Project Specification

Project Name: CMS-FED

Version: 2.0

Approval:

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Doc # CMS-FED-001

1. Description

CMS is one of four planned experiments (ATLAS, CMS, LHCb and ALICE) at the LHC at CERN due to start operation in 2007. The CMS-FED project is aimed at the design and production of the tracker Front-End Driver (FED) card, part of the off-detector electronics instrumentation of the CMS silicon strip tracking detector.

The tracking detector consists of over 10M silicon micro-strip channels instrumented on the detector by approximately 80K radiation hard Analogue Pipeline Chips (APV) designed by the Instrumentation Department's Microelectronics Design Group. Each analogue pipeline chip handles 128 detector channels with pairs of chips having their outputs multiplexed in analogue form at 40 MHz onto a single fibre for transmission to the off-detector electronics. This 256:1 multiplexing results in 40K optical signals, which are received by the tracker FED cards. The latter modules perform optical to electrical conversion, digitisation, zero-suppression and transmission of the data to the CMS central data acquisition system.

The target implementation for the tracker FED is a 96 ADC channel VME module in a 9U x 400mm form factor. The CMS tracker system will require approximately 440 such FED cards (plus spares) to provide the necessary 40K channels of ADC instrumentation.

2. Scope

2.1 Includes

The design, implementation, production and testing (excluding optical testing) of the FED 9U VME cards.

The design, implementation and testing of all firmware for FPGAs on FED.

The provision of Trigger Control System (TCS) signals on specified VME backplane pins.

The assembly of opto-receiver modules on FEDs.

Ancillary test cards for electrical tests (analogue and digital, including JTAG Boundary Scan).

Debug level software for testing Firmware. Restricted for use in RAL and Imperial test systems (i.e. not for final system at CMS).

The provision of assistance during the commissioning of the FEDs at CMS.

The responsibility for the maintenance and the repair of faulty FEDs. The funding of FED maintenance is to be decided in the Maintenance Review.

The provision of documentation: including a user guide and technical manuals.

Assistance in the overall design of final FED in tracker system at CMS.

2.2 Excludes

The design and manufacture of the opto-receiver modules.

The test equipment for opto-receiver modules on FEDs.

The design, implementation, production and testing of a scheme, e.g. VME Transition card, to hold the DAQ link mezzanine card (as required by final CMS system.)

The DAQ link mezzanine card and the downstream electronics DAQ chain (including the merging of data from more than one FED.)

The TCS link card and its associated downstream electronics chain.

The APV emulator system.

Any other modules in the FED VME crates e.g. crate controllers, PC-VME link cards, TCS link cards.

The control and monitor PCs and their associated networks.

The Trigger Timing and Control (TTC) system equipment and its operation.

The provision of VME crate and rack hardware at CMS.

The design, implementation and testing of the final crate/rack system at CMS.

The design, implementation and testing of the CMS system cabling schemes to the FEDs, including analogue Opto-links, TTC links, DAQ links, TCS links.

All (low and high level) final software for operation of the FED in CMS DAQ.

The software for silicon module test setups.

The day to day operation of the FED system during CMS running.

3. Deliverables

RAL will deliver to CERN:

Prototypes:

10 off (to be confirmed by customer) tested prototype FEDs (with subset of firmware for raw data capture via VME).

Production:

440 off (plus spares) tested production FEDs.

Firmware with functionality as described in User Requirements document CMS NOTE 2001/043 v0.54.

Full expert documentation describing hardware and firmware (see section 5.) User guide.

Items expected for delivery to RAL from CMS:

Tested opto-receiver modules at RAL on a schedule to permit a minimum of 3 months testing of FEDs with assembled opto-receivers at RAL prior to FED delivery to CERN.

Test equipment for opto-receivers operational prior to arrival of FEDs with assembled opto-receivers.

Test equipment for driving TTCrx.

Specification of DAQ link interface and data formats.

DAQ Link CMC card sender and receiver test equipment.

Specification of TTS interface (backplane pinout and signal standards).

Specification of CMS standard 9U crate including backplane pinouts.

CMS standard crate hardware.

Final software for operation of the FED in CMS DAQ.

4. Constraints

4.1 Budget

Project budget and resource allocations are as specified by CMS UK Management Committee.

Target cost for 1 off 96 channel production FED = 10,000 CHF

Cost estimates spreadsheets (CMS-FED-003.)

Staff Effort spreadsheets (CMS-FED-004.)

NB All expenditure should be made on an approved CMS project code (e.g. FK50800) to enable VAT to be recovered.

4.2 Schedule

Refer to Project Schedule (CMS-FED-005).

Delivery of approx 10 off prototype FEDs[1] to CERN sufficient to match tracker Large Scale Assembly test needs over period Q4 2003 -> Q2 2004 (numbers and dates to be confirmed by customer).

Manufacture of approx 16 off pre-series FEDs in Q4/2004->Q1/2005 for full crate tests in UK.

Delivery of 440 production FEDs (plus spares) in batches to CERN over a period to match installation schedule required by CMS tracker. Earliest projected installation period Q3/2005->Q2/2006 (profile to be confirmed by customer.)

[1] With firmware for basic LSA test requirements.

4.3 Performance

The FEDs should satisfy at least the minimum set of system requirements as outlined in Requirements document CMS NOTE 2001/043 v0.54.

4.4 Regulatory

The FEDs will not be tested for EMC or CE marked.

5. IPR and Confidentiality

Instrumentation Department owns the design databases it has produced, including FPGA firmware Intellectual Property. These items will not be released unless the appropriate protective agreements are in place.

6. Project Monitoring

Customer meetings in UK are held every 2 to 3 weeks.
Contributions to regular CMS tracker and general meetings at CERN.
Project Monitor Forms to be produced at least monthly.

7. Glossary

APV	Analogue Pipeline Voltage
CE	Conformité Européenne
CMC	Compact Mezzanine Card
CMS	Compact Muon Solenoid
EMC	Electromagnetic Compatibility
FED	Front End Driver
FPGA	Field Programmable Gate Array
JTAG	Joint Test Action Group
TCS	Trigger Control System
TTC	Timing Trigger & Controls
VME	VERSA-module Europe