SCT-BM-FDR-3_Appendix 1

SCT BARREL MODULE : ELECTRICAL HARNESS INTERFACE

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1. Scope of the document

This document describes the interface of the SCT barrel modules to the opto-harness. An overview of the SCT links system is given in Section 2. The electrical specification of the SCT links for the barrel harness is given in Section 3 and the mechanical specification is given in Section 4.

2. SCT Links system overview

Optical links will be used in the SCT to transmit data from the silicon strip detector modules to the RODs and to distribute the Timing, Trigger and Control (TTC) data from the RODs to the ABCD ASICs. The SCT optical links are based on VCSELs and epitaxial silicon PIN diodes operating at a wavelength of 850 nm. There will be one opto-package for each of the 4088 SCT detector modules. Each of these opto-packages will contain two VCSELs for the data links and one PIN diode for the TTC link (see Figure 1).

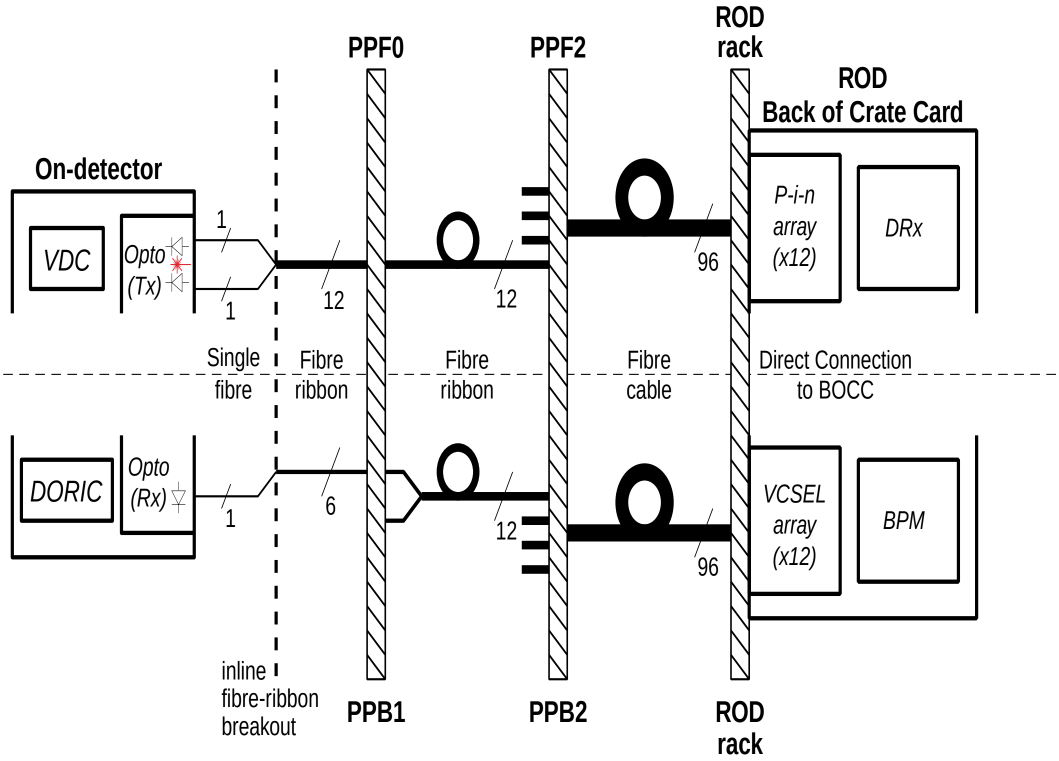

Figure 1 SCT Links architecture. PPB1, PPF0, PPB2, PPF2 refer to fibre and cable patch panels.

The opto-packages are pig-tailed with multi-mode radiation-hard fibres. The data from the SCT front end modules are read out serially via the VDC ASIC. The data link uses an NRZ data format and the minimum fibre coupled power will be 300 µW. The off-detector opto-electronics for the data links consists of 12 way arrays of silicon PIN diodes to receive the optical signals and the DRX-12 ASIC to amplify and discriminate the resulting electrical signals.

The TTC links use BiPhase Mark encoding to send the 40 MHz bunch crossing (BC) signal and the 40 Mbits/s control data stream for each module down the same fibre. For the TTC links, the off-detector opto-electronics consists of the BPM12 ASICs and 12 way VCSEL arrays. The BPM12 performs the BiPhase Mark encoding and drives the VCSELs. The TTC optical signal is converted to an electrical signal by the PIN diode in the on-detector opto-package and the resulting electrical signal is decoded by the DORIC4A ASIC to produce the recovered BC clock and control data signals.

Redundancy is provided for in the data links by having two independent data channels per module. If one link fails or a master ABCD fails, then the data can be routed via the other data link of the same module. Redundancy is built into the TTC system in that if a TTC link fails, then the TTC data can be taken from a neighbouring module.
This redundancy links the modules along one half row. Two neighbouring rows in φ are joined together to produce a redundancy loop covering 12 modules.

3. ELECTRICAL SPECIFICATIONS

The opto-electronic components (opto-package and DORIC4A and VDC ASICs) for the barrel SCT will be mounted on opto-flex cables. The opto-flex cables will be produced as a four layer flexible copper/kapton circuit. There will be two signal/ground layers and one ground screen plane so that the tracks for the high speed signals can be laid out as strip lines. There will be one thermal layer, which will be used to transfer heat from the opto-electronics to the cooling pipe.

The schematic diagrams, layouts and details of the connectors used for the opto-flex cables are available on the web at http://webnt.physics.ox.ac.uk/wastie/dogleg.htm
The pin-out of the connectors on the opto-flex cable is defined in the schematic.
The module connector is used to contact the opto-flex cable to the module pig-tail. The pin-out of the interface PCB connector is available on the web at
http://webnt.physics.ox.ac.uk/wastie/dogleg.htm

The connector at the opposite end of the opto-flex cable is used to connect to an interface PCB. The low mass Al tapes will be thermode soldered to the opposite side of this interface PCB. The Samtec horizontal mating connectors on the opto-flex and the interface PCB are also defined at http://webnt.physics.ox.ac.uk/wastie/dogleg.htm
The low mass cables are made from single sided aluminium/kapton cables. Two pairs of tapes are glued together to form a pair with each pair supplying one SCT module. The schematic diagrams of the low mass Al tapes are available on the web at http://www-f9.ijs.si/~cindro/cables/cable2001_barrel.pdf

The specifications for the DORIC4A and VDC ASICs are available on the web at
http://www-pnp.physics.ox.ac.uk/~weidberg/doric_specs.pdf
http://www-pnp.physics.ox.ac.uk/~weidberg/vdc_specs.pdf

In order to have the possibility of implementing two different grounding schemes there will be a 50 µm thick aluminum foil below each barrel harness. Two different grounding schemes can be implemented:

1. **Shunt Shield Configuration**. In this option the foils are unconnected to the modules or thermal shield. Another 50 μm thick aluminum foil, 5mm wide makes an electrical connection from the cooling pipe to the digital ground on the opto-flex near the module connector.
2. **Solid Ground Configuration**. In this option arms of the foils are unfolded so as to connect to the opto-flex digital ground. The other ends of the foils are connected to the thermal shield. The digital ground near the module connector is then connected to the cooling pipe by a 50 μm thick aluminum foil, 5mm wide.

4. MECHANICAL SPECIFICATIONS

The opto-flex cable should have a minimum bend radius of 4.5mm. There are 16 different flavours of the opto-flex cables to take into account the following factors:

1. left handed or right handed opto-flex;
2. left or right redundancy flow;
3. opto-flexes for barrels 3 and 5 are different to 4 and 6 because of the different stereo angles (uφ compared to vφ stereo).
4. High and low modules have different opto-flex cables to allow for the extra length and the need to respect the minimum bend radius.

The mechanical drawing for one of the 16 flavours of the opto-flex cable is on the web at http://webnt.physics.ox.ac.uk/wastie/dogleg.htm
The opto-package dimensions are 5.5*5.5*1.6 mm^3. The wire bonds from the opto-package to the ASICS and the wire bonds from the ASICs to the opto-flex will be protected by a plastic u-profile lid. Allowing for this lid, the space envelope for the opto-package plus ASICs is 1.6*9*11 mm^3. The clearances for the opto-package to the silicon is 1.27 mm. The total height of the Al tapes plus interface PCB, plus opto-flex and connector is 5.6mm. This leaves a minimum of 2.4mm clearance (6 pairs low mass tapes and worst case barrel radii and eccentricity variations). The positions of the opto-package, opto-flex and SCT modules on the barrels is illustrated in the CDD drawings number 252683P0, 252684P0, 252685P0 and 252686P0.

Six SCT barrel modules are supplied by low mass tapes and optical fibres that come in from the +Z side of the barrel and the other six in the same row from the –Z side. Each set of six tapes (called an opto-harness) will be assembled and mounted onto the barrel together (see drawing RAL-A0-TB-0045-742-00-A). The 12 data fibres for one opto-harness will be fusion spliced to a 12 way fibre ribbon and the 6 TTC fibres for one opto-harness will be fusion spliced onto a six way ribbon fibre. The location of the splices will be after the fibres have left the barrel surface. The lengths of bare fibre near the modules will be protected by 900 micron furcation tubing which will allow the fibre to be strain relieved at the back of the opto-package. The individual fibres run in parallel with the low mass tapes along the surface of the barrel. The fibres are routed from the barrel to the opto-flex so as to respect the minimum bend radius of 20mm. The tapes are held on the surface of the barrel by a clamp to isolate them from mechanical strain. The clamp will allow movement of the tapes on thermal cycling. The opto-flex leaves the barrel at the location of the clamp and is fastened to the bracket by two screws. The bend of the opto-flex will respect the minimum bend radius of 4.5 mm. The screws used will be smaller than the 3.5mm diameter of the holes (see the CDD drawings number 252683P0, 252684P0, 252685P0 and 252686P0). This tolerance will be used to accommodate the actual module dimensions in order to ensure that the connector at the end of the opto-flex can mate with the connector on the end of the module pig-tail. The opto-flex is routed underneath the cooling pipe and is held against the tube by two spring clips. The opto-electronics are all on the upper side of the opto-flex. A heat sink layer is used to transfer the heat from the opto-electronics to the area under the cooling pipe. Thermal calculations are being performed to optimise the heat transfer as to allow the VCSELs and PIN diodes to operate around 0^0C.

The SCT barrel opto harnesses will be fully tested at RAL before mounting on the barrel. The tests that will be performed are defined in the document
http://www-pnp.physics.ox.ac.uk/~weidberg/assembly_and_test_procedures.doc
The opto-harnesses will be mounted on the barrels and simple functionality tests will be performed.