HIGH POWER,MEDIUM VOLTAGE DC/DC CONVERTER

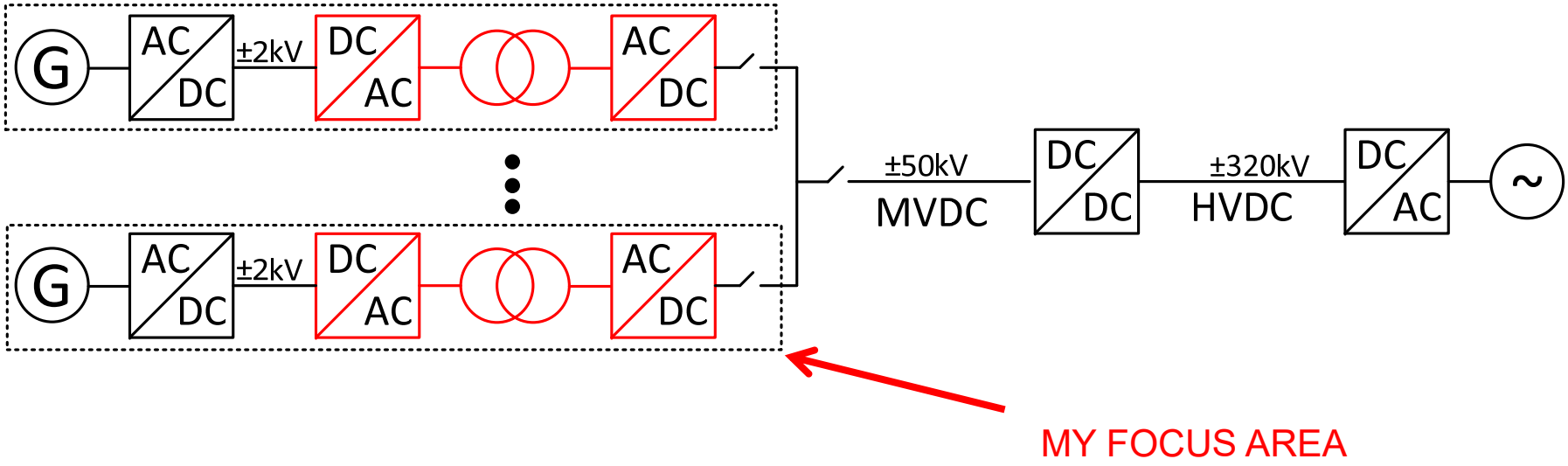
CATALIN DINCAN FEBRUARY-2017

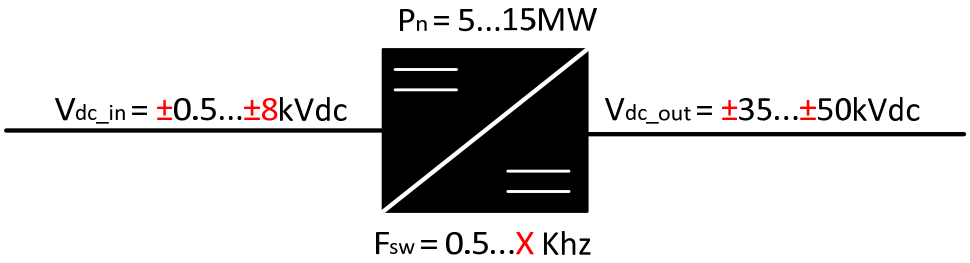
AALBORG UNIVERSITY
DENMARK

Agenda

1. Review of application and initial selection
2. Initial selected topology
3. Resonant converter with new method of operation
4. Experiments

1. Review of application and initial selection



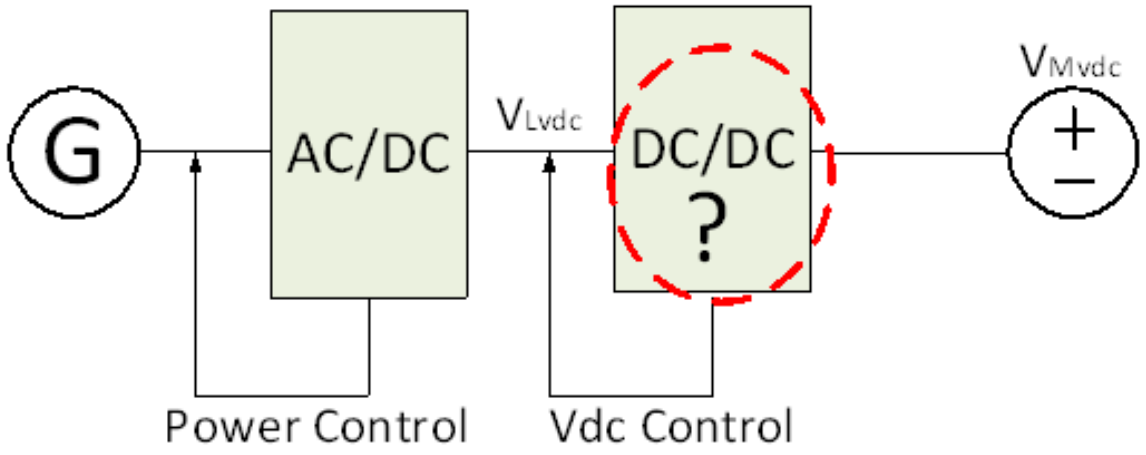


List of functionalities:

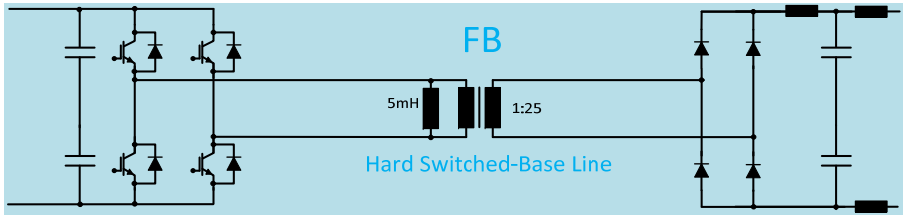
1. Control DC power, voltage, current
2. Reliable valve commutation
3. Maintenance
4. Reliability
5. Redundancy
6. Protection
7. EMC/EMI

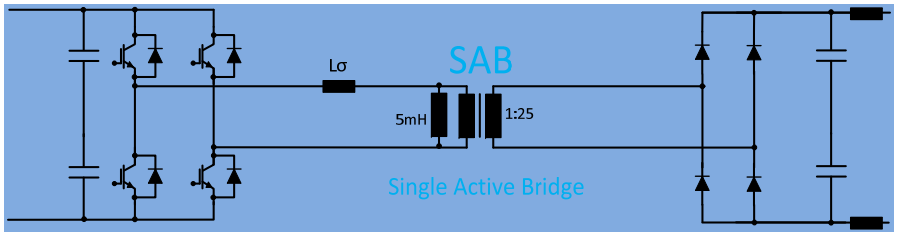
Design drivers:

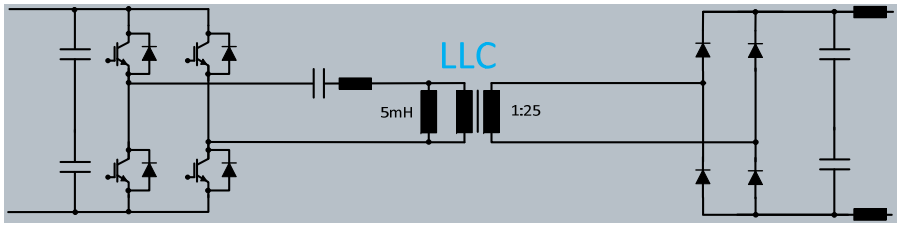
1. Availability
2. Electrical losses
3. Ratings
4. Repair costs
5. Power density

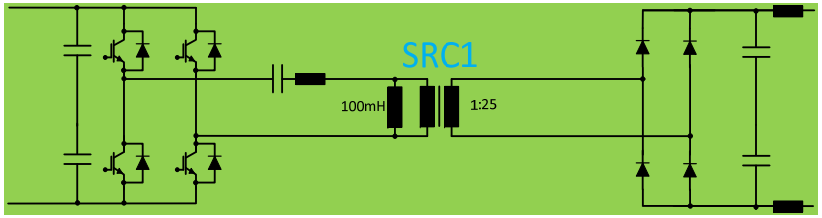


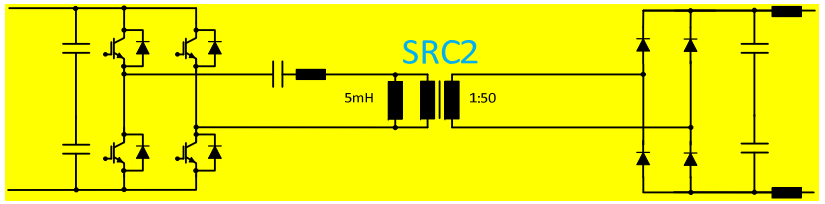
From 35 topologies, down select 6 topologies

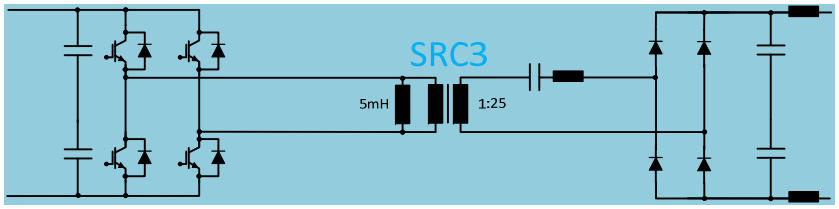








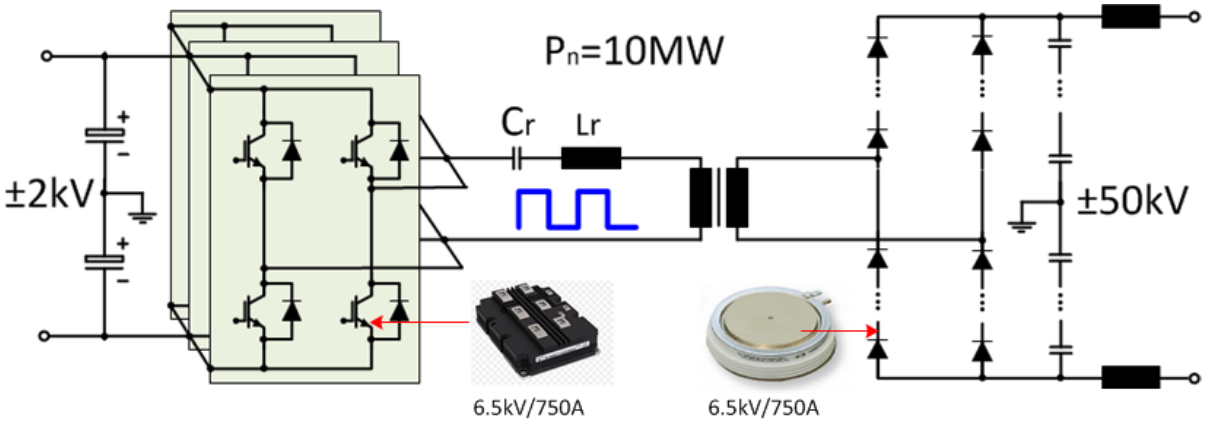




Developed semiconductor and transformer loss model

2. Initial selected topology

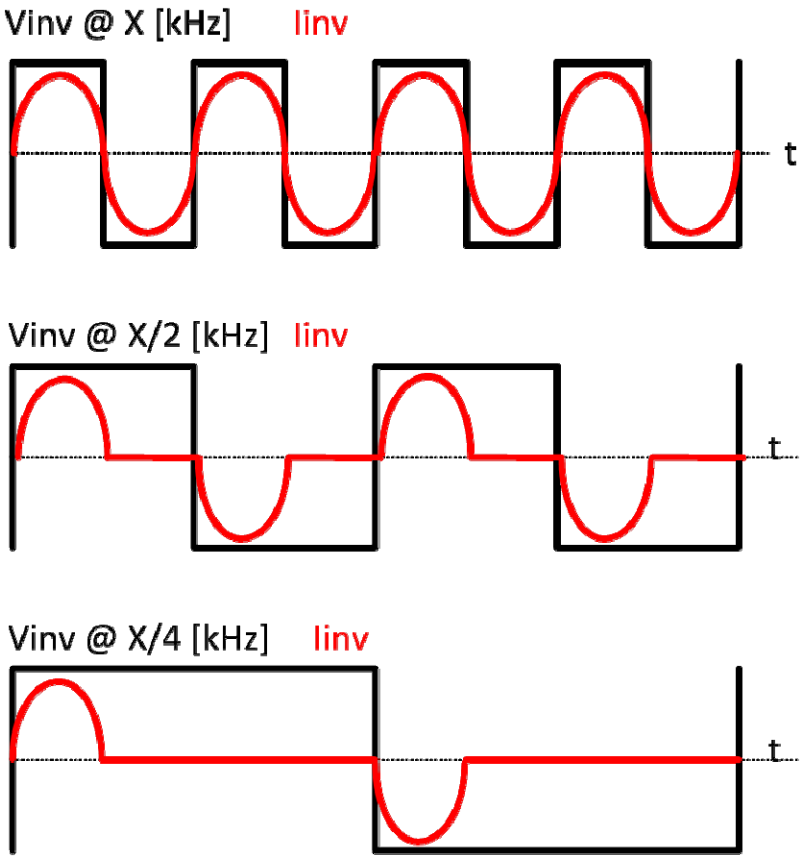
SERIES RESONANT CONVERTER, TANK ON PRIMARY SIDE, FREQUENCY CONTROL



Nominal Power	P_n	10 MVA	DC/AC Device	3x4 x IGBT (6500V x 750A)**[4]**
Input DC Voltage	V_{LVDC}	±2 kV	AC/DC Device	4x40 x Diode (6500V x 750A)**[4]**
Output DC Voltage	V_{MVDC}	±50 kV	Isolation level	150 kV
Resonant Capacitor	C_R	78 uF	$I_{Short\_circuit\_MVDC}$	50 x I_{MVDC}
Resonant Inductor	L_R	250 uH	E_{cap}	2500 J
Magnetizing Inductor	L_m	20 mH	E_{ind}	2500 J

Table 1 Converter Nominal Specifications

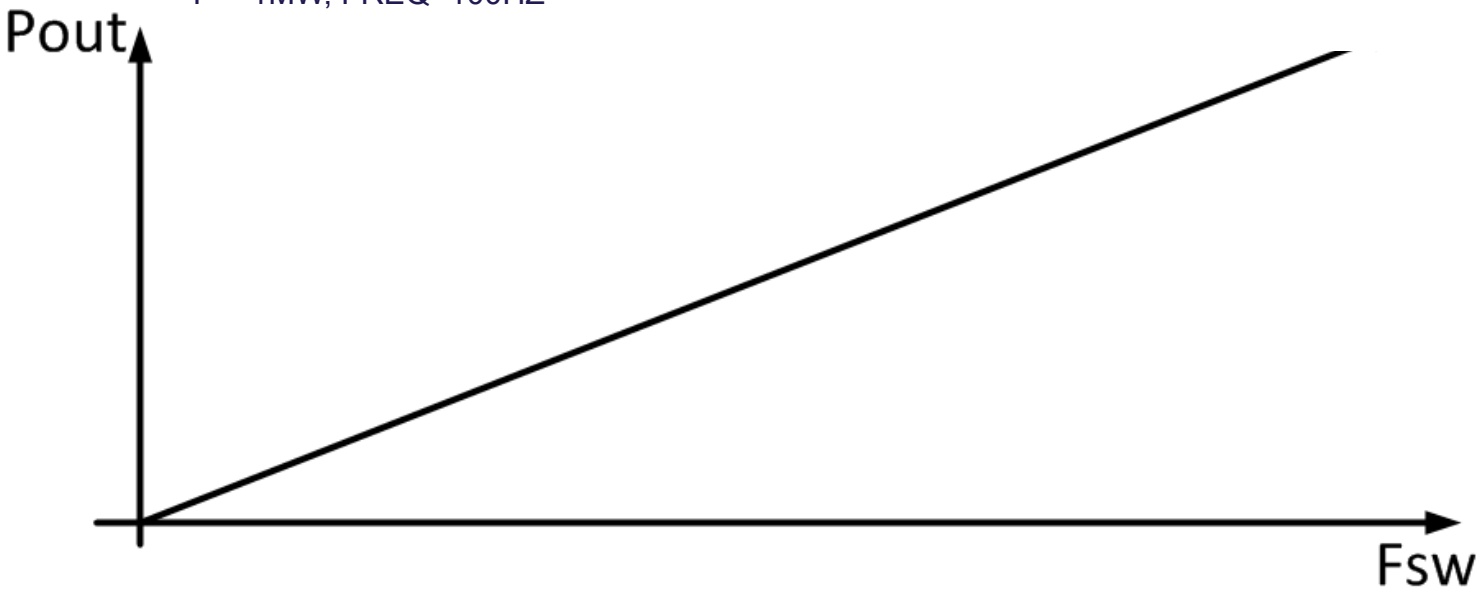
2. Initial selected topology



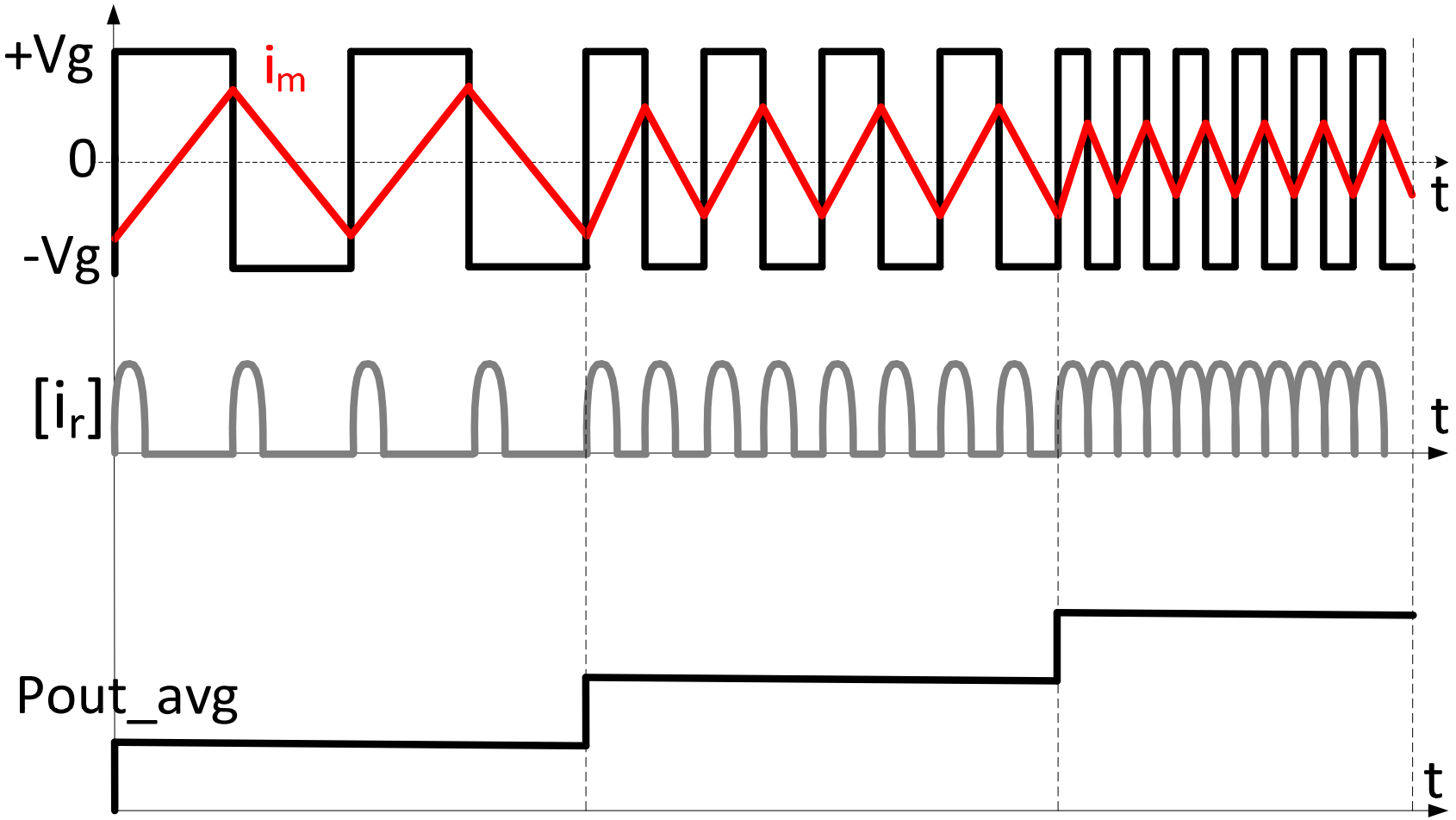
2. Initial selected topology

POWER BECOMES A FUNCTION OF SWITCHING FREQUENCY

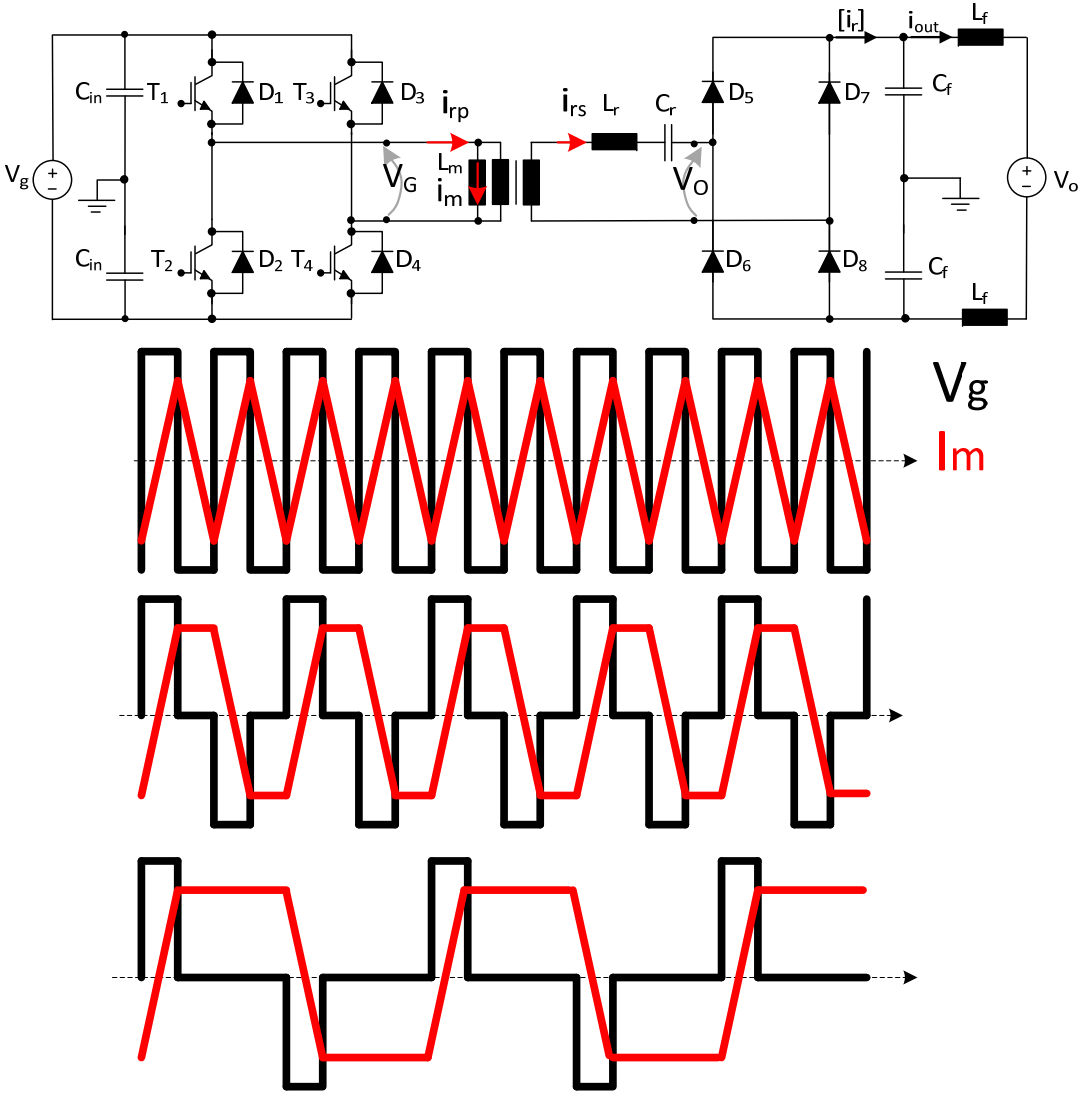
EX.
P = 10MW, FREQ=1000HZ
P = 1MW, FREQ=100HZ



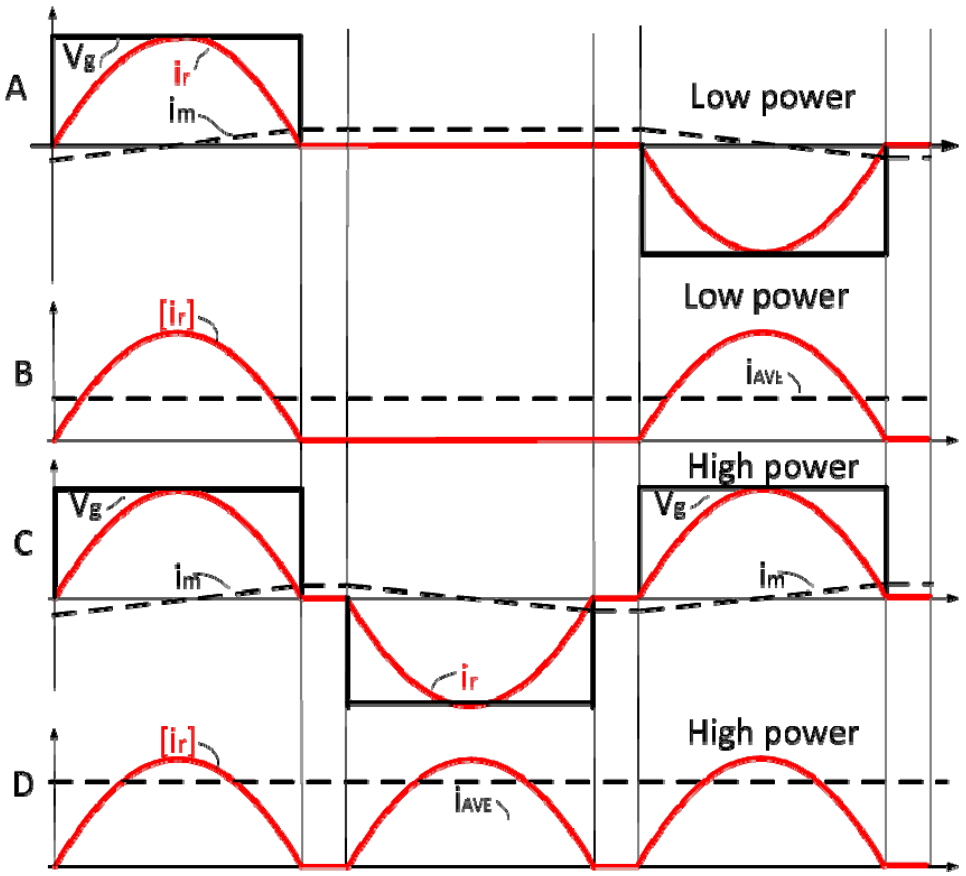
2. Initial selected topology



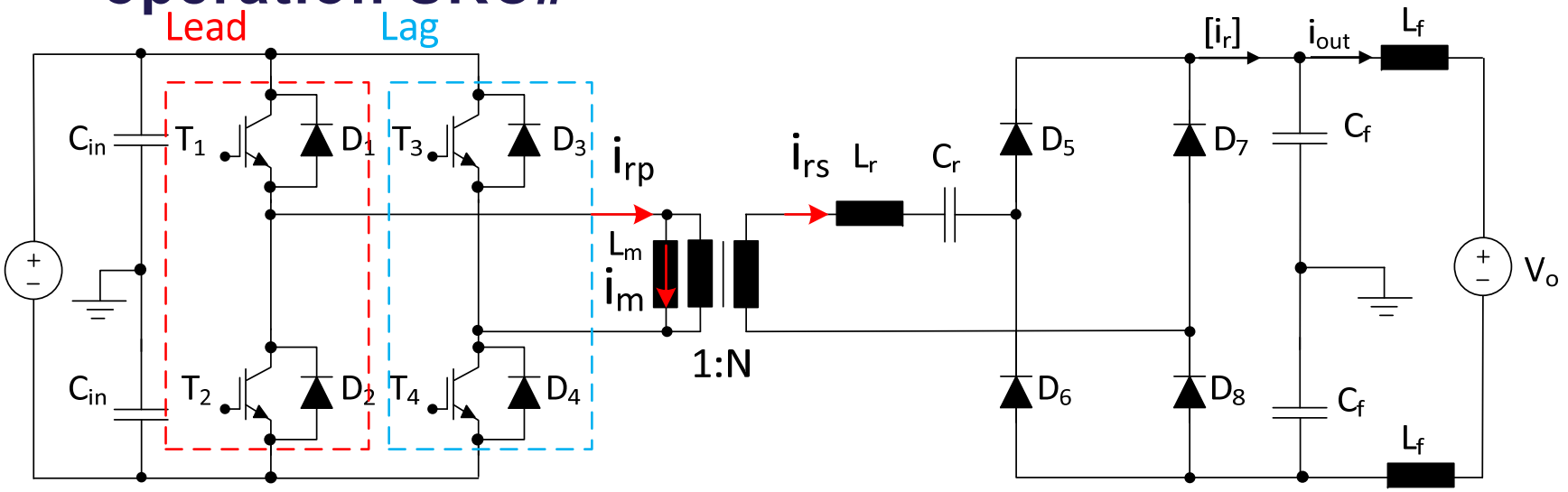
3. Developed new method of operation:Pulse Removal Technique

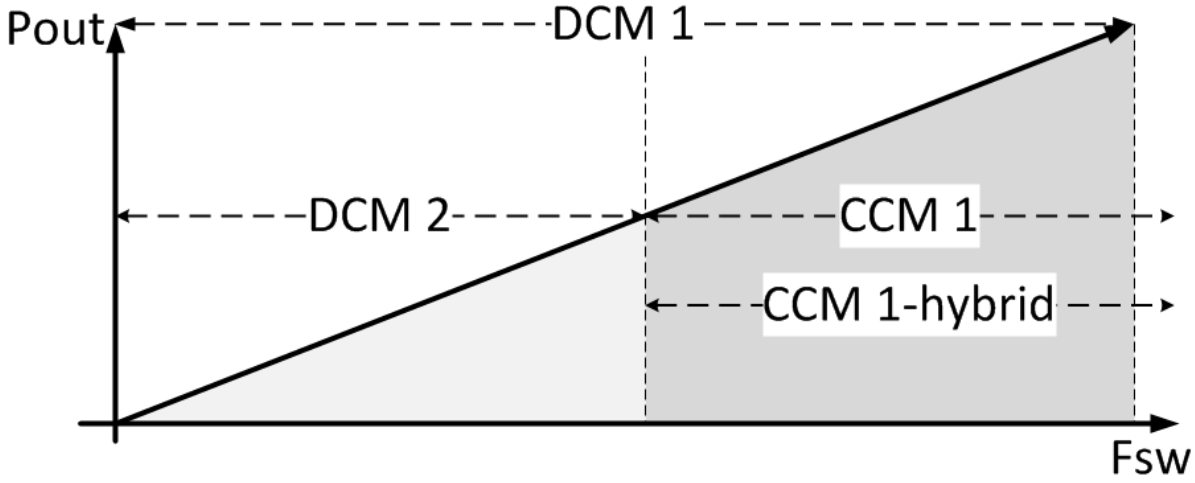


3. Resonant converter with new method of operation

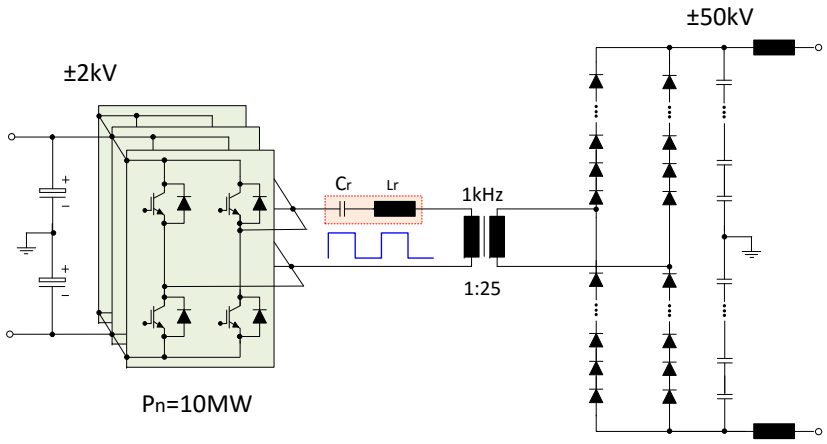


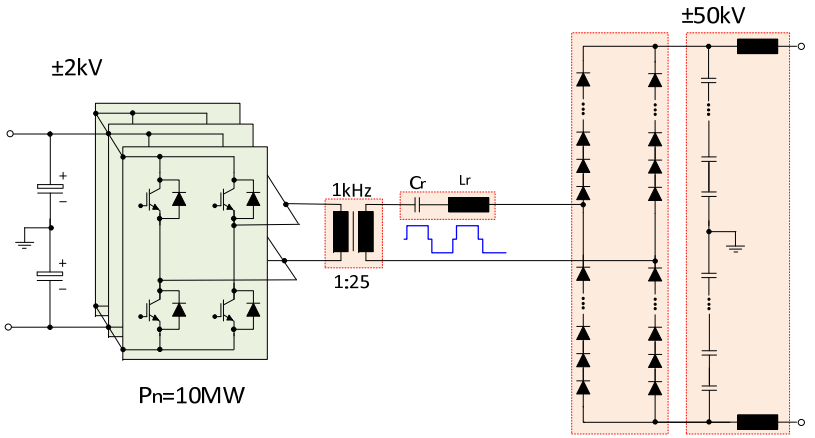
3.Resonant converter with new method of operation SRC#

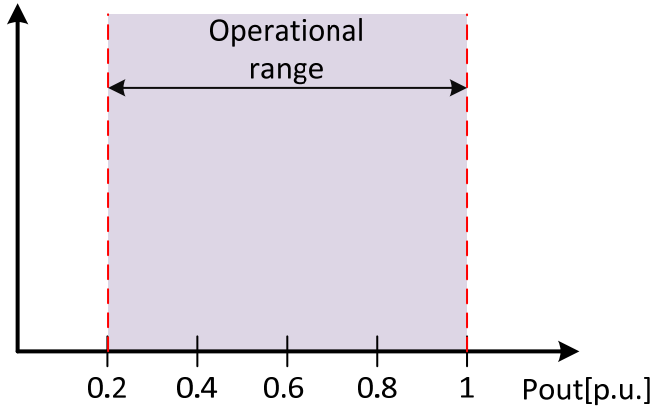


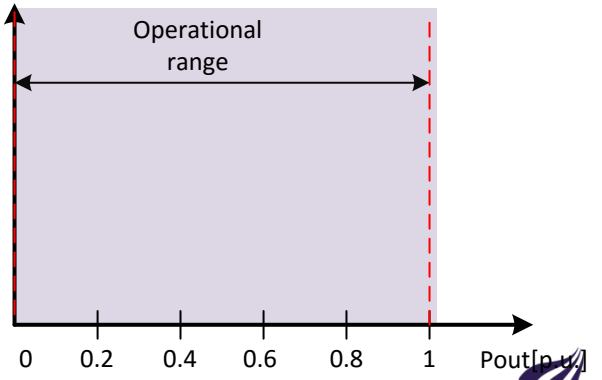


4. Comparison of ratings SRC vs SRC#









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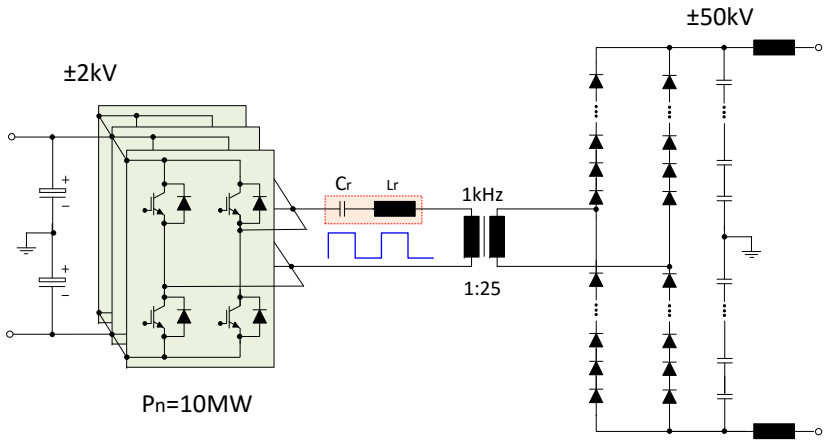
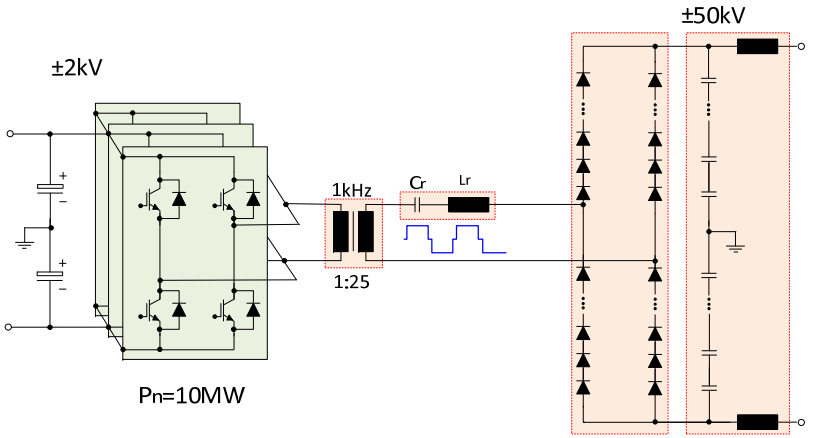
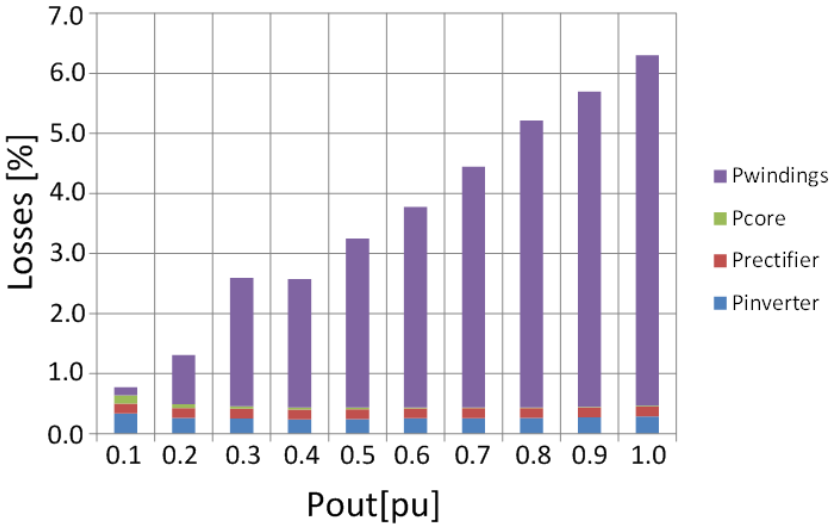
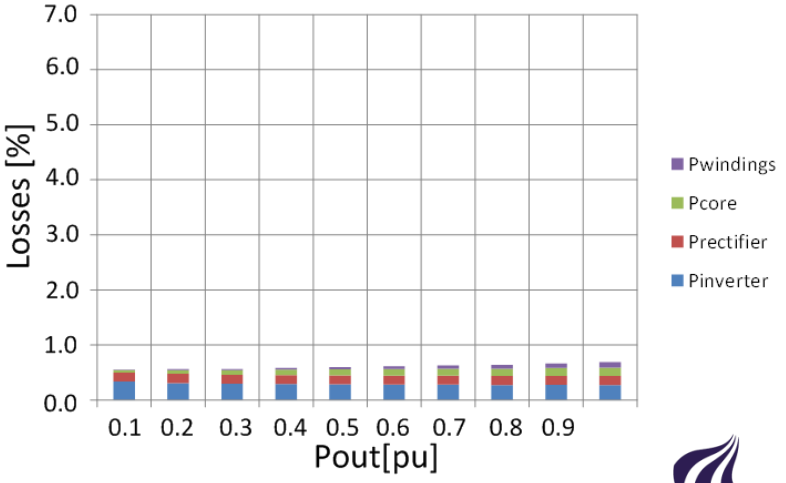
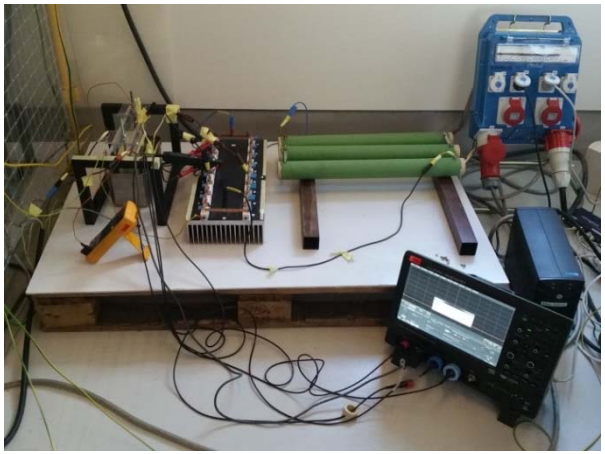


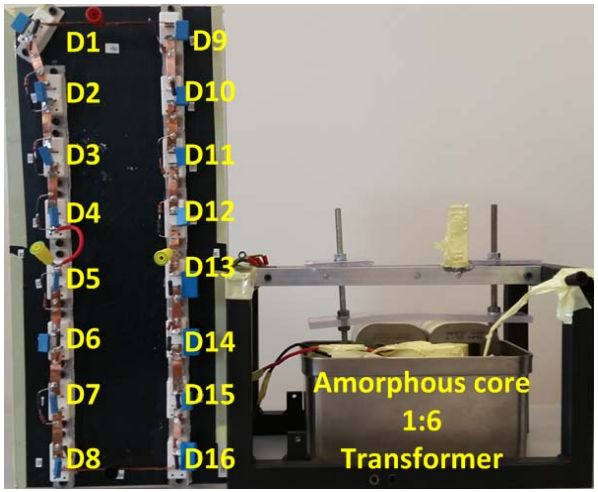


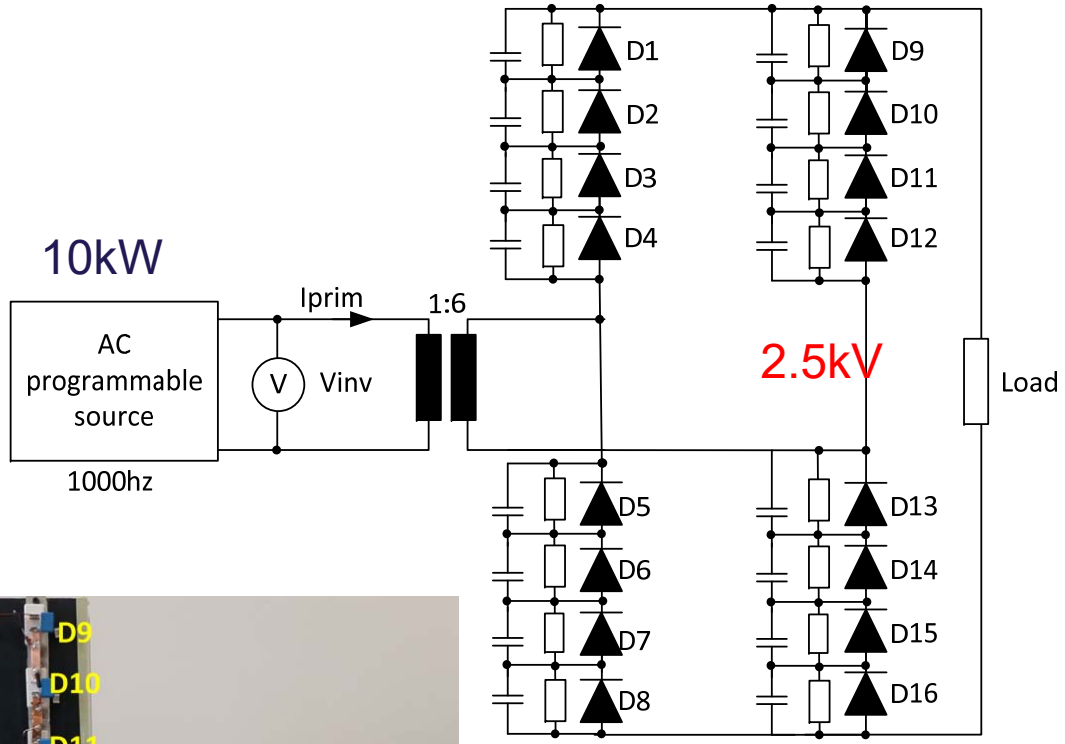




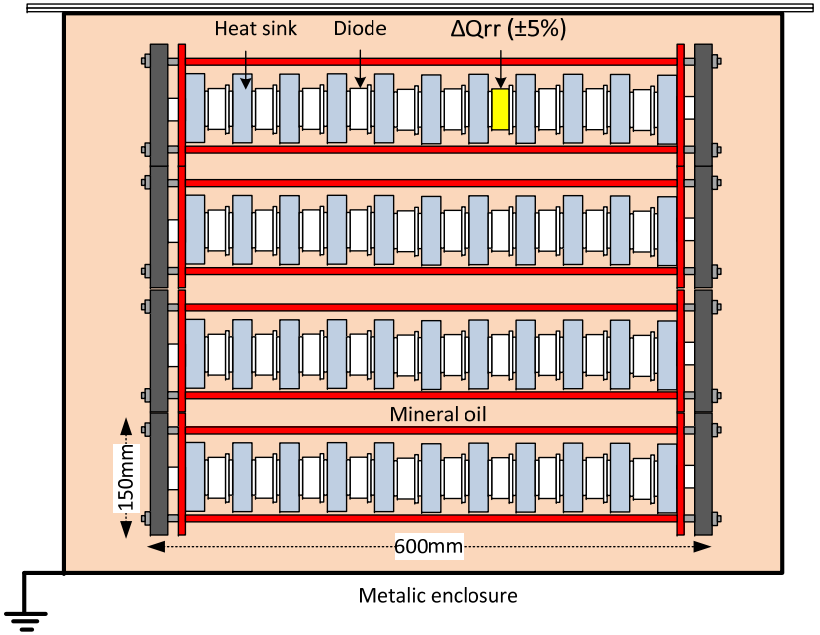
Experiment 0:
Characterization of series connected diodes

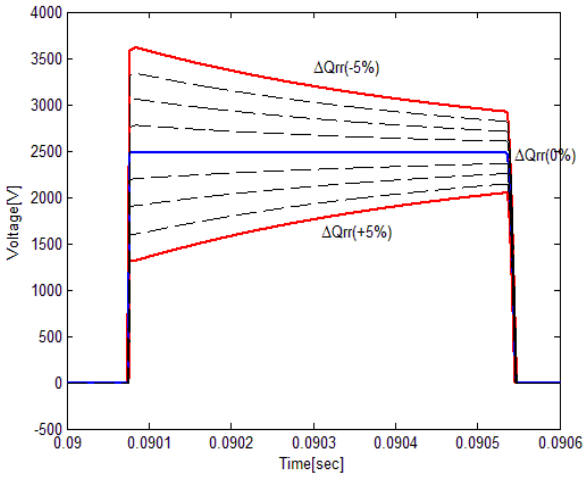


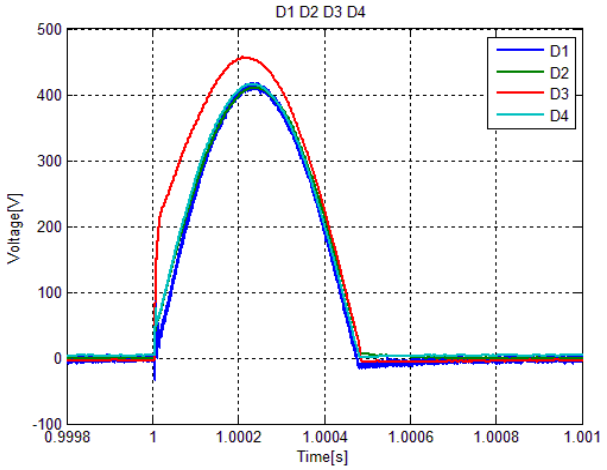




Experiment 0





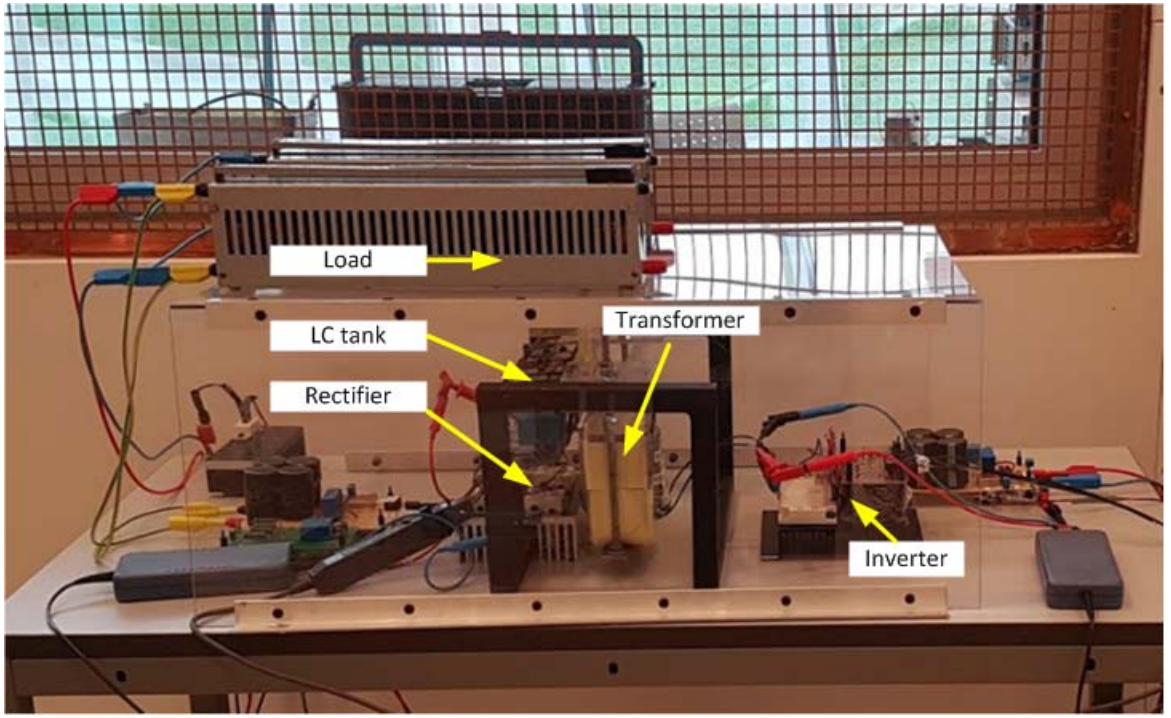


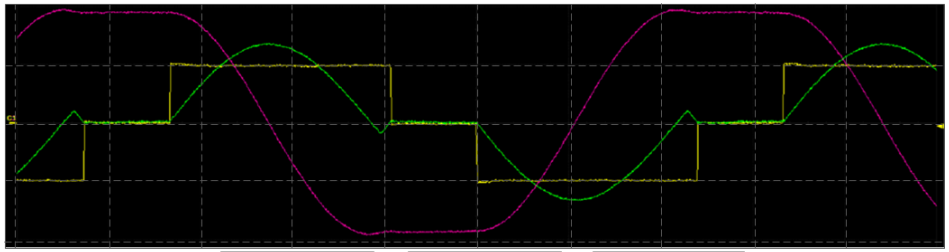
Experiment 1-baby converter

Pn=1kW;
Vin=250V;
Vout=500V;
Fsw=1000Hz;

Control

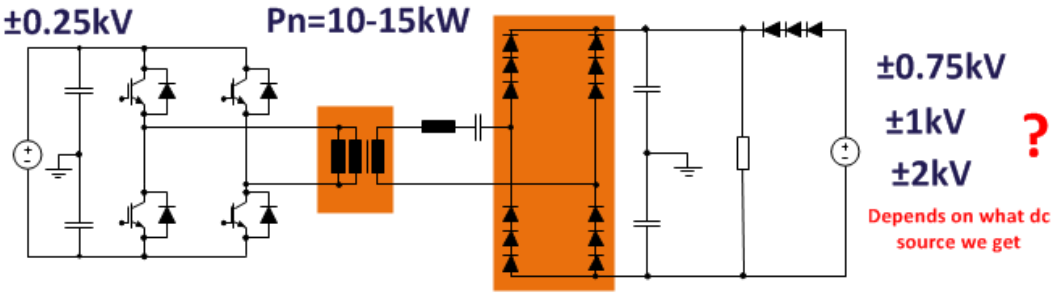
Protection





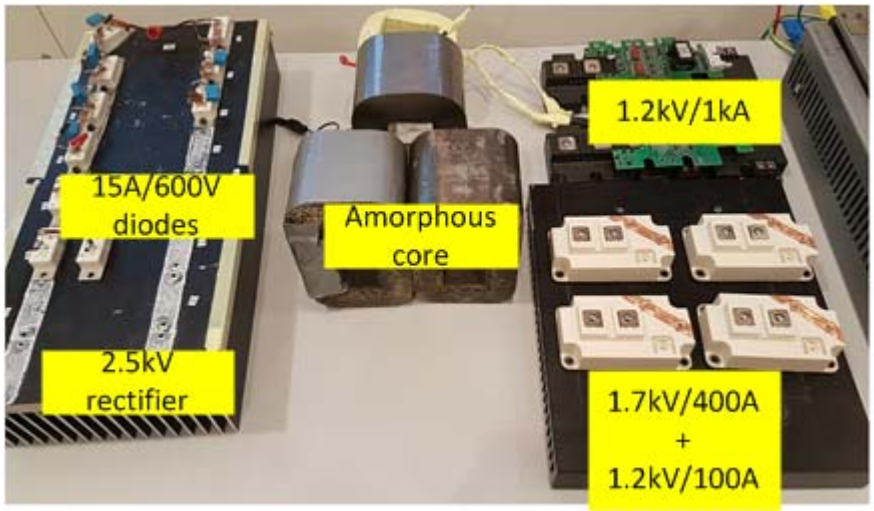
Irs 2A/div Vg 200V/div Vc 200V/div

Experiment 2



Validation of:

1.Basic loss measurement
2.Control and protection
3.Basic rectifier series connection



EXPERIMENT 3 ????

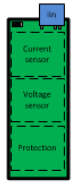
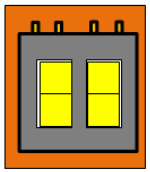
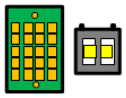
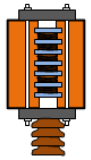
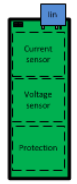
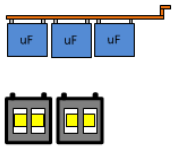
?

Intermediate converter

Pn=100kW; Vin=1000V; Vout=10000V; Fsw=1000Hz

Ctrl board

1month for coding!

DC-source	Input DC-Link	Meas.Prot.1	6.5kV power modules	Meas.Prot.2	1kHz	Resonant tank	Meas.Prot.3	Oil-Immersion cooling	Meas.Prot.4	Output DC-Link
										
Use same SOURCE	Re-design bank	Use same board	Up-date previous design with power module Find heat sink	Use same board	Design transformer for higher power	Re-design bank	Use same board	Up-date previous design With more modules	Use same board	Re-design bank

Thank you for your attention