



ROSETTA project - MIP experiment
MIP/PIU Data Handling Interface

RPC/MIP/RP/126/990253/LPCE

Ed. 3, Rev. 3

May 23, 2001

D. Lagoutte, J.L. Michau, F. Colin, T. Hachemi and P. Zamora

LABORATOIRE DE PHYSIQUE ET CHIMIE DE L'ENVIRONNEMENT
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/Fax : (33/0) 2.38.63.12.34



DIFFUSION LIST

C. Carr	IC
C. Lee	IC
P. Howarth	IC
M. Ludlam	IC
J.P. Lebreton	ESTEC
W. Schmidt	FMI
H. Laakso	FMI
R. Gill	IRF-U
A. Eriksson	IRF-U
F. Colin	LPCE
T. Hachemi	LPCE
D. Lagoutte	LPCE
J.L. Michau	LPCE
J.G. Trotignon	LPCE
P. Zamora	LPCE

Version 3.3 only distributed at LPCE (attached pdf file, Acrobat 4.0).

MODIFICATIONS

•••Version 1.0

- Proposal of Data Exchange Formats, MIP/97/369/DL, October 27, 1997;
- Proposal of PIU/MIP Interface, MIP/97/457/DL, December 15, 1997;
- Proposal for the MIP_ON/MIP_OFF procedures, May 4, 1998;
- MIP/PIU Interface, version 1.0, November 30, 1998.

•••Version 2.0

- AQP active high;
- Configuration table : new parameters and structure;
- Definition of commands : load table and modes, set parameters;
- Definition of HK type II;
- Command acknowledgment by HK type II : table return;
- HK packets (I and II) sent first before the science packets;
- Modification of the contents of HK type I;
- Mode LDL : commands and execution scheme;

•••Version 2.1

- Modification of HK type I contents;
- HK type II acknowledgment : if the table received during a Control sequence is incomplete (from 0 to 5 bytes), MIP return an HK type II containing the MIP default table; if it is during a Science sequence, MIP ignores the command and no HK is returned;
- Modification of commands 'MIP_modes' and 'TM_rate';
- Definition of MIP autotest.

•••Version 3.0

- PIU does not send time packets to MIP (paragraph 2.2);
- Modification of the configuration table (paragraph 1.1);
- Contents of HK type I modified to take into account the 2 synchronization bits of the LDL mode (paragraph 4.2.1);
- HK type I sent in every sequence (paragraph 4.2.1);
- Modification of the command names (paragraph 5.1);
- New individual command to set the LDL mode type: Set_LDLT (paragraph 5.1);
- LDL mixed mode has been added (paragraph 5.2);
- MIP-LAP synchronization in LDL mode (paragraph 5.2);

•••Version 3.1 (LPCE internal distribution)

- Byte order has been modified in Tables 6, 7;
- Type and sub-type of commands have changed;
- HK packetization by PIU.

•••Version 3.2 (LPCE internal distribution)

- Two-byte time delay added as parameters of the Ld_Cfg and Ld_CCfg commands;
- One two-byte word added at the end of the HK packet with the temperature value;
- Appendix added with the I/F test description,
- Bug correction of the first byte value of the Control sequence (B4, 94, 84 instead of B6, 96, 86 in respectively burst, normal and minimum rates).



•••**Version 3.3 (LPCE internal distribution)**

- Modifications for FM, LDL mixed not yet tested;
- This version will be updated and distributed (see list) after LDL tests with PIU and LAP (normal and mixed modes);
- Maximum autoloop value for FM is F6 (instead F4 for EM).



REFERENCES

- [RD1] Lagoutte D., J.L. Michau and J.G. Trotignon, ROSETTA project - MIP experiment - Onboard Data Handling, RPC/MIP/RP/13/980317/LPCE, Ed.3 Rev.4, Lab. Phys. Chimie Environn., Orléans, September, 2000.
- [RD2] C. Carr, Rosetta RPC - PIU Interfaces Document, Part II - Data-Handling Interfaces, Issue 2, Revision 0, Imperial College, London, September 8, 2000.



CONTENTS

1. MIP OPERATING CONCEPT	Page 1
1.1. Configuration Table	Page 1
1.2. Elementary modes	Page 1
1.3. Sequences	Page 2
1.4. Typical output data series	Page 3
2. TIME MANAGEMENT	Page 3
2.1. Start pulse	Page 3
2.2. Time packet	Page 3
3. SCIENCE DATA TRANSFER	Page 4
3.1. Telemetry rates	Page 4
3.2. Exchange protocol	Page 4
3.3. Link-Packet identifier	Page 6
4. HOUSE-KEEPING DATA	Page 6
4.1. HK generated by S/C and PIU/MAG	Page 6
4.2. HK generated by MIP	Page 6
4.2.1. HK type I	Page 6
4.2.2. HK type II	Page 7
4.3. HK sending MIP to PIU	Page 7
4.4. HK packetization by PIU	Page 8
5. MIP COMMANDING	Page 9
5.1. Commands	Page 9
5.2. LDL mode	Page 11
5.2.1. LDL mode type	Page 11
5.2.2. LDL commanding	Page 11
5.2.3. MIP-LAP command coherence	Page 13
5.2.4. MIP-LAP synchronization	Page 13
6. MIP_ON PROCEDURE	Page 15
7. EVENT REPORTING	Page 16
8. PIU SPECIAL MANAGEMENT	Page 16
8.1. Alarm procedure	Page 16
8.2. Others	Page 16
9. AUTOTEST	Page 16
ANNEX A : TEST PROCEDURES	Page 18
A1. Thermistor managed by S/C	Page 18
A2. Thermistor managed by MIP/RPC	Page 18



A3. MIP mode test	Page 18
A3. MIP SFT	Page 23
A3.1. Checking list	Page 23
A3.2. SFT commands and checking list	Page 24
A3.3. Time diagrams	Page 25
A4. MIP Bench Test	Page 26
A4.1. Checking list	Page 26
A4.2. Bench Test commands and checking list	Page 27
A4.3. Time diagrams	Page 31
A5. Alarm test	Page 33



1. MIP OPERATING CONCEPT

1.1. Configuration Table

A parameter table of 6 bytes is required for software initialization and configuration.

This table contains :

- internal parameters (transmitter selection, transmission level, ...),
- commands for selection of working modes and telemetry rates.

The size of 6 bytes corresponds to one link-packet between PIU and MIP.

The description is done in Table 1. Details are given in [RD1];

	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 1. Description of the configuration table.

A default table is stored in a MIP PROM. This default table cannot be updated. It will only be used in case of transmission problems between PIU and MIP.

The default table is : 0x00 00 00 45 02 00;

The type of table 'PIU_update' or 'MIP_default' and its contents are sent back in the CONTROL or TABLE sequence as data (paragraph 1.3). The table 'PIU_update' is sent back in the HK packet type II (paragraph 4.2.2).

The MIP commands used to set the whole table and the parameters individually are given in paragraph 5.

1.2. Elementary modes

An elementary internal mode corresponds to a well defined experiment configuration. Several output frames are possible for an internal mode; the frame size is fixed for a given telemetry data rate (see paragraph 3.2).

Four elementary modes are defined :

- **SURVEY** mode : active sweep over the whole frequency bandwidth (basic mode). The different output frames are FULL (all the computed values are transmitted), WINDOW

(only values around the resonance peak are sent) and MINMAX (2 maximums and 2 minimums are sent).

- Triggered SWEEP mode : active sweep over a limited frequency interval with a frequency resolution better than the SURVEY mode; the SWEEP mode is always triggered by a SURVEY mode. The output frames are FULL, WINDOW and MINMAX.
- PASSIVE mode : spectrum of the natural waves. The output frames are FULL, WINDOW (only the low frequency part is transmitted) and POWER (integrated power is sent).
- LDL (Long Debye Length) mode : active sweep with a LAP2 transmission and a MIP reception. The output frames are FULL and WINDOW.

All the modes are based on active or passive spectra that will be averaged to fulfil the telemetry allocation. More details are given in [RD1].

1.3. Sequences

Two kinds of sequences are defined [RD1] :

•• SCIENCE SEQUENCES

- A MIP SCIENCE sequence is a series of different elementary MIP modes. The modes (SURVEY, SWEEP, PASSIVE) are automatically linked and run (Figure 1). The duration of a sequence is constant (32 seconds) and will start with a start pulse sent by the PIU.

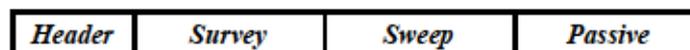


Figure 1. Example of science sequence output frame. This sequence is constituted by an header/status followed by three working modes.

- A LDL SCIENCE sequence is a series of different elementary modes for the LDL common (MIP and LAP) working state. The modes (LDL, PASSIVE) are automatically linked and run every 32s sequence in the normal type of LDL sequence. In the mixed type, one sequence over two, MIP run only PASSIVE modes (paragraph 5.2).

Eight Science sequences with different mode arrangements are defined to fulfil the science requirements according to the allocated telemetry rate. The science sequence index is selected by telecommand (Set_SqNb [0-7]). The data of these sequences, which are sent to PIU, are called 'Science data' in this document.

•• CONTROL SEQUENCES

- The CONTROL sequence is run during every switching on procedure (see paragraph 6). No science modes are run during this particular sequence (Figure

2). The aim is to check the working state of the experiment (check-sums, watchdogs, Transmission/Reception tests) and to wait the configuration table. The output size of the control sequence is the same as a science sequence (size adapted to the telemetry rate). The data of this sequences, which are sent to PIU, are called 'Control data' in this document. The CONTROL sequence is used for the experiment autotest paragraph 9.).

Header	H/W, S/W tests	Configuration table	T/R tests
--------	----------------	---------------------	-----------

Figure 2. Control sequence output frame. It is constituted by a header/status followed by the results of tests and the parameter table.

- The TABLE sequence is run after a command reception during a science sequence to report the new status and the updated configuration. The data format is identical to the CONTROL sequence; the contents is also identical, except for the H/W and S/W tests results which are replaced by a sequence counter [RD1].

1.4. Typical output data series

A typical MIP to PIU data series (Figure 3) consists of :

- one CONTROL sequence,
- a lot of SCIENCE sequences (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	

Figure 3. Format of a typical MIP to PIU data series (without packetization).

2. TIME MANAGEMENT

2.1. Start pulse

All the MIP sequences start with the AQP pulse [RD2].

The time duration between 2 consecutive pulses is 32 seconds [RD2]; the pulse is active-high.

The DSP is set in an idle configuration at the end of every sequence and is waked up with the next pulse.

2.2. Time packet

Absolute time resolution required for MIP is about several hundreds of ms (no waveform sent, averaged spectra are computed). Relative time resolution within RPC is of the same order.

Science data packets are time-stamped by the PIU (AQP time). HK data packets are time-stamped



by the PIU (next AQP time !).

MIP does not need the S/C time to insert time in its data. All the data packets are time-stamped by PIU and to time tag data inside a packet, MIP will use on ground the execution time of the internal modes.

PIU does not send the time packets to MIP.

3. SCIENCE DATA TRANSFER

3.1. Telemetry rates

The bit-rates are :

- minimal : 5 bits/s,
- nominal : 50 bits/s,
- burst : 300 bits/s.

3.2. Exchange protocol

A link packet consists of 8 bytes [RD2] : 1 header, 6 bytes of data, 1 trailer; only the 6 bytes of data are assembled into a TM packet.

The output data frames of the sequences are adapted to fulfil these rates. The size of the frames transferred every 32 seconds from MIP to PIU are :

- minimal : 18 bytes, 3 link-packets;
- normal : 198 bytes, 33 link-packets;
- burst : 1200 bytes, 200 link-packets;

MIP does not acknowledge the data transmission to PIU. The execution' acknowledgment (table returned into an HK type II) is only used to acknowledge the transmission of configuration table from PIU to MIP (see paragraph 5).

A MIP header, used to recognize the type of working sequence, is added at the beginning of every data frame (included within the science data).

As presented in Figure 4, MIP operates with repetitive science sequences. In normal and burst telemetry rates, the output frame (MIP to PIU) will be stored into MIP memory and sent at the end of every sequence, before the next start pulse (active and passive spectra are generally averaged over 32 seconds). In minimum rate, the PIU sending is done about 10 seconds after the AQP (22 seconds idle). Timing diagrams are given in Figure 5. The MIP internal procedure which creates the link packets will be activated once, with a loop over the link packet number (byte number / 6).

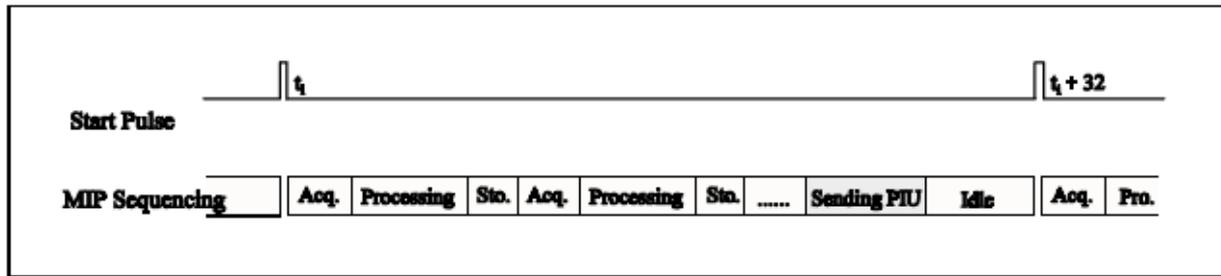


Figure 4. Details of a MIP Science sequence. The three main tasks, signal acquisition from the sensor, processing and data storage into RAM, are successively run. The data sending to PIU is done before the reception of the next start pulse (HK data first, then science data).

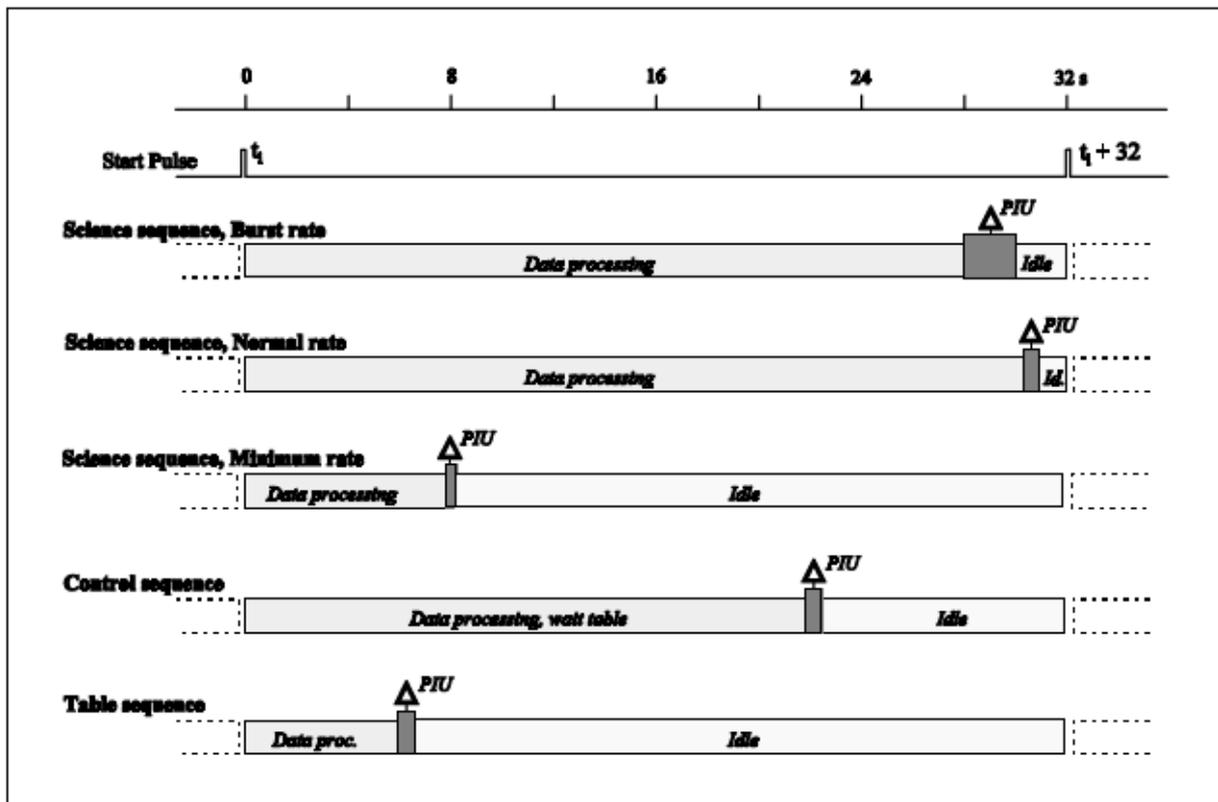


Figure 5. Timing diagrams of the sequence duration and data sending to PIU.

The effective time durations of the sequences defined as the processing time (from the start pulse to the end of packet sending) are (TBC after interface tests) :

- CONTROL sequence : ~ 23 seconds,
- TABLE sequences : ~ 7 seconds,
- SCIENCE sequences (MIP or LDL) in minimum rate : ~ 8 seconds,
- SCIENCE sequences (MIP or LDL) in normal rate : ~ 31 seconds,
- SCIENCE sequences (MIP or LDL) in burst rate : ~ 30 seconds,

The idle duration is 32 s. minus the effective duration.

The idle duration is about 1 second in normal rate and 2 seconds in burst rate; it approximately corresponds to the time of data sending from MIP to PIU.

MIP fills up the 6 data bytes of a link packet; no extraction is requested.

3.3. Link-Packet identifier

The field "Data type" is :

- 0×2 HK type I
- 0×3 HK type II
- 0×6 SID 1 : Science minimum rate
- 0×7 SID 2 : Science normal rate
- 0×8 SID 3 : Science burst rate

No HK types III and IV and are defined. No Science SID 4, 5, 6 are defined.

4. HOUSE-KEEPING DATA

4.1. HK generated by S/C and PIU/MAG

The voltages from the PIU power supply are digitized by the MAG experiment; the corresponding data are reported into its HK packet [RD2].

No information about an over current detection is reported into HK.

The 1st thermistor signal is managed by the S/C. The 2nd thermistor signal (from -2.5 V to +2.5 V) is digitized by MAG experiment and the corresponding data are reported into its HK packet. This value is also reported into the full MIP HK packet (paragraph 4.4).

No temperature control is required from the thermistors.

Diagnostic data reporting must be sent into an event HK' for every I/F error like 'reset', 'no data', 'alarm' (see paragraph 7).

4.2. HK generated by MIP

4.2.1. HK type I

MIP HK packet consists of a Type I HK (6 bytes). Its contents is given in Figure 6-a. Detail of byte 5 is given in Figure 6-b.

HK type I is sent in every sequence (SCIENCE, CONTROL or TABLE).

	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

Figure 6-a. House-Keeping type I array : MIP HK parameters.

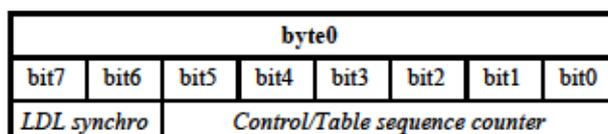


Figure 6-b. Detail of byte 5 of HK type I.

The 'LDL synchro' bits will be used to check the synchronization of the 32s sequences between MIP and LAP in the LDL mixed mode. Its value is :

- 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).

As all the HK packets are not transmitted to the ground, the CAN overflows information are put into the MIP data header/status.

4.2.2. HK type II

Command return (execution acknowledgment) is sent into an HK packet of Type II. Its contents is given in Figure 7. HK type II are only sent during a CONTROL or a TABLE sequence. No verification of this HK packet is requested to PIU.

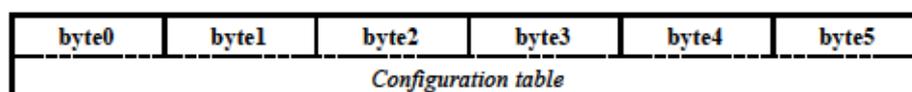


Figure 7. House-Keeping type II array : command return.

All the HK type II sent by MIP have to be transmitted to the ground, i.e. one packet for each configuration change.

The contents of HK type II is dependent on the transmission/reception status :

- the table transmission/reception is OK : the table returned is identical to the received table;
- MIP does not receive the table during the switching on procedure : the default table is returned; its value is given in paragraph 1.1;
- a LDL command mode is received during the switching on procedure : this is not allowed, MIP ignores the command and returns the default table;
- No HK returned if the received table during a Science sequence (not at switching on) is incomplete.

4.3. HK sending MIP to PIU

The HK packets type I are sent every 32 seconds before a data packet (MIP, LDL, Control or Table).

For HK of type II (command return), two cases have to be considered according to the MIP

sequence type :

(i) MIP receives the configuration table during its CONTROL sequence. This is the nominal case according to the switching on procedure (see paragraph 6); the time Δt_1 between the AQP and the table sending is programmable (see paragraph 5).

The time Δt_1 is set by default to 15.75 s (TBC).

MIP returns an HK packet at the end of this sequence (before the Control data), about 22 seconds after the AQP (Figure 8) and 6.25 s after the table reception.

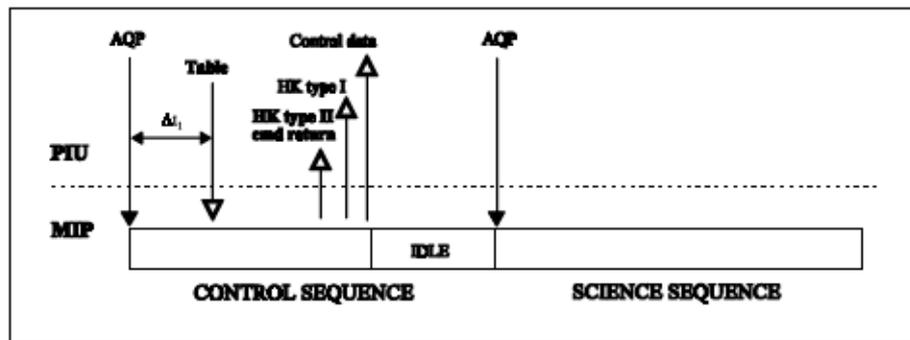


Figure 8. Command return with HK type II when the configuration table is received during the switching on procedure.

(ii) MIP is running a SCIENCE sequence and receives a command, as for example the LDL mode command. The time Δt_2 between the AQP and the table sending is programmable (see paragraph 5). MIP finishes the current Science sequence and then processes the command with an HK packet return in the next sequence that is a TABLE one.

The time Δt_2 is set by default to 31 s (TBC). In that case, a delay of about 8 seconds will be observed between the command reception and the HK packet return (Figure 9).

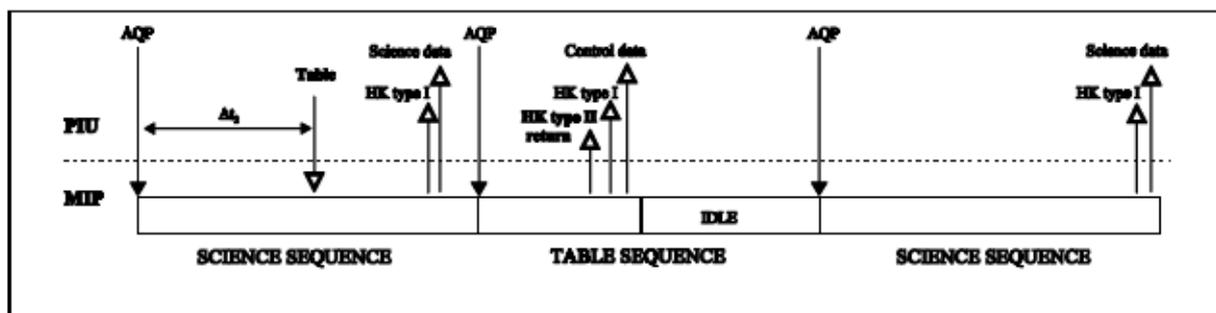


Figure 9. Command return with HK type II when the table is received during a Science sequence.

4.4. HK packetization by PIU

PIU makes every AQP one full HK packet containing the HK type I, the HK type II and the 1st temperature value; the detail is given in RD1. The creation of the full HK packet is done by PIU at the AQP after the MIP sending. This means that the time of the full HK packet is 32s later than the corresponding science data packet. Be careful of that in the data interpretation.

5. MIP COMMANDING

5.1. Commands

All the commands for mode selection and/or for software configuration are stored into the configuration table (see paragraph 1.1).

MIP has one general command to load the whole table, several individual commands to set each parameter of the table and mode commands; they are given in Table 2.

The time between the AQP and the table sending is programmable. Two bytes are inserted as first parameter corresponding to the time in milliseconds.

Command	Type, sub-type	Parameter values	Comments
Ld_cfg	240, 1	2 + 6 bytes	Set the time when PIU sends the table (2 bytes, 0x3d86 as default); Load the full configuration table (6 bytes); This command has to be sent during the switching on procedure;
Ld_CCfg	240, 2	2 bytes	Set the time when PIU sends the table (2 bytes, 0x7918 as default); Load the current configuration table; This command is sent after updates of table parameters by individual commands;
Set_Fq1	241, 1	from 0 to 255	Set the interference frequency index number 1
Set_Fq2	241, 2	from 0 to 255	Set the interference frequency index number 2
Set_Fq3	241, 3	from 0 to 255	Set the interference frequency index number 3
Set_Lvl	242, 1	from 0 to 3	Set the transmission signal level (1/ α , level divided by α); [0: full (1/1), 1: /2, 2: /4, 3: /8]
Set_Oswp	242, 2	from 0 to 3	Select the transmitter for the odd sweeps (1, 3, 5, ...); E1 is monopole 1, E2 monopole 2, E1E2p phased dipole, E1E2ap anti-phased dipole; [0: E1, 1: E2, 2: E1E2p, 3: E1E2ap]
Set_Eswp	242, 3	from 0 to 3	Select the transmitter for the even sweeps (2, 4, 6, ...); E1 is monopole 1, E2 monopole 2, E1E2p phased dipole, E1E2ap anti-phased dipole; [0: E1, 1: E2, 2: E1E2p, 3: E1E2ap]
Set_Thr	242, 4	from 0 to 3	Set the amplitude threshold for the maximum/minimum detections; [0: 1 dB, 1: 2 dB, 2: 4 dB, 3: 8 dB]
Set_SwpB	243, 1	from 0 to 7	Select the frequency bandwidth in Sweep mode; [0: auto-selection, 1-7: forced bandwidth number 1 to 7]
Set_SurB	243, 2	from 0 to 7	Select the frequency bandwidth in Survey mode; [0: nominal bandwidth, 1-7: complementary number 1 to 7]
Set_PRes	243, 3	0 or 1	Set the coding level of the Passive spectrum; [0: 2 dB, 1: 4 dB]
Set_AuLp	243, 4	0 or 1	Set the transmission/reception autoloop status; [0: off, 1: on]

Set_Wd	244, 1	0 or 1	Set the watchdog status; [0: on, 1: off]
Set_SqNb	244, 2	from 0 to 7	Select the sequence number; [0: nominal, 1-7: complementary sequences 1 to 7]
Set_LDLT	244, 3	0 or 1	Set the LDL type; [0: LDL normal, 1: LDL mixed]
Set_Mode	244, 4	0 or 1	Set the working mode; [0: MIP, 1: LDL]
Set_TmRt	244, 5	from 0 to 3	Set the telemetry rate [0: minimum, 1: normal, 2: reserved, 3: burst]

Table 2. MIP commands.

PIU acknowledges the command reception, updates the configuration table into the PIU SDRAM with the individual commands received and sends the whole table of 6 bytes to MIP (Figure 10-a). The PIU acknowledgment packet is returned to the ground as a MIP packet (see RD1).

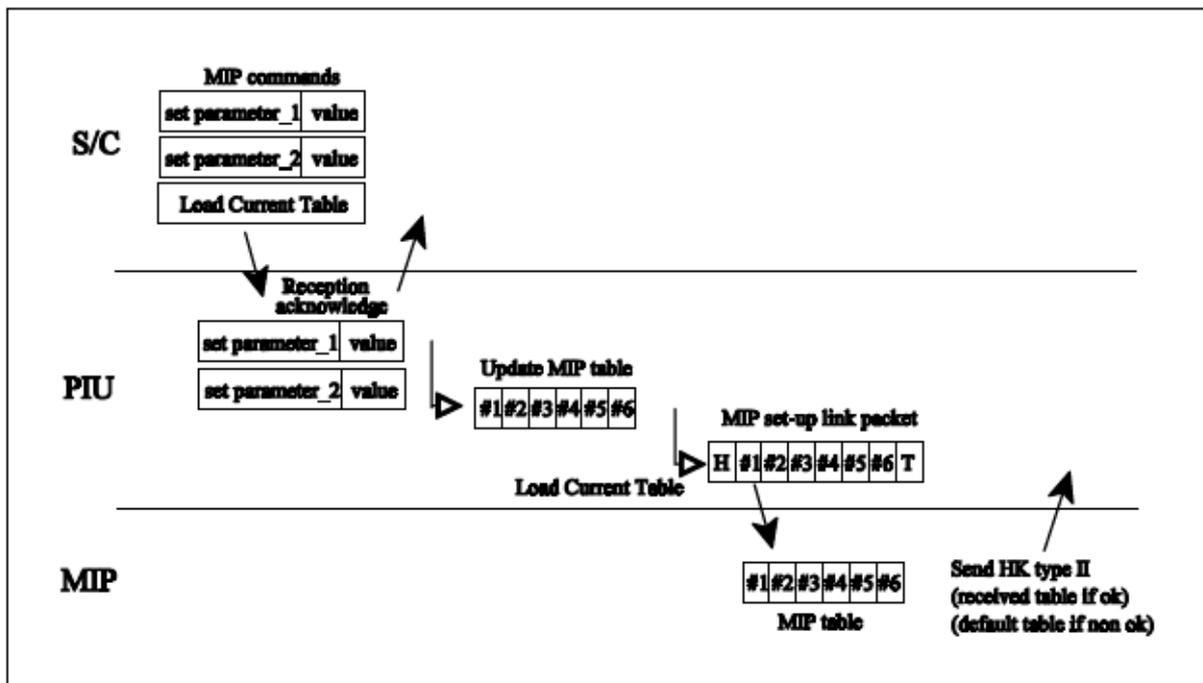


Figure 10-a. MIP commanding procedure.

When several consecutive individual commands are sent to MIP, PIU makes an update of the configuration table once per AQP. This means that only one table can be sent to MIP per AQP (Figure 10-b).

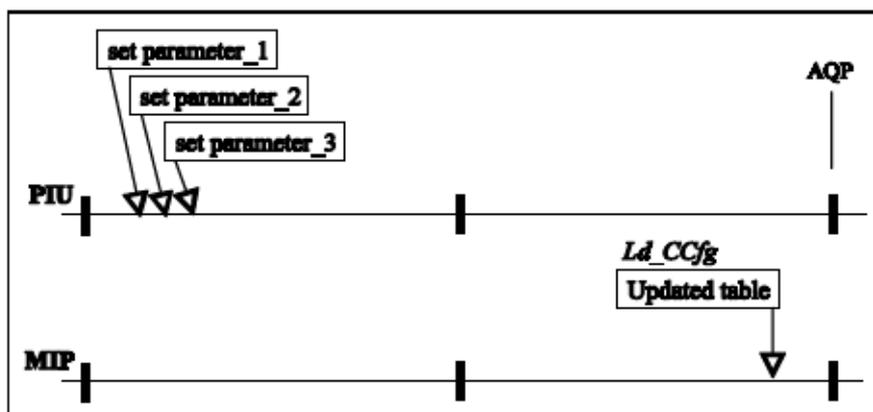


Figure 10-b. PIU updates the MIP configuration table once per AQP with all the consecutive individual commands received.

No code patching or memory dump is required.

MIP has no hazard command.

MIP has no time critical command.

5.2. LDL mode

5.2.1. LDL mode type

Two types of LDL mode have been defined :

- Normal :

MIP uses the LAP2 probe as a transmitter in every 32s sequence. LAP uses the LAP1 only in a passive mode (TBC);

- Mixed :

MIP uses the LAP2 probe as a transmitter and LAP works with LAP1 in passive mode one sequence over 2. During the other sequences, LAP uses LAP1 in active mode and MIP is in passive mode.

All the data packets are managed as MIP packets.

5.2.2. LDL commanding

To run the LDL mode, PIU has to send the load commands successively to MIP and to LAP. To avoid a non-synchronization between LAP and MIP in mixed mode type, it is requested to send the respective commands to MIP and LAP at the same time at the beginning of the first AQP following the command reception (as in Figure 10-b).

For MIP, the LDL mode is set from ground with the following commands:

- Normal LDL :
 "Set_Mode' [1]" + "Set_LDLT' [0]" + eventually commands to set parameters;
- Mixed LDL :
 "Set_Mode' [1]" + "Set_LDLT' [1]" + eventually commands to set parameters;

These commands can also be inserted into the general table loading command : Ld_Cfg.

The table (commands) will be processed after the next AQP and it will be effective at the beginning of the next second AQP (Figure 11).

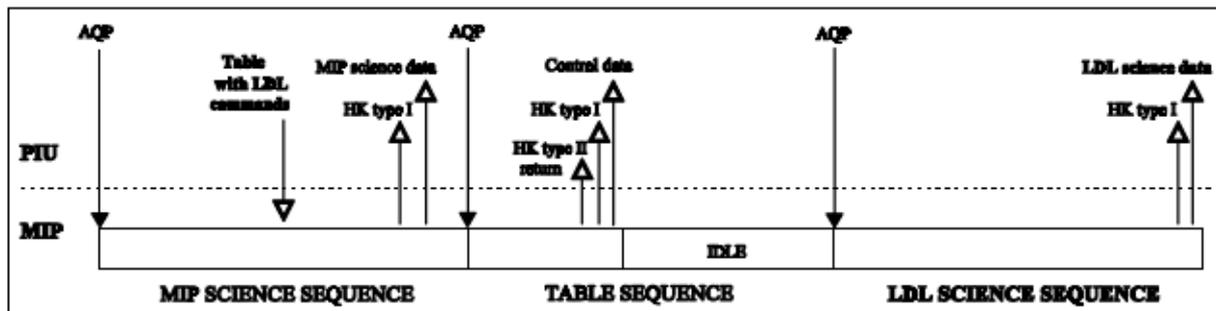


Figure 11. LDL mode command received during a MIP science sequence.

A LDL mode command received during the switching on procedure is ignored.

The LDL mode stops when a "End LDL" command is sent (Figure 14).

There are several ways to terminate the LDL mode :

A/ Stop Mixed LDL when no synchronization with LAP

- The LDL mode is directly stopped by PIU with the commands :
 Set_Mode [0] + Set_LDLT[1] + Ld_CCfg
 The corresponding table sent to MIP is in hex form : 0x00 00 00 00 00 08; all the other parameters of the table will be ignored by MIP. In that case, MIP has stored the previous table (MIP science mode) and will restore it at the end of mixed LDL mode.
 Note that, in this case, the data rate will also be the previous one.

B/ End Normal and Mixed LDL nominally

- PIU receives a new set of MIP commands, updates the current table and sends it to MIP. MIP will take into account this new table only if the mode and LDL type parameters are :
 Set_Mode [0] + Set_LDLT[0] + Ld_CCfg
 A whole table can also be sent to stop the LDL mode; be careful to set the mode and LDL type parameters to '00'.

Note that in Normal LDL mode , the commands "Set_Mode [0] + Set_LDLT[1] + Ld_CCfg" act as "Set_Mode [0] + Set_LDLT[0] + Ld_CCfg" (the previous table is never restored for that type).

5.2.3. MIP-LAP command coherence

- a - PIU checks that MIP and LAP have both requested to be in the LDL mode. If only one experiment has sent an LDL command, then no LDL mode has to be triggered (TBC). It is a failure case, since from ground, the commands will be time tagged with the same time.
- b - The commands are sent at the same time to MIP and LAP, just after an AQP; it will be easier for MIP and LAP to adjust the synchronization of the 32s sequences in mixed LDL.
- c - PIU does not check the acknowledgments of the LDL command (reliable interface).

5.2.4. MIP-LAP synchronization

The synchronization of the mixed LDL mode has to be managed by PIU. This synchronization starts at the beginning of the second next AQP after command sending (Figure 12). This delay is necessary for the LDL mode initialization and to be sure that MIP and LAP have sent their HK packet.

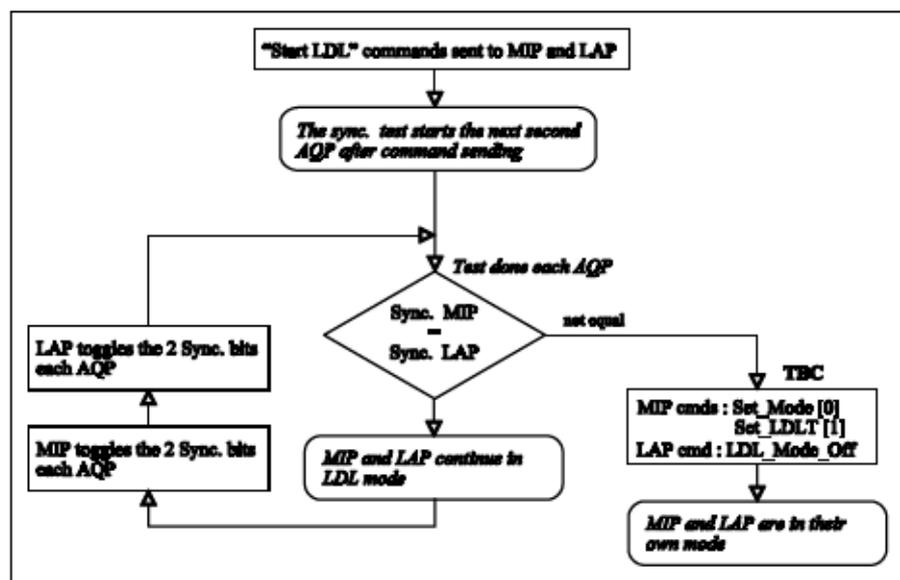


Figure 12. MIP and LAP synchronization.

To synchronize the LDL mode, two bits are coded by MIP and LAP in their HK packets. The definition is :

- 00 : MIP and LAP own mode (MIP and LAP not in LDL mode);
- 01 : MIP and LAP are in mixed LDL mode, MIP is passive and LAP active;
- 10 : MIP and LAP are in normal LDL mode;
- 11 : MIP and LAP are in mixed LDL mode, MIP is active and LAP passive.

For MIP the 2 bits are in HK type I (see paragraph 4.2.1).

The diagrams are presented in Figure 13-a for the mixed LDL mode and in Figure 13-b for the normal LDL mode.

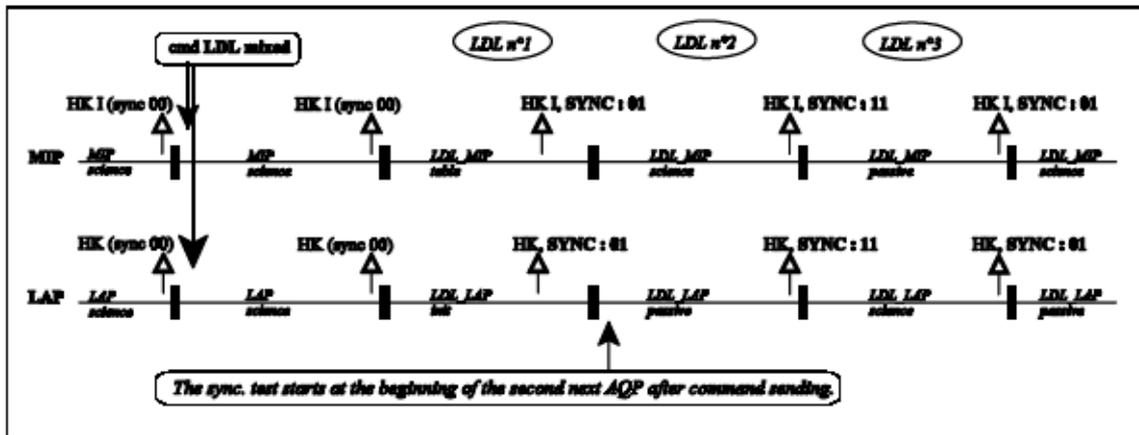


Figure 13-a. Synchronization of MIP and LAP in mixed LDL.

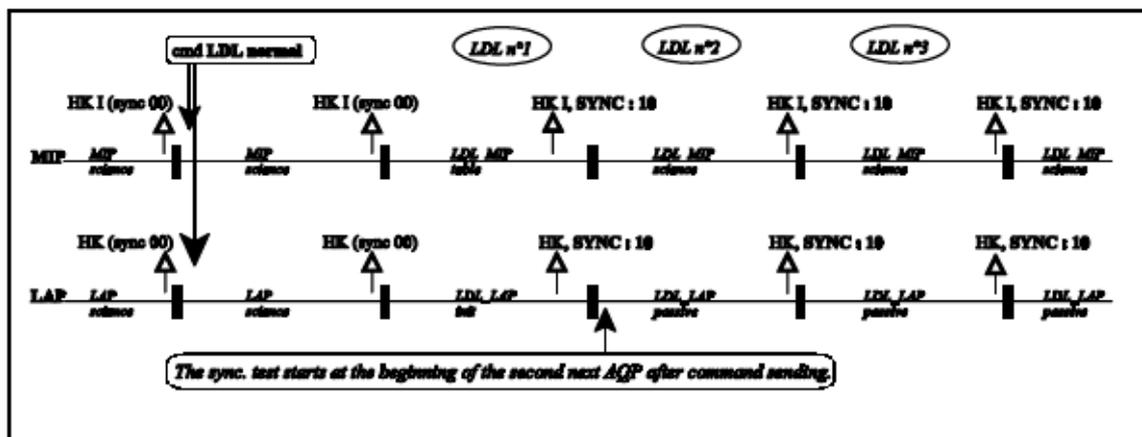


Figure 13-b. Synchronization of MIP and LAP in normal LDL.

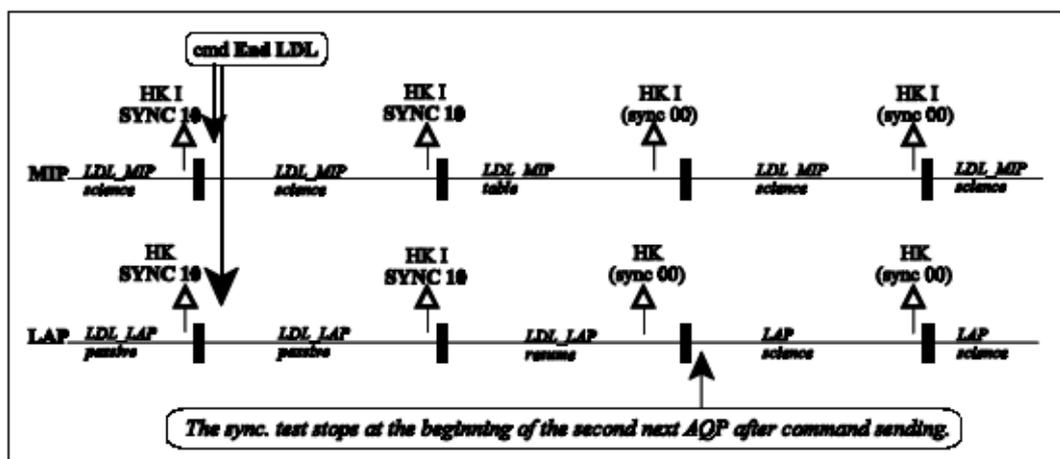


Figure 14. End of mixed LDL mode.

The synchronization task stops the second next AQP after sending the commands “End LDL” (Figure 14).

If the LDL command is not received during a Science sequence (MIP receives the command during the switching on procedure), then :

- the LDL command is ignored (Figure 15),
- MIP starts a MIP mode with its default table (minimum rate),
- MIP sends an HK type II containing the default table.

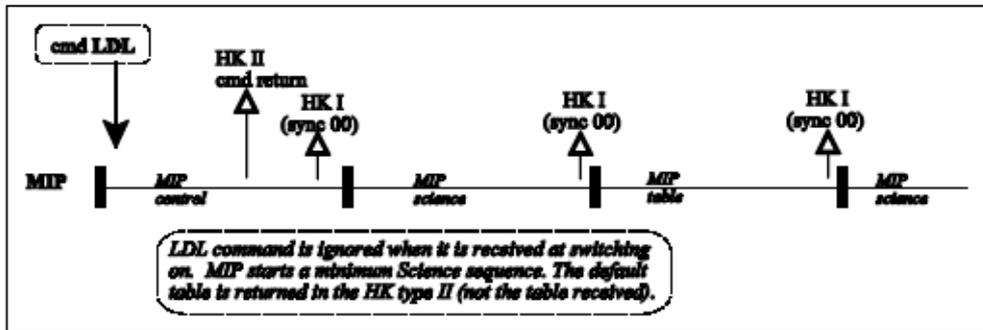


Figure 15. LDL command not received in a Science sequence.

6. MIP_ON PROCEDURE

MIP is switched on after an AQP (Figure 16). After current stabilization (2 s), MIP starts a check-out phase (CONTROL sequence).

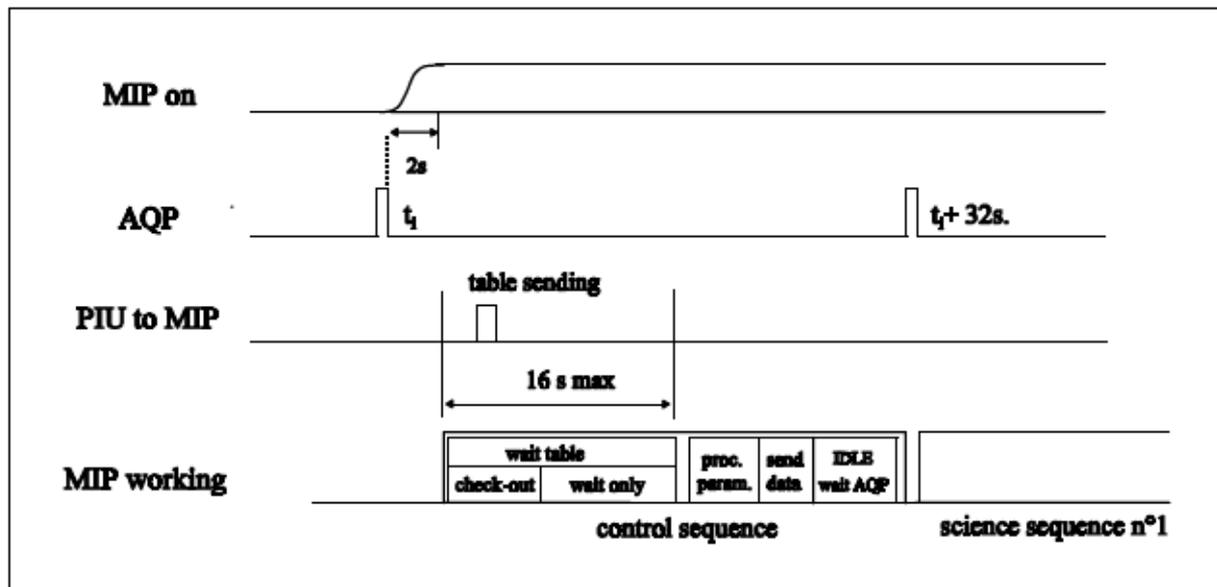


Figure 16. MIP_ON procedure.

A six bytes command (table) must be systematically sent to MIP at each switching on. This command link-packet can be sent just after the stabilization, during the check-out phase or the command waiting phase. MIP waits the command link-packet during about 16 seconds from the



AQP; the default table is selected if no command is received (or incomplete command).

The time when PIU sends the table is programmable (2 bytes in the Ld_Cfg command). Per default, the value is set to 15.75 s (0x3d86 in hex form).

7. EVENT REPORTING

MIP/PIU interface events are reported into an "Event HK packet" :

- alarm',
- reset',
- no data from MIP',
- other TBD.

The MIP_on', MIP_off' will be reported in PIU HK.

The 'no HK type II return from MIP' will be part of the command verification cycle (TBC).

8. PIU SPECIAL MANAGEMENT

8.1. Alarm procedure

MIP has a watchdog which consists of a counter periodically reset. If the watchdog is not refreshed, an alarm signal is sent to PIU (through the link). PIU powers immediately MIP off when an alarm signal is sent.

The MIP watchdog can be inhibited with a command (Set_Wd [1]).

The alarm protocol has been simplified; no retry to be on after an alarm signal :

- 1/ PIU powers MIP off when alarm' and over-current detection';
- 2/ The status of this alarm signal is put into an event reporting;
- 3/ MIP stays off until the next on command.

If no data are received during TBD consecutive sequences, PIU resets the link.

8.2. Others

Control of the data rate of the experiments (TBC).

9. AUTOTEST

MIP has no testing mode. A nominal Science sequence (MIP or MIP+LDL) in any rate can be used as autotest since the first sequence run is automatically a Control sequence; its duration of 32 seconds. This Control sequence [RD1] contains :

- one byte test with results of watchdogs and memory tests;
- one loop Survey mode in which the transmission signal is directly connected to the receiving electronics (through an attenuator); the power of this special active spectra is



constant and known;
- samples of the input FIFO;

The MIP autotest has a duration of 32 seconds.



ANNEX A : TEST PROCEDURES

A1. Thermistor managed by S/C

A simple test of the thermistor n°1 (managed by the S/C) consists of checking the resistance value using a break-out box and a ohm-meter. Of course this value is related to the ambient temperature: 10 kΩ at 25 °C (see the reference curve).

A2. Thermistor managed by MIP/RPC

The test of the thermistor n°2 (managed by PIU/MAG) consists of a calibration of the temperature transfer function.

The input value is simulated using a set of resistors of different values (through a break-out box connected to the sensor harness); the corresponding temperature value is given in the full HK packet. The values of resistors used are : 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ.

This data can be checked at different points of RPC device using adequate break-out boxes. The table A.2.1 gives the corresponding values (TBC).

	1 kΩ	10 kΩ	100 kΩ	1 MΩ
MIP output (V)	-2.45	-1.95	+0.10	+2.00
MAG output (hexa)	028F6	1C28F	851EC	E6666
MIP HK type II (hexa)	FD71	E3D8	7AE2	199A

Table A.2.1. MIP temperature calibration curves.

A3. MIP mode test

The goal is to test all the individual commands of MIP (all the command configurations will be tested at LPCE before delivery).

The different modes and rates are checked in this test.

This test will be first performed at LPCE.

```

*/=====
*/ MIP Mode Test
*/ Version 1.0
*/ Duration ~ 1 heure 8 minutes
*/
*/ Power ON
      MIP_ON
***Wait 2s
*/ The configuration table must be sent from 2 to 16 seconds after the power on command
*/
*/ Load configuration table with normal rate, autoloop on, passive 4dB, nominal sequence n0
      Send 1404 240,1 0x3d86 0000 0045 0301          Ld_Cfg[00 00 00 45 03 01]
***Wait 60s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> HK type I next AQP is [01 00 00 xx F4 xx] for EM
*/ B> HK type I next AQP is [01 00 00 xx F6 xx] for FM

```



```
*/ - byte 0 is Control/Table sequence counter =0x01
*/ - byte 1 is LDL sequence counter = 0x00
*/ - byte 2 is MIP sequence counter = 0x00
*/ - byte 4 is the resonance power = 0xF4 (for EM, when auto-looped, nominal transmission level)
*/ - byte 4 is the resonance power = 0xF6 (for FM, when auto-looped, nominal transmission level)
*/ - bytes 3 and 5 can be variable, depending on the test environment
*/ B> 2 sequences will be run, 1 Control and 1 Science auto-looped MIP
*/ B> The Control sequence contains the following data :
*/ - header byte = 0x94
*/ - test results byte = 0x00 (all initialization tests OK)
*/ - configuration table = [00 00 00 45 03 01]
*/ - software version = 0x34 (version 3.4)
*/ - Auto-looped survey mode values (for nominal transmission level) start with 0xF4 for EM
*/ - Auto-looped survey mode values (for nominal transmission level) start with 0xF6 for EM
*/
*/ Check Set_Fq1 (interference frequency equal to 448 kHz)
      Send 1404 241, 1 0x0040          Set_Fq1 [40]
      Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [40 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Fq1
      Send 1404 241, 1 0x0000          Set_Fq1 [0]
      Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_Fq2 (interference frequency equal to 896 kHz)
      Send 1404 241, 2 0x0080          Set_Fq2 [80]
      Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 80 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Fq2
      Send 1404 241, 2 0x0000          Set_Fq2 [0]
      Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_Fq3 (interference frequency equal to 1792 kHz)
      Send 1404 241, 3 0x00C0          Set_Fq3 [C0]
      Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 C0 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Fq3
      Send 1404 241, 3 0x0000          Set_Fq3 [0]
      Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_Lvl (transmission level full)
      Send 1404 242, 1 0x0000          Set_Lvl [0]
```



```
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 05 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Lvl
Send 1404 242, 1 0x0001 Set_Lvl [1]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_Oswp (Odd sweep E1E2 anti-phase)
Send 1404 242, 2 0x0003 Set_Oswp [3]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 75 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Oswp
Send 1404 242, 2 0x0000 Set_Oswp [0]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_Eswp (Even sweep E1E2 phase)
Send 1404 242, 3 0x0002 Set_Eswp [2]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 49 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Eswp
Send 1404 242, 3 0x0001 Set_Eswp [1]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_Thr (threshold equal to 8 dB)
Send 1404 242, 4 0x0003 Set_Thr [3]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 47 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Thr
Send 1404 242, 4 0x0001 Set_Thr [1]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_SwpB (selection of bandwidth 6 in Sweep mode)
Send 1404 243, 1 0x0006 Set_SwpB [6]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 C3 01]
```



```
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_SwpB
    Send 1404 243, 1 0x0000          Set_SwpB [0]
    Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_SurB (selection of bandwidth 1 in Survey mode)
    Send 1404 243, 2 0x0001          Set_SurB [1]
    Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 07 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_SurB
    Send 1404 243, 2 0x0000          Set_SurB [0]
    Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_PRes (resolution passive mode equal to 2 dB)
    Send 1404 243, 3 0x0000          Set_PRes [0]
    Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 01 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_PRes
    Send 1404 243, 3 0x0001          Set_PRes [1]
    Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_AuLp (Auto-Loop off)
    Send 1404 243, 4 0x0000          Set_AuLp [0]
    Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 02 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_AuLp
    Send 1404 243, 4 0x0001          Set_AuLp [1]
    Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_Wd (watchdog off)
    Send 1404 244, 1 0x0001          Set_Wd [1]
    Send 1404 240, 2 0x7918          Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 81]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Wd
```



```
Send 1404 244, 1 0x0000 Set_Wd [0]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_SqNb (complementary sequence 1)
Send 1404 244, 2 0x0001 Set_SqNb [1]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 12]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_SqNb
Send 1404 244, 2 0x0001 Set_SqNb [0]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_Mode (activation LDL normal mode, type 0)
Send 1404 244, 4 0x0001 Set_Mode [1]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 05]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_LDLT (activation LDL mixed mode, type 1)
Send 1404 244, 3 0x0001 Set_LDLT [1]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 0D]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Mode
Send 1404 244, 4 0x0000 Set_Mode [0]
Send 1404 244, 3 0x0000 Set_LDLT [0]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_TmRt (minimum rate)
Send 1404 244, 5 0x0000 Set_TmRt [0]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 00]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Check Set_TmRt (burst rate)
Send 1404 244, 5 0x0003 Set_TmRt [3]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 124s
*/ -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 03]
*/ B> 2 sequences will be run, 1 Table and 1 Science MIP
*/
*/ Return to standard configuration after test Set_Mode
Send 1404 244, 5 0x0001 Set_PRes [1]
Send 1404 240, 2 0x7918 Ld_CCfg
```



*****Wait 124s**

* / -> HK type II next AQP contains the command echo with the table [00 00 00 45 03 01]

* / B> 2 sequences will be run, 1 Table and 1 Science MIP

* /

* /=====

A3. MIP SFT

To verify the MIP working state, the best way is to use the SFT or part of the SFT (MIP part).

The MIP SFT is composed of two parts, the first one to check MIP instrument and the second one to check the LDL mode common with the LAP instrument.

The full MIP instrument checking has to be done with its sensor; when the MIP sensor is not present, it can be replaced by an external coupling through an attenuator.

The LDL mode checking requires MIP and LAP instruments and sensors. For the test activities performed without booms or with folded booms, the LDL stimulus (capacitive coupling) has to be used. For more information, see the note 'LDL Mode Stimulus, Ed. 3, Rev. 1, 16/05/00', reference RPC/MIP/RP/142/990003/LPCE.

A3.1. Checking list

The MIP instrument can be checked-up by a verification of the following parameters :

a) House-Keepings

Note : HK packets of type I and type II are sent by MIP every AQP, before the data packets. PIU stamps the HK with the time of the next AQP. Consequently, be careful that the time of the HK corresponding to the data set is 32s later.

- a. The HK type II contains the command echo with the configuration table of 6 bytes. This has to be checked for each command sent.
- b. The HK type I contains information of sequence counters (first 3 bytes) that has to be checked. The 2 MSB bits of byte 0 are the LDL mode synchronization bits (00 when MIP sequence, 10 for LDL normal and 11 for LDL mixed).
- c. The HK type I contains information on the sensor response (last 3 bytes). This can be verified only when transmission and reception are auto-looped. In the other cases, the response depends on the test environment.

b) CONTROL Sequence

The Control sequence is the first sequence run after powering on.

- a. The first byte (byte 0) is the data header which has to be 0x94.
- b. The second byte contains the results of initialization tests; this has to be 0x00 when all tests are OK.
- c. Bytes 2 to 7 contain the validated configuration table (redundant with HK type II).
- d. Byte 8 is the software version; this has to be 0x32 for the EM (version 3.2) and 0x34 for the FM (version 3.4).
- e. From byte 9, starts the amplitude of the auto-looped survey mode. The first values are 0xF4 for EM and 0xF6 for FM.



c) TABLE Sequence

The Table sequence is run when decoding commands received during a Science sequence.

- a. The first byte (byte 0) is the data header which has to be 0xDC.
- b. Bytes 2 to 7 contain the configuration table used (redundant with HK type II).
- c. Byte 8 is the software version; this has to be 0x32 for the EM (version 3.2) and 0x34 for the FM (version 3.4).
- d. From byte 9, starts the amplitude of the auto-looped survey mode. The first values are 0xF4 for EM and 0xF6 for FM.

d) Science Sequence (MIP or LDL)

Nothing to test rapidly, the data depending on the test environment.

The amplitude of the LDL mode can be checked when the stimulus will be present.

A3.2. SFT commands and checking list

The SFT will be performed to verify the experiment during RPC integration. The main working modes are run with the normal telemetry rates.

The SFT has been defined with 2 sub-sets :

- MIP instrument test part,
- LDL mode test (MIP, LAP and SENSORS).

```

*/=====
*/ MIP SFT
*/ Version 2.0
*/ Duration ~ 5 minutes
*/
*/ Power ON from PIU
      MIP_ON
***Wait 2s
*/ The configuration table must be sent from 2 to 16 seconds after the power on command
*/
*/ Load configuration table with normal rate, autoloop on, nominal sequence n0
      Send 1404 240, 1 0x3d86 0000 0045 0101          Ld_Cfg[00 00 00 45 01 01]
***Wait 64s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 01 01]
*/ B> HK type I next AQP is [01 00 00 xx F4 xx] for EM
*/ B> HK type I next AQP is [01 00 00 xx F6 xx] for FM
*/ - byte 0 is Control/Table sequence counter =0x01
*/ - byte 1 is LDL sequence counter = 0x00
*/ - byte 2 is MIP sequence counter = 0x00
*/ - byte 4 is the resonance power = 0xF4 (when auto-looped, nominal transmission level) for EM
*/ - byte 4 is the resonance power = 0xF6 (when auto-looped, nominal transmission level) for FM
*/ - bytes 3 and 5 can be variable, depending on the test environment
*/ B> 3 sequences will be run, 1 Control and 2 Science auto-looped MIP
*/ B> The Control sequence contains the following data :
*/ - header byte = 0x94
*/ - test results byte = 0x00 (all initialization tests OK)
*/ - configuration table = [00 00 00 45 01 01]
*/ - software version = 0x34 (version 3.4 for the FM, version 3.2 for the EM)
*/ - Auto-looped survey mode values (for nominal transmission level) start with 0xF4 for EM
*/ - Auto-looped survey mode values (for nominal transmission level) start with 0xF6 for FM
*/
*/ Check Science, autoloop off
      Send 1404 243, 4 0x0000          Set_AuLp [0]
      Send 1404 240, 2 0x7918          Ld_CCfg
  
```


A3.3. Time diagrams

The time diagrams for the MIP test part and for the LDL test part are given in the Figure A3.3.1.

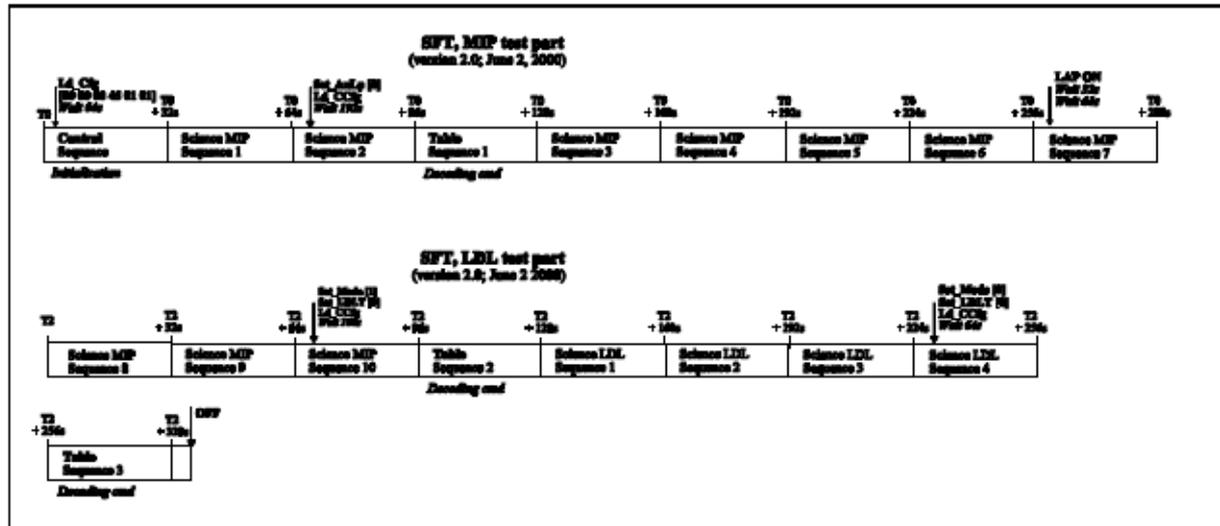


Figure A3.3.1. SFT : Time diagrams for the MIP and LDL (type 0 only) parts.

A4. MIP Bench Test

The MIP Bench Test is composed of two parts, the first one to check MIP instrument and the second one to check the LDL mode common with the LAP instrument.

The full MIP instrument checking has to be done with its sensor; when the MIP sensor is not present, it can be replaced by an external coupling through an attenuator. The MIP part of the Bench Test has already run during the RPC integration of the EM at Imperial College.

The LDL mode checking requires MIP and LAP instruments and sensors. For the test activities performed without booms or with folded booms, the LDL stimulus (capacitive coupling) has to be used. For more information, see the note 'LDL Mode Stimulus, Ed. 3, Rev. 1, 16/05/00', reference RPC/MIP/RP/142/990003/LPCE. The LDL part has never run (LDL type 1 not implemented in LAP software for the EM).

A4.1. Checking list

The MIP instrument can be checked-up by a verification of the following parameters :

a) House-Keepings

Note : HK packets of type I and type II are sent by MIP every AQP, before the data packets. PIU stamps the HK with the time of the next AQP. Consequently, be careful that the time of the HK corresponding to the data set is 32s later.



- a. The HK type II contains the command echo with the configuration table of 6 bytes. This has to be checked for each command sent.
- b. The HK type I contains information of sequence counters (first 3 bytes) that has to be checked. The 2 MSB bits of byte 0 are the LDL mode synchronization bits (00 when MIP sequence, 10 for LDL normal and 11 for LDL mixed).
- c. The HK type I contains information on the sensor response (last 3 bytes). This can be verified only when transmission and reception are auto-looped. In the other cases, the response depends on the test environment.

b) CONTROL Sequence

The Control sequence is the first sequence run after powering on.

- a. The first byte (byte 0) is the data header which has to be 0x94.
- b. The second byte contains the results of initialization tests; this has to be 0x00 when all tests are OK.
- c. Bytes 2 to 7 contain the validated configuration table (redundant with HK type II).
- d. Byte 8 is the software version; this has to be 0x32 for the EM (version 3.2) and 0x34 for the FM (version 3.4).
- e. From byte 9, starts the amplitude of the auto-looped survey mode. The first values are 0xF4 for EM and 0xF6 for FM.

c) TABLE Sequence

The Table sequence is run when decoding commands received during a Science sequence.

- a. The first byte (byte 0) is the data header which has to be 0xDC.
- b. Bytes 2 to 7 contain the configuration table used (redundant with HK type II).
- c. Byte 8 is the software version; this has to be 0x32 for the EM (version 3.2) and 0x34 for the FM (version 3.4).
- d. From byte 9, starts the amplitude of the auto-looped survey mode. The first values are 0xF4 for EM 0xF6 for FM.

d) Science Sequence (MIP or LDL)

Nothing to test rapidly, the data depending on the test environment.

The amplitude of the LDL mode can be checked when the stimulus will be present.

A4.2. Bench Test commands and checking list

The Bench Test (BT) will be performed to verify the experiment during RPC integration. All the working modes and all the telemetry rates are run.

The BT has been defined with 2 sub-sets :

- MIP instrument test part,
- LDL mode test (MIP, LAP and SENSORS).

```
*/=====
*/ MIP Bench Test
*/ Version 2.0
*/ Duration ~ 14 minutes
*/
*/ Power ON from PIU
   MIP_ON
***Wait 2s
*/ The configuration table must be sent from 2 to 16 seconds after the power on command
*/
*/ Load configuration table with normal rate, autoloop on, nominal sequence n0
```



```
Send 1404 240, 1 0x3d86 0000 0045 0101 Ld_Cfg [00 00 00 45 01 01]
***Wait 64s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 01 01]
*/ B> HK type I next AQP is [01 00 00 xx F4 xx] for EM
*/ B> HK type I next AQP is [01 00 00 xx F6 xx] for FM
*/ - byte 0 is Control/Table sequence counter =0x01
*/ - byte 1 is LDL sequence counter = 0x00
*/ - byte 2 is MIP sequence counter = 0x00
*/ - byte 4 is the resonance power = 0xF4 (when auto-looped, nominal transmission level) for EM
*/ - byte 4 is the resonance power = 0xF6 (when auto-looped, nominal transmission level) for FM
*/ - bytes 3 and 5 can be variable, depending on the test environment
*/ B> 3 sequences will be run, 1 Control and 2 Science auto-looped MIP
*/ B> The Control sequence contains the following data :
*/ - header byte = 0x94
*/ - test results byte = 0x00 (all initialization tests OK)
*/ - configuration table = [00 00 00 45 01 01]
*/ - software version = 0x34 (version 3.4 for the FM, version 3.2 for the EM)
*/ - Auto-looped survey mode values (for nominal transmission level) start with 0xF4 for EM
*/ - Auto-looped survey mode values (for nominal transmission level) start with 0xF6 for FM
*/
*/ Check Science, autoloop off
Send 1404 243, 4 0x0000 Set_AuLp [0]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 192s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 01]
*/ B> HK type I next AQP is [02 00 02 xx F4 xx] for EM
*/ B> HK type I next AQP is [02 00 02 xx F6 xx] for FM
*/ - byte 0 is Control/Table sequence counter =0x02
*/ - byte 1 is LDL sequence counter = 0x00
*/ - byte 2 is MIP sequence counter = 0x02 (2 science MIP run from the beginning of the test,
then this counter will be incremented by 1 for each next sequence)
*/ - byte 4 is the resonance power = 0xF4 (when auto-looped, nominal transmission level) for EM
*/ - byte 4 is the resonance power = 0xF6 (when auto-looped, nominal transmission level) for FM
*/ - bytes 3 and 5 can be variable, depending on the test environment
*/ B> 6 sequences will be run, 1 Table and 5 Science MIP
*/ Check minimum rate
Send 1404 244, 5 0x0000 Set_TmRt [0]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 192s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 00]
*/ B> HK type I next AQP is [03 00 07 xx F4 xx] for EM
*/ B> HK type I next AQP is [03 00 07 xx F6 xx] for FM
*/ - byte 0 is Control/Table sequence counter =0x03
*/ - byte 1 is LDL sequence counter = 0x00
*/ - byte 2 is MIP sequence counter = 0x07
*/ - byte 4 is the resonance power = 0xF4 (when auto-looped, nominal transmission level) for EM
*/ - byte 4 is the resonance power = 0xF6 (when auto-looped, nominal transmission level) for FM
*/ - bytes 3 and 5 can be variable, depending on the test environment
*/ B> 6 sequences will be run, 1 Table and 5 Science MIP
*/
*/ Check burst rate
Send 1404 244, 5 0x0003 Set_TmRt [3]
Send 1404 240, 2 0x7918 Ld_CCfg
***Wait 192s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 03]
*/ B> HK type I next AQP is [04 00 0C xx F4 xx] for EM
*/ B> HK type I next AQP is [04 00 0C xx F6 xx] for FM
*/ - byte 0 is Control/Table sequence counter =0x04
*/ - byte 1 is LDL sequence counter = 0x00
```



```
*/ - byte 2 is MIP sequence counter = 0x0C (12 science sequences run from the beginning)
*/ - byte 4 is the resonance power = 0xF4 (when auto-looped, nominal transmission level) for EM
*/ - byte 4 is the resonance power = 0xF6 (when auto-looped, nominal transmission level) for FM
*/ - bytes 3 and 5 can be variable, depending on the test environment
*/ B> 6 sequences will be run, 1 Table and 5 Science MIP
```

```
*/Set nominal rate, complementary sequence n1, Survey bandwidth 2
```

```
Send 1404 243, 2 0x0002 Set_SurB [2]
Send 1404 244, 2 0x0001 Set_SqNb [1]
Send 1404 244, 5 0x0001 Set_TmRt [1]
Send 1404 240, 2 0x7918 Ld_CCfg
```

```
***Wait 192s
```

```
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 08 11]
```

```
*/ B> HK type I next AQP is [05 00 11 xx F4 xx] for EM
```

```
*/ B> HK type I next AQP is [05 00 11 xx F6 xx] for FM
```

```
*/ - byte 0 is Control/Table sequence counter =0x05
```

```
*/ - byte 1 is LDL sequence counter = 0x00
```

```
*/ - byte 2 is MIP sequence counter = 0x11 (17 science sequences run from the beginning)
```

```
*/ - byte 4 is the resonance power = 0xF4 (when auto-looped, nominal transmission level) for EM
```

```
*/ - byte 4 is the resonance power = 0xF6 (when auto-looped, nominal transmission level) for FM
```

```
*/ - bytes 3 and 5 can be variable, depending on the test environment
```

```
*/ B> 5 sequences will be run, 1 Table and 4 Science MIP
```

```
*/
```

```
MIP_OFF
```

```
*/=====
```

```
*/
```

```
*/
```

```
*/=====
```

```
*/ LDL Bench Test
```

```
*/ PIU, MIP, LAP and SENSORS involved
```

```
*/ Version 2.0
```

```
*/ Duration ~ 24 minutes
```

```
*/ Tests of the LDL mode type 0 and type 1 for all telemetry rates
```

```
*/ LDL mode command has to be sent during a MIP science sequence (LAP sequence for LAP)
```

```
*/
```

```
*/ Power ON from PIU
```

```
    MIP_ON
```

```
***Wait 2s
```

```
*/ The configuration table must be sent from 2 to 16 seconds after the power on command
```

```
*/ Load configuration table with normal rate, nominal sequence n0
```

```
Send 1404 240, 1 0x3d86 0000 0045 0001 Ld_cfg [00 00 00 45 00 01]
```

```
***Wait 64s
```

```
*/ B> 3 sequences will be run, 1 Control and 2 Science auto-looped MIP
```

```
*/
```

```
*/ START LDL TEST TYPE 0
```

```
*/ Check LDL type 0, nominal rate
```

```
Send 1404 244, 4 0x0001 Set_Mode [1]
```

```
Send 1404 244, 3 0x0000 Set_LDLT [0]
```

```
Send 1404 240, 2 0x7918 Ld_CCfg
```

```
*/ Insert CMD to LAP to set LDL mode type 0
```

```
***Wait 96s
```

```
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 05]
```

```
*/ B> HK type I next AQP is [yy 00 xx xx xx xx]
```

```
*/ - 2 MSB bits of byte 0 are the LDL synchro = 10
```

```
*/ - 6 LSB bits of byte 0 are the LDL Control/Table sequence counter
```

```
*/ - byte 1 is LDL sequence counter = 0x00 (this counter will be incremented by 1 for each next sequence)
```

```
*/ B> 3 sequences will be run, 1 Table and 2 Science LDL
```

```
*/
```



```
*/ Stop LDL mode, return to MIP normal, nominal rate (configuration updated by PIU)
    Send 1404 244, 4 0x0000          Set_Mode [0]
    Send 1404 244, 3 0x0000          Set_LDLT [0]
    Send 1404 240, 2 0x7918          Ld_CCfg
*/ Insert CMD to LAP to stop LDL mode
***Wait 96s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 01]
*/ B> 3 sequences will be run, 1 Table and 2 Science MIP
*/
*/ Check LDL mode, type 0, minimum rate
    Send 1404 244, 4 0x0001          Set_Mode [1]
    Send 1404 244, 3 0x0000          Set_LDLT [0]
    Send 1404 244, 5 0x0000          Set_TmRt [0]
    Send 1404 240, 2 0x7918          Ld_CCfg
*/ Insert CMD to LAP to set LDL mode type 0
***Wait 96s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 04]
*/ B> HK type I next AQP is [xx 02 xx xx xx xx]
*/ - byte 1 is LDL sequence counter = 0x02 (2 LDL sequences run from the beginning)
*/ B> 3 sequences will be run, 1 Table and 2 Science LDL
*/
*/ Stop LDL mode, return to MIP normal, minimum rate (configuration updated by PIU)
    Send 1404 244, 4 0x0000          Set_Mode [0]
    Send 1404 244, 3 0x0000          Set_LDLT [0]
    Send 1404 240, 2 0x7918          Ld_CCfg
*/ Insert CMD to LAP to stop LDL mode
***Wait 96s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 00]
*/ B> 3 sequences will be run, 1 Table and 2 Science MIP
*/
*/ Check LDL mode, type 0, burst rate
    Send 1404 244, 4 0x0001          Set_Mode [1]
    Send 1404 244, 3 0x0000          Set_LDLT [0]
    Send 1404 244, 5 0x0003          Set_TmRt [3]
    Send 1404 240, 2 0x7918          Ld_CCfg
*/ Insert CMD to LAP to set LDL mode type 0
***Wait 96s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 07]
*/ B> HK type I next AQP is [xx 04 xx xx xx xx]
*/ - byte 1 is LDL sequence counter = 0x04
*/ B> 3 sequences will be run, 1 Table and 2 Science LDL
*/
*/ Stop LDL mode, return to MIP normal, burst rate (configuration updated by PIU)
    Send 1404 244, 4 0x0000          Set_Mode [0]
    Send 1404 244, 3 0x0000          Set_LDLT [0]
    Send 1404 240, 2 0x7918          Ld_CCfg
*/ Insert CMD to LAP to stop LDL mode
***Wait 96s
*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 00]
*/ B> 3 sequences will be run, 1 Table and 2 Science MIP
*/ END OF TEST LDL TYPE 0
*/
*/ START LDL TEST TYPE 1
*/ Check LDL mode, type 1, nominal rate
    Send 1404 244, 4 0x0001          Set_Mode [1]
    Send 1404 244, 3 0x0001          Set_LDLT [1]
    Send 1404 244, 5 0x0001          Set_TmRt [1]
    Send 1404 240, 2 0x7918          Ld_CCfg
*/ Insert CMD to LAP to set LDL mode type 1
```



*****Wait 160s**

*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 0D]

*/ B> HK type I next AQP is [yy 06 xx xx xx xx]

*/ - 2 MSB bits of byte 0 are the LDL synchro = 00 when MIP, = 11 when LDL

*/ - 6 LSB bits of byte 0 are the LDL Control/Table sequence counter

*/ B> 5 sequences will be run, 1 Table, 2 Science LDL, 2 Science MIP

*/

*/ Stop LDL mode, return to MIP normal, nominal rate

Send 1404 244, 4 0x0000 Set_Mode [0]

Send 1404 244, 3 0x0000 Set_LDLT [0]

Send 1404 240, 2 0x7918 Ld_CCfg

*/ Insert CMD to LAP to stop LDL mode

*****Wait 96s**

*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 00]

*/ B> 3 sequences will be run, 1 Table and 2 Science MIP

*/

*/ Check LDL mode, type 1, minimum rate

Send 1404 244, 4 0x0001 Set_Mode [1]

Send 1404 244, 3 0x0001 Set_LDLT [1]

Send 1404 244, 5 0x0000 Set_TmRt [0]

Send 1404 240, 2 0x7918 Ld_CCfg

*/ Insert CMD to LAP to set LDL mode type 1

*****Wait 160s**

*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 0C]

*/ B> HK type I next AQP is [xx 08 xx xx xx xx]

*/ - byte 1 is LDL sequence counter = 0x08

*/ B> 5 sequences will be run, 1 Table, 2 Science LDL, 2 Science MIP

*/

*/ Stop LDL mode, return to MIP normal, minimum rate

Send 1404 244, 4 0x0000 Set_Mode [0]

Send 1404 244, 3 0x0000 Set_LDLT [0]

Send 1404 240, 2 0x7918 Ld_CCfg

*/ Insert CMD to LAP to stop LDL mode

*****Wait 96s**

*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 00]

*/ B> 3 sequences will be run, 1 Table and 2 Science MIP

*/

*/ Check LDL mode, type 1, burst rate

Send 1404 244, 4 0x0001 Set_Mode [1]

Send 1404 244, 3 0x0001 Set_LDLT [1]

Send 1404 244, 5 0x0003 Set_TmRt [3]

Send 1404 240, 2 0x7918 Ld_CCfg

*/ Insert CMD to LAP to set LDL mode type 1

*****Wait 160s**

*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 0F]

*/ B> HK type I next AQP is [xx 0A xx xx xx xx]

*/ - byte 1 is LDL sequence counter = 0x0A

*/ B> 5 sequences will be run, 1 Table, 2 Science LDL, 2 Science MIP

*/

*/ Stop LDL mode, return to MIP normal, normal rate

Send 1404 244, 4 0x0000 Set_Mode [0]

Send 1404 244, 3 0x0000 Set_LDLT [0]

Send 1404 244, 5 0x0001 Set_TmRt [1]

Send 1404 240, 2 0x7918 Ld_CCfg

*/ Insert CMD to LAP to stop LDL mode

*****Wait 96s**

*/ B> HK type II next AQP contains the command echo with the table [00 00 00 45 00 01]

*/ B> 2 sequences will be run, 1 Table and 1 Science MIP

*/ B> HK type I next AQP is [xx 0C xx xx xx xx]

```

*/ - byte 1 is LDL sequence counter = 0x0C
*/END OF TEST LDL TYPE 1
*/
*/ Power OFF from PIU
      MIP_OFF
*/=====

```

A4.3. Time diagrams

The time diagram for the MIP test part is given in the Figure A4.3.1. The time diagram for the LDL test part is given in the Figure A4.3.2 .

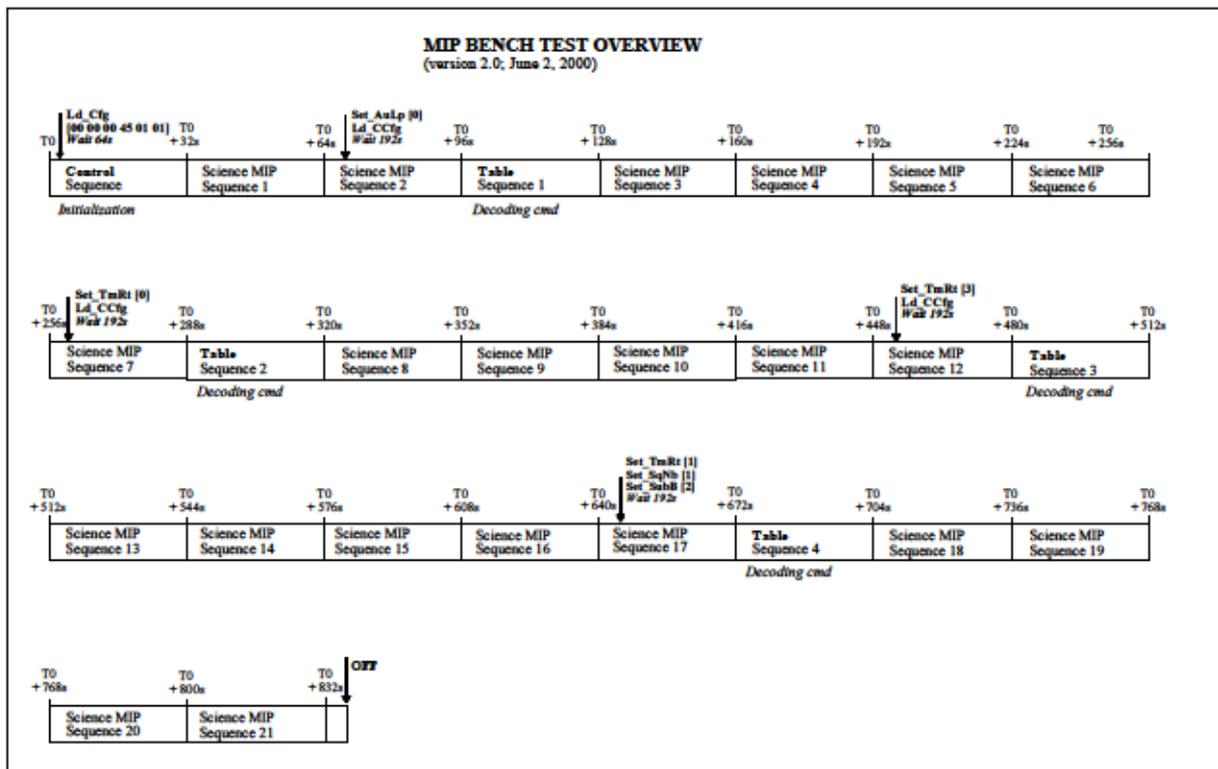


Figure A4.3.1. Bench Test : Time diagram for the MIP part.

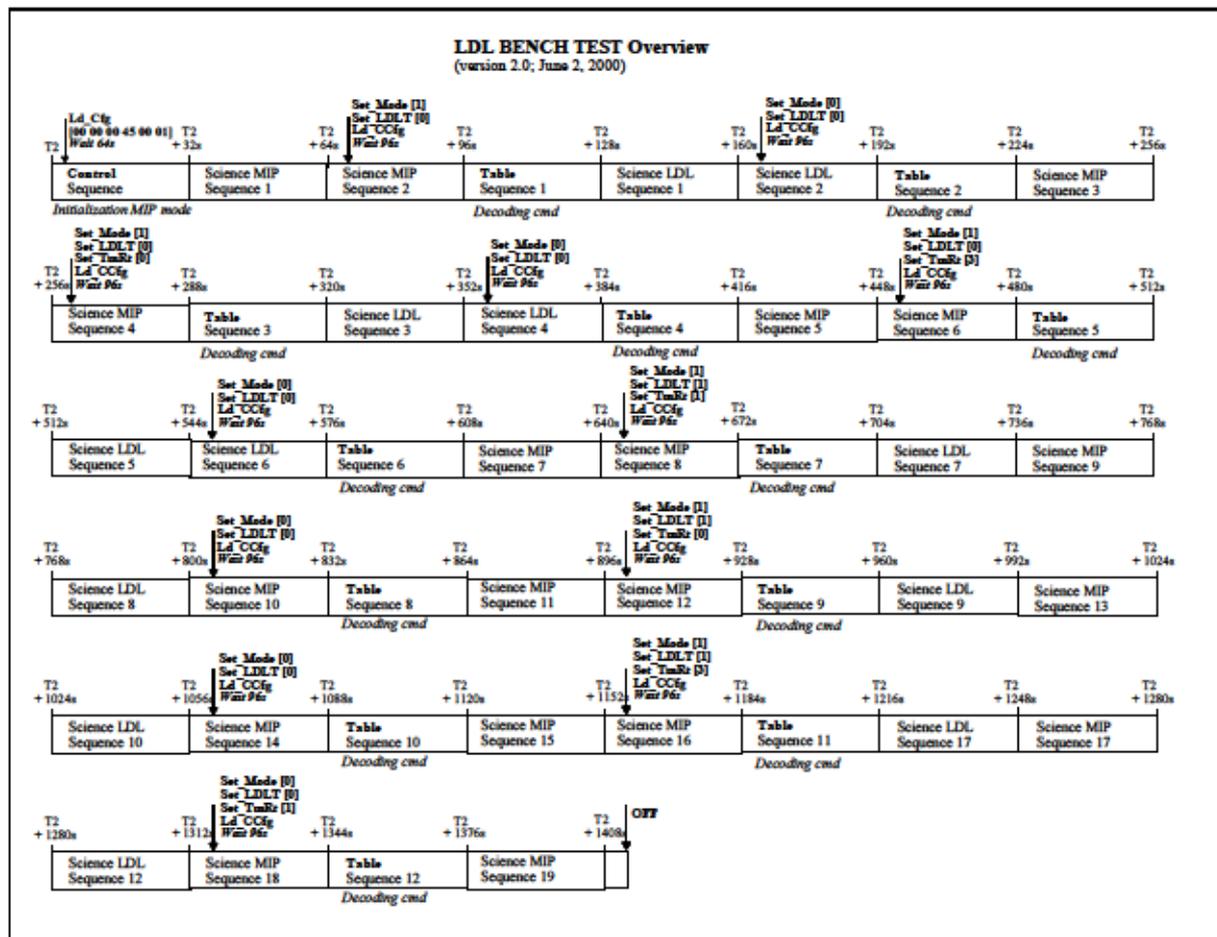


Figure A4.3.2. Bench Test : Time diagram for the LDL part (types 0 and 1).

A5. Alarm test

The goal of this interface test is to check the procedure when PIU switches off MIP in case of alarm signal. Since this alarm is only generated by software default (counter not refreshed), it is not possible to test it when in flight configuration.

The flight software is contained in three PROM (version 3.4) mounted on the board with socket terminals. If these PROM are accessible during the integration with PIU, we propose to



replace, on sockets, the PROM by EEPROM especially configured to test this alarm. In this configuration an oscilloscope is needed to measure the time between MIP alarm and PIU switch-off command. This time shall be around 20 ms.

Then don't forget to remount the flight PROM.