	Hybrid fabrication in the SCT barrel hybrid production

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Hybrid fabrication in the SCT barrel hybrid production

abstract

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Distribution List

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History of Changes

Rev. No.	Date	Pages	Description of changes
A	dd/mm/yy	All	First version

Table of Contents

How to make Table of Contents (TOC) in the FrameMaker:

1. High-light the section title to include
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5. From the menu, click “File” > “Generate”
6. In the pop-up window, mark “Table of Content” and click “generate”
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1 Introduction

The ATLAS SCT barrel module is a double sided module, two front side detectors and the other two back side detectors glued in back to back. A readout hybrid is placed on top of the silicon detectors for both front and back sides detectors near the middle of the module. A four metal layer copper polyimide laminated flex circuit is used for the hybrid. As a part of unified structure, the flex circuit can have a cable section which provides a simple and reliable connection between the front and back sides hybrids. The cable section, which is a two metal layer circuit, is flexible enough to be bent in small radius to lap around the module. The flex circuit is reinforced with a pair of low mass carbon bridges glued on its backside. The carbon bridge works as not only a reinforcement but also an excellent thermal and electrical conductor.

Flex circuits are produced in industry. Gluing the carbon bridge and stuffing passive components are also done in industry in a separate step. Once the passive components are stuffed, the hybrids are shipped to the module assembly sites.

ASIC stuffing and its replacement are also described in this document.

2 Flex circuit production

About 2,500 flex circuits are to be produced for the SCT barrel modules. Flex circuit production and details of QA are specified in the document [xx]. Major items for the QA can be classified as in the followings:

Tests by manufacturer:

- Visual inspection for all products

- Specimen tests

- Integrity test of lines: Open/short test for all products, and resistance measurement by sampling

3 Glueing Carbon-carbon bridges and pitch-adaptors

3.1 C-C bridge gluing

The surface of the C-C bridge is covered with a polymer coating of Parylene. Surface roughing has been applied to make the gluing reliable. A set of small windows has been cut out in order to improve thermal and electrical contact between the carbon bridge and the ASICs. An alumina filler epoxy provided as a thin film is used for the gluing except for the windows where a silver loaded epoxy, which is also provided as a thin film, is used. A curing process is applied at the temperature of 125 deg.C for two hours. During the curing process, the flex circuit and bridge are mutually pressed uniformly by means of a vacuum bag with the atmospheric pressure. The CTEs' of the flex circuit and bridge are 25 and -0.8 ppm/K respectively. In the curing process at 125 deg.C, the elongation of the flex circuit with respect to the bridge is carefully adjusted using an appropriate jig so that the length of the flex circuit at room temperature shall match the length of the bridge. The amount of bow allowed at room temperature is less than 50 μm in sagitta at the middle of the bridge.

3.2 Glass pitch adaptor gluing

A room temperature curing epoxy is used for gluing the pitch adaptor. Guided by the fiducial marks on the flex circuit, the pitch adaptors are carefully positioned and pressed with a jig. A relatively low viscosity epoxy without a filler is applied so as to make glue layers as thin as possible without trapping air bubbles. The hybrid top is carefully covered with a masking tape to protect from overflowing of the glue.

4 Passive component stuffing

4.1 Soldering of surface-mount components (SMD parts)

About 50 SMD parts, resistors, capacitors, and thermistors as listed in Table 1, are to be installed on the hybrid. The component loading drawing shows where components are physically stuffed. The hybrid is held and fixed with an appropriate jig, then the resistors and capacitors are soldered by hand. The details of the procedure will be defined further interpolating the process involved in industry.

4.2 Soldering of connector

The connector to be used is a 36 contacts, Samtec SFMC-140-L3-S-D which is soldered by hand at the end of the flex pig tail.

The hybrid completed up to this stage will be distributed to the module production sites. The hybrid to be distributed has finished with

- Carbon-carbon bridges glued

- All passive components stuffed

- Glass pitch-adaptor glued

5 ASICs stuffing

After the receipt of the passive-component-stuffed hybrids, the fabrication of the hybrid and into a module proceeds as in the following steps:

1. glue ASICs with silver-loaded conductive epoxy and cure
2. wire-bond ASICs and AGND-DGND pads
3. glue the hybrid on the sensor-baseboard assembly
4. wire-bond channels and HV bias connections

The circuit diagram appended in Figure 1, Figure 2 and Figure 3 shows the details of electrical connections and wire-bondings. The glass pitch adaptor drawing, Figure 4, shows the detail of the wire-bondings around the pitch adaptor. The pin assignment of the hybrid connector is listed in Table 1, and the components in Table 2.

5.1 ASIC gluing

In order to enhance heat and electrical conduction, a number of throughholes are prepared in the area where the ASIC is glued. The ASICs' should be glued with conductive epoxy to have good heat and electrical conduction. Use silver-loaded conductive epoxy. Glue full area. We think the conductive epoxy is important although the backside of the chips is not metalized. We use a low-temperature curing and do curing at 50 °C for 2 hrs. The epoxy being used at KEK is made by a Japanese company.

5.2 wire-bondings

Wire-bondings with 25 μmϕ aluminium wire are used for electrical connections. Some places are recommended to use more than single wire-bonding per pad. They are listed as follows:

1. GND (D-, A-, ring-a, det-,...), Vcc, Vdd pads: at least 2 wires per pad if possible,
2. AGND-DGND stitching pads: as many wires as possible, mod0 = 5 wires/pad,
3. Detector bias connections: at least 2 wires per pad. There are four corners of the hybrid which can be used to connect to the detector strip and backplane bias. The strip bias connection is done at four corners. The backplane bias connection is done only on the top side two corners, since the baseboard has only those contacts.

5.3 Other recommendations

1. dry up the hybrid in a low humidity environment (<50% RH) before soldering
2. mask the wire-bonding pads when soldering in order not to contaminate the bonding surface
3. do not burn out the hybrid with a soldering iron. The spec is <10 sec at 260 deg.C. The higher the temperature, the shorter the time (than 10 sec).
4. when wire-bonding, keep in mind that the width of the pads on hybrid, which are mating with the output pads of the chip, is narrow
5. recommend to confirm the performance of the chips before wire-bonding between the chip and the pitch adaptor
6. keep the masking tape on the pitch adaptor until the wire-bondings between the chips and the pitch adaptor will occur.

6 ASIC replacement

ASIC replacement has been successfully tested. A special jig for the ASIC replacement has been developed. The jig is a 8 mm x 8 mm x 12 mm copper block. The block has a trench of 6.5 mm wide and 0.3 mm deep in which the ASIC can be fit and held with vacuum-chucking. The jig can be attached to a conventional soldering iron. The ASIC to be replaced can be heated up locally with the jig avoiding any damage to the flex circuit and the other components near by. The glue underneath the ASIC becomes soft in about 5 sec. with the jig temperature of about 250 deg.C. By applying a small twist to the ASIC, it can be removed easily. We recommend to use a high power soldering iron (e.g., 20W) in order to make the heat-up time as short as possible. A photo of the jig is shown in Figure 5.

Table 1
Pin assignment of the hybrid connector.

1	+bias(HV)	10	analog ground	19	digital ground	28	com0-bar
2	+bias(HV)	11	V_{CC}	20	digital ground	29	clock0
3	NC	12	analog ground	21	V_{DD}	30	clock0-bar
4	NC	13	(digital ground)	22	V_{DD}	31	led
5	-bias(ag)	14	select	23	digital ground	32	led-bar
6	-bias(ag)	15	com1	24	digital ground	33	ledx
7	calib0	16	com1-bar	25	reset	34	ledx-bar
8	analog ground	17	clock1	26	select	34	temp1
9	V_{CC}	18	clock1-bar	27	com0	36	temp2

Table 2
List of components

parts No.	# of pieces	dimensions (mm)	specifications	products
U1 ~ U12	12	6.550 x 8.400	ABCD2T chip (V2.1)	
C1 ~ C28	28	1.6 x 0.8 x 0.8	Ceramic capacitor 100 nF, 25 V,	Murata GRM39-X7R-104-K-25
C51 ~ C58	8	3.2 x 1.6 x 1.25	Ceramic capacitor 330 nF, 25 V,	Murata GRM42-6-X7R-334-K-25
C71 ~ C72 (C73 ~ C75)	3 (+2)	3.2 x 1.6 x 1.25	Ceramic capacitor 10 nF, 630 V	Murata GHM1530-B-103-K-630
R27 ~ R30	4	1.6 x 0.8 x 0.8	Resistor, 100Ω	
R33, R34	2	1.6 x 0.8 x 0.8	Resistor, 5.1 kΩ	
R35	1	1.6 x 0.8 x 0.8	Resistor, 1 kΩ	
R36	1		jumper wire	
TM1, TM2	2		Temperature sensor	Semitec 103KT1608-1P
CON	1		connector, 2x18pins, 1.27mm pitch,	Samtec SFMC-140-L3-S-D or 0.05”x0.05” 40 square-pins female
PA	2		pitch adaptor	

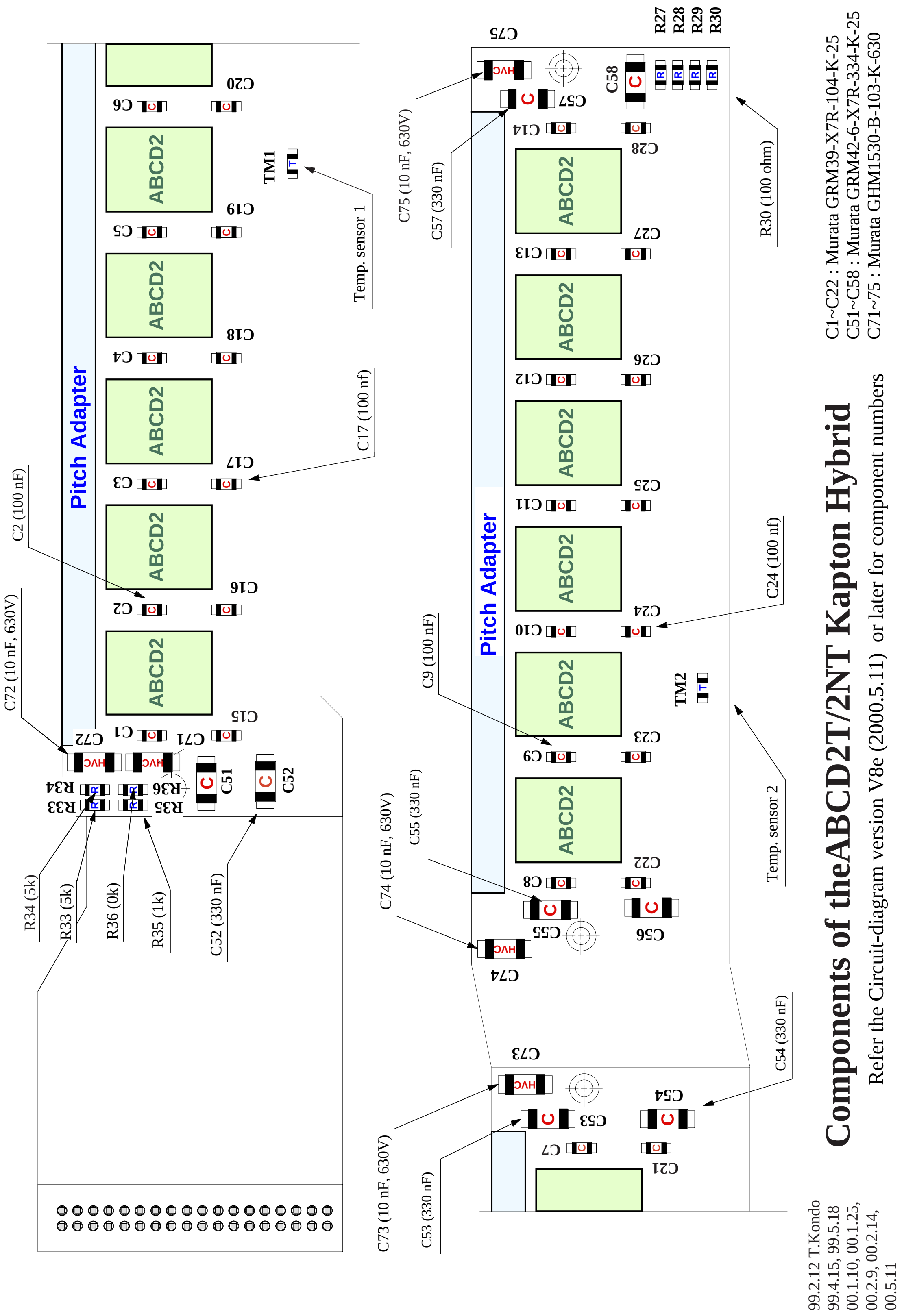

Figure 1: Component loading diagram of ABCD Kapton hybrid (version 3)

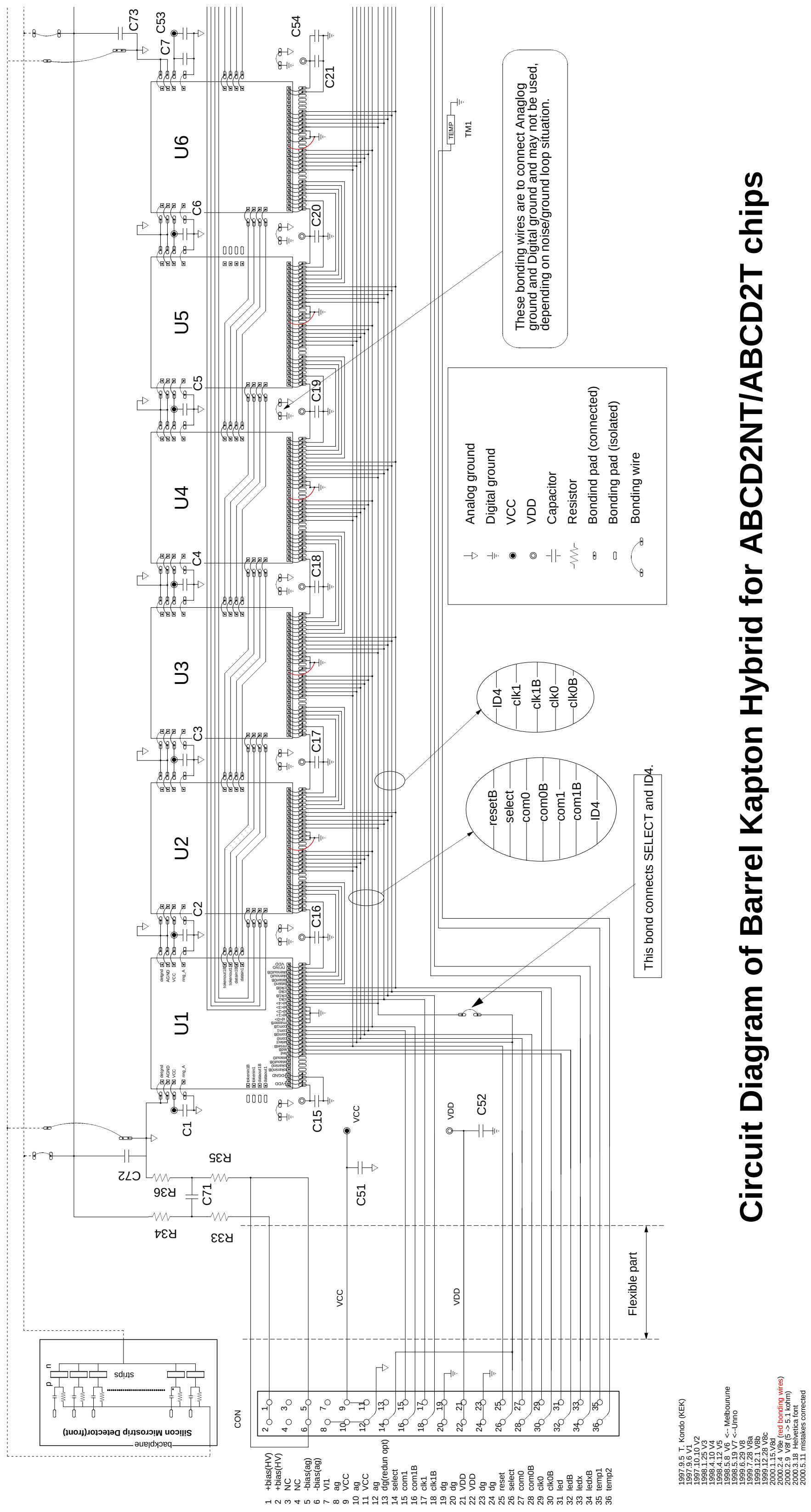

Figure 2: Circuit diagram of ABCD Kapton hybrid (version 3), top-side hybrid

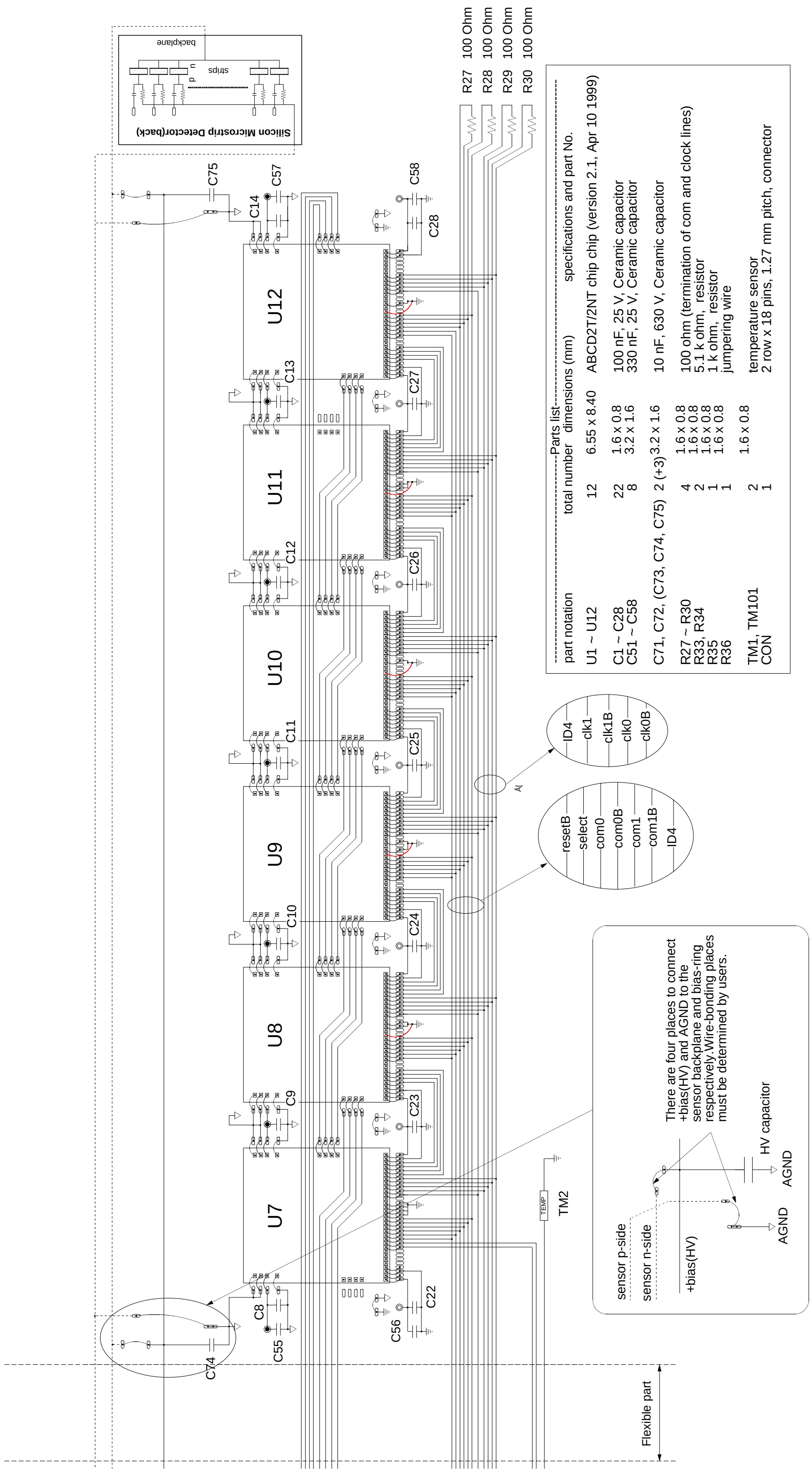

Figure 3: Circuit diagram of ABCD Kapton hybrid (version 3), bottom-side hybrid

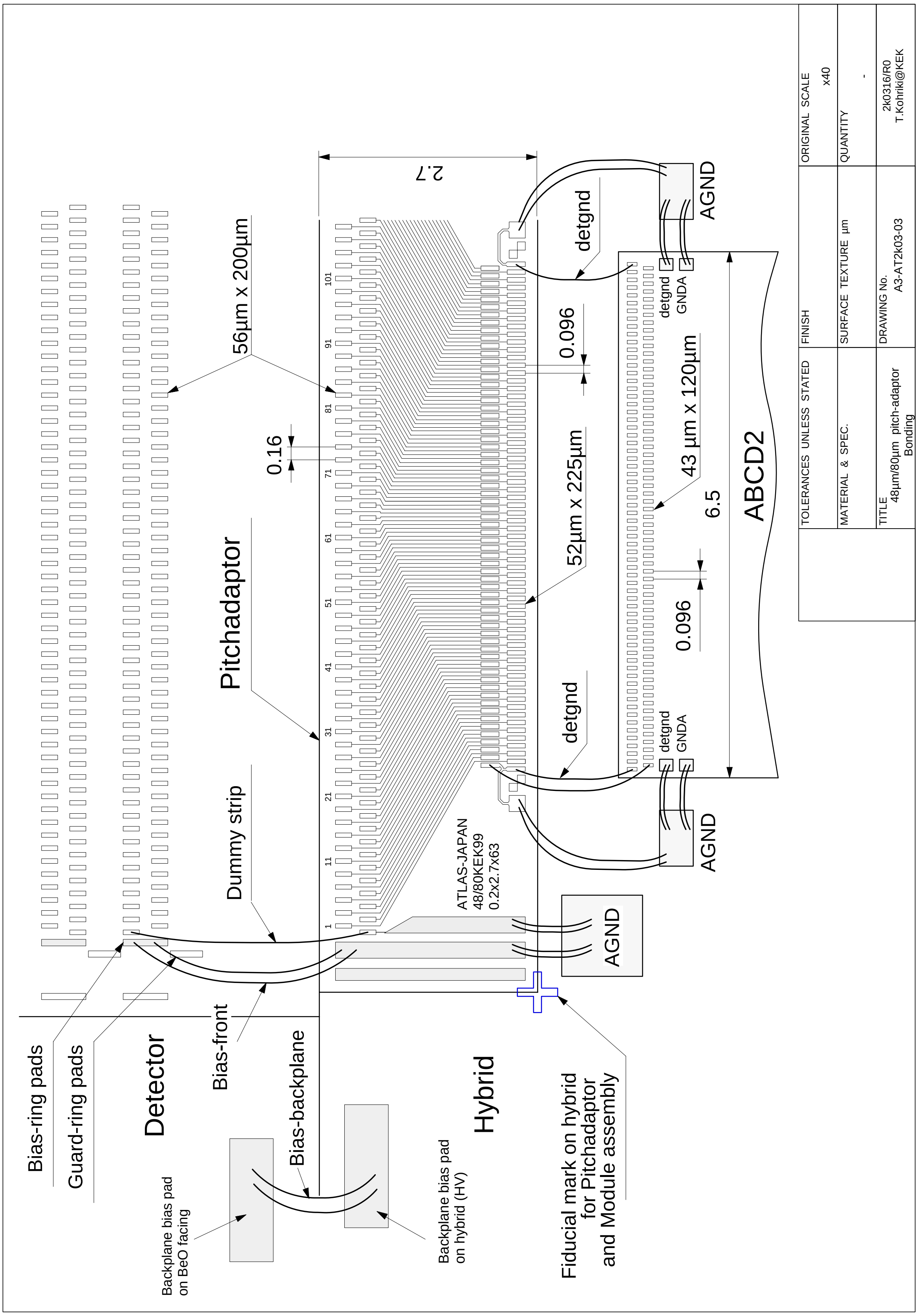

Figure 4: Glass pitch-adaptor of ABCD Kapton hybrid

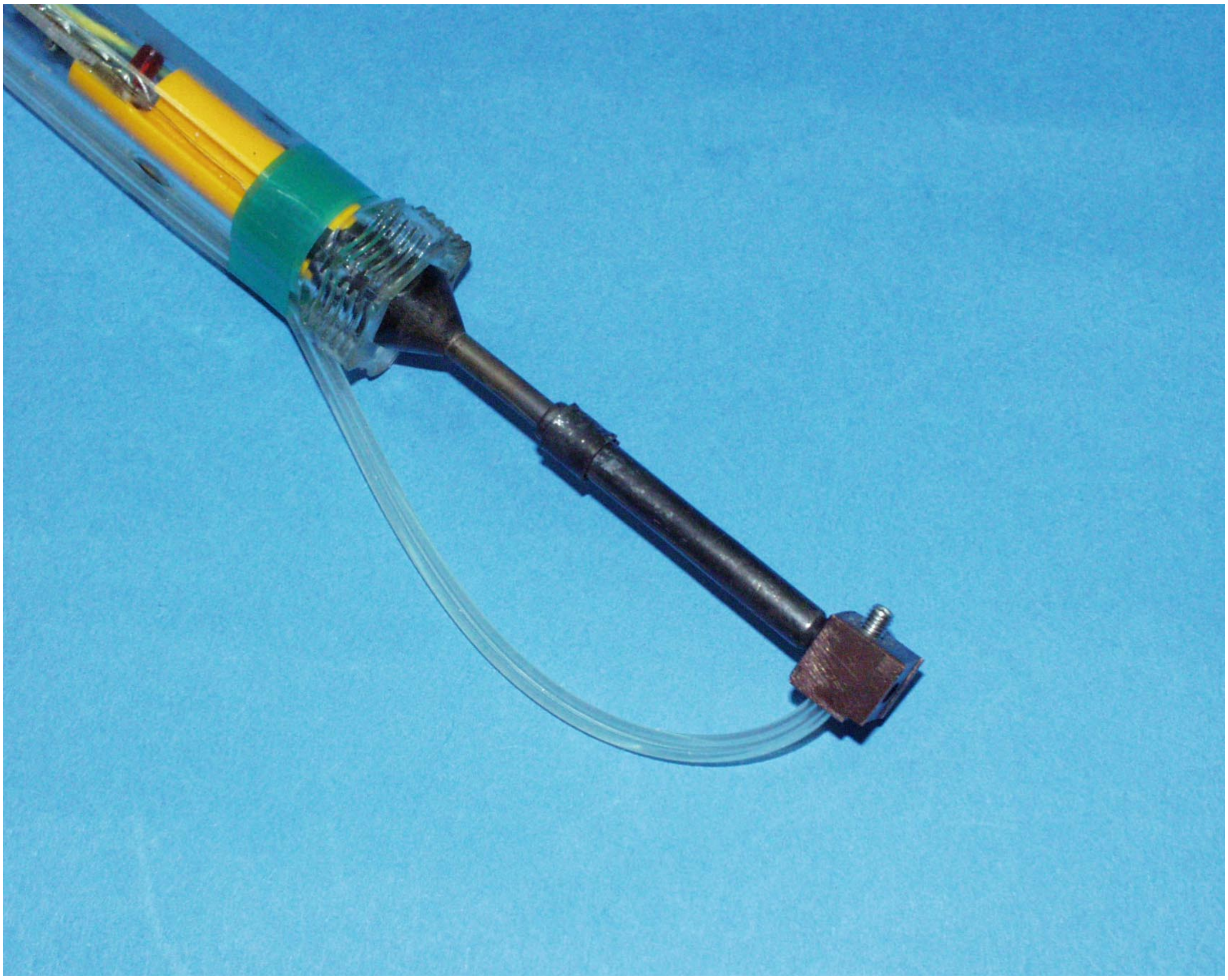

Figure 5: An IC heating and picking-up jig