Power Supply and Energy Extraction System for the CBM magnet

Conceptual Design Report

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Power Supply and Energy Extraction System for the CBM magnet

- Introduction
- Powering Circuit
- Power Supply – VCH1000
- Quench detection
- Energy Extraction System, basic elements
- Experience
- Conclusion.

Power Supply and Energy Extraction System for the CBM magnet

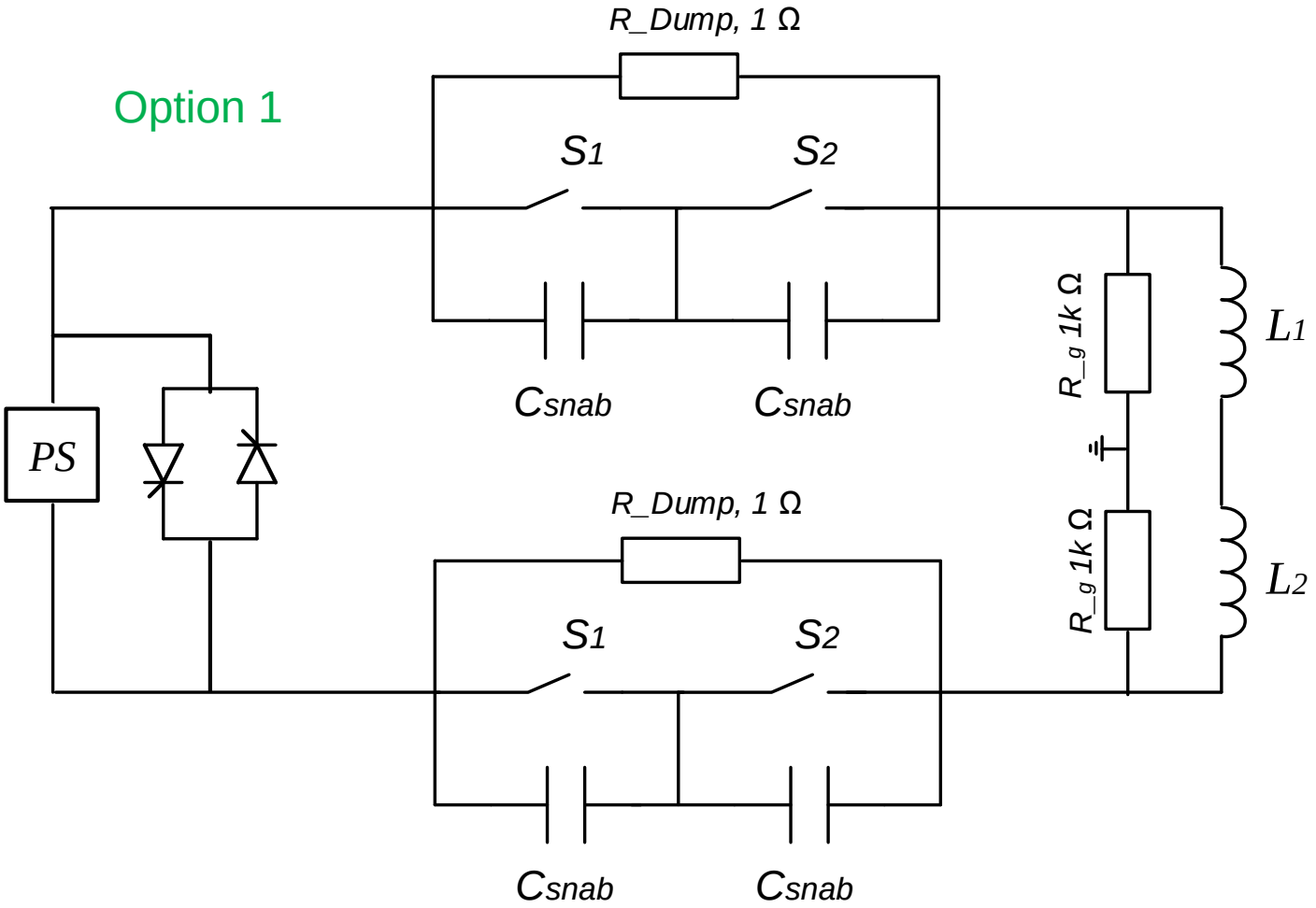
Introduction

Requirements for the external protection system (Quench detection and Energy Extraction):

- The amount of the stored energy to be extracted is 5.1MJ. Stored energy should be extracted to the external dump resistor with the value of 2 Ohm. The active elements of the dump resistor should not be hotter than 100C. Cooling time should be specified;
- Quench detection circuit should provide fast detection of the normal phase appearing. The discrimination time should be about 6ms and the threshold – about 0.6V (0.6V corresponds to 6 wounds in the normal state);
- Number of the voltage tabs and the locations of their connections should be determined;
- Dump resistor should be introduced to the circuit not later than in 40 ms. That gives the demands on the energy extraction switch (current breaker);
- Dump resistor value - 2 Ohm. Middle point should be introduced and grounded in order to minimize the voltage between the coil and ground.

Power Supply and Energy Extraction System for the CBM magnet

Powering circuit



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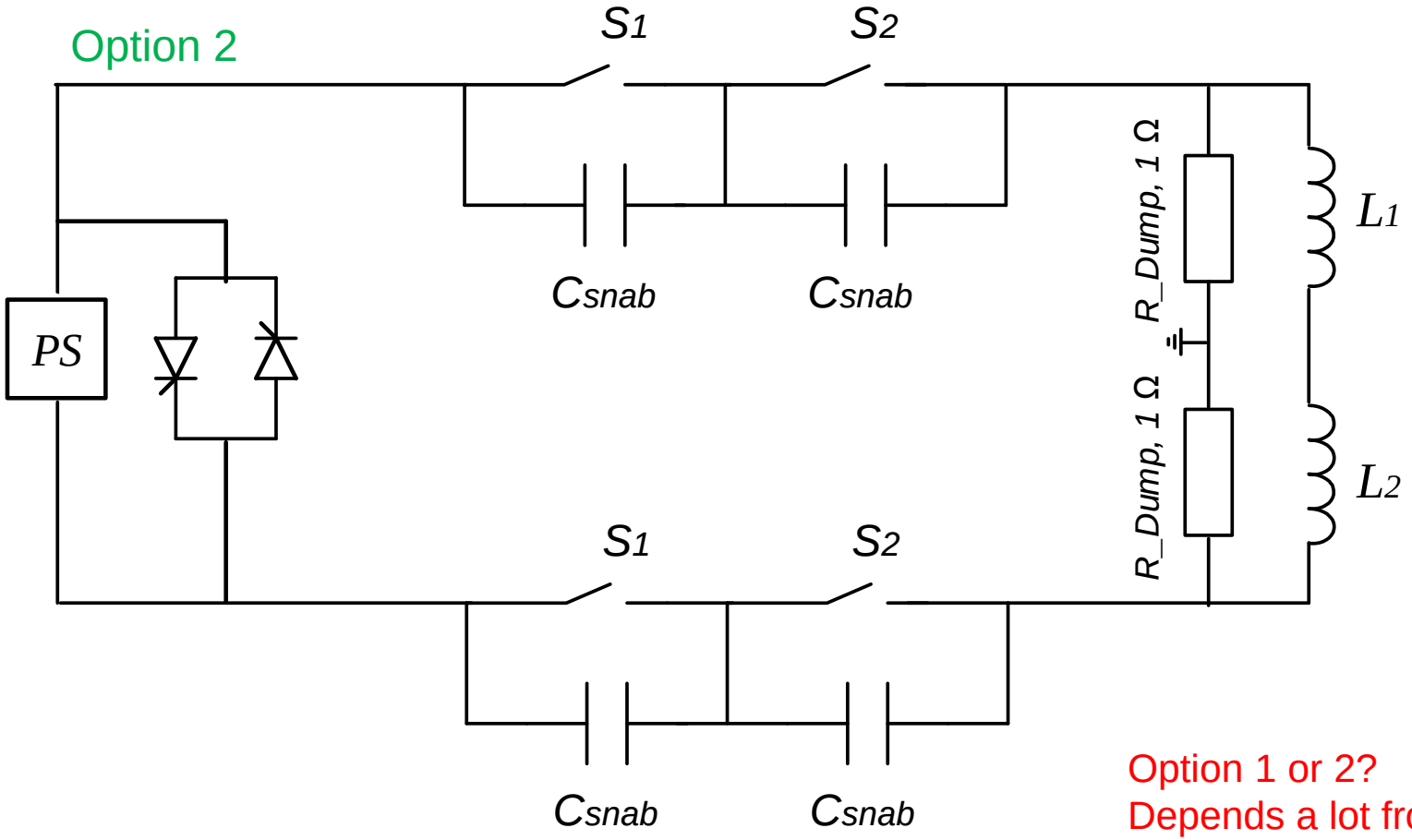
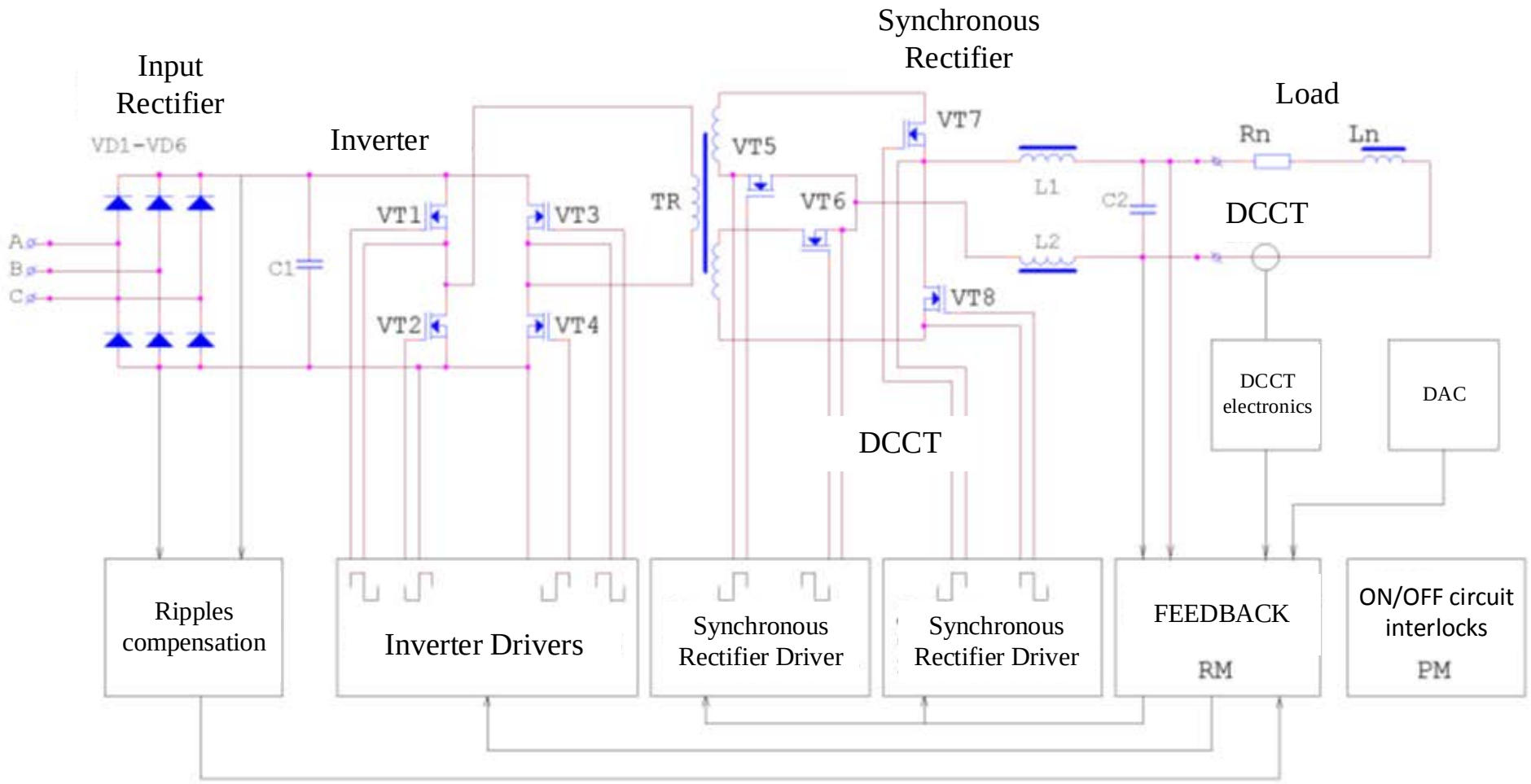
Powering circuit



Option 1 or 2?
Depends a lot from the racks positions

Power Supply (Current Source – VCH1000)

Power Supply – block diagram



PS

Power Supply – parameters:

- Nominal output power 12kWt;
- Nominal output current 1000A;
- Nominal output voltage 12V;
- 8 hours run Stability - < 0.01% from nominal;
- Output ripples in voltage:
  0-300Hz - < 10mV rms,
  0-40кГц – < 100mV rms;
- Control Interface – CAN
- Form factor 19” x 4U

PS

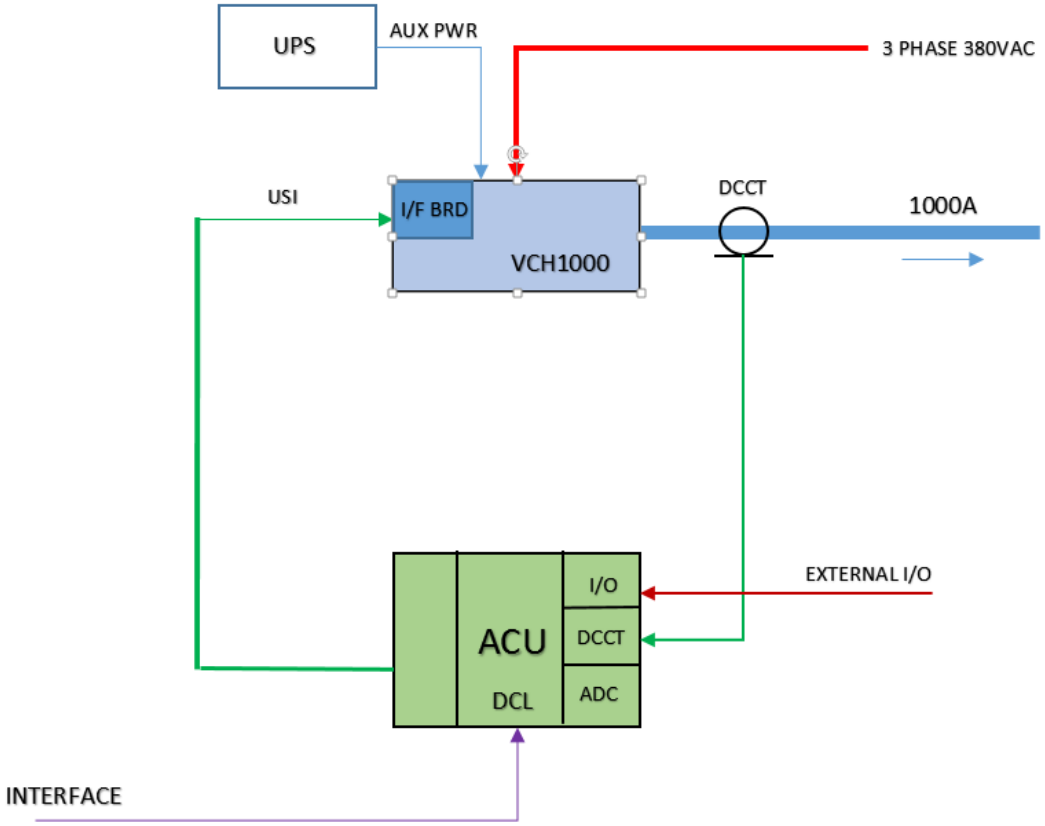
Interlocks:

- Overcurrent (I > “Imax”);
- Overpower (Pload > “Pmax”);
- Phase distortion for more than 20% ;
- Over temperature of the power part;
- External Load faults (temperature, water).

Conditions:

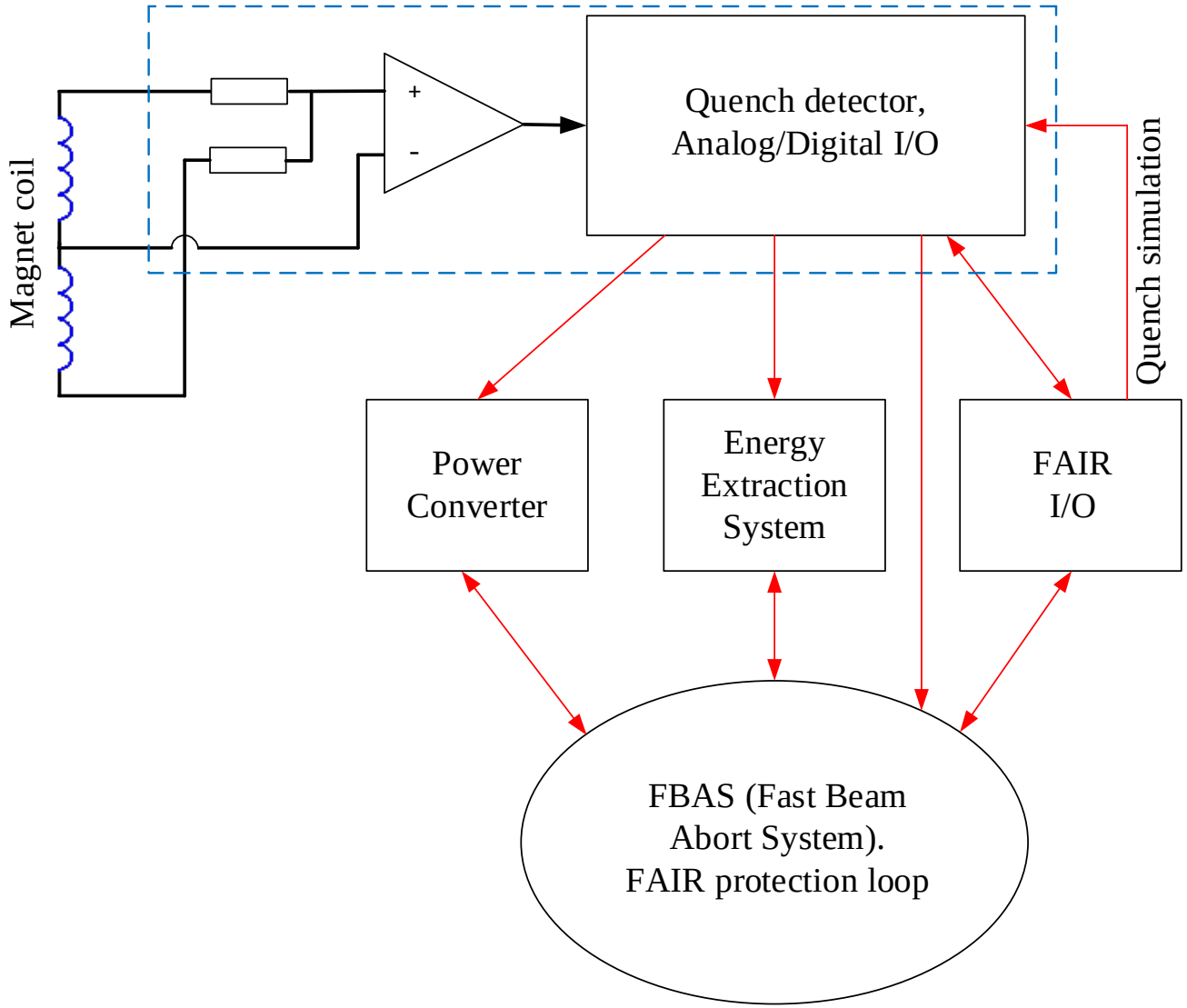
- External conditions – room temperature 10– 35^{0}C;
- Input power line – 3 phases 380V with neutral.
- Cooling – distilled water not warmer than 30^{0}C,
- Maximal input pressure 6bars,
- Water consumption 2 liters/min,
- Water gradient with the maximal power < 10^{o}C
- Sizes 547*550*133mm, weight 25kg.

PS control electronics

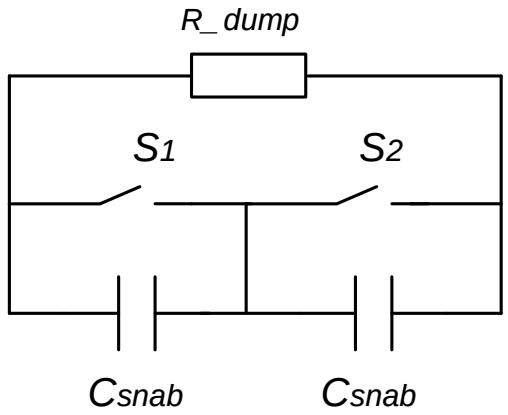


DCCT – digital control loop current sensor
ACU – Adaptive Control Unit
DCL – digital control loop

Quench detection, functional diagram

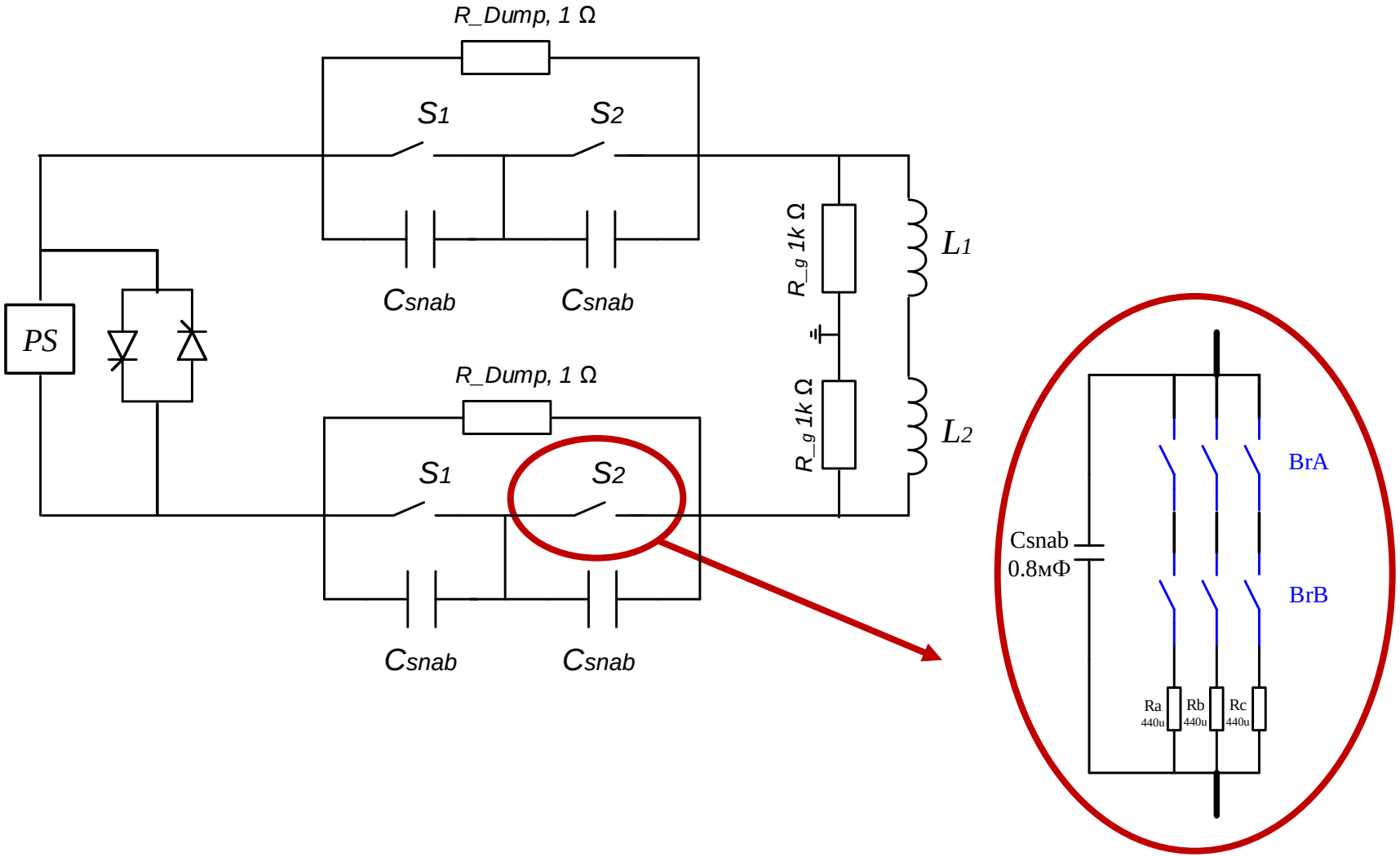


Energy extraction system

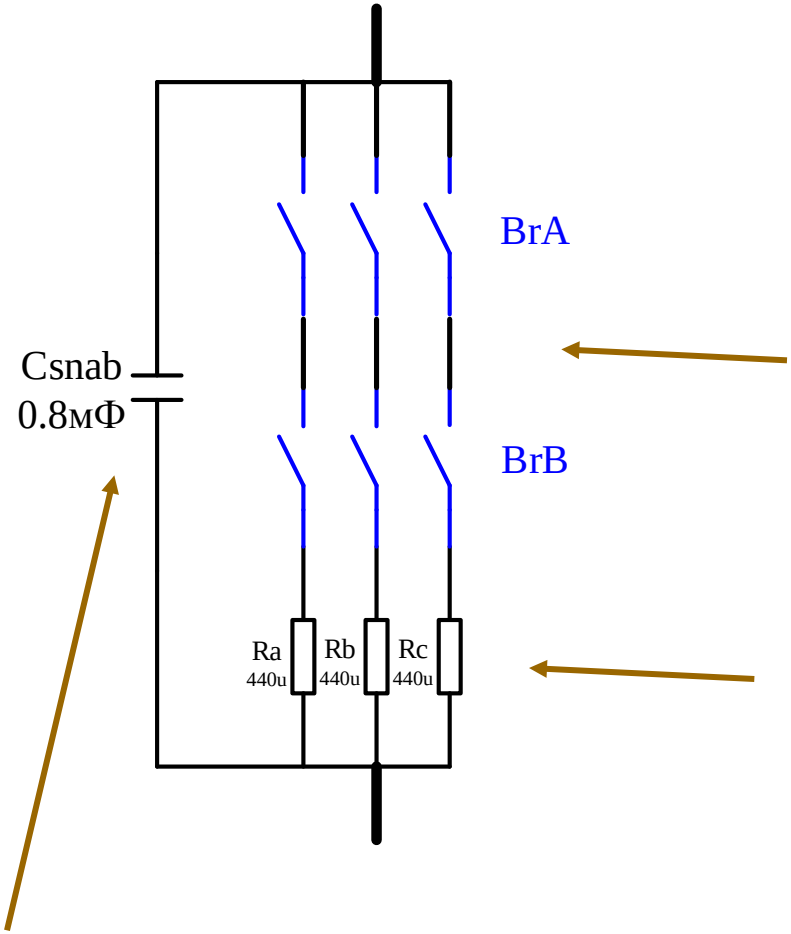


№	Parameter	Value	Unit
1.	Maximal current	686	A
2.	Energy stored in the magnet	5.1	MJ
3.	Current polarity	bipolar	
4.	Maximal inductance in a circuit	20+20	Hn
5.	Dump resistor value	2 ± 5%	Ohm
7.	Maximal overtemperature of the Dump Resistor	80	K
8.	Maximal time delay for the energy extraction	<0.04	s

Energy extraction system



Energy extraction system



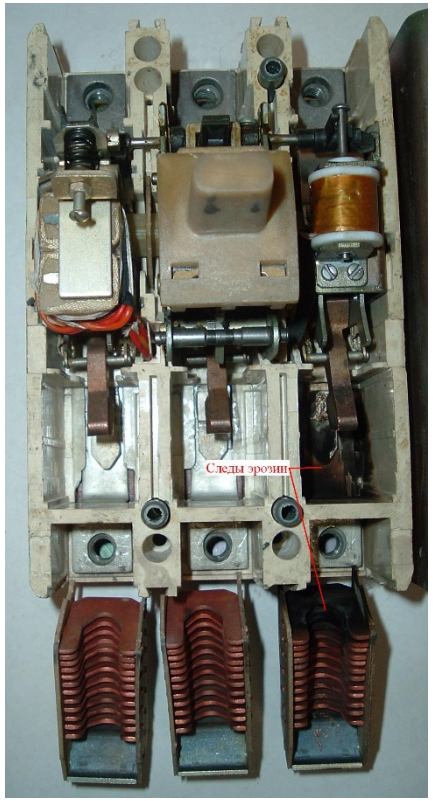
Two breakers for redundancy.
Each one is drived by the independent electronic channel

Equalizing resistors to improve the current sharing between phases

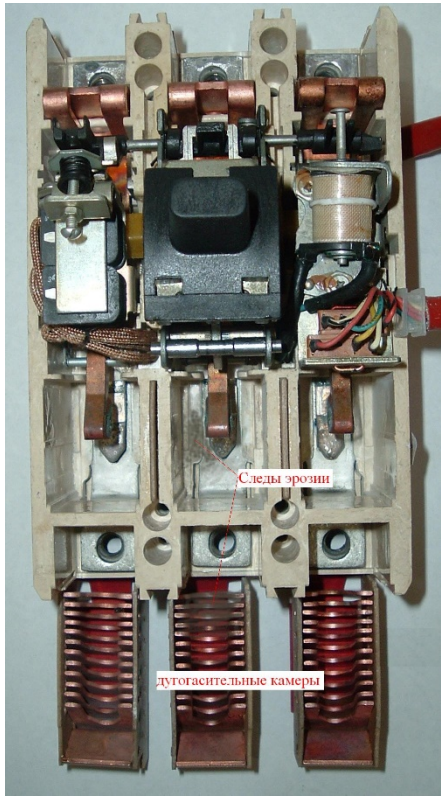
Csnab – snubber capacitor to minimize the arc effect.

Energy extraction system

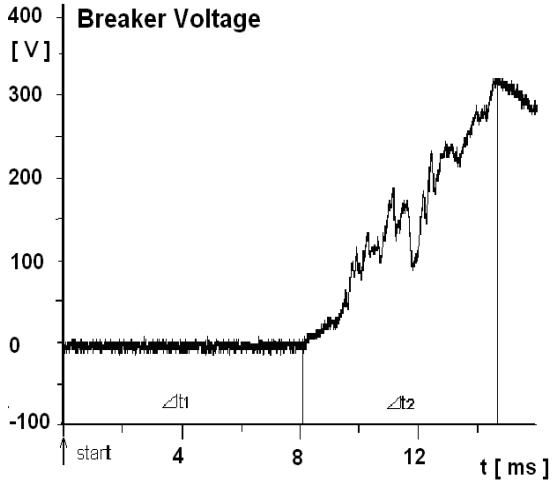
Electromechanical Breaker and use of snubber



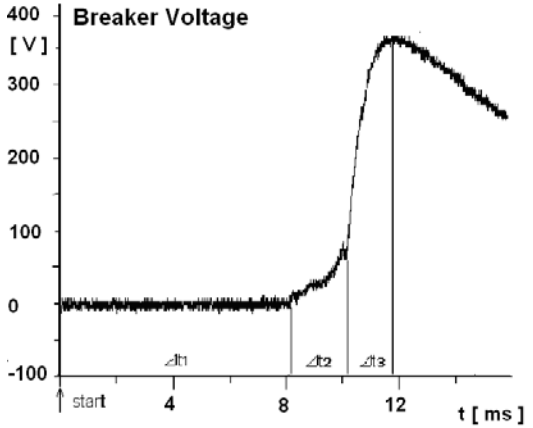
VA57-35 after 100 cycles under the full current , without snabber



VA57-35 after 100 cycles under the full current , with snabber , Csnab = 0.8 mF



Voltage over the contacts while opening the circuit with Csnab = 0



Voltage over the contacts while opening the circuit with Csnab = 0.8 mF

Energy extraction system

Example - 202 energy extraction systems for the LHC corrector magnets delivered by BINP to CERN.

Two systems per rack

Racks in the LHC tunel

Thanks for Your Attention!