HERSCHEL / PLANCK

Planck grounding diagrams
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TABLE OF CONTENTS

1. SCOPE 5

2. DOCUMENTS 6

2.1 Applicable documents 6

2.2 Reference documents 6

3. OVERVIEW OF SVM STRUCTURAL GROUND REFERENCE 7

3.1 Grounding Rails 7
3.1.1 Lower Closure Panel 9
3.1.2 Shear Webs 10
3.1.3 Upper Closure Panels 11
3.1.4 Payload Sub-platform 11

3.2 Overview of SVM-PLM Structure ground connections 12

3.3 PPLM Grounding scheme 12
3.3.1 Bonding of the cryogenic pipes 12
3.3.2 Bonding of the LFI Waveguides 13

4. ANNEX 1 – PLANCK GROUNDING DIAGRAM 15

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1. SCOPE

The purpose of a grounding diagram is to be a reference document allowing to :

- check the compliance of the design with the grounding requirements
- help to anticipate and/or solve common impedance coupling problems

The present document summarises Planck spacecraft grounding philosophy and implementation, that is driven by two specific kinds of constraints :

Thermal constraints :

Because of the high thermal decoupling required between the Service Module (SVM) were the platform electronics and the two Instruments (LFI and HFI) warm electronics are installed, and the Focal Plan Unit (FPU) were the Instrument cold sensitive electronics are set, the structure electrical continuity between SVM and FPU is limited to what is absolutely necessary, i.e. cryogenic piping, waveguides, detection chains shielding.

Instruments sensitivity :

Because of the low level low frequency analogue signals to be detected by HFI (noise level specification between detectors and Pre-Amplifier Unit : 10nV/√Hz), HFI FPU 4K and 18K enclosures are DC isolated from LFI and from the cryogenic piping.

Because of the thermal constraints leading to unusual ground reference continuity design, this document not only deals with the grounding of circuits (anyway covered on more detail in some of the Instruments documents), but also with the bonding of structure parts.

A detailed (A2+) grounding diagram showing the SVM and the two Instruments electronics is given in annex 1.

This document presents the methods by which the grounding scheme presented in annex 1 is physically realised on the Planck spacecraft.

Please note that this document describes only the general principles applied in creating the PLANCK ground referencing network, for any specific details refer to the latest issues of the relevant reference document.

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2. DOCUMENTS

2.1 Applicable documents

[AD-1] IID Part B, HFI, SCI-PT-IIDB/HFI-0414, Issue 3.0 (draft 5)

[AD-2] IID Part B, LFI, SCI-PT-IIDB/HFI-04142, Issue 3.1

[AD-3] IID Part B, SCS, PL-LFI-PST-ID-002, Issue 3.0

[AD-4] SVM Grounding and Bonding, H-P-TN-AI-0079, Issue 1 (draft)

2.2 Reference documents

- Planck PLM Design Report, H-P-3-ASPI-RP-0050, Issue 1
- Dedicated Planck EMC WG meeting, H-P-ASPI-MN-811, 17/01/02 (for LFI grounding diagram)
- "An IC Amplifier User's Guide to Decoupling, Grounding, and Making Things Go Right for a Change", Analog Devices Application Note AN-202

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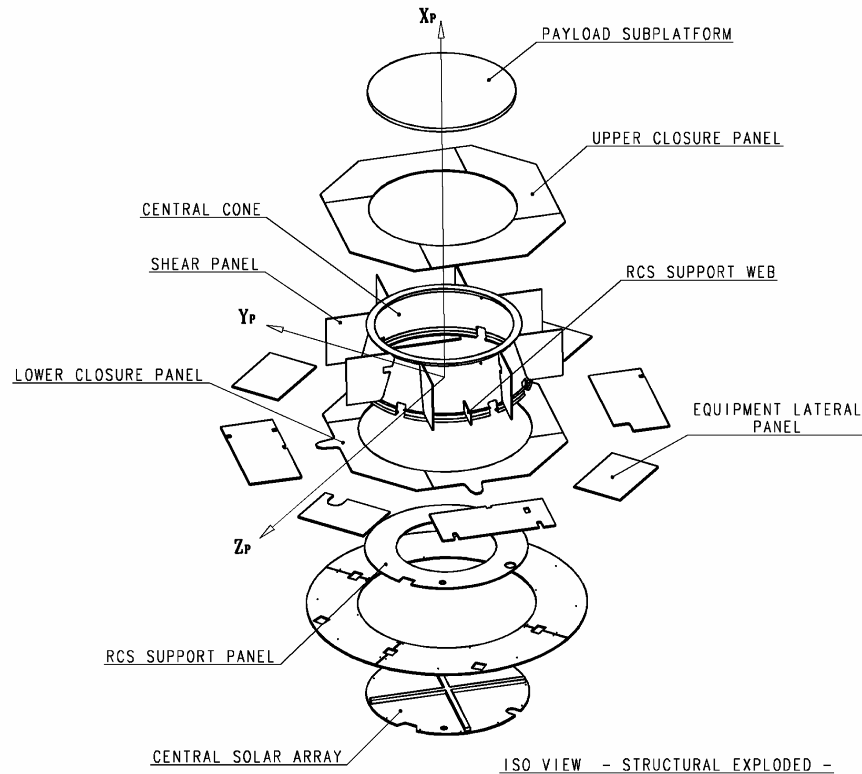
3. OVERVIEW OF SVM STRUCTURAL GROUND REFERENCE

The SVM structure consists of many component parts as indicated in the following diagram



With the exception of the equipment lateral panels (Aluminum) the SVM structure is primarily made from CRFP. The surface conductivity of the CRFP is not sufficient for electrical bonding by simply making a contact into it, this is overcome through the use of strategically placed grounding rails.

3.1 Grounding Rails

Grounding rails are selectively placed semi-rigid aluminum foils used in order to achieve the necessary bonding of the units mounted on the CRFP panels.

The grounding rails are routed as close as possible to each unit installed on the CRFP and attachment points are provided for bonding straps. For structural reasons the grounding rails do not go under any unit installed on the CRFP.

The grounding rails generally follow the harness routing and are also used for grounding of the connector brackets

The thickness of the grounding rails is 0.3mm, which is approximately equal to the skin depth of the aluminum alloy at 100kHz

The minimum width of each if the grounding rails is 3cm (in accordance with GDEL-048a)

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The surface treatment of the Aluminum grounding rails is either Alodine or nickel plating (to be agreed).

The requirement is for each bonding junction to have sufficient cross sectional area such that it can carry 150% of the unit maximal fault current. The largest electrical load installed on the PLANCK satellite is the Sorption Cooler Sub-system (SCS). The SCS is powered through 4 class III LCLs in parallel so the grounding rails are sized to carry a maximum fault current of 45A (i.e. 4*7.5*150%A). For a complete justification of this refer to [AD3].

The following sections provide a general description of the SVM ground rails together with the basic methods by which they are connected together to form a complete ground reference plane.

This section is intended to indicate the methods used, for complete definition refer to [AD3].

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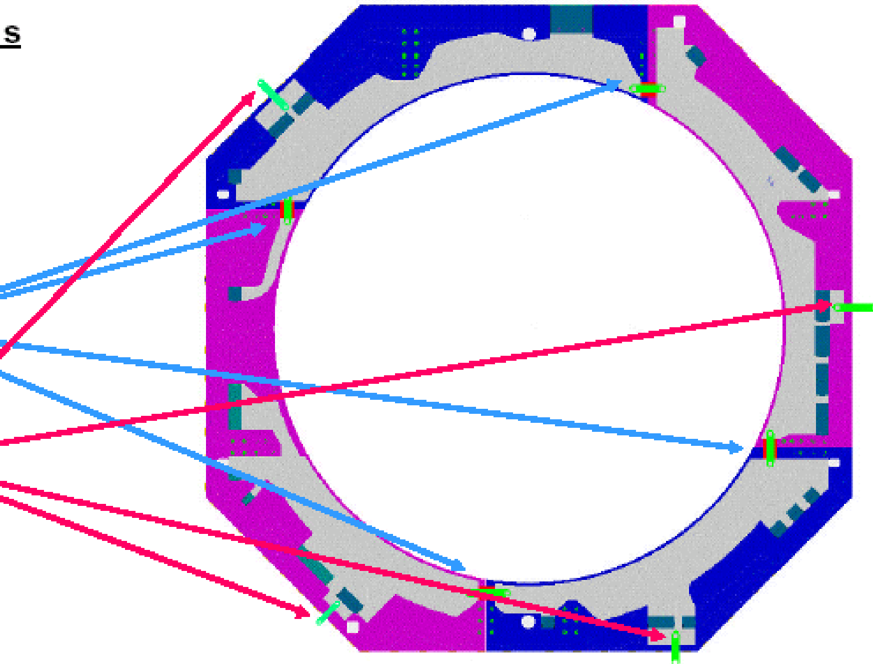
3.1.1 Lower Closure Panel

- **Grounding Rails**

•It is foreseen to install on the Lower Platform four segments (one for each panel forming the Lower Platform). Each segment is connected to the others via bonding strap.

• The entire network is bonded to the lateral aluminium panel via bonding strap.

Each independent aluminium lateral panel will require a dedicate strap for the connection with the lower Platform.



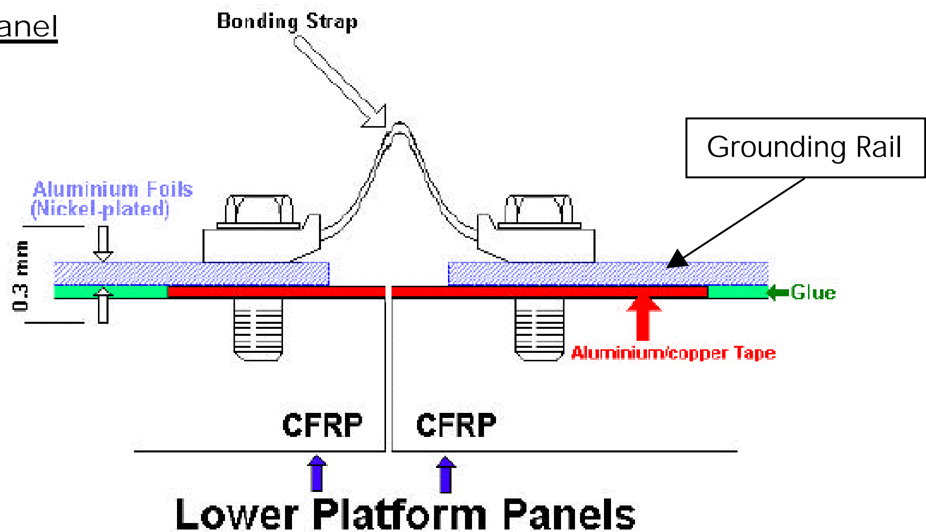
As shown in the above figure, the lower closure panel is fabricated from four separate sections. The interconnection of the grounding rails between these sections is achieved by using bonding straps, the location of which are indicated in the above Figure.

As stated earlier the lateral panels are made from Aluminum, so bonding between the discrete lateral panel sections is easily achieved through the fixtures holding one to another.

Bonding of the grounding rails on the lower closure panel to this lateral panel ring is achieved through the use of bonding straps, one strap per each independent panel section.

Bonding Strap used to interconnect the lower panel

Lower Platform Junctions



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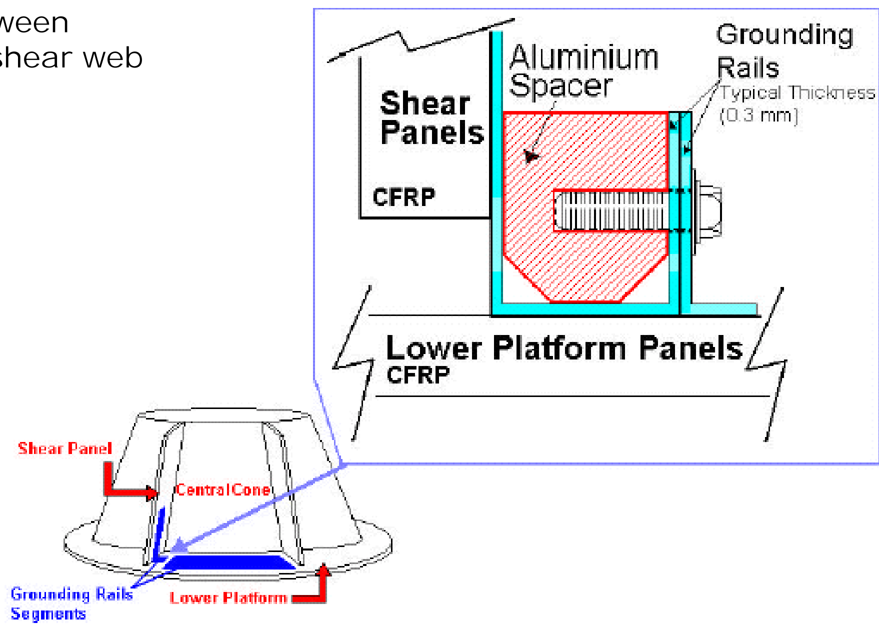
3.1.2 Shear Webs

Each of the shear webs is an independent CFPR panel and grounding rails are applied to each web in a similar way as for the lower closure panel.

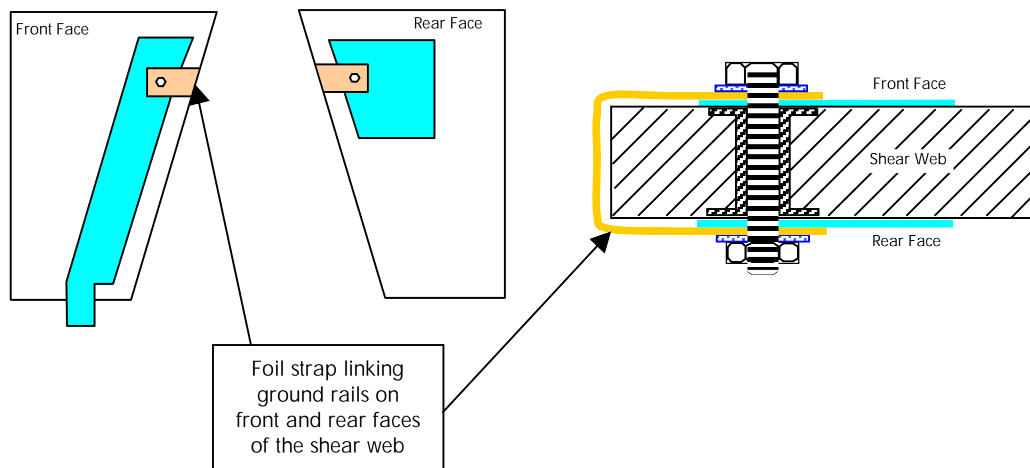
Electrical connection into the lower platform ground network is achieved through an extension of the shear web foil being bolted onto an extension of the lower platform foil via an aluminum spacer, as shown in the figure below;

Interconnection between
grounding rails on shear web

Shear Panel-Lower Platform Junctions



On shear webs where there are grounding foils required on both sides, they are interconnected by a metallic foil strap, as shown below;



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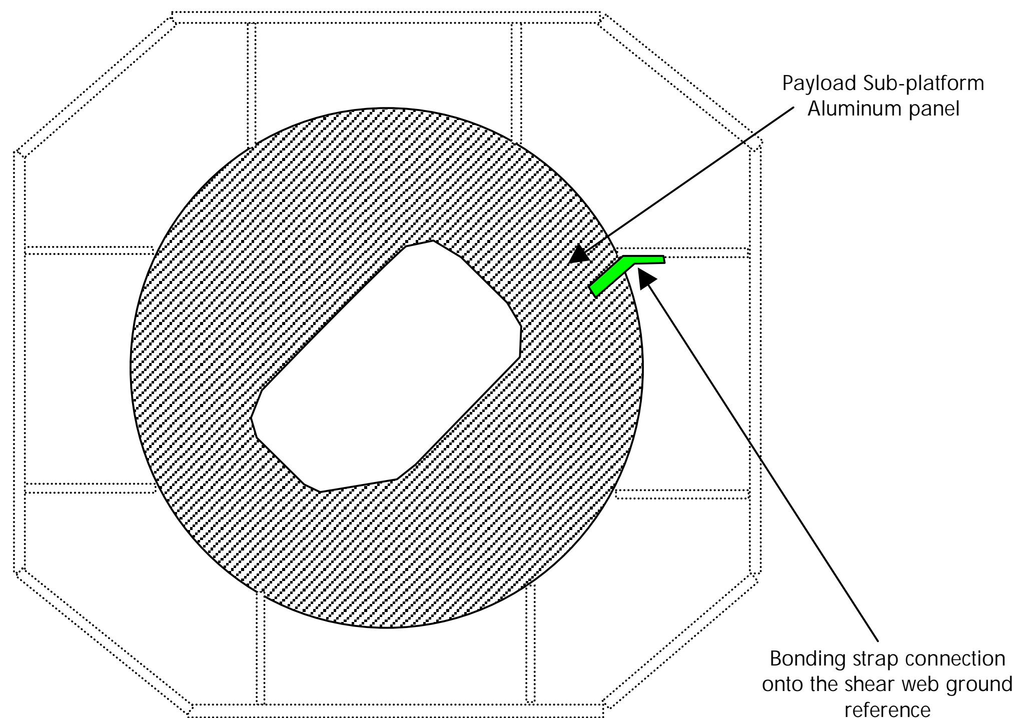
3.1.3 Upper Closure Panels

These panels are CFRP, there are no grounding rails applied

3.1.4 Payload Sub-platform

The payload sub-platform is an Aluminum panel which has several warm electronics units and the PAU-REU harness mounted onto it, therefore the SVM ground reference foils are connected onto it.

Electrical connection is made to the payload sub-platform via a 1-inch width aluminum bonding strap (equivalent cross sectional area 10.16mm²) fixed onto the SVM grounding reference at the shear web.



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3.2 Overview of SVM-PLM Structure ground connections

There is no dedicated chassis ground connection between the FPU and SVM structures.

The chassis ground connections between the PPLM and the SVM are achieved through :

- the cryogenic piping (20K, 4K and 0.1K)
- LFI waveguides from the 20 K stage to the BEM trays (themselves connected to the subplatform ground reference)
- HFI SST bellows between the 4K stage, the JFET box and the PAU (itself connected to the subplatform ground reference)
- LFI cryo-harness shielding
- HFI PAU is grounded to the subplatform for thermal dissipation purpose

3.3 PPLM Grounding scheme

The PPLM grounding figure, presented in the next section shows the following grounding features :

- Grounding of the Grooves is achieved through the cryogenic pipes and the waveguides
- Grounding of the LFI mainframe is achieved through the connections of the waveguides
- Grounding of the HFI JFET is achieved through the connection of the SST bellows at the PAU

These points are expanded below.

3.3.1 Bonding of the cryogenic pipes

- the cooler piping (20K, 4K, 0.1K) and LFI waveguides cross each one of the 3 PPLM grooves, and in each case thermal or mechanical connections are performed at the interface that result in electrical continuity
- the interface between the piping and HFI is designed so as to ensure electrical isolation between the high impedance part of HFI detection chains and the rest of the spacecraft (use of sapphire and ceramic).
- The cooler pipes are connected into the ground reference through their attachment points. In the case of the 20K pipe it is the attachment at the Sorption cooler unit, in the case of the 0,1K pipe it is the attachment at the panel mounted gas bottle. In the case of the 4K pipes there is an isolation fitted within the pipe, so for the PPLM mounted section of the pipe, grounding is achieved through the mounting/heat exchanger fitted onto groove 3 (which itself is grounded by the other pipes and the LFI waveguides). The SVM portion of the 4K pipe is grounded through its attachment onto the 4K cooler unit.

Note: the Bonding of the HFI JFET Box is achieved through the conductive bellows (SST) which connects into the ground reference at the PAU

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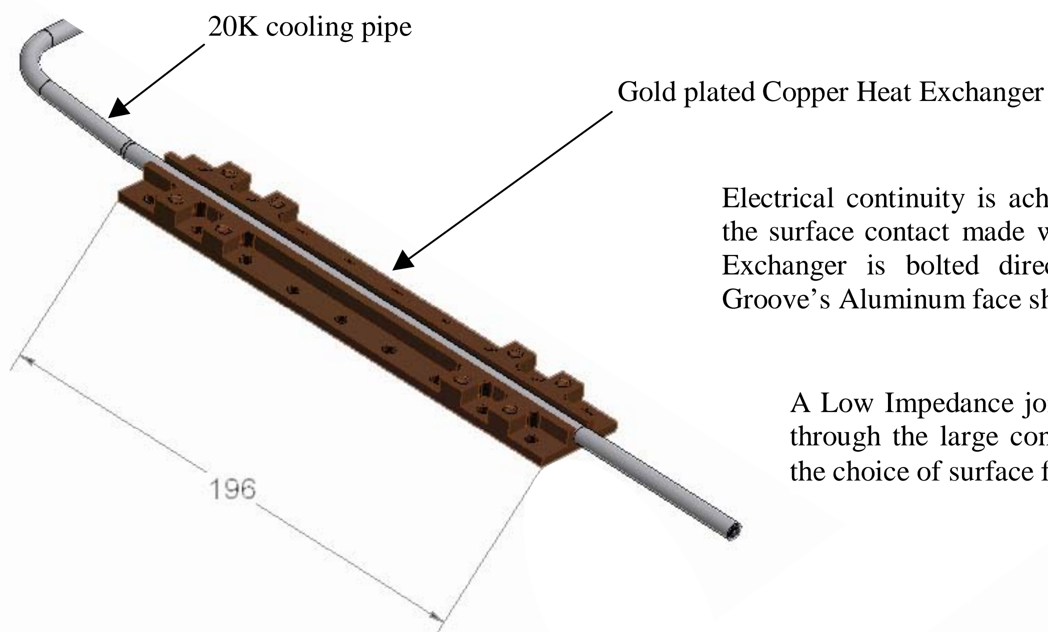
A typical interface connection between the cryogenic pipes and the grooves is shown in the figure below, for each of the pipes the heat exchanger will be sized according to the individual requirement but the principal remains valid for all.

20K coolant pipe heat exchanger



3.3.2 Bonding of the LFI Waveguides

The Waveguides provide a good ground reference for the LFI mainframe and the PPLM Grooves.

The connection between the waveguides and the grooves is formed through the use of thermal straps, these straps are fitted onto each groove and form part of the basic ground referencing of the PPLM.

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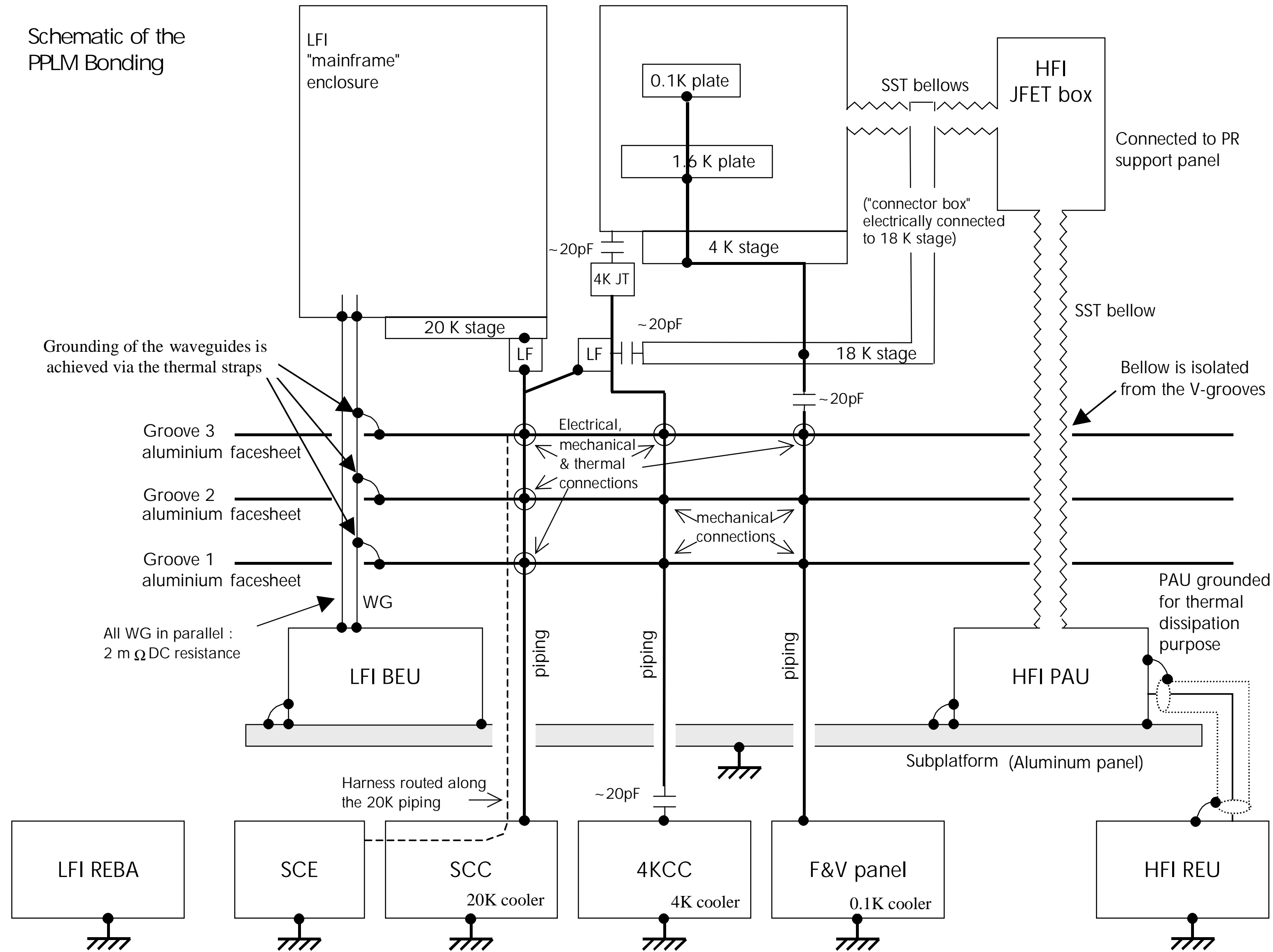
Schematic of the PPLM Bonding



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4. ANNEX 1 – PLANCK GROUNDING DIAGRAM

(Attached Visio File: Planck_grounding_diagram_1_2)

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SVM

LFI

HFI

RCS

Sep Straps

ACC

FOG Electronics

FOG Sensor

SCE

SCC

DAE POWER BOX

DAE LATERAL TRAYS

LFI FPU

BEM TRAYS

LFI REBA

DAE BEU BOX

QRS 1

QRS 2

QRS 3

STR 1

2

SAS 1

SAS 2

AAD

SREM

CDMU

RFDN

EPC 1

TWTA 1

XPND 1

PCDU

HEATERS

SOLAR ARRAY

BATTERY

HFI DPU

Digital REU

Analogue REU

HFI PAU

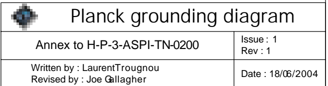
JFET BOX

4K Regulator

4KCDE

4KCC

DCCU



Planck grounding diagram

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END OF DOCUMENT

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