EMR'22
HES-SO Sion
June 2022

EMR'22 Summer School
"Energetic Macroscopic Representation"

« EMR-based Simulation of a N-level Inverter Including Loss Estimation »

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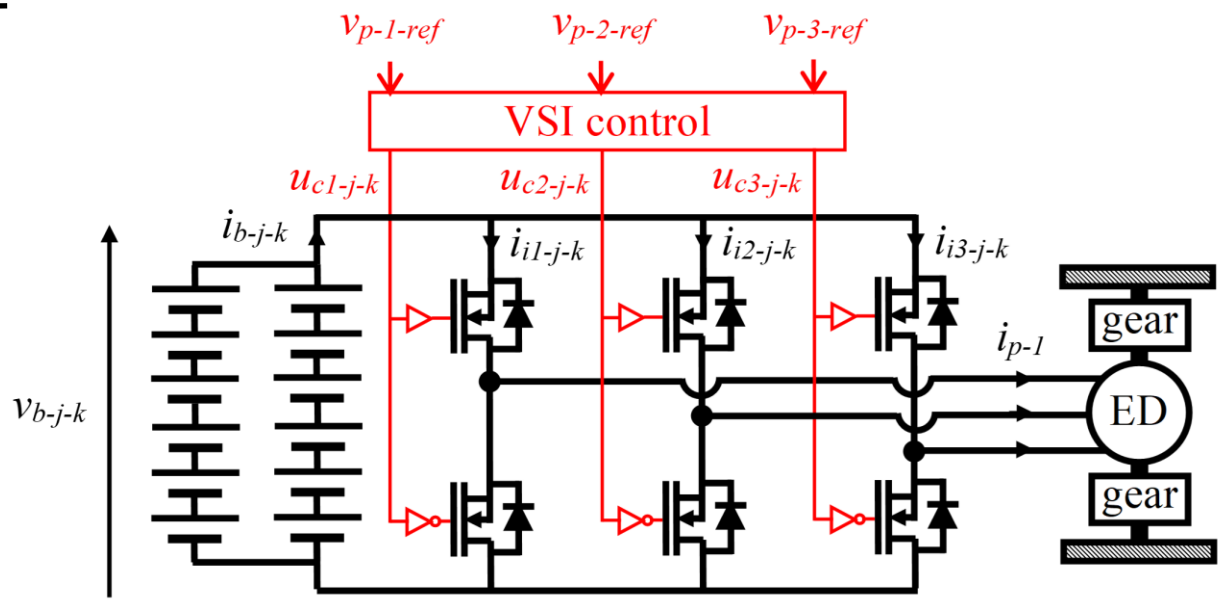
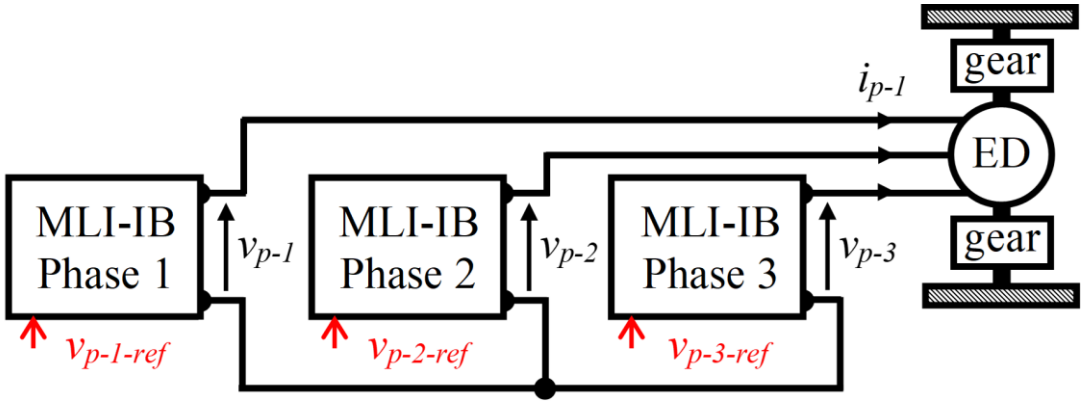
- Outline -

1. Presentation of the N-level inverter
2. EMR of the N-level inverter
3. Consideration of the losses
4. Results and Conclusion

Conventional topology



Proposed topology with Multi-level Inverter (MLI)



Cascaded H-Bridge converters (different modules in series)

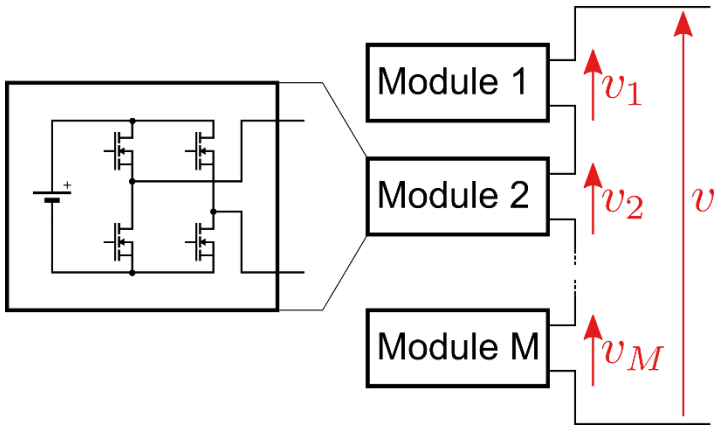
Module = H-Bridge + Battery

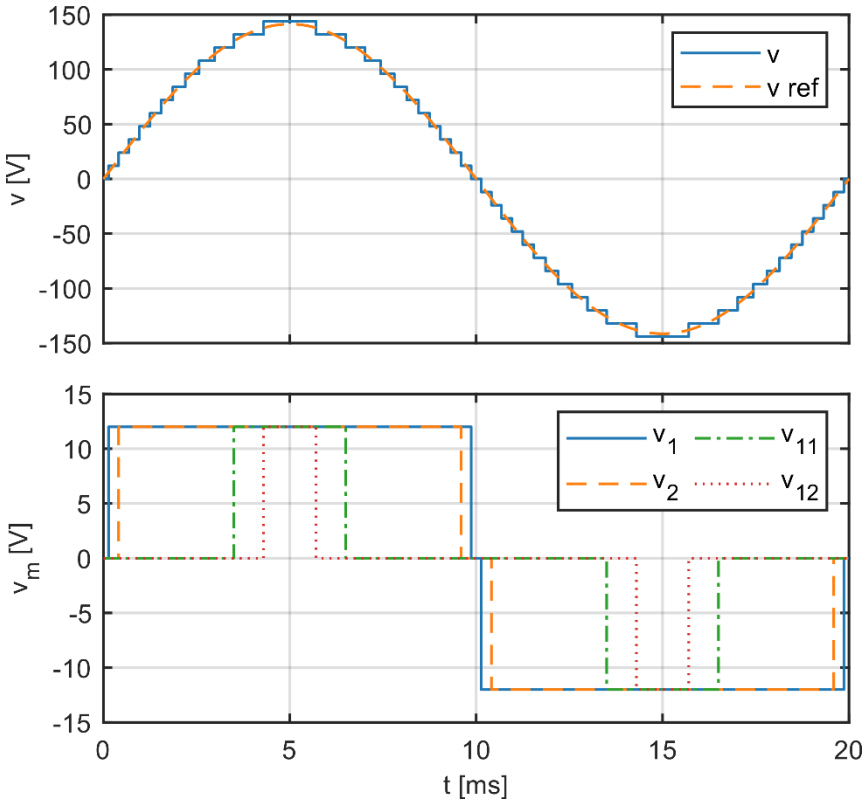
No need for an external converter to reload the battery

No PWM → fewer losses

Embedded BMS

More switches → cost issues





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- Vectorial EMR of the N-level Inverter -

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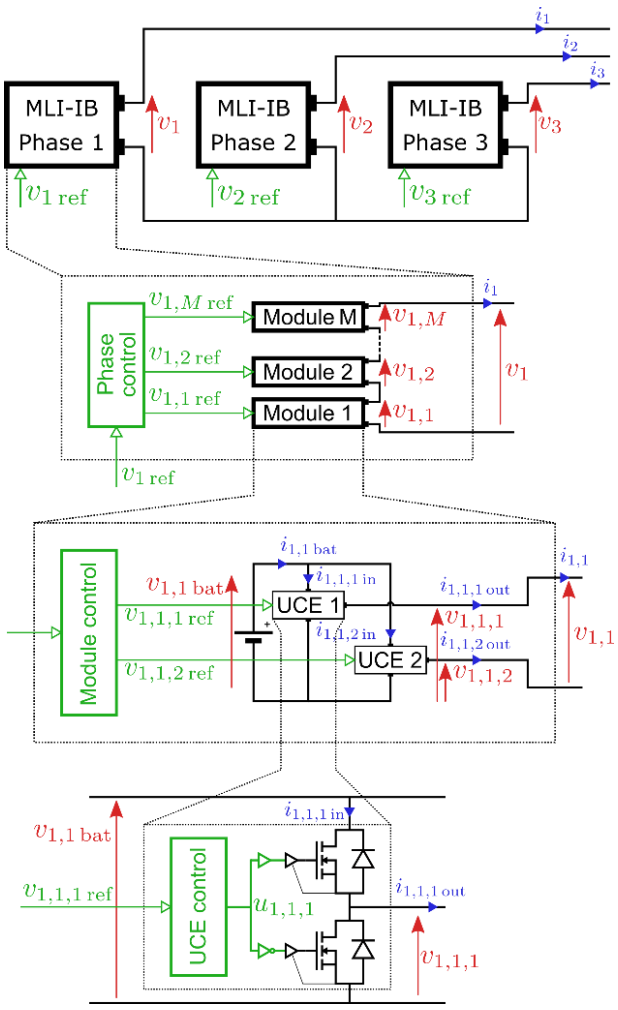
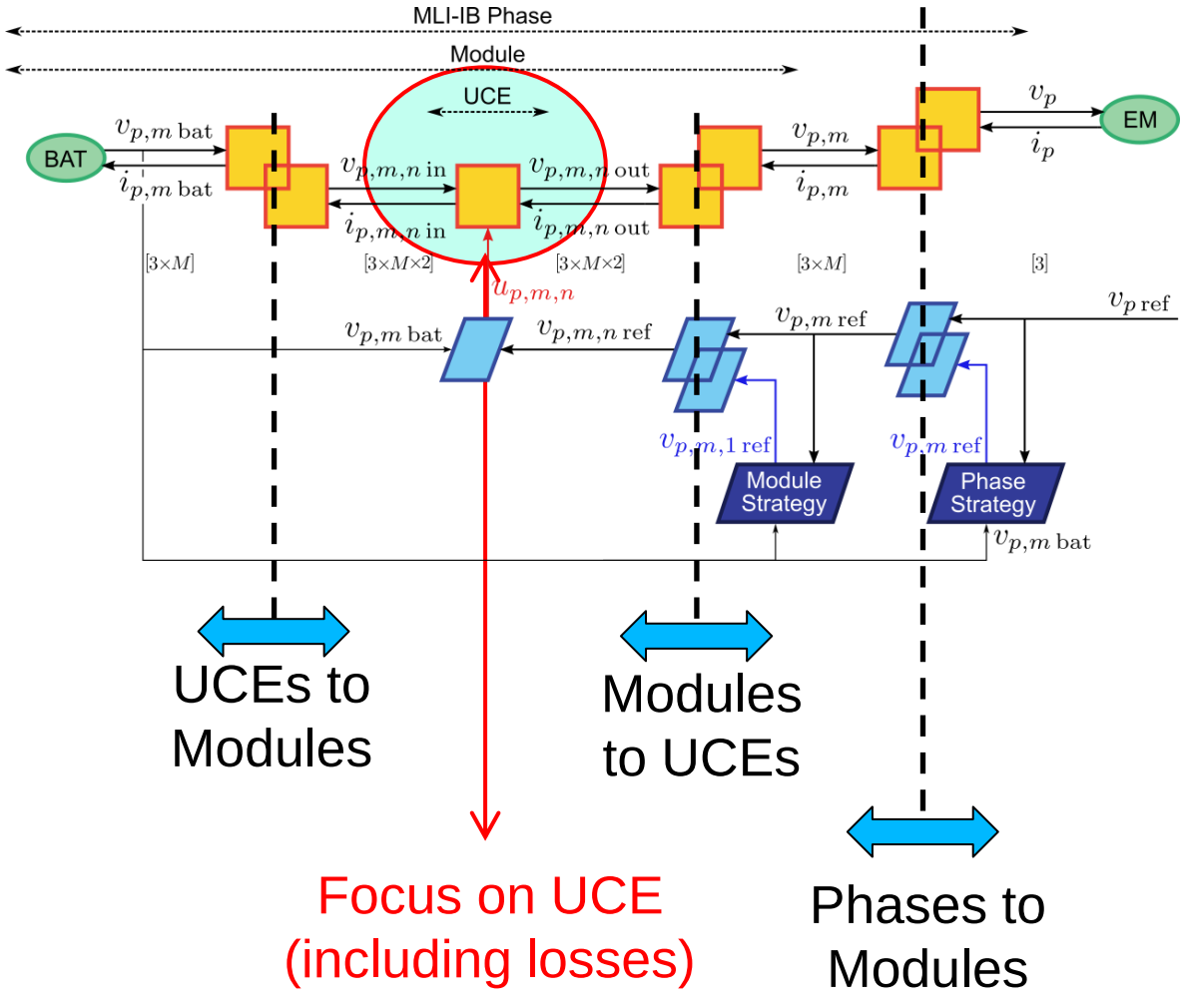
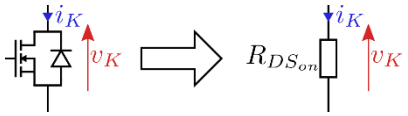


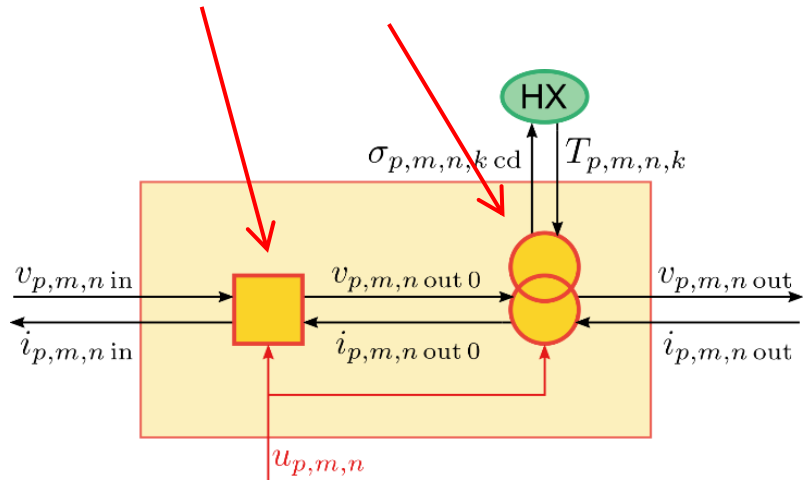


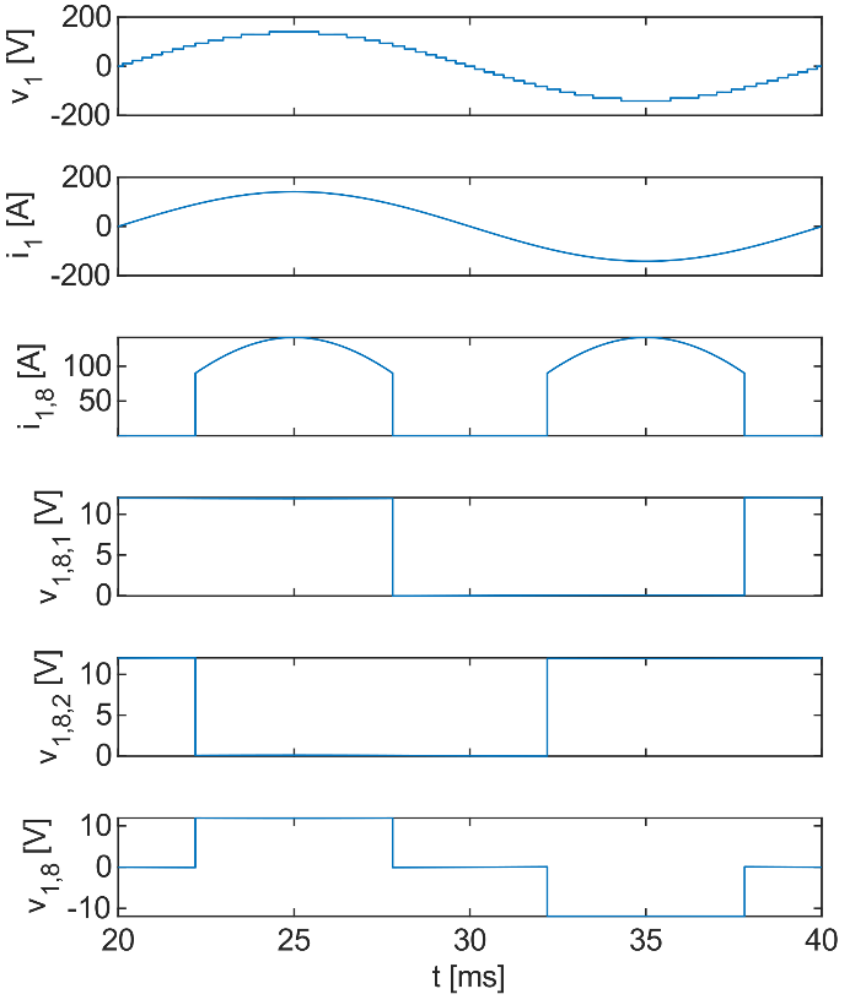
Conduction losses



MOSFET is modeled by a resistor $R_{DS_{on}}(T)$. The voltage drop is proportional to the current.

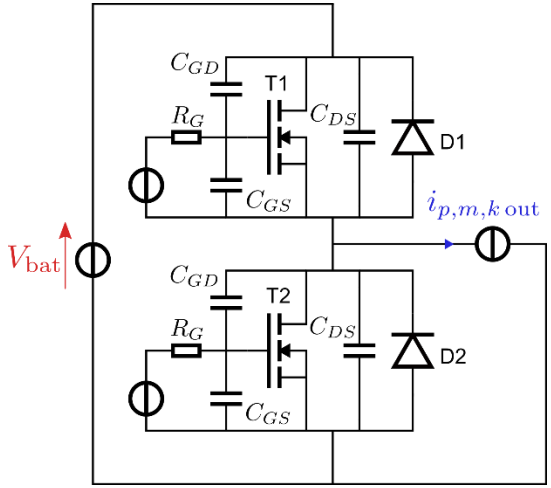
$$v_{out} = \underbrace{u\, v_{in}} + \underbrace{(1-2u) R_{DS_{on}} i_{out}}$$

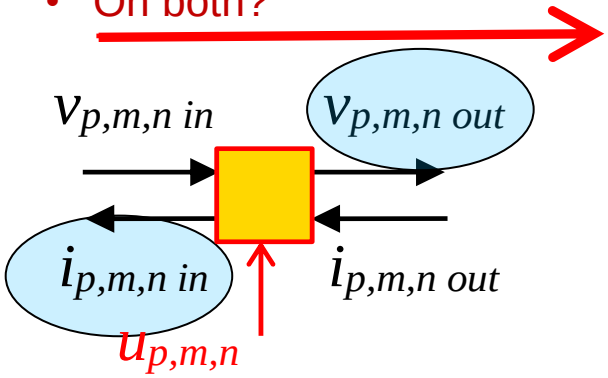


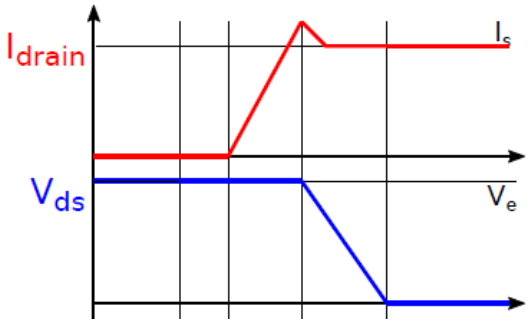


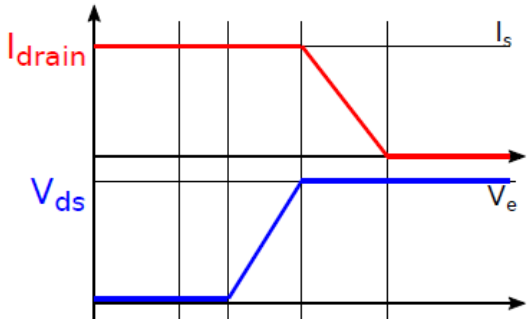
Switching losses

- Three types of losses during a switching
  - Channel conduction
  - Body-diode conduction
  - Reverse recovery
- Analytical calculations using parasitic elements!
- But, where to apply the switching losses ?
  - On the current (battery side)?
  - On the voltage (output side)?
  - On both?

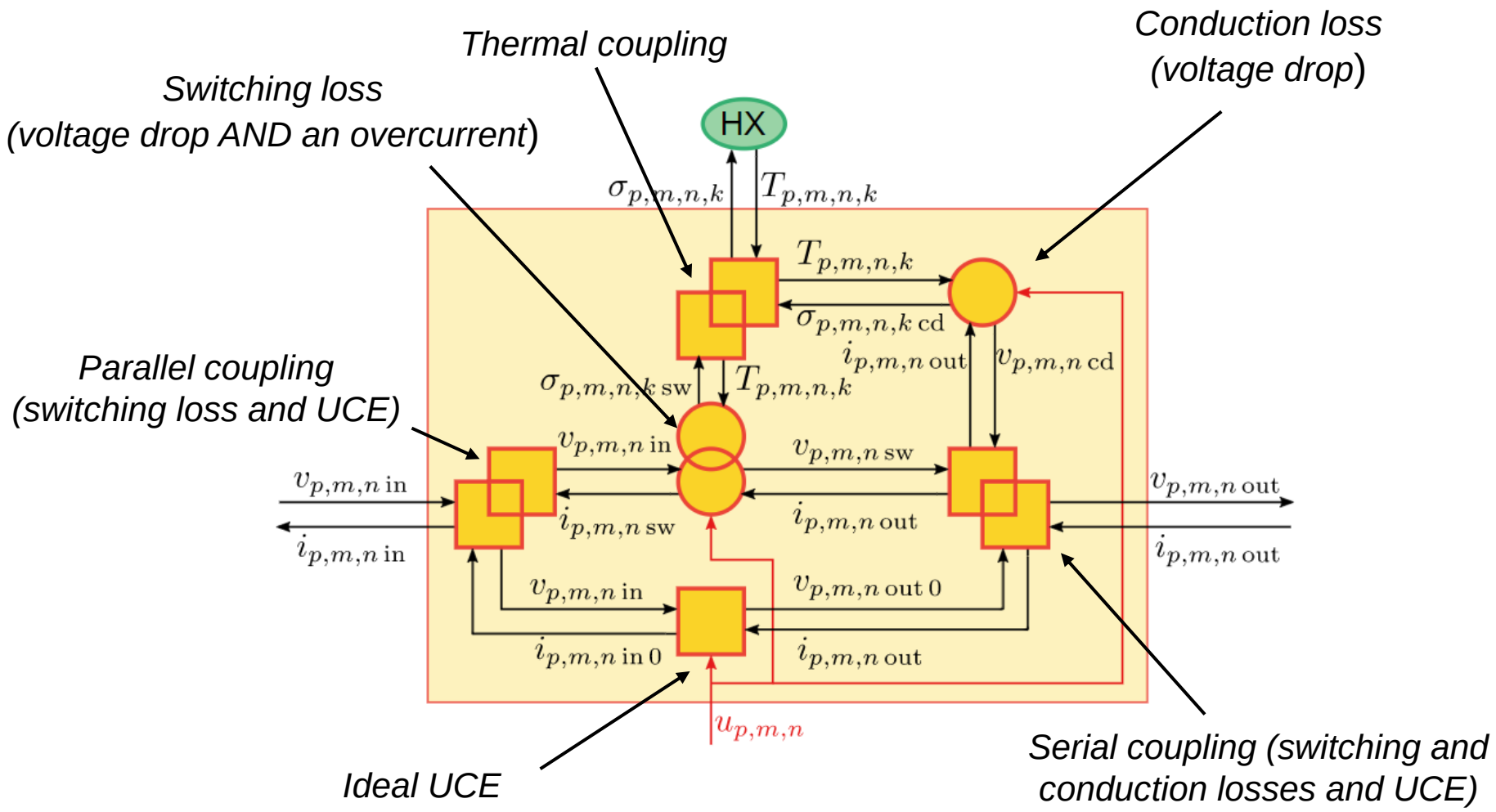




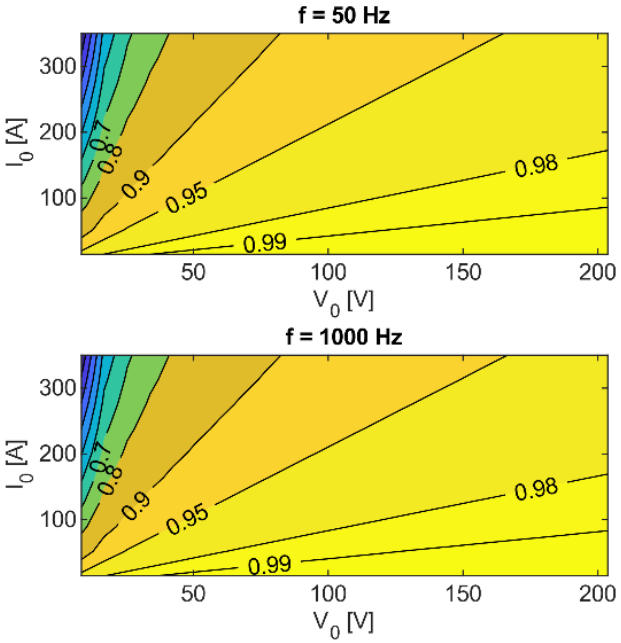




Conduction and switching losses



Results and conclusion



- EMR of an N-level Inverter, including losses
- Estimation of losses according to different variables
- Can be used to optimize the topology
- Useful for comparison with other inverters
- Must be coupled with the EMR of the other subsystems
- Model reduction

- References -

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