

Cross checking of the Scandinavian site qualification module, 20220380200004,

at KEK

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2002/11/3

1 Introduction

One of the site qualification modules made by the Scandinavian group, 20220380200004, was received at KEK for cross-checking. The module has gone through 3 steps: visual inspection, metrology, and DAQ. The results and comments, from the point of view of KEK, are summarized briefly.

2 Visual inspection

The visual inspection was made in each side (Front or Back) for: (1) Sensors, (2) Facings, (3) Hybrids (including IC's), (4) Wire-bonds (IC-hybrid, IC-PA, PA-S, S-S), (5) Hybrid attaching, and (6) Connector and others. The results/comments are:

- (1) Sensors: none
- (2) Facings: none
- (3) Hybrid: none
- (4) Wire-bonding: none
- (5) Hybrid attaching: not enough adhesive at all corners of the feet of hybrids (F and B) (Comment: should have sufficient epoxy and pressure so that the smooth fillet is formed fully surrounding the feet)
- (6) Connector and others: none

3 Metrology

3.1 Survey in XY

A comparison of the results of XY survey in the Nordic and at KEK is shown in Table 1. Coincidence of the parameters is good, except $midyf$. The $midyf$ measured at KEK is close to zero: $-0.2 \mu\text{m}$, which shows a very good assembly alignment of the upper and the lower alignment. However, the difference of the $midyf$ between the Nordic and KEK is large: $5.03 \mu\text{m}$. The survey machine of KEK has been cross-checked with two other machines (including a machine of the MITUTOYO laboratory). The source of discrepancy has to be identified.

1.2 Survey in Z

A comparison of the results of Z survey in the Nordic and at KEK is shown in Table 2. Coincidence of the parameters is good. Some discrepancies are seen in $loCoolingFacing a, b$ and "sensorSkew x". The KEK results gave much smaller numbers for those parameters. The "loCoolingFacing a" should be zero by definition. Since the "loCoolingFacing a" is non-zero in the Nordic measurement, there seems a mis-treatment/mis-understanding in the derivation of the axis/plane along the x-coordinate, which may also explain the discrepancy in the "sensorSkew x".

The heights of hybrids in the left and the right side, as obtained in the "tolerance sheet" in the z analysis excel file, version 2.4.1, are shown in Table 3. There was an asymmetry in height in the far-end by 0.1 to 0.2 mm. Since the nominal glue thickness is 0.08 mm, this asymmetry is better to be minimized.

2 DAQ

2.1 I-V curve

At KEK, the I-V was measured at 15 C without hybrid power. The current at 500V was 0.389 microA. The current measured in Nordic was 0.49 microA at 18 C. The current did not deteriorate from the sum of four sensors before the strip wire-bonding which was 1.45 microA at 26.3 C in the Nordic data.

2.2 Hybrid temperature

At KEK, the module was operated in an environment chamber which temperature was set at 15 C. The temperature of the hybrids were monitored in the SCTDAQ program. Near the end of characterization, the temperatures of the link0 (top) and the link1 (bottom) were 30 and 30 C. In comparison, the temperature is typically 27 to 29 C in case of the KEK modules. The temperatures of this module tell that there is a room for improving the gluing of the hybrid feet.

2.3 ENC

The ENC from the response curve of 10-point charge injection are listed in Table 4. The ENC at KEK is 1412 (average) which is larger than the Nordics of 1345 (average) by 67.

2.4 Noise occupancy

Since KEK does not have CLOAC in this DAQ bench, the default "noise occupancy" scan was not available. Instead, a simple "noise scan" with 10^4 events per threshold was made. The noise occupancy results at Nordic showed wavy structures in the individual s-curves in the link1, as shown in Figure 1. Even in the link 0, there were wavy structures at lower threshold region. In comparison, the individual s-curves measured at KEK were much smoother though slight structures were observed at around 40 mV in the link 1, as shown in Figure 2, while in link 0 they were quite smooth. This indicates there is a room to improve in the Nordic DAQ setup.

2.5 Defective channels

This module has no unbonded channels (Nordic and KEK), 4 noisy (Nordic) and 3 noisy (KEK) channels.

3 Summary

We observed that an amount of adhesive at the corners of the feet of the hybrid was not sufficient and an asymmetric glue thickness in the left and the right side of the feet. It can be improved by optimizing an amount of epoxy, gap thickness, and pressure so as to form a symmetric gap and smooth fillet surrounding the hybrid feet.

We observed inconsistency in the metrology measurements in Nordic and Japan, namely, `midyf`, `loCoolingFacing a`, `loCoolingFacing b` and `sensorSkew x`. The KEK measurement gave better values for those parameters.

The DAQ results were also slightly inconsistent. Nordic had smaller ENC. KEK obtained much better individual s-curves.

Table 1. Comparison of the survey in XY

Parameter	Tolerance	Nordic	KEK	diff(Nordic-KEK)	Comment
mhx [um]	30	7.95	11.9	-3.95	
mhy [um]	30	-20.15	-23.6	3.45	
msx [um]	100	28.01	31.3	-3.29	
msy [um]	30	-5.88	-9.5	3.62	
sepf [um]	10	-2.25	-2.7	0.45	
sepb [um]	10	-2.21	-2.3	0.09	
midxf [um]	10	3.65	2.7	0.95	
midyf [um]	5	4.83	-0.2	5.03	
a1 [mrad]	0.13	0.03	0.01	0.02	
a2 [mrad]	0.13	0.04	0.00	0.04	
a3 [mrad]	0.13	0.05	0.05	0.00	
a4 [mrad]	0.13	0.06	0.09	-0.03	
stereo [mrad]	0.13	-0.05	0.02	-0.07	
hymxf [um]	100.0	-27.07	-12.7	-14.37	
hymyf [um]	100.0	-33.46	-21.0	-12.46	
hymaf [mrad]	3.1	-1.41	-1.35	-0.06	
hymxb [um]	100.0	25.30	35.8	-10.5	
hymyb [um]	100.0	15.95	49.6	-33.65	
hymab [mrad]	3.1	-0.45	-0.77	0.32	
conp1x [um]	320.1	-125.12	-106.2	-18.92	
conp1y [um]	100.0	-38.49	-25.8	-12.69	

Table 2. Comparison of survey in Z

	Tolerance	Nordic	KEK	diff(Nordic-KEK)	Comment
maxZlower [mm]	-0.2	-0.088	-0.055	-0.033	
maxZupper [mm]	0.2	0.059	0.028	0.031	
midplaneEq		$z=ax+by+c$	$z=ax+by+c$		
Left a		0.002	0.001	0.001	
b		-0.001	-0.001	0.000	
c		0.444	0.451	-0.007	
Right a		0.001	0.001	0.000	
b		0.000	0.000	0.000	
c		0.449	0.453	-0.004	
midplaneHeight [mm]		0.446	0.452	-0.006	
moduleThickness [mm]	1.25	1.237	1.217	0.020	
optimalMaxZerrorLower [mm]	0.05	0.031	0.025	0.006	
optimalMaxZerrorUpper [mm]	0.05	0.028	0.027	0.001	
optimalRmsZerrorLower [mm]	0.025	0.012	0.010	0.002	
optimalRmsZerrorUpper [mm]	0.025	0.012	0.010	0.002	
moduleConcavity x [mm]		0.007	0.014	-0.007	
y		-0.008	-0.005	-0.003	
sensorSkew x [mm]		0.204	0.100	0.104	
y		-0.044	-0.032	-0.012	
coolingTabThickness [mm]		0.920	0.926	-0.006	
farTabThickness [mm]		0.952	0.926	0.026	
halfTabThickness [mm]		0.468	0.472	-0.004	
tabSkew y [mm]		-0.016	-0.018	0.002	
adhesiveThicknessTotal [mm]		0.231	0.203	0.028	
adhesiveAsymmetry [mm]		0.022	0.020	0.002	
loCoolingFacing a [mrad]	0.5	0.211	0.004	0.207	
b [mrad]	3	1.217	0.409	0.808	
loCoolingFacingConcavity [mm]	0.03	0.011	0.003	0.008	
hyb1NearH [mm]		1.082	1.103	-0.021	
hyb1FarH[mm]		1.175	1.152	0.023	
hyb2NearH [mm]		1.111	1.110	0.001	
hyb2FarH [mm]		1.114	1.137	-0.023	
hyb1Concavity [mm]		0.026	0.046	-0.020	
hyb2Concavity [mm]		-0.042	-0.010	-0.032	
hyb1CapMaxH [mm]		2.533	2.496	0.037	
hyb2CapMaxH [mm]		2.438	2.433	0.005	
hybridMaxThickness [mm]		3.268	3.418	-0.150	
capMaxThickness [mm]	6.44	5.860	5.855	0.005	

Table 3. Heights of hybrids in the left and the right side

hyb1LeftNearH [mm]	1.080
hyb1RightNearH [mm]	1.126
hyb1LeftFarH [mm]	1.266
hyb1RightFarH [mm]	1.037
hyb2LeftNearH [mm]	1.135
hyb2RightNearH [mm]	1.085
hyb2LeftFarH [mm]	1.190
hyb2RightFarH [mm]	1.084

Table 4. ENC's from the 10 point Response Curve fit

RC fit			
Noise [e]			
uncorrected			
	Nordic	KEK	diff(Nordic-KEK)
M0	1343	1411	-68
S1	1277	1352	-75
S2	1303	1399	-96
S3	1303	1389	-86
S4	1311	1383	-72
E5	1315	1406	-91
M8	1409	1451	-42
S9	1426	1499	-73
S10	1430	1481	-51
S11	1319	1373	-54
S12	1379	1426	-47
E13	1321	1372	-51
average	1345	1412	-67

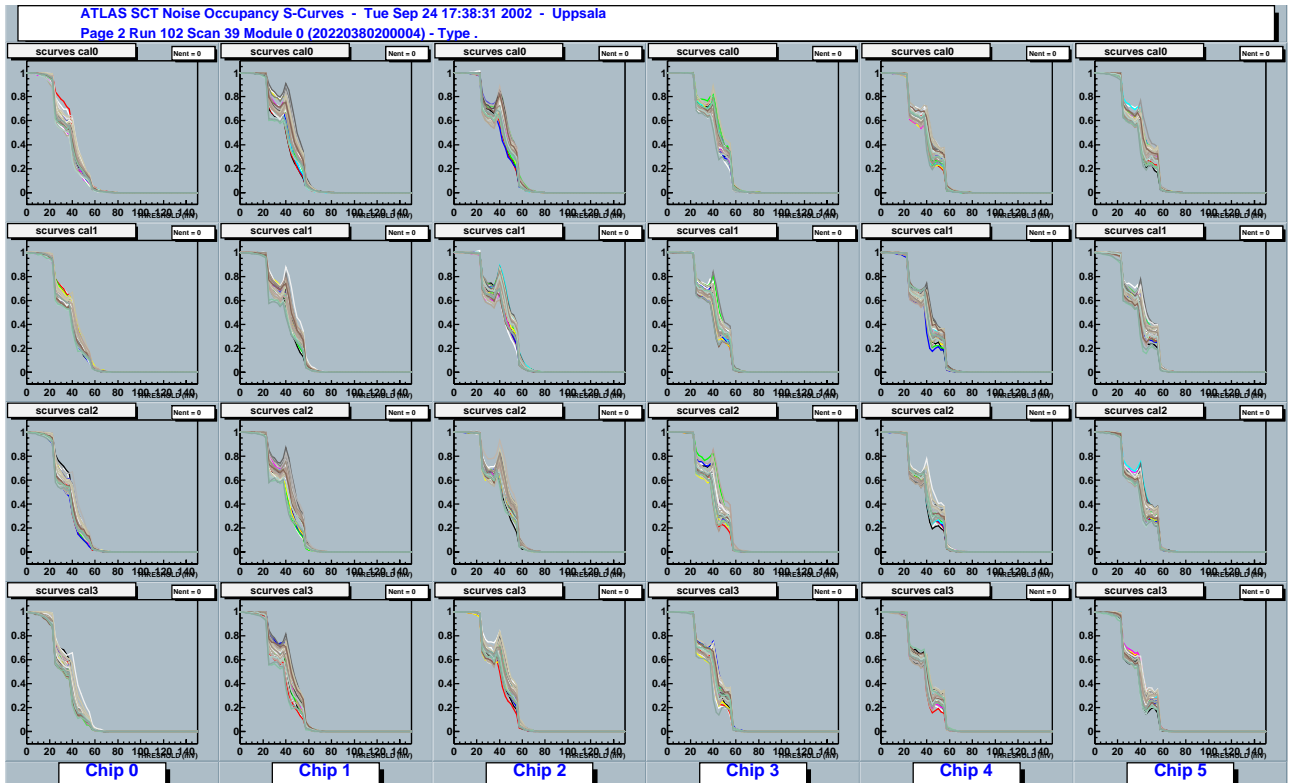


Figure 1. Individual s-curves of link 1, measured at Nordic. Note the full-scale of horizontal axis is 0-150 mV

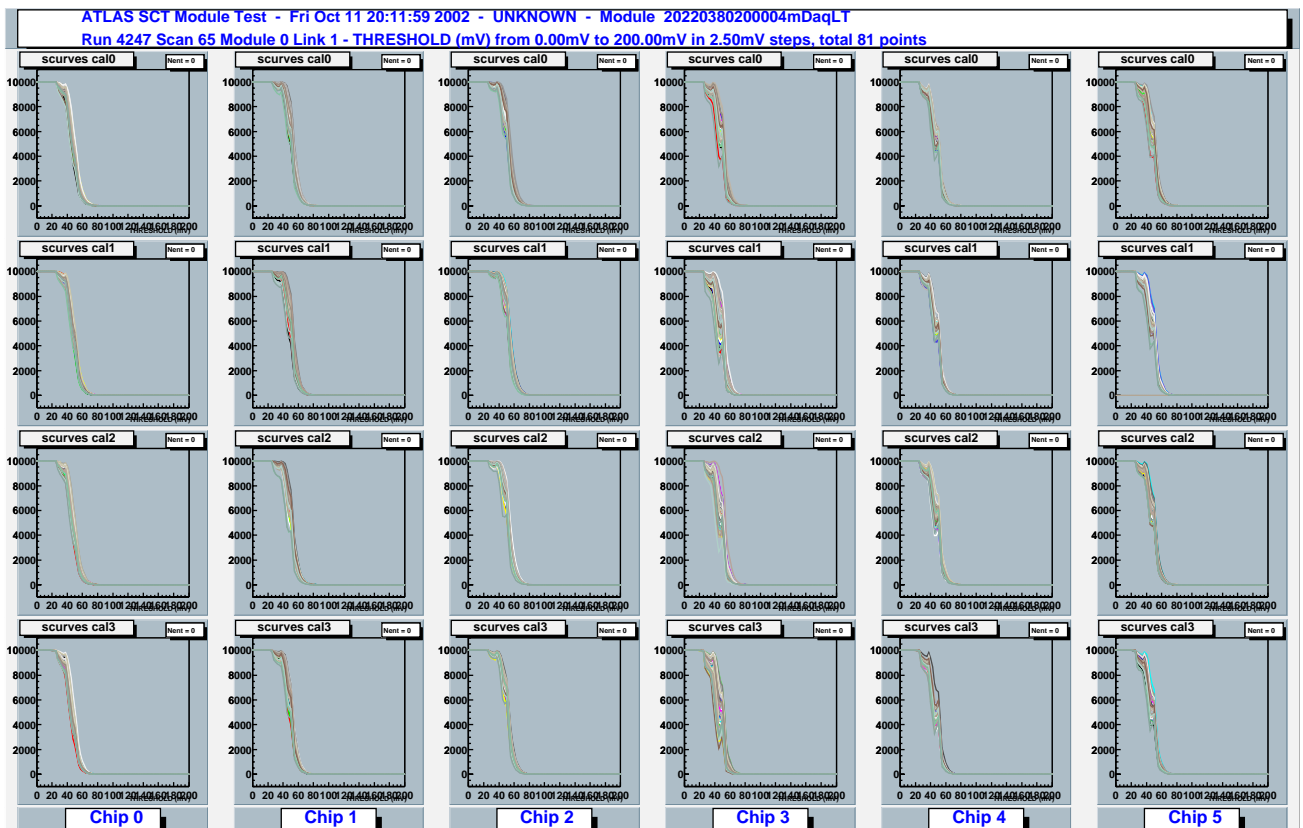


Figure 2. Individual s-curves of link 1, measured at KEK. Note the full-scale of horizontal axis is 0-200 mV