

The Secrets of UL.

You have our support.





Entering North America – You Have Our Support with Regards to UL

Product liability laws in the USA are way stricter than in Europe. Whoever plans to export products to North America should have them UL-certified, particularly when it comes to industrial control equipment. This brochure is to explain the meaning of UL certification and to describe the corresponding aspects to be considered. It furthermore provides information on how to benefit from our comprehensive know-how and broad portfolio of UL-certified low-voltage controls and distribution products.

Who or what is UL?

UL (Underwriters Laboratories Inc.®) is one of the world's leading organizations for testing and certification in the field of product safety. This independent, non-profit US organization was founded in 1894 at the request of American fire insurance companies to analyze the fire hazards posed by electrically operated devices. Today, UL tests and certifies the most varying materials, components and end products for their operational safety, particularly with regard to potential personal injury and fire formation. The organization maintains subsidiaries in numerous European countries. Detailed information on the US organization as well as contact details for the various European subsidiaries are also available on the Internet at www.ul.com.

UL and IEC differ fundamentally. The IEC standards for the IEC market merely specify the minimum safety requirements of a device or system. Technical details of the safety requirements' constructional implementation are up to the manufacturers. In contrast, the standards for the American market are far more detailed. Depending on the standard, the required process may be monitored from product design to product production down to application, mounting and operation.

IEC and UL markets at a glance



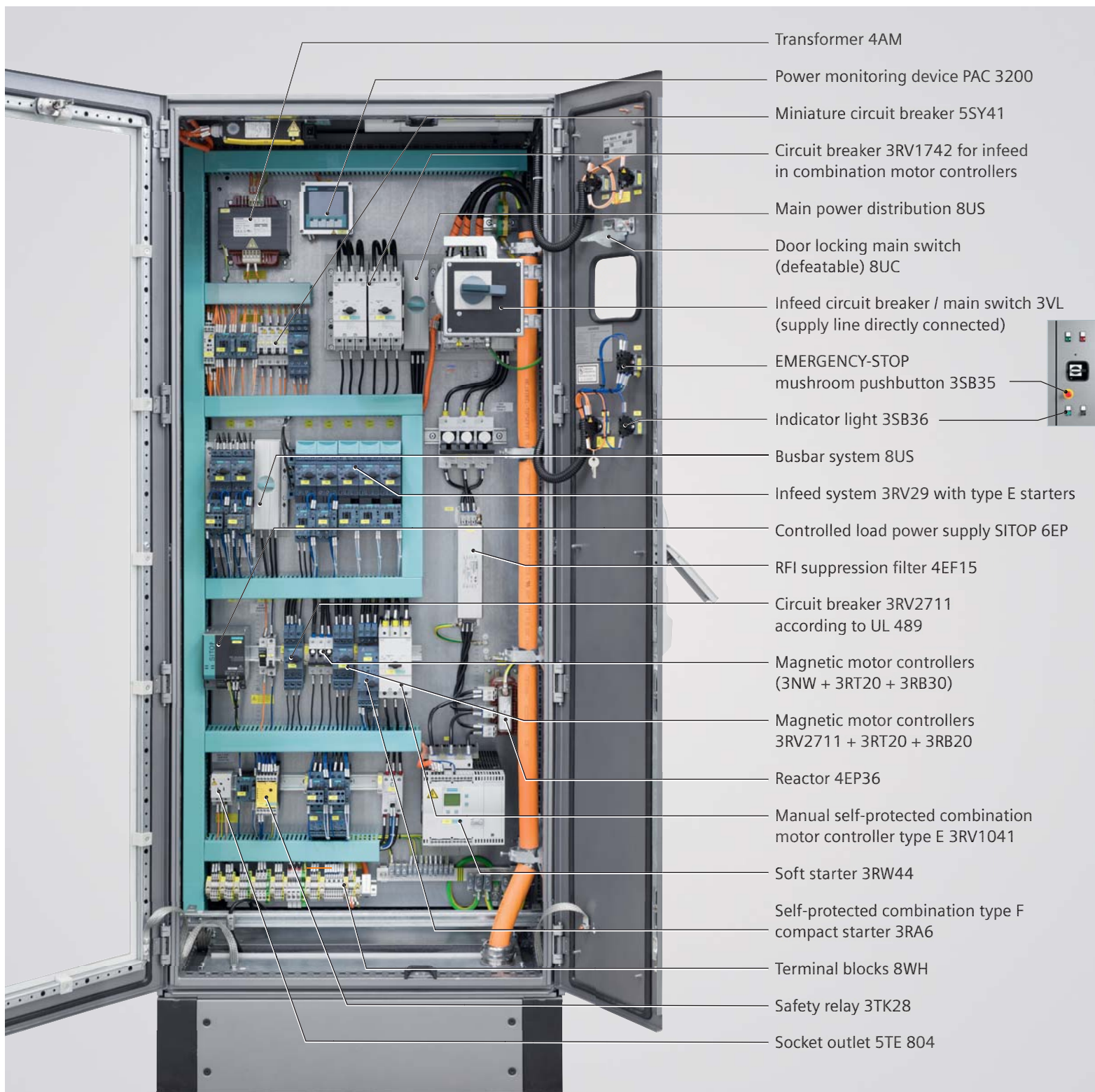
Siemens production facility Amberg – UL partner since 1969

To avoid unnecessary trouble and save time- and cost-intensive expenditures, it is recommendable to rely on a competent partner like Siemens. Our production facility Amberg, where the complete diversity of our low-voltage controls and distribution portfolio is developed and produced, has been closely cooperating with Underwriters Laboratories Inc. already since 1969. We therefore offer comprehensive know-how on the subject of UL certification, ranging from production down to control panel wiring according to UL standards, and we would be pleased to share this knowledge with you within the scope of various training programs. Also the UL competence of our further sites, e.g. the Berlin switching plant and the Regensburg factory for electrical installation technology, should not be forgotten in this context.

Our consideration of both IEC directives as well as UL standards as early as in our products' development phase results in a broad portfolio of UL-certified products for low-voltage switching and protection technology. Whether circuit breakers SENTRON, switching devices SIRIUS – including manual motor controllers, starters, contactors, and overload relays –, disconnect switches SENTRON, detecting and commanding devices SIRIUS, busbar systems SENTRON, terminals, miniature circuit breakers, fuses or transformers and filters SIRIUS – our portfolio of low-voltage controls and distribution products ensures your being on the safer side in terms of UL and facilitates the easy and fast assembly of control panels according to UL.

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A Small Selection of our Large UL Portfolio



Benefiting All Along the Line – with the UL Know-How by Siemens

Efficient construction of Industrial Control Panels

Efficiency

- **High solution flexibility** through comprehensive and matched product portfolio, from the supply of the industrial control panel to the machine's smallest actuator
- **Easy stock-keeping** of switching devices SENTRON and SIRIUS as well as BETA low-voltage circuit protection devices through the products' universal applicability (IEC-UL/CSA)
- **Uniform operation and maintenance concept** through our standard system

Professionalism/authoritative

- **Comprehensive UL know-how** by Siemens through long-standing close cooperation with Underwriters Laboratories Inc.
- **Secure UL connection** through strong and reliable product and system portfolio which considers UL right from the development phase
- **Easier and faster commissioning** through competent UL consulting services

Support

- **Easy and fast access to approvals, test certificates and technical product details** via www.siemens.com/automation/service&support
- **Global availability of products** through online order placement via www.siemens.de/automation/mall
- **On-site support** through global presence
- **UL training programs**

Efficient and safer operation of Industrial Control Panels

Efficiency

- **Reduced costs** through matched product interfaces
- **Easy expandability and retrofitting** through modular products and systems
- **Minimum space requirements** through compact designs
- **Comfortable and efficient on-site operation** through ease of handling

Professionalism/authoritative

- **Comprehensive UL know-how** as well as **proven UL portfolio** through long-standing close cooperation of Siemens with Underwriters Laboratories Inc.
- **Easy expandability and retrofitting** through globally available products

Support









- **Fast and competent product consulting** through global presence
- **24/7 service** via www.siemens.com/automation/service&support
- **Manifold UL training programs**






Our Portfolio for Industrial Control Panels









	Product	Order No. body	UL standard	Explanation
	Air circuit breakers (ACB) SENTRON	3WL5	UL 489	Thanks to their modular design and UL 489 as well as IEC 60947 approvals, the SENTRON 3WL air circuit breakers facilitate global applicability. With only three sizes, they cover a power range from 250 A to 5,000 A. This makes them universally applicable. All models feature the same design, operation and mechanical and electric accessories, which can also be retrofitted thanks to the breakers' modular design. Result: Unique planning reliability and global applicability – with a single circuit breaker range!
	Molded-case circuit breakers (MCCB) SENTRON	3VL	UL 489	Covering the range from 20 A to 1,600 A, the molded-case circuit breakers SENTRON 3VL provide safety while simplifying operation. As main disconnecting means or as branch circuit protector, they protect systems, motors and generators against short circuit and overload. Their versatile industrial control panel installation options as well as their space-saving design are major advantages.
	Circuit breakers SIRIUS	3RV17, 3RV18 3RV27, 3RV28	UL 489	The circuit breakers SIRIUS 3RV17/18/27/28 are compact circuit breakers with 100% rating. They guarantee secure disconnection in case of a short circuit and protect consumers and system against overload.
	Motor starter protectors / manual motor controllers SIRIUS	3RV10	UL 508	The manual motor controllers SIRIUS 3RV10/20 are compact switching devices. Depending on the application (and on the UL approval), they guarantee secure disconnection in case of a short circuit and protect motors against overload.
	Contactors / magnetic motor controllers SIRIUS	3RT, 3RH	UL 508	Contactors SIRIUS for motor switching as well as contactor relays for the control and auxiliary circuit are particularly rugged and feature a high switching contact reliability. They cover the power range from 3 kW to 250 kW with 400 V for AC or DC actuation and can be connected with minimum time and cost expenditures. Their long service life even under extreme application conditions is a convincing advantage.
	Thermal overload relays SIRIUS	3RU	UL 508	The overload relays of the SIRIUS range, which are available as thermal and solid-state versions, assume the current-dependent overload protection of consumers in the power circuit and other switching and protection devices in the respective load feeder. With minimum variance, they ensure integrated motor protection in numerous applications.
	Solid-state overload relays SIRIUS	3RB	UL 508	
	Soft starters SIRIUS	3RW	UL 508	The soft starters SIRIUS 3RW offer a complete portfolio which covers all standard and high-feature applications of soft motor start-up and ramp-down. Their soft start-up and ramp-down behavior facilitates jerk-free motions to protect the motors' mechanics. The soft starter range can be flexibly adjusted to the various conditions on site and thus allows for the easy and efficient realization of optimum machine concepts.
	Fuseless load feeders SIRIUS	3RA	UL 508	The fuseless load feeder SIRIUS 3RA are assembled from 3RV self-protected combination motor controllers (type E) and 3RT contactors. Thanks to their integrated prewiring, the fuseless load feeders can be rapidly and easily mounted. They are the optimum solution particularly for distributed and wide-spread system structures.

	Product	Order No. body	UL standard	Explanation
	Busbar system / fast bus SENTRON	8US1	UL 508	The busbar system (fast bus system) SENTRON 8US is ideal for applications in industrial control panels, motor control centers and power distribution systems. The adapters, which are amongst others available for circuit breakers SIRIUS and SENTRON as well as disconnect switches SENTRON, facilitate numerous assemblies.
	Manual motor disconnect SENTRON	3LD2	UL 508	The particularly compact manual motor disconnect units SENTRON 3LD2 are employed for the switching of power and auxiliary circuits as well as for three-phase motors and other consumers for maintenance and repair cases. Amongst others, they facilitate the cable bending radius specified by UL.
	Disconnect switches SENTRON (manual motor controllers)	3KA	UL 508	The disconnect switches SENTRON in three-pole design assume the tasks "disconnecting" and "switching under load" for the stated rated current and guarantee safety disconnection in all low voltage networks. They are thus predestined for use as EMERGENCY-STOP, repair or load transfer switch. (According to UL, only applicable with fuses SITOR – special-purpose fuse.)
	Disconnect switches SENTRON with fuses (manual motor controllers)	3KL	UL 508	
	Transformers SIRIUS	4AJ, 4AM, 4AP, 4AW 4AT, 4BT, 4AP, 4AU, 4BU	UL 506 UL 1561	The transformers SIRIUS offer optimum protection through high permissible ambient temperatures up to 40 °C or 55 °C (104 °F or 131 °F), high short-time rating with control transformers, fuseless design and their "safety inside" standard in accordance with IEC 61558. They are employed for the voltage and power supply of systems, controls and series products (medical engineering, machine tool construction, robots and compressors).
	Power supplies SIRIUS	4AV	UL 1012	
	Reactors SIDAC	4EM, 4ET, 4EP, 4EU 4EV	UL 1561 UL 506	The reactors and filters SIDAC can be used as options for variable-speed drives in all sectors and applications. They improve the line quality and efficiency of systems by reducing harmonics, increase the reliability of applications and thus enhance the availability of installations and systems. The portfolio comprises line, commutation, smoothing, output and filter reactors as well as radio interference suppression, dv/dt and sinewave filters.
	Filters SIDAC	4EF11 4EF15	UL 508 UL 1283	
	Miniature circuit breakers (MCBs)	5SJ4...-HG	UL 489	Serving as all-round solution for protection tasks, miniature circuit breakers according to UL 489 can be used as branch circuit protector in branches inside distribution boards, control panels and controls in accordance with UL 508A. Furthermore, they are also approved for circuit protection in heating, air-conditioning and ventilation systems as well as for DC applications up to 60 V / 125 V. All additional 5ST3...-HG components can be combined with 5SJ4...-HG miniature circuit breakers in accordance with the mounting concept.
	Miniature circuit breakers (MCBs)	5SY4, 5SY6, 5SY7, 5SY8, 5SP4, 5ST30	UL 1077	Within the scope of the UL 1077 standard, we offer a series of miniature circuit breakers for various residential and non-residential buildings as well as industrial applications.

	Product Compact starter SIRIUS	Order No. body 3RA6	UL standard UL 508 Type E	Explanation Using a compact design, the universal motor feeder according to UL 508 Type E combines the functions of circuit breaker /MSP, solid-state overload relay and contactor. The compact starter SIRIUS can be used as direct-on-line and reversing starter for three-phase standard motors up to 32 A (approx. 15 kW/400 V). Advantage: weld-free contacts
	Motor starters SIRIUS	3RK	UL 508	Whether central or distributed assembly in the industrial control panel or in high degree of protection in the field – motor starters SIRIUS are always an optimum and easy solution. The motor starters of the ET 200S system are, for example, suitable for central assembly in the control panel or for distributed solutions directly in the field. The distributed I/O system SIMATIC ET 200pro is ideal for complete solutions in particularly high degree of protection thanks to its modular design.
	Motor management and control devices SIMOCODE pro	3UF7	UL 508	SIMOCODE pro is a flexible and modular motor management system for motors with constant speeds in the low-voltage range. It optimizes the connection between control technology and motor starter, improves the system availability and simultaneously facilitates considerable savings in terms of system construction, commissioning, operation, and maintenance.
	Coupling relays SIRIUS	3TX70, 3RS18	UL 508	The very narrow SIRIUS 3TX70 coupling relays allow for particularly space-saving assemblies in the control panel and offer a large range of input and output coupling links. In addition to combined-voltage devices, the SIRIUS 3RS18 coupling relay range also comprises wide-voltage versions. All 3RS18 versions are consistently available with screw-type or spring-loaded connection system. The optional hard gold-plated contacts ensure maximum contact reliability even with low currents.
	Plug-in relays SIRIUS	LZX	UL 508	The plug-in relays SIRIUS LZX are available both as complete units and as individual modules for self-assembly or spare parts requirements. They are employed as coupling relays for coupling between the inputs and outputs of electronic controls, for contact multiplication, for switching of small loads, and as measuring transducer.
	Power relays SIRIUS	3TG10	UL 508	With a width of only 36 mm, the compact power relays /small contactors SIRIUS 3TG10 are particularly suitable for applications in minimum space, e.g. for air-conditioning units, heatings, pumps, fans – as well as generally for simple electric controls. Thanks to their hum-free operation, they are also ideally suited for application in household appliances or power distributions in office and residential buildings.
	Solid-state switching devices SIRIUS	3RF2, 3RF3	UL 508	The solid-state switching devices SIRIUS are optimized for the frequent switching of resistive loads and motors. They do not feature any mechanically moved parts and therefore facilitate noise-free, wear-free and almost unlimited switching. Their compact design allows for space-saving assemblies in the control panel.
	Timing relays SIRIUS	3RP15, 3RP20, 7PV15	UL 508	The electronic timing relays SIRIUS 3RP15, 3RP20 und 7PV15 are employed for all time-delayed switching operations in control, start-up, protection and regulation circuits. They ensure a high functionality as well as a high repeat accuracy of the set operating time.

	Product	Order No. body	UL standard	Explanation
	SIRIUS timing relays for mounting on 3RT1 contactors	3RT1916/26	UL 508	The 3RT1916/26 timing relays for mounting on 3RT1 contactors facilitate the easy, rapid and space-saving realization of timing functions in connection with 3RT1 contactors.
	SIRIUS timing relays for mounting on 3RT2 contactors	3RA28	UL 508	The SIRIUS 3RA28 timing relay function modules for mounting on 3RT2 contactors facilitate the space-saving assembly of starters and contactor combinations for direct-on-line and reversing starting without additional wiring of individual components.
	SIRIUS monitoring relays Monitoring Relays	3UG4	UL 508	The SIRIUS 3UG4 solid-state monitoring relays facilitate the maximum protection of machines and systems – particularly in instable networks, with undesired load states or in case of insulation faults. Faults can be detected and rectified early before leading to far more substantial consequential damage.
	SIRIUS monitoring relays for mounting on 3RT2 contactors	3RR2	UL 508	The SIRIUS 3RR2 current monitoring relays are suitable for the multi-phase monitoring of motors and other consumers for underload, phase sequence, phase failure and fault current. They thus allow for detailed conclusions regarding the connected machines or processes. When mounted on 3RT2 contactors, the monitoring function is directly integrated in the branch.
	Temperature monitoring relays SIRIUS	3RS10, 3RS11	UL 508	The temperature monitoring relays SIRIUS 3RS10/3RS11, which are available as analog and digital versions, offer precise and reliable measurement of temperatures in solid, liquid and gaseous media.
	Thermistor motor protection SIRIUS	3RN1	UL 508	The thermistor motor protection devices SIRIUS 3RN1 offer a professional and reliable temperature-dependent overload protection of three-phase motors.
	SIRIUS safety relays	3TK28	UL 508	<p>SIRIUS safety relays represent essential components of integrated and efficient safety chains. Whether EMERGENCY-STOP disconnection, protective door monitoring or protection of presses or punches – SIRIUS safety relays support the optimum realization of any safety application, both in terms of technology and efficiency.</p> <p>SIRIUS safety relays offer numerous safety-related functions:</p> <ul style="list-style-type: none"> • Monitoring of the sensors' safety functions • Monitoring of the sensor lines • Monitoring of the safety relay's correct function • Monitoring of the actuators for standstill • Safety-related disconnection of hazardous states <p>Depending on the respective device version, SIRIUS safety relays meet the strictest requirements (PL e) in accordance with ISO 13849 – and attain the highest safety integrity level (SIL 3) in accordance with IEC 61508.</p>

	Product	Order No. body	UL standard	Explanation
	Modular safety systems	3RK	UL 508	<p>The 3RK3 (MSS) modular safety system represents a freely parameterizable and modular safety relay. Depending on the external circuitry, safety-related applications up to Category 4 in accordance with EN 954-1, Performance Level e in accordance with ISO 13849-1 or SIL 3 in accordance with IEC 62061 can be realized.</p> <p>The modular safety relay supports the interconnection of multiple safety applications. A graphical parameterization tool facilitates the safety functions' easy PC-based creation. Amongst others, disconnection areas can be specified and other dependencies defined. The system can be flexibly adjusted to the required safety applications by means of additional safety-related extension modules.</p> <p>The MSS consists of the following system components:</p> <ul style="list-style-type: none"> • Central module • Extension modules • Interface module • Diagnostics module • Parameterization software • Accessories <p>The comprehensive fault and status diagnostics allows for troubleshooting in the system and for the localization of sensor signals, resulting in reduced system downtimes. Optional interface modules transmit diagnostics data to superior bus systems (e.g. PROFIBUS DP). These data are then available in the automation system for further processing.</p>
	Interface converters SIRIUS	3RS17	UL 508	The interface converters SIRIUS 3RS17 assume the coupling function for analog signals, both on the input and the output side. They are indispensable for the processing of analog values with electronic controls.
	Position switches SIRIUS	3SE5	UL 508	The standard position switches SIRIUS 3SE5 with and without solenoid interlocking convert the mechanical positions of moved machine parts to electronic signals. They are available with a multitude of different drive variants.
	Magnetically operated switches SIRIUS	3SE6	UL 508	The magnetically operated switches SIRIUS 3SE6 are designed for attachment to mobile protective devices. Evaluation is realized via a safety relay or connection to a bus system. The touch-free, magnetically operated 3SE6 safety switches are characterized by their closed design and high degree of protection IP67.
	Cable-operated switches SIRIUS	3SE7	UL 508	The cable-operated switches SIRIUS are employed for monitoring applications or as EMERGENCY-STOP device in particularly hazardous system components.
	Pushbutton units and indicator lights SIRIUS	3SB	UL 508	The pushbuttons and indicator lights SIRIUS are characterized by maximum functionality, their modern and flat design as well as particular ease of mounting.

	Product	Order No. body	UL standard	Explanation
	Signaling columns SIRIUS	8WD4	UL 508	The signaling columns SIRIUS 8WD4 are employed for checking complex machine functions or in automated processes and serve as visual or acoustic warning device.
	ALPHA FIX Terminal blocks	8WA, 8WH	UL 1059 (completely or partially)	A complete range of terminal blocks is available in all conventional connection technologies for the secure connection of wires, conductors and lines.
	LV HRC fuse bases	3NH3, 3NH4	UL 512 (only down- stream the branch pro- tection)	In combination with the SITOR fuse link, the LV HRC fuse bases of the BETA low-voltage circuit protection portfolio ensure the reliable protection of power semiconductors.
	Cylindric fuse holders and Class CC fuse holders Class CC fuse links	3NW7 0xx/ 3NW7 1xx, 3NW7 5x3-0HG 3NW1 xxx-0HG, 3NW2 xxx-0HG, 3NW3 xxx-0HG	UL 512 UL 248-4	Our range of cylindric fuses is particularly characterized by a high switching capacity, high current limiting and minimized design.
	SITOR Semiconductor fuses and fuse holders	3NE, 3NC3 3NC1 0, 3NC1 4, 3NC2 2	UL 248-13 UL 512	The particularly compact and flexible fuses SITOR for semiconductor protection are suitable for a multitude of industrial applications.
	Overvoltage protection devices	5SD7 424-1 5SD7 423-1 5SD7 422-1 5SD7 444-1 5SD7 443-1 5SD7 442-1 5SD7 414-1 5SD7 413-1	UL 1449	Surge arresters protect the low-voltage systems against over-voltages and high currents that can be triggered by direct lightning strikes.
	Switch disconnectors	5TE1	UL 508	The switch disconnectors 5TE1 from 100 A to 200 A in 3- and 4-pole design can be employed as motor disconnect switch, repair switch, outgoing isolator and emergency disconnecter unit.
	Power monitoring devices SENTRON PAC3100, SENTRON PAC3200, SENTRON PAC4200	7KM	UL 61010-1 UL 50, enclosure type 5	The innovative SENTRON PAC3100, PAC3200 and SENTRON PAC4200 power monitoring devices, which can be connected to various consumers, facilitate precise energy consumption detection. The devices provide measured values for assessment of the system state and line quality. These values are displayed on the device or centrally evaluated with an energy management software such as SENTRON Powermanager, SIMATIC WinCC powerrate or SIMATIC PCS 7.

For further UL-approved devices, refer to www.siemens.com/lowvoltage/ul-europe or our UL catalog LV16 "Controls and Components for Applications according to UL".

Application Examples

Mechanical engineering

Circuit breakers and contactors with UL certification in tunnel boring machines



Requirements

Herrenknecht AG, leading manufacturer of tunnel boring machines, was looking for a new supplier for its switching and protection technology. The project comprised the equipment of two so-called hydro-shields, which were to bore a wastewater tunnel spanning a length of 10 km and a diameter of 5.33 m in Seattle, USA.

Project name: Brightwater Conveyance System

The most important requirements included:

- UL-certified low-voltage protection and switching devices for the 480 V on-board power supply system with 60 Hz and a max. short-circuit current of 65 kA
- Switching devices for wye-delta starter
- Protective devices for protection of the entire tunnel boring machine
- High supply and product quality, comprehensive consulting services and documentation

Solution

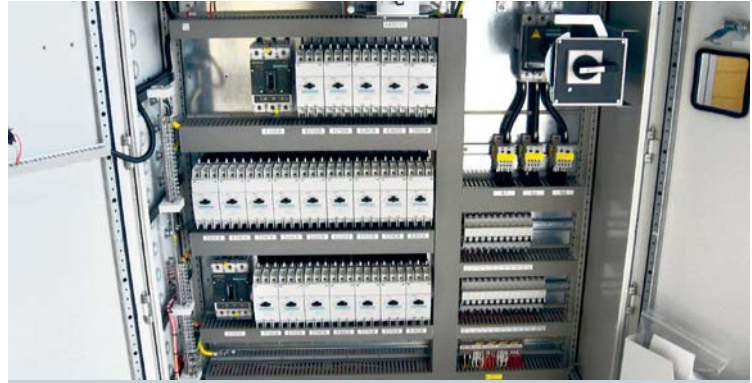
- All pumps and drive motors are protected with molded-case circuit breakers SENTRON 3VL; they facilitate extended distances through air and over surface, are available for nominal currents from 150 A to 1,600 A with thermal-magnetic or electronic trip units and feature a switching capacity of up to 100 kA at 480 V AC
- UL-certified contactors SIRIUS 3RT realize wye-delta starter
- Protection of the entire hydro-shield is ensured by air circuit breakers SENTRON 3WL (3,000 A) with approval according to UL 489
- As manual self-protected combination motor controller type E, motor controllers SIRIUS 3RV, integrated disconnect, overload protection and short-circuit protection as well as extended distances through air and over surface are employed in the terminal area

Added value

- Structured device documentation which considerably eased UL-compliant dimensioning compared to the previous competitor product
- Reliable UL conformity: the order specifications were accurately complied with
- Comprehensive consulting services: Siemens provided its broad expertise for dimensioning according to all relevant UL standards
- Easy retrofitting of circuit breakers with electronic trip units or communication module for direct PROFIBUS connection
- Uniform design through identical construction of IEC/UL devices

Automotive

Renowned automotive manufacturer relies on Siemens quality worldwide



Requirements

To reduce the costs for the planning and commissioning of new systems and ease maintenance, a well-known international automotive manufacturer opted for a worldwide standardization of its entire production equipment. The objective: less product diversity, fewer product suppliers. Siemens soon turned out to be the ideal partner for meeting this challenge. Compared to other manufacturers, Siemens offers one of the market's most comprehensive product portfolio, which is furthermore matched to the country specifics of international automotive markets and operates on the basis of a unique global network.

Solution

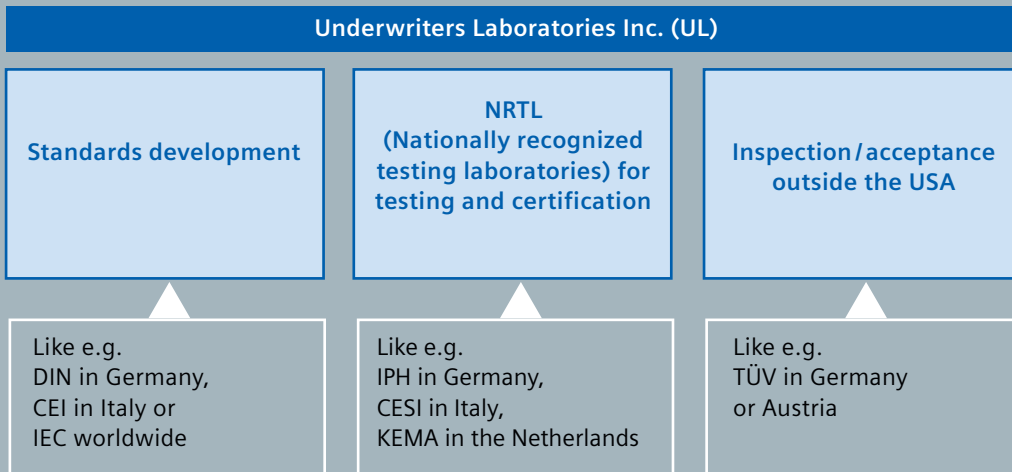
- Together with the engineers of the automotive manufacturer, the Siemens engineering team developed the layout of standardized control panel types for typical automation processes in automotive production, e.g. paint, press and body shop
- The tried-and-tested switching technology by Siemens is part of the globally available product portfolio: e.g. molded-case circuit breakers SENTRON 3VL, manual motor controllers SIRIUS 3RV, load feeders SIRIUS 3RA, overload relays SIRIUS 3RB/3RU as well as transformers SIRIUS
- In addition, Siemens supplied the distributed I/O SIMATIC ET 200, HMI panels as well as RFID identification systems
- The control panels are globally produced at three production sites in Germany, USA and China in high and tested quality and are directly delivered to the automotive factories

Added value

- Optimum solutions through comprehensive, high-performance and flexible product portfolio on maximum quality level
- Comprehensive know-how of the automotive production sector and country specifics
- Easy order and project implementation process as well as stock-keeping due to a high degree of standardization
- Fast and high product availability through global production
- Easy product tracking and high quality reliability through concentration of the control panel production to three sites
- Fast service and support through global Siemens network

Basic Information on UL

The three columns of UL:
Standards development, certification authority, inspection



As previously mentioned, the IEC (International Electrotechnical Commission) and UL (Underwriters Laboratories Inc.) standards differ significantly. IEC standards specify the minimum device safety requirements. UL standards, in contrast, specify comprehensive technical details in terms of product safety and application.

With IEC applications or configurations, it is largely sufficient to ensure that the device characteristics (utilization category) comply with the load. With UL standards, also the application in which the devices are employed is important. Various applications are subject to various standards.

Example: According to UL 508, the decisive standard for industrial control equipment, devices for control transformer protection must be classified as "suitable for control transformer protection".

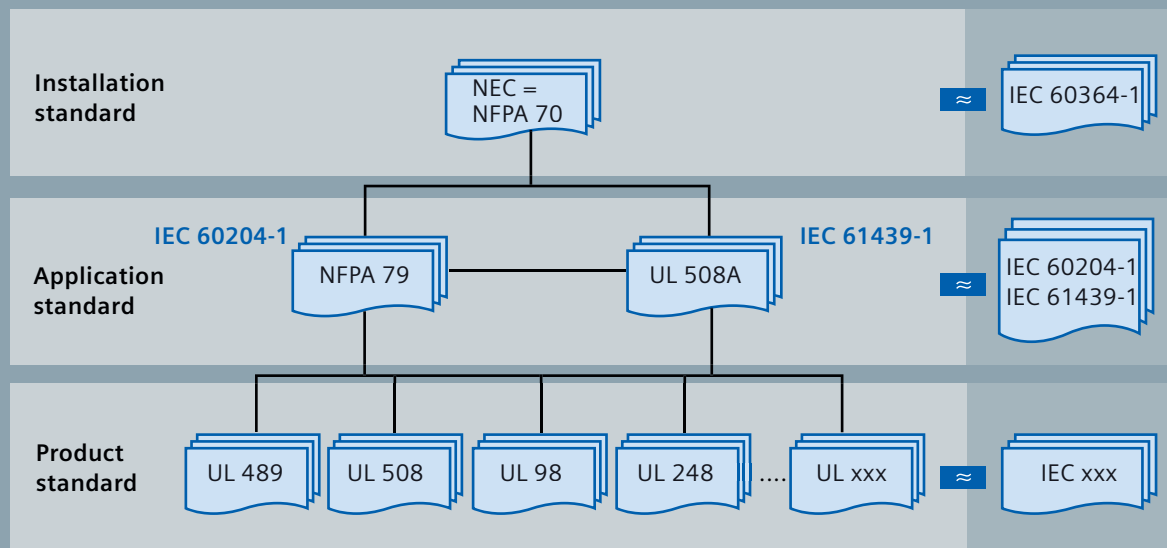
The IEC and UL organizations also differ greatly in terms of their general approach. In addition to standards development, the UL is also responsible for certification (general third-party certification) as well as field acceptance. Compliance with the standards is monitored more strictly, for example through factory inspections of device manufacturers, to ensure that the framework conditions specified together with the certification are met. Of course, UL inspectors also regularly visit our factories, e.g. in Amberg, Berlin and Regensburg, to control the impeccable production of UL-conforming products. Product adjustments have to be approved by the UL prior to production start.



Overview of the Most Important US Standards



Interaction of the most important US standards



In addition to the UL, there is a whole series of further organizations dedicated to promoting technical safety in the USA. Which standards and directives are relevant in the individual case can only be safely determined in connection with the respective application.

The following directives/standards are of essential importance for mechanical engineers:

- The **UL standard** for products and applications
- the **NFPA 79** – Electrical Standard for Industrial Machinery
- the **NFPA 70 (NEC, National Electrical Code)** for electrical on-site installations

The NFPA 79 and the NFPA 70 (NEC) were specified by the **NFPA** (National Fire Protection Association), an organization which publishes a comprehensive set of regulations for fire protection.

The NFPA 70 (NEC) is considered state-of-the-art technology by the US legal system. In addition, the local conditions have to be considered.

These local conditions are specified by the **OSHA** (Occupational Safety and Health Administration), one of the most important organizations for the enforcement of safety-technical requirements. It ensures safe and healthy occupational conditions and the protection of persons at their workplace by law, which became effective in 1970. In this context, the OSHA also publishes various standards on safety technology pertaining to machines and systems, which are to be considered for the respective application case.

Example: When it comes to the equipment of a liquid filling system, the **FDA** (Food and Drug Administration) has to be consulted if it is for foodstuff. Additionally, the conditions for hazardous locations may be observed if there is alcohol processed (danger of inflammable liquids or explosive gases).

US standard			Approximate IEC standard ¹⁾
Product standards			
UL 489	Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures	Standard for power distribution equipment, e.g. molded-case circuit breakers/MCCBs, miniature circuit breakers/MCBs, molded-case switches and instantaneous trip circuit breakers	IEC 60947-2
UL 508	Industrial Control Equipment	Standard for industrial control equipment, e.g. contactors, overload relays, PLCs, etc.	IEC 60947-2, IEC 60947-4-1
UL 508C	Power Conversion Equipment	Standard for power conversion equipment, e.g. converters	IEC 61800-5-1
UL 98	Enclosed and Dead-Front Switches	Standard for enclosed and dead-front switches, e.g. disconnectors, main switches	IEC 60947-3
UL 1077	Supplementary Protectors for Use in Electrical Equipment	Standard for miniature circuit breakers (MCBs) not covered by UL 489; application as "supplementary protectors"	IEC 60947-2, IEC 60934
UL 248	Low-Voltage Fuses	Standard for fuses with fuse holder UL 512	IEC 60269-XX
UL XXX	Further codes for devices used can be found under www.ul.com		IEC XXXXX
Application standards			
NFPA 79	Electrical Standard for Industrial Machinery	The "Electrical Standard for Industrial Machinery" is mainly applied in the automotive and machine tool industry	IEC 60204-1
UL 508A	Industrial Control Panels	Standard for industrial control panels	IEC 60204-1
UL 1741	Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources	Standard for installation of converters and their protection and control devices; it is particularly applicable to the testing of systems which serve the energy supply to the public network (grid connection), e.g. wind power, photovoltaics, etc.	IEC 60364-7-712
General installation standards			
NEC (NFPA 70)	National Electrical Code (NEC)	Installation standard for the USA; all electrical installations shall comply with this code; the NEC is generally applied by local inspectors (Authority Having Jurisdiction, AHJ) and revised every 3 years	IEC 60364-1

¹⁾ The IEC standards stated here serve as orientation. A one-to-one comparison of IEC and UL standards is not possible.

The UL Marks in Detail

For the marking of UL-certified products, a general differentiation is made between listed devices and recognized components. Further variants exist for the Canadian market.



UL Listing Mark: This is one of the most common UL marks. If a product carries this mark, it means UL found that representative samples of this product met UL's safety requirements. These requirements are primarily based on UL's own published standards for safety. This type of mark is seen commonly on appliances and computer equipment, furnaces and heaters, fuses, electrical panelboards, smoke and carbon monoxide detectors, fire extinguishers and sprinkler systems, personal flotation devices like life jackets and life preservers, bullet resistant glass, and thousands of other products.



C-UL Listing Mark: This mark is applied to products for the Canadian market. The products with this type of mark have been evaluated to Canadian safety requirements, which may be somewhat different from U.S. safety requirements. You will see this type of mark on appliances and computer equipment, vending machines, household burglar alarm systems, lighting fixtures, and many other types of products.



C-UL US Listing Mark: UL introduced this new Listing Mark in early 1998. It indicates compliance with both Canadian and U.S. requirements. The Canada/U.S. UL mark is optional. UL encourages those manufacturers with products certified for both countries to use this new, combined mark, but they may continue using separate UL marks for the United States and Canada.





Recognized Component Mark: This mark consumers rarely see because it is specifically used on component parts that are part of a larger product or system. These components may have restrictions on their performance or may be incomplete in construction. The Component Recognition marking is found on a wide range of products, including some switches, power supplies, printed wiring boards, some kinds of industrial control equipment and thousands of other products. They shall only be installed by experts of the manufacturer according to the so-called "Conditions of Acceptability (CoA)" apply to these devices. Amongst others, our portfolio contains the following products with UR mark: miniature circuit breakers according to UL 1077, time switches according to UL 917 and fuses SITOR.



Canadian Recognized Component Mark: Similar as the Recognized Mark (see above). Products intended for Canada carry the Recognized Component Mark "C."



Recognized Component Mark for Canada and the United States: This new UL Recognized Component Mark, which became effective April 1, 1998, may be used on components certified by UL to both Canadian and U.S. requirements. Although UL had not originally planned to introduce a combined Recognized Component Mark, the popularity of the Canada/U.S. Listing and Classification marks among clients with UL certifications for both Canada and the United States has led to the new mark.

Certifications such as  and  are issued by the so-called NRTLs (Nationally Recognized Testing Laboratories) after successful testing. The OSHA (Occupational Safety and Health Administration) has accredited Underwriters Laboratories Inc. as NRTL.

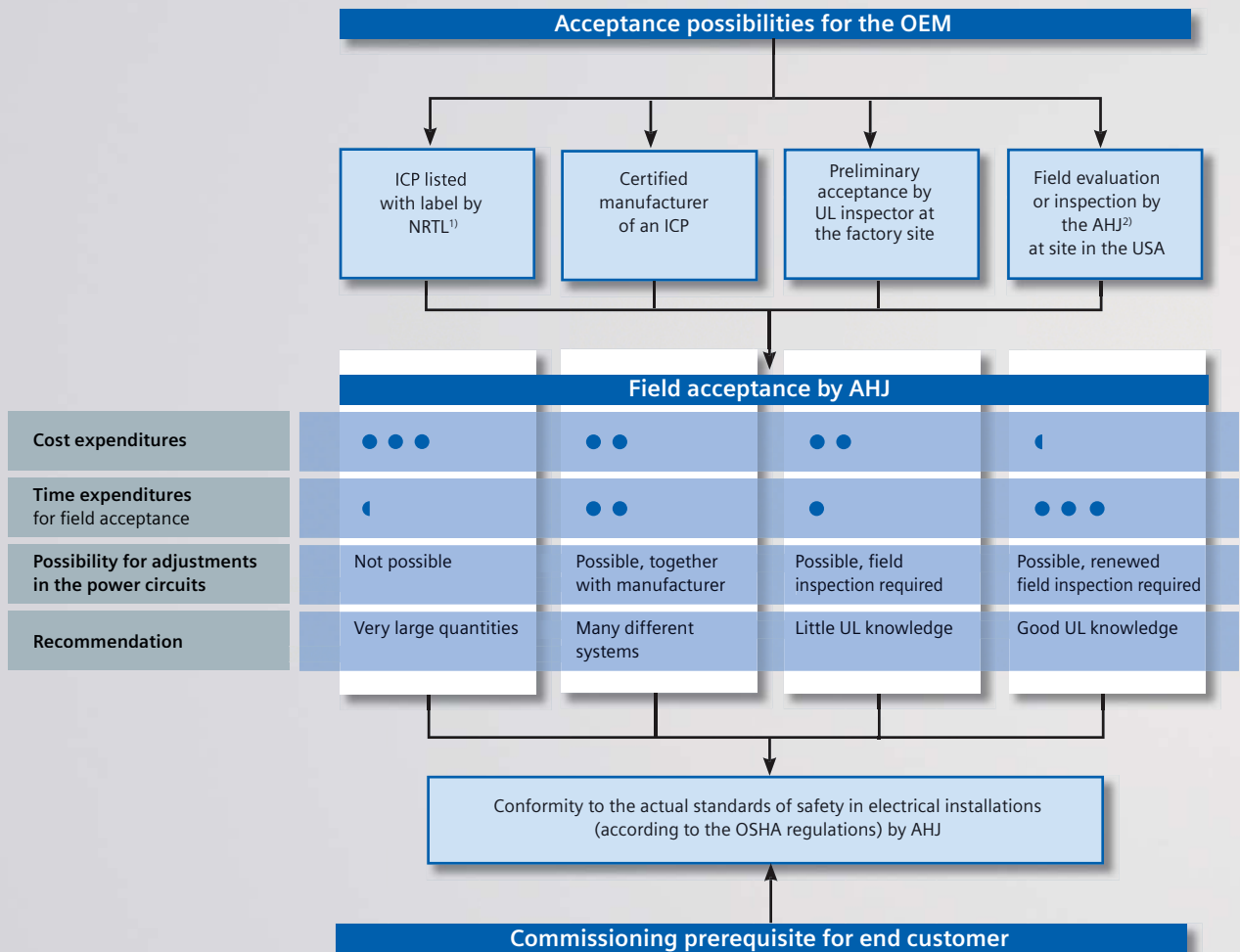


Test Privileges of the Production Facility Amberg

In 1995, the production facility Amberg was granted the authorization of implementing certifications in accordance with the Client Test Data Program (CTDP). As CTDP customer of UL, the production facility is entitled to carry out tests and independently prepare test as well as UL reports which contain the product description. UL merely verifies the compliance of the test and UL report with the UL standards. This way, the production facility Amberg has acquired a way higher degree of autonomy for the testing and certification process.

To ensure the products' compliance with the UL standards, UL inspectors regularly audit our factory within the so-called follow-up service. Follow-up service means that one or several devices are compared with the UL-certified documents, which are described in detail in a report. UL inspectors regularly visit the production plants to verify that the product is produced as described (example: SIRIUS contactors). With some devices, repeat tests are additionally implemented in regular intervals.

Field Inspection and Acceptance



¹⁾ Nationally Recognized Testing Laboratories

²⁾ Authority Having Jurisdiction

Every electrical machine or system in the USA is investigated by an inspector, the so-called **AHJ** (Authority Having Jurisdiction) prior to commissioning. The **NEC** (National Electrical Code, also called NFPA 70), the respective application-specific standards such as NFPA 79 as well as local standards and specifications form the basis for acceptance. Acceptance is required by law in the USA. Operators failing to have their machines or systems inspected by an AHJ both risk loss of insurance as well as power supply. For successful field acceptance, a correct configuration according to the applicable standards is of the essence. The illustration above shows four possible acceptance methods.

Conclusion

For manufacturing UL-conforming industrial control panels, the employment of UL-certified products alone is not sufficient. Also the interaction of devices in accordance with the respective application standard as well as the acceptance of the industrial control panel in its actual application environment are critical.

Particularities of the UL Market

Low-voltage networks in the USA

The network types used in the USA significantly differ from European networks. Other than in the IEC, also corner-grounded delta networks as well as solidly grounded wyes, which closely resemble the TN-S network, are employed.

In the United States of America /UL/NEC, all voltages used in the respective network type are stated (see table). As regards device selection, close attention must be paid to checking the network type used at the application site and the network types for which the individual devices are approved. The common network types used in industrial and functional building applications are 3-phase networks with 240 V and 480 V as well as 3- and 4-wire systems with 480Y/277 V. Furthermore, the single-phase system with 120/240 V can be frequently found particularly in residential buildings, but also in offices in industrial and functional buildings.

Industrial and commercial buildings



3 phase, 4 wire Solidly grounded wye

Caution: The PE must not carry any current. There is no PEN conductor
→ N = grounded conductor (white or gray); separate conductors must be used for PE and N

600Y / 347 V¹⁾

480Y / 277 V¹⁾

240Y / 131 V¹⁾

208Y / 120 V¹⁾



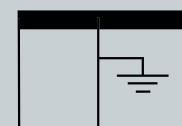
3 phase, 3 wire Corner-grounded delta

600 V

480 V

240 V

Residential buildings



1 phase, 3 wire Single phase, 120 / 240 V Grounded midpoint

Example: 120 V are used on the wall receptacle and 240 V for household cookers, air-conditioning units and laundry dryers

240 V to phase conductor

120 V to ground

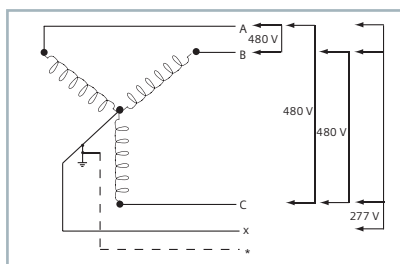
¹⁾ Y describes the solidly grounded circuit. The value "Y" indicates the voltage between the phases (e.g. 480 V), the value behind the slash indicates the voltage between the phase and the grounding or the neutral conductor (e.g. 277 V with 480 V voltage between the phases).

Circuits with straight and slash voltages

In the USA, the voltages are classified from the power utility or the secondary side of the power transformers. The circuit type (wye or delta) as well as the grounding method are very important.

In circuits with grounded wye, the circuit breaker only switches the full voltage between the phases (e.g. 480 V). The voltage phase-ground merely amounts to e.g. 277 V here, resulting in a 480Y/277 V slash voltage. Industrial control panels accommodating such devices must be marked with the following label: *"For use on a solidly grounded wye source only"* (UL 508A, Art. 54.12).

In ungrounded or high-resistance grounded wye or delta circuits as well as in corner-grounded delta circuits, only devices (e.g. circuit breakers) marked with a straight voltage, e.g. 240 V, 480 V or 600 V, shall be used. These devices must be able to switch the full voltage between the phases and one phase to ground.



Grounded wye, 480Y / 277 V,
3 phase, 4 wire

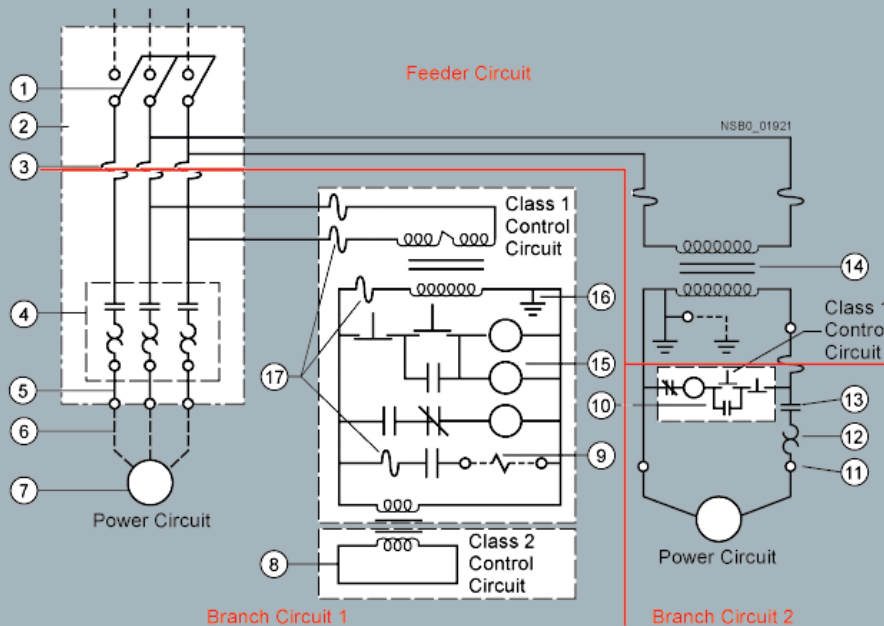
The self-protected combination motor controllers type E and F are restricted to circuits with grounded wye.

Short-circuit current rating of the control panel power circuit

An industrial control panel must be marked with a so-called SCCR (short-circuit current rating). In the IEC, this approximately corresponds to the I_{cw} value of the switchboard. The NEC 2008 Art. 409 describes the specifications of short-circuit current rating mark on industrial control panels (with reference to the UL 508A, SB4). For short-circuit rating, not only the short-circuit breaking capacity, e.g. of the circuit breaker, but also the short-circuit rating of every individual device in the power circuit is relevant. The SCCR-relevant components in the power circuit include circuit breakers, contactors, overload relays, solid-state switching devices, terminals, busbars, the line side of control transformers and frequency converters, however, no internal wiring of the industrial control panel.

The lowest value is applicable to the entire industrial control panel. No higher short-circuit current shall occur on the industrial control panel's supply terminals.

Circuit and Switching Elements of an Industrial Control Panel



Feeder circuit

The conductors and circuitry **on the supply side** of the branch circuit overcurrent protective device.

Branch circuit

The conductors and components **following** the last overcurrent protective device protecting the load.

Power circuit

Conductors and components of branch and feeder circuits. The power circuit can both be connected directly to the supply or via power transformers. Motor-driven loads are mostly classified as power circuits.

Here, respective protective devices are to be used, e.g. circuit breakers according to UL 489.

Control circuit

A circuit that carries the electric signals directing the performance of a controller, and which does not carry the main power circuit. A control circuit is, in most cases, limited to 15 amperes.

There are various ways of realizing control circuits:

- Direct tap-off upstream the branch circuit protective device. Here, respective protective devices are to be used, e.g. circuit breakers according to UL 489.
- Direct tap-off downstream the branch circuit protective device. Here, also so-called supplementary protectors can be used, e.g. miniature circuit breakers according to UL 1077.
- Via control transformers or DC power supply units. Caution: Various protective devices may not be approved for this application.

Class 2 control circuit

A control circuit supplied from a source having limited voltage ($30 V_{rms}$ or less) and current capacity, such as from the secondary of a Class 2 transformer, and rated for use with Class 2 remote-control or signaling circuits.

Class 1 control circuit (acc. to UL 508A)

A control circuit on the load side of an overcurrent protective device where the voltage does not exceed 600 volts, and where the power available is not limited, or a control circuit on the load side of a power limiting supply, such as a transformer.

Branch circuit protection

Overcurrent protection with an ampere rating selected to protect the branch circuit. For a motor branch circuit, the overcurrent protection is required for overcurrents due to short circuits and faults to ground only.

Field wiring

Conductors to be installed by others to connect the industrial control panel to source(s) of supply, remote control devices, and loads.

Power circuit internal wiring / Factory wiring

The devices shall only be connected by the factory.

Overcurrent protection

A device designed to open a circuit when the current through it exceeds a predetermined value. The ampere rating of the device is selected for a circuit to terminate a condition where the current exceeds the rating of conductors and equipment due to overloads, short circuits and faults to ground.

- 1 Fused disconnect switch acc. to UL 98, circuit breaker acc. to UL 489 or miniature circuit breaker acc. to UL 489
- 2 Combination motor controller
- 3 Branch circuit protection
- 4 Starter
- 5 Power circuit internal wiring / Factory wiring
- 6 Field wiring
- 7 Load (provided in the field)
- 8 Class 2 circuit
- 9 Solenoid or other control devices (provided in the field)
- 10 Control circuit / class 1 circuit / common control circuit
- 11 Field wiring terminals
- 12 Overload relay
- 13 Contactor / controller
- 14 Power transformer – for motor load and control circuit
- 15 Control circuit devices and wiring / class 1 circuit / isolated secondary circuit
- 16 Control transformer ground (for 1,000 VA max. control transformer)
- 17 Supplementary protection (miniature circuit breaker acc. to UL 1077)

Combination Motor Controller Examples

Assembly options of motor branch circuits

The assembly options of combination motor controllers within the IEC greatly differ from those for the UL market. Combination motor controllers according to IEC may cause UL inspectors or the AHJ to impose the so-called “red flag”, which means that the machine can only be put into operation after a significant change.

Motor branch functions:

- Disconnect
- Short-circuit protection / branch circuit protection
- Motor overload protection
- Motor control

Motor branch configuration types:

- Magnetic or manual motor controller
- Magnetic or manual motor controller in group installation
- Manual motor controller in group installation suitable for tap conductor protection
- Manual self-protected combination motor controller type E
- Magnetic / manual self-protected combination motor controller type F

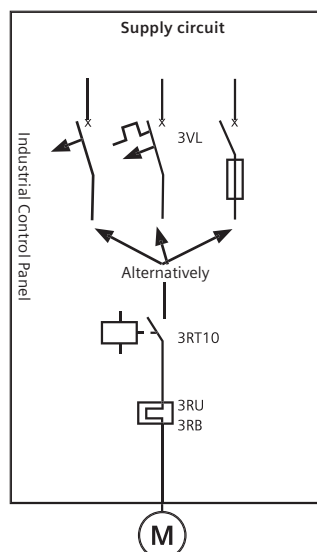
Magnetic motor controller

Application:

- With decentrally installed single motors (e.g. fans in factory hall)
- For few motors in the machine
- Motor branches for high voltages

Assembly:

- 1 short-circuit protective device
- 1 magnetic motor controller (contactor for remote motor switching)
- 1 overload relay



Devices	UL standard	Device functions			
		Discon-nect	Short-circuit protection	Motor control	Overload protection
Circuit breaker or disconnect switch / fuses	UL 489 UL 98 / UL 248	•	•		
Magnetic motor controller	UL 508		•	•	
Overload relay	UL 508				•

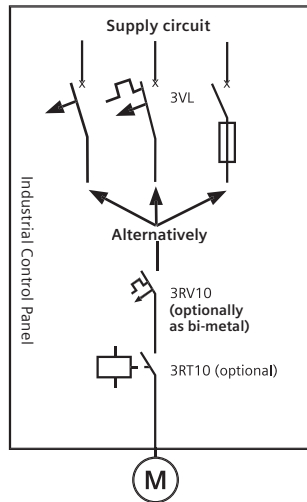
Manual motor controller (optionally magnetic with contactor)

Application:

- With decentrally installed single motors (e.g. fans in factory hall)
- For few motors in the machine
- Motor branches for high voltages

Assembly:

- 1 short-circuit protective device
- 1 manual motor controller (motor controller for manual motor switching and overload protection)
- Optional: 1 control device (contactor for remote motor switching)



Devices	UL standard	Device functions			
		Discon-nect	Short-circuit protection	Motor control	Overload protection
Circuit breaker or disconnect switch / fuses	UL 489	•	•		
	UL 98 / UL 248	•	•		
Manual motor controller	UL 508	•		•	•
Contactor (optional)	UL 508			•	

Magnetic or manual motor controller in group installation

Application:

- For systems comprising several motors

Assembly:

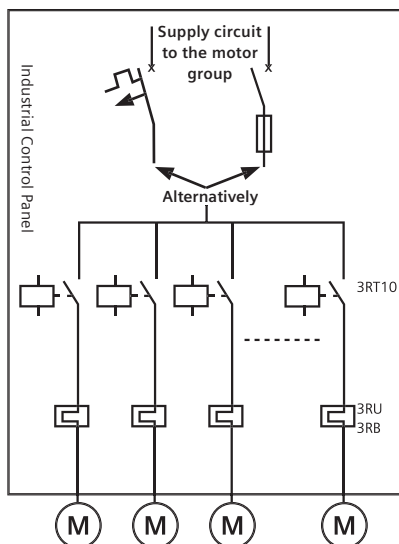
- 1 short-circuit protective device as group protection
- 1 magnetic motor controller per motor (contactor for remote motor switching)
- 1 overload relay per motor

or

- 1 short-circuit protective device as group protection
- 1 manual motor controller per motor (motor controller for manual motor switching)
- Optional: 1 control device per motor (contactor for remote motor switching)

Note: • Conventional assembly type if no certification as "type E" or "suitable for tap conductor protection in group installation" is available
• Often inefficient in practical applications due to the cable/wire size dimensioning rule

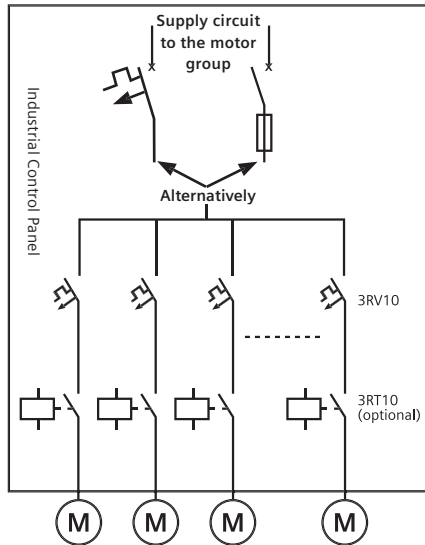
Magnetic motor controller in group installation



Devices	UL standard	Device functions			
		Discon-nect	Short-circuit protection	Motor control	Overload protection
Circuit breaker or disconnect switch / fuses	UL 489	•	•		
	UL 98 / UL 248	•	•		
Magnetic motor controller	UL 508			•	
Overload relay	UL 508				•

Magnetic or manual motor controller in group installation

Or: Manual motor controller in group installation (optionally magnetic with contactor)



Devices	UL standard	Device functions			
		Discon-nect	Short-circuit protection	Motor control	Overload protection
Circuit breaker or disconnect switch / fuses	UL 489 UL 98 / UL 248	•	•		
Manual motor controller	UL 508	•		•	•
Contactor (optional)	UL 508			•	

Manual motor controller in group installation suitable for tap conductor protection

Application:

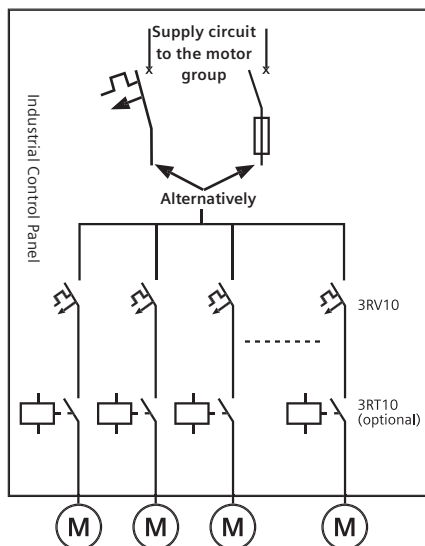
- For systems comprising several motors

Assembly:

- 1 short-circuit protective device as group protection
- 1 manual motor controller per motor with certification "suitable for tap conductor protection in group installation" (motor controller for manual motor switching)
- Optional: 1 control device (contactor for remote motor switching) per motor

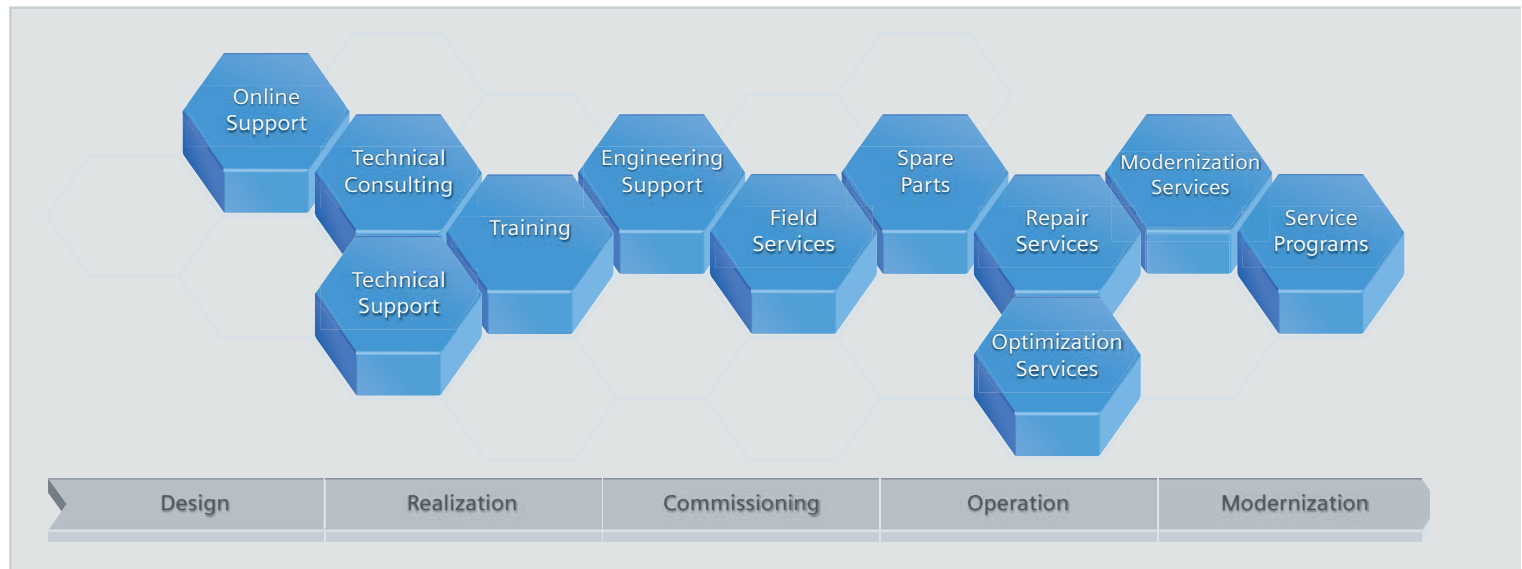
Note:

- Smaller line cross-sections permitted than with standard group installation
- No adapter required as opposed to type E
- As opposed to manual motor controllers in group installation, line protection is not realized by the upstream short-circuit protective device here, but by the devices themselves






Devices	UL standard	Device functions			
		Discon-nect	Short-circuit protection	Motor control	Overload protection
Circuit breaker or disconnect switch / fuses	UL 489 UL 98 / UL 248	•	•		
Manual motor controller	UL 508	•	•	•	•
Contactor (optional)	UL 508			•	

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Manual self-protected combination motor controller type E

Application:

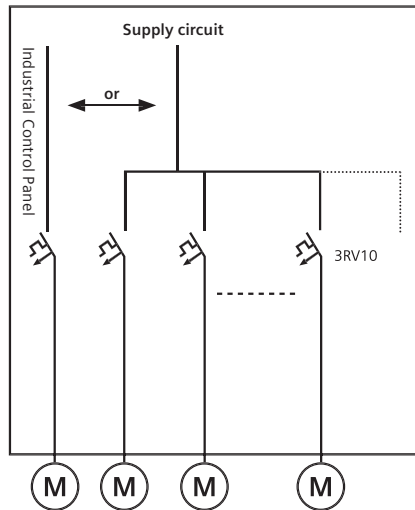
- For systems comprising one or several motors

Assembly:

- 1 manual self-protected combination motor controller type E per motor

Note:

- Upstream circuit breakers or fuses are not required
- Smaller cross-sections for motor supply line permitted than with group installation
- Type E controllers are only certified for motor protection
- Type E controllers require 1 inch through air and 2 inch over surface (for 251 V and higher) on the line side to comply with UL



Devices	UL standard	Device functions			
		Discon-nect	Short-circuit protection	Motor control	Overload protection
Manual self-protected combination motor controller	UL 508	•	•	•	•

Magnetic/manual self-protected combination motor controller type F

Application:

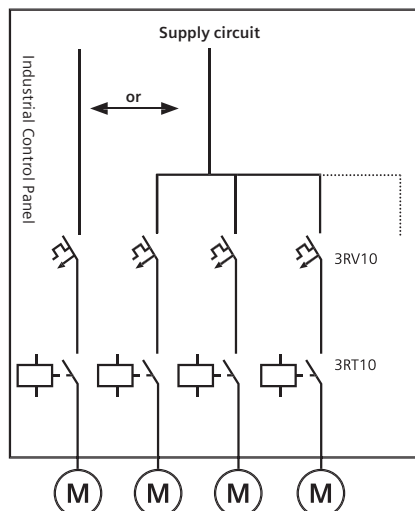
- For systems comprising one or several motors

Assembly:

- 1 manual self-protected combination motor controller per motor
- 1 magnetic motor controller per motor

Note:

- Upstream circuit breakers or fuses are not required
- Smaller cross-sections for motor supply line permitted than with group installation
- Type F controllers are only certified for motor protection
- Type F controllers require 1 inch through air and 2 inches over surface (251 V or higher) on the line side to comply with UL



Devices	UL standard	Device functions			
		Discon-nect	Short-circuit protection	Motor control	Overload protection
Manual self-protected combination motor controller	UL 508	•	•	•	•
Contactor	UL 508			•	

Notes:

For further information,

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