MARS EXPRESS

PLANETARY FOURIER SPECTROMETER

PFS PID-B

MEX-CNR-IQAR-06

PFS – IQAR- 06

DOCUMENT CHANGE RECORD

Iss/rev.	Date	Pages affected	Description
Draft	28/2/98	All	First draft
IRR	12 /4/99	ALL	IRR DOCUMENT
IPDR	30/11/99	all	Mex.cnr.ipdr
Signature	5/6/2000		
fm	14-9-01		

TABLE OF CONTENT

1- INSTRUMENT REQUIREMENTS

1.1 - MASS

The complete PFS Instrument consist of four modules

module "O" is the main double pendulum interferometer
dimensions (mm) : 260x350x430 and mass = 19.9 kg +0.4 kg for interface cups.+ 1 kg for the mass increase of the balancing mass. = 21.5 kg
module "S" is the IR scanner module
dimensions (mm) :200x190x322 and mass = 3.0 kg+ 0.5 kg margin. = 3.5 kg.
module "E" is the Digital Processing Unit
dimensions (mm) : 200x146x180 and mass = 3.0 kg
module "P" is the power supply
dimensions (mm) : 60x230x180 and mass = 2.3 kg

Interconnecting Harness mass <= 0.8 kg

The total extimated weight will be = 31.2 kg.

1.2 - POWER and THERMAL

The experiment power consumption will be:

6 Watts **in Cruise phase (ASTRA MODE) heating power.**
10 Watts **Power Stand-by (Sleeping mode, 5.5 hours along the orbit)**
35 Watts **Average Operational Power (Science mode 1.5 Hours along the obit)**
44 Watts **Peak Operational Power (when moving the scanner , for 1 minute).**

These values are based on the Mars Express hardware . 10 % variation in either direction can be the possible fluctuations of the values. The peak power here should be considered an upper limit .

1.3.- ENERGY

We need to cool down the SW detector, therefore there is a need of a spacecraft passive cooler (thermal radiator) to dissipate 3 W in deep space.

Furthermore there may be a problem of thermal heat of Module O , in the sense that , presently O is considered covered with MLI , which means isolation from the spacecraft. The 15 watts dissipated inside O , then , can be a problem unless we find a way to dissipate that heat to space by means of thermal contact to the spacecraft.

1.4.- RF LINK

We give our data to the spacecraft mass memory for the downlink trasmission.

1.5.- TM/TC
We have at the moment 61 telecommands. These may increase in the future , as we know that for Mars 96 we had about 80 telecommands. In any case our telecommands number will be less than 100. Each telecommand may have data words , see PFS-ICDR-10.

Our nominal data rate allocation is 15 % of spacecraft data volume per day to be able to transmit all the observations and the calibrations and the housekeeping data. We can take more data and transmit more , depending on the orbit operation cyclogram. On the basis of our data compression schemes (with loss of information) we can go down OCCASIONALLY ONLY to 105 Mbits per day (corresponding to 35 Mbit per orbit).

1.6.- SYNCH AND DATE
We do not need any synch. However we need the information available on board about the pericenter. This info is the time dt after the last pericenter , or , better , after the last time the spacecraft has decreased altitude below 1200 Km from the planetary surface.

PFS also needs the on board time to be added to the data , and to be used later to reconstruct the footprint location on Martian surface.

1.7.- PYRO
Pfs has no pyro on board.

1.8.- SOFTWARE AND MEMORY
There are 3 on board software , therefore there are 3 RAM and 3 ROM , plus there is a Mass memory of 32 Mbit (redundant to 49 Mbit).

Module E	**DAM**	**RAM**	**ROM**
	ICM	**RAM**	**ROM**

Mass memory = 32 (49) Mbits

Module O	**OBDM**	**RAM**	**ROM**

1.9. - EMC/EMI
The EMC test report has been produced separately. There were 2 NCR , for which it was requested to repeat two measurements. The report on these 2 measurements is also produced separately.

1.10.- POINTING

PFS has a pointing device because needs to point nadir to measure Martian radiation, but in order to calibrate the measurements, we need to point also to a Blackbody of known temperature , and to deep space. Occasionally , also , we may use our scanner to point off nadir. The IFOV is 4 deg for the LW and 2 deg for the SW channel. The IFOV can be rotated by 110 deg in a plane across track , with respect to the orbit trace. We also request an unobstructed FOV of 10 x 120 deg .

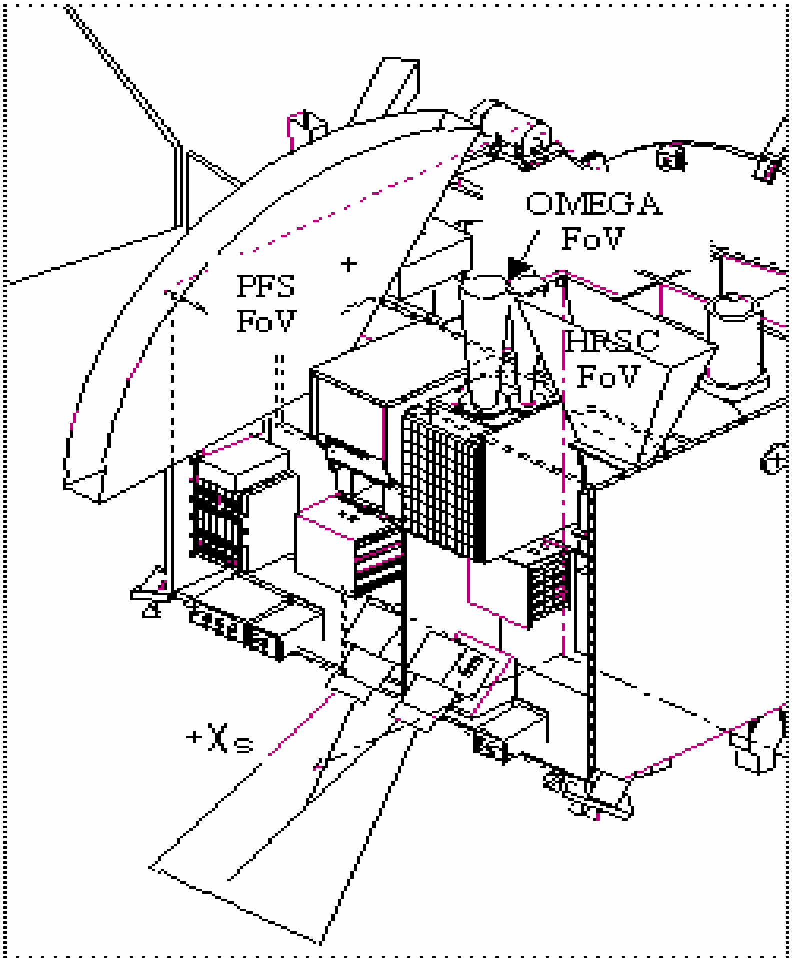


Image courtesy of MMS

1.11.- RELIABILITY

1.12 SCANNER FOV REQUIREMENTS

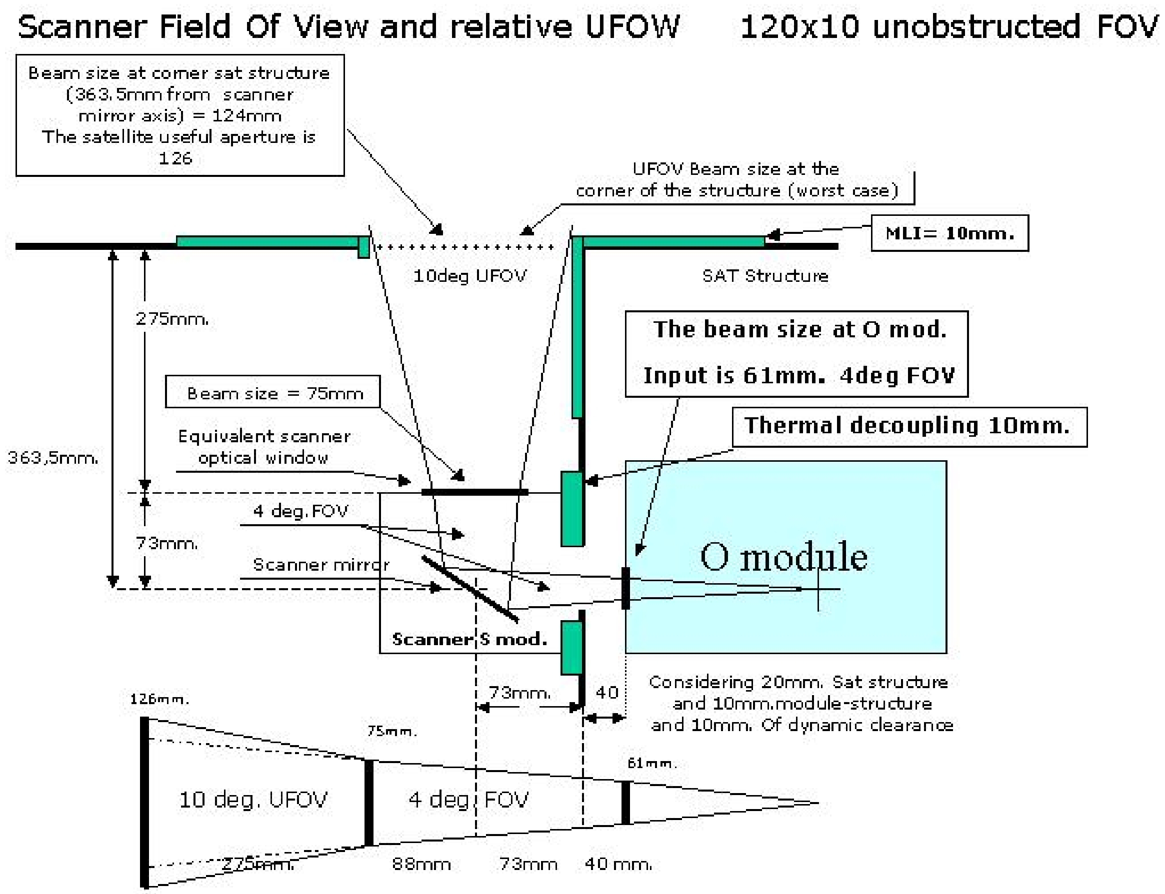


Fig. 1.13 NOTE: in the figure above the exit of O module should be 65 mm not 61 .

Diagram in fig 1.13 show the PFS FOW-UFOW requirements in details.

The beam size at O module input window is 65 mm. with a beam aperture of 4 deg.

The UFOV is 10deg. From the scanner main entrance and the beam size at the satellite structure (worst case) is 124mm.

2. - MECHANICAL INTERFACES

2.1 - UNITS CHARACTERISTIC MASS and DIMENTIONS

UNIT	MASS in kg.	DIMENSIONS in mm.
O	21.5	260 x 350 x 430
S	3.5	200 x 190 x 322
P	2.3	60 x 230 x 180
E	3.0	200 x 146 x 180
HARNESS	0.9	N/A
	TOTAL 31.2	

2.2 - UNITS CENTER Of GRAVITY CoG in mm.

UNIT	Xu [mm]	Yu [mm]	Zu [mm]	NOTE
O	-152.5	155	178.5	
S	106.0	80.0	78.0	
P	22.0	108.5	90.0	
E	75.0	100.0	90.0	

2.3 - UNITS MOMENT Of INERTIA [kgm^2]

UNIT	Ixu	Iyu	Izu	NOTE
O	0.53	0.33	0.43	
S	0.0189	0.0223	0.0223	
P	0.69	1.66	1.10	
E	2.1	1.6	1.8	

2.4 - MODULES BASEPLATES CONTACT AREA

MODULE	BASEPLATE CONTACT AREA in mm2 And Thickness	NOTE
O	N/A	REQUIRE EXTERNAL HEATSINK + 5W @ 200K
S		
P	6000 @ 8mm	
E	10000 @ 7mm	

2.5 - UNITS MATERIAL , SURFACES FINISHES TYPE and SURFACES CHARACTERISTIC

UNIT	MATERIAL	Surface Finishes Type	Epsilon	Alfa	NOTE
O	AA7075	Black Anodized	0.85	0.9	MLI outer layer
S	AA2024	Golden Kapton	0.03	0.3	
P	AA2024	Black Anodized	0.84	0.8	
E	AA2024	Black Anodized	0.84	0.8	

*** All materials (DIN 1725, BS) standard according to ESA PSS-01-701**

2.6 - ALIGNEMENT and CO-ALIGNEMENT REQUIREMENTS

Experiment Unit Wrt S/C	Accuracy [mrad]		Knowledge [mrad]		Stability [mrad]	
	Y	Z.	Y	Z	Y	Z
Module "S"	10	10	0.1	0.1	5.0	5.0

2.6.1 - O vs. S ALIGNEMENT REQUIREMENTS

Experiment Unit wrt other Units	Accuracy [mrad]		Knowledge [mrad]		Stability [mrad]	
	Y	Z	Y	Z	Y	Z
Module “O” wrt Module “S”	1.0	1.0	0.1	0.1	0.5	0.5

2.6.2 - COVERS DEFINITION

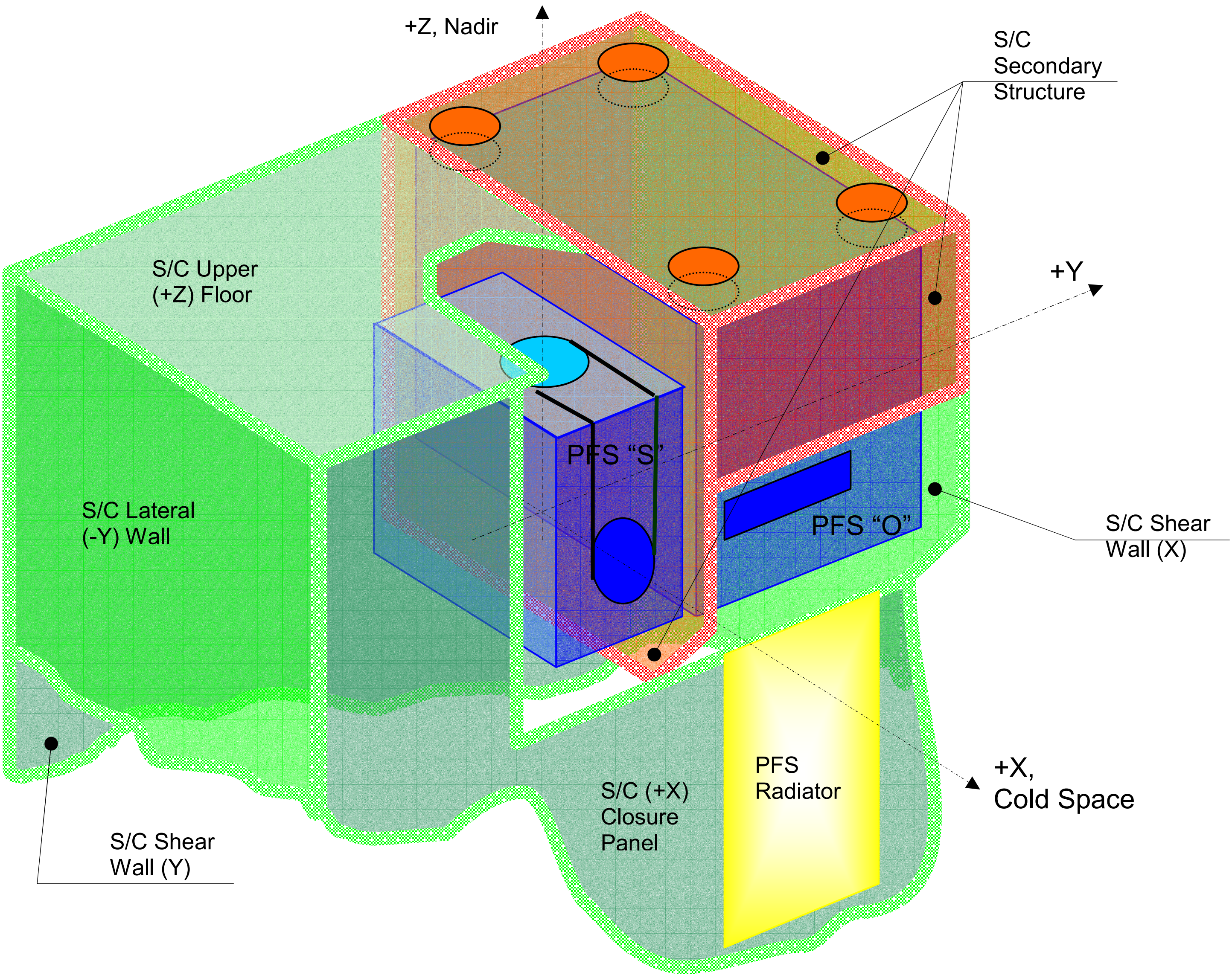
The only covers foreseen are "non flight" elements removed before launch.

2.6.2.1 - DEPLOYEMENT and RETENTION SYSTEMS DEFINITION

No deployable elements are foreseen

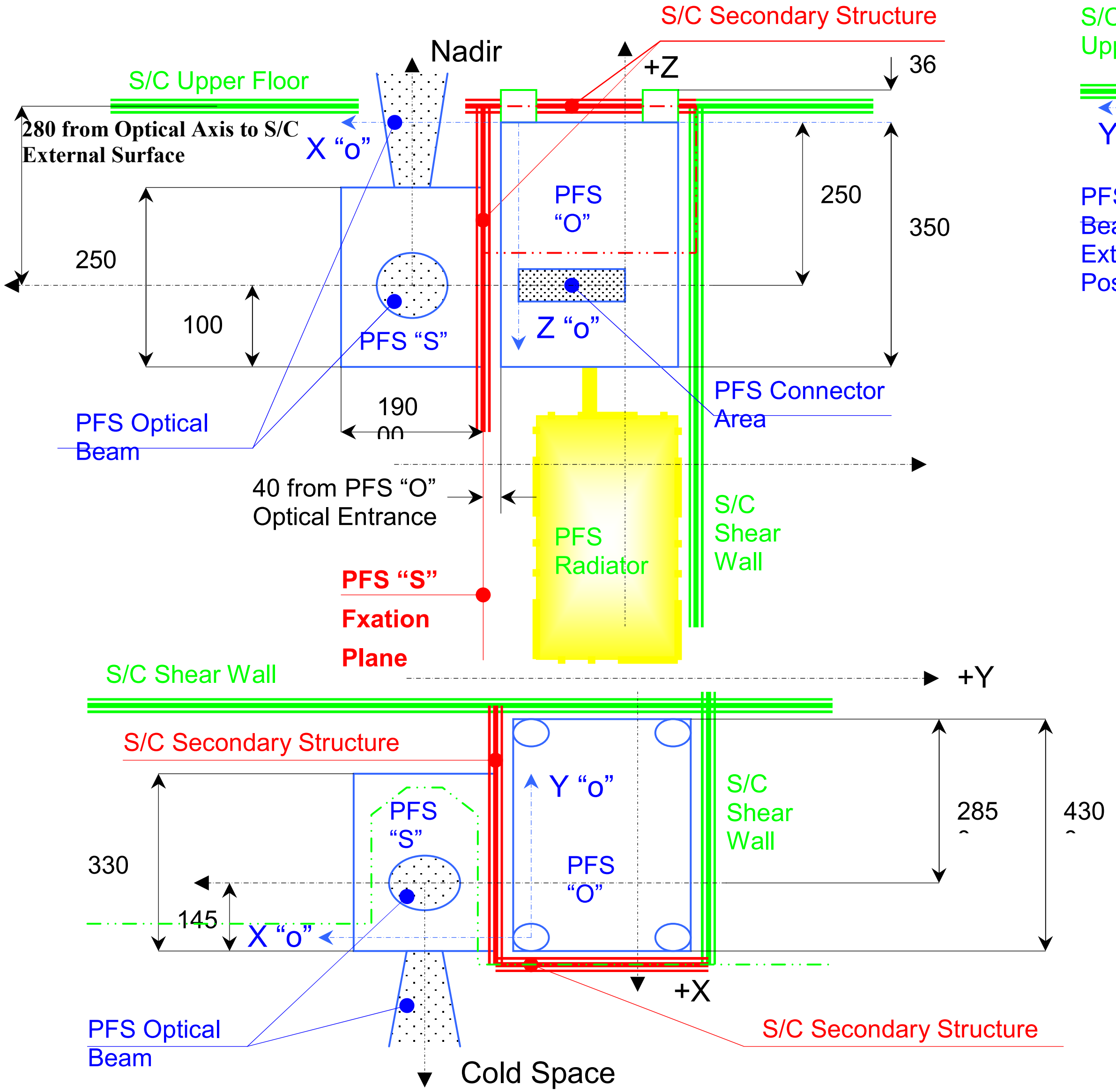
2.6.3 - PURGING INTERFACES

Nitrogen filling is required to keep umidity inside O mod. Less then 50% and will be used after termovacuum test and during transportation



Courtesy of C. Lebranchu ACEMATRA MARCONI SPA

Figure 1 S/C layout



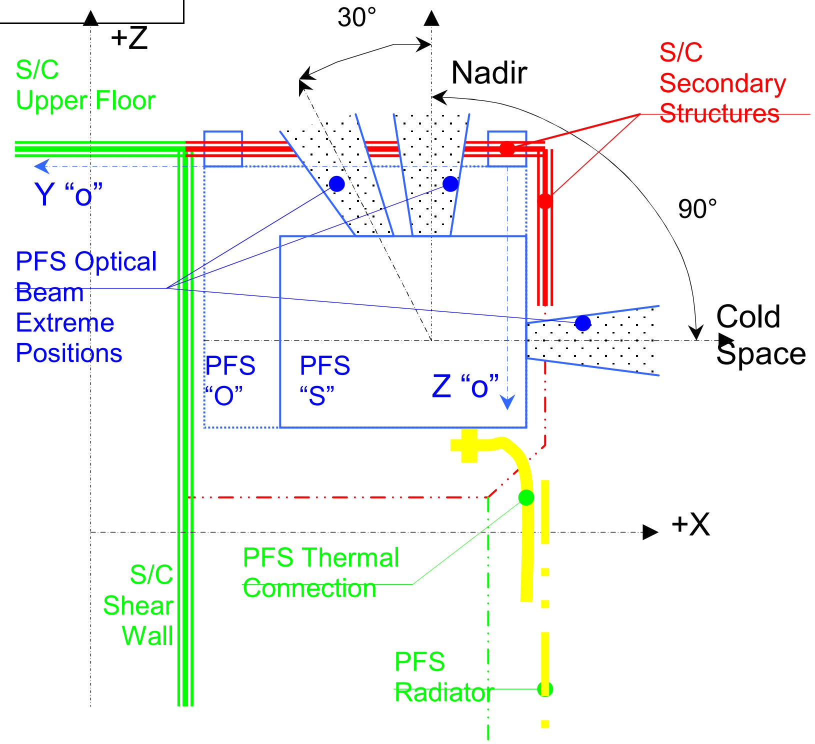


Figure 2 Module S and O accomodation

Courtesy of C. Lebranchu MATRA MARCONI SPACE

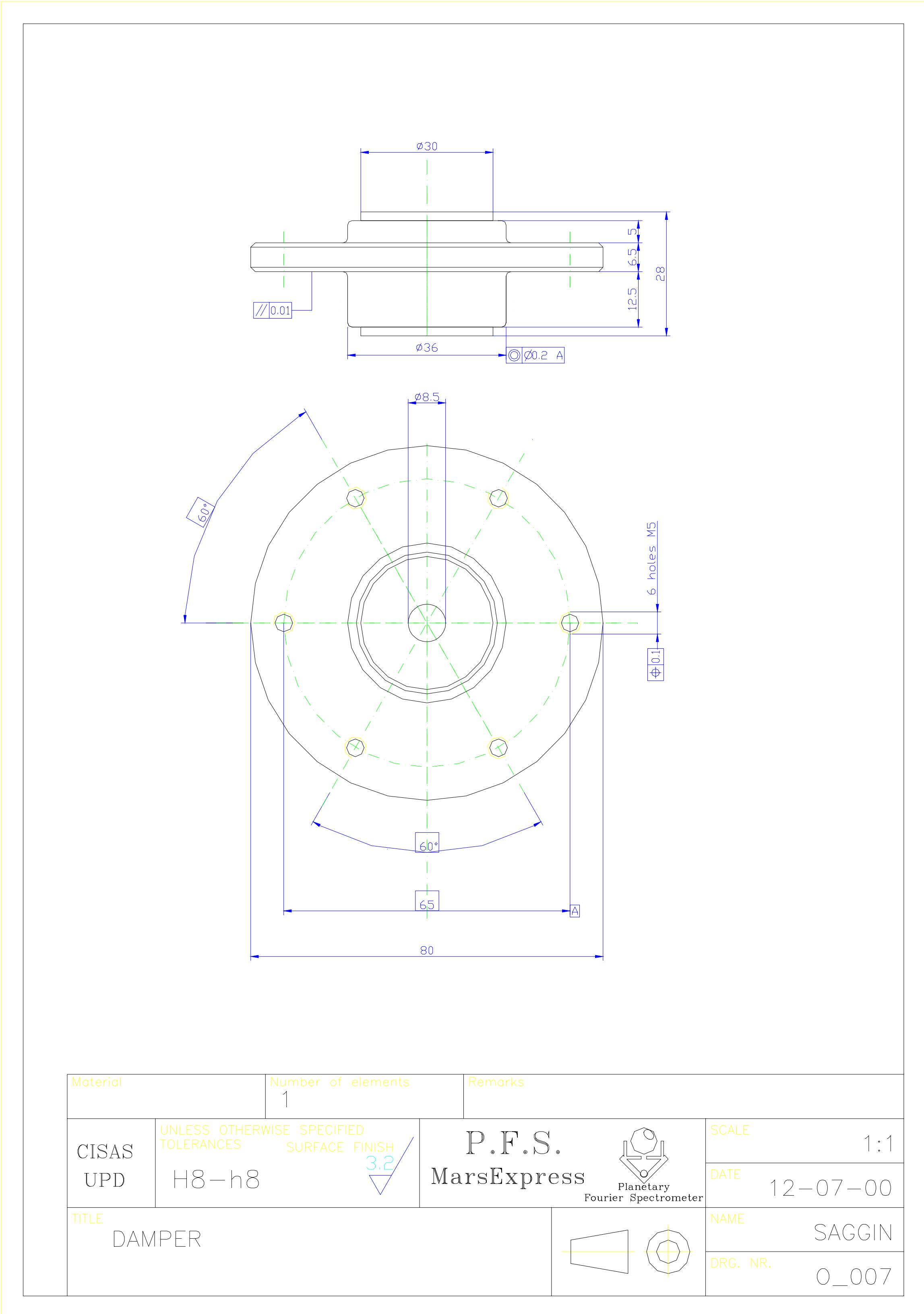


Figure 3 Module O damper

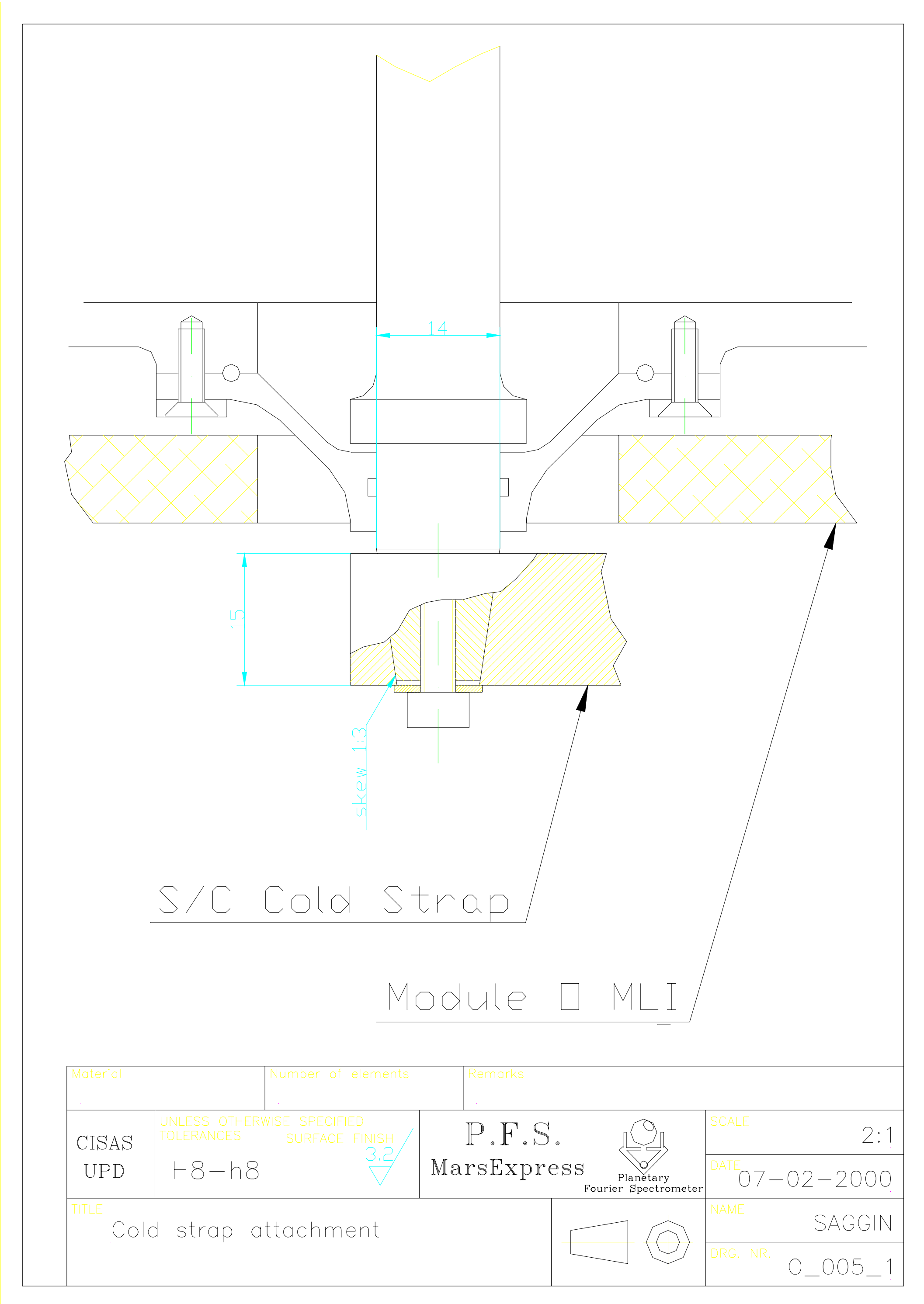


Figure 4 Cold strap interface.

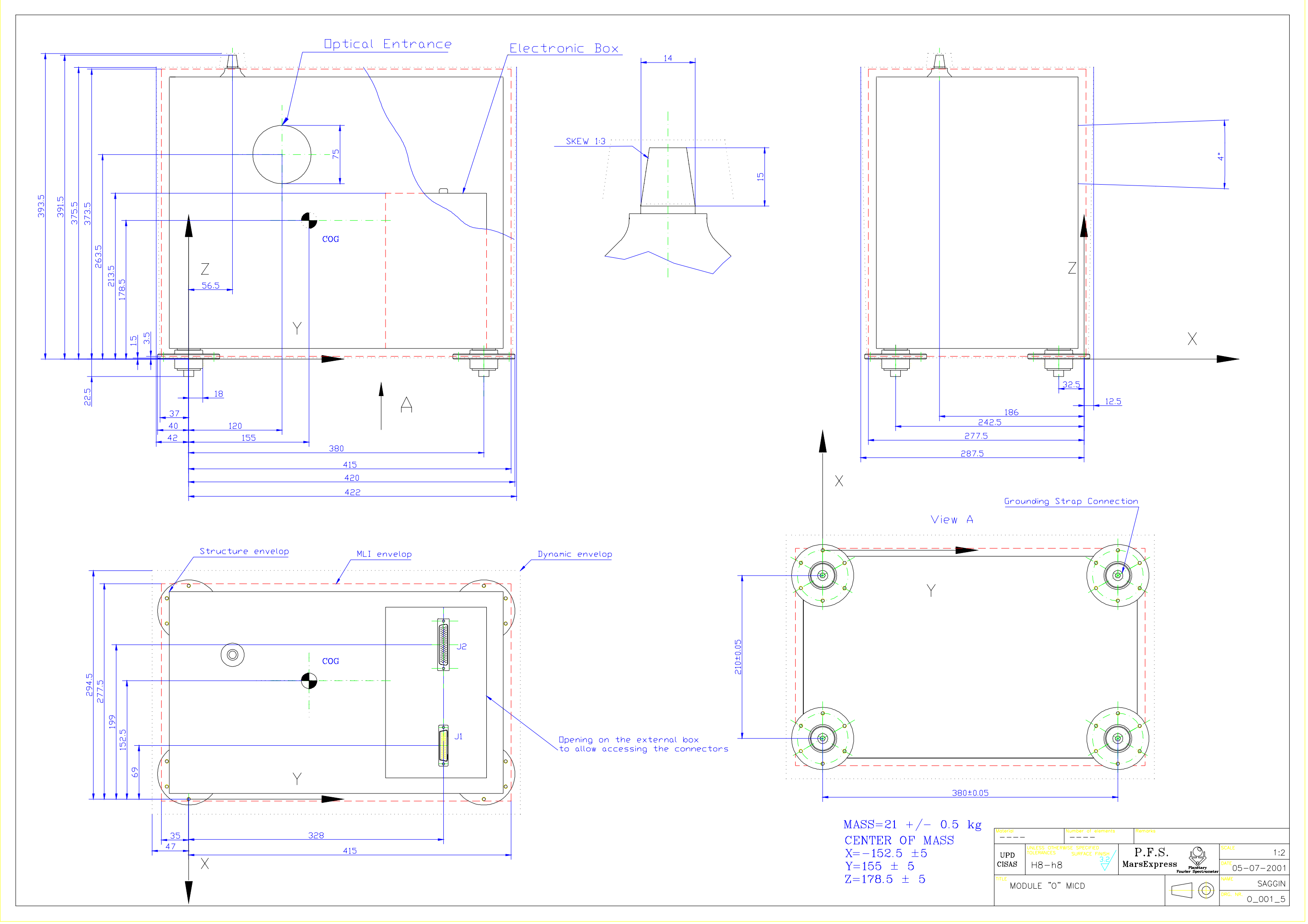


Figure 5 Module O general drawing

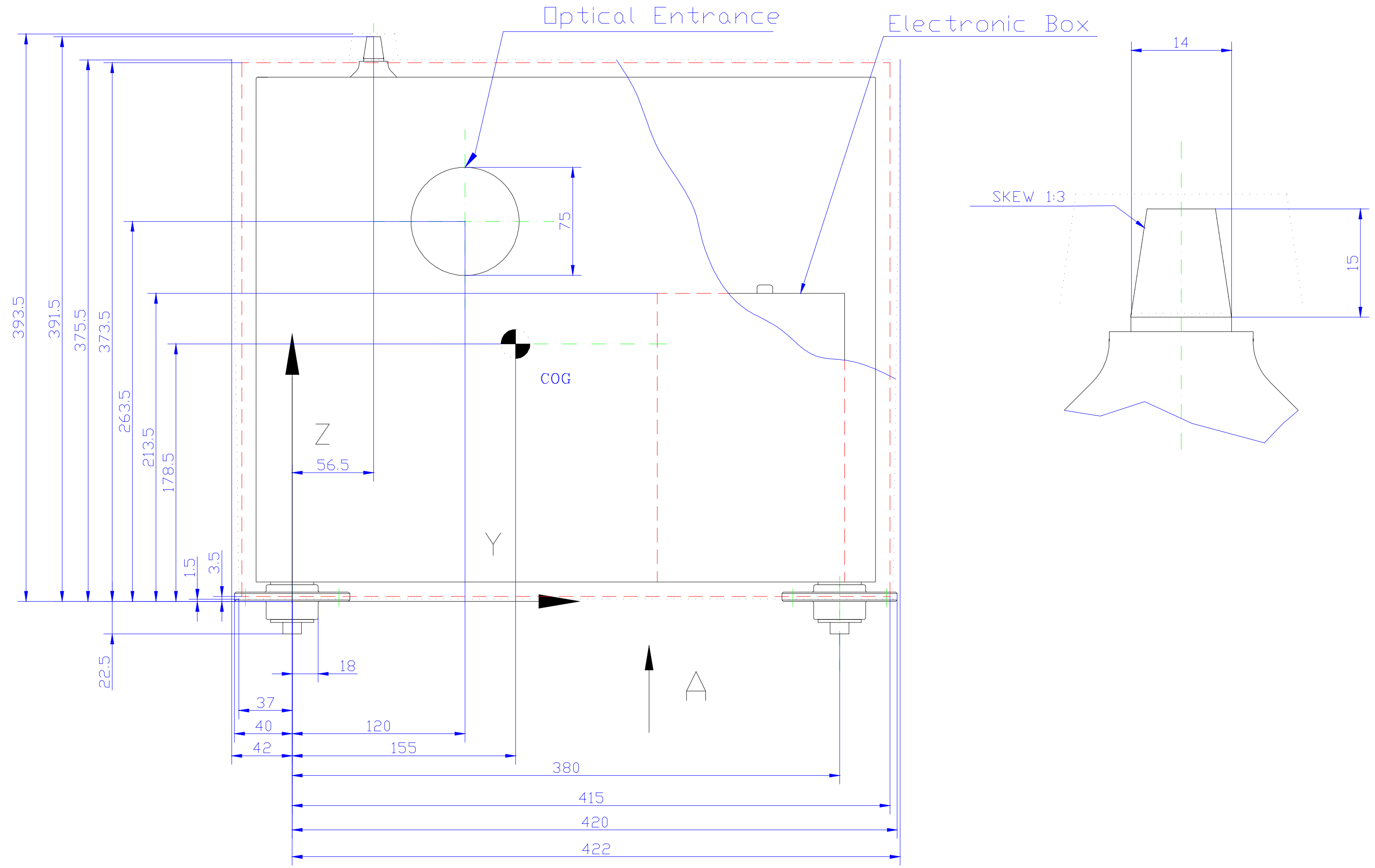


Figure 6 Module O view 1

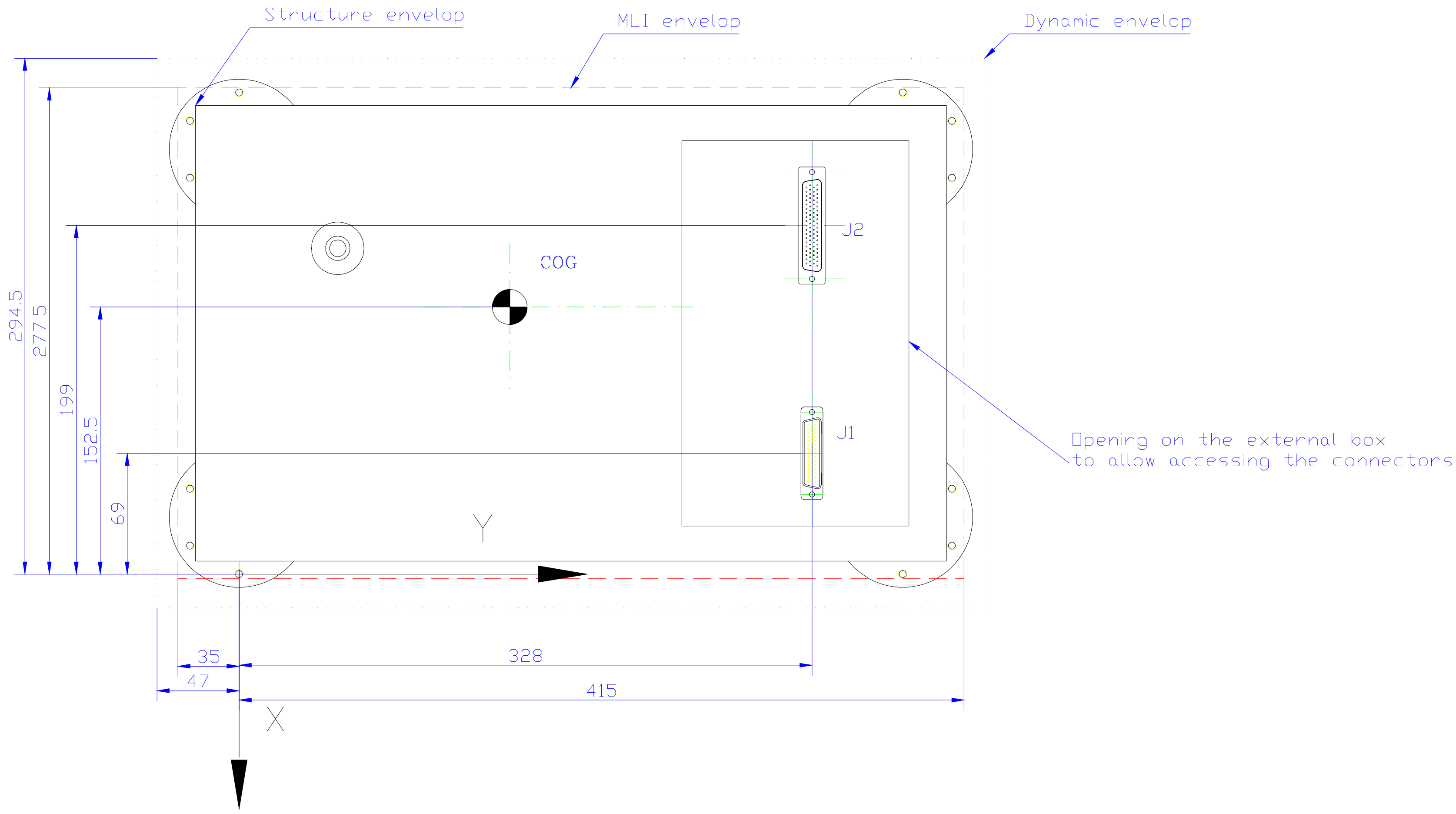


Figure 7 Module O view 2

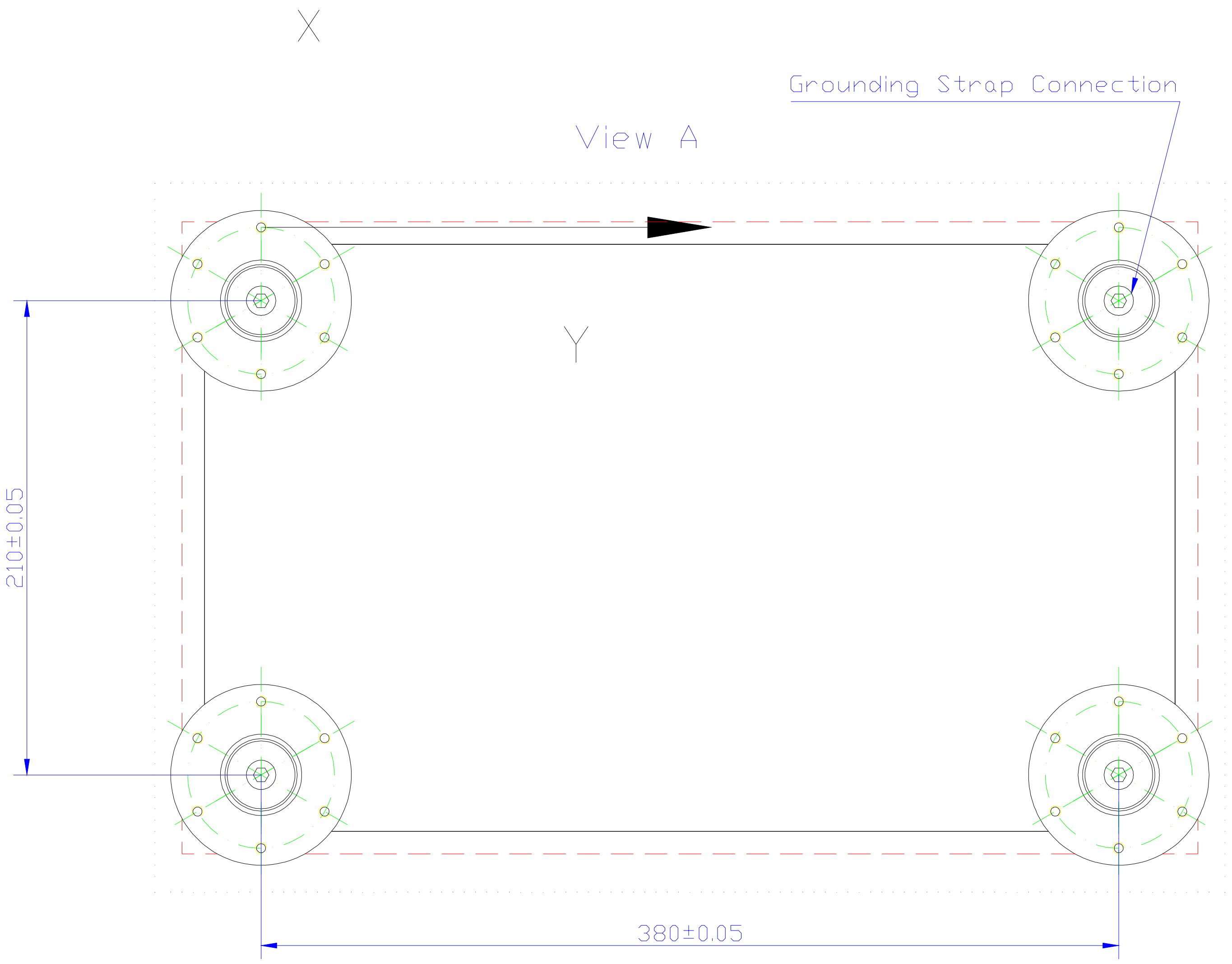


Figure 8 Module O view 3

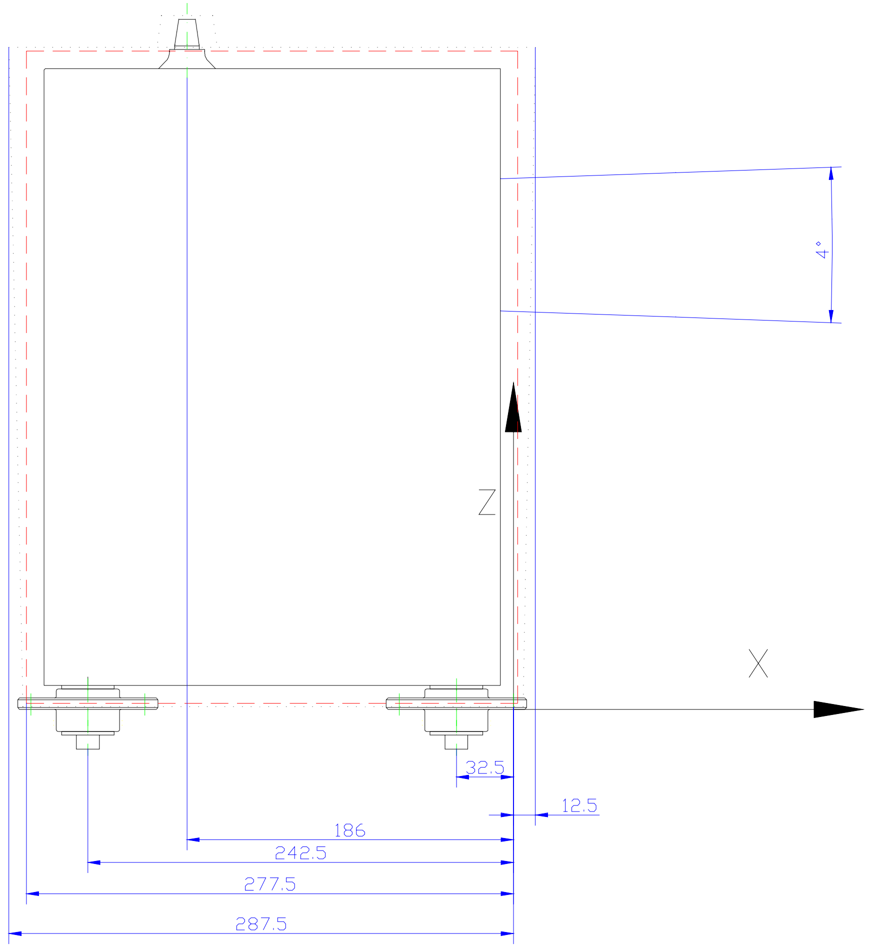


Figure 9 Module O view 4

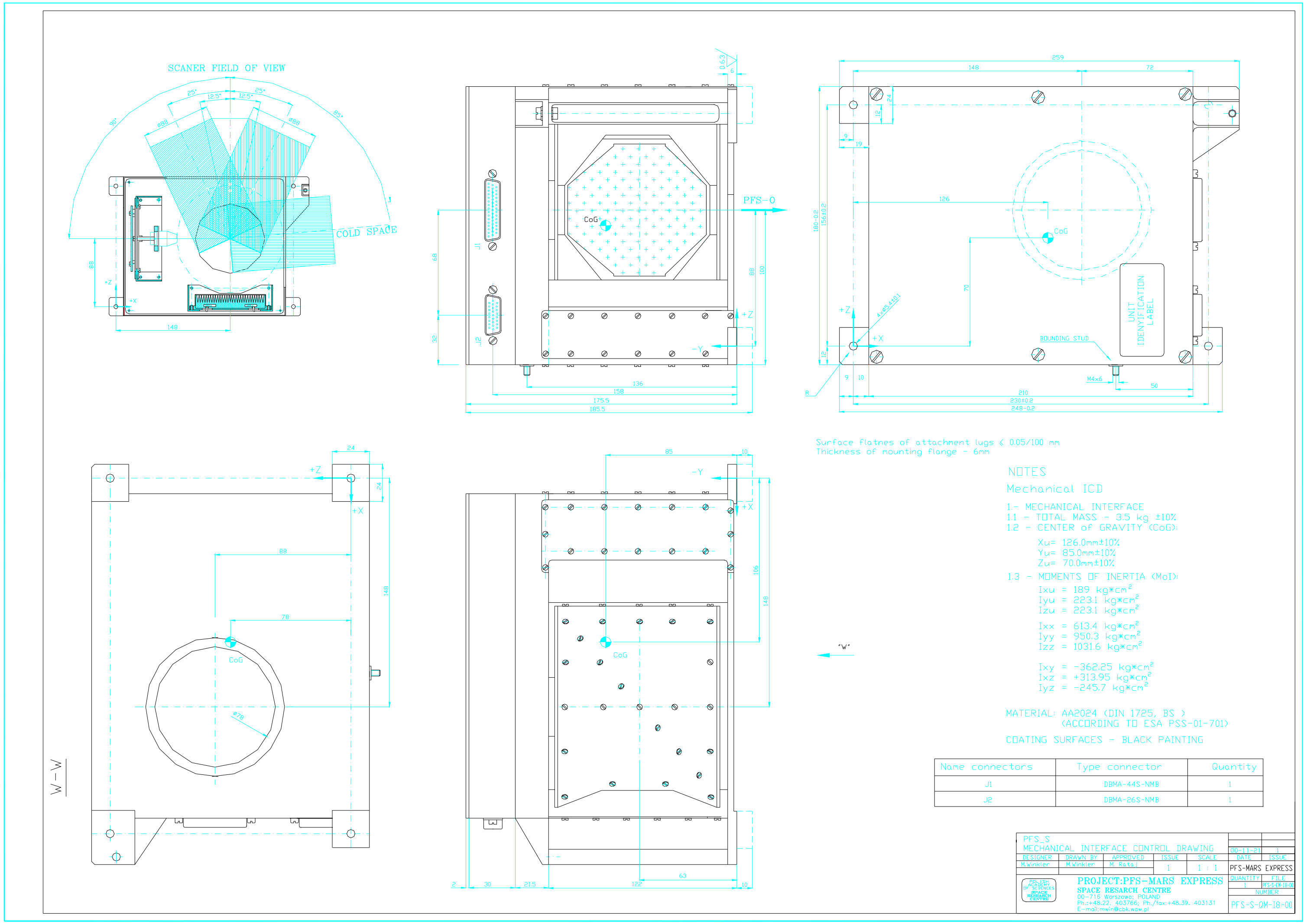


Figure 10 Module S general drawing

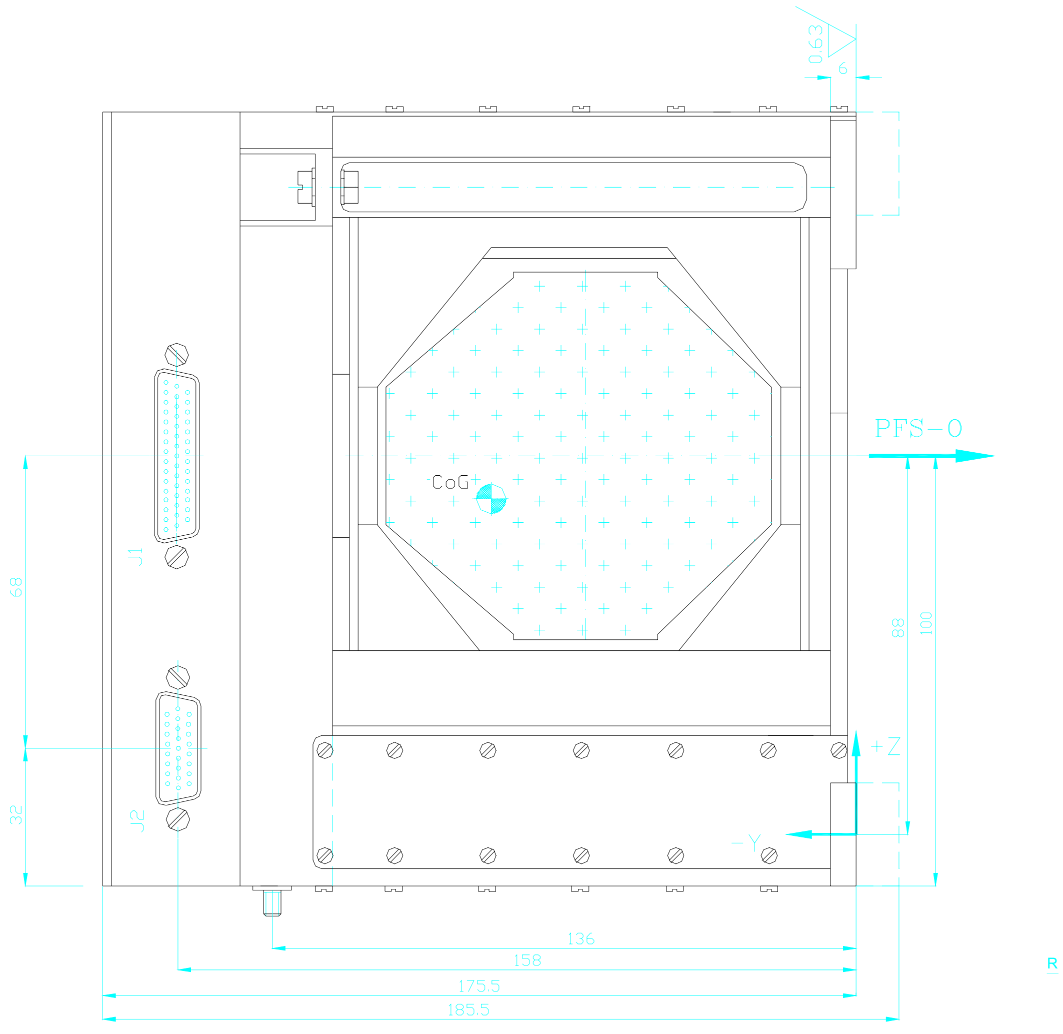


Figure 11 Module S view 1

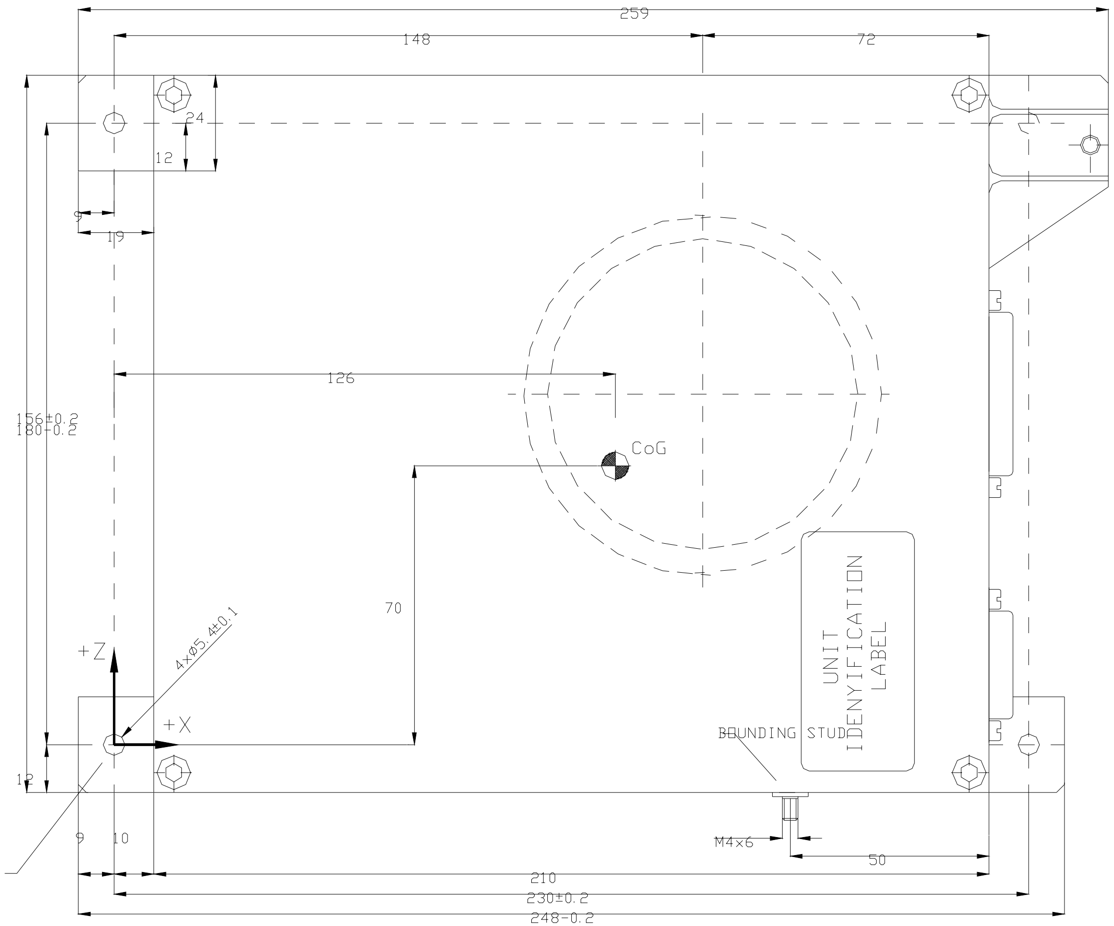


Figure 12 Module S view 2

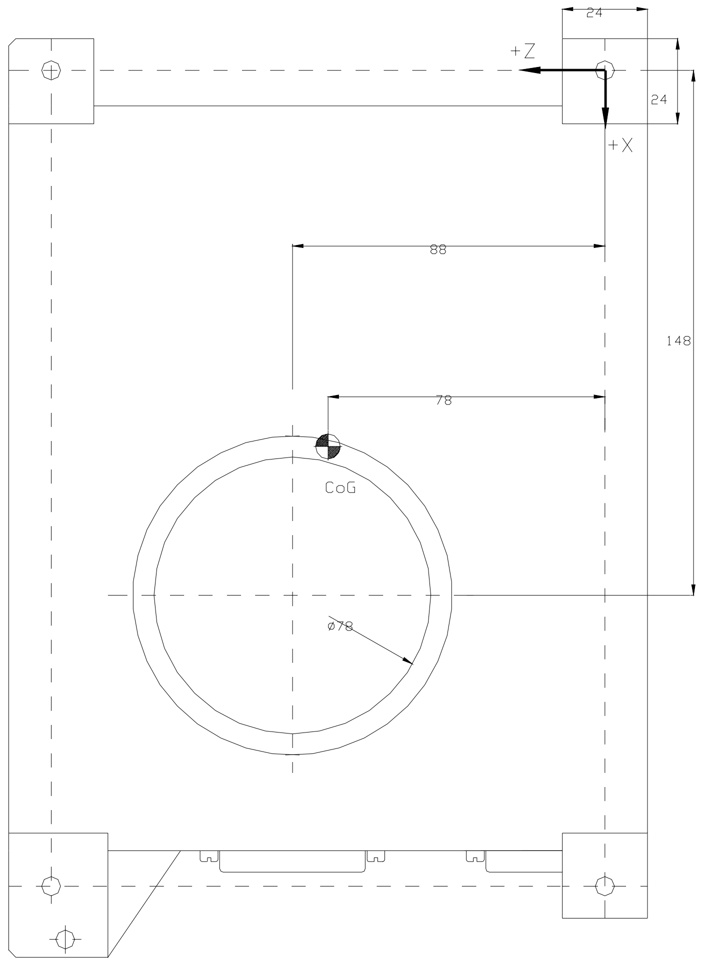


Figure 13 Module S view 3

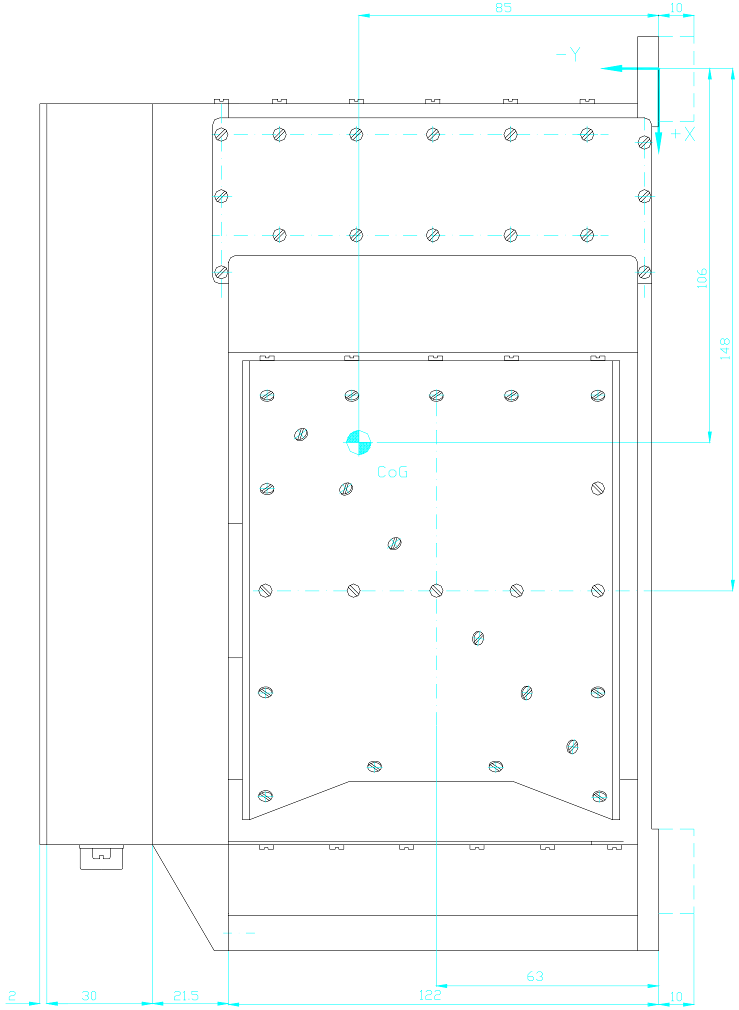


Figure 14 Module S view 4

Surface flatnes of attachment lugs < 0.05/100 mm
Thickness of mounting flange - 6mm

NOTES

Mechanical ICD

1.- MECHANICAL INTERFACE
1.1 - TOTAL MASS - 3.5 kg ±10%
1.2 - CENTER of GRAVITY (CoG):

Xu= 126.0mm±10%
Yu= 85.0mm±10%
Zu= 70.0mm±10%

1.3 - MOMENTS OF INERTIA (MoI):

I_{xu} = 189 $kg*cm^2$
I_{yu} = 223.1 $kg*cm^2$
I_{zu} = 223.1 $kg*cm^2$

I_{xx} = 613.4 $kg*cm^2$
I_{yy} = 950.3 $kg*cm^2$
I_{zz} = 1031.6 $kg*cm^2$

"W"

I_{xy} = -362.25 $kg*cm^2$
I_{xz} = +313.95 $kg*cm^2$
I_{yz} = -245.7 $kg*cm^2$

MATERIAL: AA2024 (DIN 1725, BS)
(ACCORDING TO ESA PSS-01-701)

COATING SURFACES - BLACK PAINTING

Name connectors	Type connector	Quantity
J1	DBMA-44S-NMB	1
J2	DBMA-26S-NMB	1

Figure 15 Module S view 4

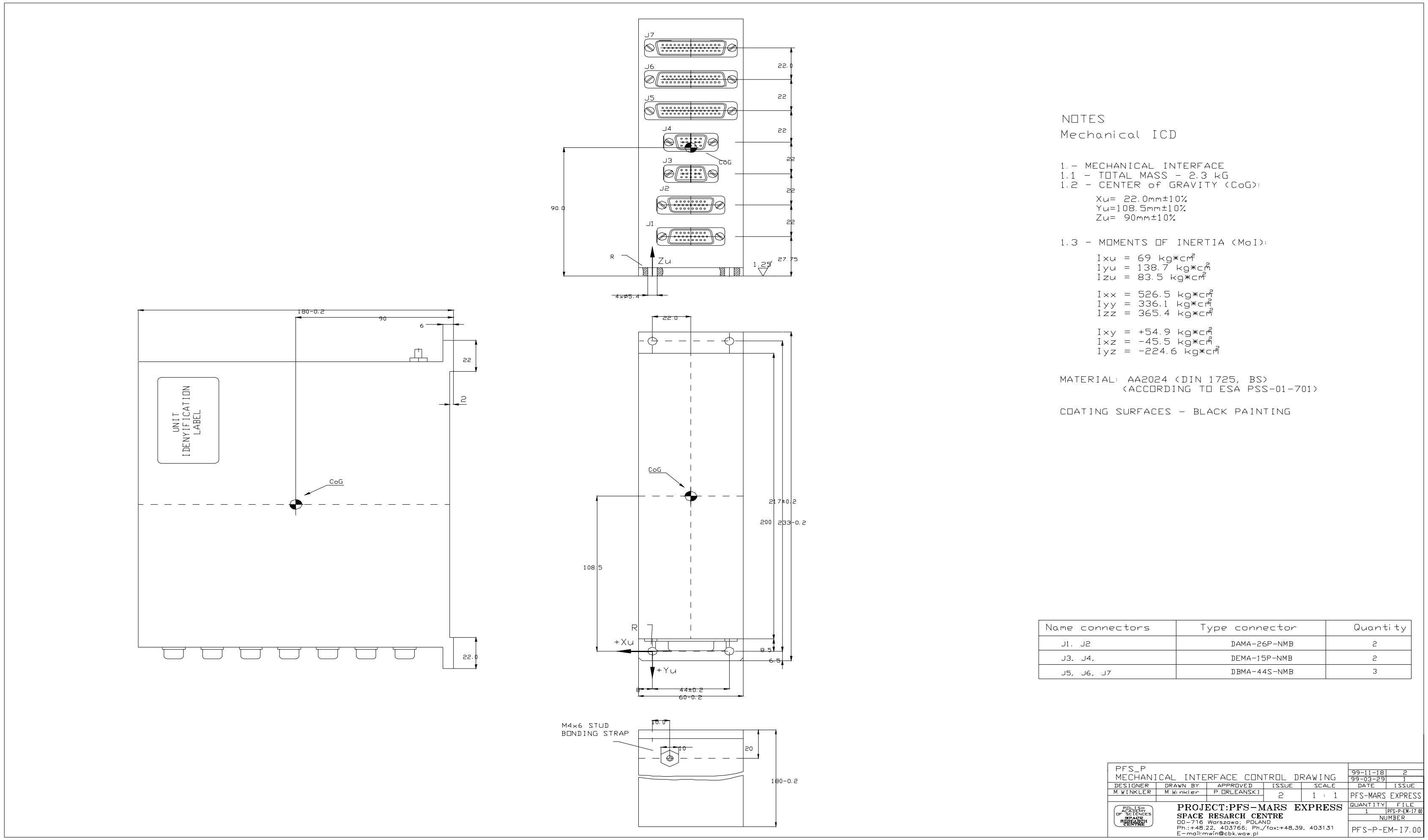


Figure 16 Module P general drawing

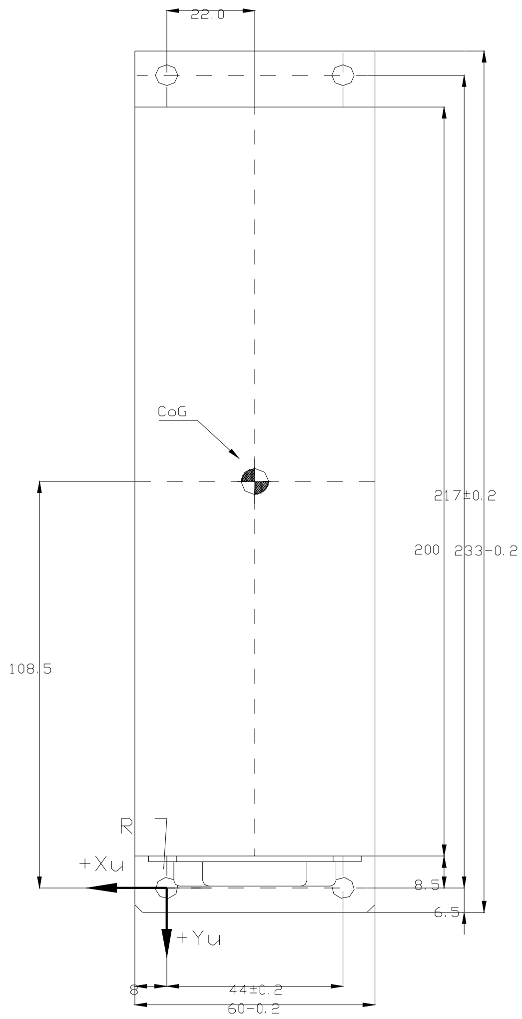


Figure 17 Module P view 1

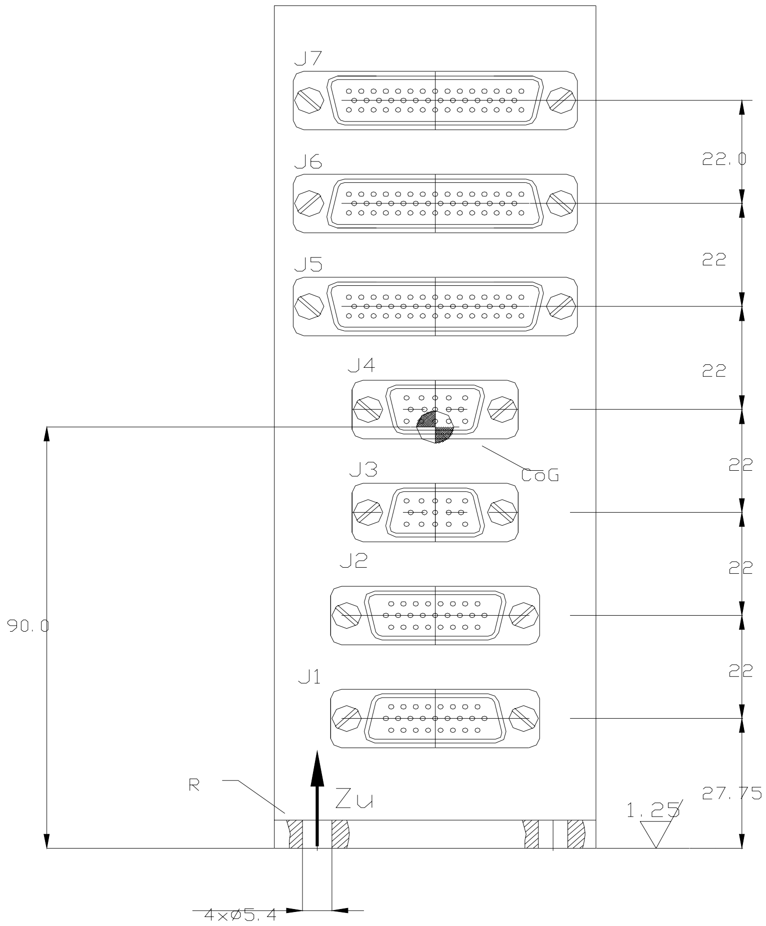


Figure 18 Module P view 2

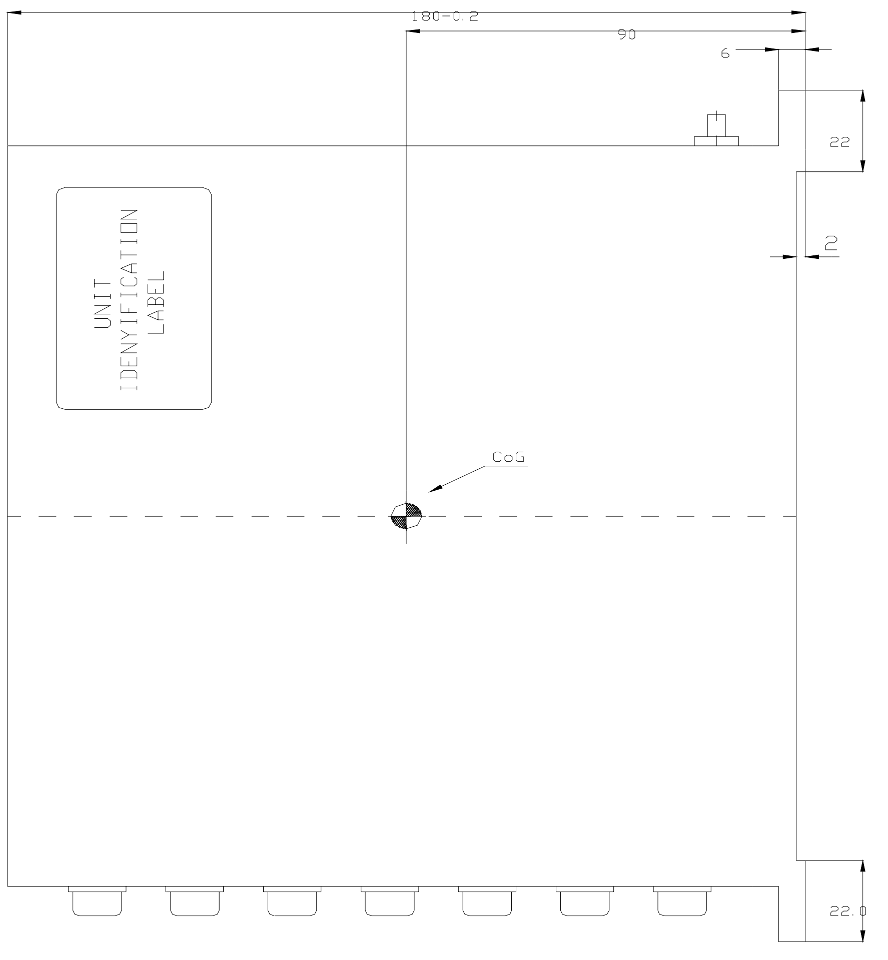


Figure 19 Module P view 3

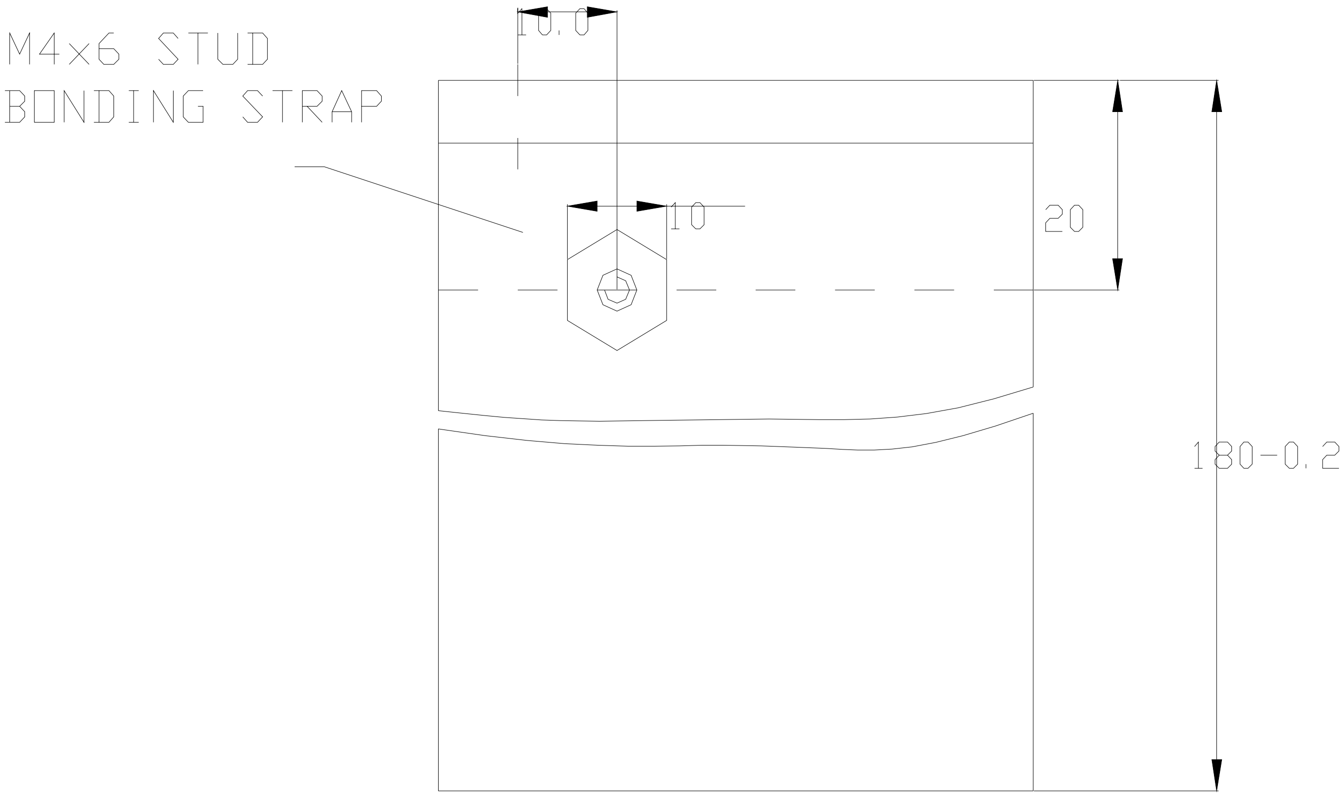


Figure 20 Module P view 4

NOTES

Mechanical ICD

1.- MECHANICAL INTERFACE

1.1 - TOTAL MASS - 2.3 kG

1.2 - CENTER of GRAVITY (CoG):

Xu= 22.0mm±10%
Yu=108.5mm±10%
Zu= 90mm±10%

1.3 - MOMENTS OF INERTIA (MoI):

Ixu = 69 kg*cm²
Iyu = 138.7 kg*cm²
Izu = 83.5 kg*cm²

Ixx = 526.5 kg*cm²
Iyy = 336.1 kg*cm²
Izz = 365.4 kg*cm²

Ixy = +54.9 kg*cm²
Ixz = -45.5 kg*cm²
Iyz = -224.6 kg*cm²

MATERIAL: AA2024 (DIN 1725, BS)
(ACCORDING TO ESA PSS-01-701)

COATING SURFACES - BLACK PAINTING

Figure 21 Module P view 5

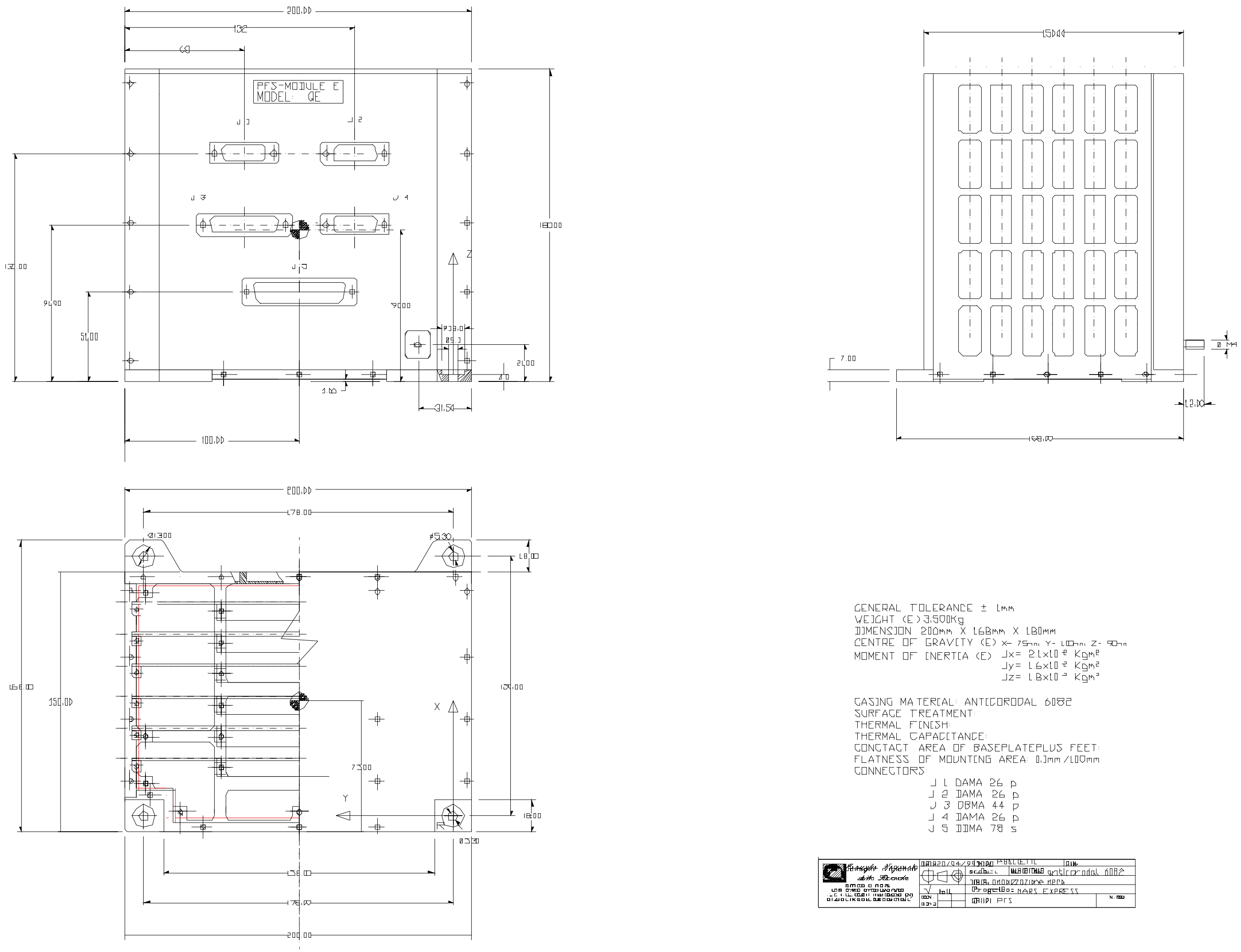


Figure 22 Module E general drawing

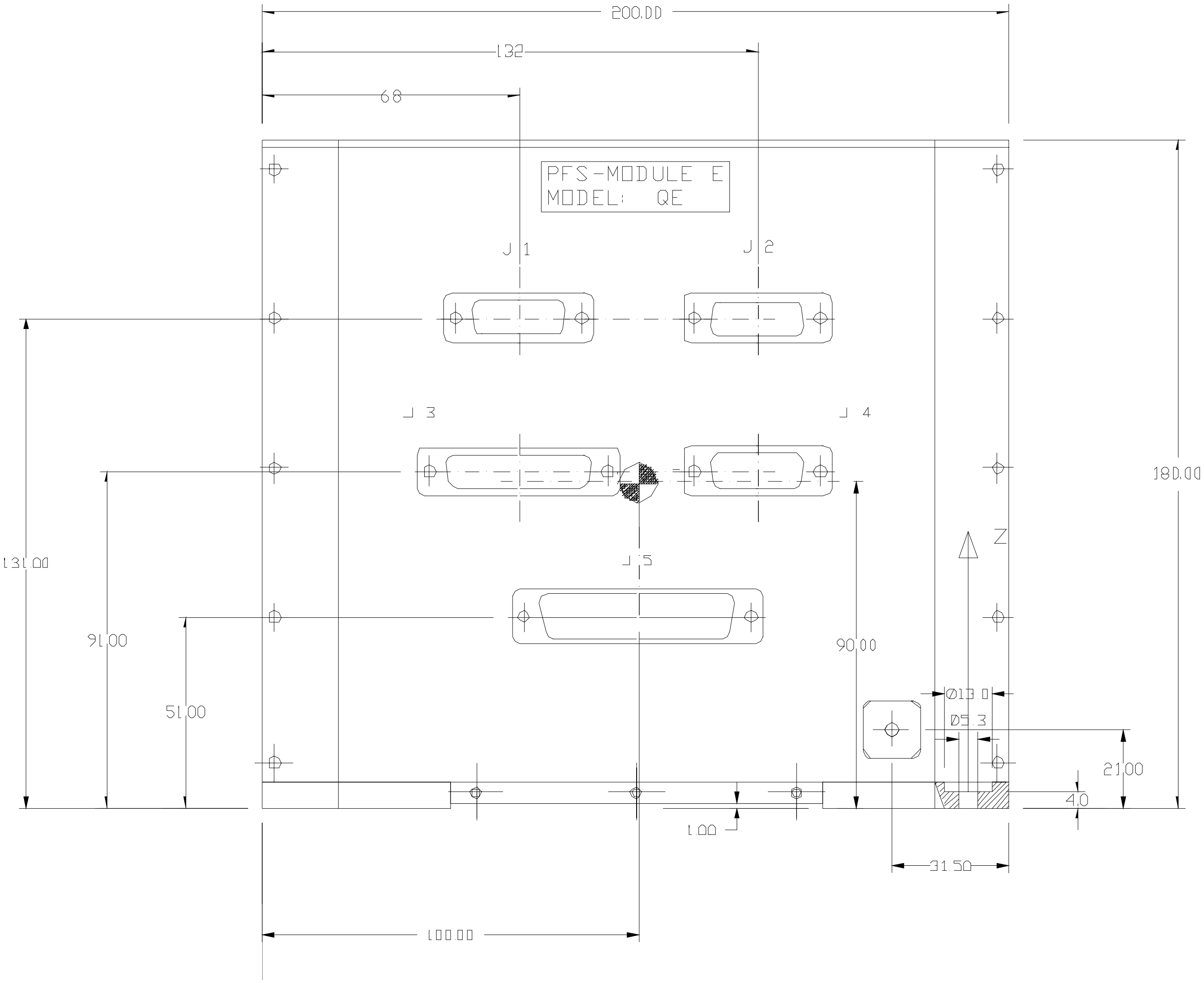


Figure 23 Module E view 1

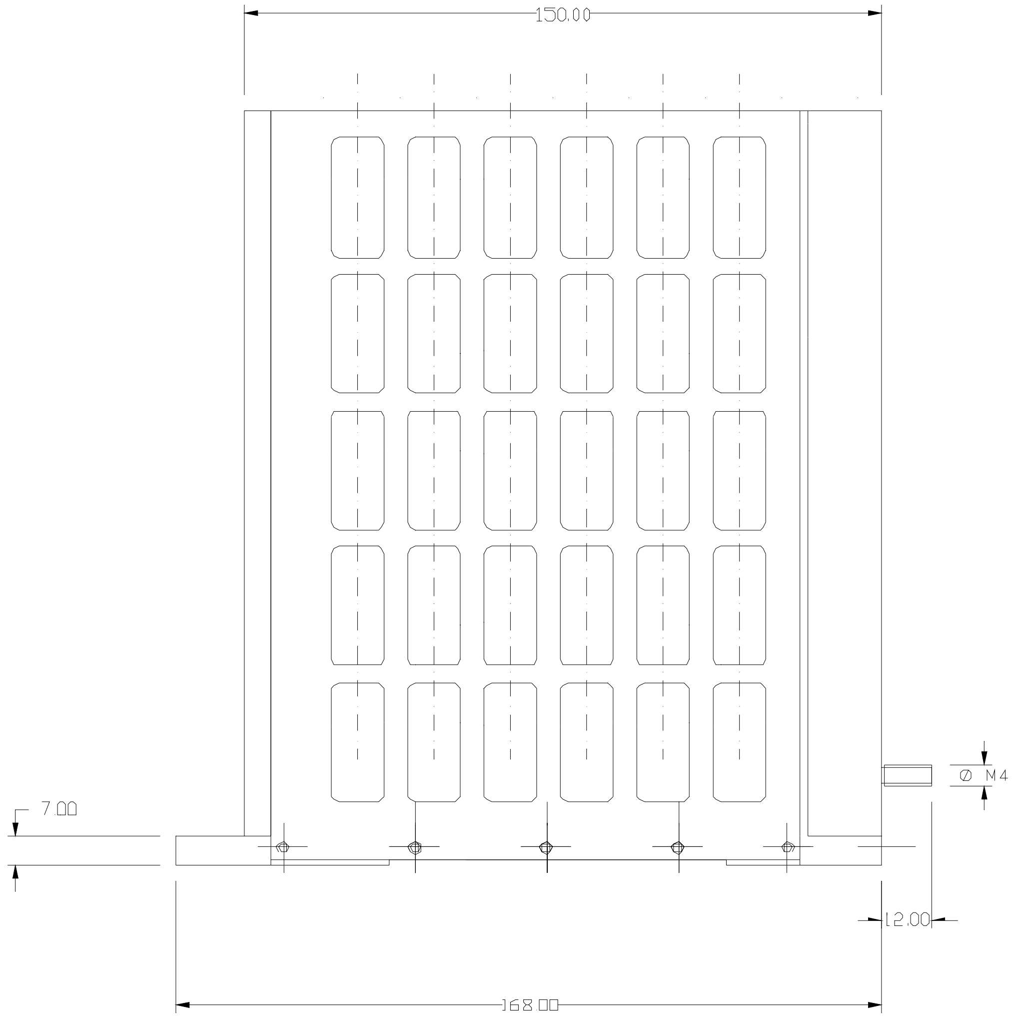


Figure 24 Module E view 2

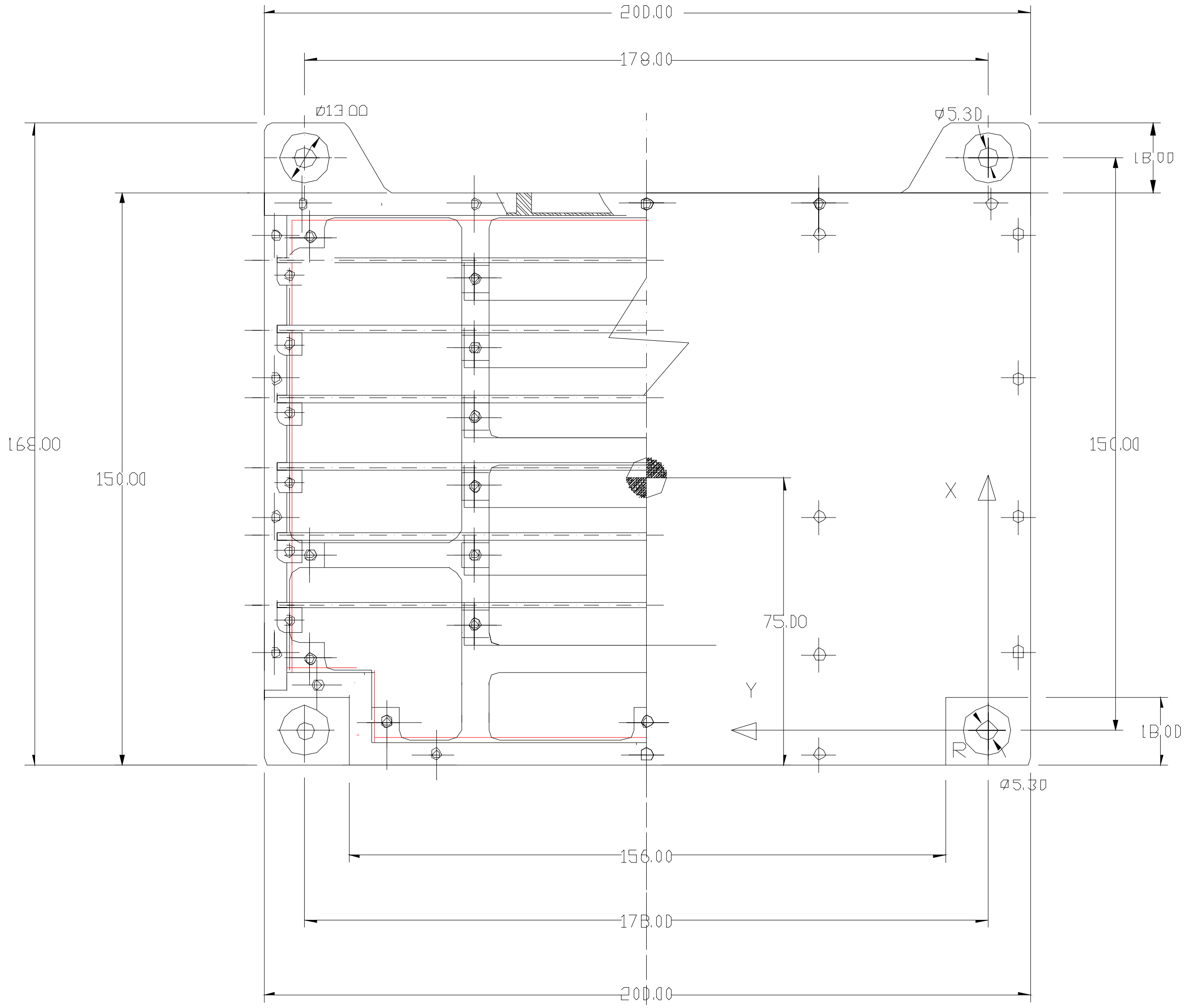


Figure 25 Module E view 3

.

GENERAL TOLERANCE ± 1mm
WEIGHT (E) 3.500Kg
DIMENSION 200mm X 168mm X 180mm
CENTRE OF GRAVITY (E) X= 75mm; Y= 100mm; Z= 90mm
MOMENT OF INERTIA (E) $J_x = 2.1\times10^{-2}$ Kgm^2
$J_y = 1.6\times10^{-2}$ Kgm^2
$J_z = 1.8\times10^{-2}$ Kgm^2

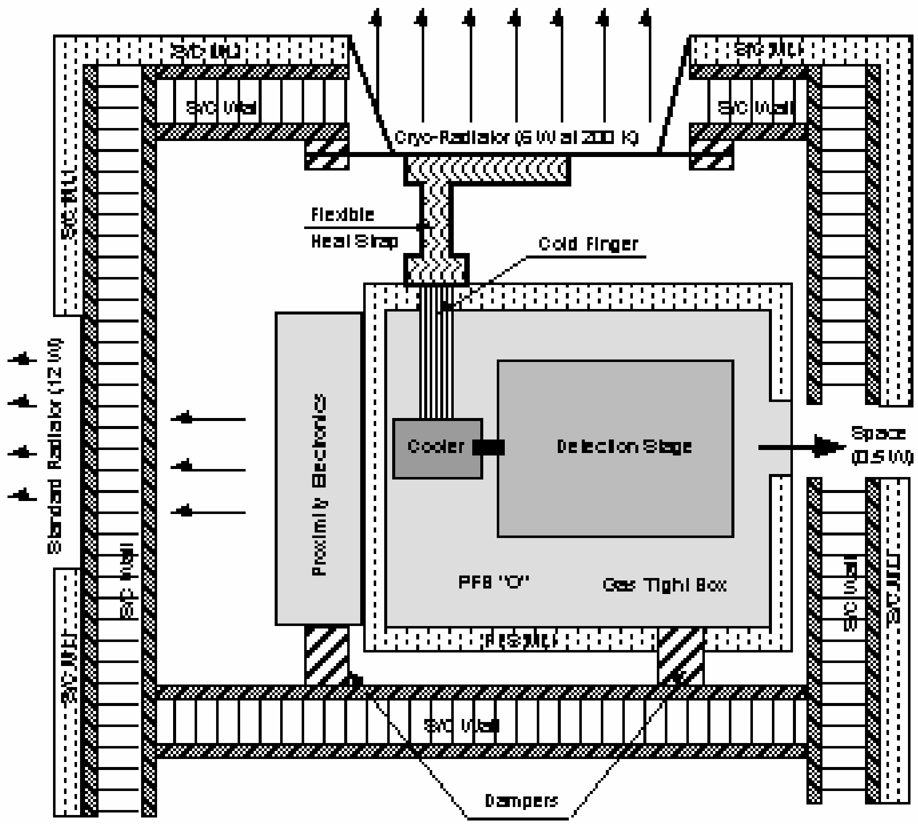
CASING MATERIAL: ANTICORODAL 6082
SURFACE TREATMENT:
THERMAL FINISH:
THERMAL CAPACITANCE:
CONCTACT AREA OF BASEPLATEPLUS FEET:
FLATNESS OF MOUNTING AREA: 0.1mm/100mm
CONNECTORS:

J 1 DAMA 26 p
J 2 DAMA 26 p
J 3 DBMA 44 p
J 4 DAMA 26 p
J 5 DDMA 78 s

Consiglio Nazionale delle Ricerche ISTITUTO di FISICA dello SPAZIO INTERPLANETARIO	data 20/04/99	prog. P.BALDETTI	dis.
	scala 1=1	materiale anticorodal 6082	
		tratt. anodizzazione nera	
	toll.	Progetto: MARS EXPRESS	
	rev. data	titolo: PFS	N.dis

Figure 26 Module E view 3.

4 . - THERMAL INTERFACES 4.1 - THERMAL ACCOMODATION



Thermal budget of the interferometer O Module .

The unit will be covered bt MLI (TBC)

The Power dissipated by external radiator will be of 6 Watts to keep the internal detector at temperature below 220K.

The thermal bonding strap need to be flexible enough avoiding mechanical stress and need to be long enough to compensate mechanical movement due to the launch or any vibration.

Image courtesy of MMS

4.2 - OPERATIONAL TEMPERATURES

Experiment Unit-location	Operating Temperature		Nonoperating Temperature		Switch-on Temperature		Temperature Stability
	Min [K]	max [K]	Min [K]	max [K]	min [K]	max [K]	[K/h]
Module "O" IB	280	290	<233	>310	280	290	5
Module "O" EB	250	310	<220	>360	250	310	NA
Module "O" SWS	200	200	NA	NA	NA	NA	5 (internally controlled)
Module "O" LWS	280	290	NA	NA	NA	NA	0.01 (internally controlled)
Module "E"	250	310	220	360	250	300	NA
Module "S"	250	310	220	360	250	300	NA
Module "P"	250	310	220	360	250	300	NA

4.3 - GROUND OPERATIONAL TEMPERATURES

Experiment Unit-location	Operating Temperature		Nonoperating Temperature		Switch-on Temperature		Temperature Stability
	Min [K]	max [K]	Min [K]	max [K]	min [K]	max [K]	[K/h]
Module "O"	230	300	<230	>310	230	300	5
Module "E"	250	310	220	360	250	310	NA
Module "S"	250	310	220	360	250	300	NA
Module "P"	250	310	220	360	250	310	NA

4.4 - CONDUCTIVE INTERFACE

Module "O" Module "O" is conductively insulated from the mounting points. There is an additional conductive interface between the cold finger for SWS cooling and the S/C thermal pipe providing cooling.

Module "S" The conductive interface is through the four mounting feet.

Module "E" The conductive interface is through the four mounting feet.

Module "P" The conductive interface is through the four mounting feet.

4.5 - RADIATIVE INTERFACE

Module "O"	**The "IB" is radiatively insulated from the environment by means of MLI blanket internal to the experiment. Moreover the entire Module "O" is radiatively insulated from the spacecraft by means of another external MLI blanket.**
Module "E"	**The module is radiatively coupled with the spacecraft to improve the heat transfer towards the S/C during operation.**
Module "P"	**The module is radiatively coupled with the spacecraft to improve the heat transfer towards the S/C during operation.**
Module "S"	**The module is radiatively not coupled to the spacecraft.**

4.6 - SPECIAL THERMAL REQUIREMENTS

The "O" Module needs a passive cooling system to keep the temperature of the SW detector at <=220K.The thermal power to be radiated is 6 Watts. On Mars 96 Spacecraft this was realized by using a radiator by 26 x 26 cm. exposed to outer space and located under the "O" module and thermally connected to the detector cold finger.
Solution to this point has been provided by the spacecraft manufacturer with external 6 Watts radiator .

4.7 - HEATERS

Module "O"	**Module "O" requires 5 W non-op heaters to prevent the IB temperature to go below 280 K. During operation a temperature control system powers a heaters net controlling critical points, the power is included in the power budget in operation.** **This is needed also during cruise phase (at experiment off) and is called ASTRA mode.**

4.8 - COATINGS and FINISHES

The outher surfaces of the "O" Module will be covered by MLI insulator, the emissivity will be 0.1 BOL, equivalent emissivity will be 0.03, solar absorptivity 0.2 BOL, 0.5 EOL (TBC).
The "E", "P" Modules will be black anodized, total hemisherical emissivity 0.8.
The "S" module will be golden kapton.

4.9 - UNITS MEAN HEAT CAPACITY

UNIT	HEAT CAPACITY J / kgK	NOTE
O	19400	
S	3600	
P	2070	
E	3150	

4.10 - UNITS HEAT DISSIPATION

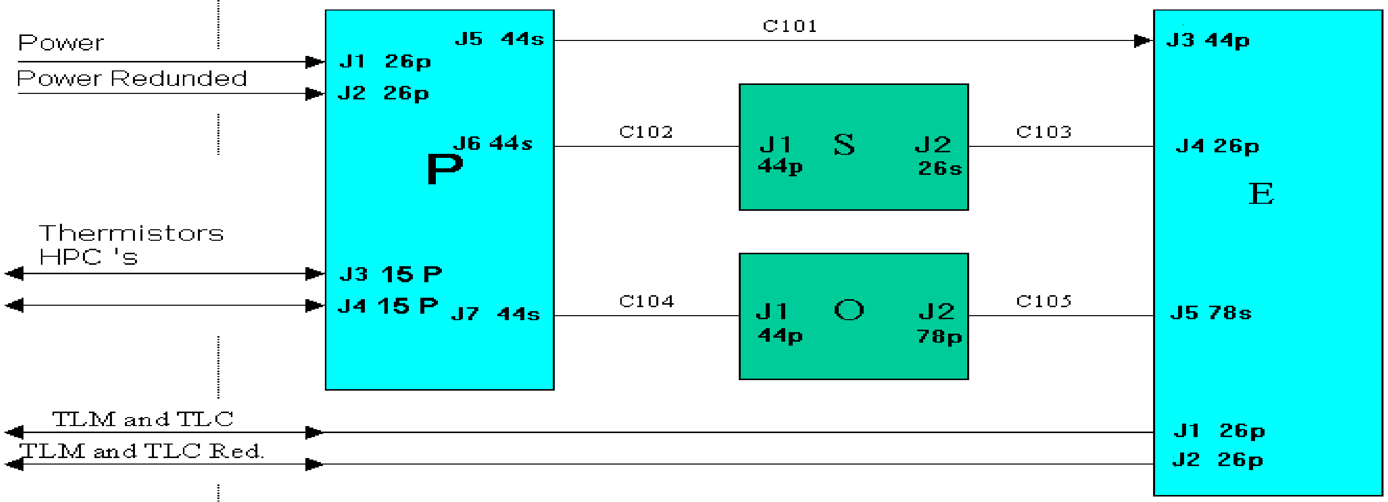
MODULE	MEAN HEAT DISSIPATION Watts	PEAK POWER DISSIPATION Watts
O	2.5	15
S	1	10W. For 10Sec
P	6	
E	5	

This page is intentionally left blank

5.1 ELECTRICAL ARCHITECTURE BLOCK DIAGRAM

ELECTRICAL ARCHITECTURE DIAGRAM	INSTRUMENT: PFS overall	MODEL: all

PFS for MARS EXPRESS harness Updated November 12 1999



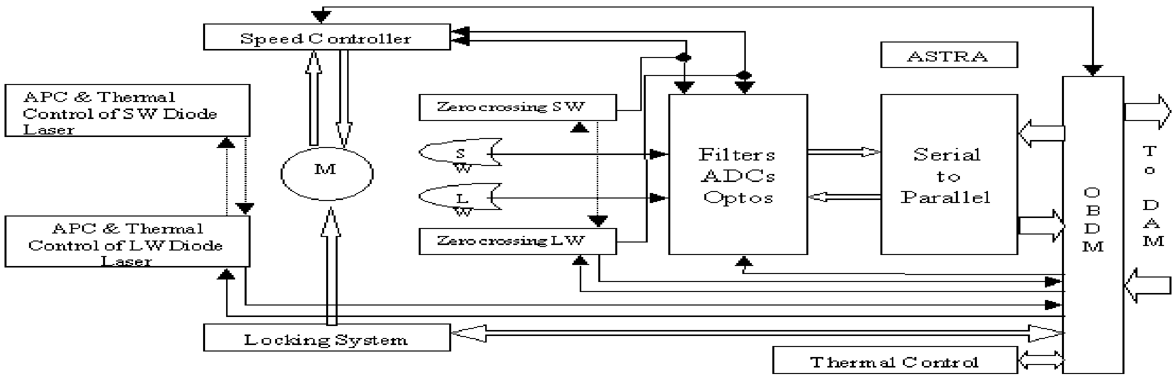
PFS for MARS EXPRESS Cabling

Connectors Items ending P are pins, S are sockets

C101 Power to E module , temp housekeeping E module, commands to S module and P module
C102 Power to S module , temp housekeeping of S module, Emergency Mirror Position
C103 Scanner commanding & housekeeping, Black Body temp mon. and lamp monitor.
C104 Power to O module & temp housekeeping
C105 O module commanding & data, calibration control and status

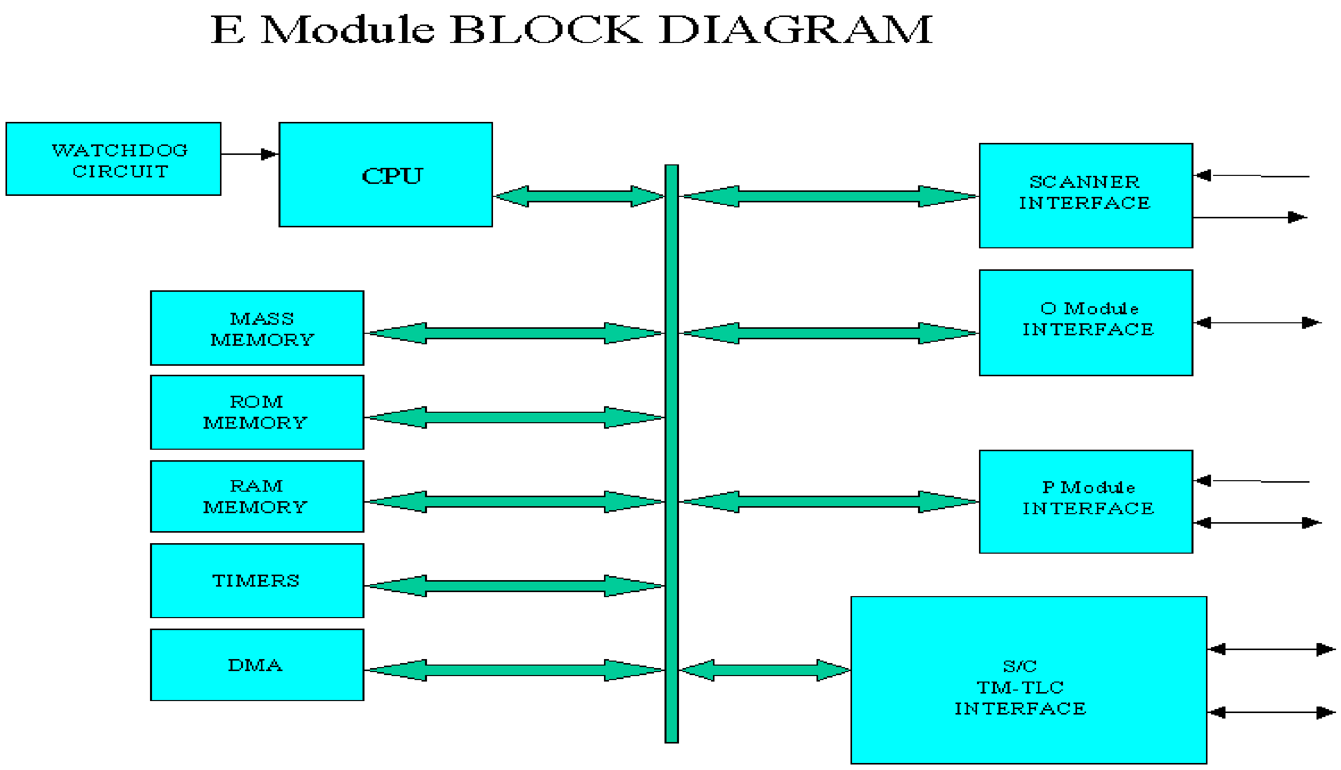
5.2- O MODULE BLOCK DIAGRAM

BLOCK DIAGRAM	INSTRUMENT: O Module	MODEL: ALL



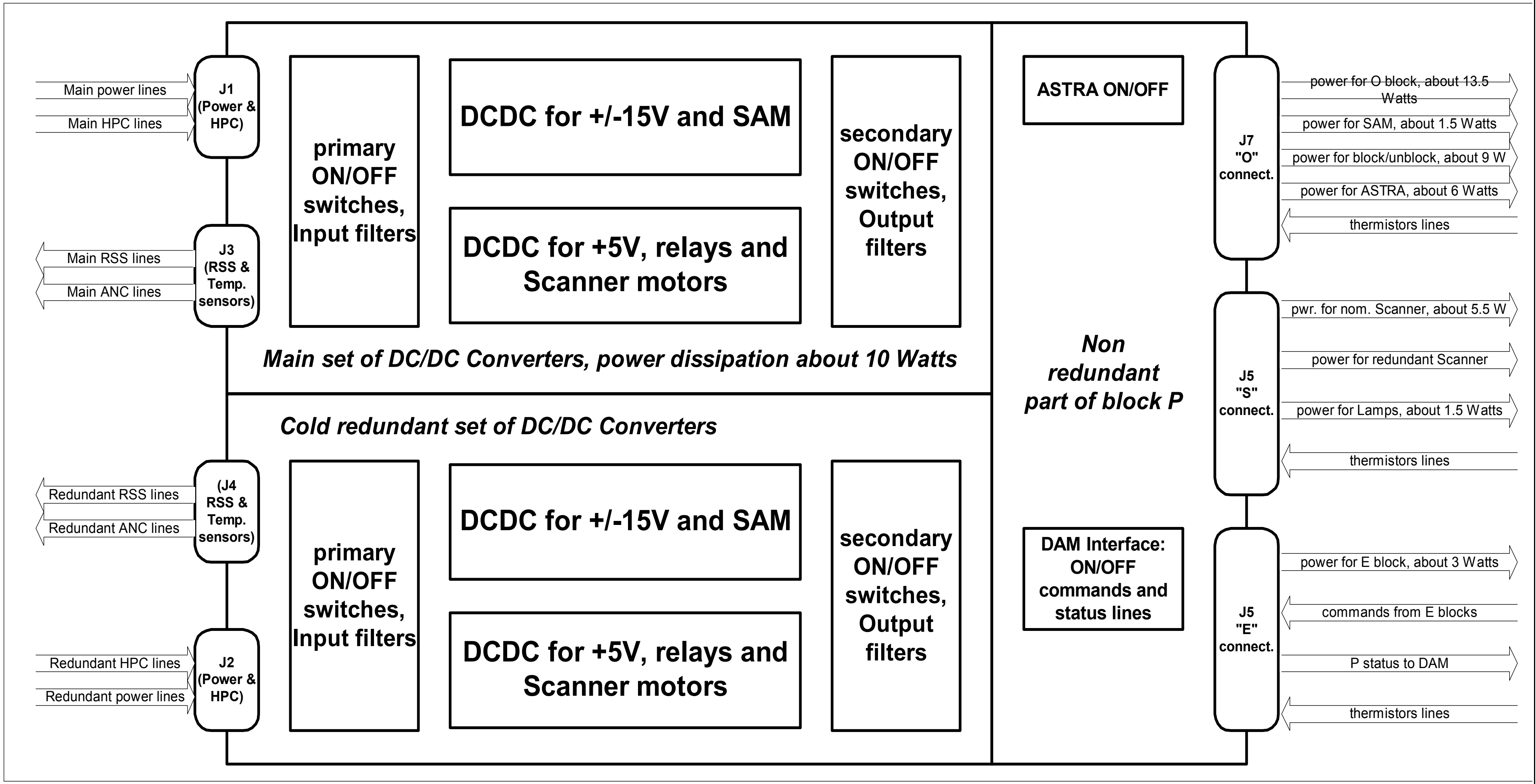
5.3- E MODULE BLOCK DIAGRAM

BLOCK DIAGRAM	INSTRUMENT: E module	MODEL: all



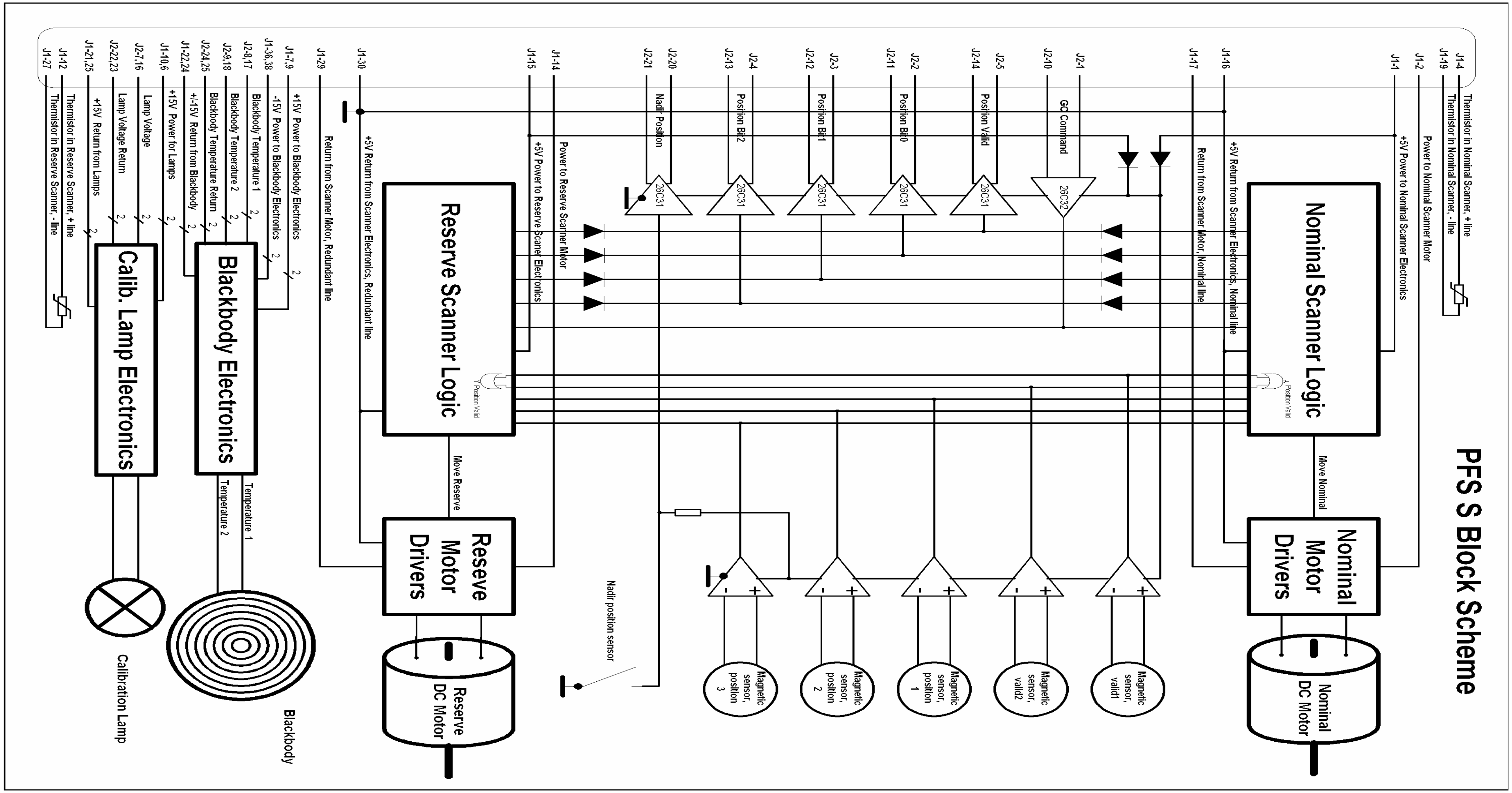
5.4 - P MODULE BLOCK DIAGRAM

BLOCK DIAGRAM	INSTRUMENT: P module	MODEL: All



5.5- S MODULE BLOCK DIAGRAM

BLOCK DIAGRAM	INSTRUMENT: S Module	MODEL: All



5.6 - PFS EXPERIMENT POWER REQUIREMENTS

POWER DEMAND	INSTRUMENT:	PFS	UNIT:	PFS-P	MODEL:	ALL
	ESTIMATED VALUES: X ■		MEASURED VALUES: ☐			

Power Lines Description	Average Power BOL [W]				Average Power EOL [W]				Long Peak Power		Short Peak Power	
	Modes				Modes				Peak [W]	Duration [s]	Peak [W]	Duration [s]
	ASTRA	SLEEP	NORMAL		ASTRA	SLEEP	NORMAL					
NOMINAL SET												
PFS Main, 28V Primary Power Con. J1, pins: 1(power) and 10(return)	**0**	**10**	**35**		**0**	**10**	**35**		**44**	**300**	**70**	**0.005**
ASTRA 28V Primary Power, Main line Con. J1, pins 2(power) and 11(return)	**6**	**0**	**0**		**6**	**0**	**0**		**-**	**-**	**-**	**-**
REDUNDANT SET												
PFS Redundant, 28V Primary Power Con. J2, pins: 1(power) and 10(return)	**0**	**10**	**35**		**0**	**10**	**35**		**44**	**300**	**70**	**0.005**

Notes:

1. **The data is estimated from PFS-Mars 96.**
2. **Only one set PFS Main/Redundant or ASTRA Main/Redundant is supplied at a time.**
3. **All PFS is supplied trough PFS-P and connectors J1 and J2. There are no other connections between PFS and Mars Express Power Supply System.**

5.7 - ELECTRICAL PFS/SAT REQUIREMENTS on POWER

VOLTAGE	LCL CLASS DEFINITION	Max nom.Power@Current	Trip-off /Limiting Point after 5uS
28 v.+- 1%	CLASS D	67.2W@2.3 Amp.	82W / 3.0 Amp.
28 v.+- 1%	CLASS B *	16.8W@0.6 Amp.	22W / 0.8 Amp.

*Not redunded (ASTRA heater power)

5.8 - ELECTRICAL PFS/SAT REQUIREMENTS on HIGH POWER COMMANDS

CMD NAME	MAIN CMD.	REDUNDED CMD.	NOTE
MAIN DC/DC ON	1	--	Intf. Fig. 3.1.3 in PID/URD annex RED.USER
MAIN DC/DC OFF	1	--	Intf. Fig. 3.1.3 in PID/URD annex RED.USER
REDUN. DC/DC ON	--	1	Intf. Fig. 3.1.3 in PID/URD annex RED.USER
REDUN. DC/DC OFF	--	1	Intf. Fig. 3.1.3 in PID/URD annex RED.USER
ASTRA ON	1	1	USED as NON REDUNDANT USER As in PID/URD ANNEX , Schematic 3.1.2
ASTRA OFF	1	1	USED as NON REDUNDANT USER As in PID/URD ANNEX , Schematic 3.1.2

5.9 - ELECTRICAL PFS/SAT REQUIREMENTS on THERMISTORS

FUNCTION NAME	MAIN	REDUNDED	NOTE
P MOD Temp.	1	1	USED as RED. USER
E MOD Temp.	1	1	USED as RED. USER
S MOD Temp.	1	1	USED as RED. USER
O MOD Eb Temp	1	1	USED as RED. USER
O MOD Ib Temp	1	1	USED as RED. USER

Thermistors are Yellowspring YSI-44907 model.

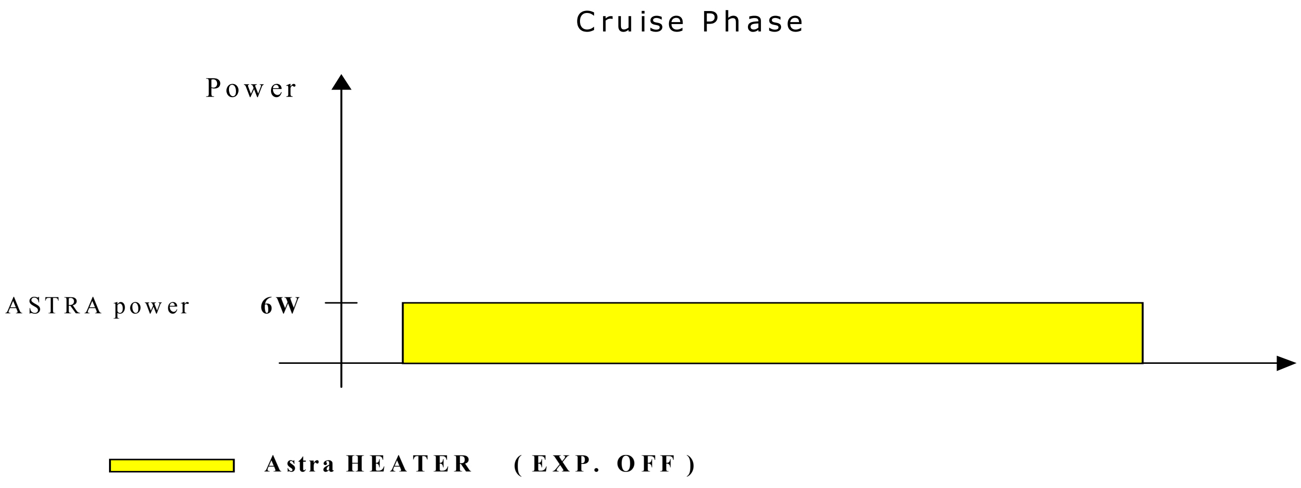
5.10 - ELECTRICAL PFS/SAT REQUIREMENTS on RELAY SWITCH STATUS

FUNCTION NAME	MAIN	REDUNDED	NOTE
MAIN DC/DC ON RSS	1	--	
RESE. DC/DC ON RSS	--	1	
ASTRA ON RSS	1	1	

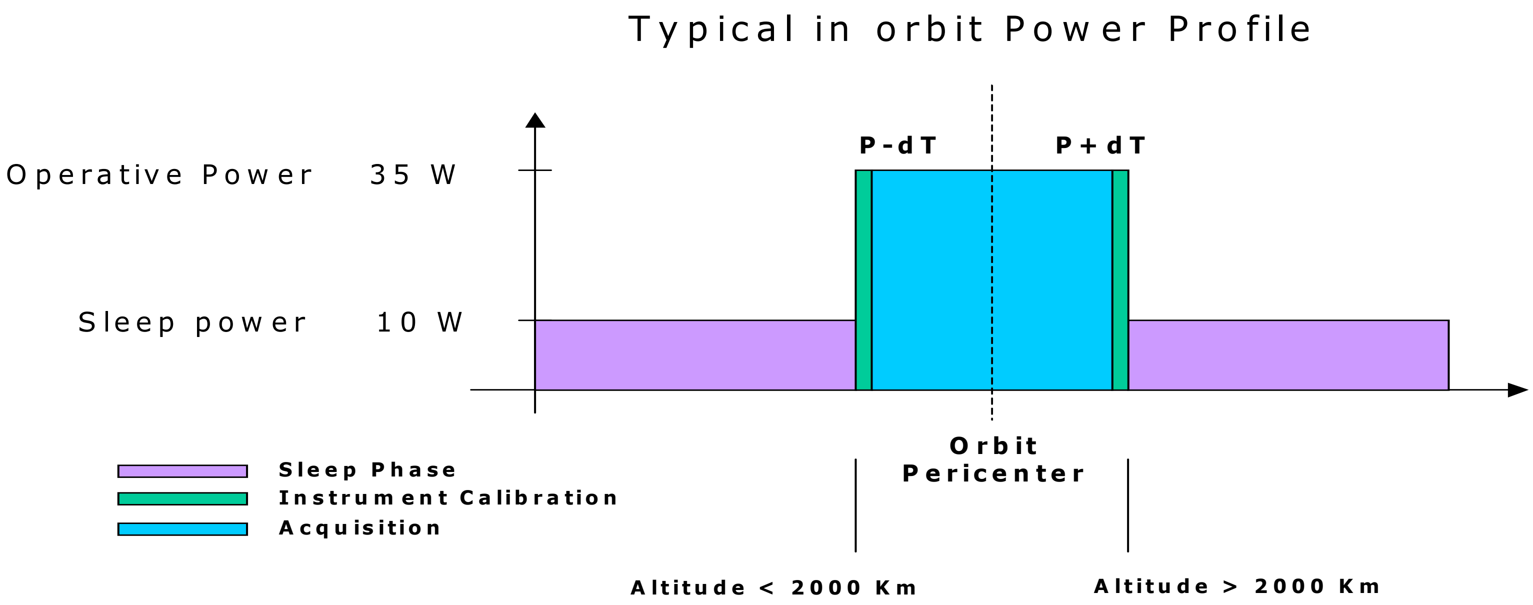
5.11 - ELECTRICAL SAT/PFS REQUIREMENTS on TTC01-B TLM/TC

FUNCTION NAME	MAIN	REDUNDED	NOTE
MLC	1	1	
TSY	1	1	
SDT	1	1	USED as NON REDUNDANT USER As in PID/URD ANNEX , Schematic 3.1.2
SDC	1	1	USED as NON REDUNDANT USER As in PID/URD ANNEX , Schematic 3.1.2

5.12 POWER PROFILE in CRUISE PHASE (ASTRA HEATER)

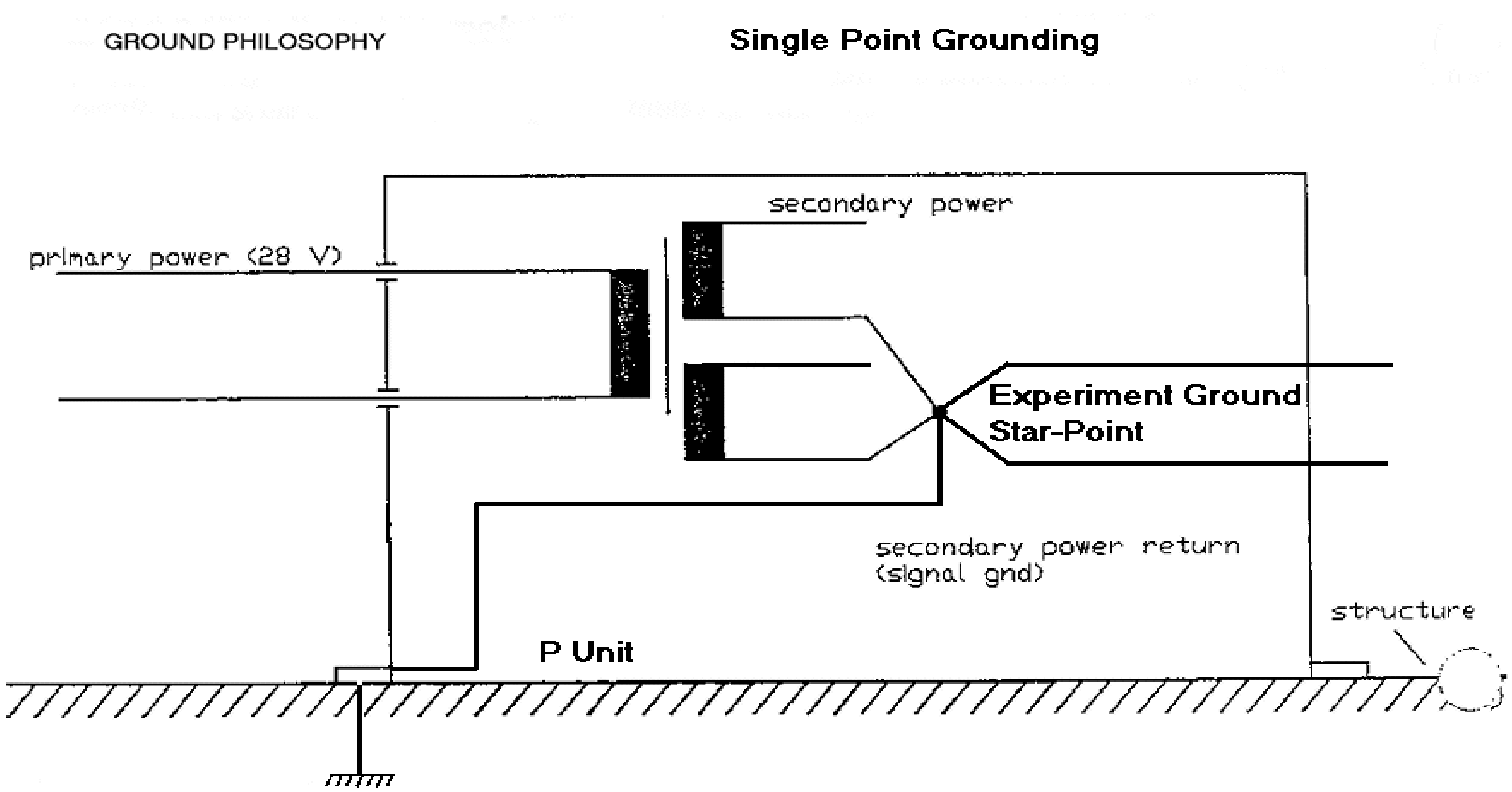


5.13 POWER PROFILE of TYPICAL INSTRUMENT OPERATION AROUND MARS PERICENTER

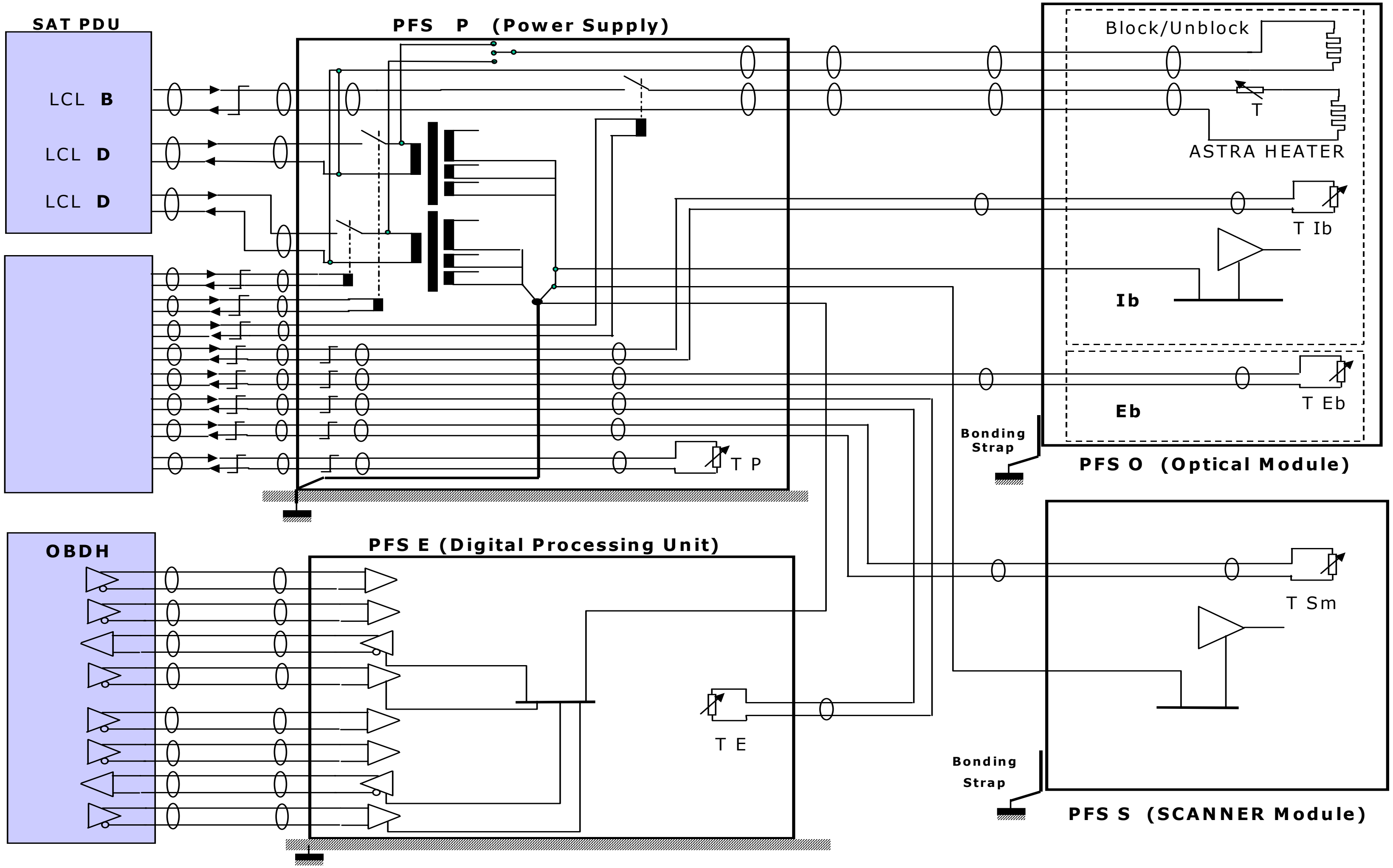


5.14 GROUNDING DETAIL

GROUNDING DIAGRAM	INSTRUMENT:PFS	MODEL: All



5.15 SAT – EXP. INTERCONNECTION and GROUNDING OVERVIEW



SAT PDU
LCL B
LCL D
LCL D
PFS P (Power Supply)
Block/Unblock
T
ASTRA HEATER
T Ib
Ib
T Eb
Eb
Bonding Strap
PFS O (Optical Module)
T P
OBDH
PFS E (Digital Processing Unit)
T Sm
T E
Bonding Strap
PFS S (SCANNER Module)

Thermistors in P and S modules are redunded.

The S and O modules are electrically insulated and need bond-strap for proper grounding.

The Block/Unblock switch in P box is a three position relay Main supply-off-Redundant supply. The off position guarantees the electrical load disconnection.

Details on the Block/Unblock are shown on paragraph 5.7

5.16 PFS EXPERIMENT CONNECTOR LIST

CONNECTORS LIST			INSTRUMENT: PFS			MODEL: ALL	
Item code	Connector Function	Connector	Connector Type	Harness Connector.	Harness Connector Type	EMC	Back Shell Type
PFS-P (to S/C)	Nominal supply & HPC	J1	DAMA-26P-NMB	P1	DAMA-26S-NMB	POW	EMC
PFS-P (to S/C)	Redundant supply & HPC	J2	DAMA-26P-NMB	P2	DAMA-26S-NMB	POW	EMC
PFS-P (to S/C)	Nominal RSS & ANC	J3	DEMA-15P-NMB	P3	DEMA-15S-NMB	SIG	EMC
PFS-P (to S/C)	Redundant RSS & ANC	J4	DEMA-15P-NMB	P4	DEMA-15S-NMB	SIG	EMC
PFS-P	P-O Interface	PJ7/OJ1	DBMA-44S-NMB	P7	DBMA-44P-NMB	IEH	EMC
PFS-O	E-O Interface	EJ5/OJ2	DDMA-78S-NMB	P5	DDMA-78P-NMB	IEH	EMC
PFS-P	P-S Interface	PJ6/SJ1	DBMA-44S-NMB	P6	DAMA-44P-NMB	IEH	EMC
PFS-P	P-E Interface	PJ5/EJ3	DBMA-44S-NMB	P5	DBMA-44P-NMB	IEH	EMC
PFS-E	E-S Interface	EJ4/SJ2	DAMA-26P-NMB	P4	DAMA-26S-NMB	IEH	EMC
PFS-E (to S/C)	TLM-TC Main	J1-E	DAMA-26P-NMB	P1	DAMA-26S-NMB	SIG	EMC
PFS-E (to S/C)	TLM-TC Redunded	J2-E	DAMA-26P-NMB	P2	DAMA-26S-NMB	SIG	EMC

* Backshell is type EMC type (shielded) in FRAMATONE catalogue (Enquiring for qualified part)

5.16.1 Connector J1 (P Mod. Power Main)

PIN ALLOCATION			INSTRUMENT: PFS			UNIT: PFS-P		MODEL: ALL	
			CONNECTOR: J1			CONNECTOR TYPE: DAMA-26P-NMB			
Pin	Function	Signal Type	Type of line	Cabling Req.	Destination Unit	Connector	Pin	Interface	EMC
1	PFS Main DCDC 28V Primary Power	LCD	T4S(2,10,11)	SHD 19	PDU			POW INTF.	POW
2	PFS Main DCDC 28V Primary Power	LCD	T4S(1,10,11)	SHD 19	PDU			POW INTF.	POW
3	ASTRA 28V Primary Power	LCB	T4S(4,12,13)	SHD 21	PDU			POW INTF.	POW
4	ASTRA 28V Primary Power	LCB	T4S(3,12,13)	SHD 21	PDU			POW INTF.	POW
5									
6	PFS Main DCDC ON HPC	HPC	T3S(7,15)	SHD 23	RTU			HPC INTF.	SIG
7	PFS Main DCDC OFF HPC	HPC	T3S(6,15)	SHD 23	RTU			HPC INTF.	SIG
8									
9	ASTRA ON/OFF HPC Return	HPC	T3S(17,18)	SHD 24	RTU			HPC INTF.	SIG
10	Main PFS 28V Return	LCD	T4S(1,2,11)	SHD 19	PDU			POW INTF.	POW
11	Main PFS 28V Return	LCD	T4S(1,2,10)	SHD 19	PDU			POW INTF.	POW
12	ASTRA 28V Return	LCB	T4S(3,4,13)	SHD 21	PDU			POW INTF.	POW
13	ASTRA 28V Return	LCB	T4S(3,4,12)	SHD 21	PDU			POW INTF.	POW
14									
15	PFS Main DCDC ON/OFF HPC Return	HPC	T3S(6,7)	SHD 23	RTU			HPC INTF.	SIG
16									
17	ASTRA ON HPC, Nominal line	HPC	T3S(9,18)	SHD 24	RTU			HPC INTF.	SIG
18	ASTRA OFF HPC, Nominal line	HPC	T3S(9,17)	SHD 24	RTU			HPC INTF.	SIG

19	**Shielding for PFS Main 28V Primary (1,2,10,11)**				**PDU**				
20									
21	**Shielding for ASTRA 28V Primary (3,4,12,13)**				**PDU**				
22									
23	**Shielding for PFS Main ON/OFF HPC (6,7,15)**				**RTU**				
24	**Shielding for ASTRA ON/OFF HPC (9,17,18)**				**RTU**				
25									
26	**PFS Secondary Reference Point**				**RTU**				

5.16.2 Connector J2 (P Mod. Power Redundant)

PIN ALLOCATION			INSTRUMENT:		PFS	UNIT:	PFS-P	MODEL:	ALL
			CONNECTOR:		J2	CONNECTOR TYPE:		DAMA-26P-NMB	
Pin	**Function**	**Signal Type**	**Type of line**	**Cabling Req.**	**Destination Unit**	**Connector**	**Pin**	**Interface**	**EMC**
1	PFS Reserve DCDC 28V Primary Power	LCD	T4S(2,10,11)	SHD 19	PDU			POW INTF.	POW
2	PFS Reserve DCDC 28V Primary Power	LCD	T4S(1,10,11)	SHD 19	PDU			POW INTF.	POW
3									
4									
5									
6	PFS Reserve DCDC ON HPC	HPC	T3S(7,15)	SHD 23	RTU			HPC INTF.	SIG
7	PFS Reserve DCDC OFF HPC	HPC	T3S(6,15)	SHD 23	RTU			HPC INTF.	SIG
8									
9	ASTRA ON/OFF HPC Return	HPC	T3S(17,18)	SHD 24	RTU			HPC INTF.	SIG
10	Main PFS 28V Return	LCD	T4S(1,2,11)	SHD 19	PDU			POW INTF.	POW
11	Main PFS 28V Return	LCD	T4S(1,2,10)	SHD 19	PDU			POW INTF.	POW
12									
13									
14									
15	PFS Reserve DCDC ON/OFF HPC Return	HPC	T3S(6,7)	SHD 23	RTU			HPC INTF.	SIG
16									
17	ASTRA ON HPC	HPC	T3S(9,18)	SHD 24	RTU			HPC INTF.	SIG
18	ASTRA OFF HPC	HPC	T3S(9,17)	SHD 24	RTU			HPC INTF.	SIG

19	**Shielding for PFS Reserve 28V Primary (1,2,10,11)**									
20										
21										
22										
23	**Shielding for PFS Reserve ON/OFF HPC (6,7,15)**									
24	**Shielding for ASTRA ON/OFF HPC (9,17,18)**									
25										
26	**PFS Secondary Reference Point**									

5.16.3 Connector J3 (P to RSS and Thermistors Interface, Nominal)

PIN ALLOCATION			INSTRUMENT:		PFS	UNIT:	PFS-P	MODEL:	ALL
			CONNECTOR:		J3	CONNECTOR TYPE:		DEMA-15P-NMB	
Pin	**Function**	**Signal Type**	**Type of line**	**Cabling req.**	**Destination Unit**	**Connector**	**Pin**	**Interface**	**EMC**
1	PFS Main DCDC ON RSS	RSS	T3S(2,6)	SHD 11	RTU			RSS INTF.	SIG/POW
2	ASTRA ON RSS, Nominal	RSS	T3S(1,6)	SHD 11	RTU			RSS INTF.	SIG/POW
3	Thermistor in P, +line, Nominal	ANC	T4S(4,8,9)	SHD 13	RTU			THERM.INTF.	LAS
4	Thermistor in E, +line, Nominal	ANC	T4S(3,8,9)	SHD 13	RTU			THERM.INTF.	LAS
5	Thermistor in O1, +line, Nominal	ANC	T3S(10,14)	SHD 15	RTU			THERM.INTF.	LAS
6	Return for RSS, Nominal	CRT	T3S(1,2)	SHD 11	RTU			RSS INTF.	SIG/POW
7									
8	Thermistor in S, +line, Nominal	ANC	T4S(3,4,9)	SHD 13	RTU			THERM.INTF.	LAS
9	Thermistors in P, E, S, Return, Nominal	CRT	T4S(3,4,8)	SHD 13	RTU			THERM.INTF.	LAS
10	Thermistor in O2, +line, Nominal	ANC	T3S(5,14)	SHD 15	RTU			THERM.INTF.	LAS
11	Shielding for Nominal RSS lines (1,2,6)								
12									
13	Shielding for P, E and S Thermistors (3,4,8,9)								
14	Thermistors in O1 and O2, Return, Nominal	CRT	T3S(5,10)	SHD 15	RTU			THERM.INTF.	LAS
15	Shielding for O1 and O2 Thermistors (5,10,14)								

5.16.4 Connector J4 (P to RSS and Thermistors Interface, Redundant)

PIN ALLOCATION			INSTRUMENT:		PFS	UNIT:	PFS-P	MODEL:	ALL
			CONNECTOR:		J4	CONNECTOR TYPE:		DEMA-15P-NMB	
Pin	**Function**	**Signal Type**	**Type of line**	**Cabling req.**	**Destination Unit**	**Connector**	**Pin**	**Interface**	**EMC**
1	PFS Reserve DCDC ON RSS	RSS	T3S(2,6)	SHD 11	RTU			RSS INTF.	SIG/POW
2									
3	Thermistor in P, +line, Reserve	ANC	T4S(4,8,9)	SHD 13	RTU			THERM.INTF.	LAS
4									
5									
6	Return for RSS, Reserve	CRT	T3S(1,2)	SHD 11	RTU			RSS INTF.	SIG/POW
7									
8	Thermistor in S, +line, Reserve	ANC	T4S(3,4,9)	SHD 13	RTU			THERM.INTF.	LAS
9	Thermistors in P, E, S, Return, Reserve	CRT	T4S(3,4,8)	SHD 13	RTU			THERM.INTF.	LAS
10									
11	Shielding for Reserve RSS lines (1,2,6)								
12									
13	Shielding for P, E and S Thermistors (3,4,8,9)								
14									
15	Shielding for O1 and O2 Thermistors (5,10,14)								

5.16.5 Connector J1-E (E Mod. TM/TC Main)

PIN ALLOCATION			INSTRUMENT: PFS			UNIT: MODULE E		MODEL: ALL	
			CONNECTOR: J1			CONNECTOR TYPE: DAMA26P			
Pin	Function	Signal type	Type of line	Cabling req.	Destination Unit	Connector	Pin	INTERFACE	EMC
2	Serial TM/TC Clock True (Normal)	SDC	SIG	TSPL	RTU			*	SIG
3	Serial TM/TC Clock Comp (Normal)	SDC	SIG	TSPL	RTU			*	SIG
4	Memory load data True (Normal)	MLD	SIG	TSPL	RTU			*	SIG
5	Memory load data Comp (Normal)	MLD	SIG	TSPL	RTU			*	SIG
6	Memory load address True (Normal)	MLS	SIG	TSPL	RTU			*	SIG
7	Memory load address Comp (Normal)	MLS	SIG	TSPL	RTU			*	SIG
11	Serial telemetry address Shield (Normal)							*	SIG
12	Serial TM/TC Clock Shield (Normal)							*	SIG
13	Serial telemetry data Shield (Normal)							*	SIG
14	Memory load data Shield (Normal)							*	SIG
15	Timer Synchronisation Pulse Shield (Normal)							*	SIG
16	Memory load address Shield (Normal)							*	SIG
19	Serial telemetry address True (Normal)	SDS	SIG	TSPL	RTU			*	SIG
20	Serial telemetry address Comp (Normal)	SDS	SIG	TSPL	RTU			*	SIG
21	Serial telemetry data True (Normal)	SDD	SIG	TSPL	RTU			*	SIG
22	Serial telemetry data Comp (Normal)	SDD	SIG	TSPL	RTU			*	SIG
23	Timer Synchronisation Pulse True (Normal)	TSY	SIG	TSPL	RTU			*	SIG
24	Timer Synchronisation Pulse Comp (Normal)	TSY	SIG	TSPL	RTU			*	SIG
26	Chassis Ground								
1,8,9,10	Spare								
17,18,25	Spare								

5.16.6 Connector J2-E (E Mod. TM/TC Redunded)

PIN ALLOCATION		INSTRUMENT: PFS				UNIT: MODULE E		MODEL: ALL	
		CONNECTOR: J2				CONNECTOR TYPE: DAMA26P			
Pin	**Function**	**Signal Type**	**Type of line**	**Cabling req.**	**Destination Unit**	**Connector**	**Pin**	**INTERFACE**	**EMC**
2	Serial TM/TC Clock True (Redundant)	SDC	SIG	TSPL	RTU			*	SIG
3	Serial TM/TC Clock Comp (Redundant)	SDC	SIG	TSPL	RTU			*	SIG
4	Memory load data True (Redundant)	MLD	SIG	TSPL	RTU			*	SIG
5	Memory load data Comp (Redundant)	MLD	SIG	TSPL	RTU			*	SIG
6	Memory load address True (Redundant)	MLS	SIG	TSPL	RTU			*	SIG
7	Memory load address Comp (Redundant)	MLS	SIG	TSPL	RTU			*	SIG
11	Serial telemetry address Shield (Redundant)							*	SIG
12	Serial TM/TC Clock Shield (Redundant)							*	SIG
13	Serial telemetry data Shield (Redundant)							*	SIG
14	Memory load data Shield (Redundant)							*	SIG
15	Timer Synchronisation Pulse Shield (Redundant)							*	SIG
16	Memory load address Shield (Redundant)							*	SIG
19	Serial telemetry address True (Redundant)	SDS	SIG	TSPL	RTU			*	SIG
20	Serial telemetry address Comp (Redundant)	SDS	SIG	TSPL	RTU			*	SIG
21	Serial telemetry data True (Redundant)	SDD	SIG	TSPL	RTU			*	SIG
22	Serial telemetry data Comp (Redundant)	SDD	SIG	TSPL	RTU			*	SIG
23	Timer Synchronisation Pulse True (Redundant)	TSY	SIG	TSPL	RTU			*	SIG
24	Timer Synchronisation Pulse Comp (Redundant)	TSY	SIG	TSPL	RTU				SIG

26	Chassis Ground							
1,8,9,10	Spare							
17,18,25	Spare							

5.16.7 Connector J7 (P to O internal connection)

PIN ALLOCATION			INSTRUMENT: PFS			UNIT: PFS-P		MODEL: ALL	
			CONNECTOR: J7			CONNECTOR TYPE: DBMA-44S-NMB			
Pin	**Function**	**Signal Type**	**Type of Line**	**Cabling req.**	**Destination Unit**	**Connector**	**Pin**	**INTERFACE**	**EMC**
1	+5V Power to O	Sec. Power	TSP(2)	SHIELD 31	PFS-O	J1	1		IEH
2	+5V Return from O	Sec. Power	TSP(1)	SHIELD 31	PFS-O	J1	2		IEH
3									
4	+15V Power to O	Sec. Power	SL	SHIELD 32	PFS-O	J1	4		IEH
5	-15V Power to O	Sec. Power	SL	SHIELD 32	PFS-O	J1	5		IEH
6	+5V Power to SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	6		IEH
7	-5V Power to SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	7		IEH
8	+15V Power to SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	8		IEH
9	-15V Power to SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	9		IEH
10	Temperature in O, Sensor 1+	ANC	TSP(11)	SHIELD 38	PFS-O	J1	10		IEH
11	Temperature in O, Sensor 1-	ANC	TSP(10)	SHIELD 38	PFS-O	J1	11		IEH
12	Temperature in O, Sensor 2+	ANC	T4S(27)	SHIELD 38	PFS-O	J1	12		IEH
13	Block-Unblock 28V Power	LCB	TSP(28)	SHIELD 41	PFS-O	J1	13		IEH
14	28V Power to ASTRA	LCB	TSP(15)	SHIELD 44	PFS-O	J1	14		IEH
15	28V Return from ASTRA	LCB	TSP(14)	SHIELD 44	PFS-O	J1	15		IEH

16	+5V Power to O	Sec. Power	TSP(17)	SHIELD 31	PFS-O	J1	16		IEH
17	+5V Return from O	Sec. Power	TSP(16)	SHIELD 31	PFS-O	J1	17		IEH
18									
19	+15V Power to O	Sec. Power	SL	SHIELD 32	PFS-O	J1	19		IEH
20	-15V Power to O	Sec. Power	SL	SHIELD 32	PFS-O	J1	20		IEH
21	+5V Power to SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	21		IEH
22	-5V Power to SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	22		IEH
23	+15V Power to SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	23		IEH
24	-15V Power to SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	24		IEH
25	Temperature in O, Sensor 1+	ANC	TSP(26)	SHIELD 38	PFS-O	J1	25		IEH
26	Temperature in O, Sensor 1-	ANC	TSP(25)	SHIELD 38	PFS-O	J1	26		IEH
27	Temperature in O, Sensor 2-	ANC	TSP(12)	SHIELD 38	PFS-O	J1	27		IEH
28	Block-Unblock 28V Power Return	LCB	TSP(13)	SHIELD 41	PFS-O	J1	28		IEH
29	28V Power to ASTRA	LCB	TSP(30)	SHIELD 44	PFS-O	J1	29		IEH
30	28V Return from ASTRA	LCB	TSP(29)	SHIELD 44	PFS-O	J1	30		IEH
31	Shielding for all +5V lines (1,2,16,17)								
32	Shielding for all +/-15V lines (4,5,19,20,33,34)								
33	15V Return from O	Sec. Power	SL	SHIELD 32	PFS-O	J1	33		IEH
34	15V Return from O	Sec. Power	SL	SHIELD 32	PFS-O	J1	34		IEH

35	Shielding for all SAM lines (6,7,8,9,21,22,23,24,36,37)								
36	Return from SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	36		IEH
37	Return from SAM	Sec. Power	SL	SHIELD 35	PFS-O	J1	37		IEH
38	Shielding for all Thermistor lines (10,11,12,25,26,27,39,40)								
39	Temperature in O, Sensor 2+	ANC	TSP(40)	SHIELD 38	PFS-O	J1	39		IEH
40	Temperature in O, Sensor 2-	ANC	TSP(39)	SHIELD 38	PFS-O	J1	40		IEH
41	Shielding for all Block Unblock lines (13,28,42,43)								
42	Block-Unblock 28V Power	LCB	TSP(43)	SHIELD 41	PFS-O	J1	42		IEH
43	Block-Unblock 28V Power Return	LCB	TSP(42)	SHIELD 41	PFS-O	J1	43		IEH
44	Shielding for all ASTTRA lines (14,15,29,30)								

5.16.8 Connector J5 P (P to E internal connection)

PIN ALLOCATION			INSTRUMENT:		PFS	UNIT:	PFS-P	MODEL:	ALL
			CONNECTOR:		J5	CONNECTOR TYPE:		DBMA-44S-NMB	
Pin	**Function**	**Signal Type**	**Type of Line**	**Cabling req.**	**Destination Unit**	**Connector**	**Pin**	**INTEFACE**	**EMC**
1	5V Power to E	Sec. Power	TSP(16)	SHIELD 31	PFS-E	J3	1		IEH
2	5V Power to E	Sec. Power	TSP(17)	SHIELD 31	PFS-E	J3	2		IEH
3									
4	5V DCDC Main/Reserve, Status	Sec. Status	SL	SHIELD 33	PFS-E	J3	4		IEH
5	Power for Motors OK., Status	Sec. Status	SL	SHIELD 33	PFS-E	J3	5		IEH
6	Power for Relays OK., Status	Sec. Status	SL	SHIELD 33	PFS-E	J3	6		IEH
7	Scanner Main/Reserve, Status	Sec. Status	SL	SHIELD 33	PFS-E	J3	7		IEH
8									
9	Scanner Block Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	9		IEH
10	Scanner Unblock Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	10		IEH
11	Scanner M/R, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	11		IEH
12	Oanalog/A/SAM ON, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	12		IEH
13	Scanner ON, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	13		IEH
14									
15	Thermistor in E, + line	ANC	TSP(30)	SHIELD 44	PFS-E	J3	15		IEH

16	5V Return from E	Sec. Power	TSP(1)	SHIELD 31	PFS-E	J3	16		IEH
17	5V Return from E	Sec. Power	TSP(2)	SHIELD 41	PFS-E	J3	17		IEH
18									
19	5V DCDC OK, Status	Sec. Status	SL	SHIELD 33	PFS-E	J3	19		IEH
20	15V DCDC OK, Status	Sec. Status	SL	SHIELD 33	PFS-E	J3	20		IEH
21	SAM DCDC OK, Status	Sec. Status	SL	SHIELD 33	PFS-E	J3	21		IEH
22	Scanner Block/Unblock Status	Sec. Status	SL	SHIELD 33	PFS-E	J3	22		IEH
23									
24	Scanner Block Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	24		IEH
25	Scanner Unblock Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	25		IEH
26	Scanner M/R, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	26		IEH
27	Oanalog/A/SAM ON, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	27		IEH
28	Scanner ON, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	28		IEH
29									
30	Thermistor in E, - line	ANC	TSP(15)	SHIELD 44	PFS-E	J3	30		IEH
31	Shielding for all 5V lines (1,2,16,17)								
32									
33	Shielding for all Status lines (4-7, 19-22, 34)								
34	Return from Status lines	Sec. Status	SL	SHIELD 33	PFS-E	J3	34		IEH
35	Return from Commands	Sec. Status	SL	SHIELD 43	PFS-E	J3	35		IEH

36	Return from Commands	Sec. Status	SL	SHIELD 43	PFS-E	J3	36		IEH
37	OdigitalON, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	37		IEH
38	OdigitalON, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	38		IEH
39	CMD Valid, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	39		IEH
40	CMD Valid, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	40		IEH
41	Lamp ON, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	41		IEH
42	Lamp ON, Command	Sec. CMD	SL	SHIELD 43	PFS-E	J3	42		IEH
43	Shielding for all CMD lines (9-14, 24-28, 35-42)								
44	Shielding for Thermistor lines (15,30)								

5.16.9 Connector J6 (P to S internal connection)

PIN ALLOCATION		INSTRUMENT:			PFS	UNIT: PFS-P		MODEL: ALL	
		CONNECTOR:			J6	CONNECTOR TYPE:		DBMA-44S-NMB	
Pin	**Function**	**Signal Type**	**Type of line**	**Cabling req.**	**Destination Unit**	**Connector**	**Pin**		**EMC**
1	+5V Power to Nominal Scanner electronics	Sec. Power	TSP(16)	SHIELD 31	PFS-S	J1	1		*IEH*
2	Power to Nominal Scanner Motor	Sec. Power	TSP(17)	SHIELD 31	PFS-S	J1	2		IEH
3	Scanner Block/Unblock, Status	Sec. Status	TSP(18)	SHIELD 31	PFS-S	J1	3		IEH
4	Thermistor in Nominal Scanner, +line,	ANC	TSP(19)	SHIELD 32	PFS-S	J1	4		IEH
5	Scanner Block, Command	Sec. CMD	T3C(20,34)	SHIELD 33	PFS-S	J1	5		IEH
6	+15V Power for Lamps	Sec. Power	TSP(21)	SHIELD 35	PFS-S	J1	6		IEH
7	+15V Power to Black Body	Sec. Power	T3S(22,36)	SHIELD 37	PFS-S	J1	7		IEH
8									
9	+15V Power to Black Body	Sec. Power	T3S(24,38)	SHIELD 23	PFS-S	J1	9		IEH
10	+15V Power for Lamps	Sec. Power	TSP(25)	SHIELD 39	PFS-S	J1	10		IEH
11	Scanner Block, Command	Sec. CMD	T3C(26,40)	SHIELD 41	PFS-S	J1	11		IEH
12	Thermistor in Reserve Scanner, +line	ANC	TSP(27)	SHIELD 42	PFS-S	J1	12		IEH
13	Scanner Block/Unblock, Status	Sec. Status	TSP(28)	SHIELD 43	PFS-S	J1	13		IEH
14	Power to Reserve Scanner Motor	Sec. Power	TSP(29)	SHIELD 43	PFS-S	J1	14		IEH
15	+5V Power to Reserve Scanner electronics	Sec. Power	TSP(30)	SHIELD 43	PFS-S	J1	15		IEH

16	+5V Return from Nominal Scanner electr.	Sec. Power	TSP(1)	SHIELD 31	PFS-S	J1	16		IEH
17	Return from Nominal Scanner Motor	Sec. Power	TSP(2)	SHIELD 31	PFS-S	J1	17		IEH
18	Return from Scanner Block/Unblock Status	Sec.Status	TSP(3)	SHIELD 31	PFS-S	J1	18		IEH
19	Thermistor in Nominal Scanner, -line	ANC	TSP(4)	SHIELD 32	PFS-S	J1	19		IEH
20	Return from Scanner Block/Unblock Command	Sec. CMD	T3C(5,34)	SHIELD 33	PFS-S	J1	20		IEH
21	+15V Return from Lamps	Sec. Power	TSP(6)	SHIELD 35	PFS-S	J1	21		IEH
22	+/-15V Return from Scanner Blackbody	Sec. Power	T3C(7,36)	SHIELD 37	PFS-S	J1	22		IEH
23	Shielding for +/- 15V Blackbody (9,24,38)								
24	+/-15V Return from Scanner Blackbody	Sec. Power	T3C(9,38)	SHIELD 23	PFS-S	J1	24		IEH
25	+15V Return from Lamps	Sec. Power	TSP(10)	SHIELD 39	PFS-S	J1	25		IEH
26	Return from Scanner Block/Unblock Command	Sec. CMD	T3C(11,40)	SHIELD 41	PFS-S	J1	26		IEH
27	Thermistor in Reserve Scanner, -line	Sec. Power	TSP(12)	SHIELD 42	PFS-S	J1	27		IEH
28	Return from Scanner Block/Unblock Status	Sec.Status	TSP(13)	SHIELD 43	PFS-S	J1	28		IEH
29	Return from Reserve Scanner Motor	Sec. Power	TSP(14)	SHIELD 43	PFS-S	J1	29		IEH
30	+5V Return from Reserve Scanner electronics	Sec. Power	TSP(15)	SHIELD 43	PFS-S	J1	30		IEH
31	Shielding for+5V, Motor & Status Nominal lines (1,2,3,16,17,18)								
32	Shielding for Nominal Thermistors lines (4,19)								
33	Shielding for Block/Unblock Commands (5,20,34)								
34	Scanner Unblock, Command	Sec. CMD	T3C(5,20)	SHIELD 33	PFS-S	J1	34		IEH
35	Shielding for +15V Lamps (6,21)								

36	**-15V Power to Black Body**	**Sec. Power**	**T3C(7,22)**	**SHIELD 37**	**PFS-S**	**J1**	**36**		**IEH**
37	**Shielding for +/- 15V Blackbody (7,22,36)**								
38	**-15V Power to Black Body**	**Sec. Power**	**T3C(9,24)**	**SHIELD 23**	**PFS-S**	**J1**	**38**		**IEH**
39	**Shielding for +15V Lamps (10,25)**								
40	**Scanner Unblock, Command**	**Sec. CMD**	**T3C(11,26)**	**SHIELD 41**	**PFS-S**	**J1**	**40**		**IEH**
41	**Shielding for Block/Unblock Commands (11,26,40)**								
42	**Shielding for Reserve Thermistors lines (12,27)**								
43	**Shielding for+5V, Motor & Status Reserve lines (13,14,15,28,29,30)**								
44									

5.16.10 Connector J4-E (E to S internal connection)

PIN ALLOCATION					INSTRUMENT: PFS			UNIT: PFS-E	MODEL: ALL
					CONNECTOR: J4			CONNECTOR TYPE: DAMA-26S-NMB	
Pin	Function	Signal type	Type of line	Cabling req.	Destination Unit	Connector	Pin	INTERFACE	EMC
1	Scanner GO Command, True	Sec. CMD	TSP(10)	SHIELD 19	PFS-S	J2	1		IEH
2	Scanner Position, Status, Bit 0, True	Sec. Status	TSP(11)	SHIELD 19	PFS-S	J2	2		IEH
3	Scanner Position, Status, Bit 1, True	Sec. Status	TSP(12)	SHIELD 19	PFS-S	J2	3		IEH
4	Scanner Position, Status, Bit 2, True	Sec. Status	TSP(13)	SHIELD 19	PFS-S	J2	4		IEH
5	Scanner Position, Status, Valid, True	Sec. Status	TSP(14)	SHIELD 19	PFS-S	J2	5		IEH
6									
7	Lamp Voltage	Sec. ANA	SL	SHIELD 26	PFS-S	J2	7		IEH
8	Blackbody Temperature 1	Sec. ANA	SL	SHIELD 26	PFS-S	J2	8		IEH
9	Blackbody Temperature 2	Sec. ANA	SL	SHIELD 26	PFS-S	J2	9		IEH
10	Scanner GO Command, Compl.	Sec. CMD	TSP(1)	SHIELD 19	PFS-S	J2	10		IEH
11	Scanner Position, Status, Bit 0, Compl.	Sec. Status	TSP(2)	SHIELD 19	PFS-S	J2	11		IEH
12	Scanner Position, Status, Bit 1, Compl.	Sec. Status	TSP(3)	SHIELD 19	PFS-S	J2	12		IEH
13	Scanner Position, Status, Bit 2, Compl.	Sec. Status	TSP(4)	SHIELD 19	PFS-S	J2	13		IEH

14	Scanner Position, Status Valid, Compl.	Sec. Status	TSP(5)	SHIELD 19	PFS-S	J2	14		IEH
15									
16	Lamp Voltage	Sec. ANA	SL	SHIELD 26	PFS-S	J2	16		IEH
17	Blackbody Temperature 1	Sec. ANA	SL	SHIELD 26	PFS-S	J2	17		IEH
18	Blackbody Temperature 2	Sec. ANA	SL	SHIELD 26	PFS-S	J2	18		IEH
19	Shielding of Command and Status lines (1-5, 10-14, 20, 21)				PFS-S	J2	19		IEH
20	Scanner NADIR Position, Status, True	Sec. Status	TSP(21)	SHIELD 19	PFS-S	J2	20		IEH
21	Scanner NADIR Position, Status, Compl.	Sec. Status	TSP(20)	SHIELD 19	PFS-S	J2	21		IEH
22	Lamp Voltage Return	Sec. ANA	SL	SHIELD 26	PFS-S	J2	22		IEH
23	Lamp Voltage Return	Sec. ANA	SL	SHIELD 26	PFS-S	J2	23		IEH
24	Blackbody Temp. Return	Sec. ANA	SL	SHIELD 26	PFS-S	J2	24		IEH
25	Blackbody Temp. Return	Sec. ANA	SL	SHIELD 26	PFS-S	J2	25		IEH
26	Shielding of Analogue lines (7,8,9,16,17,18,22,23,24,25)				PFS-S	J2	26		IEH

5.16.11 Connector J5-E (E to O internal connection)

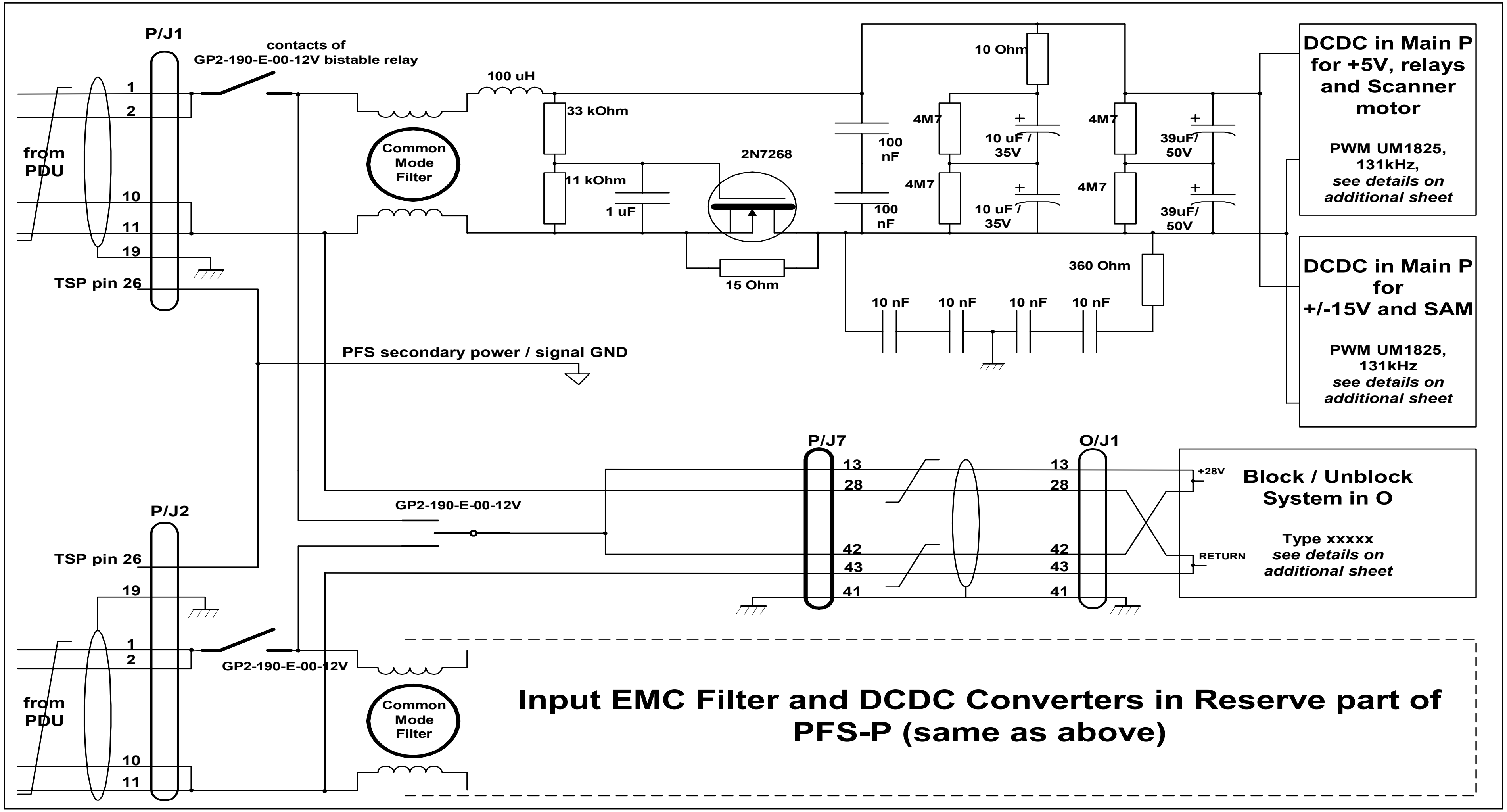
PIN ALLOCATION			INSTRUMENT: PFS			UNIT: MODULE E		MODEL: ALL	
			CONNECTOR: J5			CONNECTOR TYPE: DDMA78S			
Pin	Function	Signal Type	Type of line	Cabling req.	Destination Unit	Connector	Pin		EMC
1	DO0-DO7 SHIELD						1		IEH
2	DO0	HDI-O	IEH	SL	PFS-O	J2	2		IEH
3	DO0	HDI-O	IEH	SL	PFS-O	J2	3		IEH
4	DO1	HDI-O	IEH	SL	PFS-O	J2	4		IEH
5	DO1	HDI-O	IEH	SL	PFS-O	J2	5		IEH
6	DO2	HDI-O	IEH	SL	PFS-O	J2	6		IEH
7	DO2	HDI-O	IEH	SL	PFS-O	J2	7		IEH
8	DO3	HDI-O	IEH	SL	PFS-O	J2	8		IEH
9	DO3	HDI-O	IEH	SL	PFS-O	J2	9		IEH
10	DO4	HDI-O	IEH	SL	PFS-O	J2	*10*		IEH
11	DO4	HDI-O	IEH	SL	PFS-O	J2	*11*		IEH
12	DO5	HDI-O	IEH	SL	PFS-O	J2	*12*		IEH
13	DO5	HDI-O	IEH	SL	PFS-O	J2	*13*		IEH
14	DO6	HDI-O	IEH	SL	PFS-O	J2	14		IEH
15	DO6	HDI-O	IEH	SL	PFS-O	J2	15		IEH
16	DO7	HDI-O	IEH	SL	PFS-O	J2	16		IEH
17	DO7	HDI-O	IEH	SL	PFS-O	J2	17		IEH

18	RES_OBDM	BLD	IEH	SL	PFS-O	J2	18		IEH
19	RES_OBDM	BLD	IEH	SL	PFS-O	J2	19		IEH
20	RES_OBDM SHIELD					J2	20		IEH
21	DO8-DO14 SHIELD					J2	21		IEH
22	DO8	HDI-O	IEH	SL	PFS-O	J2	22		IEH
23	DO8	HDI-O	IEH	SL	PFS-O	J2	23		IEH
24	DO9	HDI-O	IEH	SL	PFS-O	J2	24		IEH
25	DO9	HDI-O	IEH	SL	PFS-O	J2	25		IEH
26	DO10	HDI-O	IEH	SL	PFS-O	J2	26		IEH
27	DO10	HDI-O	IEH	SL	PFS-O	J2	27		IEH
28	DO11	HDI-O	IEH	SL	PFS-O	J2	28		IEH
29	DO11	HDI-O	IEH	SL	PFS-O	J2	29		IEH
30	DO12	HDI-O	IEH	SL	PFS-O	J2	30		IEH
31	DO12	HDI-O	IEH	SL	PFS-O	J2	31		IEH
32	DO13	HDI-O	IEH	SL	PFS-O	J2	32		IEH
33	DO13	HDI-O	IEH	SL	PFS-O	J2	33		IEH
34	DO14	HDI-O	IEH	SL	PFS-O	J2	34		IEH
35	DO14	HDI-O	IEH	SL	PFS-O	J2	35		IEH
40	DO15-DO21 SHIELD					J2	40		IEH
41	DO15	HDI-O	IEH	SL	PFS-O	J2	41		IEH
42	DO15	HDI-O	IEH	SL	PFS-O	J2	42		IEH
43	DO16	HDI-O	IEH	SL	PFS-O	J2	43		IEH
44	DO16	HDI-O	IEH	SL	PFS-O	J2	44		IEH
45	DO17	HDI-O	IEH	SL	PFS-O	J2	45		IEH
46	DO17	HDI-O	IEH	SL	PFS-O	J2	46		IEH
47	DO18	HDI-O	IEH	SL	PFS-O	J2	47		IEH

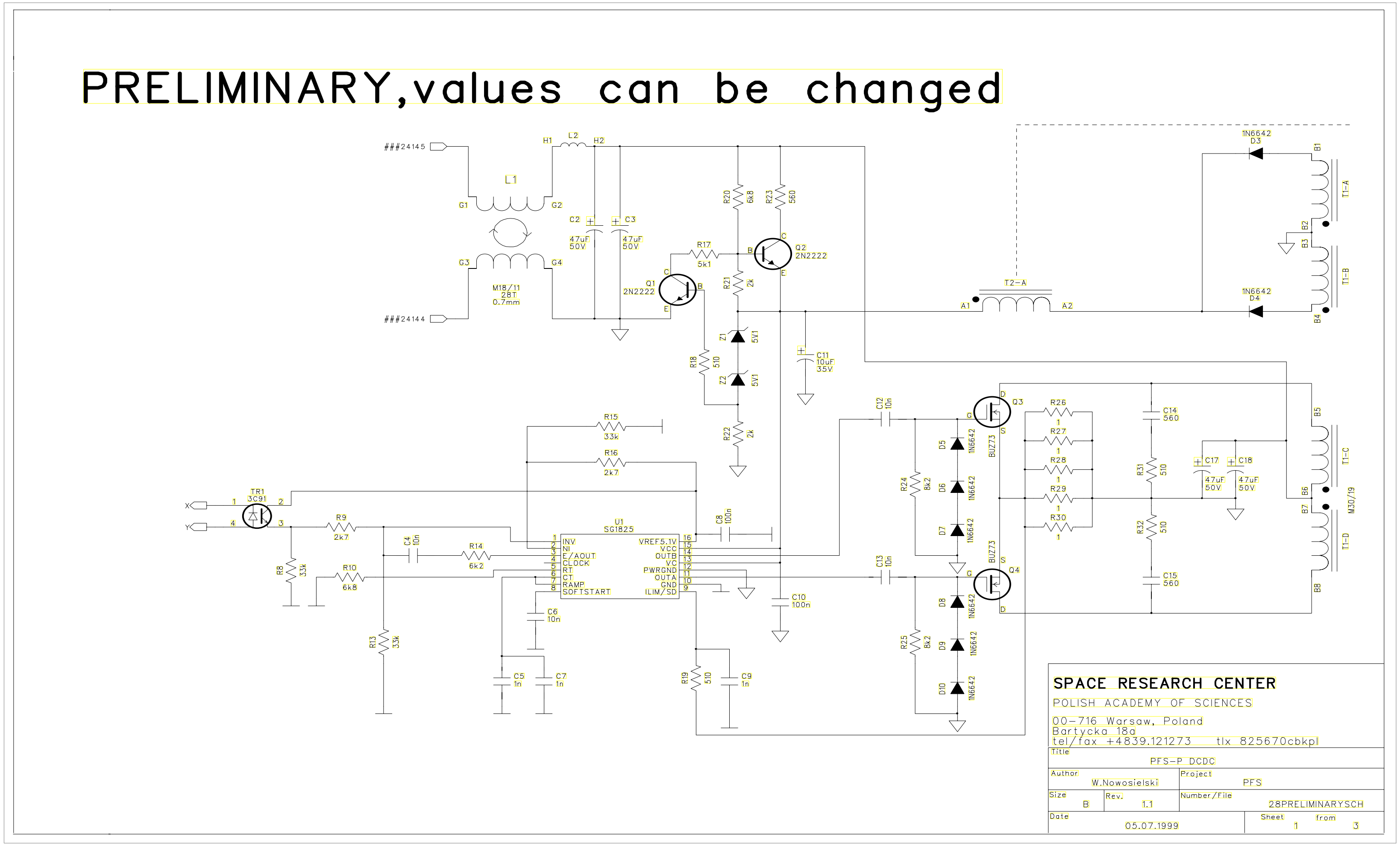
48	DO18	HDI-O	IEH	SL	PFS-O	J2	48		IEH
49	DO19	HDI-O	IEH	SL	PFS-O	J2	49		IEH
50	DO19	HDI-O	IEH	SL	PFS-O	J2	50		IEH
51	DO20	HDI-O	IEH	SL	PFS-O	J2	51		IEH
52	DO20	HDI-O	IEH	SL	PFS-O	J2	52		IEH
53	DO21	HDI-O	IEH	SL	PFS-O	J2	53		IEH
54	DO21	HDI-O	IEH	SL	PFS-O	J2	54		IEH
60	BB Temperature 1, 0-10 V SHIELD					J2	60		IEH
61	BB Temperature 1, 0-10 V	ANS	IEH	SL	PFS-O	J2	61		IEH
62	BB Temperature 1, 0-10 V	ANS	IEH	SL	PFS-O	J2	62		IEH
63	BB Temperature 1, 0-10 V Ground	ANS	IEH	SL	PFS-O	J2	63		IEH
64	BB Temperature 2, 0-10 V SHIELD					J2	64		IEH
65	BB Temperature 2, 0-10 V	ANS	IEH	SL	PFS-O	J2	65		IEH
66	BB Temperature 2, 0-10 V	ANS	IEH	SL	PFS-O	J2	66		IEH
67	BB Temperature 2, 0-10 V Ground	ANS	IEH	SL	PFS-O	J2	67		IEH
68	Lamp voltage 0-10 V	ANS	IEH	SL	PFS-O	J2	68		IEH
69	Lamp voltage 0-10 V	ANS	IEH	SL	PFS-O	J2	69		IEH
70	Lamp voltage 0-10 V Ground	ANS	IEH	SL	PFS-O	J2	70		IEH
71	Lamp voltage 0-10 V Ground	ANS	IEH	SL	PFS-O	J2	71		IEH
72	Lamp voltage 0-10 V SHIELD					J2	72		IEH
78	CHASSIS GROUND					J2	78		IEH
36,37,38,39,55,56,57,58,59,73,74,75,76,77	SPARE					J2	36,37,38,39,55,56,57,58,59,73,74,75,76,77		IEH

This page is left intentionally blank

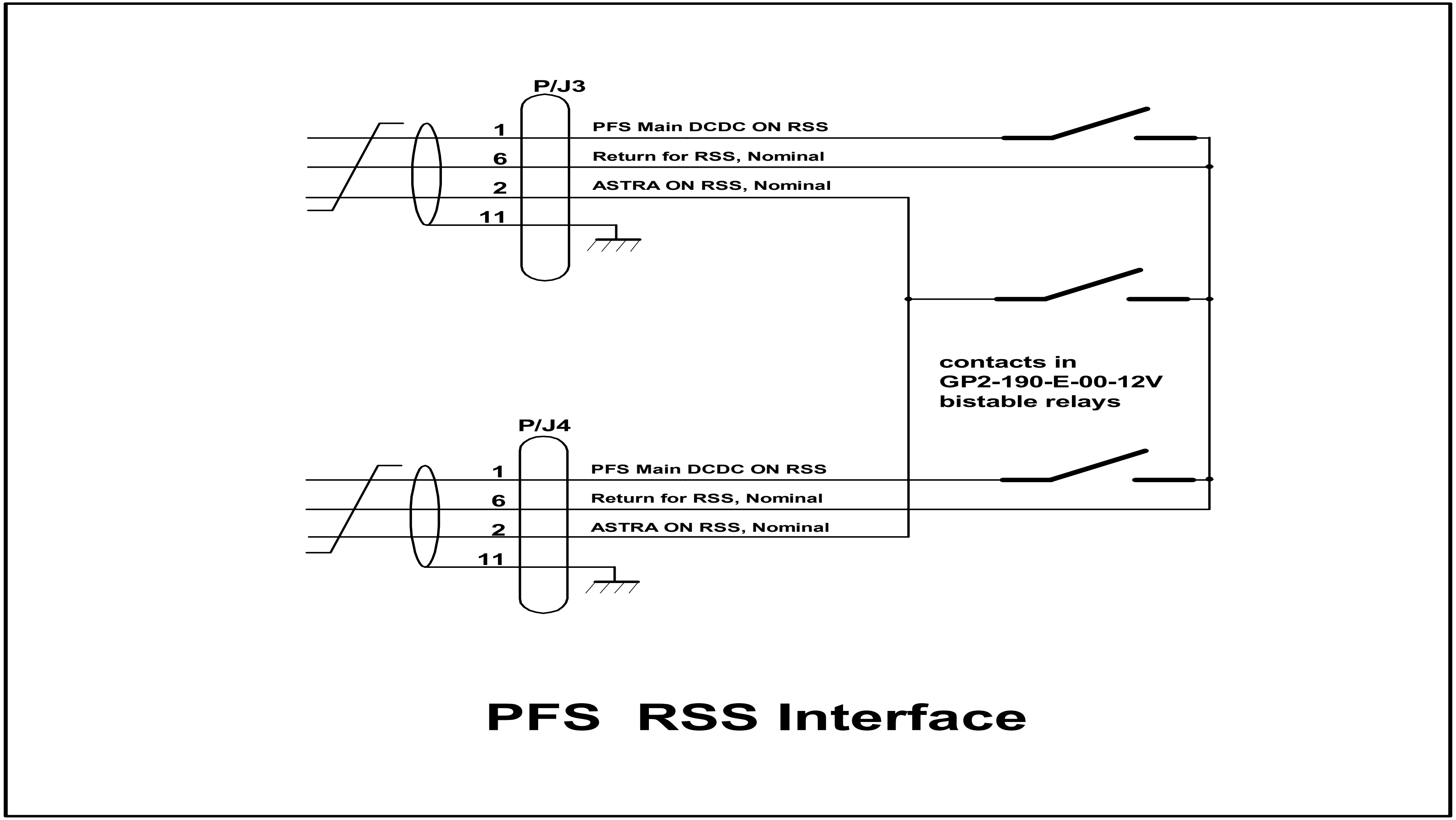
5.17 P Module POWER INTERFACE CIRCUIT



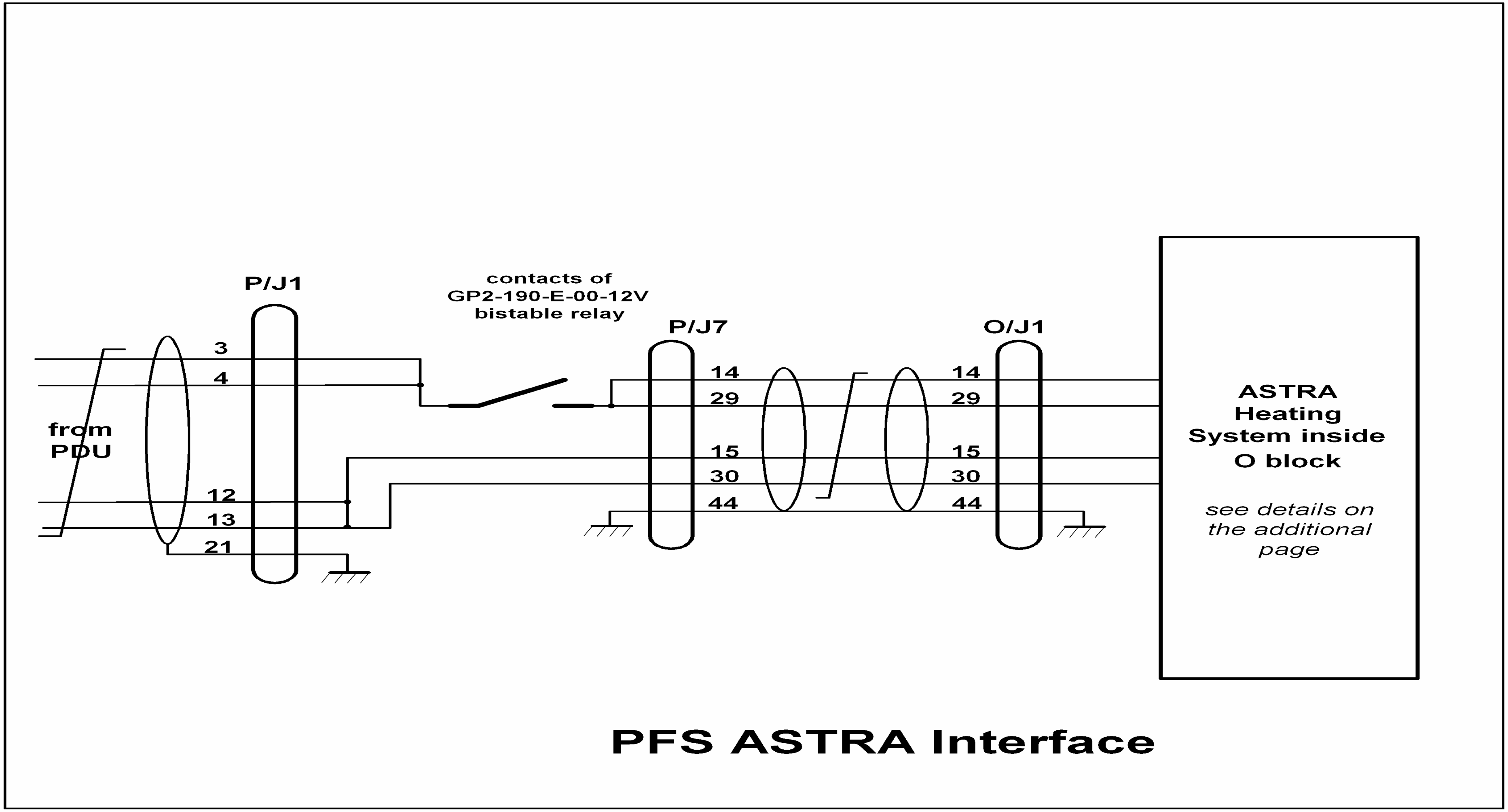
5.1b POWER INTERFACE CIRCUIT INPUT DETAILS



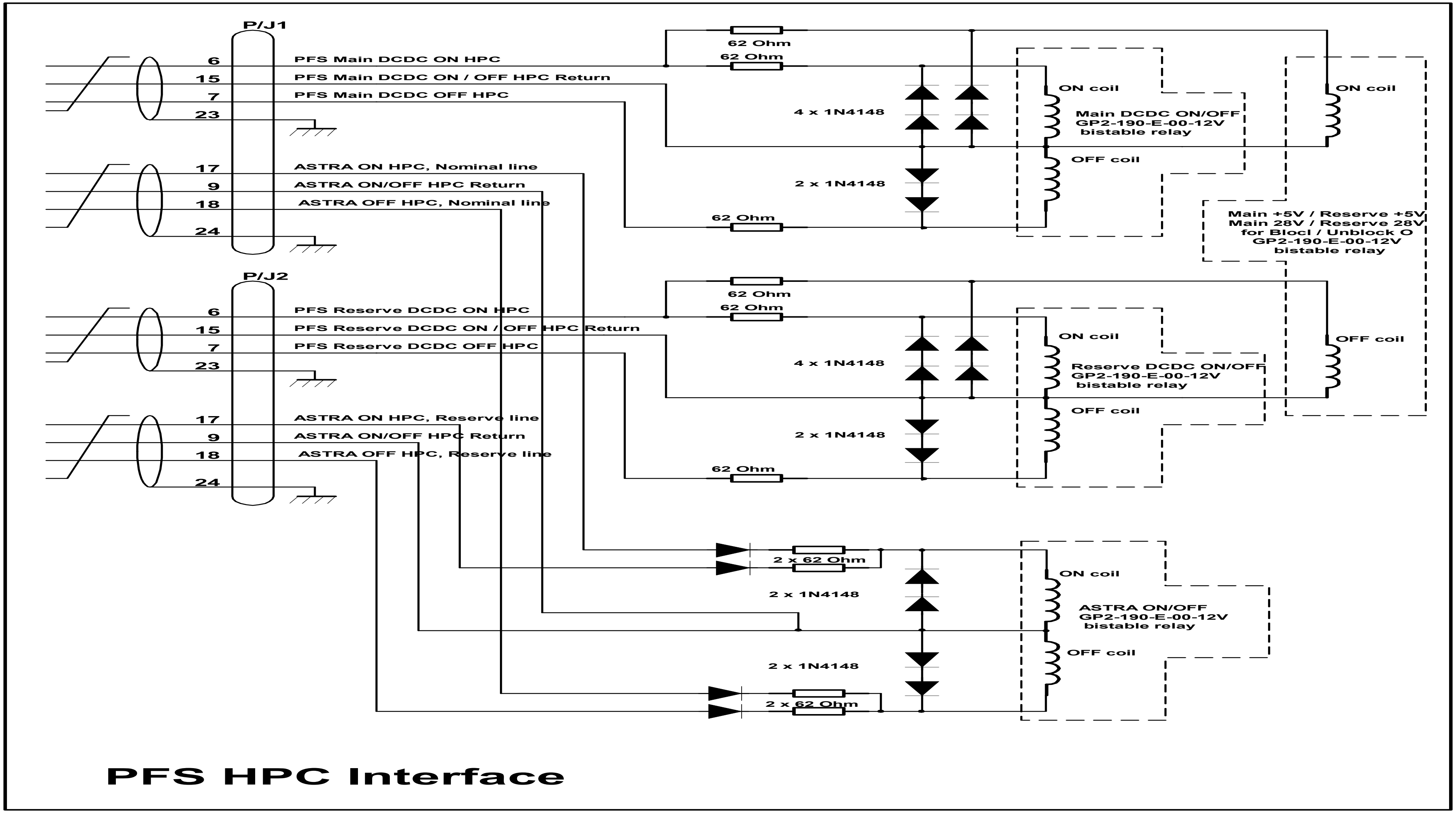
5.18 RELAY SWITCH STATUS INTERFACES



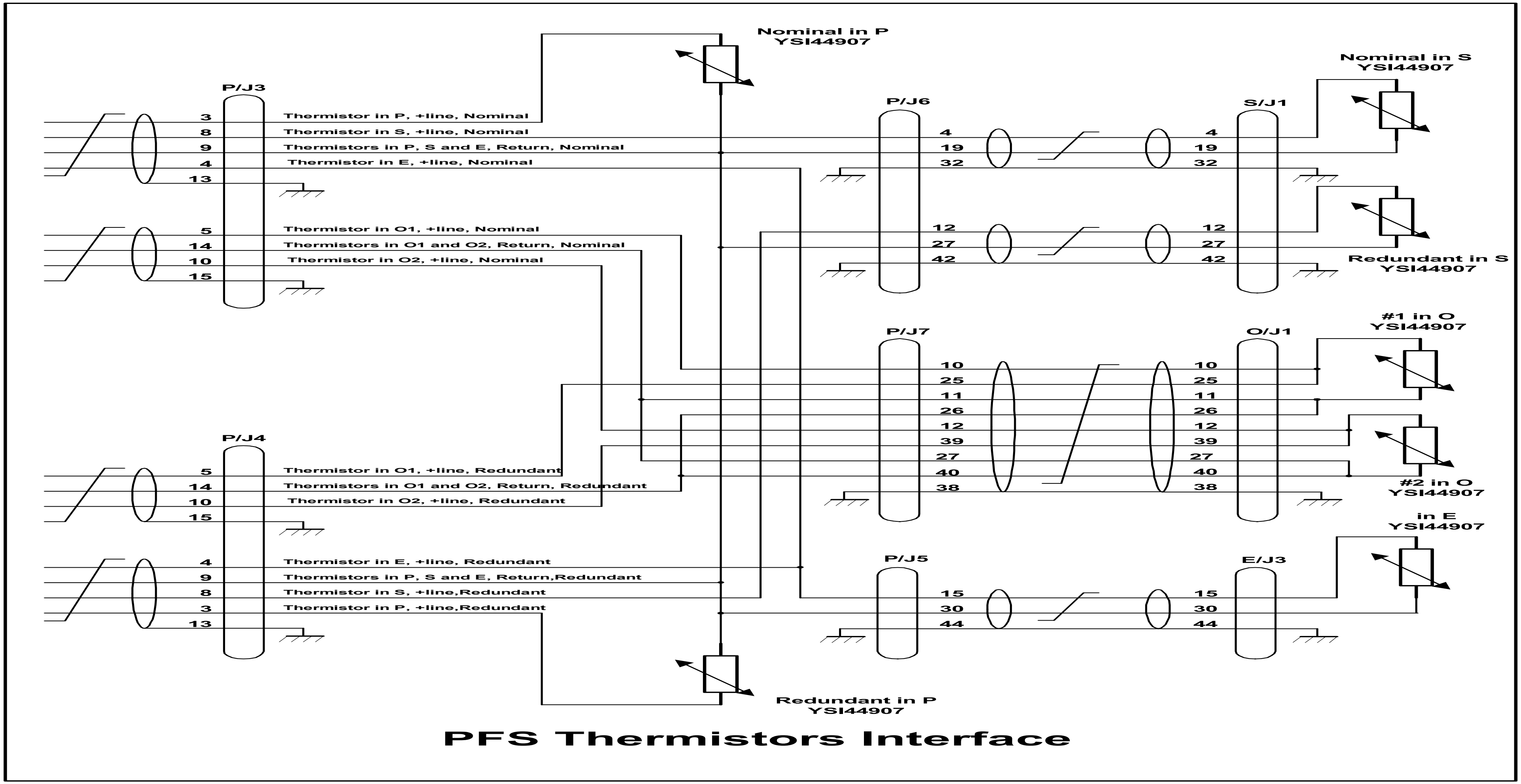
5.19 PFS HEATER INTERFACE ASTRA



5.20 PFS HPC INTERFACE

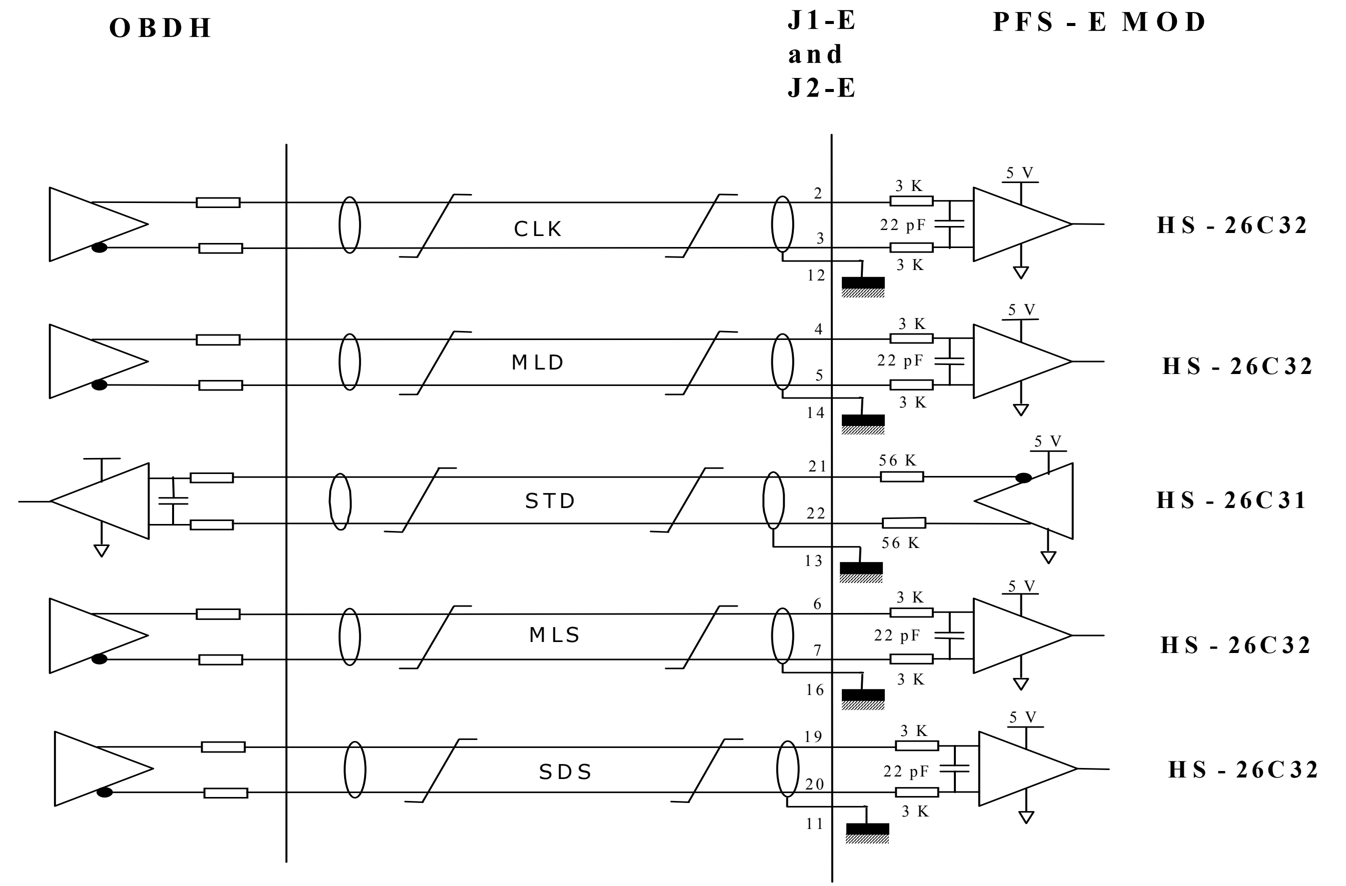


5.21 THERMISTOR INTERFACE



Thermistors are Yellowspring YSI-44907 model

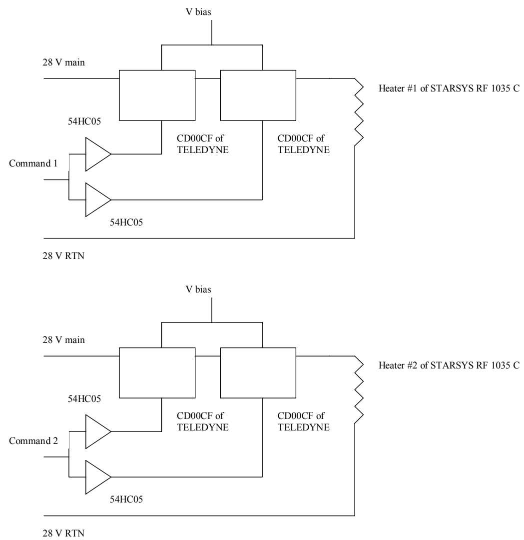
5.22 RTU to E mod. INTERFACES



Main INTERFACE on J1-E and Redundant INTERFACE on J2-E

5.23 Block Unblock detail in O Ib box

Consist of an doubled heater driven by solid state switches (Teledyne type CD00CF) with the command optically insulated .



This page is intentionally left blank

6 – EXPERIMENT DATA AND COMMANDING

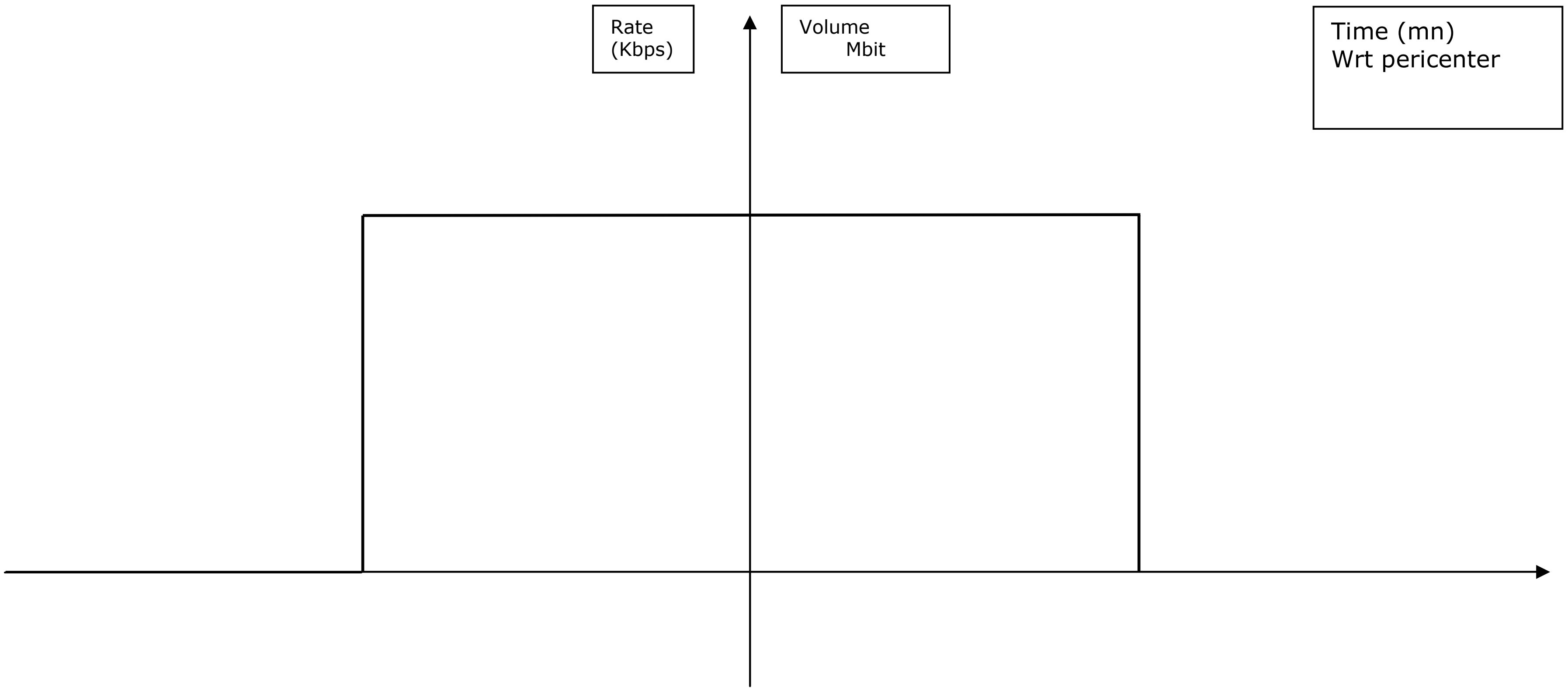
6.1 DATA RATE and VOLUME

DATA RATE AND VOLUME						INSTRUMENT: PFS				MODEL: ALL	
DATA	OPERATIONAL PHASE/MODE									Maximum length	
	1: Experiment in Mode 1			2: Experiment in Mode 9 extended			3: Experiment in Mode 12 extended				
	Rate (kbps)	Duration (s/orbit)	Volume (Mbit)	Rate (kbps)	Duration (s/orbit)	Volume (Mbit)	Rate (kbps)	Duration (s/orbit)	Volume (Mbit)	Block	Packet
SDT HK	**32**			**32**			**32**				
SDT SCIENCE	**32**	**3750**	**120**	**32**	**3906**	**125**	**32**	**3780**	**64.6**	**6.2k Words**	
TOTAL SDT			**120**			**125**			**64.6**		
IEEE 1355											

Note: 1) Values shown are acquired PER ORBIT at Pericenter pass.
2) PFS Experiment Modes shown here are some operational modes selected as the most suitable for Mars Express in orbit operations.

6.2 DATA PROFILE

DATA PROFILE	INSTRUMENT: PFS	MODEL: ALL
	DATA LINE:	SDT



Data Rate is assumed fixed at 32Kbit/s.
For Data Volume and timings around Pericenter please refer to Data Rate and Volume Table

6.3 TIPYCAL INSTRUMENT TIMELINE

INSTRUMENT TIMELINE	INSTRUMENT: PFS	MODEL: ALL
TIME	**EVENTS**	**REMARKS**
-3600 sec	Wake up, Switch on Module O and Scanner	According to the Cyclogram
-3590 sec	Wait for warm up	If Module O delay is set to 30 min
-1790 sec	Autonomous Test	
-1780 sec	Calibration LW	If 10 measurements should be taken
-1720 sec	Calibration SW	If 10 measurements should be taken
-1660 sec	Calibration deep space	If 10 measurements should be taken
-1600 sec	Move scanner to nadir position	
-1592 sec	Start Martian observations	
+1592 sec	Stop Martian observations	According to the Cyclogram
+2400 sec	Calibration LW	If 10 measurements should be taken
+2460 sec	Calibration SW	If 10 measurements should be taken
+2520 sec	Calibration deep space	If 10 measurements should be taken
+2580 sec	Autonomous Test	
+2590 sec	Switch off Module O and Scanner	
+2600 sec	Go to Sleeping Mode	

Time related events are referred to Pericenter Pass

6.4 EXPERIMENT TELECOMMANDS TABLE (RTU Operated)

6.4.1 HI – POWER COMMANDS TELECOMMANDS TABLE (RTU Operated)

These commands will be operated by Satellite side upon experiment request and shall be verified by relative RSS Relay Switch Status read by PDU in PFS-P module and inserted on the Satellite TLM.
Only one Power command will be sent to the experiment with the preference to the main DC/DC power converter and result will be verified by electrical current absortion from the satellite and by internal experiment flag detailed later on this chapter.
In case of failure of the main DC/DC a command PFSMAINOFF shall be executed and the redundant DC/DC will be Powered. PFS has two complete and indipendent power sets.
The ASTRA Heater command will be actuated after launch for the entire cruise phase. We reserve to operate this command also sometimes in orbit phase if the Omod. Ib temperature approach the non operative limit.

MNEMONIC TELECOMMAND LIST				INSTRUMENT: PFS		MODEL: ALL
ACRONYM	DESCRIPTION	APID		DESTINATION	VERIFIED BY TM	REMARKS
		PID	PCAT			
PFSMAINON	MAIN PFS POWER SWITCH			PFS P	RSSMAINON	MAIN DC/DC ON
PFSMAINOFF	MAIN PFS POWER SWITCH			PFS P	RSSMAINOFF	MAIN DC/DC OFF
PFSREDON	REDUNDANT PFS POWER SWITCH			PFS P	RSSREDON	REDUND. DC/DC ON
PFSREDOFF	REDUNDANT PFS POWER SWITCH			PFS P	RSSREDOFF	REDUND. DC/DC OFF
ASTRAON	O Mod CRUISE HEATER			PFS P	RSSASTRAON	ASTRA HEATER ON
ASTRAOFF	O Mod CRUISE HEATER			PFS P	RSSASTRAOFF	ASTRA HEATER OFF

6.4.2 PFS TELECOMMANDS TABLE

TELECOMMAND LIST				INSTRUMENT: PFS		MODEL:
ACRONYM	DESCRIPTION	APID		DESTINATION	VERIFIED BY TM	REMARKS
		PID	PCAT			
PFSTC01	Define timer for Cyclogram subsystem	86	12	PFSE	PFSHKBLOCK	Immediate
PFSTC02	Set Twakeup and Tsleep for Cyclogram N	86	12	PFSE	PFSDATAPACK	Next Session
PFSTC03	Set Data Transmission Mode for Cyclogram N	86	12	PFSE	PFSDATAPACK	Next Session
PFSTC04	Set Module O delay for Cyclogram N	86	12	PFSE	PFSDATAPACK	Next Session
PFSTC05	Start/terminate the Measurement Session	86	12	PFSE	PFSDATAPACK	Next Session
PFSTC06	Set Scanner angle for Cyclogram N	86	12	PFSE	PFSDATAPACK	Next Session
PFSTC07	Change Cyclogram State	86	12	PFSE	PFSHKBLOCK	Immediate
PFSTC08	Set First Pericenter Time	86	12	PFSE	PFSHKBLOCK	Immediate
PFSTC09	Set Orbital Period	86	12	PFSE	PFSHKBLOCK	Immediate
PFSTC10	Change ClockSec	86	12	PFSE	PFSHKBLOCK	Immediate
PFSTC11	Set period of HK Report Packet generation	86	12	PFSE	PFSHKBLOCK	Immediate
PFSTC12	Enable/disable subsystems	86	12	PFSE	PFSHKBLOCK	Next Session
PFSTC13	Set/clear OBDM Test Mode	86	12	PFSE	PFSHKBLOCK	Immediate

PFSTC14	Set temperature inside IB	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC15	Set power of laser diode	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC16	Set temperature of laser diode/detector	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC17	Set TRW current of laser diode	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC18	Set gain sensors	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC19	Set ADC configuration	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC20	Select motor coil	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC21	Set gain Zero Crossing	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC22	Set period of filter	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC23	Select Zero Crossing LW/SW	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC24	Switch laser diodes	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC25	Set Autotest parameter	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC26	Change Speed Controller STOP command	86	12	PFSO	PFSDATAPACK	Next Session
PFSTC27	Work with Module O in Sleeping Mode	86	12	PFSE	PFSDATAPACK	After the Session
PFSTC28	Set upper boundary of LW spectral band	86	12	PFSE	PFSDATAPACK	Next Session
PFSTC29	Set upper boundary of SW spectral band	86	12	PFSE	PFSDATAPACK	Next Session

PFSTC30	**Set OpCode of LW spectral band**	**86**	**12**	**PFSE**	**PFSDATAPACK**	**Next Session**
PFSTC31	**Set OpCode of SW spectral band**	**86**	**12**	**PFSE**	**PFSDATAPACK**	**Next Session**
PFSTC32	**Set/clear simulation mode**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Immediate**
PFSTC33	**Set ICM mode**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Immediate**
PFSTC34	**Set source timer**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Immediate**
PFSTC35	**Change parameter in DAM Control Table**	**86**	**12**	**PFSE**	**PFSDATAPACK**	**Next Session**
PFSTC36	**Set Scanner Mode**	**86**	**12**	**PFSS**	**PFSHKBLOCK**	**Immediate**
PFSTC37	**Set period between measurements**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Next Session**
PFSTC38	**Set number of SCAN retries**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Immediate**
PFSTC39	**Set number of OBDM retries**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Immediate**
PFSTC40	**Set POWR event ignore mask**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Immediate**
PFSTC41	**Set SCAN event ignore mask**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Immediate**
PFSTC42	**Set OBDM event ignore mask**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Immediate**
PFSTC43	**Set ICM event ignore mask**	**86**	**12**	**PFSE**	**PFSHKBLOCK**	**Immediate**

6.5 TELEMETRY LIST

TELEMETRY LIST							INSTRUMENT: PFS		MODEL:
ACRONYM	DESCRIPTION	APID		SOURCE	POSITION	VERIFIED TC	VALUES	REMARKS	
		PID	PCAT						

7 – PFS DATA OPERATION DESCRIPTION

In order to describe the data transmission modes we give first some information on the data acquisition modes.

7.1 - Modes of operation, data acquisition cycle

PFS has 5 operating modes:ASTRA, Autotest , Sleeping , Calibration , Science mode . In the Sleeping mode all peripherals are switched off except DAM which is able to receive telecommands and send telemetry information. In the ASTRA mode no data are taken . During the Autotest mode all modules are switched on and PFS makes measurements testing all its parts , gain factors, speed of double pendulum and so on. These operation modes of PFS are described in the Flight Operation Manual .

A transition between Sleeping and Observation modes is controlled by the cyclogram subsystem of the DAM software. The cyclogram subsystem can be deactivated by a telecommand, and PFS will always operate in the Sleeping mode. This possibility should be used during the orbital spacecraft maneuver and following setup of a new observation program.

DAM, ICM (FFT module), the Scanner and module O work in parallel during the Observation session, and DAM coordinates operations of other modules by sending commands and receiving messages. The commands and messages are specific for the modules, but each module begins every operation by a command "START" and sends a message "DONE" upon completion of the operation. When the operation is completed, DAM sends commands to get data (interferograms from module O, spectra from ICM, *etc*) and status information.

During the measurements the Scanner must be motionless while module O acquires data. This is the only synchronization point in the data acquisition cycle. Upon completion of the acquisition all modules work asynchronously while DAM coordinates their operations:

- **starts rotation of the Scanner.**
- **receives LW and SW interferograms from module O.**
- **if spectra required, uploads LW and SW interferograms received during the previous cycle into ICM and downloads computed spectra.**

- **prepares the telemetry data pack i.e. splits information into frames and stores them in the Mass Memory.**
- **upon completion of the Scanner rotation gives a command to module O to start new acquisition.**

After each data acquisition cycle PFS checks whether new telecommands have been received and executes them (if any). The telemetry information can be sent at any time on request from the spacecraft.

7.2 - IN FLIGHT CALIBRATION

During the Observation session on the Martian orbit PFS periodically performs calibrations by sending commands to the Scanner to point sequentially to following calibration sources:

- **the black body (module A)**
- **a calibration lamp**
- **the deep space**

The measurement conditions obtained from module O after each calibration measurement contain, in particular, temperatures of sensors and the black body. These data are used for the computation of the absolute spectra for the LW channel.

PFS has a Calibration Table which defines the calibration period (number of measurements between calibrations), the number of calibration measurements for each calibration source and the sequence of calibration sources to observe. The table can be changed by a telecommand during the space flight in order to achieve the better interpretation of measurements.

7.3 – DATA TRASMISSION MODE

For every measurement PFS sends measurement conditions and data. The measurement conditions contain an angle of the Scanner position, a state of the module O during the acquisition, a data transmission mode and other parameters to be used for the correct interpretation of the scientific data. The data transmission mode defines the kind of scientific data PFS must select and store in the Mass Memory to be sent to the Earth.

THE DATA TRASMISSION MODES 1-16 ARE OBTAINED WITH PFS OPERATING IN THE SCIENCE OPERATING MODE DESCRIBED LATER. ONLY DATA TRASMISSION MODE 0 IS OBTAINED IN THE PFS OPERATING MODE CALLED AUTONOMOUS TEST. DATA TRANSMISSION MODE 17 and 18 IS USED ONLY FOR GROUND CALIBRATION WHEN NEEDED.

For any science data transmission mode PFS acquires both LW and SW interferograms. If spectra are required, PFS makes fast Fourier transform of the interferograms. Then, depending on the data transmission mode, PFS selects required data. Interferograms can be selected either completely or in half (the central part) giving reduced resolution. Modules (absolute values) of spectra can be selected in terms of spectral intervals (reduced range) with optional averaging (reduced resolution).
There are defined 16 data transmission modes, 8 modes provide with interferograms and 8 modes provide with spectra:

- **MODE 1 - full interferograms (4096 points in the LW channel and 16384 points in the SW channel).**

THE INTERFEROGRAMS ARE TRASMITTED AS SINGLE BYTES, EXCEPT 2048 MEASUREMENT AROUND THE CENTER. THEREFORE LW IS 2048x2 +2048 BYTES, AND THE SW IS 2048x2+14336 BYTES =24576 BYTES. This data compression may eventually be switched off; in that case the number of measurements that can be taken and transmitted is going to be reduced (less operating time along the pericenter) in order to be compliant with the 32 Kbits / sec internal satellite limitation. 1 MEASUREMENT WITHOUT HEADER and with NO PACKETIZATION IS 196 608 BITS.

- **MODE 2 - full LW interferograms. 4096 MEASUREMENTS , 65 536 BITS.**
- **MODE 3 - full SW interferograms.**

THE INTERFEROGRAMS ARE TRASMITTED AS SINGLE BYTES, EXCEPT 2048 MEASUREMENT AROUND THE CENTER. THEREFORE THE SW IS 2048x2+14336 BYTES =18432 BYTES. This data compression may eventually be switched off; in that case the number of measurements that can be taken and transmitted is going to be reduced (less operating time along the pericenter) in order to be compliant with the 32 Kbits / sec internal satellite limitation. 147 456 BITS.

- **MODE 4 - reduced resolution interferograms (2048 points in the LW channel and 8192 in the SW channel). 163 840 BITS. (115 072 if we use wing compression for interferograms)**

- **MODE 5 - reduced resolution LW interferograms. 32 768 BITS.**
- **MODE 6 - reduced resolution SW interferograms. 131 072 BITS.**
- **MODE 7 - complex LW and SW spectra (4096 spectral points in the LW channel and 16384 points in the SW channel). 327 680 BITS.**
- **MODE 8 - SW interferograms and complex LW spectra. 327 680 BITS.**
- **MODE 9 - modules of LW and SW spectra (8192 spectral points in the SW channel and 2048 points in the LW channel).**

NOTE THAT THE NUMBER OF BITS WOULD BE 163 840 BITS, BUT THERE IS NO SPECTRAL INFORMATION IN THE FIRST 200 POINTS OF LW CHANNEL AND IN THE FIRST 2000 POINTS OF SW CHANNEL , THEREFORE WE HAVE 6192 + 1848 POINTS = 128 640 BITS.

- **MODE 10 - modules of LW spectra. 29 568 bits per measurement.**
- **MODE 11 - modules of LW and SW spectra with reduced resolution in some ranges (900 points in the LW channel and 5100 points in the SW channel) - aimed to study atmospheric gases. TOTAL 6000 measurements, 96 000 bits.**
- **MODE 12 - modules of LW spectra with reduced resolution and SW spectra with reduced range up to 5500 cm^{-1} (900 points in the LW channel and 4550 points in the SW channel).total 5450 measurements 87 200 bits.**

- **MODE 13 - modules of SW and LW spectra with reduced range (600 points in the LW channel and 1800 points in the SW channel) - aimed to study water bands. Total of 2400 measurements , 38 400 bits.**
- **MODE 14 - modules of LW and SW spectra with reduced resolution in full range (675 points in the LW channel and 1550 points in the SW channel). Total of 2225 measurements , 35 600 bits.**
- **MODE 15 - modules of SW and LW spectra with reduced range (300 points in the LW channel and 2500 points in the SW channel). Total 2800 measurements , 44 800 bits.**
- **MODE 16 - modules of SW spectra (6144 points) , 98 304 bits.**

FOR GROUND USE ONLY

- **MODE 17 - full interferograms (4096 points in the LW channel and 16384 points in the SW channel)**
- **MODE 18 - full SW interferograms (and 16384 points in the SW channel)**

In the reduced spectral modes 11..15 the LW and SW spectral ranges are divided into intervals. PFS has a Spectral Table which defines interval boundaries and detail levels for each mode. The detail level for every interval can be:

- **full data set - all points will be sent**
- **averaged data - four spectral points are averaged together giving reduced spectral resolution**

- **no data - data of this interval will not be sent; this gives reduced spectral range**

The Spectral Table allows to select spectra of either gases or minerals depending on a scientific goal to be achieved. The table can be changed by a telecommand during the space flight.

The default Spectral Table is shown below:

spectral interval	scientific information	Wave Length [cm^{-1}]	points tobe sent	Number of points	detail level for mode				
					11	12	13	14	15
LW-1	H_2O	200-500	200-500	300	F	F	F	A	N
LW-2	CO_2	500-800	501-800	300	F	F	F	F	F
LW-3	minerals	800-2000	801-2000	1200	A	F	N	A	N
SW-1	CO, N_2O	2000- 2500	2000-2500	500	F	F	N	A	F
SW-2	HDO	2500-2800	2500-2800	300	A	F	F	A	F
SW-3	NO_2, H_2CO, CH_4	2800-3000	2800-3000	200	A	F	N	A	F
SW-4	H_2O, CH_4	3000 -3400	3000-3400	400	F	F	F	A	F
SW-5	CO_2	3400-3800	3400-3800	400	A	F	F	A	F
SW-6	H_2O	3800-4500	3800-4500	700	F	F	F	A	F
SW-7		4500-5200	4500-5200	700	A	F	N	A	N
SW-8		5200-6000	5200-6000	800	F	F	N	A	N
SW-9		6000-7000	6000-7000	1000	F	N	N	A	N
SW10		7000-8200	7000-8200	1200	N	N	N	N	N

F - full data set, A - averaged data, N - no data

7.4 - DATA TAKING ALONG THE ORBIT

First we ask how many bits we take in the 16 modes.
Repetition time has been assumed to be 6 sec.

WORKING BELOW 2000 KM ALTITUDE WE HAVE 53.06MINUTES , IF EACH MEASUREMENT TAKES 6 SEC , WE HAVE 530 MEASUREMENTS PER ORBIT TO WHICH WE HAVE TO ADD 60 CALIBRATION MEASUREMENTS (120 PER ORBIT IN COMMISSIONING PHASE) and two autotest data set:

NUMBER	MODE	BITS-PER-MEASUR	MEGABTS-ORB	MEGABTS-DAY
1	INTERF SW LW	196 608**	116.46**	349.39**
2	INTERF LW	65 536	38.82	116.46
3	INTERF SW	147 456**	87.34**	262.04**
4	INTERF (S+L)/2	163 840	97.05	291.16
5	INTERF LW/2	32 768	19.41	58.23
6	INTERF SW/2	131 072	77.64	232.93
7	LW+SW COS	327 680	132.00	396.00 ***
8	LW COS +SW	327 680	132.00	396.00 ***
9	SPECTR LW+SW	128 640	76.19	228.60
10	SPECTR LW	29 568	17.51	52.53
11	SPECTR PARTS	96 000	56.86	170.51
12	SPECTR PARTS	87 200	51.65	154,95
13	SPECTR PARTS	38 400	22.74	68.22
14	SPECTR PARTS	35 600	21.08	63.24
15	SPECTR PARTS	44 800	26.53	79.59
16	SPECTR PARTS	98 304	58.23	174.69

**** with the data compression scheme of 1 byte for tails of interferograms.**
***** WORKING REDUCED TIME AROUND THE PERICENTER (ONLY 2164 SEC).**

THE PREVIOUS NUMBERS INCLUDE THE PACKETIZATION OF THE INFORMATION, BUT DO NOT INCLUDE THE MEASUREMENTS HEADER WHICH ARE EVALUATED TO BE 256 BYTES PER MEASUREMENT = 1213.64 Kbits PER ORBIT, THEREFORE = 3639.46 Kbits PER DAY.
TO HAVE THE TOTAL DATA VOLUME REQUESTED FOR PFS WE HAVE TO ADD THE HOUSEKEEPING DATA WHICH WILL BE 256 BYTES EVERY 10 MINUTES, 295 Kbits per day.
IN TOTAL 3.93 MEGABITS PER DAY SHOULD BE ADDED TO THE PREVIOUS TABLE.

IN TOTAL 590 MEASUREMENTS PER ORBIT,
1770 MEASUREMENTS PER DAY,
1 214 220 SPECTRA IN ONE MARTIAN YEAR.

THIS IS OUR BASELINE

NOTE THAT THE FOOT PRINT FOR OBSERVATIONS FROM 2000 Km IS OF THE ORDER OF 68 Km FOR THE SW CHANNEL AND 136 KM FOR THE LW CHANNEL , THEREFORE STILL RELATIVELY SMALL

Our formal request is to work below 2000 Km , but we are ready to work below 4000 Km or lower when needed.

We note that we would get as many spectra as IRIS in 40 days , if we are able to work every orbit all the orbits .
The data will be taken around pericenter. Indeed we have the following footprint size :

altitude Km	**250**	**300**	**400**	**800**	**1200**	**2000**
sw	**8.5**	**10**	**13.6**	**27.2**	**40.8**	**68**
lw	**17.0**	**20**	**27.2**	**54.4**	**81.6**	**136**

In order to explain how PFS will make use of the mass memory , we have to take into account that the spacecraft will accept data from PFS at the average rate of 32 Kbits per second, max rate 74 Kbits per second. In order to have the data production rate congruent with the rate with which the data are given to the spacecraft we need to study the cyclogram of PFS activity along the orbit and around the pericenter.
PFS will take martian spectra when the altitude of the spacecraft above the surface is lower than 2000 Km. But the weak-up from the sleepig mode is some time before. We shall follow the scheme given below:

- **apocenter :**
  pfs is in sleeping mode . telecommands can be received.
- **Pericenter – 60 minutes :**
  weak-up ; wait for warm-up ; start autonomous test ; calibration LW ; calibration SW ; calibration deep space. Scanner in nadir direction.Give data to the spacecraft.
- **Pericenter – 1592 seconds, start martian observations. Give data to the spacecraft.**
- **Pericenter + 1592 seconds, stop martian observations. Give data to the spacecraft.**
- **Pericenter +40 minutes : calibration LW ; calibration SW ; calibration deep space. Autonomous test. Give data to satellite . Go to sleep mode.**
- **Up to apocenter in sleep mode.**

With the table given above we can coupe with the spacecraft limitation of an average 32 Kbits / sec for internal data trasmission. Indeed we should consider that the autonomous test and the calibrations are taken separately, so there is no problem in providing that information to the spacecraft , making use, if needed of the PFS mass memory. The total number of bits we can transmit in real time when operating is 32000 Kbits/sec x 3183 sec = 101 856 000 bits. To this we can add a delayied transmission of 32 Megabits (our mass memory) . A total of 134 Megabit becomes available. This would correspond to 251 879 bits per measurement if 530 measurement with packetization are to be transmitted. In the mode 7 and 8 in the above table we see that each measurement needs more than 251 Kbits , therefore we are forced to decrease the number of measurements. In modes 7 and 8 we shall take martian measurements for only 2164 seconds, i.e. 36 minutes.

7.5 – PFS DATA VOLUMES

PFS HAS 15% OF THE DATA VOLUME ALLOCATED FOR TELEMETRY DOWNLINK , WE SHALL DISCUSS HERE HOW TO USE THIS DATA SHARE AND THE MODES OF DATA TRASMISSION GIVEN ABOVE.

We shall consider the 3 bit rate of the spacecraft :

case 1 = 2500 Megabits / day	**PFS share : 375 Megabits / day**
case 2 = 1300 Megabits /day	**PFS share : 195 Megabits/ day**
case 3 = 700 Megabits / day	**PFS share : 105 Megabits /day**

case 1

In the first 30-40 days we have :

commissioning phase : 14 days
science high rate : 25 days

commissioning phase : calibrations 13+13+13 13+13+13 tot 78 meas.
mode 1 interferograms 530 meas.
header , housekeeping etc autotest

total data volume : 15.3 Megabit
104.2 Megabit
5.0 Megabit
total 124.5 Megabits/orbit
total 373.5 Megabits/ day

MODE 1 science high rate : calibrations 10+10+10 10+10+10 tot 60 meas.
Measurements mode 1 530
Header housekeeping autotest.
total data volume : 11.8 Megabit
104.2 Megabit

5.0 Megabit
total 120.0 Megabits/orbit
total 360.0 Megabits/day

MODE 9 science high rate : calibrations 60 meas.
Measurements mode 9 530
Headeer housekeeping autotest.
Total data volume : 7.7 Megabit
68.2 Megabit
5.0 Megabit
total 80.9 Megabit/orbit
total 243 Megabits/day

MODE 9 EXTENDED science high rate :
Calibrations 60 meas.
Measurements mode 9 870
Header housekeeping autotest.
Data volume : 7.7 Megabit
111.9 Megabit
5.4 Megabit
total 125.0 Megabit/orbit
total 375.0 Megabits/day

To take 870 measurements we need 87 minutes , so the data taking should start earlier.

Note that at the end of the first period we should have :
14 x 3 x 78 + 20 x 3 x 60 calibrations = 3276 + 3600 = 6876 calibrations
14 x 3 x 530 + 20 x 3 x 870 = 22260 + 52200 = 74460 spectra
The preferred modes are MODE 1 for the commissioning phase and EXTENDED MODE 9 for the next 25 days.

case 2

After 34 days of very high data volume return , we will have 60 days with 1300 Megabits /day, corresponding to 195 Megabits per day for PFS :

science high rate : 60 days

MODE 1 science rate : calibrations 10+10+10 10+10+10 tot 60 meas.
Measurements mode 1 260
Header housekeeping autotest.
total data volume : 11.8 Megabit
51.1 Megabit
2.5 Megabit
total 65.4 Megabits/orbit
total 196.0 Megabits/day

MODE 9 science rate : calibrations 60 meas.
Measurements mode 9 410
Headeer housekeeping autotest.
Total data volume : 7.7 Megabit
52.7 Megabit
4.0 Megabit
total 64.4 Megabit/orbit
total 193.2 Megabits/day

MODE 12 EXTENDED science high rate :
Calibrations 60 meas.
Measurements mode 12 630
Header housekeeping autotest.
Data volume : 5.2 Megabit
54.9 Megabit
4.5 Megabit
total 64.6 Megabit/orbit
total 193.8 Megabits/day

To take 630 measurements we need 63 minutes , so the data taking should start 5 min earlier and stop 5 min later.

Note that at the end of the first period we should have :

14 x 3 x 78 + 20 x 3 x 60 calibrations = 3276 + 3600 = 6876 calibrations
14 x 3 x 530 + 20 x 3 x 870 = 22260 + 52200 = 74460 spectra

Note that at the end of the second period , assuming we use 30 days in mode 9 and 30 in mode 12 we should have :

30 x 3 x 60 + 30 x 3 x 60 calibrations = 5400 + 5400 = 10800 calibrations
30 x 3 x 410 + 30 x 3 x 630 = 36 900 + 56700 = 93 600 spectra
total 168 060 spectra and 17 676 calibrations

case 3

After 94 days of high data volume return , we will have 300 days with 700 Megabits /day, corresponding to 105 Megabits per day for PFS , 35 Mbits per orbit :

science low rate : 300 days

MODE 1 science rate : calibrations 10+10+10 10+10+10 tot 60 meas.
Measurements mode 1 110
Header housekeeping autotest.
total data volume : 11.8 Megabit
21.6 Megabit
1.2 Megabit
total 34.6 Megabits/orbit
total 103.8 Megabits/day

MODE 9 science rate : calibrations 60 meas.
Measurements mode 9 180
Headeer housekeeping autotest.
total data volume : 7.7 Megabit

23.15 Megabit
4.0 Megabit
total 34.85 Megabit/orbit
total 104.5 Megabits/day

THE ABOVE MODES GIVE TOO LITTLE DATA , WE HAVE TO USE THE SCISSOR MODES : AVERAGE OF THE DATA (MODE 14) , NEGLECTING MINERALS (MODE 13) , OR AVERAGE THE MINERALS (MODE 12) . WE HAVE :

MODE 12 science low rate :

Calibrations 60 meas.
Measurements mode 12 290
Header housekeeping autotest.
Data volume : 5.2 Megabit
25.2 Megabit
4.5 Megabit
total 34.9 Megabit/orbit
total 104.7 Megabits/day

MODE 13 science low rate :

Calibrations 60 meas.
Measurements mode 13 734
Header housekeeping autotest.
Data volume : 2.3 Megabit
28.1 Megabit
4.5 Megabit
total 34.9 Megabit/orbit
total 104.7 Megabits/day

To take 734 measurements we need 73 minutes , so the data taking should start 10 min earlier and stop 10 min later.

MODE 14 science low rate :

Calibrations 60 meas.
Measurements mode 14 790
Header housekeeping autotest.

Data volume : 2.1 Megabit
28.1 Megabit
4.5 Megabit
total 34.7 Megabit/orbit
total 104.1 Megabits/day

To take 790 measurements we need 79 minutes , so the data taking should start 13 min earlier and stop 13 min later.

7.6 – TWO POSSIBLE STRATEGIES OF OBSERVATIONS

THERE ARE TWO PROPOSED STRATEGY TO BE SELECTED :

FIRST PERIOD = 375 Mbit/DAY
14 DAYS MODE 1
20 DAYS MODE 9 EXTENDED

Note that at the end of the first period we should have :
14 x 3 x 78 + 20 x 3 x 60 calibrations = 3276 + 3600 = 6876 calibrations
14 x 3 x 530 + 20 x 3 x 870 = 22260 + 52200 = 74460 spectra

SECOND PERIOD = 195 Mbits/DAY
6 PERIODS OF 10 DAYS :
1 ORBIT MODE 1
1 ORBIT MODE 9
28 ORBITS MODE 12

Note that at the end of the second period , we should have :
6 x 35 x 60 calibrations == 12600 calibrations
6 x 260 = 1560 interferograms
6 x 410 = 2460 full spectra
6 x 28 x 630 = 105 840 mode 12 spectra

THIRD PERIOD = 105 Mbits/DAY
30 PERIODS OF 10 DAYS
1 ORBIT MODE 1
1 ORBIT MODE 9
28 ORBITS MODE 14

Note that at the end of the third period , we should have :

30 x 35 x 60 calibrations == 63000 calibrations
30 x 110 = 3300 interferograms
30 x 180 = 5400 full spectra
30 x 28 x 790 = 663 600 mode 14 spectra

In one year we should have 27 120 mode 1 , 60060 mode 9 , 105 840 mode 12 , 663 600 mode 14 , in total 856 620 spectra. With mode 14 we study minerals , with mode 12 we get minerals and co2 and water . On top we should get 82 476 calibrations. In total 7 gigabytes in 394 days, later the data volume increases to previous values.

ALTERNATIVELY WE CAN HAVE :

FIRST PERIOD = 375 Mbit/DAY

14 DAYS MODE 1
20 DAYS MODE 9 EXTENDED

Note that at the end of the first period we should have :

14 x 3 x 78 + 20 x 3 x 60 calibrations = 3276 + 3600 = 6876 calibrations
14 x 3 x 530 + 20 x 3 x 870 = 22260 + 52200 = 74460 spectra

SECOND PERIOD = 195 Mbits/DAY

6 PERIODS OF 10 DAYS :

1 DAY MODE 1
1 DAY MODE 9
8 DAYS MODE 12

Note that at the end of the second period , we should have :

6 x 35 x 60 calibrations == 12600 calibrations
6 x 260 X 3 = 4680 interferograms
6 x 410 x 3 = 7380 full spectra
6 x 24 x 630 = 90 720 mode 12 spectra

THIRD PERIOD = 105 Mbits/DAY

30 PERIODS OF 10 DAYS

1 DAY MODE 1
1 DAY MODE 9
8 DAYS MODE 14

Note that at the end of the third period , we should have :

30 x 35 x 60 calibrations == 63000 calibrations
30 x 110 x3 = 9900 interferograms
30 x 180 x3 = 16 200 full spectra
30 x 24 x 790 = 568 800 mode 14 spectra

USING THE SECOND STRATEGY OF OBSERVATION WE SHALL HAVE:

In one year we should have 36 840 mode 1 , 75780 mode 9 , 90 720 mode 12 , 568 800 mode 14 , in total 772 140 spectra. With mode 14 we study minerals , with mode 12 we get minerals and co2 and water . On top we should get 82 476 calibrations. In total 7 gigabytes in 394 days, later the data volume increases to previous values.

mode 1	mode9	mode12	mode14	calib	
36840	75780	90720	568800	82476	3 periods
4680	7380	90720		12600	period 4
79500	130500			18000	period 5
121020	213660	181440	568800	113076	total

Period 4 is assumed to be identical to period 2 , while period 5 is assumed to be 100 days with high data volumes .

8 - TELEMETRY

8.1 - TELEMETRY SUBSYSTEM

DAM prepares Data Packs obtained during the Measurement Session according to the Data Transmission Mode, defined for this Session:

0 result of the Autotest
1 compressed interferograms
2 full LW interferogram
3 compressed SW interferogram
4 reduced resolution interferograms
5 reduced resolution LW interferogram
6 reduced resolution SW interferogram
7 complex LW and SW spectra
8 SW interferogram and complex LW spectrum
9 modules of LW and SW spectra
10 module of LW spectrum
11 atmospheric gases
12 instrument mode 1
13 water bands
14 average mode
15 instrument mode 2
16 module of SW spectrum
17 full interferograms
18 full SW interferogram

Depending on the Data Transmission Mode, the Data Pack can contain fields:

- **MH1 - time of acquisition, Scanner position, OBDM status, etc.**
- **MH2 - OBDM MC data**

- MH3 - OBDM Control Table and selftest; other stuff related to Session
- SW - either SW interf., or SW spectrum, or SW part of Autotest
- LW - either LW interf., or LW spectrum, or LW part of Autotest
The full definition is given in 3.1.4.

The telemetry information is prepared according to ESA and MARS-EXPRESS mission standards. The main telemetry data unit, Source Packet, contains following fields:
- Source Packet Header
- Data Field Header
- Source Data
The Source Packet Header and the Data Field Header have predefined structure. Only the Source Data can contain private PFS information. There is no use to store headers together with the Source Data.

The Telemetry subsystem prepares only Source Data and stores them in the Mass Memory. The Source Data will be extracted from the Mass Memory, included into the Source Packet and sent to the spacecraft by the TM interface task.

Since the maximal length of the Source Data field is 4096 bytes, when the full size of the Data Pack can be as big as 40 Kbytes, the data segmentation should be used. The Telemetry subsystem cuts the Data Pack by pieces and adds a header to each piece. The header contains:
- acquisition number within the Session
- segment number within the acquisition
This allows to distinguish all segments obtained during the Session rather than during one acquisition.

8.2 - STRUCTURE OF THE TELEMETRY SOURCE PACKET

As defined by [12] (ME-ESC-IF-5001), the Telemetry Source Packet has following fields:

Field name	Size[b]	Comment
Packet ID	2	Identifies the experiment
Packet Sequence Control	2	Contains packet counter
Packet Length	2	Length ≤ 4106 incl. Data Field Header
Data Field Header	10	Contains service stuff
Source Data	Variable	Contains PFS TM information

The Packet ID field is costant. It contains following fields:

Field Name	Size[bit]	Value	Comment
Version Number	3	000b	Fixed by [12]
Type	1	0b	Fixed by [12]
Data Field Header Flag	1	1b	Fixed by [12]
Process ID (PID)	7	1010110b	=86d - PID assigned to PFS
Packet Category	4	1100b	Fixed by [12]

The Process ID allows to distinguish PFS packets among other ones from different experiments.
The Packet Sequence Control field contains following fields:

Field Name	Size[bit]	Value	Comment
Segmentation Flags	2	11b	Fixed by [12]
Source Sequence Count	14	0..3FFFh	Packet counter

The Packet Length field contains a value which gives information about the length of both Data Field Header and Source Data. The value is given by: Packet Length = 10 + length(Source Data) - 1.

The content of Data Field Header is fixed by [12]. The Data Field Header has following structure:

Field Name	Size[bit]	Value	Comment
SCET Time	48	time	Packet creation time
PUS Version	3	000b	To be corrected
Checksum Flag	1	0b	To be corrected
Spare	4	0000b	To be corrected
Packet Type	8	00010100b	=20 - for TM(20,3)
Packet Subtype	8	00000011b	=3 - for TM(20,3)
Pad	8	00000000b	To be corrected

8.3 - Structure of the Source Data

Since the size of the Packet Source Data field can not exceed 4096 bytes, the content of the Data Pack is cutted by segments. A header is added to each segment. The header contains an acquisition number and a segment number. The Source Data field has following fields:

Field name	Size[b]	Comment
Acquis. Number	2	Abs. number within Session, starting from 0
Segment Number	2	Abs. number within Data Pack, start from 0
TM segment	1024	Piece of the Data Pack

8.4 - Structure of MH1, MH2 and MH3 fields

The field MH1 (128 bytes) is generated during each acquisition and contains common information about conditions of the acquisition, obtained from different sources:

Field name	Size[b]	Comment
Acquisition number	2	Absolute number within the Session
Acquisition time (SCET)	6	Spacecraft time (accuracy 1/8 sec)
Acquisition time (DAM)	6	DAM time (accuracy 10 msec)

Orbital time	4	At the beginning of acquisition
Data Trans. Mode	1	Defined for the Session
Actual DTM	1	May differ for Autotest, ICM failure
Disabled subsystems	1	Data were simulated or garbage
Flags	1	Validity of OBDM MC, status, etc.
OBDM status	32	Received from OBDM or simulated
OBDM selftest	48	Obtained during OBDM bootstrap
Scanner Position	1	Obtained from Scanner Status port
ICM mode	1	Current ICM mode
ICM blk_exponent for LW	2	If spectral mode, otherwise 0
ICM sum_exponent for LW	2	If spectral mode, otherwise 0
ICM blk_exponent for SW	2	If spectral mode, otherwise 0
ICM sum_exponent for SW	2	If spectral mode, otherwise 0
ICM message after LW FFT	2	If spectral mode, otherwise 0
ICM message after SW FFT	2	If spectral mode, otherwise 0
Power Status	2	After completion the acquisition
Simulation sign	1	All data simulated by DAM
Synthetic interf. sign	1	OBDM sends synthetic interferograms
Free Mass Memory	2	Before Data Pack stored in MM
Measurement Period	2	Period between measurements
Length of LW field	2	Length of field in Data Pack
Length of SW field	2	Length of field in Data Pack

The acquisition time is taken at the moment when OMES "Acquisition completed" was received.

During the Autotest the Data Pack is prepared at DTM=0 although the current DTM is different. The "Actual DTM" field in the MH1 reflects this fact.

During the acquisition from a calibration source the Data Pack is prepared at DTM=1 although the current DTM is different. The "Actual DTM" field in the MH1 reflects this fact.
In the case of ICM failure the Data Pack is prepared at DTM=1 although the current DTM is different. The "Actual DTM" field in the MH1 reflects this fact.

The field MH2 is generated during each acquisition and contains the measurement conditions (128 bytes) obtained from OBDM during the acquisition.

The field MH3 (256 bytes) is generated at the beginning and termination of the Session and contains general information related to the Session:

Field name	Size[b]	Comment
Power Status	2	Before pow.ON or after pow.OFF
Reason of start/term	2	Why Session was started or terminated:
Pericenter Time	4	these are taken at the moment the
Orbital Period	4	Cyclogram subsys. takes a decision
Orbital Time	4	and could be used for Cycl. tuning
Twakeup	4	For current record in Session Table
Tsleep	4	For current record in Session Table
DTM	1	For current record in Session Table
ScanPos	1	For current record in Session Table
Odelay	2	For current record in Session Table
RecNum in Session Table	1	Current record in Session Table
Autotest parameter	1	Parameter during the Autotest

Reserve	**2**	**Reserved for future use**
OBDM Control Table	**32**	**Control Table was loaded at Ses.start**
LW spectral bands	**64**	**Table of LW spectral bands**
SW spectral bands	**64**	**Table of SW spectral bands**
LW spectral OpCodes	**32**	**For the actual DTM (11..15), otherwise zeroes**
SW spectral OpCodes	**32**	**For the actual DTM (11..15), otherwise zeroes**

8.5 - Structure of the Data Pack

DTM=0 - result of the Autotest. The Data Pack contains following fields:

Field Name	**Size[b]**	**Comment**
MH1	**128**	**During the Autotest**
MH2	**128**	**During the Autotest**
MH3	**256**	**At the Session starting/termination**
SW	**32768**	**SW area of Autotest**
LW	**32768**	**LW area of Autotest**

DTM=1 - compressed LW and SW interferograms. The Data Pack contains following fields:

Field Name	**Size[b]**	**Comment**
MH1	**128**	**During the acquisition**
MH2	**128**	**During the acquisition**
SW	**18432**	**SW interferogram (compressed)**
LW	**6144**	**LW interferogram (compressed)**

DTM=2 - full LW interferogram. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
LW	8192	LW interferogram

DTM=3 - compressed SW interferogram. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	18432	SW interferogram (compressed)

DTM=4 - reduced resolution LW and SW interferograms. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	16384	SW interferogram (reduced)
LW	4096	LW interferogram (reduced)

DTM=5 - reduced resolution LW interferogram. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
LW	4096	LW interferogram (reduced)

DTM=6 - reduced resolution SW interferogram. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	16384	SW interferogram (reduced)

DTM=7 - complex LW and SW spectra. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	32768	SW spectrum (complex)
LW	8192	LW spectrum (complex)

DTM=8 - SW interferogram and complex LW spectrum. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	32768	SW interferogram
LW	8192	LW spectrum (complex)

DTM=9 - modules of LW and SW spectra. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	12384	SW spectrum (module)
LW	3696	LW spectrum (module)

DTM=10 - module of LW spectrum. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
LW	4096	LW spectrum (module)

DTM=11 - atmospheric gases. The SW and LW areas are prepared according to tables A and B. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	8994	LW and SW spectra (m11) - size can be changed

DTM=12 - instrument mode 1. The SW and LW areas are prepared according to tables A and B. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	8490	LW and SW spectra (m12) - size can be changed

DTM=13 - water bands. The SW and LW areas are prepared according to tables A and B. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition

MH2	128	During the acquisition
SW	5696	LW and SW spectra (m13) - size can be changed

DTM=14 - average mode. The SW and LW areas are prepared according to tables A and B. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	4578	LW and SW spectra (m14) - size can be changed

DTM=15 - instrument mode 2. The SW and LW areas are prepared according to tables A and B. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	5384	LW and SW spectra (m15) - size can be changed

DTM=16 - module of SW spectrum. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	12288	SW spectrum (module)

Table A. Definition of spectral ranges

section number	scientific information	points to be sent	wave length [cm^{-1}]	measurements in interval
LW 1	H_2O	196 - 419	500	224
LW 2	CO_2	420 - 783	800	364
LW 3	minerals	784 - 1571	1600	788
SW 1	CO, N_2O	1948 - 2455	2500	508
SW 2	HDO	2456 - 2751	2800	296
SW 3	NO_2, H_2CO, CH_4	2752 - 2947	3000	196
SW 4	H_2O, CH_4	2948 - 3391	3450	444
SW 5		3392 - 3491	3550	100
SW 6	CO_2	3492 - 3735	3800	244
SW 7	H_2O	3736 - 3979	4050	244
SW 8	CO	3980 - 4275	4350	296
SW 9		4276 - 4619	4700	344
SW 10	2.0 μm	4620 - 4815	4900	196
SW 11	CO_2	4816 - 4963	5050	148
SW 12		4964 - 5111	5200	148
SW 13	H_2O	5112 - 5407	5500	296
SW 14		5408 - 6783	6900	1376
SW 15	H_2O	6784 - 7371	7500	588
SW 16		7372 - 7567	7700	196
SW 17	O_2	7568 - 7763	7900	196
SW 18		7764 - 8191	8333	428

Table B. Operative code to be used for each interval (see also table in section 1)

section number	scientific information	mode 11 T+MIN	mode 12 T only	mode 13 T+min	mode 14 T+CO2	mode 15 T+CO2
LW 1	H_2O	1	1	1	4	0
LW 2	CO_2	1	1	1	1	1
LW 3	minerals	4	4	0	4	0
SW 1	CO, N_2O	1	1	0	4	1
SW 2	HDO	4	1	1	4	1
SW 3	NO_2, H_2CO, CH_4	4	1	0	4	1
SW 4	H_2O, CH_4	1	1	1	4	1
SW 5		4	1	0	4	1
SW 6	CO_2	4	1	1	4	1
SW 7	H_2O	1	1	1	4	1
SW 8	CO	1	1	0	4	1
SW 9		4	1	0	4	0
SW 10	2.0 μm	1	1	0	4	0
SW 11	CO_2	1	1	1	1	0
SW 12		1	1	0	4	0
SW 13	H_2O	1	1	1	4	0
SW 14		4	0	0	4	0
SW 15	H_2O	1	0	1	4	0
SW 16		4	0	0	4	0
SW 17	O_2	4	0	0	4	0
SW 18		4	0	0	4	0

A code number means:
1 - each point from this interval is transmitted to the Earth.
4 - 4 points are averaged.
0 - the spectral interval is omitted.

Tables A and B can be changed by Telecommands. As a result, the size of SW field in DTM=11..15 can be changed. The correct field length can be obtained from the MH1 field. The actual spectral bands and OpCodes are sent in the MH3 field of the Data Pack.

DTM=17 - full LW and SW interferograms. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	32768	SW interferogram
LW	8192	LW interferogram

DTM=18 - full SW interferogram. The Data Pack contains following fields:

Field Name	Size[b]	Comment
MH1	128	During the acquisition
MH2	128	During the acquisition
SW	32768	SW interferogram

8.6 - PFS HOUSEKEEPING

PFS Housekeeping block is 256 bytes long and contains following fields:

Field	Length [b]	Meaning
RAM status	4	Status of RAM (zero bit means good block)
POWR status	4	Status of power supply
MMEM status	16	Status of Mass Memory

MmfreeList	**8**	**List of free MM blocks**
MmsciList	**8**	**List of MM blocks occupied by science data**
MmhkList	**8**	**List of MM blocks occupied by HK data**
MmbadList	**8**	**List of bad MM blocks**
Reserve	**8**	**Reserved for future use**
Field	**Length [b]**	**Meaning**
SCET	**4**	**Spacecraft Elapsed Time [sec]**
ClockSec	**4**	**DAM internal clock [sec]**
FirstPericenter	**4**	**First Pericenter time [sec]**
OrbitalPeriod	**4**	**Orbital Period [sec]**
OrbitNo	**2**	**Orbit Number after the First Pericenter**
SessionNo	**2**	**Measurement Session number**
DeltaPT	**2**	**Pericenter correction**
LastOrbit	**2**	**OrbitNo after last wakeup**
LastSes	**2**	**SessionNo after last wakeup**
TwBefore	**1**	**Flag "Twakeup is before the Pericenter"**
CorrectPT	**1**	**Flag "Correct PericenterTime"**
ProcessNo	**2**	**Measurement Number within a Session**
DelayCnt2	**2**	**Delay Counter [10 ms]**
SecDelayCnt	**2**	**Long Delay Counter [sec]**
OBDMdelay	**2**	**Delay of OBDM operations after Twakeup**
OBDMtimeout	**2**	**Timeout for OBDM command**
SCANtimeout	**2**	**Timeout for SCAN command**
ICMtimeout	**2**	**Timeout for ICM command**
OperatMode	**1**	**Operatimg Mode**
CyclMode	**1**	**Cyclogram Mode**
CyclTimer	**1**	**Timer for the Cyclogram Subsystem**
ClockSrc	**1**	**Source for SlockSec, timeouts, delays**

AbortSign	1	Signal to abort the Session
DisableCurr	1	Disable subsystems duing the current Session
DisableNext	1	Disable subsystems during the next Session
IgnorePOWR	1	Ignore Power events
IgnoreOBDM	1	Ignore OBDM events
IgnoreSCAN	1	Ignore SCAN events
IgnoreICM	1	Ignore ICM events
OBDMtest	1	OBDM test mode
OBDMauto	1	OBDM Autotest parameter
SimulMode	1	Simulation Mode
SCANmode	1	Scanner Mode
ICMmode	1	ICM Mode
SCANretNum	1	Number of SCAN retries
OBDMretNum	1	Number of OBDM retries
Reserve	6	Reserved for future use
Field	Length [b]	Meaning
VersionCafe	2	Software version header
VersionDate	2	Software version date
VersionName	8	Software file name
MonCycle	2	Monitor Cycle Counter
HKperiod	2	Period of HK Report Packet generation
Reserve	24	Reserved for future use
DMAaddr	2	DMA Address register
DMAcount	2	DMA Word Count register
DMAstatReq	2	DMA Status and Request registers
DMAcomMask	2	DMA Command and Mask registers
DMAmod0	2	DMA Mode register for channel 0
DMAmod1	2	DMA Mode register for channel 1

DMAmod2	2	DMA Mode register for channel 2
DMAmod3	2	DMA Mode register for channel 3
Sec100	2	Counter of 1/100 sec
IntMask	2	Masks of PICs
IntNMI	2	Counter of nonmaskable interrupts
IntU	2	Counter of spurious interrupts
Field	Length [b]	Meaning
IntM0	2	Counter of Timer 2.0 interrupts
IntM1	2	Counter of DMA EOP interrupts
IntM2	2	Counter of ICM interrupts
IntM3	2	Counter of Timer2.2 interrupts
IntM4	2	Counter of Hamming Processor requests
IntM5	2	Counter of parallel port input interrupts
IntM6	2	SecondCounter of ICM interrupts
IntM7	2	Counter of parallel port output interrupts
IntS0	2	Counter of Timer 1.0 interrupts
IntS1	2	Counter of PICS1 interrupts
IntS2	2	Counter of SCAN port output interrupts
IntS3	2	Counter of SCAN port input interrupts
IntS4	2	Counter of TC reception interrupts
IntS5	2	Counter of SCET interrupts
IntS6	2	Counter of FIFO half full interrupts
IntS7	2	Counter of glitch interrupts
OBDMstat	32	OBDM status

9 – EVENTS

If something goes wrong, DAM considers this as an Event and sends an Event Report to the spacecraft. The Event Report can be also sent in order to inform PFS team that some checkpoint passed. All failures detected by DAM are considered as Events. EventInfo gives additional information about the Event.

In the case of some Events the DAM software performs operations in order to avoid the cause of the Event. But if the Event is ignored, the DAM software only sends a report and continues normal operations. The possibility to ignore the Event should be used in the case of wrong information about the failure due to the hardware damage. The Event is ignored if a corresponding bit in the Event Ignore Mask is set. There are masks for different subsystems.

9.1 - Summary of PFS Events

EID	Severity	Event
SSTC	Normal	Session started by a Telecommand
SSTW	Normal	Session started by Twakeup
SSUR	Error	Session started by undefined reason
WOSM	Normal	Work with Module O in Sleeping Mode
STTC	Normal	Session terminated by a Telecommand
STTS	Normal	Session terminated by Tsleep
STUR	Error	Session terminated by undefined reason

STAB	**Error**	**Session aborted**
SFMM	**Error**	**Session suspended by MM full signal**
OMNB	**Error**	**No OBDM message 'booted' within predefined time**
OMCB	**Error**	**Communication with OBDM is bad**
ODPB	**Error**	**Doulbe Pendulum to be moved is blocked**
OMOK	**Normal**	**Communication with OBDM is OK**
OMNR	**Error**	**No responce on the OBDM command**
OMER	**Error**	**Error in the OBDM message**
DPUB	**Normal**	**Double Pendulum is unblocked**
DPBL	**Normal**	**Double Pendulum is blocked**
SWTS	**Normal**	**SW transfer started**
SWTC	**Normal**	**SW transfer completed**
LWTS	**Normal**	**LW transfer started**
LWTC	**Normal**	**LW transfer completed**
FP5V	**Error**	**Failure of power supply for 5V detected**
F15V	**Error**	**Failure of power supply for 15V detected**
FSAM	**Error**	**Failure of power supply for SAM detected**
FPUN	**Error**	**Unexpected power supply status**
SMER	**Error**	**Wrong Scanner position**
SMNR	**Error**	**No responce from Scanner within predefined time**
ISNM	**Error**	**ICM send: no message**

ISWM	**Error**	**ICM send: wrong message**
ISC2	**Error**	**ICM send: no TC in DMA channel 2**
IRNM	**Error**	**ICM recv: no message**
IRWM	**Error**	**ICM recv: wrong message**
IRC2	**Error**	**ICM recv: no TC in DMA channel 2**
DNTI	**Error**	**DAM: no Timer interrupts**
DIS4	**Error**	**DAM: IRQS4 was masked**
MMSE	**Error**	**MMEM: single error**
MMDE	**Error**	**MMEM: double error**