RO-LAX-DP-3202-RG

Alpha Proton X-ray Spectrometer

APXS

Rosetta Lander

FM ADP Document

Version: 3

Date: May 5, 2001

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Type of DLR required document	**Comment**	**Found in part**
Delivered items	EQM Hardware, software, GSE	1
Design reference	Reference to LID or spec according to which the equipment has been build	1
System and GSE user manual	• Functionality • How to operate • Means to operate • List of all commands • List of T/M packets (science and H/K) • Description of used action codes and request codes	10 , 10.6
Detailed S/W design document	The SW is fully described by command set.	10
Open work		12
Installation procedure	Transport and handling if relevant	3
Drawing tree	Hierarchically drawing overview	5.1
Top level drawings		5.2
Interface drawings	Electrical interface drawings, cable pin layout, grounding concept	4 , 6
S/W flow diagram	The SW is fully described by command set.	10.1
Functional diagram	Interaction of main equipment components on block level	2, 4.4
Budget data	Mass, CoG, foot pattern	4.6
Material list, mechanical parts list, process list	The lists are added in separate documents because of MPAe and DLR templates	Attached documents, 13
Historical record card		
Connector mating record		
Qualification status matrix		
Qualification reports		
EEE parts list		
Non-conformance reports		11
Safety data	As applicable, e.g. pressure vessels, radioactive sources, batteries	9,14, attached documents

The following documents are aatached at the end of this document

RO-LAX-DP-3500-RG	**Definition of FM HK data**
RO-LAX-DP-3400-RG	**Testprocedures, LFT and FFT**
RO-LAX-TR-3210-RG	**various Testreport**
RO-LAX-TR-3220-WM	**Testreport APXS/MUPUS FM acceptance vibe test**
RO-LAX-DP-3210-RG	**Disassembly and assembly procedure for FM board**
RO-LAX-DPL-3000-RG	**Declared Processes list (DPL)**
RO-LAX-DML-3000-RG	**Declared Material list (DML)**
RO-LAX-DCL-3000-RG	**Declared Component list (DCL), EEE part list**
RO-LAX-CMR-3000-RG	**Connector mating record**
RO-LAX-DMPL-3000-RG	**Declared Mechanical Part list (DMPL) Sensorhead and deployment device**
RO-LAX-RA-3200-RR	**Dose calculation of Cm 244 source**
RO-LAX-TR-3230-RG	**Qualification test report vibration**

change record of this document

Version, date	Issue	Remarks
Draft 0, 1/31/00	EQM delivery	Preliminary version for EQM delivery
Draft 1, 2/22/00	ADP, as required by DLR	EQM incoming inspection considered, NCRs included, several lists added.
Draft 0 09/14/2000	ADP for FM	APXS commands changed from EQM to FM version. All paragraphs concerning APXS EB updated. All issues concerning APX DD unchanged.
Version 1 10/10/2000	ADP delivered for FM incoming inspection	FM thermal cycles protocol added
Version 2 01/31/2001	FM Software updated, FM2 delivery	New HK definitions, updated Command set, new testprocedure document, electronics diagrams added, failure protection added
Version 3 , 05.05.2001	Delivery FM Deployment device and SH	Updates electrical and mechanical properties for SH and DD from EQM to FM and suggestions after PSR

1 Delivered items, design reference and schedules

All delivered FM items were designed and manufactured to meet the FM specifications given in the document Rosetta Lander REID A.

APXS EB (<u>labled FM1</u>) delivered Oct. 12. 2000 at MPAe

- No flight qualified CDMS interface
- Flight components on APXS boards
- Commercial EPROM for Software testing
- NCRs about workmanship

This board will be reworked and used as Flight Spare

APXS EB (labled FM2) scheduled Feb. 05. 2001 at MPAe

- Flight qualified CDMS interface with radhard FPGA
- Flight components on APXS boards
- NCRs of FM1 have been taken into account during manufacturing
- Radhard PROM

Delivered and accepted by MPAe

APXS DD and Sensorhead, scheduled CW 20 2001

- The sensorhead will be flight qualified, but not equipped with radioactive sources and only precalibrated.
- Vibe acceptance test together with MUPUS PEN performed CW 16 in Warschau
- **Cable between APX** sensorhead and electronics board

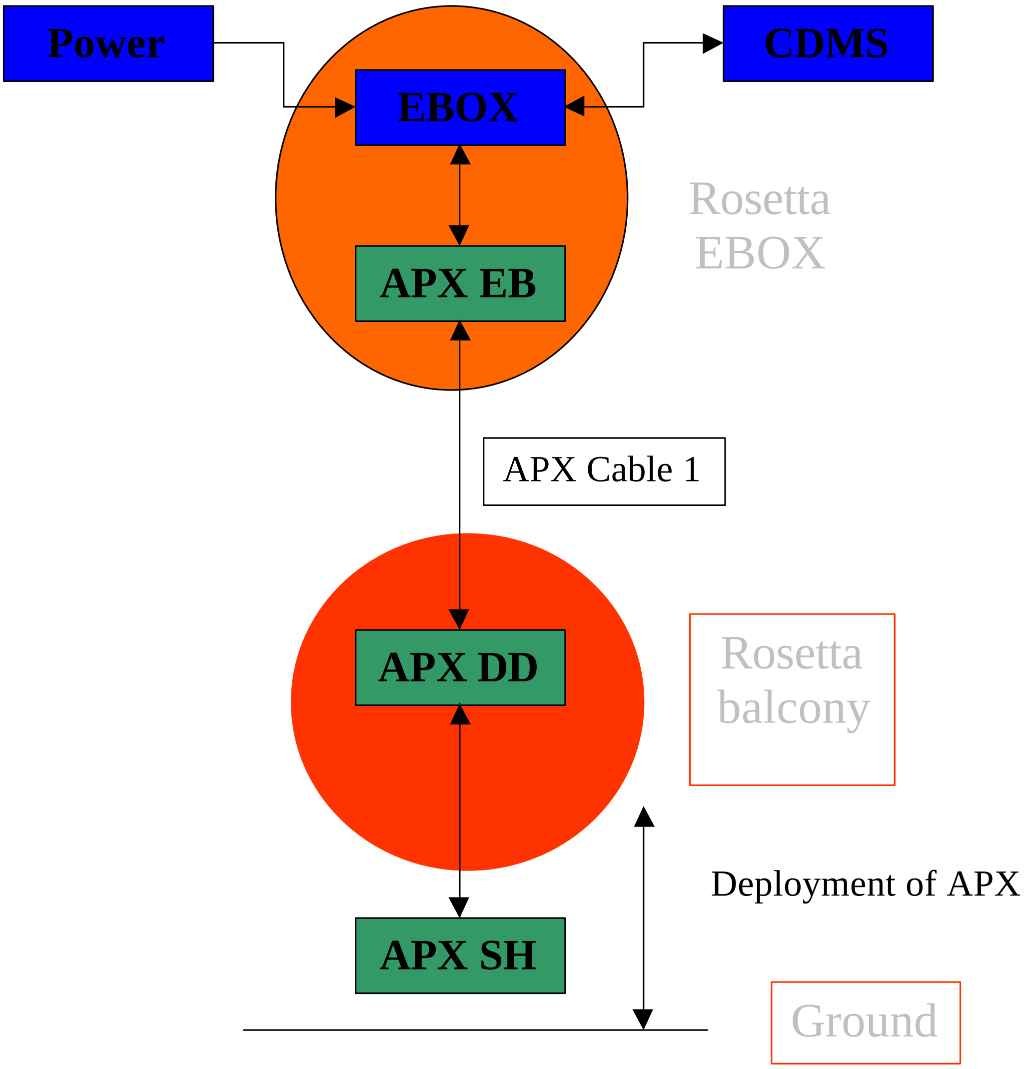
- GSE software for benchtop test, DOS GSE Tools
- Scripts for benchtop test, DOS Batches

- **APX Deployment Device simulator, APX DDS**
  It allows to simulate the full deployment of the APXS. It is equipped with motors and end switches to test the deployment device commands. It has BNC connectors for inputs of α,P,X signals to test the analogue electronics and the software that controls the measuring procedure.

2 Functional diagram

This chapter describes the functionality of the APXS on a block diagram level.

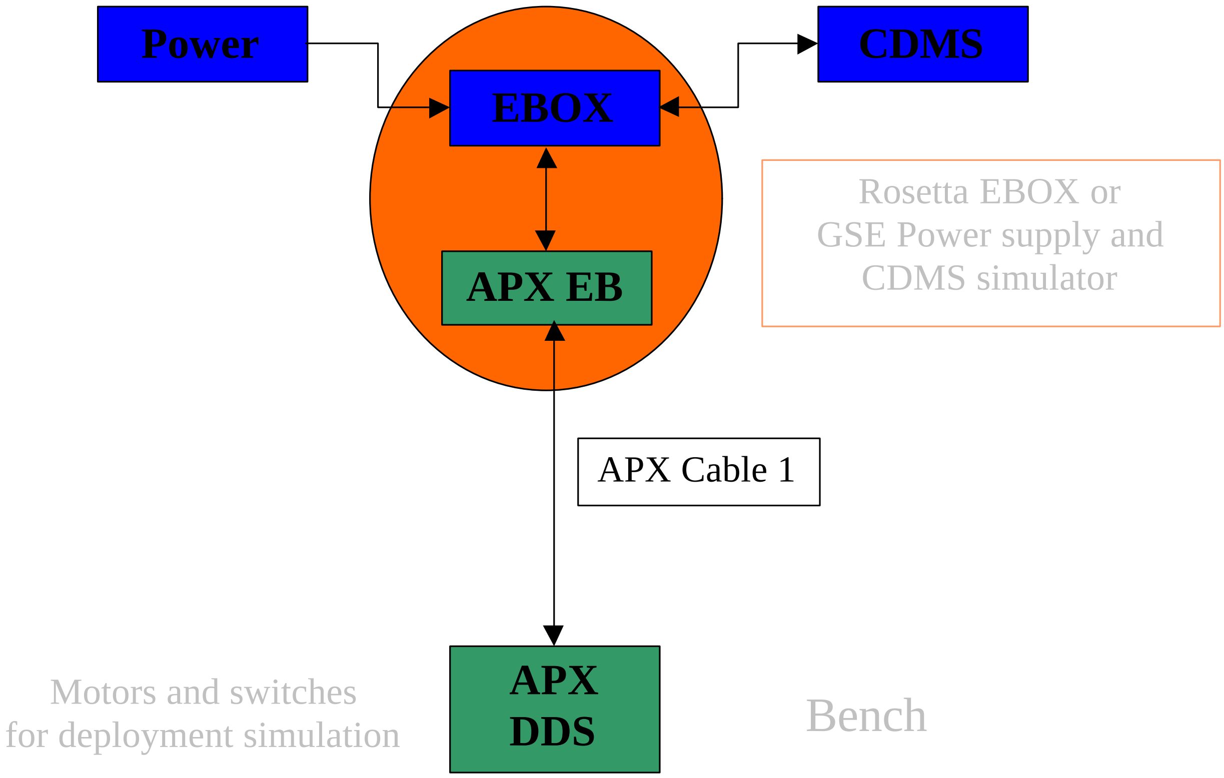
2.1 Overview of fully functionality



APX fully functional diagram

2.2 Overview of functionality with APX DDS

This section describes how the functionality can be simulated with the APX DDS. The EBOX interface to the APX EB can be either the real EBOX or a GSE Power supply with an additional connection to a CDMS simulator box with the CDMS address APX SS/ADR=00001.



APX functional diagram with device deployment simulator

3 Installation Procedures, Handling

3.1 Benchtop test.

For benchtop testing the 80 Pin Connector coming from the EBOX can be replaced by one, which has the identical power supply and CDMS pin layout. Through the CDMS simulator with SSADR of APX (00001) one can send script files to the APX EB to test the functionality. The scripts are described in detail in chapter 10.

3.2 Installation of APX EB

The APX EB has to be inserted into the EBOX. The 9 Pin GSE connector at the frontpanel can be covered, if the EBOX is integrated. The APX Cable 1 between APX EB and the APX DD can be folded with a minimal distance of 5mm between 2 layers. The following feature can identify the correct boot procedure of the APX EB after a hardreset or power on :
About 2 seconds after the click of the power relays the APX EB toggles an internal relay. This double click shows that the board has started correctly. It also detects a reset by the internal watchdog or a power loss for some µs.

3.3 Installation of APX DD

3.3.1 Integration of APXS DD

- Insert APXS Cone, fix with 4 screws at lower side of balcony
- Insert APXS adaption flansch, fix with 4 screws at upper side of balcony
- Put APXS gear box tube onto adaption flansch
- Place SH under Cone (with soldered PP cable and connected APXS cable and connected gear box top housing.
- Feed gear box top housing (including cables and stainless steel bands) through cone. Place gear box top housing beside of gear box tube
- Screw 2 threaded rods through Gearbox (from lower side). Put Gearbox onto gear box tube. Feed the cables of PP and APXS through the slits on both sides. One connector of gearbox tube has to be feed through hole of gear box.
- Srew threaded rods into SH cone. Fix SH with worm srew.
- Connect 2 connectors on the top of the gear box with sockets on the lower side of top gear box housing. Put gear box top housing onto gear box and fix with 4 M4 screws.
- Put cable supporter on top of threaded rods. Fix stainless steel band with worm srews.
- Let motor run upwards. Measure distance of SH cone to Cone. If differences appear, remove synchronization cap of gear box, remove synchronization wheels and stop one motor until APXS SH is paralell to balcony. Fix synchronization wheels and cap again.
- Feed cables and steel bands into MUPUS tubes.

- Ready

3.3.2 Deintegration APXS from balcony

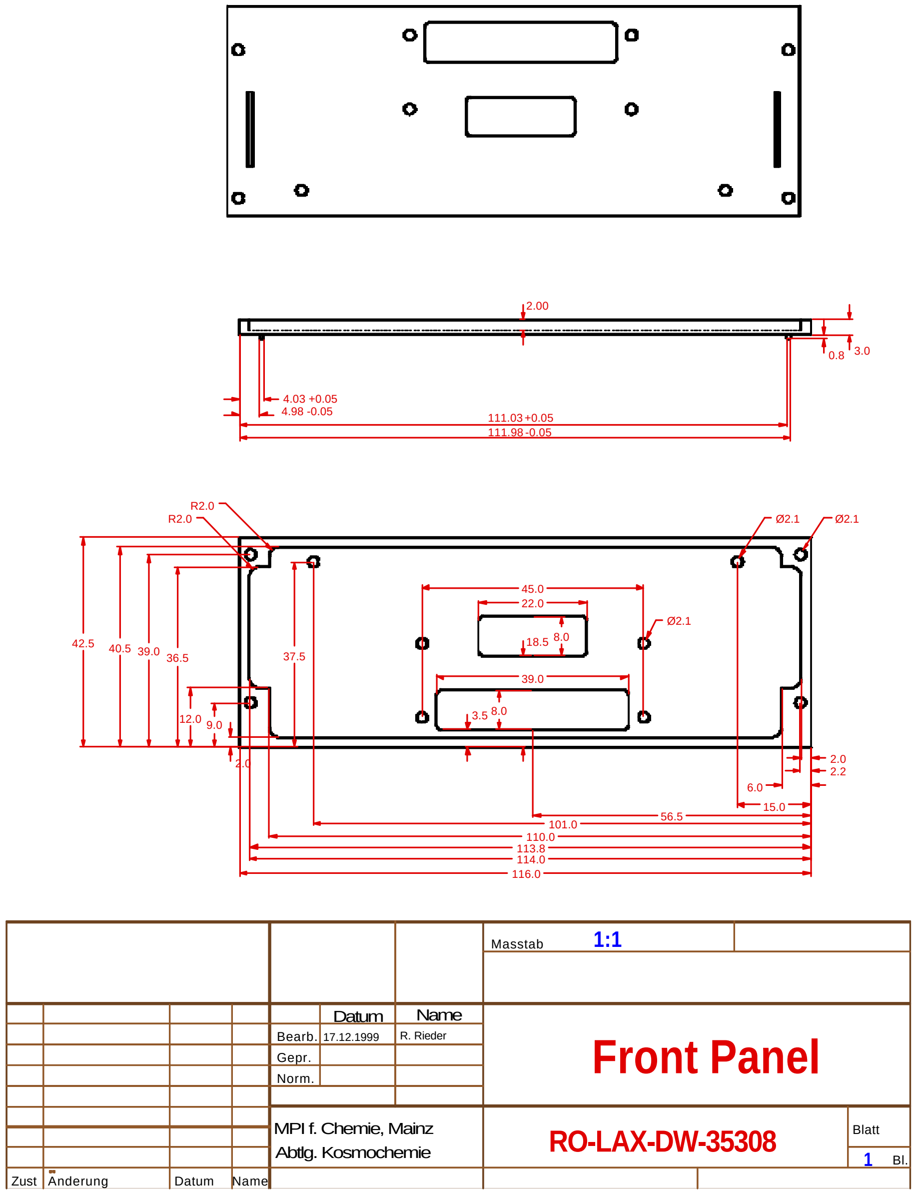
- Remove MUPUS tubes
- Run APXS down (~ 10 cm)
- Remove 4 srews on top of gear box housing
- Remove worm srews between SH and threaded rods.
- Screw threaded rods through gear box.
- Lift carefully top of sensorhead housing(e.g. with razor in slit)
- Remove 2 connectors.
- Remove gearbox by feeding cables through slits
- Feed top of gear box housing through cone
- ready

Remark:

The grease inside the gears and motors has been removed, so that the guaranteed lifetime is limited. Therefore unnecessarily movement should be avoided. The moving time can be held short if testing is made only with a deployment way of only about some cm.

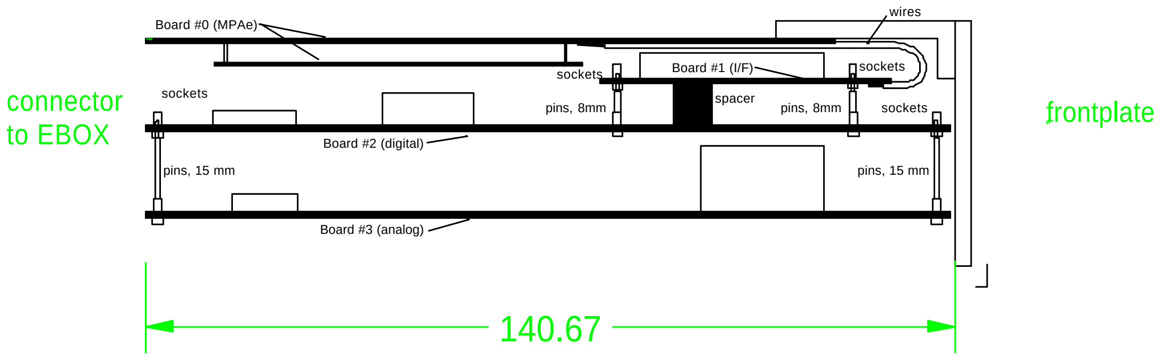
4 APXS Electronics Board

4.1 APXS EBOX Front panel



4.2 APX Electronics board stack

The APX electronics board is build as a stack, which is shown in the following picture.



The APXS digital and analogue boards were manufactured with the following qualification levels by company Micro-Hybrid, Hermsdorf:

- ANSI / IPC - A - 610 Class 3
- JPL D-8202 / D-8208 Spacecraft Electronic Packaging
- ESA-PSS-01-738

4.3 Connector layout front plate

The 9 Pin connector is a RS232 compatible interface with the APX EB. By GSE tools one can send all commands and receive the output of the digital board independently from CDMS. This GSE tool is for laboratory use only and not further described here.

<u>Connector layout MDM 9 (GSE Tool) (socket) **J156**</u>

Signal	Pin Number
Grnd	1 (left 5pin line)
Tx	3
Rx	4.

All other pins are not connected.

Connector type : Manufactor Glenair, DCDM9S-5C3-1 MC240

The 15 Pin connector **J155** is the interface between APX EB and the APX DD including the sensorhead. It contains the analogue signals of the detectors, the sense lines for the endswitches and temperature and the power supply for the motor movement and the preamplifiers.

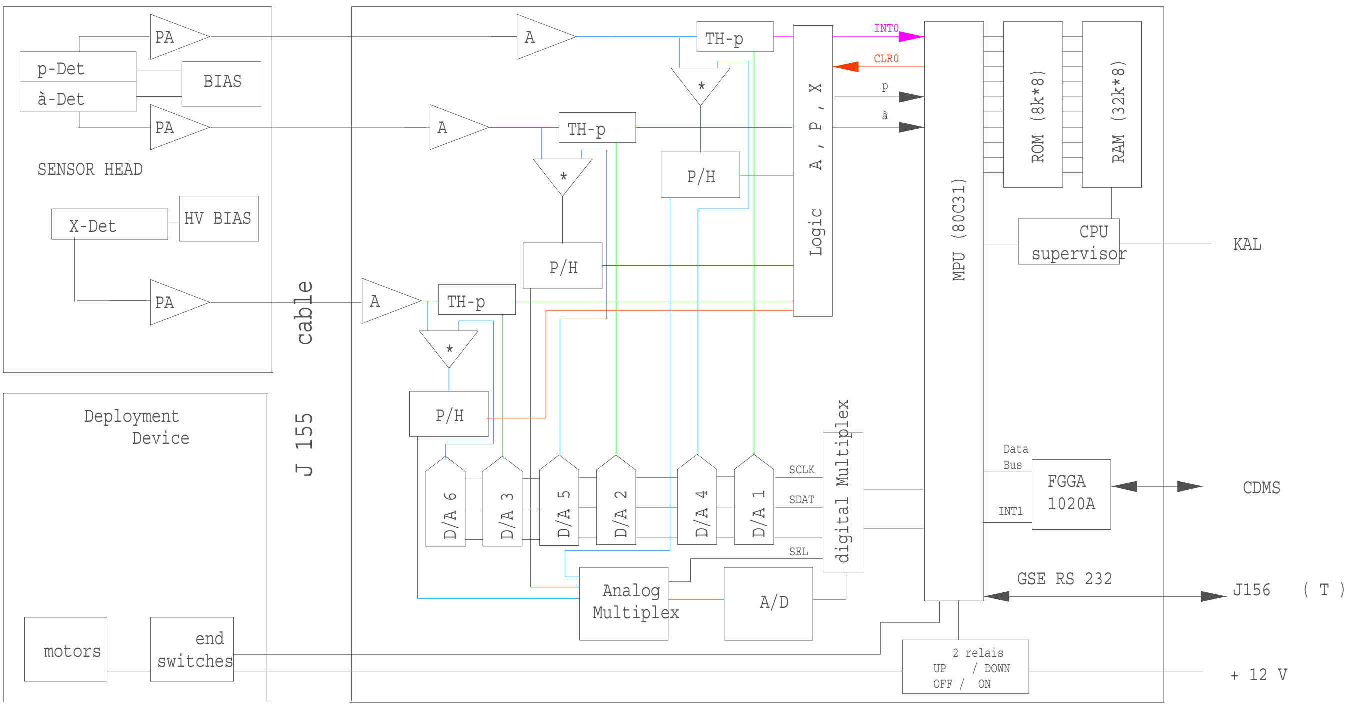
Connector layout MDM 15 (socket) (**J155**)

1	GRD	
2	Signal +	xray
3	Signal grd	xray
4	Signal grd	proton
5	Signal +	proton
6	Signal grd	alpha
7	Signal +	alpha
8	GRD	
9	Motor 1	
10	Motor 2	
11	Motor sense 1	
12	Motor sense 2	
13	Temperature sense Sensorhead	
14	+12 V	
15	– 12 V	

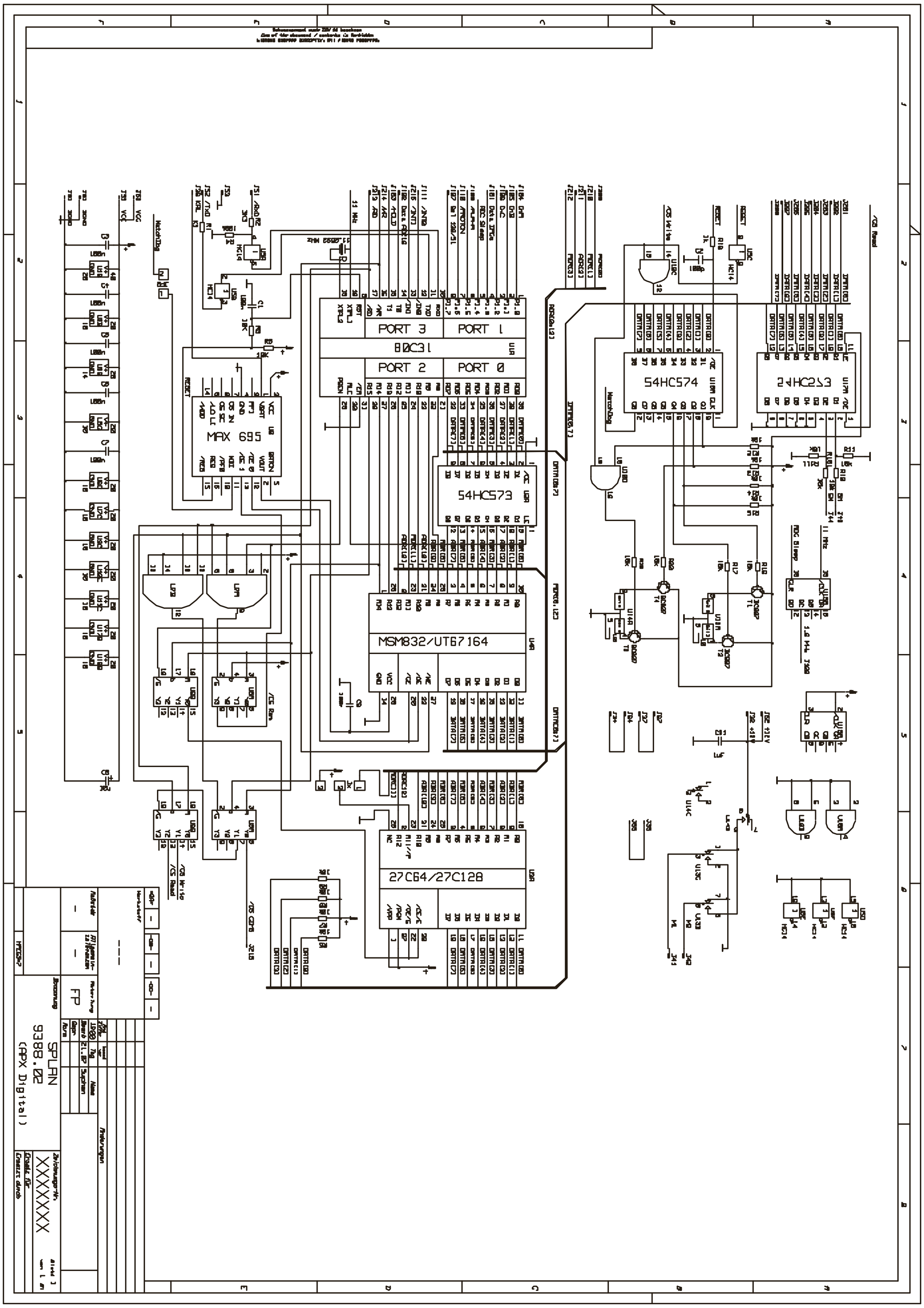
Connector type : Manufactor Glenair, DCDM15S-5C3-1 MC240

4.4 Layout APXS electronics boards

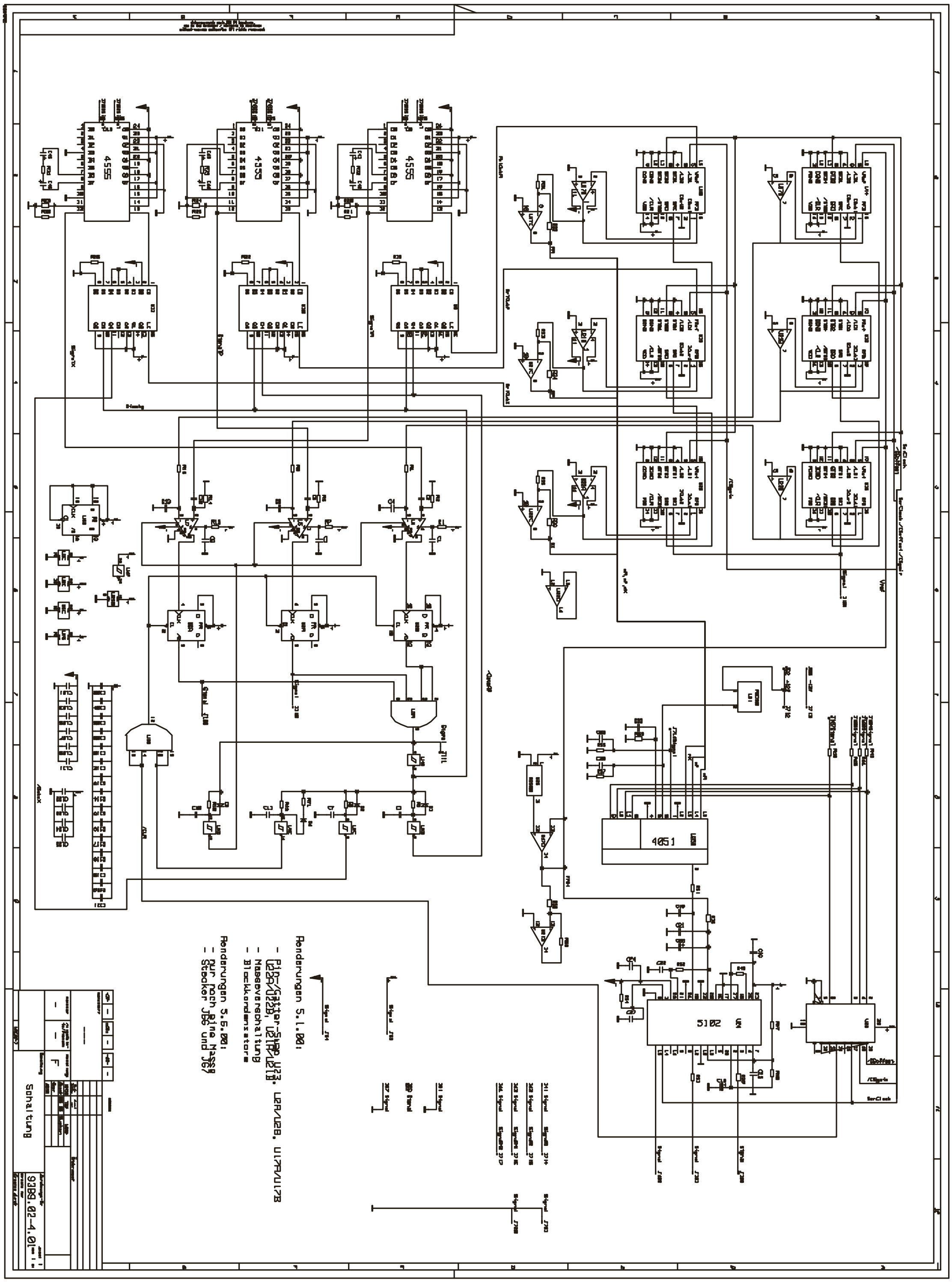
Block Diagram APXS EB



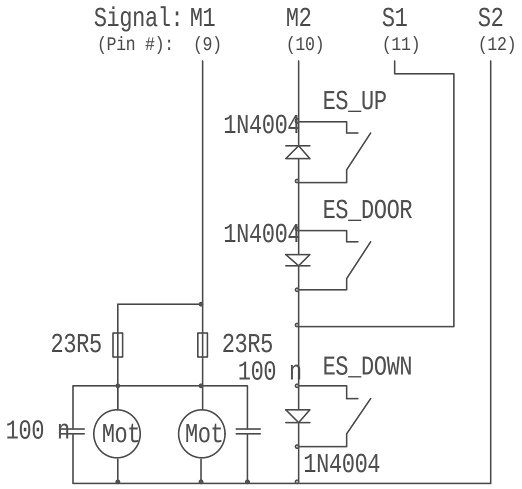
Digital board, current flow diagram



Analogue board, current flow diagram



4.5 Electronics gearbox



MOTION	ES_UP	ES_DOWN	ES_DOOR	M1	M2	S1	S2
DOWN ↓	CLOSED *)	CLOSED	CLOSED	+V	0	0	0
	CLOSED	OPEN	CLOSED	+V	0	0	+V
	CLOSED	CLOSED	OPEN	+V	0	+V	+V
UP ↑	CLOSED	CLOSED *)	CLOSED *)	0	+V	+V	+V
	OPEN	CLOSED	CLOSED	0	+V	0	0

*) CLOSED by DIODE

4.6 Budget data

The budget data of APXS DD, SH and cable were determined during EQM incoming inspection at MPAe., document number RO-LAN-RP-32040/429-WB. The final data taken during FM incoming inspection will be updated ASAA.

4.7 Mass

The EQM mass data were taken from step id 14, chapter 7.

Item	Mass of parts [g]	Total Mass [g]
APX EB FM2	310 g (+6 g connector saver)	310
Harness (APX Cable 1)	31	31
APX DD consisting of		816.3
Sensor head	216.3	
Gear Box	395	
Adaption flansch	32	
2 threaded rods	173	

4.8 CoG

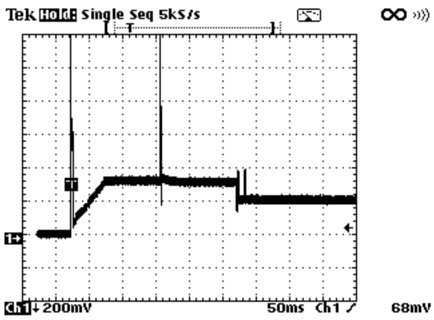
The COG data were taken from step id 15 ff, chapter 7. The reference point is defined in chapter 0

Item	X–axis[mm]	Y-axis[mm]	Z-axis[mm]
Gear box + adaption flansch	52.5	-41.8	40.5
Sensorhead	40	40	-3
2 Threaded rods	40	40	250

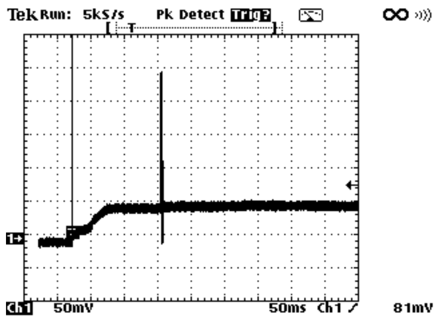
4.9 Inrush currents

The following inrush currents were measured with APXS EB FM2 at MPCh
[200 mV = 100 mA each current line]

+5.2 V

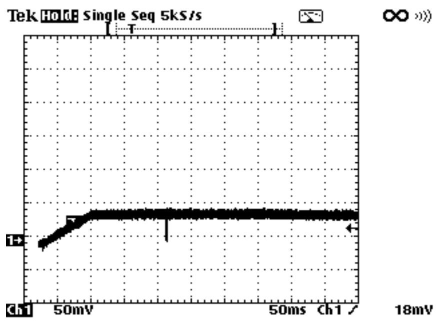


-5 V



+ 12 V
equivalent to
-12 V

-12 V



4.10 Power dissipation

Based on mean power consumption, the dissipation power is distributed the following way.

APXS EB (EBOX) ~ 700 mW

APXS SH (balcony or deployed at comet surface) ~ 500 mW

Only during deployment there is additional:

APXS DD (on balcony) ~1500 mW

4.11 Grounding concept

The grounding concept is as follows :

APXS is grounded via power interface and isolated against frontplate.

Ground is feed through APXS cable to SH. SH is isolated against APXS Deployment device housing. APXS DD is isolated against ground

5 Mechanical drawings

5.1 Drawing tree

The following files contain all mechanical parts of the APXS Deployment device and Sensorhead. The files are not added to this document, as this would burst the scope of this document. Each filename has to be added with the APXS preface RO-LAN-

```
APXS overview
            350000.FCW
   Sensorbox
               351000.fcw
         Sensorhead housing
                  351101.fcw
                  351102a.fcw
                  351102b.fcw
                  351103.fcw
                  351104.fcw
                  351105.fcw
                  351106.fcw
         sensorhead electronics
                  351201.fcw
                  351202.FCW
                  351203.FCW
                  351204.FCW
         detectors, sources
                  351301.fcw
                  351302.fcw
                  351303.fcw
                  351304.fcw
                  351305.fcw
                  351306-1.fcw
                  351306-2.fcw
                  351306-3.fcw
                  351306-4.fcw
         Doors
                  351401.fcw
                  351402.fcw
                  351403.FCW
                  351404.FCW
   Gearbox
                  352000.fcw
         Gearbox housing
                  352101.fcw
                  352102.fcw
                  352103.fcw
                  352104.fcw
                  352105.fcw
```

```
                    352106.fcw
                    352107.FCW
                    352108.FCW
                    352109.FCW
          Gearbox internal
                    352210.fcw
                    352211.fcw
                    352222.fcw
                    352230.fcw
                    352231.fcw
                    352232.fcw
   housing
                    353000.fcw
          housing
                    353100.FCW
                    353101.fcw
                    353102.fcw
                    353103.fcw
                    353104.fcw
                    353105.fcw
          APX-housing
                    353201.fcw
                    353202.fcw
                    353203.fcw
                    353204.fcw
                    353205.fcw
                    353206.fcw
                    353207.fcw
                    353208.fcw
                    353209.fcw
                    353210.fcw
```

The following mechanical drawings of the above drawing tree are inserted in this chapter.

RO-LAX-350000 overview of whole system, including APX DD and APX SH
RO-LAX-DW-351000 APXS Sensorhead
RO-LAX-DW-352000 APXS Gearbox

The Sensorhead is drawn with the electronics and detectors. The delivered sensorhead contains a mass equivalent dummy instead.
For assembly and overview purpose two additional drawings were added.

5.2 Top level drawings

The following pages contain top level drawings of the main mechanical parts of the APXS sensorhead and APXS deployment device.
More detailed drawings of each component are not included because this would burst the scope of this document.

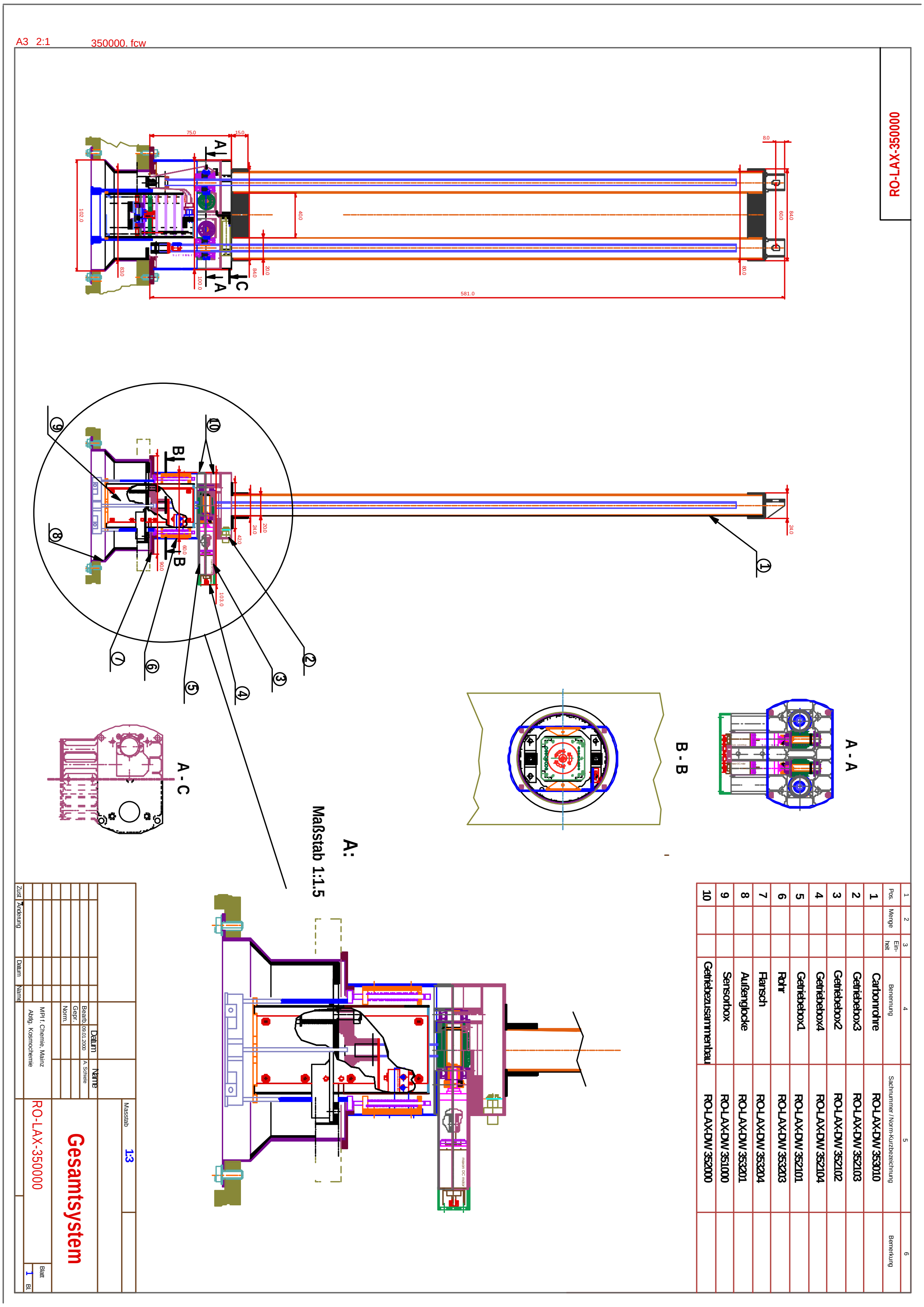


Figure 1 RO-LAX-350000 overview of whole system, including APX DD and APX SH

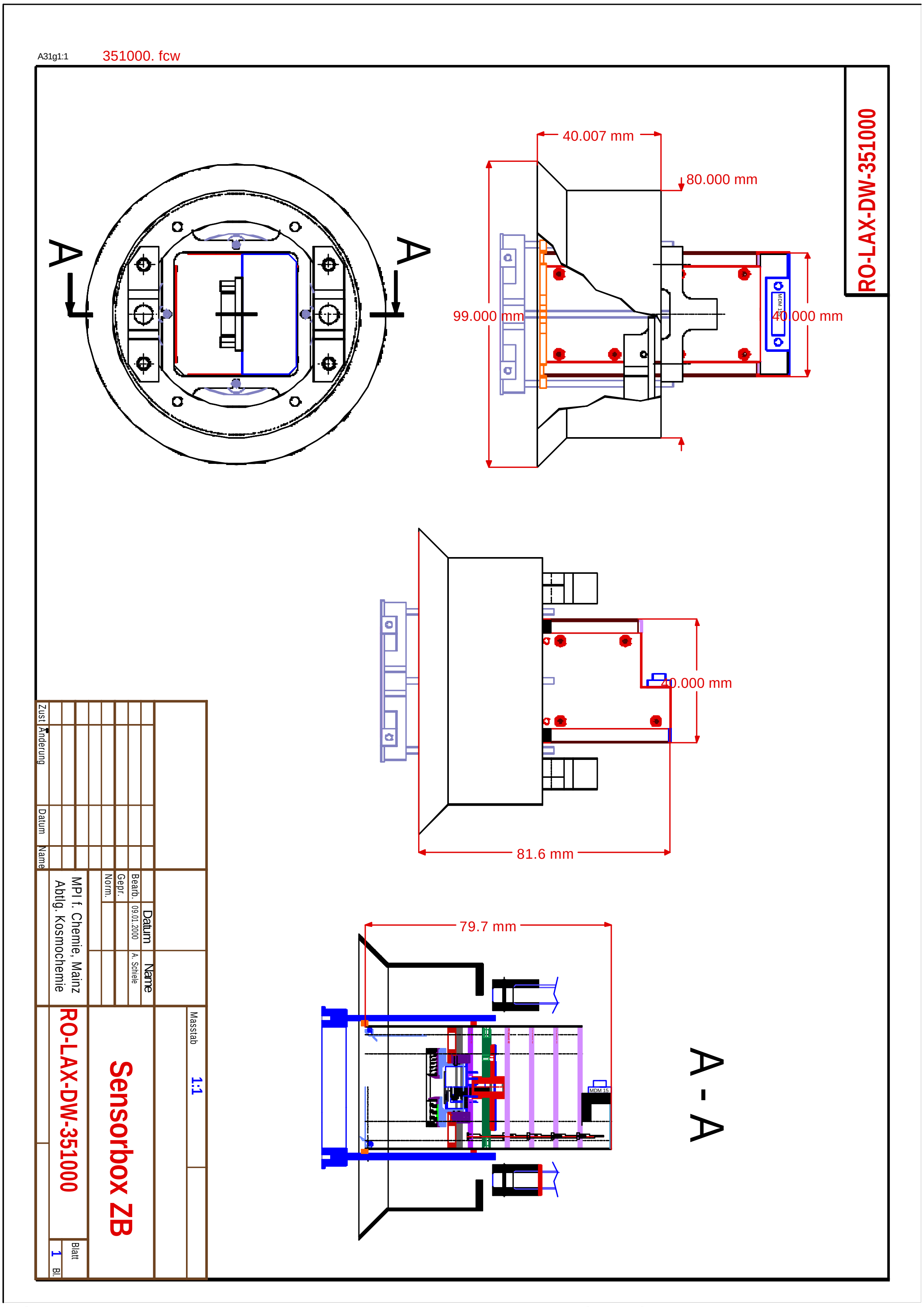


Figure 2 RO-LAX-DW-351000 APXS Sensorhead

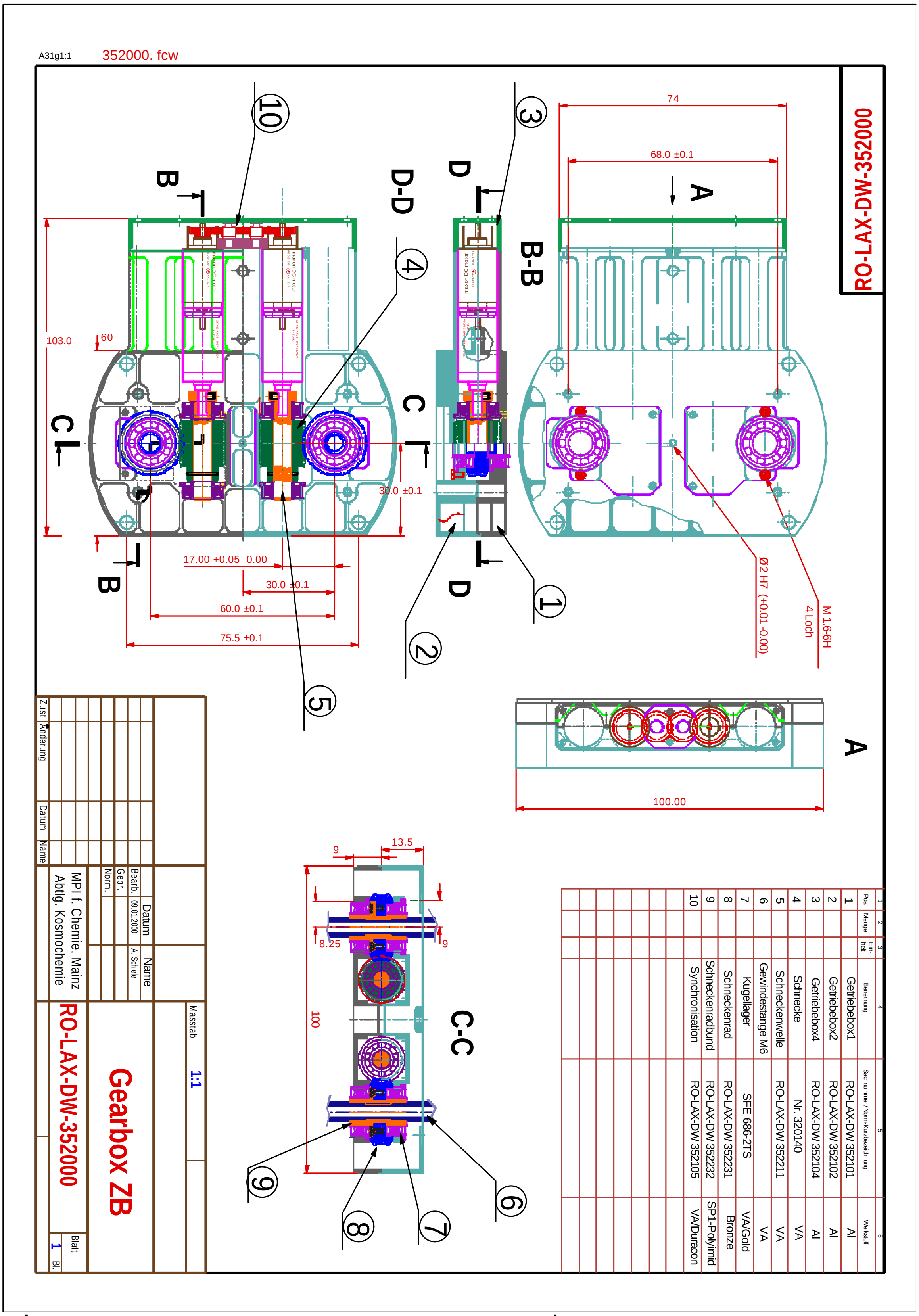


Figure 3 RO-LAX-DW-352000 APXS Gearbox

5.3 Attachments, footprints

The APXS sensorhead is located on the cold platform. It is positioned in the APXS Deployment Device, the so-called ‘hat’, at the lower end of the deployment device of MUPUS. The hat is attached to the platform, which has a hole at this position, through which the APXS can be moved. In the hat, there is a mechanism to lower and raise the APXS sensorhead from the platform to the comet surface. For measurements, the sensorhead has to be deployed, otherwise, it will be in the stowed position. The hat also contains a device to lock the APXS during launch (launch look device).

For the integration of the APX DD, the gearbox has to be connected by 4 screws at the bottom of the Rosetta balcony and 2 screws at the end of the black tubes belonging to MUPS. The housing of the gearbox has to be adapted to the adaption flansch, which is inserted in the bottom of the Rosetta balcony.
The reference point for APXS measures is one of the screw holes of this adaption flansch, shown in the picture RO-LAN-DW-353203. The housing of the gears points to the centre of the balcony !
The fit check of the FM gearbox housing with MUPUS FM during vibe acception test integration was successful.

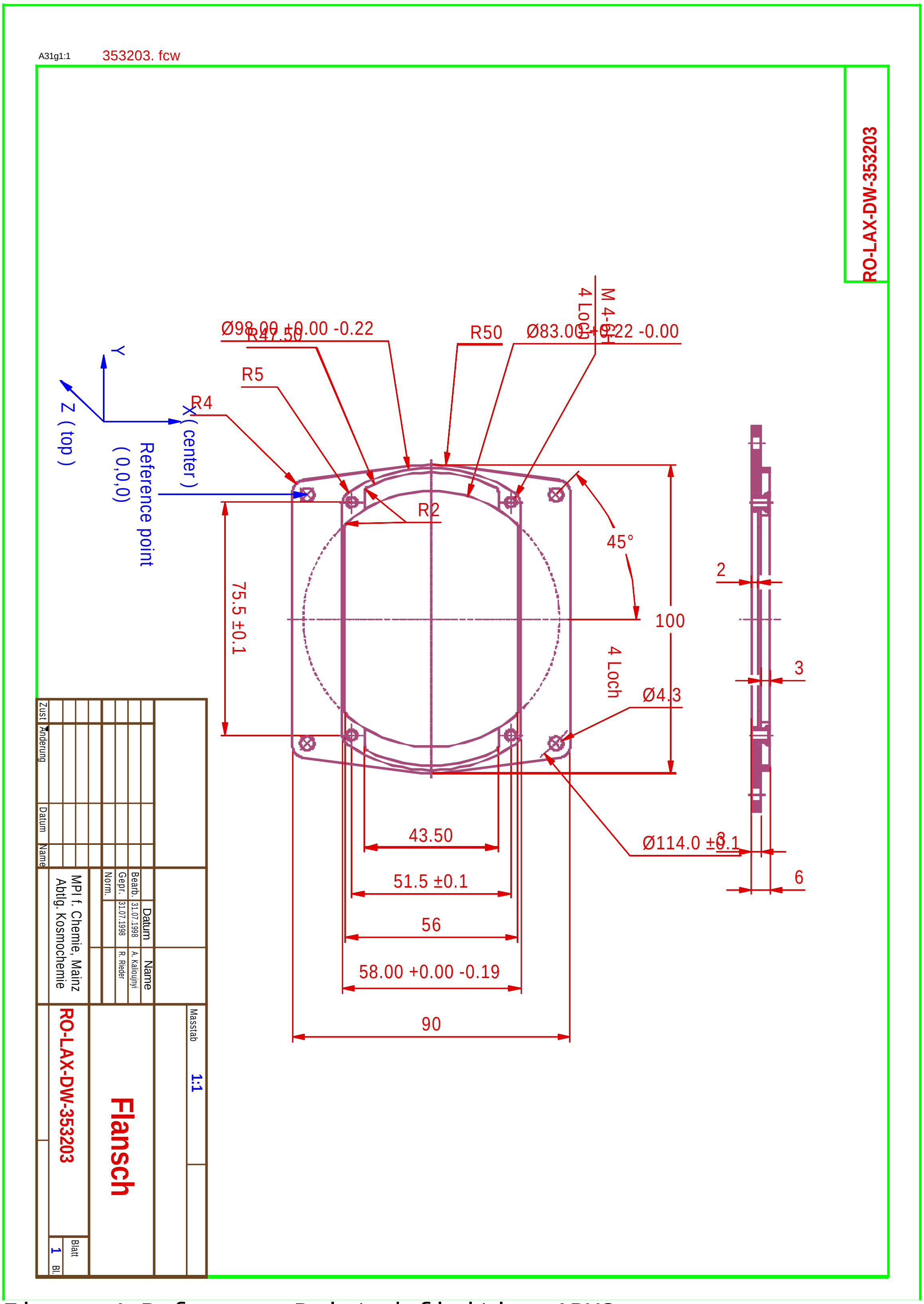


Figure 4 Reference Point definition APXS

5.4 Operational envelope required

The operational envelope is defined by the tube and deployment space below the platform. When the APXS is going to be deployed, an empty cylindrical sub-platform volume reaching from the platform down to the comet surface is required.

Item	Specs	Size [mm]
Deployment Device	Height	75 mm
	Diameter	100 mm
	conical launch lock ring dia.	125 mm
Sub-platform volume	Diameter	120 mm
	Length	500 mm

The following picture shows an overview of the APX Deployment Device assembly and measures

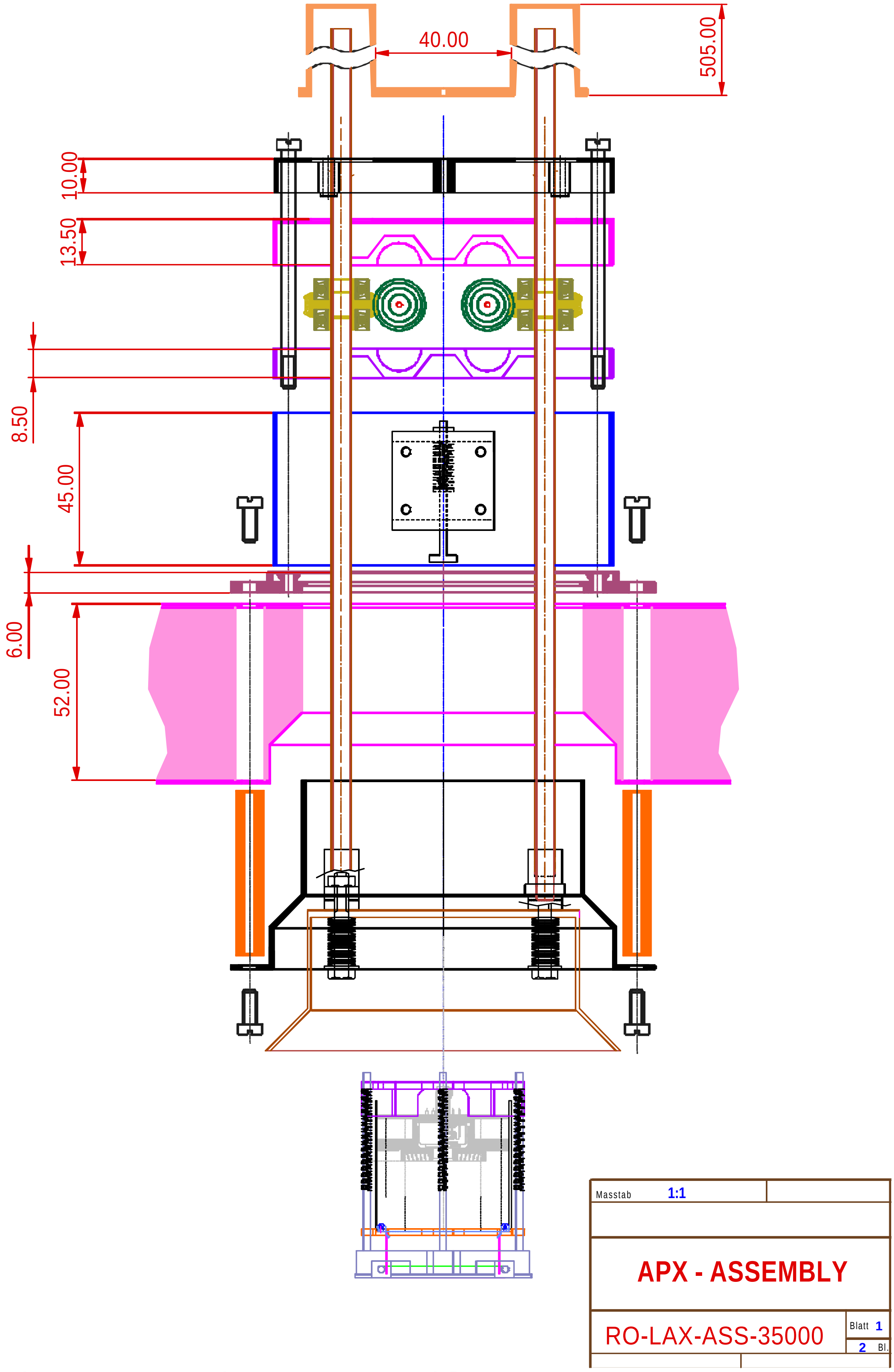


Figure 5 Overview APXS Assembly

5.5 APX Sensorhead

The APX sensorhead is mainly composed of

- α –sources
- 1 x-ray detector, 6 α-and Proton detectors
- electronics boards for detector preamplifier
- door mechanism that opens front doors automatically on sample approach
- housing and “hat“
- Launch lock, that fixes the APX SH inside bottom of Rosetta balcony
- Screwholes to fix the 2 threaded rods from APX DD.

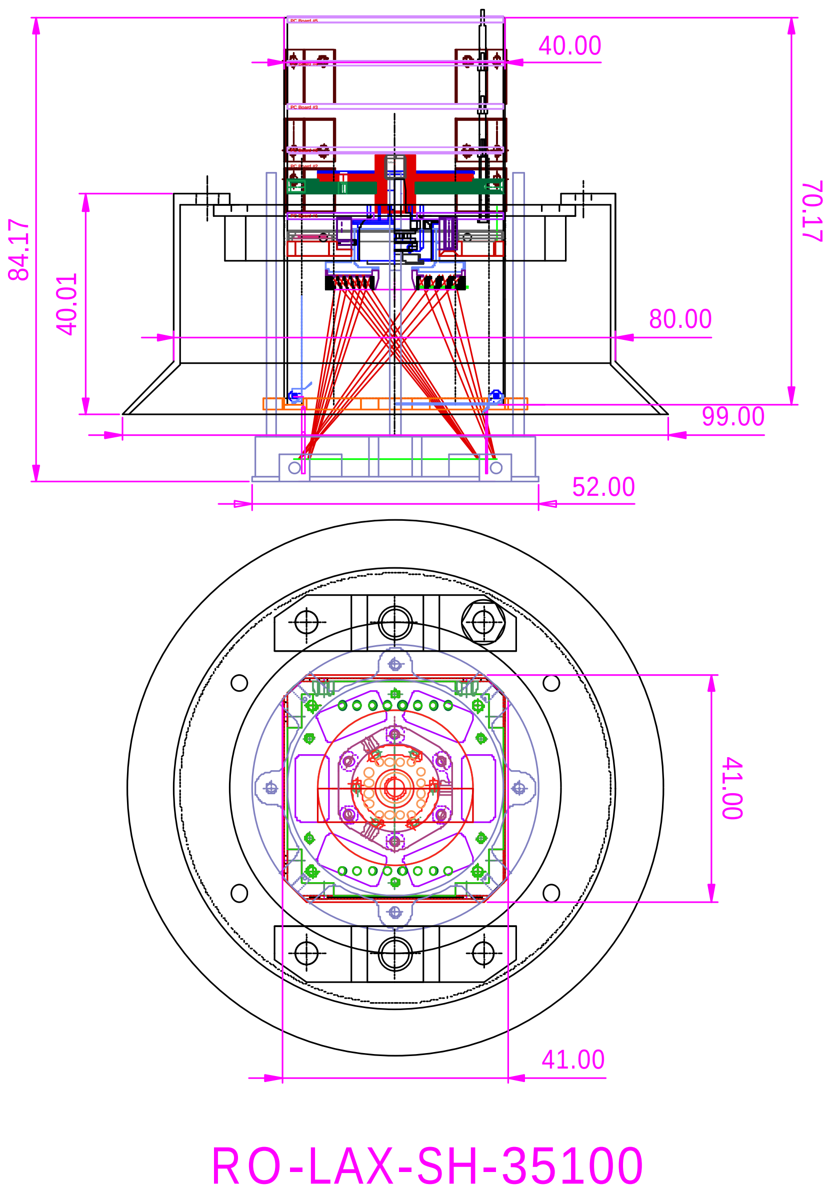


Figure 6 overview APX Sensor head

6 Interface Drawings

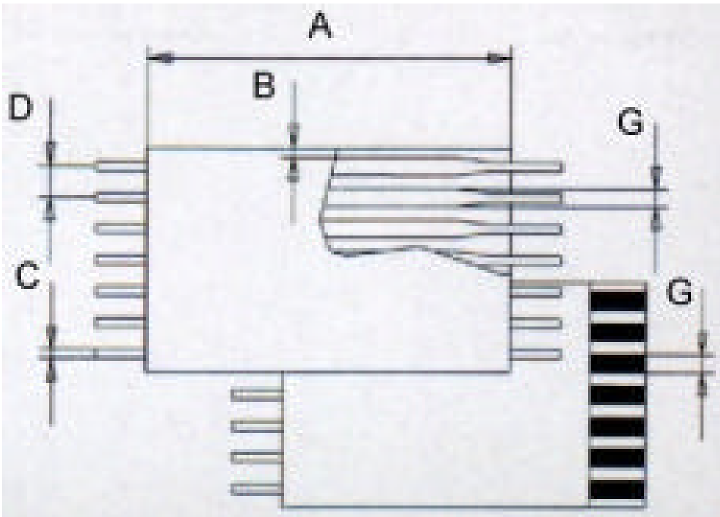
6.1 Interface APX electronics board, Common EBOX

The electronic interface board delivered by MPAe gives the interface between the APX electronics board and the common EBOX, see REID A Fig 5-13. The connector MCEM1-08SRA 9849 is connected according to FIG 5-17, REID A.

6.2 Interface APX electronics board, APX Deployment device, APXS cable

The pin connector layout is defined in chapter 4.

The scheme of the used flexcable is shown in the following picture.



Manufacture:	Panta GMbH, Radeberg
Isolation material	Capton
Conductor Material	Cu, acc. DIN 40500
Spec. oper. temp. range	-40°-150° , tested and specified for lower temperature by MPI Chemie, Mainz , see test report
Glue used for connector	Hysol EA 9309NA
Wire size	AWG 28

Dimensions for the cable:

A:	1200 mm
B:	0.3 mm
D:	1.27 mm
G:	0.7 mm

Two parallel cables (7 and 8 wires) were used to give the 15 Pin connector. The end to each connector is filled with Epoxy glue (HYSOL EA 9309N)

The minimal distance for **bending** the cable in an angle about 90° was found to be 5 mm. This is the minimal distance of two plates, if the cable is bent in between with an angle of about 90 °

7 Sensorhead Dummy

For fully functional test of the APX EB and the APX Cable, a dummy can simulate the APX Deployment device and the APX SH. The same cable connects it with the APX EB.
The FM version of the APXS Sensorhead dummy is equipped with 2 prototype MAXXON motors to simulate power consumption, functionality and inrush currents.
3 external signal sources can be used to feed the EB with APXS SH representative signals. A GRD connector has to be connected to the external signal source.
End switches can simulate the movement handling of the Deployment device. If closed (on), the movement has not yet reached the end position.
The down end switch divides into doors (measuring position reached)
and down (means end of threaded rods reached – emergency stop).

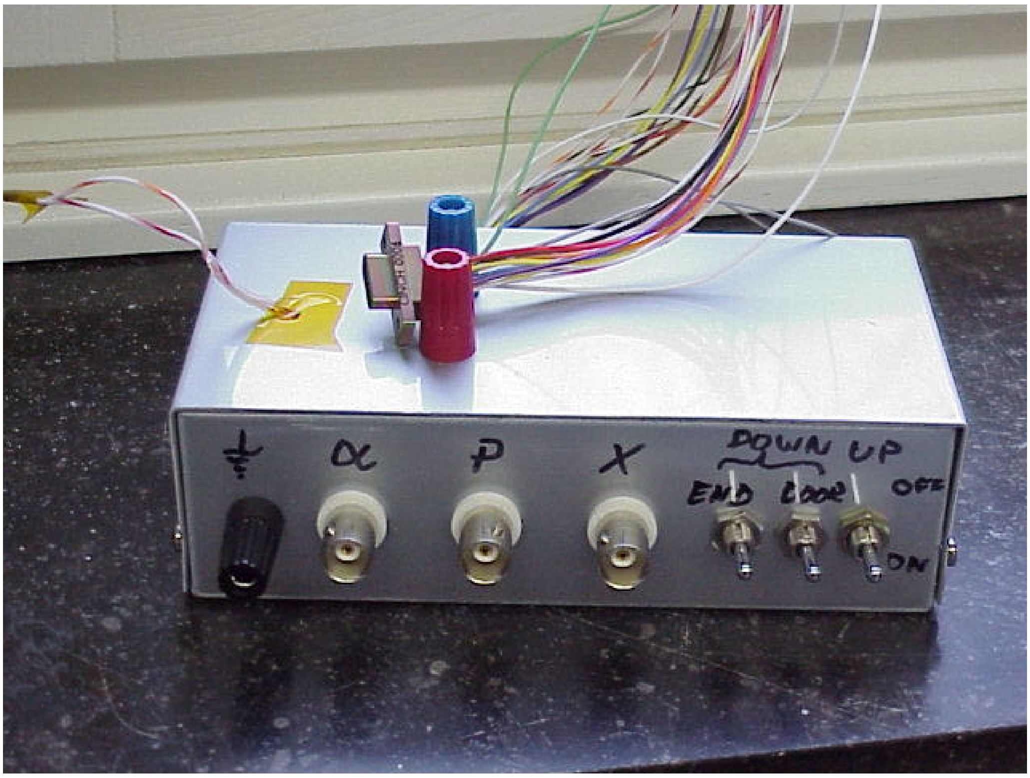


Figure 7: APX Deployment device simulator with connector for J155

8 Material lists

For several lists, MPAe delivered templates. These lists are available in attached applicable documents.

9 Safety data

The APXS FM delivered to MPAe is not equipped with any radioactive sources. No batteries or Pyros are installed. No high voltage is provided to any part outside the APXS housing.

9.1 Source Installation

For installation of flight sources two scenarios are taken into account.

a) Installation before integration of lander to orbiter:

The Cm244 sources can be installed into APXS SH by simply pushing onto contact sensor ring. The APXS is fully integrated in this phase, therefore one has to push against the launch lock springs of the doors. Then the sources are inserted into the sensorhead with a mechanical GSE tool. This procedure will be made by a APXS team member.
Advantage of this scenario is the easy access to the lower side of the balcony where the APXS SH is positioned.
Disadvantage is the longer period when radioactive security precaution because of installed sources is recommended.

b) Installation with the lander integrated to the orbiter.

As the lower side of the lander is much less accessible by parts of the orbiter, a special tool will be designed, to open the doors and to insert the source.

The APXS team strongly recommends the scenario a) . Decision has to be made by Rosetta management.

Information about the properties of the Cm244 source concerning dose levels are given in document RO-LAX-RA-3200-RR, attached to the ADP package.

10 Software design

This chapter describes the software interface between APXS electronics boards (APX EB) and CDMS. It includes the APXS command set and the telemetry data including science data, housekeeping data and Backup RAM contents.
A description of test procedures (FFT) and GSE tools for benchtests is given in seperate documents.

10.1 APXS Command Set

The command set of the APX consists of the following basic commands, that are sent by the Action Code RCMD (01000) to the APX (Subaddress 00001).

SSADR/AC/WRDC (HEX)	Cmd word (HEX)	Name	Command to APX
09 01	01 00	APXS_Start	Start APX Measurement
09 01	02 00	APXS_Stop	Stop APX Measurement
09 01	03 XX	APXS_Setparameter	Write Values to APXS XRAM, see appendix of table
09 01	04 00	APXS_Motor_Off	Stop Motors (only for emergency)
09 01	05 00	APXS_Up	Move APX sensorhead up (into lander)
09 01	06 00	APXS_Down	Move APX sensorhead down (towards sample)
09 01	07 00	APXS_Cycle_Start	Makes Backup, clears spectrum, and starts new spectrum
09 01	09 00	APXS_SetRamp	Sets science data to a ramp (FOR TESTING PURPOSE ONLY !!!)
09 01	AA 00	APXS_Reset	Clears spectrum
09 01	10 00	APXS_transmit	Transmits actual spectrum
09 01	11 00	APXS_transmit1	Transmits Backup spectrum 1
09 01	12 00	APXS_transmit2	Transmits Backup spectrum 2
09 01	13 00	APXS_transmit3	Transmits Backup spectrum 3
09 01	14 00	APXS_transmit4	Transmits Backup spectrum 4
09 01	15 00	APXS_transmit5	Transmits Backup spectrum 5
09 01	16 00	APXS_transmit6	Transmits Backup spectrum 6
09 01	17 00	APXS_transmit7	Transmits APXS XRAM containing the internal parameters

Appendix : APXS_Setparameter is used to reload the temperature dependant gain values, that are available after calibration. Also it is used to reload the safe/unsafe regions of LG.
MPI will provide a tool to convert a simple ascii table containing the values to a script containing CDMS commands.

The syntax of APXS_Setparameter ist as follows:

09 01	RCMD to SSADR APX
03 WRDC	Command Word 03 , Proper wordcount
ADDHIGH ADDLOW	address of APX RAM region
byte1 byte2	bytes to send to the APX RAM
byte byte4	
.....	

For sending **x** words to APX the wordcount has to be set to **x+2** (includes the command word and one word for the address)

The command to set the Landing gear parameter is given by the following Command words

09 01	RCMD /SSADR
03 0E	command word 03, wordcount 14 decimal
FD 00	address FD00 in APX RAM
11 80	11 = pointer on angle in first record of LG, 80 = SSADR of LG
20 00	low limit of safe interval 1
22 00	high limit of safe interval 1
24 00	low limit of safe interval 2
28 00	high limit of safe interval 2
2A 00	low limit of safe interval 3
2E 00	high limit of safe interval 3
30 00	low limit of safe interval 4
34 00	high limit of safe interval 4
05 2F	timout motors [minutes] , threshold xray
2F 2F	threshold alpha , threshold proton
9B 55	start temperature EBOX, start temperature balcony

with this settings APXS DD will lower down, if uncalibrated (!) angle of LG is between 2000 and 2200 or between 2400 and 2800, ...

10.2 Used action Codes

Mnemo	Used/not used	Remarks
TRSW	Used	
TRQC	Used	
STBY	Not used	
RMOD	Not used	
RTIM	Not used	
RSST	Not used	
RAXT	Not used	
RHFM	Used	
THKD	Used	
RCMD	Used	Used to send command set
TCMO	Not used	
RCMS	Not used	
RASV	Not used	
TSCR	Used	
RSCS	Not used	
RBUS	Not used	
TBUP	Used	Used to inform about APX position and to read LG position
TBUF	Used	
RBUF	Used	
TTRG	Not used	
RTRG	Not used	
RERC	Not used	

10.3 Used Request codes

Mnemo	Used/not used	Remarks
SSST	Not used	
SCMD	Not used	
SASV	Not used	
SRDY	Used	Used for science data
SBUS	Not used	
WRBF	Used	Write APXS position data
RDBF	Used	Read LG position data
PTRG	Not used	
FLSP	Not used	
OCPL	Used	Stop operation if it is not safe to deploy APXS SH

10.4 Telemetry data

10.4.1 Housekeeping data

There are two kinds of APXS housekeeping data. The low byte of the HK data provides analogue information about power consumption and currents of the APXS.
These data are autonomously prepared by the APXS-CDMS interface board.
The high byte provides digital information about the status of the APXS.

The definition of the HK data is made in the document RO-LAX-DP-3500-RG.xls

10.4.2 Science data

A science data packet from APXS consists of 1500 words (3 KB).
It contains :

1024 byte	X-ray spectra
512 byte	alpha spectra
512 byte	proton or 2. Alpha spectra (TBD)
512 byte	background spectra
512 byte	temperature record during measurement

This structure holds for the actual spectra and also each backup spectra.
The format of each spectrum is: 2 byte counter LSB first.
The first channel of each spectrum contains the lifetime [LSB first in 10 sec steps]
(lifetime = data acquisition time minus dead time)
The temperature record contains 1. byte = temperature of EBOX and 2. byte = temperature Sensorhead(balcony). The unit of the temperature is [1.442 K].

The capability to set a ramp to the spectra, that was included in the EQM model for proper CDMS testing, was left in the FM code. It is highly important to recognise, that this command destroys the actual science data, that are contained in the RAM !
The command is also still available through GSE RS232 connector.

MPCh will provide a GSE tool to view and evaluate a science data packet.

10.4.3 APXS Backup Ram

Backup RAM of CDMS is used to store the position of the APX sensorhead. At position 0x00 of the APXS Backup Ram a hex value is stored with the following meaning. The following 31 words have the same content.

Value	Meaning
0x00	APX is up (in launch lock position)
0x44	APX is moving down
0x77	APX down movement stopped, because of timeout or end switch of threaded rods is reached.
0x99	APX upwards movement stopped, because of timeout
0xBB	APX is moving up
0xFF	APX is down (measuring position)

The values 0x77 and 0x99 indicate an Error condition. APX was moving more than TBD minutes, without reaching the desired end position, indicated by switches at the end. In this case the motors are switched off automatically.
In each case of position changing, APX informs CDMS immediately by setting the Service request flag SRF.

There are no intentions to run a position detecting sequence by APXS after each power on of APXS and to update the data in Backup RAM. So it is the responsibility of CDMS to hold the data valid for other Instruments and Subsystems.

10.5 Benchtop testing

10.5.1 Via CDMS simulator

A tool called CDMS_SIM.EXE running under DOS allows the software simulation of the CDMS. For communication the transparent mode of the CDMS simulator is used. Handling, interpretation and timing of the data transfer is done automatically by this softwaretool.
It handles all features of CDMS, that are needed for APXS operation, including BACKUPRAM of LG and APXS, science data and HK data and sending commands to CDMS.

10.5.2 Via RS232 GSE tool

Without a CDMS simulator APXS can be fully controlled much easier by the RS232 GSE interface.

A tool called GSE_ROS.EXE is used to send command bytes to the APXS. These data are handled identically like CDMS commands, except the LG question before moving APXS down is neglected in RS232.
The RS232 command interpreter of APXS Firmware is switched off by default after a power on. It has to be activated by sending a command “a” including a proper Handshake protocol.

Run GSE_ROS.EXE and press F1 for a summary of used keys.

Running APXS via GSE RS232 tools can be done to test the APXS Hard and software Independently from CDMS . It will be used for calibration and thermal test of APXS at MPCh.

10.6 Test Procedures, command scripts

All testprocedures, LFT and FFT, can be found in the document
RO-LAX-DP-3400-RG.

Extract of scripts , used in Lindau for FM acceptance test, is given here. The scripts for setting all APXS parameter setpar00..setpar15 would burst the scope of this document.

Format :

Name

Command Words (Hex , High byte first)

```
dataramp       ; set science data to ramp

0901 0900

getidata       ; get instrument data

0901 1700

getsdata       ; get science data

0901 1000

sensdown       ; sensor down

0901 0600

sensup         ; sensor up

0901 0500
```

```
setlglim        ; sets LG safe intervals and some APXS
                ;parameters ( see chapter 10.1 )

09 0D 0300 FD00 1180 2000 2200 2400 2800 2A00 2E00 3000
3400 052F 2F2F 9B55


startcyc        ; starts an APXS measurement and makes
                ;backup before

09 01 07 00
```

11 Issues of NCRs

No open NCRS

12 Open work

- Rework of FM1 APXS EB to be acceptable as flight spare (scheduled for August 2001)

- Upgrade of EQM model as a ground equivalent flight model (scheduled spring 2001)

13 Qualification status matrix

	STM			EQM			FM(electronics)			FM DD			FM SH		
	E	SSP	S/C	E	SSP	S/C	E	SSP	S/C	E	SSP	S/C	E	SSP	S/C
Mech. Interface	R,T			R,T	R,T		R,T			R,T			R,T		
Mass Prop	R,T			R,T	R,T		R,T			R,T			R,T		
Electr Performance	R,T			R,T	R,T		R,T			T			T		
Funcional test	T			T	T		T			T			T		
Telecom link															
Strength load	T_Q									T_A			T_A		
Shock				T_Q											
Sine vibration	T_Q									T_A			T_A		
Low level signal	T_Q									T_A			T_A		
Random vibration	T_Q									T_A			T_A		
Accustic Noise															
Outgassing															
Thermal balance															
Thermal vacuum										T_A			T_A		
Thermal cycle							T_Q, T_A			T_A			T_A,T_Q		
Grounding	R,T			R,T			T			T			T		
EMC cond interf				T			T			T			T		
EMC rad interf															
DC magnetic															
Purging rate															

T_A acceptance test
T_Q qualification test
R reviewed
T tested (incoming inspection, laborty ... etc)

E performed by APXS team
SSP performed integrated into Lander (has to be filled out by Test director)
S/C Orbiter Level (has to be filled out by Test director)

For each test, see test reports in ADP and incoming inspection protocols

14 Failure protection

This chapter summarizes numerous emails about unintended deployment during flight

For APXS the following situation holds :

The APXS deployment device lowers after a certain CDMS command the sensorhead down. This is driven by two motors that rotate two threaded rods. The overall velocity is ~ 50 cm / 30 min. Both ending sides of the movement are protected by end switches. The contact of the sensorhead with any obsticle (normally the surface of the comet) stops the motors.

Hardware

The motors are driven by 2 sequential magnetically bistable relays . By default after a APXS power on or any reset the relays are set to : Direction UP(inside balcony) and Motors OFF.
Even if one relays hangs, Deployment can not happen.

Software
Before lowering the sensorhead the position of landing gear is asked to avoid hitting the gear. The default PROM values for safe LG intervals are set out of range of LG. So before Deployment the correct LG safe intervals have to be set by CDMS.

15 List of acronyms

ADP	acceptance data package
APXS,APX	Alpha Proton X-ray Spectrometer
APX EB	APXS electronics Board
APX DD	APX Deployment Device
APX DDS	APX Deployment Device simulator
APX SH	APX Sensor head
APX SHD	APX Sensor head dummy
ASAA	as soon as available
CDMS	Rosetta Lander Command and Data Management System
DD	Deployment Device
EGSE	Electrical Ground Support Equipment
FFT	typically Fast Fourier Transformation, but here fully functional test
HSS	Hard and software Scientist
LFT	Low functional test
LG	landing gear
MPCh	Max Planck Institute for Chemistry
MPAe	Max Planck Institute for Aeronomy
MPU	Micro Processor Unit
NCR	Non conformance report
REID	Rosetta Lander Experiment Interface Document
TBC	to Be Confirmed
TBD	to Be Defined

16 Appendix and applicable documents

The following list contains all applicable documents. All are attached at the end of this document. These documents were splitted because of different requirements of templates provided by various institutions.

RO-LAX-DP-3500-RG	**Definition of FM HK data**
RO-LAX-DP-3400-RG	**Testprocedures, LFT and FFT**
RO-LAX-TR-3210-RG	**various Testreport**
RO-LAX-TR-3220-WM	**Testreport APXS/MUPUS FM acceptance vibe test**
RO-LAX-DP-3210-RG	**Disassembly and assembly procedure for FM board**
RO-LAX-DPL-3000-RG	**Declared Processes list (DPL)**
RO-LAX-DML-3000-RG	**Declared Material list (DML)**
RO-LAX-DCL-3000-RG	**Declared Component list (DCL), EEE part list**
RO-LAX-CMR-3000-RG	**Connector mating record**
RO-LAX-DMPL-3000-RG	**Declared Mechanical Part list (DMPL) Sensorhead and deployment device**
RO-LAX-RA-3200-RR	**Dose calculation of Cm 244 source**
RO-LAX-TR-3230-RG	**Qualification test report vibration**

Telemetry Parameter Table/ Version 1G (RO-LAX-DP-3500-RG)

Unit:	**APX**
PID:	**110**
RSDB Code	**LA**
Service:	**3,25**
Name:	**HK Block**

No	Signal	Description	Category	SID	Packet Position			Format	Value Range		Unit	Transfer Function		Limit check		Condition	Remarks
					Word from	Bit from	length		min	max		Type	Calibration	low	high		
0	Status	High nibble: Status measurement	HK	1	0	12	4		0	15	N/A	N	N	0	15	PID=110	0x00 (BIN 0000): measurement stopped 0xF0 (BIN 1111): measurement started
	Pos_SH	Low nibble: Position Sensorhead	HK	1	0	8	4		0	15	N/A	N	N	0	15	PID=110	0x00 : APX is up (launch lock position) 0x04 : APX is moving down 0x07 : APX down movement stopped, timeout,error 0x09 : APX upwards movement stopped, timeout 0x0B : APX is moving up 0x0F : APX is down (measurement position)
1	Power	Power	HK	1	0	0	8	U1	0	255	W	F	TBD	15	31	PID=110	0x0F (15): normal mode 0x1F (31): deployment mode
2	Temp_EB	Temperature APX EB	HK	1	1	8	8	U1	0	255	K	F	x*1.442	0	255	PID=110	Temperature inside EBOX [Kelvin]
3	Curr+12V	+12V current	HK	1	1	0	8	U1	0	255	mA	F	x/0,208	TBD	TBD	PID=110	Normal mode: ~ 30mA Deployment mode: ~ 100mA -> ~ 400 mA
4	Temp_SH	Temperature APX SH	HK	1	2	8	8	U1	0	255	K	F	x*1.442	0	255	PID=110	Temperature balcony [Kelvin]
5	Curr+5V	+5V current	HK	1	2	0	8	U1	0	255	mA	F	x/0,104	TBD	TBD	PID=110	Normal mode: ~ 115mA Deployment mode: ~ 115mA
6	Uptime	Uptime	HK	1	3	8	8	U1	0	255	sec	N	x*10sec	0	255	PID=110	Uptime, increases every ~10sec
7	Curr-5V	-5V current	HK	1	3	8	8	U1	0	255	mA	F	-(x/1,04)	TBD	TBD	PID=110	Normal mode: ~ 30mA Deployment mode: ~ 30mA
8	Checksum RAM	Checksum of APXS internal RAM	HK	1	4	8	8	U1	0	255	N/A	N	N	0	255	PID=110	low byte of sum of APXS internal RAM from 0xFB00 to 0xFD17. (68 Hex after default PROM
9	Curr-12V	-12V current	HK	1	4	0	8	U1	0	255	mA	F	-(x/1,04)	TBD	TBD	PID=110	Normal mode: ~ 20 mA Deployment mode: ~20mA
10	Checksum ROM	Checksum of APXS program ROM	HK	1	5	8	8	U1	0	255	N/A	N	N	6F	6F	PID=110	Low byte of checksum of APXS PROM. Flight version =6F Hex
11	Not used	Not used	HK	1	5	0	8	U1	0	255	N/A	X	X	X	X	PID=110	
12	Cntrate_H	high byte counts / or high byte LG angle	HK	1	6	8	8	U1	0	255	Cts/LG HK	N/A	N/A	0	255	PID=110	If measurement started : high byte Counts, if not started High byte LG angle
13	Not used	Not used	HK	1	6	0	8	U1	0	255	N/A	X	X	X	X	PID=110	
14	Cntrate_L	low byte counts / or low byte LG angle	HK	1	7	8	8	U1	0	255	Cts/LG HK	N/A	N/A	0	255	PID=110	If measurement started : low byte Counts, if not started : low bytes LG angle
15	Not used	Not used	HK	1	7	0	8	U1	0	255	N/A	X	X	X	X	PID=110	

Important Note: values, that are unknown for APXS are inititialized with HEX 11 . This holds for POS_SH and cntrate_H and Cntrate_L if measurement was not started and no APXS_DOWN command was send

Testprocedure APXS
for
Rosetta Lander

RO-LAX-DP-3400-RG

31 Januar 2001

Prepared by Ralf Gellert, HSS APXS

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1. Scope of this document

Scope of this document is to define test procedures for APXS for Rosetta lander.

2. Available data files

There is a list of tct scripts available, that contain all commands needed for APXS operation. The files can be divided into several areas. The first two types (a and b) set the internal temperature dependant gain values. Type c sets the values of the angular region of the LG, that are safe for a lowering of the APXS sensorhead.
Type a,b,c use the APXS command word 0x03, together with transmitted data words.
Type d are the normal APXS commands using various command words and NO data words.

a)
SETPAR00.TCT
SETPAR01.TCT
SETPAR02.TCT
SETPAR03.TCT
SETPAR04.TCT
SETPAR05.TCT
SETPAR06.TCT
SETPAR07.TCT
SETPAR08.TCT

These scripts are setting the external temperature (balcony) gain values of the alpha, proton and xray channels. Each command sends an amount of 16 words to the instrument. Given 3 analog channels (a,P,X) and 48 external temperature intervals this gives 9 command scripts for setting all external gain values.
For testing purpose the gain values are set to a data ramp. The values are set as a wordbased ramp from 0x0000 to 0x008F.
The real values will be provided by APXS team after calibration of the sensorhead.

b)
SETPAR10.TCT
SETPAR11.TCT
SETPAR12.TCT
SETPAR13.TCT
SETPAR14.TCT
SETPAR15.TCT

These scripts are setting the internal temperature (EBOX) gain values of the alpha, proton and xray channels. Each command sends an amount of 16 words to the instrument. Given 3 analog channels (a,P,X) and 32 internal temperature intervals this gives 6 command scripts for setting all internal gain values.
For testing purpose the gain values are set to a data ramp. The values are set as a wordbased ramp from 0x0100 to 0x015F.
The real values will be provided by APXS team after calibration of the electronics board.

c)
SETLGLIM.TCT

This script sets the parameter of the interaction with the Landing gear. Additional it sets some APX parameter, that might be changed under unnormal conditions. This script has to be filled out with the values given by the LG team determing the safe angular values for the deployment of APXS sensorhead.

d)

The last type of scripts are used to run the APXS in normal operation. Each script sends only one command word to the APXS.

Script name	command Word (hex)	description
GETSDATA.TCT	0x10	Gets science data (3 Kbytes data)
GETIDATA.TCT	0x17	Gets instrument data (3 Kbytes data)
STARTCYC.TCT	0x07	Starts a new measuring cycle
DATARAMP.TCT	0x09	Sets a wordbased data ramp into science data (ONLY FOR TESTING PURPUSE !!!!!!!)
SENSUP.TCT	0x05	Starts APXS sensorhead moving up
SENSDOWN.TCT	0x06	Starts APXS sensorhead moving down. Before starting, LG backupRAM is requested, to determine, if it is safe to move down.

3. Short functional test

This chapter describes a short functional test. It shows, if the basic communication of APXS with CDMS is OK and gives APXS instrument information via housekeeping data. For testing purpose a ramp can be generated inside science data by APXS.

Time [min.sec]	Script name	Function	Expected result	Observed result
0.00		Power APXS ON		
0.05	Dataramp.tct	Generates a ramp in APXS science data	-	
0.10	GetSdata.tct	Transmit science data	Ramp, see below	

Results: 12 science data packets
1 housekeeping packet

Science data should contain of a word based ramp from 0x0000 to 0x05FF

Duration of Test: about 5 minute (Housekeeping packet collection)

4. Full Functional Tests

This chapter describes a full functional test of APXS electronics. It includes the APXS electronics functionality like starting deployment device, housekeeping data, science data transmission, APXS parameter setting and interaction with CDMS and LG. The expected results are splitted into several parts if the results depends on the handling of the Sensorhead end switches.

General Remarks:

Before starting each test set every switch on APXS Sensorhead simulator to ON
Handle switch (doors,up,down) on DD simulator means, toggle the switch e.g. from on to off. After reaction of APXS to this action turn back the switch to on position.
The marks on the simulator box are ment as follow:
 ON means motors can run(end switch not reached)
 OFF means end switch is reached so that motors should stop.
Description UP and DOWN means DIRECTION not POSITION.
 GREEN means that APXS is moving DOWN if motors are running
 RED means that APXS is moving UP if motors are running

To test the APXS interaction with the LG via CDMS either

a) the LG electronics together with a potentiometer as rotational simulator must be equipped or
b) the BackupRAM of LG must be manipulated manually by CDMS EGSE.
c) The CDMS software must be able to write HK data of LG to BackupRAM of LG

The tests are divided into several parts :

a) Setting LG parameters of APX like angular intervals. These tests should show, that it is possible to reload the angular intervals as variables. This is necessary to change the angular intervals , that allow APXS to deploy, after the burning of the APXS FM PROM.
b) Setting internal APXS parameters. This test should show, that it is possible to reload the gain values, that are determined by calibration after the FM PROM is burned.
c) APXS deployment. This test should show, that the APXS deployment considers the LG angular value before lowering down. This is necessary to prevent destruction of LG and APXS.
d) Nominal operation of APXS is tested, like data communication and measuring procedure.

SET APXS parameters for interaction with LG

This procedure sets the APXS parameters to interact with the LG. It defines the safe intervals for moving the APXS sensorhead down.

Time [min.sec]	Script name	Function	Expected result	Observed result
0.00		Power APXS ON		
0.05	Setlglim.tct	Sets APXS LG parameters	-	
0.30	GetIdata.tct	Transmit instrument data	LG parameters	

Results: 1 housekeeping packet
12 science data packets
First 24 bytes of packet 10 should contain the landing gear parameters in the same order as they were defined in Setlglim.tct

Duration of Test: about 5 minutes (Housekeeping packet collection)

The values of the safe intervals can be changed by editing the file setLGlim.tct. The description of the file is given in the comments. The values of the angles are the same raw data that come from LG. There is no calibration to angles inside APXS. The tilt angle of the LG is not considered. ´This means that the small intervals resulting from a perpendicular position of the Lander must be considered with a margin !

Example for script file to set APXS landing gear parameter

```
;***   Rosetta Lander TC Packet Editor version 2.02
;***   Hungarian Academy of Sciences (C) 1999; 2000
;***   KFKI Research Institute for Particle and Nuclear Physics
;***   Department of Space Technology http://dst.rmki.kfki.hu/
;***   author: Anisics Zsolt: anisics@sgiserv.rmki.kfki.hu 2000 feb. 24
;***   ON-BOARD DATA HANDLING INTERFACE REQUIREMENTS ref: RO-EST-RS-3001/EID A: 1999
;***   CDMS ON-BOARD SW ref: RO-LCD-SW-3610: 1999 jun. 2
;***   CDMS Subsystem Specification ref: RO-LCD-SP-3101 2/3: 2000 feb. 10
;
;      EXECUTE USER COMMAND OF APX
;      set APXS instrument parameters (setLGlim.tct )
;
PSMH^1ACF     ; "1. Synchron Pattern"
PSML^FC1D     ; "2. Synchron Pattern"
APID^1EEC     ; "Ver:0; Type:1; DHDF:1; Apid:APX(110); Cat:Private(12)"
PSEQ^C000     ; "Flag:3; CountSource:0; Sequence:0"
PLEN^0055     ; "Constant Length"
DHDR^11C08000 ; "PUS:0; ChkSumType:1; ACK:1; Service:192" "Subtype:128; PadField:0"
FMID^00000D00 ; "Prot:0; Ext:0; Vis:0; SSIF:0; SubA:0; DWC:0" "T/R:0; T/S:0; UCWC:1; '
UC00^0300     ; "CMD0: command word = 0x03 "
UC01^FD00     ; "____: internal APX RAM address region FD00H "
UC02^1180     ; "____: 11H = pointer in first record of LG, 80H =SSADR LG"
UC03^2000     ; "____: HI LO byte, lower limit 1 "
UC04^2200     ; "____: HI LO byte, high  limit 1 "
UC05^2400     ; "____: HI LO byte, lower limit 2 "
UC06^2800     ; "____: HI LO byte, high  limit 2 "
UC07^2A00     ; "____: HI LO byte, lower limit 3 "
UC08^2E00     ; "____: HI LO byte, high  limit 3 "
UC09^3000     ; "____: HI LO byte, lower limit 4 "
UC10^3400     ; "____: HI LO byte, high  limit 4 "
UC11^052F     ; "____: Motor Timeout(minutes), Threshold Xray "
UC12^2F2F     ; "____: Threshold alpha, Threshold Proton "
UC13^9B55     ; "____: Temperaturestart IN , Temperaturestart IN "
____^0000     ; "____: TC Data Word 14"
____^0000     ; "____: TC Data Word 15"
____^0000     ; "____: TC Data Word 16"
____^0000     ; "____: TC Data Word 17"
____^0000     ; "____: TC Data Word 18"
____^0000     ; "____: TC Data Word 19"
____^0000     ; "____: TC Data Word 20"
____^0000     ; "____: TC Data Word 21"
____^0000     ; "____: TC Data Word 22"
____^0000     ; "____: TC Data Word 23"
____^0000     ; "____: TC Data Word 24"
____^0000     ; "____: TC Data Word 25"
____^0000     ; "____: TC Data Word 26"
____^0000     ; "____: TC Data Word 27"
____^0000     ; "____: TC Data Word 28"
____^0000     ; "____: TC Data Word 29"
____^0000     ; "____: TC Data Word 30"
____^0000     ; "____: TC Data Word 31"
____^0000     ; "____: TC Data Word 32"
____^0000     ; "____: TC Data Word 33"
____^0000     ; "____: TC Data Word 34"
____^0000     ; "____: TC Data Word 35"
____^0000     ; "____: TC Data Word 36"
____^0000     ; "____: TC Data Word 37"
CECW^B070     ; "Command Error Control Word"
PECW^0000     ; "Packet Error Control Word"
```

APXS Sensorhead down (UNSAFE LG case)

1.) turn all switches of Sensorhead simulator to ON
2.) Set LG to an unsafe position.
3.) Let LG electronics run until BackupRAM is equally populated (TBC)
4.) Switch LG Off

Time [min.sec]	Script name	Function	Expected result	Observed result
0.00		Power APXS ON		
0.05	Sensdown.tct	Start APXS moving down	APXS sends OCPL, Motors may not start	

Results: 1 housekeeping packet

Duration of Test: about 5 minutes (Housekeeping packet collection)

APXS Sensorhead down (SAFE LG case)

1.) turn all switches of Sensorhead simulator to ON
2.) Set LG to a safe position.
3.) Let LG electronics run until BackupRAM is equally populated (TBC)
4.) Switch LG Off

Time [min.sec]	Script name/ Action	Function	Expected result	Observed result
0.00		Power APXS ON		
0.05	Sensdown.tct	Start APXS moving down	APXS starts motors down BackupRAM -> 0x44	
1.00	**Handle simulator**	Turn switch UP to OFF	Nothing happens	
2.00	**Handle Simulator**	Turn switch Doors to Off	Motors stop BackupRAM -> 0xFF	
3.00	Sensdown.tct	Start APXS moving down	APXS starts motors down BackupRAM -> 0x44	
4.00	**Handle Simulator**	Turn switch down to Off	Motors stop BackupRAM -> 0x77	
5.00	Sensdown.tct	Start APXS moving down	APXS starts motors down BackupRAM -> 0x44	
~13.00	**Wait**	Timeout of moving down	Motors stop BackupRAM -> 0x77	

Results: 1 housekeeping packet

Duration of Test: about 15 minutes (Housekeeping packet collection)

APXS Sensorhead up (independant of LG)

1.) turn all switches of Sensorhead simulator to ON

Time [min.sec]	Script name/ Action	Function	Expected result	Observed result
0.00		Power APXS ON		
0.05	Sensup.tct	Start APXS moving up	APXS starts motors up BackupRAM -> 0xBB	
1.00	**Handle simulator**	Turn switch DOWN to OFF	Nothing happens	
2.00	**Handle simulator**	Turn switch DOORS to OFF	Nothing happens	
3.00	**Handle Simulator**	Turn switch UP to Off	Motors stop BackupRAM -> 0x00	
4.00	Sensup.tct	Start APXS moving up	APXS starts motors up BackupRAM -> 0xBB	
~12.00	**Wait**	Timeout of moving up	Motors stop BackupRAM -> 0x99	

Results: 1 housekeeping packet

Duration of Test: about 15 minutes (Housekeeping packet collection)

SET APXS internal parameters

This procedure sets all internal APXS parameters to a test ramp. The order of sending the scripts is without meaning.

NO LG needed

Time [min.sec]	Script name	Function	Expected result	Observed result
0.00		Power APXS ON		
0.05	Setpar0.tct	Set APXS internal parameter	-	
0.06	Setpar1.tct	"	-	
0.07	Setpar2.tct	Set APXS internal parameter	-	
"	"	"	-	
"	"	Send all files setpar*.tct (15 files)	-	
0.20	Setpar15.tct	"	-	
0.30	GetIdata.tct	Transmit instrument data	Ramp, see below	

Results: 1 housekeeping packet
12 science data packets
packet 8 and packet 9 should contain a ramp from 0x0000 to 0x008F following a next ramp from 0x0100 to 0x015F.

Duration of Test: about 5 minutes (Housekeeping packet collection)

5. Abbreviations

APXS	Alpha Proton Xray Spectrometer
HSS	Hard and Software Scientist
LG	Landing gear

RO-LAX-TR-3211-RG

Alpha Proton X-Ray Spectrometer

APXS

FM Electronics Board Test Reports

Version: 1

J. Brückner, R. Rieder, R. Gellert

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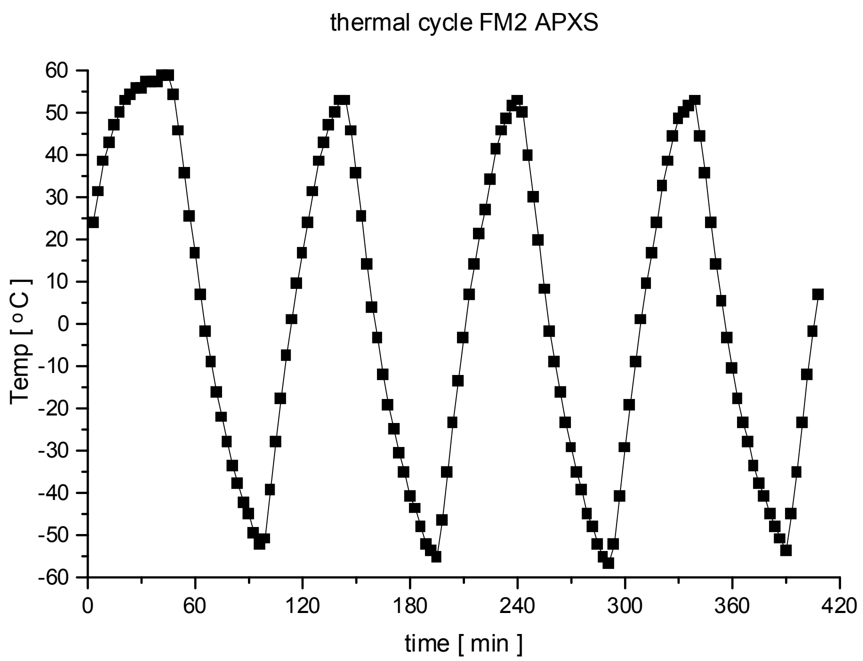
1 Scope of the document

This document describes the preshipment tests that have been performed with the APXS electronics board FM2 and the APXS DD and SH.

2 Thermal cycle

The FM boards were thermal cycled in dry nitrogen atmosphere at MPCH. The boards were powered on and data acquisition was running. The temperature log file of the spectrum was used to control the actual board temperature and to ensure the functionality of the electronics during the test. The temperature is recorded with the on board temperature sensor and read out with the APXS analogue electronics.
Any communication was performed with the GSE RS232 test connector.



3 EMC tests

The following EMC tests were performed at MPCH.

Primary Power Bus:
Nominal 5.2 V was shifted to +5.5 V -> 4.7 V : APXS operating normal. Under 4.7 V APXS resets

4 Thermal tests of various components

- 0.1mm stainless steel band, capton flexible cable
  items were integrated into MUPUS carbon tubes with holder at top of the APXS threaded rods. MUPUS tupes were then dipped into liquid nitrogen and the rods were deployed 100 times with a velocity of ~ 30 cm/s
  No damage was observed. The steel band didn't even break, if it was at LN2 temperature bended with a tongs.

- Microswitch RS 331-384 microswitch
  The item was dipped into LN2. The switch was deployed 100 times with each
  a) 1 motor (~ 15 mA)
  b) ~ 100 mA current
  c) no current
  no damage was observed

- Flight motor compatible part was tested in vacuum at LN2. Duration ~ 1 week. No mechanical load was connected.
  ~ 5 times the motor hung, ~ 200 it started properly
  no damage of motor was observed
  if motor hangs, the motor had to be warmed up to ~-80°, then it started again

5 FM acceptance vibe test with MUPUS

The acceptance vibe test was performed together with MUPUS on 20.04.01 in Warsaw according to vibe test levels given in RO-LAN-SP-3302.
Short functional test after vibe test (deployment) was successfully. No further tests were performed.

6 Thermal vacuum test together with MUPUS in Lindau

Thermal vacuum tests were performed in Lindau from 24.04-30.04.01.
Several technical problems during deployment (Motors hang at –40 to –150 °C) were observed. Problems will be analyzed as soon as we get the DD back.
Thermal tests will be repeated at MPI in LN2

MUPUS /APX -FM

Vibration Test Report
RO-LMU-TR-3???-SRC

Issue Final
Revision 1

28 April 2001

prepared by: Wojciech Marczewski

test performed by:
Col. Eng. Maciej Kamiński, Technical Institute of Air Forces, ITWL, Warsaw
Ralf Gellert, University of Mainz
Jerzy Grygorczuk, SRC, Warsaw
Marek Hłond, SRC, Warsaw
Jerzy Roman, SRC, Warsaw
Wojciech Marczewski, SRC, Warsaw
Krzysztof Urbanek, WZR RADWAR, Warsaw

Warsaw
April 2001

Table of Contents

1 Scope

The document reports results of the vibration test performed on the instruments MUPUS-FM and APX-FM assembled in a joint unit

1.1 Tested Items

The tested items are:

- MUP-DD-FM-001
- MUP-PEN-FM-001 (equipped with the MUPUS/SESAME/PP-FM antenna - flexible substrate)
- APX-FM (equipped with the APX/SESAME/PP-FM antenna - stiff substrate)
- Integration cage made of composite material compatible to the structure of the ROSETTA LANDER.

1.2 Test Facility

The tests were performed in the Technical Institute of Air Forces in Warsaw employing the tester THERMOTRON, type DS-642-930-24M manufactured in USA capable for testing loads up to 500kg and envelope diameter less than 800mm.

1.3 Test Personnel

The tests were performed by the personnel:

Col. Eng. Maciej Kamiński, Technical Institute of Air Forces, ITWL, Warsaw
Ralf Gellert, University of Mainz,
Jerzy Grygorczuk, SRC, Warsaw,
Marek Hłond, SRC, Warsaw - functional tests,
Jerzy Roman, SRC, Warsaw,
Wojciech Marczewski, SRC, Warsaw,
Krzysztof Urbanek, WZR RADWAR, Warsaw - a specialist who assisted the tests on EQM.

1.4 Test Setup

The test setup is shown on the following figures.

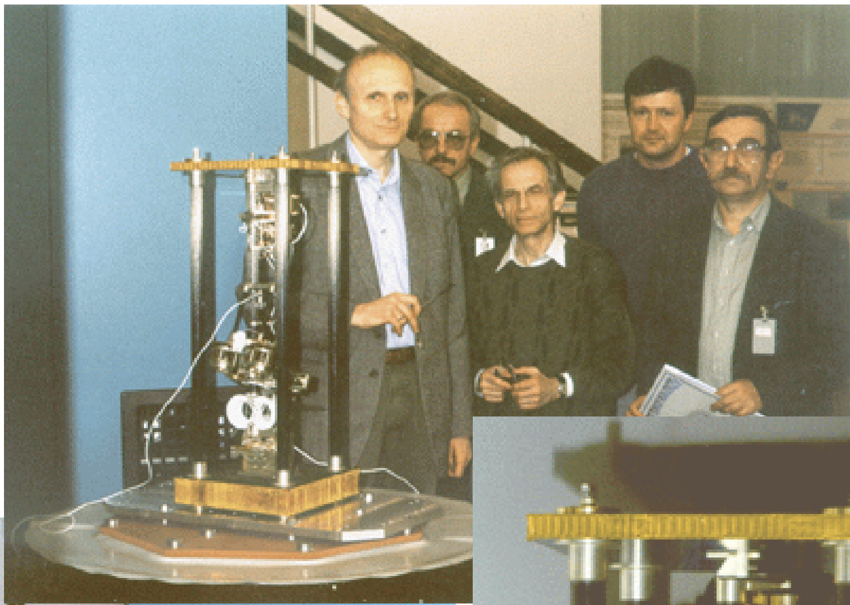
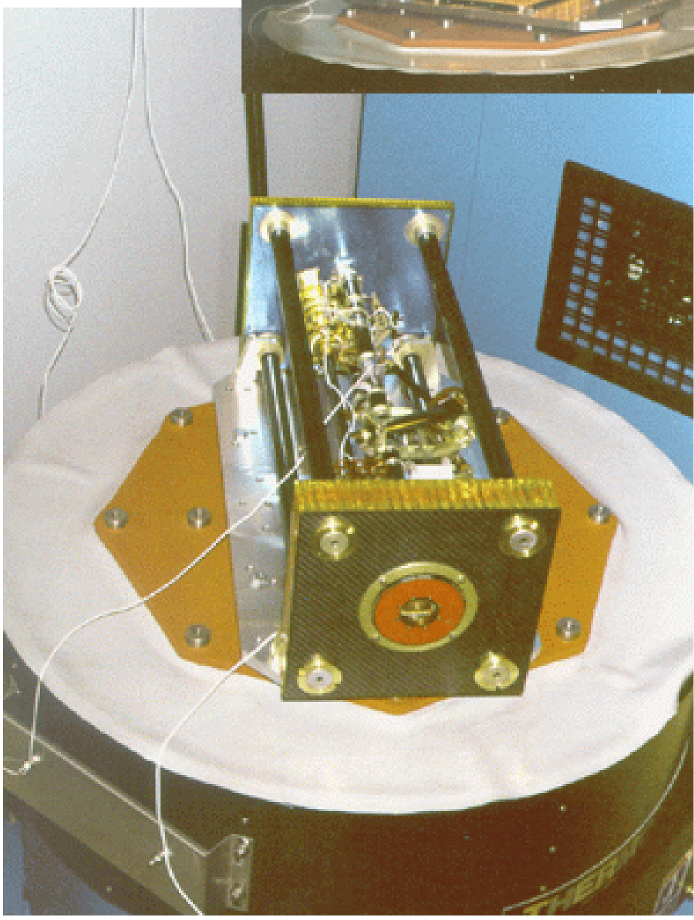


Fig. 1



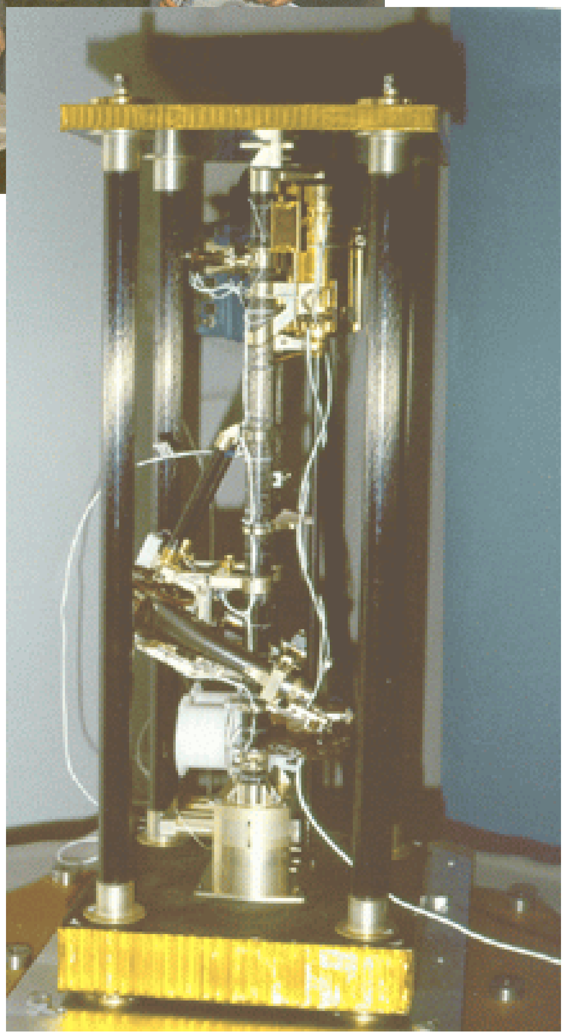


Fig.2

Fig. 3

1.5 Test Parameters

Relevant requirements on the vibration tests were taken from the document RO-LAN-SP-3302, issue: 1.2, date 20.03.01. The requirements for APX and MUPUS are:

Table 29

Sine tests	Freq. Range	Input Level
all axes (base)	5-20 Hz 20-25 Hz 25-65 Hz 65-85 Hz 85-100 Hz	±9.4 mm 15 g 10 g linear int. 3 g

Table 31

Sine tests	Freq. Range	Input Level
X axes (top)	5-20 Hz 20-25 Hz 25-65 Hz 65-75 Hz 75-85 Hz 85-100 Hz	±9.4 mm 15 g 12 g 10 g linear int. 8g
Y an Z axes (top)	5-20 Hz 20-25 Hz 25-65 Hz 65-75 Hz 75-85 Hz 85-100 Hz	±9.4 mm 15 g 12 g 8 g linear int. 4g

Table 30

Random tests	Freq. Range	Input Level
all axes (base) G rms=6.45	20-100 Hz 100-200 Hz 200-2000 Hz	+6 dB/oct 0.15 g^2/Hz -7 dB/oct

Table 32

Random tests	Freq. Range	Input Level
x-axis (top) G rms=8.32	20-100 Hz 100-200 Hz 200-2000 Hz	+6 dB/oct 0.25 g^2/Hz -7 dB/oct
Y and Z axes (top) G rms=7.93	20-100 Hz 100-200 Hz 200-2000 Hz	+6 dB/oct 0.2 g^2/Hz -6 dB/oct

The acceptance levels for the mechanical tests are generally
by a factor 1/1.5 (i.e. 0,67) below the Q-levels for sine vibration and, correspondingly,
by a factor of $1/1.5^2$ (i.e. 0.44) below Q-levels for random vibration tests.

Besides, the sweep rate for sine vibration tests shall be 4 Oct/min (instead of 2) and the duration for the random vibration tests shall be 1 min/axis (instead of 2.5).

Both MUPUS and APX representatives agreed on employing one common set of requirements specified for the top of the tested structure in the tables 31, 31 shown above. Requirements for the top are stronger and the tests within requirements specified for the base were skipped.

1.6 Test Sequence

The test sequence was as following:

1) - Short Functional Tests were performed on MUPUS and APX before mounting the test cage,
2) - Vibration tests for each of the axes X,Y,Z were performed separately in the order:
   - vibration test on identification eigen frequencies before applying sine and random,
   - sine and then random vibration,
   - vibration test on identification eigen frequencies after applying sine and random,
3) - Short Functional Tests were performed on MUPUS and APX after remounting the test cage,

2 Results

Vibrations were applied as shown on the Fig. 4,5,6,7,8,9,10,11,12. Short Functional Tests performed for both instruments - MUPUS and APX after vibration proved normal operation.

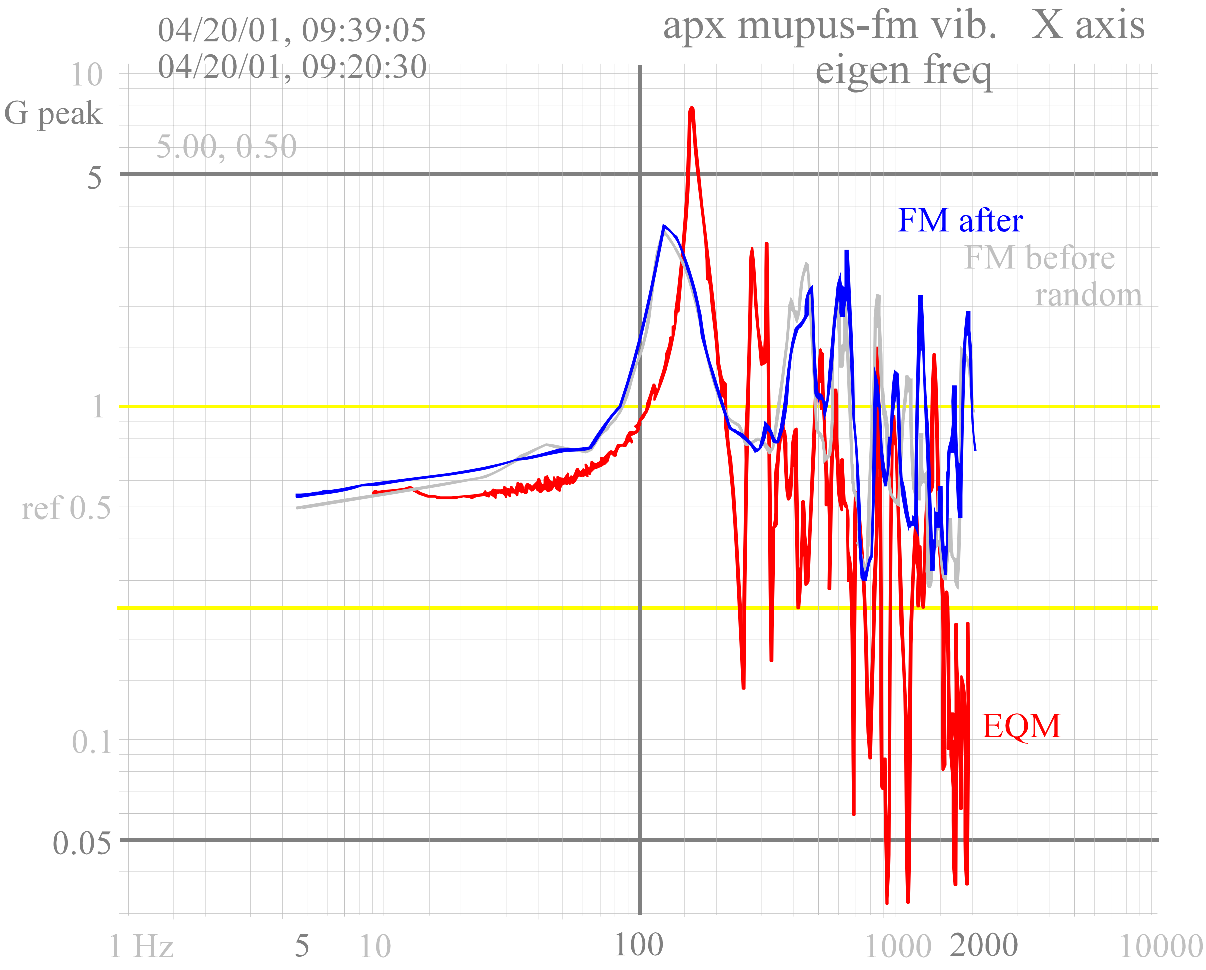


Fig. 4 Response on vibrations in the tests of eigen-frequencies in axis X

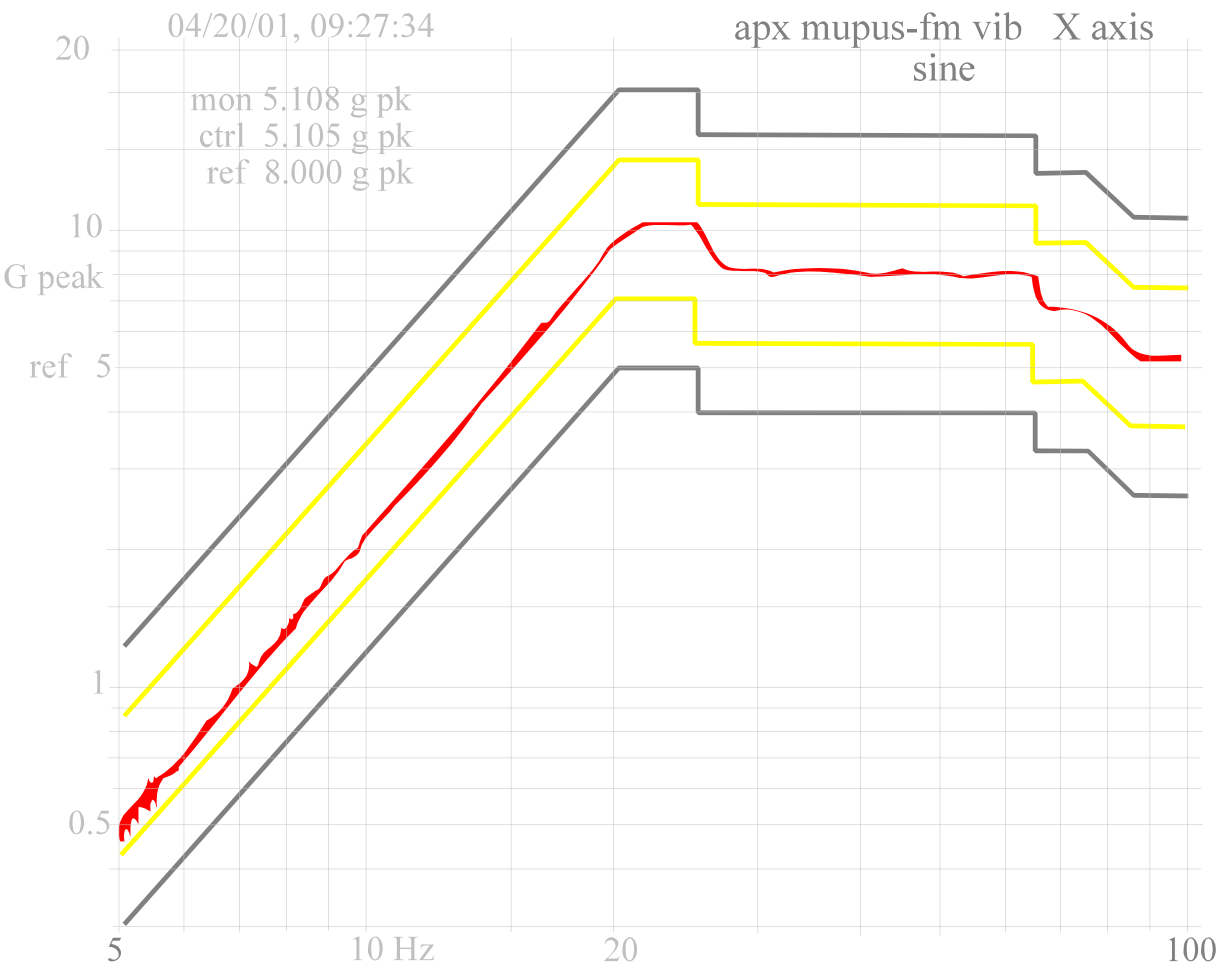


Fig. 5 Response on sine vibrations in axis X

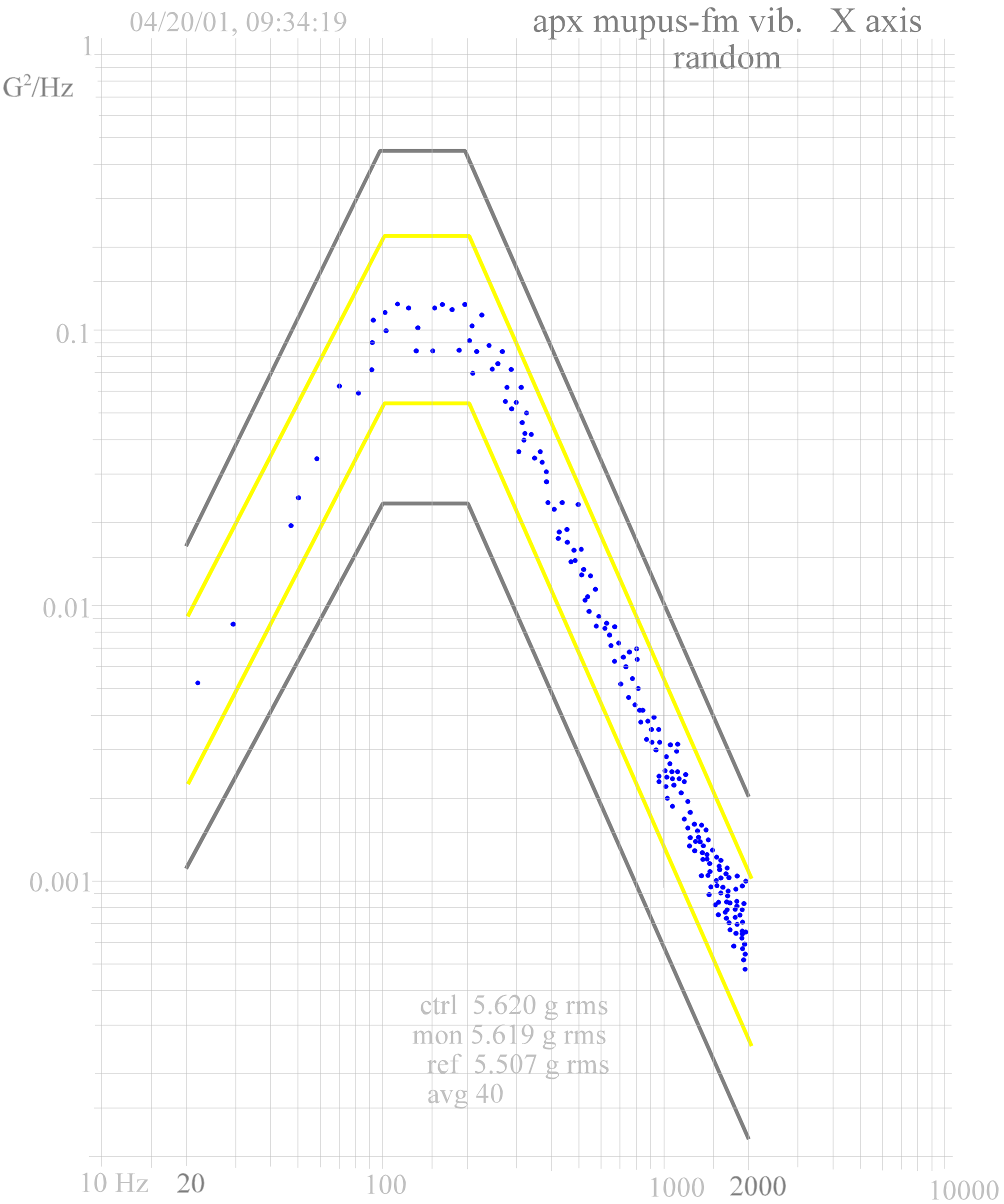


Fig. 6 Response on random vibrations in axis X

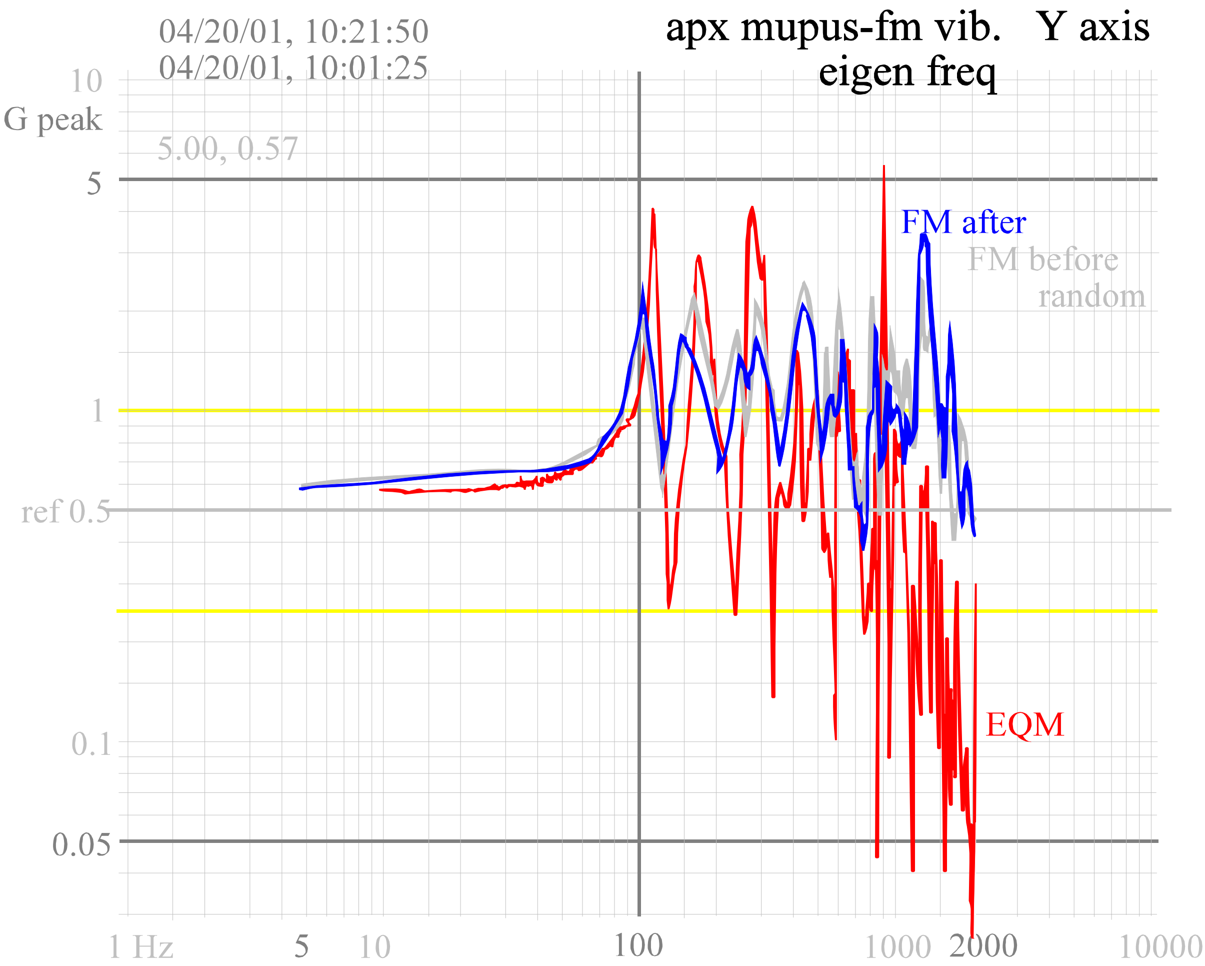


Fig. 7 Response on vibrations in the tests of eigen-frequencies in axis Y

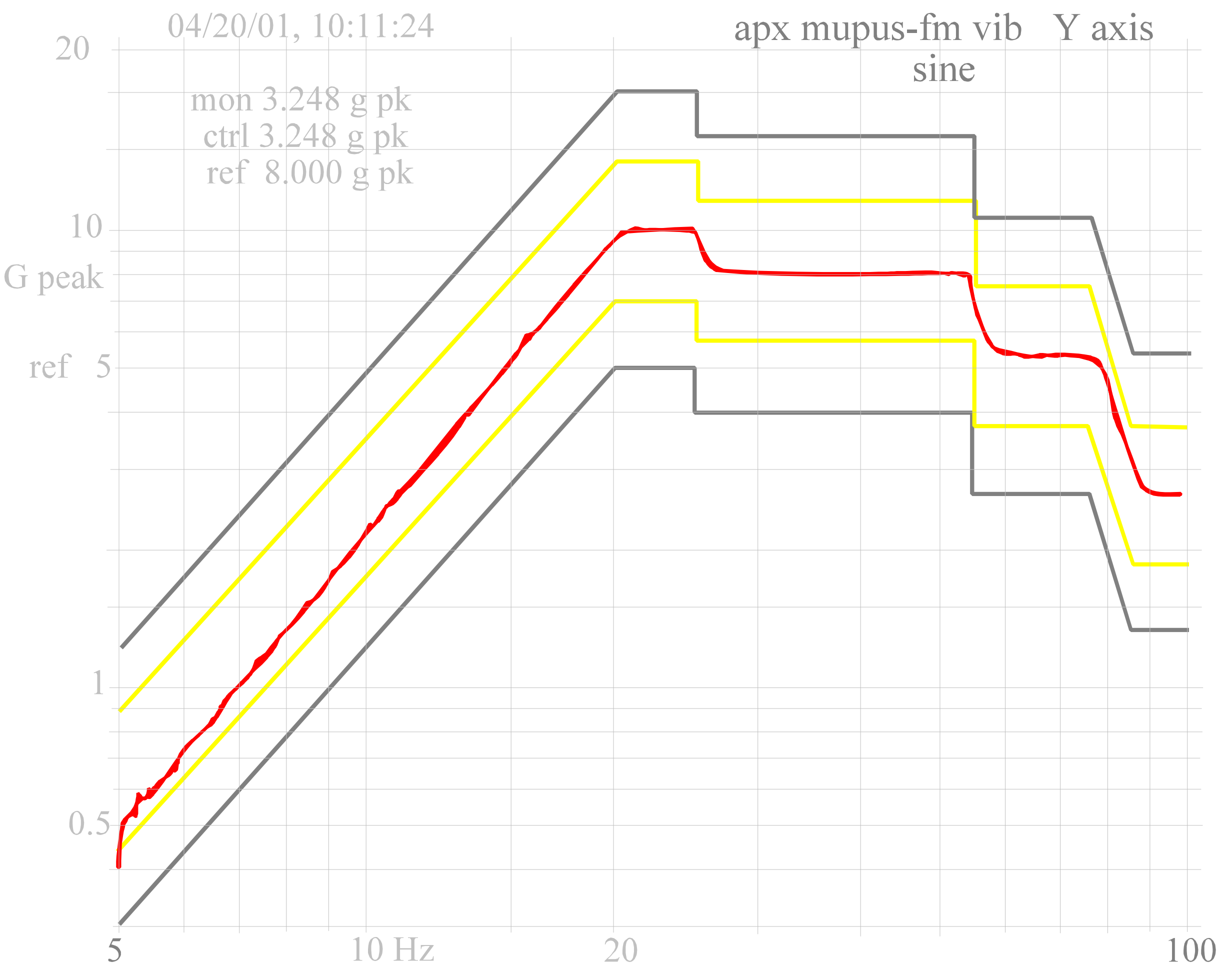


Fig. 8 Response on sine vibrations in axis Y

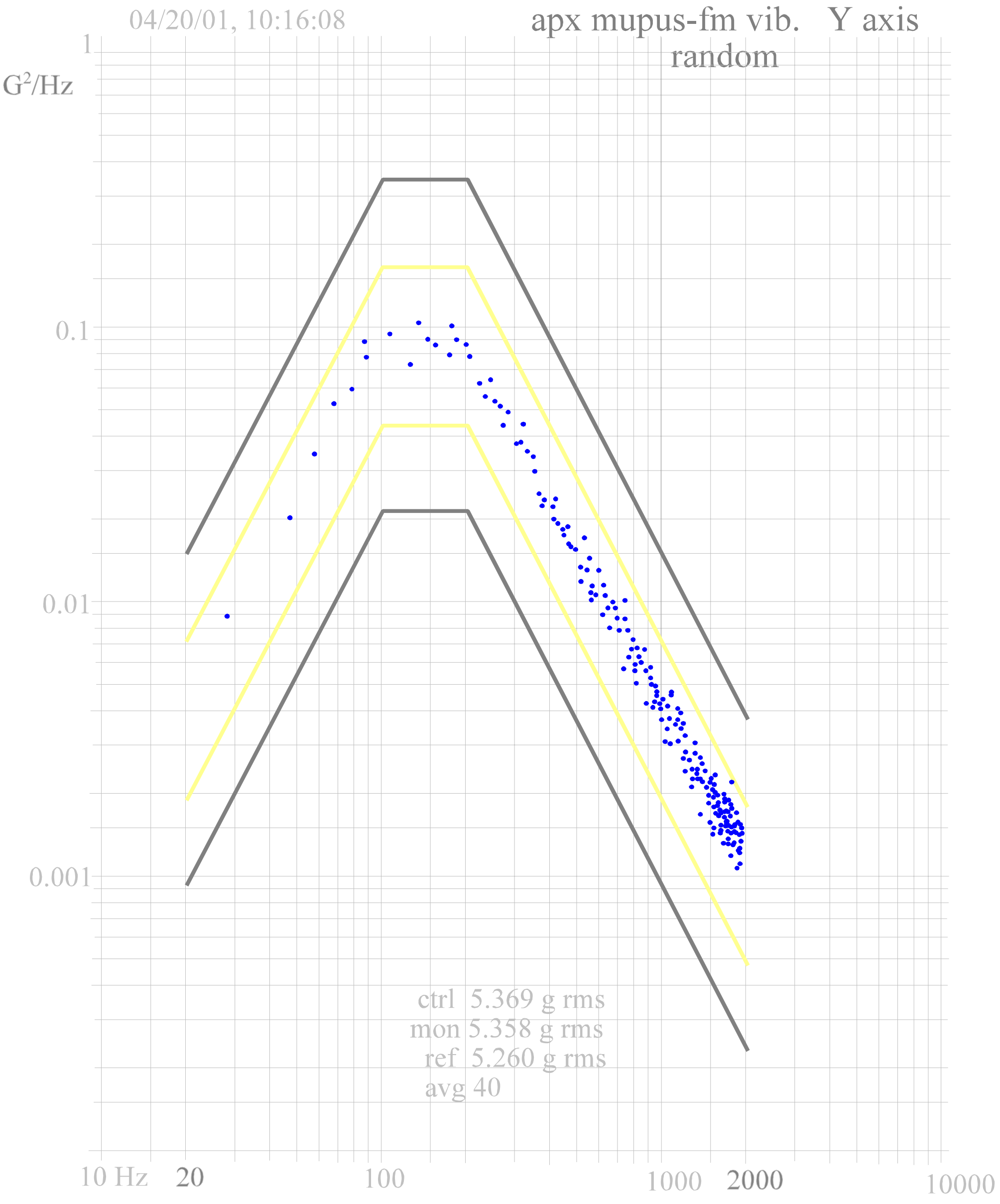


Fig. 9 Response on random vibrations in axis Y

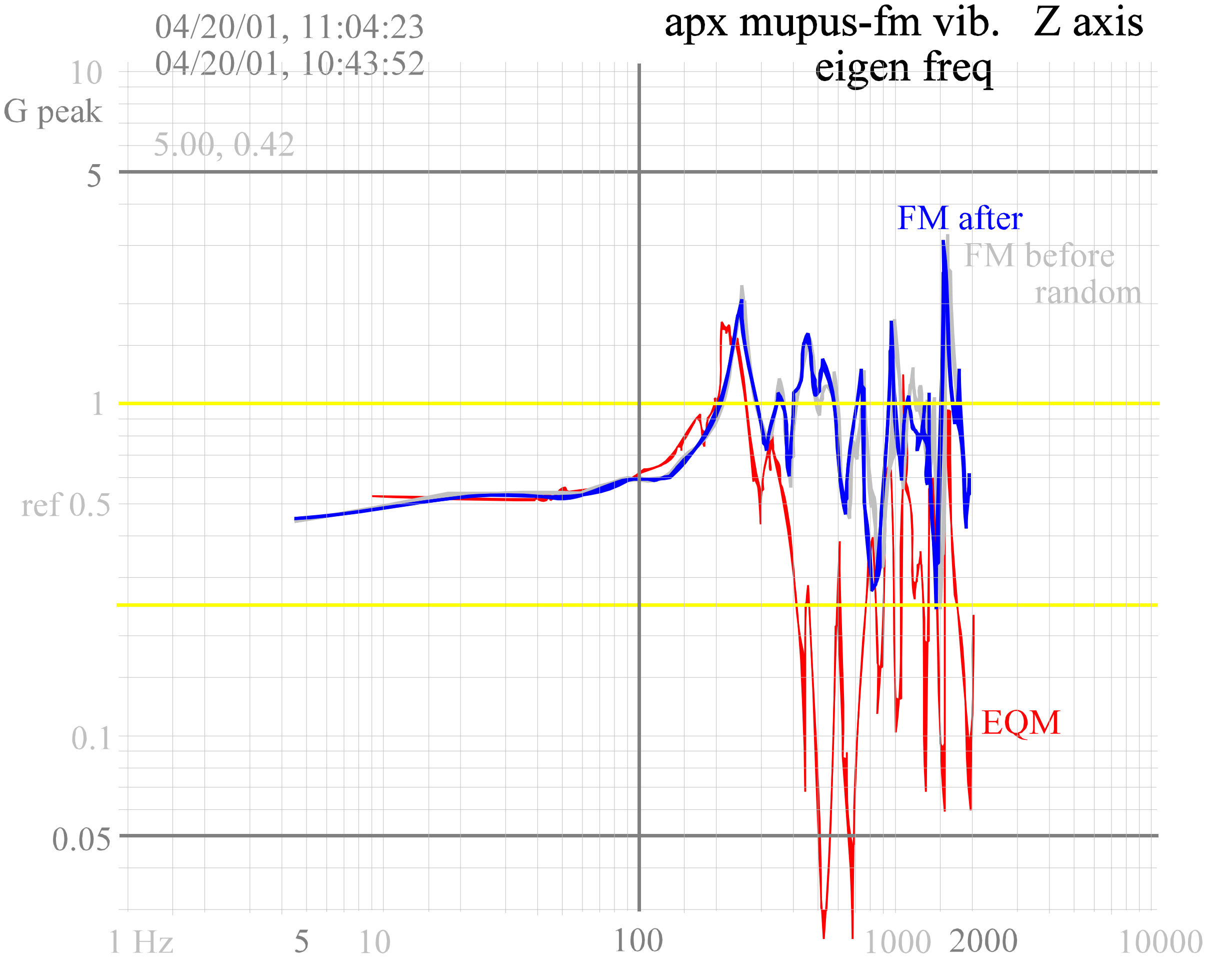


Fig. 10 Response on vibrations in the tests of eigen-frequencies in axis Z

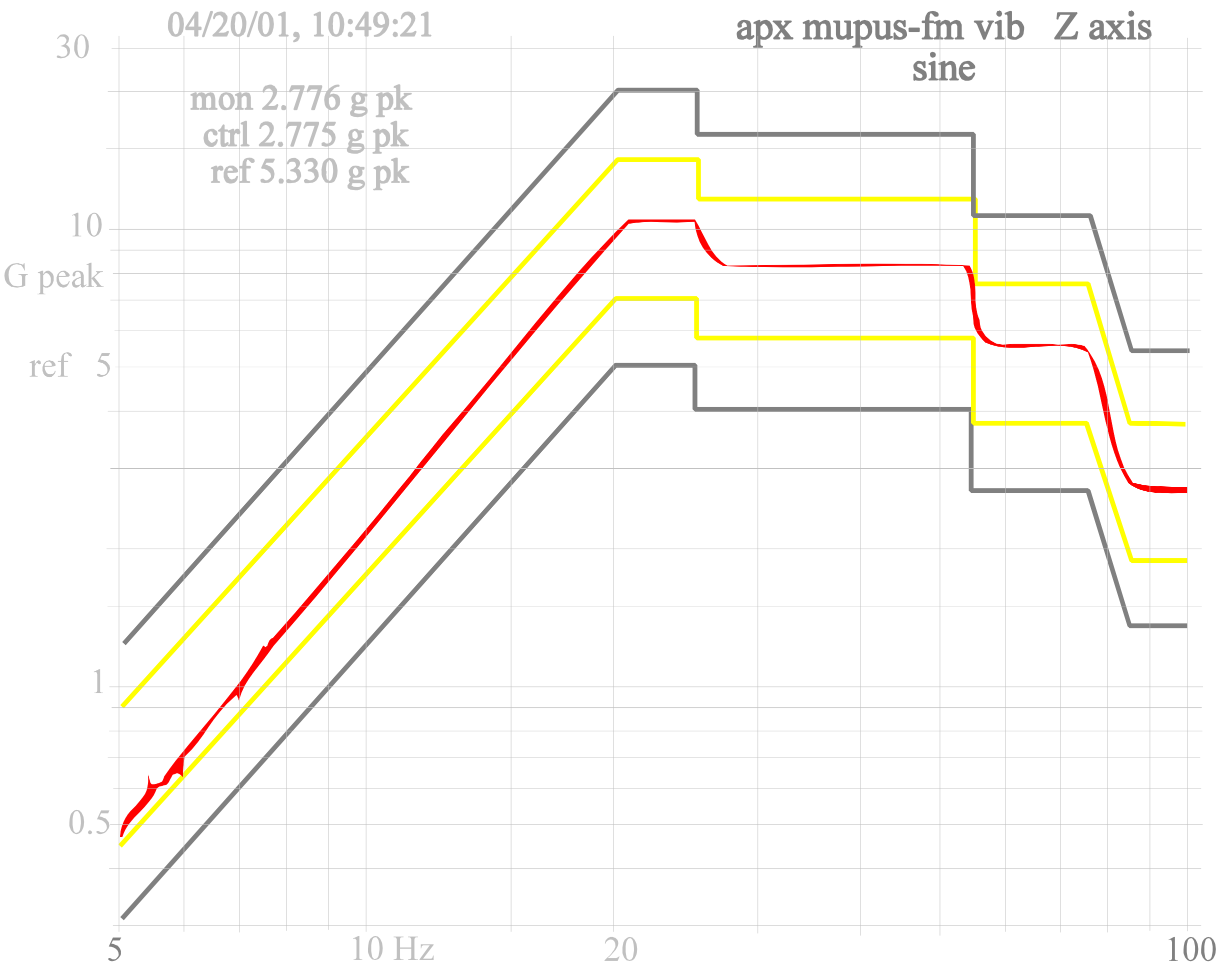


Fig. 11 Response on sine vibrations in axis Z

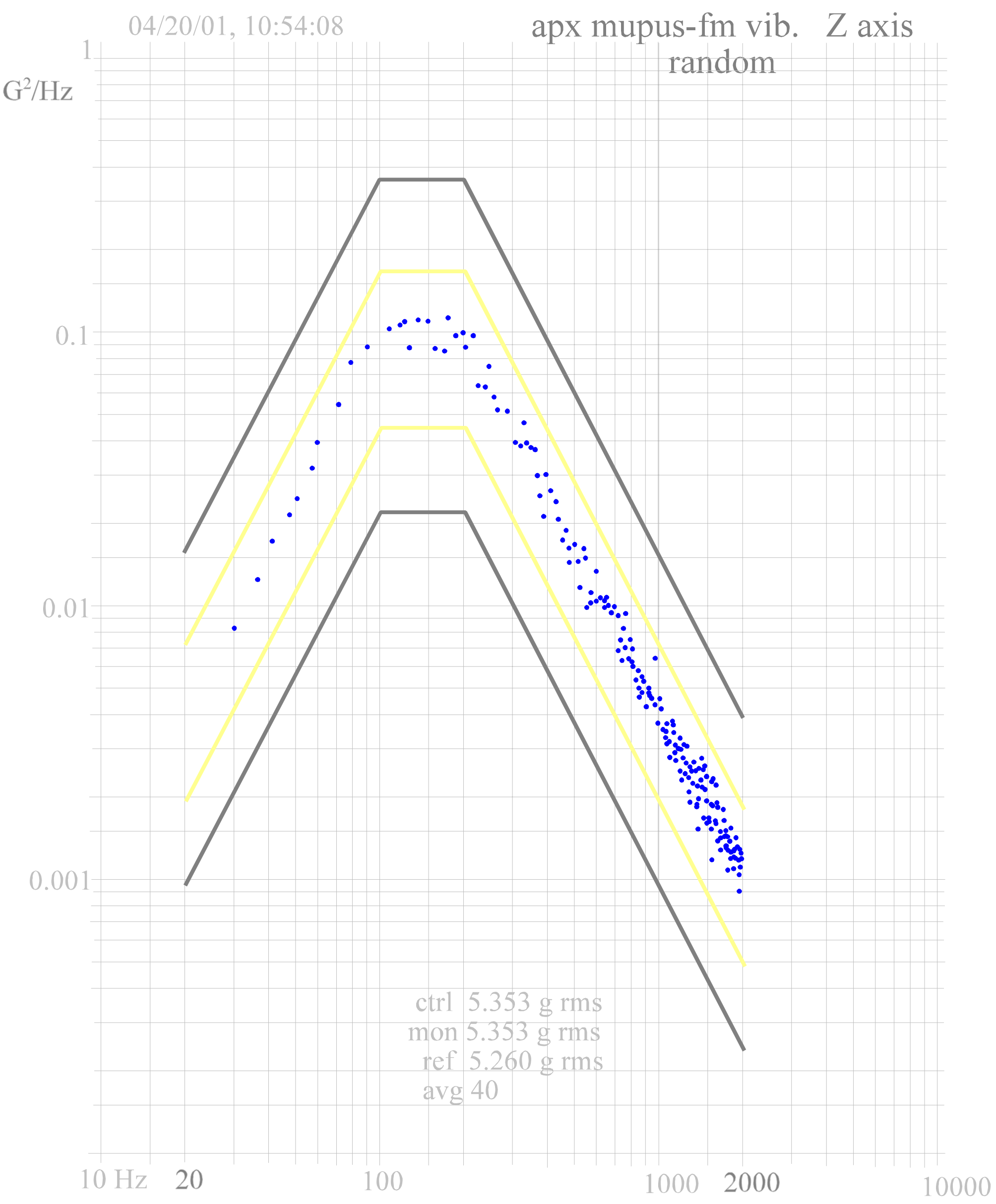


Fig. 12 Response on sine vibrations in axis Z

3 Conclusions

1) Eigen-frequencies monitored before and after sine and random tests in each axis proved that the structure under tests survived unaffected.

2) The MUPUS-PEN was equipped with the SESAME/PP-FM flexible The PP antenna survived vibration test unaffected.

3) The tests on vibration performed in EQM phase for MUPUS were different than in FM phase in
- presence of APX integrated with MUPUS in a common assembly,
- the tests cage employed EQM phase was shorter respectively to the length of APX, and
- the EQM cage was made of solid aluminum struts and base plates while the FM cage was prepared of composite struts and base plates made of metal honeycomb composite compatible to the structure of the ROSETTA LANDER.

In effect of the above differences the value of lowest eigen frequency for Y-axis (shown on the Fig. 7) is lower (102 Hz) than related values measured in EQM phase (120 Hz). The results for EQM have been included in background of the plots on the Fig.4,7,10.

The conclusion is that a joint assembly of APX-MUPUS fulfills the requirement on lowest resonance not lower than 100 Hz.

EOF MUP_FM_VIB_test.wpd

RO-LAX-DP-3210-RG

Alpha Proton X-Ray Spectrometer

APXS

FM Electronics board description

Version: 1

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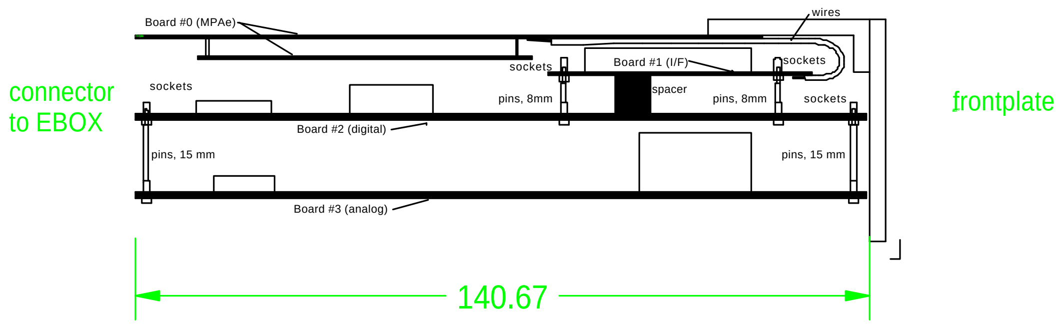
1 Scope of the document

Scope of this document is to describe assembly and disassembly of the APXS FM electronics boards for ROSETTA. It furthermore describes procedures that have to be taken into account before conformal coating.

2 APXS electronics board design

The APX electronics board is build as a stack, which is shown in the following picture.



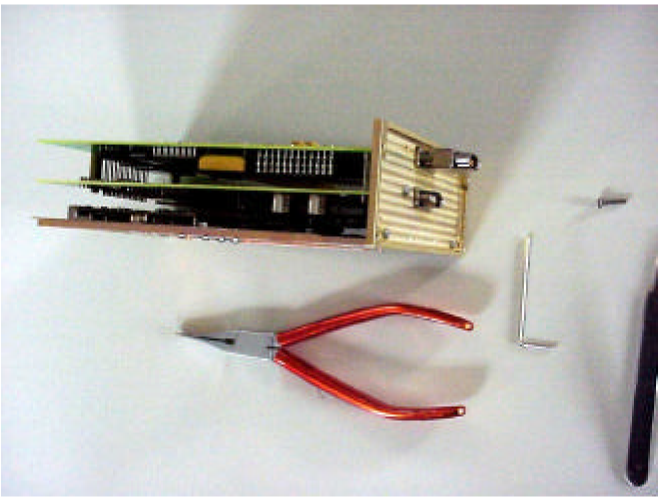
It contains the following boards.

Board 0	:	MPAe Powerboard
Board 1	:	small CDMS/APXS interface board
Board 2	:	APXS digital board
Board 3	:	APXS analogue board

3 disassembly procedure

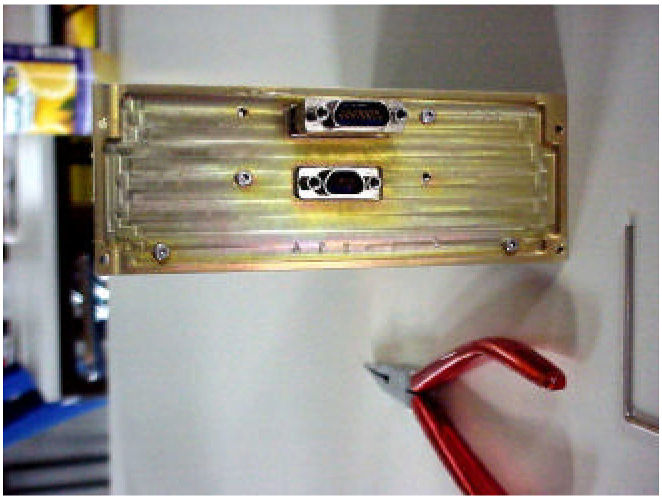
The disassembly procedure is described step by step with fotos taken from the FM boards.

3.1 A)



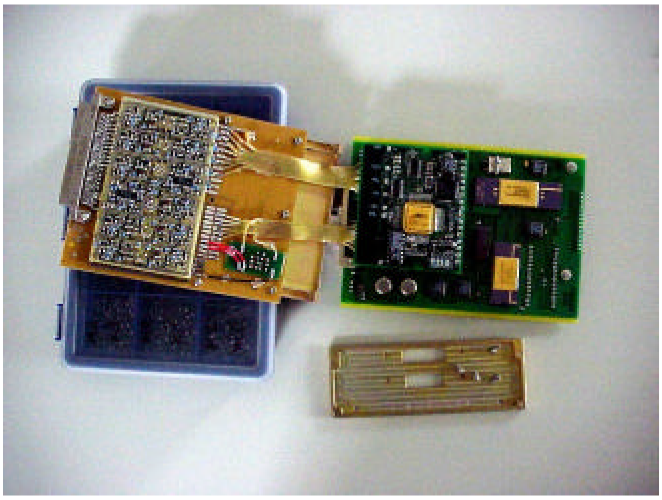
Picture A) shows the assembled board and the used tools (tong with flat heads and an imbus screwdriver for M2)

3.2 B)



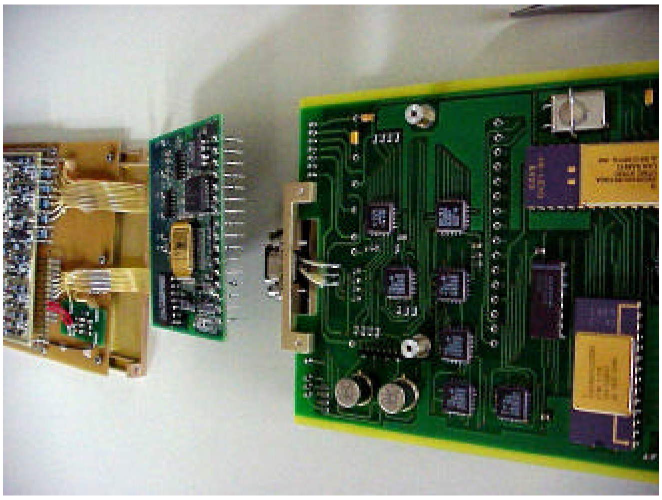
Remove all 6 M2 Screws from the frontplate. Thereby hold the whole stack in your hands to stabilize the loosened stack.

3.3 C)



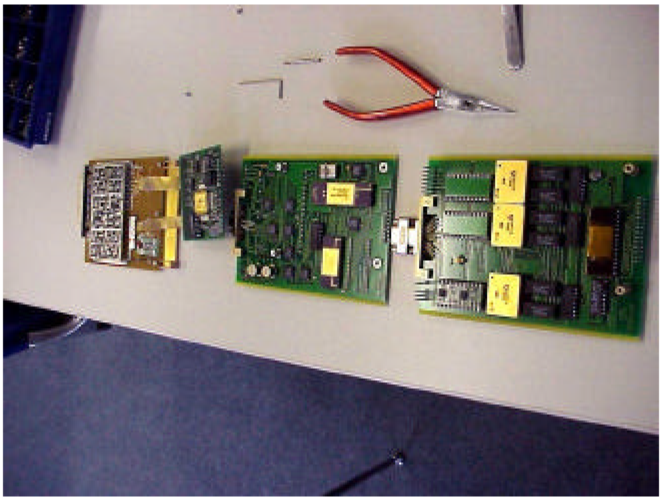
Flap the MPAe power board to the side. Use some supporting box as the cable bundle is too short to place the powerboard at the ground. Loose the 2 M2 screw on the small interface board. Then lift the interface board with the tongs from the lower stacks. Lift only in small steps from all four directions.

3.4 D)



Now loose the 2 M2 screws on the digital board. You can then disconnect the 2 APXS boards with the tongs. First loose the two pin connectors at the front side then disconnect the broad pin connectors at the back side.

3.5 E)



You now have the FM boards disassembled.

4 Assembly procedure

The assembly goes as follows.

1) if no PROM is equipped, insert the PROM. Place the backside of the digital board on a desk to support the board while pushing the PROM into the connectors.

2) (see Step C) connect the small interface board to the digital board. Again use the desk to support the digital board while pushing the interface board into the connectors. Fix the 2 M2 srews.

3) (see Step D) Connect the Analog board to the digital board. Fix the 2 M2 crews.

4) (see Step B) Attach the frontplate and fix the 6 M2 screws.

5 Conformal coating additional procedures

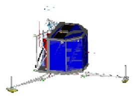
For conformal coating the PIN connectors have to be coverd against coating. This holds for the following connectors :

1. Connectors interface board / digital board.
2. Connectors digital board / analog board
3. Connectors of the PROM
4. 2 front connectors (J155 and test)
5. Connector to EBOX
6. MPAe has to provide informations if powerboard needs any covering for conformal coating.

Therefore the APXS boards have to be disassembled and conformal coated seperatly (3 pieces) !

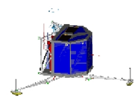
After conformal coating the PROM has to be reinserted. It must be fixed with glue to the digital board. All M2 srews of the stacks have to be fixed with loctite.

Declared Processes List (DPL)

MPAE	Max Planck Institut für Aeronomie Germany	**Unit** APXS	**Sub-Unit** APX EB			**Reference**	L A N D E R 	**Reference:** APXS ADP **Issue:** FM **Rev.:** 1 **Date:** 04/27/01 **Page:** 1 **Author:** R. Gellert

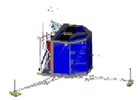
Nr.	Process Name / Identification	Specification or Procedure Nr.	Description	Material	Application/ Location	Approval Status	Rem.
APXS EB							
1	Soldering SMD Components	State of the art	- ANSI / IPC - A - 610 Class 3 - JPL D-8202 / D-8208 Spacecraft Electronic packaging - ESA-PSS-01-738		Company Mikro- Hybrid, Hermsdorf		
2	Soldering active Components and wires	ESA-PSS-01-708 Issue 1			MPI Chemie, Mainz		
3	Isopropanol Cleaning	State of the art			MPI Chemie, Mainz		
APXS DD							
1	Manufacturing of mechanical Parts	State of the art			Veit, Budenheim		
2	Isopropanol Cleaning	State of the art			MPI Chemie, Mainz		
3	Chromatisation of surface	State of the art			Jäger, Neu-Isenburg		
4	Cleaning of gears and Motors	MPCH knowledge base	Removing of grease by cleaning in TetraChlorKohlenstoff. ~ 15 minutes, (2 stages). After that evaporating at ~ 50 ° in vacuum		MPI Chemie, Mainz		

Declared Processes List (DPL)

	Max Planck Institut für Aeronomie Germany	**Unit** **APXS**	**Sub-Unit** **APX EB**			**Reference**	L A N D E R 	**Reference: APXS ADP** **Issue: FM Rev.: 1** **Date: 04/27/01 Page:**2 **Author: R. Gellert**

Nr.	Process Name / Identification	Specification or Procedure Nr.	Description	Material	Application/ Location	Approval Status	Rem.
APXS Cable							
1	Soldering of connectors	ESA-PSS-01-708 Issue 1			MPI Chemie, Mainz		
2	Fixing of Connector with Flight Epoxy	State of the art	Glueing and heating at 70° for 30 minutes		MPI Chemie, Mainz		
APXS SH							
1	Manufacturing of mechanical Parts	State of the art			Veit, Budenheim		
2	Manufacturing of electronics boards	State of the art	FR4 Milling, drilling		MPI Chemie, Mainz		
3	Chromatisation of aluminium surface	State of the art			Jäger, Neu-Isenburg		
4	Soldering of components	ESA-PSS-01-708 Issue 1		Sn63Pb37	MPI Chemie, Mainz		
5	Isopropanol cleaning				MPI Chemie, Mainz		

Declared Material List (DML)

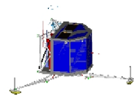
Max Planck Institut für Aeronomie Germany	**Unit** APXS	**Sub-Unit**			**Add. Info's**	**L A N D E R**		**Ref.: APXS ADP** **Issue: FM** **Rev.: 1** **Date:04/27/01** **Page** 1 **Prepared by: R.Gellert**

Nr.	Qty	Manufacturer Specification	Group **(1)**	Chem. Nature/ Type of Prod.	Processing Parameter	Application	Use Location	Env. Code R A T **(3)**	ESA Approval	Outgassing or SCC-res., Data & Ref. **(2)**	Size-Code **(4)**	Remarks
APXS electronics board												
1	10 g	Aluminum Alloy		AlCuMnPb2	Milling, Drilling, Chromatizing	Frontplate, distance holder, structure of power interface						
2	~ 270 g	Various Materials				Rest of electronics						
3	5 g	FR4				Boards						
4	2g	Epoxy glue		Hysol EA 9309N	Glueing	Fixing of cables, extender board						
5	? g	Solder tin		Sn63Pb37	Soldering	soldering						
6	~2 g	Tantalum shielding of ADC		Ta	Glued and taped with Kapton tape	Shielding of ADC						

LAN-FO-04.doc

Notes: **(1) PSS-01-700 Annex B / S. 28**
(2) PSS-01-736 , Tab. 1
(3) PSS-01-700 Column 7 / S.30
(4) PSS-01-700 S. 29-32

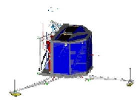
Declared Material List (DML)

	Max Planck Institut für Aeronomie Germany	**Unit** **APXS**	**Sub-Unit**			**Add. Info's**	**L A N D E R** 	**Ref.: APXS ADP** **Issue: FM** **Rev.: 1** **Date:04/27/01** **Page** 2 **Prepared by: R.Gellert**

Nr.	Qty	Manufacturer Specification	Group (1)	Chem. Nature/ Type of Prod.	Processing Parameter	Application	Use Location	Env. Code R A T (3)	ESA Approval	Outgassing or SCC-res., Data & Ref. (2)	Size-Code (4)	Remarks
APXS Deployment device												
1	100 g	Aluminum Alloy		ACP 50/80 And AlCuMgPb	Milling, Drilling, Chromatizing	Housing, structure						
2	200 g	Stainless Steel		A2, A4		Screws, worm, 2 threaded rods						
3	1 g	FR4				Boards						
4	2 g	Epoxy glue		Hysol EA 9309N	Glueing							
5	2 g	Solder tin		Sn63Pb37	Soldering	Soldering						
6	32 g	Densimet		W95Cu5	Milling	Shielding of SH against MUPUS source						
9	20 g	Vespel		Vespel	Milling, drilling	Worm for threaded rods						

Notes: **(1) PSS-01-700 Annex B / S. 28**
(2) PSS-01-736 , Tab. 1
(3) PSS-01-700 Column 7 / S.30
(4) PSS-01-700 S. 29-32

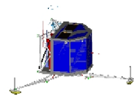
Declared Material List (DML)

Max Planck Institut für Aeronomie Germany	**Unit** APXS	**Sub-Unit**			**Add. Info's**	LANDER 	**Ref.: APXS ADP** **Issue: FM Rev.: 1** **Date:04/27/01 Page** 3 **Prepared by: R.Gellert**

Nr.	Qty	Manufacturer Specification	Group (1)	Chem. Nature/ Type of Prod.	Processing Parameter	Application	Use Location	Env. Code R A T (3)	ESA Approval	Outgassing or SCC-res., Data & Ref. (2)	Size-Code (4)	Remarks
APXS Sensor head												
1	100 g	Aluminum Alloy		ACP 50/80 And AlCuMgPb	Milling, Drilling, Chromatizing	Housing, structure						
2	50 g	Stainless Steel Materials				Screws, Source holder and collimator						
3	1 g	Zirkonium				Internal shielding xray detector						
4	1 g	Epoxy glue		Hysol EA 9309N	Glueing							
5	2 g	Solder tin		Sn63Pb37	Soldering	Soldering						
6	10 g	FR4			Milling, drilling	Boards						
7	1 g	CuBe		CuBe	Milling, drilling	Doors						
8	30 g	Electronics ,parts,Ics, detectors		Si, Cu, ???	Soldering, bonding	Needed for working						
9	20 g	Vespel		Vespel	Milling, drilling	Contact ring,adaption to cone, isolating						

Notes: **(1) PSS-01-700 Annex B / S. 28**
(2) PSS-01-736 , Tab. 1
(3) PSS-01-700 Column 7 / S.30
(4) PSS-01-700 S. 29-32

Declared Material List (DML)

Max Planck Institut für Aeronomie Germany	**Unit** APXS	**Sub-Unit**			**Add. Info's**	**L A N D E R**		**Ref.: APXS ADP** **Issue: FM** **Rev.: 1** **Date:04/27/01** **Page** 4 **Prepared by: R.Gellert**

Nr.	Qty	Manufacturer Specification	Group **(1)**	Chem. Nature/ Type of Prod.	Processing Parameter	Application	Use Location	Env. Code R A T **(3)**	ESA Approval	Outgassing or SCC-res., Data & Ref. **(2)**	Size-Code **(4)**	Remarks

Notes: **(1) PSS-01-700 Annex B / S. 28**
(2) PSS-01-736 , Tab. 1
(3) PSS-01-700 Column 7 / S.30
(4) PSS-01-700 S. 29-32

Declared Component List (DCL)

Max Planck Institut für Chemie Germany	**Unit** **APXS FM**		**Reference: APXS ADP** **Issue: FM Rev.: 1** **Date: 04/27/01 Page: 1** **Author : R. Gellert**

Nr.	Qty.	Component Part Number	Specification	Manufacturer	Housing	Function	Ref to current flow diagram
		Digital Board APXS		Produced by Company Micro-Hybrid			Reference to flow diagram
1	A lot	SMD resistors, diodes and capacitors		Selected for space application by Micro-Hybrid	0805		
2	1	5962R9563801QQA	Rad Hard	UTMC	CDIP 40	80C31 CPU	U1
3	1	5962R9215303QMA	Rad Hard	UTMC	CDIP 28	32 KB SRAM	U4
4	1	MAX695MJE		Maxim	CDIP 16	CPU Supervisor	U8
5	1	5962R9687302QXC	Rad Hard	UTMC	CDIP 28	8KB PROM	U3
6	2	J 422-DD-5M		Teledyne	SO 10	Relais	U13,U14
7	1	SNJ54HC21FK		TI	LCCC 20	Dual 4 AND	U7
8	2	SNJ54HC573AFK		TI	LCCC 20	Latch	U17
9	1	SNJ54HC393FK		TI	LCCC 20	4 Bit Counter	U15
10	2	SNJ54HC139FK		TI	LCCC 20	Demultiplexer	U6,U9
11	1	SNJ54HC08FK		TI	LCCC 20	Quad AND	U10
12	1	SNJ54HC14FK		TI	LCCC 20	Hex Schmitt Trig inv	U5
13	1	SNJ54HC574FK		TI	LCCC 20	FlipFlop	U18

Declared Component List (DCL)

Max Planck Institut für Chemie Germany	Unit APXS FM		Reference: APXS ADP Issue: FM Rev.: 1 Date: 04/27/01 Page: 2 Author : R. Gellert

Nr.	Qty.	Component Part Number	Specification	Manufacturer	Housing	Function	Ref to current flow diagram
		Analog Board APXS		Produced by Micro-hybrid			
1	1	CS5102A-TD	shielded with 0.4 mm Tantalum top and bottom	Crystal	CDIP 28	ADC	U24
2	1	CD54HC4051F3A		TI	CDIP 16	Analog Multiplexer	U25
3	3	HAI-5144-2		TI	DIP 14	OP	U17,U21,U22
4	6	PMI DAC8143		Analog	DIP 16	DAC	U14,U15,U16,U18,U19,U20
5	3	PH 300		Amptek	Hybrid	Peak hold detector	U8,U10,U12
6	14	CLC505AJE		National Semi	SOIC 8	OP	Amplifiers in 4555
7	1	AD580SH		Analog devices	TO3	V ref	U26
8	1	AD590KF		Analog devices	?	Temp. Sensor	U31
9	3	MAX909ESA		Maxim	SOIC 8	Analog Comparator	U1,U5,U7
10	2	SNJ54HC74FK		TI	LCCC 20	Pos edge FlipFlop	U2,U6
11	1	SNJ54HC21FK		TI	LCCC 20	Dual 4 AND	U3
12	1	SNJ54HC14FK		TI	LCCC 20	Hex Schmitt Trig inv	U4
13	1	SNJ54HC138FK		TI	LCCC 20	Digital Multiplexer	U23
14	A lot	SMD resistors, capacitors and diodes		Selected by Microhybrid for space application			

Declared Component List (DCL)

Max Planck Institut für Chemie Germany	**Unit** **APXS FM**		**Reference: APXS ADP** **Issue: FM Rev.: 1** **Date: 04/27/01 Page:** 3 **Author : R. Gellert**

Nr.	Qty.	Component Part Number	Specification	Manufacturer	Housing	Function	Ref to current flow diagram
		APXS CDMS Interface		Board produced by KFKI, soldered by Microhybrid			
1	1	A1020A	Rad Hard	Actel	CQ84C	FPGA	
2	1	TLC1550IFN	Shielded with Ta	TI	PLCC 28	ADC	
3	1	TLC2201MJGB		TI	DIP 8		
4	1	MM74HC4050M		TI	SOIC 16		
5	1	HCT4051M		TI	SOIC 16		
6	1	SNJ54HCT04J		TI	DIP 14		
7	A lot	SMD resistors, capitors and diodes		Selected by Microhybrid for space application			

Declared Component List (DCL)

Max Planck Institut für Chemie Germany	**Unit** **APXS FM**		**Reference: APXS ADP** **Issue: FM Rev.: 1** **Date: 04/27/01 Page:** 4 **Author : R. Gellert**

Nr.	Qty.	Component Part Number	Specification	Manufacturer	Housing	Function	Ref to current flow diagram
		APXS SH		maufactured by MPCh			
1	3	A250F	100 K	Amptek		PreAmplifier	
2	1	A275NF	100 K	Amptek		x-ray Amplifier	
3	1	5962R9660301VCC (CD40106BMS)	Rad Hard (100k)	Intersil	CDIP 14	Hex Schmitt Trigger for High Voltage Cascade	
4	1	2SK152		?	?	FET for current source	
5	A lot	SMD resistors, diodes and capacitors			0805		
6	1	AD590KF		Analog devices	?	Temp. Sensor Sensorhead	

APX cable 1 (J155) Connector Log Book , FM2 , equipped with connector saver

APX_CMR

Sheet :1

	1	12	13	14	15	16	17	18	19	20
Date of Mate Signature	11 x at MPCH									
Date of Demate Signature	11 x at MPCH									

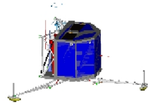
	21	22	23	24	25	26	27	28	29	30
Date of Mate Signature										
Date of Demate Signature										

Declared Mechanical Parts List

Max Planck Institut für Aeronomie Germany

Unit: APXS | **Sub-Unit** | **Category** | **Ref. Doc's**

L A N D E R



Reference: RO-LAX-DMPL-3000-RG
Issue: FM **Rev.: 1**
Date:27.04.01 **Page:**1
Author: Ralf Gellert

APXS DD

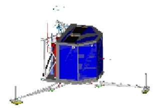
Nr.	Qty.	Component/ Part Number	Specificat.	Manufact./ Source	Qualification	Reference/ Draw. Nr.	Material (Mass)	Processing	Qual.Test (PAD.Nr.)	Elementary Function	Critically Hazard	Rem.
1	1	Cap of gear box				352103						
2	1	Mechanical transmitter and holder of DOWN Endswitch				352106						
3	1	Gear box upper side				352102						
4	1	Gear box lower				352102						
5	2	Faulhaber Motor 1331T012S				-						
6	2	Maxxon planetary gear 1:16				-						
7	2	Worm wheel				352211						
8	2	Vespel Worm wheel				352232						
9	4	Vespel synchronization wheels				352240						
10	1	tubeholder for synchronization wheels				352222						
11	1	Holder for synchronization wheels				352105						
12	1	Cap of synchronization wheels box				352104						
13	1	APXS tube housing				353202						
14	1	Holder for UP endswitch				353204						
15	2	Pin holder for Door launch lock				353209						
16	2	Pin for Door launch lock				353210						

Declared Mechanical Parts List

Max Planck Institut für Aeronomie Germany

Unit: APXS | **Sub-Unit** | **Category** | **Ref. Doc's**

L A N D E R



Reference: RO-LAX-DMPL-3000-RG
Issue: FM **Rev.: 1**
Date:27.04.01 **Page:**2
Author: Ralf Gellert

Nr.	Qty.	Component/ Part Number	Specificat.	Manufact./ Source	Qualification	Reference/ Draw. Nr.	Material (Mass)	Processing	Qual.Test (PAD.Nr.)	Elementary Function	Critically Hazard	Rem.
17	2	Springs for doors lauch lock				-						
18	1	Adaption flangue				353203						
19	1	APXS cone				353201						
20	1	APXS inner cone for SH				351104						
21	2	Holder of inner cone with threaded rods				351104						
22	2	Upper holder for cable and st. St band				353212						

Dose Calculation for Cm-244 Sources:

Isotope	Cm-244		Decay Product	Pu-240			
$t_{1/2}$ (α), (years)	18,11		$t_{1/2}$ (α), (years)	6,60E+03			
$t_{1/2}$ (SF), (years)	1,35E+07						
Activity (Curie)	3,00E-02						
Activity (Becquerel)	1,11E+09						
						Dose (mSv/h in 1 m)	**Dose (mSv/h in 1 m)**
	Energy (MeV)	Fraction (%)	equiv. Activity (Ci)	equiv. Activity (Bq)	Flux/cm²/h in 1 m	**a fully shielded**	**a fully shielded**
				= Flux/s into 4π	(4π = 125664 cm²)	**g and n following (a)**	**g and n following (a)**
						unshielded	**Shielding 1 mm Fe (b)**
Alpha-1	5,806	76,7	2,30E-02	8,51E+08	(2.44E+07)	0	0
Alpha-2	5,764	23,3	6,99E-03	2,59E+08	(7.41E+06)	0	0
Neutrons from spont. Fission	ca. 2.0		4,04E-08	1,49E+03	4,28E+01	1,71E-05	1,71E-05
Gamma	**0,043**	23,3	6,99E-03	2,59E+08	7,41E+06	**2,22E-03**	**1,33E-04**
	0,099	2,66E-02	7,98E-06	2,95E+05	8,46E+03	4,26E-06	3,19E-06
	0,153	9,94E-01	2,98E-04	1,10E+07	3,16E+05	**2,46E-04**	**2,12E-04**
	0,252	1,30E-05	3,90E-09	1,44E+02	4,13E+00	5,30E-09	5,30E-09
	0,263	8,00E-05	2,40E-08	8,88E+02	2,54E+01	3,41E-08	3,41E-08
	0,289	2,00E-08	6,00E-12	2,22E-01	6,36E-03	9,37E-12	9,37E-12
	0,303	1,50E-05	4,50E-09	1,67E+02	4,77E+00	7,36E-09	7,36E-09
	0,341	1,00E-07	3,00E-11	1,11E+00	3,18E-02	5,52E-11	5,52E-11
	0,507	2,50E-06	7,50E-10	2,78E+01	7,95E-01	2,05E-09	2,05E-09
	0,555	3,60E-05	1,08E-08	4,00E+02	1,14E+01	3,23E-08	3,23E-08
	0,597	2,40E-05	7,20E-09	2,66E+02	7,63E+00	2,32E-08	2,32E-08
	0,606	2,50E-06	7,50E-10	2,78E+01	7,95E-01	2,45E-09	2,45E-09
	0,759	1,50E-05	4,50E-09	1,67E+02	4,77E+00	1,84E-08	1,84E-08
	0,818	8,00E-05	2,40E-08	8,88E+02	2,54E+01	1,06E-07	1,06E-07
	0,858	6,00E-06	1,80E-09	6,66E+01	1,91E+00	8,33E-09	8,33E-09
	0,860	8,00E-06	2,40E-09	8,88E+01	2,54E+00	1,11E-08	1,11E-08
	0,895	8,00E-08	2,40E-11	8,88E-01	2,54E-02	1,16E-10	1,16E-10
	0,900	1,50E-06	4,50E-10	1,67E+01	4,77E-01	2,19E-09	2,19E-09
	0,938	1,80E-06	5,40E-10	2,00E+01	5,72E-01	2,74E-09	2,74E-09
Total Gamma						**2,47E-03**	**3,49E-04**
Total (Gamma+Neutrons)						**2,49E-03**	**3,66E-04**

(a) for 0.07 < E(MeV) < 4: D (0.3 m) = 60 * A * E (mSv/h); D (1 m) = 5.4 * A * E (mSv/h)
A.... Activity in Ci, E...Energy in MeV
for 0.043 MeV "Fluence to dose equivalent conversion factor": 1 γ / cm² = 3E-01 pSv = 3E-10 mSv
for Neutrons of 2 MeV: 1 n / cm² = 4E+02 pSv = 4E-07 mSv; from Fig. 25.4 (for γ extrapolated)

Ref. for (a): D.E. Groom et al., The European Physical Journal C15 (2000) 1, Chapter 25: "Radioactivity and Radiation Protection"
see also: http://pdg.web.cern.ch/pdg/2000/radiorppbook.pdf

(b) the attenuation factors for 1 mm Fe (0.78 g/cm²) are: 0.06 @ 0.043 MeV, 0.75 @ 0.099 MeV and 0.86 @ 0.153 MeV;
for all other γ-lines attenuation has not been considered in this calculation.

Ref. for (b): "X-Ray Mass Attenuation Coefficients" in: http://physics.nist.gov/PhysRefData/XrayMassCoef

RO-LAX-TR-3230-RG

Qualification vibe test report

The vibe qualification test was performed with the STM in December 98 in France. CNES was supervising the test.

Extracts from the test report, that is available only in printed form –
LAS.ESS.EXT.PRV.022609 from 15.12.98 - are added the following pages.
The test was using the qualification levels given in RO-LAN-TS-3301

	LABORATOIRE D'ASTRONOMIE SPATIALE SERVICE ESSAIS	N°LAS.ESS.EXT.PRV.022609 Page : 1 Indice : 01 Date : 15 Décembre 1998

PROJET : ROSETTA APXS

Sous ensemble : MAQUETTE

Modèle : Prototype

N° d'identification :

COMPTE RENDU D'ESSAIS -VIBRATIONS-

Objet : Qualification en vibrations

Référence : LAS.ESS.EXT.PRV.022609

Auteur : P LAURENT
Vérifié :J C BERGES

Diffusion : Service ESSAIS 1 exemplaires , PROJET 2 exemplaires.

5.2 SPECIFICATIONS

A) VIBRATIONS SINUSOÏDALES

Bas Niveau - Axe Y	20- 2000Hz	Acc 1g	2oct/mn.

- **qualification**

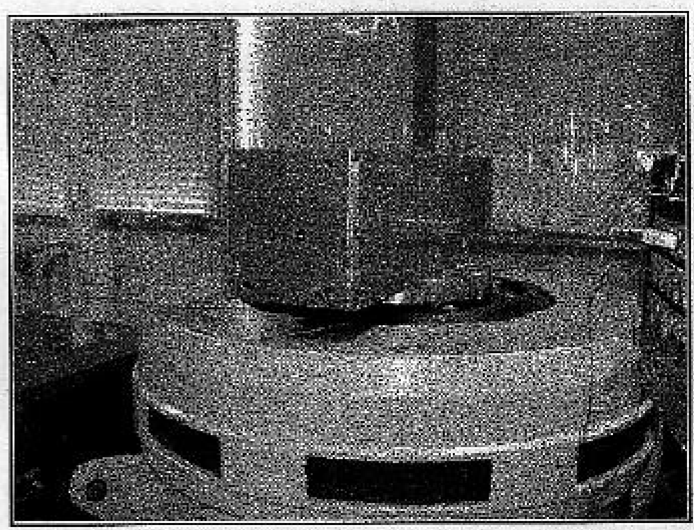
- Axe **X**	5 - 15Hz	Depl 22mm (peak - peak)	2oct/mn.
	15- 60Hz	Acc 10.5g (0 to peak)	2oct/mn.
	60 - 100Hz	Acc 6.0g (0 to peak)	2oct/mn.
	100 - 150Hz	Acc 3.0g (0 to peak)	2oct/mn.
- Axe **Y**	5 - 15Hz	Depl 22mm (peak - peak)	2oct/mn.
	15- 60Hz	Acc 10.5g (0 to peak)	2oct/mn.
	60 - 100Hz	Acc 6.0g (0 to peak)	2oct/mn.
	100 - 150Hz	Acc 3.0g (0 to peak)	2oct/mn.
- Axe **Z**	5 - 15Hz	Depl 22mm (peak - peak)	2oct/mn.
	15- 60Hz	Acc 10.5g (0 to peak)	2oct/mn.
	60 - 100Hz	Acc 6.0g (0 to peak)	2oct/mn.
	100 - 150Hz	Acc 3.0g (0 to peak)	2oct/mn.

B) VIBRATIONS ALEATOIRES

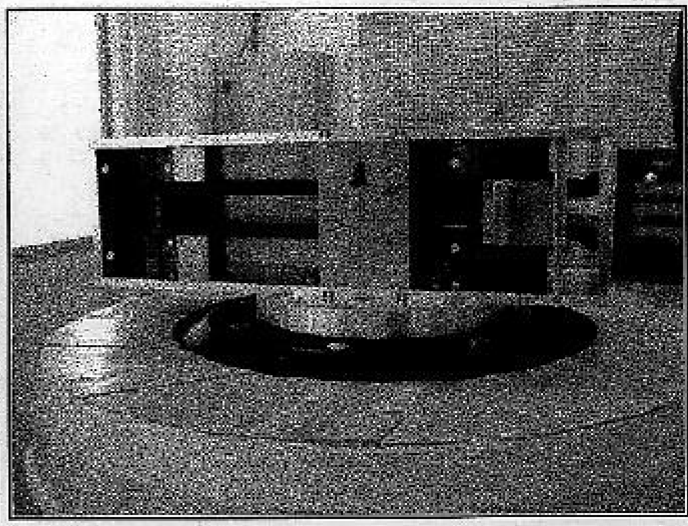
- Axe **X**	20Hz	$0.23 g^2/Hz$	+3dB/oct
	110Hz	$1.26\ g^2/Hz$	
	300Hz	$1.26\ g^2/Hz$	
	2000Hz	$0.053\ g^2/Hz$	-5dB/oct
	Niveau global 26.74g RMS , durée 2.5 min.		
- Axe **Y**	20Hz	$0.23 g^2/Hz$	+3dB/oct
	110Hz	$1.26\ g^2/Hz$	
	300Hz	$1.26\ g^2/Hz$	
	2000Hz	$0.053\ g^2/Hz$	-5dB/oct
	Niveau global 26.74g RMS , durée 2.5 min.		
- Axe **Z**	20Hz	$0.23 g^2/Hz$	+3dB/oct
	110Hz	$1.26\ g^2/Hz$	
	300Hz	$1.26\ g^2/Hz$	
	2000Hz	$0.053\ g^2/Hz$	-5dB/oct
	Niveau global 26.74g RMS , durée 2.5 min.		

8- PHOTOGRAPHIES

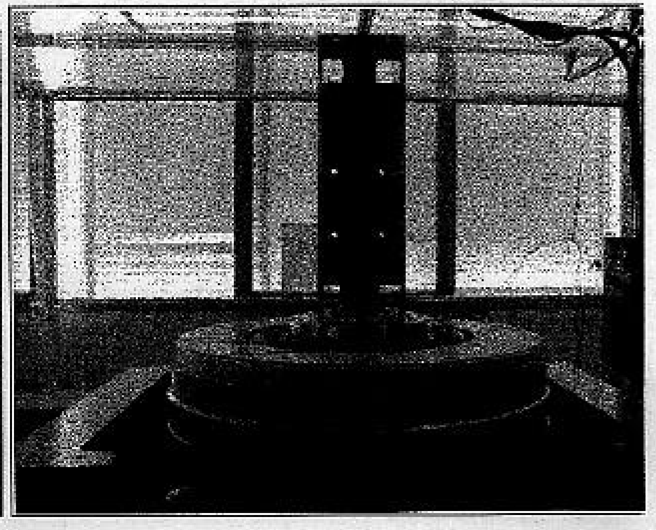
Axe X



Axe Y



Axe Z



10 - RESULTATS

Les résultats sont donnés par les courbes ci-après.

L'analyse des courbes sera effectuées par le C E S R .