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DETECTOR OF PRECIPITATING ELECTRONS

PEEL

FOR SOUNDING ROCKET PROJECT

HotPay-2

Technical description

and

User's guide

(v 2.8)

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IEP-SAS Košice, November 2007

CONTENT

LIST OF ACRONYMS

A/D	Analog to Digital
ADC	Analog to Digital Converter
BCC	Checksum
CLK	Clock (bit synchronization clock 1.25 MHz)
CMOS	Complementary Metal-Oxid-Silicon semiconductor technology
CSA	Charge Sensitive Amplifier
D/A	Digital to Analog
DAC	Digital to Analog Converter
DCDC	DC (direct current) to DC converter
DSP-IEP-SAS	Department of Space Physics, Inst. of Experimental Physics SAS
EEPROM	Electrically Eraseable Programmable Read Only Memory
EMI	ElectroMagnetic Interference
GSE	Ground Support Equipment
HK	HouseKeeping information
I/F	Interface
ID	IDentifier
IEP-SAS	Institute of Experimental Physics, Slovak Academy of Sciences
ITG	Inflight Test Generator
MAF	Major Frame
MIF	Minor Frame
MGSE	Mechanical Ground Support Equipment
MLI	Multi-Layer Insulation (thermal blanket)
PA	Pulse Amplifier
PC	Personal Computer
PCB	Printed Circuit Board
PEEL	(Detector of) Precipitating Energetic Electrons at high Latitude
PIPS	Passivated Ion-implanted Planar Silicon detector
PROM	Programmable Read Only Memory
SA	Shaping Amplifier
SSD	Solid State Detector
TEM	TEMperature
TM	TeleMetry
TR	Registration period

1 INTRODUCTION

The Hot Pay-2 atmospheric and ionospheric sounding rocket project is conducted by Andoya Rocket Range (ARR) and Arctic Lidar Observatory for Mid-Atmospheric Reserach (ALOMAR), Norway in the frame of 6th EU framework. The project has wide international (EU) background and involves launch of variety of scientific instruments for atmospheric and ionospheric research on board of the sounding rocket upto altitude 350 km from ARR (69° 16' 42" North, 16° 00' 31" East), located on Norwegian island Andoya. The rocket launch and operation will be supported by variety of ground-based scientific facilities (LIDAR, riometers, etc…). The launch of the Hot Pay-2 is planned in October 2007.

The Department od Space Physics IEP-SAS has been invited to participate in this project with development, manufacture and operation of a detector of precipitating electrons (Principal Investigator prof. Karel Kudela, scientific objectives in 1.1).

PEEL (acronym from „detector of Precipitating Energetic Electrons at high Latitude") is a joint international scientific project of IEP-SAS, Demokritus University of Thrace, Greece, Andoya Rocket Range and ALOMAR observatory.

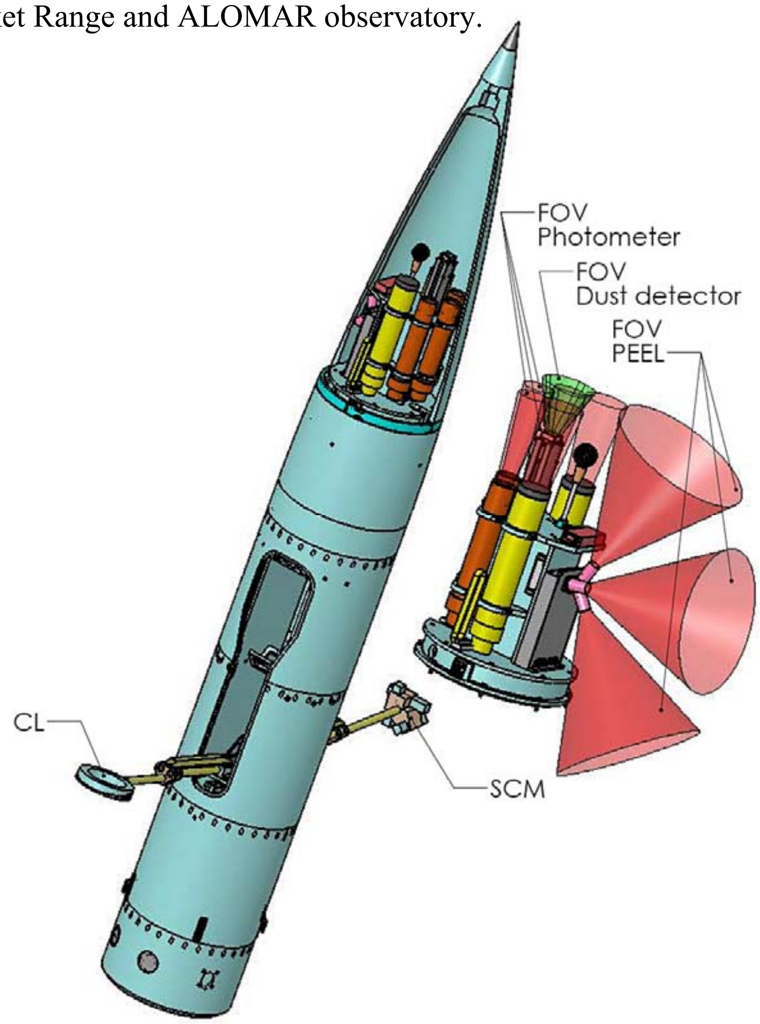

Figure 1-1. PEEL as a part of the HP2 payload (figure copyright: ARR)

1.1 SCIENTIFIC OBJECTIVES

- to describe the fine structure (temporal, angular, spatial) of the electrons at energies > 30keV having the influence on ionisation of the atmosphere down to 50km

- to check the relations of electron characteristics with those of auroral optical emissions, plasma fine structures measured at the same position during the experiment

- to provide computations of energy deposition of electrons measured and to compare the ionization rate as well as X-ray and optical emissions caused by the electrons

- to obtain characteristics of the fine structure of energetic electrons during the flight within or near the boundary of the local loss cone

1.2 BASIC SPECIFICATION OF PEEL

Weight	0.96 kg
Max. dimensions:	226mm × 124mm × 77mm
Power consumption:	2.1 W (28 V / 75mA)
Powering voltage:	28 V
Operating temperature range:	- 25 °C ... + 40 °C
Number of sensors:	3
Field of view.......................................	3 x 50°, conical
Geometrical factor:	0.077 cm^2. ster
Detector type:	silicon, solid state, ORTEC
Detector active area:...........................	25 mm^2
Detector thickness:	300 μm
Ion stop-foil …………..………………	3 μm polyester with 50nm of aluminium
Energy range …………....................	30keV - 350 keV
Number of energy channels:	4
Energy channels: …………………...	30 keV - 60keV,
	60 keV -120 keV,
	120 keV - 240 keV,
	> 240keV, (top E limited by detector thickness)
Time resolution:	16,384 ms (61,035 samples / s)
Registration dead time:	8 μs
Telemetry rate:	31 250 bit/s (1/48 of total TM 1.5 Mbit)
Data output interface: ………………	serial, 16-bit, clk=1.5 MHz (HP2 standard)
Data frame size:……………………..	32 byte
Technological interface………………	RS422, 38400bps, 8N1 (via umbilical link)
	RS232, 38400bps, 8N1 (local PC)
	standard terminal mode

2 MECHANICAL DESIGN

2.1 GENERAL REQUIREMENTS – FIELD OF VIEW

In the interest of appropriate sampling of the angular distribution of the electrons in the elevation plane, PEEL incorporates three sensors with conical field of view (50°), with inclination of 20°, 80° and 140° respectively to the rocket spin axis.

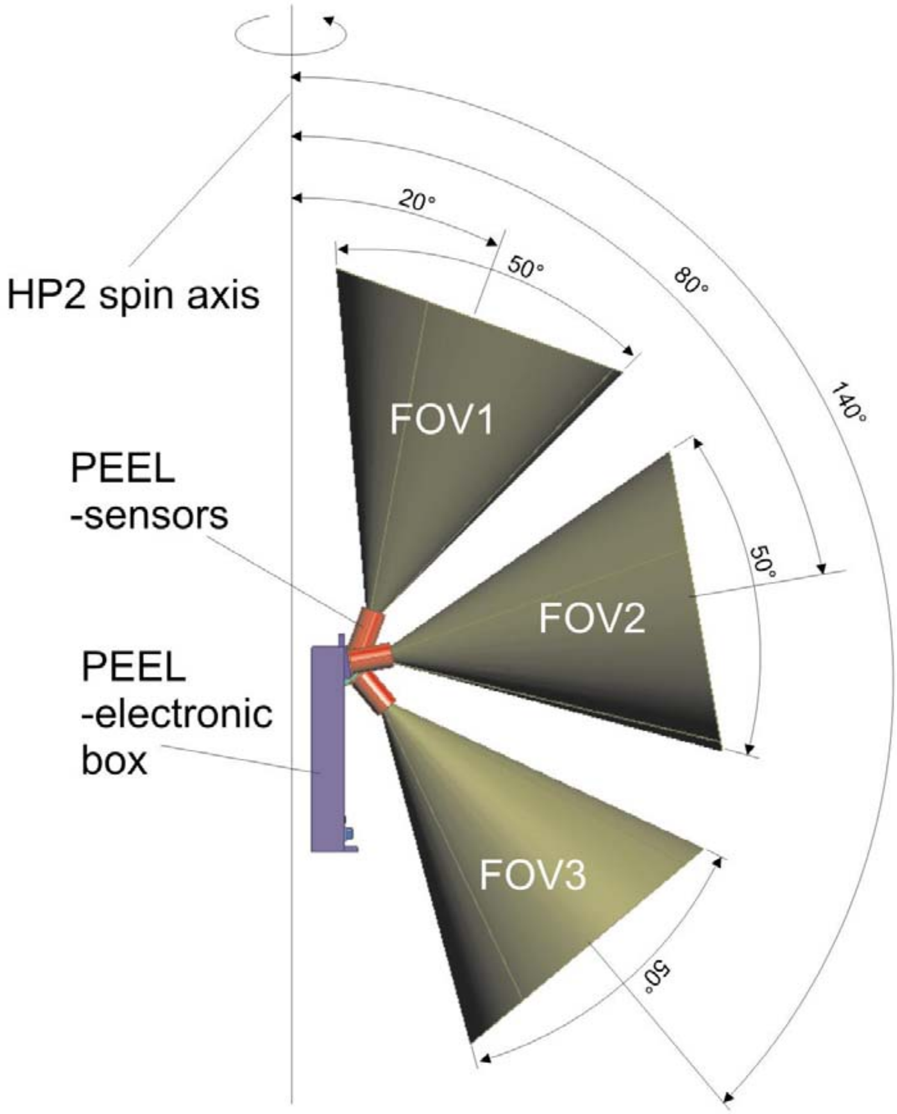

Figure 2-1. PEEL field of view related to the HP2 spin axis.

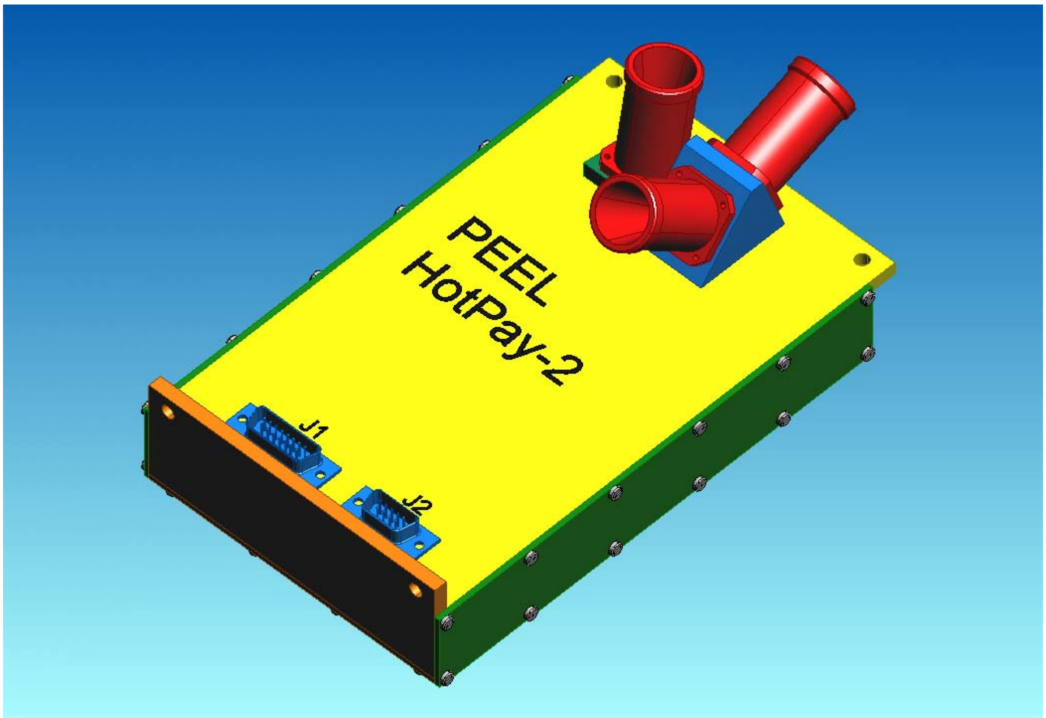

Figure 2-2. The PEEL instrument – virtual 3D model

2.2 SENSORS

The sensors of energetic electrons are based on solid state semiconductor detectors mounted inside the collimator that provides an appropriate field of view. The depleted layer of the detectors is 300 μm. The sensor is also equipped with a thin (3 μm) polyester foil that stops relatively heavy ions (up to the „stop energy“) while the light small electrons are penetrating the foil with much better efficiency. Thus a separation of the electrons is provided.

There are three identical sensors installed in PEEL instrument, their angular orientation is provided by mechanical adaptors mounted directly on the electronic box.

The detector active area is 25 mm^2 and the geometrical factor of the sensor is 0.077 cm^2sr.

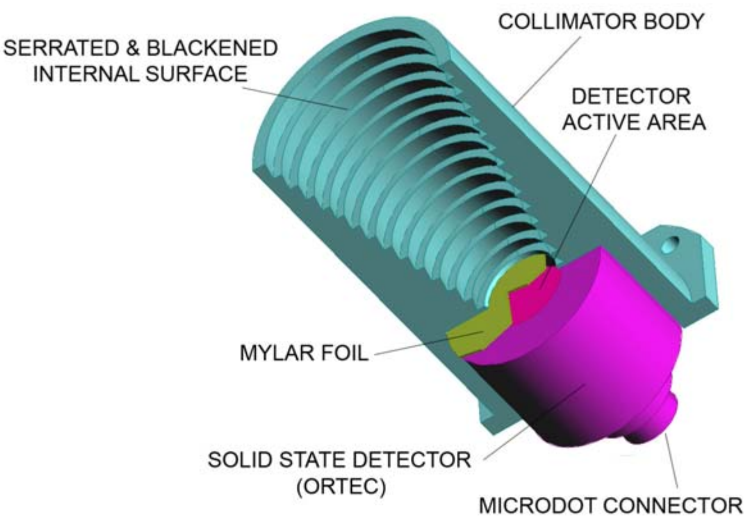

Figure 2-3. The electron sensor cross section

2.3 MECHANICAL INTERFACE CONTROL DRAWINGS

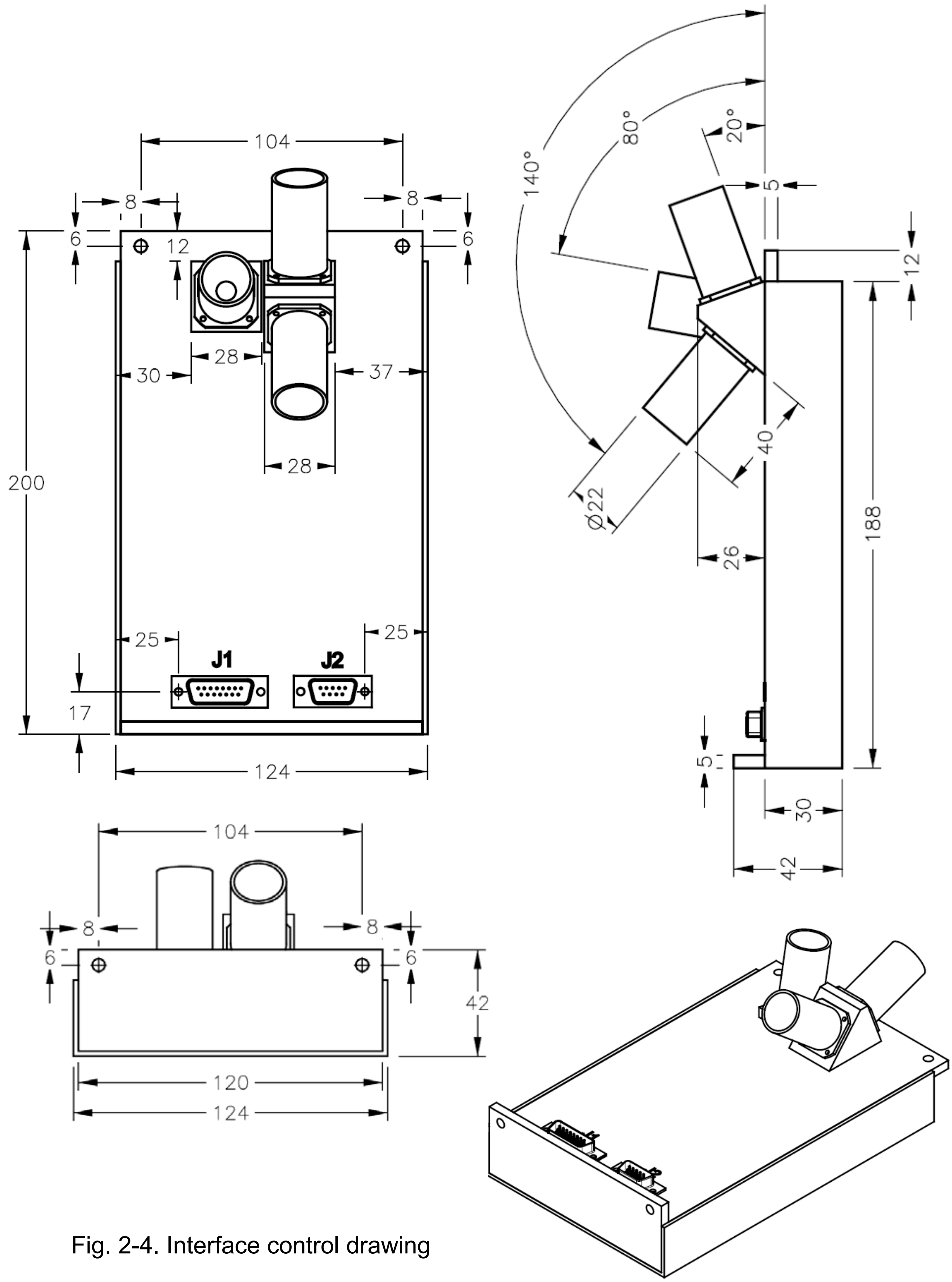

Fig. 2-4. Interface control drawing

2.4 MATERIAL AND ASSEMBLY

The instrument structure is manufactured from AlMg5 alloy by milling from 5mm thick plates. The sensor collimators and wedge adaptors are manufactured from duraluminium alloy. The surface treatment is provided by the ALLODYNE process, i.e. electrically conductive yellow chromating. There is a single electronic board size of 180mm x 125 mm x 1.6mm integrated inside the box. The interface connectors are soldered directly to the printed circuit board and extruding through dedicated box openings. The PEEL unit is fixed to the mechanical structure inside the nosecone payload compartment by dedicated flanges with four M4 screws.

Figure 2-5. PEEL mechanics

3 ELECTRICAL DESIGN

3.1 SIGNAL PROCESSING AND REGISTRATION

PEEL incorporates three identical channels for signal processing and registration.

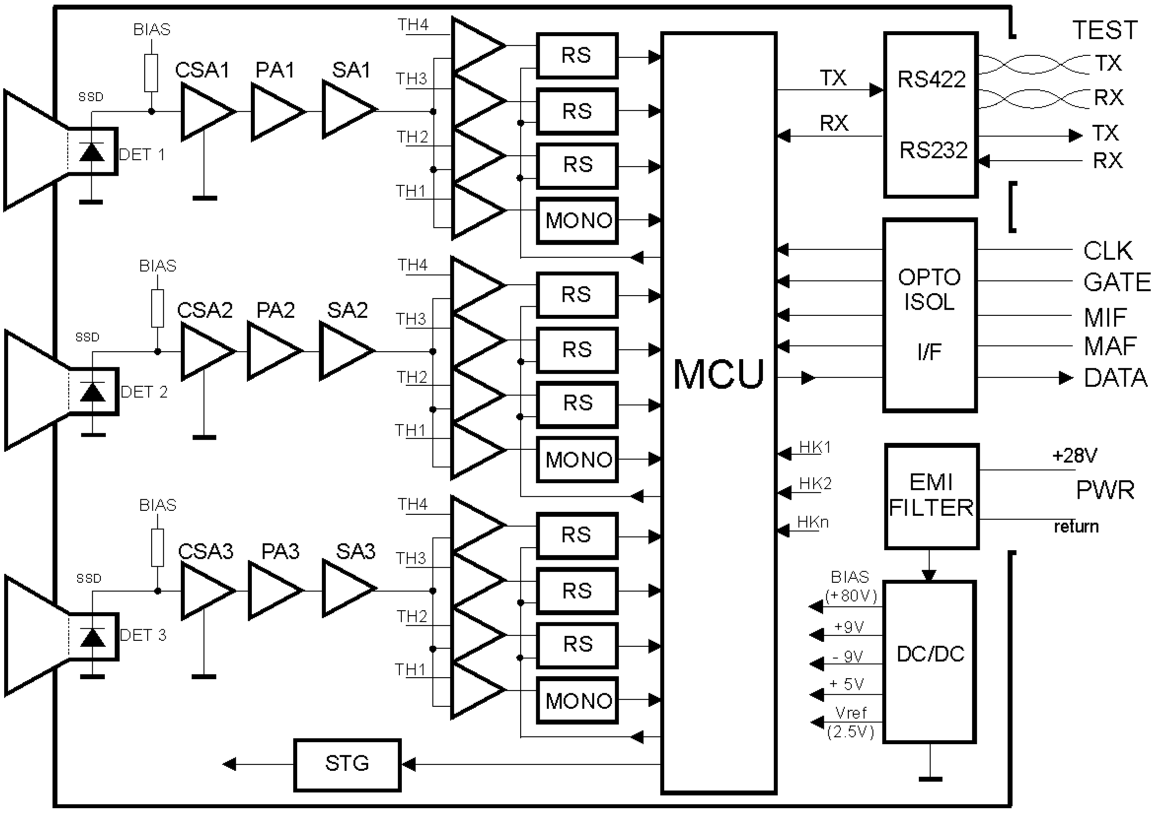

Figure 3-1. Functional block diagram of PEEL

The energetic particle penetrating into the solid state detector (SSD) deposits its energy by ionization losses in the detector material. The free charge generated is proportional to the energy deposited in the detector depleted volume. The charge is drained from detector to the Charge Sensitive Amplifier (CSA, Cremat CR110), where it is converted to the voltage pulse with an amplitude proportional to the deposited particle energy. The voltage pulse is then amplified by a Pulse Amplifier (PA, Harris HA5114) and shaped by a Gaussian Shaping Amplifier (SA, Cremat CR200) with the shaping time constant of 1 μs. The conversion gain of the complete analog preprocessing channel is 6.66mV / keV and is subject of a precise physical calibration with ^{109}Cd radioisotope (source of monoenergetic electrons at 62keV and 84keV). The signal is then discriminated to four energy thresholds by a stack of discriminators (MAX908). The lowest energy discriminator triggers the monostable flip-flop that provides an interruption to the microcontroller unit (MCU, Atmel ATMEGA32L at 16MHz). Simultaneously, the relevant higher energy thresholds are temptatively recorded by the RS-type flip-flop chain. The MCU reads the status of the activated thresholds and provides an incrementation of the highest energy channel counter in the MCU memory. Consequently, the MCU will reset the RS flip-flop chain and from this moment, the system is ready for a new registration process. There are 12 counters size of 16 bit organized in the MCU memory (3 detectors × 4 thresholds). The registration (accumulation) period lasts 16,386 ms and is derived from the telemetry synchronization signals (32 MIF periods).

3.2 TIMING

The PEEL overall timing is directly derived from the signals generated by the HP telemetry system. The timing is illustrated by the diagram in Fig. 8.

The data registration starts with MAF synchronization signal and lasts 32 MIF periods. After that, the status of the event counters is copied to dedicated memory buffer, the counters are reset and enabled for new counting. During this new registration period, the data recorded in preceding registration period are transferred byte-by-byte (32×) to the telemetry system. Generally, the registration and data transfer are overlapped the way that during recording of the data frame “N”, the data frame “N-1” is transferred to telemetry. For the practical reason, there are two complete PEEL data frames recorded and transferred within one Major Frame. The status of 16-bit event counters is separated into two bytes (8-bit MSB and 8-bit LSB) and transferred to the telemetry in consequent Minor Frames. Only 8-bits of the 16-bit telemetry words is used, another 8-bits are identical and serve as dual data redundancy.

Table 3-1. Telemetry pattern of the HP-2 telemetry system (16-bit words) and location of PEEL data.

W1-1	W2-1	….	W44-1	….	W48-1
W1-2	W2-2	….	W44-2	….	W48-2
W1-3	W2-3	….	W44-3	….	W48-3
W1-4	W2-4	….	W44-4	….	W48-4
...			….		
W1-64	W2-64	….	W44-64	….	W48-64

Fclk	=	1,5	MHz
Tclk	= 1 / Fclk =	0,6666	μs
Tw	= 16 x Tclk =	10,6666	μs
Tmif	= 48 x Tw =	512	μs
Fmif	= 1 / Tmif =	1953,125	Hz
Tmaf	= 64 x Tmif =	32,768	ms
Fmaf	= 1 / Tmaf =	30,517578	Hz
Fsamp	= Fmaf x 2 =	61,035156	samp / s

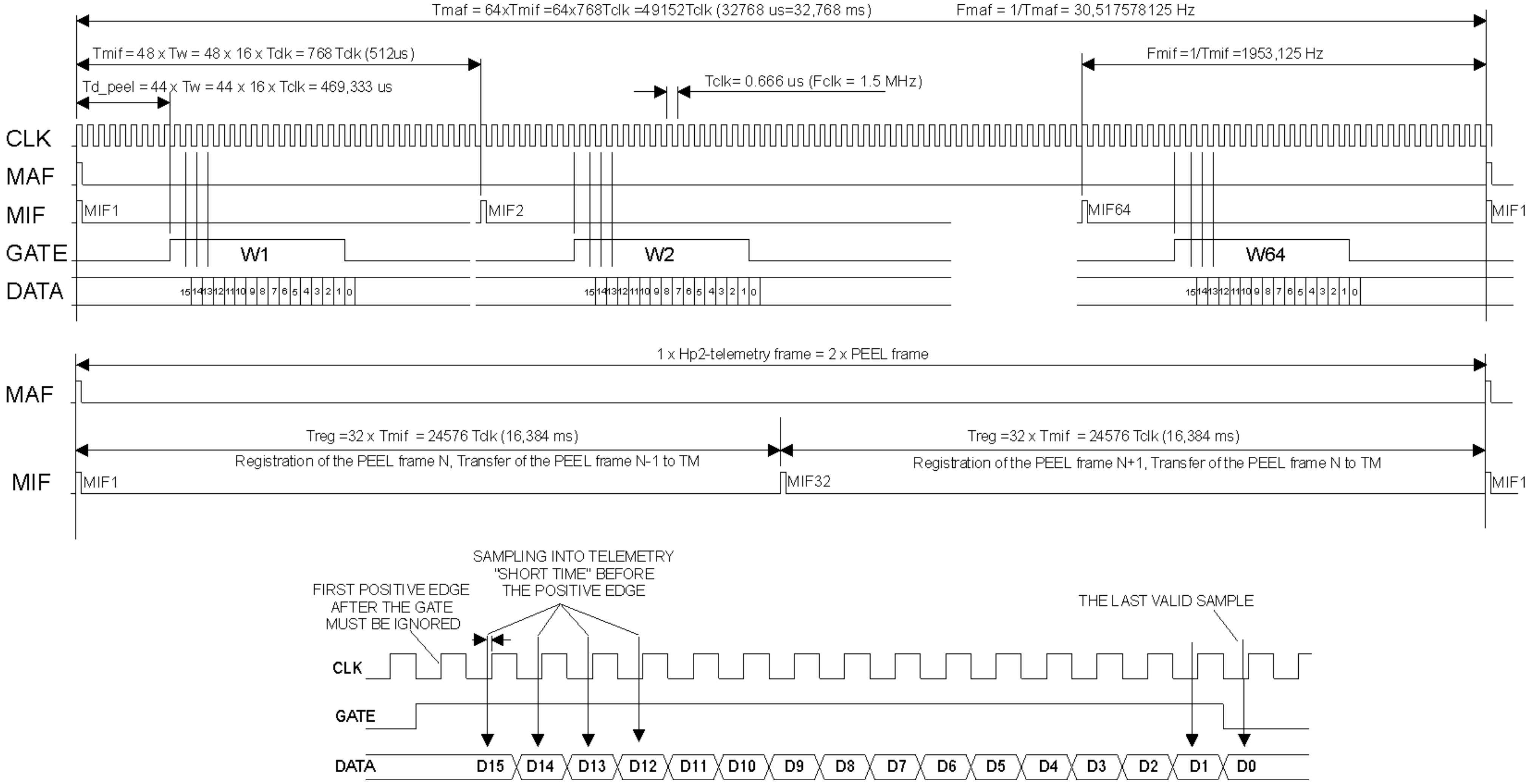

Figure.3-2. Timing of the PEEL operation

3.3 TELEMETRY DATA INTERFACE

Table 3-2. HotPay-2 digital telemetry signals

Abbr.	Meaning	I / O	Note.
CLK	Bit synchronization clock (1.5 MHz)	Input	Optocoupler in PEEL
MIF	Minor Frame synchronization pulse	Input	Optocoupler in PEEL
MAF	Major Frame synchronization pulse	Input	Optocoupler in PEEL
GATE	PEEL data transfer strob-envelope	Input	Optocoupler in PEEL
DATA	Serial Data Bits	Output	Optocoupler in TM

The telemetry signal inputs are galvanically separated at the PEEL side by fast optocouplers (6N137A). The output signal (DATA) is provided by differential LED-driver (current loop) and drives the dedicated optocoupler located at the HP telemetry input, so that the PEEL electronics is completely galvanically separated from the HP telemetry system. The input signals are after galvanical separation supplied directly to dedicated MCU inputs. The output DATA signal is supplied from MCU via the D-type flip-flop, providing the signal delay (by 1 clock), necessary for proper TM timing.

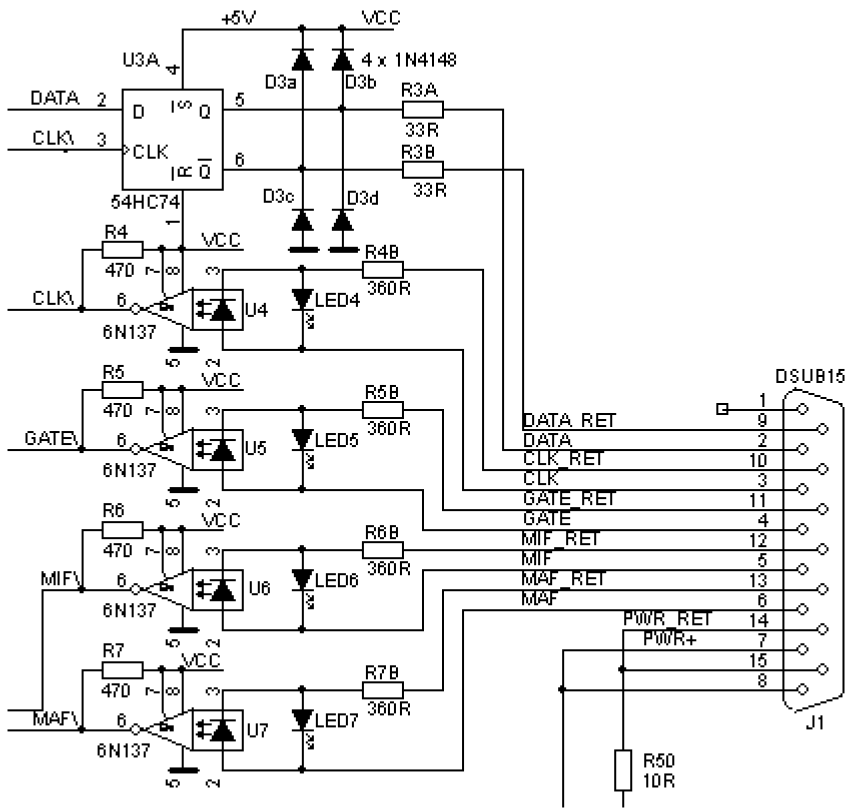

Figure 3-3. Electrical diagram of the telemetry data interface

3.4 TECHNOLOGICAL DATA / COMMAND INTERFACE

The technological interface serves for software development and debugging as well as for PEEL operation monitoring and control during the ground tests. The interface consists of serial asynchronous link with two available standard physical levels RS422 and RS232 with communication parameters 38400 bps, 8N1. The RS422 interface is dedicated also for connection with PEEL via umbilical link. The technological interfaces are not galvanically separated at the PEEL side.

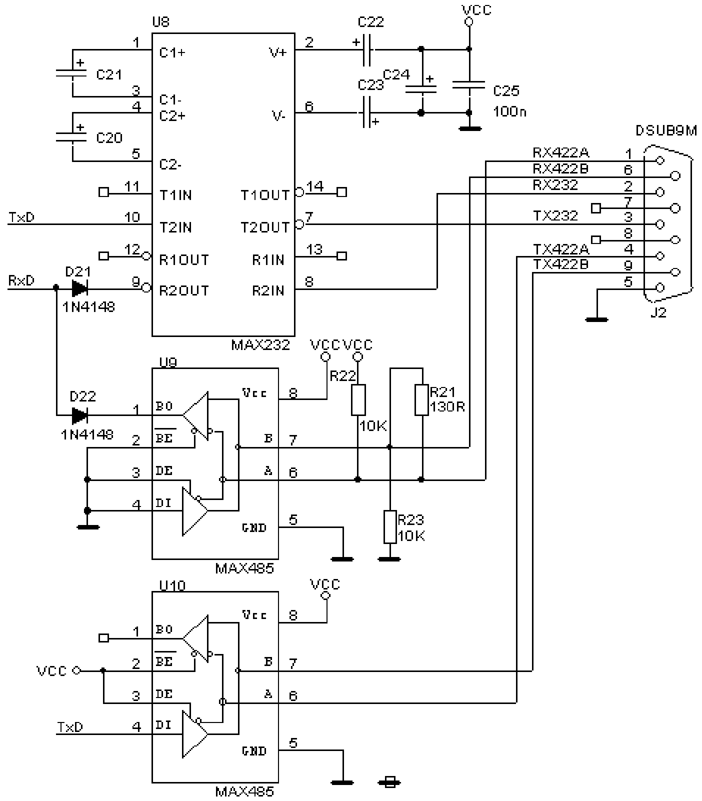

Figure 3-4. Electrical diagram of the technological interface

Table. 3-3. Umbilical interface

Function lines in the umbilical plug	current	comments
RX422A	15mA	Balanced twisted pair 1
RX422B	15mA	Balanced twisted pair 1
TX422A	15mA	Balanced twisted pair 2
TX422B	15mA	Balanced twisted pair 2

3.5 POWERING INTERFACE

Powering interface provides generation of the PEEL internal powering voltages from primary HP-2 power distribution 28V dc. The interface is galvanically separated, non-regulated symmetric push-pull DC/DC converter operating at frequency 200 kHz. At the primary voltage 28V, the converter output voltages of the converter are ± 8V and +80V. The ±8V voltages are directly used for powering of the analog circuitry, the +5V voltage for powering of the digital circuitry is provided by a low-drop linear regulator from the +8V voltage. The +80V bias voltage is provided by a special winding, voltage multiplier and a Zener-diode stabilizer. The DC/DC converter is connected to the HP-2 primary power through a multi-stage EMI filter, providing a suppression of EMI in both directions.

3.6 HOUSEKEEPING DATA

The internal HK data include measuring of the instrument internal temperature and three internal voltages.

Table 3-4. Housekeeping data

n	Measured Parameter	Conversion formula
HK1	Temperature	Temp = VAL (HK1) – 124 [°C]
HK2	Bias voltage	Vbias = VAL (HK2) * 0.5063 [V]
HK3	V5 – digital power +5V	V8 = VAL (HK3) * 0.02776 [V]
HK4	V8 – digital power +5V	V5 = VAL (HK4) * 0.0465 [V]

The data are measured directly by the MCU A/D converter, the temperature is sensed by LM35 temperature sensor, the voltages are sensed by dedicated resistor dividers.

3.7 TEST GENERATOR

The test generator can be activated by the command from technological interface (RS232 or RS422) and provides pulse charge injection to the charge sensitive preamplifiers and thus providing a simulation of high count rate particle flux. The generator only serves for ground testing of the PEEL instrument. The test is automatically deactivated after 20 sec timeout – to prevent a launch with active generator.

3.8 DETAILED ELECTRICAL DIAGRAM

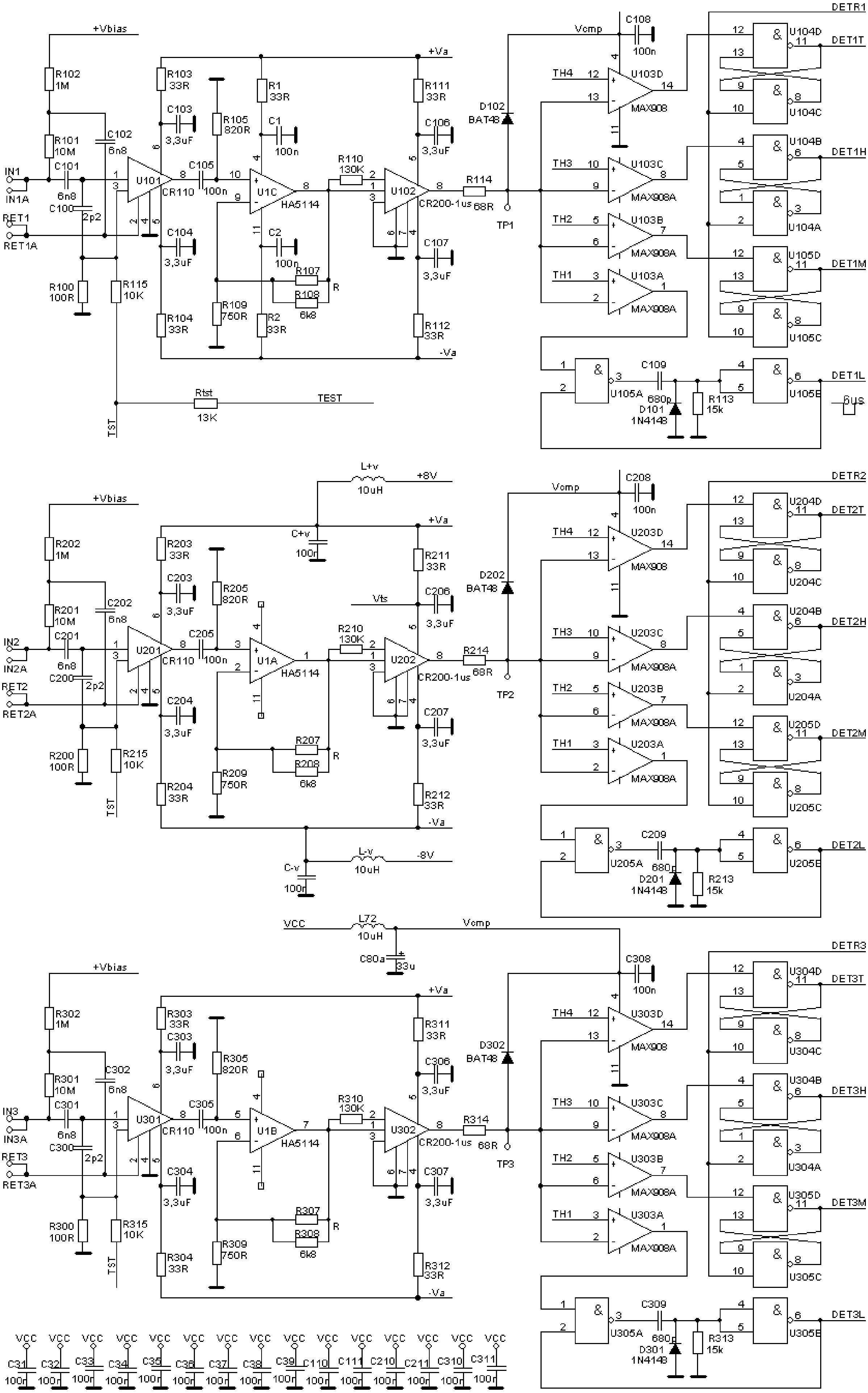

Figure 3-5. Detailed electrical diagram (Part A – signal preprocessing)

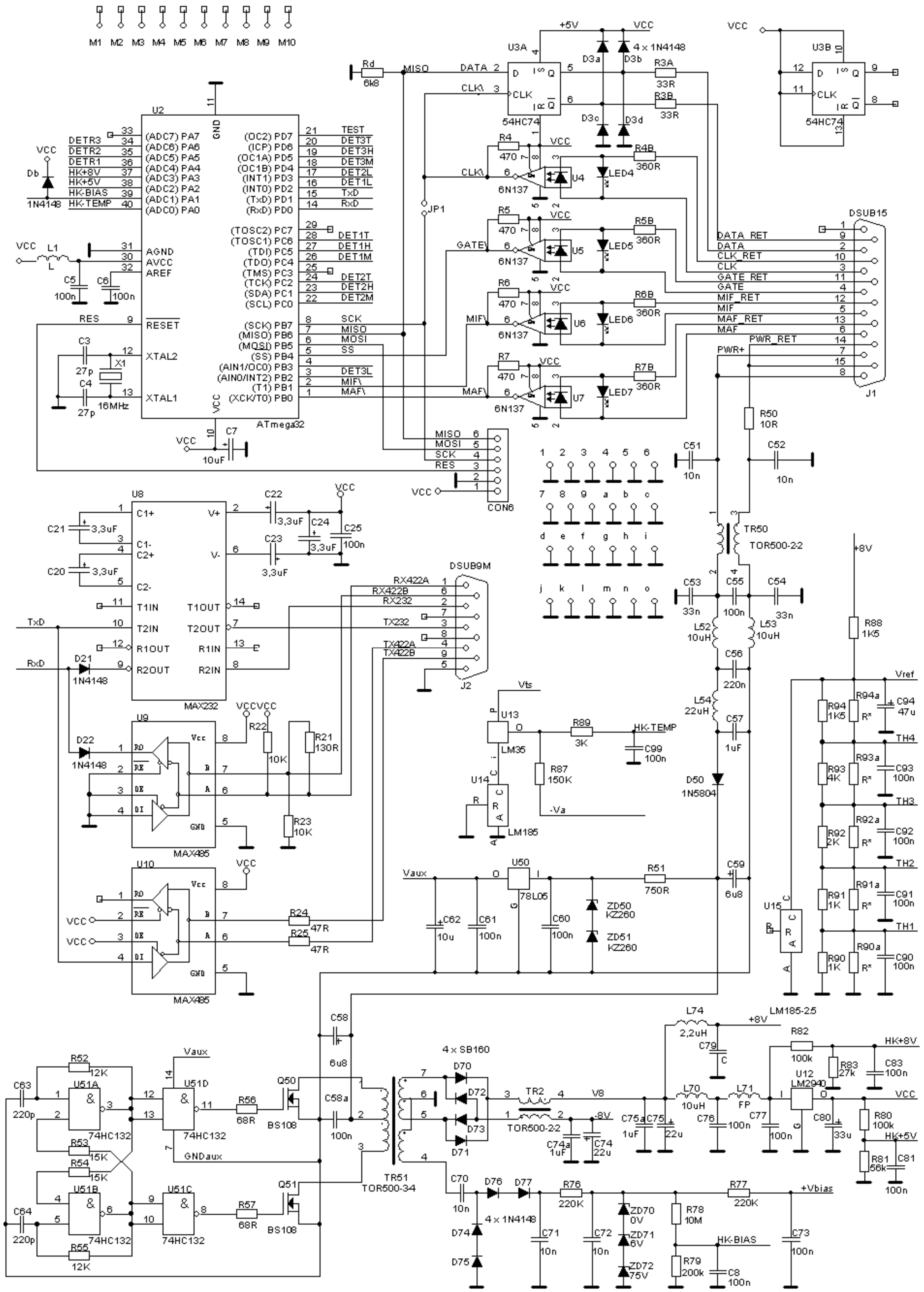

Figure 3-6. Detailed electrical diagram (Part B – CPU, interfaces, powering)

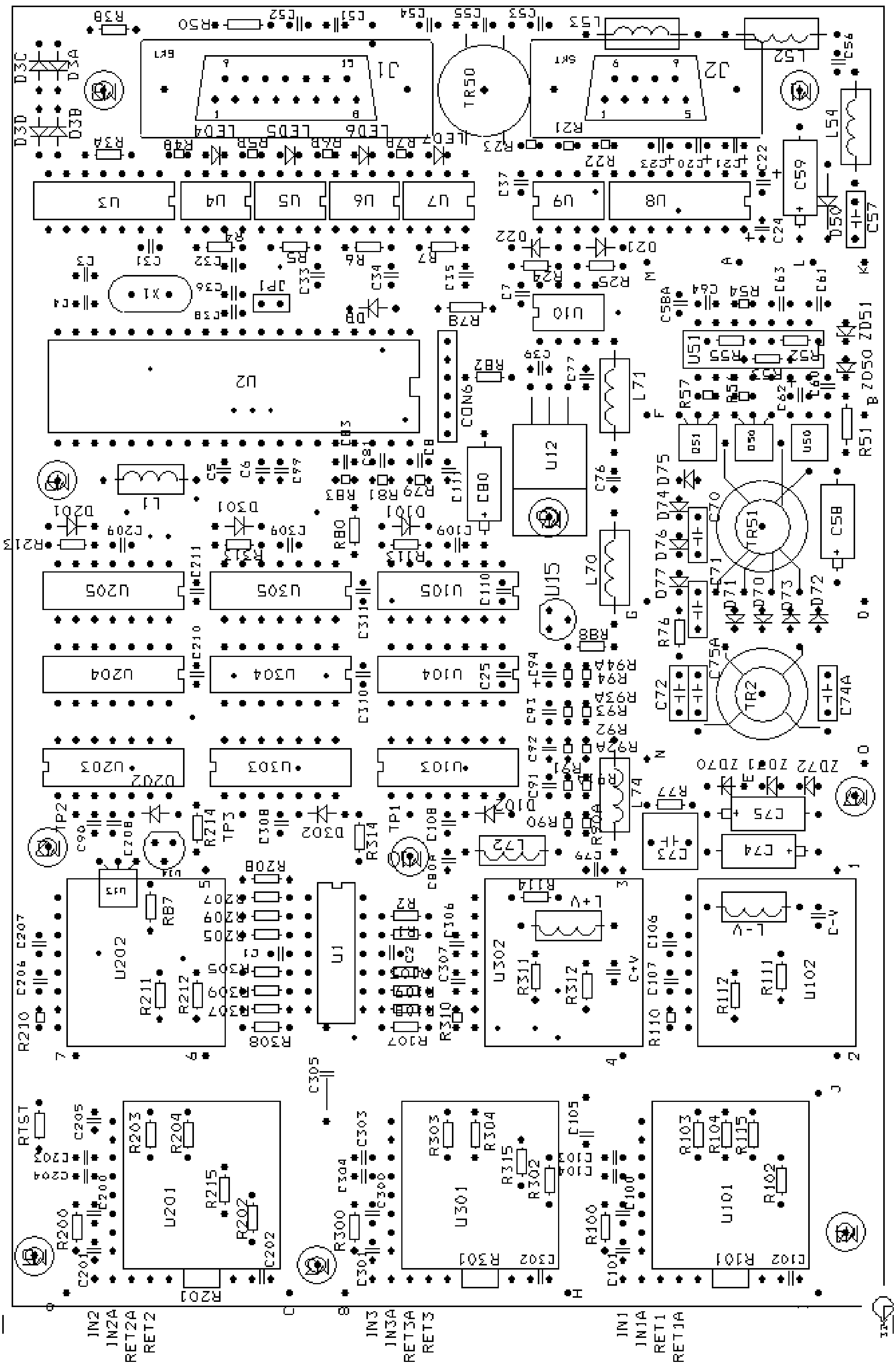

Figure 3-7. PCB design and component placing diagram

3.9 INTERFACE CONNECTORS

Table. 3-5. PEEL interface connector J1 (DSUB-15M)

Pin Number	Signal Name	Direction (for PEEL)	Level	Remark
1	nc	-	-	
2	DATA	Output	Loop 8mA to +LED	
3	CLK	Input	LED+	
4	GATE	Input	LED+	
5	MIF	Input	LED+	
6	MAF	Input	LED+	
7	POWER+	Input	+28V	
8	POWER+	Input	+28V	
9	DATA_RET	Output	Loop 8mA to -LED	
10	CLK_RET	Input	LED-	
11	GATE_RET	Input	LED-	
12	MIF_RET	Input	LED-	
13	MAF_RET	Input	LED-	
14	POWER_RET	Input	28V_return	
15	POWER_RET	Input	28V_return	

Table 3-6. PEEL technological connector J2 (DSUB-9M)

Pin Number	Signal Name	Direction (for PEEL)	Level	Remark
1	RX422A	Input	Loop +/- 5V	Umbilical pair 1
2	RX232	Input	+/- 10V	Local test
3	TX232	Output	+/- 10V	Local test
4	TX422A	Output	Loop +/- 5V	Umbilical pair 2
5	GND	GND	0	GND-local
6	RX422B	Input	Loop +/- 5V	Umbilical pair 1
7	nc			
8	nc			
9	TX422B	Output	Loop +/- 5V	Umbilical pair 2

4. TELEMETRY DATA

4.1 DATA FRAME STRUCTURE

Index	Meaning	Value (hex) 16bit	Value (ASCII)	Note
1	Sync1	50 50	PP	Fixed pattern
2	Sync2	45 45	EE	Fixed pattern
3	Sync3	45 45	EE	Fixed pattern
4	Sync4	4C 4C	LL	Fixed pattern
5	D1L-LSB	MX LX		MX = LX
6	D1L-MSB	MX LX		MX = LX
7	D1M-LSB	MX LX		MX = LX
8	D1M-MSB	MX LX		MX = LX
9	D1H-LSB	MX LX		MX = LX
10	D1H-MSB	MX LX		MX = LX
11	D1T-LSB	MX LX		MX = LX
12	D1T-MSB	MX LX		MX = LX
13	D2L-LSB	MX LX		MX = LX
14	D2L-MSB	MX LX		MX = LX
15	D2M-LSB	MX LX		MX = LX
16	D2M-MSB	MX LX		MX = LX
17	D2H-LSB	MX LX		MX = LX
18	D2H-MSB	MX LX		MX = LX
19	D2T-LSB	MX LX		MX = LX
20	D2T-MSB	MX LX		MX = LX
21	D3L-LSB	MX LX		MX = LX
22	D3L-MSB	MX LX		MX = LX
23	D3M-LSB	MX LX		MX = LX
24	D3M-MSB	MX LX		MX = LX
25	D3H-LSB	MX LX		MX = LX
26	D3H-MSB	MX LX		MX = LX
27	D3T-LSB	MX LX		MX = LX
28	D3T-MSB	MX LX		MX = LX
29	HK1 (TEMP)	MH LH		MH = LH
30	HK2 (BIAS)	MH LH		MH = LH
31	HK3 (+5V)	MH LH		MH = LH
32	HK4 (+8V)	MH LH		MH = LH

D1, D2, D3 = detector index
L = Low energy threshold, M = Medium, H = High, T = Top energy threshold
LSB = Low Significant Byte of particle count, MSB = Most Significant Byte of count
MX, LX = variable data (particle counts) but MX=LX, 8bits relevant, then duplicated
MH, LH = variable data (housekeeping), but MH=LH, 8bits relevant, then duplicated

4.2 PEEL DATA LOCATION IN EIDEL DATA STREAM

MIF synchronization word (EB90) | PEEL data (hexadecimal) | PEEL data (ASCII)

```
00 07C0: 00 00 90 EB  00 60 70 7C  70 77 40 78  C0 BC 00 00  .....`p|pw@x....
00 07D0: 00 00 20 7A  60 7B 90 78  F0 FF 00 00  00 00 30 7C  .. z`{.x......0|
00 07E0: 90 7B 80 7B  50 BB 00 00  40 41 20 7C  50 7D D0 79  .{.{P...@A |P}.y
00 07F0: E4 42 00 00  00 00 D0 7B  10 7B 70 7C  70 B9 00 00  .B.....{.{p|p...
00 0800: 40 77 A0 7C  30 7E 00 7D  F0 FF 00 00  00 00 90 7D  @w.|0~.}.......}
00 0810: D0 80 A0 7D  40 B7 20 06  50 50 80 81  E0 7E 70 7D  ...}@. .PP...~p}
00 0820: 00 00 90 EB  00 61 D0 7F  E0 80 80 7C  70 B3 00 00  .....a.....|p...
00 0830: 00 00 40 80  30 7F 60 7E  F0 FF 00 00  00 00 50 7C  ..@.0.`~......P|
00 0840: F0 7D 00 7C  10 B1 00 00  40 66 40 7F  F0 78 40 7B  .}.|....@f@..x@{
00 0850: 47 7F 00 00  00 00 90 7E  60 7E E0 75  50 AD 00 00  G......~`~.uP...
00 0860: 70 90 40 7E  D0 7D F0 78  F0 FF 00 00  00 00 60 7E  p.@~.}.x......`~
00 0870: F0 7B D0 7A  A0 AA 00 00  45 45 E0 7D  E0 7A 40 7A  .{.z....EE.}.z@z
00 0880: 00 00 90 EB  00 62 C0 7D  B0 7B 10 78  00 A6 00 00  .....b.}.{.x....
00 0890: 00 00 D0 7A  50 7C 60 78  F0 FF 00 00  00 00 10 7D  ...zP|`x.......}
00 08A0: F0 79 20 78  F0 A1 00 00  80 75 A0 79  60 7C 00 76  .y x.....u.y`|.v
00 08B0: C7 7E 00 00  00 00 30 7D  40 7A 60 77  40 9D 00 00  .~....0}@z`w@...
00 08C0: F0 89 E0 78  60 78 80 75  F0 FF 00 00  00 00 60 79  ...x`x.u......`y
00 08D0: D0 77 00 74  D0 98 B0 04  45 45 60 79  40 75 A0 6E  .w.t....EE`y@u.n
00 08E0: 00 00 90 EB  00 63 30 76  00 75 F0 71  10 95 00 00  .....c0v.u.q....
00 08F0: 00 00 50 7A  90 73 D0 70  F0 FF 00 00  00 00 40 77  ..Pz.s.p......@w
00 0900: 00 76 A0 71  60 90 00 00  00 00 F0 77  E0 75 20 72  .v.q`......w.u r
00 0910: 30 80 00 00  00 00 00 75  C0 77 C0 71  70 8C 00 00  0......u.w.qp...
00 0920: 90 8B 60 77  20 73 60 72  F0 FF 00 00  00 00 E0 77  ..`w s`r.......w
00 0930: 80 78 50 6E  60 87 10 02  4C 4C 60 78  E0 78 00 74  .xPn`...LL`x.x.t
00 0940: 00 00 90 EB  00 64 20 78  30 78 D0 73  30 83 00 00  .....d x0x.s0...
00 0950: 00 00 D0 79  B0 77 10 75  F0 FF 00 00  00 00 C0 7B  ...y.w.u.......{
00 0960: 30 79 C0 75  E0 7D 00 00  42 00 10 78  80 7A E0 75  0y.u.}..B..x.z.u
00 0970: 67 7F 00 00  00 00 60 7B  B0 77 20 76  C0 79 00 00  g.....`{.w v.y..
00 0980: 00 00 40 7C  50 7A 10 73  F0 FF 00 00  00 00 80 7B  ..@|Pz.s.......{
00 0990: E0 78 D0 77  20 75 10 06  00 00 40 79  D0 79 60 73  .x.w u....@y.y`s
00 09A0: 00 00 90 EB  00 65 20 7B  90 77 60 72  50 70 00 00  .....e {.w`rPp..
00 09B0: 00 00 F0 79  70 77 30 6D  F0 FF 00 00  00 00 C0 79  ...ypw0m.......y
00 09C0: D0 76 10 6F  80 6C 00 00  2A 15 B0 7A  70 75 40 6F  .v.o.l..*..zpu@o
00 09D0: 3D 80 00 00  00 00 C0 79  E0 76 90 6E  F0 66 00 00  =......y.v.n.f..
00 09E0: 00 00 20 79  20 75 A0 6F  F0 FF 00 00  00 00 D0 73  .. y u.o.......s
00 09F0: 50 73 E0 6E  70 62 30 00  00 00 80 79  90 70 00 70  Ps.npb0....y.p.p
00 0A00: 00 00 90 EB  00 66 30 79  00 74 40 69  F0 5C 00 00  .....f0y.t@i.\..
00 0A10: 00 00 A0 76  40 72 30 6E  F0 FF 00 00  00 00 80 72  ...v@r0n.......r
00 0A20: 00 70 10 6D  10 59 00 00  7C 01 B0 71  A0 6A B0 6B  .p.m.Y..|..q.j.k
00 0A30: 74 79 00 00  00 00 10 71  60 69 10 69  B0 54 00 00  ty.....q`i.i.T..
00 0A40: 00 00 D0 6D  E0 69 40 67  F0 FF 00 00  00 00 40 6E  ...m.i@g......@n
00 0A50: 90 67 C0 68  90 51 C0 03  00 00 E0 6D  D0 6A 60 65  .g.h.Q....m.j`e
00 0A60: 00 00 90 EB  00 67 90 6D  60 68 50 69  D0 4D 00 00  .....g.m`hPi.M..
```

Figure 4-1. Authentic record of the EIDEL data with well visible PEEL data during the First integration meeting at ARR (May 2007)

5. GROUND SUPPORT EQUIPMENT GSE-PEEL

5.1 GENERAL

The ground support equipment GSE-PEEL provides simulation of the HotPay-2 telemetry and powering system for the on-desk (laboratory) PEEL development and testing activities. The unit supplies +28V powering and complete telemetry signals (CLK, MAF, MIF, GATE) to the PEEL device and receives the DATA telemetry signal from the PEEL. The DATA signal received in HP telemetry format is in real time converted to RS232/RS422 format (38400 bps, 8N1) and is available as continuous data stream on the GSE-PEEL data interface – to be received and processed by a control PC with dedicated control software PEELWIN.EXE. Also, any standard RS232/RS422 terminal can be used for a simple monitoring and control.

5.2 ELECTRICAL DESIGN

The power supply unit consists from a transformer, bridge rectifier, filtering capacitor and LM317 linear regulator. The PEEL power ON-OFF switching is provided by a lever switch, the power-ON status is indicated by a dedicated (red) LED.
The telemetry simulator consists of ATMEL ATmega8 microcontroller at 12MHz, the DS26LS31 differential driver (for optocouplers at PEEL side) and 6N137 optocoupler for DATA receiving. The unit also includes RS422 interface based on two MAX485 chips and RS232 interface equipped with MAX232 chip. The dedicated lever switch allows selection of the data stream from the TM simulator or monitoring (MON) from the PEEL technological connector.

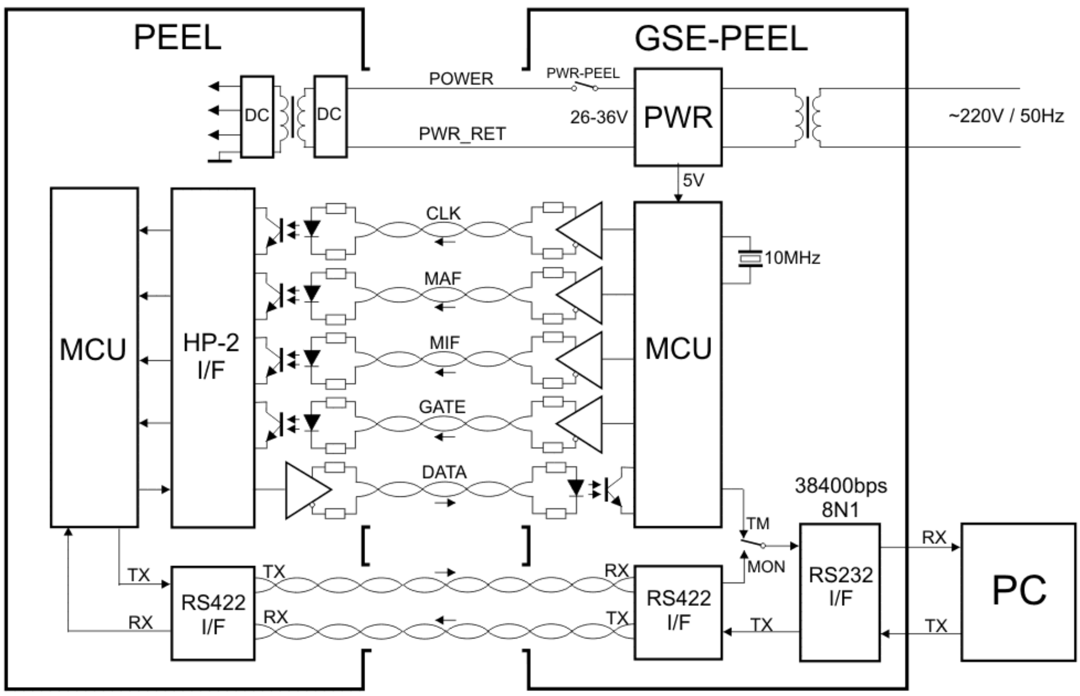

Figure 5-1. PEEL connected to the Ground support equipment GSE-PEEL

f_xo = 12 MHz (quartz oscillator)
f_clk = f_xo / 8 = 1,5 MHz (bit-sync-rate)

f_word = f_clk / 16 = 93750 Hz (word-rate)
f_mif = f_gate = f_word / 48 = f_clk / 768 = 1953,128 Hz (minor frame rate)
f_maf = f_mif / 64 = 31,517578 Hz (major frame rate)

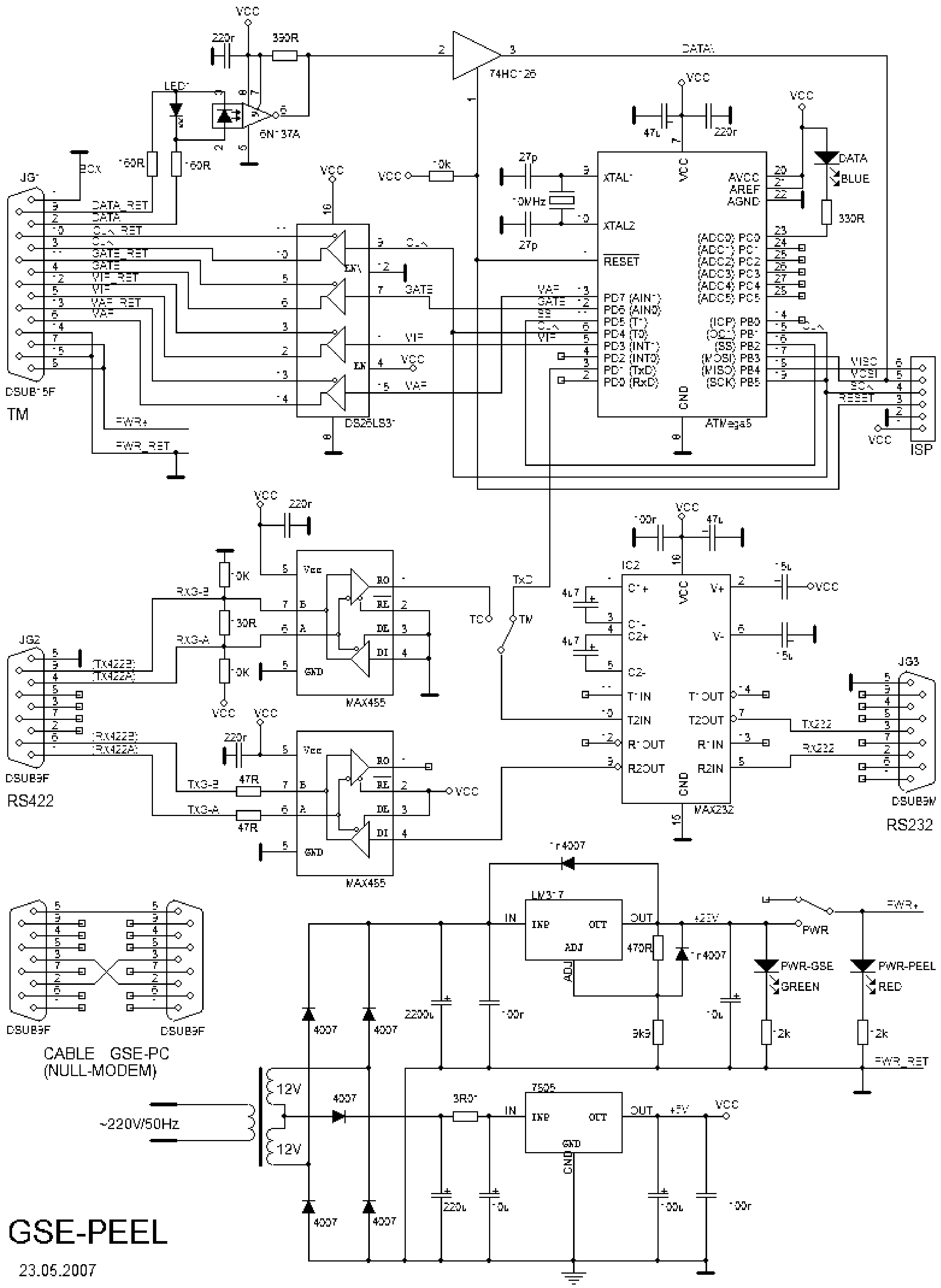

Figure 5-2. Electrical diagram of the GSE-PEEL

5.3 TESTING SOFTWARE PEELWIN.EXE

The testing software PEELWIN.EXE allows receiving and interpretation of the PEEL data frames in comfortable graphic mode. The frames are also recorded to the file and can be reviewed later offline. If technological cable is connected, the interface also allows switching ON-OFF the internal test-generator.

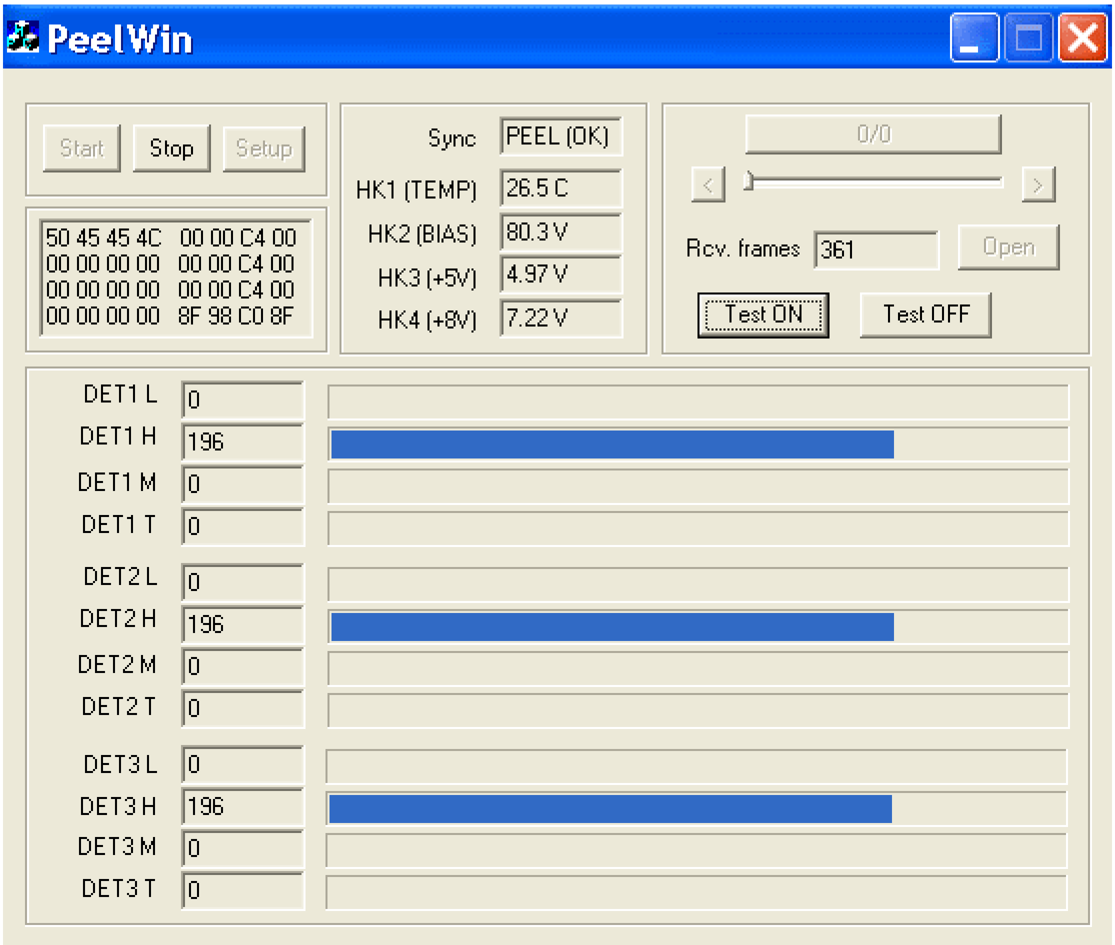

Figure 5-3. Graphic user interface of the PEELWIN.EXE software

The interface simultaneously displays entire dataframe (32 bytes) in hexadecimal format and also in physical interpretation where synchronization sequence (PEEL), the housekeeping information and the particle counts are decoded and displayed. The Figure 15 shows the normal frame with selftest generator ON, when 196 particle counts are recorded in “H”-energy channel of each detector.

5.4 TERMINAL MONITORING AND CONTROL

The terminal mode allows any standard terminal (including PC terminal emulators) to be connected to PEEL via RS232 link. In the terminal mode following commands are defined:

RST	- software reset (bootloader is skipped)
REBOOT	- rebooting of entire embeded software (equal to power-ON)
STATUS	- displays version of the firmware
SAVECFG	- save configuration
TON	- Test generator ON (injects “particle” pulses to preamplifiers)
TOFF	- Test generator OFF
DATA	- Data stream also to terminal via technological connector (Q to quit)
HELP	- Help
?	- Help

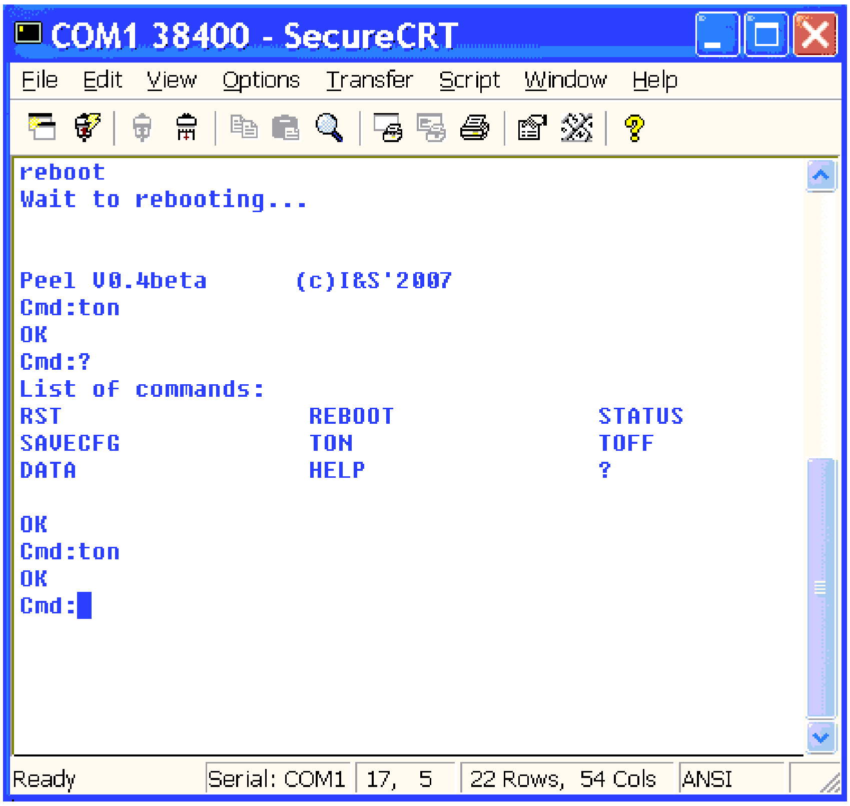

Figure 5-4. Terminal communication via technological connector

IMPORTANT NOTE: The cable to connect the standard PC to PEEL via RS232 interface (COM port) can only be three-wire (TxD, RxD, GND), null-modem (crossed) cable with DSUB9F connectors on both sides (see Fig. 14). Using “full” (9 wire) RS232 cable will cause conflict with RS422 interface of PEEL as this interface is located on the same connector (J2).

5.5 MECHANICAL DESIGN OF GSE-PEEL

The GSE-PEEL is a rectangular unit with dimensions of 125mm × 70mm × 40mm.

Figure 5-5. Ground Support Equipment GSE-PEEL

6. CONCLUSION

The scientific instrument PEEL was already successfully integrated (electrically and mechanically) to the HP-2 system during the first integration meeting (22-25 May 2007) at ARR. The instrument.and its ground support equipment GSE-PEEL were definitely finished with regard to development and construction works and also calibrated with ^{241}Am and ^{109}Cd radioisotopes in July 2007. Also preliminary environmental / reliability testing was conducted at IEP SAS with temperature cycling in the range -20°C ...+60°C, the vibration tests, the pressure transients and high vacuum tests (10^{-6} mBar) were done. The official integration and environmental tests of entire HP-2 payload including PEEL was done at PackForsk Stockholm in August. PEEL passed he tests without any problems and was delivered to ARR onboard the rocket. The launch of the HotPay-2 was scheduled for October 2007 from ARR, however, it was postponed to 2008 due to problems with rocket motor for first stage of the HotPay-2 rocket.

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