Solutions for the machine building industry
Contents

A company with a vision 3

How to set up a DC 24 V supply 4

Fundamental Challenges 5-6
- Why do miniature circuit breakers (MCBs) not trip when powered by a switch mode power supply?
- Why do long cable lengths and too small cable cross sections aggravate the tripping problems with switch mode power supplies?
- Why do I have to protect my cables?

Other challenges in DC 24 V protection 6-9
- What do I need to observe for the North American market?
- Why do intelligent protection solutions help to increase machine uptime?
- How to create the urgently required space in control cabinets?
- How can clearly structured power distribution solutions enhance machine uptime?
- What do you have to observe when selecting overcurrent protection for drives?

Typical design of a DC 24 V protection 10-11
- AC protection
- Switch mode power supply
- Electronic overcurrent protection

Solutions for injection-moulding machines 12-13

Solutions for machine tools 14-15

Solutions for packaging machines 16-17

E-T-A – a globe-spanning network 18-19
Welcome to E-T-A
Founded in 1948, E-T-A pioneered the development of precision performance circuit breakers for equipment protection and is now the market leader in the field of overcurrent protection and power distribution. We produce a wide range of circuit breakers and electronic circuit protectors, solid state relays and remote power controllers, power relays and system solutions for global markets in our production facilities in Germany, Tunisia, Indonesia and the USA.

One thing is always at the heart of our endeavours: E-T-A products provide protection. In everything we do, with each and every unit we produce that our customers install in their applications, we protect man and machine against the effects of overcurrent and short circuit.

For this purpose we offer mechanical and electronic solutions, single components or entire systems, standardised or customer-specific. We ensure that the current, without which our modern life is simply unthinkable, remains manageable. We ensure that it does not cause any damage in the event of a failure.

The protection of lives is at the core of our endeavours.
This is also a matter of value protection. We ensure that the equipment and systems where our solutions are installed do not get damaged by the consequences of overcurrent and short circuit. We ensure permanent function, smooth production and eventually the profitability of the target products. No matter if it is an assembly line, a chemical production plant, a machine tool or if it is only one component or an entire system including power supply.

We know that you want to offer your customers the best possible solution. You’ll manage even better by using E-T-A’s superior quality solutions. We hope we can support you with our products and make the world a little safer.

Please do not hesitate to get in touch.

Dr. Clifford Sell
Director
E-T-A Elektrotechnische Apparate GmbH
Good to know

Control voltage in the voltage rating range of DC 24 V (DC 48 V) continues to be on the rise. Control systems, sensors, actuators, safety and drive engineering systems are powered with DC 24 V. This can only work if the necessary components are rated correctly, including the AC protection as well as the switch mode power supply and the DC overcurrent protection. These constituent parts form the core of any automation solution and ensure trouble-free machine operation.

More and more frequently, smart communication protection systems are used here. They make monitoring and remote maintenance of the control voltage level easier. Any user wants to have maximum machine uptime and this can be achieved when all components are matched so that they work together perfectly. When selecting the suitable products, fundamental challenges have to be faced which are explained in detail in this brochure.
**Fundamental Challenges**

**Why do miniature circuit breakers (MCBs) not trip when powered by a switch mode power supply?**

Switch mode power supplies have meanwhile become state-of-the-art in the DC 24 V systems of machine and panel builders and are actually indispensable. They are characterised by a compact design and high reliability in continuous operation mode. However, in the overload range they can offer only very limited power reserves. These are frequently only 1.5 times rated current. If we look at the example of a 20 A s, it means: 20 A x 1.5 = 30 A

Even if an overload or short circuit theoretically exceeds this, the power supply would practically protect itself and turn down the output voltage correspondingly. If an MCB is operated at such an output for protection purposes, this MCB is technically not capable of disconnection. The current required to trip an MCB simply cannot be provided by the power supply. Electronic circuit protectors, however, have a specific characteristic curve which ensures tripping nevertheless.

*Exclusively the faulty path is disconnected due to selective protection. This makes trouble-shooting much easier and increases machine uptime.*

---

**Why do long cable lengths and too small cable cross sections aggravate the tripping problems with switch mode power supplies?**

Increased resistance limits the actually available current and can cause undesired disturbances. The available current I is determined by the supply voltage U and the total resistance R.

\[ I_{\text{max}} = \frac{U_{\text{supply}}}{R_{\text{tot}}} \]

Hence the following applies:

\[ I_{\text{max}} = \frac{U_{\text{supply}}}{(R_{\text{line}} + R_{\text{transition resistance}} + R_{\text{overcurrent protective device}})} \]

---

**Example:**

\[ R_{\text{line}} = 50 \text{ m/1.5mm}^2 \]

**MCB C6A**

The Ohmic law aggravates the tripping problems with switch mode power supplies.

---

**The magnetic trip range of an MCB with C characteristic (45 A ... 90 A) is not always within the allowed overload range of the 20A power supply: the DC 24 V output voltage breaks down.**

**The electronic trip range is within the permissible overload range of the 20A power supply.**

The DC 24 V supply remains stable.

**Example: electronic circuit protectors**

---

The fundamental challenges of modern switch mode power supplies.
Why do I have to protect my cables?

Circuits must be protected against overcurrent. The section for the overcurrent protection of control circuits (section 7.2.4 of DIN VDE 0113-1) says that circuits have to be protected by overcurrent protection equipment. For cable protection, the maximum load capacity of the conductor must be taken into account in addition to the type of installation and the ambient temperature. The load capacity depends on the cross section and thus on the max. current per time unit (I²t value) in the event of a short circuit. A copper cable with a cross section of 0.5 mm² can carry max. 9 A in accordance with VDE 0891 T1 at 30 °C ambient temperature. Smaller cross sections are very often used when connecting actuators and sensors.

In order to avoid overload of the selected cables in the event of a failure, the circuit breaker need to be selected in accordance with the cables installed. Both the active current limitation and the time-controlled disconnection offer perfect protection in the event of a short circuit or overload. Both types of function limit the max. I²t value and thus offer precise overcurrent protection.

Other challenges of DC 24 V protection

What do I need to observe for the North American market?

A lot of machinery and equipment manufactured in Europe is in the end delivered to North America. For this market, it is paramount to have components approved to UL standards which are accepted both by European and North American UL inspectors. The switching and control cabinets for North America must normally comply with UL508A ("Industrial Control Panel"). For protection of the DC 24 V control voltage, it is mandatory to have circuit breakers at least with UL1077 approval, so-called «Supplementary Protectors». The ESS31 electronic circuit breaker fully meets this requirement and can therefore be used to UL508A.

Electronic circuit protectors:
Purely electronic circuit protectors normally have an approval to UL508listed ("Industrial Control Equipment") and/or UL2367 ("Solid State Overcurrent Protector"). UL2367 can for some circuit protectors up to 4A be supplemented by the approval UL1310 (Class 2 Power Unit NEC Class 2). Thus these devices can also be used in secondary circuits to UL508A. Due to the «listed» approval, a procedure description is not required.

UL approvals are required for the North American market.
Why do intelligent protection solutions help to increase machine uptime?

Increasing machine uptime to have a machinery that keeps producing on an invariably high level is in the focus of machine and panel builders. The quick implementation of the IO link system offers a great number of available components, transmission of measuring values and status information, all in all unrivalled transparency. It allows early detection of fault conditions on the machinery and prevention of unexpected standstills.

The EM12D-T10 supply module has an IO link interface. Status information and important measuring values are transmitted via this interface to the IO link master. The IO link master is able to collect the information of the entire DC 24 V power supply and to transmit it to the superordinate control unit with only one port.

How to create the urgently required space in control cabinets?

Saving space in control cabinets is a topical subject in machine building. Many end customers do not only wish to have smaller control cabinets, but also additional space in reserve of at least 20% to 30%. This would allow later revisions or extensions. With modular electronic circuit protectors, the user saves up to 65% space in the control cabinet. For ease of integration into an application, we can of course provide ePlan macros.

Meet the requirements of many customers: E-T-A's electronic circuit protectors provide more space in the control cabinet.
Other challenges of DC 24 V protection

How can clearly structured power distribution solutions enhance machine uptime?

Frequently, terminal blocks are used for the distribution of DC 24 V applications. It very often causes completely unclear layouts and complex wiring structures in the control cabinet.

The +output of the DC 24 V supply is connected with the terminal blocks by means of suitable cables. From there, sub-supply is wired up with the protection equipment and finally connected with the loads. In order to close the circuit, the load must be wired up with the minus cable arrangement, which are often placed apart from each other.

Placing the distribution directly beside the protection generates a clearly structured wiring. In the same system, the +DC 24 V distribution can very easily be built up with the minus distribution 0V and loads can clearly be assigned.

Clearly structured power distribution solutions make trouble-shooting easier through a clear wiring assignment.
What do you have to observe when selecting overcurrent protection for drives?

Today many applications in mechanical engineering require precise positioning, quick transportation or powerful actions such as lifting or lowering. In order to be able to realise these complex processes in the applications precisely enough and in the desired speed, DC motors are used as well as multiphase motors and servomotors. These drives are electronic 48 VDC loads in the applications and have therefore to be protected against the consequences of overcurrent and short circuit.

The robust design ensures unrivalled stability for selective protection of more loads at one DC 48 V supply. Particularly for the protection of power trains such as DC motors, multiphase motors, servomotors and their control systems, the ESX10-TC-101-DC 48 V electronic circuit protector ensures unrivalled operational reliability.

Overcurrent protection for drives has to tolerate inrush currents

Electronic circuit protector
ESX10-TC-101-DC-48 V
AC protection provided by MCBs is the prerequisite for protection of the line leading to the switch mode power supply. In the event of short circuit or overcurrent, the MCB will reliably trip to prevent hazardous situations caused by high leakage currents.

Switch mode power supply

The switch mode power supply transforms the AC 230 V/400 V voltage into DC 24 V which is very frequently required in machine building. The current limited by the switch mode power supply is now available for the load supply.

Electronic overcurrent protection

The loads and their supply lines have to be protected against overload and short circuit. Electronic overcurrent protection is the most reliable solution. For this application range, E-T-A offers a great number of professional solutions in a compact design for your machinery.
<table>
<thead>
<tr>
<th><strong>Thermal-magnetic MCB</strong></th>
<th><strong>Benefits</strong></th>
</tr>
</thead>
</table>
| ![Thermal-magnetic MCB](image1.png) | • Global and comprehensive application range through meeting all relevant international standards  
• High safety level for the entire machinery through reliable cable protection  
• Reduced wiring time through flexible systems for conductor connection and terminals in all current ratings |

<table>
<thead>
<tr>
<th><strong>Power supply</strong></th>
<th><strong>Benefits</strong></th>
</tr>
</thead>
</table>
| ![Power supply](image2.png) | • Superior reliability because the switch mode power supply and the overcurrent protection equipment are perfectly matched  
• Reduced system cost through a very high performance at a very low installation width  
• Enhanced machine uptime through a long life span and reliable operatability |

<table>
<thead>
<tr>
<th><strong>Electronic overcurrent protection</strong></th>
<th><strong>Benefits</strong></th>
</tr>
</thead>
</table>
| ![Electronic overcurrent protection](image3.png) | • Cost-saving design with a flexible and innovative mounting and connection technology without accessories  
• Minimum space requirement through a compact design with a width of only 12.5 mm, even with two channels  
• Enhanced machine uptime through selectivity, quick failure detection, transparency and remote diagnosis |
Typical solution for injection-moulding machines

Manufacturers of injection-moulding machines often complain about shortage of space in their control cabinets. The compact design of E-T-A’s DC 24 V overcurrent protection solutions, compliant with the relevant standards, create the desperately needed space in the control cabinet. The components’ modular design additionally makes handling of the devices easier for the end customer.

Cable protection in accordance with EN 60204-1

NEC Class 2 to UL 1310 up to 4 A

Electronic circuit protector REX12-T
Cost-conscious, standard-compliant overcurrent protection

REX12 Electronic Circuit Protector

The flexible and compact all-in-one solution consists of various, perfectly matched components and has been especially designed for the cost-conscious machine building industry.

It starts with the EM12 supply module, which can process up to 40 A supply current at DC 24 V and which provides group signalisation for error indication. Single or double channel REX12 devices can then easily be mounted side by side to the supply module in any optional sequence.

They are available in standard current ratings from 1 A to 10 A. Finally, the PM12 potential distribution modules are added for plus and minus distribution.

Connection of the only 12.5 mm wide modules is exclusively with push-in terminals which allow no-tool time-saving wiring.

Besides the UL508listed approval and NEC Class2, the REX12-T also meets the requirements of cable protection to EN60204-1.

Your benefits

- Reduction of cost and time, no further accessories required
- 50% space savings thanks to modules that are only 12.5 mm wide
- Overcurrent protection compliant with the relevant standards – fail-safe elements are adjusted to the current rating

Typical solution for injection-molding machines

Supply module EM12-T

© KraussMaffei
In industrial use, utilisation and permanent availability of machines must be ensured around the clock. In order to avoid unnecessary failures, E-T-A overcurrent protection solutions provide maximum transparency in machine tools as well as quick trouble-shooting and failure resolution. In combination with remote diagnosis, they enable a significantly enhanced machine uptime.

Machine tools for the metal-cutting surface treatment of workpieces
The REX12D series combines the advantages of the flexible and compact REX all-in-one solution with the properties of a digital and intelligent circuit protector with IO link connection.

The system combines the well-proven quality of DC 24 V overcurrent protection with the communication capabilities of the IO link system. This smart communication allows complete transparency of the DC 24 V power supply and provides all necessary information for a reliable production process at an early stage.

Up to 16 channels of REX12D overcurrent protection can be mounted side-by-side as single or double channel devices in fixed or variable ratings. No additional accessories are required for the mechanical connection of the individual components.

Early notification in the event of any disturbances and a fast response to current problems will increase system availability, are cost-effective and improve the overall stability of the production process.

Your benefits

- **Enhanced machine uptime** because IO link technology offers more transparency and remote diagnosis
- **Ease of PLC integration** through pre-cut functional modules and libraries
- **Minimised stock levels** because only one adjustable device is required for all current ratings from 1 A to 10 A
Typical solution for

packaging machines

Manufacturers of packaging machines depend on the permanent and reliable uptime of their machines. Besides unrivalled operational reliability with overcurrent protection in compliance with relevant standards, E-T-A protection solutions also ensure compact and clearly structured power distribution in control cabinets.

Packaging machines for shaping, filling, closing and packing of goods

| Electronic circuit protector ESX10-TB with active current limitation |
| Electronic supplementary protector ESS31-T with physical isolation |
Versatile overcurrent protection with current limitation
ESX10 and ESS31 electronic circuit protectors

The ESX10 is a single-channeled electronic overcurrent protection device for the selective protection of DC 12 V, 24 V and 48 V applications.

Active current limitation provides optimum protection for the switch mode power supply. Inrush currents of capacitive loads are tolerated, current peaks are limited.

Besides fixed current ratings from 0.5 A to 16 A, adjustable devices are also available. In the event of a failure the device disconnects the faulty path after max. 3 seconds. It increases system machine uptime by means of a selective disconnection.

ESS31
The ESS31 circuit breaker combines standard electronic overcurrent protection with active current limitation and physical isolation. Selective protection excludes back feed because overload currents at disconnected at 1.2 times rated current within 500 ms. With a single characteristic curve, the ESS31 offers standard-compliant protection, even with long load lines or small cable cross sections.

In addition, the ESS31 can be used everywhere in the world thanks to comprehensive approvals such as UL1077 and EN/IEC60934.

Your benefits

- **Individual use world-wide** thanks to a comprehensive range of international approvals
- **Enhanced stability** of the DC 24 and 48 V supply voltage through integral linear current limitation
- **Reduced complexity** of the application by way of an integral wiring solution
E-T-A – a globe-spanning network

For information on our global network please visit: www.e-t-a.de/contact
Europe
- Belgium (including Luxemburg and the Netherlands)
- Germany
- Finland
- France
- Italy
- Croatia
- Norway
- Austria
- Poland
- Russia
- Sweden (including Denmark)
- Switzerland
- Serbia
- Slovenia (including Bulgaria)
- Spain (including Portugal)
- Czech Republic (including Slovakia)
- Turkey (including Middle East)
- Hungary
- United Kingdom (and Ireland)