EMC-DAG VOOR INSTALLATEURS EN MACHINEBOUWERS 13.10.2015 FHI LEUSDEN



LEAKAGE CURRENTS IN DRIVE SYSTEMS **CAUSES / PROBLEMS / SOLUTIONS** Dipl.-Ing. Malte Heuermann Productmanager EMC Phone +49 (0) 4231 678 253 Malte.heuermann@block.eu AGENDA

BLOCK

Measurement of leakage currents









MALTE HEUERMANN

LEAKAGE CURRENT IN DRIVE SYSTEMS

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BLOCK IN NUMBERS





LEAKAGE CURRENT IN DRIVE SYSTEMS

OUR PRODUCTS





FERRITES

BLOCK SOLUTIONS ARE FOUND IN EVERY APPLICATION





DEFINITION



Leakage current (for operational reasons)

"Leakage current is the current in an unwanted current path under normal conditions" (acc. VDE 0100-200).

Conditional operating current flowing in fault-free devices or systems via the protective conductor or other conductive parts to earth potential.

Fault current (in case of error)

"current flowing through a given point of failure due to an insulation fault" (acc. VDE 0100-200).

Current flowing through the protective conductor or other conductive parts to ground potential in the event of a fault.

DISTRIBUTION OF DISTURBANCES DIFFERENTIAL MODE UND COMMON MODE





The inverter generates no pure symmetrical voltage system. A common mode voltage remains. Differential mode voltage



Common mode voltage



DISTRIBUTION OF DISTURBANCES DIFFERENTIAL MODE AND COMMON MODE





DISTRIBUTION OF DISTURBANCES DIFFERENTIAL MODE AND COMMON MODE





The motor side inverter generates differential mode disturbances between the phases on motor and line side. Common mode currents are driven over the motor and cable capacitances to earth and back over the line side to the input rectifier and the DC link.

DISTRIBUTION OF DISTURBANCES LEAKAGE CURRENT





MEASUREMENT OF LEAKAGE CURRENTS RESIDUAL CURRENTS





MEASUREMENT OF LEAKAGE CURRENTS RCD (RESIDUAL CURRENT OPERATED PROTECTIVE DEVICE)





Multi-phase operated electronic equipment such as e. g. frequency converters (FC) or current inverters can generate residual DC currents, in case of DClink short circuit.

Only type B RCD's correctly detect residual DC currents and fault currents in the high-frequency range (up to 100kHz)

MEASUREMENT OF LEAKAGE CURRENTS FREQUENCY SPECTRUM OF RESIDUAL CURRENTS





The individual frequency components in the spectrum of the residual current have different causes. To reduce these currents, different measures need to be taken.

MEASUREMENT OF LEAKAGE CURRENTS VALUATION OF RESIDUAL CURRENTS



Switching frequenzy

2kHz

Switching frequenzy 4kHz



The switching frequency of the frequency converter has a significant impact on the leakage currents.

FILTER COMPONENTS EMI-FILTER





The grid can be safely protected against disturbances of all frequencies with a line inductor or a harmonic filter and in addition an EMI-Filter.

FILTER COMPONENTS LIMITS 150KHZ TO 30MHZ (CONDUCTED EMISSIONS)





FILTER COMPONENTS LIMITS 150KHZ TO 30MHZ (CONDUCTED EMISSIONS)





FILTER COMPONENTS PRODUCT OVERVIEW – EMC-FILTER





HFE 104-230/1 /65 1 ~ EMI filter for example to protect the control technology (SPS)	HLD X10-500/8 /250 3 ~ EMI filter for suppression of drive systems HLD 110 ILC=<30mA HLD 710 ILC=<6mA HLD 310 ILC=<0,4mA HLD 810 ILC=IT-Grids	HFD 210-500/7 180 3 ~ two stage EMI filter for use by using several drive systems in a cabinet	HFD 510-500/8 180 3~ multiple stage EMI- Filter for highest requirements	HLD 103-500/270 /1800 3~ EMI-Filter for high current applications
	HLD 810 ILC>II-Grids			

PRODUKTSCHULUNG PASSIVE FILTER RUND UM DEN FREQUENZUMRICHTER

DISTRIBUTION OF DISTURBANCES DIFFERENTIAL MODE UND COMMON MODE





FILTER COMPONENTS ALLPOLE SINE FILTER - SFA





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dBµV

Pegel in 31

20

30M

50 60

Pegel in dBµ\

20

150k

LEAKAGE CURRENT IN DRIVE SYSTEMS

No filter

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radiated emissions

Line conducted emissions

FILTER COMPONENTS ALLPOLE SINE FILTER - SFA





FILTER COMPONENTS ALLPOLE SINE FILTER – SFA 500





Properties

- New innovative filter technology
- Optimum filter effect to differential-mode and common-mode interference
- Improve the overall efficiency of the drive system
- Smallest All-pole sinusoidal filter on the market
- Power rating from 2,2kW to 22kW (Step 1)
- 500V output voltage
- Switching frequency > = 4 kHz
- Rotational frequency 150Hz
- Use infinite long motor cable lengths possible
- Improvement of conducted and radiated interference (150kHz -300MHz) -> reduction of the line-side filter expense (EMI filters) possible
- Considerable reduction of Leakage currents
- Also suitable for use in regenerative drives
- Elimination of bearing currents
- DC link connection Uz the frequency required

SOLUTIONS MEASURES FOR THE REDUCTION OF RESIDUAL CURRENTS







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• Increasing the switching frequency

Insert Low leakage current filters

- When using multiple Inverters disable the internal filter and use a summary EMC-Filter
- At Excessively high 150Hz leakage currents remove DC bus capacitance against PE (IT mains operation) -> use a summary filter





- Using an All-pole sine filter
 - Use the shortest possible motor cable lengths





• Use disconnector with snap-action switching function

SOLUTIONS MEASURES FOR THE REDUCTION OF RESIDUAL CURRENTS



Frequency range	Cause	Solution
50Hz	High leakage capacitances in EMI filter components (EMI filter / FU)	 Insert Low leakage filter Replace single filter by a sum filter at the mains input of the system (disable internal filters of the inverter) Use 3~+N-Filters and connect the N on the Line side
150Hz	Y-capacitors from the VSD to ground	 If possible switch the inverter to operate on IT-mains (Cy at the DC Link to be taken out) -> Insert a sum filter at the mains input of the system
ca. 1,5 – 2,5kHz	Resonant frequency of the EMI filter	- Do not put the switching frequency of the inverter in the near of the resonant frequency of the filter

SOLUTIONS MEASURES FOR THE REDUCTION OF RESIDUAL CURRENTS



Frequency range	Cause	Solution
2/4/8/16kHz	Switching frequency of the inverter be transmitted by parasitic line and motor capacity to the ground system	 Increase switching frequency (The higher the switching frequency, the lower the current ripple at the output of the inverter and thus also the coupling to the ground system) Use Sum filters with larger Y-capacities to lead back the common mode currents to the source (DC link inverter) -> Warning! Through greater Y-capacitors, the leakage current 50Hz increases
RCD tripping in the event of turn-on/turn- off	Capacities in EMI filters are too high	 Insert Low leakage filters Insert disconnector with snap-action switching function Delayed connection of the Y-capacitors in the filter (OEM-Filter)





VIELEN DANK! THANK YOU!

HABEN SIE FRAGEN? DO YOU HAVE QUESTIONS?

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