# Sensor Specifications for the SiD Outer Tracker

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## 1 Introduction

The SiD detector concept for the International Linear Collider envisions a tracking system comprised entirely of silicon microstrips. The sensors for this detector are generally similar to other single-sided sensors fabricated in recent years for the LHC experiments. The most significant differences relate to the much different environment at the ILC. First, the radiation environment is relatively benign, so the radiation tolerance required for the LHC is not necessary here. Second, timing and material requirements motivate a very different readout scheme, with the readout chip bump-bonded directly to the surface of the sensor, as has been done for hybrid pixel detectors in the past.

The sensors are <100>, p+/n, single-sided, AC-coupled, poly-biased microstrip sensors with double-metal readout to two fine-pitch bump-bonding arrays in addition to standard wirebonding arrays along both ends. The double-metal layer also has power and readout traces that connect the bump-bonding arrays to another array for a polyimide power/readout cable. The width of these traces should be the same as others on the double-metal layer except as otherwise shown. The sense pitch is 25 $\mu$m with alternating strips read out for a readout pitch of 50 $\mu$m. All strips are biased via polysilicon resistors: the bias connections and DC-probing-pads for the readout strips are arranged along one edge, while the bias connections for the intermediate strips are along the opposite edge. The vendor may alter the dimensions of the probing pads, vias and polysilicon resistors to match current design rules. The bias and guard rings are relatively simple since extreme high-voltage operation is not required. The vendor may design the bias and guard as desired to minimize the width of the inactive region at the edges of the sensor. There are openings in the passivation for the bias and guard, not only adjacent to the wirebonding arrays, but also along the edges of the sensors for wirebonding to the power/readout cable. Changes to the bias ring must leave these unpassivated regions wide enough, at least 200 $\mu$m, to allow for wirebonding perpendicular to the ring. Fiducial marks at the four corners of each sensor permit precision mechanical alignment of the sensors during assembly. Similar marks around each bump bonding array permit alignment during bump bonding. A scratch pad is provided for marking sensors.

## 2 Production and Delivery

| | |
|---|---|
| Number of devices | 20 sensors, diced |
| Schedule | Delivery before 08/2007 |

# 3 Wafer Specifications

| Parameter | Value |
|---|---|
| Wafer diameter | 6 inch |
| Thickness | 320 $\mu$m $\pm$ 20 $\mu$m |
| Wafer type (orientation) | $n$-type (<100>) |
| Resistivity | *see depletion voltage spec* |
| Wafer warp | <80 $\mu$m (on best-effort basis) |
| Polishing | mirror finish on one side |

# 4 Detector Specifications

| Parameter | Value |
|---|---|
| Overall Dimensions | 93.531$\pm$0.1mm $\times$ 93.531$\pm$0.1mm |
| Active Area | 92.031mm$\times$92.031mm |
| Strip pitch | 25 $\mu$m |
| Readout pitch | 50 $\mu$m |
| Number of strips | 3679 |
| Number of readout strips | 1840 |
| Depletion voltage | <100V |
| Biasing scheme | poly resistors along both ends |
| Poly resistor value | 20-40M$\Omega$ |
| Implant strip width | 8 to 9 $\mu$m |
| Width of Al sense strips | 8 to 9 $\mu$m |
| Width of double-metal readout traces | 3 to 4 $\mu$m |
| Resistivity of Al sense strips | $< 25\Omega$/cm |
| Resistivity of double-metal readout traces | $< 60\Omega$/cm |
| Insulation thickness between metal layers | 0.9 $\mu$m (3 $\mu$m if possible) [1] |
| Coupling capacitor value | $>$ 10 pf/cm |
| Passivation (except bonding areas) | $SiO_2$, 0.5-1.0$\mu$m thick |
| Width of unpassivated regions on bias ring | $\geq 200\mu$m |
| Junction breakdown | $>$ 200 V |
| Micro-discharge breakdown | $>$ 150 V |
| Coupling capacitor breakdown | $>$ 100 V |
| Total detector current at 150V | $< 4\mu$A |
| Interstrip capacitance | $<$ 1.2 pf/cm |
| Non-working strips | $<$ 20 readout strips/detector |

[1] For this application, it would be very desirable to achieve the thickest oxide possible between the metal layers. If necessary, loosening other specifications (e.g. wafer warp) to allow this processing is a possibility. The manufacturer is encouraged to make a proposal for modified specifications to allow for a thicker oxide layer.

# 5 Testing and Measurements by Manufacturer

All strips shall be tested for defects by measuring the capacitance value of the coupling capacitor and the current through the coupling capacitor to identify shorts, opens and pinholes. A channel with any of these three defects shall be considered a bad channel. Because of variations in the double-metal readout, it should be anticipated during testing that readout capacitances will vary across the sensor. For this reason, the expected capacitance for a strip will need to be defined by an average over some number of similar, neighboring strips.

In addition to providing a list of bad channels according to the above criteria, the vendor shall perform the following inspections and tests:

- A visual inspection of each sensor to ensure that there are no significant scratches, blemishes or edge chipping
- A measurement of the depletion voltage on test structures of each wafer
- A measurement of the interstrip capacitance for each lot
- A measurement of the value of the polysilicon resistor on test structures of each lot
- Total leakage current up to 250V or until breakdown occurs at intervals of 5V or less.

The bad channel lists and results of these tests shall be supplied in a .pdf file. In addition, the I-V data shall be supplied in spreadsheet format.