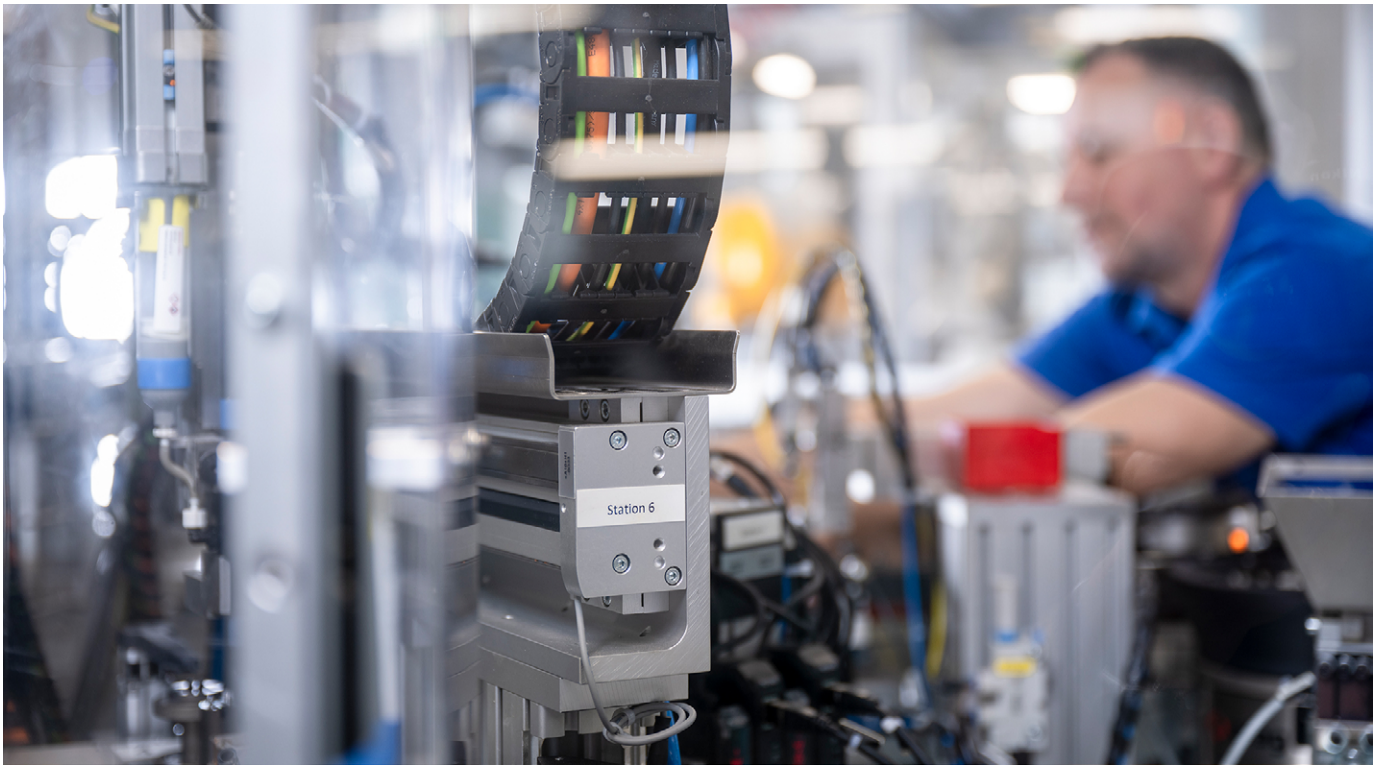
IEC 60204-1: machine safety

Any machine or system that wants to be brought onto the market in the EU and associated countries must bear a CE marking issued by the manufacturer himself. With this marking, the manufacturer guarantees that his product complies with all applicable legal and technical requirements. It is a matter of safety. For humans and machines.



Safety for humans and machines is defined in the harmonising standard IEC 60204-1.

In Europe, the Machinery Directive 2006/42/EC and the Low Voltage Directive 2014/35/EU set minimum standards for safety and occupational health requirements. The details and designs for implementation are defined in separate technical specifications, known as harmonising standards.

IEC 60204-1

One of these harmonising standards is IEC 60204-1, which specifies the requirements for the electrical equipment of machines.
It applies to electrical, electronic and programmable electronic equipment as well as to groups of networked machines, including control cabinet constructions.

Coverage

IEC 60204-1 basically covers devices and components that are operated with nominal voltages up to 1000 VAC or 1500 VDC and with nominal frequencies up to 200 Hz. It covers the complete electrical installation of a machine all the way to the mains cable.

EMC

Chapter 4 of IEC 60204-1 defines electromagnetic compatibility (EMC). EMC immunity and emission tests are mandatory. However, the standard provides for the possibility of waiving certain tests if the electrical components used already fulfil the relevant EMC requirements and the wiring of the components has been carried out in accordance with the manufacturer's operating instructions. The CE marking of the components basically guarantees that they fulfil the EMC requirements. However, it should be noted here that the components only have to fulfil the EMC limit values of the component standard. And this is not necessarily sufficient to also comply with the application standard. For example, a motor drive meets the EMC requirement for drives, but not necessarily the requirement for machines. It is therefore advisable to carry out an EMC measurement on the finished system

Mains connection

IEC 60204-1 sets requirements for the mains connection in chapter 5. Part of this

SCHURTER offers mobile EMC measuring systems

is that a disconnecting device must be provided to prevent unexpected start-up. In the event of a mechanical hazard, it is mandatory to provide an emergency stop (chapter 10).
The protective elements are defined in chapter 7. In addition to the necessary overcurrent protection, the use of residual current circuit breakers (RCD = Residual Current Protective Device) is also defined. Accessory sockets on the machine must be equipped with a personal protection RCD max. 30 mA. Please note that RCDs for personal protection must trip at 30 mA earth leakage current, but may already trip at 50 % of the limit value.

Leakage currents

The residual current circuit breakers provide reliable personal protection. They detect fault currents to earth, for example caused by an insulation fault, and switch them off before persons are endangered. The problem is that an RCD cannot distinguish between leakage currents that occur during normal operation and dangerous residual currents. Frequency converters in particular, which are needed for the energy-efficient operation of motors, cause large leakage currents.
It is therefore advisable to measure the leakage currents of the entire system in different operating states. This is the only way to be sure that the system can be operated without problems in a fault-current protected installation. Special attention should be paid to the switch-on and switch-off earth currents. These can be tricky and cause the RCD to switch off. Furthermore, it is advisable not only to measure the currents in the 50 Hz mains frequency: In modern systems with many frequency converters, leakage currents can occur over a wider frequency range.

Safety checks

Chapter 18 describes the safety checks. Special attention is paid to the earth conductor and the documentation of the electrical power supply. Furthermore, an insulation measurement is required. This must show an insulation resistance of at least 1 MΩ at a test voltage of 500 VDC between voltage-carrying parts and the protective conductor or metal housing.
The standard also requires testing of the ambient conditions. The installed components must be checked to ensure that they are suitable for the expected loads in terms of vibration, shock and impact resistance. The altitude of the future place of use must also be taken into account.

EMC filter

In order to comply with the required EMC limits, it is advisable to ensure that the machine is designed in accordance with EMC requirements and to use one or more filters. Often, a 1- or 2-stage summation filter at the mains input is sufficient. If this is not sufficient, it usually helps to place filters or filter elements close to the sources of interference - especially the frequency converters. The measure taken must be verified with an EMC measurement.
Earth leakage currents should be measured urgently. If these are too high for a mains connection with RCD, an attempt must be made to reduce them. For example, if the inrush leakage currents are too high, the machine can be started up gradually. This effectively reduces the currents to earth and can often be achieved simply by adjusting the control system. Many EMC filters, especially those for motor drives, generate high leakage currents to earth due to their construction with many large capacitors between phases and earth. These filters can be exchanged for low-leakage current variants. The use of 4-wire filters with neutral conductor instead of 3-wire filters can also provide a remedy.

If a machine is plugged into the mains, the touchable voltage at the plug pins must be max. 60 V after 1 second. For machines permanently connected to the mains, a discharge time of 5 seconds is sufficient. To comply with the EMC limits, filters with many large capacitors between the phases are often used. These allow a large attenuation of the interference voltage. The problem is that these capacitors store a lot of energy, which is still present when they are disconnected from the mains. It is recommended to select filters with shorter discharge times. In this case, the discharge time of the capacitors is shortened by using leakage


SCHURTER FMBD EP: 2-stage 3-phase filter with neutral conductor

resistors with smaller nominal values. This allows a filter's time of >6 seconds for discharging the residual voltage of 400 V to 60 V within less than two seconds. Some filters even have discharge times of <1 second and are therefore suitable for plug-in connections.
It should be noted that additional capacitors are often installed next to the filter. The entire system must always be evaluated. Therefore, it makes sense to measure the discharge time of the entire system to the required extra-low voltage. For the insulation measurement against earth, it must be noted that in EMC filters resistors are often wired to the capacitors between phases and earth. For the insulation measurement, these should have a resistance value of at least 1 MΩ. Important: It should also be noted here that there may be other resistors between phases and protective earth throughout the installation. It is therefore essential to measure the insulation resistance of the entire system.

Machines must also be tested with regard to their environmental conditions. This includes vibration, shock and impact resistance as well as the altitude of the place of use. EMC filters consist of components such as chokes and capacitors, which could be damaged by high vibration levels or mechanical shock. Therefore, filters with a robust design are recommended. For example, filters with partially potted components are much better protected against vibrations.
Most filters are qualified for altitudes up to 2000 m.a.s.l. according to the filter standard IEC 60939. For applications at higher altitudes, the extended air and creepage distances according to IEC 60664-1 must be observed.
SCHURTER has developed very specific new filter variants which fully meet the requirements of IEC 60204-1.

About SCHURTER

The SCHURTER Group is a globally successful Swiss family business. With our components ensuring the clean and safe supply of power, input systems for ease of use and sophisticated overall solutions, we impress our customers with agility and excellent product and service quality.

SCHURTER AG
Werkhofstrasse 8-12
6002 Lucerne
CH-Switzerland
+41 41 369 31 11
contact.ch@schurter.com
schurter.com

References / Downloads

1. SCHURTER EMC-Service
2. White Paper Leakage Currents
3. White Paper High Altitude