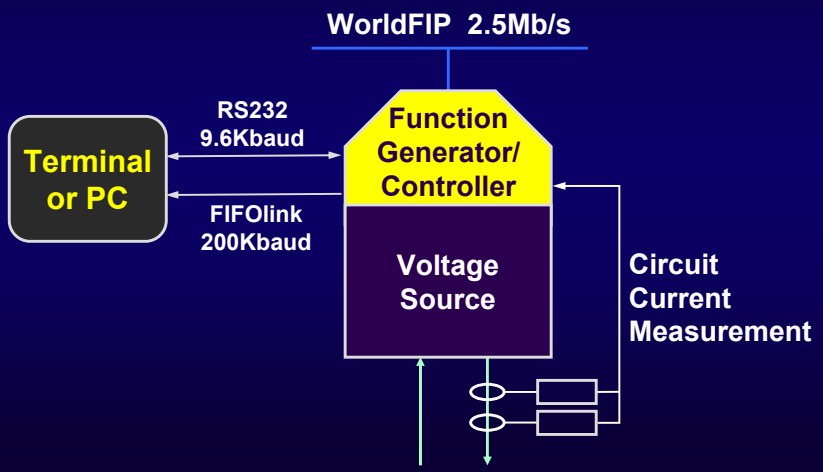
Hardware Commissioning Power Converters

- Scope of the problem
- Timescale
- Services required
- Controls architecture
- Control functionality required
- Diagnostic Interface Module

Hardware Commissioning Scope of the problem

- 1712 power converters from 500W to 2.4MW
  - 752 in the LHC tunnel
  - 262 in the RRs
  - 680 in the UAs/UJs
  - 18 In the SRs
- First sector 7-8: Q4 2004
- Last sector 1-2: Q4 2006
- 3.5 converters per working day to be tested, transported, installed and commissioned!

Hardware Commissioning Overview of a Power Converter



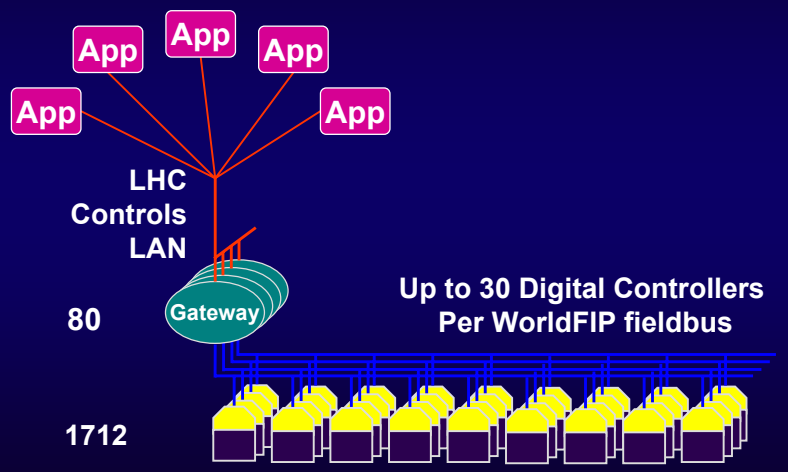
Hardware Commissioning Procedure

- Every converter must go through various stages:
  - Integration with control electronics and current measurement DCCTs
  - Power converter acceptance testing
  - Transportation to final installation position
  - Installation and integration with services:
    - 3-phase power 400V or 18kV
    - Cooling water
    - WorldFIP (linked to an FGC Gateway)
    - Powering interlocks

Hardware Commissioning Procedure

- On site commissioning can follow:
  - Interlock signal tests (Power Permit, Fast Power Abort, Powering Failure)
  - Powering tests on a local short circuit
  - Powering tests on a remote short circuit (i.e. to test the cables)
  - Powering tests on the magnet circuit, when cryo and interlocks are ready
- This is all possible with local control but using the WorldFIP network is preferred, especially for magnet powering tests (alarms and logging will then be available)

Hardware Commissioning System Architecture



Hardware Commissioning Controls Functionality Required

- The commissioning team need to be able to work locally with a converter:
  - Run self-test/calibration procedures on electronics
  - Control and observe the converter operating state (Off / Standby / Idle)
  - Operate in voltage mode (open loop) and then current mode (closed loop)
  - Measure analogue performance (stability, noise, drift)
  - Diagnose and correct faults
- The same activities should be possible remotely

Hardware Commissioning Controls Implementation

- Local commissioning is via the serial interfaces:
  - FGC supports a Unix shell like interface with real-time display and set/get commands for use with a VT100/ANSI terminal
  - FGC supports a direct serial communications mode for local control programs running on a PC (e.g. Labview)
  - FGC supports a diagnostic serial communications mode for real-time diagnostics programs running under Labview on a PC
  - High speed FIFOlink serial interface allows for detailed analogue analysis on a PC using Matlab

Hardware Commissioning Controls Implementation

- Identical facilities will be available remotely via WorldFIP and the Gateway
  - Remote terminal
  - Remote set/get commands
  - Remote diagnostic session (e.g. for Labview app)
- Remote connection has additional features
  - Ten times faster than RS232 serial interface
  - Links to alarms, logging, post mortem, JAPC

Hardware Commissioning Diagnostic Interface Module

- LHC is a big machine, so time to reach equipment will be significant
- Most of the big power converters are composed of sub-converters, if one trips it may trip the rest, so which tripped first?
- Big investment in remote diagnostics
  - Diagnostic Interface Module (DIM) has been designed and will be included in all the power converters

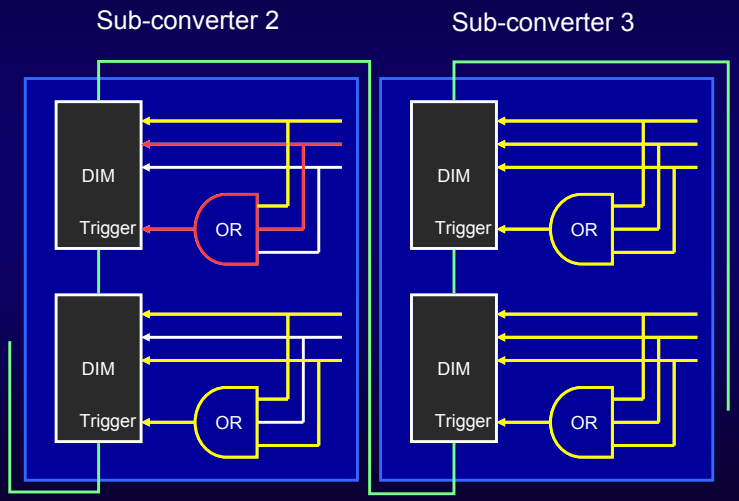
Hardware Commissioning Diagnostic Interface Module

- What is a "DIM"? It is a Data Acquisition device:
  - 24 digital inputs (2 banks for 12 inputs)
  - 4 analogue inputs (12-bit ADC)
  - 1 trigger input
- How is it used?
  - Daughter board inside power converter electronics
  - Up to 15 can be linked in a daisy chain
  - Up to two daisy chains can be connected to the FGC
  - One chain can be read every 10ms (100Hz or 50Hz)
- What does it cost?
  - 70SF per card (3000 will be used in total)

Hardware Commissioning Diagnostic Interface Module

- What is the trigger input for?
  - The trigger input will allow the cause of power converter trips to be identified
  - Converter manufacturer adds OR logic for all the faults so the trigger is the sum of all faults monitored by the DIM
  - When the trigger is activated, the DIM freezes the digital inputs (revealing the first fault) and freezes an 8μs timer revealing which DIM card was triggered first

Hardware Commissioning Diagnostic Interface Module



Hardware Commissioning Diagnostic Interface Module

- What will the FGC do with all the data?
  - Circular buffers will log several seconds for all analogue signals – buffers will be frozen when a converter trips to allow post-mortem analysis
  - Digital signals will be time stamped and logged when changes occur
  - Two channels are exported over the WorldFIP and/or serial interface every 10ms (1 Channel = 1 analogue input or one bank of 12 digital inputs)
  - 64 software channels are available (e.g. task timing)

Hardware Commissioning Diagnostic Interface Module

- How are channels specified?
  - Signals are described in XML (e.g. for analogue signals: name, units, gain and offset)
  - Channel organisation includes the concept of an array of DIMs with the same set of signals – this maps to the sub-converter structure of the big converters
  - Complete channel definition for every converter type is documented in automatically generated web pages