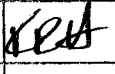
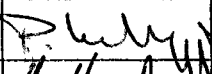
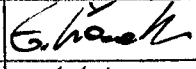
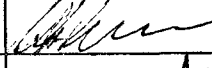
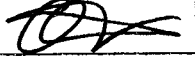
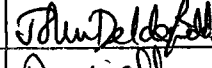
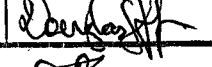


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|                                                  | SPIRE-ALC-MOM-000725  |                      |
|                                                  | DATE: 13-06-01        | PAGE: 1              |
| COMPTE RENDU DE REUNION / MINUTES OF MEETING     |                       | LIEU / PLACE: CANNES |

OBJET / PURPOSE :

EMC/POWER WORKING GROUP MEETING.

CLASSIFICATION :

| PARTICIPANTS<br>ATTENDEES | SOCIETE<br>FIRM | SIGNATURE<br>SIGNATURE                                                              | PARTICIPANTS<br>ATTENDEES | SOCIETE<br>FIRM | SIGNATURE<br>SIGNATURE                                                                |
|---------------------------|-----------------|-------------------------------------------------------------------------------------|---------------------------|-----------------|---------------------------------------------------------------------------------------|
| HIBBERD                   | ALCATEL         |    | P. LEUTENEGGER            | LABEN           |    |
| TROUGNOU                  | ALCATEL         |                                                                                     | M. NICOLIS                | LABEN           |    |
| B. JACKSON                | ESA             |                                                                                     | B.J. VAN LEEUWEN          | SRON            |                                                                                       |
| P. RUEDA                  | ESA             |                                                                                     | A. Naber                  | SRON            |    |
| F. MARLIANI               | ESA             |                                                                                     | E. CIANCETTA              | ALENIA          |   |
| M. RUMITZ                 | MPE             |  | C. CUNNINGHAM             | UK ATC          |  |
| C VESCOVI                 | ISN             |  | J. DELDERFIELD            | RAL             |  |
| REDACTEUR / WRITTEN BY :  |                 |                                                                                     | D. GRIFFIN                | RAL             |  |

CONCLUSION :

Agenda.

J. Luc Béneux

RAL



- Status of IID's
- Power and LCL budgets
- 4k cooler interface (inc launch lock )
- SCE interface
- DC/DC synchronization
- Harness (routing, feedthroughs, EMC)
- Placement of the electronic panels
- Position of HIFI's LO and PACS BOLA.
- micro-vibrations generated by reaction-wheels etc.
- magnetic fields generated by the solar panel current switching
- Action Items from previous meeting
- Any other business

|                                               |                                       |  |  |  |
|-----------------------------------------------|---------------------------------------|--|--|--|
| DISTRIBUTION :<br>PARTICIPANTS /<br>ATTENDEES | POUR ACTION :<br>FOR FURTHER ACTION   |  |  |  |
|                                               | POUR INFORMATION :<br>FOR INFORMATION |  |  |  |
| APPROUVE PAR / APPROVED BY                    |                                       |  |  |  |
| NOM / NAME                                    |                                       |  |  |  |
| SIGNATURE /<br>SIGNATURE                      |                                       |  |  |  |

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SUITE / CONTINUED :

ACTION

# 1) STATUS of IID'S

\* IID-A being updated. Power & EMC aspects nearly finished, to be released by end of June.

## \* GDIR & IID.

ESA stated that they would like all instrument requirements to be placed in the IID-A.

The GDIR covers all the spacecraft interfaces, some of which might be applicable to the instruments.

In this case these requirements should be duplicated in the IID-A (to be discussed ESA/AEC in case that some requirements have to be x-referenced).

Next issue of GDIR: august 2001.

ESA stated that some PCDU requirements present at EMC spec. should be moved to the GDIR.

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SUITE / CONTINUED :

ACTION

## 2) Power and LCL budgets

Alc. presented a definition of how the Instrument power definitions should be made (para 6.7.5 of GDR)  
definitions of Max Average power, Long peaks (5mins), short peaks (1ms) see attach Annex 7

Instrument teams are requested to check their power requirements in the IID-B and define them in line with these definitions.

## 3) Overvoltage / Undervoltage protection - a requirement that these shall "be avoided" was presented by Alc.

This will be discussed with ESA (- if instruments already know that this is a problem then please inform ESA / Alc)

Breadboard LCL's / LCL's for EGSE's.

Alcatel will ~~not~~ provide LCL's for instrument EGSE's.

Alcatel will investigate providing 'some' LCL's to instruments which can be used in a compatibility test between the S/C and instrument.

Also Alc. will perform a worst case analysis of the LCL to show that it will perform within spec

|                                                                                            |                      |                      |
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| COMPTE RENDU DE REUNION / MINUTES OF MEETING                                               |                      | LIEU / PLACE: CANNES |

SUITE / CONTINUED :

ACTION

### Status of IID-B's :

Issues II of IID-B will have to be agreed by ESA  
+ by Alcatel (release beginning of July).

### Power and LCL budgets :

EPS's of Herxhel and Plouck designed to  
be the same.

Some margin between power supplied by EPS  
and power demand from IID-B's exists.

The w.c. peak and <sup>Issue 1</sup> average consumption  
per LCL is needed from each Instrument (to be included  
in issue 2 of IID-B's)

A template has been defined by Alcatel  
(Circuit current profile) for each LCL user,  
to be compatible with.

|                                                                                            |  |                      |         |
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SUITE / CONTINUED :

ACTION

Scope of Power / EMC Working Group & way ahead

We've been concentrating on Power aspects  
 So far, the EMC aspects may be the actual  
 "hard point".

Needs of Instruments for EMC analyses

- impedance of Satellite Structure :

(long harness between warm and cold electronics.)

- harness routing
- shielding strategy

Alcatel role is to give all T/F information  
 they have, to the Instruments.

Way to start could be to list the  
 Structure / routing / layout differences between  
 Herschel and ISO → to be done in a  
 separate meeting with Herschel.

|                                                                                            |  |                            |         |
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SUITE / CONTINUED :

ACTION

Main point of interest for All Instrument  
should be common mode rejection  
problems at low frequency (i.e. in  
detectors bandwidth).

→ Need to share information on the strategies  
adopted for it between Instruments.

EMC testing: (If necessary —)

Need for a meeting to discuss EMC testing  
in cold conditions, i.e. the only representative  
susceptibility tests.

For Herschel a ~~separate~~ meeting with Alcatel, Astrium  
and the 3 Instruments is to be planned.

Idem for Planck with Alcatel and the 2 Instruments.

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SUITE / CONTINUED :

ACTION

4k cooler interface (inc launch lock)

Planck/HFI slides in Annex I.

During INTEGRAL testing a test was done first without a current limiter & then with a 6A current limiter. (This gives a 6db margin because in flight case 2x 6A LCL's will be used)

The test with 1x 6A LCL as launch lock was successful

(J. Delderfield reported that on ENVISAT, MIPAS instrument the cooler compressor was controlled and the displacer was shorted during the launch).

Alcatel stated that they ~~are prepared~~ <sup>in the laboratory</sup> to provide upto 2 protected (LCL) lines - the definition of the (short peak, long peak) current requirements for the LCL should follow the definitions given in Annex 1 attached

(J. Delderfield) will provide the requirements for the LCL.  
(+ J. Luc Berney)

(AI)

25/6/01.

|                                                                                                                                       |                      |                      |
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SUITE / CONTINUED :

ACTION

## SCE Interface:

### Slides in ANNEX II

The Sorption Cooler power breakdown shows 2 LCL lines to each Sorption cooler, 1 x 120W (worst case) 1 x 535W. (" " )

These power figures are based (26-29V) at the input to the cooler

(Converter)  
DC/DC Synchronisation.

Planch.

LF1 stated that they do not need external synchronisation slides in ANNEX III

HFI (J. Le Bary)

stated that they do not need external synchronisation. Note HFI showed the use

of opto couplers - this is possible but it was suggested at the meeting that the design could be easier / improved if another form of isolation (eg transformer) was used.

LF1 pointed out that they still require the On Board clock (131072 Hz) slides in ANNEX III

|                                                                                   |                      |                      |
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SUITE / CONTINUED: DC/DC Converter Sync.

ACTION

Herschel  
SPIRE

(J. Dolderfield) stated that SPIRE does not need ext sync

PACS

(M. Runtz) stated that PACS does not need ext. synchronisation.

Nabe

SPIRE & PAC's may have their own 'internal' synchronisation but this will place no additional requirements on the spacecraft and any IID-B requirement for DC/DC converter synchronisation will be removed.

HIFI

(A. Nabe) HIFI does not need external synchronisation.

Sorption Cooler

(C. Versari) SCE does not need ext synchronisation.

Conclusion

Herschel spacecraft will not provide any DC/DC Converter synchronisation.

Alcatel will check if the On Board Master clock signal (131072 Hz) is hot (or cold) redundant.

AI. 2.

Alcatel  
25/6/01

|                                                                                   |                          |                      |
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| COMpte Rendu de Reunion / MINUTES OF MEETING                                      |                          | LIEU / PLACE: CANNES |

SUITE / CONTINUED :

ACTION

### Placement of SVM units

Alc presented the graphs of the unit layout on the SVM see Ann IV. Several of these have not yet been updated following information given in the mechanical working group.

### $\mu$ Vibrations of Reaction Wheels (etc)

ESA previously handed over  $\mu$ -vibration spec requirements for the MIDAS expt on Rosetta (see Ann V). At present there are no requirements defined in the SPIRE IID.

SPIRE proposes the following levels for  $\mu$ -vibration at the mechanical interface of the FPU

10  $\mu$ g 0.1 Hz to 300 Hz. These values are to be considered for normal operations (these values are TBC).

### Magnetic fields generated by Solar Array

PAs is concerned that the magnetic field generated by the switching of the solar array strings may cause problems for their instruments. Alcatel have said that it is normal work to reduce the magnetic field by the arrangement of the solar

|                                                                                   |  |                      |          |
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SUITE / CONTINUED:

ACTION

Alcatel will provide results from a previous program for the residual magnetic fields for info. However Alcatel would like to remind the instruments that the Magnetic fields have been specified.

Alcatel will also provide the typical waveform in time & frequency domain as seen on a LEL output (voltage) - for info only.

AI 3  
25/6/01

### Cryo Harness:

In general the cryostat cryo harness matters should be discussed in cooperation with Astrum.

LFI have shown their approach to their cryo harness solution. <sup>Annex 6</sup> It depends upon the V groove managing a thermal load (of  $\approx 1/2W$ ). This approach is under discussion with the Alcatel thermal group (in laben). The consensus of opinion based upon previous experience is that the use of copper wires for this harness is rather optimistic.

|                                                                                            |  |                      |          |
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SUITE / CONTINUED: Ref SCI-PT/8

ACTION

AI 1 - Instruments that have not given an answer will send an Email AS.AP.

AI 2 - Alcatel action still open - the reconfiguration concepts are still being defined.

AI 3 - This approach is acceptable for all instruments (but only the LFI actually use this interface). AI closed.

AI 4 - HIFI confirmed not required - AI closed  
PACS  
LFI  
SPICE  
HFI

AI 5 - Closed. (confirmed).

AI 6 - Closed.

AOB. SPICE & PACS have identified that the procurement of low noise power supplies is longer than anticipated and no longer compatible with the planning. This means that these power supplies will not be available for QM testing. The planning recovery is being investigated and alternative strategy is being considered for the QM testing.

## ANNEX I



EMC/Power working group meeting

**PLANCK**  
**HFI**

### Plan

- Open actions after Alcatel meeting
  - HP-ASPI-MN37-1 (T. Bradshaw)
    - HFI is requested to clarify the need for a launch lock for the 4K cooler, as a 30A line cannot be supplied.
  - HP-ASPI-MN37-2 (R. Pons)
    - DC-DC converter synchronisation requirement
- Questions and Remarks
  - Power supplies for 4KCDE
  - Input current limiter in DC-DC converter
  - S/C-Instrument electrical interface : status

13/06/2001

CESR/LAL/RAL

1



EMC/Power working group meeting

**PLANCK**  
**HFI**

### HP-ASPI-MN37-1

1

- HFI is requested to clarify the need for a launch lock for the 4K cooler, as a 30A line cannot be supplied.
- HFI/RAL requires launch lock
- For this power line, a 7A LCL is now sufficient.
  - Tests with INTEGRAL at 8.53 g random levels along the compressor axis :
    - Current spikes of up to 7.5A with duration less than 150 microseconds. Highest average current of 1.6 A
    - a 6A LCL was used successfully
  - On Planck, level is 5.27 along the plane of the SVM.  
(compressor pistons orientation).



## REU DC/DC synchronization

- The DC/DC converter in processor module will have to start up free running and synchronize once the secondary voltages become available
- The 12 DC/DC converters in analog modules will be always synchronized
- The isolation of the synchronization clock from the secondary to the primary will be done by optocoupler (66179 from MPC)

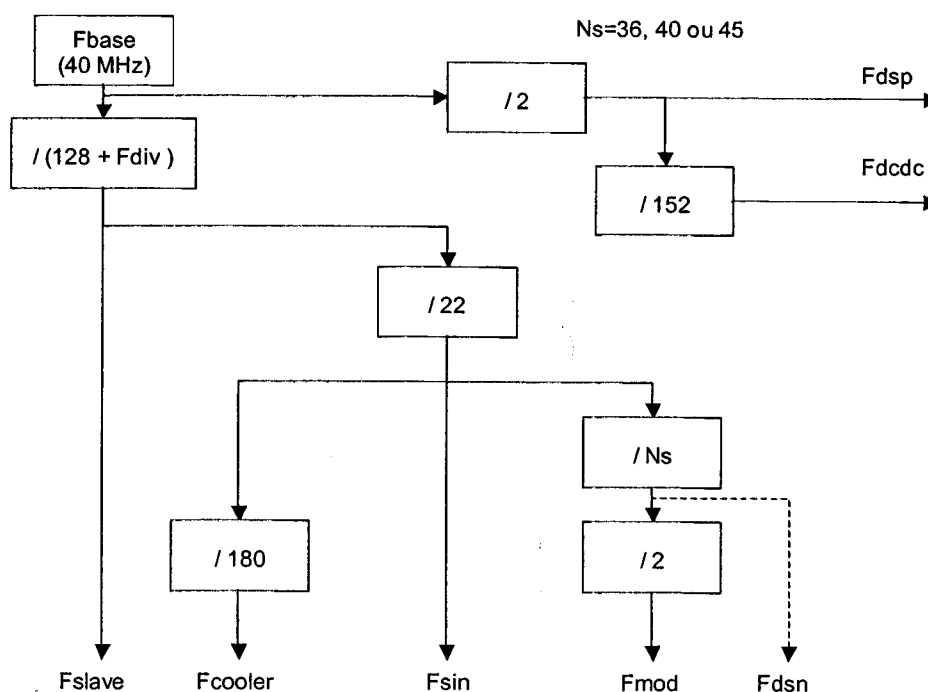
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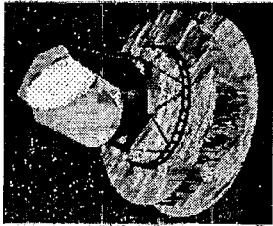
CESR/LAL/RAL

5



## Frequencies Generation in REU

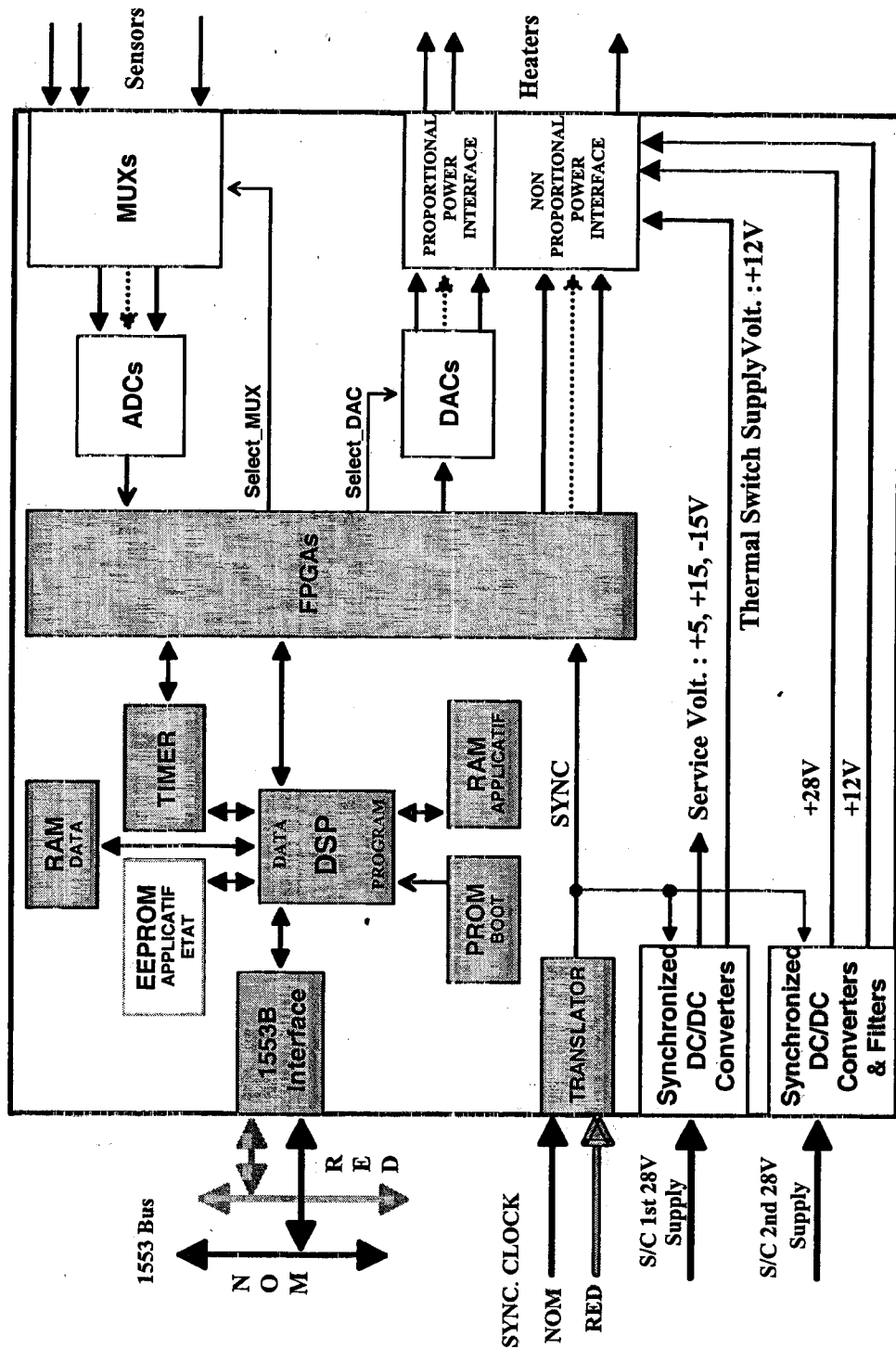


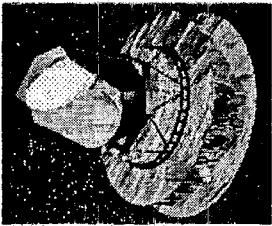


SORPTION COOLER ELECTRONICS



SCE – Block Diagram



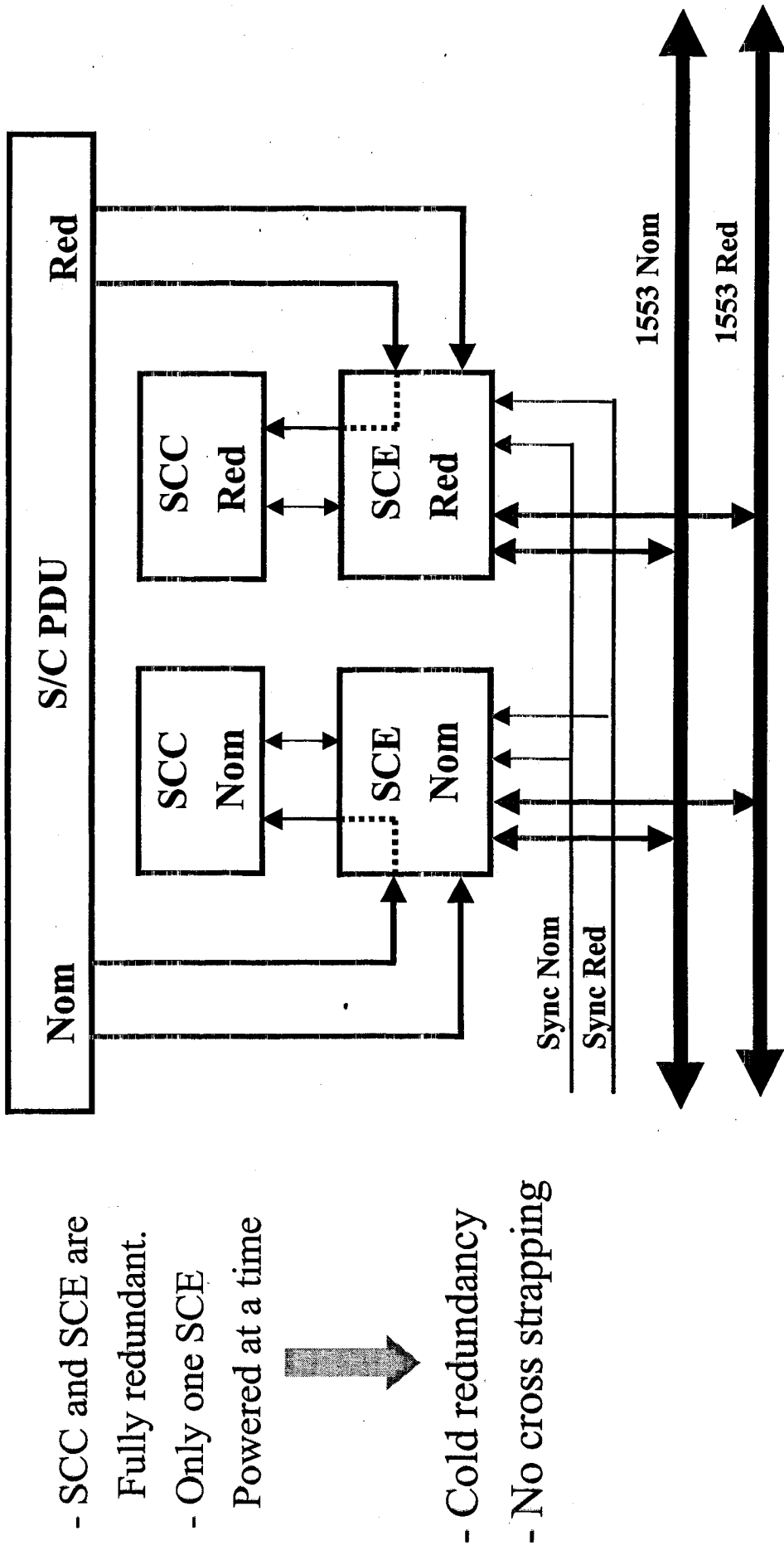


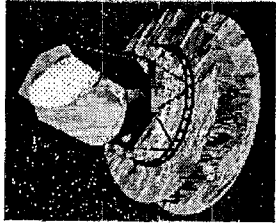
SORPTION COOLER ELECTRONICS



S/C Interface configuration

Redundancy

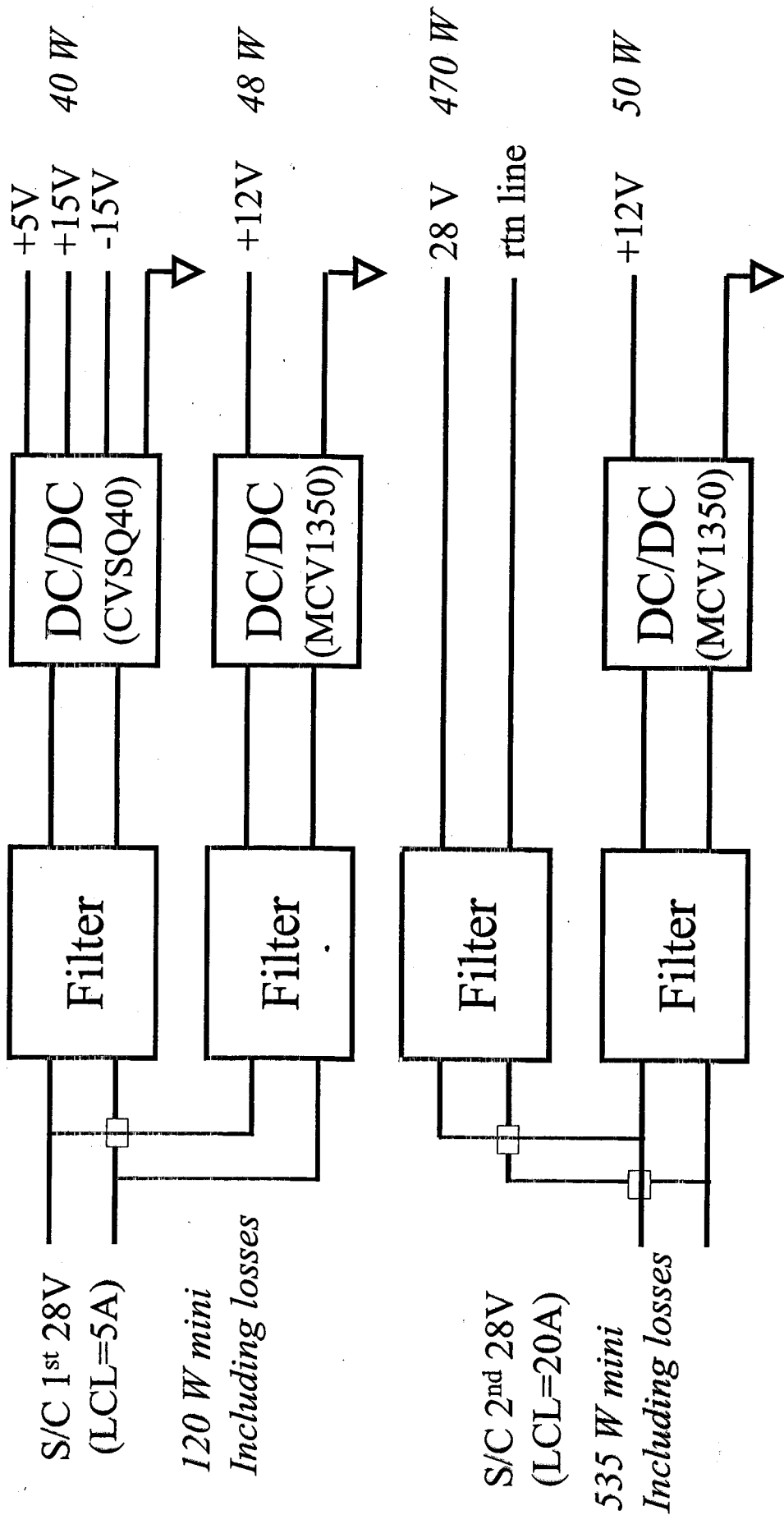




SORPTION COOLER ELECTRONICS

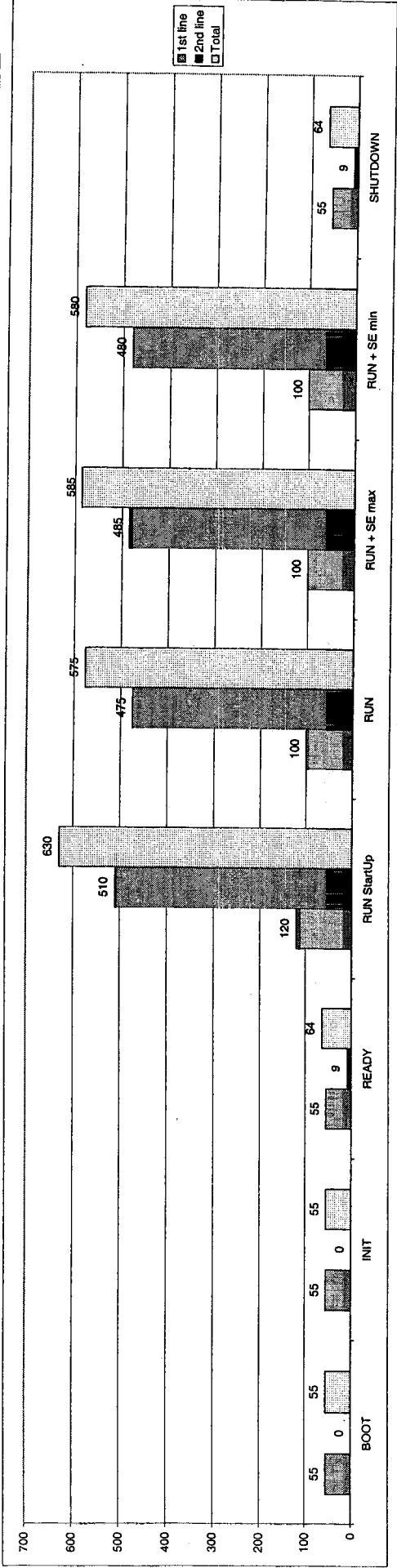
Power Interface (Nom or Red)

PLANCK  
HFI/LFI



Sorption Cooler System Power Breakdown

| LOAD ON FIRST POWER LINE  |                                                                         |      |      |       |             |     |              |              |  |  |  |  |
|---------------------------|-------------------------------------------------------------------------|------|------|-------|-------------|-----|--------------|--------------|--|--|--|--|
| Voltage (v)               | Power (W), Worst case                                                   | BOOT | INIT | READY | RUN StartUp | RUN | RUN + SE max | RUN + SE min |  |  |  |  |
| ± 15, +5<br>12            | EOL                                                                     | 55   | 55   | 55    | 55          | 55  | 55           | 55           |  |  |  |  |
|                           | Electronics (Low power DC/DC loss included)                             | 48   | 0    | 0     | 48          | 34  | 34           | 34           |  |  |  |  |
|                           | Compressor Element, THERMAL SWITCHES (8w, 4 but 6 in startup procedure) | 12   | 0    | 0     | 12          | 8   | 8            | 8            |  |  |  |  |
|                           | Losses in high power DC/DC 12v                                          | 5    | 0    | 0     | 5           | 3   | 3            | 3            |  |  |  |  |
|                           | Margin                                                                  | 120  | 55   | 55    | 120         | 100 | 100          | 100          |  |  |  |  |
| SUB TOTAL                 |                                                                         |      |      |       |             |     |              |              |  |  |  |  |
| LOAD ON SECOND POWER LINE |                                                                         |      |      |       |             |     |              |              |  |  |  |  |
| Compressor Elements       |                                                                         |      |      |       |             |     |              |              |  |  |  |  |
| 28                        | 117                                                                     | 0    | 0    |       | 117         | 117 | 117          | 117          |  |  |  |  |
| 0 to 28                   | 100                                                                     | 0    | 0    |       | 100         | 100 | 100          | 100          |  |  |  |  |
| 28                        | 117                                                                     | 0    | 0    |       | 117         | 117 | 117          | 117          |  |  |  |  |
| 0 to 28                   | 71                                                                      | 0    | 0    |       | 71          | 71  | 71           | 71           |  |  |  |  |
| 28                        | 54                                                                      | 0    | 0    |       | 54          | 54  | 54           | 54           |  |  |  |  |
| 28                        | 2                                                                       | 0    | 0    |       | 2           | 2   | 2            | 2            |  |  |  |  |
| 28                        | 8                                                                       | 0    | 0    | 8     | 8           | 8   | 8            | 8            |  |  |  |  |
| 12                        | 1                                                                       | 0    | 0    | 1     | 1           | 1   | 1            | 1            |  |  |  |  |
| SUB TOTAL                 |                                                                         | 470  | 0    | 9     | 470         | 470 | 470          | 470          |  |  |  |  |
| Single events             |                                                                         |      |      |       |             |     |              |              |  |  |  |  |
| 12                        | 40                                                                      | 0    | 0    | 0     | 40          | 0   | 0            | 0            |  |  |  |  |
| 12                        | 4                                                                       | 0    | 0    | 0     |             | 0   | 4            | 0            |  |  |  |  |
| 12                        | 4                                                                       | 0    | 0    | 0     |             | 0   | 4            | 0            |  |  |  |  |
|                           | 12                                                                      | 0    | 0    | 0     |             | 0   | 4            | 4            |  |  |  |  |
| SUB TOTAL                 |                                                                         | 60   | 0    | 0     | 40          | 0   | 2            | 1            |  |  |  |  |
| Margin                    |                                                                         |      |      |       |             |     | 10           | 5            |  |  |  |  |
| SUB TOTAL                 |                                                                         | 5    | 0    | 0     | 0           | 5   | 5            | 5            |  |  |  |  |
| SUB TOTAL                 |                                                                         | 535  | 0    | 9     | 510         | 475 | 485          | 480          |  |  |  |  |
| TOTAL                     |                                                                         | 655  | 55   | 64    | 630         | 575 | 585          | 580          |  |  |  |  |



# PLANCK – LFI

H/P Power/EMC WG #10

## ELECTRICAL INTERFACES TO THE SATELLITE

| Interface              | Previous configuration                       | New configuration              | Variations                           |
|------------------------|----------------------------------------------|--------------------------------|--------------------------------------|
| Data bus to REBA       | Mil 1553B                                    | Mil 1553B                      | None                                 |
| Power bus to REBA      | +28V regulated                               | +28V regulated                 | LCL protections only on primary side |
| On Board Clock to REBA | Common signal @ 131072 Hz<br>2 Nom. + 2 Red. | High quality clock @ 131072 Hz | Different (RS422) electrical I/F     |
|                        |                                              | Nom. + Red.                    | Nom. + Red.                          |
| DC/DC synch to REBA    |                                              | Deleted                        | Deleted                              |
| Power bus to DAE       | +28V regulated                               | +28V regulated                 | LCL protections only on primary side |
| On Board Clock to DAE  | Common signal @ 131072 Hz<br>2 Nom. + 2 Red. | High quality clock @ 131072 Hz | Different (RS422) electrical I/F     |
|                        |                                              | Nom. + Red.                    | Nom. + Red.                          |
| DC/DC synch to DAE     |                                              | Deleted                        | Deleted                              |

ANNEX III

## PLANCK – LFI

H/P Power/EMC WG #10

### POWER REQUIREMENTS

Average values for LFI subsystems power requirements

#### REBA

Nominal Power: 35.6W No contingency

Voltage: 26V - 29V

Current: 1.23A - 1.37A

#### DAE

Nominal Power: 75W No contingency

Voltage: 26V - 29V

Current: 2.59A - 2.88A

## PLANCK – LFI

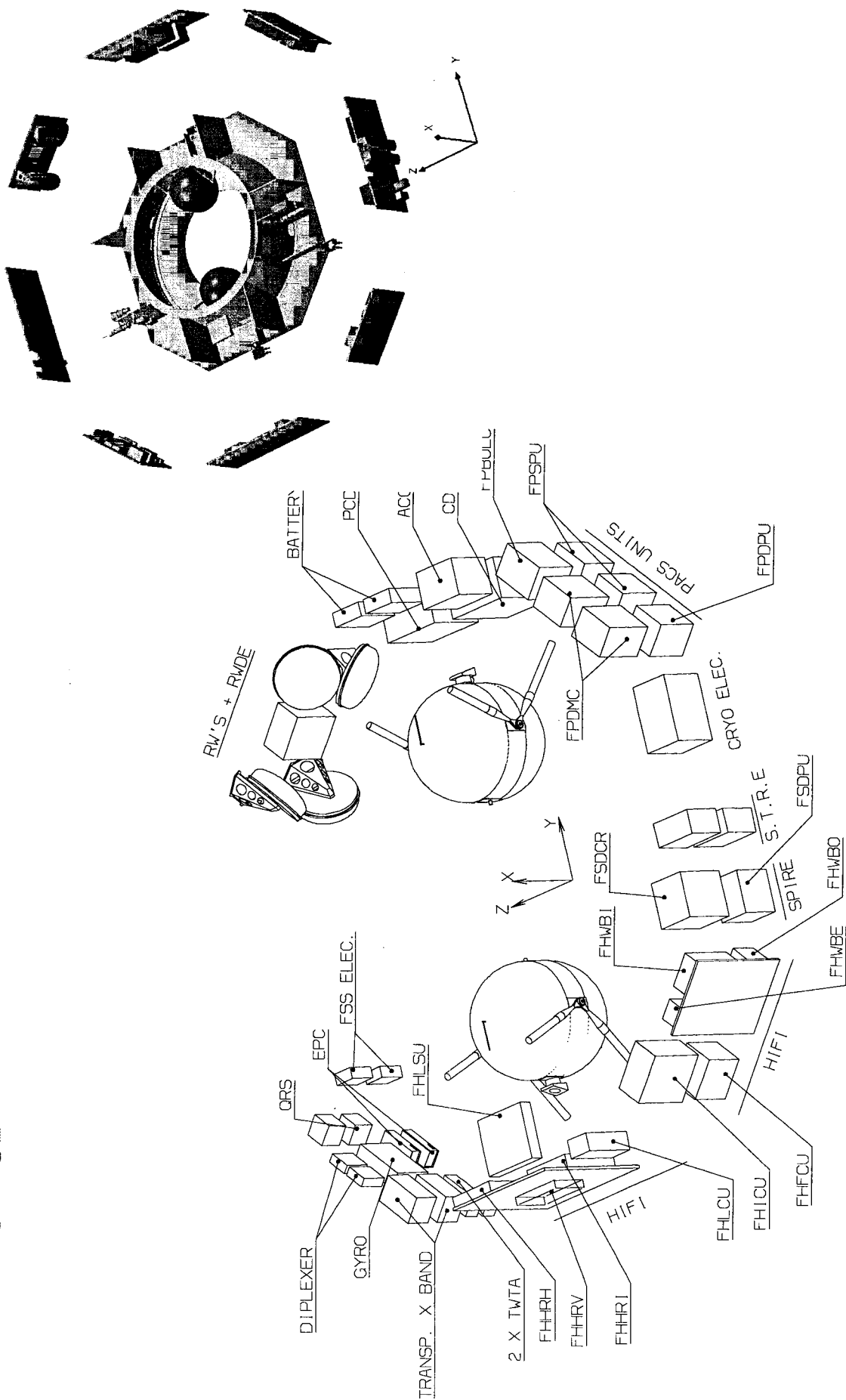
H/P Power/EMC WG #10

### On Board Clock Interface

- **Functional:**  
Square waveform with a frequency of 131072 Hz and a stability of  $1 \cdot 10^{-8}$  over 30 days.
- **Electrical:**  
Balanced RS 422 interface circuit.  
The driver is powered by a secondary winding into the S/C, whereas the receiver is powered by a secondary winding of the P/L.  
The impedance of the driver's output and of the cable will be about  $120\Omega$ .  
EMC class: "Digital signals".
- **Redundancy:**  
One nominal line to the nominal REBA (DAE) and one redundant line to the redundant REBA (DAE).  
Cross coupling between nominal and redundant clock generators performed on the S/C side.
- **Connectors:**  
Each OBC line will be carried by a single connector that will house only the OBC signal.

# Herschel SVM

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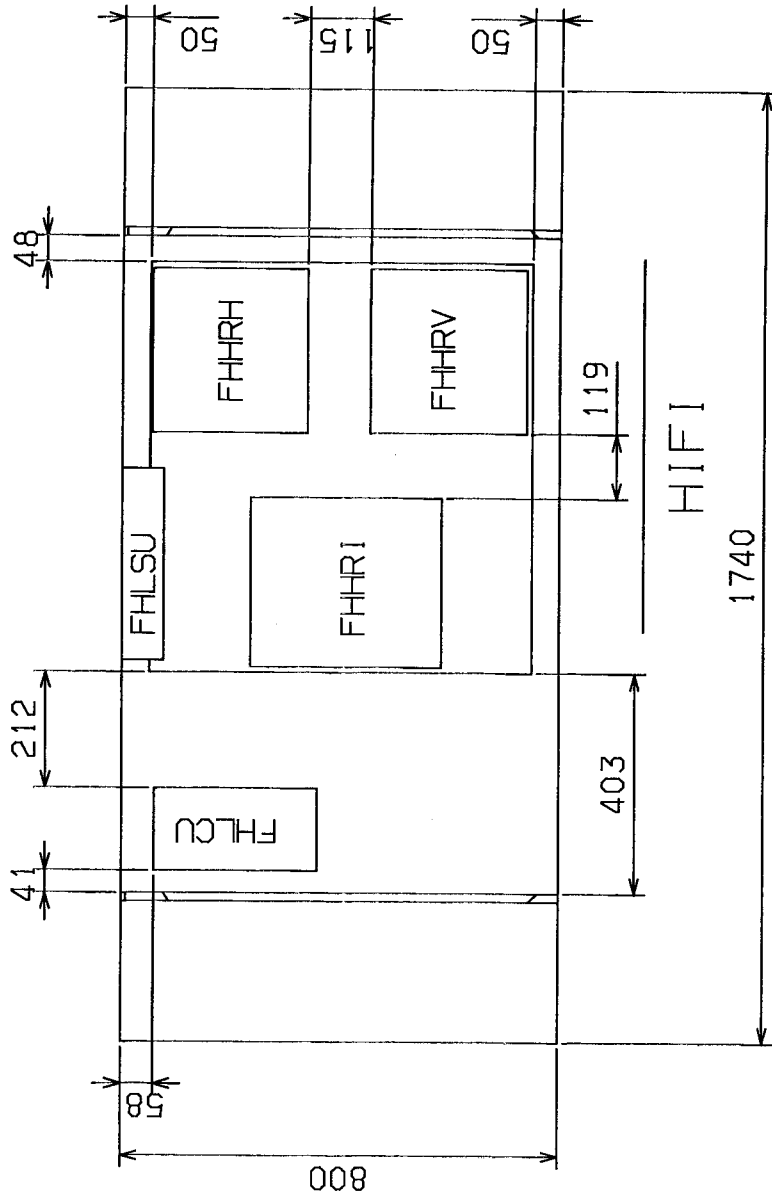
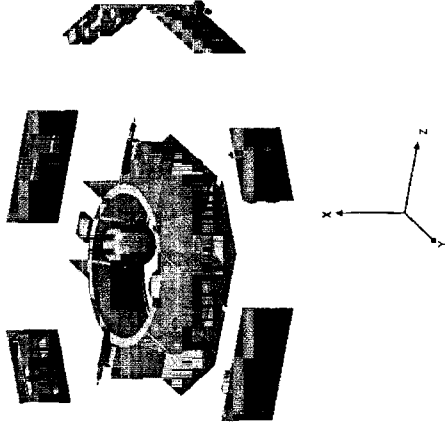


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# Herschel SVM

– Equipment and PLM "warm units" accommodation:

- HIFI: Units accommodation

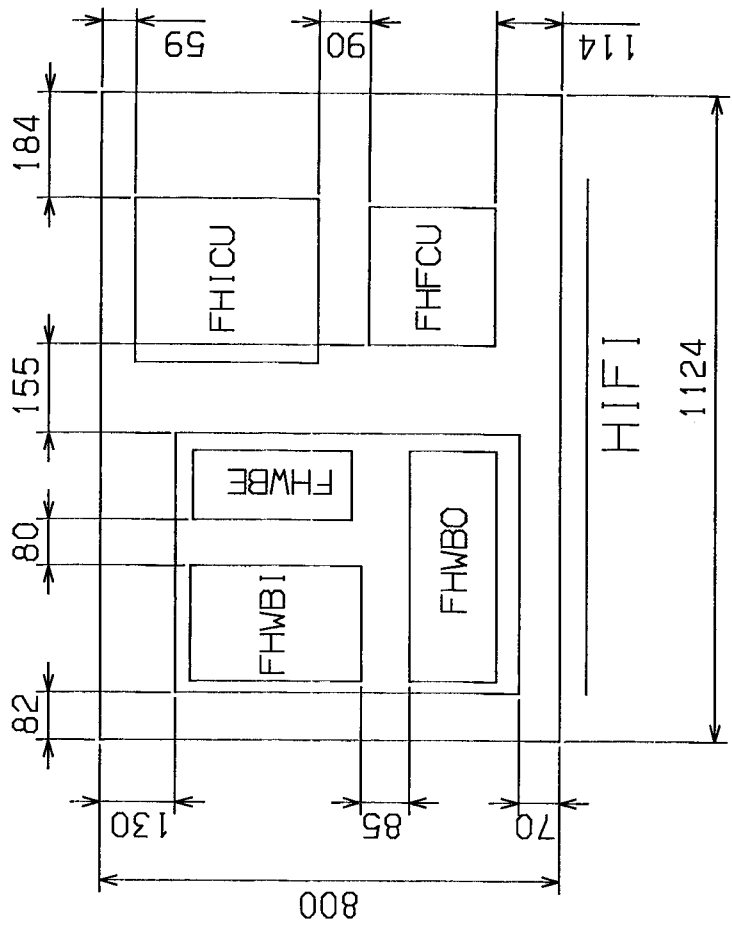
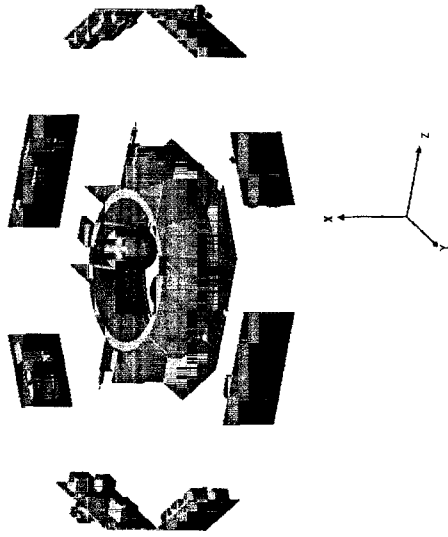




# Herschel SVM

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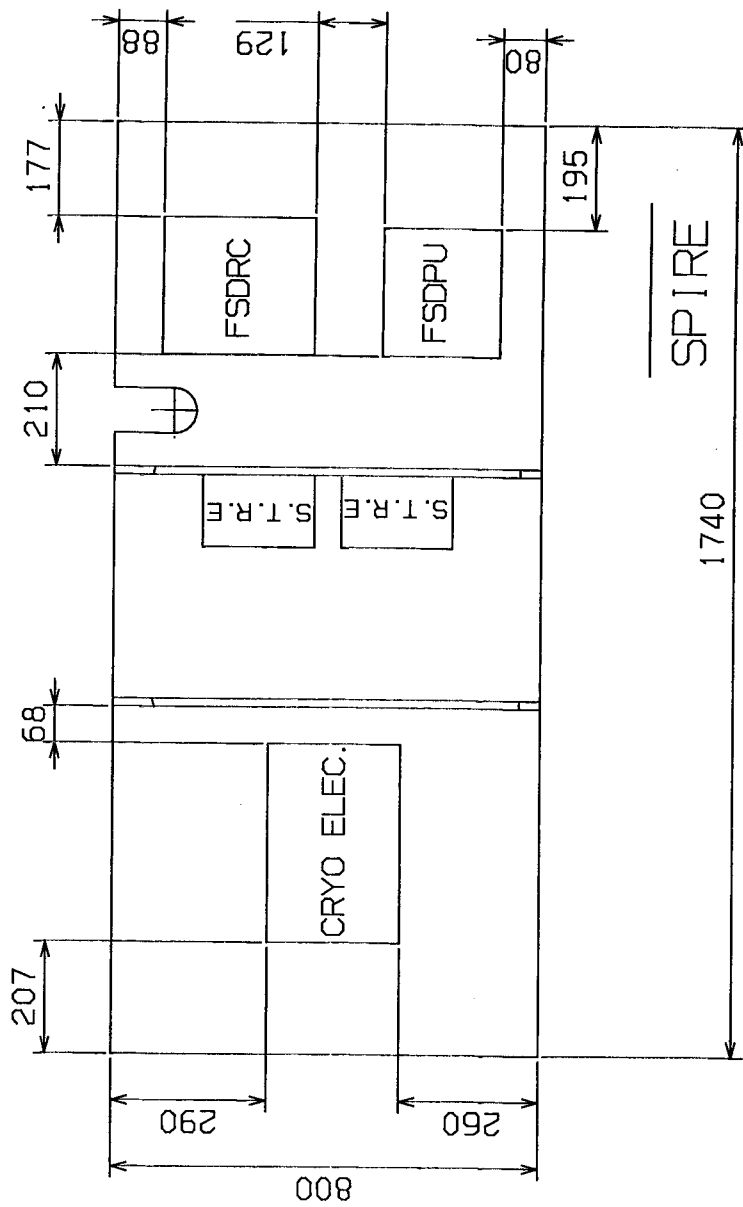
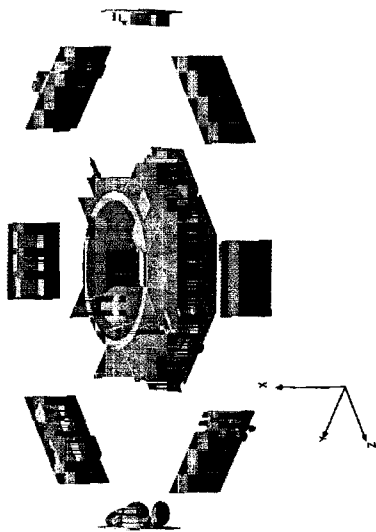
- Equipment and PLM "warm units" accommodation:
- HIFI: Units Accommodation



# Herschel SVM

– Equipment and PLM "warm units" accommodation:

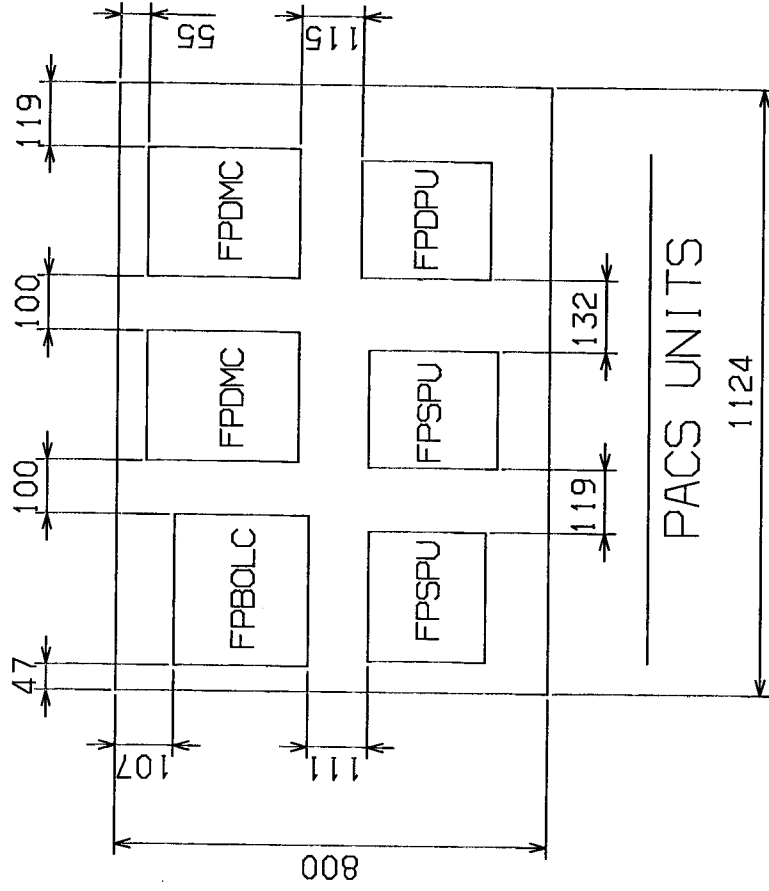
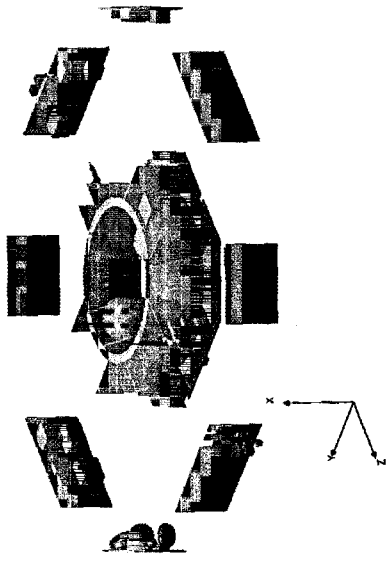
- SPIRE: Units accommodation



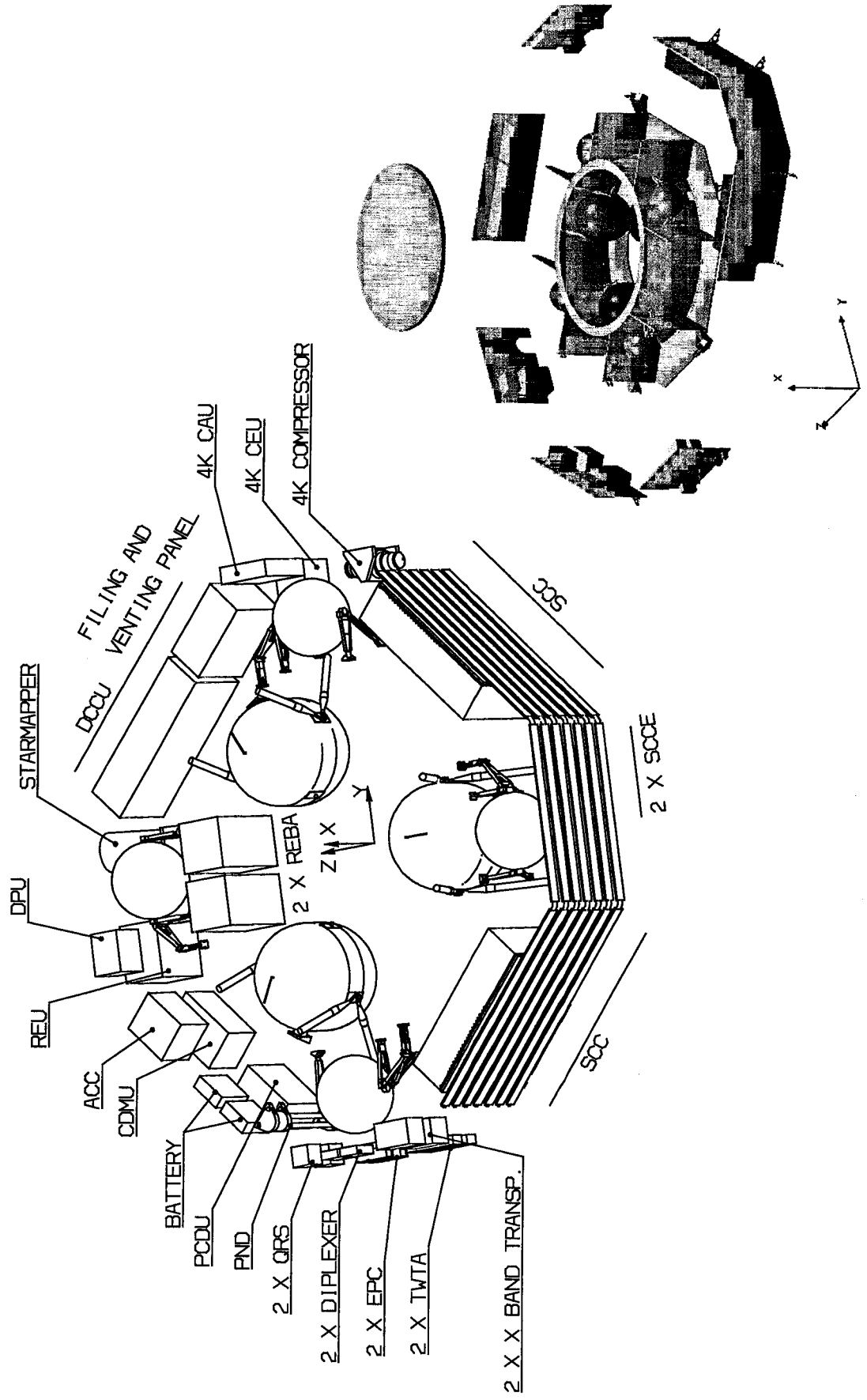


# SPACE Herschel SVM 8

- Equipment and PLM "warm units" accommodation:
- PACS: Units accommodation

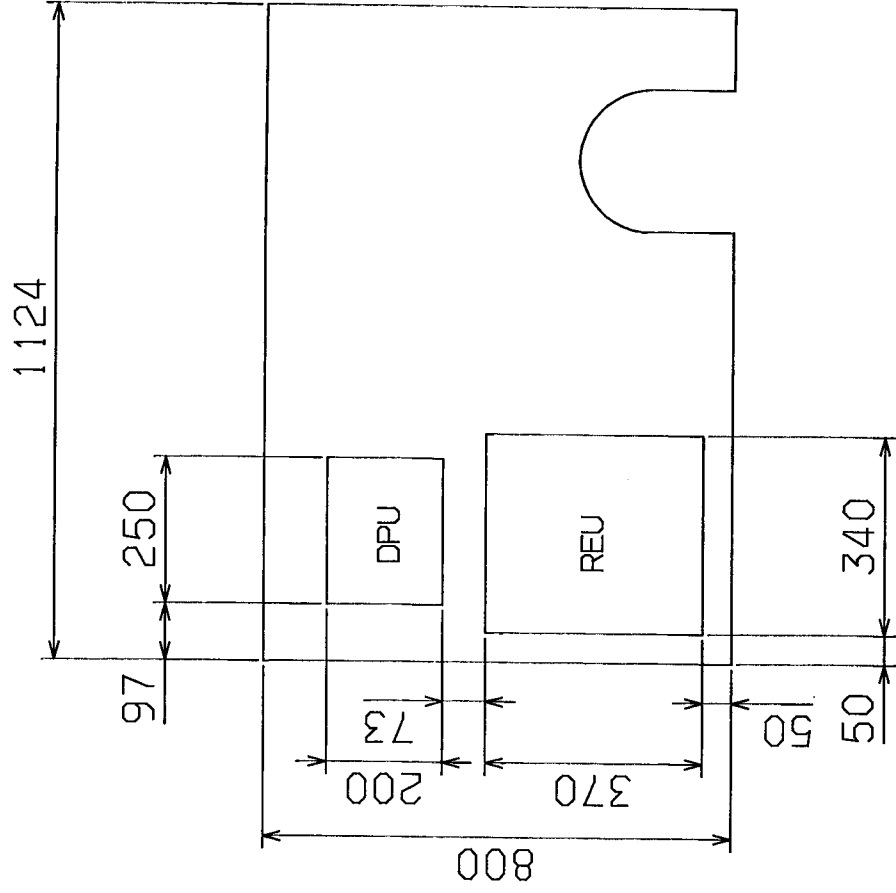
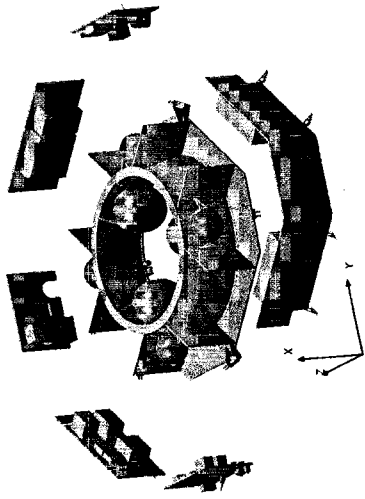


# Planck SVM



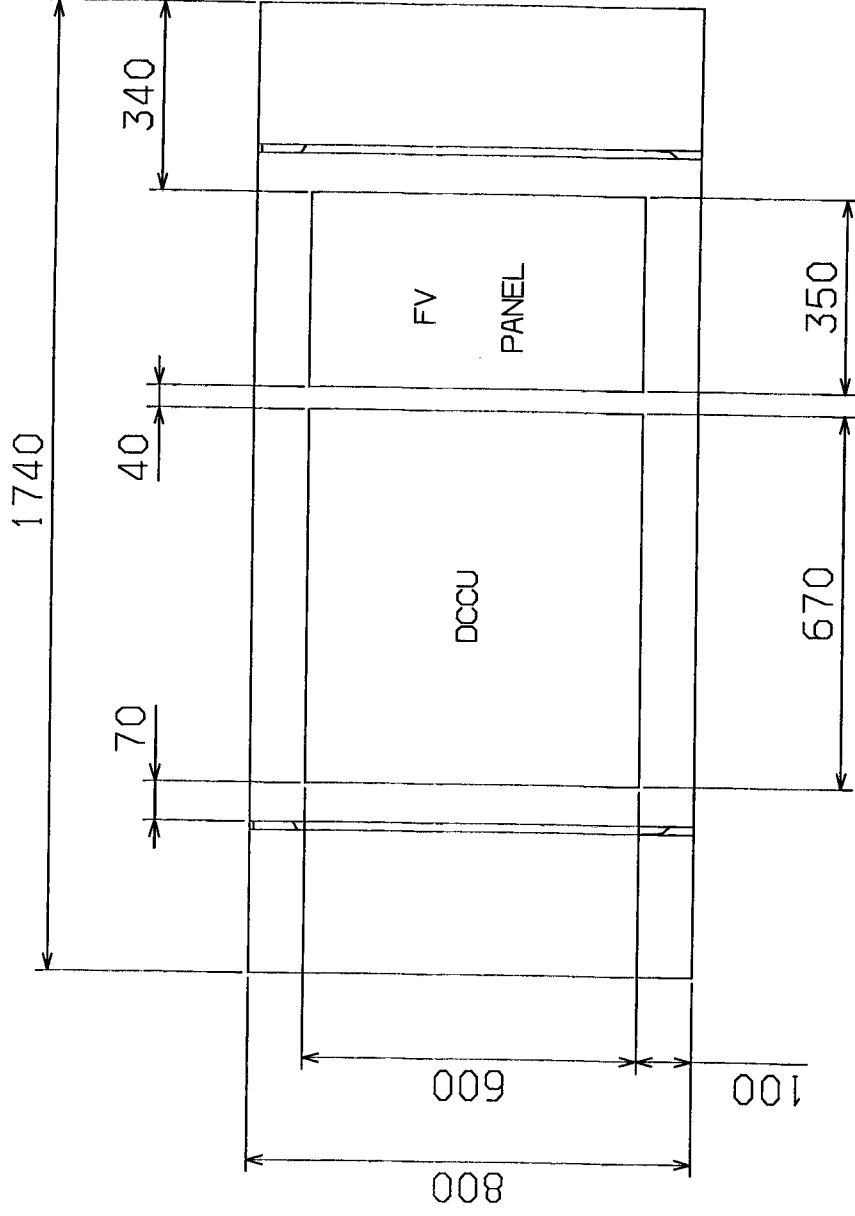
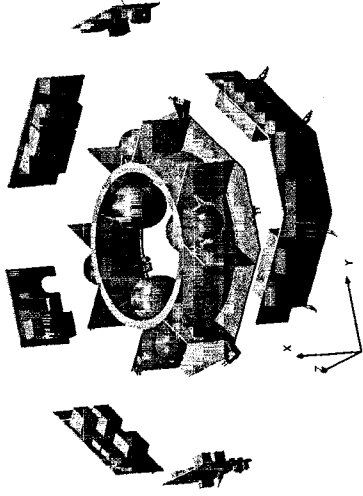
# Planck SVM

- Equipment and PLM "warm units" accommodation:
- HFI Accommodation



# Planck SVM

- Equipment and PLM "warm units" accommodation:
- HFI Accommodation



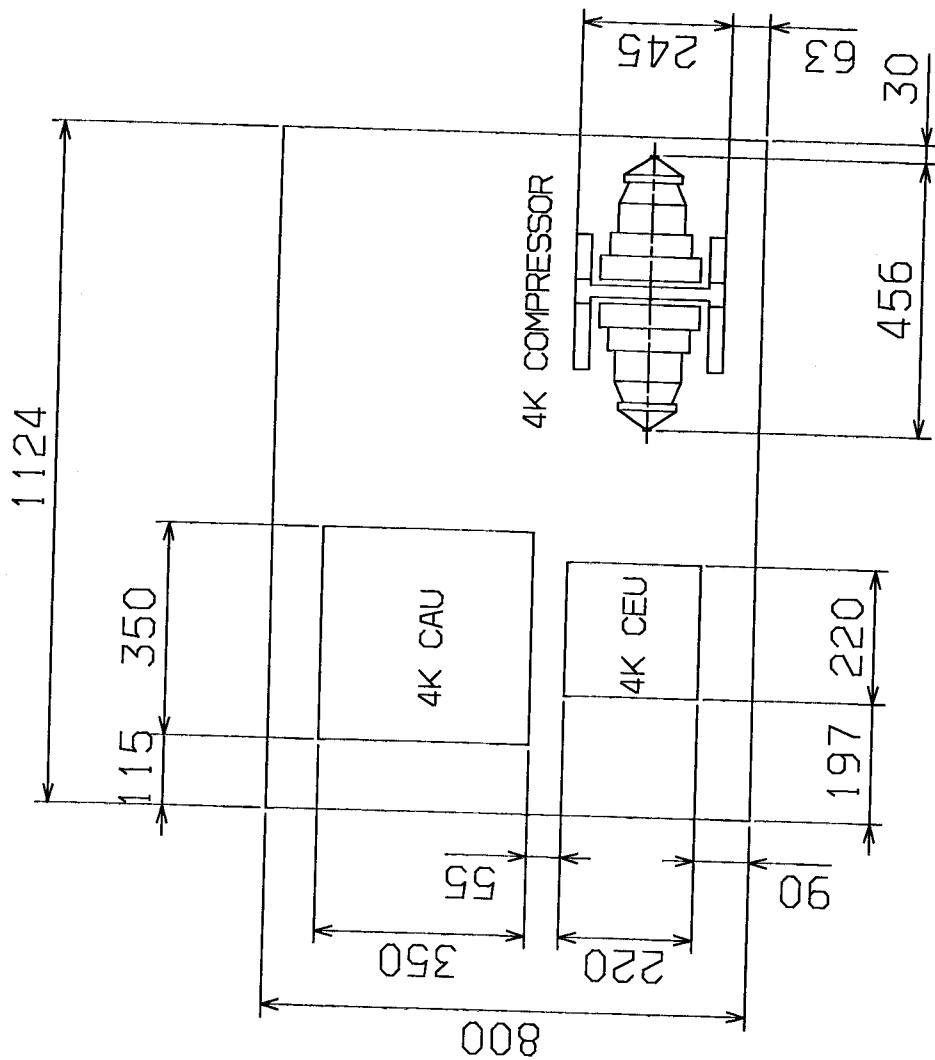
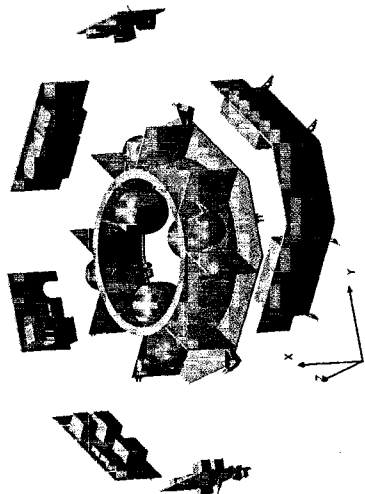
**DCCU modified**



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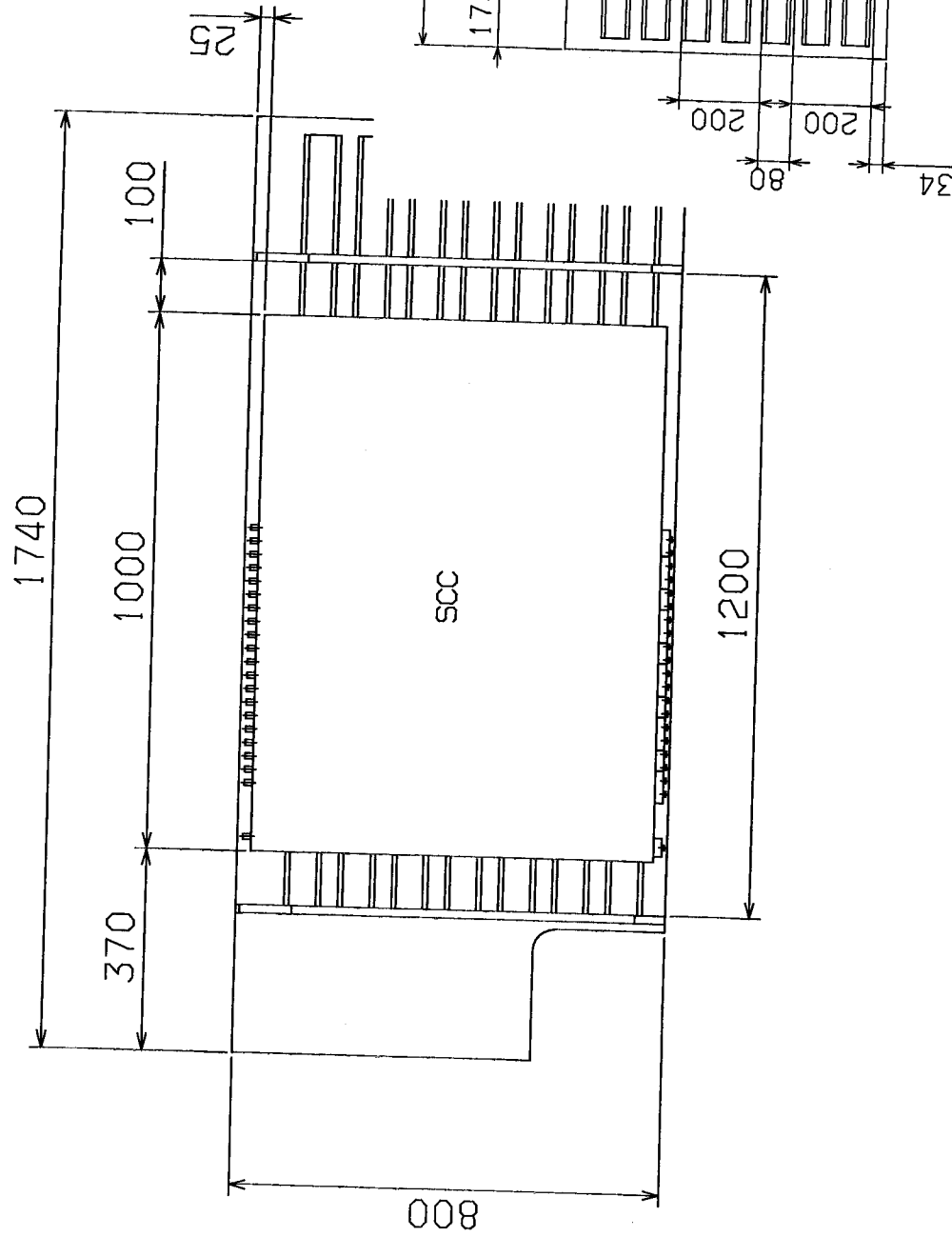
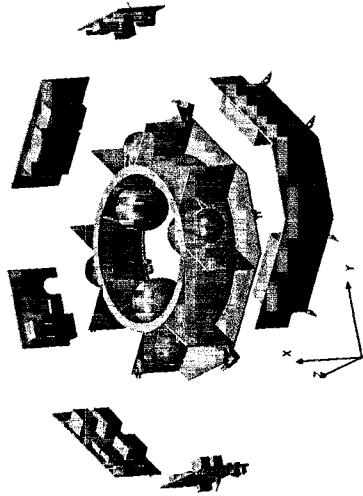
# Planck SVM

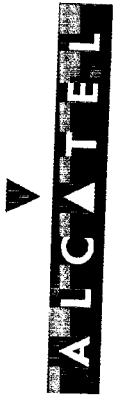
- Equipment and PLM "warm units" accommodation:
- HFI Accommodation



# Planck SVM

- Equipment and PLM "warm units" accommodation:
- SCC Accommodation

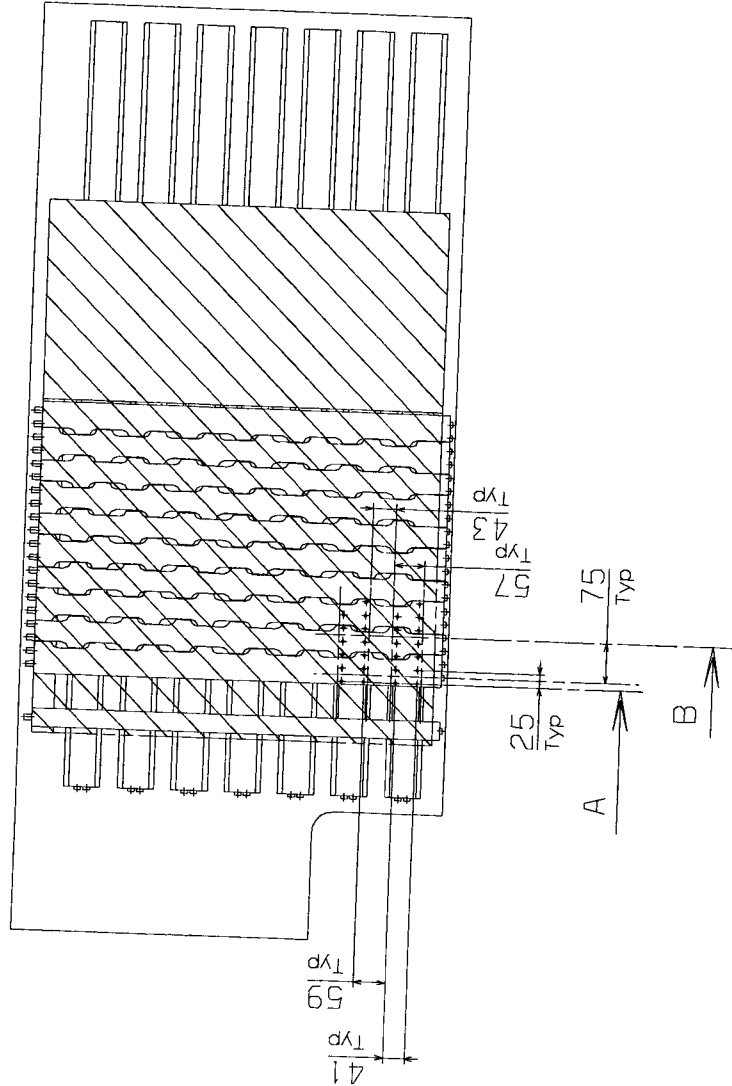




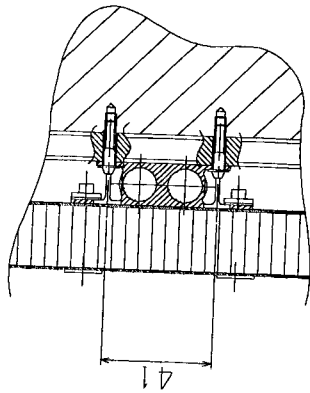
# Planck SVM

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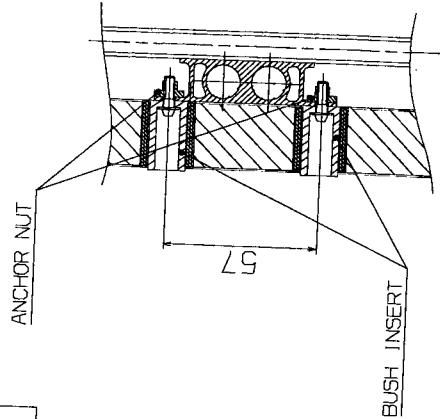
- Equipment and PLM "warm units" accommodation:
- SCC Accommodation



SECTION A



SECTION B

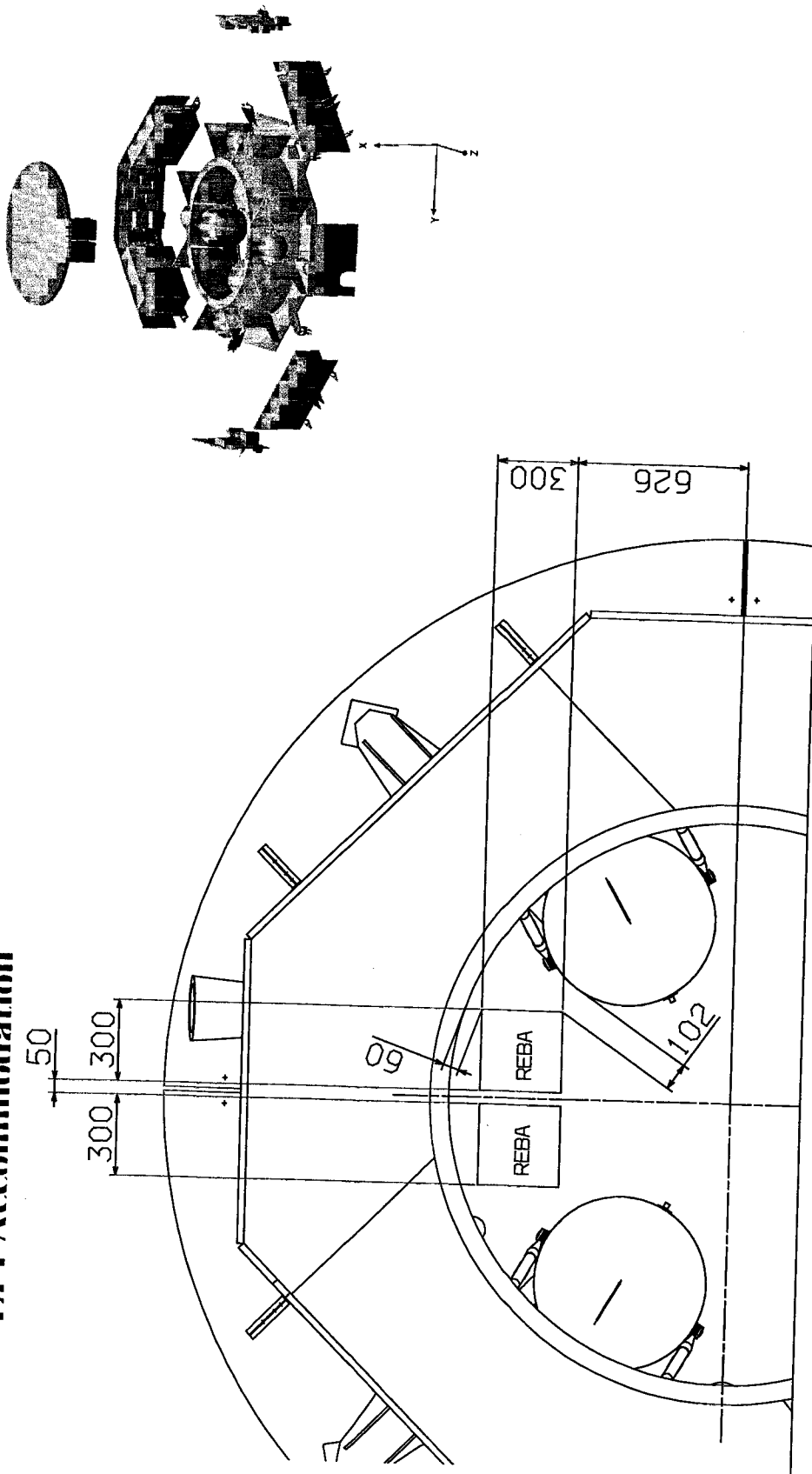


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# Planck SVM

- Equipment and PLM "warm units" accommodation:
- I/FI Accommodation



**2.2.6. Mechanisms Design**

**2.2.6.1. General Requirements**

Mechanisms shall be functionally analysed to determine loads deriving from their activation, both in-orbit or on ground, as applicable.

Mechanisms shall be designed to the same criteria as all other structural items.

They shall be also compliant with the EMC and cleanliness requirements.

They shall therefore:

- withstand without degradation all the environments they will be subjected to during their life.
- be designed with the same loads and safety factors as other structural items .
- fulfil the minimum frequency requirement of 100 Hz in their stowed condition (same margin applicable as addressed in Sec. 2.2.5.3).
- be subjected to fracture mechanics procedures as required by safety analysis.

Elements to be deployed in orbit (or otherwise showing important changes in their configuration between the launch and the orbital phase) shall also be verified under orbital environmental loads.

Any mechanism interfering with the spacecraft shall be compliant with ECSS-E-30-00 part 2-3. Other mechanisms are recommended to follow this specification.

**2.2.6.2. Mechanism Perturbation**

Experiments equipped with active mechanisms used during observation shall be designed to minimise the perturbations induced on the S/C and the production of microvibration. The torque impulses shall be less than 0.002 Nms around any S/C axes and the vibrations shall be less than 0.04 N in the range 50-100 Hz.

**Rosetta  
Midas**

Reference : RO-EST-RS-3010/EID B  
Issue : 2d Rev. : 0  
Date : 15 Feb, 2001  
Section : 2.10 Page : 5

**2.10.4. Specific MIDAS Requirements**

Scanning a tip in the very close proximity of a sample surface requires a mechanically stable environment. Earth bound instruments suffer mostly from externally induced vibrations which are in the order of a few Hertz and are mainly induced by traffic, heavy machinery or people moving in the vicinity of the Atomic Force Microscope. In space, vibrations are generated by satellite manoeuvres or mechanisms like reaction wheels, gyroscopes, tape recorders antenna motors solar arrays etc.

At this stage information on the vibration environment at the Rosetta S/C is still incomplete. According to a preliminary assumption, one has to take into account the following situation:

- The dominant source of mechanical noise will be the reaction wheels. The effect of all other S/C mechanisms which are permanently on is considered to be negligible.
- Noise contributions resulting from occasional operations like e.g. wind/rewind of the tape recorder, pyro firings or movement of the high gain antenna may not be negligible.
- Contribution from other experiments (e.g. stirling coolers, other TBD motors/mechanisms) may not be negligible.

Realistic limits of acceptable noise limits are in the process of being defined and are expected to fall into the region of  $\approx (0) \text{ Hz} \dots 1 \text{ KHz}$ .

The susceptibility of MIDAS will be determined and additional damping in the mounting of the instrument has been implemented.

The susceptibility of MIDAS to microvibrations, preliminarily calculated for a non-dimensional rigid body system, assumes the basic resonance frequency of the damping system to lie between 3 and 8 Hz, single harmonic inputs, and a maximum tolerable displacement of 1 nm at the sensor.

|                     |                                                                             |
|---------------------|-----------------------------------------------------------------------------|
| LABEN<br>PLANCK LFI | Power/EMC Working Group Meeting #10<br>Cannes, June 13 <sup>th</sup> , 2001 |
|---------------------|-----------------------------------------------------------------------------|

## Cryo harness

| 30 GHz                                     |           |     |
|--------------------------------------------|-----------|-----|
| <b>Number of wires</b>                     |           |     |
| # FEM                                      | 2         |     |
| # channels per FEM                         | 4         |     |
| DRAIN bias                                 | 1         |     |
| GATE bias                                  | 2         |     |
| phase switch bias                          | 2         |     |
|                                            | 5         | 20  |
| Common signals                             |           |     |
| Bias GND                                   | 1         |     |
| phase switch GND                           | 1         |     |
|                                            | 2         | 2   |
| <b>TOTAL # wires per FEM</b>               | <b>22</b> |     |
| <b>TOTAL # wires per freq. group</b>       | <b>44</b> |     |
| <b>Electrical characteristics of wires</b> |           |     |
|                                            | Signal    | GND |
| Current (mA)                               | 10        | 40  |
| Voltage to GND (V)                         | 2         | -   |

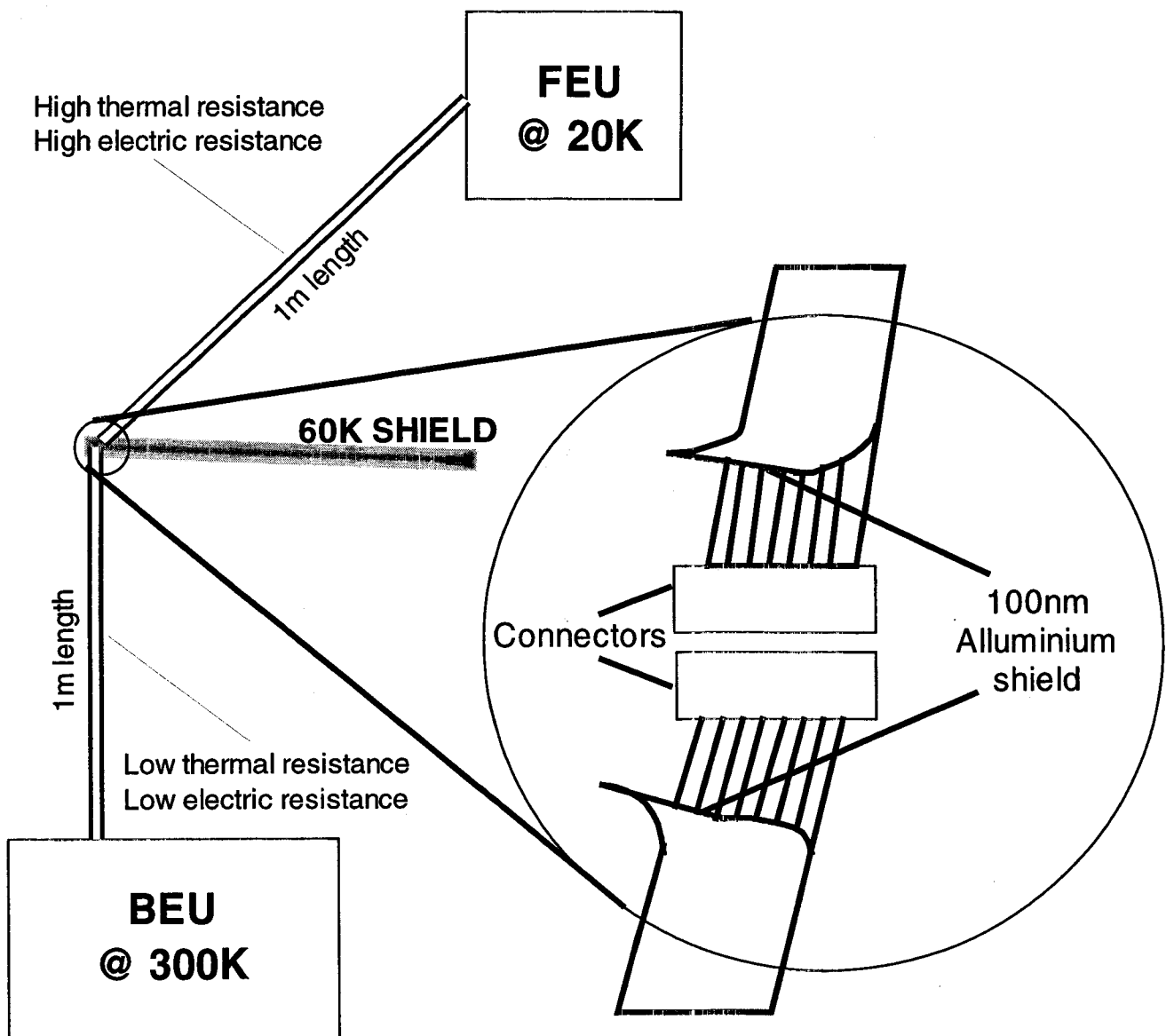
| 44 GHz                                     |           |     |
|--------------------------------------------|-----------|-----|
| <b>Number of wires</b>                     |           |     |
| # FEM                                      | 3         |     |
| # channels per FEM                         | 4         |     |
| DRAIN bias                                 | 1         |     |
| GATE bias                                  | 2         |     |
| phase switch bias                          | 2         |     |
|                                            | 5         | 20  |
| Common signals                             |           |     |
| Bias GND                                   | 1         |     |
| phase switch GND                           | 1         |     |
|                                            | 2         | 2   |
| <b>TOTAL # wires per FEM</b>               | <b>22</b> |     |
| <b>TOTAL # wires per freq. group</b>       | <b>66</b> |     |
| <b>Electrical characteristics of wires</b> |           |     |
|                                            | Signal    | GND |
| Current (mA)                               | 10        | 40  |
| Voltage to GND (V)                         | 2         | -   |

| 70 GHz                                 |            |     |
|----------------------------------------|------------|-----|
| <b>Number of wires</b>                 |            |     |
| # FEM                                  | 6          |     |
| # channels per FEM                     | 4          |     |
| DRAIN bias                             | 1          |     |
| GATE bias                              | 2          |     |
| phase switch bias                      | 2          |     |
|                                        | 5          | 20  |
| Common signals                         |            |     |
| Bias GND                               | 1          |     |
| phase switch GND                       | 1          |     |
|                                        | 2          | 2   |
| <b>TOTAL # wires per FEM</b>           | <b>22</b>  |     |
| <b>TOTAL # wires per freq. group</b>   | <b>132</b> |     |
| <b>Electrical wire characteristics</b> |            |     |
|                                        | Signal     | GND |
| Current (mA)                           | 10         | 40  |
| Voltage to GND (V)                     | 2          | -   |

| 100 GHz                                |            |     |
|----------------------------------------|------------|-----|
| <b>Number of wires</b>                 |            |     |
| # FEM                                  | 16         |     |
| # channels per FEM                     | 4          |     |
| DRAIN bias                             | 1          |     |
| GATE bias                              | 2          |     |
| phase switch bias                      | 2          |     |
|                                        | 5          | 20  |
| Common signals                         |            |     |
| Bias GND                               | 1          |     |
| phase switch GND                       | 1          |     |
|                                        | 2          | 2   |
| <b>TOTAL # wires per FEM</b>           | <b>22</b>  |     |
| <b>TOTAL # wires per freq. group</b>   | <b>352</b> |     |
| <b>Electrical wire characteristics</b> |            |     |
|                                        | Signal     | GND |
| Current (mA)                           | 10         | 40  |
| Voltage to GND (V)                     | 2          | -   |

|                                               |            |
|-----------------------------------------------|------------|
| <b>TOTAL # wires for 30, 44, 70, 100 GHz</b>  | <b>594</b> |
| <b>+ 12 x 4 wires for temperature sensors</b> | <b>48</b>  |
| <b>GRAND TOTAL</b>                            | <b>642</b> |

|                     |                                                                             |
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Wire diameter and materials characteristics definition is in progress

## 6.7 ELECTRICAL POWER SYSTEM INTERFACE

### 6.7.1 Power supply voltages

The DC main bus is regulated to 28 V with a maximum tolerance at the source (regulation point) of +1 %/- 2 %. This tolerance includes effects of load regulation, temperature and ageing.

Each Distribution Unit output is protected by a Latch Current Limit (LCL) or Fall-back Current Limiter (FCL).

In case of a redundant user, a non-redundant protection is provided for each redundancy.

In case of a non-redundant user, a redundant protection is provided for the user.

**GDEL-575:** Each satellite user Subsystem/Equipment shall be able to operate nominally within the following steady state voltage limits (applicable to S/C harness-Subsystems interface i.e. the voltage drop inside the Subsystem harness is not covered by these limits)

- 26 V as minimum voltage (mean voltage excluding any noise, ripple and spikes)
- 29 V as maximum voltage (mean voltage excluding any noise, ripple and spikes)

This range shall be used to establish Subsystem or Unit power budgets as reported in the IDS.

**GDEL-580:** All the users shall safely survive when being supplied with any continuous or fluctuating voltage in the full range 0V ↔ 35 V. In this case, survive means that equipment have to recover their nominal performance capabilities when the main bus recovers its nominal voltage.

### 6.7.2 Voltage transients and ripple

Transients and overvoltages are specified in the EMC Specification (document AD- 3)

**GDEL-585:** The ripple and spikes shall be less than (at Distribution Unit output connectors):

- 300 mV peak to peak on 28 V lines.

This peak to peak value is defined in a 50 MHz bandwidth.

### 6.7.3 Bus output impedance

**GDEL-590:** The primary bus impedance at S/C harness-Subsystem interface level (interface connector level) is specified in Figure 6.6.4.3-1.

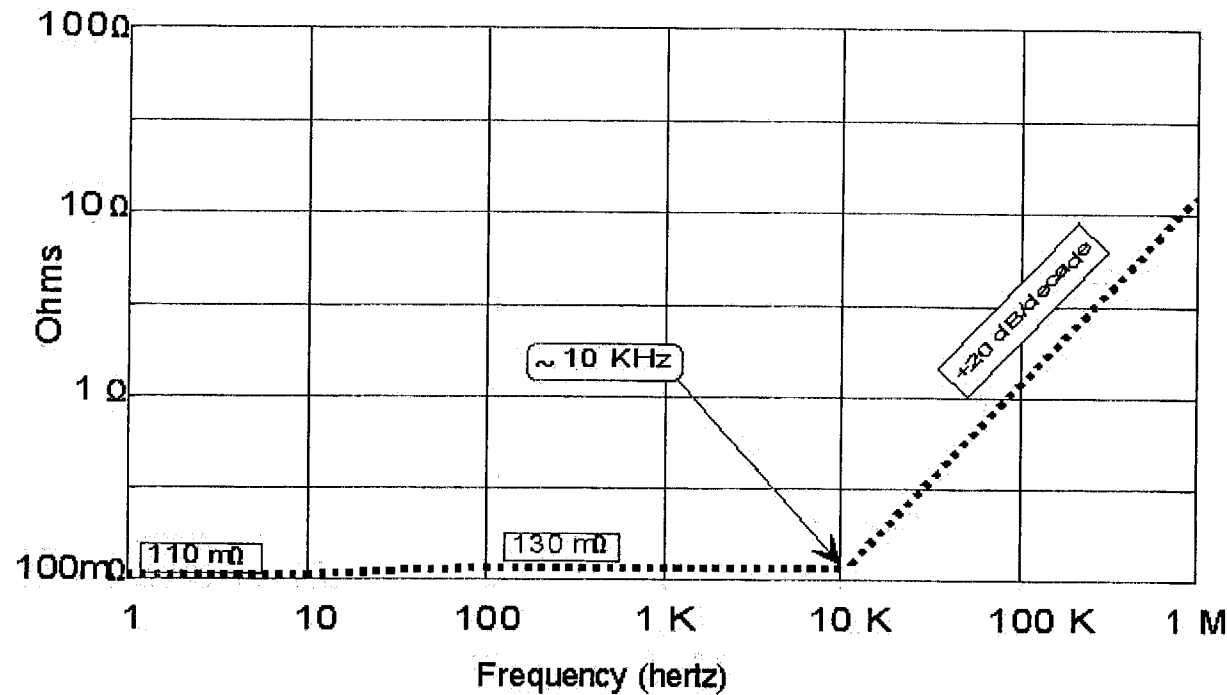


Figure 6.6.4.3-1: Bus Impedance at S/C Harness-User Subsystem Interface

**GDEL-595:** In addition, the Subsystem internal power harness (if exists) impedance from Subsystem interface connector level up to input connector sockets of the equipment (user) shall be considered as follows :

- The maximum ohmic component shall be such that the voltage drop (including forward and return lines) does not exceed 1% of the nominal supply voltage when the maximum current is drawn by the user. In no case it shall exceed half of the concerned bus DC output impedance (specified in Figure 6.6.4.3-1).

6.7.4 Current limiter characteristics

**GDEL-600:** The current limiters used in the power subsystem (equipments and instruments power supply lines) shall have the following characteristics:

- current limitation at a value  $I_l$ , with  $1.2 I_{max} \leq I_l \leq 1.5 I_{max}$  (TBC) except during first 50  $\mu s$
- If  $I_l$  is exceeded  $I_l$  for a time greater than 10 ms (TBC) then the LCL will automatically switch-off .
- Controlled  $di/dt$  during switch on of LCL . max  $di/dt$  = TBD A/s, min  $di/dt$  = TBD A/s
- Undervoltage protection – LCL switches OFF if bus voltage is <23.5V (TBC)



- **ON/OFF function shall be provided as well as its status and current telemetry for monitoring.**

**GDEL-602: Three types of current limiters shall be available:**

- **ON/OFF switchable current limiters (LCL) for "non-essential" loads, i.e; those items which if they are switched OFF do not jeopardise the spacecraft.**
- **Permanent ON foldback current limiters (FCL) for essential loads (receiver, decoder....)**
- **Electronic fuse + electronic switch (EF/ES) for resistive loads (heaters)**
- **Two levels of OFF command shall be provided within the LCL for those LCLs whose users cannot tolerate a failed permanent ON condition.**

$I_{max}$  is the current related to peak power calculated assuming the minimal supply voltage as defined in 6.7.6 short peak definition..

#### **6.7.4.1 Heaters line**

The PCDU will provide switchable power lines protected by an electronic fuse suitable to drive a resistive heater load.

**GDEL-603: The maximum voltage drop due to the electronic fuse + electronic switch shall be  $V_{drop} \leq 0.9V$  (TBC)**

#### **6.7.5 Average power demand definition**

The **average power** demand is defined for an equipment as the maximum average power drawn from its dedicated power lines in the worst case voltage conditions of paragraph 6.7.1.

Specifically, the **maximum average** is defined as the average during a period of 5 minutes shifted to any point in time where this average will yield a maximum and does not include peak power defined hereafter.

**GDEL-605: Each subsystem shall define its average power requirement per power line.**

#### **6.7.6 Peak power demand definition**

##### **a. Long peak**

Long peak power demand is defined for an equipment as the maximum peak drawn from its dedicated power lines, in the worst case voltage conditions of paragraph 6.7.1.

Specifically, the maximum long peak is defined using the integral during a period of 5 minutes shifted to any point in time over 100 minutes where the integral will yield a maximum.

##### **b. Short peak**



Short peak power demand is defined for an equipment as the maximum peak drawn for its dedicated power lines in the worst case voltage conditions of paragraph 6.7.1.

Specifically, the maximum short peak is defined using the integral during a period of 1 ms shifted to any point in time where the integral will yield the maximum.

To be defined as a short peak, the power demand shall last less than 100 ms.

The  $I_{max}$  defined for the LCL characteristics in 6.7.4 shall correspond to the current drawn during the short peak condition.

**GDEL-610: Each subsystem shall define its long and short peak power requirement per power line.**

### 6.7.7 Distribution and Protection Requirements

**GDEL-615: Any standing or variable current drawn by any unit from the supply lines shall be limited by the Power Supply to a value  $I_l$  defined in 6.7.4 under nominal conditions.**

Such a limitation is achieved by active current limiter on the power lines.

**GDEL-620: In particular, this limit shall be sustained for a single part failure at user's input and for the full voltage range specified (see paragraph 6.7.1).**

**GDEL-625: The use of current protection circuits on the primary side of user DC/DC converters shall be avoided since the PCDU LCLs will provide all the necessary protection. If the use of protection circuits cannot be avoided, then the protection threshold shall be set lower than the PCDU LCL and tests must be performed with a representative PCDU LCL as early as possible.**

**GDEL-627: Overvoltage/Undervoltage protection circuits on the primary side of user DC/DC converters shall be avoided since the PCDU LCLs will provide all the necessary protection. The user may incorporate overvoltage protection on the secondary side of the DC/DC converter.**

### 6.7.8 Load current transitions

#### 6.7.8.1 In-rush current

At power ON of the Distribution Unit power line via the LCL, the inrush current is limited to a value comprised between  $1.2 I_{max}$  (TBC) and  $1.5 I_{max}$  (TBC) during a duration  $t$  (minimum value guaranteed: 10 ms)

If the inrush current demand from the user is not under limitation value at  $t_{tripoff}$  the equipment will be switched off.

The Figure 6.7.8.1-1 gives the nominal current envelope.

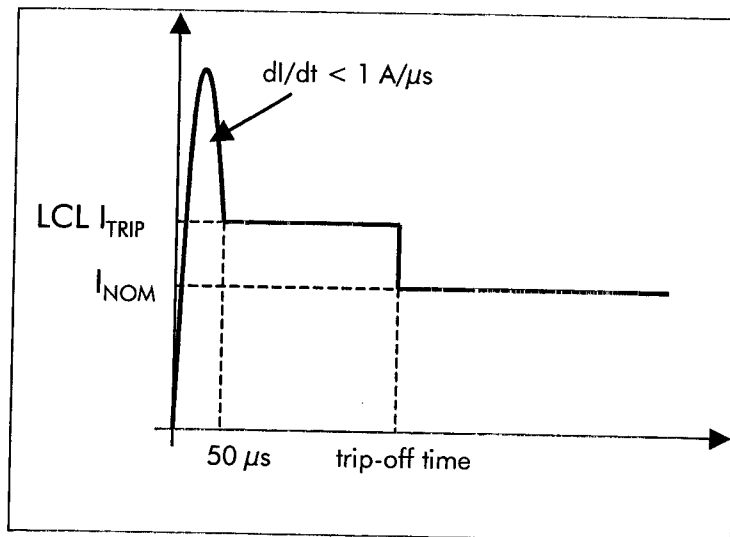


Figure 6.7.8.1-1: Nominal current envelope

- GDEL-630:** The instantaneous rate of change of current ( $di/dt$ ) variation shall not exceed  $10^6$  A/s either positive or negative.
- GDEL-635:** When connected to a non limiting current source (in test configuration) the inrush current at switch-on of the equipment shall be within the envelop defined in AD-3, § 3.2.4.8.2.
- GDEL-640:** When connected to the current limiter the inrush current at switch-on will be constrained to the envelope shown in Figure 6.7.8.1-1 by the Power Distribution Unit.

In this condition the user shall operate nominally ( $I$  nominal under nominal voltage) before  $t_{tripoff}$ .

#### 6.7.8.2 Load current transitions

In case of step or pulse transitions of supply current demand the transient voltage remains into limits given in EMC/ESD specification (AD- 3).

- GDEL-645:** Users shall not exceed their  $I_{max}$  during any planned operations.

In case of inadvertant user overload the supply current will be limited (by the Distribution Unit) to  $I_l$  in a period  $< 50 \mu s$ . It is from user responsibility to limit by itself the  $di/dt$  to  $10^6$  A/s during this transient phase.

If the overload lasts more than  $t$  ( $t > 10$  ms) the user will be switched off.

- GDEL-650:** The instantaneous rate of change of current ( $di/dt$ ) variation shall not exceed  $10^6$  A/s either positive or negative.
- GDEL-655:** Pulse repetition frequency shall not exceed 1 Hz unless confined to the limits of admissible ripple current as specified in EMC/ESD specification (AD- 3).