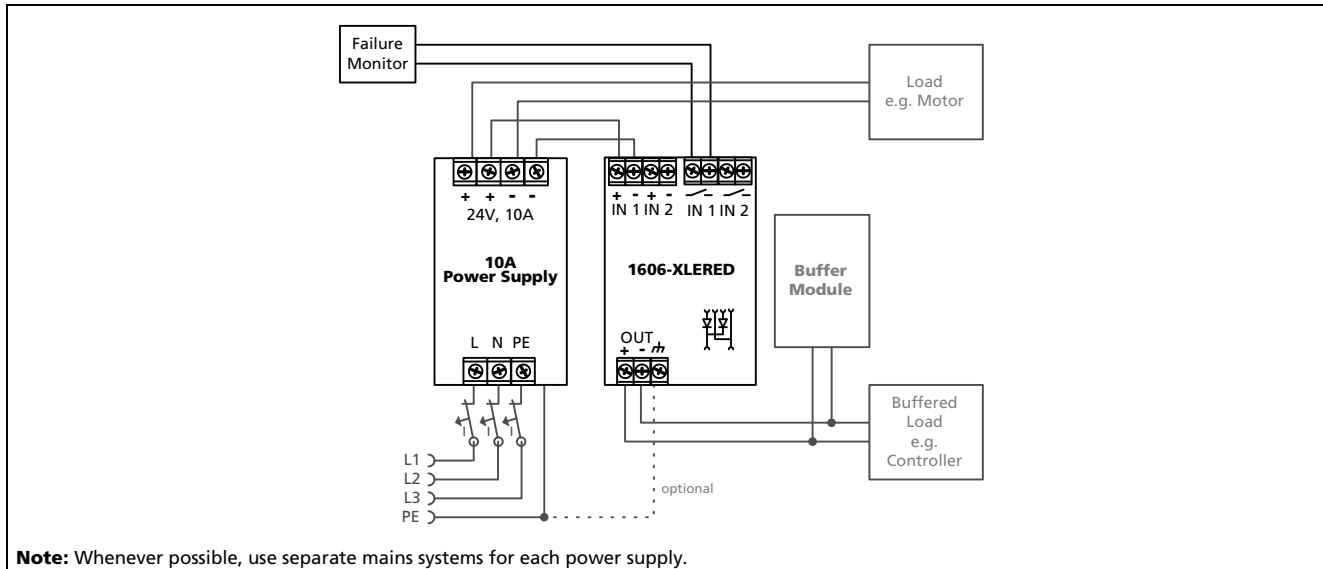
19.7. Example: Decoupling of Branches

Buffer energy supplied from a DC UPS or buffer module is not wasted in “power branches.”

Please note:

Set output voltage of the power supply to a level sufficient to prevent the buffer unit or DC UPS from starting unexpectedly. Take the voltage drop of the 1606-XLERED into account.

Fig. 19-5 **Wiring diagram, decoupling of buffered branches**



19.8. Use in a Tightly Sealed Enclosure

When the redundancy module is installed in a tightly sealed enclosure, the temperature inside the enclosure will be higher than outside. The inside temperature defines the ambient temperature for the redundancy module.

Results from such an installation:

Power supply is placed in the middle of the box; no other heat producer is inside the box.

Enclosure: Rittal Typ IP66 Box PK 9516 100, plastic, 110x180x165mm

Load: 24V, 16A; (=80%) load is placed outside the box

Input: 24Vdc

Temperature inside enclosure: 58.8°C (in the middle of the right side of the power supply with a distance of 2cm)

Temperature outside enclosure: 24.6°C

Temperature rise: 34.2K

19.9. 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 amount of reduction influences the lifetime expectancy of the power supply. Therefore, two different derating curves for continuous operation can be found below:

Curve A1 Recommended output current.

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

Fig. 19-6

Mounting Orientation A
(Standard orientation)

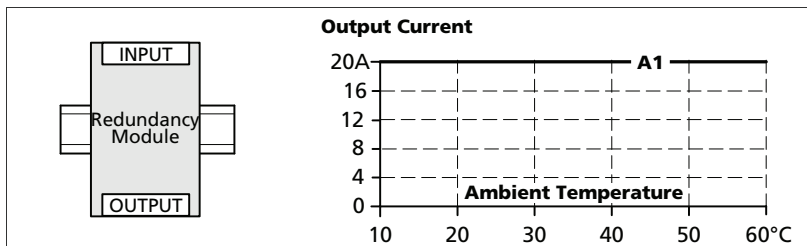


Fig. 19-7

Mounting Orientation B
(Upside down)

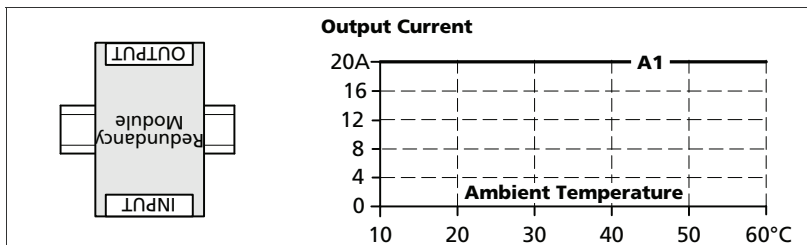


Fig. 19-8

Mounting Orientation C
(Table-top mounting)

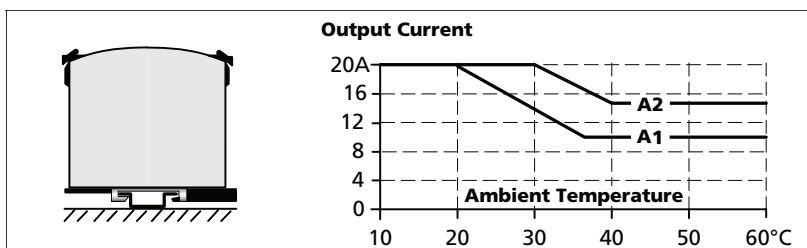


Fig. 19-9

Mounting Orientation D
(Horizontal cw)

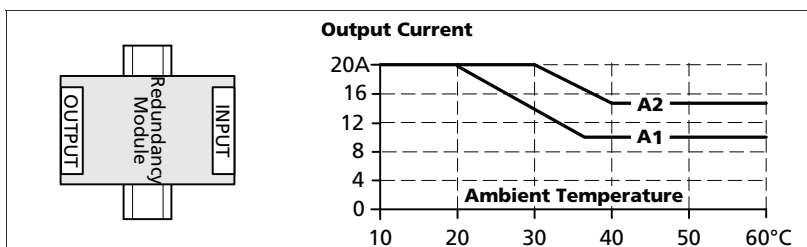
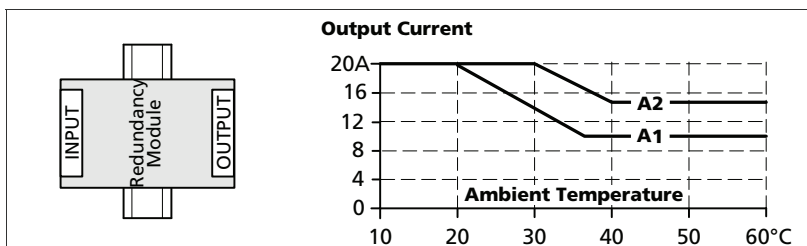


Fig. 19-10

Mounting Orientation E
(Horizontal ccw)



All parameters are specified at 24V, 2.5A, 230Vac input, 25°C ambient and after a 5 minutes run-in time unless noted otherwise.

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