Version 6.1
May 15th 2002

CDF sensors specifications for RunIIb

Introduction

The CDF detector at the Tevatron Collider in Fermilab (Batavia, Illinois USA) will undergo a new upgrade in order to be ready for the RunIIb data taking period (Jan 2005-Dec 2007).
CDF will replace most of the present silicon detector system (the SVXII and L00 parts) with a new single-sided based silicon detector capable of coping with a substantial increase in the delivered luminosity by the Tevatron Collider.
We will base the new detector on single sided, AC-coupled, poly biased, microstrip silicon sensors P+/N, <100>, 6" material with different geometry and pitches. All detectors have one intermediate strip.
Total number of runiib silicon sensors is about 2,300.
They should be able to withstand a dose level of $1x10^{14}$ 1 MeV equivalent neutron/cm^2 so their characteristics should be similar to those already developed for CMS and CDF-L00.

Prototype and Production

Delivery of production sensors should occur between January 2003 December 2003 at a rate of at least 200 detector per month. Option for a higher delivery rate should be evaluated and priced by the vendor.
In the present layout there are 4 different detector flavors:

type	Production Quantity	Dimensions (mm)	Readout Pitch/pitch (um)
Outer Axial	1512	96.392x40.550	75/37.5
Small Angle stereo	648	96.392x43.100	80/40
Inner Axial	144	78.5x14.850	50/25
TOTAL	2,304		

Production quantities may change as the detector design progresses. Above numbers are best estimate at the moment. Nonetheless we are not expecting those numbers to be significantly different from the final request.
We would like to prototype the **Outer Axial** and **Small Angle Stereo** detectors only (which represents more than 90% of the total number of silicon detectors).
Following specs are for the Prototype sensors. Even though we are estimating the final sensor specs to be identical, small changes might be required.
We are not going to prototype the Inner Axial sensors, however, we have those preliminary sensor specs only for the purpose of getting production quantity quotes.

Sensor Specifications for CDF runIIb
Prototype Sensors

Required

Number of Outer Axial Sensors	30 grade "A" and 30 grade "B"
Number of Outer Small Angle Sensors	30 grade "A" and 30 grade "B"
Schedule	delivery before 08/2002

Wafers

Thickness	320 μm ± 15 μm
Wafer diameter	*6 inch*
Wafer type (orientation)	*n*-type (<100>)
Resistivity	(see depletion voltage specs)
Wafer warp	Vendor can specify what's normally achievable

Sensor general

Sensors are p+/n, single sided, AC coupled, poly biased silicon microstrip detectors with intermediate strips. Sensors need to withstand a dose of $1x10^{14}$ 1 MeV equivalent neutron/cm^2 and an ionizing dose of 10 Mrad, consequently the high voltage operation should exceed 500 V. All sensor have one floating strip such that the readout strip pitch is twice the value of the strip pitch. All sensors have 3 μm overhanging metal except for the inner axial for which this value is ~1μm.

– Outer axial sensors have a strip pitch of 37.5 μm (readout pitch of 75 μm).
– The small angle sensors have strips at an angle of about 1.2 degrees with respect to the axial (long side of the detector). Strips not reaching the short edge of the sensor will be properly terminated at the edge of the active area on the long edge of the sensor.
– Inner axial sensors have a very fine pitch of 25 um (readout pitch is 50 μm).

Important Note:

You will receive final mechanical drawings for the Outer Axials sensors from Dr. Kazuhiko Hara. We are still debating what angle to have for the SAS sensors (which may have a small impact on the width and pitch of the SAS sensors themselves).
Dr. Kazuhiko Hara will inform you as soon as this decision is taken and will provide you with detail mechanical drawings. However you should start already with the Outer Axial prototype effort.
We don't have yet final mechanical drawings for the Inner Axial sensors. Preliminary specs are given only for the purpose of getting production quantity quotes. We are NOT going to prototype the Inner Axial sensors.

Prototype Sensors

Specifications:

Axial: Active area dimensions[a]	~ 40.5 x 95.4 mm^2
Axial: Overall dimensions	40.550 x 96.392 mm^2 (2 detectors per 6" wafer)
Axial: Strip Pitch	37.5 μm
Axial: Readout Pitch	75 μm
Axial: Number of Strips	1024
Axial: Number of Readout Strips	512

Stereo: Active area dimensions[a]	~ 42.1 x 95.4 mm^2
Stereo: Overall dimensions	43.100 x 96.392 mm^2 (2 detectors per 6" wafer)
Stereo: Strip Pitch	40 μm
Stereo: Readout Pitch	80 μm
Stereo: Number of Strips	>1024
Stereo: Number of Readout Strips	512

Inner Axial: Active area dimensions[b]	~12.9x78.5 mm^2
Inner Axial: Overall dimensions	14.850x96.392 mm^2 (6 detectors per 6" wafer)
Inner Axial: Strip Pitch	25 μm
Inner Axial: Readout Pitch	50 μm
Inner Axial: Number of Strips	512
Inner Axial: Number of Readout Strips	256

[a] 1 mm is allowed from the active area to the physical edge of the sensor, but the active area can grow larger if less space is needed between the end of the active area and the physical edge of the sensor.

[b] 1 mm is allowed from the active area to the physical edge of the sensor, but the active area can grow larger if less space is needed between the end of the active area and the physical edge of the sensor.

Common Specifications:

Depletion Voltage	From 100 to 250 V (200V as upper limit preferable)
Biasing scheme	Poly resistor (see drawings)[c]
Poly resistor values	1.5 ± 0.5 MΩ (<10% variation within a sensor)
Passivation	SiO_2 0.5÷1.0 μm thick
Implant strip width	~9 μm
Implant depth	>1.2 μm
Doping of implant	> $1x10^{18}$ ions/cm^3
Width of aluminum strip[d]	~15 μm (~11 μm for the inner axials)
Thickness of Al strips	>1 μm
Resistivity of Al strips	<30 Ω/cm
Coupling Capacitor value	>10 pF/cm
Coupling capacitor breakdown voltage	>100 V
Interstrip resistance	> 1 GΩ
Total interstrip capacitance	<1.2 pF/cm (<1.5pF/cm total for the 90dgr)
Total sensor current[e] at T=20° C	grade **"A":** <50 nA/cm^2 at 500V grade **"B":** < 4uA/ cm^2 at 350V and < 10uA/ cm^2 at 500V
Bad channels for grade **"A"**	<1% (No more than 5 per sensor)
Bad channels for grade **"B"**	<5% (No more than 25 per sensor)

[c] Resistor on one side only is an equivalent option but has to be agreed with the customer because it can have an impact on the active area dimensions and the positioning of the small angle stereo sensors.

[d] Only readout strips will be metalized and will have bonding pads. Intermediate strips will have only DC pad (see drawings for details).

[e] For the grade "A" we would like to consider the option of a lower breakdown voltage value of 350V if it comes with some cost saving. In other words the optional specs for the grade "A" detectors would read 350V instead of 500V.

Bad channels definition:

Parameter	Rule	ID of the defect
Single strip leakage current at 500 V [f]	> 10 nA	Leaky
Coupling capacitor	> 1.1 times the typical value	Short
Coupling capacitor	< 0.9 times the typical value	Open
Coupling capacitor	>1.1 times the typical value but the neighbors are normal	PH (pin hole)
Current through the Coupling capacitor with 80 V across the dielectric	>1 nA	PH (pin hole)

Above bad channel definition is based on measuring the coupling capacitance on each strip. We will consider other means of determining bad strips count based on vendor's proposal. Please attach a description of what measurement you would propose in order to determine the bad strip count and location for each sensor.

Quality Control by manufacturer:

Value of the poly resistor	Measured on Test Structures on each wafer
Value of the depletion voltage	Measured on Test Structures on each wafer
Visual inspection, verifying that no significant scratches, blemishes and/or edge chipping are present	Performed on each sensor
Total leakage current up to 1000 V[g] (or until current=20 μA)[h] in steps of 10 V.	Measured on each sensor
Bad strips identification and count	Measured on each sensor

Quality Control results have to be provided to the customer on an electronic format as well as on a paper format.

[f] The measurement of strip leakage current of individual sensors is foreseen only for the prototypes. For mass-production, based on the prototype data, the measurement will be made only for those sensors with the total leakage current exceeding some criterion to be agreed upon.
[g] Or lower value if there is some instrumental limit. In any case at least up to 500V.
[h] We can accept other values of voltage and/or current if more convenient for the manufacturer.