Specifications of Low Mass Flexible Cables for the New Layer 0 Silicon Detector at DØ

Version 2.0, date 02/12/04

Description of Layer 0 Module

Tight space constrains, material budget and heat dissipation issues require the Layer 0 silicon sensors to be connected to the associated electronics with low mass flexible cables (also called in the following analog cables).

At the one end of the cables, they will be wire-bonded to the silicon sensors through a pitch adapter as it is shown in figure 1.

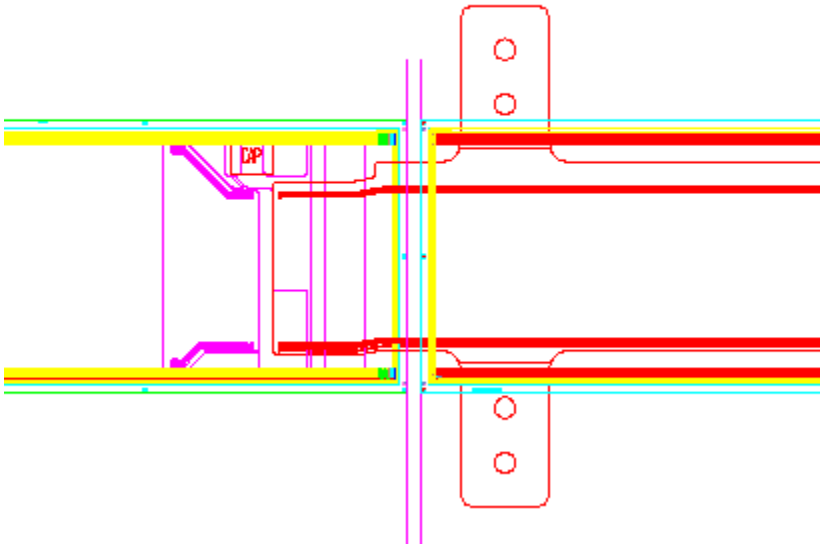

Figure 1: Drawing of the sensor region. The cables are wirebonded to the sensor via a pitch adapter

Figure 2 shows the other end of the cables. The cables will be wire-bonded to the hybrid carrying the front-end electronics. Two analog cables ("top" and "bottom") with a trace pitch of 91 μm will be laminated together. The cables will be displaced with respect to each other by half of a pitch, so the resulting assembly will have an effective pitch of about 45 μm that will match the pitch of traces on the pitch adapter on the sensor end. The HV and ground traces on the cable will be wire-bonded respectively to the HV and ground bias pads on the sensor and on the hybrid.

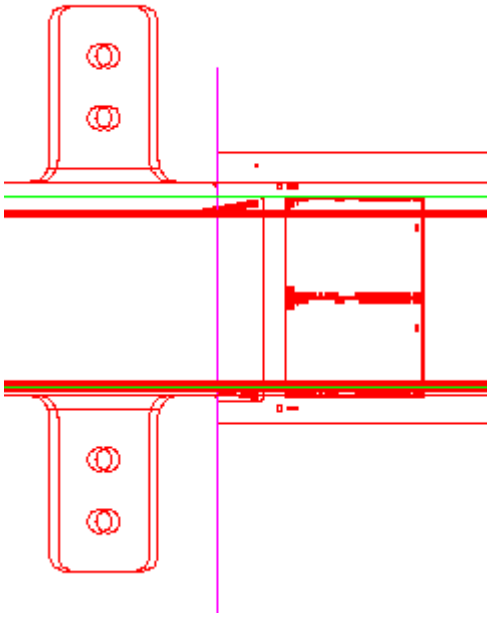

Figure 2: Drawing of the hybrid region. This cable end is connected to the front-end electronics.

The Layer 0 will operate in a strong radiation environment and is expected to accumulate a total radiation dose of 7 Mrad over period of 4 years. The operational temperature for the L0 modules can be as low as –15 deg C.

Description of analog cables

There will be 8 types of cables with different lengths. The length of cables will vary from about 16 cm to 34 cm. The two cables ("top" and "bottom") that are going to the same sensor will have a length different by 2.15 mm. The cable has 128 signal traces, one HV bias trace and one ground bias trace. Figure 3 shows a drawing part of the cable.

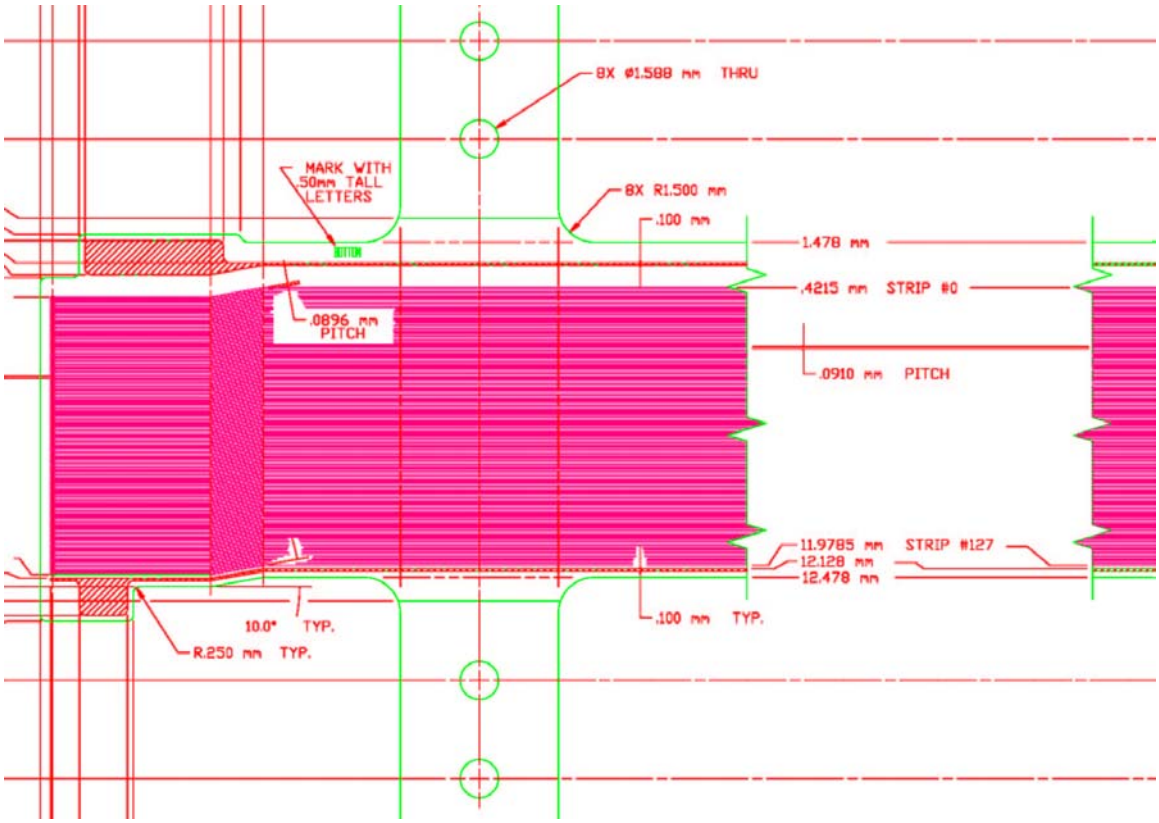

Figure 3: Part of the drawing of the cable

Detailed drawings of the top and bottom cable will be attached to this specification document. The cable will have a jog at one end (sensor end) and a fan-out region under an angle of 10º from 91 μm to 97 μm at the other end (hybrid end).

The main goals for the cables are:

1. Minimal trace capacitance
2. Minimal material
3. Continuity of all traces
4. Low cost

The substrate material is 50 μm Kapton and the conductor traces are gold-plated copper. The traces have a line width of 15 μm for signal lines and 100 μm for bias and GND lines.

Specifications of cables

.

1. Substrate material: polyimide (e.g. Kapton HN) film 50 μm thick, no fluoropolymer doping, adhesiveless copper cladding
2. Copper backplane: no
3. Signal traces:
    a. Au-plated copper with Ni-underplating, thickness 1 – 1.5 μm
    b. Width 15±2 μm
    c. Thickness 5-8 μm
    d. Constant pitch 91±0.5 μm and 97±0.5 μm after fan-out
    e. Bonding pads on traces 55 x 150 μm
    f. All 128 signal traces are continuous
    g. No shorts between traces
    h. Trace capacitance < 0.4 pF/cm
    i. DC resistance of traces < 3 Ohm/cm
    j. No protective coating (solder mask) on the top of the traces
4. HV and ground bias traces
    a. Gold-plated copper
    b. Width 100±5 μm
    c. Thickness 5-8 μm
    d. HV trace holds 1000 V with respect to neighboring traces
    e. HV trace is covered with coating (solder mask) everywhere except 2.5 mm at the ends
    f. All traces are continuous, no shorts to other traces
    g. Resistance of traces < 0.5 Ohm/cm
5. The exact "Bottom" and "Top" cable lengths dimensions are given in the attached drawing files
    a. Length refers to trace length (center bond pad-center bond pad)
    b. Tolerance on trace length is ±0.025 mm
6. Length difference between "bottom" and "top" cables is 2.15±0.025 mm
7. Bonding pads
    a. Bonding pads should be suitable for aluminum wedge bonding with required pull strength of 8 grams
    b. Bonding pads should be clean and free of any organic residue
    c. Manufacturer should specify a cleaning process and the used cleaning agents in case a pad cleaning becomes necessary
8. Cable ears
    a. Cables have four "ears" with drilled holes for mounting/alignment purposes. Position and diameter of drilled holes according to drawing
    b. Drilled holes should be copper reinforced
    c. Ears can be copper cladded and Au (Ni)-plated

9. Cables should have “Bottom” and “Top” marks as indicated on drawing
10. Shorting frame: the implementation of the shorting frame necessary for plating is at the discretion of the manufacturer. DØ prefers to have the shorting line for the HV trace to come out on the side near the “ears” as in the latest prototypes. The layout of the shorting frame requires the approval of DØ
11. Trimming:
    a. Cable should only be laser trimmed on the sides parallel to the traces.
    b. This trimming line should be parallel within ±0.05 mm.
    c. We request the trimmed cable width at the cable ends to be within ±0.03 mm of the nominal width of the cable as given in the drawing
    d. The cable ends perpendicular to the traces will be cut at Fermilab.

Tests at vendor

1. Visual inspection for shorts, opens and pad surface finish
2. Vendor should provide information on Au/Ni-plating thickness & solder mask thickness for HV trace

Terms of agreements

The initial acceptance of the cables will be based upon the results of the quality control of the manufacturer. The cables will be visually inspected at the University of Zurich and/or Fermi National Accelerator Laboratory. Based upon the results of these inspections, we reserve the right to reject a cable within 3 months after delivery by filing a written reclamation and sending the cable back to manufacturer. Both parties can agree upon the acceptance of individual cables if specifications are missed only marginally. We request to obtain mechanical grade cables, as available, at no charge.