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Layer 2-5 silicon sensor specifications for D0 SMTII

o Project description

For the extended run of the Tevatron collider at Fermilab, the DØ collaboration is building a new silicon tracker system – SMTII. It is a six layer device, located between 1.8 and 16 cm radii. It is expected to become operational in mid 2006 and continue to take data well until the year 2009. Reliable operation of the silicon sensors in a high radiation environment is critical to the experiment's success. Over the operation period, the inner layers of the SMTII will be subject to a fluency of 2×10^{14} 1 MeV equivalent neutrons per cm^2.

o Wafers

- 320 ± 20 µm thick, n-type, phosphorus doped, <100> crystal orientation
- wafer warp < ±25 µm. This specification is on a best effort base. However, we will return individual sensors having a warp exceeding ±50 µm.
- cutting accuracy ± 20 µm with respect to nominal dicing line
- cutting lines parallel to ± 10 µm with respect to nominal dicing line

o Detectors (general)

All detectors are p+n, single sided, AC coupled, polybiased silicon microstrip detectors. The sensors need to withstand a dose of 2×10^{13} 1 MeV equivalent neutrons per cm^2. The detector break down voltage must exceed 350V after the irradiation. The exact location of fiducial marks and bond pads as well as strip numbering definition has to be in accordance to drawing number 3823.210-ME-399565. The sensor has a 24-field scratch pad for a unique identification. The sensor serial number is to be encoded in binary format in this scratch pad (details provided below).

➢ L2-L5 sensor characteristics

- 10.0 cm cut length,
- 9.833 cm minimal acceptable active length,
- 1277 strips,
- 639 readout strips,
- 30 µm strip pitch,
- 60 µm readout pitch,
- readout strips metallized, intermediate strips have only DC pads
- 4.034 cm cutting width,
- 3.834 cm active width,
- AC and DC bond pads according to drawing,
- every 10^{th} strip numbered as indicated on drawing,
- fiducial marks and scratchpad according to drawings,

- number of preproduction devices – 100
- number of production devices - 2735,
- tentative schedule – all sensors delivered by May 2004

○ Detector Specifications for L2-L5 sensors

➢ Depletion voltage	40 < Udep < 300V
➢ Biasing scheme :	polyresistors on both ends
➢ Poly resistor values:	0.8 ± 0.3 MΩ
➢ Passivation:	SiO_2 > 0.25 µm thick or an equivalent passivation material like polyimide
➢ Unpassivated regions:	Passivation windows around fiducial marks, Bias/guard rings etc as specified in drawing
➢ Implant strip width:	8 µm
➢ Metal strips:	Al, AC-coupled over the p-implant
➢ Al strip width:	2 - 3 µm metal overhang on each side
➢ Al strip thickness:	> 1 µm
➢ Al strip resistivity:	< 20 Ω/cm
➢ Coupling capacitance:	> 12 pF/cm
➢ Junction breakdown:	> 350 V

- Micro-discharge breakdown: > 350 V
- Coupling capacitor breakdown: > 100 V
- Total detector current: < 100 nA/cm^2 (at RT, full depletion voltage + 20V)
- Total detector current at 350V: < 16 µA
- Interstrip resistance (DC): > 2 GΩ
- Total interstrip capacitance: < 1.2 pF/cm
- Defective channels: <1%

Definition of defective channels:

- Pinholes – current through capacitor >10 nA at 80 V and RT
- Short – coupling capacitor >1.2 times the typical value
- Open - coupling capacitor <0.8 times the typical value
- Leakage current above 10 nA/strip at FDV and RT
- Strips with bias and interstrip resistance values, measured at FDV + 20V at 1 MHz, out of the specifications defined above shall be included in the defective channel count.

Tests performed by supplier.

On each sensor

- IV to 500 V (T = 25 ± 3°C, RH < 50%)
- Optical inspection for opens, shorts and defects, mask alignment (better than ±2.0 µm)
- Depletion voltage measurement (C-V method)

On each strip

- AC capacitance value measurement and pinhole determination
- Use the smaller AC pads near the sensor edge for probing. They are labeled as AC test pads in the corresponding drawing.

On test structure

- Polyresistor mean and RMS value
- Implant resistance value
- Aluminium resistance value
- Coupling capacitor breakdown voltage

The corresponding quality control data of the applied tests from the supplier shall be provided together with each sensor on paper and in a computer readable format that is agreed upon by both parties. Furthermore, we request that the test structure measurements and the test structures on the wafer have to be supplied.

The sensor contains a scratch pad field consisting of 6x4=24 pads as specified in drawing number 3823.210-ME-399382. The vendor is expected to provide a unique serial numbering for each sensor. We would suggest to the vendor that the leading 1x4 pads should be used for vendor identification and the neighboring 3x4=12 pads should be used for a unique serial number coding (binary) of the sensor. The remaining pads are reserved by the buyer for QC pass/fail marks.

Terms of agreements

The initial acceptance of the sensors will be based upon the results of the measurements performed by the supplier, according to the criteria described above. For a sub sample of the delivered sensors, these measurements will be confirmed by independent measurements at Fermi National Accelerator Laboratory or at universities. Based upon the results of these measurements, we reserve the right to reject a sensor within 6 months after delivery. The manufacturer will be notified and upon request the sensors will be returned for re-measurements. Both parties can agree upon the acceptance of individual sensors if specifications are missed only marginally.