

White Paper

One Circuit Fits All

One control circuit solution for the whole world



Introduction

The requirements for control circuits can vary greatly if machines and systems are designed to operate in different regions around the world.

Companies that export a large number of machines to international markets have to create different concepts for control cabinet power supplies. Murrelektronik offers a portfolio of solutions for multi-norm power supplies that can be used as standard in all systems and machines – regardless of where they are installed.



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I. Abstract

Multi-norm power supply components from Murrelektronik such as power supplies and load circuit fuses have various relevant safety tests and approvals depending on the application in order to enable and facilitate their use in machines (or control cabinets) in multinational target markets. The circuit examples shown in the whitepaper show solutions for cross-standard (EN/IEC & UL/CSA) and standardized DC control circuits.

II. Normative background

The requirements for the electrical equipment of control/switch cabinets, machines and plants (the field of application of industrial power supplies) vary when used in multinational markets. Different standards and requirements must be applied, such as the EU directives (CE) and EN standards in Europe (EU), UL, NFPA, CSA in USA/Canada or IEC standards internationally.

The most frequently used standards to be observed by control/switch cabinet, machine and plant manufacturers and thus indirectly by manufacturers of industrial power supplies/power supply units are listed in the following table:

Europa (EN) and International (IEC)	North America (USA / Canada)
IEC / EN 61204-1 (Machines)	NFPA 79 (industrial machinery) / NFPA 70/NEC CEC (installation instructions)
IEC / EN 61439-1 (Control/switch cabinets)	UL508A / C22.2 No. 286-17

For Murrelektronik's industrial power supply units, all relevant product standards and norms for the above-mentioned applications are generally applied for the assessment of electrical safety or as a basis for the necessary approvals:

Europa (EN) und International (IEC)	Nordamerika (USA / Kanada)
IEC / EN 60950-1	UL / CSA 60950-1
IEC / EN 61010-2-201	UL / CSA 61010-2-201
IEC / EN 61010-1	UL / CSA 61010-1
	UL 508 / CSA-C22.2 No. 107.1

Basically, there are significant differences between Europe and North America in terms of criteria, requirements and approach that should be considered when selecting the right power supply for the intended end application.

In Europe, manufacturers of machines, control cabinets and power supplies must comply with EU directives. As a rule, compliance with these directives is substantiated by the application of harmonized standards (e.g. IEC/EN 60204-1, IEC/EN 61439-1, IEC / EN 61010-2-201), confirmed by the issue of corresponding EU declarations of conformity and affixing of a conformity mark (CE) on the product.

Selling and using power supplies in the EU therefore does not require any special certification by a third party but is based on the manufacturer's confirmation and is verified and documented in the final application by the machine or switch cabinet manufacturer.

The Murrelektronik power supplies meet these requirements, are CE marked and can therefore be used without any problems.

Anyone wishing to design and supply industrial machines (electrical equipment for machines) or control/switch cabinets for North America must comply with the existing legal regulations in the USA on electrical safety and occupational health and safety from the OSHA (Occupational Safety and Health Administration) and the binding NFPA installation regulations (e.g. NFPA 70, NFPA 79, UL508A). Compliance with these installation instructions is checked and approved before the machine/system is put into operation for the first time. The safety testing/acceptance is normally carried out by designated inspectors (AHJ: Authority Having Jurisdiction) or an independent National Recognized Testing Laboratory (NRTL).

According to NFPA 70 (installation), NFPA 79 (industrial machines) or UL508A (switch cabinet), successful acceptance requires that the equipment used therein (also applies to power supplies) must be approved/ listed for the application, i.e. tested by an accredited independent laboratory (NRTL).

The necessary tests and certifications can be carried out by different NRTLs. The Underwriters Laboratories (UL) has the highest degree of recognition and acceptance in the USA. Alternative approvals and the approval marks of e.g. CSA can be accepted. Since most certification bodies are accredited for both the USA and Canada, it is generally possible and recommended to seek and apply for joint certification for both countries. After successful testing and certification, the certification mark may be affixed to the equipment, indicating that the product complies with the relevant requirements.

A special feature of UL's certification program is to distinguish between UL "LISTED" (end product certification) and UL "Recognized" (component certification) and to issue different approval marks for them.

Murrelektronik's power supplies meet these requirements and are UL approved for the USA and Canada and marked with the cULus "LISTED" mark.

Most industrial power supplies are used in control cabinets according to UL508A to supply 24 VDC control circuits. For this reason, the relevant requirements for the design of control cabinets and the selection of power supplies for use in switch cabinets according to UL508A must be considered.








As the standard was issued by UL, it contains many specific requirements and design features that must be taken into account when selecting electrical equipment, e.g.:





- Significance and subdivision of main circuits into feeder circuit and branch circuit: It is particularly important to note that fuse protection or overcurrent protection in such circuits must only be provided with specially approved "Branch Circuit Protective Device" overcurrent protection devices (BCPD, fuses to UL 248 or circuit-breakers to UL 489). When using UL listed Murrelektronik power supplies, no additional external device protection is required in the installation if a BCPD (max. 20A) is already present in the installation.
- Differentiation of control circuits into Class 1, Class 2 and Low Voltage Limited Energy Circuits (LVLEC): When using UL listed Murrelektronik power supply components such as switch mode power supplies and load circuit monitors (Mico Pro®), all relevant types of 24VDC control circuits can be implemented.
- No proof of approval for equipment when used in "Class 2" or "LVLEC" control circuits.

- Selection of the electrical equipment considers the operating conditions (application) and the UL specific approval classification according to standard and approval category (Category Control Number/CCN); Info: Supplement SA of UL 508A, Table 1. All Murrelektronik power supplies have approvals in the relevant UL approval categories (NMTR, NMTR7) and can therefore be used without problems in switch cabinets according to UL508A.
- Power limitation regarding power supplies according to UL 60950-1: Power supplies certified according to these standards may only be operated with a maximum load of 50 %. All Murrelektronik power supplies are approved according to UL 508 or UL 61010-2-201 UL and can therefore be used without power limitation.

III. Overview of relevant standards and certification/conformity marks

Standards / Approvals	Description
	User and Installation Standards
IEC / EN 61204-1	Safety of machinery - Electrical equipment of machines – Part 1: General requirements
NFPA 79	Electrical standard for industrial machines (industrial machines)
IEC / EN 61439-1	Low-voltage switchgear and control gear assemblies – Part 1: General requirements (control cabinet)
UL 508A	Industrial Control Panel (control cabinet)
C22.2 No. 286-17	Industrial Control Panels and Assemblies
NEC (NFPA 70)	National Electrical Code (USA)
CEC	Canadian Electrical Code
	Product norms
UL/IEC / EN 60950-1 CSA-C22.2 No. 60950-1	Information technology equipment – Safety – Part 1: General requirements
UL508 CSA-C22.2 No. 14	Industrial Control Equipment
CSA-C22.2 No. 107.1	General Use Power Supplies
UL / IEC / EN 61010-1 CSA-C22.2 No. 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements
UL / IEC / EN 61010-2-201 CSA-C22.2 No. 61010-2-201	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 2-201: particular requirements for control equipment
UL 1310	Safety Standard for Class 2 Power Units (limited energy)

Standards / Approvals	Description
	Product norms
	<p>CE mark in which the manufacturer declares that a product/equipment satisfies the essential requirements laid down in the relevant harmonization legislation (EU directives) of the European Union (EU).</p> <p>Low Voltage Directive No.: 2014/35/EU EMC Directive No.: 2014/30/EU RoHS - Directive No.: 2011/65/EU Machinery Directive No. 2006/42/EC</p>
	<p>cCSAus Mark is a certification mark issued by CSA Group and confirms the compliance of a product/device with the tested safety requirements for the USA and Canada. These safety requirements are based on the safety standards developed and published by UL and CSA.</p>
	<p>CSA Mark is a certification mark issued by CSA Group and confirms that a product/device conforms to the tested safety requirements for Canada. These safety requirements are based on the safety standards developed and published by CSA.</p>
	<p>CSAus Mark is a certification mark issued by the CSA Group and confirms that a product/device complies with the tested safety requirements for the USA. These safety requirements are based on safety standards developed and published by UL.</p>
	<p>cULus LISTED Mark is a UL-awarded certification mark confirming the compliance of a product/device with the tested safety requirements for the USA and Canada. These safety requirements are based on the safety standards developed and published by UL and CSA. It is a certification mark intended for end products.</p>
	<p>UL-Listed Mark is a UL-awarded certification mark that certifies a product/device's compliance with U.S. approved safety requirements. These safety requirements are based on safety standards developed and published by UL. It is a certification mark intended for end products.</p>
	<p>cUL-LISTED Mark is a UL-awarded certification mark confirming that a product/device conforms to Canada's approved safety requirements. These safety requirements are based on safety standards developed and published by UL and CSA. It is a certification mark intended for end products.</p>

Standards / Approvals	Description
	Product norms
	cULus-Recognized Component Mark is a UL-awarded certification mark confirming that a product/device conforms to the tested safety requirements for the United States and Canada. These safety requirements are based on the safety standards developed and published by UL and CSA. It is a component certification mark.
	UR-Recognized Component Mark is a UL-awarded certification mark confirming that a product/device conforms to U.S. approved safety requirements. These safety requirements are based on the safety standards developed and published by UL and CSA. It is a component certification mark.
	cUR-Recognized Component Mark is a UL-awarded certification mark confirming that a product/device conforms to the approved safety requirements for Canada. These safety requirements are based on the safety standards developed and published by CSA. It is a component certification mark.
	EAC (Eurasian Conformity) conformity mark as market access for Russia, Belarus, Kazakhstan, Armenia, Kyrgyzstan.

IV. Detailed description of the structure of multi-norm power supplies

a. Objective

The circuit examples shown in the white paper show solutions for cross-standard (EN/IEC and UL/CSA) and standardized DC control circuits. The concept significantly reduces engineering costs and creates resilient standards while maintaining the same electrical components. The solutions shown are scalable and flexible.

b. Detailed structure of cross-standard DC circuits

The core of the Branch Circuit and the Control Circuit are the power supplies.

Power supplies must meet special requirements in order to be used in different countries. On the one hand, there must be common approvals for Europe and North America ((EN/IEC & UL/CSA)). But also the input voltage range and the common network forms must be covered.

Emparro® power supply units from Murrelektronik are UL 508 (listed) and UL/IEC/ EN 60950-1 (recognized) certified and can be permanently loaded with full rated current. In addition, an internal UL device protection (Recognized Special Purpose Fuses JFHR2) is integrated, so that only a miniature circuit breaker according to UL/IEC/ EN 60950-2 or UL 489 must be used for the primary protection. UL 508 A stipulates that the branch circuit (main circuits) must be designed for a maximum current of 20 A. The circuit breaker must not be used in a branch circuit. Emparro® power supply units can thus be connected directly without intermediate fuses and additional terminals with 6 mm² or 10 AWG.

On the secondary control circuit side, grounding of the 0 V / GND terminal creates a PELV circuit (Protective Extra Low Voltage with electrically safe supply).

An electronic load circuit monitoring system is ideal for economical and selective control circuit monitoring. With the 24 VDC/40 A provided by the power supply, Mico Pro® can be connected directly with 16 mm² / 6 AWG wires without intermediate distribution terminals. All load circuit monitoring modules are UL 508 (listed) and UL 2367 (Special Purpose Solid State Overcurrent Protector Recognized) certified.

One of the major challenges is to ensure UL certification for all devices in the entire control circuit of a machine or plant. With NEC Class 2 energy-limited Mico Pro® circuits, connected consumers do not require any further UL approval, as the fire hazard and the risk of electric shock are classified as non-hazardous. This saves a lot of documentation effort, time and money.

Murrelektronik recommends in connection with the electronic load circuit monitoring system Mico Pro® to wire the internal circuits with a load up to 7 A with 1 mm² / 18 AWG and from 8 – 10 A with 1.5 mm² / 16 AWG.

What are the concrete customer benefits?

Advantages of a multi-norm power supply concept from Murrelektronik:

- Reduce the number of different products needed
- Employees only have to be familiar with one system instead of many
- Reduce engineering time
- NEC Class 2 circuits reduce approval time and control circuits to a minimum
- In total: you can optimize material cost and installation time!

Murrelektronik's product portfolio has many solutions for multi-norm power supply concepts. Our products follow a uniform design and have the approvals and certifications that you need. They have been developed and tested to work perfectly together. Our solutions meet international standards so that your machine or system can be used anywhere in the world.

V. Did you know?

a. Switch mode power supplies from the Emparro® series

- Emparro® power supply units offer a wide voltage input (360 V AC to 500 V AC) for a wide range of mains voltages and mains forms such as TN, TT and IT.
- The Emparro® power supply unit supports the connection of 6 mm² or 10 AWG for 20A Branch Circuits.
- Emparro® power supply units with their high quality and long life (MTBF > 1,000,000 hours or 114 years) are ideal for worldwide use. Due to the high efficiency, the control cabinet temperature increases only minimally and saves electricity.
- The installation height of at least 1000 meters required by DIN EN 60204-1 is twice that of the Emparro® series without derating: the maximum installation height for Emparro® series switch-mode power supplies is 2000 meters.
- In North America, classic motor-protective circuit breakers are not permitted for fusing power supply units. The power and branch circuits must be protected with a miniature circuit breaker with high requirements for clearances and creepage distances in accordance with UL 489.
- The Emparro® power supply unit housing must be grounded on the primary side due to their metal housing (protection class 1).

b. Control circuit monitoring system Mico Pro®

- With Mico Pro®, the distribution of a maximum of 40 A is particularly simple and intuitive. The monitoring modules (1/2/4-channel variants) are contacted quickly and easily by means of an integrated jumper system.
- An integrated potential agreement concept with connection options for +24V and 0V potential unbundles installations, reduces wiring and saves space in the control cabinet.
- Mico Pro® monitors the voltage ranges 12-24 VDC and 1-20 A control circuits (control circuit class 1 & 2).
- Detailed diagnostics with LED display on each channel and signal contacts always provide the user with detailed information on the current status of the Mico Pro® system.
- NEC Class 2 circuits must switch off in accordance with standards before 100 VA is exceeded in the event of a fault. In addition, the modules must be equipped with redundant fault detection, since shutdown must also be guaranteed in the event of a fault within the circuit. Murrelektronik recommends checking every NEC Class 2 device to ensure that redundancy within the current monitoring modules is ensured in addition to the 100 VA limitation. With Mico Pro®, the portfolio includes five NEC Class 2 variants that have been fully tested and provide the maximum current depending on the voltage.

VI. Glossary

OSHA

Occupational Safety and Health Administration, Federal Agency for the Enforcement of the Occupational Safety Act in the United States

NRTL

National Recognized Testing Laboratory, OSHA accredited laboratory for testing and certification of equipment, machinery and plants.

AHJ

Authority Having Jurisdiction, Official authority or inspector in the USA, responsible for the assessment, acceptance and release of machines and systems at the installation site.

CSA

Canadian Standards Association, an independent standardization and testing organization from Canada with accreditation for, among others, the USA and Canada.

UL

Underwriters Laboratories Inc., an independent standardization and testing organization from Canada with accreditation for, among others, the USA and Canada.

NFPA

National Fire Protection Association, publisher of safety standards and installation regulations such as NFPA70 (NEC) or NFPA79.

Main circuit

All conductive parts in a circuit that transmits electrical power to equipment used in the production process, including the transformer for control circuits.

Feeder Circuit

Input-side main circuit of a control/switch cabinet (distribution circuit according to UL508A) to the Branch Circuit Protective Device of the circuit.

Branch Circuit

Main circuit of a control/switch cabinet (distribution circuit to UL508A) from the load side of the Branch Circuit Protective Device to the load.

Control circuit

Circuit used for control (including monitoring of the machine, plant, system and electrical equipment).

Class 1 Circuit

Control circuit of a control cabinet according to UL508A, where the voltage must not exceed 600V without current limitation.

Class 2 Circuit

A secondary control circuit with limited voltage and power (typically 100W), which can only be realized by using an approved power supply unit or power limiting modules with class 2 output. Such control circuits are considered harmless in terms of electrical shock and fire hazard.

Low Voltage Limited Energy Circuit

A secondary control circuit with limited voltage (max. 42.4VDC) and power (typically 100W), which can be realized by using a power supply unit and an overcurrent protection device in a control/switch cabinet according to UL 508A. Such control circuits are comparable to class 2 control circuits (only valid in control cabinets according to UL 508A).

BCPD

Branch Circuit Protective Devices, e.g. fuses according to UL 248 or circuit breakers according to UL 489. They fulfil protective functions about overcurrent and short-circuit protection and must be certified according to a suitable standard.

CCN

UL uses the Category Control Number to divide all approved devices and components into categories, depending on the product type, underlying test standard and intended application. Which categories may be used and how is, for example, defined in UL 508A under Table SA1.1. The UL Online Certification Directory/ Product iQ on UL's website can be used to find or verify UL certifications for products based on the CCN.

VII. Exclusion of liability

The data provided does always not claim to be complete and up-to-date. Murrelektronik GmbH does not guarantee the accuracy of the information. We reserve the right to make changes or updates at any time and without prior notice. Any changes and misuse of the information provided are prohibited.

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About Murrelektronik

Murrelektronik is an international, family-run company in the automation technology sector with more than 2,700 employees. The vision and mission of Murrelektronik is to optimize machinery and plant installations and thus generate a competitive edge for its customers. Decentralization is the company's speciality: the control layer of machinery

and plant is optimally connected to the sensor-actuator layer with proven concepts and innovative technologies. Close customer cooperation is vital to develop customized solutions for optimum machine installation. High product availability rounds off the Murrelektronik portfolio and the customer experience.