Powering the damping rings wigglers

OUTLINE : Powering superconductive magnets, Powering wigglers strategy, Existing converters, Control and Magnet protection .

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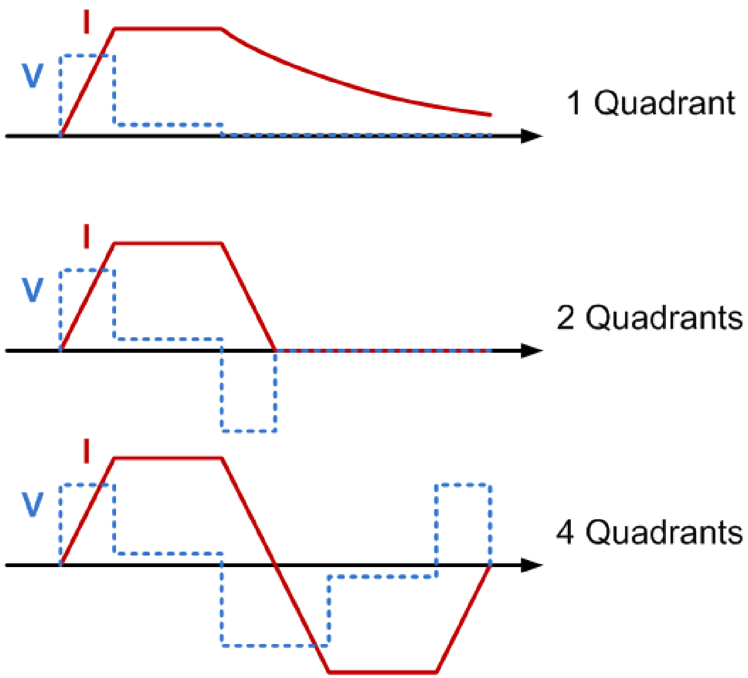
Superconductive magnets

- The powering of superconducting magnets doesn't require much power when it comes to DC steady state operation.
- What counts essentially is the requirement in the dynamics in start/stop procedures which is essentially dependent on the inductance and the applied voltage (U=Ldi/dt).

- In one quadrant operation, the current decreases only with dissipative components.
- In two quadrants operation, the magnet energy is taken back to the power converter
- Four quadrant converters allow full flexibility.

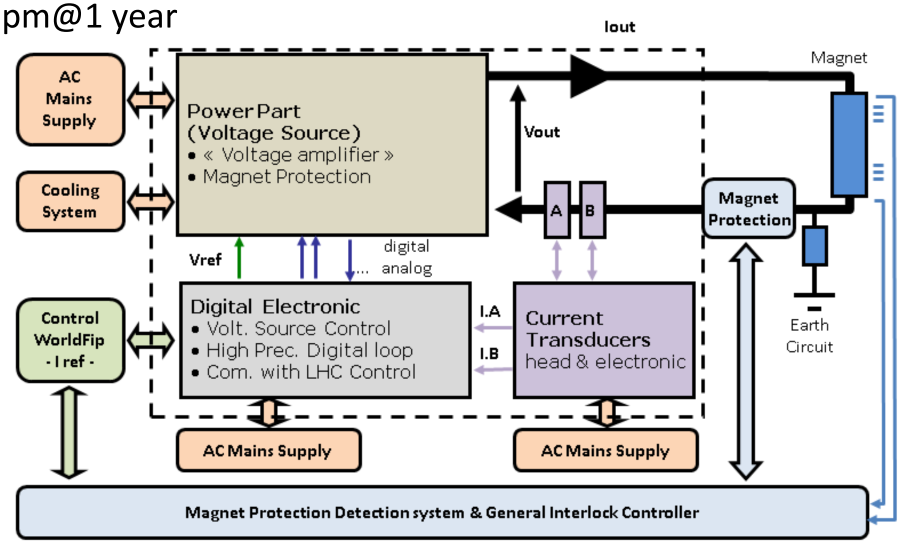


Powering CLIC wigglers

- Wigglers parameters :
  - L = 1.6 H
  - I = 600A (possibly 1kA)
  - Stored Energy = 250kJ (possibly 1MJ)
  - Precision = 50ppm
  - dI/dt =1A/s (given by D. Schoerling)
- Voltage required for bringing one wigglers to nominal current:
  - V_{rise}=LdI/dt = 1.6V
  - V_{cable}=3.6V (@L_{cable}=100m, S_{cable}=300mm^2, R_{cable}=6mΩ)
  - V_{magnet}=0?
- Power converter minimum voltage is 6V.
- For powering 104 wigglers:
  - Individual powering: 104 (600A/6V) power converters + 5 spare (30kCHF/converter => 3.3MCHF in total).
  - Serial powering: 4 (600A/45V) power converter +1 hot spare (55kCHF/convert => 275kCHF in total).
- In case of 1kA wigglers, price of converter doubles.

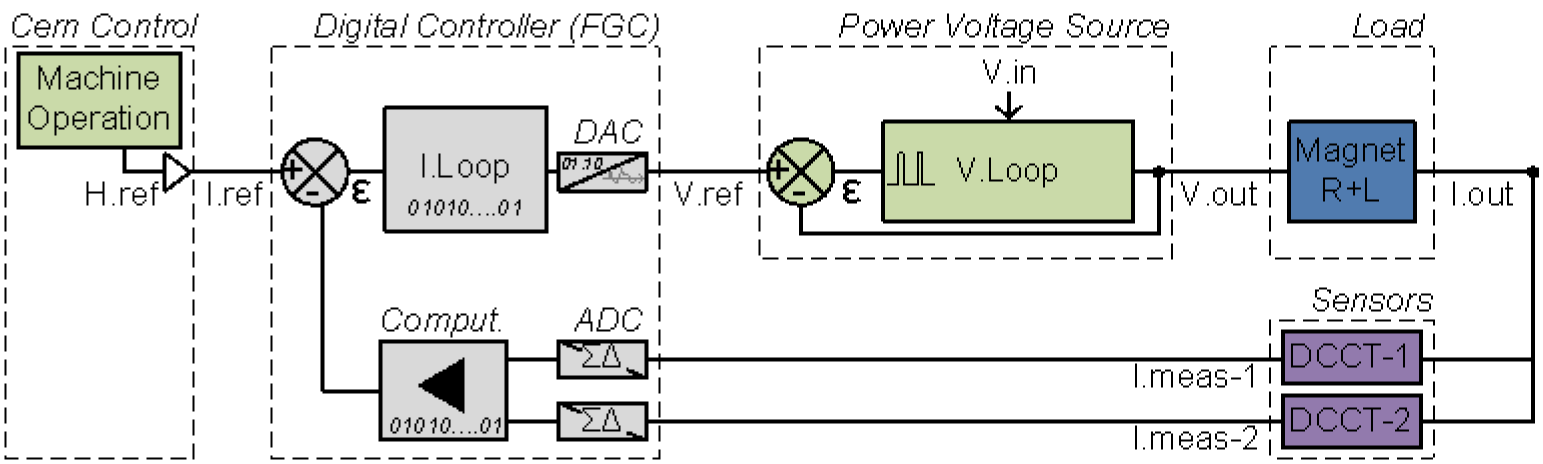
Similar converter in the LHC

- Power converter used in LHC to power superconductive magnets, located in underground installation, close to the load to limit cable losses.
- ±600A/±40V.
- Current precision:
  - 10ppm@30 min
  - 50ppm@24 h
  - 500ppm@1 year



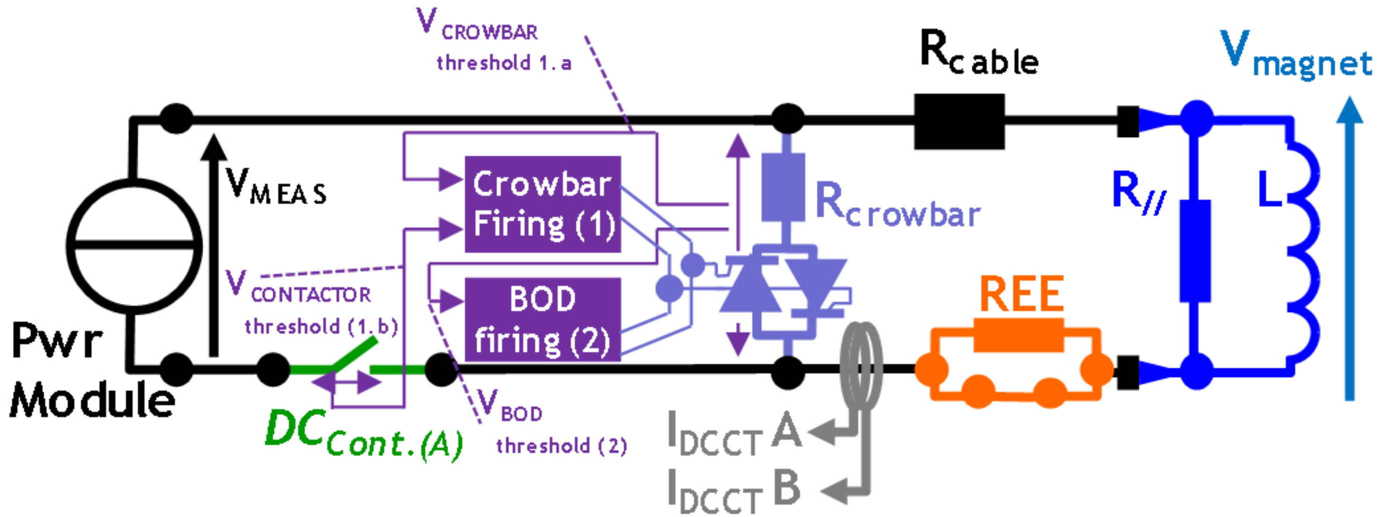
Control

- High precision current loop managed by digital controller.
- High precision Analog to Digital Converter digitalizing the analog current measurement coming from DCCT (DC current Transducer).
- Precision is directly relying on sensor precision DCCT, ADCs and regulation algorithm.
- High bandwidth low precision voltage loop controlled by slow current high precision regulation loop.



Magnet Protection

- Power converter is part of magnet protection without being responsible of the protection itself, diagnosis and monitoring of the magnet status.
- Power converter ensures that powering is stopped and its output is shorted in case of ‘Fast abort’.
- Monitor Earth current in converter and magnet.



Conclusions

- All technical challenges of CLIC wigglers have been solved for LHC superconductive magnets.
- Powering of wigglers based on existing and proven solution.
- Serial connection of wigglers allows reductions in costs, maintenance and spare management (Cold connections allow to reduce overall resistance).
- Magnet discharge path ensured by power converter through its crowbar.
- Protection, monitoring and diagnosis of magnet status not performed by the power converter.