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Installation information for power wiring of frequency inverters

Frequency inverters in the high power range require special attention to correct planning, design and installation of the equipment in order to ensure proper protection of persons, wiring and the device. For this, the state of the art must be complied with, which can be found in the relevant national regulations and standards, as well as in the design and installation information in the manuals from Getriebebau NORD GmbH & Co. (subsequently referred to as NORD).

In order to achieve proper protection, the safety elements must be carefully selected. Suitable safety elements for frequency inverters from NORD can be found in the respective manual (Section 7, technical data). Depending on the maximum short circuit current at the mains connection point, these are automatic circuit breakers or fuses with particular trigger characteristic curves.

The trigger times depending on the short circuit current are stated in the data sheets for the safety elements. The maximum short circuit current results from the mains voltage and all impedances in the circuit:

- power source
- selected connection cables
- lengths of the connection cables (on the mains and motor side)
- mains or DC choke at the frequency inverter input
- internal resistance of the device and return line
- protective earth (PE)

In case of a short circuit to the frame, the short circuit current flows back to the supply via the protective earth. The impedance of the protective earth is usually somewhat lower than the impedance of the supply line. At first, this results in a contact voltage at the housing which is slightly less than half of the external cable voltage (> 80 V AC with a string voltage of 230 V AC).

The standard IEC/EN 61800-5-1 stipulates that above a contact voltage of >25 V AC a time limit must be complied with. The time reduces with increasing contact voltage.

For 80 V AC, the switch-off must be less than 0.19 s.

The required protection of persons, cables and the device is ensured if these specifications are complied with.

Example

The following example shows a typical layout of a frequency inverter installation with the associated fuse element for an American mains system (480 V AC, 60 Hz, TN network).

Mains transformer

Power	630 kV
Longitudinal inductance L_T	31.7 µH

Resistance R_T	1.8 mΩ
Reactance X_T	12 mΩ

Frequency inverter

Type	SK 515E-113-340-A
Input voltage	480 V
Internal resistance R_{FI}	1.5 mΩ
Cable cross section	120 mm²

Motor power	110 kW
Input current	180 A [1]
Output current	180 A
Tightening torque terminals	15 Nm

1) with DC choke connected to the link circuit

DC choke

Resistance R_D	2.14 mΩ

Output current	180 A

Due to the direct current in the link circuit as well as the saturation characteristics of the DC choke, only the ohmic resistance component of the DC choke is effective in case of short circuit.

The equivalent circuit data L_D, R_D and X_D can be found in the frequency inverter manual.

Connecting cables

Mains cable length	50 m
Cable cross section	120 mm²

Motor cable length	10 m

Fuse type (specified in the frequency inverter manual)

Fuse element	350 A (Class J)

Determination of the trigger time (e.g. short circuit in the frequency inverter)

String voltage	277 V AC
Short circuit current in case of error I_{KF} ($R_{PE} = R_L$, $X_{PE} = X_L$)	9.719 kA
Short circuit current with arcing I_K ($I_K = I_{KF} / 2$)	4.859 kA [1]

1) Source: DGUV, DGUV Information 203-007, October 2012

The typical trigger time of the fuse is determined on the basis of the time/current curve of its data sheet. The worst case for the duration is a short circuit with arcing.

The trigger time with arcing is 0.02 s for this example.

Result

The trigger time is significantly less than 0.19 s and thus complies with the standard IEC/EN 61800-5-1.