User Guide for 8CBC2 flex prototype

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1. Introduction

The 8CBC2 Flex board is designed to investigate the suitability of the Hicoflex material and manufacturing process of Hightec AG. The board serves as a readout board prototype of the silicon microstrip tracker of the CMS experiment in the HL-LHC. The board contains 8 pieces of CBC2 readout chips, decoupling capacitors, termination resistors, probe pads, wirebond pads, alignment holes and a flexible joint. The main purpose of the board is to connect the readout chips to each strip-line on the silicon sensor by a wirebond pad. The CBC2 chips are read out the charge generated by ionizing events within the silicon strips of the detector and convert the events into a hit or no hit data. Then after several events and data preparation, the data can be read out through the flexible connector, using a special interface card. The board also serves as a mechanical evaluation board to investigate the handling of this flexible substrate, to investigate the assembly, reliability and quality issues of the product. The board is compatible to the "strip-line module design" which will be the complete readout module, containing the silicon sensors, mechanical stiffener materials, readout boards and other important components.

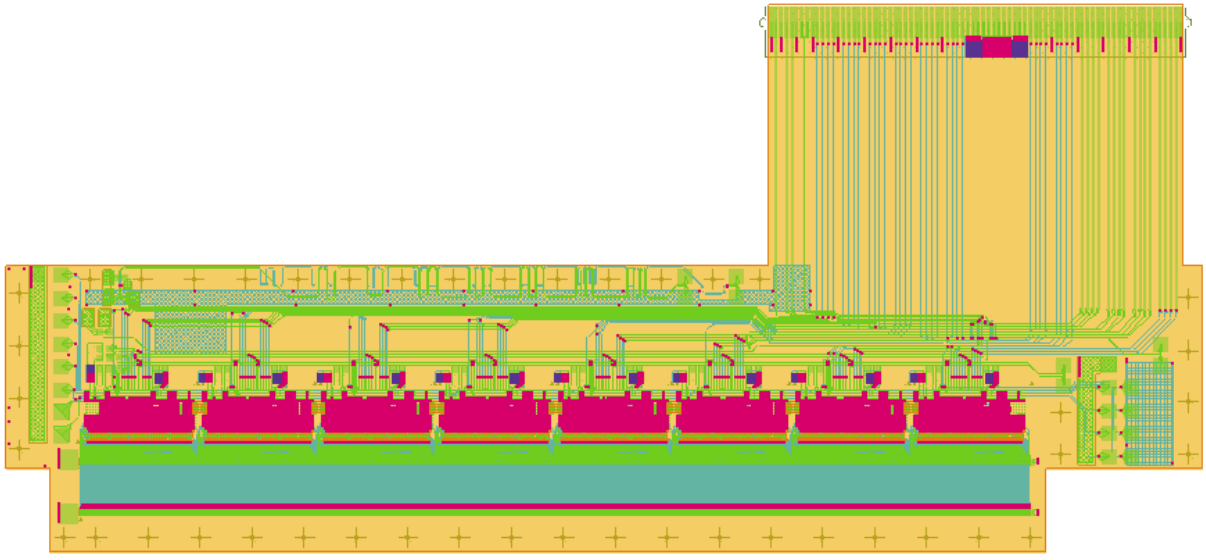

Figure 1: Screen capture of the Cadence Allegro top view of the board

2. Contents of the board

A. **8 pcs of readout chips**

B. **2 times 2016 bond pads**

C. **6 pcs of 100 Ω termination resistors**

D. **16 pcs of 220nF decoupling capacitors**

E. **20 pcs of probe pads**

F. **Flexible connector**

G. **Test differential pairs with probe pads**

H. **Alignment holes**

I. **Fiducial points**

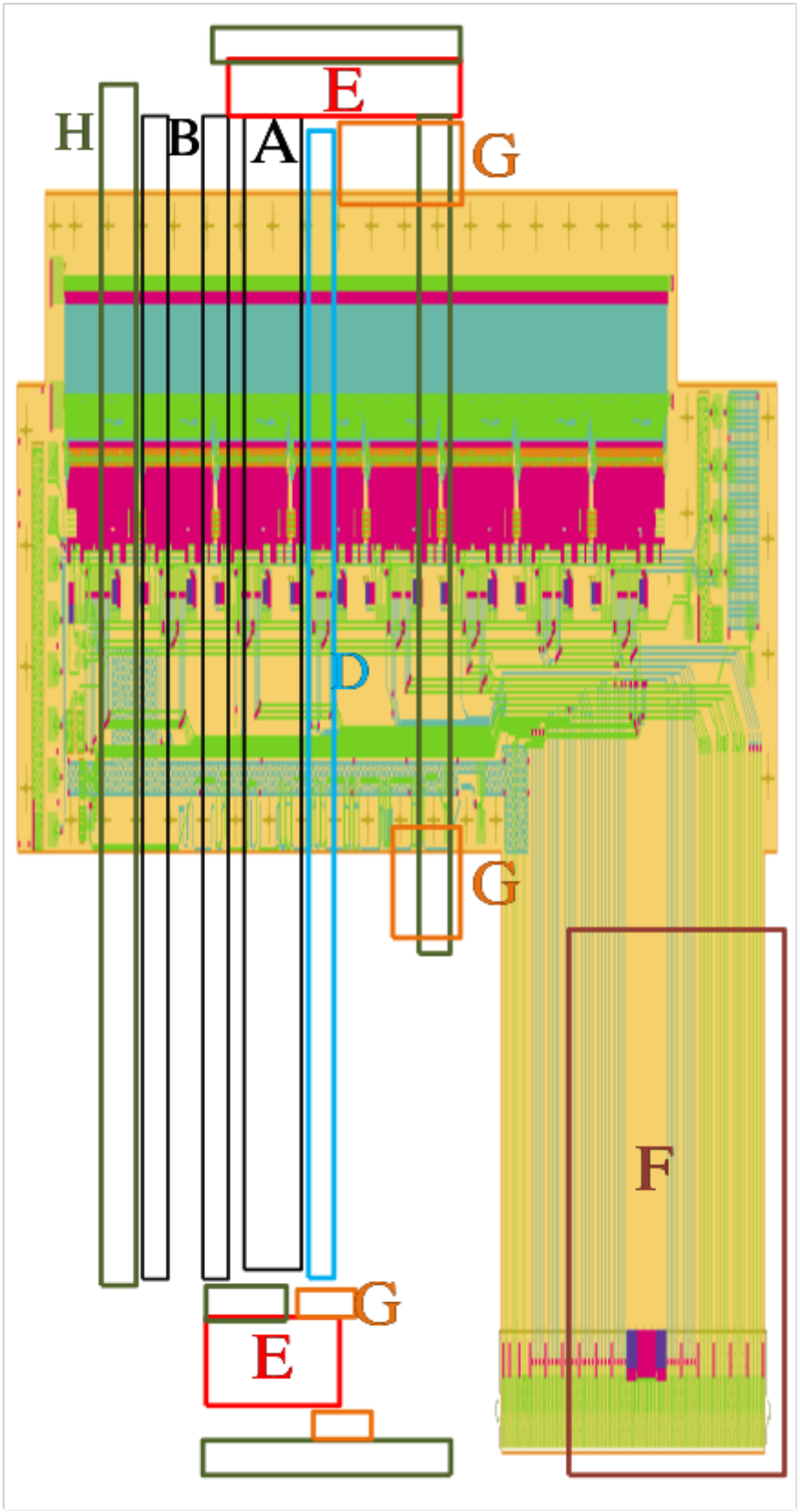

Figure 2: Contents of the board

2.1. CBC2 Readout chips

The board contains 8 pieces of the CBC2 asics. The chips are placed near the first sensor bond pad group. The distance from the center of the closer bond pads to the center of the closest row of bumps is 2,3 mm. The placement of the chips is indicated by 3 fiducials.

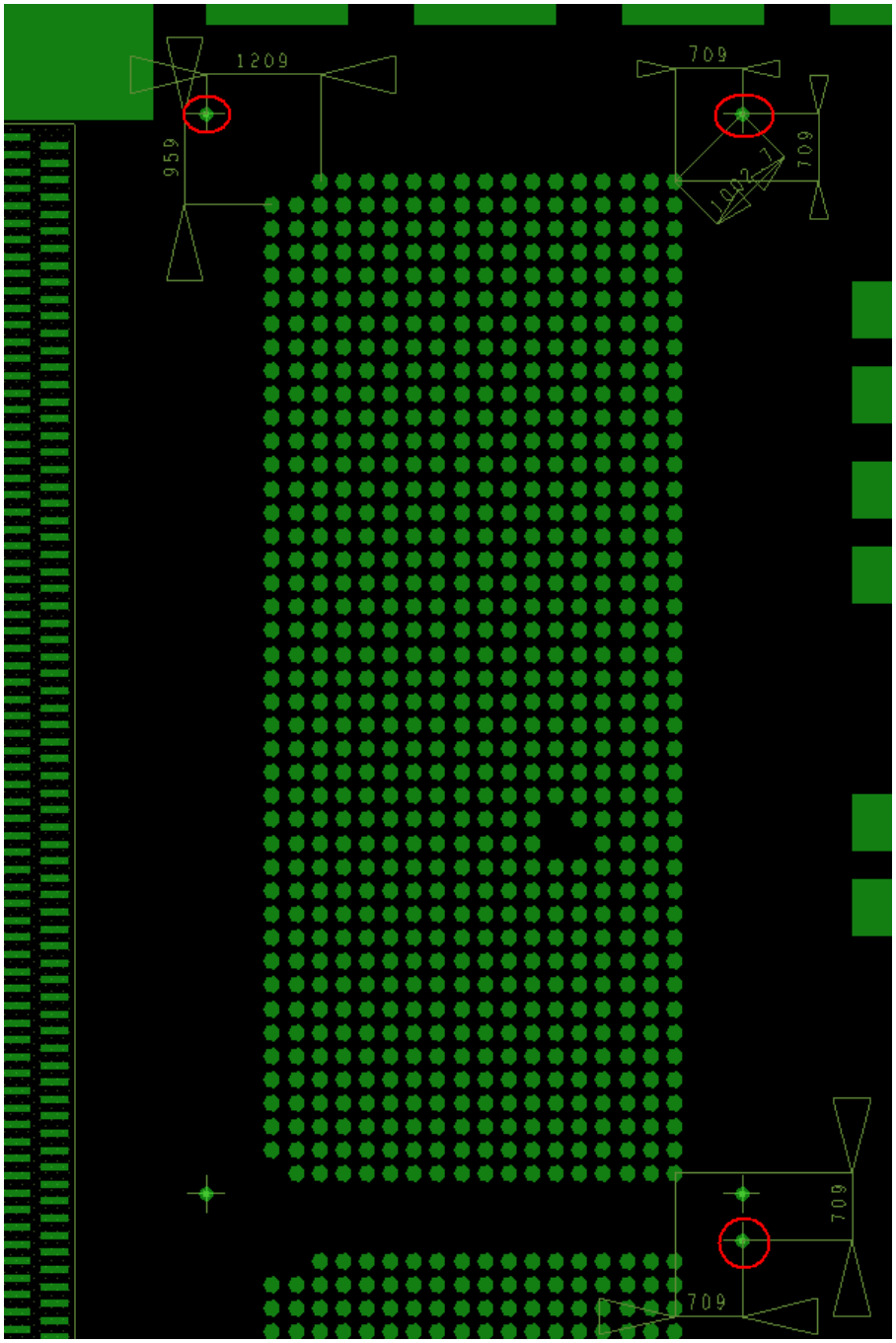

Figure 3: Fiducials for CBC2 chip placement

2.2. Sensor bond pads

In this prototype, there are two groups of bonding pads to provide wirebond connection from the silicon strip sensor to the board. One group is for the top sensor and one for the bottom sensor

connection. Each group contains two columns of 808 pieces 80µm x 300µm size rectangular bond pads. These pads will have an ENEPIG or ENIG surface finish appropriate for aluminium wirebonds. The pitch of the pads is 80 µm and the spacing between the two columns is 100 µm. The first bond pad is indicated by a 150 µm diameter fiducial as shown in the figure 4.

Figure 4: Fiducials indicating the first bonding pads

2.3. Differential pairs

The purpose of most of the differential pairs on the board is to test the diff. impedance, propagation delay and other properties of differential pairs in a Hicoflex based PCB. The names of these nets are:

- **CLK_40**
- **CLK_160**
- **DIFFTEST**
- **DIFFTEST_1**
- **DIFFTEST_2**

The termination resistors of the pairs are found in the upper orange G letter signed part of the board. All the resistors are 100Ω 0402 components.

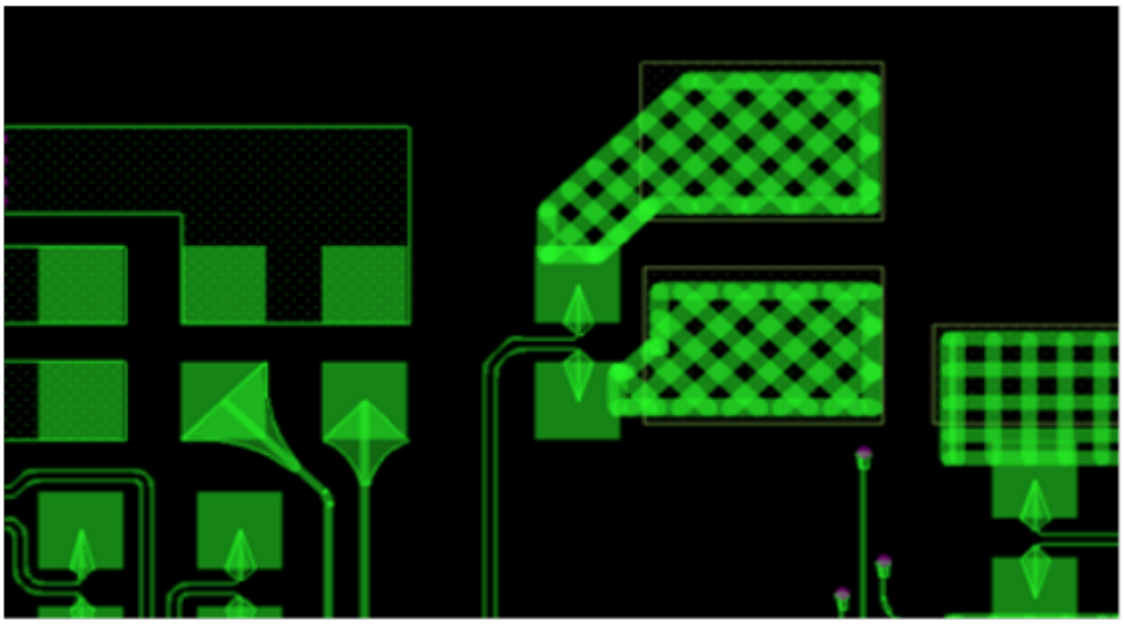

Figure 5: Termination resistors and test pads in the design file

2.3.1. CLK_40

CLK_40 is distributed to every CBC2 chips. This differential pair provides the driving 40MHZ clock for the ASICs. The pair is connected to the flexible connector and will be drove from the testing devices connected to the board. The termination resistor is near CBC2_A1 referenced as R3.

2.3.2. CLK_160

CLK_160 is a test differential pair to test the propagation delay of higher frequency signals. Each chip has a separated driver for this clock to use it in a chain arrangement. The signal pass through the eight chips and has a 100 Ω termination resistor near the CBC2_A1 chip. The termination resistor referenced as R4. Each CBC2 chip has a single ended output to probe this signals. On the bottom left corner of the top layer (near CBC2_4B) a group of probe pads are for this test purpose. These probe pads shown on the figure No. 7 below. The upper L shape is a ground pad.

- Pad no. 1 is connected to CBC2_1A
- Pad no. 2 is connected to CBC2_1B
- Pad no. 3 is connected to CBC2_2A
- Pad no. 4 is connected to CBC2_2B

- Pad no. 5 is connected to CBC2_3A
- Pad no. 6 is connected to CBC2_3B
- Pad no. 7 is connected to CBC2_4A
- Pad no. 8 is connected to CBC2_4B

Figure 6: Input pads for CLK_160

Figure 7: Test pads to probe single ended 160MHZ outputs

2.3.3. DIFFTEST

DIFFTEST is a test differential pair on the top layer. Starts from near the CBC2_4B chip and ends at the termination resistor with probe pads. This differential pair contains vias and sections going in L3 and L2 layers. It's structure is similar to the CLK_40 differential pair without the T-connections to the CBC2 chips. The termination resistor is referenced as R5.

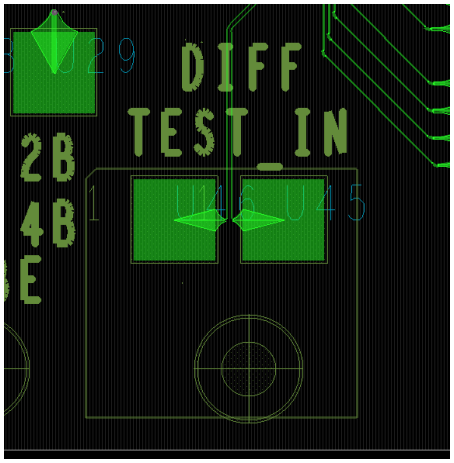

Figure 8: Input pads for DIFFTEST

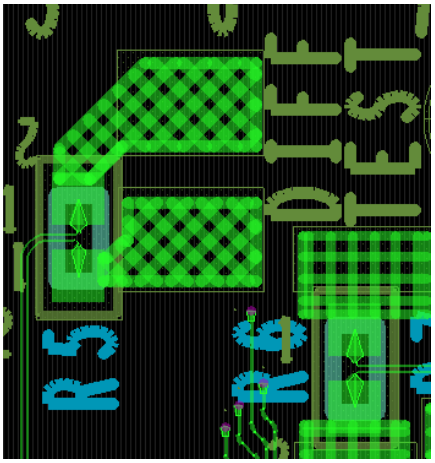

Figure 9: Termination and test pads

2.3.4. DIFFTEST_1

DIFFTEST_1 is a test differential pair on the top layer. This differential pair has only sections on the top layer. The aim of this pair to test differential pairs on the Hicoflex material without T-connections and vias. This signal is terminated on R7. The probe pads for this signal are attached to R7 resistor's footprint.

2.3.5. DIFFTEST_2

DIFFTEST_2 is a test differential pair on the L2 layer. The most of this differential pair goes on the L2 layer. Only the termination and the input pads are on the top layer. The aim of this pair to test differential pairs on the layer L2 on Hicoflex material without T-connections and with only few vias. This signal is terminated on R6. The probe pads for this signal are attached to R6 resistor's footprint.

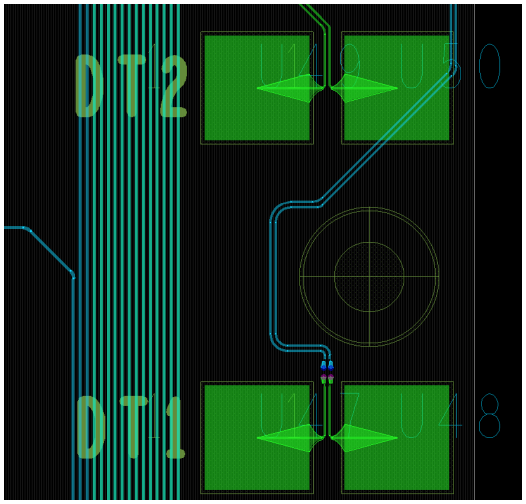

Figure 10: Input pads for DIFFTEST_1,2

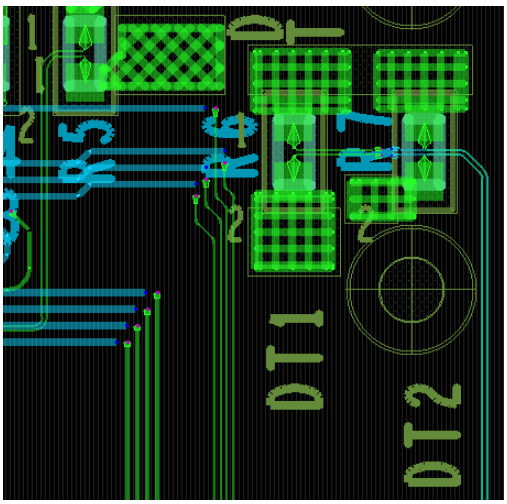

Figure 11: Termination and probe pads

2.4. VDDA test pads

There are 8 test pads and a GND L shape near the CBC2_1A. The purpose of these pads to probe the VDDA voltage individually for each CBC2 chips.

- Pad No. 1 is connected to CBC2_1A
- Pad No. 2 is connected to CBC2_1B
- Pad No. 3 is connected to CBC2_2A
- Pad No. 4 is connected to CBC2_2B
- Pad No. 5 is connected to CBC2_3A
- Pad No. 6 is connected to CBC2_3B
- Pad No. 7 is connected to CBC2_4A
- Pad No. 8 is connected to CBC2_4B

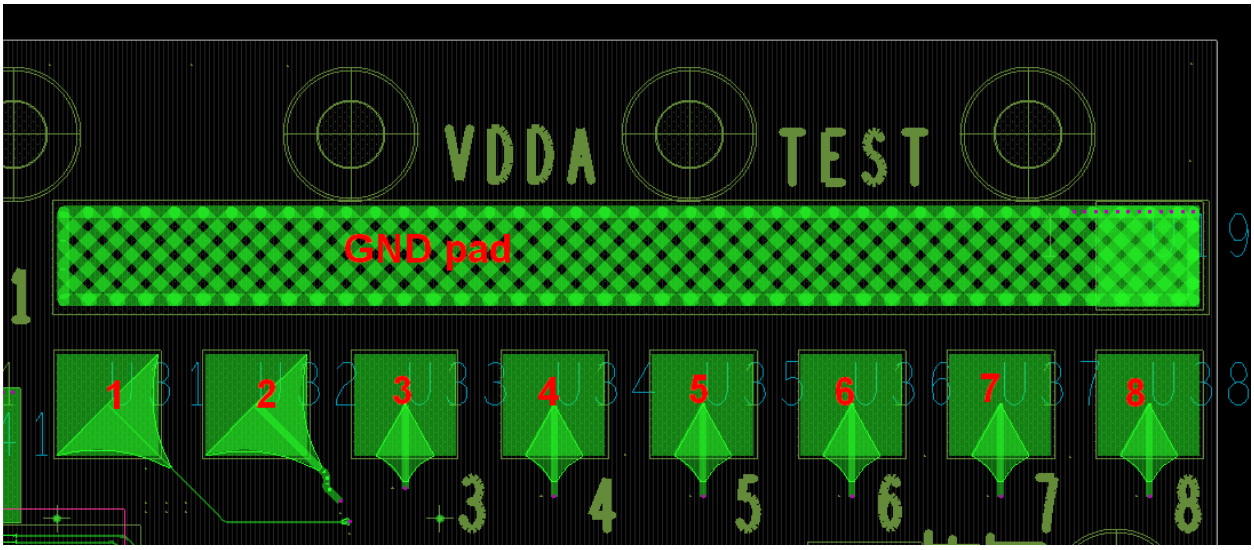

Figure 12: VDDA probe pads

2.5. Alignment holes

44 pcs of alignment holes with 1mm diameter are placed near the board outline. The aim of these alignment holes to provide mechanical fixation during the assembly process. All alignment holes are placed 1,5mm far from the board outline, but the yellow circle signed ones showed in the figure 13 are in different distance. The spacing between the holes is 5 mm with some exeptions. The figure 13 show the placement of these alignment holes.

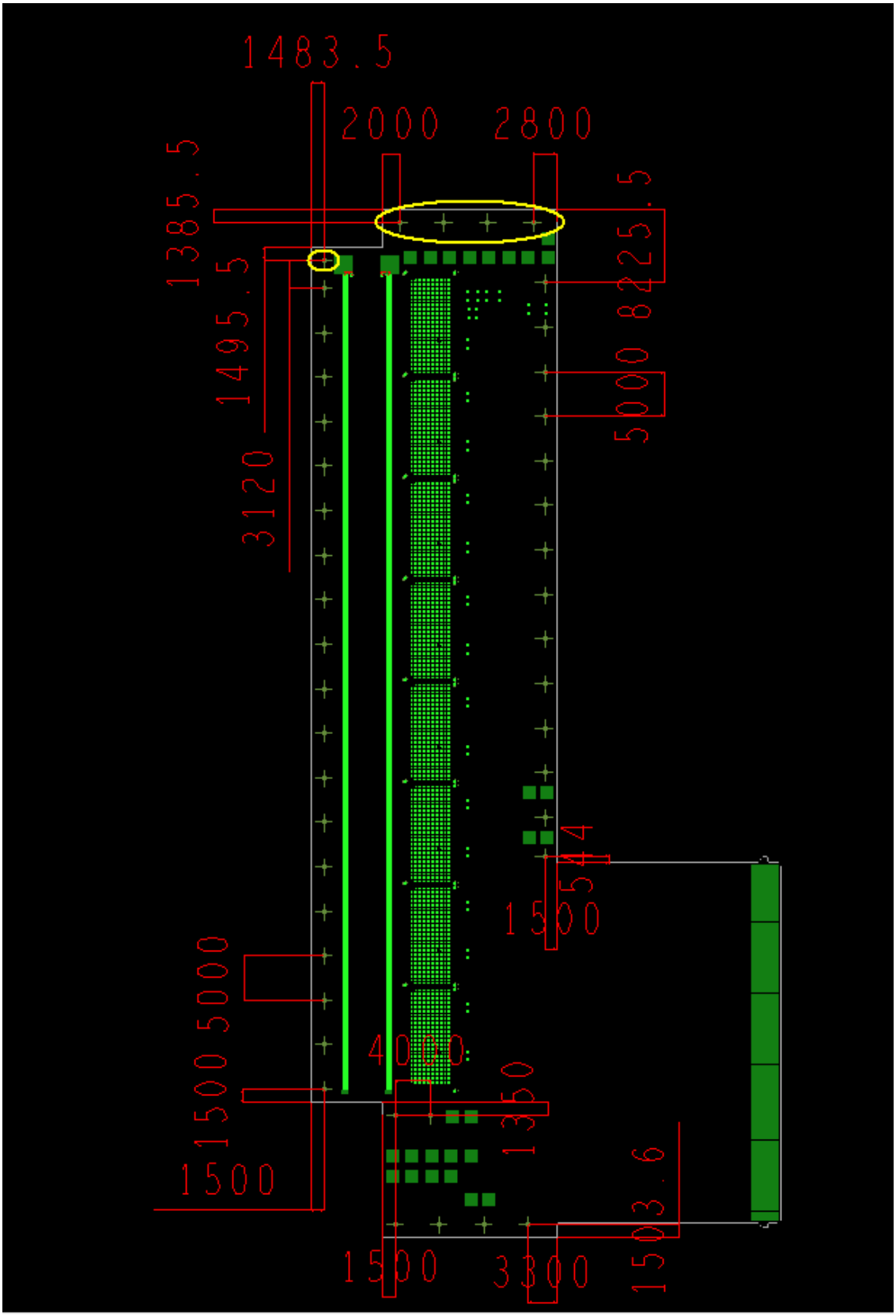

Figure 13: Placement of alignment holes in µm

2.6. Flexible connector

To provide connectivity to the readout and test circuits, this board contains a flexible extension with stiffened contact pads. This contact fits into two types of flexible connectors:

- Molex 502790-8091
- Molex 503366-8011

The table 1 below contains the arrangement of nets in the connector layout.

Table 1: Pin layout of the flexible connector

Comment	Net Name	PIN No.
GND	GND	1
Hard Reset	RESET	2
GND	GND	3
I2C common to both CBCs	SDA	4
I2C common to both CBCs	SCLK	5
GND	GND	6
Common 40 MHZ clock for all 2CBC	CLK_40_P	7
Common 40 MHZ clock for all 2CBC	CLK_40_N	8
GND	GND	9
Output from CBC2_1_A: OR of Stub pairs	CBC2_1_A_COIN_OR	10
MUX OUTPUT from CBC2_1_A	CBC2_1_A_AMUX	11
Output from CBC2_1_A: stub flags serial output	CBC2_1_A_COIN_DATA	12
Ouptut from CBC2_1_A: pipeline output	CBC2_1_A_DATA	13
GND	GND	14
Output from CBC2_1_B: OR of Stub pairs	CBC2_1_B_COIN_OR	15
MUX OUTPUT from CBC2_1_B	CBC2_1_B_AMUX	16
Output from CBC2_1_B: stub flags serial output	CBC2_1_B_COIN_DATA	17
Ouptut from CBC2_1_B: pipeline output	CBC2_1_B_DATA	18
GND	GND	19
Output from CBC2_2_A: OR of Stub pairs	CBC2_2_A_COIN_OR	20
MUX OUTPUT from CBC2_2_A	CBC2_2_A_AMUX	21
Output from CBC2_2_A: stub flags serial output	CBC2_2_A_COIN_DATA	22
Ouptut from CBC2_2_A: pipeline output	CBC2_2_A_DATA	23
GND	GND	24
Output from CBC2_2_B: OR of Stub pairs	CBC2_2_B_COIN_OR	25

MUX OUTPUT from CBC2_2_B	CBC2_2_B_AMUX	26
Output from CBC2_2_B: stub flags serial output	CBC2_2_B_COIN_DATA	27
Ouptut from CBC2_2_B: pipeline output	CBC2_2_B_DATA	28
GND	GND	29
Output from CBC2_3_A: OR of Stub pairs	CBC2_3_A_COIN_OR	30
MUX OUTPUT from CBC2_3_A	CBC2_3_A_AMUX	31
Output from CBC2_3_A: stub flags serial output	CBC2_3_A_COIN_DATA	32
Ouptut from CBC2_3_A: pipeline output	CBC2_3_A_DATA	33
GND	GND	34
Output from CBC2_3_B: OR of Stub pairs	CBC2_3_B_COIN_OR	35
MUX OUTPUT from CBC2_3_B	CBC2_3_B_AMUX	36
Output from CBC2_3_B: stub flags serial output	CBC2_3_B_COIN_DATA	37
Ouptut from CBC2_3_B: pipeline output	CBC2_3_B_DATA	38
GND	GND	39
GND	GND	40
GND	GND	41
P1V2	P1V2	42
P1V2	P1V2	43
P1V2	P1V2	44
P1V2	P1V2	45
P1V2	P1V2	46
P1V2	P1V2	47
GND	GND	48
GND	GND	49
GND	GND	50
Output from CBC2_4_A: OR of Stub pairs	CBC2_4_A_COIN_OR	51
MUX OUTPUT from CBC2_4_A	CBC2_4_A_AMUX	52
Output from CBC2_4_A: stub flags serial output	CBC2_4_A_COIN_DATA	53
Ouptut from CBC2_4_A: pipeline output	CBC2_4_A_DATA	54
GND	GND	55
Output from CBC2_4_B: OR of Stub pairs	CBC2_4_B_COIN_OR	56
MUX OUTPUT from CBC2_4_B	CBC2_4_B_AMUX	57
Output from CBC2_4_B: stub flags serial output	CBC2_4_B_COIN_DATA	58
Ouptut from CBC2_4_B: pipeline output	CBC2_4_B_DATA	59
GND	GND	60
Common for group of 2 CBC2s	I2C_refresh_1	61
Common for group of 2 CBC2s	Test_Pulse_1	62
Common for group of 2 CBC2s	FAST_RESET_1	63
Common for group of 2 CBC2s	T1_Trigger_1	64
GND	GND	65

Common for group of 2 CBC2s	I2C_refresh_2	66
Common for group of 2 CBC2s	Test_Pulse_2	67
Common for group of 2 CBC2s	FAST_RESET_2	68
Common for group of 2 CBC2s	T1_Trigger_2	69
GND	GND	70
Common for group of 2 CBC2s	I2C_refresh_3	71
Common for group of 2 CBC2s	Test_Pulse_3	72
Common for group of 2 CBC2s	FAST_RESET_3	73
Common for group of 2 CBC2s	T1_Trigger_3	74
GND	GND	75
Common for group of 2 CBC2s	I2C_refresh_4	76
Common for group of 2 CBC2s	Test_Pulse_4	77
Common for group of 2 CBC2s	FAST_RESET_4	78
Common for group of 2 CBC2s	T1_Trigger_4	79
GND	GND	80

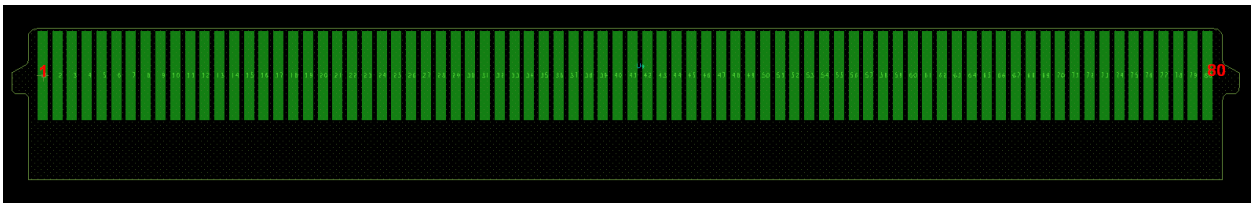

Figure 14: Top view of the contact pads for the connector

More information and documentation about the connectors attached to this document.

3. Drawings

Several stiffeners provides the rigidity for different areas of the board. The assembly of these stiffeners is a comlicated process, which requires drawings about the placement and the size of stiffeners and components on the borad. These drawings are found below.