ROMAP - Electronics

FM-2

Acceptance Data Package

Prepared by:	U. Auster	TU Braunschweig
	I. Apathy	KFKI Budapest
	G. Berghofer	IWF Graz
	R. Kroth	Magson GmbH Berlin
	A. Remizov	MPAE Lindau
	R. Roll	MPAE Lindau

Change record

Date	*Section*	*Page*	*Change*

Table of Contents

1 General

1.1 Scope

This ADP covers the Romap FM-2 electronics.
The document describes the Hardware in detail. That includes the mechanics as well as the electronics. The interface to the Lander and to other Romap parts inclusive test procedures are described. The instrument software is documented.
Functional test to check the software are included.

1.2 Qualification Status

The following table indicates which tests have been performed on the FM-2 prior to delivery:

No	Description	Status
1.	Physical properties (mass)	see section 3.2.
2.	Electrical verification	see Appendix 8
3.	Software verification	see Appendix 8
4.	Thermal vacuum test	see Appendix 4
5.	Thermal balance test	see Appendix 5
6.	Inrush current measurement	see Appendix 6
7.	Magnetometer / SPM calibration	see ADP sesnsors

1.3 Configuration Status

No	Description	Status
8.	REID version	RO-LRO-REID-1000
9.	Schematic versions	see Appendix 2
10.	Software version	RO-LRO-REID-1000
11.	mechanical drawings version	RO-LEB-DW-351012-BC (cover plate) RO-LRO-DW-300001-IA (HV-Box)

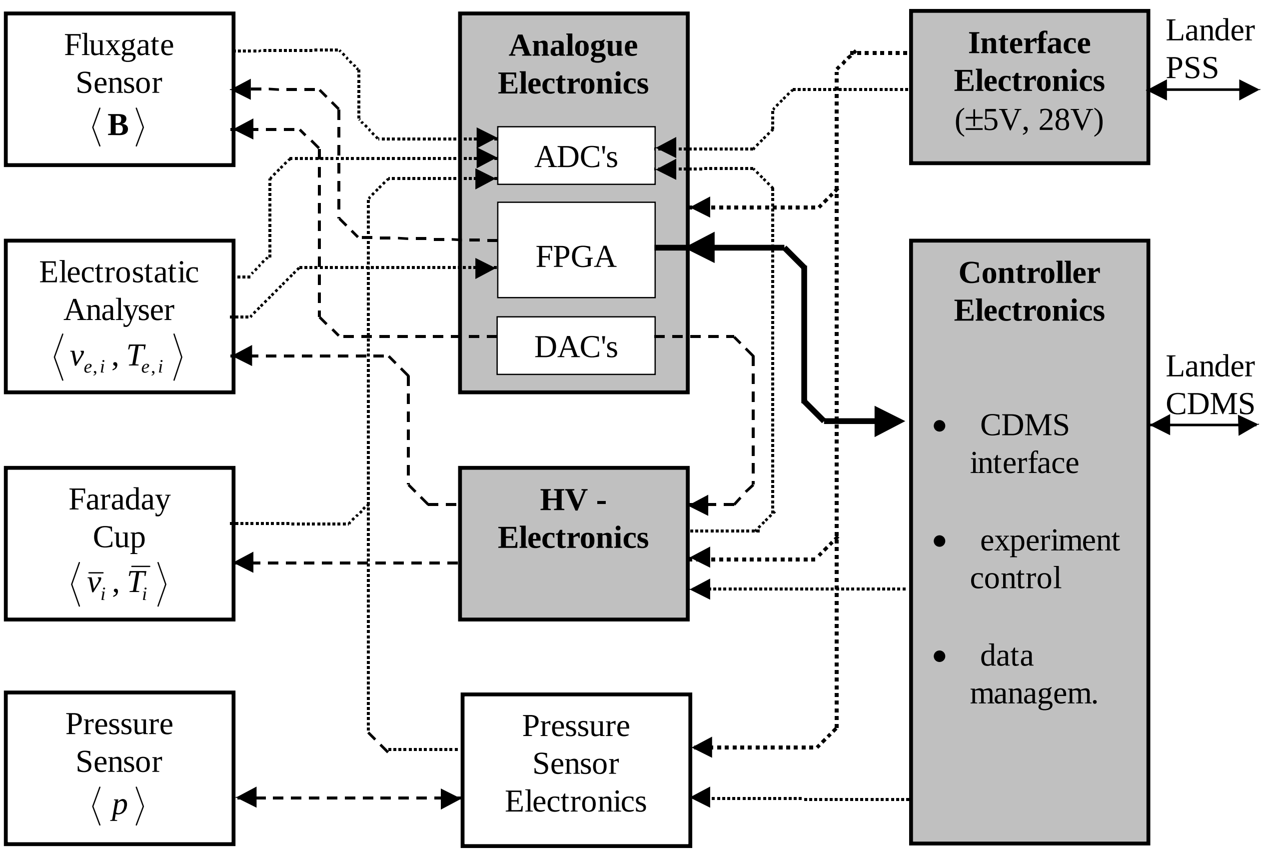
1.4 Deliverable Items

Romap elctronics (three boards +HV box mountet on the cover plate) +saver

2 Description of the Romap Electronics

2.1 Parts of the Romap Electronics

The ROMAP electronics consists of three boards placed inside the common electronics box and the high voltage (HV) electronics integrated in the cover plate.
In the block diagram the electronics parts are marked with grew colour. The data flow is drawn with dotted lines.



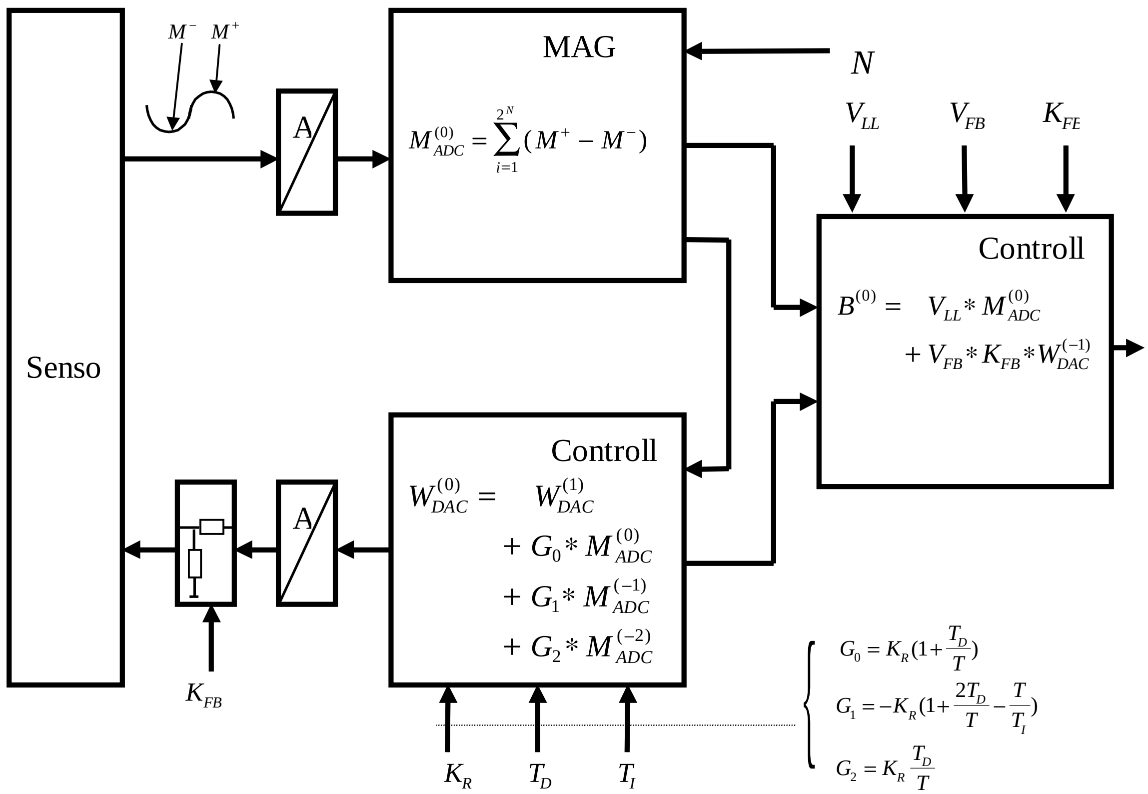
Block diagram of the ROMAP hardware

The interface electronics (soft switches for the supply voltages and current measurement) is provided by the MPAE. The interface board will be used also by other experiments and subsystems.
The central part of the analogue electronics is the FPGA which controls AD and DA-converters. The 16-bit AD converters are digitizing science and housekeeping data from all three sensors. Typical analogue parts of fluxgate magnetometers like filters or phase-sensitive integrators are substituted by fast digitalization of the sensor AC-signal and the following data processing in FPGA’s (which overtakes the functions of the former analogue parts). In this way mass is saved without any loss of accuracy. Compensation fields for the magnetometer and

high voltage steps for electrostatic analyser and Faraday cup are controlled via DA-converters (dashed lines). The near sensor electronics is developed by Magson GmbH Berlin The high voltage generator (developed by the KFKI) is in a separate shielded box on the front panel of the common electronics box.
The controller is located on the second ROMAP board. It controls MAG and SPM, stores their data output and implements the interface to the Lander Command and Data Management System (CDMS). It triggers the measurement cycle of the magnetometer, implements the digital magnetometer algorithm, controls the magnetometer feedback and generates data frames. For the SPM sensors the controller has implemented the counting logic for electrons and ions, samples Faraday cup data, generates SPM data frames, controls the high voltage parameters (energy, elevation), controls the channeltron HV-supply and computes the plasma parameters. In the parameter mode only the sums of the rows and columns of the sampled ion and ion-current arrays are transmitted. The controller is based on a RTX2010. Address decoder, reset logic, clock generators, control signals generator, watchdog logic and CDMS interface are integrated within a FPGA. Hard- and software are developed by the IWF Graz.
The required recourses of the complete experiment are given in the following table. The mass of the instrument electronics is marked grew.

recourses	*experiment part*	*recourse requirement*	*Σ*
mass	MAG sensor	40g	
	SPM sensor	120g	
	Pressure sensor	110g	
	boom + hinge + cable	80g	
	launch lock	40g	
	pressure harness	50g	
	electronics in CEB (interface, analogue, controller, HV-box, connectors, frontplate)	360g	
	Pressure E-Box	130g	930g
power	sensor electronics	350...550mW	
	controller	180mW	
	penning electronics	100mW	
	pirani electronics	50mW	
	HV-part	200mW	<900mW
telemetry rate	surface mode MAG SPM	 70 bits/s 30 bits/s	 80 bits/s
	slow mode MAG	 70 bits/s	 68 bits/s
	fast mode MAG	 4400 bits/s	 4369 bits/s

2.2 MAG Measurement Algorithm



At power-up, the ROMAP-Controller switches on the clock for MAG and disables the reset line. At the beginning of a measurement, it programs the phase (valid for X-, Y- and Z-component) and the MAG internal averaging value, which depends on the data rate.

If MAG is working in the FAST or SLOW mode, the excitation is switched on continuously, in SURFACE mode it is only enabled during MAG vector sampling for reducing the power consumption.

After MAG has released an interrupt (sampling finished), the Controller reads three 24-bit values representing the three magnetic field components. After this the feedback values for X, Y and Z are computed and then programmed at the X-, Y- and Z-DACs (rounded to 12 bit accuracy).

$U(n)_{X,Y,Z} = U(n-1)_{X,Y,Z} + Y(n)_{X,Y,Z} / G1_{X,Y,Z}$

U .. computed component feedback value (signed 16bit value)
Y .. measured component value (signed 32bit value)
G1.. coefficient (signed 16bit value)

Then the magnetic field components are computed:

$U'(n)_{X,Y,Z} = U(n-1)_{X,Y,Z} * G1_{X,Y,Z} + Y(n)_{X,Y,Z}$

U' .. computed component value (32 bit)
U .. computed component feedback value (16 bit)
Y .. measured component value (32 bit)
G1.. coefficient (signed 16bit)

The computed component values are rounded to 21 bit accuracy and then packed into one 64 bit wide field, which represents a magnetic field vector.

2.3 SPM Measurement Algorithm

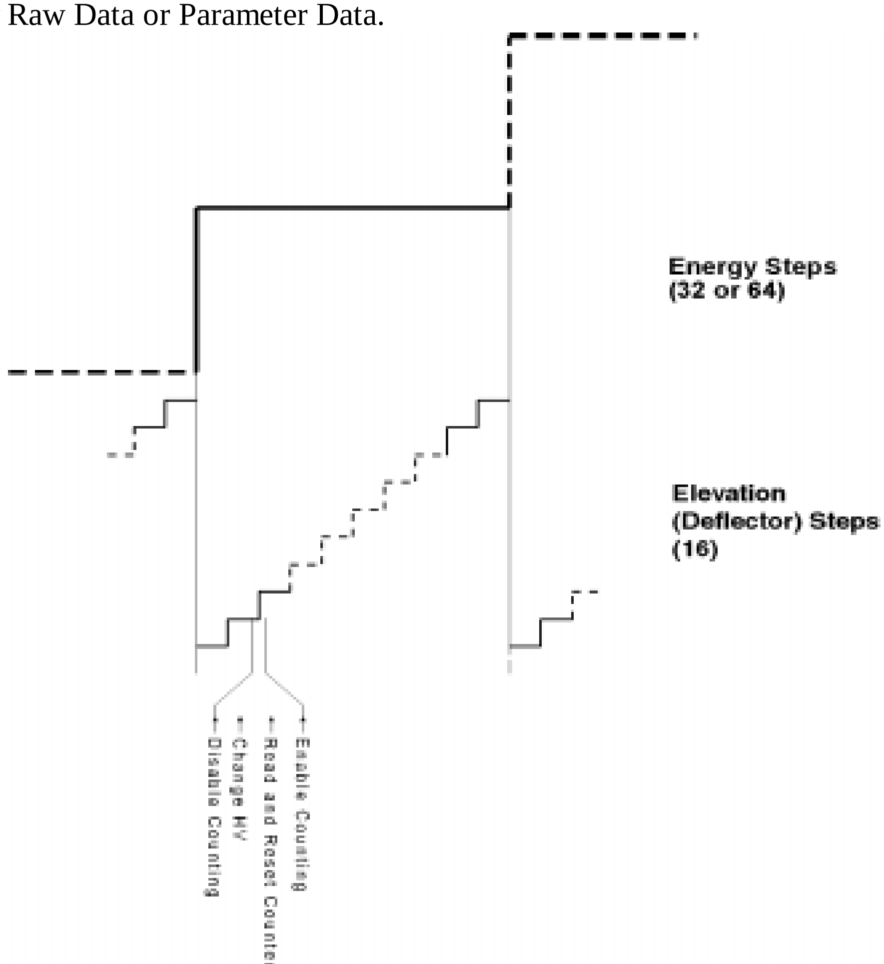
The ROMAP-Controller programs energy and elevation steps via DACs and counts electrons and ions. The Controller sets an energy step and at this energy step the different deflector voltages (elevations) are programmed. The deflector step width is defined by the **exposition time**. Two different types of data are generated by the SPM instrument, which differ in the kind of data that is transmitted; the sampling procedure is the same.

2.3.1 Raw Data:

Counts for the two ion channels and one electron channel are sampled in the specified mode via the counters integrated by the ROMAP-Controller.
The two ion current values (8bit resolution) and the Faraday Cup voltage (16bit resolution) are sampled via the MAG ADC:
Ion current sampling:
The ion currents are sampled once at the beginning of the exposition time at each deflector step.
Faraday Cup sampling:
When sampling ions, one sample is taken at each positive maximum deflector step. When sampling electrons, one sample is taken at the first energy step, one at the middle.
The sampled data of one measurement cycle for the ion and ion-current channels are held in arrays (energy•elevation) in the ROMAP-Controller RAM.
After sampling for one measurement cycle is finished, data is packet into a specific amount of science data frames and transmitted via the CDMS interface.
For reducing the data amount, even and odd energies of both ion and ion-current channels can be transmitted alternating in consecutive Raw Data measurement cycles (at one measurement cycle the even energies of one ion channel and the odd energies of the other ion channel are transmitted and at the next measurement cycle vice versa). This is the default setting for SPM.
But also a full transmission of all energies can be selected. In this case for one cycle all data of one ion channel is transmitted and at the next cycle all of the other.
If one ion channel fails, it can be faded out from transmission (although it is sampled!), if both ion channels fail, both can be faded out. In this case only electron data is transmitted (counts and corresponding Faraday Cup data). No Parameter Data is generated in this case. The data amount for electrons is small compared to the amount of ion data and can therefore not be faded out from transmission in case of malfunction.
After preparing and transmitting all data frames, a new measurement cycle is started.

2.3.2 Parameter Data:

Raw Data is sampled in the specified mode. For reducing the amount of data to transmit, only the sums of the rows and columns of the sampled ion and ion-current arrays are transmitted. The sampling procedure is the same as for Raw Data transmission. If sampling is finished, the sums are computed.
Because of the multitasking mechanism of the ROMAP-Controller, a 50ms time slice is available for SPM every 100ms. The sum of one row or column is computed during one time slice. Only 16bit (ion counts) and 8bit (ion currents) long sums are transmitted, therefore overflow flags are contained in the data frame of detecting range overflows. Furthermore the maximum and the position of the maximum of the ion and ion current arrays are transmitted. The counts for electrons and the Faraday Cup data for ions and electrons are fully transmitted.
After all data frames are transmitted, a new measurement cycle is started.
ROMAP can be programmed to transmit Raw Data and Parameter Data (ratio 1:10 or 1:20) or only Raw Data or Parameter Data.



2.3.3 SPM Sampling Modes

SPM sampling can be performed in low or high resolution mode and in short or long exposition time mode. Any combination is selectable.

a) Resolution Modes

Low Resolution Mode:
32 energy steps and 16 deflector steps for each energy step, which gives 512 steps together, are used in this mode for ions. During sampling ions, the *ion exposition time* is used. Ion currents and the Faraday Cup voltage are sampled as described above.
For sampling electron counts 32 energy steps are applied. During sampling electrons, the *electron exposition time* is used. The Faraday Cup voltage is sampled as described above. During sampling electrons, the deflector HV is set to zero for avoiding disturbances.

High Resolution Mode:
64 energy steps and 16 deflector steps for each energy step, which gives 1024 steps together, are used in this mode for ions. During sampling ions, the *ion exposition time* is used. Ion currents and the Faraday Cup voltage are sampled as described above.
For sampling electron counts 64 energy steps are applied. During sampling electrons, the *electron exposition time* is used. The Faraday Cup voltage is sampled as described above. During sampling electrons, the deflector HV is set to zero for avoiding disturbances.

b) Exposition Time Modes

Two different gate times for the counters are implemented in the ROMAP-Controller FPGA (7.8125ms and 40ms), but only the 40ms exposition time is used. If exposition times of more than 40ms are requested, it must be a multiple of 40ms. In this case the gate of the counter is opened multiple times without resetting the counter. Because of the multitasking mechanism of the ROMAP-Controller, a 50ms time slice is available for SPM every 100ms. The gate for the counters is opened only once during one time slice.

Resulting Sample Times:

Exposition Time [ms]	Sample Time [ms]
7.8125 (not used)	100
40	100
200	500 (5*40ms)
1000	2500 (25*40ms)

Short Exposition Time Mode
The following exposition times are applied:
Ion exposition time: 40ms
Electron exposition time: 200ms (5 * 40ms)

Long Exposition Time Mode

The following exposition times are applied:
Ion exposition time: 200ms (5 * 40ms)
Electron exposition time: 1000ms (25 * 40ms)

For SPM any combination of resolution mode and exposition time mode for Raw Data and Parameter Data is selectable separately. Furthermore the ration Raw Data transmission : Parameter Data transmission can be selected between 1:10 and 1:20.

2.3.4 SPM Default Setting

Ion channel 1,2 and ion currents: on
Electron channel: on (always on)
CEM setting: 2
Raw Data + Parameter Data generated
Raw Data: high resolution, long exposition time
Parameter Data: high resolution, long exposition time
Raw Data : Parameter Data 1:10
This configuration is only used, if a Surface-Mode telecommand with an invalid SPM setup is received.

2.3.5 Calibration Mode

For detecting the ageing effects on the CEMs, a calibration mode is implemented for SPM. If the instrument is commanded to enter SPM calibration, five measurement cycles with the following setup are initiated:

Ion channel 1,2 and ion currents: on
Electron channel: on (always on)
CEM setting: cycling 1-5

Only Parameter Data is generated with low resolution and short exposition time mode
If these cycles are finished, SPM enters the mode that is selected in the telecommand that initiates calibration mode.
After analysing calibration data on ground, the ageing of the CEMs can be determined an a new setting for the CEM supply HV can be selected.

2.3.6 High Voltage Switching Requirements

a) Primary HV: 0 .. 2.4kV (3.5kV)
This voltage is used to supply the channeltrons (CEMs) and can be programmed via DAC (0..4V output voltage).

Because of ageing effects in the CEMs this voltage must set to higher levels during the ongoing mission. The necessary high voltage level (one out of 5 available) is detected after analysing SPM calibration cycle data on ground. The current working level of the HV is selectable via telecommand.
For security reasons, after the instrument is switched on the voltage level is set to zero, then it is increased in 8 steps until it reaches it's current working level.

b) Deflector HV: ± 2.2kV
This voltage is used to set the elevation steps. The controlling DAC is programmed via the MAG interface (+/- 2V output voltage).

c) Analyser HV: 0 .. 1.5 kV
This voltage is used to set the energy steps. The controlling DAC is programmed via the MAG interface (0..4V output voltage)
.
The ***SPM Range Bit*** for the HV is used to increase the resolution for the Deflector and the Analyser HV. The Range Bit is cleared for the first half of the energy steps, for the second half it is set.

When changing voltage levels for the energy or elevation HV, a ***transient time*** of 10..20ms is needed for the HV supply to settle at the new level. The ROMAP-Controller guarantees a time period of at least 50 ms between setting a new HV step and opening the gate of the counters (and sampling of the Faraday Cup and the ion currents).

2.3.7 Switching On Procedure for the SPM High Voltage:

After selecting a Surface Mode via telecommand, the HV is switched on during the SPM initialisation phase.
First the ROMAP-Controller resets all DACs for producing a HV zero level, then it waits for 30 seconds. Then the HV is switched on by setting the HV-ON signal. The HV supply needs around 1 second to come up. After this the primary HV is increased to the working level that is given in the telecommand in 8 steps (the working level is divided by 8 to compute the step amplitude, then the voltage is increased by these steps, each voltage step is 1 second long). After the working level is reached, the HV has one additional second to stabilise.

2.3.8 HV Security Mechanisms:

The Primary HV is limited to a few hundred volts during ground tests. This is done by grounding a specific point inside the HV cascade (by a red tagged item).

2.3.9 HV step tables:

Notes:
$V_{ref\ def1} = -\ V_{ref\ def2}$
$/V_{ref\ def\ max}/ = V_{ref\ an}/2$
$\Delta\ V_{ref\ def} = V_{ref\ def\ max}/15$

ions deflector electrons

N_{an}	N_{an}	E_i	V_{an_i}	R_{ange}	$V_{ref\_an\_i}$	$V_{ref\_def\_max}$	•V_{ref_def}	E_e	V_{an_e}	$V_{ref\_an\_e}$
“64”	“32”	eV	V		V	V (16 steps)	V	eV	V	V
0		38.6	4.83	LR	0.29	-0.145…+0.145	0.019	0.35	0.083	0.005
1	0	42.6	5.33	LR	0.32	-0.16… +0.16	0.021	0.42	0.100	0.006
2		46.6	5.83	LR	0.35	-0.175…+0.175	0.023	0.49	0.117	0.007
3	1	50.6	6.33	LR	0.38	-0.19… +0.19	0.025	0.56	0.133	0.008
4		54.6	6.83	LR	0.41	-0.205…+0.205	0.027	0.63	0.15	0.009
5	2	59.9	7.49	LR	0.45	-0.225…+0.225	0.03	0.70	0.17	0.01
6		65.3	8.16	LR	0.49	-0.245…+0.245	0.033	0.84	0.20	0.012
7	3	70.6	8.82	LR	0.53	-0.265…+0.265	0.035	0.98	0.23	0.014
8		77.3	9.66	LR	0.58	-0.29… +0.29	0.039	1.12	0.27	0.016
9	4	83.9	10.4	LR	0.63	-0.315…+0.315	0.042	1.30	0.31	0.0185
10		90.6	11.3	LR	0.68	-0.34… +0.34	0.045	1.47	0.35	0.021
11	5	98.6	12.3	LR	0.74	-0.37… +0.37	0.049	1.75	0.42	0.025
12		107	13.4	LR	0.81	-0.405…+0.405	0.054	2.03	0.48	0.029
13	6	117	14.6	LR	0.88	-0.44… +0.44	0.059	2.38	0.57	0.034
14		127	15.9	LR	0.96	-0.48… +0.48	0.064	2.74	0.65	0.039
15	7	138	17.3	LR	1.04	-0.52… +0.52	0.069	3.16	0.75	0.045
16		150	18.8	LR	1.13	-0.565…+0.565	0.075	3.72	0.88	0.053
17	8	163	20.4	LR	1.23	-0.615…+0.615	0.082	4.28	1.02	0.061
18		178	22.3	LR	1.34	-0.67… +067	0.089	4.98	1.18	0.071
19	9	194	24.3	LR	1.46	-0.73… +073	0.097	5.82	1.38	0.083
20		211	26.4	LR	1.59	-0.795…+0.795	0.106	6.73	1.60	0.096
21	10	230	28.8	LR	1.73	-0.865…+0.865	0.115	7.79	1.85	0.111
22		250	31.3	LR	1.88	-0.94… +0.94	0.125	9.05	2.15	0.129
23	11	271	33.9	LR	2.04	-1.02… +1.02	0.136	10.52	2.50	0.15
24		295	36.9	LR	2.22	-1.11… +1.11	0.148	12.27	2.92	0.175
25	12	321	40.1	LR	2.41	-1.205…+1.205	0.160	14.23	3.38	0.203
26		350	43.8	LR	2.63	-1.315…+1.315	0.175	16.55	3.93	0.236
27	13	381	47.6	LR	2.86	-1.43… +1.43	0.191	19.22	4.56	0.274
28		414	51.8	LR	3.11	-1.555…+1.555	0.207	22.30	5.30	0.318
29	14	450	56.3	LR	3.38	-1.69… +1.69	0.225	25.88	6.15	0.369
30		490	61.3	LR	3.68	-1.84… +1.84	0.245	30.09	7.15	0.429
31	15	533	66.7	LR	4.00	-2.00… +2.00	0.267	34.93	8.30	0.498
32		580	72.5	HR	0.29	-0.145…+0.145	1.933	41.05	9.75	0.039
33	16	640	80	HR	0.32	-0.16… +0.16	0.021	47.36	11.3	0.045
34		700	87.5	HR	0.35	-0.175…+0.175	0.023	54.73	13	0.052
35	17	760	95	HR	0.38	-0.19… +0.19	0.025	63.15	15	0.06
36		820	102	HR	0.41	-0.205…+0.205	0.027	73.68	17.5	0.07
37	18	900	112	HR	0.45	-0.225…+0.225	0.03	86.31	20.5	0.082
38		980	122	HR	0.49	-0.245…+0.245	0.033	99.99	23.7	0.095
39	19	1060	132	HR	0.53	-0.265…+0.265	0.035	116	27.5	0.11
40		1160	145	HR	0.58	-0.29… +0.29	0.039	135	32	0.128
41	20	1260	157	HR	0.63	-0.315…+0.315	0.042	156	37	0.148
42		1360	170	HR	0.68	-0.34… +0.34	0.045	181	43	0.172
43	21	1480	185	HR	0.74	-0.37… +0.37	0.049	211	50	0.2
44		1620	202	HR	0.81	-0.405…+0.405	0.054	245	58.2	0.233
45	22	1760	220	HR	0.88	-0.44… +0.44	0.059	284	67.5	0.27

46		1920	240	HR	0.96	-0.48… +048	0.064	330	78.5	0.314
47	23	2080	260	HR	1.04	-0.52… +0.52	0.069	383	91	0.364
48		2260	282.	HR	1.13	-0.565…+0.565	0.075	445	106	0.423
49	24	2460	307	HR	1.23	-0.615…+0.615	0.082	517	123	0.492
50		2680	335	HR	1.34	-0.67… +0.67	0.089	600	143	0.57
51	25	2920	365	HR	1.46	-0.73… +073	0.097	695	165	0.66
52		3180	397	HR	1.59	-0.795…+0.795	0.106	810	193	0.77
53	26	3460	432	HR	1.73	-0.865…+0.865	0.115	937	223	0.89
54		3760	470	HR	1.88	-0.94… +0.94	0.125	1095	260	1.04
55	27	4080	510	HR	2.04	-1.02… +1.02	0.136	1274	303	1.21
56		4440	555	HR	2.22	-1.11… +1.11	0.148	1474	350	1.4
57	28	4820	602	HR	2.41	-1.205…+1.205	0.160	1716	408	1.63
58		5260	657	HR	2.63	-1.315…+1.315	0.175	1989	473	1.89
59	29	5720	715	HR	2.86	-1.43… +1.43	0.191	2316	550	2.2
60		6220	777	HR	3.11	-1.555…+1.555	0.207	2684	638	2.55
61	30	6760	845	HR	3.38	-1.69… +1.69	0.225	3115	740	2.96
62		7360	920	HR	3.68	-1.84… +1.84	0.245	3621	860	3.44
63	31	8000	1000	HR	4.00	-2.00… +2.00	0.267	4210	1000	4.00

HV Step Tables (implemented values):

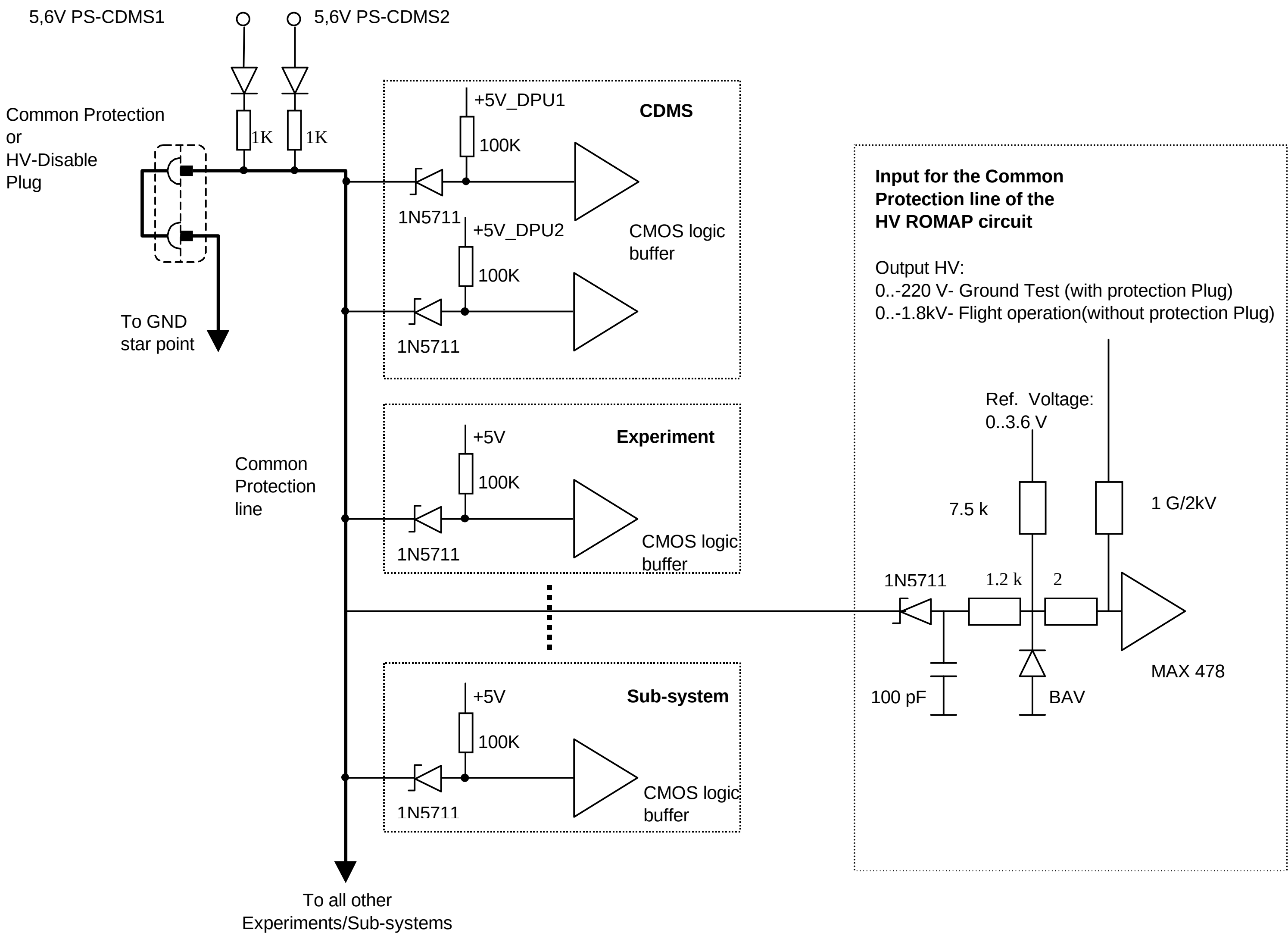
DAC Resolution: 4095

DAC Range [V]: 4,00

Step #	***DAC Voltage [V] (Analyser Ions)***	***DAC Setting (hex)***	***DAC Voltage [V] (Deflector)***	***DAC Setting (hex)***	***DAC Voltage [V] (Analyer Electrons)***	***DAC Setting (hex)***	***DAC Voltage [V] (CEM Supply)***	***DAC Setting (hex)***
0	0,29	0128	-2,000	0000	0,005	0005	2,600	0A65
1	0,32	0147	-1,733	0111	0,006	0006	2,850	0B65
2	0,35	0166	-1,467	0222	0,007	0007	3,100	0C65
3	0,38	0185	-1,200	0333	0,008	0008	3,350	0D65
4	0,41	01A3	-0,933	0444	0,009	0009	3,600	0E65
5	0,45	01CC	-0,667	0555	0,010	000A		
6	0,49	01F5	-0,400	0666	0,012	000C		
7	0,53	021E	-0,133	0777	0,014	000E		
8	0,58	0251	0,133	0887	0,016	0010		
9	0,63	0284	0,400	0999	0,0185	0012		
10	0,68	02B8	0,667	0AA9	0,021	0015		
11	0,74	02F5	0,933	0BBA	0,025	0019		
12	0,81	033D	1,200	0CCC	0,029	001D		
13	0,88	0384	1,467	0DDC	0,034	0022		
14	0,96	03D6	1,733	0EED	0,039	0027		
15	1,04	0428	2,000	0FFF	0,045	002E		
16	1,13	0484			0,053	0036		
17	1,23	04EB			0,061	003E		
18	1,34	055B			0,071	0048		
19	1,46	05D6			0,083	0054		
20	1,59	065B			0,096	0062		
21	1,73	06EB			0,111	0071		
22	1,88	0784			0,129	0084		
23	2,04	0828			0,150	0099		
24	2,22	08E0			0,175	00B3		

25	2,41	09A3			0,203	00CF		
26	2,63	0A84			0,236	00F1		
27	2,86	0B6F			0,274	0118		
28	3,11	0C6F			0,318	0145		
29	3,38	0D84			0,369	0179		
30	3,68	0EB7			0,429	01B7		
31	4,00	0FFF			0,498	01FD		
32					0,039	0027		
33					0,045	002E		
34					0,052	0035		
35					0,060	003D		
36					0,070	0047		
37					0,082	0053		
38					0,095	0061		
39					0,110	0070		
40					0,128	0083		
41					0,148	0097		
42					0,172	00B0		
43					0,200	00CC		
44					0,233	00EE		
45					0,270	0114		
46					0,314	0141		
47					0,364	0174		
48					0,423	01B1		
49					0,492	01F7		
50					0,570	0247		
51					0,660	02A3		
52					0,770	0314		
53					0,890	038F		
54					1,040	0428		
55					1,210	04D6		
56					1,400	0599		
57					1,630	0684		
58					1,890	078E		
59					2,200	08CC		
60					2,550	0A32		
61					2,960	0BD6		
62					3,440	0DC1		
63					4,000	0FFF		

2.3.10 HV Protection Circuit



2.3.11 SPM Data Volume, Cycle Times and Data Rates

The following tables are showing the data volume and the data rates produced by SPM in the different working modes.
The calculations are assuming a data frame length of 256 bytes (128 words), where 244 bytes can be used for containing data, the remaining 12 bytes per data frame are occupied by the frame header information.

Raw Data:
It is assumed that both ion channels are sampled, which is the case if there is no malfunction in one of the channels. For reducing the data volume for the raw data, even and odd energies are transmitted alternating for the different raw data cycles.
If there is a fault in one ion channel, this channel can be faded out from transmission. In this case the other channel is transmitted.
If ROMAP transmits SPM raw data, the Faraday Cup samples belonging to the ion channels are transmitted redundantly with each separate ion channel.
If there is a fault in both ion channels, only the electron channel and the corresponding Faraday Cup samples are transmitted. Only raw data frames containing the electron data are generated in this case.

Parameter Data:
For making the parameter data transmission as compact as possible, the samples of one cycle containing both ion channels and ion current channels, the electron channel and the corresponding Faraday Cup samples is transmitted within three 128 word data frames. The composition of the parameter data frames is always the same, regardless whether one ion channel is faulty or not. If there is a malfunction in both ion channels, electron data is transmitted in raw data frames and no Parameter Data frames are generated.
If raw data and parameter data frames are enabled, the ratio can be selected to be either 1:10 or 1:20.

ROMAP-SPM: Data Volume per Measurement Cycle

Frame Size [bytes] 256

Data Area in Frame [bytes] 244

a) Raw Data

	High Res. Mode	Low Res. Mode
Ion Channel:		
Energy Steps	64	32
Elevation Steps	16	16
Data Size [bytes]	2	2
Data Amount [bytes]	2048	1024
Even/Odd Energy Reduction	2	2
Data Amount Even/Odd [bytes]	1024	512
Ion Current Channel:		
Energy Steps	64	32
Elevation Steps	16	16
Data Size [bytes]	1	1
Data Amount [bytes]	1024	512
Even/Odd Energy Reduction	2	2
Data Amount Even/Odd [bytes]	512	256
Faraday Cup Channel (Ions):		
Samples	64	32
Data Size [bytes]	2	2
Data Amount [bytes]	128	64
Data Amount Ions (Ion Counts, Ion Current, Faraday Cup):		
# Data Frames per ion channel (even or odd)	7	4
# Data Frames Ion Channel 1&2 (even or odd)	**14**	**8**
# Data Frames for one full ion channel	**14**	**7**
Electrons Channel:		
Energy Steps	64	32
Data Size [bytes]	2	2
Data Amount [bytes]	128	64
Faraday Cup Channel (Electrons):		
Samples	2	2
Data Size [bytes]	2	2
Data Amount [bytes]	4	4
Data Amount Electrons (Electron Counts, Faraday Cup):		
# Data Frames	**1**	**1**
Data Amount Ions + Electrons		
# Data Frames (even /odd ion data transmission	**15**	**9**
# Data Frames (one full ion channel)	**15**	**8**
# Data Bytes (even /odd ion data transmission)	**3840**	**2304**
# Data Bytes (one full ion channel)	**3840**	**2048**

b) Parameter Data

	High Res. Mode	Low Res. Mode
Ion Channel:		
Energy Steps	64	32
Elevation Steps	16	16
Data Size [bytes]	2	2
Overflow Flags	10	6
Maximum and Position	4	4
Data Amount [bytes]	174	106
Ion Current Channel:		
Energy Steps	64	32
Elevation Steps	16	16
Data Size [bytes]	1	1
Overflow Flags	10	6
Maximum and Position	4	4
Data Amount [bytes]	94	58
Faraday Cup Channel:		
Samples (every 2nd transmitted)	64	32
Data Size [bytes]	2	2
Data Amount [bytes]	64	32
Electron Channel:		
Energy Steps	64	32
Data Size [bytes]	2	2
Data Amount [bytes]	128	64
Faraday Cup Channel:		
Samples	2	2
Data Size [bytes]	2	2
Data Amount [bytes]	4	4
Data Amount Ions + Electrons (2*ion counts, 2*ion currents, FC, electron counts, FC):		
# Data Frames	**3**	**2**
# Data Bytes	**768**	**512**

ROMAP-SPM: Measurement Cycle Times

Time for taking one 7.8125 ms samples [s]	0.1
Time for taking one 40 ms sample [s]	0.1
Time for taking one 200 ms sample [s]	0.5
Time for taking one 1000 ms sample [s]	2.5

a) High Resolution Mode

Short Exposition Time Mode:

Ions:

		Time [s]
Elevation Steps	16	
Energy Steps with 7,8125ms Exp. Time	0	**0**
Energy Steps with 40ms Exp. Time	64	**102.4**
Energy Steps Total	64	**102.4**

Electrons:

		Time [s]
Energy Steps with 40ms Exp. Time	0	**0**
Energy Steps with 200ms Exp. Time	64	**32**
Energy Steps Total	64	**32**

Cycle Time Ions + Electrons [s] **134.4**

Long Exposition Time Mode:

Ions:

		Time [s]
Elevation Steps	16	
Energy Steps with 40ms Exp. Time	0	**0**
Energy Steps with 200ms Exp. Time	64	**512**
Energy Steps Total	64	**512**

Electrons:

		Time [s]
Energy Steps with 200ms Exp. Time	0	**0**
Energy Steps with 1000ms Exp. Time	64	**160**
Energy Steps Total	64	**160**

Cycle Time Ions + Electrons [s] **672**

Parameter Data Computation Time **32**

b) Low Resolution Mode

Short Exposition Time Mode:

Ions:

		Time [s]
Elevation Steps	16	
Energy Steps with 7,8125ms Exp. Time	0	**0**
Energy Steps with 40ms Exp. Time	32	**51.2**
Energy Steps Total	32	**51.2**

Electrons:

		Time [s]
Energy Steps with 40ms Exp. Time	0	**0**
Energy Steps with 200ms Exp. Time	32	**16**
Energy Steps Total	32	**16**

Cycle Time Ions + Electrons [s] **67.2**

Long Exposition Time Mode:

Ions:

		Time [s]
Elevation Steps	16	
Energy Steps with 40ms Exp. Time	0	**0**
Energy Steps with 200ms Exp. Time	32	**256**
Energy Steps Total	32	**256**

Electrons:

		Time [s]
Energy Steps with 200ms Exp. Time	0	**0**
Energy Steps with 1000ms Exp. Time	32	**80**
Energy Steps Total	32	**80**

Cycle Time Ions + Electrons [s] **336**

Parameter Data Computation Time **19.20**

a) High Resolution Mode

Short Exposition Time Mode:

	# Frames	Cycle Time [s]	Data Rate [bit/s]
Raw Data (alternating even/odd tran	15	134.40	**228.57**
Raw Data (full transmission)	15	134.40	**228.57**
Parameter Data	3	166.40	**36.92**

Long Exposition Time Mode:

	# Frames	Cycle Time [s]	Data Rate [bit/s]
Raw Data (alternating even/odd tran	15	672.00	**45.71**
Raw Data (full transmission)	15	672.00	**45.71**
Parameter Data	3	704.00	**8.73**

a) Low Resolution Mode

Short Exposition Time Mode:

	# Frames	Cycle Time [s]	Data Rate [bit/s]
Raw Data (alternating even/odd tran	9	67.20	**274.29**
Raw Data (full transmission)	8	67.20	**243.81**
Parameter Data	2	86.40	**47.41**

Long Exposition Time Mode:

	# Frames	Cycle Time [s]	Data Rate [bit/s]
Raw Data (alternating even/odd tran	9	336.00	**54.86**
Raw Data (full transmission)	8	336.00	**48.76**
Parameter Data	2	355.20	**11.53**

ROMAP-SPM: Available Data Rates

(valid for alternating even/odd Raw Data transmission and Parameter Data transmission)

Raw Data:				**Parameter Data:**					**Total:**		
Resolution	*#Frames*	*Exp. Time*	*Cycle Time[s]*	*Resolution*	*#Frames*	*Exp. Time*	*Cycle Time[s]*	*Ratio R:P = 1:*	*Cycle Time [min]*	*Data Amount [bytes]*	*Data Rate [bits/s]*
low	9	short	67.20	low	2	short	86.40	10	15.52	7424	**63.78**
low	9	short	67.20	low	2	long	355.20	10	60.32	7424	**16.41**
low	9	short	67.20	high	3	short	166.40	10	28.85	9984	**46.14**
low	9	short	67.20	high	3	long	704.00	10	118.45	9984	**11.24**
low	9	long	336.00	low	2	short	86.40	10	20.00	7424	**49.49**
low	9	long	336.00	low	2	long	355.20	10	64.80	7424	**15.28**
low	9	long	336.00	high	3	short	166.40	10	33.33	9984	**39.94**
low	9	long	336.00	high	3	long	704.00	10	122.93	9984	**10.83**
high	15	short	134.40	low	2	short	86.40	10	16.64	8960	**71.79**
high	15	short	134.40	low	2	long	355.20	10	61.44	8960	**19.44**
high	15	short	134.40	high	3	short	166.40	10	29.97	11520	**51.25**
high	15	short	134.40	high	3	long	704.00	10	119.57	11520	**12.85**
high	15	long	672.00	low	2	short	86.40	10	25.60	8960	**46.67**
high	15	long	672.00	low	2	long	355.20	10	70.40	8960	**16.97**
high	15	long	672.00	high	3	short	166.40	10	38.93	11520	**39.45**
high	***15***	***long***	***672.00***	***high***	***3***	***long***	***704.00***	***10***	***128.53***	***11520***	***11.95***
low	9	short	67.20	low	2	short	86.40	20	29.92	12544	**55.90**
low	9	short	67.20	low	2	long	355.20	20	119.52	12544	**13.99**
low	9	short	67.20	high	3	short	166.40	20	56.59	17664	**41.62**
low	9	short	67.20	high	3	long	704.00	20	235.79	17664	**9.99**
low	9	long	336.00	low	2	short	86.40	20	34.40	12544	**48.62**
low	9	long	336.00	low	2	long	355.20	20	124.00	12544	**13.49**
low	9	long	336.00	high	3	short	166.40	20	61.07	17664	**38.57**
low	9	long	336.00	high	3	long	704.00	20	240.27	17664	**9.80**
high	15	short	134.40	low	2	short	86.40	20	31.04	14080	**60.48**
high	15	short	134.40	low	2	long	355.20	20	120.64	14080	**15.56**
high	15	short	134.40	high	3	short	166.40	20	57.71	19200	**44.36**
high	15	short	134.40	high	3	long	704.00	20	236.91	19200	**10.81**
high	15	long	672.00	low	2	short	86.40	20	40.00	14080	**46.93**
high	15	long	672.00	low	2	long	355.20	20	129.60	14080	**14.49**
high	15	long	672.00	high	3	short	166.40	20	66.67	19200	**38.40**
high	15	long	672.00	high	3	long	704.00	20	245.87	19200	**10.41**

2.4 The ROMAP Controller

The ROMAP-Controller controls MAG and SPM, stores their data output and implements the interface to the ROSETTA Lander CDMS (Command and Data Management System).

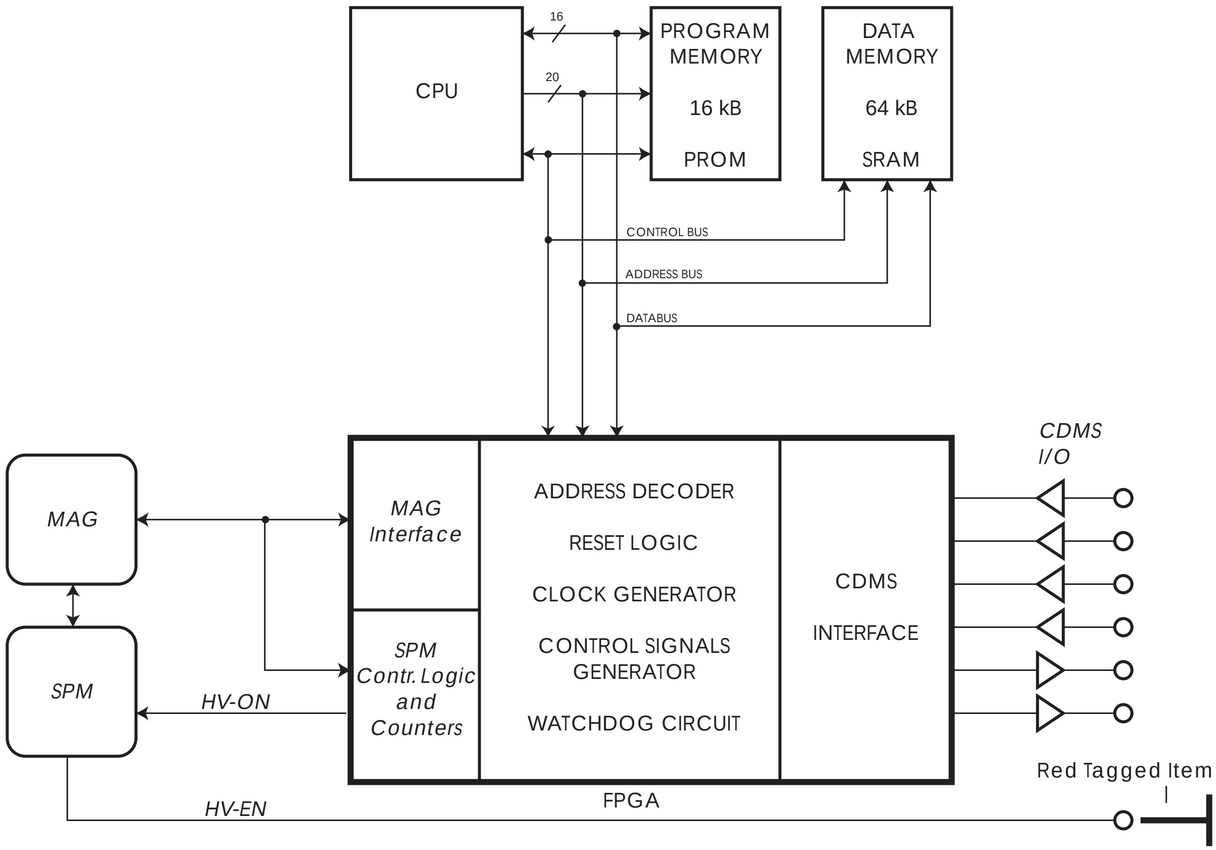
2.4.1 Tasks of the controller

ROMAP-MAG:
start measurement cycle
implement the digital magnetometer algorithm
control the magnetometer feedback via DACs
store data output of the magnetometer and generate data frames
ROMAP-SPM:
implement counting logic for electrons and ions
sample ion current data and the Faraday Cup voltage via the MAG ADC
store SPM output and generate data frames
control the high voltage parameters for the SPM sensor (energy, elevation) via DACs
control the channeltron HV supply (primary HV) via DAC
switch on the high-voltage supply for the SPM sensor
compute plasma parameters
CDMS:
implement redundant intelligent interface to CDMS
transmit stored data of MAG and SPM to CMDS
save and recall various settings in CDMS Backup RAM
receive commands from CDMS and execute them
transmit housekeeping and status words to CDMS on periodic requests

2.4.2 Controller Hardware

The ROMAP-Controller consists of five main hardware blocks (see Figure)

CPU: RTX2010 micro-controller at a clock frequency of 921600 Hz
RAM: 64kB static RAM
PROM: 16kB one time programmable PROM
FPGA: Actel RH1280 that integrates
address decoder, reset logic, clock generators, control signals generator
watchdog logic
MAG interface
SPM counters and controlling logic
redundant CDMS Interface
CDMS transmitter and receiver circuit (CD4050B)



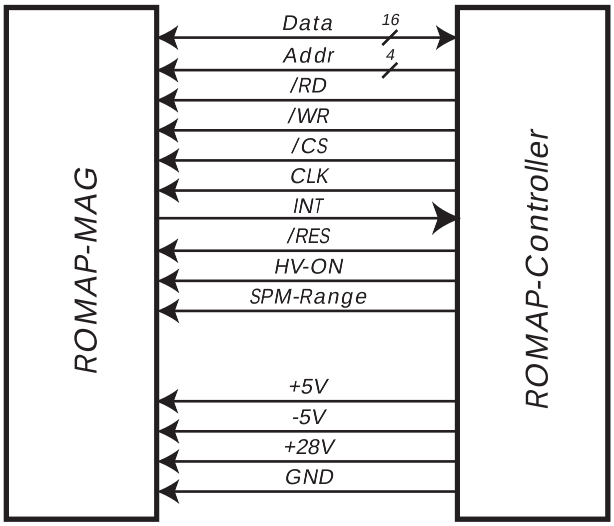
2.4.3 Instrument Power-Up Procedure

After the processor reset cycle is finished, all significant variables are reset. Then the CDMS telemetry buffer is flushed for avoiding incomplete frame transmissions. After this the Controller waits for the MAG-ADC reset cycle to finish (3 seconds). Then the TC-Buffer area that holds initialisation data is read and the received data is processed. Then all housekeeping channels are sampled and the pressure values and the pressure electronics temperature are stored to CDMS Backup RAM. The whole power-up procedure takes around 5 seconds.
Finally the ROMAP starts working in either the instrument mode is has received from the TC-Buffer or in it's default instrument mode (SLOW mode).

2.4.4 Controller-MAG Interface:

The interface to ROMAP-MAG lies in the memory map of the ROMAP-Controller at a defined. address. MAG is addressed more or less like a memory chip with 4 address lines and requests service via the interrupt (INT) line.

Parts of the SPM interface are also implemented by ROMAP-MAG. The SPM DACs are programmed via the MAG interface and furthermore the ion current values, the Faraday Cup output and the SPM housekeeping values are sampled via the ROMAP-MAG ADC.



The different interface lines to ROMAP-MAG have the following meaning:

Line	Meaning
Data	16 bit bi-directional data bus to/from the MAG interface
Addr	4 bit address bus to the MAG interface
/RD	read line for the MAG interface, low active! (/LOE)
/WR	write line for the MAG interface, low active! (/LWE)
/CS	select line for the MAG interface, low active!
CLK	clock line for the MAG instrument, 1,8432 MHz
INT	interrupt line from the MAG interface, high active! automatically cleared with reading of Z-component
/RES	reset line to the MAG interface, low active!
SPM Range	range selection line for the SPM instrument
HV-ON	for switching on the high voltage for the SPM sensor

All possible actions of the MAG interface are released by writing or reading the sixteen available addresses of the interface.

Address	Read Access	Write Access
0	read low word of X component or housekeeping word (also resets MAG interrupt)	MAG phase (lower 8 bits)
1	read high word of X component	MAG internal averaging (lower 8 bits)
2	read low word of Y component	start vector sampling (dummy data)
3	read high word of Y component	excitation on/off (set/reset bit 0)
4	read low word of Z component	start HK sampling (dummy data)

5	read high word of Z component	set DAC (DAC address in lower 3 bits)
6	not used	pressure measurement control
7	not used	set HK channel to sample (MUX address in lower 4 bits)
8 .. 15	not used	not used

Excitation on/off:

Bit 0	Meaning
0	switch excitation off
1	switch excitation on

MAG Internal Averaging:

lower 8 bit value	Averaging Value
4	32
5	64
6	128
7	256

Pressure Measurement Control:

Bit	Setting	Meaning
0	0	switch Penning Sensor OFF
	1	switch Penning Sensor ON
1	0	switch Pirani Sensor OFF
	1	switch Pirani Sensor ON
4	1	enable for switching Penning Sensor ON/OFF
5	1	enable for switching Pirani Sensor ON/OFF

The control outputs for switching the Penning/Pirani pressure sensors on/off are generated by the MAG-FPGA. The MAG-FPGA outputs are controlled by a write access to address 6

MAG ADC Muliplexer Layout:

Value	Multiplexer Channel
0	SPM ion current 1 (only MSB used!)
1	SPM ion current 2 (only MSB used!)
2	SPM Faraday Cup voltage
3	HK overall instrument power consumption
4	HK +5V current
5	HK –5V current
6	HK electronics temperature
7	HK +28V current
8	HK SPM HV status 1
9	HK SPM HV status 2
10	HK SPM HV status 3
11	HK SPM HV status 4
12	HK Penning pressure
13	HK Pirani pressure
14	pressure electronics temperature
15	spare

Housekeeping Data Sampling:

When the ROMAP-Controller starts sampling of housekeeping values, it passes a multiplexer address to MAG to select a specific HK-channel (mux. address 3 .. 14). Then it starts sampling by write access to address 7. After sampling of the HK-channel is finished, MAG activates the interrupt line and the ROMAP-Controller reads the 16-bit data word (non-averaged data) from the interface. The interrupt line is automatically cleared with the read access.

MAG DAC Channels:

ROMAP-MAG and SPM both use 12-bit DACs that are programmed via the MAG interface.
The DACs are programmed by writing a data word to the MAG DAC register. The lower 3 bits contain the DAC address. Bit 3 is unused. Bits 4-15 contain the DAC word.

Bit 2	Bit 1	Bit 0	Addressed DAC
0	0	0	MAG X-Channel
0	0	1	MAG Y-Channel
0	1	0	MAG Z-Channel
0	1	1	SPM Analyser HV control (0..4V output)
1	0	0	SPM Primary HV control (0..4V output)
1	0	1	SPM Deflector HV control (+/- 2V output)
1	1	0	dummy
1	1	1	dummy

2.4.5 Controller-SPM Interface

ROMAP-SPM integrates one electron channeltron and two ion channeltrons which deliver pulses (rate < 1 MHz) representing electrons and ion rates. For detecting saturations of the ion channeltrons in case of high pulse rates, ion currents for both ion channels are separately sampled via the MAG ADC in 8bit resolution. Furthermore a Faraday Cup sensor is implemented, which integrates all ions with a high field of view and provides the integration of the solar wind flux. The Faraday Cup output voltage is also sampled via the MAG ADC in 16bit resolution.

The ROMAP-Controller implements one 16 bit counter for counting electrons and two 16 bit counters for counting ions. Two different counter gate times can be selected (7.8125ms and 40ms).

The ROMAP-Controller is responsible for switching ON/OFF the SPM high voltage and furthermore the Controller programs DACs for setting the energy steps, the deflector voltage and the channeltron supply. The programming of the DACs is done via the ROMAP-MAG interface. The ROMAP-MAG interface also delivers the five housekeeping values for status of the high voltages of SPM.

3 Mechanical Interface

3.1 Experiment Structural Design and Analysis

The electronics for the Magnetometer, for SPM the controller and the interface board are integrated on standard boards in the common electronics box with a overall height of 4.3cm (see Figure). For the HV generation and its control a small box will be mounted directly on the top of ROMAP slot in the common electronics box .

3.2 Measurement Results

Mass: g (including saver)
Dimensions:
Cover plate – End of boards: mm
Interface board – Controller mm
Interface board – Analogue board mm

3.3 Material List

Materials list HV box:
aluminium AlZnMgCu 1.5 15g

Materials list electronics:
The EEE Part List is given in the Appendix 3. The components are either contained in the PPL or are already used on previous missions (EQUATOR-S). For the boards the following materials will be used:

Material Identification	Application	Amount	Processing
Glas-epoxy FR-4	printed circuit board multilayer	magn. board - 120cm² / 22g contr. board - 120cm² / 22g HV box - 50cm² / 8g	
Solder Soft, flux R Sn60Pb40	soldering pretinning degolding	25g	
Titan	screws distance pieces	20g	
Vespel	harness fixing	10g	
tbd	coating		

All mechanical parts are processed in well selected, space approved companies.

3.4 Experiment Mass

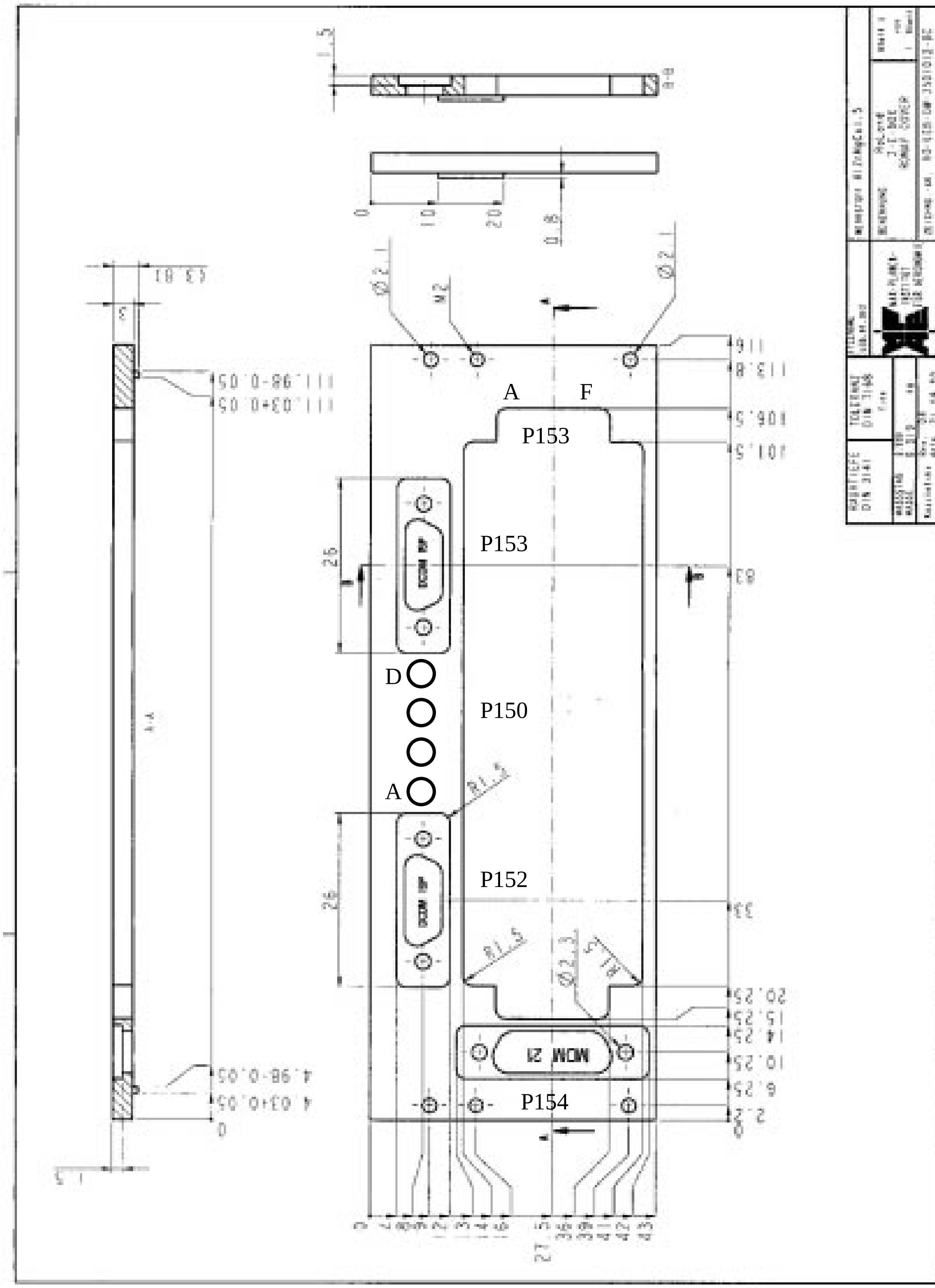
Overall Dimensions and Weight

Experiment Unit	Mass (g)	Reliability of mass value	Dimensions wrt URF axes (mm)	Location required	Remarks
MAG sensor.	40g	B	sphere ∅4cm	cold	
SPM sensor	120g	B	110 x 120 x 80	cold	
Pressure sensor	110g	B		cold	
Electronics inside CEB	**360g**	**B**	**160 x 100 x 43**	**warm**	**interface, analogue and controller board + HV box (total)**
Pressure electronics	130g	C		warm	
Mag harness	25g	B	1500 length	warm / cold	
Pres. harness	50g	B	1500 length	warm / cold	
boom	25g	B	600 x 25 x 25	cold	
hinge plate	30g	B	5 x 70 x 122	cold	
launch lock	40g	B	80 x 60 x 5	cold	
$\sum$	930g				

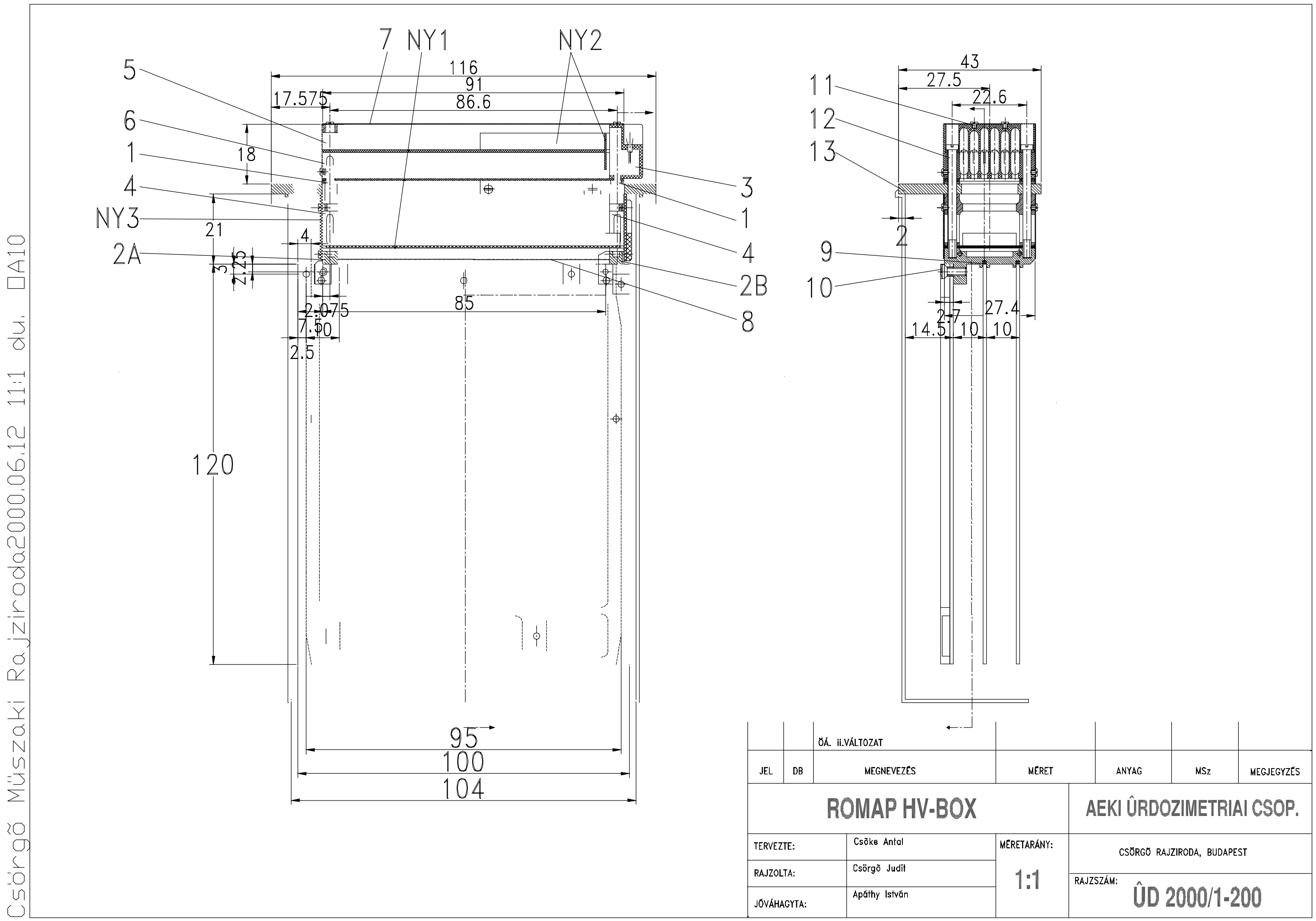
B mass of breadboard
C: careful mass analysis based on design and drawing
E: mass estimate

3.5 Mechanical Interface Drawings Romap Electronics

The ROMAP electronics consists as three boards (interface, analogue and controller board) inside the common electronics box and a small HV box which is mounted directly on the electronics box. In the HV box the diodes to generate and control the high voltage will be distribute so that the risk for a discharge is minimised. The discharge current is limited. Drawings of the frontplate and of the integrated HV-Box are shown in the following Figures.



Cover Plate



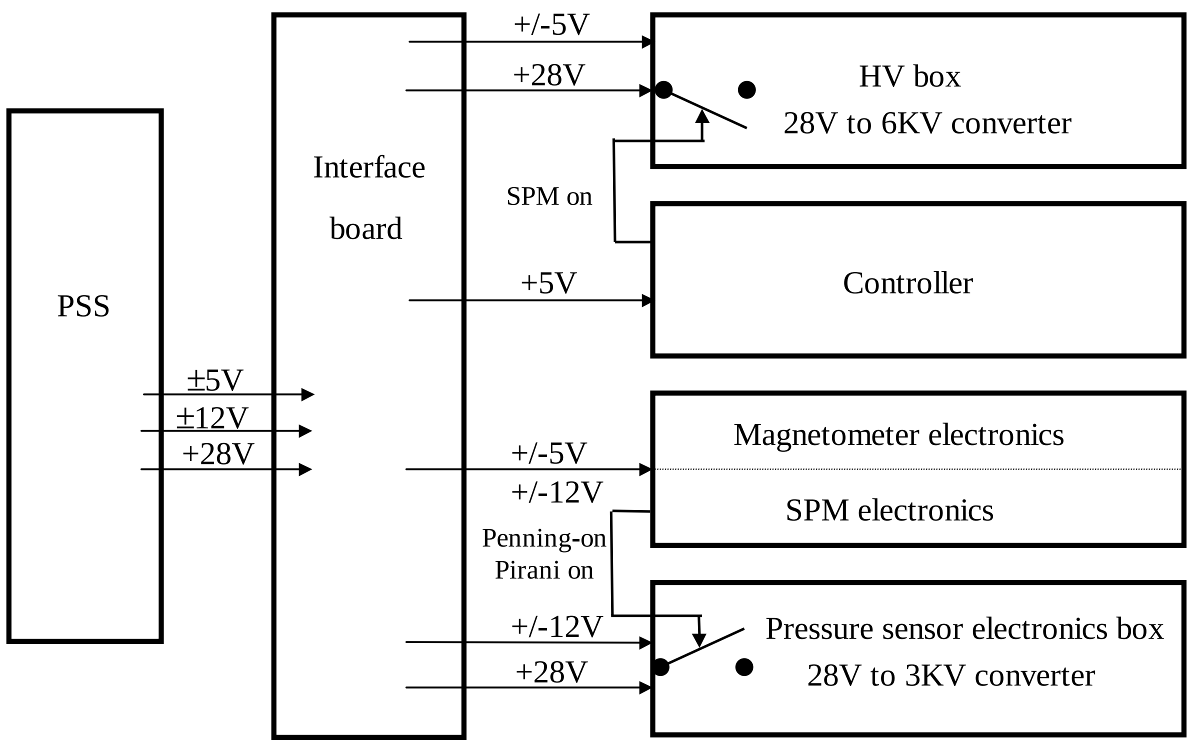
ROMAP board and HV box inside the CEBox RO-LRO-DW-300001

4 Electrical Interface

4.1 Power Supply Interfaces

4.1.1 Voltages

ROMAP requires ±5V, ±12V and +28V.
The following Figure shows how the supply voltages will be distributed to the boards:



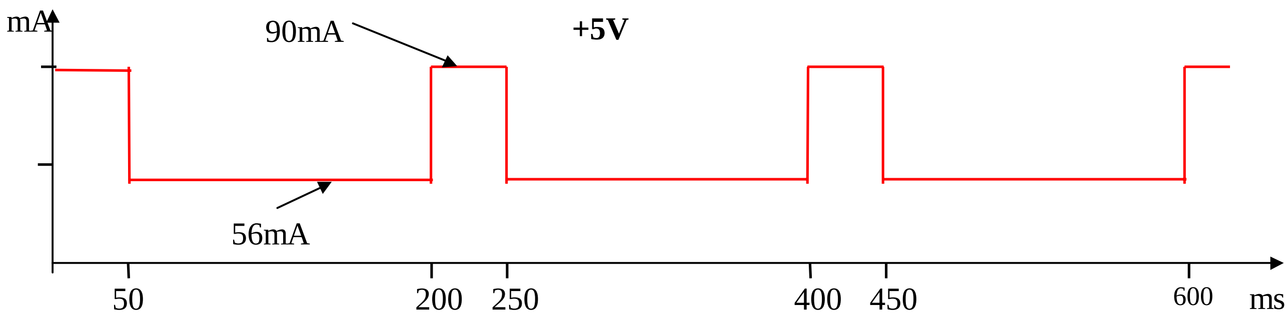
Power block diagram

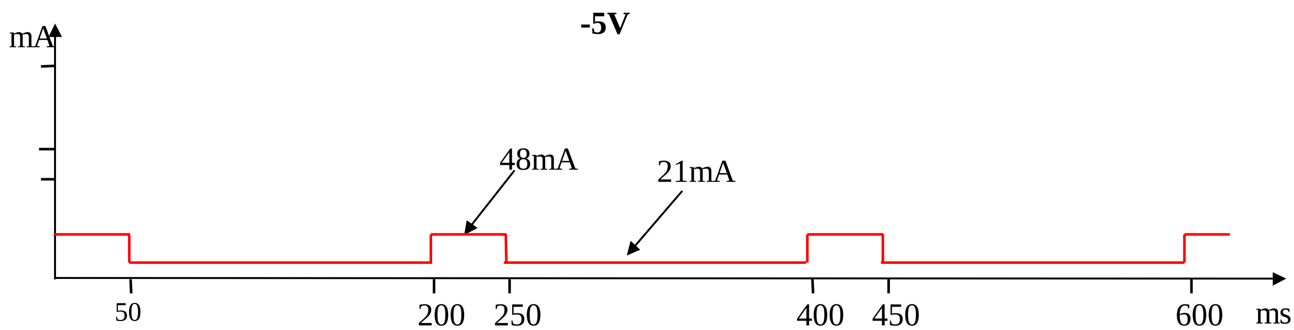
4.1.2 Power requirements

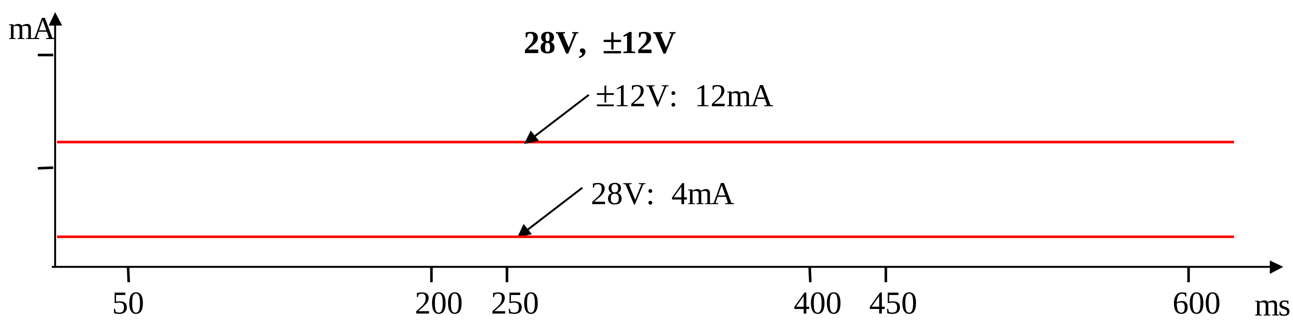
ROMAP uses the ±5V, ±12V and +28V supplies.
No keep-alive lines, heaters or over-current protection will be used. Supplies for the HV converters and for the pressure measurement as well as the clock for the excitation of the fluxgate sensor could be switched off and on separately.
In the following tables the current required and the overall power consumption are given.
The current/power diagrams show the switching behaviour of the instrument.

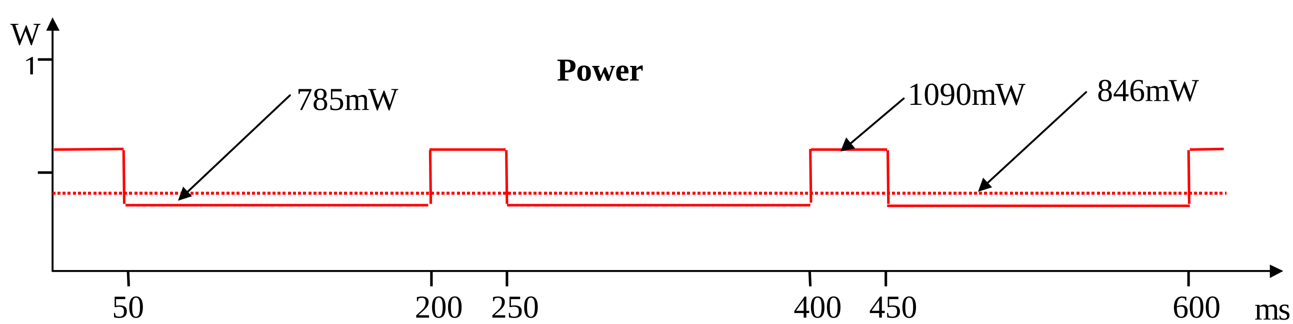
SURFACE Mode (850mW)

	+5V	-5V	+12V	-12V	28V
Controller	35mA	-			-
Analogue + FPGA	6mA	6mA	12mA	12mA	-
ADC	15mA	15mA			-
MAG Excitation	34 / 0mA	27 / 0mA			-
SPM High Voltages	-	-			4mA
	90 / 56mA	48 / 21mA	12mA	12mA	4mA









SLOW-MAG Mode / FAST-MAG Mode (980mW)

	+5V	-5V	+12V	-12V	28V	Power
Controller	35mA	-			-	175
Analogue + FPGA	6mA	6mA	12mA	12mA	-	348
ADC	15mA	15mA			-	150
MAG Excitation	34mA	27mA			-	305
SPM High Voltages	-	-			-	
	90mA	48mA	12mA	12mA		978

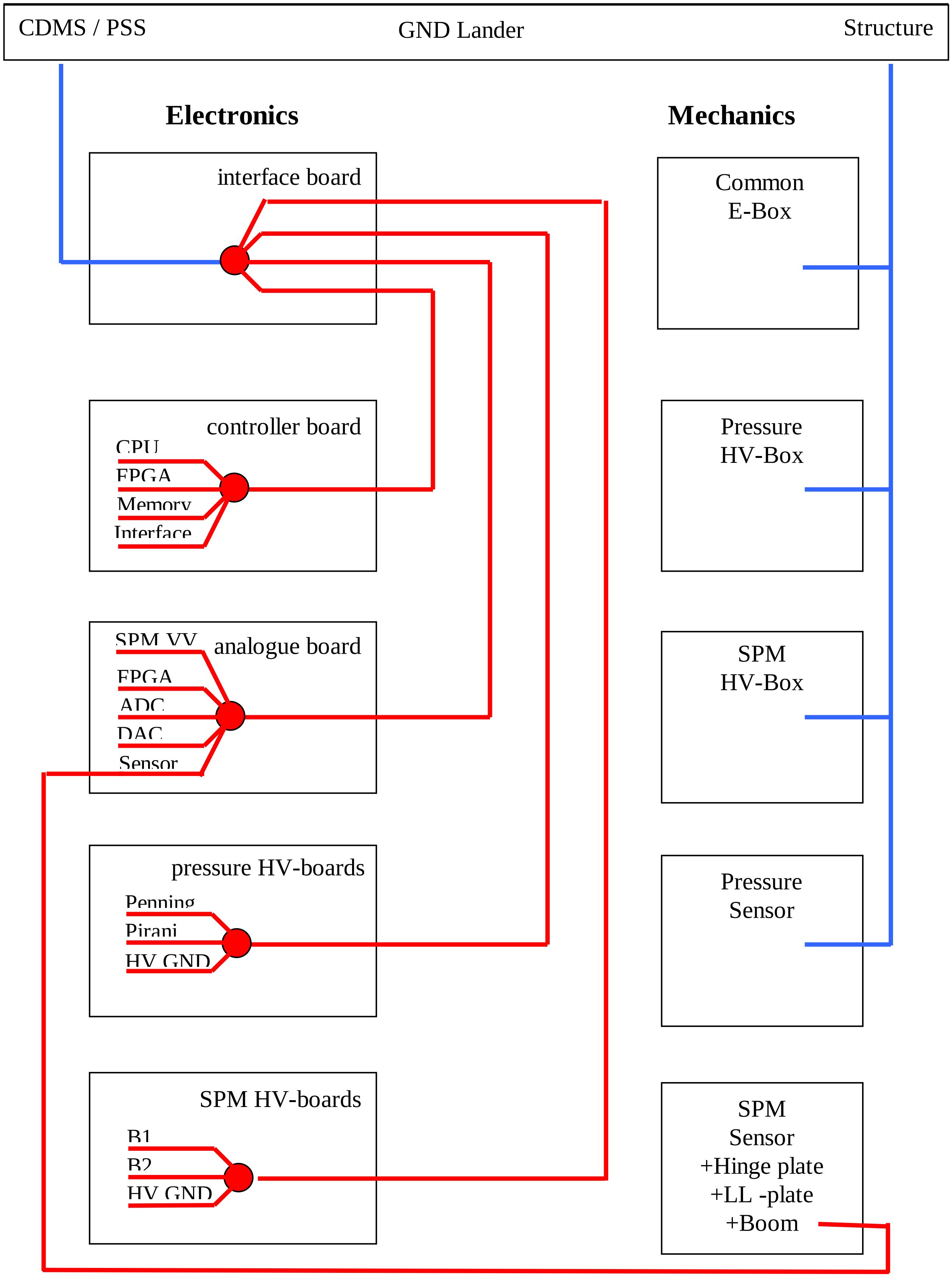
Power and data resources in dependency of the instrument mode:

Mode Name	max. currrent [mA] (incl. peaks longer than 10ms)			max. current [mA] (incl. peaks shorter than 10ms)			Power [	Produced Data	Constraints
	±5V	±12V	+28V	±5V	±12V	+28V	mW]	[bits/s]	
powerup	56 / 21	12 / 12	0	500	40	0	790	0.00	
slowmag	90 / 48	12 / 12	0	200	40	0	980	68.26	RPC on
fastmag	90 / 48	12 / 12	0	200	40	0	980	4369.06	RPC, PP on,
surface	90 / 48	12 / 12	80	400	40	80	850	80.21	RPC on

Power and data resources in dependency of the flight operation:

	Activity Name	*Start Time*	*Duration*	*Total Energy*	*Produced Data*	*Description*
t0: Separation		(t0+x[s])	(s)	(Wh)	(bytes)	
	powerup-start	600,00	0,04	0,00		
Descent	powerup	600,04	10,00	0,00		
(3h)	slow mode	610,04	10190,00	3,00	87.040	340 frames in 2h 50min
t1: Touch Down		(t1+x[s])	(s)	(Wh	(bytes)	
	slowmode		60,00	0,02	512	2 frames in 1min
	surface mode	60,00	1200,00	0,30	18.688	73 frames in 20min
First	power off	1260,00				
sc. Sequence						
(65h)						
	powerup-start	43200,00	0,04	0,00		
	powerup	43200,04	10,00	0,00		
	slow mode	43210,00	60,00	0,02	512	2 frames in 1min
	surface mode	43270,00	14340,00	3,40	144.384	564 frames in 4h
	power off	57610,00				

4.1.3 Grounding Concept



4.2 Pyrotechnic Interfaces

None

4.3 Data and Command Interfaces

Three instrument modes are foreseen for ROMAP:

Slow MAG Mode
Only MAG is working in this mode. It produces 1 Hz magnetic field vectors. The excitation of MAG is continuously on in this mode.
This mode is ROMAPs default instrument mode and is also used for the Lander descent.

Fast MAG Mode
Only MAG is working, it produces 64 Hz magnetic field vectors.
This mode is used when high telemetry capacity is available for ROMAP.

Surface Mode
Both instrument parts, MAG and SPM, are working. MAG is producing 1 Hz magnetic field vectors and SPM is working in it's default setting. The MAG excitation is switched off if SPM is serviced to reduce the power consumption and to avoid disturbing the SPM sensor.
ROMAP-Controller is servicing one instrument after the other at a fixed time schedule; first MAG is serviced for 50 ms, then SPM for 50 ms (100 ms cycle time).
SPM can be switched to ***calibration mode***, where it produces calibration data for five measurement cycles. After this it switches to it's default mode automatically.

4.3.1 Data requirements

Data Rate

1) FAST MAG Instrument Mode
Only MAG is working. It produces 64 Hz magnetic field vectors.
In this mode the instrument generates one 128-word data frame every 468.75ms which gives a word rate of 273.06 words/s (***4369.06 bits/s***).

2) SLOW MAG Instrument Mode
Only MAG is working. It produces 1 Hz magnetic field vectors. The instrument generates one 128-word data frame every 30 sec (4.26 words/s = ***68.26 bits/s***)

3) SURFACE Mode

a) MAG
In Surface Mode MAG generates 1 Hz magnetic field vectors (*68.26 bits/s*).

b) SPM
For the exact SPM data rates in the various instrument settings refer to the table 'ROMAP-SPM Available Data Rates'.

Default setting (Raw Data: high res. long exp.; Param. Data: high res., long exp.; R:P=1:10): 11.95 bits/sec
Max. data rate (only Raw Data generated: low res. short exp.: 274 bits/sec
Min. data rate (only Param. Data generated: high res., long exp.: 8.72 bits/sec
SPM Calibration: If SPM is in Calibration Mode, it produces 2560 bytes (10 data frames) in 432 seconds (***5.92 bits/s***). After these cycles it switches to it's commanded mode.

SPM generates data frames at the end of a measurement cycle and therefore produces ***data frame bursts!***

c) MAG + SPM

Default SPM setting:	68.26 bits/s + 11.95 bits/s = ***80.21 bits/s***
Max. SPM setting:	68.26 bits/s + 274 bits/s = ***342.26 bits/s***
Min. SPM setting:	68.26 bits/s + 8.72 bits/s = ***76.98 bits/s***
Calibration:	68.26 bits/s + 5.92 bits/s = ***74.18 bits/s***

4.3.2 Data Volume

1.) Descent (6 h)
The Descent Mode will be used. 720 science data frames will be generated by ROMAP (***185 kbytes***).

2) First Science Sequence (until 20 min after touch-down)
The instrument will work in Surface Mode:
SPM: (Raw Data: high res. long exp.; Param. Data: high res., short exp.; R:P=1:10)
24 science data frames
MAG: 40 science data frames
Together 64 science data frames will be generated (***16384 bytes***).

3) Long Term Operation (4 h periods)
If the ***Slow MAG Mode*** is used, 480 science data frames will be generated during a 4 hour period (***122 kbytes***).

If the instrument is working in ***Surface Mode*** (default SPM setting) together 564 science data frames will be generated in this mode (***144.384 bytes***).

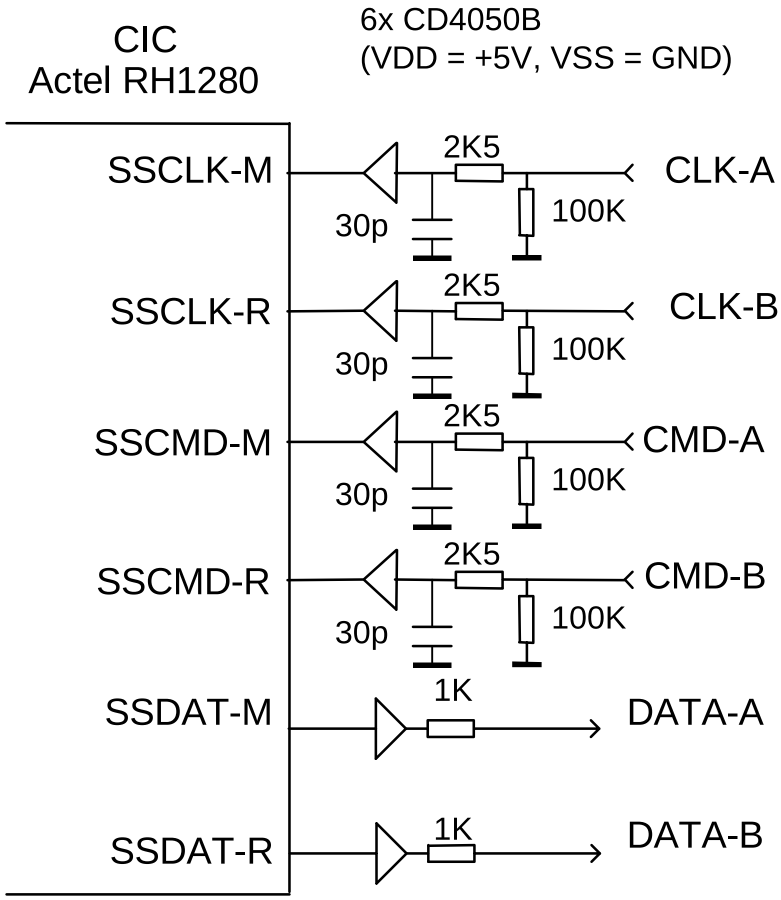
SPM:	84	science data frames
MAG:	480	science data frames

4) Fast Mag Mode (1 h period):
The Fast MAG Mode is foreseen for short time measurements parallel with the orbiter Magnetometer and/or the PP instrument onboard the Lander.7680 science data frames are generated (***1.95 Mbytes***).

4.3.3 CDMS Interface Implementation

Hardware Interface

The CDMS RIU inside ROMAP is realised using the proposed Common Interface Chip design (non redundant RIU in intelligent/non redundant unit). The implementation refers to the "CDMS Subsystems & Instruments Electrical Interface Definition and Generic Payload Control".



4.3.4 CDMS Flags, Action and Request Codes

CDMS Flag	***Description***
Message Error (ME)	handling implemented
Count Error (CE)	handling implemented
Service Request (SR)	handling implemented
Busy Flag (BSY)	not used
Sleep Mode (SM)	not used

Action Code	***Description***
Transmit Status Word	used
Transmit Request Code Word	used
Standby/Power Down Mode	implemented, but not used
Receive Current CDMS Mode	implemented, but not used
Receive On-board Time	used
Receive Service System Status	used
Receive Action Code/Subaddress Extension	implemented, but not used
Receive Housekeeping Data Format Count	used
Transmit Housekeeping Data Word	used
Receive Telecommand Sequence	used
Transmit Offset/Length of Stored Telecommand Buffer Section	used
Receive Stored Telecommand Buffer Section	used
Receive Allocated Science Data Volume	implemented, but not used
Transmit Science Data Burst	used
Receive Science Data Packet Checksum	used, no retransmission is performed in case of checksum errors; if checksum errors occur, flag in HK data is set
Receive Allocated Backup RAM Buffer Size	implemented, but not used
Transmit Pointer of Backup RAM Record	used
Transmit Backup RAM Record	used
Receive Backup RAM Record	implemented, but not used
Transmit Trigger Word	implemented, but not used (dummy data transmitted on request)
Receive Trigger Word	implemented, but not used
Receive Error Code Word	used

"Implemented, but not used" means, that the instrument is able to receive the action code and does recognise it as a valid action code, but it does not use it. If there is a request to transmit data, dummy data is transmitted.

Request Code	***Description***
Send Service System Status	used
Send Stored Telecommand Buffer Section	used
Send Allocated Science Data Volume	not used
Science Data Ready	used
Send Allocated Backup RAM Buffer Size	not used
Write Backup RAM Record	used
Read Backup RAM Record	not used
Pass Trigger Word	not used
Flush Last Science Data Packet	used

Requirements to the CDMS System

The CDMS system has to collect science data that is produced by the instrument. ROMAP generates 128 word data frames and integrates an internal frame buffer of 16 kBytes for buffering a maximum of 64 science data frames.
Housekeeping data has to be collected in word by word mode. The requested HK scanning period is 2 seconds.
The onboard time should be transmitted in regular intervals to the ROMAP instrument. It is used to synchronise the internal clock for producing time stamps for the science data frames.
ROMAP does not used the higher part of the onboard time in the RSST message.
ROMAP relies on the implementation of CDMS Backup RAM. Currently only 16 bytes of the requested size of 512 bytes are used. ROMAP will not use more than 64 bytes in the backup RAM in future.

Requested reply times:
ROMAP waits 10 seconds for a reply after a “Send Service System Status” or a Backup RAM handling request. If there is no reaction during this time period, a HK error flag is set, then the instrument continues with default settings.

If ROMAPs internal frames buffer is filled because the instrument was not sampled from the CDMS system frequently enough, ROMAPs internal data sampling of MAG and SPM data is stopped to reduce the power consumption of the instrument. Data sampling starts again in the same instrument mode, if there is room for at least one data frame in the internal frame buffer.

Reprogramming Concept

Because no EEPROMs are integrated at the ROMAP-Controller, no software reprogramming is available.

Autonomy Concept

ROMAP is in general working completely independent of any other instruments or subsystems.
After power-up the instrument needs information about the current Lander status to select the appropriate instrument mode.
Furthermore the ROMAP sensor temperature has to be measured by the TCU (Thermal Control Unit). Required sampling rate during decent: 1 sample per 2 minutes.
Detailed explanation shows, that a sampling interval of 8 minutes corresponds with a temperature gradient of 3.2 °C, which is not acceptable.

4.3.5 Science Data Frames

ROMAP transmits it's scientific data output within 128 word data frames, which are transmitted via the CDMS interface. Each data frame contains a ***header section*** (6 words) and a ***science data section*** (122 words).
This 128 word frame is encapsulated by the CDMS science data frame format (refer to CDMS description). All multi-byte values are transmitted with the LSB first.

Header Section:

The header section (word 0 .. 5) has the following content in the described order

Frame Synchronisation Word (2 bytes = $AA55_h$)
Measurement Time in OBT format, counter with 1/32s resolution (4 bytes)
  time of first vector in a frame (MAG) or start time of a SPM measurement cycle
Frame Sequence Counter (1 byte)
Frame Identifier (1 byte)
  0: MAG data frame ; > 0: SPM data frame
Instrument Status (2 bytes)
  detailed MAG and SPM setting
Multiplexed Housekeeping Data (2 bytes)
  housekeeping and status information is transmitted redundantly to the HK information collected by the CDMS system. The frame sequence counter is used for channel identification

Frame Identifier:

ID	Description	Resolution	#Frames
1 – 7	Raw Data: ion + ion current channel 1 (even energies) and corresponding Faraday Cup samples	high	7
8 – 14	Raw Data: ion + ion current channel 1 (odd energies) and corresponding Faraday Cup samples	high	7
15 – 21	Raw Data: ion + ion current channel (even energies) and corresponding Faraday Cup samples	high	7
22 – 28	Raw Data: ion + ion current channel (odd energies) and corresponding Faraday Cup samples	high	7
29 – 42	Raw Data: ion + ion current channel 1 (all data) and corresponding Faraday Cup samples	high	14
43 – 56	Raw Data: ion + ion current channel 2 (all data) and corresponding Faraday Cup samples	high	14
57	Raw Data: electrons and corresponding Faraday Cup samples	high	1
60 – 63	Raw Data: ion + ion current channel 1 (even energies)and corresponding Faraday Cup samples	low	4
64 – 67	Raw Data: ion + ion current channel 1 (odd energies)and corresponding Faraday Cup samples	low	4
68 – 71	Raw Data: ion + ion current channel 2 (even energies) and corresponding Faraday Cup samples	low	4
72 – 75	Raw Data: ion + ion current channel 2 (odd energies)and corresponding Faraday Cup samples	low	4

76 – 82	Raw Data: ion + ion current channel 1 (all data) and corresponding Faraday Cup samples	low	7
83 – 89	Raw Data: ion + ion current channel 2 (all data) and corresponding Faraday Cup samples	low	7
90	Raw Data: electrons and corresponding Faraday Cup samples	low	1
128 – 130	Parameter Data	high	3
131 – 132	Parameter Data	low	2

Instrument Status:

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
descr.	IM1	IM0	R:P	PR	PE	RR	RE	CAL	P	F	R	I2	I1	CEM2	CEM1	CEM0

CEM2..0: currently selected CEM supply setting
000: step 1
001: step 2
010: step 3
011: step 4
100: step 5
I1 ion channel 1 and ion current channel 1 on(1)/off(0)
I2 ion channel 2 and ion current channel 2 on(1)/off(0)
R raw data frames are generated on(1)/off(0)
F all rows/columns are transmitted in a raw data frame on(1)/off(0)
P parameter data frames are generated on(1)/off(0)
CAL SPM calibration active(1)/inactive(0)
RE Raw Data exposition time setting: Short(0)/Long(1)
RR Raw Data resolution setting: Low(0)/High(1)
PE Parameter Data exposition time setting: Short(0)/Long(1)
PR Parameter Data resolution setting: Low(0)/High(1)
R:P Raw Data : Parameter Data Cycles: 1:10(0)/1:20(1)
IM1, IM0 Instrument Mode identifier
00: Fast MAG Mode
01: Slow MAG Mode
10: Surface Mode

Science Data Section

a) MAG

The science data section contains 30 magnetic field vectors for a MAG data frame. Each vector occupies 4 data words. A vector consists of X-, Y-, Z-components, each has a length of 21 bits. The last two words in the data frame are unused.

15		0	
15	X	0	word 1
15		0	
15	Y	0	word 2

15				0	
15	Z			0	word 3
15				0	
0	20 Z 16	20 Y 16	20 X 16		word 4

b) SPM

The content of a frame's science data section is identified by the 'Frame Identifier' in the frame header. A maximum of 244 bytes is available in a data frame.

Raw Data Frames

a) Ion Channel 1 or 2, even or odd energies; high resolution mode

Frame 1: (Frame ID: 1, 8, 15, 22)

Frame Offset [bytes]	*Contents*
0 – 31	16 bit Ion Counts for energy step 0 (even) or 1 (odd) transmission: deflector steps 0..15
32 – 63	16 bit Counts for energy step 2 (3) deflector steps 0..15
64 – 95	16 bit Counts for energy step 4 (5) deflector steps 0..15
96 – 127	16 bit Counts for energy step 6 (7) deflector steps 0..15
128 – 159	16 bit Counts for energy step 8 (9) deflector steps 0..15
160 – 191	16 bit Counts for energy step 10 (11) deflector steps 0..15
192 – 223	16 bit Counts for energy step 12 (13) deflector steps 0..15
224 – 239	16 bit Counts for energy step 14 (15) deflector steps 0..7
240 – 243	not used

Frame 2: (Frame ID 2, 9, 16, 23)

Frame Offset [bytes]	*Contents*
0 – 15	16 bit Ion Counts for energy step 14 (even) or 15 (odd) transmission: deflector steps 8..15
16 – 47	16 bit Counts for energy step 16 (17) deflector steps 0..15
48 – 79	16 bit Counts for energy step 18 (19) deflector steps 0..15
80 - 111	16 bit Counts for energy step 20 (21) deflector steps 0..15
112 – 143	16 bit Counts for energy step 22 (23) deflector steps 0..15
144 – 175	16 bit Counts for energy step 24 (25) deflector steps 0..15
176 – 207	16 bit Counts for energy step 26 (27) deflector steps 0..15
208 – 239	16 bit Counts for energy step 28 (29) deflector steps 0..15
240 – 243	not used

Frame 3: (Frame ID: 3, 10, 17, 24)

Frame	*Contents*

Offset [bytes]	
0 – 31	16 bit Ion Counts for energy step 30 (even) or 31 (odd) transmission: deflector steps 0..15
32 – 63	16 bit Counts for energy step 32 (33) deflector steps 0..15
64 – 95	16 bit Counts for energy step 34 (35) deflector steps 0..15
96 – 127	16 bit Counts for energy step 36 (37) deflector steps 0..15
128 – 159	16 bit Counts for energy step 38 (39) deflector steps 0..15
160 – 191	16 bit Counts for energy step 40 (41) deflector steps 0..15
192 – 223	16 bit Counts for energy step 42 (43) deflector steps 0..15
224 – 239	16 bit Counts for energy step 44 (45) deflector steps 0..7
240 – 243	not used

Frame 4: (Frame ID 4, 11, 18, 25)

Frame Offset [bytes]	Contents
0 – 15	16 bit Ion Counts for energy step 44 (even) or 45 (odd) transmission: deflector steps 8..15
16 – 47	16 bit Counts for energy step 46 (47) deflector steps 0..15
48 – 79	16 bit Counts for energy step 48 (49) deflector steps 0..15
80 - 111	16 bit Counts for energy step 50 (51) deflector steps 0..15
112 – 143	16 bit Counts for energy step 52 (53) deflector steps 0..15
144 – 175	16 bit Counts for energy step 54 (55) deflector steps 0..15
176 – 207	16 bit Counts for energy step 56 (57) deflector steps 0..15
208 – 239	16 bit Counts for energy step 58 (59) deflector steps 0..15
240 – 243	not used

Frame 5: (Frame ID 5, 12, 19, 26)

Frame Offset [bytes]	Contents
0 – 31	16 bit Counts for energy step 60 (even) 61 (odd) transmission: deflector steps 0..15
32 – 63	16 bit Counts for energy step 62 (63) deflector steps 0..15
64 – 79	8 bit Ion Current value for energy step 0 (even) 1 (odd) transmission: deflector steps 0..15
80 – 95	8 bit Ion Current values for energy step 2 (3) deflector steps 0..15
96 – 111	8 bit Ion Current values for energy step 4 (5) deflector steps 0..15
112 – 127	8 bit Ion Current values for energy step 6 (7) deflector steps 0..15
128 – 143	8 bit Ion Current values for energy step 8 (9) deflector steps 0..15
144 – 159	8 bit Ion Current values for energy step 10 (11) deflector steps 0..15
160 – 175	8 bit Ion Current values for energy step 12 (13) deflector steps 0..15
176 – 191	8 bit Ion Current values for energy step 14 (15) deflector steps 0..15
192 – 207	8 bit Ion Current values for energy step 16 (17) deflector steps 0..15
208 – 223	8 bit Ion Current values for energy step 18 (19) deflector steps 0..15
224 – 239	8 bit Ion Current values for energy step 20 (21) deflector steps 0..15
240 – 243	not used

Frame 6: (Frame ID 6, 13, 20, 27)

Frame Offset [bytes]	Contents
0 – 15	8 bit Ion Current value for energy step 22 (even) 23 (odd) transmission: deflector steps 0..15
16 – 31	8 bit Ion Current values for energy step 24 (25) deflector steps 0..15
32 – 47	8 bit Ion Current values for energy step 26 (27) deflector steps 0..15
48 – 63	8 bit Ion Current values for energy step 28 (29) deflector steps 0..15
64 – 79	8 bit Ion Current values for energy step 30 (31) deflector steps 0..15
80 – 95	8 bit Ion Current values for energy step 32 (33) deflector steps 0..15
96 – 111	8 bit Ion Current values for energy step 34 (35) deflector steps 0..15
112 - 127	8 bit Ion Current values for energy step 36 (37) deflector steps 0..15
128 – 143	8 bit Ion Current values for energy step 38 (39) deflector steps 0..15
144 – 159	8 bit Ion Current values for energy step 40 (41) deflector steps 0..15
160 – 175	8 bit Ion Current values for energy step 42 (43) deflector steps 0..15
176 – 191	8 bit Ion Current values for energy step 44 (45) deflector steps 0..15
192 – 207	8 bit Ion Current values for energy step 46 (47) deflector steps 0..15
208 – 223	8 bit Ion Current values for energy step 48 (49) deflector steps 0..15
224 – 239	8 bit Ion Current values for energy step 50 (51) deflector steps 0..15
240 – 243	not used

Frame 7: (Frame ID 7, 14, 21, 28)

Frame Offset [bytes]	Contents
0 – 15	8 bit Ion Current value for energy step 52 (even) 53 (odd) transmission: deflector steps 0..15
16 – 31	8 bit Ion Current values for energy step 54 (55) deflector steps 0..15
32 – 47	8 bit Ion Current values for energy step 56 (57) deflector steps 0..15
48 – 63	8 bit Ion Current values for energy step 58 (59) deflector steps 0..15
64 – 79	8 bit Ion Current values for energy step 60 (61) deflector steps 0..15
80 - 95	8 bit Ion Current values for energy step 62 (63) deflector steps 0..15
96 – 223	64 16bit Faraday Cup values corresponding to ion sampling for energy steps 0..63
224 – 243	not used

b) Ion Channel 1 or 2, all energy transmission; high resolution mode

(Frame IDs 29-42 or 43-56)

Frame Number	Contents
1	16 bit Ion Counts for energy steps 0 – 6 (deflector steps 0..15) bytes 224 – 243 are unused
2	16 bit Ions Counts for energy steps 7 – 13
3	16 bit Ions Counts for energy steps 14 – 20
4	16 bit Ions Counts for energy steps 21 – 27
5	16 bit Ions Counts for energy steps 28 – 34

6	16 bit Ions Counts for energy steps 35 – 41
7	16 bit Ions Counts for energy steps 42 – 48
8	16 bit Ions Counts for energy steps 49 – 55
9	16 bit Ions Counts for energy steps 56 – 62
10	16 bit Ions Counts for energy step 63 and 8bit Ion Current values for energy steps 0 – 12 (deflector steps 0 – 15) bytes 240 – 243 unused
11	8bit Ion Current values for energy steps 13 – 27 bytes 240 – 243 unused
12	8bit Ion Current values for energy steps 28 – 42
13	8bit Ion Current values for energy steps 43 – 57
14	8bit Ion Current values for energy steps 58 – 63 and 64 16bit Faraday Cup values corresponding to ion sampling for energy steps 0..63 bytes 224 – 243 unused

c) Electron Counts and corresponding Faraday Cup values; high resolution mode

(Frame ID 57)

Frame Offset [bytes]	***Contents***
0 . 127	16bit Electron Counts for energy steps 0..63
128 – 131	2 16bit Faraday Cup values corresponding to energy step 0 and 32
132 – 243	not used

d) Ion Channel 1 or 2, even or odd energies; low resolution mode

Frame 1: (Frame ID: 60, 64, 68, 72)

Frame Offset [bytes]	***Contents***
0 – 31	16 bit Ion Counts for energy step 0 (even) or 1 (odd) transmission: deflector steps 0..15
32 – 63	16 bit Counts for energy step 2 (3) deflector steps 0..15
64 – 95	16 bit Counts for energy step 4 (5) deflector steps 0..15
96 – 127	16 bit Counts for energy step 6 (7) deflector steps 0..15
128 – 159	16 bit Counts for energy step 8 (9) deflector steps 0..15
160 – 191	16 bit Counts for energy step 10 (11) deflector steps 0..15
192 – 223	16 bit Counts for energy step 12 (13) deflector steps 0..15
224 – 239	16 bit Counts for energy step 14 (15) deflector steps 0..7
240 – 243	not used

Frame 2: (Frame ID 61, 65, 69, 73)

Frame Offset [bytes]	***Contents***

0 – 15	16 bit Ion Counts for energy step 14 (even) or 15 (odd) transmission: deflector steps 8..15
16 – 47	16 bit Counts for energy step 16 (17) deflector steps 0..15
48 – 79	16 bit Counts for energy step 18 (19) deflector steps 0..15
80 - 111	16 bit Counts for energy step 20 (21) deflector steps 0..15
112 – 143	16 bit Counts for energy step 22 (23) deflector steps 0..15
144 – 175	16 bit Counts for energy step 24 (25) deflector steps 0..15
176 – 207	16 bit Counts for energy step 26 (27) deflector steps 0..15
208 – 239	16 bit Counts for energy step 28 (29) deflector steps 0..15
240 – 243	not used

Frame 3: (Frame ID 62, 66, 70, 74)

Frame Offset [bytes]	***Contents***
0 – 31	16 bit Counts for energy step 30 (even) 31 (odd) transmission: deflector steps 0..15
32 – 47	8 bit Ion Current value for energy step 0 (even) 1 (odd) transmission: deflector steps 0..15
48 – 63	8 bit Ion Current values for energy step 2 (3) deflector steps 0..15
64 – 79	8 bit Ion Current values for energy step 4 (5) deflector steps 0..15
80 – 95	8 bit Ion Current values for energy step 6 (7) deflector steps 0..15
96 – 111	8 bit Ion Current values for energy step 8 (9) deflector steps 0..15
112 – 127	8 bit Ion Current values for energy step 10 (11) deflector steps 0..15
128 – 143	8 bit Ion Current values for energy step 12 (13) deflector steps 0..15
144 – 159	8 bit Ion Current values for energy step 14 (15) deflector steps 0..15
160 – 175	8 bit Ion Current values for energy step 16 (17) deflector steps 0..15
176 – 191	8 bit Ion Current values for energy step 18 (19) deflector steps 0..15
192 – 207	8 bit Ion Current values for energy step 20 (21) deflector steps 0..15
208 – 223	8 bit Ion Current values for energy step 22 (23) deflector steps 0..15
224 – 239	8 bit Ion Current values for energy step 24 (25) deflector steps 0..15
240 – 243	not used

Frame 4: (Frame ID 63, 67, 71, 75)

Frame Offset [bytes]	***Contents***
0 – 15	8 bit Ion Current value for energy step 26 (even) 27 (odd) transmission: deflector steps 0..15
16 – 31	8 bit Ion Current values for energy step 28 (29) deflector steps 0..15
32 – 47	8 bit Ion Current values for energy step 30 (31) deflector steps 0..15
48 – 111	32 16bit Faraday Cup values corresponding to ion sampling for energy steps 0..31
112 – 243	not used

e) Ion Channel 1 or 2, all energy transmission; low resolution mode

(Frame IDs 76-82 or 83-89)

Frame	***Contents***

Number	
1	16 bit Ion Counts for energy steps 0 – 6 (deflector steps 0..15) bytes 224 – 243 are unused
2	16 bit Ions Counts for energy steps 7 – 13
3	16 bit Ions Counts for energy steps 14 – 20
4	16 bit Ions Counts for energy steps 21 – 27
5	16 bit Ions Counts for energy steps 28 – 34 and 8bit Ion Current values for energy steps 0 – 6 (deflector steps 0 – 15) bytes 240 – 243 unused
6	8 bit Ions Counts for energy steps 7– 21
7	8 bit Ions Counts for energy steps 22 – 31 and 32 16bit Faraday Cup values corresponding to ion sampling for energy steps 0..31 bytes 224 – 243 unused

f) Electron Counts and corresponding Faraday Cup values; low resolution mode

(Frame ID 90)

Frame Offset [bytes]	Contents
0 . 63	16bit Electron Counts for energy steps 0..31
64 – 67	2 16bit Faraday Cup values corresponding to energy step 0 and 16
68 – 243	not used

Parameter Data Frames

a) High resolution mode

Frame 1: (Frame ID 128)

Frame Offset [bytes]	Contents
0 - 127	Ion Channel 1: 16bit sums of deflector steps 0 - 15 for energy steps 0 - 63
128 – 169	Ion Channel 1: 16bit sums of energy steps 0 - 63 for deflector steps 0 - 15
170 – 243	Ion Channel 2: 16bit sums of deflector steps 0 - 15 for energy steps 0 – 41

Frame 2: (Frame ID 129)

Frame Offset [bytes]	Contents
0 . 43	Ion Channel 2: 16bit sums of deflector steps 0 - 15 for energy steps 42 – 63
44 – 75	Ion Channel 2: 16bit sums of energy steps 0 - 63 for deflector steps 0 – 15
76 – 139	Ion Current Channel 1: 8bit sums of deflector steps 0 - 15 for energy steps 0 – 63
140 - 155	Ion Current Channel 1: 8bit sums of energy steps 0 - 63 for deflector steps 0 – 15
156 - 219	Ion Current Channel 2: 8bit sums of deflector steps 0 - 15 for energy steps 0 – 63
220 – 235	Ion Current Channel 2: 8bit sums of energy steps 0 - 63 for deflector steps 0 – 15

236 - 243	16bit Faraday Cup values corresponding to ion sampling for energy steps 0, 2, 4, 6

Frame 3: (Frame ID 130)

Frame Offset [bytes]	Contents
0 . 55	16bit Faraday Cup values corresponding to ion sampling for energy steps 8 .. 62 (every second transmitted)
56 – 183	16bit Electron Counts for energy steps 0..63
184 – 187	16bit Faraday Cup values corresponding to energy step 0 and 32
188 – 189	overflow flags for Ion Channel 1 deflector step sums for energy steps 0 - 15
190 – 191	overflow flags for Ion Channel 1 deflector step sums for energy steps 16 – 31
192 – 193	overflow flags for Ion Channel 1 deflector step sums for energy steps 32 – 47
194 –195	overflow flags for Ion Channel 1 deflector step sums for energy steps 48 - 63
196 – 197	overflow flags for Ion Channel 1 energy step sums for deflector steps 0 - 15
198 – 199	overflow flags for Ion Channel 2 deflector step sums for energy steps 0 - 15
200 – 201	overflow flags for Ion Channel 2 deflector step sums for energy steps 16 – 31
202 – 203	overflow flags for Ion Channel 2 deflector step sums for energy steps 32 – 47
204 – 205	overflow flags for Ion Channel 2 deflector step sums for energy steps 48 - 63
206 – 207	overflow flags for Ion Channel 2 energy step sums for deflector steps 0 - 15
208 – 209	overflow flags for Ion Current Channel 1 deflector step sums for energy steps 0 – 15
210 – 211	overflow flags for Ion Current Channel 1 deflector step sums for energy steps 16 – 31
212 – 213	overflow flags for Ion Current Channel 1 deflector step sums for energy steps 32 – 47
214 – 215	overflow flags for Ion Current Channel 1 deflector step sums for energy steps 48 – 63
216 – 217	overflow flags for Ion Current Channel 1 energy step sums for deflector steps 0 – 15
218 – 219	overflow flags for Ion Current Channel 2 deflector step sums for energy steps 0 – 15
220 – 221	overflow flags for Ion Current Channel 2 deflector step sums for energy steps 16 – 31
222 – 223	overflow flags for Ion Current Channel 2 deflector step sums for energy steps 32 – 47
224 – 225	overflow flags for Ion Current Channel 2 deflector step sums for energy steps 48 – 63
226 – 227	overflow flags for Ion Current Channel 2 energy step sums for deflector steps 0 – 15
228 – 229	Maximum Ion Channel 1 count
230	Energy step at which maximum was found
231	Deflector step at which maximum was found
232 – 233	Maximum Ion Channel 2 count
234	Energy step at which maximum was found
235	Deflector step at which maximum was found
236 – 237	Maximum Ion Current Channel 1 value
238	Energy step at which maximum was found
239	Deflector step at which maximum was found
240 – 241	Maximum Ion Current Channel 2 value
242	Energy step at which maximum was found
243	Deflector step at which maximum was found

b) Low resolution mode

Frame 1: (Frame ID 131)

Frame Offset	Contents

[bytes]	
0 - 63	Ion Channel 1:16bit sums of deflector steps 0 - 15 for energy steps 0 - 31
64 - 95	Ion Channel 1:16bit sums of energy steps 0 - 31 for deflector steps 0 – 15
96 – 159	Ion Channel 2:16bit sums of deflector steps 0 - 15 for energy steps 0 - 31
160 – 191	Ion Channel 2:16bit sums of energy steps 0 - 31 for deflector steps 0 – 15
192 - 223	Ion Current Channel 1:8bit sums of deflector steps 0 - 15 for energy steps 0 – 31
224 - 239	Ion Current Channel 1: 8bit sums of energy steps 0 – 31 for deflector steps 0 – 15
240 – 243	Ion Current Channel 2:8bit sums of deflector steps 0 - 15 for energy steps 0 – 3

Frame 2: (Frame ID 132)

Frame Offset [bytes]	Contents
0 - 27	Ion Current Channel 2:8bit sums of deflector steps 0 - 15 for energy steps 4 – 31
28 - 43	Ion Current Channel 2: 8bit sums of energy steps 0 – 31 for deflector steps 0 – 15
44 . 75	16bit Faraday Cup values corresponding to ion sampling for energy steps 0 – 30 (every second transmitted)
76 – 139	16bit Electron Counts for energy steps 0..31
140 – 143	16bit Faraday Cup values corresponding to energy step 0 and 16
144 - 145	overflow flags for Ion Channel 1 deflector step sums for energy steps 0 – 15
146 – 147	overflow flags for Ion Channel 1 deflector step sums for energy steps 16 – 31
148 – 149	overflow flags for Ion Channel 1 energy step sums for deflector steps 0 – 15
150 - 151	overflow flags for Ion Channel 2 deflector step sums for energy steps 0 – 15
152 – 153	overflow flags for Ion Channel 2 deflector step sums for energy steps 16 – 31
154 – 155	overflow flags for Ion Channel 2 energy step sums for deflector steps 0 – 15
156 – 157	overflow flags for Ion Current Channel 1 deflector step sums for energy steps 0 – 15
158 – 159	overflow flags for Ion Current Channel 1 deflector step sums for energy steps 16 – 31
160 – 161	overflow flags for Ion Current Channel 1 energy step sums for deflector steps 0 – 15
162 – 163	overflow flags for Ion Current Channel 2 deflector step sums for energy steps 0 – 15
164 – 165	overflow flags for Ion Current Channel 2 deflector step sums for energy steps 16 – 31
166 - 167	overflow flags for Ion Current Channel 2 energy step sums for deflector steps 0 - 15
168 – 169	Maximum Ion Channel 1 count
170	Energy step at which maximum was found
171	Deflector step at which maximum was found
172 – 173	Maximum Ion Channel 2 count
174	Energy step at which maximum was found
175	Deflector step at which maximum was found
176 – 177	Maximum Ion Current Channel 1 value
178	Energy step at which maximum was found
179	Deflector step at which maximum was found
180 – 181	Maximum Ion Current Channel 2 value
182	Energy step at which maximum was found
183	Deflector step at which maximum was found
184 – 243	not used

4.3.6 Generated Housekeeping Data

ROMAP generates 16 different housekeeping data words which are held in an internal buffer and are updated in continuosly. The requested HK scanning period for the CDMS system in word-by-word mode is 2 seconds.

ID	***HK Channel***
0	Controller Status bits
1	Last received TC (word 1)
2	Last received TC (word 2)
3	overall instrument power consumption P = N * 76.3E-3 * 4 [mW]
4	+5V current I = N * 76.3E-3 * 0.5 [mA]
5	–5V current I = N * 76.3E-3 * 0.05 [mA]
6	electronics temperature T = (N * 76.3E-6 – 0.535) * 472.9 [°C]
7	+28V current I = N * 76.3E-3 * 0.025 [mA]
8	SPM HV status 1
9	SPM HV status 2
10	SPM HV status 3
11	SPM HV status 4
12	Penning pressure
13	Pirani pressure
14	PROM checksum (computed at power-up)
15	Instrument Error Flags

Controller Status Bits:

Bit	***Description***
0	Status flag: Instrument Mode was loaded at power-up from TC-Buffer
1	Status flag: MAG setting was loaded from TC-Buffer
3	Error flag: read TC-Buffer error at power-up
4	Error flag: write BRAM error; cleared after successfully writing BRAM
5	Error flag: TC-Buffer content error (illegal checksum)
6	Error flag: SPM Ion 1 counter overflow occurred (cleared after displaying SPM overflow error flag in HK data)
7	Error flag: SPM Ion 2 counter overflow occurred (cleared after displaying SPM overflow error flag in HK data)
8	Error flag: SPM Electron counter overflow occurred (cleared after displaying SPM overflow error flag in HK data)
9	Status flag: Penning pressure sensor on/off
10	Status flag: Pirani pressure sensor on/off
11	Status flag: DUMMY FPGA output on/off
12..13	not used
14..15	Status flags: I0, I1 identify instrument mode

If one of the bits 0 .. 5 is set once, it stays active until the instrument is switched off.

Instrument Error Flags:

Bit	*Description*
0	Command overflow (a TC was received before the former was processed)
1	CDMS illegal word count
2	CDMS message error
3	general CDMS receiving error
4	general CDMS transmission error
5	wrong telecommand received
6.	CDMS request overflow (a CDMS request occurs before the former was processed)
7	frame buffer overflow
8	MAG vector sampling overflow
9	CDMS error code word received
10	CDMS checksum error
11	checksum error in received CDMS SST word
12	SPM counter overflow
13	ADC sampling overflow
14	SPM transmission overflow
15	SPM setup error

4.3.7 Telecommands

ROMAP is designed to work as autonomously as possible without the need for telecommands. Single telecommands are foreseen for engineering purposes and for changing the instrument mode manually.

Telecommand Format

In general, ROMAP uses a four-word (4*16bits) telecommand structure. Actually, only 2 words are needed. Word 1 is used to distinguish the different commands (ID), word 2 is the parameter word.
Word 3 has the same content than word 1, word 4 is the same as word2. This is used for detecting transmission errors. If the words are different, the telecommand is ignored and an error flag is set in the HK error flag word.

Telecommand Coding

TC Name	*Word 1 (ID in hex)*	*Word 2 (Parameter)*	*Description*
MODE	0x1001	Mode Selector	select new instrument mode
STORE-P	0x2002	0	store sampled pressure values and pressure electronics temperature to BRAM (pressure electronics temperature is not sampled with other HK data but is updated when this TC is received)
PENNING	0x0110	0: OFF >0: ON	switch Penning pressure sensor ON/OFF
PIRANI	0x0220	0: OFF >0: ON	switch Pirani pressure sensor ON/OFF

GET-MAG	0x0440	0	get MAG setup from BRAM
DUMMY	0x0880	0: OFF >0: ON	switch DUMMY output on FPGA ON/OFF

Mode selector coding:

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
descr.	IM1	IM0	R:P	PR	PE	RR	RE	CAL	P	F	R	I2	I1	CEM2	CEM1	CEM0

CEM2..0: currently selected CEM supply setting
- 000: step 1
- 001: step 2
- 010: step 3
- 011: step 4
- 100: step 5

I1 ion channel 1 and ion current channel 1 on(1)/off(0)
I2 ion channel 2 and ion current channel 2 on(1)/off(0)
R raw data frames are generated on(1)/off(0)
F all energies are transmitted in a raw data frame on(1)/off(0)
P parameter data frames are generated on(1)/off(0)
CAL SPM calibration active(1)/inactive(0)
RE Raw Data exposition time setting: Short(0)/Long(1)
RR Raw Data resolution setting: Low(0)/High(1)
PE Parameter Data exposition time setting: Short(0)/Long(1)
PR Parameter Data resolution setting: Low(0)/High(1)
R:P Raw Data : Parameter Data Cycles: 1:10(0)/1:20(1)
IM1, IM0 Instrument Mode identifier
- 00: Fast MAG Mode
- 01: Slow MAG Mode
- 10: Surface Mode

For any other selected instrument mode than the Surface Mode, settings in bits 0..13 are ignored and should be zero.
If the CAL bit is set, bits 0..7 and bits 9..13 are identifying the setting for SPM after the five SPM calibration cycles are finished.

Valid settings for bits 3 .. 7 in the mode selector:

P	*F*	*R*	*I2*	*I1*	*Description*
0	0	1	0	0	only raw data frames generated that contain only electron counts and corresponding Faraday Cup data
0	0	1	1	1	only raw data frames are generated; even and odd rows/columns are transmitted alternating
0	1	1	0	1	only raw data frames are generated; ion channel 1 data is transmitted fully
0	1	1	1	0	only raw data frames are generated; ion channel 2 data is transmitted fully
0	1	1	1	1	only raw data frames are generated; full information of ion

					channel 1 and 2 is transmitted alternating
1	0	0	0	0	only parameter data frames are generated
1	0	1	1	1	raw and parameter data frames are generated; even and odd rows/columns are transmitted alternating for raw data
1	1	1	0	1	raw and parameter data frames are generated; ion channel 1 is transmitted fully in raw data frames; ion channel 2 is off
1	1	1	1	0	raw and parameter data frames are generated; ion channel 2 is transmitted fully in raw data frames; ion channel 1 is off
1	1	1	1	1	raw data and parameter data frames are generated; full information of ion channel 1 and 2 is transmitted alternating for raw data

Only these combinations are allowed in telecommands. All other settings are ignored and are causing a set error flag in the HK error flag word. In this case the SPM default setting is used.

4.3.8 OBT Handling

ROMAP puts a time stamp of the first vector in a science data frame (MAG) or of the beginning of a data collection cycle (SPM) into the frame header. The timing information for subsequent data in the frame can be computed with the time stamp as reference.
Because the interval of the received OBT is too low, the ROMAP-Controller integrates a 16bit counter with 1/32s resolution that is reset when a new OBT is received.
For getting accurate time stamps, the value of the internal counter is read and added to the last received OBT. Then the time is stored to the data frame.

4.3.9 Error Handling

ROMAP tries to catch and solve all possible error conditions automatically. In case of an error condition, the instrument continuos working in it’s selected mode and shows an error flag in the HK error flag word.
The instrument monitors, if the error flags were transmitted in the housekeeping data, then they are cleared again.
In case of a non-recoverable system crash a watchdog circuit releases a hardware reset and the instrument performs a cold start.

4.3.10 Backup RAM Handling

The Backup RAM is used to store pressure sensor values and the pressure sensor electronics temperature. These values can be read from any other instrument on the Rosetta Lander. The values are updated once at power up (3 seconds after switching-on ROMAP) or if requested by telecommand. The pressure values are sampled continuously with other housekeeping data, the pressure electronics temperature is only sampled before the value is written to Backup RAM.

Address	Description
0	Penning Pressure
1.	Pirani Pressure
2	Pressure electronics temperature

4.3.11 TC Buffer Handling

ROMAP is using 8 data words at the beginning of it's reserved TC-Buffer space for storing setup information, flags and parameters. After reading the TC-Buffer at power-up, the content is checked by computing and comparing the stored checksum value. The TC-Buffer content has to be modified from ground.
If there is any failure in the TC-Buffer access (read, write, checksum), this is shown in a flag in the HK Controller Status bits.

Address	Description
0	Instrument Mode
1	Penning and Pirani pressure sensor status: LSB = 0: Penning OFF LSB > 0: Penning ON MSB = 0: Pirani OFF MSB > 0: Pirani ON
2	Flag: get Instrument Mode from TC-Buffer at power up
3	MAG G1X
4	MAG G1Y
5	MAG G1Z
6.	MAG Averaging
7	TC-Buffer checksum

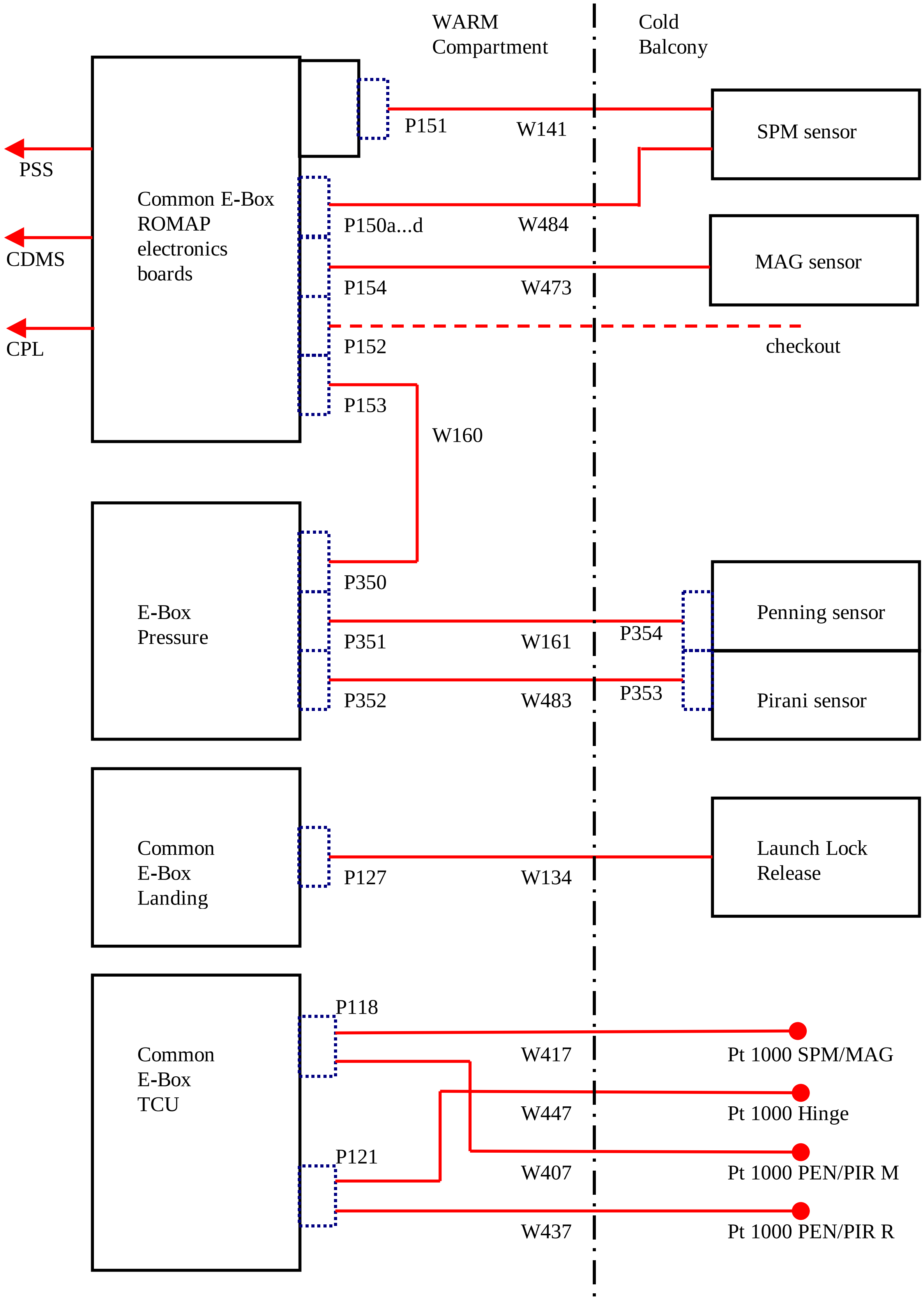
4.3.12 Housekeeping data requirements

The following Rosetta Lander housekeeping values are of interest for ROMAP:
- temperature inside of the central tube (location of the electronics)
- attitude of Rosetta Lander
- information about status of other instruments and it's moving parts

The housekeeping information from the Lander is not time critical. It has to be available on ground.
The temperature control system has to measure the ROMAP sensor temperature. Two lines, connected with a PT1000 will be provided by ROMAP.

4.4 Connector and Harness Requirements

4.4.1 Cable concept



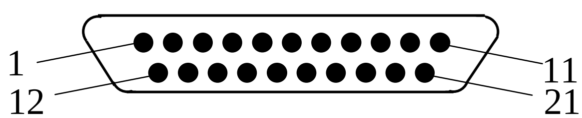
The Figure shows the connection between ROMAP sensor and instrument electronics and temperature electronics and the connection between launch lock and release electronics.

The boom with the mounted sensor has two pig tails. Both, HV and LV pig tails have to be connected with the Romap electronics in the common E-box. The 6 HV wires are connected to pins on the HV box and the LV lines are connected to a 21 pin MCPM connector. Outside of the warm area the cable is conducted inside the three boom tubes. From the Hinge Ground Plate into the warm area the cables will be passed through the thermal isolation layers.
Cables from four temperature sensors (one inside the Romap sensor, one at the hinge and two near the pressure sensor) have to be connected with the TCU. Pigtails with PT1000 elements have mini connectors (Pins) inside the warm compartement. The other side of the mini connectors (sockets) is connected with the TCU electronic. Romap ist responsible for the PT1000 pigtail for the temperature measurement in the Romap sensor. Al other pigtails and the connections between mini connectors and TCU electronics will be provided by the TCU team. The Launch Lock Resistor is connected with the release electronics via a separate cable and a connector at the common E-Box.

4.4.2 Detailed cable description

P154 → Sensor pig tail (male) - ROMAP electronics (female):

(male connector front view)



MCPM_21

Pin No	Destination in Warm Area (ROMAP analogue board)	Pad	Destination in Cold Area (ROMAP sensor)	Pad
1	excitation	PE2	MAG ringcore	I
2	preamplifier X	PX2	MAG pick up coil X	E
3	preamplifier Y	PY2	MAG pick up coil Y	C
4	preamplifier Z	PZ2	MAG pick up coil Z	A
5	DAC output X (GND)	PX4	MAG feedback coil X	Q
6	DAC output Y (GND)	PY4	MAG feedback coil Y	O
7	DAC output Z (GND)	PZ4	MAG feedback coil Z	L
8	GND	PB03	GND boom	
9	nc			
10	nc			
11	nc			
12	excitation	PE1	MAG ringcore	K
13	preamplifier X	PX1	MAG pick up coil X	F
14	preamplifier Y	PY1	MAG pick up coil Y	D
15	preamplifier Z	PZ1	MAG pick up coil Z	B
16	DAC output X	PX3	MAG feedback coil X	P
17	DAC output Y	PY3	MAG feedback coil Y	N
18	DAC output Z	PZ3	MAG feedback coil Z	M

19	nc			
20	GND	PB02	GND channeltrons	
21	nc			

The cable between E-Box and Sensor consists of 16 isolated strings. Each litz contains 7 single silver plated wires with a diameter of 0.08mm (0.035mm² / AWG 32) .

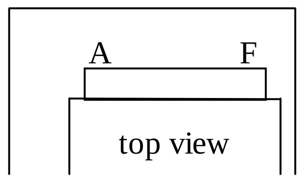
P150a....d → Sensor pig tail (male) - ROMAP electronics (female):

Pin No	Destination in Warm Area (ROMAP analogue board)	Pad	Destination in Cold Area (ROMAP sensor)	Pad
a (near P152)	SPM Ions 1	PC10	SPM channeltron 1	
b	SPM Ions 2	PC20	SPM channeltron 2	
c	SPM electrons	PC30	SPM channeltron 3	
d (near P153)	SPM Faraday Cup	PC34	SPM	

The cable between E-Box and Sensor consists of 4 shielded strings.

W141 → Sensor - High voltage Box

Separate connectors for each line are inside the HV-Box
The HV lines have to be connected during integration



Pin No	Destination in Warm Area	Destination in Cold Area	Color
A	electron-CEM voltage	electron-CEM	black
B (nc)	GND	outer hemispherical plates	green
C	deflection +/-	deflection plate 1	black
D	deflection -/+	deflection plate 2	red
E	analyser	hemispherical energy analyser	black
F	ion-CEM voltage	both ion-CEM‘s	black

W417 / W447 → Sensor - Temperature Control

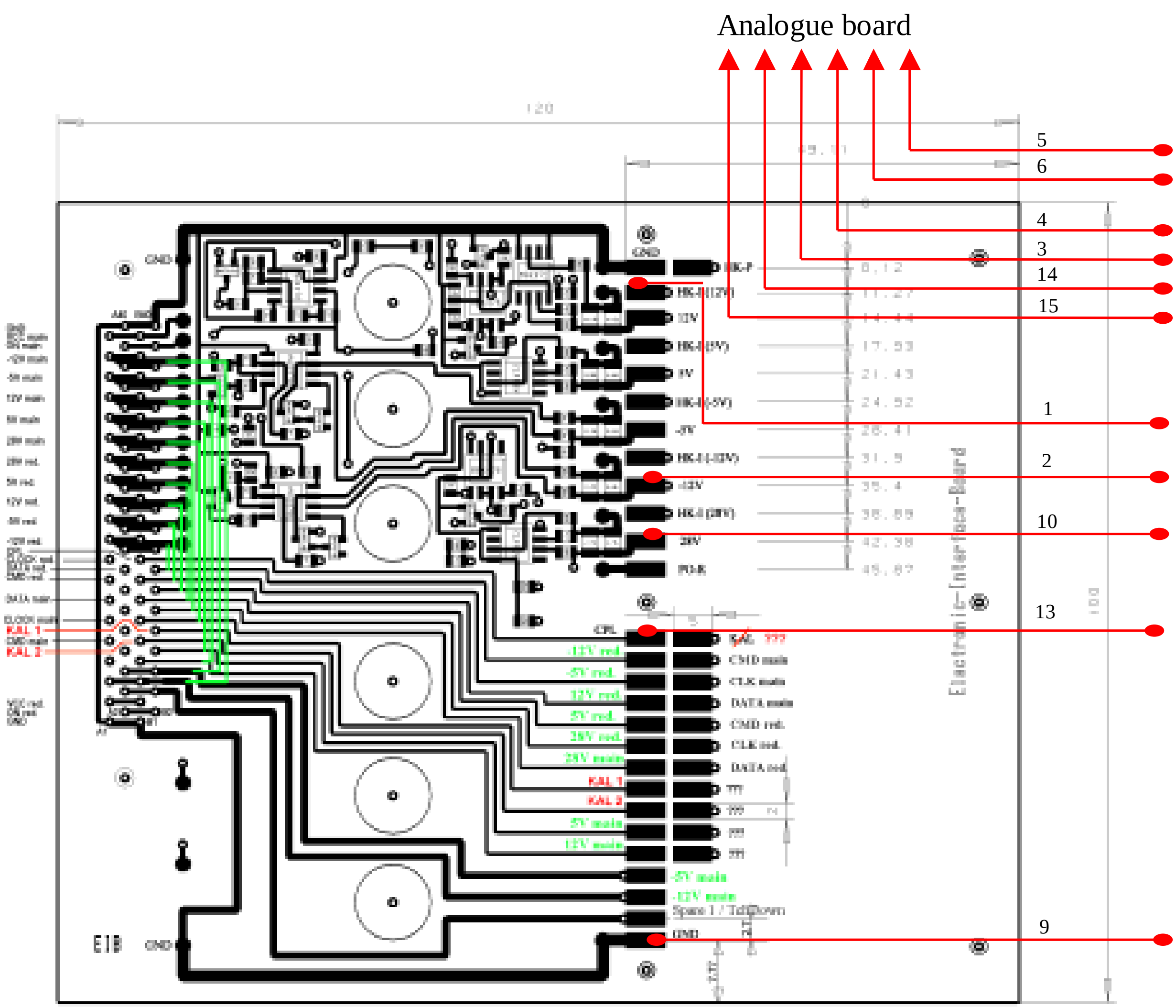
Two lines, connected with a PT 1000 on the sensor, will be passed parallel with the other sensor cables the boom. The cables ends 30cm behind the ROMAP hinge with a mini connector (MCS DB1-02P). The second PT 1000 is mounted on the hinge. The 30cm pigtail ends also with a mini connector (MCS DB1-02P). Both mini connectors will be connected with the TCU cables W417 and W447 after passing the thermal cover. The thermal sensors near the pressure sensors are completely managed by the TCU team.

W134 → Launch Lock - Release Control

Four (two redundant) lines, connected with a resistor for the release mechanism on the launch lock, will be passed through the thermal cover into the warm area. The cable ends are not connected until integration.

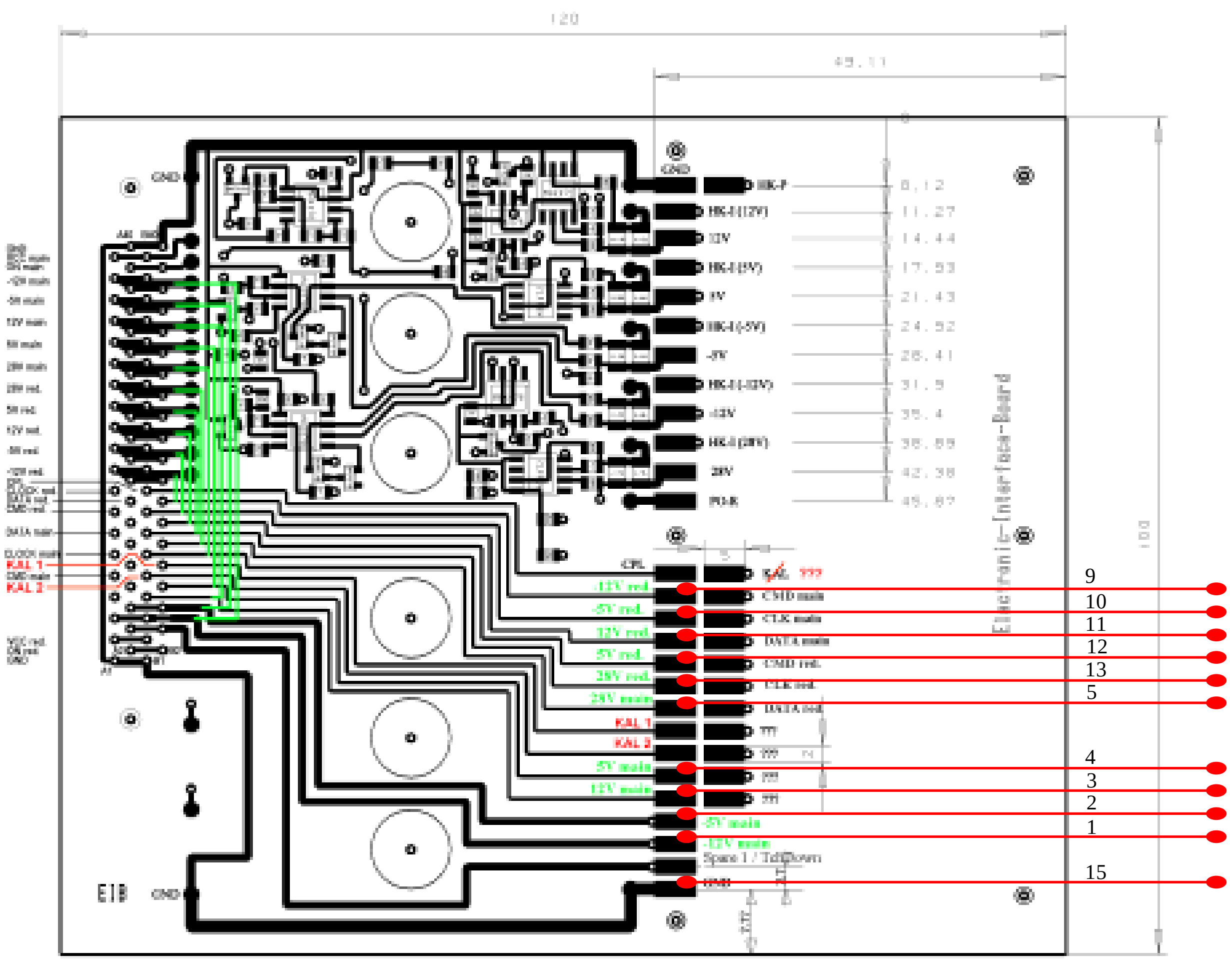
P153 → Cable to E-Box Pressure (female) - ROMAP electronics (male DCDM 15):

Pin No	Signal Name	Board	Pad
1	+12V	Interface board	+12V
2	-12V	Interface board	-12V
3	nc		
4	nc		
5	Penning on	Analogue board	PEN ON
6	Pirani on	Analogue board	PIR ON
7	HK temperature	Analogue board	P TEMP P
8	HK penning	Analogue board	P HK PEN
9	GND power	Interface board	GND
10	+28V	Interface board	+28V
11	nc		
12	nc		
13	CPL (weiß)	Interface board	CPL
14	HK pirani	Analogue board	P HK PIR
15	GND signal	Analogue board	PP4



P152 → Check out cable (female) - ROMAP electronics (male DCDM 15):

Pin No	Signal Name	Board	Pad
1	-12V main	Interface board	-12V main
2	-5V main	Interface board	-5V main
3	+12V main	Interface board	+12V main
4	+5V main	Interface board	+5V main
5	+28V main	Interface board	+28V main
6			
7			
8			
9	-12V red.	Interface board	-12V red.
10	-5V red.	Interface board	-5V red.
11	+12V red.	Interface board	+12V red.
12	+5V red.	Interface board	+5V red.
13	+28V red.	Interface board	+28V red.
14			
15	GND	Interface board	GND



P352/P353 (W483) → Pirani sensor cable:

Pin No P152	Pin Name	Pin No P153
1	Pirani +	1
2	Mittelabgriff	2
3	GND Pirani	3
4	GND Penning	4

P351/P354 (W161) → Penning sensor cable:

Pin No P152	Pin Name	Pin No P153
1	HV signal	1
2	Shielding	2

List of ROMAP Harness

Harness No.	Source Unit/Conn. No.		Target Unit/Conn. No.		Function	Cable Types Wire AWG	Biegerad. (mm)	Length (m)	Supplier Exp./ S/C
W134	CE-Box Y1	P127	ROMAP Launch L.	pigtale	Boom Release	4*AWG30	15		LG
W141	CE-Box Z	P151	ROMAP sensor	pigtale	High voltage	6*AWG36SL	15	64cm	ROMAP
W473	CE-Box Z	P154	ROMAP sensor	pigtale	MAG signals	16*AWG32SL	10	50cm	ROMAP
W484	CE-Box Z	P150a-d	ROMAP sensor	pigtale	SPM signals	4*shielded cables	15	57cm	ROMAP
W160	CE-Box Z	P153	ROMAP PE-box	P350	Pressure Measurem.	10*AWG30	15		ROMAP
W161	PE-Box Z	P351	Penning Sensor HV	P354	HV Penning.	1*shielded HVcable			ROMAP
W483	PE-Box Z	P352	Pirani Sensor	P353	Sign. Penning + Pirani	4*AWG32TP			ROMAP
W417	CE-Box Y1	P118	Pt1000 at Romap sensor *	pigtale	t.sens ROMAP sensor	2*AWG32TP			TCU/ROMAP**
W447	CE-Box Y1	P121	Pt1000 at Romap hinge *	pigtale	t.sens Hinge Plate	2*AWG32TP			TCU
W407	CE-Box Y1	P118	Pt1000 at pressure sensor *	pigtale	t.sens Pressure main	2*AWG32TP			TCU
W437	CE-Box Y1	P121	Pt1000 at pressure sensor *	pigtale	t.sens Pressure red	2*AWG32TP			TCU

* via mini connector MSC DB 1-028 (Pin on Pt1000 pigtail, Socket at cable to TCU electronics)

** Romap is responsible for the Pt1000 pigtail, the distance between hinge and mini connector has to be 30cm

List of ROMAP Connectors:

Experiment Unit	Conn. No.	Function	Connector Type	Manufacturer
CE-Box Z	P150a-d	SPM sensor	4 * BNC	
CE-Box Z	P152	PSS check out	DCDM 15P	Glenn Air
CE-Box Z	P153	Pressure sensor	DCDM 15P	
CE-Box Z	P154	MAG sensor	MCPM 21S	Malco
CE-Box Z	P151	HV-SPM sensor	6 single contacts	
CE-Box Y	P127	Boom Release		Glenn Air
PE-Box	P350	to CE-Box Romap	MCDM15S	
PE-Box	P351	Penning sensor HV	178-7111	Reynolds
PE-Box	P352	Pirani sensor	MCDM9P	Glenn Air
Pi-Sensor	P353	to Pirani electronics	MCDM9S	Glenn Air
Pe-Sensor	P354	to Penning electronics	178-7111	Reynolds
interrupt W417	------	Sensor Temperature	MCS DB1-02 Pin	

4.4.3 Shielding requirements

A common screen is not necessary.

4.4.4 Moving cables

Both sensor cables have a high flexibility in a wide temperature range
see GSC-05-80499-00 used for EQUATOR-S (-150°C...200°C)

4.4.5 Connector philosophy

The boom mounted sensors have Pig Tails (Pin). The sockets are located on the Romap Front plate of the common e-box. All other connection between the experiment parts are realized by connecting cables.

4.4.6 Internal Harness

Interface Board to others:

Pad interface board	Destination	Color	Pad / Pin
HK-P	Analogue board	weiß	PI1
GND (top)	Analogue board Analogue board Controller board HV box connector	schwarz schwarz schwarz schwarz	PPO2 PC GND CON 4 A5
HK-I (+5V)	Analogue board	rot	PI3
+5V	Analogue board Controller board HV box connector	rot rot rot	PPO1 PWR-CON P1 A2
+12V	J153	rot	Pin1
HK-I (-5V)	Analogue board	blau	PI4
-5V	Analogue board HV box connector	blau blau	PPO3 A9
-12V	J153	blau	Pin2
HK-I (28V)	Analogue board	braun	PI2
28V	HV box connector J153	braun braun	A4 Pin10
CMD A	Controller board	rot	SSCMDM
CLK A	Controller board	blau	SSCLKM
DATA A	Controller board	schwarz	SSDATM
CMD B	Controller board	braun	SSCMDR
CLK B	Controller board	gelb	SSCLKR

DATA B	Controller board	weiß	SSDATR
Safety Plug (CPL)	HV box connector		A6
-12V red.	J152	weiß	Pin9
-5V red.	J152	weiß	Pin10
12V red.	J152	weiß	Pin11
5V red.	J152	weiß	Pin12
28V red.	J152	weiß	Pin13
-12V main	J152	weiß	Pin5
-5V main	J152	weiß	Pin4
12V main	J152	weiß	Pin3
5V main	J152	weiß	Pin2
28V main	J152	weiß	Pin1
GND (bottom)	J153 J152	schwarz schwarz	Pin9 Pin15

Analog board to others

Pad analogue board	Signal	Color	Destination	Pad
P1	A0	grün	Controller board	MA1
P2	A1	grün	Controller board	MA2
P3	A2	grün	Controller board	MA3
P4	A3	grün	Controller board	MA4
P5	D0	grün	Controller board	MD0
P6	D1	grün	Controller board	MD1
P7	D2	grün	Controller board	MD2
P8	D3	grün	Controller board	MD3
P9	D4	grün	Controller board	MD4
P10	D5	grün	Controller board	MD5
P11	D6	grün	Controller board	MD6
P12	D7	grün	Controller board	MD7
P13	D8	grün	Controller board	MD8
P14	D9	grün	Controller board	MD9
P15	D10	grün	Controller board	MD10
P16	D11	grün	Controller board	MD11
P17	D12	grün	Controller board	MD12
P18	D13	grün	Controller board	MD13
P19	D14	grün	Controller board	MD14
P20	D15	grün	Controller board	MD15
P21	/CS	grün	Controller board	CSIO2
P22	/RD	grün	Controller board	MAGRD
P23	/WR	grün	Controller board	MAGWR
P24	INT	grün	Controller board	EI4
P25	/RES	grün	Controller board	MAGRES
P26	CLK	grün	Controller board	ICLK
PS7	SPM Range	grün	Controller board	SPMRB
PC12	ION 1	braun	Controller board	ION1
PC22	ION 2	gelb	Controller board	ION2

PC32	EL 1	weiß	Controller board	EL1
PX1	Sec.X1	grün	J154	PIN 13
PX2	Sec.X2	grün	J154	PIN 2
PX3	FBX1	grün	J154	PIN 16
PX4	FBX2	grün	J154	PIN 5
PY1	Sec.Y1	grün	J154	PIN 14
PY2	Sec.Y2	grün	J154	PIN 3
PY3	FBY1	grün	J154	PIN 17
PY4	FBY2	grün	J154	PIN 4
PZ1	Sec.Z1	grün	J154	PIN 15
PZ2	Sec.Z2	grün	J154	PIN 4
PZ3	FBZ1	grün	J154	PIN 18
PZ4	FBZ2	grün	J154	PIN 7
PE1	Excitation1	grün	J154	PIN 1
PE2	Excitation2	grün	J154	PIN 12
PHK3	HK +6.5V	weiß	HV BOX	A7
PHK4	HK Analyser	blau	HV BOX	B2
PHK5	HK Def1	braun	HV BOX	B4
PHK6	HK Def2	rot	HV BOX	B3
PC30	SPM Electr.		J150c	
PC31	Abschirmung			
PC10	SPM ION 1		J150a	
PC11	Abschirmung			
PC20	SPM ION 2		J150b	
PC21	Abschirmung			
PC34	SPM Far. Cup		J150d	
PC33	Abschirmung			
PS1	Analyser_LR	blau	HV Box	A1
PS2	Def1FC_LR	weiß	HV Box	B6
PS3	Def2_LR	schwarz	HV Box	B8
PS4	Analyser_HR	rot	HV Box	B1
PS5	Def1FC_HR	braun	HV Box	B5
PS6	Def2_HR	blau	HV Box	B7
PS8	Ref HV	gelb	HV Box	A3
P HK Pen	P HK Pen	braun	J153	Pin8
P HK Pir	P HK Pir	gelb	J153	Pin14
P HK Tempp	P HK Tempp	blau	J153	Pin7
PP4	PP4	schwarz	J153	Pin15
PIR on	PIR on	rot	J153	Pin13
PEN on	PEN on	weiß	J153	Pin5
PI1	HK-P	weiß	Interface board	HK-P
PI2	HK-I(28V)	braun	Interface board	HK-I(28V)
PI3	HK-I(+5V)	rot	Interface board	HK-I(+5V)
PI4	HK-I(-5V)	blau	Interface board	HK-I(-5V)
PC GND	GND	schwarz	Interface board	GND top
PP01	+5V	rot (AWG 28)	Interface board	+5V
PP02	GND	schw. (AWG 28)	Interface board	GND top
PP03	-5V	blau (AWG 28)	Interface board	-5V

HV boards to others

Pad HV-connector	Signal	Color	Destination	Pad
A1	Analyser LR	blau	Analogue board	PS1
A2	+5V	rot	Interface board	+5V
A3	Ref. HV	gelb	Analogue board	PS8
A4	+28V	braun	Interface board	+28V
A5	GND	schwarz	Interface board	GND
A6	CPL	weiß	Interface board	CPL
A7	HK +6.5V	weiß	Analogue board	P HK 3
A8	HV on	braun	Controller board	SPMON
A9	-5V	blau	Interface board	-5V
B1	Analyser HR	rot	Analogue board	PS4
B2	HK Analyser	blau	Analogue board	P-HK4
B3	HK Def2	rot	Analogue board	P-HK6
B4	HK Def1	braun	Analogue board	P-HK5
B5	Def1 HR	braun	Analogue board	PS5
B6	Def1 LR	weiß	Analogue board	PS2
B7	Def2 HR	blau	Analogue board	PS6
B8	Def2 LR	schwarz	Analogue board	PS3

Controller board to others

Pad controller board	Signal	Color	Destination	Pad
EL1	EL 1	weiß	Analogue board	PC32
ION1	ION 1	braun	Analogue board	PC12
ION2	ION 2	gelb	Analogue board	PC22
SPMRB	SPM Range	grün	Analogue board	PS7
SPMON	HV on	braun	HV-Box	A8
GND			nc	
GND$1			nc	
MA1	A0	grün	Analogue board	P1
MA2	A1	grün	Analogue board	P2
MA3	A2	grün	Analogue board	P3
MA4	A3	grün	Analogue board	P4
MD0	D0	grün	Analogue board	P5
MD1	D1	grün	Analogue board	P6
MD2	D2	grün	Analogue board	P7
MD3	D3	grün	Analogue board	P8
MD4	D4	grün	Analogue board	P9
MD5	D5	grün	Analogue board	P10
MD6	D6	grün	Analogue board	P11
MD7	D7	grün	Analogue board	P12
MD8	D8	grün	Analogue board	P13
MD9	D9	grün	Analogue board	P14
MD10	D10	grün	Analogue board	P15
MD11	D11	grün	Analogue board	P16
MD12	D12	grün	Analogue board	P17
MD13	D13	grün	Analogue board	P18
MD14	D14	grün	Analogue board	P19

MD15	D15	grün	Analogue board	P20
CSIO2	/CS	grün	Analogue board	P21
MAGRD	/RD	grün	Analogue board	P22
MAGWR	/WR	grün	Analogue board	P23
EI4	INT	grün	Analogue board	P24
MAGRES	/RES	grün	Analogue board	P25
ICLK	CLK	grün	Analogue board	P26
GND$4	GND	schwarz	Interface board	GND top
GND$5			nc	
+5V$1	+5V	rot	Interface board	+5V
+5V$2			nc	
GND$3			nc	
GND$2			nc	
SSDATM	Data main	schwarz	Interface board	DATA main
SSDATR	Data red.	weiß	Interface board	DATA red.
SSCMDR	Cmd red.	braun	Interface board	CMD red.
SSCMDM	Cmd main	rot	Interface board	CMD main
SSCLKM	Clock main	blau	Interface board	CLK main
SSCLKR	Clock red.	gelb	Interface board	CLK red.

4.4.7 Safety plugs

To avoid unintentional switching on of the ROMAP-SPM high voltage supply during ground tests, the common protection line will be used for pulling down the enable line for switching the HV. The interface drawing of this line in given in 1.2.2. (HV switching requirements). Switching on the high voltage supply during ground test could lead to damage of the SPM sensor and of the HV supply itself.

4.4.8 Test connectors

P152 is a PSS test connector. It will be used to measure the supply voltages after integration of all experiments into the CE-Box.

5 Software

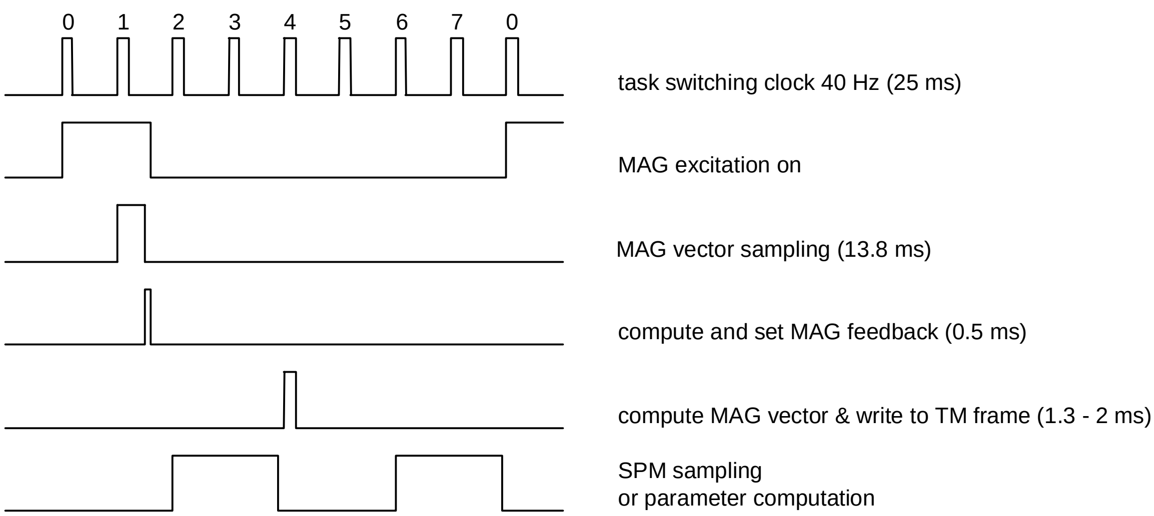
5.1 Software Tasks

Surface Mode

There is time sharing between MAG (50%) and SPM (50%).

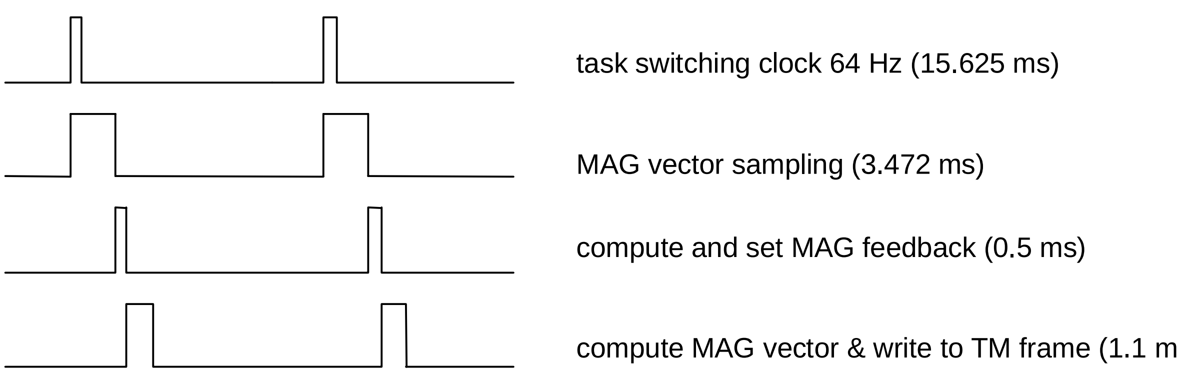
MAG: the cycle time is 200 ms; 5 vectors are averaged => 1 Hz vectors generated
excitation is switched off if vector sampling finished MAG (reduced power consumption)

SPM: sampling of counts or computation of parameters



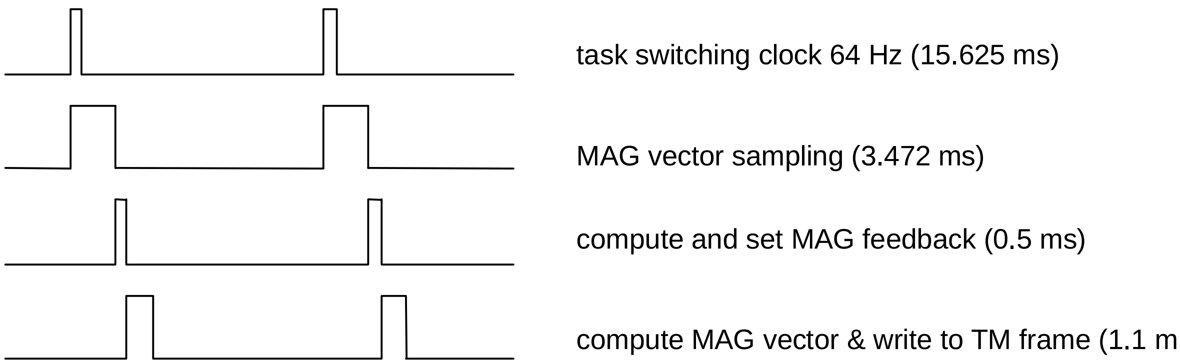
Slow MAG Mode

Only MAG is working. The task switching clock is used to initiate sampling every 15.625 ms.
64 vectors are averaged to one, which results in a 1Hz vector output.
The MAG excitation is continuously on.



Fast MAG Mode

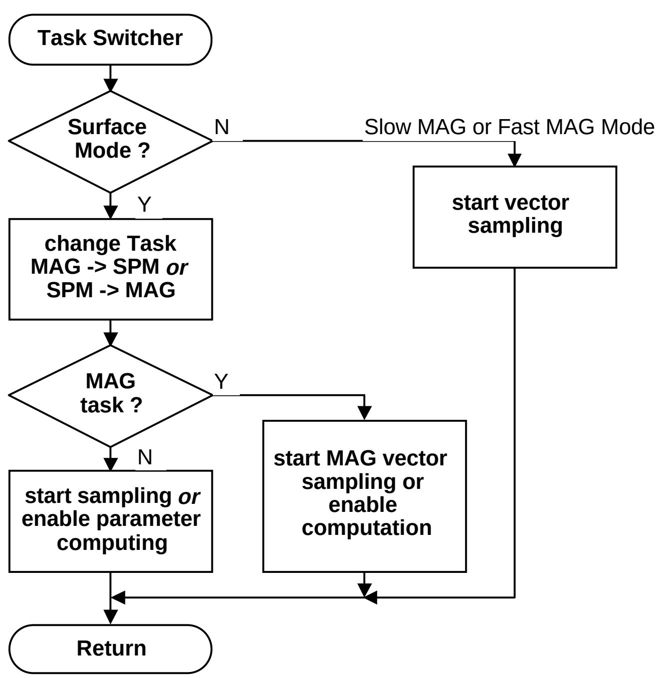
Only MAG is working. The task switching clock is used to initiate sampling every 15.625 ms. No vector averaging is used. The MAG excitation is continuously on.



5.2 Software Modules

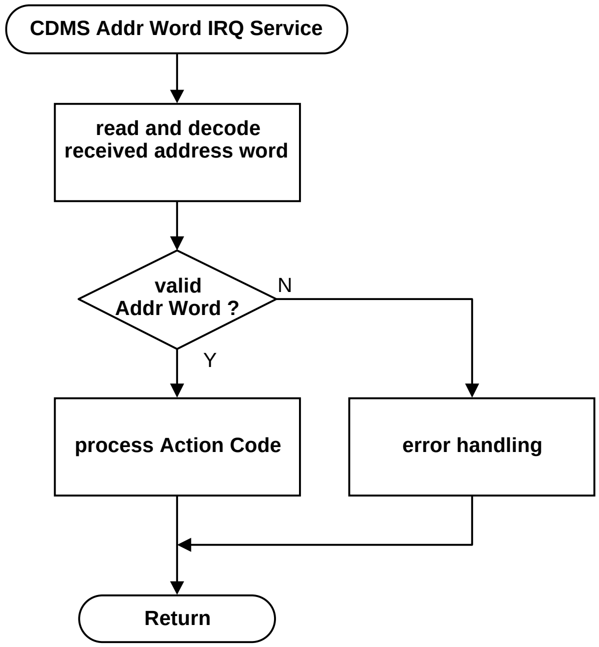
Task Switcher Module

The task switcher module is an interrupt service procedure and is activated by the rising edge of the task switching clock.



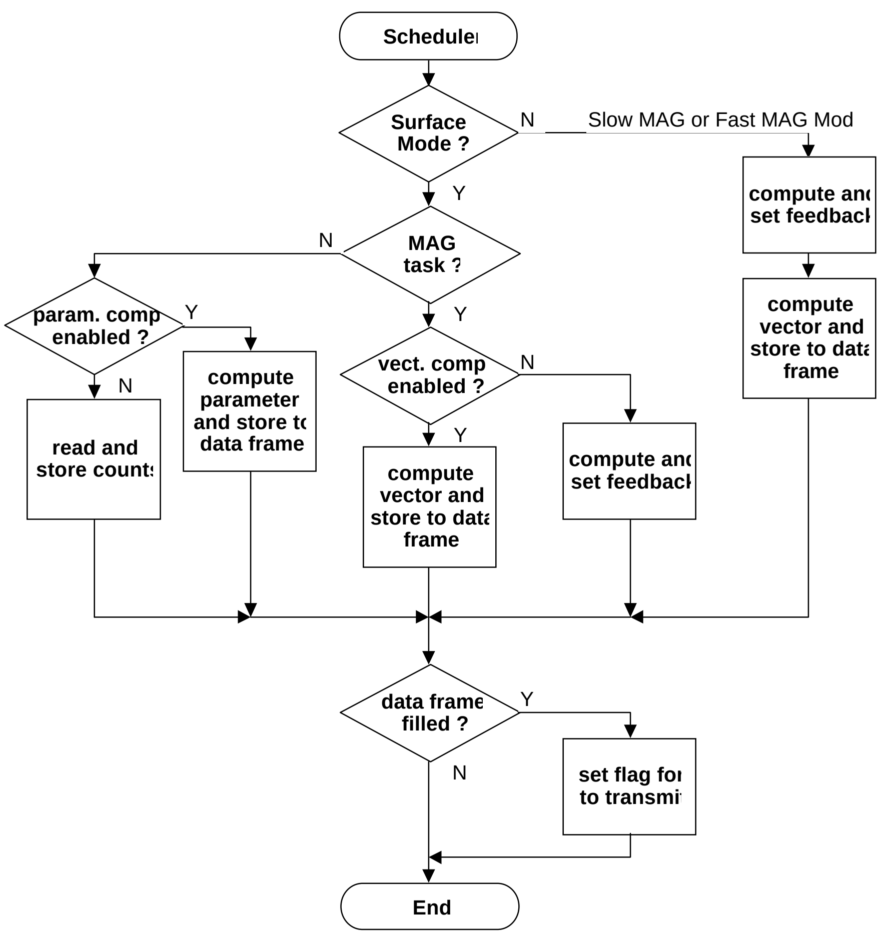
CDMS Address Word IRQ Service Module

This module is activated by CDMS Address Word interrupt. The Action Code processing is done directly in the interrupt service procedure because most Action Codes require immediate reaction.



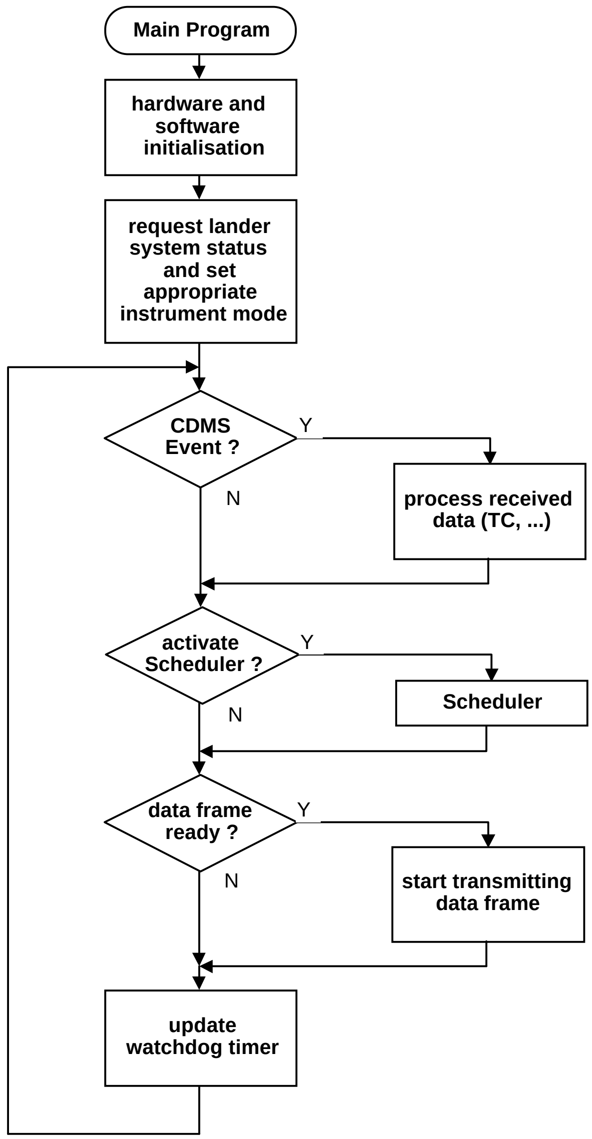
Scheduler Module

The scheduler module is activated after data sampling for one vector (MAG) or for a step (SPM) finished *or* after computation was enabled by the Task Switcher module



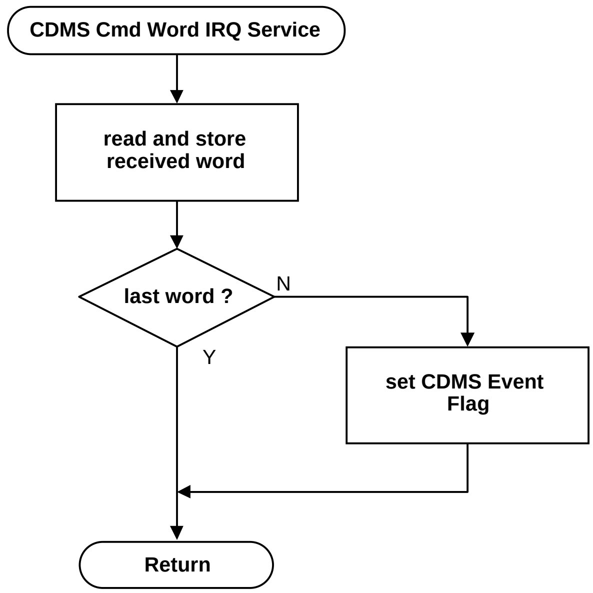
Main Program Module

The main program module implements the endless loop for main program.



CDMS Command Word IRQ Service Module

This interrupt service module is activated by CDMS Command Word interrupt.
An event flag is set after whole command sequence was read.



5.3 Language and Development Platform

The ROMAP-Controller is programmed in the language **Forth**. This language was chosen because the RTX2010 processor implements Forth as machine language and therefore executes it very efficiently.
An IBM-PC compatible is used as development platform.
No tools for graphical software analysis are currently available

5.4 Verification and Validation Concept

Forth requires bottom-up software implementation and offers no conventional debugger.
Forth words are implemented from bottom up and can be extensively tested at the target hardware or on a Forth system under Windows, if they are hardware independent.
Special care must be taken for correct stack handling.

5.5 Analysis and Test of the Hardware – Software Interaction

CDMS:

The CDMS interface is integrated using a proven design (CIC). The design is extensively simulated in the FPGA development system. There will be extensive tests of the interface by using the CDMS simulator and observing the interface by logic state analyser.

MAG:
A simple interface is used between MAG and the Controller (easy to analyse).
Extensive real-world tests in known magnetic environment will be performed, which helps detecting errors in hard- and software.

SPM:
A simple interface is also used between SPM and Controler (same as for MAG).
The SPM output can be simulated with a pulse generator for checking hardware counters and software. Calibration tests will be done with the SPM sensor in a vacuum chamber.

6 Romap Electronics Delivery

6.1 Transport and Installation Procedure

This section describes the packing, unpacking and installation of Romap electronics FM-1.
The Romap team is responsible for the transport of the flight electronics to the integration room in Lindau. At the integration room the flight hardware will be installed by personal from Lander and Romap team.
For all electrical test the Romap team provides a magnetometer sensor to consume the representative power. To shield the terrestrial field from the sensor (designed for fields less than 1000nT) a ferromegnetic box will be provided by the Romap team.

6.2 Hazards and Safety

The Romap FM-1 is a small unit and requires no specialised lifting equipment.

Anti-Static precautions shall be taken at all times. Both data and power lines have to be non powered during integration of Romap into the CE-Box. The CPL as well as the CE-Box (including the Romap cover plate) have to be grounded before switching on Romap.

Romap contains no pressure vessels, no harmful chemical substances, no pyrotechnic devices and no radioactive substances.

The high voltage (up to 6 keV) is on in the surface mode. Please don't touch the high voltage connector.

7 Electrical Tests during Incoming Inspection

In the following section tests are described, which demonstrate the functionality of the Romap electronics and the interaction with the CDMS.
At first the signals at the connectors P151,P152 and P53 have to be checked (see 7.2 - 7.4). Connector P154 can't be tested separately. The MAG data (measured with the EQM2 sensor) are test criteria for this connector.
In short and complete functional tests (see 7.5; 7.6) all soft- and hardware functions will be tested. HK-values are the test criteria. Nominal values as well as upper and lower limit are given in the following chapters. Detailed drawings are given in Attachment 11.

7.1 Conversation table for the HK-values

ID	*HK Channel*	*Conversation*	*Unit*
0	Controller Status bits	-	
1	Last received TC (word 1)	-	
2	Last received TC (word 2)	-	
3	overall instrument power consumption	P = 0.3052 N	[mW]
4	+5V current	I = 0.03815 N	[mA]
5	–5V current	I = 0.003815 N	[mA]
6	electronics temperature	T = 0.03608 N -253.0	[°C]
7	+28V current	I = 0.001908 N	[mA]
8	SPM HV status 1	U = 0.0000763 N	[V]
9	SPM HV status 2	U = 0.0000763 N	[V]
10	SPM HV status 3	U = 0.0000763 N	[V]
11	SPM HV status 4	U = 0.0000763 N	[V]
12	Penning pressure	U = 0.0000763 N	[V]
13	Pirani pressure	U = 0.0000763 N	[V]
14	PROM checksum (computed at power-up)	-	
15	Instrument Error Flags	-	

Frequency of HK values is 0.03125Hz

7.2 Test of the checkout connector (P152)

P152 has to be connected with a break out box. (If not available Romap provides a break out board). PSS has to be switched on, Romap has to be still switched off. The supply voltages have to be measured (Pin allocation see chapter 4.4.2)

7.3 Test of the pressure connector (P153)

P153 has to be connected with a break out box. (If not available Romap provides a break out board). PSS has to be switched on, Romap has to be switched on (default mode).

1. Pin 9 (GND power) and Pin 15 (GND signal) have to be 0Ohm (<1Ohm) to the Ground of the Box).
2. All measurements have to made with respect to Pin 15.
3. The following sequence has to be performed:

Step	**Step Description**	**Nominal Value**	**Remark**
1	Send command to PSS: Switch ON ROMAP	Pin 1 (+5V): +5V Pin 2 (-5V): -5V Pin 10 (28V): 28V	ROMAP is switched ON; HK data collection starts
2	TC ... is sent after 200sec	Pin 5 (Penning on): +5V Pin 13 (Pirani on): 0V	set Penning on
3	TC ... is sent after 400sec	Pin 5 (Penning on): 0V Pin 13 (Pirani on): 0V	set Penning off
4	TC ... is sent after 600sec	Pin 5 (Penning on): 0V Pin 13 (Pirani on): +5V	set Pirani on
5	TC ... is sent after 800sec	Pin 5 (Penning on): 0V Pin 13 (Pirani on): 0V	set Pirani off
6	after 1000sec Pin 8 (HK/Penning) to +1V Pin 14 (HK/Pirani) to -1V	HK 12: 0.9 ...1.0V HK 13: -0.9 ...-1.0V	check Pressure HK
7	after 1200sec Pin 8 (HK/Penning) to -1V Pin 14 (HK/Pirani) to +1V	HK 12: -0.9 ...-1.0V HK 13: 0.9 ...1.0V	check Pressure HK
8	after 1400sec Pin 8 (HK/Penning) to 0V Pin 14 (HK/Pirani) to 0V	HK 12: -0.05 ...0.05V HK 13: -0.05 ...0.05V	check Pressure HK
9	Send after 1600sec command to PSS: Switch OFF ROMAP		ROMAP is switched OFF; HK data collection stops

7.4 Test of the HV-connector (P151)

Connect P154 with magnetometer sensor (EQM-2). The MAG sensor has to be located in a box made by ferromagnetic material to suppress the Earth field. With the help of a high voltage probe and an oscilloscope the voltage at Pin A-F of P151 (versus GND at Pin B)has to be measured after switching the instrument into the surface mode (low resolution, short exposition time). The results must be identical with the drawings in Appendix 12.

7.5 Short Functional Test

Connect P154 with magnetometer sensor (EQM-2). The MAG sensor has to be located in a box made by ferromagnetic material to suppress the Earth field.

A) Test Conduction: (22Min.)

Step	**Step Description**	**Nominal Value**	**Remark**
1	Send command to PSS: Switch ON ROMAP		ROMAP is switched ON; HK data collection starts
2	1. TC Packet is sent after 30 sec TC: MODE (1001 4000 1001 4000)	First scientific data frame after 60 sec, then every 30 sec	Set SLOW MODE
3	2. TC packet is sent after 360 sec TC: MODE (1001 0000 1001 0000)	First scientific data frame almost immediately, then 2 frames per sec	Set FAST MODE
4	3. TC packet is sent after 460 sec TC: MODE (1001 81BA 1001 81BA)	MAG: 1 science frame / 30s after SPM initialisation SPM: 1) 40s initialisation 2) CAL: 10 frames / 432s 3) 40s initialisation 4) after CAL: 9 frames / 67.2s RAW; 2*2 frames / 2*86.4s PARAM	SURFACE-Mode with Calibration cycles; Low-Short cycles after calibration during calibration instrument status shows current HV step in last digit; after calibration it shows the selected step
5	Wait for time offset 1280 sec		4. HK packet is completed
6	Send command to PSS: Switch OFF ROMAP		ROMAP is switched OFF; HK data collection stops

B) Offline TM Verification:

Step	**Check List**	**Nominal Value**	**Remark**
1.	Number of Science Packets: Number of HK Packets: HK0 (controller status): HK1 (last TC W1): HK2 (last TC W2): HK3 (Instrument Power): HK4 (Current +5V): HK5 (Current -5V): HK6 (Temperature): HK7 (Current 28V): HK8 (Analyser HV):	10 1 4600 1001 4000 700...800mW 85...100mA 45...60mA $T_{room.}$...T_{room} +10°C 0...1mA -0.05...0.05V	 SLOW MODE

2.	Number of Science Packets: Number of HK Packets: HK0 (controller status): HK1 (last TC W1): HK2 (last TC W2): HK3 (Instrument Power): HK4 (Current +5V): HK5 (Current -5V): HK6 (Temperature): HK7 (Current 28V): HK8 (Analyser HV):	100 0 0600 1001 0000 700...800mW 85...100mA 45...60mA $T_{room.}$...T_{room} +10°C 0...1mA -0.05...0.05V	FAST MODE
3.	Number of Science Packets: Number of HK Packets: HK0 (controller status): HK1 (last TC W1): HK2 (last TC W2): HK3 (Instrument Power): HK4 (Current +5V): HK5 (Current -5V): HK6 (Temperature): HK7 (Current 28V): HK8 (Analyser HV):	10 MAG + 6 SPM 3 8600 1001 81ba 600...700mW 60...80mA 20...40mA $T_{room.}$...T_{room} +10°C 3...6mA 1.3...1.6V / CPL open	SURFACE MODE (short exp. time, low resolution, with calibration)

7.6 Complete Functional Test

Connect P154 with magnetometer sensor (EQM-2). The MAG sensor has to be located in a box made by ferromagnetic material to suppress the Earth field.

A) Test Conduction: (67 Min.)

Step	**Time**	**Action (all values in hex)**	**Nominal Ouput**	**Remark**
1	0	Start HK-Collection; Setup ROMAP TC-Buffer: (TCBuf-Offset: Value) 0: 9EBA 1: FFFF 2: 0000 3: 0000 4: 0000 5: 0000 6: 0006 7: 9EBF		HK collection has to be restarted because HK data collection corresponds to science data collection for this test!!
2	5	switch ROMAP ON		

3	30	TC: GET-MAG (0440 0000 0440 0000)	1 science frame/30s (8 frames generated) Controller Status: 4602h Instrument Status: 4000h	SLOW Mode, MAG in open-loop
4	280	switch ROMAP OFF		
5	285	switch ROMAP ON		
6	300	TC: MODE (1001 4000 1001 4000)	1 science frame / 30s (8 frames generated) Controller Status: 4600h Instrument Status: 4000h	SLOW Mode
7	550	TC: MODE (1001 0000 1001 0000)	1 science frame / 0.469s (490 frames generated) Controller Status: 0600h Instrument Status: 0000h	FAST Mode
8	780	TC: MODE (1001 4000 1001 4000)	1 science frame / 30s Controller Status: 4600h Instrument Status: 4000h	SLOW Mode
9	820	TC: STORE-P (2002 0000 2002 0000)		write pressure values to BRAM. Controller Status and Error flags should show no BRAM access error conditions
10	860	TC: Penning-OFF (0110 0000 0110 0000)	Controller Status: 4400	switch Penning pressure sensor off
11	900	TC: Pirani-OFF (0220 0000 0220 0000)	Controller Status: 4000	switch Pirani pressure sensor off
12	940	TC: Penning-ON (0110 FFFF 0110 FFFF)	Controller Status: 4200	switch Penning pressure sensor on
13	980	TC: Pirani-ON (0220 FFFF 0220 FFFF)	Controller Status: 4600	switch Pirani pressure sensor on
14	1020	TC: STORE-P (2002 0000 2002 0000		write pressure values to BRAM. Controller Status and Error flags should show no BRAM access error conditions
15	1040	TC: MODE (1001 81BA 1001 81BA)	Controller Status: 8600h Instrument Status: 81BXh MAG: 1 science frame / 30s after SPM initialisation SPM: 1) 40s initialisation	SURFACE-Mode with Calibration cycles; Low-Short cycles after calibration during calibration instrument status shows current HV step in last digit; after

			2) CAL: 10 frames / 432s 3) 40s initialisation 4) after CAL: 9 frames / 67.2s RAW; 2*2 frames / 2*86.4s PARAM	calibration it shows the selected step
16	1830	TC: MODE (1001 9EBA 1001 9EBA)	Controller Status: 8600h Instrument Status: 9EBAh MAG: 1 science frame / 30s after SPM initialisation SPM: 1) 40s initialisation 2) 15 frames / 672s RAW; 2*3 frames/ 2*704s PARAM	SURFACE Mode; High-Long cycles
17	4000	switch ROMAP OFF		

B) Offline TM Verification:

The data evaluation (HK and Science) of the CFT will be done by the Romap team during the incomming inspection.

8 Reports

8.1 Process List

No	Process	Standard	By
1.	Manufacturing printed circuit boards	protocol see Appendix 4 ADP FM1	Straschuh
2.	Mounting / Soldering	ESA ...	smd Lötservice Berlin
3.	Manufacturing internal harness / cutting	description of tools see appendix 4 ADP FM1	M.Erdmann MPE
4.	cleaning	description of procedure see appendix 4 ADP FM1	M.Erdmann MPE
5.			

8.2 ECR's and NCR's

ECR's and NCR's are attached in Appendix 8 (if any).

8.3 Connector Mating Record

Date	*Interface Connector*	*P154 (Sensor)*	*P153 (Pressure)*
01.03.	1	1	1
27.04.	1		
04.05.	1		
17.05.	4		

8.4 Test and Calibration Reports

All test reports are given in the following Appendixes:

Attachment 4: Thermal vacuum test
Attachment 5: Thermal balance test
Attachment 6: Inrush current measurement
Attachment 7: functional tests

All calibration reports are given in the Appendixes of the sensor ADPs:

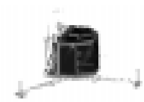
8.5 Open Work / Deferred Work / Open Tests

Open Work	*Schedule*	*Status*

8.6 Historical Record Sheets

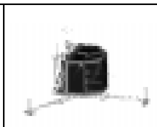
Pos.	**Date**	**Start Time**	**End Time**	**Operation**	**Location / Facility**	**Reference/ Drawing Nr.**	**En**	**Remarks**	**Operator / executer**	**QA**
HV-Box										
1.	08.18. 2000			Manufacturing mechanics	Rigó L. vállalkozó	ŰD 2000/1-200/…			L. Rigó	I.Apáthy
2.	12.05. 2000			Modifying electrical schematics	KFKI AEKI	HV-CTR2.SCH/Rev3			S.Cseri	I.Apáthy
3.	12.14. 2000			Modifying electrical layout	KFKI AEKI	HV-CTR2.BRD/Rev3			S.Cseri	I.Apáthy
4.	01.08. 2001			Manufacturing printed circuit boards	Hitelap Kft.	HV-CTR1.SCH,BRD/Rev2 HV-CTR2.SCH,BRD/Rev3 HV-MOD.SCH,BRD/Rev2 HV-COMP.SCH,BRD/Rev2			S.Cseri	I.Apáthy
5.	01.15. 2001			Mounting Control1-Board	KFKI AEKI	HV-CTR1.SCH,BRD/Rev2	C		S.Cseri	I.Apáthy
6.	01.19. 2001			Mounting Modul-Board	KFKI AEKI	HV-MOD.SCH,BRD/Rev2	C		S.Cseri	I.Apáthy
7.	01.22. 2001			Manufacturing transformers	KFKI AEKI		C		S.Cseri	I.Apáthy

History Record

	KFKI Atomic Energy Research	**Unit** **ROMAP**	**Sub-Unit** **HV-box**	**Model** **FM-2**		L A N D E R	R O S E T T A	* Environment A = Air G = Gas V = Vacuum C = Clean T = Temperatur	**Reference:** RO-LRO-LI-300020-IA **Issue:** 1 **Rev.:** 1 **Date:** 03.27.01 **Page:** 86/93 **Author :** István Apáthy

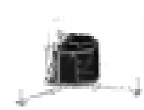
Pos.	Date	Start Time	End Time	Operation	Location / Facility	Reference/ Drawing Nr.	En	Remarks	Operator / executer	QA
8.	01.26 2001			Mounting Control2-Board	KFKI AEKI	HV-CTR2.SCH,BRD/Rev3	C		S.Cseri	I.Apáthy
9.	02.03. 2001			Mounting Comp-Board	KFKI AEKI	HV-COMP.SCH,BRD/Rev2	C		S.Cseri	I.Apáthy
10.	02.08. 2001			Functional testing and tuning Control1- and Control2-Boards	KFKI AEKI	HV-CTR1.SCH,BRD/Rev2 HV-CTR2.SCH,BRD/Rev3	A		I.Apáthy	L.Mihály
11.	02.13. 2001			Functional testing and tuning Modul-Board	KFKI AEKI	HV-MOD.SCH,BRD/Rev2	A		I.Apáthy	L.Mihály
12.	03.01. 2001			Final assembling and visual checking	KFKI AEKI		C		S.Cseri	I.Apáthy
13.	03.02. 2001			Final functional testing and calibrating	KFKI AEKI		A		I.Apáthy	L.Mihály
14.	03.20. 2001	11:20	15:50	Functional testing at +50°C ambient temperature	KFKI AEKI		T		I.Apáthy	L.Mihály
15.	03.21. 2001	08:50	13:20	Functional testing at –50°C ambient temperature	KFKI AEKI		T		I.Apáthy	L.Mihály
16.	03.23. 2001			Integrating with ROMAP	MPAE		A		H.U.Auster	I.Apáthy

History Record

MPAE	Max Planck Institut für Aeronomie	**Unit** **IF-Board**	**Sub-Unit** **ROMAP**	**Model** **FM**		* Environment A = Air G = Gas V = Vacuum C = Clean T = Temperatur	**LANDER**		**Reference:** RO-LRO-LI-300003-RE **Issue:** 1 **Rev.:** 1 **Date:** **Page:** 87 **Author :** R. Enge

Pos.	Date	Start Time	End Time	Operation	Location / Facility	Reference/	Env. *	Remarks	Ope-rator	QA
Interface Platine										
01	05.08. 1998			Fertigung Power-Switch-Board	Brockstedt GmbH					
02	18.01. 1999			Fertigung Electronic-Interface-Board	Brockstedt GmbH					
03	27.01. 1999			Bestückung Power-Switch-Board	Alpha Laytron					
04	05.03. 1999			Bestückung Electronic-Interface-Board	Alpha Laytron					
05	05.10. 1999			Endbestückung, Zusammenbau und visuelle Kontrolle	MPAE				G.S.	
06	14.04. 2000			Funktionstest	MPAE				R.E.	
07	17.04. 2000			Einkleben der Relais und Montage des Winkels	MPAE				G.S.	

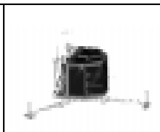
History Record

TU-Braunschweig Germany	Unit E-Box Electronic	Sub-Unit Romap	Model FM-2		* Environment A = Air G = Gas V = Vacuum C = Clean T = Temperatur	LANDER		Reference: RO-LRO-LI-300021-UA Issue: 1 Rev.: 0 Date: 19.06.01 Page: 88 Author : U. Auster

Analogue + Controller Board

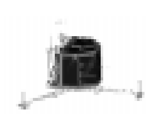
Pos.	Date	Oper. Time	Operation	Location / Facility	Reference/	Env. *	Remarks	Ope-rator	QA
			Integration in Berlin						
01	18.01.		manufacturing of the boards	Straschuh					
02	02.02.		soldering of the boards	SMD Lötervice Berlin					
03	05.02.		manufacturing of preliminary harness	MPE Berlin				ME, UA	
04	06.02 10.02.	20h	first test of the boards, adjustment input amplifier, phase adjustment, determination of sensitivity	Magson Berlin			06.02.: Union gewinnt im DFB Halbfinale gegen Glad-bach im Elfmeterschiessen	RK, UA	
			Mag-Calibration in Graz						
01	27.02.	4h	Integration Controller	IWF Graz				GB, RK, WM, UA	-
02	01.03.	12h	test DAC's, test sensitivity (open and close loop) measurement over night	IWF Graz			01mar01_1322_romap 01mar01_1348_romap 01mar01_1431_romap 01mar01_1504_romap 01mar01_1817_romap	GB, RK, WM, UA	-
03	02.03.	18h	linearity / scale values measurement	IWF Graz			01mar02_0917_romap 01mar02_1101_romap 01mar02_1124_romap	GB, RK, WM, UA	-

History Record

TU-Braunschweig Germany	**Unit** E-Box Electronic	**Sub-Unit** Romap	**Model** FM-2		* Environment A = Air G = Gas V = Vacuum C = Clean T = Temperatur	L A N D E R		**Reference:** RO-LRO-LI-300021-UA **Issue: 1** **Rev.: 0** **Date: 19.06.01** **Page:** 89 **Author :** U. Auster

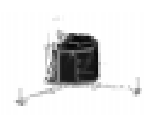
Pos.	Date	Oper. Time	Operation	Location / Facility	Reference/	Env. *	Remarks	Ope-rator	QA
			offset determination noise measurement				01mar02_1443_romap 01mar02_1545_romap 01mar02_1609_romap 01mar02_1730_romap		
04	09.03.	6h	temperature dependency of offset X and Y	IWF Graz		20° 0° -20° -40° -60° -80° -100°	10:00 X: -1.4 Y: +0.6 10:55 X: -1.5 Y: +0.4 11:45 X: -1.2 Y: +0.1 12:36 X: -1.1 Y: -0.6 13:22 X: -1.9 Y: -1.3 14:25 X: -2.4 Y: -0.1 14:42 X: -1.3 Y: -0.6	WM	-
05	13.03.	8h	transfere function temperature dependency of Z offset	IWF Graz		 20° -20° -40° -60° -80° -100° warm up	09:32 12:15 Z: +8.7 13:30 Z: +9.2 14:30 Z: +10.3 15:30 Z: +11.4 16:50 Z: +13.2 17:48 Z: +13.2 01mar13_1816_romap	WM	-
			Tests in Berlin, Lindau, JH						
1	19.03		Change of X and Y amplification (/1.5)	Magson Berlin				RK, UA	
2	22.03		determination of scale values	JH			01mar22_2221_romap X: 459.0 / 449.8	UA	

History Record

TU-Braunschweig Germany	**Unit** E-Box Electronic	**Sub-Unit** Romap	**Model** FM-2		* Environment A = Air G = Gas V = Vacuum C = Clean T = Temperatur	L A N D E R		**Reference:** RO-LRO-LI-300021-UA **Issue: 1** **Rev.: 0** **Date: 19.06.01** **Page:** 90 **Author :** U. Auster

Pos.	Date	Oper. Time	Operation	Location / Facility	Reference/	Env. *	Remarks	Ope-rator	QA
							Y: 502.9 / 500.9 Z: 164.8 / 163.3		
3	23.03	4h	Integration HV box adjustment of DAC outputs substitution of LT1013RH refresh harness measurement during Krokodil (Abbruch nach 208 frames)	Magson Berlin			01mar23_2003_romap	IA, UA	
4	.		Summary of errors: • LT 1013 bei Kurzschluß des Ausgangs mit 28V getötet • Draht von HV-Anschlußplatine (A1) abgerissen • HV-Analyser Spannung muß an Innenwiderstand des DAC's angeglichen werden • RAM ist fehlerhaft (nach langem Erkenntnisprozeß) • eine Spannung auf Interfaceboard schaltet nicht durch					UA	
5	27.03. 29.03.		Integration Mag and SPM Sensor	MPAE Lindau				KHF, TR	
6	02.04. 06.04.		Substitution of RAM	IWF Graz				GB	
7	09.04.	14h	first thermal balance test	Magson Berlin		20° 20° -50° 80°	sft 01apr09_1404_romap sft 01apr09_1431_romap 01apr09_1456_romap sft 01apr09_1532_romap 01apr09_1610_romap sft 01apr09_1643_romap	RK, UA	

History Record

TU-Braunschweig Germany	Unit E-Box Electronic	Sub-Unit Romap	Model FM-2		* Environment A = Air G = Gas V = Vacuum C = Clean T = Temperatur	L A N D E R		Reference: RO-LRO-LI-300021-UA Issue: 1 Rev.: 0 Date: 19.06.01 Page: 91 Author : U. Auster

Pos.	Date	Oper. Time	Operation	Location / Facility	Reference/	Env. *	Remarks	Ope-rator	QA
							01apr09_1704_romap		
8	10.04.	16h	second thermal balance test continously two cycles surface mode, CPL on gnd short test surface mode, CPL on +5V	Magson Berlin			01apr10_1750_romap 01apr11_0904_romap	UA	
9	12.04.	1h	mechanical integration of E-boards test with and without HV	MPE Berlin Magson Berlin			sft 01apr12_1557_romap sft 01apr12_1621_romap	ME, RK, UA	
10	13.04.-16.04.	16h	Test of SPM sensor	MPAE Lindau		sensor in vacuum	15ap_01.dat...15ap_13.dat 16ap_01.dat...16ap_06.dat	TR	
11	18.04.-19.04	3h	Vibration test	MPE Garching		sensor on shaker	sft 01apr18_1508_romap sft 01apr18_1520_romap sft 01apr19_1013_romap sft 01apr19_1609_romap	MT, FH, UA, TR	
12	20.04.	3h	Test pressure and current channels	Magson Berlin			01apr20_1628_romap	RK, UA	
13	25.04.		soldering of switchboard Ausfrasen der Stecherdurchführung	MPAE Lindau				RE BC	
14	26.04.		Test of sensitivity of Ion current channels	MPAE Lindau			01apr26_1306_romap 01apr26_1353_romap 01apr26_1454_romap	TR, UA	
15	28.04.-01.05.		TV test sensor (together with Mupus and APX)	MPAE Lindau		sensor in TV chamber	special protocoll see Test_FM.doc	TR	
16	27.04.-	100h	TV test electronics	MPAE Lindau		electron.	special protocoll	TR	

Pos.	Date	Oper. Time	Operation	Location / Facility	Reference/	Env. *	Remarks	Ope-rator	QA
	04.05.					in TV chamber	see Test_FM.doc		
17	08.05.	5h	Calibration of Magnetometer in Magnetsrode (open / close loop)	Magnetsrode (BS)			01may08_1449_romap 01may08_1613_romap X: 459.4 / 458.3 Y: 502.8 / 511.9 Z: 164.8 / 165.4	IR, KHF, WM	
18	14.05	2h	final test in ferromagnetic screen	Magson Berlin			sft 01may14_1035_romap lin 01may14_1103_romap		
19		1h	final test in a coil system	Magnetsrode			01may16_1717_romap X: 459.3 / 457.6 Y: 502.1 / 508.2 Z: 165.1 / 165.2 offsets cl. -41; 16; 7.5 offsets op. -41; 15, 14 winkel cl. -0.2; -0.02; -0.6 winkel op. 0.36; 0.5; 0.25	IR, KHF, UA	
20	17.05.-18.05.	10h	Incoming Inspection	Cleanroom Lindau					
21									
22									
23									

9 List of Attachments

9.1 Attachment 1: Pictures of the instrument electronics

9.2 Attachment 2: Drawings and schematics of boards

9.3 Attachment 3: DCL of boards

9.4 Attachment 4: Thermal vacuum test

9.5 Attachment 5: Thermal balance test

9.6 Attachment 6: Inrush current measurement

9.7 Attachment 7: SFT's / CFT's

9.8 Attachment 8: ECR's / NCR's