UNIVERSITY OF LIVERPOOL

ATLAS upgrade ABC130/HCC V1.0

Metrology of panels with OGP smartscope

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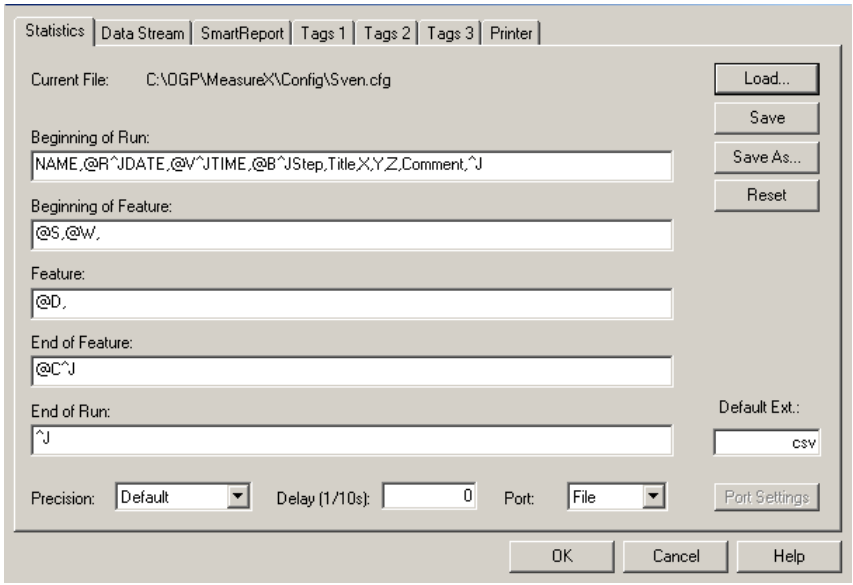
General Notes

- Use prompt windows to indicate what the user should do
- Keep the required user input as small as possible
  - Find first positions to align panel
    - Circle for panel position, 2nd circle for X-alignment
  - One fiducial for each hybrid
    - write to file will force the user to decide about file name
- Output file should be '.csv' (comma separated values)
- Suggested output file structure:
  - Program Name
  - Date
  - Time
  - Step number Step title X Y Z comment
- Use comments written to file to help with analysis
- [X,Y,Z] is only valid for points, but changes for other features
  - Always output 3 values so that all comments are in the same column
  - Points: X, Y, Z
  - Circle: Diameter, X, Y
  - MIN/MAX/AVG: min, max, average
  - Plane: flatness, furthest away+, furthest away-

If a prompt box appears in program, first click OK, then execute the instruction!

Output configuration



- @R output routine name
- ^J if in output template: tag and data values will be output in a column format; new line
- @V output date
- @B output time
- @S output step number
- @W output feature title (circle, line, etc.)
- @D actual data (output selected measurement values)
- @C feature report text (if feature has a comment)
- , in text move to next column

Output file example

Good example:

NAME zot-panel-fullPanel-new3.mxi
DATE 12/05/2016
TIME 12:48:17

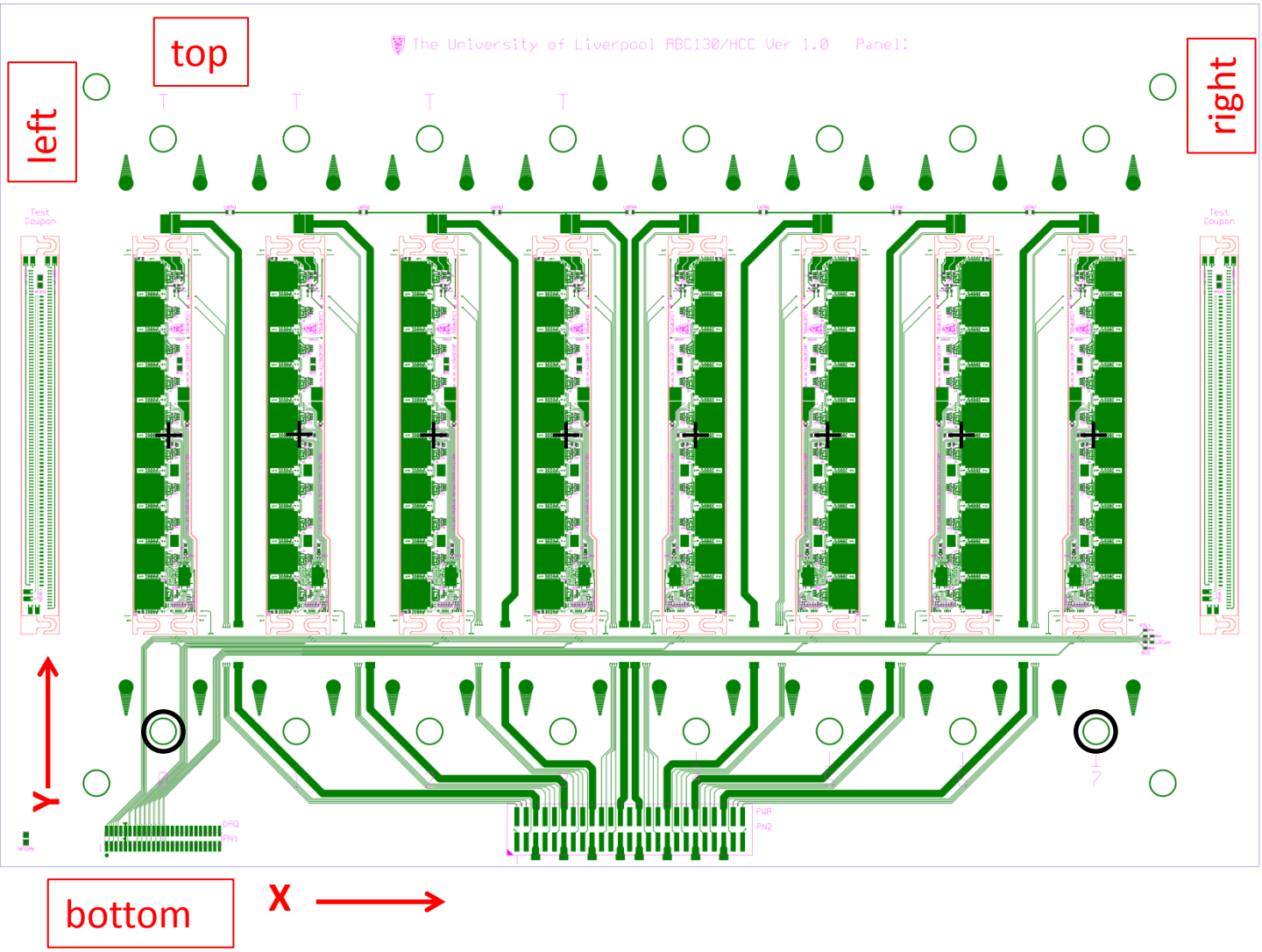
Step	Title	X	Y	Z	Comment
13	Point	0.4114	79.9275	0.433	Hybrid 0 Origin in Panel System
14	Point	36.36	79.9136	0.433	Hybrid 1 Origin in Panel System
15	Point	72.3088	79.9237	0.433	Hybrid 2 Origin in Panel System
16	Point	108.2843	79.9264	0.433	Hybrid 3 Origin in Panel System
17	Point	143.4863	79.9397	0.433	Hybrid 4 Origin in Panel System
18	Point	179.4529	79.9307	0.433	Hybrid 5 Origin in Panel System
19	Point	215.3968	79.919	0.433	Hybrid 6 Origin in Panel System
20	Point	251.3447	79.9088	0.433	Hybrid 7 Origin in Panel System
101	Point	0	0	0	Hybrid 0 Origin from Midpoint of alignment holes
102	Circle	5.0632	-0.0028	-79.942	Alignment hole bottom
103	Circle	5.0565	0.0028	79.942	Alignment hole top
104	Point	-8.8527	-49.9479	0.323	Panel fiducial bottom left
105	Point	10.7675	-49.9339	0.323	Panel fiducial bottom right
106	Point	-8.8884	49.9643	0.3555	Panel fiducial top left
107	Point	9.256	49.9617	0.355	Panel fiducial top right
108	Point	0.4206	-47.6545	0.414	Hybrid fiducial below Asic 0

Bad example:

x	y	z	
5.0633	-0.0022	-79.9372	0.0003
5.0554	0.0022	79.9372	-0.0003
-8.8559	-49.9421	0.3518	
10.7598	-49.9308	0.3513	
-8.8985	49.9692	0.3513	

Program alignment positions

Alignment positions indicated in black

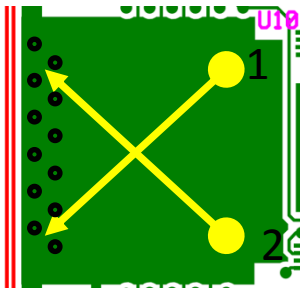


2 circles in bottom (alignment holes) and 8 + fiducials, 1 on each hybrid (between ASIC 4 and 5, closest to centre of hybrid)

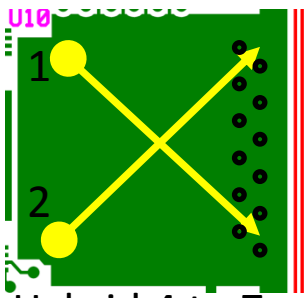
Program parameters

Choose parameter so that brightest part has 50% light level

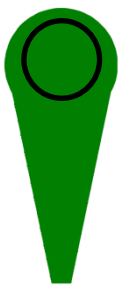
- Drill holes:
  - Backlight 30; zoom 0.848
  - Feature finder circle: Points 100; Rough 91; Weak 85
- + on hybrid/panel:
  - Ring light 84; zoom 4.595
  - Pattern centroid: width 350; height 450; Threshold 75; Filter ~40%; Fill ON
- Laser:
  - Ring light 31; zoom 0.848; Tracking ON **Focus first**
  - Circular shape for landing pads
  - X shape for ASIC pads: start point 1 & 2 at side without vias (better for focus finding); try to avoid vias



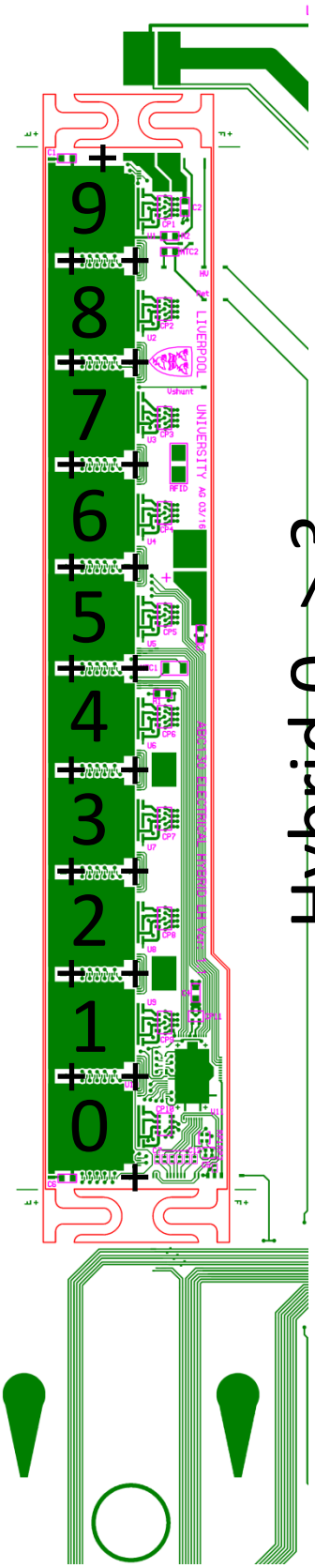
Hybrid 0 to 3



Hybrid 4 to 7

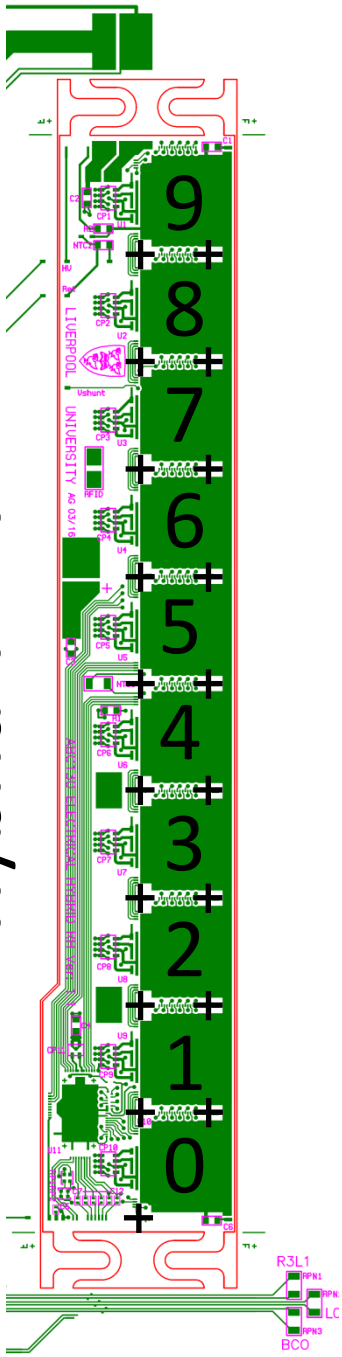

Landing pad

Hybrid Measurements



Hybrid 0 -> 3

X/Y measurement positions marked in black



Hybrid 4 -> 7

Coordinate Systems

Different coordinate are used during measurements and for the analysis

- Panel 1 (X,Y)

  At the begin of the program a global coordinate system for the full panel is defined to reference the fiducials for the hybrid measurements. It is based on the alignment holes (see Slide 5) as easy orientation points and has no further use in the analysis.

- Hybrid 1 (X,Y)

  For the first measurements of the Hybrids the + fiducials (see Slide 5) are used as origins. This will compensate for eventual stretches in X for different panels. All measurement points are chosen so that they could accommodate a stretch in Y. The only purpose for this system is to perform the measurements.

- Hybrid 2 (X,Y)

  For the output of the measurement point for each hybrid a new coordinate system is generated by the midpoint of the top and bottom alignment holes for a single hybrid (hybrid center) as origin. All fiducials as well as the alignment hole positions are written to the file in this system. (This is not the same coordinate system as Hybrid 1)

- Hybrid 3 (Z)

  For the z output a zero plane/datum level is generated by the heights of the 4 landing pads. This is used for the output of the landing pad heights as well as the ASIC pads.

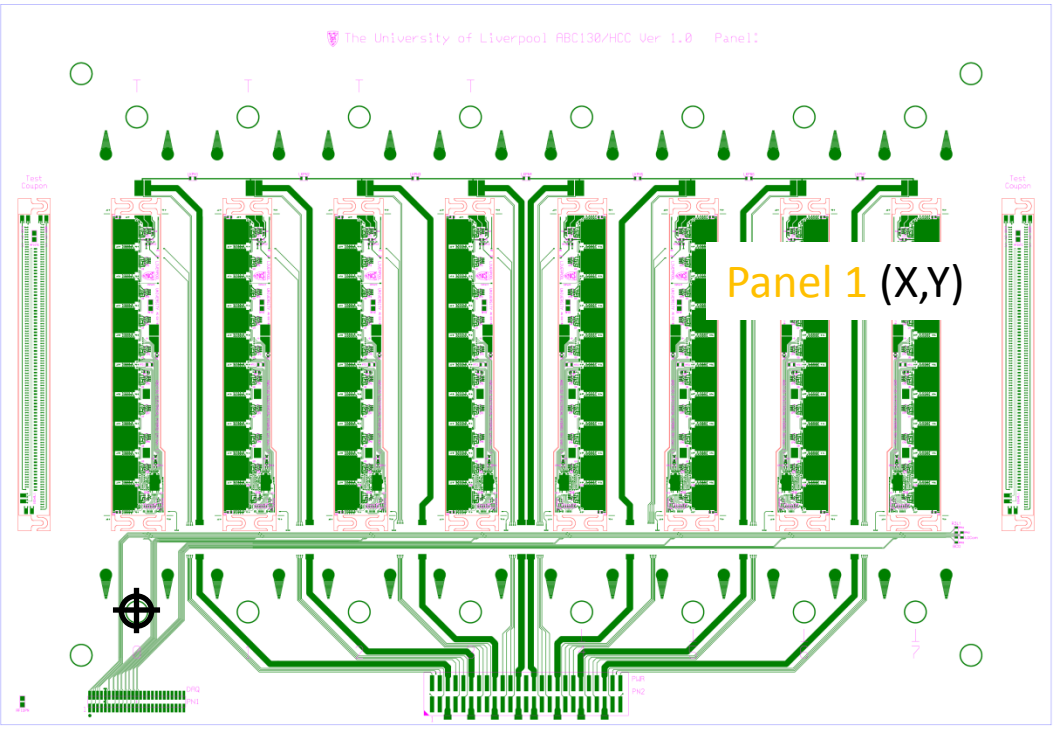
The coordinate systems Hybrid 1, Hybrid 2 and Hybrid 3 are generated for each hybrid individually

Global coordinate systems are used to get information about the full panel.

- Global Plane (Z)
  - Creating a plane / datum level from all landing pads, this coordinate system is used for the output of all landing pad heights and allows the determination of the panel bow.
- Global Center (X,Y)
  - A global coordinate system is defined, where the origin is in the center of the panel. This is done by finding the midpoints of the outermost panel fiducials for the hybrids 0 and 7. It is used to output all fiducials on the panel and the hybrids

- For the analysis a the expected coordinates in the output coordinate systems have been calculated from the coordinates in the design file

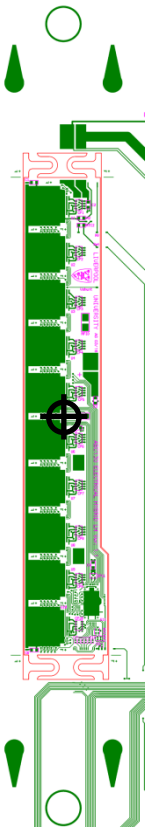
Coordinate Systems



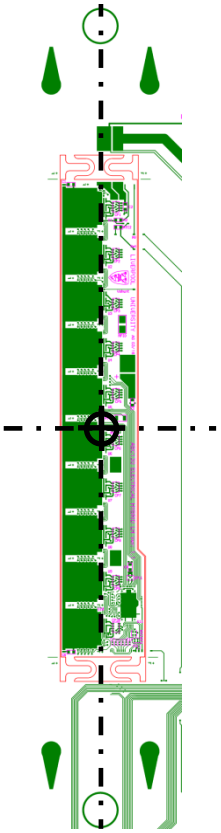
For Z systems, yellow points used to create zero-plane (blue rectangle)

⊕ Origin

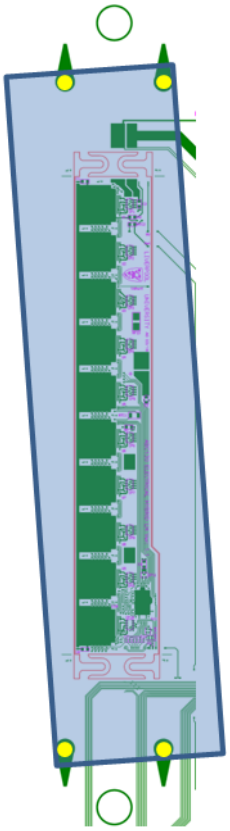
Hybrid 1 (X,Y)



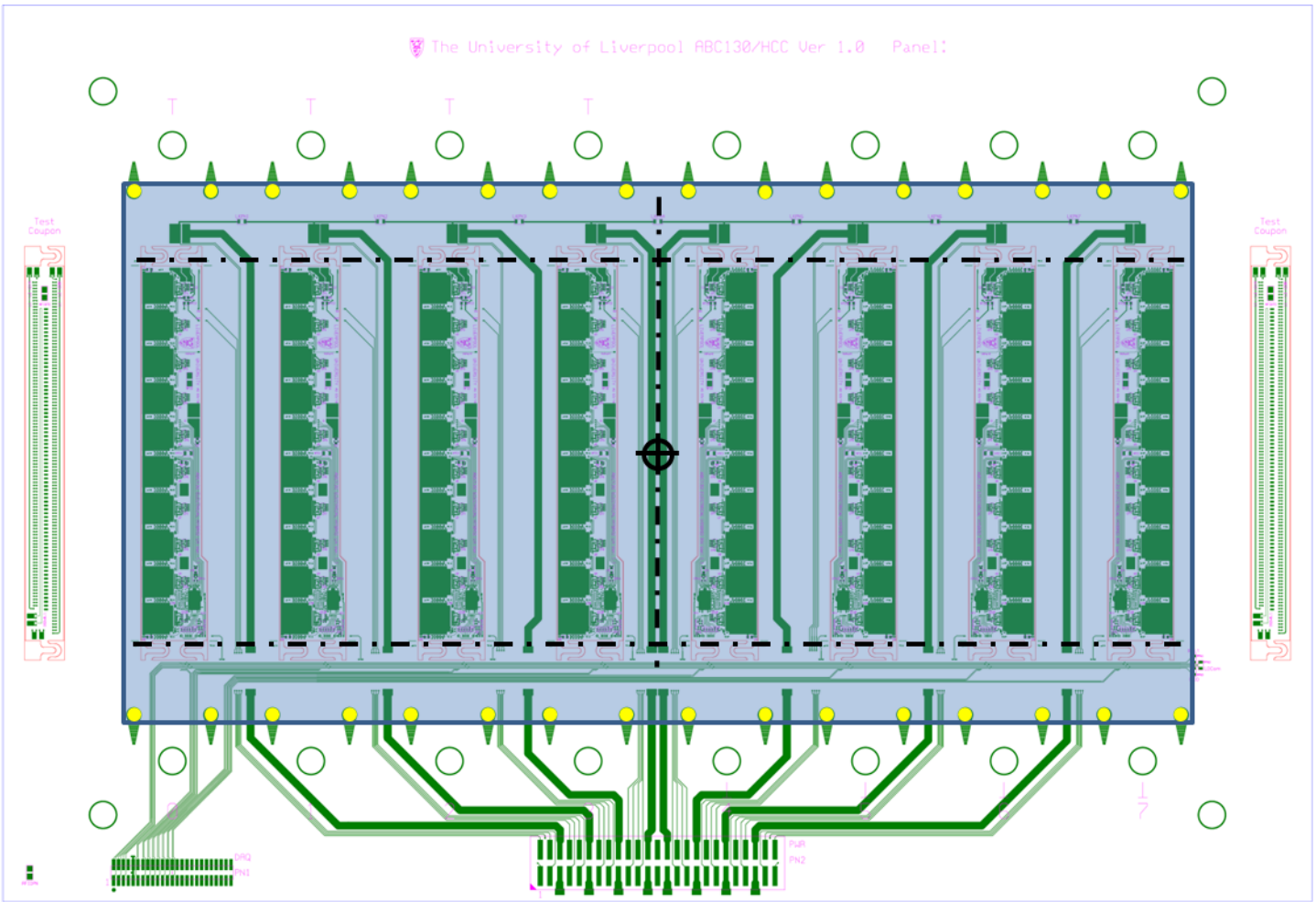
Hybrid 2 (X,Y)



Hybrid 3 (Z)



Coordinate Systems



Global Plane (Z), indicated by blue rectangle
Global Centre (X,Y)

Measurement Steps

1) Bottom left alignment hole
2) Set (1) as origin — Panel 1 coordinate system
3) Point (2) (could be used for output)
4) Bottom right alignment hole
5) Align X axis with (4)
6) Focus at bottom right alignment hole
7) Feature finder circle at bottom right alignment hole
8) Focus at bottom left alignment hole
9) Feature finder circle at bottom left alignment hole
10) Set (9) as origin — Panel 1 coordinate system (redefine)
11) Align X axis with (7)
12) Focus at + fiducial between ASIC 5 & 6 of Hybrid 0
13-20) + fiducials for each hybrid (close to center, left to right); output written to file [X,Y,Z]

No more user input required after this point of the routine

21) Set (13) as new origin for hybrid 0 Hybrid 1 coordinate system
22) Focus at bottom alignment hole
23) Feature finder circle (bottom alignment hole)
24) Focus at top alignment hole
25) Feature finder circle (top alignment hole)
26-29) Panel fiducials bottom (left to right, focus first, pattern recognition)
30-69) Fiducials of hybrid (bottom to top, left to right, focus first, pattern recognition)
70-73) Panel fiducials top (left to right, focus first, pattern recognition)
74) Focus bottom left landing pad
75-76) Laser height bottom landing pads (left to right, circular scan)
77-96) Laser height ASIC pads (X shape [2 lines], bottom to top, linear scan)
97-98) Laser height top landing pads (left to right, circular scan)

Comments

2) So that all further coordinates are set

5) Necessary to align all points, especially the feature finder

7, 9) Better precision than circles

20) Last step that needs user input

Output Steps

99) Construct midpoint from (23) and (25)

100) Set midpoint (99) as origin Hybrid 2 coordinate system for data output (centre of hybrid)

101) Output new origin [X,Y,Z]

102-103) Output alignment holes (23) & (24) [diameter, X,Y]

104-107) Output panel fiducials (left to right, bottom to top)[X,Y,Z]

108-127) Output hybrid fiducials (bottom to top, left to right) [X,Y,Z]

128) Construct datum plane from (75)(76)(97)(98) (composites ON)

129) Datum level form (128) Hybrid 3 coordinate system for data output (z-plane)

130-133) Average height of landing pads(left to right, bottom to top, composites ON) [min,max,average]

134-143) Average height of ASIC pads (from X) (bottom to top, composites ON) [min,max,average]

Comments

99) Centre of hybrid from alignment holes

128/129) z height of hybrid

Hybrids 1->3

144) Set (14) as new origin for hybrid 1 Hybrid 1 coordinate system

145-266) Copy of steps (23) to (143) for hybrid 1

267) Set (15) as new origin for hybrid 2 Hybrid 1 coordinate system

268-389) Copy steps (145) to (266) for hybrid 2

390) Set (16) as new origin for hybrid 3 Hybrid 1 coordinate system

391-512) Copy steps (268) to (389) for hybrid 4

Comments

Copy steps from previous hybrid to next

Measure distance between the origin points to shift the copies in X and Y (by hand)

For hybrids 4 – 7 have to rewrite all steps because of orientation

Hybrid 4 Steps

513) Set (17) as new origin for hybrid 4 Hybrid 1 coordinate system
514) Focus at bottom alignment hole
515) Feature finder circle at bottom alignment hole
516) Focus at top alignment hole
517) Feature finder circle at top alignment hole
518-521) Panel fiducials bottom (left to right, focus first, pattern recognition)
522-559) Fiducials on hybrid (bottom to top, left to right, focus first, pattern recognition)
560-563) Panel fiducials top (left to right, focus first, pattern recognition)
564) Focus bottom left landing pad
565-566) Laser height bottom landing pads (left to right, circular)
567-586) Laser height ASIC pads (bottom to top, X shape [2 lines])
587-588) Laser height top landing pads (left to right, circular)

589) Construct midpoint from (515) & (517)
590) Set midpoint (589) as origin Hybrid 2 coordinate system for data output (centre of hybrid)
591) Output new origin [X,Y,Z]
592-593) Output alignment holes [diameter,X,Y]
594-597) Output panel fiducials (left to right, bottom to top) [X,Y,Z]
598-616) Output hybrid fiducials (bottom to top, left to right) [X,Y,Z]
617) Construct datum plane from (565),(566),(587) and (588)
618) Datum level from (617) Hybrid 3 coordinate system for data output (z-plane)
619-622) Average height of landing pads (left to right, bottom to top, composites ON) [min,max,average]
623-632) Average height of ASIC pads (bottom to top, X shape, composites ON) [min,max,average]

Comments

There are no hybrid fiducials above ASIC 9 for hybrids 4 to 7

Hybrid 5 -> 7

633) Set (18) as new origin of hybrid 5 Hybrid 1 coordinate system

634-752) Copy (514) to (632) for hybrid 5

753) Set (19) as new origin for hybrid 6 Hybrid 1 coordinate system

754-872) Copy (632) to (752) for hybrid 6

873) Set (20) as new origin for hybrid 7 Hybrid 1 coordinate system

874-992) Copy (754) to (872) for hybrid 7

Comments

Copy steps from previous hybrid to next

Measures distance between the origin points to shift the copies in X and Y (by hand)

Global output

993) Construct plane from all landing pads and output data [flatness, furthest away+, furthest away-]

994) Datum level form plane (993) Global Plane coordinate system for data output (z-plane)

995-1026) Average landing pad heights (left to right, bottom to top) [min,max,average]

1027) Midpoint form panel fiducials (hybrid 0 bottom left -> hybrid 7 bottom right) [X,Y,Z]

1028) Midpoint from panel fiducials (hybrid 0 top left -> hybrid 7 top right) [X,Y,Z]

1029) Midpoint form (1027) and (1028) [X,Y,Z]

1030) Set (1029) as new origin Global Centre coordinate system for data output (centre of panel)

1031) Output new origin [X,Y,Z]

1032-1047) Output alignment holes (bottom to top, left to right) [diameter, X, Y]

1048-1079) Output panel fiducials for each hybrid (left to right, bottom to top) [X,Y,Z]

1080-1111) Fiducials on hybrid (between ASIC 0 & 1 and 8 & 9; left to right, top to bottom) [X,Y,Z]

1112) Midpoint for panel fiducials (hybrid 0 bottom left -> hybrid 7 top right) [X,Y,Z]

1113) Midpoint for panel fiducials (hybrid 0 top left -> hybrid 7 bottom right) [X,Y,Z]

Elapsed time: ~50 min

Analysis done with Excel spreadsheet:
Dimension-Analysis-Master.xlsx

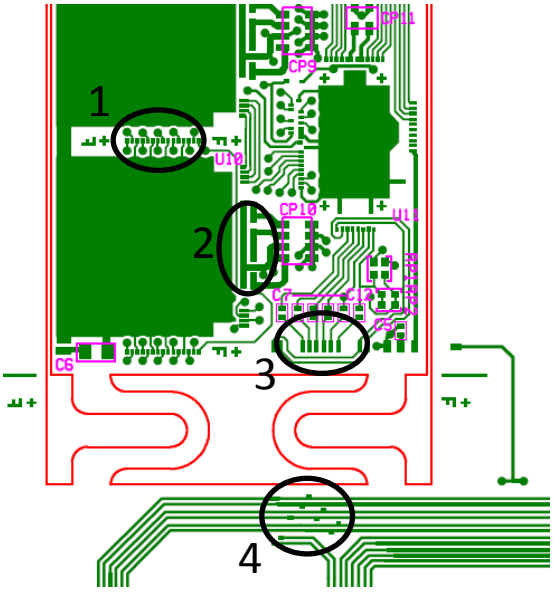
Comments

Output of some values for the full panel in panel coordinate system

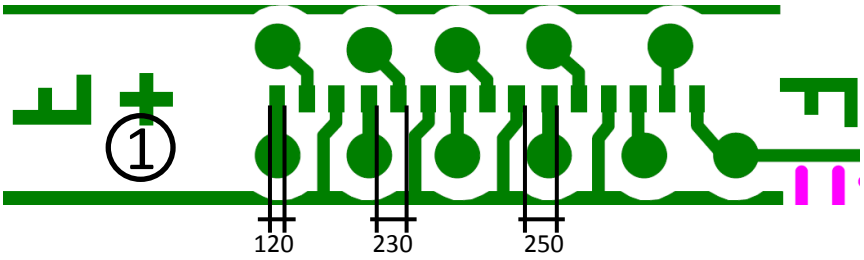
993/994) global height for full panel

1112/1113) are not necessary and were used as a different way of determining the panel origin

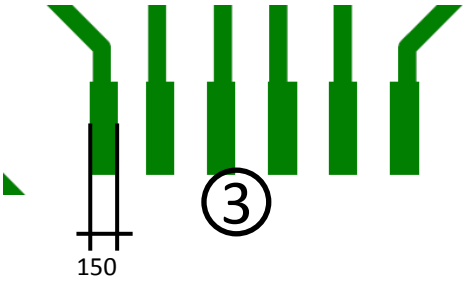
Test places for over-etching (with good microscope)

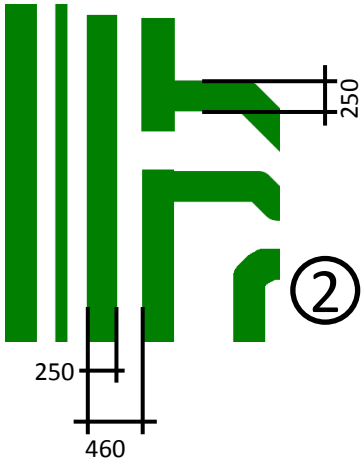


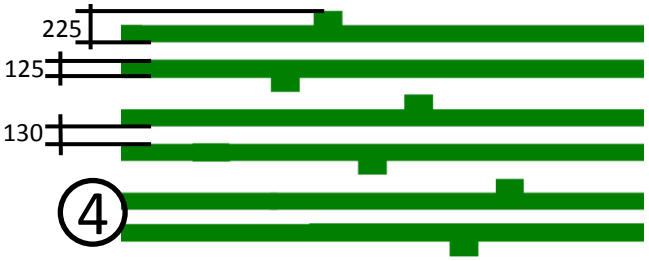
1: Bondpads between ASICs
2: Thick traces next to ASICs
3: Bondpads for connection of hybrid with panel
4: Thin traces on panel and bondpads



Distances may deviate (match ASIC pads) but pad width is constant





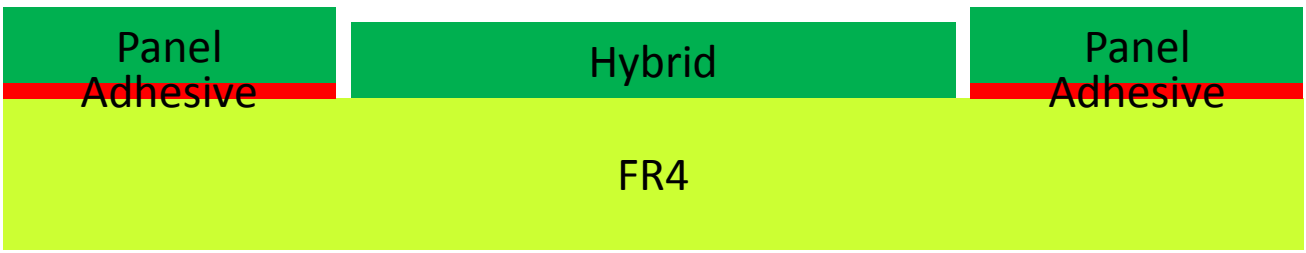


Dimensions in µm

Hybrid Heights

- Heights of the ASIC pads measured with respect to the landing pads
  - Using the 4 landing pads to create a plane, which is used as 'datum level'
- Expected difference between landing pads and ASIC pads due to adhesive used to glue the laminate to the FR4
  - Not under the hybrids, but under the landing pads
- Panel and Hybrids created in same lamination steps therefore the Panel laminate should have the same thickness as the Hybrid

- Adhesive: approximately 50µm thick



Program Filenames

C:\Documents and Settings\Administrator\Desktop\Sven\Zot-Panel

Filename	Max step	comment
zot-panel-align	11	panel alignment
zot-panel-align2	19	all hybrid origins
zot-panel-1hybrid	70	All hybrid fiducials (+)
zot-panel-1hybrid2	95	All laser measurements
zot-panel-1hybrid3	139	Including all output steps (elapsed time 7:06 min)
zot-panel-align-new1	11	Panel alignment
zot-panel-align-new2	20	All hybrid origins
zot-panel-1hybrid-new1	143	Full hybrid with output
zot-panle-4hybrid-new1	512	Hybrid 0 to 3
zot-panel-5hybrid-new1	632	Hybrid 0 to 4
zot-panel-8hybrid-new1	992	All hybrids
zot-panel-fullPanel-new1	1109	Including global output
zot-panel-fullPanel-new2		
zot-panel-fullPanel-new3	1113	New origin compared to version 1/2

Old files