Proposed Master thesis

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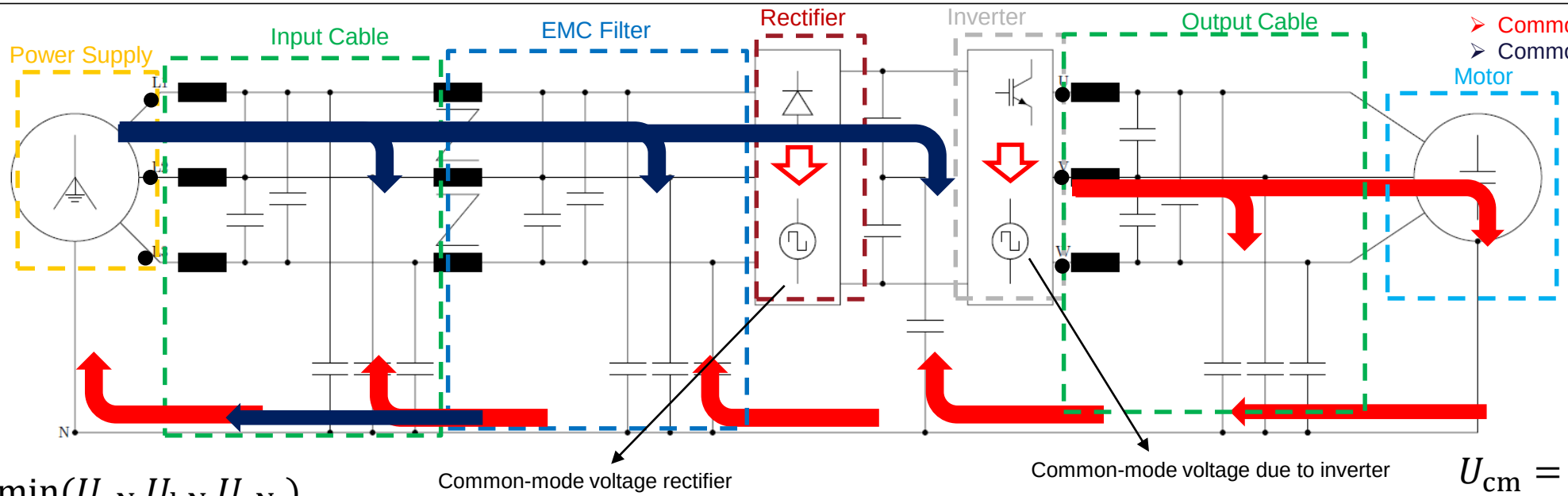
LEA

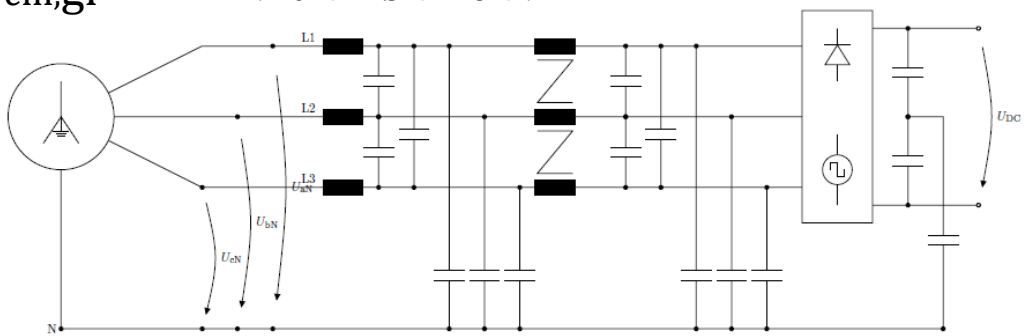
Electric motors and common-mode currents

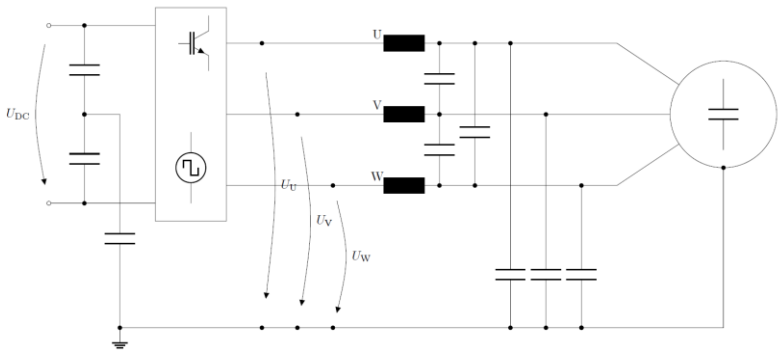


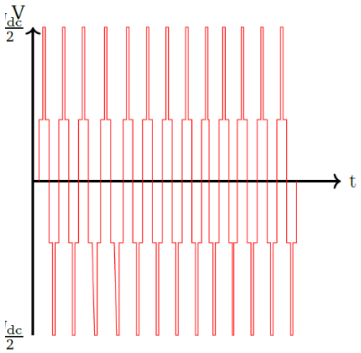
- Common-mode current of inverter
- Common-mode current of rectifier

$$U_{\mathrm{cm,gl}} = \min(U_{\mathrm{aN}}, U_{\mathrm{bN}}, U_{\mathrm{cN}})$$

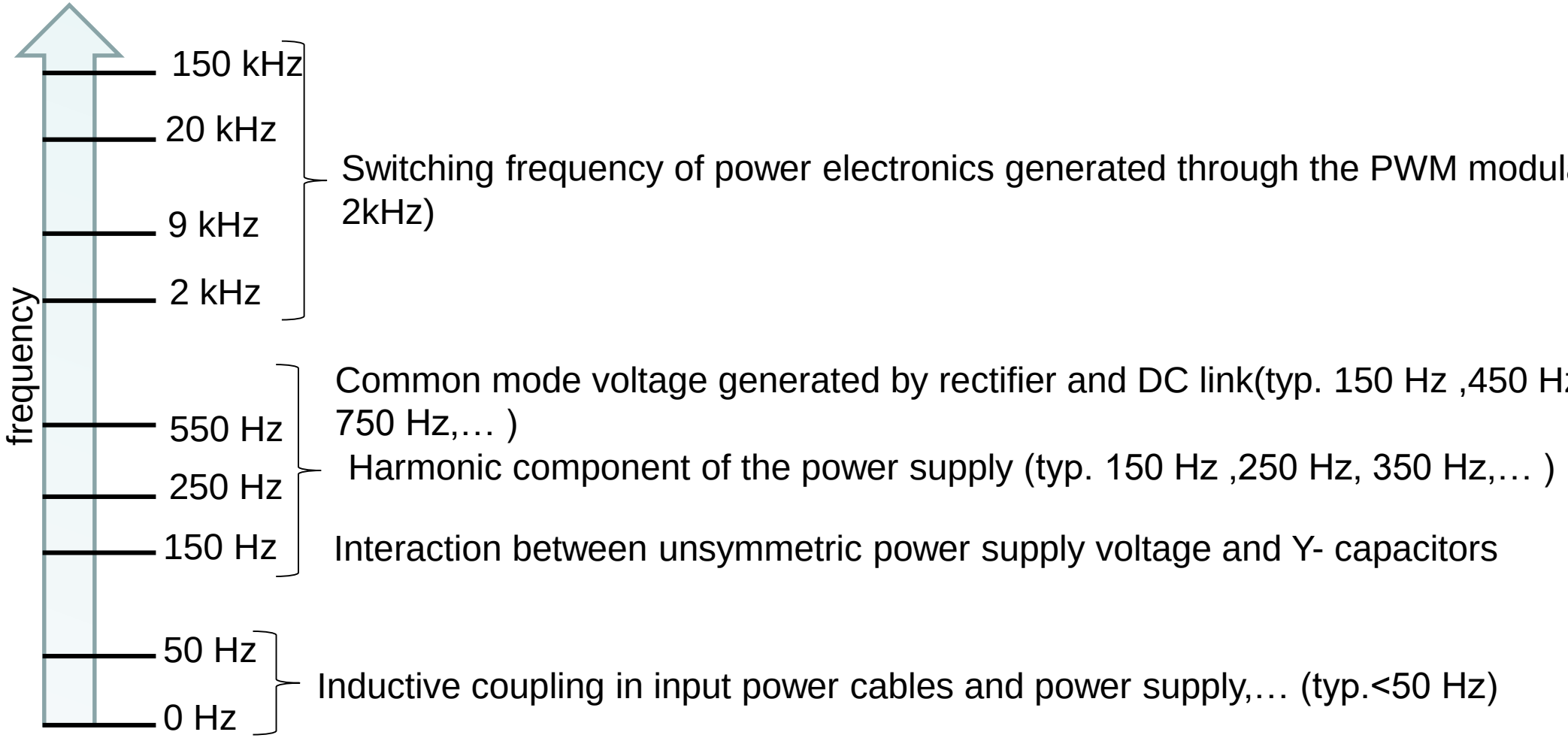
$$U_{\mathrm{cm}} = \frac{U_{\mathrm{U}} + U_{\mathrm{V}} + U_{\mathrm{W}}}{3}$$







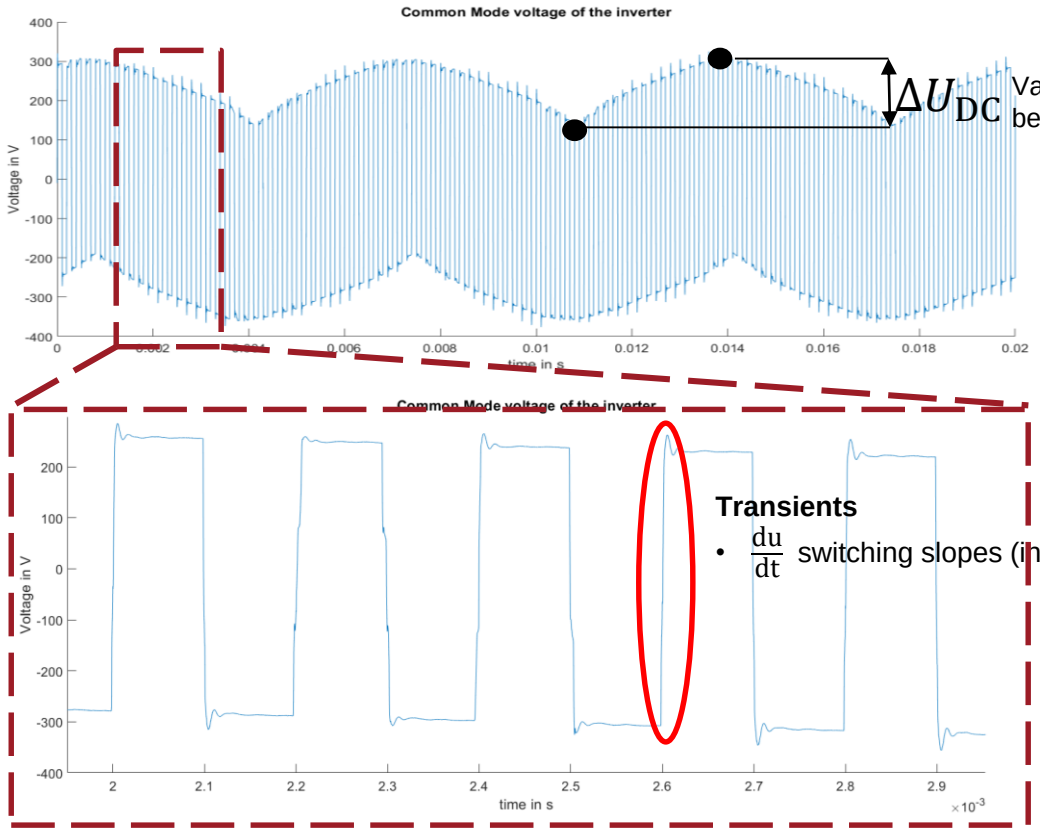
Frequency components of the common mode currents



Common-mode (CM) voltage of the inverter

$$U_{\mathrm{cm}} = \frac{U_{\mathrm{U}} + U_{\mathrm{V}} + U_{\mathrm{W}}}{3}$$

- The CM voltage is a staircase function with step $\pm\frac{1}{3}U_{\mathrm{DC}}$ (U_{DC}= DC Link voltage)



Variation of the DC link voltage because of the rectifier

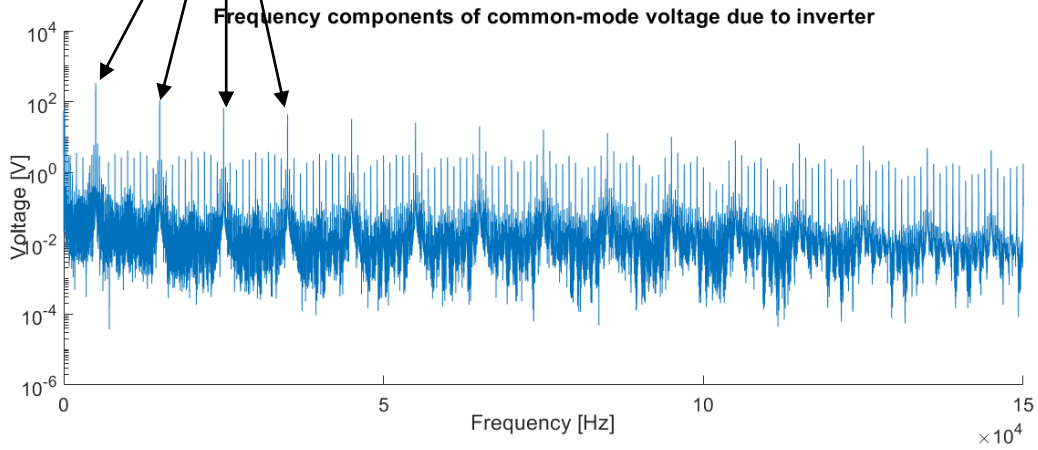
Transients

- $\frac{\mathrm{du}}{\mathrm{dt}}$ switching slopes (in high Frequency)

FFT

Fundamental wave and harmonics

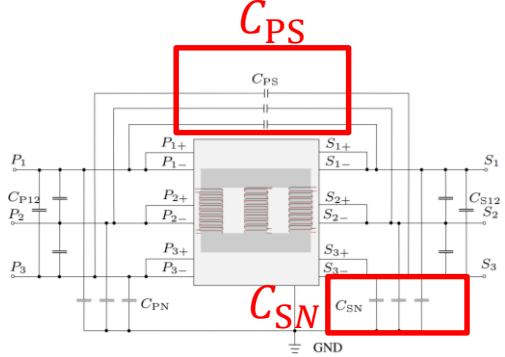
- Switching frequency (f_S) and harmonics ($3 \cdot f_S, 5 \cdot f_S$, etc)
- Modulation technique
- Topology of the inverter



- Inverter adds common-mode voltage components at the switching frequency and its harmonics
- The kind of modulation also influences the frequency components

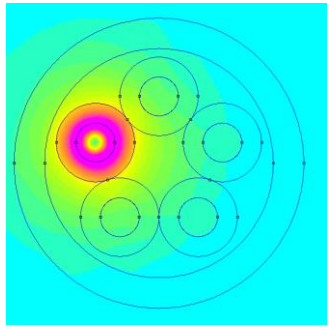
Propagation Paths

Transformer



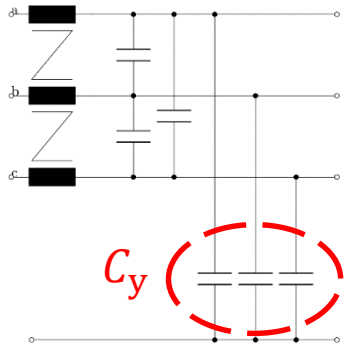
- C_{ps} provides a coupling path for the common-mode between primary and secondary
- C_{ps} provides a coupling path for the common-mode between secondary side and ground

Input Cable



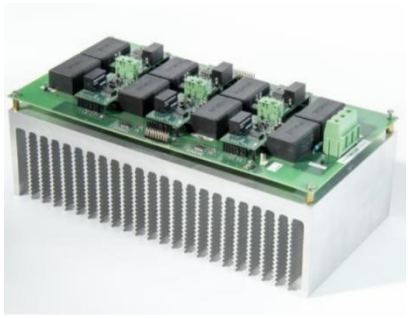
- 2 possible paths for the common-mode
  - PE wire
  - N wire

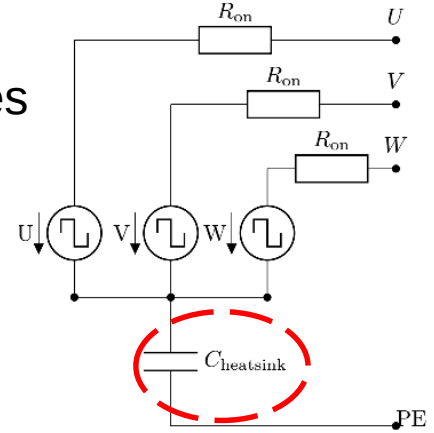
EMC Filter



- C_y capacitances provides a path for the common-mode

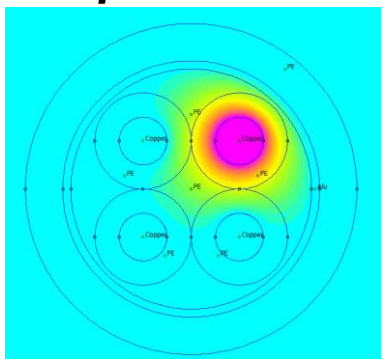
Converter





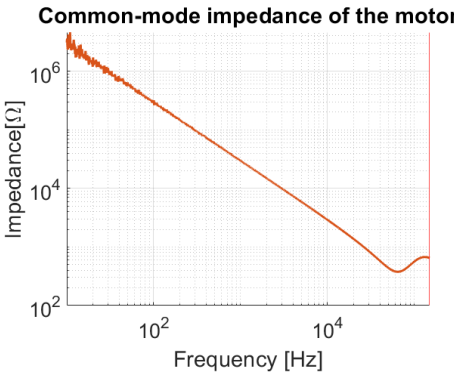
- Path→ Capacitance of the heatsink

Output Cable



- 2 possible paths for the common-mode current:
  - PE wire
  - Shield

Motor



Induction motor

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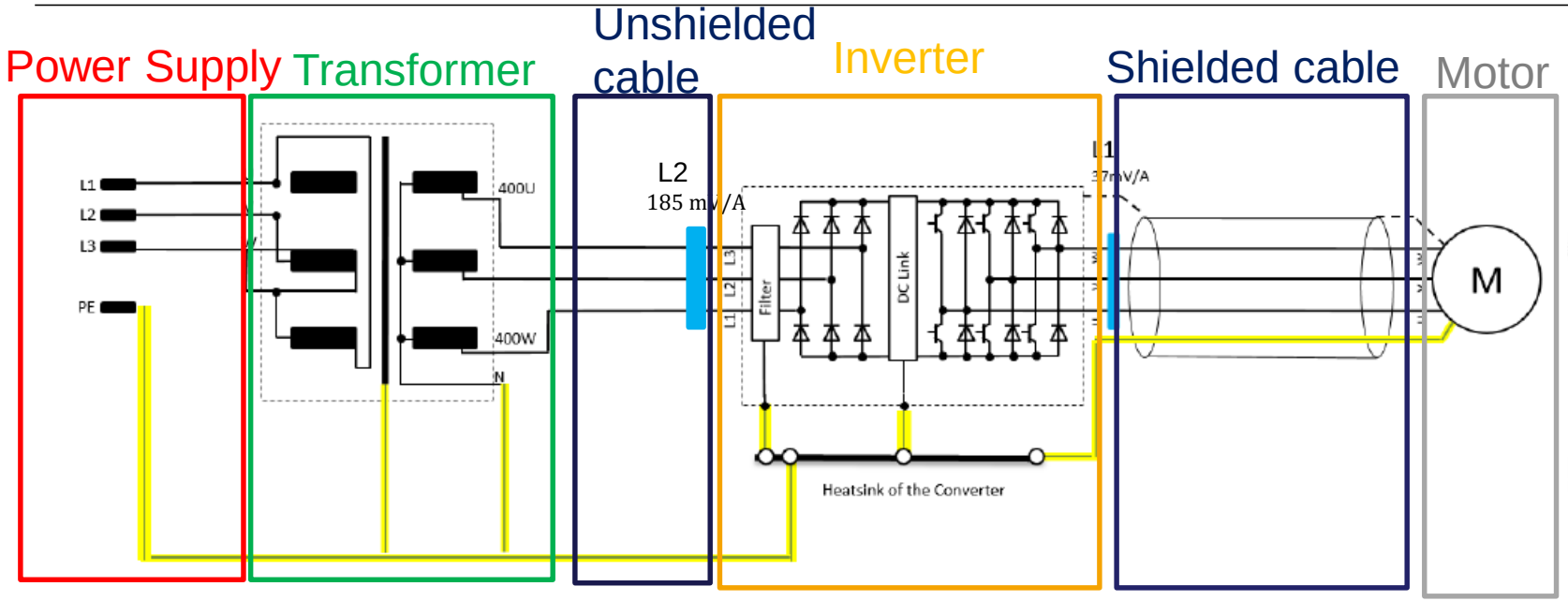
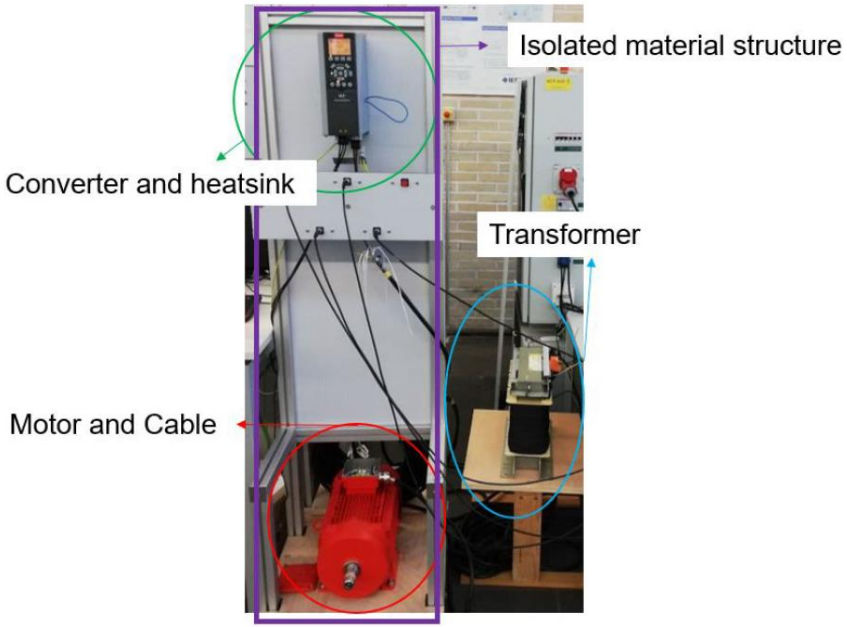
Capacitive behaviour for the common-mode

REFERENCE SYSTEM

Reference system





- The system is isolated → The whole common-mode current flows through the PE of the cable and the shield of the cable

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PROPOSED MASTERTHESIS

High frequency representation of the leakage current at higher frequency

Task

- Development of a double pulse test and application on the reference system
- Evaluation from the measurements to the common-mode voltage in relation to the length of the cables
- Usage of the Bewley lattice to foresee the leakage current because of the effect of the pulses

Requisites:

- Knowledge of Matlab and Simulink
- PLECS knowledge is a plus
- Experience in PCB is also helpful for this task
- Knowledge of transimssion line theory

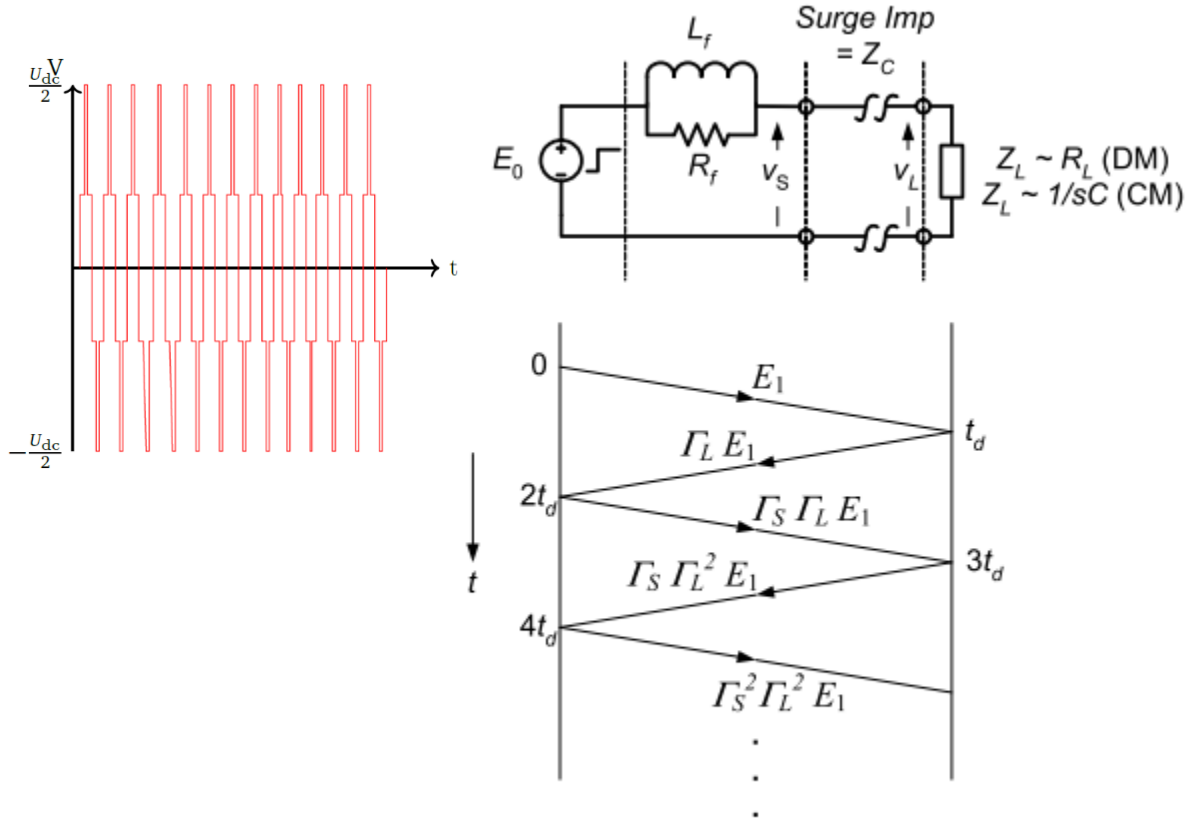

Fig. 6. Bewley lattice diagram showing reflections on motor cable with L-R filter