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RICH System

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Titolo : *Title :*	ECAL HEATERS AND THERMOSTATS INTEGRATION DESCRIPTION				

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1. ACRONYMS

AMS: Alpha Magnetic Spectrometer

ISS : International Space Station

PMT: Photo Multiplier Tube

RICH : Ring Imaging Cherenkov Counter

EM : Engineering Model

FM : Flight Model

PA : PRODUCT ASSURANCE

PDS: Power Distribution System

PI : Principal Investigator

TOF: Time Of Flight

USS: Unique Support Structure

2. APPLICABLE DOCUMENT

AD	Doc. Number	Issue	Date	Title/Applicability
1	AMS02-TN-CGS-007	2	16/10/2006	AMS-02 120VDC AND 28 VDC HEATER DESCRIPTION
2	AMS02-TN-CGS-004	5	02/03/2005	PRELIMINARY THERMAL REQUIREMENTS FOR AMS02 INTERNAL INTERFACES
3	RICSYS-RP-CGS-020	1	15/01/2007	ECAL Thermal control system design report

3. REFERENCE DOCUMENT

RD	Doc. Number	Issue	Date	Title/Applicability

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4. SCOPE

The scope of this document is to provide the required information to install the ECAL heaters and thermostats according to the applicable documents.

5. ECAL HEATERS AND THERMOSTATS DESCRIPTION

ECAL is equipped by 16 Kapton foil heaters glued on the 4 radiators. The ECAL heaters are double-layer type and the two layers of each heater are supplied by line A and line B of the PDS respectively.
Heater operation are controlled by means of PDS switch and 4 mechanical thermostats for each of the two PDS bus. Heater schematics is provided hereafter:

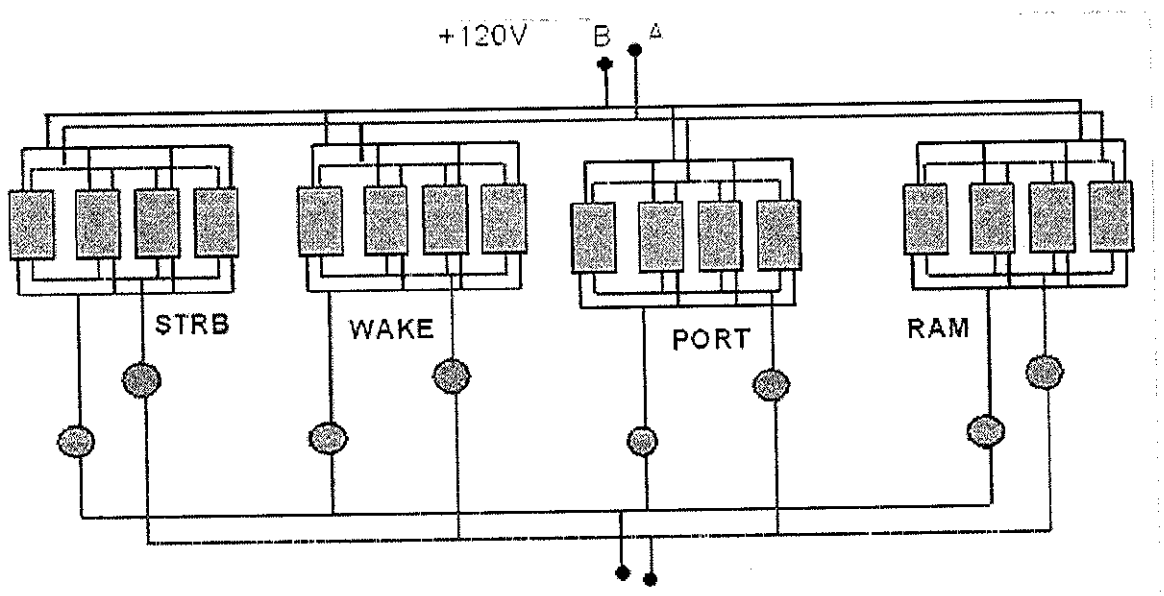

Figure 5-1: RICH heaters and thermostats schematics

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6. HEATERS INTEGRATION

6.1 INTEGRATION POSITION

The following picture shows heater position on the 4 ECAL radiators.
All the 16 heaters are equal.
Each radiator hosts 4 heater patches, on the inclined aluminium panels, at the four corners of the radiators, according to the following figure:

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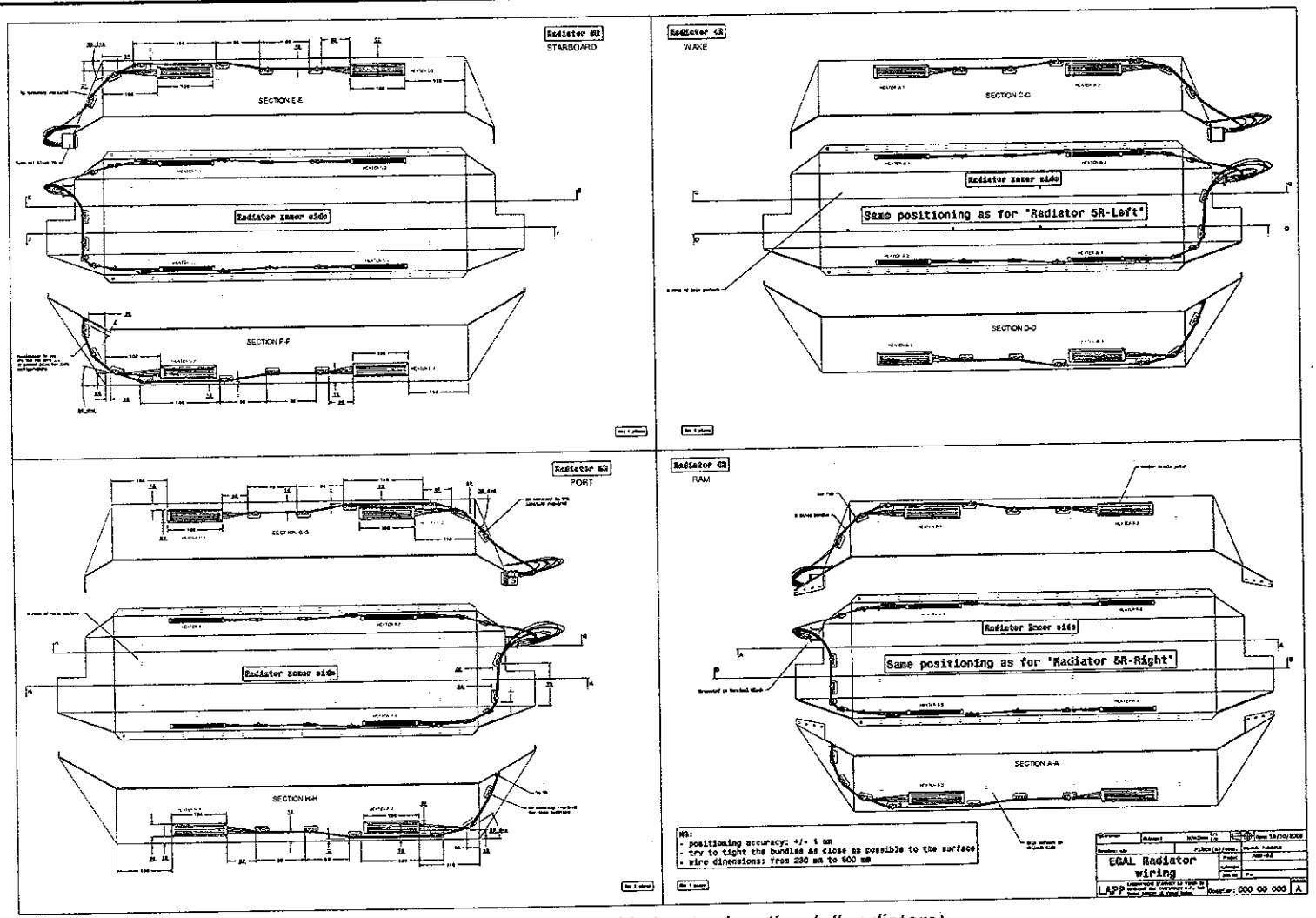

Figure 6-1: *ECAL 120Vdc heater location (all radiators)*

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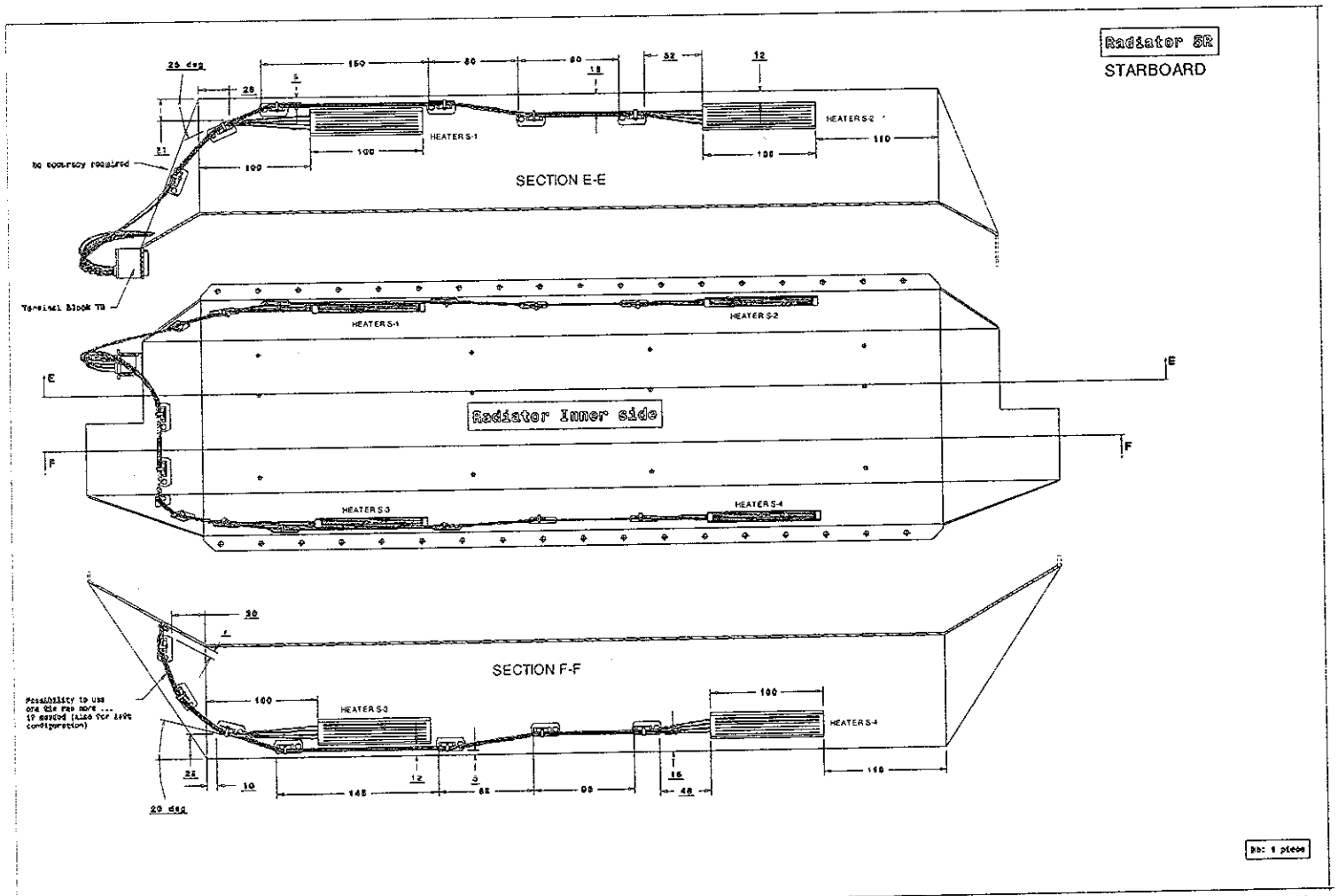

Figure 6-2: *ECAL 120Vdc heater location (detail of starboard radiator. – the heaters position is identical on all the radiators)*

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The following table summarizes the information related to the heaters used at RICH level:

PDS bus	PDS line	Patch Heater power @ at 113Vdc, W	Patch Heater resistance, Ω	Number of patches	Patch dimensions, mm	Power density @ 126.5Vdc, W/cm2	Total power consumption @ 113Vdc, W
A	1	4.375	2919	16	100x40	0.137	4.375 x 16 = 70W
B	1	4.375	2919	16	100x40	0.137	4.375 x 16 = 70W

Table 6-1 *ECAL 120Vdc heaters. A patch contains both bus A and bus B circuits.*

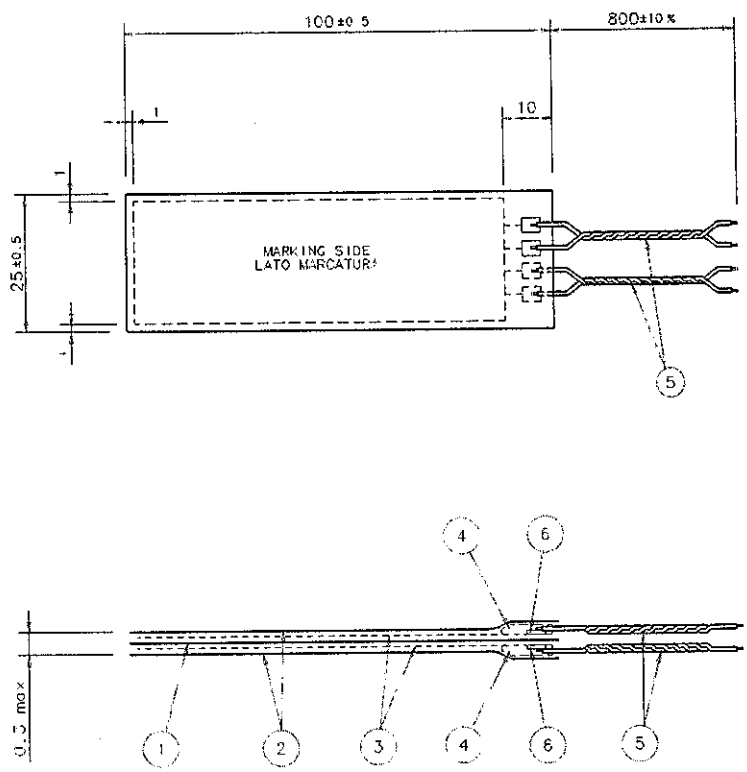

Figure 6-3: *ECAL 120Vdc heater*

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6.2 GLUING SEQUENCE

Haters patches are provided with a self-adhesive side.

01 Clean the areas dedicated to heaters with isopropyl alcohol and wait for complete evaporation.
Always use gloves (no latex, but cotton gloves)

02 Make a dry test, positioning the heaters in the foreseen position, marking with a pen the corners and some reference points to help during the gluing phase

03 Remove the protection paper from the heaters and bond it on the structure surface with care.
During this operation, avoid trapping air bubbles.
Start from one of the short edge, gluing from that edge towards the opposite one

04 Fix the corners of the heaters, the cables area and the 4 edges (one drop every 3-5 cm) with drops of EC 2216 A/B adhesive (see following example image).

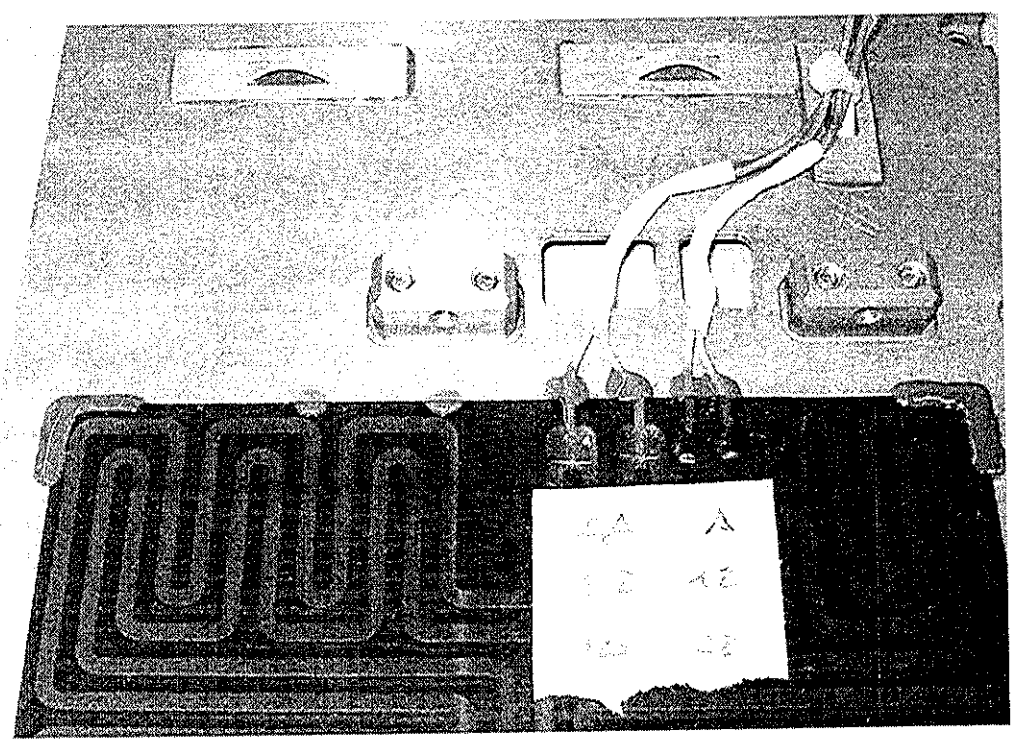

Figure 6-4: heaters gluing example

05 Wait for curing time according to supplier data sheet

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6.3 LABELLING

Each heater has two twisted pairs cables, and therefore has 4 flying leads.

Each flying lead shall be equipped with a label, in order to uniquely identify it. The labelling scheme shall be as follows:

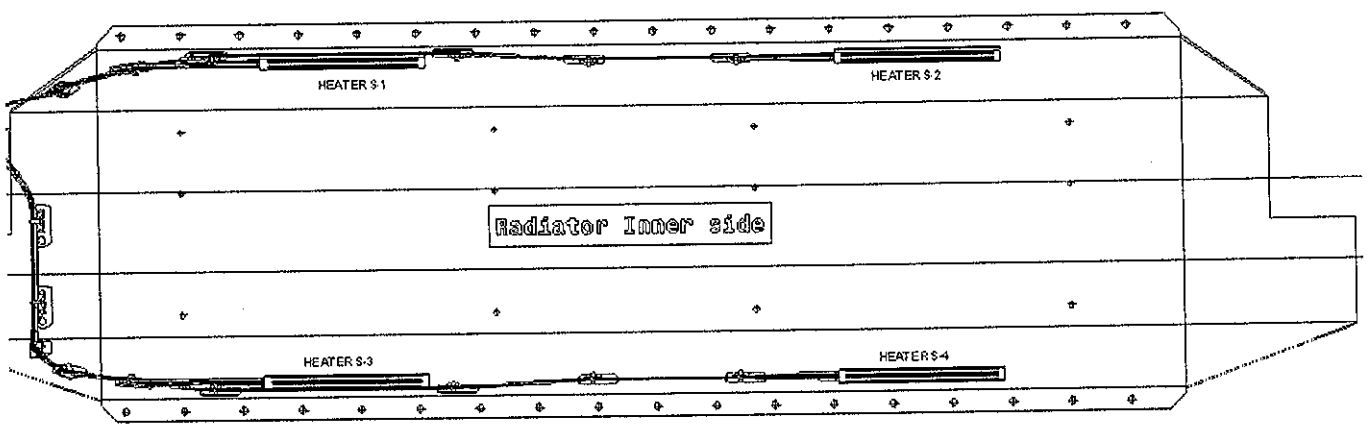
Label content: **X-n-Y-z**

Where:
X is a code identifying the radiator, according to the following table:

XX	Description	Position w.r.t. AMS & RICH axis
S	Starboard side radiator	–X
W	Wake side radiator	+Y
P	Port side radiator	+X
R	Ram side radiator	–Y

Table 6-2 *ECAL directions nomenclature.*

n indicates the heater patch number within the same radiator. Patches are numbered from **1** to **4**. The numbering of the patches is arbitrary, since the 4 heater patches are equivalent. The conventional numbering is the following: when looking at the internal side of the radiator, the upper left is the patch number one, the upper right the number 2, the lower left is number 3 and the lower right is number 4. (see the example below for the starboard radiator heaters).



Y indicates the bus, and its values are **A** or **B**.
The cables belonging to the same twisted pair shall have the same bus letter. Two twisted pairs of the same heater patch shall have of course different bus letters. The choice of which twisted pair is **A** or **B** is arbitrary, being the two circuits equivalent.

z serves to discriminate the wires in each twisted pair, and takes the two values **p** and **m**. Once again, the choice of which flying lead is **p** or **m** is arbitrary, being the circuit a simple electrical resistance.

An example of the label names for an heater is given in the figure below.

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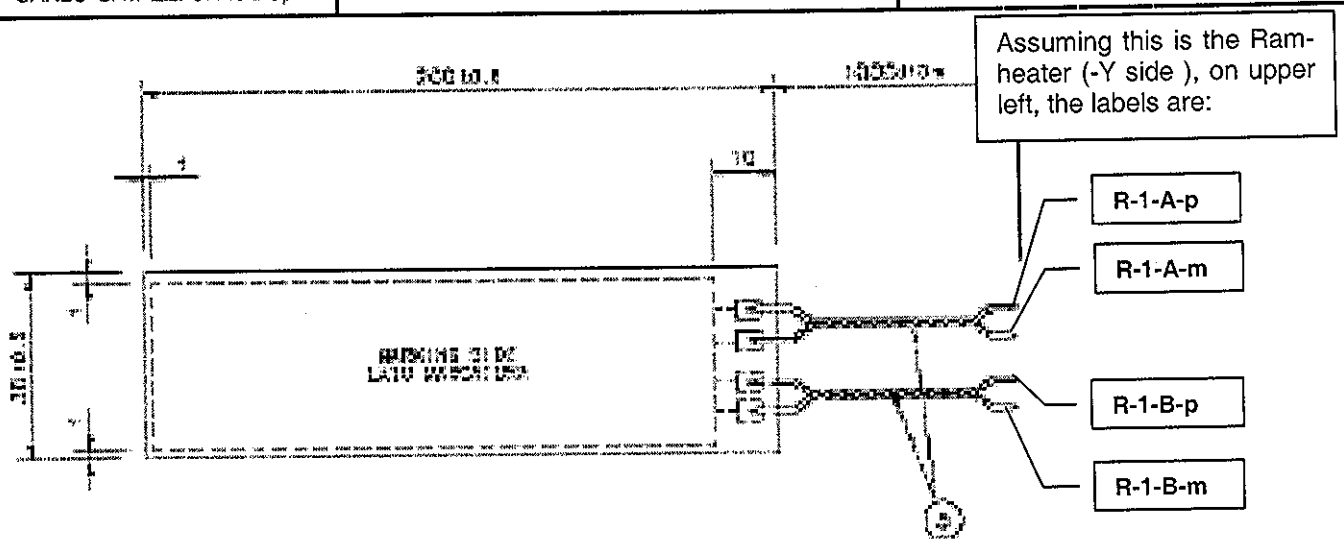

Figure 6-5: Example of labels content for an heater (specifically, the Ram one, upper left)

The complete list of labels then becomes:

#	LABEL	ECAL Side	Position on radiator	Bus (twisted pair)	polarity
1	R-1-A-p	RAM	Upper left	A	+
2	R-1-A-m	RAM	Upper left	A	-
3	R-1-B-p	RAM	Upper left	B	+
4	R-1-B-m	RAM	Upper left	B	-
5	R-2-A-p	RAM	Upper right	A	+
6	R-2-A-m	RAM	Upper right	A	-
7	R-2-B-p	RAM	Upper right	B	+
8	R-2-B-m	RAM	Upper right	B	-
9	R-3-A-p	RAM	Lower left	A	+
10	R-3-A-m	RAM	Lower left	A	-
11	R-3-B-p	RAM	Lower left	B	+
12	R-3-B-m	RAM	Lower left	B	-
13	R-4-A-p	RAM	Lower right	A	+
14	R-4-A-m	RAM	Lower right	A	-
15	R-4-B-p	RAM	Lower right	B	+
16	R-4-B-m	RAM	Lower right	B	-
17	W-1-A-p	WAKE	Upper left	A	+
18	W-1-A-m	WAKE	Upper left	A	-
19	W-1-B-p	WAKE	Upper left	B	+
20	W-1-B-m	WAKE	Upper left	B	-
21	W-2-A-p	WAKE	Upper right	A	+
22	W-2-A-m	WAKE	Upper right	A	-
23	W-2-B-p	WAKE	Upper right	B	+
24	W-2-B-m	WAKE	Upper right	B	-
25	W-3-A-p	WAKE	Lower left	A	+
26	W-3-A-m	WAKE	Lower left	A	-
27	W-3-B-p	WAKE	Lower left	B	+

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#	LABEL	ECAL Side	Position on radiator	Bus (twisted pair)	polarity
28	W-3-B-m	WAKE	Lower left	B	-
29	W-4-A-p	WAKE	Lower right	A	+
30	W-4-A-m	WAKE	Lower right	A	-
31	W-4-B-p	WAKE	Lower right	B	+
32	W-4-B-m	WAKE	Lower right	B	-
33	P-1-A-p	PORT	Upper left	A	+
34	P-1-A-m	PORT	Upper left	A	-
35	P-1-B-p	PORT	Upper left	B	+
36	P-1-B-m	PORT	Upper left	B	-
37	P-2-A-p	PORT	Upper right	A	+
38	P-2-A-m	PORT	Upper right	A	-
39	P-2-B-p	PORT	Upper right	B	+
40	P-2-B-m	PORT	Upper right	B	-
41	P-3-A-p	PORT	Lower left	A	+
42	P-3-A-m	PORT	Lower left	A	-
43	P-3-B-p	PORT	Lower left	B	+
44	P-3-B-m	PORT	Lower left	B	-
45	P-4-A-p	PORT	Lower right	A	+
46	P-4-A-m	PORT	Lower right	A	-
47	P-4-B-p	PORT	Lower right	B	+
48	P-4-B-m	PORT	Lower right	B	-
49	S-1-A-p	STARBOARD	Upper left	A	+
50	S-1-A-m	STARBOARD	Upper left	A	-
51	S-1-B-p	STARBOARD	Upper left	B	+
52	S-1-B-m	STARBOARD	Upper left	B	-
53	S-2-A-p	STARBOARD	Upper right	A	+
54	S-2-A-m	STARBOARD	Upper right	A	-
55	S-2-B-p	STARBOARD	Upper right	B	+
56	S-2-B-m	STARBOARD	Upper right	B	-
57	S-3-A-p	STARBOARD	Lower left	A	+
58	S-3-A-m	STARBOARD	Lower left	A	-
59	S-3-B-p	STARBOARD	Lower left	B	+
60	S-3-B-m	STARBOARD	Lower left	B	-
61	S-4-A-p	STARBOARD	Lower right	A	+
62	S-4-A-m	STARBOARD	Lower right	A	-
63	S-4-B-p	STARBOARD	Lower right	B	+
64	S-4-B-m	STARBOARD	Lower right	B	-

Table 6-3 *ECAL heaters label list*

6.4 LABELLING SEQUENCE

Labels shall be made of Kapton tape

Labels shall serve to identify the flying leads, but are not flight hardware.
Therefore, the labels must be removed before final installation by the AMS integrator responsible.

As a consequence, the labels can be realized with a folded Kapton tape, containing a piece of paper

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The label shall be hand-written on the paper. The Kapton tape shall be folded over the paper on both sides, enveloping it The non-perfectly overlapped kapton rims shall be cut. **Particular care shall be paid not to damage the wire.**

Conside the next scheme as a reference:

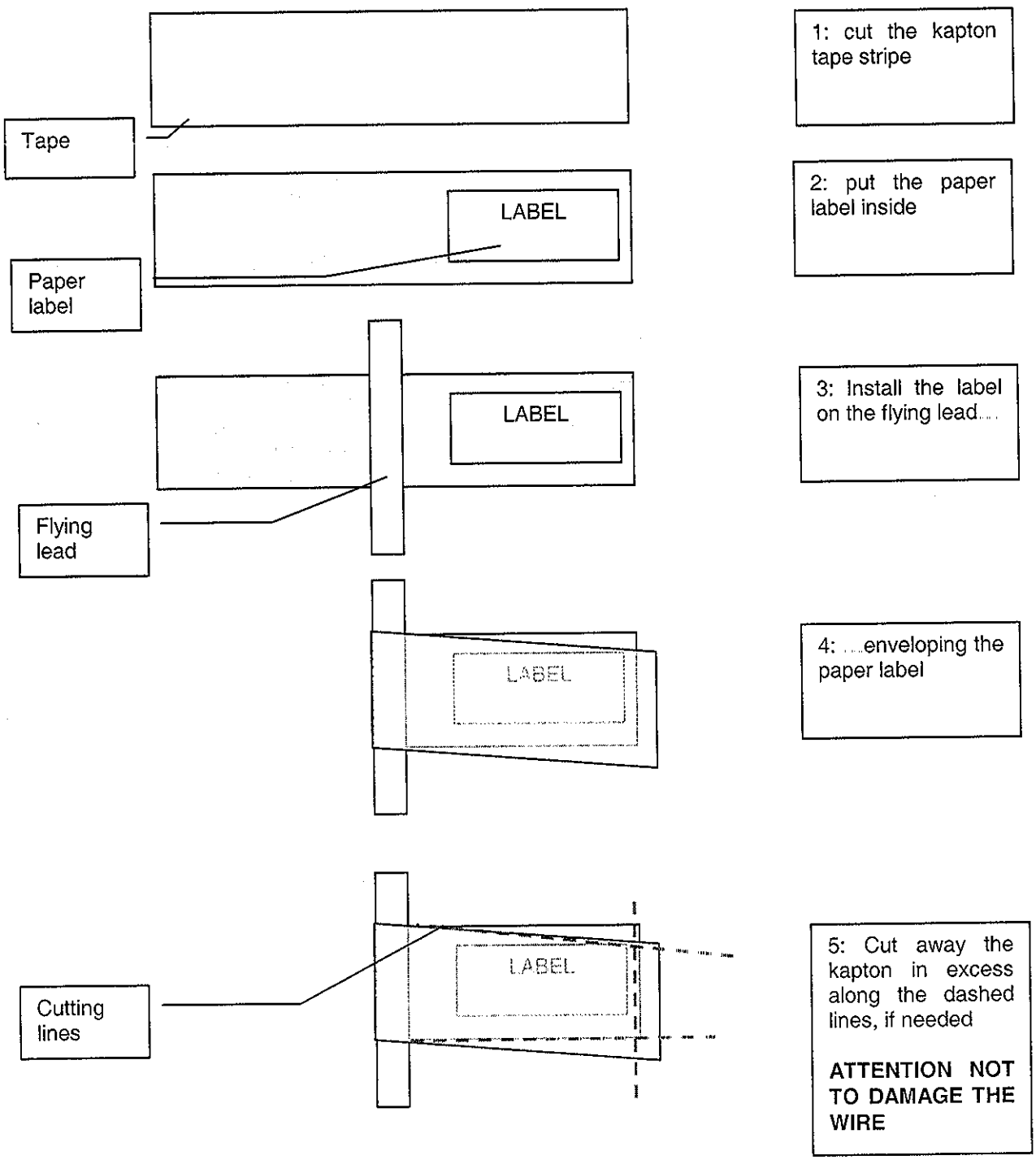

*Figure 6-6: Labeling sequence (not flight labels, **remove before flight!**)*

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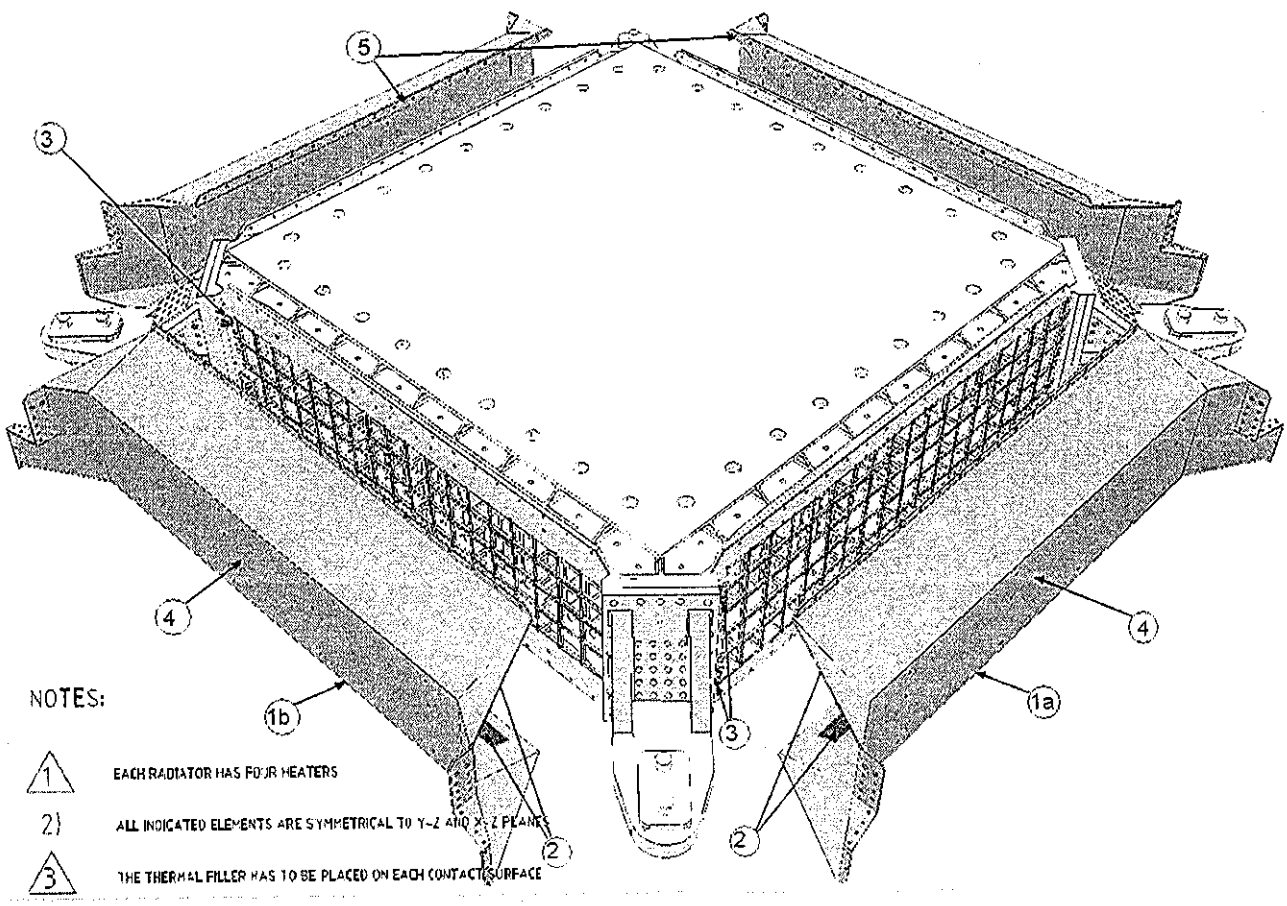
7. THERMOSTATS INTEGRATION

7.1 INTEGRATION POSITION

The eight thermostats are mounted on the 4 back panels, 2 per back panel, as shown in the following figures.
Each thermostats (in each pair) controls 4 heaters in parallel (see figure 5-1). The 4 patches controlled by the heater are the ones on the radiator covering the back panel side.
ECAL back panels are equal in couples, and are of 2 kinds: 4-rows and 5-rows panels, according to the number of PMT rows that each panel is hosting



ITEM	DESCRIPTION	P/N-ID CODE	QTY
5	THERMAL FILLER	62-10-0909-A274	A.R
4	RADIATOR TAPE - EMBOSSED TEFLON	167149-001	A R
3	THERMOSTAT	7015-01A0011/3/3/7	8
2	HEATER	R0632	16
1b	ECAL RADIATOR 4R	11-RICSYS-20.001	2
1a	ECAL RADIATOR 5R	11-RICSYS-20.002	2

Figure 7-1: Assembly drawings of ECAL TCS Heaters are labeled with (3), and are in red in the figure (only 3 out of 8 in total are visible)

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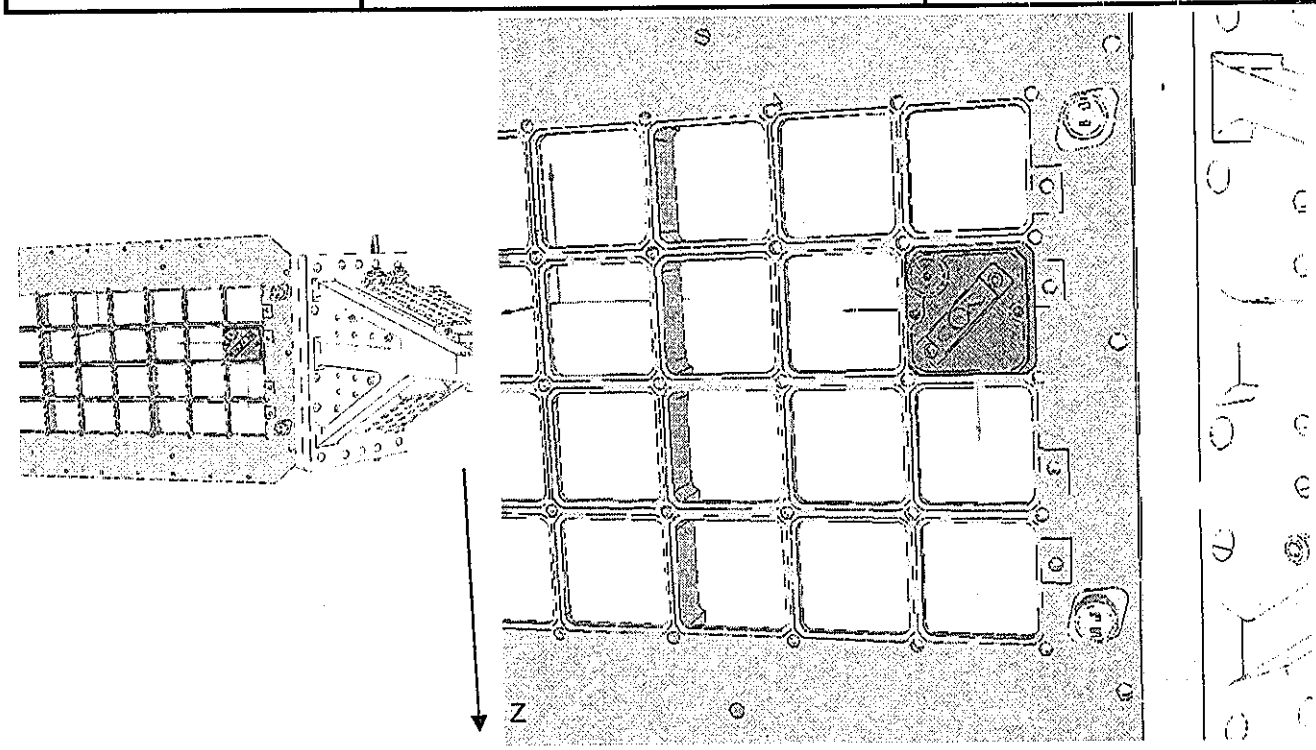

Figure 7-2: ECAL thermostats location (green), on the 4-PMT rows back panels (pink). Mounting bracket is indicated in yellow. Please note that Z axis is pointing downwards in the figure

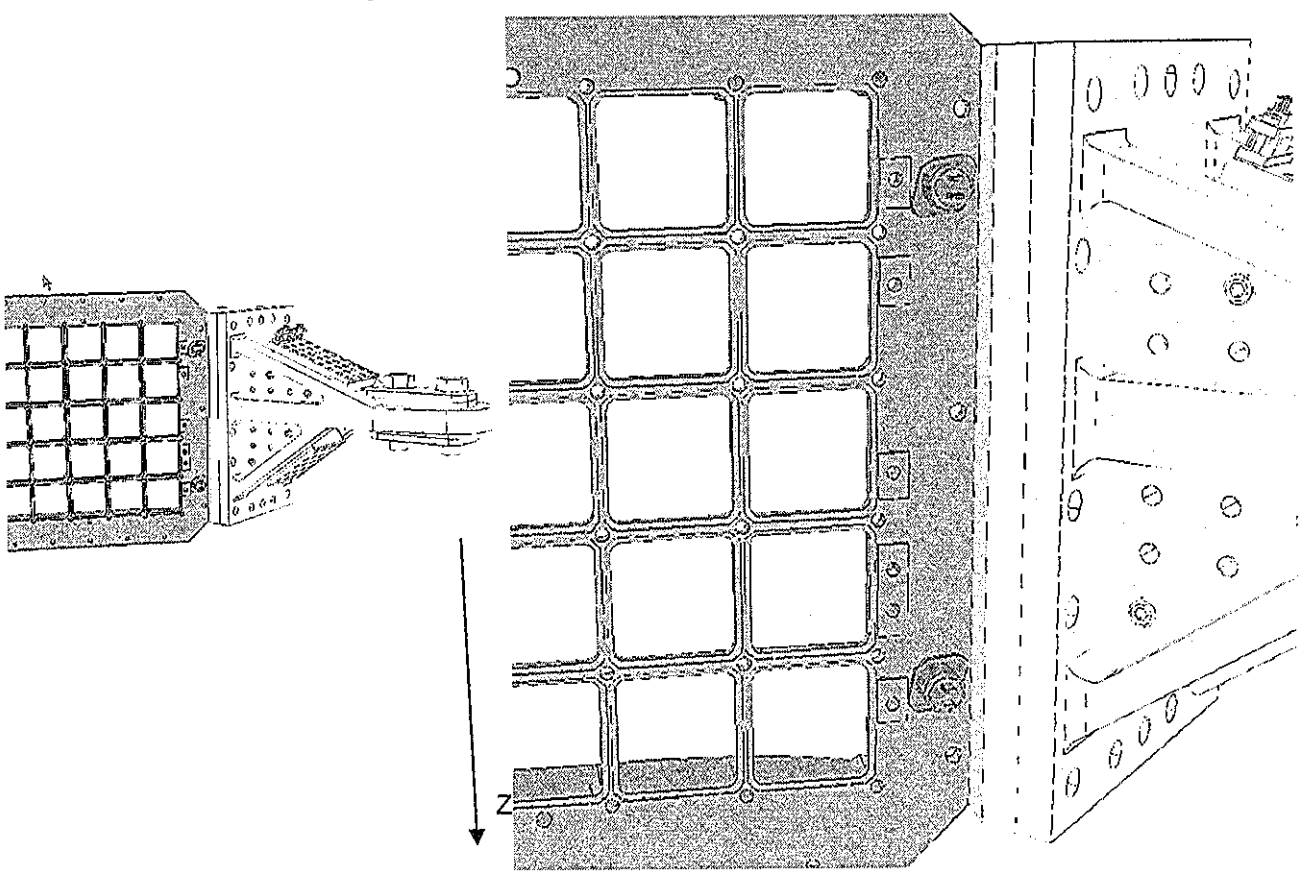

Figure 7-3: ECAL thermostats location (red), on the 5-PMT rows back panels (green). Mounting bracket is indicated in yellow. Please note that Z axis is pointing downwards in the figure

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7.2 GLUING SEQUENCE

02 Clean the areas dedicated to thermostats with isopropyl alcohol and wait for complete evaporation.
Always use gloves

03 Mask the areas dedicated to the thermostats using a Kapton tape

04 Grind the aforementioned area with sand paper 600 or a proper tool; clean after grinding with isopropyl alcohol and wait for complete evaporation.

05 Grind the thermostat area dedicated to the gluing with sand paper 600; clean after grinding with isopropyl alcohol and wait for complete evaporation.

06 Put a proper quantity of ECCOBOND 285 on both thermostats and area where it has to be glued.

07 Apply an extra quantity of glue all around the thermostat in order to make a meniscus between the thermostat and the gluing surface (see following example image).

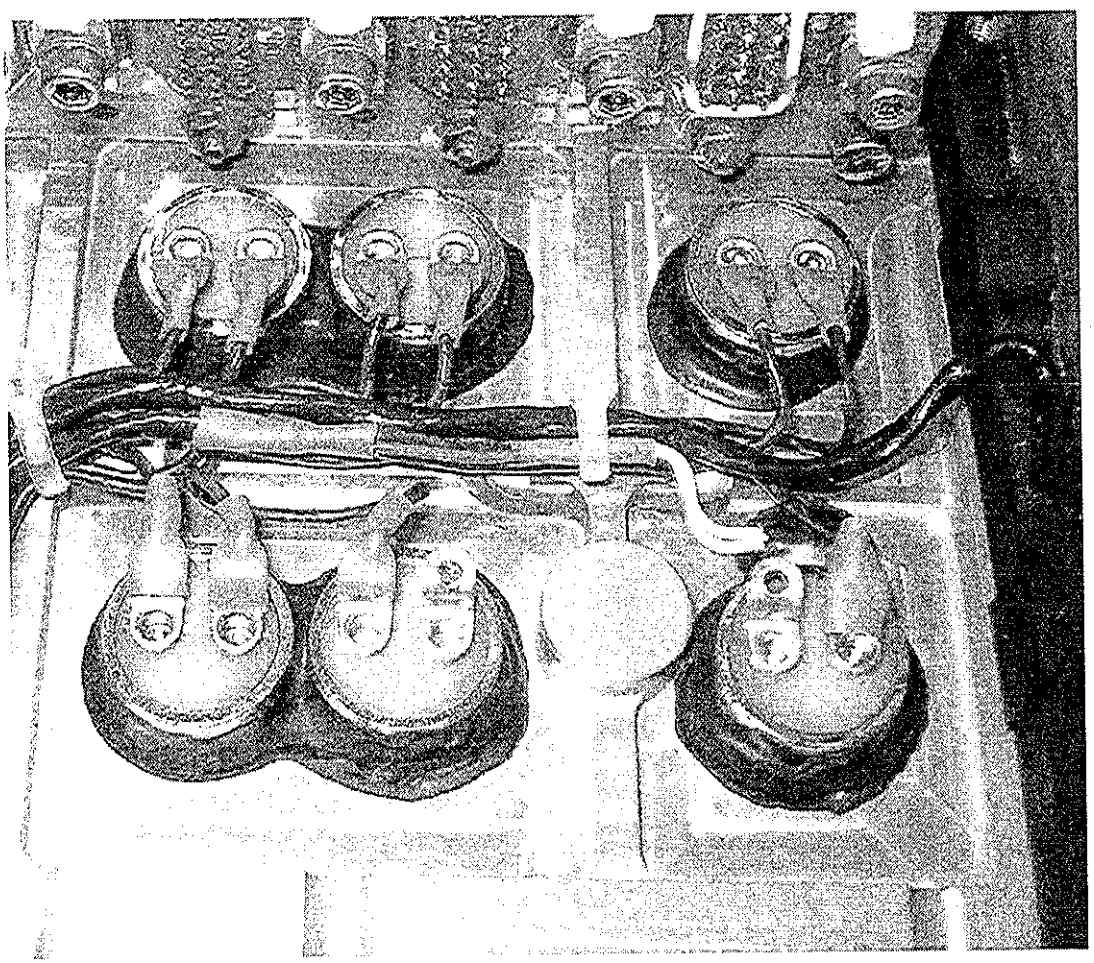

Figure 7-4: thermostats gluing example

07 Wait for curing time according to supplier data sheet

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7.3 LABELLING

Each thermostats shall have 2 flying leads, already soldered prior to the shipment.

The flying leads of each thermostat are different, one being 2 meters long, the other is 4 meters long. Thermostats are shipped without labeling, and the appropriate labels shall applied during integration.

The labelling shall be as follows: **TXZY** ,

X = **A** or **B** is the bus. Both flying leads of a thermostats have the same bus label. Thermostats on the same back panel belong to different busses. The choice of which thermostat is **A** and **B** is arbitrary. By convention, the upper thermostat shall be labeled as **A** and the lower one shall be labeled **B**.

Y = **+** or **2** identifies the short or long wire of each thermostat. The thermostat long wire (4 meters) shall have the **2** label, the shorter (2 meters) shall have the **+** label.

Y = **P**,**R**,**W** or **S** identifies the back panel side, namely Port (+X), Ram (-Y), Wake (+Y) or Starboard (-X) sides.

An example for the two thermostats on one side (starboard) is shown below

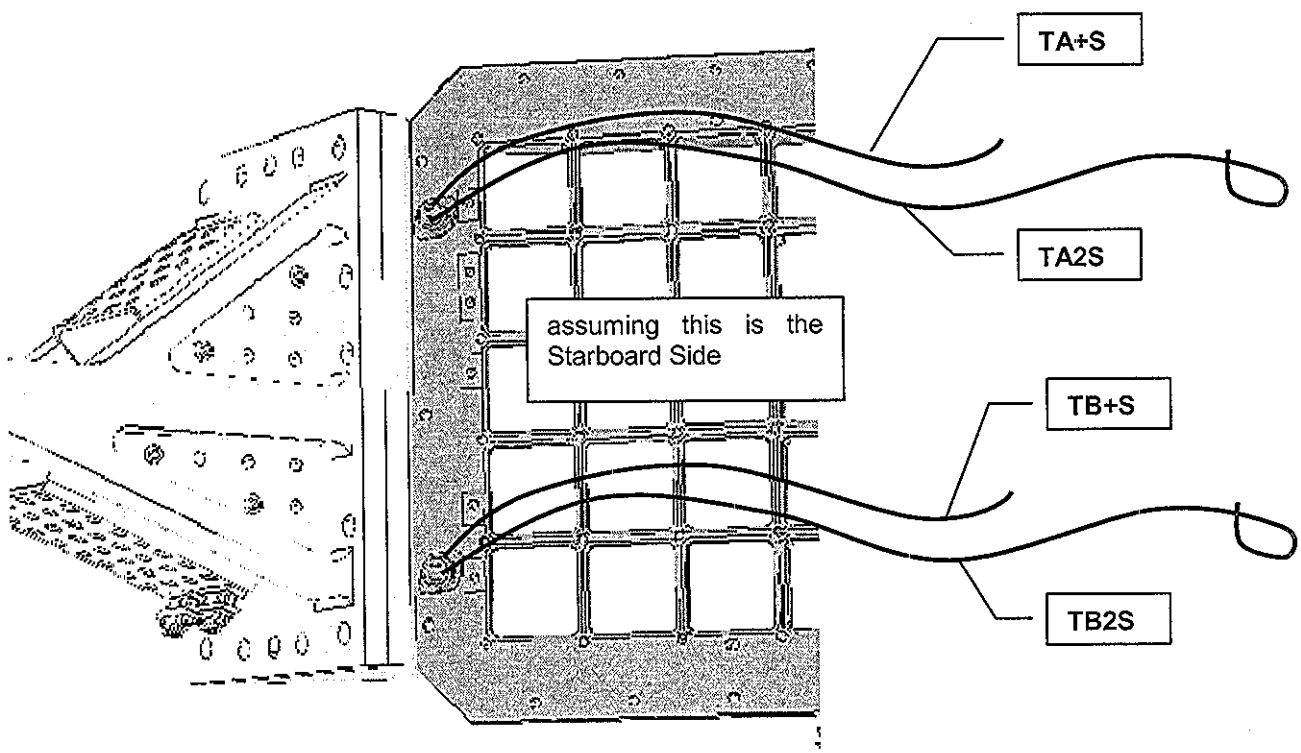

Figure 7-5: Thermostats label example for the starboard (S) side.

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The 16 thermostats wires are therefore labeled as follows:

#	LABEL	ECAL Side	Position on back panel	Bus	Wire lenght
1	TA2R	RAM	Upper	A	Long
2	TA+R	RAM	Upper	A	Short
3	TB2R	RAM	Lower	B	Long
4	TB+R	RAM	Lower	B	Short
5	TA2W	WAKE	Upper	A	Long
6	TA+W	WAKE	Upper	A	Short
7	TB2W	WAKE	Lower	B	Long
8	TB+W	WAKE	Lower	B	Short
9	TA2P	PORT	Upper	A	Long
10	TA+P	PORT	Upper	A	Short
11	TB2P	PORT	Lower	B	Long
12	TB+P	PORT	Lower	B	Short
13	TA2S	STARBOARD	Upper	A	Long
14	TA+S	STARBOARD	Upper	A	Short
15	TB2S	STARBOARD	Lower	B	Long
16	TB+S	STARBOARD	Lower	B	Short

Table 7-1 *ECAL thermostats label list.*

7.4 LABELLING SEQUENCE

For labeling, consider the procedure as per section 6.4.

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8. SILVER TEFLON TAPE INTEGRATION

Silver Teflon Tape is to be installed on the external side of each radiator.
The tape surface has to be maximized To avoid risk of tape superposition, the tape stripes shall be separated by a distance at the edges larger than 1 mm and lower than
The tape shall have cut-outs in correspondence of the radiators holes for the EIB and for the harness sustain structures.

Tape comes in form of rolls, 2 inches wide. Holes and cutouts shall be done prior to integration.

Tape with pressure sensitive adhesive (PSA) bonds best to clean, dry surfaces. Typical surface cleaning solvents include an isopropyl alcohol/water mixture and heptane. Follow the solvent manufacturer's precautionary warnings and suggested handling procedures.

Bond strength depends on the amount of adhesive to surface contact developed. Firm application pressure develops better adhesive contact and thus improves bond strength. After application the bond strength will increase as the adhesive flows onto the surface.

At room temperature approximately 50% of the ultimate bond strength will be achieved after 20 minutes, 90% after 24 hours, and 100% after 72 hours.

The ideal temperature range for applying tapes is 70°F to 100°F (21°C to 39°C). Initial tape application to surfaces at temperatures below 50°F (10°C) is not recommended because the adhesive becomes too firm to adhere readily. However, once properly applied, low temperature holding is generally satisfactory

8.1 SILVER TEFLON TAPE INSTALLATION SEQUENCE

Silver Teflon tape is provided with a self-adhesive side.

01 Clean the areas dedicated to tape with isopropyl alcohol and wait for complete evaporation.
Always use gloves (no latex, but cotton gloves)

02 Cut the stripe with the appropriate length. In case, regulate the stripe width in accordance to mechanical constraints and to the position of the previously-installed stripes.

03 Cut the holes on the tape in correspondence of the measured positions of the radiator bolts.

04 Perform a dry-run positioning to check the correctness of the cutouts positions.

05 Remove the protection paper from the tape and bond it on the structure surface with care.
During this operation, avoid trapping air bubbles.
Start from one of the short edge, gluing from that edge towards the opposite one

06 Apply a reasonable pressure on the tape, to improve adhesion.
The pressure shall not damage the radiator, and the items mounted on it.

05 Wait for curing time according to supplier data sheet
24 hours at least to reach 90% of final bond strength.

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