ROSETTA project

MIP experiment onboard data handling

Prepared by:	D. Lagoutte, J.L. Michau and J.G. Trotignon
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LABORATOIRE DE PHYSIQUE ET CHIMIE DE L'ENVIRONNEMENT ET DE L'ESPACE
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE
3A, Avenue de la Recherche Scientifique - 45071 ORLEANS cedex 2
Téléphone : (33/0) 2 38.25.52.60 - Télécopie : (33/0) 2 38.63.12.34

Document Status Sheet

Issue	*Date*	*Details*

version 2.0	Feb 1999	- Modification of the "Survey-Full" mode :
		    - size of the "Survey-Full" output frame : 122 bytes instead of 120,
		    - one more value in the phase output array,
		    - one byte more to code the index of frequency interval.
		- Modification of the "Sweep" mode :
		    - output arrays identical to Survey mode,
		    - frequency interval selectable.
		- Modification of the HK packet contents (sweep test).
		- All the 8 frequency intervals for the sweeps are now defined.
		- Complementary sequences n°1 and 2 added in minimum rate for MIP science.
		- Complementary sequences n°1, 2, 3, 4, 5 and 7 added in normal rate for MIP science.
		- Complementary sequences n°1, 2 and 7 added in burst rate for MIP science.

Version 3.1	Sept 1999	- Version 3.1 (instead 2.1) to have the same version number with the document in French "Logiciel de bord - Recueil des spécifications" and the software code; - Notes are added to give more details about the working modes and the transmitted parameters; - Power conversion in active and passive modes : 0 dB = 0.6 :V Hz$^{-1/2}$; - Modification of the Control and Table sequences; a byte containing the onboard software version (edition, revision) is added after the parameter table; - Modification of the 2 bits of reception table in Control and Table sequences; - Modification of the parameter location in the configuration table; - New MIP HK handling : type I is sent before Science sequences and type II is sent before Control or Table sequences; - Modification of the contents of HK type I (6 bytes); - HK type II contains the parameter table (6 bytes); - General sequence counter in the Table sequence output (modulo 64) and in the sequence header (modulo 4) instead of science sequence counter; - Information on the coding of the Passive mode values (2 values in one byte); - Reference to the "MIP/PIU data Handling Interface" document [DR6];
Version 3.2	Dec 1999	- Tests byte of Control sequence data (Table 14) updated : bits 11 of the reception table - information, TBD replaced by information of LDL command reception during the Control sequence;

		- Configuration table (Table 15) updated by replacing TBD by a LDL_type parameter (byte5) and rearranging byte 5; - Default configuration table added (paragraph 3.3.3.3); - HK type I are sent every sequence, Control/Table and Science; - Modification of the contents of HK type I by adding 2 bits for LDL mode synchronization; Rearrangement of HK type I (Tables 36-a and 36-b).
Version 3.3	June 2000	- Default table is modified; - Byte order is modified (Tables 36 and 37); - Full HK packet description has been added; - PIU packetization is now detailed.
Version 3.4	Sept 2000	- Sequence n°7 Passive in minimum rate has been added (paragraph 3.3.5.13).
Version 4.0	2019-03-01	- New layout; - Figures misalignment correction.

Table of Contents

List of Acronyms

ADC	Analog to Digital Converter
DFT	Discrete Fourier Transform
DSP	Digital Signal Processor
HF	High Frequency
HK	House Keeping
LDL	Long Debye Length
LF	Low Frequency
LAP	LAngmuir Probe
MIP	Mutual Impedance Probe
PIU	Plasma Interface Unit
RD	Reference Document
R/W	Read/Write

Reference Documents

RD1	Lagoutte D., Projet ROSETTA, Expérience MIP, Logiciel de bord - Recueil des spécifications, RPC/MIP/RP/13/980218/LPCE, Ed. 3, Rév. 2, Orléans, Décembre 1999.
RD2	C. Carr, Rosetta RPC - PIU Interfaces Document, Part II - Data Handling Interfaces, Issue 2, revision 0, Imperial College, London, September 2000.
RD3	Lagoutte D., J.L. Michau and J.G. Trotignon, ROSETTA project, MIP experiment, Electrical Ground Support Equipment, RPC/MIP/SP/141/970012/LPCE, Ed. 1, Rév. 0, Orléans, September 1998.
RD4	An investigation of the Electron Density and Temperature, Plasma Flow Velocity and Nucleus Gas and dust Activities proposed for the ROSETTA orbiter - Mutual Impedance Probe (MIP) Experiment - Volume 1 : Scientific and Technical plan, Proposal submitted to ESA in response of AO, July 1995.
RD5	ROSETTA - Experiment Interface Document - Part A, RO-EST-RS-3001/EIDA, Issue 2, Rev. 0, ESTEC/ESA, June 1999.
RD6	Lagoutte D., J.L. Michau, F. Colin, T. Hachemi and P. Zamora, ROSETTA project – MIP experiment - MIP/PIU Data Handling Interface, RPC/MIP/RP/126/990253/LPCE, Ed. 3, Rév. 2, Orléans, September 2000.

Contact

Pierre Henri, RPC-MIP Principal Investigator	Pierre.Henri*(at)*cnrs-orleans.fr

1. Introduction

The data received on ground have been processed and coded by the onboard software. The original data are then retrieved using a decommutation software. This specific software will be used as a component of several ground data processing programs, Ground Support Equipment [RD3], science data processing and long term data archiving.

This note gives the description of the onboard handling of the MIP experiment. The working modes, their arrangement in automatic sequences and the production of data packets are summarized. First, the measurements made with the mutual impedance probe are briefly summarized in Section 2; the frequency response, which constitutes the main output data of the experiment, is also presented in this section.

The data frames sent from MIP to PIU are fully defined in the onboard software specification document [RD1]. The packetisation made by PIU before sending to the spacecraft is defined in the PIU interface document, part II on data handling [RD2].

2. The measurements

2.1 Active modes

All the **active modes** are based on the frequency response of the mutual impedance probe (Figure 1). It represents the impedance variations, square modulus and phase, as a function of the transmitted frequency. All the main plasma parameters can be calculated from this response:

- the frequency and the phase transition of the resonance peak directly give the plasma frequency (6 the electron density);
- the amplitude of the resonance peak and the frequency of the interference structures are related to the Debye length (6 the electron temperature);
- the Doppler frequency shift of the interference structures of two opposite transmissions is related to the plasma velocity;

Details about the technique of measurements are given in the experiment proposal document [RD4].

A transmission signal is injected through one transmission electrode (monopoles E_1, E_2 or Langmuir probe LAP2) or the transmission dipole (E_1 and E_2 phased or anti-phased) in the surrounding plasma at a given frequency. Then, the signal received on the reception dipole (R_1, R_2), is analyzed by a Fourier analysis. A sweep over the frequency range allows the computation of the response. The frequency response is calculated over different frequency ranges, according to the characteristics of the encountered plasma. The overall range is 7 kHz - 3472 kHz.

The sampling frequency of the 8-bit analog-to-digital converter is f_e = 7168 kHz. All the computing tasks are done by a digital signal processor ADSP 2100 with a clock frequency of 14336 kHz. The Discrete Fourier Transform (DFT) is computed over N=1024 samples, which gives a frequency resolution $\Delta f = f_e/N$ = 7 kHz. The Fourier component is complex-valued with a relative amplitude (scale factor). The processor manages the transmission, takes in charge the signal analysis (windowing, DFT, calculation of the phase and square modulus, normalization with the scale factor) and the compaction of the output values.

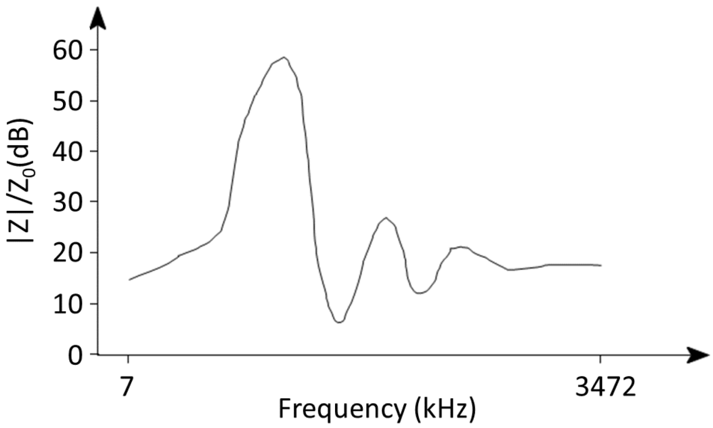

Figure 1: Example of mutual impedance probe response versus frequency (normalized square modulus).

2.2 Passive modes

When no transmission is applied, the antenna measures the natural waves. The samples are processed by a Fast Fourier transform to compute the power spectrum over all the bandwidth. The maximum frequency resolution is 7 kHz (like in active modes).

3. The data

3.1 MIP working modes

3.1.1 Rates and frames

MIP has three nominal telemetry data rates:

- minimum, 5 bits/s,
- normal, 50 bits/s,
- burst, 300 bits/s.

A data frame is defined as an array of data transferred from MIP to PIU. Each rate has a corresponding data frame. The sizes are given in the Table 1.

Rate	*Data frame*
5 b/s	18 bytes
50 b/s	198 bytes
300 b/s	1200 bytes

Table 1: Data frames transferred from MIP to PIU.

The acquisition time of a data frame is constant and equal to **32 seconds**.

3.1.2 Sequence definition

A sequence is a series of elementary working modes run during an acquisition period (32 seconds). Four types of sequences have been defined:

- MIP science sequence,
- LDL science sequence,
- Control sequence,
- Table sequence.

For one science type, several sub-sequences will be defined with different series of elementary modes.

The **MIP science sequences** correspond to the nominal operating order of the experiment around the comet when the Debye length is greater than a few millimeters and lower than ~20 cm. Transmission and reception are done with the MIP antenna. The elementary modes “Survey”, “Sweep” and “Passive” can be run.

The **LDL science sequences** correspond to the nominal operating mode with MIP and LAP experiments when the Debye length is greater than ~20 cm. The Langmuir probe LAP2 is used as a long distance transmitter and MIP antenna is used for reception. The modes “LDL” and “Passive” can be run.

The **Control sequence** is a special sequence used to check the working state of the experiment when MIP is set on [DR6]. It is automatically run once, before the science sequences. Its tasks are the reception and decoding of the commands coming from the PIU (configuration table) and a check-out of the experiment.

The **Table sequence** is defined to decode the commands which arrive during a science MIP or LDL sequence [DR6]. This case occurs for example when MIP is set first in MIP modes and then in LDL mode. This sequence is like a Control sequence without experiment check-out.

3.1.3 Elementary mode: SURVEY

The Survey mode is the basic mode of the experiment since it is a sweep over all the frequency bandwidth. The result is the mutual impedance probe (modulus and phase) response versus the frequency. Successive spectra are averaged.

This mode has three different outputs:

- **FULL**: all the computed values (modulus and phase) are transmitted,
- **WINDOW**: only the modulus values of a window around the resonance are transmitted,
- **MINMAX**: two maximums and two minimums of the response are sent.

The output arrays of the Survey mode are given in Table 2.

Output array	***Power Values***	***Phase values***	***Frequency values***	***Bandwidth index***	***Total size***
FULL	92 x 8 bits	28 x 8 bits	1 x 8 bits	1 x 8 bits	122 bytes
WINDOW	14 x 8 bits		1 x 8 bits	1 x 8 bits	16 bytes
MINMAX	4 x 8 bits		4 x 8 bits		8 bytes

Table 2: Output arrays of the Survey mode.

SURVEY-FULL notes:

- Power values:
    - all the 92 power values are transmitted;
- Phase values:
    - the phase values are not sent for all the frequency interval; only 28 points around the resonance frequency are transmitted which description is:
        - **13 points below** the frequency resonance,
        - the phase at **the frequency resonance**,
        - **14 points above** the frequency resonance.
    - to exactly know where is the resonance and where is the origin of the phase array, the **frequency of the resonance (frequency of the maximum value)** is given in the output frame. If the resonance index is lower than 14, then the phase array starts at the first frequency of the selected interval.
- Frequency value:
    - the frequency value is the frequency of the resonance.
    - the coding is given in paragraph 3.2.
- Bandwidth index:
    - the bandwidth index corresponds to the number of the frequency interval; 0 is the nominal interval and 1 to 7 are complementary intervals.

SURVEY-WINDOW notes:

- Power values:
    - only **14 power values** are transmitted around the resonance; the description is:
        - **3 points below** the frequency resonance,
        - the power at **the frequency resonance**,
        - **10 points above** the frequency resonance.
    - to exactly know where is the origin of the power array, the **frequency of the resonance (frequency of the maximum value)** is given in the output frame. If the resonance index is lower than 4, then the power array starts at the first frequency of the selected interval.

- Frequency value:
  - the frequency value corresponds to the frequency of the first point of the power array.
- Bandwidth index:
  - as SURVEY-FULL.

SURVEY-MINMAX notes:

- Power values:
  - power values of 2 maximums and 2 minimums : the resonance (max1), min1, max2 and min2.
  - if no extremum has been detected, power value is 0 (0 dB).
- Frequency values:
  - frequency values of the 2 maximums and the 2 minimums: the resonance frequency (fmax1), fmin1, fmax2 and fmin2 with fmax1 > fmin1 > fmax2 > fmin2.
  - if no extremum has been detected, frequency value is 0 (0 kHz).
- The order of the 8 transmitted values is [Power_Max1, Power_Min1, Power_Max2, Power_Min2, Frequency_Max1, Frequency_Min1, Frequency_Max2, Frequency_Min2].

The display units and the onboard coding are given in the section 3.2.

The frequency bandwidth to be scanned can be selected by command in the configuration table. The bandwidth index is sent in the output frame. The Table 3-0 gives the nominal frequency interval and the Tables 3-1, 3-2, 3-3, 3-4, 3-5, 3-6 and 3-7 give the complementary ones; the respective bandwidth indices are 0, 1, ...7. The number of output values is constant whatever the selected bandwidth.

Frequency bandwidth	*Frequency resolution*	*Number of frequency steps*
28 - 224 kHz	7 kHz	29
238 - 448 kHz	14 kHz	16
476 - 896 kHz	28 kHz	16
952 - 1792 kHz	56 kHz	16
1904 - 3472 kHz	112 kHz	15

Table 3-0: Frequency bandwidth and resolution for the nominal Survey mode.

Frequency bandwidth	*Frequency resolution*	*Number of frequency steps*
28 - 665 kHz	7 kHz	92

Table 3-1: Frequency bandwidth and resolution for the complementary n°1 Survey mode.

Frequency bandwidth	*Frequency resolution*	*Number of frequency steps*
259 - 896 kHz	7 kHz	92

Table 3-2: Frequency bandwidth and resolution for the complementary n°2 Survey mode.

Frequency bandwidth	*Frequency resolution*	*Number of frequency steps*
518 - 1792 kHz	14 kHz	92

Table 3-3: Frequency bandwidth and resolution for the complementary n°3 Survey mode.

Frequency bandwidth	*Frequency resolution*	*Number of frequency steps*
924 - 3472 kHz	28 kHz	92

Table 3-4: Frequency bandwidth and resolution for the complementary n°4 Survey mode.

Frequency bandwidth	*Frequency resolution*	*Number of frequency steps*
28 - 343 kHz	7 kHz	46
357 - 987 kHz	14 kHz	46

Table 3-5: Frequency bandwidth and resolution for the complementary n°5 Survey mode.

Frequency bandwidth	*Frequency resolution*	*Number of frequency steps*
28 - 224 kHz	7 kHz	29
238 - 630 kHz	14 kHz	29
658 – 1582 kHz	28 kHz	34

Table 3-6: Frequency bandwidth and resolution for the complementary n°6 Survey mode.

Frequency bandwidth	*Frequency resolution*	*Number of frequency steps*
266 - 896 kHz	14 kHz	46
924 - 2184 kHz	28 kHz	46

Table 3-7: Frequency bandwidth and resolution for the complementary n°7 Survey mode.

3.1.4 Elementary mode: SWEEP

The Triggered Sweep also called Sweep mode is a sweep over a limited frequency bandwidth with a frequency resolution better than the Survey mode. **The Sweep mode is always triggered by a Survey mode**. This mode has an output frame identical to the Survey mode one. See the Survey mode for the details of the transmitted values.

The three different outputs are:

- **FULL**: all the computed values (modulus and reference frequency) are transmitted,
- **WINDOW**: only the modulus values of a window around the resonance are transmitted,
- **MINMAX**: two maximums and two minimums of the response are sent. The order of the 8 transmitted values is [Power_Max1, Power_Min1, Power_Max2, Power_Min2, Frequency_Max1, Frequency_Min1, Frequency_Max2, Frequency_Min2].

The output arrays of the Sweep mode are given in Table 4.

Output array	*Power Values*	*Phase values*	*Frequency values*	*Bandwidth index*	*Total size*
FULL	92 x 8 bits	28 x 8 bits	1 x 8 bits	1 x 8 bits	122 bytes
WINDOW	14 x 8 bits		1 x 8 bits	1 x 8 bits	16 bytes
MINMAX	4 x 8 bits		4 x 8 bits		8 bytes

Table 4: Output arrays of the Sweep mode.

The display units and the onboard coding are given in the section 3.2.

The frequency bandwidth to be scanned can be selected by command in the configuration table or by the onboard software. The possible frequency intervals are given in the Survey mode description. The selected bandwidth index is sent in the output frame.

3.1.5 Elementary mode: LDL

The LDL (Long Debye Length) mode is a sweep over all the low frequency part (7 - 168 kHz) of the bandwidth. The result is the mutual impedance probe (modulus and phase) response versus the frequency.

This mode has two different outputs:

- **FULL** : all the computed values (modulus and phase) are transmitted,
- **WINDOW**: only the modulus values of a window around the resonance are transmitted.

The output arrays of the LDL mode are given in Table 5.

Output array	*Power Values*	*Phase values*	*Frequency values*	*Total size*
FULL	24 x 8 bits	24 x 8 bits		48 bytes
WINDOW	15 x 8 bits		1 x 8 bits	16 bytes

Table 5: Output arrays of the LDL mode.

LDL-FULL notes:

- Power values:
    - all the 24 power values are transmitted;
- Phase values:
    - all the 24 phase values are transmitted;

LDL-WINDOW notes:

- Power values:
    - only **15 power values** are transmitted around the resonance; the frequency of the first point is given by the frequency value in the output array.
- Frequency value:
    - the frequency of the first point of the power array.

The display units and the onboard coding are given in the section 3.2.

The frequency bandwidth which is scanned is fixed and given in Table 6.

Frequency bandwidth	Frequency resolution	Number of frequency steps
7 - 168 kHz	7 kHz	24

Table 6: Frequency bandwidth and resolution for the LDL mode.

3.1.6 Elementary mode: PASSIVE

The Passive mode consists of a power spectrum over all the frequency bandwidth. It is a listening mode, no emission is applied and the natural waves are recorded.

This mode has three different outputs:

- **FULL**: all the 96 computed square modulus values are transmitted,
- **WINDOW**: only the first 48 square modulus values are transmitted,
- **POWER**: integrated power in 2 frequency intervals, the first one from 7 to 448 kHz and the second one from 476 to 3584 kHz.

The output arrays of the Passive mode are given in Table 7.

Output array	Power Values	Total size
FULL	96 x 4 bits	48 bytes
WINDOW	48 x 4 bits	24 bytes
POWER	2 x 4 bits	1 byte

Table 7: Output arrays of the Passive mode.

PASSIVE-FULL notes:

- Power values:
    - all the 96 power values are transmitted;
    - the frequency interval and frequency resolution are given in Table 8;
    - the coding over 4 bits (2 values per byte) is given in Table 9.

PASSIVE-WINDOW notes:

- Power values:
    - only 48 power values are transmitted (the first 48 values of a PASSIVE-FULL);
    - the 48 transmitted points : 32 points from 7 to 224 kHz with a resolution of 7 kHz and 16 points from 238 to 448 kHz with a resolution of 14 kHz;
    - the coding over 4 bits (2 values per byte) is given in Table 9.

PASSIVE-POWER notes:

- Power values:

- the average of the power values in the frequency intervals 7 - 448 kHz (LF part) and 476 - 3584 kHz (HF part) are transmitted; coding is given in Table 10; the averaging is computed with the power values in dB.

Frequency bandwidth	*Frequency resolution*	*Number of frequency steps*
7 - 224 kHz	7 kHz	32
238 - 448 kHz	14 kHz	16
476 - 896 kHz	28 kHz	16
952 – 1792 kHz	56 kHz	16
1904 – 3584 kHz	112 kHz	16

Table 8: Frequency bandwidth and resolution for the Full Passive mode.

bit7	*bit6*	*bit5*	*bit4*	*bit3*	*bit2*	*bit1*	*bit0*	*bit7*	*bit6*	*bit5*	*bit4*	*bit3*	*bit2*	*bit1*	*bit0*	*…*
7 kHz				14 kHz				21 kHz				28 kHz				…

Table 9: Coding of the Passive mode values (2 values per byte).

bit7	*bit6*	*bit5*	*bit4*	*bit3*	*bit2*	*bit1*	*bit0*
HF part				LF part			

Table 10: Format of the Passive Power byte.

The display units and the onboard coding are given in the section 3.2.

3.2 Data units

Power values:

The **power** values will be expressed in **dB**. They are onboard coded with the following rules:

- in the active modes (Survey, Sweep, LDL) the coding is 0.25 dB per step;
- in the Passive mode, the coding is 2 or 4 dB per step; the conversion is given by the configuration table transmitted into the Control or Table sequence.

The conversion is: **0 dB = 0.6 µV** $\mathbf{Hz^{-1/2}}$. In Passive mode, to calculate the electric field, one has to divide by the effective length of the antenna.

Phase values:

The **phase** values will be expressed in **degrees**. They are coded with 2° by step.

Frequency values:

The **frequency** values will be expressed in **kHz**. They are onboard coded with the same rule as for the interference frequency in the configuration table:

$1 \leq i \leq 128$	$f_i = i \times 7$	$7 \leq f_i \leq 896$ kHz
$129 \leq i \leq 192$	$f_i = (i-128) \times 14 + 896$	$910 \leq f_i \leq 1792$ kHz
$193 \leq i \leq 255$	$f_i = (i-192) \times 28 + 1792$	$1820 \leq f_i \leq 3556$ kHz

3.3 Data formats

3.3.1 Typical output data frame

A typical data frame (Table 11) sent by MIP to PIU consists of:

- one Control sequence,
- a lot of Science sequence (MIP or LDL).

Control sequence	*Science sequence n°1*	*Science sequence n°2*	*…*
18, 198 or 1200 bytes	18, 198 or 1200 bytes	18, 198 or 1200 bytes	

Table 11: Format of a typical data frame.

As mentioned during the sequence definition, a table sequence can inserted between Science sequences to take into account commands received out of the Control sequence.

3.3.2 Sequence header

To identify the type of sequence, a **header of 1 byte** is put before any MIP sequence frame. The header definition is given in Table 12.

bit7	*bit6*	*bit5*	*bit4*	*bit3*	*bit2*	*bit1*	*bit0*

bit1–bit0: ADC overflow

bit3–bit2: Sequence counter (modulo 4)

bit5–bit4:
0 0 TM minimum rate
0 1 TM normal rate
1 0 reserved
1 1 TM burst rate

bit7–bit6:
0 0 MIP science sequence
0 1 LDL science sequence
1 0 control sequence
1 1 table sequence

Table 12: Definition of the sequence data header.

The overflows of the Analog to Digital Converter are coded with the following rules:

0: number = 0
1: $1 \leq$ number < 128
2: $128 \leq$ number < 1024
3: number ≥ 1024

3.3.3 Control sequence

3.3.3.1 Output frame

The Control sequence is used to get a detailed status of the experiment. The output array has a size of K = 18, 198 or 1200 bytes according to the telemetry rate allocated (see section 3.1.1.). It is composed of (Table 13):

- the header (1 byte, see section 3.3.2.),
- the test results (1 byte),
- the configuration table or commands (6 bytes),
- the onboard software version (1 byte, 4 bits edition and 4 bits revision),
- the power and phase of a auto-looped Survey mode (122 bytes or K-9 first points),
- the FIFO buffer memory of a passive mode (K-122-9 samples).

Header	***Tests***	***Configuration table***	***Version***	***Auto-loop survey***	***FIFO samples***
1 byte	1 byte	6 bytes	1 byte	K - 9 bytes (92+28+1+1 max)	K – 122 – 9 bytes

Table 13: Control sequence output frame.

3.3.3.2 Tests

The tests performed to know the working state of MIP are (Table 14):

- state of the command (table) transfer between MIP and PIU (2 bits),
- software watchdog test1 (1 bit),
- software watchdog test2 (1 bit),
- RAM tests (2 bits),
- DSP registers tests (2 bits).

bit7	***bit6***	***bit5***	***bit4***	***bit3***	***bit2***	***bit1***	***bit0***
Reception table		*wd2*	*wd1*	*RAM tests*		*DSP tests*	

DSP tests:
0 0 OK
0 1 one error R/W
1 0 two errors R/W
1 1 three errors R/W

RAM tests:
0 0 OK
0 1 one error R/W
1 0 two errors R/W
1 1 three errors R/W

wd1:
0 OK
1 false

0 OK
1 false

00 table received during the Control sequence
01 time-out during the switching on procedure
10 table received during a Science sequence
11 LDL command received during a Control sequence

Table 14: Description of the test output in the Control sequence.

3.3.3.3 Configuration table

The configuration table contains all the parameters which can be modified in the onboard software. The size of 6 bytes corresponds to one link-packet between PIU and MIP. All the commands are inserted into the table. The description is done in Table 15.

	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
byte0	Interference frequency n°1							
byte1	Interference frequency n°2							
byte2	Interference frequency n°3							
byte3	Transmission_level		Transmitter_odd_sweeps		Transmitter_even_sweeps		Extremum_threshold	
byte4	Sweep_mode_bandwidth			Survey_mode_bandwidth			Ampl_pas	Autoloop
Byte5	Watchdog	Science_sequence_number			LDL_type	Mode	TM rate	

Table 15: Description of the configuration table.

Bytes 0, 1 and 2

- Interference frequency

The interference frequencies to be suppressed during the extremum computation in the active modes are coded as follows:

$1 \le i \le 128$	$f_i = i \times 7$	$7 \le f_i \le 896$ kHz
$129 \le i \le 192$	$f_i = (i-128) \times 14 + 896$	$910 \le f_i \le 1792$ kHz
$193 \le i \le 255$	$f_i = (i-192) \times 28 + 1792$	$1820 \le f_i \le 3556$ kHz

Byte 3

- Transmission_level: level of the transmission signal
  - 00 full level
  - 01 amplitude of the transmitted sinusoid divided par 2 (nominal)
  - 10 amplitude of the transmitted sinusoid divided par 4
  - 11 amplitude of the transmitted sinusoid divided par 8

- Transmitter_odd_sweeps: selection of the transmitter for all the odd sweeps (1, 3, ...)
  - 00 transmitter mono with E1
  - 01 transmitter mono with E2

10 transmitter stereo with E1-E2 phased
11 transmitter stereo with E1-E2 anti-phased

- Transmitter_even_sweeps: selection of the transmitter for all the even sweeps (2, 4, ...)
  - 00 transmitter mono with E1
  - 01 transmitter mono with E2
  - 10 transmitter stereo with E1-E2 phased
  - 11 transmitter stereo with E1-E2 anti-phased

- Extremum_threshold: amplitude threshold for the extremum detection
  - 00 1 dB
  - 01 2 dB
  - 10 4 dB
  - 11 8 dB

Byte 4

- Sweep_bandwidth: selection of the frequency bandwidth in Sweep modes
  - 000 selection made automatically by the onboard software
  - 001 interval n°1
  - 010 interval n°2
  - 011 interval n°3
  - 100 interval n°4
  - 101 interval n°5
  - 110 interval n°6
  - 111 interval n°7

- Survey_bandwidth: selection of the frequency bandwidth in Survey modes
  - 000 nominal interval from 28 to 3472 kHz
  - 001 interval n°1
  - 010 interval n°2
  - 011 interval n°3
  - 100 interval n°4
  - 101 interval n°5
  - 110 interval n°6
  - 111 interval n°7

- Ampl_pas: coding level for the power spectrum in the Passive mode
  - 0 coding 2 dB (16 steps from 0 to 30 dB)
  - 1 coding 4 dB (16 steps from 0 to 60 dB)

- Autoloop: an auto-loop can be set between emission and reception
  - 0 MIP with sensor
  - 1 MIP auto-loop ON

Byte 5

- Watchdog: possibility to inhibit the MIP watchdog
  - 0 watchdog on
  - 1 watchdog off

- Sequence_number: selection of the sequence number
  - 000 nominal sequence
  - 001 complementary sequence n°1
  - 010 complementary sequence n°2
  - 011 complementary sequence n°3
  - 100 complementary sequence n°4
  - 101 complementary sequence n°5
  - 110 complementary sequence n°6
  - 111 complementary sequence n°7

- LDL_type
  - 0 normal LDL
  - 1 mixed LDL

- Mode: selection of a MIP alone mode or the LDL mode
  - 0 MIP alone
  - 1 LDL mode

- TM_rate: selection of the telemetry rate
  - 00 minimum rate
  - 01 normal rate
  - 10 reserved
  - 11 burst rate

The default configuration table stored in MIP memory is (hex):

00 00 00 45 02 00

3.3.3.4 Software version

The onboard software version is given in 1 byte with 4 bits edition and 4 bits revision (Table 16).

bit7	*bit6*	*bit5*	*bit4*	*bit3*	*bit2*	*bit1*	*bit0*
Edition				Revision			

Table 16: Format of the software version parameter.

3.3.3.5 Auto-loop Survey

A Survey mode is performed with a direct connection between emission and reception (auto-loop). The results are identical to a nominal Survey mode with 92 power values, 28 phase values, 1 frequency value (resonance) and the frequency interval index. In minimum rate, only the first 10 values of power are transmitted.

3.3.3.6 FIFO samples

The FIFO samples (passive mode) are not processed and directly stored. In minimum rate, no samples are transmitted. In normal rate, only the first 68 samples are sent.

3.3.4 Table sequence

3.3.4.1 Output frame

The Table sequence is only used when the commands are received during a Science sequence (and not during the Control sequence). This is the nominal way to run the LDL mode. The structure is a copy of the Control sequence (section 3.3.3). The only difference is that the tests are not performed and are replaced in the output array by a science sequence counter. It is composed of (Table 17):

- the header (1 byte),
- the sequence information (1 byte),
- the configuration table or commands (6 bytes),
- the onboard software version (1 byte, 4 bits edition and 4 bits revision),
- the power and phase of a auto-looped Survey mode (122 bytes or K-8 first points),
- the FIFO buffer memory of a Passive mode (K-122-8 samples).

Header	***Tests***	***Configuration table***	***Version***	***Auto-loop survey***	***FIFO samples***
1 byte	1 byte	6 bytes	1 byte	K - 9 bytes (92+28+1+1 max)	K – 122 – 9 bytes

Table 17: Table sequence output frame.

3.3.4.2 Information

The information reported to know the working state of MIP are (Table 18).

bit7	***bit6***	***bit5***	***bit4***	***bit3***	***bit2***	***bit1***	***bit0***
Reception table		Counter of the previous sequence					

Table 18: Description of the information output in the Table sequence.

3.3.5 MIP science sequences

In minimum telemetry rate, the following sequences are defined: 0 (nominal), 1 and 2.

In normal telemetry rate, the following sequences are defined: 0 (nominal), 1, 2, 3, 4, 5 and 7.

In burst telemetry rate, the following sequences are defined: 0 (nominal), 1, 2 and 7.

3.3.5.1 Nominal sequence n°0 in minimum rate

The MIP nominal science sequence in minimum rate (set in byte5 of configuration table) presented in Table 19, is composed of:

- a header (1 byte);
- one Survey-Window mode (16 bytes), averaged on 8 active spectra, with transmitter “Transmis_odd_sweeps”;
- one Passive-Power mode (1 byte), averaged on 8 spectra.

Header	***Survey Window***	***Passive Power***
1 byte	14 + 1 + 1 bytes	1 byte

Table 19: Description of the MIP nominal Sequence in minimum rate.

3.3.5.2 Nominal sequence n°0 in normal rate

The MIP nominal science sequence in normal rate (set in byte5 of configuration table) presented in Table 20, is composed of:

- a header (1 byte);
- one Survey-Full mode (122 bytes), averaged on 8 active spectra, with transmitter “Transmis_odd_sweeps”;
- one Passive-Power mode (1 byte), averaged on 8 spectra;
- one Survey-Minmax mode (8 bytes), averaged on 8 active spectra, with transmitter “Transmis_even_sweeps”;
- one Passive-Full mode (48 bytes), averaged on 8 spectra;
- one Survey-Minmax mode (8 bytes), averaged on 8 active spectra, with transmitter “Transmis_odd_sweeps”;
- one Passive-Power mode (1 byte), averaged on 8 spectra;
- one Survey-Minmax mode (8 bytes), averaged on 8 active spectra, with transmitter “Transmis_even_sweeps”;
- one byte pad set to 0x00.

Header	***Survey Full***	***Passive Power***	***Survey Minmax***	***Passive Full***	***Survey Minmax***	***Passive Power***	***Survey Minmax***	***Pad 0x00***
1 byte	92 + 28 + 1 +1 bytes	1 byte	4 + 4 bytes	48 bytes	4 + 4 bytes	1 byte	4 + 4 bytes	1 byte

Table 20: Description of the MIP nominal sequence in normal rate.

3.3.5.3 Nominal sequence n°0 in burst rate

The MIP nominal science sequence in burst rate (set in byte5 of configuration table) presented in Table 21 is composed of:

- a header (1 byte);
- one Survey-Full mode (122 bytes), averaged on 2 active spectra, with transmitter "Transmis_odd_sweeps";
- a series repeated 6 times :
    - one Passive-Power (1 byte), averaged on 4 spectra;
    - one Survey-Minmax mode (8 bytes), averaged on 2 active spectra, with transmitter "Transmis_even_sweeps";
    - one Passive-Full mode (48 bytes), averaged on 4 spectra;
    - one Survey-Full mode (122 bytes), averaged on 2 active spectra, with transmitter "Transmis_odd_sweeps";
- three bytes pad set to 0x00.

Header	***Survey Full***	***Passive Power***	***Survey Minmax***	***Passive Full***	***Survey Full***	***Passive Power***	***…***	***Pad 3 x 0x00***
1 byte	92 + 28 + 1 +1 bytes	1 byte	4 + 4 bytes	48 bytes	92 + 28 + 1 +1 bytes	1 byte		3 bytes

Table 21: Description of the MIP nominal sequence in burst rate.

3.3.5.4 Complementary sequence n°1 in minimum rate

The MIP complementary n°1 science sequence in minimum rate (set in byte5 of configuration table) presented in Table 22, is composed of:

- a header (1 byte);
- one Sweep-Window mode (16 bytes), averaged on 4 active spectra, with transmitter "Transmis_odd_sweeps";
- one Passive-Power mode (1 byte), averaged on 8 spectra.

The difference with the nominal sequence n°0 is that the Survey mode is replaced by a Sweep mode which has a better frequency resolution.

Header	***Sweep Window***	***Passive Power***
1 byte	14 + 1 + 1 bytes	1 byte

Table 22: Description of the MIP complementary n°1 sequence in minimum rate.

3.3.5.5 Complementary sequence n°1 in normal rate

The MIP complementary n°1 science sequence in normal rate (set in byte5 of configuration table) presented in Table 23, is composed of:

- a header (1 byte);
- one Sweep-Full mode (122 bytes), averaged on 4 active spectra, with transmitter "Transmis_odd_sweeps",
- one Passive-Power mode (1 byte), averaged on 8 spectra;
- one Sweep-Minmax mode (8 bytes), averaged on 4 active spectra, with transmitter "Transmis_even_sweeps",
- one Passive-Full mode (48 bytes), averaged on 8 spectra;
- one Sweep-Minmax mode (8 bytes), averaged on 4 active spectra, with transmitter "Transmis_odd_sweeps",
- one Passive-Power mode (1 byte), averaged on 8 spectra;
- one Sweep-Minmax mode (8 bytes), averaged on 4 active spectra, with transmitter "Transmis_even_sweeps";
- one byte pad set to 0x00.

Header	*Sweep Full*	*Passive Power*	*Sweep Minmax*	*Passive Full*	*Sweep Minmax*	*Passive Power*	*Sweep Minmax*	*Pad 0x00*
1 byte	92 + 28 + 1 +1 bytes	1 byte	4 + 4 bytes	48 bytes	4 + 4 bytes	1 byte	4 + 4 bytes	1 byte

Table 23: Description of the MIP complementary n°1 sequence in normal rate.

3.3.5.6 Complementary sequence n°1 in burst rate

The MIP complementary n°1 science sequence in burst rate (set in byte5 of configuration table) presented in Table 24 is composed of:

- a header (1 byte);
- one Sweep-Full mode (122 bytes) with transmitter "Transmis_odd_sweeps";
- a series repeated 6 times :
- one Passive-Power (1 byte), averaged on 4 spectra;
- one Sweep-Minmax mode (8 bytes);
- one Passive-Full mode (48 bytes), averaged on 4 spectra;
- one Sweep-Full mode (122 bytes);
- three bytes pad set to 0x00.

The difference with the nominal sequence n°0 is that the Survey mode is replaced by a Sweep mode which has a better frequency resolution.

Header	Sweep Full	Passive Power	Sweep Minmax	Passive Full	Sweep Full	Passive Power	…	Pad 3 x 0x00
1 byte	92 + 28 + 1 +1 bytes	1 byte	4 + 4 bytes	48 bytes	92 + 28 + 1 +1 bytes	1 byte		3 bytes

Table 24: Description of the MIP complementary n°1 sequence in burst rate.

3.3.5.7 Complementary sequence n°2 in minimum rate

The MIP complementary n°2 science sequence in minimum rate (set in byte5 of configuration table) presented in Table 25, is composed of:

- a header (1 byte);
- one Sweep-Window mode (16 bytes), averaged on 8 active spectra, with transmitter “Transmis_odd_sweeps”;
- one Passive-Power mode (1 byte), averaged on 8 spectra.

The difference with the sequence n°1 is the number of averaged spectra.

Header	Sweep Window	Passive Power
1 byte	14 + 1 + 1 bytes	1 byte

Table 25: Description of the MIP complementary n°2 sequence in minimum rate.

3.3.5.8 Complementary sequence n°2 in normal rate

The MIP complementary n°2 science sequence in normal rate (set in byte5 of configuration table) presented in Table 26, is composed of:

- a header (1 byte);
- one Sweep-Full mode (122 bytes), averaged on 8 active spectra, with transmitter “Transmis_odd_sweeps”;
- one Passive-Power mode (1 byte), averaged on 4 spectra;
- one Sweep-Minmax mode (8 bytes), averaged on 8 active spectra, with transmitter “Transmis_even_sweeps”,
- one Passive-Full mode (48 bytes), averaged on 4 spectra;
- one Sweep-Minmax mode (8 bytes), averaged on 8 active spectra, with transmitter “Transmis_odd_sweeps”,
- one Passive-Power mode (1 byte), averaged on 4 spectra;
- one Sweep-Minmax mode (8 bytes), averaged on 8 active spectra, with transmitter “Transmis_even_sweeps”;
- one byte pad set to 0x00.

The difference with the sequence n°1 is the number of averaged spectra.

Header	*Sweep Full*	*Passive Power*	*Sweep Minmax*	*Passive Full*	*Sweep Minmax*	*Passive Power*	*Sweep Minmax*	*Pad 0x00*
1 byte	92 + 28 + 1 +1 bytes	1 byte	4 + 4 bytes	48 bytes	4 + 4	1 byte	4 + 4 bytes	1 byte

Table 26: Description of the MIP complementary n°2 sequence in normal rate.

3.3.5.9 Complementary sequence n°2 in burst rate

The MIP complementary n°2 science sequence in burst rate (set in byte5 of configuration table) presented in Table 27 is composed of:

- a header (1 byte);
- one Survey-Full mode (122 bytes), averaged on 2 active spectra with transmitter "Transmis_odd_sweeps";
- one Passive-Full (48 bytes), averaged on 4 spectra;
- a series repeated 7 times :
  - one Survey-Window mode (16 bytes), averaged on 2 active spectra;
  - one Sweep-Full mode (122 bytes), averaged on 2 active spectra;
  - one Passive-Power mode (1 byte), averaged on 4 spectra;
- three bytes pad set to 0x00.

Header	*Sweep Full*	*Passive Full*	*Survey Window*	*Sweep Full*	*Passive Power*	*Survey Window*	*…*	*Pad 3 x 0x00*
1 byte	92 + 28 + 1 +1 bytes	48 bytes	14 + 1 + 1 bytes	92 + 28 + 1 +1 bytes	1 byte	14 + 1 + 1 bytes		3 bytes

Table 27: Description of the MIP complementary n°2 sequence in burst rate.

3.3.5.10 Complementary sequence n°3 in normal rate

The MIP complementary n°3 science sequence in normal rate (set in byte5 of configuration table) presented in Table 28, is composed of:

- a header (1 byte);
- one Survey-Window mode (16 bytes), averaged on 4 active spectra, with transmitter "Transmis_odd_sweeps";
- one Passive-Full mode (48 bytes), averaged on 4 spectra;
- a series repeated 7 times :
  - one Sweep-Window mode (16 bytes), averaged on 2 active spectra;
  - one Passive-Power mode (1 byte), averaged on 4 spectra;
- fourteen bytes pad set to 0x00.

Header	*Survey Window*	*Passive Full*	*Sweep Window*	*Passive Power*	*Sweep Window*	*…*	*Pad 14 x 0x00*
1 byte	14 + 1 +1 bytes	48 bytes	14 + 1 + 1 bytes	1 byte	14 + 1 + 1 bytes		14 bytes

Table 28: Description of the MIP complementary n°3 sequence in normal rate.

3.3.5.11 Complementary sequence n°4 in normal rate

The MIP complementary n°4 science sequence in normal rate (set in byte5 of configuration table) presented in Table 29, is composed of:

- a header (1 byte);
- one Survey-Full mode (122 bytes), averaged on 16 active spectra, with transmitter "Transmis_odd_sweeps";
- one Passive-Full mode (48 bytes), averaged on 16 spectra;
- one Survey-Window mode (16 bytes), averaged on 16 active spectra, with transmitter "Transmis_even_sweeps";
- one Passive-Power mode (1 byte), averaged on 16 spectra;
- ten bytes pad set to 0x00.

Header	***Survey Full***	***Passive Full***	***Survey Window***	***Passive Power***	***Pad 10 x 0x00***
1 byte	92 + 28 +1 + 1 bytes	48 bytes	14 + 1 + 1 bytes	1 byte	10 bytes

Table 29: Description of the MIP complementary n°3 sequence in normal rate.

3.3.5.12 Complementary sequence n°5 in normal rate

The MIP complementary n°5 science sequence in normal rate (set in byte5 of configuration table) presented in Table 30, is composed of:

- a header (1 byte);
- one Survey-Window mode (16 bytes), averaged on 4 active spectra, with transmitter "Transmis_odd_sweeps";
- one Passive-Full mode (48 bytes), averaged on 2 spectra;
- a series repeated 8 times :
  - a Survey-Window mode (16 bytes), averaged on 4 active spectra;
- five bytes pad set to 0x00.

Header	***Survey window***	***Passive Full***	***Survey Window***	***Survey Window***	***…***	***Pad 5 x 0x00***
1 byte	14 +1 + 1 bytes	48 bytes	14 + 1 + 1 bytes	14 + 1 + 1 bytes		5 bytes

Table 30: Description of the MIP complementary n°5 sequence in normal rate.

3.3.5.13 Complementary sequence n°7 in minimum rate

The MIP complementary n°7 science sequence in minimum rate (set in byte5 of configuration table) presented in Table 31, is composed of:

- a header (1 byte);
- a series of 16 Passive-Power modes (16×1 bytes), averaged on 8 spectra;
- one byte pad set to 0x00.

Header	***Passive Power***	***…***	***Passive Power***	***Pad 0x00***
1 byte	1 byte		14 + 1 + 1 bytes	1 byte

Table 31: Description of the MIP complementary n°7 sequence in minimum rate.

3.3.5.14 Complementary sequence n°7 in normal rate

The MIP complementary n°7 science sequence in minimum rate (set in byte5 of configuration table) presented in Table 32, is composed of:

- a header (1 byte);
- a series of 4 Passive-Full modes (4×48 bytes), averaged on 32 spectra;
- five bytes pad set to 0x00.

Header	***Passive Full***	***Passive Full***	***Passive Full***	***Passive Full***	***Pad 5 x 0x00***
1 byte	48 bytes	48 bytes	48 bytes	48 bytes	5 bytes

Table 32: Description of the MIP complementary n°7 sequence in normal rate.

3.3.5.15 Complementary sequence n°7 in burst mode

The MIP complementary n°7 science sequence in burst rate (set in byte5 of configuration table) presented in Table 33, is composed of:

- a header (1 byte);
- a series of 24 Passive-Full modes (24×48 bytes), averaged on 4 spectra;
- five bytes pad set to 0x00.

Header	***Passive Full***	***Passive Full***	***Passive Full***	***…***	***Pad 5 x 0x00***
1 byte	48 bytes	48 bytes	48 bytes		5 bytes

Table 33: Description of the MIP complementary n°7 sequence in burst rate.

3.3.6 LDL sciences sequences

No complementary LDL sequences have been defined. Two types of LDL sequences have been defined:

- type 0, normal LDL sequences with an LDL sequence every 32 seconds;
- type 1, mixed LDL sequences with an LDL sequence alternated with a MIP sequence; the synchronization is made by PIU [RD6].

3.3.6.1 Nominal sequence n°0 in minimum rate

The LDL nominal science sequence in minimum rate (set in byte5 of configuration table) presented in Table 34, is composed of:

- a header (1 byte);
- one LDL-Window mode (16 bytes), averaged on 32 active spectra;
- one Passive-Power mode (1 byte), averaged on 16 spectra.

Header	***LDL Window***	***Passive Power***
1 byte	16 bytes	1 byte

Table 34: Description of the LDL nominal sequence in burst rate.

3.3.6.2 Nominal sequence n°0 in normal rate

The LDL nominal science sequence in normal rate (set in byte5 of configuration table) presented in Table 35, is composed of:

- a header (1 byte);
- one LDL-Full mode (48 bytes), averaged on 32 active spectra;
- one Passive-Window mode (24 bytes), averaged on 16 spectra;
- one LDL-Full mode (48 bytes), averaged on 32 active spectra;
- one Passive-Window (24 bytes), averaged on 16 spectra;
- one LDL-Full mode (48 bytes), averaged on 32 active spectra;
- five bytes pad set to 0x00.

Header	***LDL Full***	***Passive Window***	***LDL Full***	***Passive Window***	***LDL Full***	***Pad 5 x 0x00***
1 byte	48 bytes	24 bytes	48 bytes	24 bytes	48 bytes	5 bytes

Table 35: Description of the LDL nominal sequence in normal rate.

3.3.6.3 Nominal sequence n°0 in burst rate

The LDL nominal science sequence in burst rate (set in byte5 of configuration table) presented in Table 36, is composed of:

- a header (1 byte);
- a series repeated 10 times :
    - one LDL-Full mode (48 bytes), averaged on 4 active spectra;
    - one Passive-Window mode (24 bytes), averaged on 2 spectra;
    - one LDL-Window mode (16 bytes), averaged on 4 active spectra;
    - one Passive-Window mode (24 bytes), averaged on 2 spectra;
- one LDL-Full mode (48 bytes), averaged on 4 active spectra;

- one Passive-Window mode (24 bytes), averaged on 2 spectra;
- seven bytes pad set to 0x00.

Header	*LDL Full*	*Passive Window*	*LDL Window*	*Passive Window*	*LDL Full*	*Passive Window*	*…*	*LDL Full*	*Passive Window*	*Pad 7 x 0x00*
1 byte	48 bytes	24 bytes	16 bytes	24 bytes	48 bytes	24 bytes		48 bytes	24 bytes	7 bytes

Table 36: Description of the LDL nominal sequence in burst rate.

3.3.7 House-keepings

The MIP house-keepings (HK) are stored in different files according to the instrument that is in charge of their management, Spacecraft, MAG/PIU or MIP.

3.3.7.1 HK handled by S/C

The first thermistor located into one reception electrode is handled by the S/C; the sensor temperature value is stored into the spacecraft HK frame.

3.3.7.2 HK handled by MAG and/or PIU

The analog HK of RPC are digitized by the MAG instrument; the corresponding values are stored into MAG HK frames; for MIP, it concerns:

- second sensor temperature value (thermistor located into the second reception electrode),
- voltages information.

Note that the temperature value is reported into the full MIP HK packet (paragraph 3.3.7.4).

The alarm signal will be handled by PIU.
The LDL synchronization is handled by PIU.
The working state (on/off) will be stored into the PIU HK frame [RD2].

3.3.7.3 HK handled by MIP

The parameters used to check the working state of the experiment are sent once with the Control sequence (memory check-out, watchdog).

MIP has 2 different HK packets, HK type I transmitted every sequence and HK type II transmitted before Control or Table sequence [RD6].

The HK type I contains information about the active and passive sweeps (Table 37-a). Details of byte 5 is given in Table 37-b.

byte0		***byte1***	***byte2***	***byte3***	***byte4***	***byte5***
LDL sync.	Control/table Sequence counter	LDL Science sequence counter	MIP Science sequence counter	Mean power in Passive mode	Resonance power in Survey mode	Resonance frequency in Survey mode

Table 37-a: HK type I data format.

byte0							
bit7	***bit6***	***bit5***	***bit4***	***bit3***	***bit2***	***bit1***	***bit0***
LDL synchro		Control/Table sequence counter					

Table 37-b: Details of byte of HK type I.

The values of the 2 bits of the LDL synchronization are:

- 00 for a MIP sequence,
- 10 for a LDL sequence of type 0,
- 01 for a MIP sequence in a mixed LDL mode (type 1),
- 11 for a LDL sequence in a mixed LDL mode (type 1).

The HK type II is used to return the command from PIU to MIP (it is not an acknowledgment). It contains the configuration table (Table 37-c) described in paragraph 3.3.3.3.

byte0	***byte1***	***byte2***	***byte3***	***byte4***	***byte5***
Configuration table					

Table 37-c: HK type II data format.

3.3.7.4 Full HK packet

PIU makes one full HK packet containing HK type I, HK type II and temperature. This full packet is sent every AQP.

SID	***HK type I***	***HK type II***	***Temperature***
0x0001	6 bytes	6 bytes	2 bytes

Table 38: Full HK packet sent by PIU.

Notes:

- SID in an HK identifier;
- The temperature value is coded over a 16-bit word (two-complement).

3.4 PIU packetization

PIU adds 16 bytes to each sequence frame (see RD5, section 2.7.2.1). The structure, given in Table 39, is composed of:

- a packet header of 6 bytes (Table 40-a) containing
  - a packet identifier (2 bytes) with inside a process identifier (APID),
  - a packet control (2 bytes),

  - a packet length (2 bytes),
- a packet data field of 10 bytes (Table 40-b) containing
  - the onboard time over 6 bytes (Table 40-c), see [RD2] for details,
  - information specific to the source data onboard ROSETTA spacecraft (4 bytes).

Packet Header	***Packet Data Field***	
	Data field header	*Experiment data*
6 bytes	10 bytes	variable

Table 39: Structure of the data packets.

Packet Header (6 bytes)						
Packet ID				*Packet Control*		*Packet Length*
Version Number	*Type*	*Data field header*	*APID*	*Segment Flag*	*Sequence counter*	
3 bits ‘000’	1 bit ‘0’	1 bit ‘1’	11 bits	2 bits ‘11’	14 bits	16 bits

Table 40-a: Details of the CCSDS packet header.

The parameters of the packet header are:

- version set to ‘000',
- type set to ‘0',
- data field header set to ‘1',
- APID set to
  - 1404 (decimal) for a data packet,
  - 1396 (decimal) for a HK packet,
  - 1393 (decimal) for PIU acknowledgment packet.
- segment flag set to ‘11',
- sequence counter gives the number of packet per APID,
- packet length gives the number of bytes in the data field **- 1** as
  - 0xCF for data packet (208 bytes, 10 data field header + 198 data values);
  - 0x19 for HK packet (26 bytes, 10 data field header + 16 HK values);
  - 0x0D for PIU ack. packet (14 bytes, 10 data field header + 4 PIU ack. values).

The 2 first bytes of the data header will be:

- **0x0D71** when ack. packet,
- **0x0D74** when HK packet,
- **0x0D7C** when data packet.

Data field header (10 bytes)						
Time	*PUS version*	*Checksum flag*	*Spare*	*Packet type*	*Packet Sub-type*	*Pad*
48 bits	3 bits 000 data 010 HK 010 ack.	1 bit '0'	4 bits '0000'	8 bits 0x14 data 0x03 HK 0x01 ack.	8 bits 0x03 data 0x19 HK 0x01 ack.	8 bits

Table 40-b: Details of the data field header of 10 bytes.

The parameters of the data field header are:

- time over 6 bytes (Table 39-c),
- PUS-version set to
  - '000' when data values,
  - '010' when HK and ack. values,
- checksum flag set to '0',
- spare set to '0000',
- packet type and packet sub-type set respectively to
  - 20 and 03 (decimal) when data values,
  - 03 and 25 (decimal) when HK values,
  - 01 and 01 (decimal) when PIU ack. values.

Time (6 bytes)					
Seconds				*Sub-seconds*	
2^{31} xxxxxxxx	2^{23} xxxxxxxx	2^{15} xxxxxxxx	2^{7} xxxxxxxx	2^{-1} 2^{-8} xxxxxxxx	2^{-16} xx000000

Table 40-c: Structure of the time code.