

Bulletin 1606 Switched Mode Power Supplies

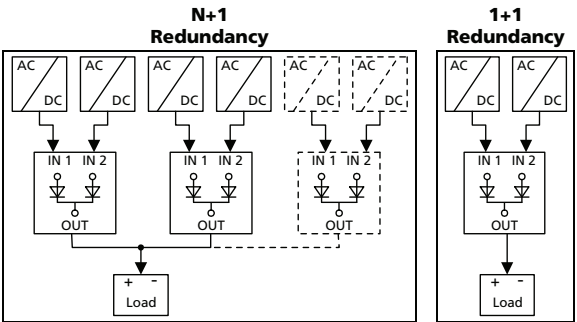
Catalog Number: 1606-XLSRED

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Terminology and Abbreviations

- **PE and **—PE is the abbreviation for **Protective Earth** 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”.
- **T.b.d.**—To be defined, value or description will follow later.
- **DC 24V**—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 whether it is full (13.7V) or flat (10V)
- **24Vdc**—A figure with the unit (Vdc) at the end is a momentary figure with no additional tolerance included.
- **may, shall, should**—Three key words indicating, respectively: flexibility of choice with no implied preference, a mandatory requirement, flexibility of choice with a strongly preferred implementation.
- **1+1 Redundancy**—Use of two identical power supplies in parallel to provide continued operation following most failures in a single power supply. The two power supply outputs should be isolated from each other by using diodes or other switching arrangements. E.g. two 10A power supplies are needed to achieve a 10A redundant system.
- **N+1 Redundancy**—Use of three or more identical power supplies in parallel to provide continued operation following most failures in a single power supply. All power supply outputs should be isolated from each other by using diodes or other switching arrangements. E.g. to achieve a 40A redundant system, five 10A power supplies are required in a N+1 redundant system.





Redundancy Module

- Cost Effective Solution to Build Redundant Systems
- Dual Input with Single Output
- Two Diodes (Common Cathode)
- DC12-48V (120V) $\pm 25\%$ Wide-range Input
- Full Power Between -40°C and $+60^{\circ}\text{C}$
- Width only 32mm
- Rugged Metal Housing
- Quick-connect Spring-clamp Terminals
- Easy Wiring:
Distribution Terminal for Negative Pole Included
- 3 Year Warranty

Description

The 1606-XLSRED is a redundancy module that can be used to build 1+1 and N+1 redundant systems. It is equipped with two input channels, which can be connected to power supplies with up to 10A output current and one output, able to carry nominal currents up to 20A. The module is suitable for power supplies with constant current overload behavior as well as any kind of "Hiccup" overload behavior.

The 1606-XLSRED is the perfect solution to use in a redundant system, if the power supply itself is equipped with a DC-OK signal.

In addition to the 1606-XLSRED is the 1606-XLERED which includes monitoring circuitry. LEDs and relay contacts signal when one of the two DC-input voltages is out of range due to a non-functioning power supply.

Another interesting application for the redundancy module is to separate sensitive loads from non-sensitive loads. This avoids the distortion of the power quality for the sensitive loads which can cause controller failures.

Unique quick-connect spring-clamp terminals allow a safe and fast installation and a large international approval package for a variety of applications makes this unit suitable for nearly every situation.

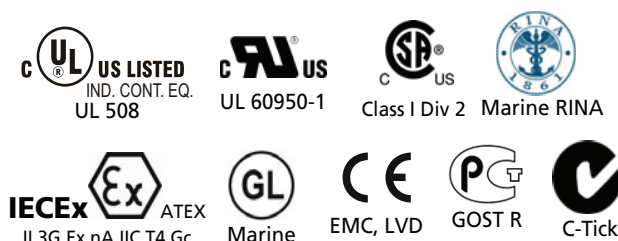
Catalog Numbers

Redundancy Module	1606-XLSRED	12-48V (120V) Standard unit
Accessory	1606-XLB	Wall/panel mount bracket

Specification Quick Reference

Input voltage	DC 12-48V $\pm 25\%$ DC 12-120V $\pm 25\%$	w/o restrictions with restrictions
Input voltage range	9-60Vdc 9-150Vdc	w/o restrictions with restrictions
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. 0W typ. 7.8W typ. 8.5W typ. 17W	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	32x124x102mm	WxHxD

Certification Marks

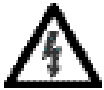


1. Intended Use

- This redundancy module is designed for installation in an enclosure and is intended for general use such as in industrial control, office, communication and instrumentation equipment.
- This redundancy module can be used with any type of power supply as long as the maximum ratings are not exceeded. It is suitable for power supplies with constant current overload behavior as well as any kind of “Hiccup” overload behavior.
- Do not use this power supply in equipment 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 occurs 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 input terminals are located on top and the output terminals on the bottom of the unit. For other mounting orientations, see derating requirements in the present document.
- 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 30%!
- 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 unless power has been switched off or the area is known to be non-hazardous.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and meets the requirements of the EN 60079-15:2010.

Notes for use in hazardous location areas:

- The unit is suitable for use in Class I Division 2 Groups A, B, C, D locations and for use in Group II Category 3 (Zone 2) environments and is evaluated according to EN 60079-0:2009 and EN 60079-15:2010.

3. Input and Output Characteristics

Number of inputs	-	2	
Number of outputs	-	1	
Input voltage	nom.	DC 12-48V $\pm 25\%$	The input circuitry must meet the SELV requirements stipulated by IEC/EN/UL 60950-1.
Input voltage range	-	9-60Vdc	
Input voltage with restrictions	nom.	DC 12-120V $\pm 25\%$	See Note 3 below table.
Input voltage range with restrictions	-	9-150Vdc	Restrictions apply, see Note 3 below table.
Voltage drop, input to output	typ.	0.78V	at 2x5A, see Fig. 3-2
	typ.	0.85V	at 1x10A, see Fig. 3-3
	typ.	0.85V	at 2x10A, see Fig. 3-2
Input current	nom.	2x 0-10A	continuous
	nom.	1x 0-20A	continuous, see note 1
	nom.	2x 10-16A	for 5 seconds
Peak input current	max.	150A	for maximal 10ms per input
Output current	nom.	20A	continuous
	nom.	20-32A	for 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.

Note 3: The redundancy module can be used with input voltages up to 150Vdc with the constraint, that it can be used only as a single input module at voltages above 60Vdc. Both inputs need to be connected together as shown in Fig. 3-1. Ensure proper means to protect against touching this voltage.

Fig. 3-1 Restrictions for utilizing voltages between 60 and 150Vdc (See also Note 3)

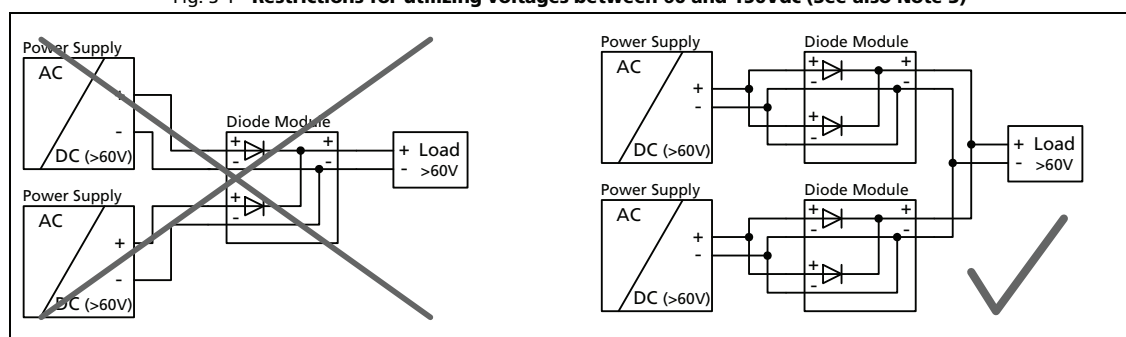


Fig. 3-2 **Input to output voltage drop when both inputs draw current**
(typical 1+1 redundant case, when the output voltages of the two units are equal or set into "parallel use" mode)

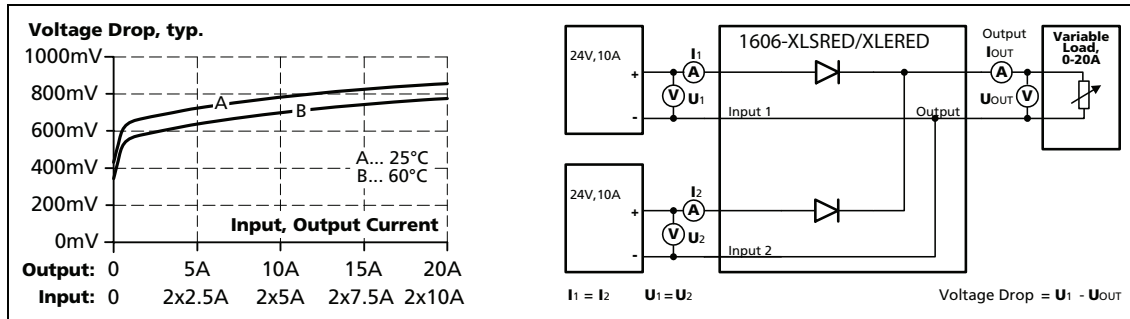
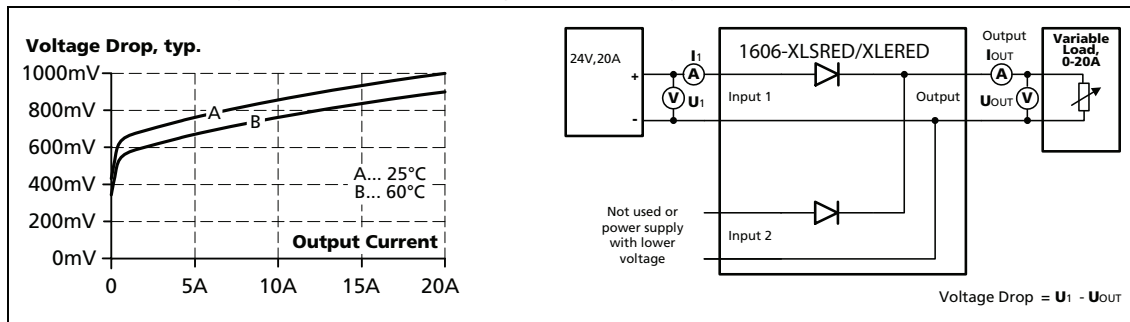


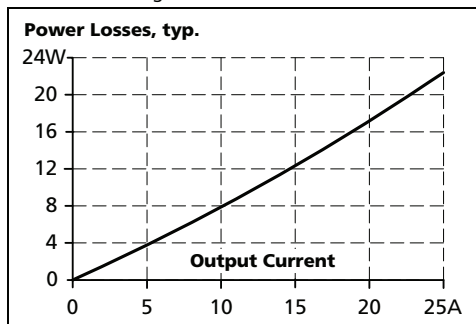
Fig. 3-3 **Input to output voltage drop when only one input draws current**



4. Power Losses

DC 24V			
Power losses	typ.	7.8W	input: 2x5A
	typ.	8.5W	input: 1x10A
	typ.	17.0W	input: 2x10A
Standby power losses	typ.	0W	at no output current

Fig. 4-1 **Power losses**



5. Life Expectancy and MTBF

The redundancy module has two input channels which are completely independent from each other. Each control circuit, auxiliary voltage source, or other circuitry in the module are designed separately for each input. The dual input redundancy module can be considered as two single redundancy modules combined together in one housing. The only common point is the circuit trace that ties the two separate circuits together at the output.

The MTBF figures below are for the entire dual input module. If the MTBF number of only one path is needed, simply double the value from the table.

The redundancy module does not have electrolytic capacitors included. Therefore, the lifetime expectancy is 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		46 500 000h	55 700 000h	at 24V 40°C
		70 000 000h	84 000 000h	at 24V 25°C
MTBF **) MIL HDBK 217F		36 200 000h	43 500 000h	at 24V and 40°C (Ground Benign GB40)
		41 100 000h	49 300 000h	at 24V and 25°C (Ground Benign GB25)

*) 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. The MTBF figure is a statistical representation of the likelihood of a device to fail. A MTBF figure of e.g. 1 000 000h means that statistically one unit will fail every 100 hours if 10 000 units are installed in the field. However, it can not be determined if the failed unit has been running for 50 000h or only for 100h.

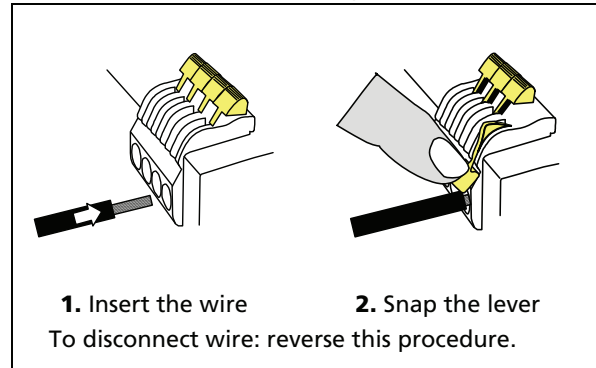
6. Terminals and Wiring

	Input and output
Type	Bi-stable, quick-connect spring clamp terminals. IP20 Finger safe construction. Suitable for field- and factory installation. Shipped in open position.
Solid wire	0.5-6mm ²
Stranded wire	0.5-4mm ²
American Wire Gauge	20-10 AWG
Max. wire diameter	2.8mm (including ferrule)
Wire stripping length	10mm / 0.4inch
Pull-out force	10AWG:80N, 12AWG:60N, 14AWG:50N, 16AWG:40N (according to UL486E)

Instructions:

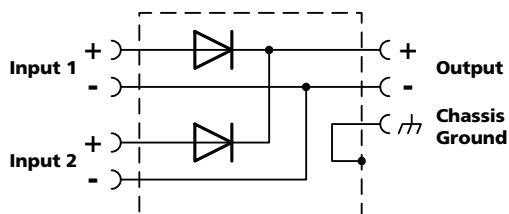
- Use appropriate copper cables that are designed for minimum operating temperatures of:
60°C for ambient up to 45°C and
75°C for ambient up to 60°C and
90°C for ambient up to 70°C minimum.
- Follow national installation codes and installation regulations!
- Ensure that all strands of a stranded wire enter the terminal connection!
- Ferrules are allowed.
- Do not connect or disconnect the wires from the terminals below -25°C (-13°F).

Fig. 6-1 **Connecting a wire**



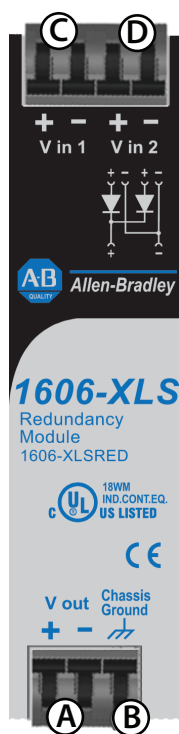
7. Functional Diagram

Fig. 7-1 Functional diagram



8. Front Side and User Elements

Fig. 8-1 Front side



A Output terminals

B Chassis ground terminal

Connection of the chassis to ground 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

9. EMC

The redundancy module is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. 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
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
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 *)	
	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	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.

10. 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: g 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 2000m (0 to 6 560ft) 2000 to 6000m (6 560 to 20 000ft)	without any restrictions reduce output power or ambient temperature, see Fig. 10-2
Altitude de-rating	1.25A/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 10-2
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
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

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

**) Do not energize while condensation is present

Fig. 10-1 Output current vs. ambient temp.

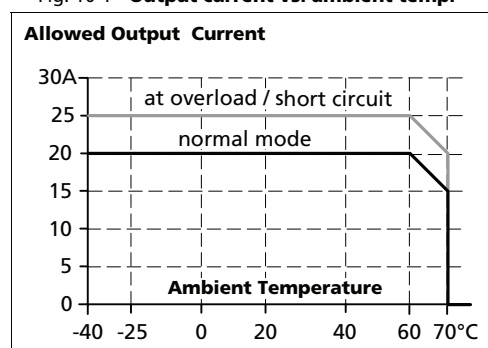
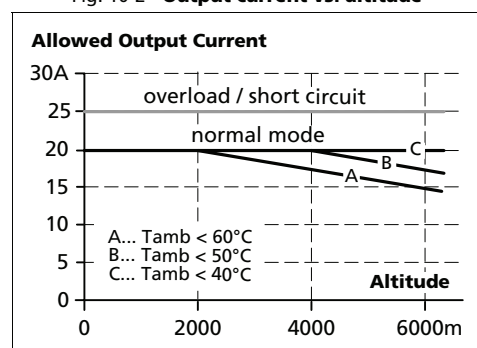


Fig. 10-2 Output current vs. altitude



11. 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	

12. Safety Features

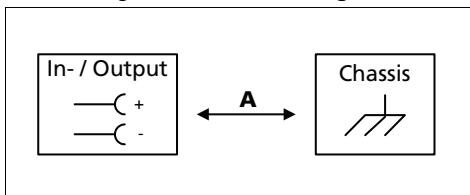
Input / output separation	no galvanic separation	200V epitaxial diode between input and output
Safety level of output voltage	The output voltage is regarded to be SELV (EN 60950-1) or PELV (EN 60204-1, EN 50178, IEC 60364-4-41) if the input voltage fulfills the requirements for a SELV source or PELV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

13. 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 terminals together before conducting the test.

When testing, set the cut-off current settings to the value in the table below.

Fig. 13-1 Dielectric strength



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

14. Certifications

EC Declaration of
Conformity



Complies with
- CE EMC directive,
- CE Low-voltage directive



The CE mark indicates conformance with the
- ATEX directive 94/9/EC (Equipment and protection systems
intended for use in potentially explosive atmospheres)

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 107,1-01



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

ISA 12.12.01, CSA
C22.2 No. 213



RECOGNIZED UNDER FILE NUMBER E244404 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

ATEX



II 3G Ex nA IIC T4 Gc
EPS 11 ATEX 1 312 X

Marine GL



GL (Germanischer Lloyd) classified for marine and offshore
applications. Environmental category: C, EMC2. See below for link
to Certificate.

Marine Rina



RINA (Registro Italiano Navale) certified. See below for the 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.

C-TICK

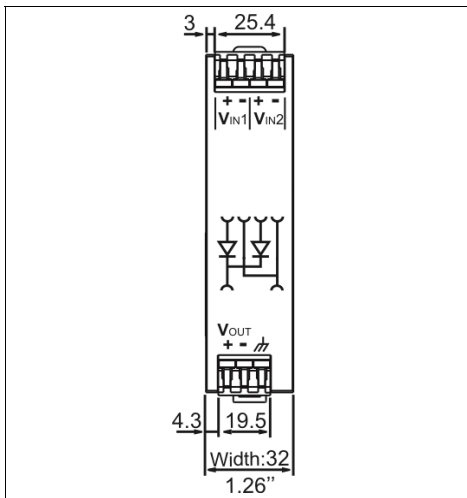
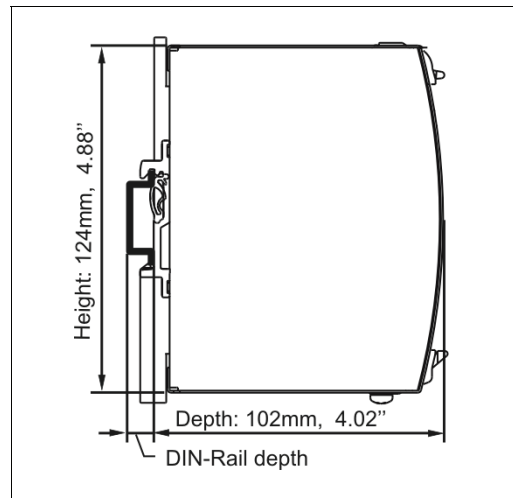


C-tick compliance is for products intended for sale and use within
the Australian market. See below for the link to the C-tick
Declarations of Conformity.

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

15. Physical Dimensions and Weight

Weight	290g / 0.64lb
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 (102mm) to calculate the total required installation depth.
Installation clearances	See section 2.

Fig. 15-1 **Front view**Fig. 15-2 **Side view**

16. Accessories

1606-XLB Wall mounting bracket

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

Fig. 16-1 **1606-XLB Wall mounting bracket**

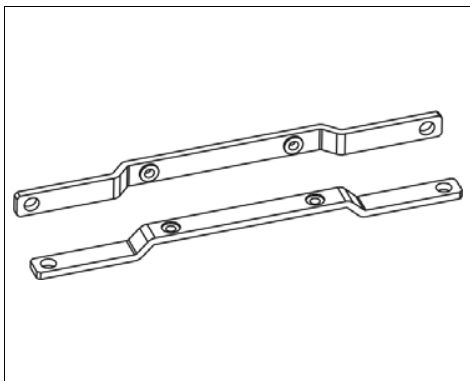
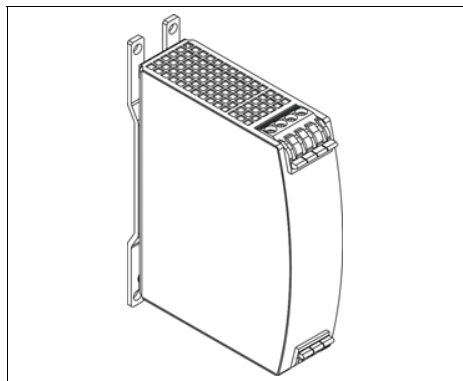


Fig. 16-2 **Assembled wall mounting bracket**



17. Application Notes

17.1. 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.

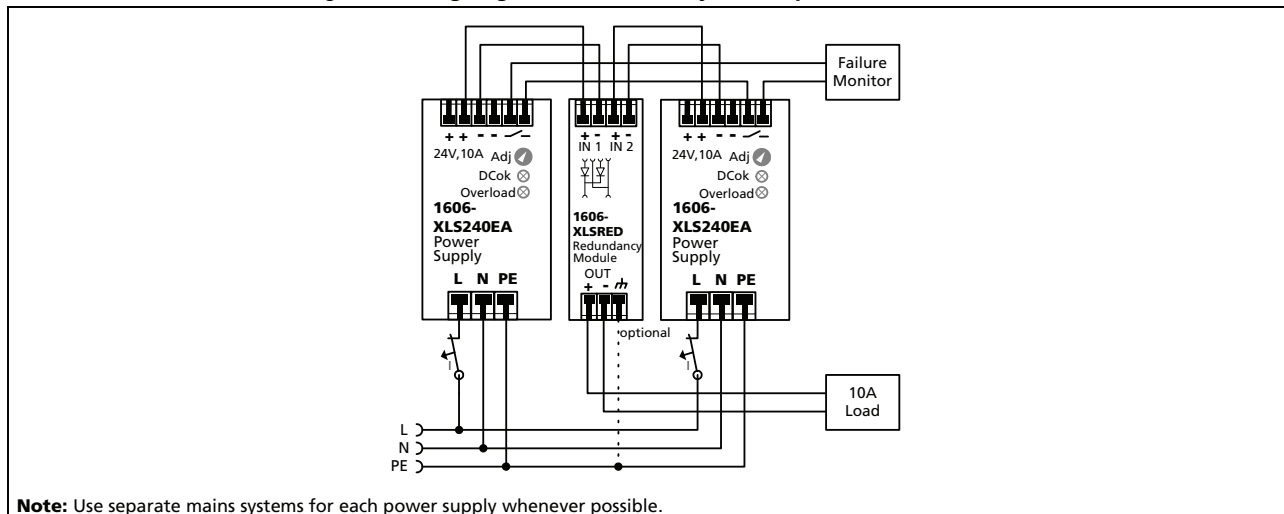
17.2. Inductive and Capacitive Loads

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

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

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

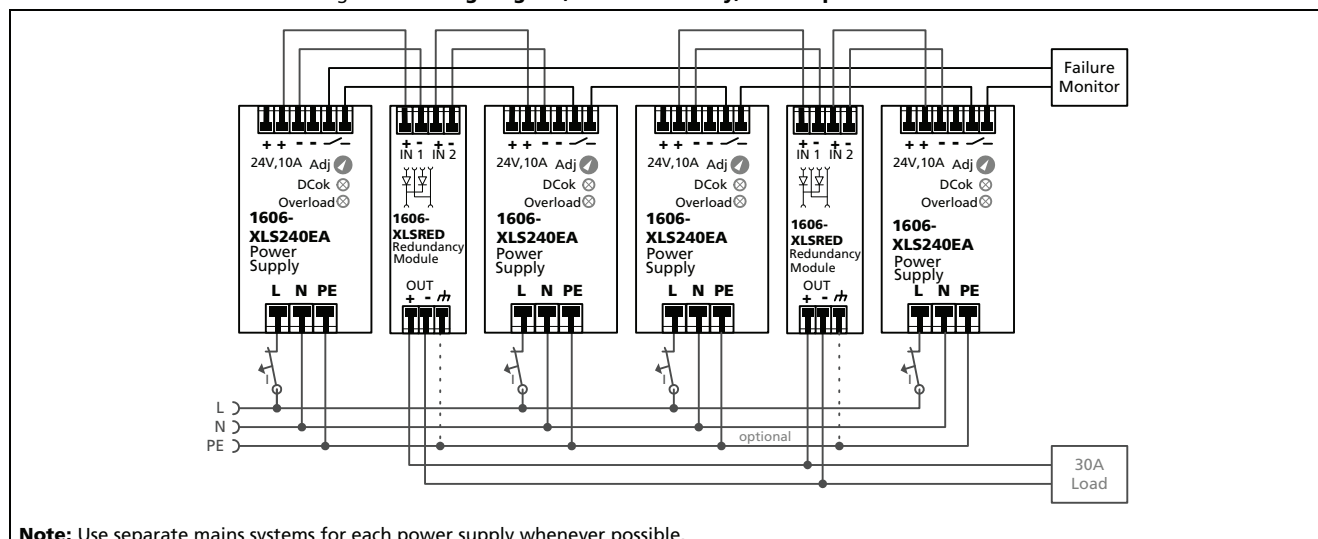
Fig. 17-1 **Wiring diagram, 1+1 Redundancy, 10A output current**



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

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

Fig. 17-2 Wiring diagram, n+1 Redundancy, 30A output current



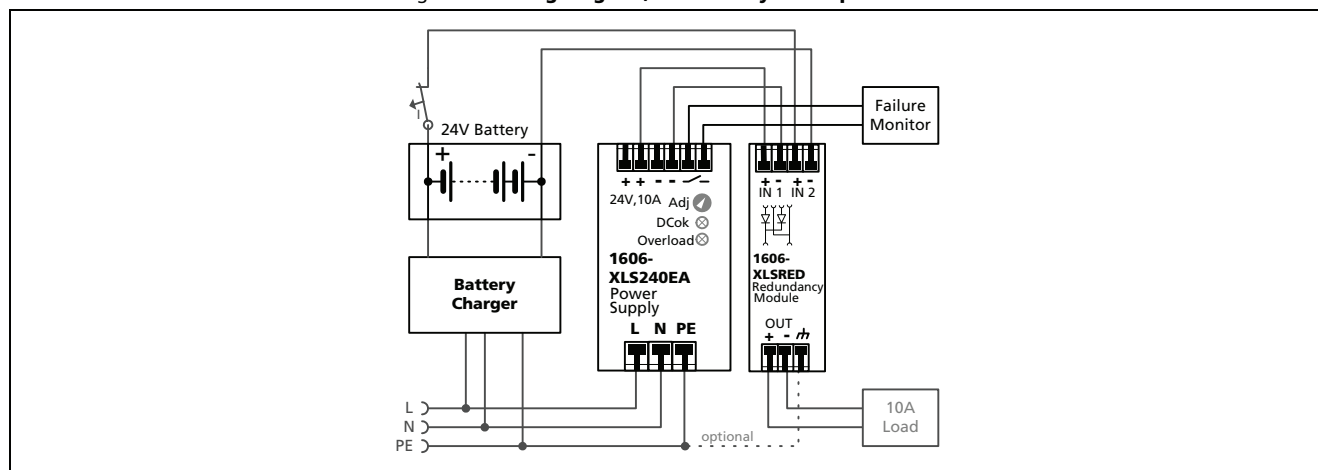
17.5. Example: Battery Back-up

A battery back-up with 10A requires one 10A power supply and one 1606-XLSRED 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 charger (battery). Use a fuse between battery and 1606-XLSRED.

Fig. 17-3 Wiring diagram, 10A Battery back-up

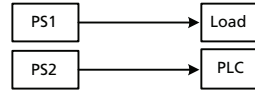


17.6. Example: Redundancy for Controls

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 another one 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:

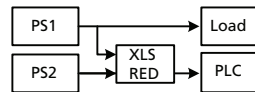
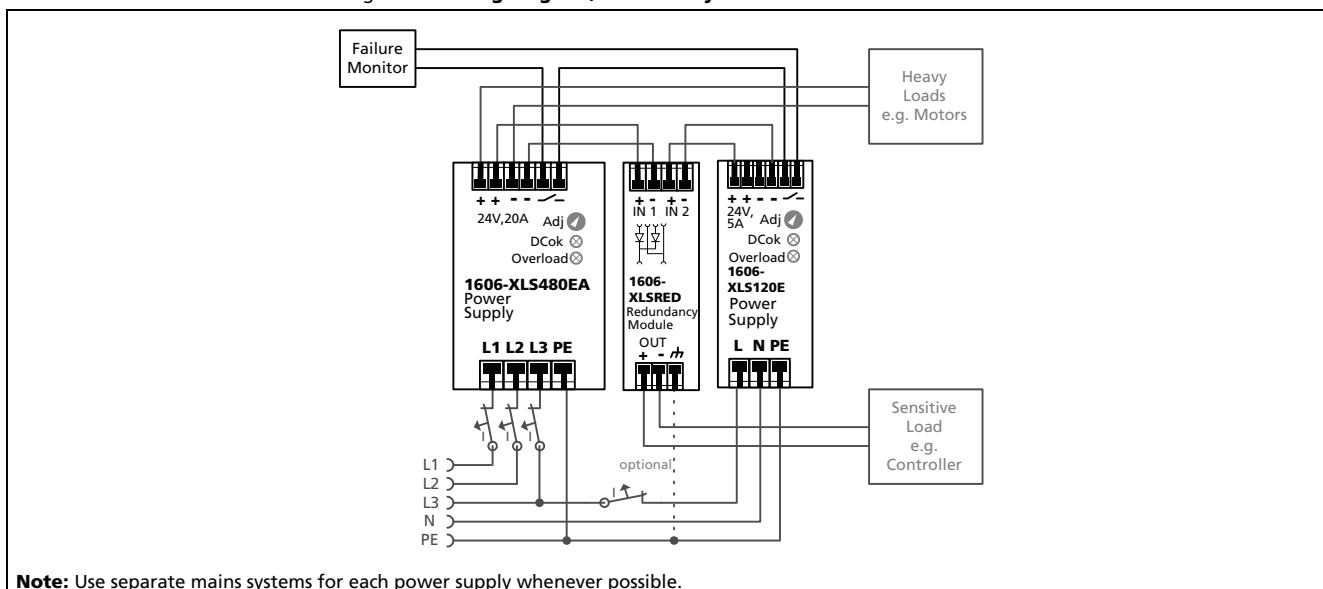


Fig. 17-4 Wiring diagram, redundancy for sensitive loads



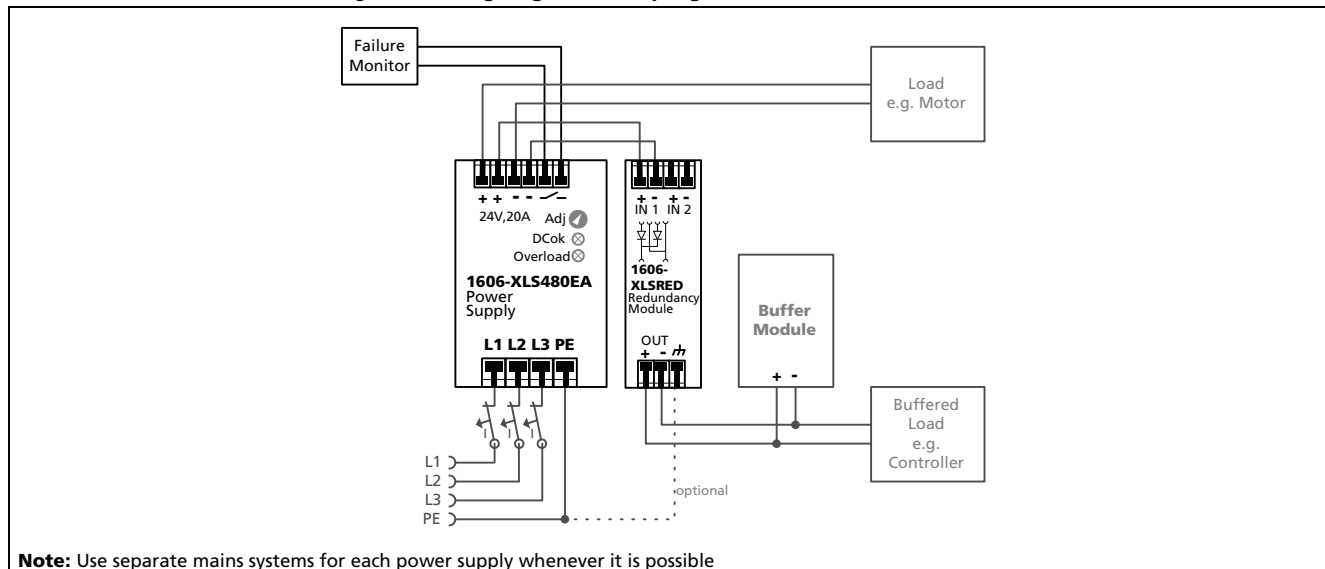
17.7. Example: Decoupling of Branches

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 that the buffer unit or DC-UPS will not start unexpectedly. Take the voltage drop of the 1606-XLSRED into account.

Fig. 17-5 **Wiring diagram, decoupling of buffered branches**



17.8. 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: 57.8°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: 33.2K

17.9. 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.

Fig. 17-6
Mounting Orientation A
(Standard orientation)

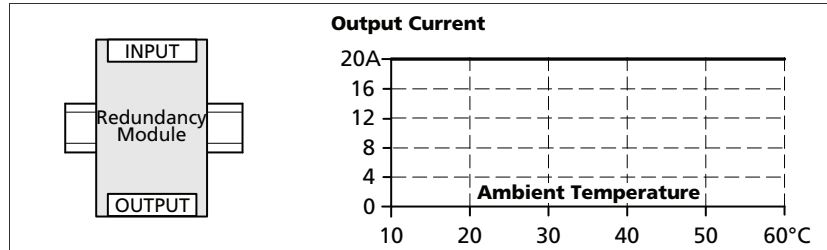


Fig. 17-7
Mounting Orientation B
(Upside down)

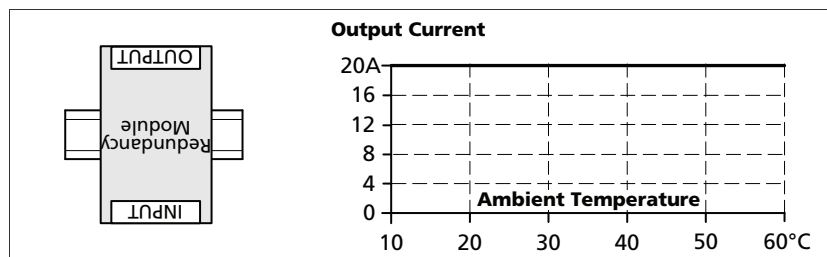


Fig. 17-8
Mounting Orientation C
(Table-top mounting)

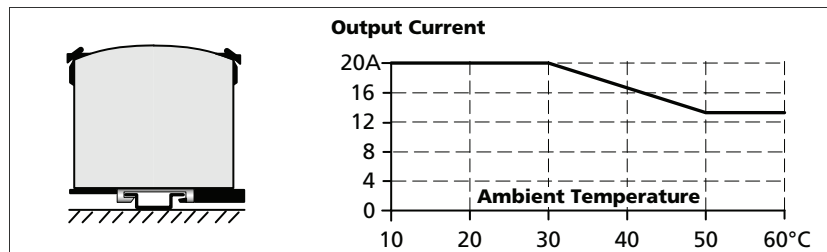


Fig. 17-9
Mounting Orientation D
(Horizontal cw)

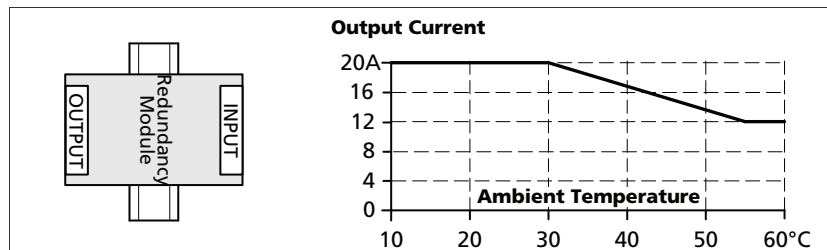
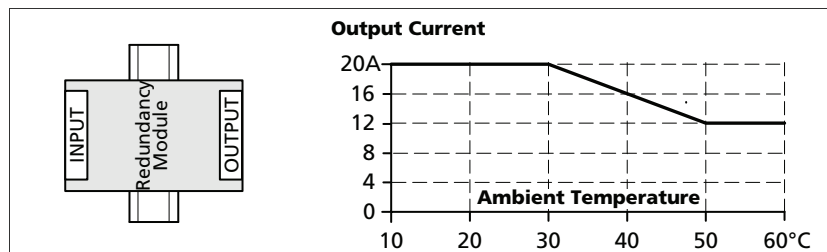


Fig. 17-10
Mounting Orientation E
(Horizontal ccw)



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Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
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