Surge protection for frequency converters

A frequency converter typically consists of a rectifier, d.c. link, inverter and control electronics (**Figure 9.1.1**).
At the inverter input, a single-phase a.c. voltage or three-phase line-to-line a.c. voltage is converted into a pulsating d.c. voltage and is fed into the d.c. link which also serves as an energy storage system (buffer).
Capacitors in the d.c. link and earthed L-C sections in the mains filter can cause problems with upstream residual current protective devices (RCDs). These problems are often incorrectly associated with surge arresters. They are, however, caused by short-time fault currents of the frequency converter which are sufficiently high to trip sensitive RCDs. This can be prevented by using a surge-proof RCD circuit breaker which is available with a discharge capacity of 3 kA (8/20 µs) and higher for a tripping current $I_{\Delta n}$ = 30 mA.
The inverter provides a pulsed output voltage via the control electronics. The higher the pulse frequency of the control electronics for pulse width modulation, the more similar is the output voltage to a sinusoidal curve. However, with each pulse a voltage peak occurs that is superimposed on the fundamental wave. This voltage peak reaches values of more than 1200 V (depending on the frequency converter). The better the simulation of the sinusoidal curve, the better the run and control performance of the motor. This, however, means that voltage peaks occur more frequently at the output of the frequency converter.
In order to pick the correct surge arrester for your frequency converter, the maximum continuous operating voltage U_c must be taken into account which specifies the maximum permissible operating voltage a surge protective device may be connected to. Owing to the voltage peaks that occur during the operation of frequency converters, arresters with a high U_c value must be used to avoid "artificial ageing" due to the heating of the surge arrester under "normal" operation conditions and the associated voltage peaks.
Heating of surge arresters can lead to a shorter service life and a disconnection of the surge arrester from the installation it is supposed to protect.

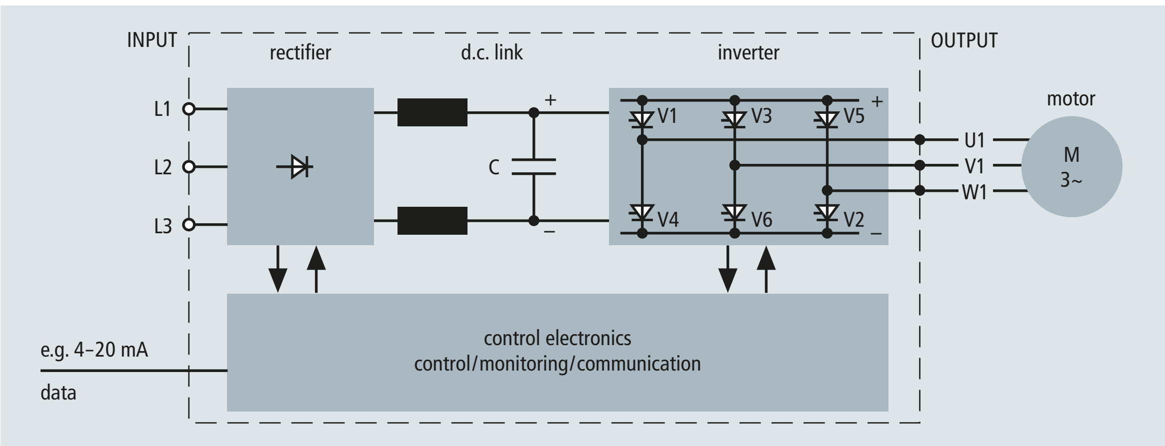


Figure 9.1.1 Basic principle of a frequency converter

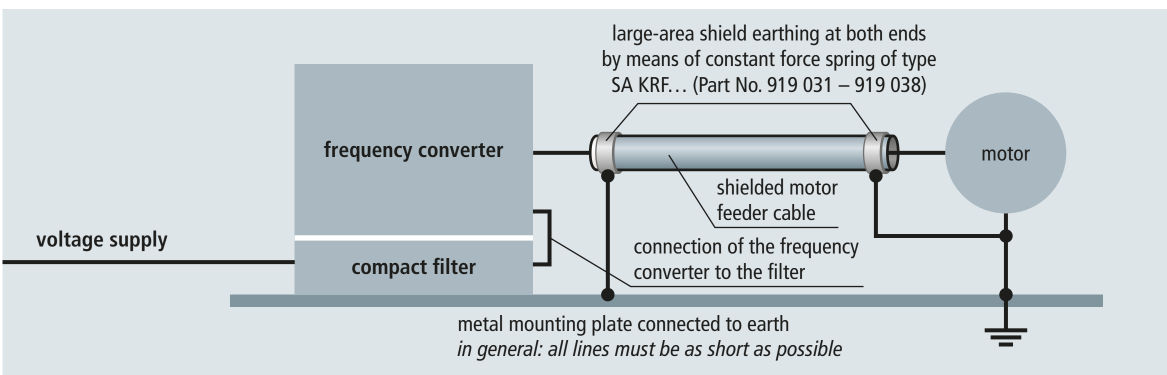
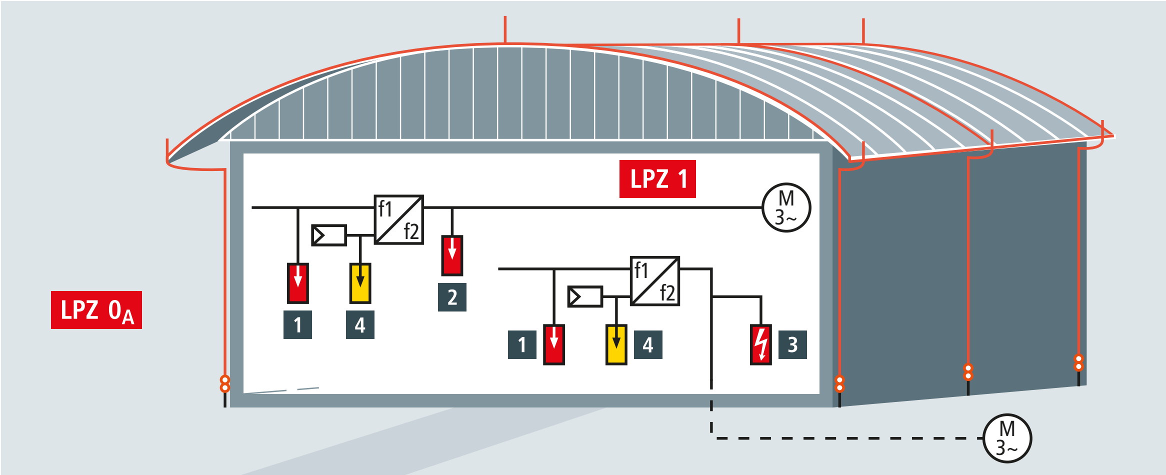


Figure 9.1.2 EMC-compatible shield connection of the motor feeder cable



No.	Surge protective device		Part No.
1	DEHNguard modular	DG M TNS 275 (TN-S system)	952 400
	DEHNguard modular	DG M TT 275 (TT system)	952 310
2	DEHNguard S	DG S WE 600 (3 items)	952 077
3	DEHNbloc Maxi + DEHNguard S	DBM 1 760 FM (3 items) DG S WE 600 (3 items)	961 175 + 952 077
4	BLITZDUCTOR XT + BLITZDUCTOR XT base part	BXT ML2 BE S 24 (e.g. 4 – 20 mA) BXT BAS	920 224 + 920 300

Figure 9.1.3 Frequency converter with drives in LPZ 0_A and LPZ 1

The high pulse frequency at the output of the frequency converter causes field-based interference. To avoid that other systems are interfered with, the motor feeder cable must be shielded. The shield of the motor feeder cable must be earthed on both ends, namely at the frequency converter and at the motor. To this end, large-area contact with the shield must be provided, preferably by constant force springs (**Figure 9.1.2**), to fulfil EMC requirements. Intermeshed earth-termination systems, namely the connection of the earth-termination system of the frequency converter to that of the drive motor, reduce potential differences between the different parts of the installation, thus preventing equalising currents from flowing through the shield.

When integrating a frequency converter in the building automation, all evaluation and communication interfaces must be protected by surge protective devices to prevent surge-related system failure. **Figure 9.1.3** shows an example of the controller interface 4 – 20 mA.