The Secrets of UL.

You have our support.

Answers for industry.
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 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.
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.
Take a look at our complete UL-certified product portfolio and see for yourself.

Further UL-approved devices, e.g. ALPHA 8HP insulated distribution systems or Insta 5TT5 7 contactors, are available at www.siemens.com/lowvoltage/ul-europe and are listed in our UL catalog LV16 "Controls and Components for Applications according to UL".
# 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.com/automation/mall.

- **On-site support** through global presence.

- **UL training programs**

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**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**
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<tr>
<td>Air circuit breakers (ACB) SENTRON 3WL5</td>
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<td>UL 489</td>
<td>The air circuit breakers SENTRON 3WL are particularly flexible. With only three sizes, they cover a power range from 250 A to 5,000 A. This makes them uncomplicated and universally applicable. All models feature the same design, operation and mechanical accessories. Result: Unique planning reliability and global applicability – with a single circuit breaker range!</td>
</tr>
<tr>
<td>Molded-case circuit breakers (MCCB) SENTRON 3VL</td>
<td></td>
<td>UL 489</td>
<td>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.</td>
</tr>
<tr>
<td>Circuit breakers SIRIUS 3RV17, 3RV18</td>
<td></td>
<td>UL 489</td>
<td>The circuit breakers SIRIUS 3RV17/18 are compact circuit breakers with 100% rating. They guarantee secure disconnection in case of a short circuit and protect consumers and system against overload.</td>
</tr>
<tr>
<td>Motor starter protectors / manual motor controllers SIRIUS 3RV10</td>
<td></td>
<td>UL 508</td>
<td>The manual motor controllers SIRIUS 3RV10 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.</td>
</tr>
<tr>
<td>Contactors / magnetic motor controllers SIRIUS 3RT, 3RH</td>
<td></td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Thermal overload relays SIRIUS 3RU</td>
<td></td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Solid-state overload relays SIRIUS 3RB</td>
<td></td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Soft starters SIRIUS 3RW</td>
<td></td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Fuseless load feeders SIRIUS 3RA</td>
<td></td>
<td>UL 508</td>
<td>The busbar system (fast bus system) SENTRON BUS 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.</td>
</tr>
<tr>
<td>Manual motor disconnect SIRIUS 3LD2</td>
<td></td>
<td>UL 508</td>
<td>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.</td>
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<tr>
<td>Disconnect switches SENTRON (manual motor controllers)</td>
<td>3KA</td>
<td>UL 508</td>
<td>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.)</td>
</tr>
<tr>
<td>Disconnect switches SENTRON with fuses (manual motor controllers)</td>
<td>3KL</td>
<td>UL 508</td>
<td></td>
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<td>Transformers SIRIUS</td>
<td>4AJ, 4AM, 4AP, 4AW 4AT, 4BT, 4AP, 4AU, 4BU</td>
<td>UL 506 UL 1561</td>
<td>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).</td>
</tr>
<tr>
<td>Power supplies SIRIUS</td>
<td>4AV</td>
<td>UL 1012</td>
<td>The power supplies SIRIUS are reliable, rugged, compact and comply with the latest standards.</td>
</tr>
<tr>
<td>Reactors SIDAC</td>
<td>4EM, 4ET, 4EP, 4EU 4EV</td>
<td>UL 1561 UL 506</td>
<td>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.</td>
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<tr>
<td>Filters SIDAC</td>
<td>4EF11 4EF15</td>
<td>UL 508 UL 1283</td>
<td></td>
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<tr>
<td>Miniature circuit breakers (MCBs)</td>
<td>5SJ4-...-HG</td>
<td>UL 489</td>
<td>The 5SJ4-...-HG miniature circuit breakers of the BETA low-voltage circuit protection portfolio can be used as “branch protector” for protection tasks in branches, distribution boards, industrial control panels and controls in accordance with UL 508A. Furthermore, they are also approved for circuit protection in heating, air-conditioning and ventilation systems.</td>
</tr>
<tr>
<td>Miniature circuit breakers (MCBs)</td>
<td>5SY4, 5SY6, 5SY7, 5SY8, 5SP4, 5ST30</td>
<td>UL 1077</td>
<td>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.</td>
</tr>
<tr>
<td>Compact starter SIRIUS</td>
<td>3RA6</td>
<td>UL 508 Type E</td>
<td>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</td>
</tr>
<tr>
<td>Motor starters SIRIUS</td>
<td>3RK</td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Motor management and control devices SIMOCODE pro</td>
<td>3UF7</td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Coupling relays SIRIUS</td>
<td>3TX70, 3RS18</td>
<td>UL 508</td>
<td>The very narrow coupling relays SIRIUS 3TX70 allow for particularly space-saving assemblies in the control panel and offer a large range of input and output coupling links.</td>
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<tr>
<td>Plug-in relays</td>
<td>LZX</td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Power relays</td>
<td>3TG10</td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Solid-state switching devices</td>
<td>3RF2</td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Timing relays</td>
<td>3RP15, 3RP20</td>
<td>UL 508</td>
<td>The electronic timing relays SIRIUS 3RP 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.</td>
</tr>
<tr>
<td>Monitoring relays</td>
<td>3UG4</td>
<td>UL 508</td>
<td>The electronic monitoring relays SIRIUS 3UG4 facilitate the maximum protection of non-stationary machines and systems – particularly in instable networks. Line and voltage faults can be detected and rectified early before leading to more substantial damage.</td>
</tr>
<tr>
<td>Temperature monitoring relays</td>
<td>3RS10, 3RS11</td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Thermistor motor protection</td>
<td>3RN1</td>
<td>UL 508</td>
<td>The thermistor motor protection devices SIRIUS 3RN1 offer a professional and reliable temperature-dependent overload protection of three-phase motors.</td>
</tr>
<tr>
<td>Interface converters</td>
<td>3RS17</td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Position switches</td>
<td>3SE5</td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Magnetically operated switches</td>
<td>3SE6</td>
<td>UL 508</td>
<td>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.</td>
</tr>
<tr>
<td>Cable-operated switches</td>
<td>3SE7</td>
<td>UL 508</td>
<td>The cable-operated switches SIRIUS are employed for monitoring applications or as EMERGENCY-STOP device in particularly hazardous system components.</td>
</tr>
<tr>
<td>Pushbutton units and indicator lights</td>
<td>3SB</td>
<td>UL 508</td>
<td>The pushbuttons and indicator lights SIRIUS are characterized by maximum functionality, their modern and flat design as well as particular ease of mounting.</td>
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<tr>
<td>Signaling columns SIRIUS</td>
<td>8WD4</td>
<td>UL 508</td>
<td>The signaling columns SIRIUS 8WD4 are employed for checking complex machine functions or in automated processes and serve as visual or acoustic warning device.</td>
</tr>
<tr>
<td>ALPHA FIX Terminal blocks</td>
<td>8WA, 8WH</td>
<td>UL 1059 (completely or partially)</td>
<td>A complete range of terminal blocks is available in all conventional connection technologies for the secure connection of wires, conductors and lines.</td>
</tr>
<tr>
<td>LV HRC fuse bases</td>
<td>3NH3, 3NH4</td>
<td>UL 512 (only downstream the branch protection)</td>
<td>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.</td>
</tr>
<tr>
<td>Cylindric fuse holders and Class CC fuse holders</td>
<td>3NW7 0xx/3NW7 1xx, 3NW7 5x3-0HG, 3NW1 xxx-0HG, 3NW2 xxx-0HG, 3NW3 xxx-0HG</td>
<td>UL 512 UL 248-4</td>
<td>Our range of cylindric fuses is particularly characterized by a high switching capacity, high current limiting and minimized design.</td>
</tr>
<tr>
<td>SITOR Semiconductor fuses and fuse holders</td>
<td>3NE, 3NC3 3NC1 0, 3NC1 4, 3NC2 2</td>
<td>UL 248-13 UL 512</td>
<td>The particularly compact and flexible fuses SITOR for semiconductor protection are suitable for a multitude of industrial applications.</td>
</tr>
<tr>
<td>Overvoltage protection devices</td>
<td>5SD7 424-1 5SD7 423-1 5SD7 422-1 5SD7 444-1 5SD7 443-1 5SD7 442-1 5SD7 414-1 5SD7 413-1</td>
<td>UL 1449</td>
<td>Surge arresters protect the low-voltage systems against overvoltages and high currents that can be triggered by direct lightning strikes.</td>
</tr>
<tr>
<td>Switch disconnectors</td>
<td>5TE1</td>
<td>UL 508</td>
<td>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 disconnector unit.</td>
</tr>
<tr>
<td>Receptacles</td>
<td>5TE6 804</td>
<td>UL 498</td>
<td>The receptacles 5TE are for example employed for the connection of plug-in communication devices in communication distribution boards or in switchboards for maintenance purposes.</td>
</tr>
<tr>
<td>Time switches</td>
<td>7LF4 4, 7LF5 3</td>
<td>UL 917</td>
<td>The digital and mechanical time switches 7LF of the latest generation offer numerous functions and ease of handling. The digital timing of process sequences ensures profitable power savings.</td>
</tr>
<tr>
<td>Time and pulse counters</td>
<td>7KT5 8</td>
<td>UL 863</td>
<td>Time and pulse counters are employed for the reliable detection of production and service times. They facilitate an accurate planning and monitoring of production sequences, maintenance cycles and warranty periods.</td>
</tr>
<tr>
<td>Power monitoring devices SENTRON PAC3200, SENTRON PAC4200</td>
<td>7KM</td>
<td>UL 61010-1 UL 50, enclosure type 5</td>
<td>The innovative power monitoring devices SENTRON PAC3200 and SENTRON PAC4200, which can be connected to a wide range of load types, allow you to record energy precisely. The provided measuring data allow analysis of the system status and power quality and are displayed on the device or centrally evaluated using power management software such as SIMATIC WinCC powerrate or SIMATIC PCS 7 powerrate.</td>
</tr>
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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”.

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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

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

Application Examples

Circuit breakers and contactors with UL certification in tunnel boring machines

Renowned automotive manufacturer relies on Siemens quality worldwide
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.
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 systems, 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).
## Product standards

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<td>UL 489</td>
<td>Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures</td>
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<tr>
<td>UL 508</td>
<td>Industrial Control Equipment</td>
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<tr>
<td>UL 508C</td>
<td>Power Conversion Equipment</td>
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<td>UL 98</td>
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<tr>
<td>UL 1077</td>
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</tr>
<tr>
<td>UL 248</td>
<td>Low-Voltage Fuses</td>
</tr>
<tr>
<td>UL XXX</td>
<td>Further codes for devices used can be found under <a href="http://www.ul.com">www.ul.com</a></td>
</tr>
</tbody>
</table>

## 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.
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.

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.

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 $I_{cu}$ 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.
**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.
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

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<th>Devices</th>
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<tr>
<td>Circuit breaker</td>
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<tr>
<td>or disconnect switch /</td>
<td>UL 98/</td>
<td>●</td>
</tr>
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<td>fuses</td>
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<tr>
<td>Magnetic motor</td>
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<td>Magnetic/motor controller</td>
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<tr>
<td>Overload relay</td>
<td>UL 508</td>
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</table>
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)

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<tr>
<th>Devices</th>
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<tr>
<td>Contactor (optional)</td>
<td>UL 508</td>
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</tbody>
</table>

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

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<tr>
<td>Overload relay</td>
<td>UL 508</td>
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</table>
Magnetic or manual motor controller in group installation

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

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

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

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<td>Manual motor controller</td>
<td>UL 508</td>
</tr>
<tr>
<td>Contactor (optional)</td>
<td>UL 508</td>
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</tbody>
</table>
**Manual self-protected combination motor controller type E**

**Application:**
- For systems comprising one or several motors

**Assembly:**
- 1 manual self-protected combination 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 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

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**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
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<tr>
<td>Amongst others, provision of rapid and targeted information on:</td>
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<td>- 2D dimension drawings, isometric illustrations and 3D models</td>
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