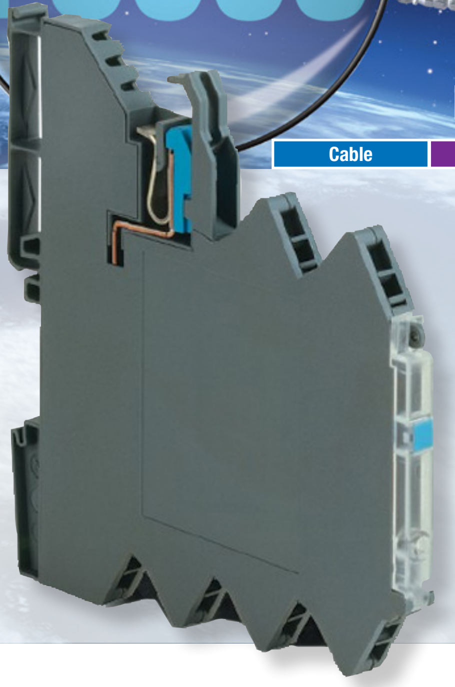
Product FOCUS

LUTZE SYSTEMATIC TECHNOLOGY

Efficiency in Automation

Cable | Connectivity | Cabinet | Control

Reliable protection of **DC 24V circuits** in automation applications



Intelligent safeguarding of selectivity

Primary switching controllers and automatic power units nowadays form the basis of the DC 24V supply level. Due to the operating behaviour of those devices, the specified selective protection of individual circuits, especially in case of overcurrent, is virtually unfeasible. A complete system shutdown is inevitable.

Unlike traditional miniature circuit breakers, electronic fuses monitor and limit the current with greater accuracy and cut-out faulty branches with much shorter delays. This means that a faulty branch can be safely opened even with long cable runs or small wire sizes.

In practice there are typically three types of loads that need to interact in a machine;

- Sensitive electronics
- Robust electromechanical components
- Safety relevant circuits

Using a shared power supply unit for types of loads has been standard practice.

Especially sensitive are the electronic loads such as a PLC that even with the shortest interruptions of the supply voltage suffers a loss of function or an accidental re-start.

The permissible limits for the ride-through time and the supply voltage range of control components are specified in EN61131-2 and shown here in figure 1. Any deviation from this is critical.

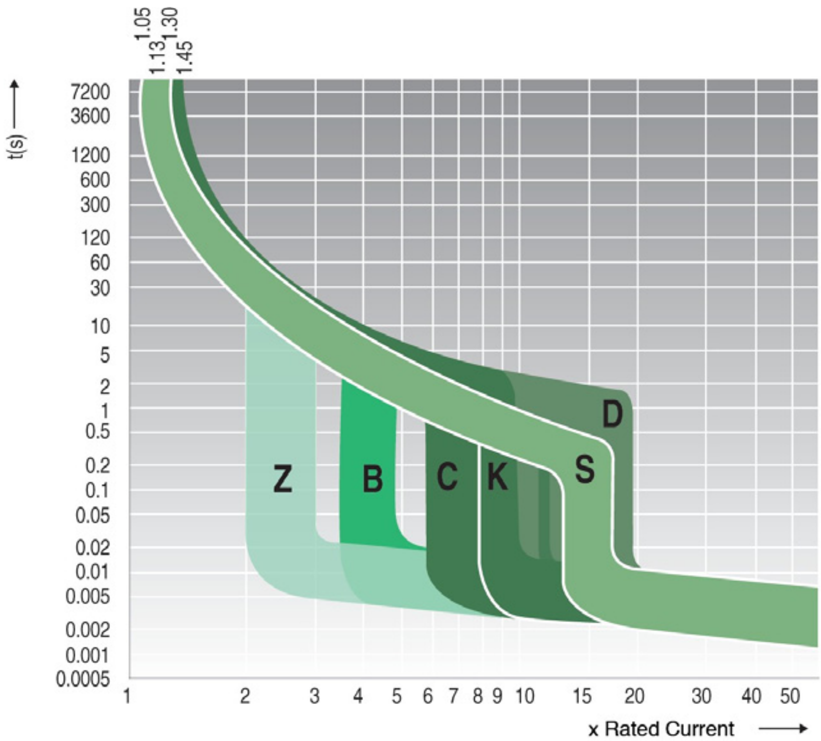
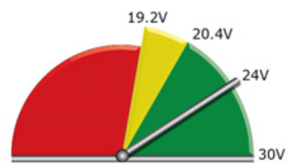
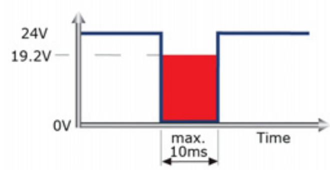


Figure 1:
Limit values conforming to EN/ IEC 61131-2



Permissible voltage range for 24V DC systems according to EN/ IEC 61131-2 section 5.1.1.1

The range from 19.2 to 20.4V is only permissible as a superim - posed AC-ripple voltage



Maximum permissible voltage interruptions for 24V DC systems according to EN/ IEC 61131-2 section 5.1.1.3

Operating behaviour of primary switching power supplies

Switched-mode power supplies and their components are rated for a specific nominal value and run hot under higher load. To protect against self-destructing, they shut down at between 1.1 and 2.5 times the nominal current, according to type. Many devices feature Hiccup mode, which switches off in case of overload and automatically switches back on after a short time. If the overload persists, the process repeats until the fault is manually rectified. This means a fuse is never tripped. Using devices with a forward characteristic does not deliver success either. The power supply does not switch off, but supplies only a 1.1 to 1.2 times higher output current when the output voltage is reduced. This characteristic likewise does not trip an automatic circuit-breaker, or if it does, then only in the hours range.

Furthermore, both output modes have the disadvantage that loads such as DC motors or capacitive consumers cannot be started. At additional cost, operation of heavy loads can be achieved in the simplest case by using a device with a higher output power or a device with integrated power boost.

In this, the device with power boost continuously supplies 1.2 to 1.3 times the nominal current in the temperature range up to +45°C. On reducing the output voltage, a maximum of 2.5 times the nominal current is reached which, dependent on the device itself and the characteristic of the automatic circuit-breaker, may be just enough to effect a shutdown.

Characteristics of automatic circuit-breakers

The trip curve of an automatic circuit-breaker with characteristic B (Figure 1) is considered by way of example. To record smaller over-currents, a thermal trip in the minutes to hours range is used (hold >1h at I = 1.13 x Inom and trip <1h at I = 1.45 x Inom). Switch-off in case of high overcurrents is effected by immediate magnetic tripping within 0.01 to

0.1 seconds. If such a device is used in conjunction with a 10A switched-mode power supply, the switch-off occurs at 1.2 times the nominal current only after 20 to 60 minutes. Even at 2.5 times nominal current (power boost) between 25 seconds and two minutes elapse until switch-off in the thermal range. In short: essential protection - in particular selective protection of connected devices - is not provided. The fuse essentially performs a dummy function. In the event of a short-circuit or faulty wire supply would be maintained at 2.5 times nominal current. System failure or even a cable fire may be the consequence.

Cable length Increases the problem as wire resistance increases and limits the current. So the breaker will take even longer to trip.

Selective switch-off

Selective load protection means that in case of overload or short-circuit only the faulty current path is switched off, with no reactive effect on the supply. The standards EN60204-1 (line protection and fire prevention) and EN 61131-1 and -2 (operating states and storage) are also applicable to the rating of the overcurrent protection device in DC 24V circuits. In concrete terms, this means withstanding a mains power failure lasting 10ms without functional impairment, which demands the deployment of large input capacities. Furthermore, hazardous overcurrents must be reduced to a safe level within 5s. Rating is made more difficult by the fact that nowadays many parallel consumers are supplied by way of one protection element.

Output-side protection

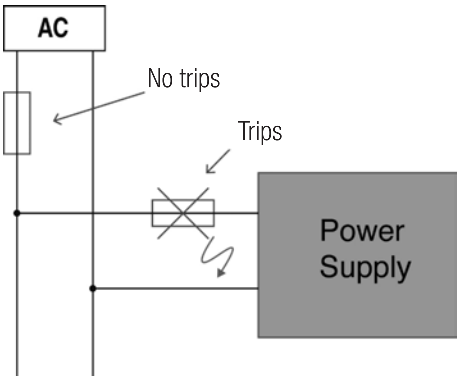
Alongside the output behaviour described earlier, there is a U/I characteristic with an additional power reserve. However, all these output behaviour modes are ultimately not suitable for safe activation of standard line protection equipment. The reason lies in the technical design of the equipment. Only electronic protection devices capable of reacting fast enough to overload or short-circuit offer a solution. These devices also feature a high degree of repeat accuracy across the entire temperature range. With the LOCC Box LÜTZE offers intelligent DC protection modules which can also be integrated into field bus communications systems.

Selectivity

Selectivity means the tripping coordination. In electrical systems, distinction can be made between "series selectivity", which means that individual fuses connected in series are selective against each other, and "parallel selectivity", which means that electrical circuits connected in parallel are selective against each other.

Series selectivity

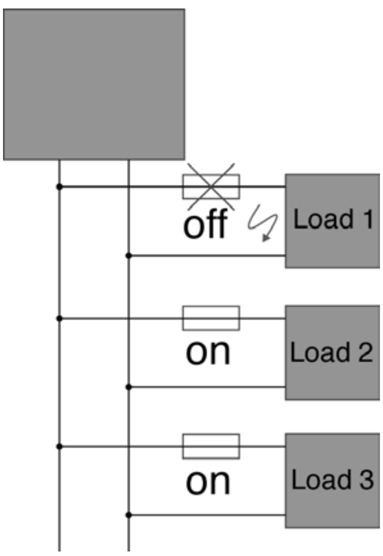
In case of series-connected fuses, the tripping coordination of fuses is considered as selective if only the fuse installed nearest to the fault trips. Fuses that are located nearer to the energy feeding point do not trip. This guarantees that as many system parts as possible remain operative in the event of one single fault, resulting in an increased availability of electrical systems.



Rule of thumb: The fuses must differ by two nominal quantities

Parallel selectivity

Based on the self-protection, the output voltage is switched off or reduced in the event of a fault. If multiple loads are carried on one power supply, a voltage drop will occur throughout the entire application. To prevent this, protective devices are installed in the individual lines to the consumers. If a fault occurs, the protective device concerned must trip fast enough so as to disconnect the faulty power supply reliably from the rest of the system and such that the other power supplies remain available.



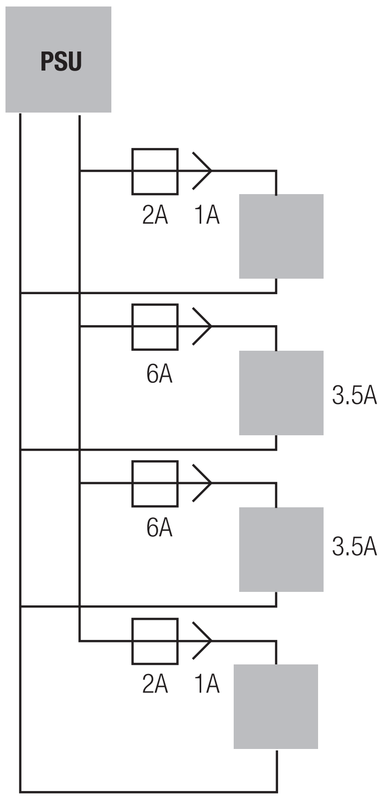
Connection cross-sections

The line cross-sections are selected dependent on the maximum output current. The following table provides an overview of the current capacities of multi-core flexible copper cables with different conductor cross-sections at a temperature of 30 °C and up to a nominal voltage of 1000 V (to DIN 57100-523).

Cross-section in mm²	A
0.75	12
1	15
1.5	18
2.5	26
4	34
6	44
10	61

What does this mean in practice?

For example, if you have four branches, two requiring 1A nominal current and two others at 3.5A each. Two electronic fuses with 2A and two with 6A would normally be chosen. In normal circumstances, 9A flows where a 10A power supply might be chosen.



If a 3.5A group then suffers a fault or a short-circuit, the 6A fuse requires 9A to trigger. This means that, together with the other three branches, the power supply must be able to supply 14.5A to shut-down the faulty branch.

The necessary current reserve is determined by the fuse with the greatest maximum ampere value and in this case is 5.5A. In practice, a 20A standard power supply would need to be used in this example, even though the nominal current is only 9A.

If a plant is modified, refurbished or extended during operation, there is a danger lurking here. At this time, it is very likely that nobody would think about the required "current reserve" any more, and the power supply is loaded up to the permitted nominal current. In the case of a branch failure, the power supply is then limiting the current before the fuse can cut-out the faulty branch.

LÜTZE LOCC-Box – the intelligent current monitoring system

LOCC-Box single module

The ideal solution would be one which is capable of optimally operating capacitive loads to start heavy loads and quickly detecting an overcurrent in operation and switching off only the affected path. Such a system should of course store the fault so as to prevent danger from switching back on and permit diagnosis. The Lütze LOCC-Box system meets those requirements in a modular design with additional intelligent functions. To meet the widely varying demands on switch-off response, the LOCC-Box system features the facility to program 10 different characteristics by way of a switch. With 5 standard characteristics pre-programmed into the device with the option to create custom characteristics. The nominal current range can additionally be selected with switch settings from 1A to 10A. The adjustable current range and characteristic is very important when retrofitting, as in such cases the device protection often has to be modified and adapted. As additional information, the capacity utilisation of the path is indicated by an LED. When 90% of the programmed current value is reached the status LED starts to flash. In the event of a switch-off due to overcurrent or short-circuit, the LED changes from green to red.

A 24V signal is set as a collective fault warning. This eliminates the need to install and wire additional auxiliary contacts. A restart after clearing the fault is then effected either using the mechanical switch on the device or from the main system by remote control. This channel-based switching facility is of great importance in particular in the commissioning phase of a system, as it enables individual system components to be activated and checked specifically.

LOCC Box network capability

The latest technology in the “LOCC Box NET” provides the user with real time data using industrial standard networks via a gateway such as Ethercat, Profinet, Profibus, RS232 and a standard USB interface. The user can obtain the values for Current/ Voltage/ I^2T curves and operating times on individual slices using the network or via USB with Lutze Locc Pads software.

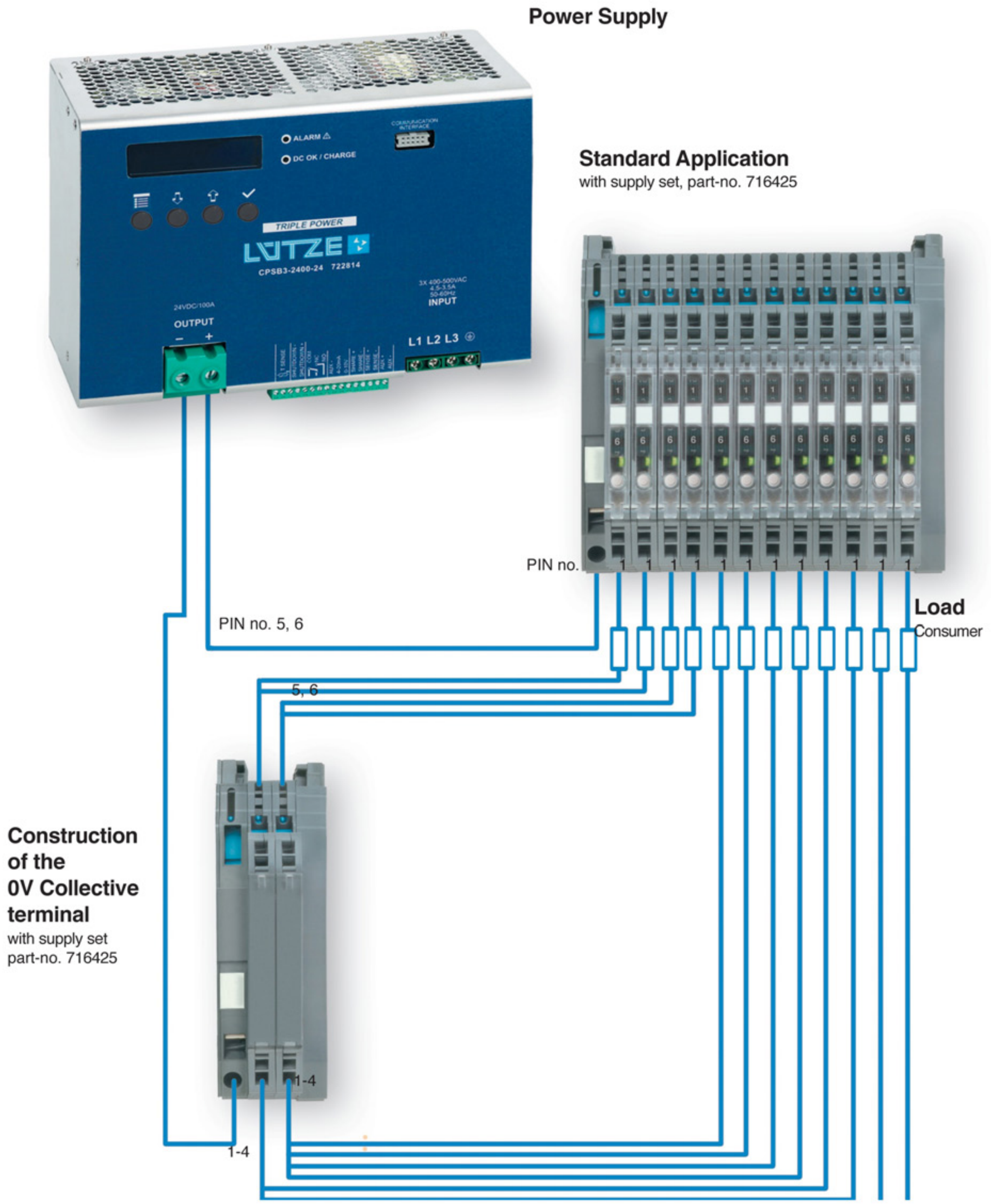
LOCC Box Gateways

LOCC-Box

The LOCC-Box system is setting new standards. The single-channel design with all the functionality described offers the highest possible flexibility. As shown below, customers can decide whether the supply is provided by each module individually or via the system supply (infeed terminal, copper rail, end terminal). The particular advantage of this method of infeed is the screwless contact carriage, which permits exchanging of individual channels in operation without interrupting the entire supply. This provides functionality to switch off individual paths to perform essential work safely. The maximum supply current is dictated by the $6mm^2$ terminal, and is rated at 40A DC. The slim width of just 8.1mm results in an installed width of just 340mm even with a 40-channel configuration. The system housing is complemented by name plate labels, seals and a jumper system to loop signals.

0 V Collective Terminal

The 0 V collective terminal 716420 enables the 0 V return from the load to the 0 V supply in the tightest space. The integrated sliding contact enables an insulation measurement when the contact is open.



Safety Relevant Circuits

Safety relay manufacturers specify the maximum fuse rating that should be used to protect their products. (Typically 6A).

Any device used to protect safety relays must not contain a protective device above this value, even if the device can be set to operate below the 6A threshold.

The fuse is designed to protect the internal contacts of the safety relay and any associated load that is being switched.

Below is a typical safety relay application.

It shows the potential fault current path if one of the devices connected to the safety relay develops a short circuit. If the safety relay is not protected sufficiently a potentially expensive replacement is required, with the associated down time that this would create to initiate the repair.

The LOCC BOX SC can be set to optimally protect any load connected to a safety relay with its settings of 1-5A providing short circuit and effective overload protection.

In the event of catastrophic failure the LOCC BOX SC has a 6A back up fuse integrated in to the device ensuring protection for the safety relay in line with the manufacturers recommendation.

The Lütze LOCC Box is not a safety switch device in compliance with EN 60947-5-1, EN 60204 or VDE 0113-1.