LOW VOLTAGE VERY HIGH CURRENT SCR CONTROLLED MAGNET POWER SUPPLY

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Figure 1: 18KA MPS.

ABSTRACT

Danfysik A/S has developed a novel approach in constructing a low voltage, very high current and highly stable magnet power supply using parallel coupled SCR converter stages. The design is well suited for driving magnets in one or two quadrant operation. A ±10V 18kA power supply has been built with four parallel converters showing excellent performances.

The power supply has been developed having the following highlights in mind:

- High accuracy and stability (50ppm.)
- Good current sharing between parallel coupled converters
- Very high current
- One or two quadrant operation
- Computer controlled.

Key Data

Output current:	18000A
Output voltage:	±10V - 2Q operation
Stability short term:	±50ppm / 30 min
Stability long term:	±50ppm / 8 hours
Current set range:	1% to 100%
Costumer:	EPFL Lausanne

OUTPUT CONVERTER

The output converter was divided into four equally sized sub converters, each having its own Zy transformer, 6 pulse SCR bridge and controller.

As all four transformers are equally built the 30° phase shift for the total of 12 pulse rectification for two converters was achieved by rotating the input lines.

The excellent matching was achieved by subtracting two converter output currents with each other and adding the difference to the set value of the second converter. The same technique was applied between the two left and the two right converter couples as shown in the block schematic on the next page.

The simulation trace below shows the output currents of two paralleled SCR converters with and without current balancing circuit simulated with a 5% transformer voltage miss match. The light purple and the light green trace are the output currents without balancing and the blue and green with balancing circuit. The grey and purple traces are the total output current.

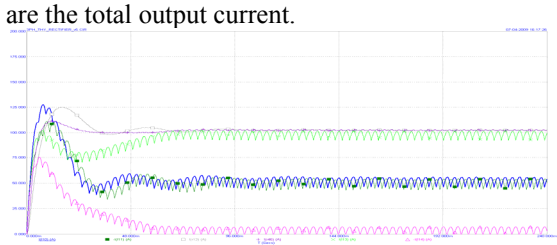

Figure 2: Current sharing simulation.

MECHANICAL LAY OUT

Utmost symmetry was taken into account for the mechanical lay out. The four individual 6 pulse rectifiers were placed in each corner of the cubicle having the same distance to the centre, the location of the DCCT. The return connection was divided into four and arranged symmetrically around the DCCT head ensuring a uniform magnetic load. The main capacitor bank was placed below the DCCT arrangement, so the current has to pass the capacitor bank before going up to the output terminals on the top of the cubicle. This ensures a very low leakage inductance of the capacitor bank giving a low commutation noise.

The cubicle also contains two large DC output breakers and dump resistors on top.

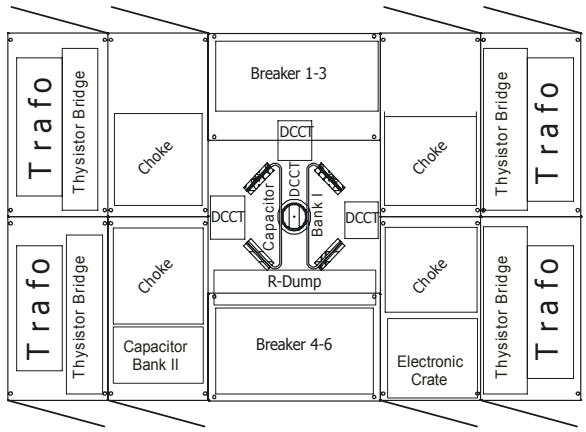

Figure 3: Mechanical lay out.

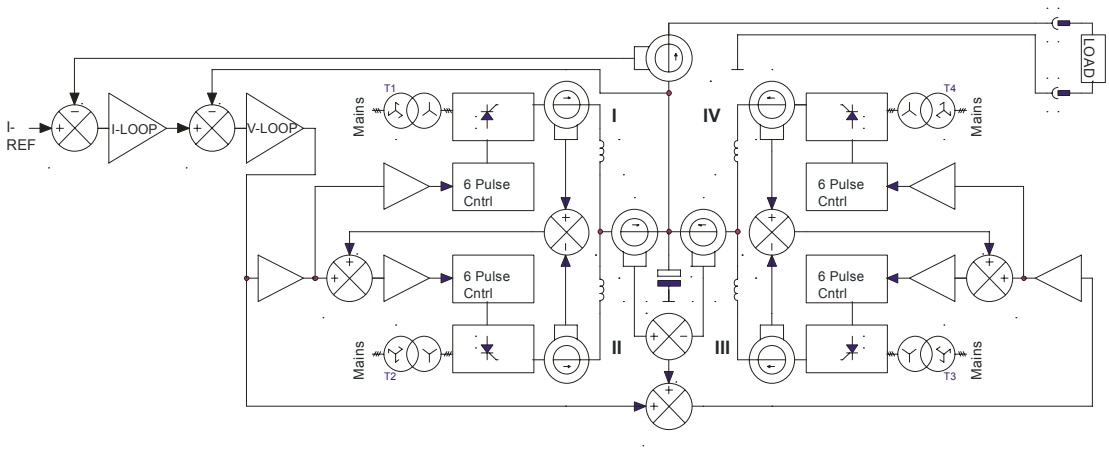

Figure 4: Converter block schematic.

TEST RESULTS

Some of the specifications for the power supply are:
Stability measurement

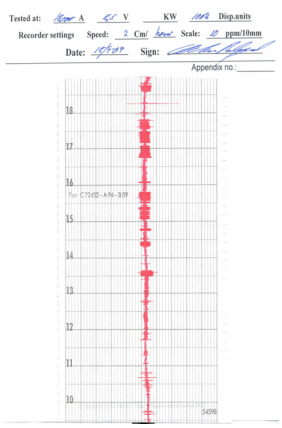

Figure 5: Long.

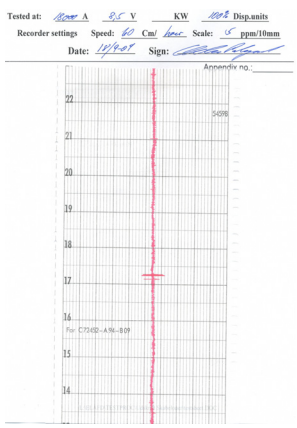

Figure 6: Short.

The current sharing between the four modules was over the whole working range better than 95% [(Imin/Imax)*100].

CONCLUSIONS

The novel "Current Balancing" Low Voltage very high current SCR converter topology design has proved to fulfil the specification concerning excellent current sharing between four parallel sub converters from nearly 0 to 100% output current, high stability, ease of construction- implementation and service due to its large component/parameter tolerance capability. The shown topology could easily be expanded for higher voltages or 24 pulse rectification still only using 6 pulse firing boards.