



ROSETTA project - MIP experiment

Onboard Data Handling

RPC/MIP/RP/13/980317/LPCE

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MODIFICATIONS

- **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 : $0 \text{ dB} = 0.6 \mu\text{V Hz}^{-1/2}$;
- 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** (LPCE internal distribution)
 - 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, September 2000**
 - Sequence n°7 Passive in minimum rate has been added (paragraph 3.3.5.13).



REFERENCES

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- [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.



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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 (\rightarrow the electron density);
- the amplitude of the resonance peak and the frequency of the interference structures are related to the Debye length (\rightarrow 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 $f_c=7168$ 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 $\Delta f = f_c/N = 7$ 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.

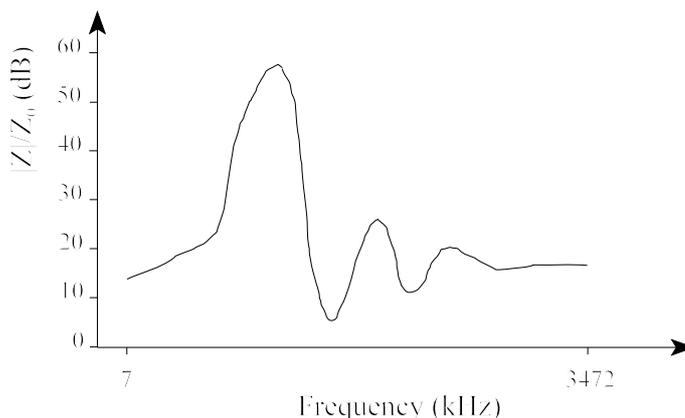


Figure 1. Example of mutual impedance probe response versus frequency (normalized square modulus).

2.2. Passive mode

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
<i>5 b/s</i>	<i>18 bytes</i>
<i>50 b/s</i>	<i>198 bytes</i>
<i>300 b/s</i>	<i>1200 bytes</i>

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
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<i>FULL</i>	<i>92 × 8 bits</i>	<i>28 × 8 bits</i>	<i>1 × 8 bits</i>	<i>1 × 8 bits</i>	<i>122 bytes</i>
<i>WINDOW</i>	<i>14 × 8 bits</i>		<i>1 × 8 bits</i>	<i>1 × 8 bits</i>	<i>16 bytes</i>
<i>MINMAX</i>	<i>4 × 8 bits</i>		<i>4 × 8 bits</i>		<i>8 bytes</i>

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 ($f_{\max1}$), $f_{\min1}$, $f_{\max2}$ and $f_{\min2}$; $f_{\max1} > f_{\min1} > f_{\max2} > f_{\min2}$.
- 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	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	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	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	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	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	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	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 fore 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
<i>FULL</i>	<i>92 × 8 bits</i>	<i>28 × 8 bits</i>	<i>1 × 8 bits</i>	<i>1 × 8 bits</i>	<i>122 bytes</i>
<i>WINDOW</i>	<i>14 × 8 bits</i>		<i>1 × 8 bits</i>	<i>1 × 8 bits</i>	<i>16 bytes</i>
<i>MINMAX</i>	<i>4 × 8 bits</i>		<i>4 × 8 bits</i>		<i>8 bytes</i>

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
<i>FULL</i>	<i>24 × 8 bits</i>	<i>24 × 8 bits</i>		<i>48 bytes</i>
<i>WINDOW</i>	<i>15 × 8 bits</i>		<i>1 × 8 bits</i>	<i>16 bytes</i>

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	Resolution	Number of frequency step
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
<i>FULL</i>	96 × 4 bits	48 bytes
<i>WINDOW</i>	48 × 4 bits	24 bytes
<i>POWER</i>	2 × 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 interval	Resolution	Number of points
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
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Table 8. Frequency bandwidth and resolution for the Full Passive mode.

<i>bit7</i>	<i>bit6</i>	<i>bit5</i>	<i>bit4</i>	<i>bit3</i>	<i>bit2</i>	<i>bit1</i>	<i>bit0</i>	<i>bit7</i>	<i>bit6</i>	<i>bit5</i>	<i>bit4</i>	<i>bit3</i>	<i>bit2</i>	<i>bit1</i>	<i>bit0</i>	...
7 kHz				14 kHz				21 kHz				28 kHz				...

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

<i>bit7</i>	<i>bit6</i>	<i>bit5</i>	<i>bit4</i>	<i>bit3</i>	<i>bit2</i>	<i>bit1</i>	<i>bit0</i>
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 $\mu\text{V Hz}^{-1/2}$** . 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 :

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

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).

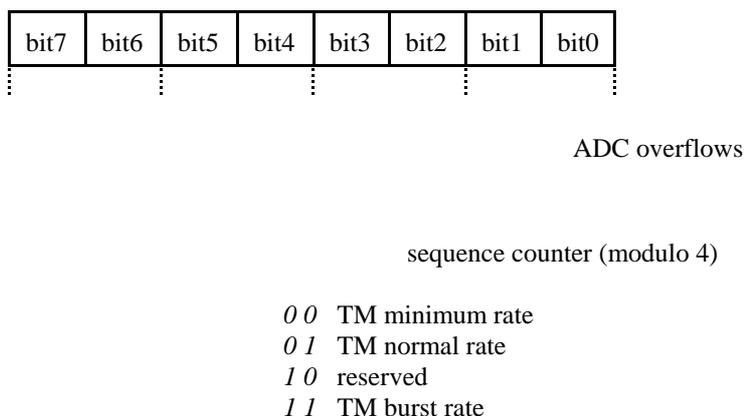
Control sequence	Science sequence n°1	Science sequence n°2
18, 198 or 1200 bytes	18, 198 or 1200 bytes	18, 198 or 1200 bytes	

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, an **header of 1 byte** is put before any MIP sequence frame. The header definition is given in Table 12.



00	MIP science sequence
01	LDL science sequence
10	control sequence
11	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 : $1 \leq \text{number} < 128$
- 2 : $128 \leq \text{number} < 1024$
- 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	

							00 OK
							01 one error R/W
							10 two errors R/W
							11 three errors R/W
							00 OK
							01 one error Read/Write
							10 two errors Read/Write
							11 three errors Read/Write
							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 :

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

● **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
- Transmis_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
- Transmis_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
- Ext_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
<i>Edition</i>				<i>Revision</i>			

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	Information	Configuration table	Version	Auto-loop survey	FIFO samples
<i>1 byte</i>	<i>1 byte</i>	<i>6 bytes</i>	<i>1 byte</i>	<i>K-9 bytes (92+28+1+1 max)</i>	<i>K-122-9 bytes</i>

Table 17. Table sequence output frame.

3.3.4.2. Information

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

- the state of the command (table) transfer between MIP and PIU (2 bits, see Table 14),
- a sequence counter (all sequences) modulo 64 (6 bits).

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	Passive
	Window	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	Passive	Survey	Passive	Survey	Passive	Survey	Pad
	<i>Full</i>	<i>Power</i>	<i>Minmax</i>	<i>Full</i>	<i>Minmax</i>	<i>Power</i>	<i>Minmax</i>	<i>0x00</i>
<i>1 byte</i>	<i>92+28+1+1 bytes</i>	<i>1 byte</i>	<i>4+4 bytes</i>	<i>48 bytes</i>	<i>4+4 bytes</i>	<i>1 byte</i>	<i>4+4 bytes</i>	<i>1 byte</i>

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	Passive	Survey	Passive	Survey	Passive	...	Pad
	<i>Full</i>	<i>Power</i>	<i>Minmax</i>	<i>Full</i>	<i>Full</i>	<i>Power</i>		<i>3*0x00</i>
<i>1 byte</i>	<i>92+28+1+1 bytes</i>	<i>1 byte</i>	<i>4+4 bytes</i>	<i>48 bytes</i>	<i>92+28+1+1 bytes</i>	<i>1 byte</i>		<i>3 bytes</i>

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	Passive
	<i>Window</i>	<i>Power</i>
<i>1 byte</i>	<i>14+1+1 bytes</i>	<i>1 byte</i>

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	Passive	Sweep	Passive	Sweep	Passive	Sweep	Pad
	<i>Full</i>	<i>Power</i>	<i>Minmax</i>	<i>Full</i>	<i>Minmax</i>	<i>Power</i>	<i>Minmax</i>	<i>0x00</i>
<i>1 byte</i>	<i>92+28+1+1 bytes</i>	<i>1 byte</i>	<i>4+4 bytes</i>	<i>48 bytes</i>	<i>4+4 bytes</i>	<i>1 byte</i>	<i>4+4 bytes</i>	<i>1 byte</i>

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	Passive	Sweep	Passive	Sweep	Passive	...	Pad

	<i>Full</i>	<i>Power</i>	<i>Minmax</i>	<i>Full</i>	<i>Full</i>	<i>Power</i>		<i>3*0x00</i>
<i>1 byte</i>	<i>92+28+1+1 bytes</i>	<i>1 byte</i>	<i>4+4 bytes</i>	<i>48 bytes</i>	<i>92+28+1+1 bytes</i>	<i>1 byte</i>		<i>3 bytes</i>

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	Passive
	<i>Window</i>	<i>Power</i>
<i>1 byte</i>	<i>14+1+1 bytes</i>	<i>1 byte</i>

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°1 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	Passive	Sweep	Passive	Sweep	Passive	Sweep	Pad
	<i>Full</i>	<i>Power</i>	<i>Minmax</i>	<i>Full</i>	<i>Minmax</i>	<i>Power</i>	<i>Minmax</i>	<i>0x00</i>
<i>1 byte</i>	<i>92+28+1+1 bytes</i>	<i>1 byte</i>	<i>4+4 bytes</i>	<i>48 bytes</i>	<i>4+4 bytes</i>	<i>1 byte</i>	<i>4+4 bytes</i>	<i>1 byte</i>

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	Passive	Survey	Sweep	Passive	Survey	...	Pad
	<i>Full</i>	<i>Full</i>	<i>Window</i>	<i>Full</i>	<i>Power</i>	<i>Window</i>		<i>3*0x00</i>
<i>1 byte</i>	<i>92+28+1+1 bytes</i>	<i>48 bytes</i>	<i>14+1+1 bytes</i>	<i>92+28+1+1 bytes</i>	<i>1 byte</i>	<i>14+1+1 bytes</i>		<i>56 bytes</i>

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	Passive	Sweep	Passive	Sweep	...	Pad
	<i>Window</i>	<i>Full</i>	<i>Window</i>	<i>Power</i>	<i>Window</i>		<i>14*0x00</i>
<i>1 byte</i>	<i>14+1+1 bytes</i>	<i>48 bytes</i>	<i>14+1+1 bytes</i>	<i>1 byte</i>	<i>14+1+1 bytes</i>		<i>14 bytes</i>

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	Passive	Survey	Passive	Pad
	<i>Full</i>	<i>Full</i>	<i>Window</i>	<i>Power</i>	<i>10*0x00</i>
<i>1 byte</i>	<i>92+28+1+1 bytes</i>	<i>48 bytes</i>	<i>14+1+1 bytes</i>	<i>1 byte</i>	<i>10 bytes</i>

Table 29. Description of the MIP complementary n°4 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	Passive	Survey	Survey	...	Pad
	<i>Window</i>	<i>Full</i>	<i>Window</i>	<i>Window</i>		<i>5*0x00</i>
<i>1 byte</i>	<i>14+1+1 bytes</i>	<i>48 bytes</i>	<i>14+1+1 bytes</i>	<i>14+1+1 bytes</i>		<i>5 bytes</i>

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	...	Passive	Pad
	<i>Power</i>		<i>Power</i>	<i>1*0x00</i>
<i>1 byte</i>	<i>1 byte</i>		<i>1 byte</i>	<i>1 byte</i>

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	Passive	Passive	Passive	Pad
	<i>Full</i>	<i>Full</i>	<i>Full</i>	<i>Full</i>	<i>5*0x00</i>
<i>1 byte</i>	<i>48 bytes</i>	<i>48 bytes</i>	<i>48 bytes</i>	<i>48 bytes</i>	<i>5 bytes</i>

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

3.3.5.15. Complementary sequence n°7 in burst rate

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	Passive	Passive	...	Pad
	<i>Full</i>	<i>Full</i>	<i>Full</i>		<i>5*0x00</i>
<i>1 byte</i>	<i>48 bytes</i>	<i>48 bytes</i>	<i>48 bytes</i>		<i>5 bytes</i>

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

3.3.6. LDL science 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	Passive
	<i>Window</i>	<i>Power</i>
<i>1 byte</i>	<i>16 bytes</i>	<i>1 byte</i>

Table 34. Description of the LDL nominal sequence in minimum 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	Passive	LDL	Passive	LDL	Pad
	<i>Full</i>	<i>Window</i>	<i>Full</i>	<i>Window</i>	<i>Full</i>	<i>5*0x00</i>
<i>1 byte</i>	<i>48 bytes</i>	<i>24 bytes</i>	<i>48 bytes</i>	<i>24 bytes</i>	<i>48 bytes</i>	<i>5 bytes</i>

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	Passive	LDL	Passive	LDL	Passive	...	LDL	Passive	Pad
	<i>Full</i>	<i>Window</i>	<i>Window</i>	<i>Window</i>	<i>Full</i>	<i>Window</i>		<i>Full</i>	<i>Window</i>	<i>7*0x00</i>
<i>1 byte</i>	<i>48 bytes</i>	<i>24 bytes</i>	<i>16 bytes</i>	<i>24 bytes</i>	<i>48 bytes</i>	<i>24 bytes</i>		<i>48 bytes</i>	<i>24 bytes</i>	<i>7 bytes</i>

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 de type I data format.

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

Table 37-b. Detail of byte 5 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
<i>Configuration table</i>					

Table 37-c. HK de 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
<i>0x0001</i>	<i>6 bytes</i>	<i>6 bytes</i>	<i>2 bytes</i>

Table 38. Full HK packet sent by PIU.

Notes :

- SID is 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	
	<i>Data field header</i>	<i>Experiment data</i>
<i>6 bytes</i>	<i>10 bytes</i>	<i>variable</i>

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	
<i>3 bits '000'</i>	<i>1 bit '0'</i>	<i>1 bit '1'</i>	<i>11 bits</i>	<i>2 bits '11'</i>	<i>14 bits</i>	<i>16 bits</i>

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	Chechsum 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} xxxxxxx	2^{23} xxxxxxx	2^{15} xxxxxxx	2^7 xxxxxxx	2^{-1} xxxxxxx	2^{-16} xx00000

Table 40-c. Structure of the time code.