CONSERT USER MANUEL

Orbiter & Lander

replaces the technical notes
RO-OCN-TN-3044 and RO-OCN-TN-3048.

CHANGE RECORDS

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This document is the User Manuel of Consert Orbiter AND Consert Lander. It replaces the technical notes RO-OCN-TN-3044 and RO-OCN-TN-3048.

This document has been re-written after launch, commissioning and prehibernation cruise.

Applicable Documents

[AD 1] RO-OCN-TN-3826 CUM - Annex C FOP Change Request Log (Excel file)

[AD 2] RO-OCN-TN-3827 CUM - Annex D OIOR Change Request Log (Excel file)

[AD 3] RO-OCN-TN-3828 CUM - Annex E LIOR Change Request Log (Excel file)

[AD 4] Consert OBCP user requirement - RO-ESC-RS-5630_CONSERT_OBCP_URD.

[AD 5] Consert_cmds.edf Revision 1.72 2008/04/15 17:20:21 RMIB_20080410M101S110

[AD 6] RO-OCN-TR-3801 FMO procedure d'integration et calibration

[AD 7] RO-OCN-TR-3803 FSL procedure d'integration et calibration

[AD 8] RO-OCN-TN-3834 Consert Science Operation V1-0

[AD 9] RO-OCN-TN-3832 Consert Interferences test report

[AD 10] RO-OCN-TN-3851 Consert Operations requests V1-0

[AD 11] RO-OCN-TN-3850 Stop and Start procedure V1-0

Reference documents

[RD 1] W. Kofman *et al.,*"Comet nucleus sounding experiment by radiowave transmission" AD. SPACE RESEARCH, vol 21, n° 11, pp 1589-1598, 1998.

[RD 2] A. Herique, W. Kofman, T. Hagfors, G. Caudal and J-P Ayanides, "A characterisation of a comet nucleus interior: Inversion of simulated radio frequency data", PLANETARY AND SPACE SCIENCE, 47, 885-904, 1999.

[RD 3] W. Kofman, A. Herique, J-P. Goutail, and Consert team Consert experiment; description and performances in view of the new targets. Rosetta. The new Rosetta targets. Edited by L. Colangeli et al, Kluwer Academic Publishers, 2004

[RD 4] W. Kofman, A. Herique, J-P. Goutail, T. Hagfors, I. P. Williams, E. Nielsen, J-P. Barriot, Y. Barbin, C.Elachi, P. Edenhofer, A-C. Levasseur-Regourd, D. Plettemeier, G. Picardi, R.Seu, V. Svedhem, " The Comet Nucleus Sounding Experiment by Radiowave Transmission (CONSERT). A short description of the instrument and of the commissioning stages." Space Science Review

[RD 5] RO-EST-TN-3488 Rosetta Constraints & PTB Generated Events for Constraint Implementation, Issue D Revision 1, 21 March 2007

1 GENERAL DESCRIPTION

1.1 Scientific objectives

The purpose of the experiment is to determine the main dielectric properties from the propagation delay and, through modelling, to set constraints on the cometary composition (materials, porosity…) to detect large-size structures (several tens of meters) and stratification, to detect and characterize small-scale irregularities within the nucleus. A detailed analysis of the radio-waves which have passed through all or parts of the nucleus will put real constraints on the materials and on inhomogeneities and will help to identify blocks, gaps or voids. From this information we attempt to answer some fundamental questions of cometary physics: How is the nucleus built up? Is it homogeneous, layered or composed of accreted blocks (cometesimals, boulders). What is the nature of the refractory component? Is it chondritic as generally expected or does it contain inclusions of unexpected electromagnetic properties? With the answer to these questions, it should also be possible to provide answers to the basic question of the formation of the comet. Did it form directly from unprocessed interstellar grain-mantle particles or from grains condensed in the presolar nebula? Did the accretion take place in a multi step process leading first to the formation of cometesimals which then collided to form a kilometres size body?
These objectives are described in several papers: [RD 1] [RD 2] [RD 3] [RD 4]

In an operational point of view, the objective of Consert is to scan the nucleus interior during complete orbits: with the Orbiter on the other side of the nucleus by regards to the Lander. So, Consert parameters and data inversion are very sensitive to the nucleus shape, nucleus motion and orbitography (See [AD 8]RO-OCN-TN-3834 Consert Science Operation V1-0):
- A priori, the Consert operation preparation requires a shape, motion and orbitography model as good a possible.
- A posterior, an accurate data analyis will require a metric accuracy for shape, motion and orbits.

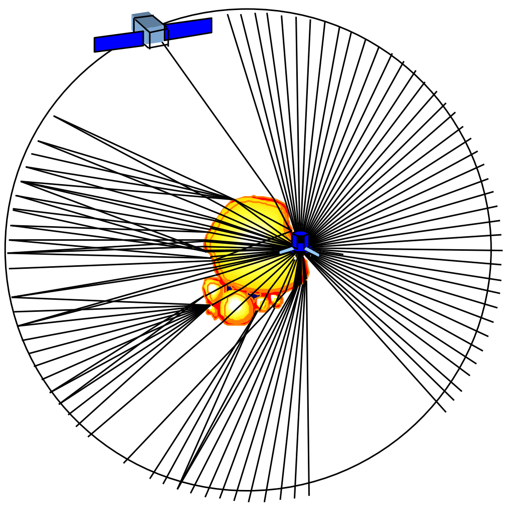


Figure 1 : Consert Operation throughout the Comet Transmission from Lander to orbiter

1.2 Experiement Overview

Consert experiment consists in the rough tomography of the comet nucleus performed by the instrument (COmet Nucleus Sounding Experiment by Radiowave Transmission). It works as a time domain transponder between one module which will land on the comet surface (Lander) and another that will fly around the comet (Orbiter). The Figure 2 gives a schematic diagram of the experiment. Basically, a 90 MHz sinusoidal waveform is phase modulated by a pseudorandom code or PSK (Phase Shift Keying) Coding. Such frequency, in the radio range, is expected to minimize the losses during the propagation inside the comet material and the generated pulse code maximizes the signal to noise ratio. In these experimental conditions great attempt is made on the good measurement of the mean dielectric properties and on the detection of large size embedded structures or small irregularities within the comet nucleus.
The complete Consert experiment is composed of one Orbiter instrument (Electronics, antenna, harness) and one Lander instrument (Electronics, antennas, harness).

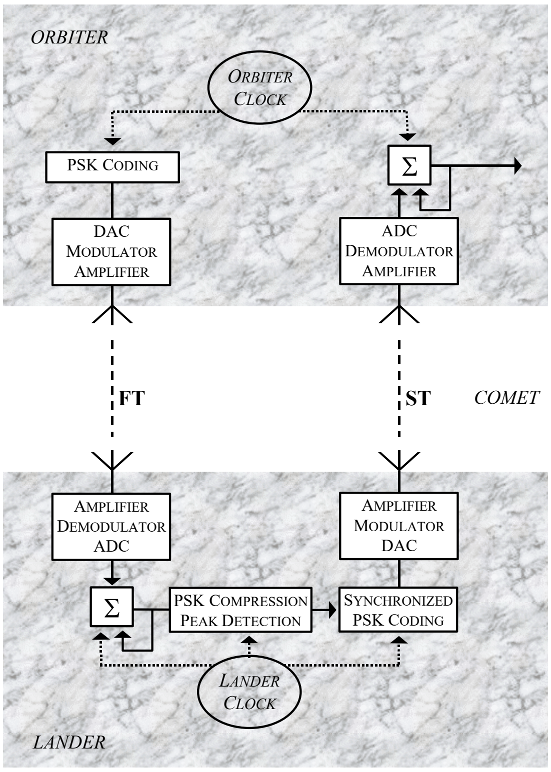


Figure 2 : Block diagram of the CONSERT experiment.
The coded signal is emitted from the Orbiter. The Lander makes a coherent addition (Σ) and a detection of the convolution principal peak. A clean coded signal is finally emitted with the found delay. The Orbiter accumulates the signal and sends it to the earth.

1.2.1 *In time transponder structure*

The time accuracy that the experiment requires defines the necessary clock stability. This accuracy is given by the time-transponder structure of Consert. The simplest explanation of this technique is to imagine Philae as a simple reflector of the signal coming from Rosetta. The signal is thus measured in the time reference of Rosetta and this enables one to relax the constraints on the stability of clocks. It is technically impossible to use Philae as a simple reflector; but it is possible to use it as a delayed active reflector.

In practice, both the orbiter and Philae have their own clocks. Both clocks are tuned and they drift during the experiment. This small frequency shift induces a drift of Philae internal time relative to the orbiter one. This drift is by-passed by the in-time transponder structure of the experiment.

- During a single measurement sequence the orbiter transmits a long signal lasting 200 ms but Philae receive the signal for only 26 ms. This localisation of Philae's receiving window within the orbiter transmitting window has to be preserved during the whole of the CONSERT measurement cycle (up to 10h). This is the first constraint on the clock accuracy.

- The transmitted signal is periodic and consists of the repetition of a 25.5µs-long Binary Phase Shift Keying (hereafter BPSK) code. At Philae, this signal is coherently accumulated with this period of 25.5µs. To have a coherent summation during the 26ms receive window, the lander carrier phase used for the signal demodulation has to remain coherent with the orbiter one. This is the second clock accuracy constraint, improving the signal to noise ratio.

- At Philae, the received signal is convolved with the BPSK code and the arrival time of the main propagation path is measured. This epoch is the time reference for the second wave transmission: a known delay after this epoch, Philae transmits the BPSK signal lasting 200 ms which is received during 26 ms and accumulated by the orbiter. This signal will be processed on ground. The arrival time of the main propagation path corresponds to twice the main propagation delay (one for each propagation way) plus the known delay added by the lander. This is because the lander was synchronized on the main path (shortest one) and due to the fact that on the time scale of measurements the orbiter is almost stationary, the paths between Philae and the orbiter and the orbiter and Philae are the same. This transponder processing delay has to be known with accuracy compliant with the scientific requirements on the propagation delay accuracy (third clock constraint).

To summarize, the propagation from the orbiter to Philae synchronizes both time systems while the scientific measurement is in the propagation from Philae to the orbiter. These constraints on the clocks stability allow a relaxation to $\Delta f/f = 10^{-7}$ during a 10-hour period. The time diagram for the synchronization principle is shown Figure 3.

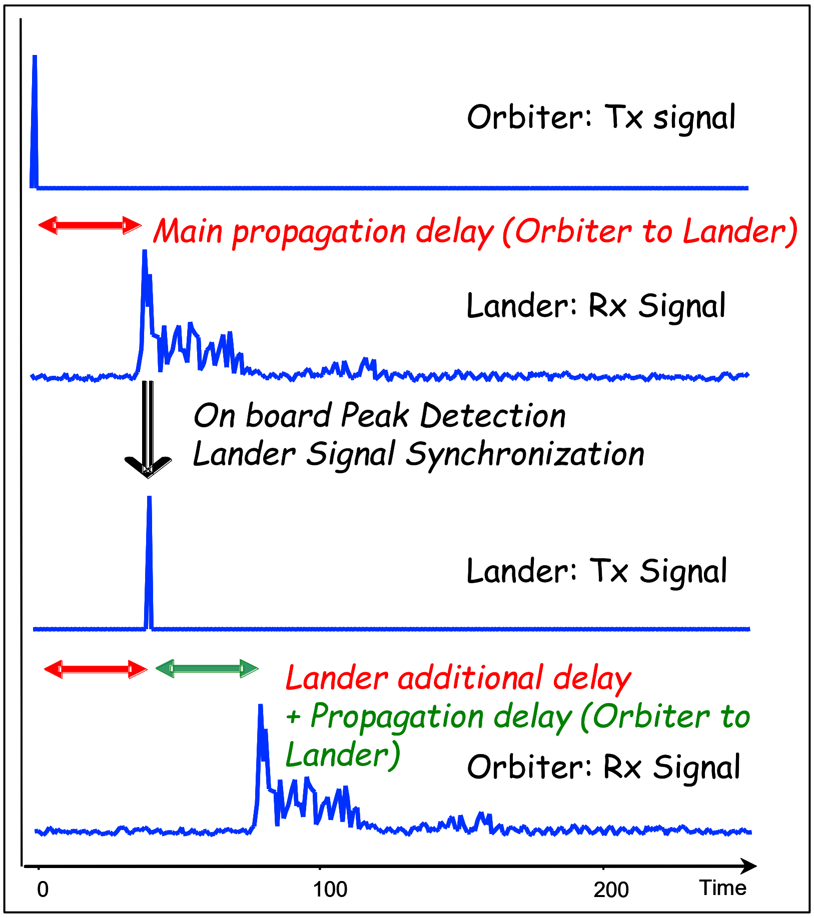


Figure 3 : In-Time transponder

1.2.2 *Electronic's concepts*

In Figure 4, a complete structure of CONSERT experiment on the orbiter is given. At the left is the antenna which is connected to the Transmit and Receive (TR) switch. The upper part of the figure shows the receiver. From left to right, one can recognize the Radio Frequency section, with Front End Amplifier (FEA), Band Pass filters, automatic gain control (AGC), then a mixer with a 120 MHz Local Oscillator. It is followed by a wide band intermediate frequency section (WIF) at 30 MHz feeding the in-phase and quadrature detectors. A low pass filter is provided for both I and Q base band amplifiers (WBB) and a high pass section is present to eliminate DC components. Each receiver section (RF, WIF, and WBB) has a maximum gain of about 30 dB and each AGC gain take a value between 0 and -31 dB. Therefore, the total gain of the analogic part takes a value between 28 and 90 dB. The in-phase and quadrature signals are converted by two 8-bits analog to digital converters. The accumulation realizes in the coherent integrator systems (CANACCU) and the tuning Phase Locked Loop (PLL) will not be considered here. The bottom part of the diagram corresponds to the Transmitter with a shift register pseudo-noise (PN) generator, frequency multipliers, a phase modulator and a power amplifier.

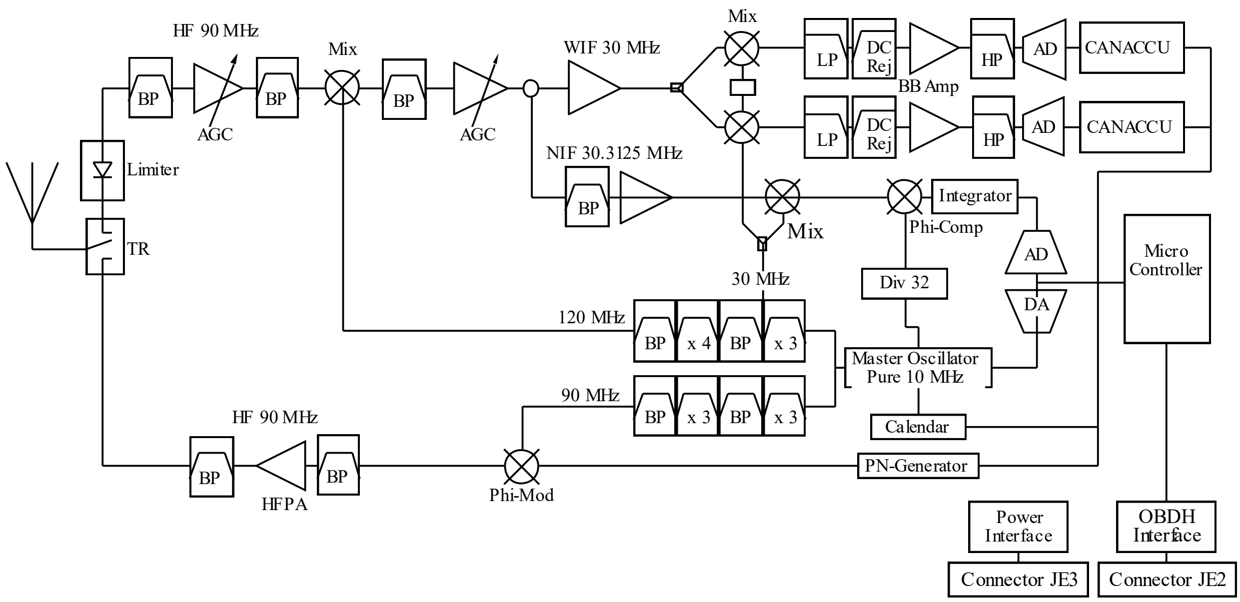


Figure 4 : Electronic box of the CONSERT experiment.

1.2.3 *Tuning*

The tuning phase is achieving two tasks:
1/ Tune the Orbiter Master Oscillator to the Lander Master Oscillator with a relative precision of 10^{-7}.
2/ Synchronize the Orbiter CONSERT Time Table and the Lander CONSERT Time Table with an Original Time Tables Offset (OTTO) which is reduced to less than 20 ms.

Tuning Principle:
The Orbiter Master Oscillator (OMO) is tuned to the remote Lander Master Oscillator (LMO) by the use of a 89.687500 MHz pure spectral line transmitted by the Lander. This line is one of the two lines produced on board the Lander by the BPSK modulation of the 90 MHz carrier by a 312.5 kHz square signal ("Delta312 operation").
The BPSK modulated signal is transmitted by the lander and so the received signal is filtered after demodulation in intermediate frequencies (30.3125 MHz).

Tuning Phase sequence
We have 3 sub-phases for the global Tuning phase:
-Gain acquisition,
-Frequency acquisition,
-Synchronization.

Each of these phases have a well-defined duration and corresponds to specific operations on Orbiter CONSERT Subsystem and on Lander CONSERT Subsystem.

The Orbiter On Board Time (OOBT) and Lander On Board Time (LOBT) must not differ by more than 20 seconds at the beginning of operations.

This maximum spacecraft to spacecraft Time Table offset induces an original offset between the two CONSERT time tables when they are started. The Lander and Orbiter CONSERT should be On with the ± 10 seconds accuracy to the absolute time reference. This original offset is called Original Time Table Offset (OTTO).Thanks to the last part of the tuning phase (Synchronization), the OTTO is reduced to less than 20 milliseconds.

1.2.3.1 Gain Acquisition Sub Phase

In the AGC process, we need to compare, in average, the amplitude of the amplified signal to a certain voltage goal, and then, increase the gain if the signal is smaller than required, or decrease the gain if the signal is bigger than required.
The gain command is a 5-bit word and it can be easily frozen and stored. Each attenuator circuit has an attenuation dynamic of 31 dB with 1 dB steps. As we use two serial attenuators in the receiver chain (one in RF section and one in IF section), then we have a 62 dB range, with 2 dB steps. With the assumption of constant mean input signal amplitude during the all tuning phase, the gain can be frozen (the gain control loop is opened) during the two following sub-phases: frequency acquisition and synchronization.

Gain Control Word Calculation method
The command generation requires four steps.
-Signal amplitude detection,
-Amplitude averaging or smoothing (averaging period or cut-of frequency has be chosen with respect to the useful signal spectrum, and its variability),
-Comparison of average amplitude to the reference goal voltage (vth on figure.),
-Increment or decrement of gain, according to the previous comparison.

Detection of the received signal level at the output of the Narrow IF section
On the CONSERT receiver, the narrow band signal level is measured at the output of the Narrow Intermediate Frequency (NIF) section.

Once the rectified signal is low pass filtered, the filtered amplitude is digitally converted at the Time Tick Frequency (TTF= 610.35Hz).
The micro-controller program builds a digital gain control integrator. The gain starts from minimum (maximum attenuation). The maximum of attenuation of the AT263 is for a Gain Control Word (GCW) with all bits equal to one. At initialization, the Integrator is loaded with all ones. After each signal level conversion, if the converted measured amplitude is lower than the required threshold (vth), one decrement the integrator, else one increment the integrator (by one or more steps). The 5 most significant bits of the integrator are the ones to directly drive the digital attenuator (GCW) with the speed of 9.5 dB/seconds. As the total gain range is 62 dB it takes a few seconds at most for the gain command to “converge” (maximum is less than 7 seconds). Even with a stable signal and a good signal to noise ratio, a one attenuator step fluctuation is possible. Then, the gain is frozen with a +/-2 dB accuracy from the goal. Once the gain setting phase is done, the frequency acquisition sub phase starts.

1.2.3.2 Frequency acquisition sub-phase

The Orbiter Master Oscillator is a Voltage Controlled Oven Crystal Oscillator (VOCXO). During the previous phase (gain setting) the frequency control voltage was constant, with the frequency set near the center of the range. During the frequency acquisition, the voltage control input is driven by the fluctuating output of the digitally controlled Phase Lock Loop.

In most cases, several seconds are required to lock the loop (convergence). At the end of a fixed duration, the micro-controller software identifies quasi convergence as a reduced quantized fluctuation around a fixed value, over a certain period (tested convergence criteria: interquartile is less than 4 quanta over the last 256 samples). The final control word is derived from an averaging (over the last 256 successive samples) and is set to the closest truncated DA converter word.

Maximum frequency tuning error.
With the averaging and rounding algorithm, the maximum command error has half quantum amplitude. This frequency control voltage error results in a frequency offset according to the frequency control slope.

The average Original Frequency Offset (OFO) is 0.19 Hz. But, the maximum Original Frequency Offset error reaches 0.70 Hz near the zero volt command, where the voltage command slope is a maximum.

To achieve the performances of the global instrument, we need the two master clocks not to be more than 2 Hz away from each other during the all comet scan (2.0 $*10^{-7}$ relative). Because of the OFO, the margin allowed to the drifting during the all scan experiment (mostly due to temperature and power supply fluctuations) is reduced.

In order to reduce the OFO, we should avoid tuning the oscillators in their lowest frequency range, near the zero command (*Figure 9* et *Figure 13*).

1.2.3.3 Time Tables Synchronization sub-phase (TTS)

The Time Tables (previously called Calendar) Synchronization results from a real time software identification of a simple amplitude modulation of the 89.6875 MHz line. As we expect synchronization as sharp as 20 ms, a modulation detection bandwidth of 100Hz is sufficient.
On the Orbiter, the micro-controller monitors the received carrier level (with some software filtering). The synchronization event is a unique carrier blank, which is expected in a known time window. As the Original CONSERT Time Tables Offset (OTTO) is less than 20 seconds, the synchro blank is detected by the orbiter program in a given time window which duration does not exceed OTTO.

2 EXPERIMENT OPERATIONS

2.1 Operation principles

2.1.1 *Consert phases*

Each scientific measurement sequence (called scanning sequence) involves the Orbiter instrument and the Lander instrument. During this scan sequence, a few thousands of individual measurements, called soundings are taken. The individual duration of this sounding is less than one second.

Each Lander ond Orbiter part is turn-on by a plateform TC. The turn-on constitue the time reference for the instrument (internal time = 0) and after this moment, the timing and setup of each part are based on their internal OCXO. The mission table defines all the transitions as described in the following tables: after the Mission table has been received, the instrument will perform all operations autonomously.

In order of achieve the time accuracy of both electronics, the Consert Orbiter OCXO is tuned to the Lander OCXO to be synchronized in frequency and in time. The end of this phase of the Consert cycle, named tuning, constitue the new t = 0 for both electronics. This new time reference defines the operation up to the electronic turn-off. **This phase is critical for the success of the whole consert scanning sequence.**

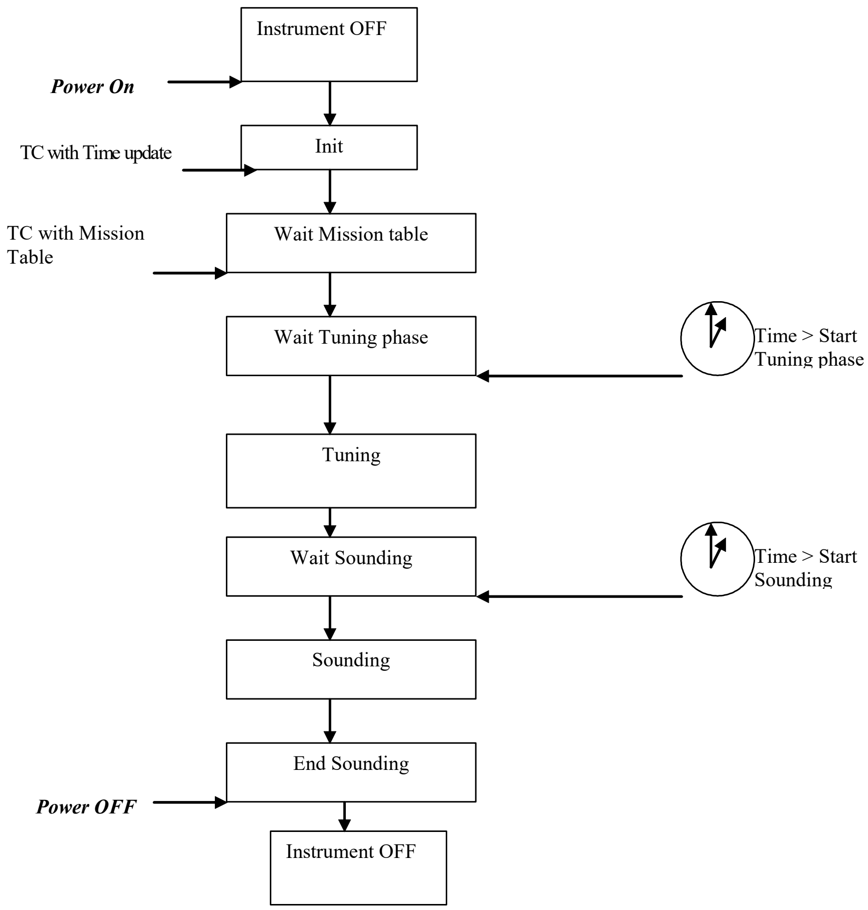


Figure 5: Phase Transition table

<table>
<tr><th></th><th>ORBITER
Phase duration and actions</th><th>LANDER
Phase duration and actions</th></tr>
<tr><td>Init phase</td><td>After switch-on and up to reception of SC Time update
• After Hardware initialization, an event report notifying the correct initialization is generated.
• Time update TC should be sent to the instrument after reception of this event report (§ 0)</td><td>After switch-on and up to end of initialization</td></tr>
<tr><td>Wait mission table phase</td><td colspan="2">After "Init" and until reception of a valid mission table.
• During nominal science operation, the instrument will wait until reception of a valid private TC with a Mission table. This table contains all the information needed for a given observation program.
• In this mode (and, to be verified, only in this mode) one or more software patches can be performed and memory areas can be dumped
• Direct test TC’s can be sent to the instrument.</td></tr>
<tr><td>Wait tuning phase</td><td colspan="2">After "Wait mission table" and until time for start of tuning is reached.
• OCXO warm up and stabilisation</td></tr>
<tr><td>Tuning phase</td><td>After "Wait tuning" and until completion of tuning activities
• On orbiter instrument, the internal Oven Controlled Quartz Oscillator is tuned to a frequency adjusted to a radio signal received from the Lander.
• At the end of this radio signal, both Orbiter instrument and Lander instrument internal calendars are reset to zero.
• At completion of this phase, an event report is generated (either tuning success or failure).</td><td>After "Wait tuning" phase and until completion of tuning activities
• The Lander instrument sends a continuous signal. On orbiter instrument, the internal Oven Controlled Quartz Oscillator is tuned to a frequency adjusted to a radio signal received from the Lander.
• At the end of this radio signal, both Orbiter instrument and Lander instrument internal calendars are reset to zero.</td></tr>
</table>

<table>
<tr><td>Wait Sounding phase</td><td colspan="2">After "Tuning" and until time for start of sounding is reached
Direct test TC's can be sent to the instrument.</td></tr>
<tr><td>Sounding phase</td><td>After "Wait Sounding" and until completion of the predefined number of soundings: Real Science activity phase
• A Radio wave is transmitted from the Orbiter to the Lander and then back from the Lander.
• The Science report Packets are only generated in this phase.
• The shape and amplitude of this signal (in phase and in quadrature) are sent in the Science Report.
• Direct test TC's can be sent to the instrument.</td><td>After "Wait Sounding" and until completion of the predefined number of soundings: Real Science activity phase
• A Radio wave is transmitted from the Orbiter to the Lander and then back from the Lander.
• The shape and amplitude of the correlation of this signal (in phase and in quadrature, 8 bit signed each) are sent in each standard packet for 21 sampling points centered aroud the peak maximum.
• Every TAB_FIOW_RATIO measurement, the full measured signal is transmitted.
• Direct test TC's can be sent to the instrument.</td></tr>
<tr><td>End Sounding phase</td><td>After "Sounding" and until Switch-off.
• Direct test TC's can be sent to the instrument.
• The dump of the CSA parameter is generally done at this moment
• A memory check is done before turn off</td><td>After "Sounding" and until Switch-off.
• Direct test TC's can be sent to the instrument.
• A memory dump is done before turn off</td></tr>
</table>

Table 1 : Phase Transition table

2.1.2 *Modes*

There are no modes for Consert experiment. The previous paragraph defines the operation cycle of Consert: all the transitions are planned in the mission table and both instrument parts (ie lander and orbiter parts) work autonomously after tuning.

When Consert is operating, Consert is in emissive and sensitive mode, in the same sequence.

2.1.3 *Consert Time*

There are three different times for CONSERT:

- Rebuilt Time on ground: SCET Time (in SFDU Header) – Zulu Time.
- On-Board Set Time: OBT time - SpaceCraft Time.
- CONSERT own Time: counter in TIC sets to zero when Consert is turned on and resets to zero after tuning phase, allows the precise synchronization between CONSERT Orbiter and CON. Lander

Consert own times are given in TIC: 1 TIC = 2^{14} / 10^{7} seconds = 1.6384 millisecond

2.1.4 *Mission table parameters*

Mission Table parameter name	Typical value	Increment value	Maximum value
Table Index			
TAB_INDEX	1	1	255
Time between power on and start of tuning			
TAB_TUNETIC	Orbiter : 038C60 hex Lander : 035A4F hex (6.21 et 6.00 minutes)	1 TIC = 1.6384 msec	4294967295 TIC = 1954 hours = 81 days
Time between end of tuning and Start of sounding			
TAB_STARTTIC	36621 (dec) TIC = 0000 8F0D (hex) TIC = 1 minute	1 TIC = 1.6384 msec	4294967295 TIC = 1954 hours = 81 days
Time between soundings			
TAB_DELTATIC	4.95 seconds = 3021 (dec) TIC = 0BCD (hex) TIC	1 TIC = 1.6384 msec	65535 TIC = 107 seconds
Total numer of soundings			
TAB_NBSOUND	100 (dec)	1	65535 (dec)
Initial clock frequency (before start of Tuning)			
TAB_INITFREQ	90 MHz Lander = 131 (dec) = 83 (hex)	1 (dec)	255 (dec)
Min and Max AGC attenuation			
TAB_MINATT	0	1 DN	31 DN
TAB_MAXATT	31 (dec)	1 DN	31 DN
ORBITER ONLY			
Minimum Level to be reached for successful tuning			
TAB_NBL_LEVEL	149 (dec) = 95 (hex)	1 DN	255 (dec) 4 Volts
Maximum Level to detect Signal disappearance			
TAB_NBL_ZERO	133 (dec) = 85 (hex)	1 DN	255 (dec) 4 Volts
Test Data			
TAB_MODEBYTE	0	0	1
LANDER ONLY			
Full signal Periodicity			
TAB_FIOW_RATIO	3		
Test Data			
TAB_MODE	0	0	7

Table 2: Mission Table Parameters

2.1.4.1 Orbiter and Lander parameters

TUNETIC

Duration between instrument switch-on and start of the Tuning phase

Orbiter TUNETIC = Lander TUNETIC + 21 s (This relation should be fulfilled corresponding in the synchronization margins)

The typical values (Orbiter: 038C60 hex = 6.21 minutes and Lander : 035A4F hex = 6 minutes) allows a thermal stabilization of the ocxo frequency before tuning in order to preserve the ocxo stability throughout the wwhole experiment.

STARTTIC

Duration between end of Tuning phase and start of the first sounding on Orbiter.

Generaly 1 minute. A larger value (36 minutes has been successfully used during SDL validation / PC#13).

INITFREQ

Setting of the OCXO frequency (in DN value from 0 to 255)

Orbiter : before the tuning phase. During the tuning phase the clock frequency will be adjusted starting from this value to try to lock on the Lander frequency. This value should correspond to a frequency as close as possible to the expected Lander frequency selected with the parameter

Lander : Setting of the OCXO frequency (in DN value from 0 to 255). The Lander clock frequency setting will remain at this setting until instrument switch-off or direct update via a Direct_TC. TheIt value corresponds in the 90 MHz frequency as measured during FSL intergration.

DELTATIC

Duration between two soundings in TIC

NBSOUND

Number of soundings

MINATT and MAXATT

These parameters limit the evolution range of the AGC: if result of AGC loop gives attenuation below mini_att, the selected GCW will be mini_att.

This function is not usable in the flight software.

2.1.4.2 Orbiter only parameters

NBL_LEVEL and NBL_ZERO

Parameter used during orbiter tuning phase.

NBL_LEVEL is the signal level to look the PLL at the end of the Frequency acquisition sub- phase

NBL_ZERO is the level to detect the end of the carrier and synchronize (Time table Sync sub-phase)

MODEBYTE

0 in normal mode, 1 in test mode (generate test data)

2.1.4.3 Lander only parameters

FIOW_RATIO

Period of Full response (0 means never a full response)

MODE

Mode byte, see definition below
Bit 0: Data from FPGA (0) or simulated data (1)
Bit 1: Flight configuration with TM type 3 (0) or test mode with TM type 4 (1)
Bit 2: Flight configuration (0) or test data with TM bloc completed at 4 (1)

2.1.5 Software hard-coded parameters

These parameters are hard-coded in the Flight software and can only be changed by a patch TC.

The definition of all these parameters is in an ASCII file called "eq_nm_o" (for Equivalence of Names Orbiter) and "eq_nm_l" (for Equivalence of Names Lander).
If this file is updated the whole flight software (all modules) should be recompiled and linked.

2.1.5.1 LANDER parameter :

TUNE_DURATION : Tuning CW period is 60 seconds (36621 TIC units)

NB : in the EML presently in our lab this value is set to only 30 seconds
The value has been updated for FM (and QML)

2.1.5.2 ORBITER Parameter :

TUNE_TIMEOUT_VAL = 60 seconds (36621 TIC units)

2.2 Synchronization Constraints

The success of the tuning requires an accuracy of 10 seconds for Consert lander and Consert orbiter turn-on. Lander on Orbiter Platforms should be able to turn Consert Electronics Boxes with a time accuracy of 10 seconds with respect to ground UT. This phase is critical for the success of the whole consert scanning sequence.

The operations have to be organized on board and on ground in order to secure the synchronization requirement and warranty the Consert success.

2.2.1 *Detailed analysis of the constraints*

The tuning sequence resynchronizes the both electronics in time and in frequency as describe in section 1.2.3. A successful tuning requires:

- The Lander starts to transmit before the begenning of the Orbiter Reception.
  (Lander_On + Lander TUNETIC < Orbiter_On + Orbiter_TUNETIC
  With Orbiter TUNETIC = Lander TUNETIC + 21 s - see section 2.1.4.1)

- The Orbiter OCXO converges before the end of the Lander Transmission.
  (Lander_On + Lander TUNETIC + 60s < Orbiter_On + Orbiter_TUNETIC + 15s
  with a TUNE_DURATION = 60 s – see section 2.1.5.2)

This constraint is illustrated in the two following tables.

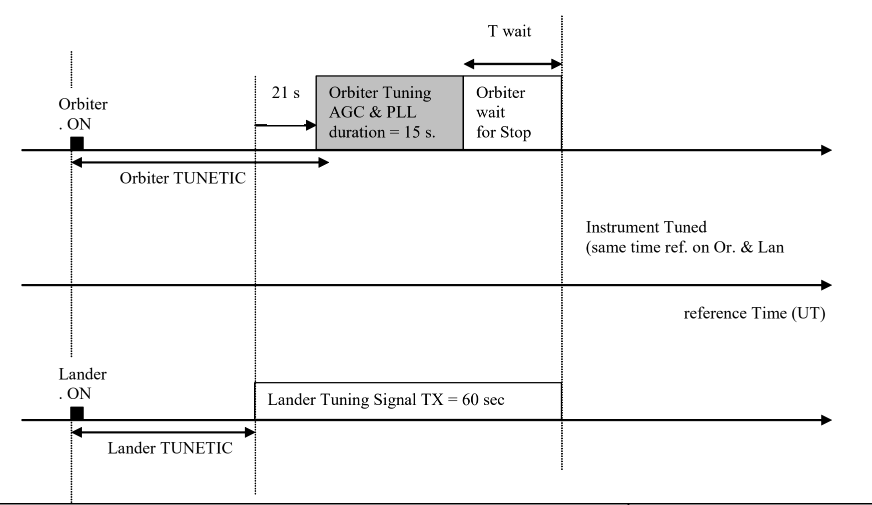
Lander activities	**Orbiter activities**
Switch On (From Lander S/C procedure)	Switch On (From S/C OBCP procedure)
Start of Lander Tuning phase (Radio signal transmission TX)	
TX	Start of Orbiter Tuning phase
TX	AGC (RX Gain will increase in order to put the signal NBL over the value NBL_LEVEL)
TX	PLL loop The Orbiter clock frequency is tuned to match the Lander TX carrier frequency (duration of AGC + PLL phase is 15 sec)
TX	Wait for Radio signal loss (ie : wait until signal NBL goes below the value of NBL_ZERO)
End of TX End of tuning phase Internal time reference (TIC count) reset to 0	End of tuning phase Internal time reference (TIC count) reset to 0

Table 3: Tuning phase scenario

Nominal case :
Orbiter and Lander instrument switched On at same time (UT reference time)

Duration when Radio signal is emitted by Lander before start of Orbiter AGC = 21 seconds

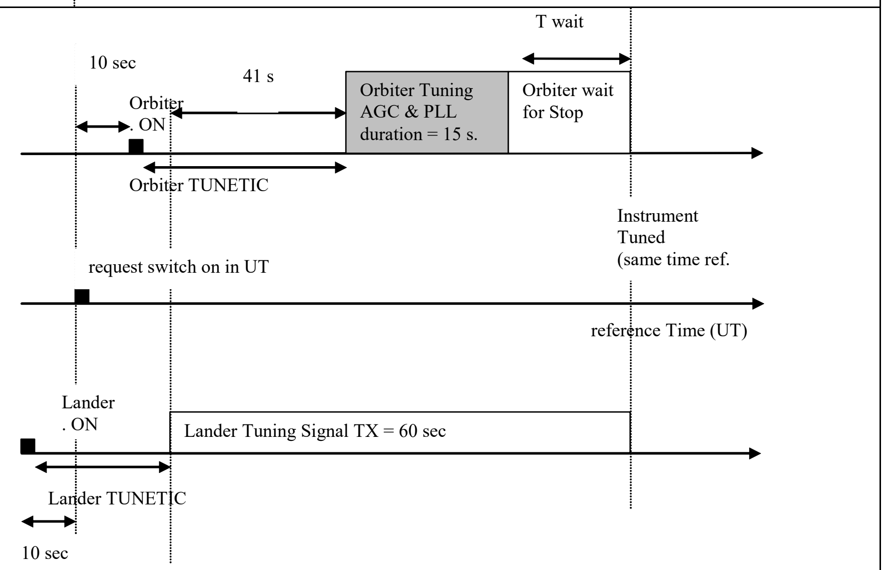
Then Orbiter wait time for = Twait = 60 – (21 + 15) = 24 seconds



Worst case 1 :
Orbiter switched On 10 seconds after reference time.
Lander switched On 10 seconds before reference time.

Duration when Radio signal is emitted by Lander before start of Orbiter AGC = 21 + (10 +10) = 41 seconds

Then Orbiter wait time for = Twait = 60 – (41 + 15) = 4 seconds



Worst case 2 :
Orbiter switched On 10 seconds before reference time.
Lander switched On 10 seconds after reference time.

Duration when Radio signal is emitted by Lander before start of Orbiter AGC = 21 – (10 +10) = 1 seconds

Then Orbiter wait time for = Twait = 60 – (1 + 15) = 44 seconds

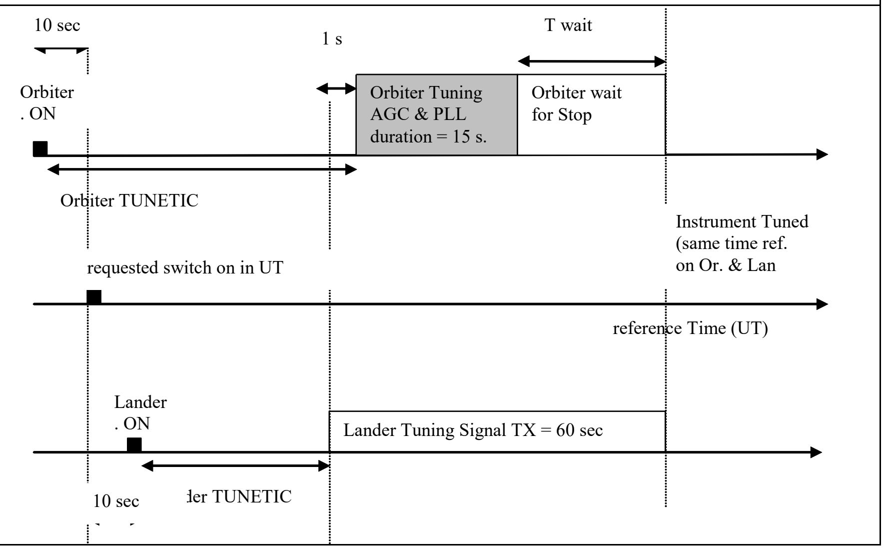


Table 4 : Turn On constraint

The purpose of this chapter is to define the rules of Mission Table Parameter Generation in order to ensure correct Orbiter & Lander synchronization.

Operational constraints :

C1 : Switch-on time of Orbiter instrument can be defined only with an accuracy of +/- 10 seconds versus UT (or some time absolute reference).
C2 : Switch-on time of Lander instrument can be defined only with an accuracy of +/- 10 seconds versus UT.

Tuning phase CONSERT constraints

C3 : When the Tuning phase starts on Orbiter instrument (with the AGC loop), the Lander instrument should already be in the radio emission (TX) phase (89.687500 MHz pure spectral line transmitted by the Lander) in order to ensure good Gain convergence.

C4 : The Orbiter instrument will stop it's tuning phase even if no signal loss is detected at the time that is called TUNE_TIMEOUT_VAL in the flight software. This happen after a duration "Twait" after the end of the PLL loop. "Twait" is varying depending on the situation and is explained below.
The total duration of tuning is coded to 60 seconds (36621 TIC units) in the Flight software and can only be changed by a patch TC (see section 2.1.5.2).

2.2.2 *Mission Table Parameters*

As previously explaint, in the mission table,

Orbiter TUNETIC = Lander TUNETIC + 21 s (This relation should be fulfilled)

2.2.3 *Mission Table TC*

Normal Consert operations requires mission table. This TC has to be send before the end the consert warmup. A mission table has to be received less than 3 minutes after turn on.

After 3 minutes without mission table Consert is in a passive mode:
- the mode could be used for AFT only (used for Lander AFT)
- Consert has to be restarted (Off / On) before "real" operation.

It is desirable to send the mission table (orbiter) at least 1 minutes 30 seconds after trun-on. If not, the MT TC can arrive before the OCN time update indicing the "loss" of the acknowledgment due tio a wrong timing.

2.3 Other Operations Constraints

2.3.1 *Switch-on Conditions*

The only switch-on restrictions applicable for Consert are the measured temperatures at the Consert E-Box TRP.

	Tmin	Tmax
Orbiter	-20 °C	+50 °C
Lander	-40 °C	+50 °C

Consert Orbiter maybe switch on at a lower temperature (-40°c) but performances aren't verified under -20°c.

Consert Lander meets some boot problems at lower temperature and lower voltage. [AD 7].

2.3.2 *Switch-off conditions*

There is no switch off condition for Consert orbiter and lander.

- In normal condition, OCN and LCN have to be turn off after the end of sounding phase. The timing and the mission table has to be calculated in this way.
- Nevertheles, in case of emergency, the electronics can be turn off during soundings without conditions.

In order to easily check the data integrity, a specific TC is send before turn off and the corresponding TM has to be received. Both OCN and LCN can be trun off without this TC.

The consert science operation consists in long synchronized senquence with lander and orbiter. If one part is turn off during science operations, the other part will continue to cycling during the planned time inducing a power and TM resources waste. This point is especially critical for the lander resources. For this reason, the operation philosophie is to limit the contengenci risqué especially at orbiter level.

2.3.3 *Time Update (Orbiter only)*

After the switch-on the OBT Time has to be delivered to Consert Orbiter (earliest 20 second, latest 60 seconds after switch on).

This platform services has to be stoped after 60s. Time updates during tuning and sounding can induces missynchronization of both Consert parts.
Indeed, the time-update stops the normal schedulling of Consert Orbiter during a waiting period up to 10 seconds (TBC) and delays the events which normally would append during this waiting time.

The time update can be manually done (CN-SEQ-250) in order to follow the Consert Orbiter ocxo drift by regard to the Rosetta PFM ocxo. This corresponds in a test mode and is not to be used during science operations.

Before Time update the Tm's aren't dated correctly and maybe lost at the ground segment level.

2.3.4 *Orbitography and S/C attitude*

Orbitography and attitude requirements are detailed in document [AD 10].

2.3.5 *Earth Swingbies*

No Consert operation inside the Earth Radiation belts [RD 5].

2.4 Consert Telemetry to follow operations

2.4.1 *Tuning Telemetry*

The event report “Tuning OK : after completion of Tuning phase “ at the end of the tuning phase provide parameters:

Clock Frequency: OCN clock frequency after tuning
Intercatille: convergence quality of the PLL
Tuning phase GCW: Gain Control Word for tuning

2.4.2 *Orbiter progress report*

See Orbiter TM description : Progress report 59, 7

Progres report:

Initialized : after completion of hardware init
Tuning OK : after completion of Tuning phase
Sounding Started : at start of sounding phase
Sounding Completed : at end of sounding phase

2.4.3 *CSA parameter*

The CSA is a data from Consert Telemetry to estimate the turn on accuracy of a ping pong sequence.

The CSA (consert synchronization accuracy) is an internal parameter of the Consert SW used to manage the SCET time on board on consert (convertion of the interal consert time to SCET time). On the Orbiter, at the end of the tunning, the CSA stores the date of the end of the tunning in consert tic time, juste before the reset of the consert internal clock. In other for, the CSA (raw value) is the number of TIC between the OCN turn on and the end of the tunning.

In ping pong mode, the end of the tunning at the OCN level is induced by the end of the tunning signal transmission by LCN. When both OCN and LCN turn-on's are perfectly synchronized, this delay is a constant equal to 0x3E95C (raw value).

The drift by regards to this value indicates the delay between OCN and LCN trun-on. This value is dumped by CN-SEQ-242 redirected and downloaded as a science TM.

CSA = engenering value = (raw value - 0x3E95C) * (2^14/10^7) secondes

The sign of the CSA (engenerign value) indicates the turn-on order:
CSA < 0 : LCN is on the first and OCN after

CSA > 0 : OCN the first.

CSA is not relevant for Consert Orbiter operating alone (CSA = ~ -26s).
CSA is not relevant before tuning (CSA = ~ -420 s)
CSA is not relevant when a Time update is happened after tuning (CSA= ~ -420s).

The CSA has been defined taking into account the standart value of TAB_TUNETIC in the mission table.

2.5 Failure detection and recovery strategy

2.5.1 *Alarms Orbiter*

2.5.1.1 Antenna temperature

The orbiter antenna temperature was an alarm related to the antenna deployment.
It is no more a Consert alarm.
NCNAT002 - PAY403-ConsertAnt Temp B
NCNAT102 - PAY402-ConsertAnt Temp A

2.5.1.2 E box temperature

The Orbiter E box temperature is an alarm related to the boot temperature.
Reaction in case of temperature out of limits: inform CNOT by e-mail.
NCNAT001 - PAY405-Consert EL Temp B
NCNAT101 - PAY404-Consert EL Temp A

2.5.1.3 CSA

The parameter Consert Synchronization accuracy is a parameter to monitor the accuracy of the synchronization of both Lander and Orbiter turn on.

Reaction in case of CSA out of limits: inform CNOT by e-mail.

CSA is not relevant for Consert Orbiter operating alone (CSA = ~ -26s).
CSA is not relevant before tuning (CSA = ~ -420 s)
CSA is not relevant when a Time update is happened after tuning (CSA= ~ -420s).

NCNG0500 - CSA - Engineer to inform CONSERT team by email

2.5.1.4 Tuning not converged

YCN00502 - EID 41020 - Tuning Not Converged
Log as unexpected in daily report and

2.5.2 *Anomalous report orbiter*

Anomaly report events are only anomaly reports; no action has to be taken by S/C or ground on reception of these reports

See Orbiter TM description : Progress report 59, 7

Analomaous report event

Agc Timeout : FPGA reset due to timeout during AGC phase
Data Timeout : FPGA reset due to timeout during data transfer phase
No Tuning : Tuning phase algorithm has not converged

2.5.3 *CRP*

The two procesure CN-CRP-301 and LN-CRP-311 have been implemented in order to checkup as in detail as possible our electronics (orbiter and Lander respectively). The CRP's are stand alone.
These procedures will be applied for the post hibernation comisionning.

The sequence CN-CRP-302 is a dump of the whole OCN memory.

See FOP for a detailed description of these sequences.

2.6 Interferences Constraints

The following tables summarize the results of the interferences test onboard and Rosetta and Philae.

The tests have been analyzed and reported in dedicated TN :
[AD 9] RO-OCN-TN-3832 Consert Interferences test report

The outputs are noted hereafter: The green colour corresponds to the instruments with which CONSERT can operate together. The yellow to these that generate some perturbation but could be acceptable, if not to many instruments of this type operates together. The red colour corresponds to instrument that can't operate together with CONSERT.

2.6.1 *Orbiter Consert*

Negligeable	Detectable	Huge	No test done
ALICE COSIMA MIDAS MIRO SREM	GIADA OSIRIS RPC/LAP RPC/IES ROSINA RSI	RPC-MAG RPC-MIP RPC/ICA VIRTIS	

2.6.2 *Lander Consert*

Negligeable	Detectable	Huge	No test done
APXS CIVA ROLLIS	ROMAP	SESAME SD2 MUPUS	COSAC PTOLEMY

3 CONSERT OPERATION SCENARIOS

3.1 Operations up to the comet

3.1.1 *Passive Payload Check Out*

During each passive PC, the followings tests have to be processed:

- Unit functional test Orbiter (UFTO) : CN-SEQ-300
- Unit functional test Lander (UFTL) : LN-SEQ-310
- Ping Pong Funtional Test (PPT) : CN-SEQ-320

These three tests are predefined in the FOP without versatility.

	UFT O	UFT L	PPT O+L
Orbiter			
DV Sci (Kbytes)	123		123
DV HK (Kbytes)	6		6
Pw mean/peak (W)	3.4 / 10.9		3.4 / 10.9
Lander			
# TM		531	531
DV Sci (Kbytes)		36	36
Pw mean/peak (W)		4 / 9.4	4 / 9.4

Table 5 : Passive PC budgets

3.1.2 *Active Payload Check Out*

During active PC's the following points have to be addressed:

- Operation in condition representatives of the comets:
  - Long poing pong test representative to comet operations : 3 to 30 hours, 10000 soundings
  - Operation with the Lander TM scheduled by the Lander itself : absolute time tagged commands
  - Operation with all the operation scheduled by the Orbiter and the use of the RF channel to command the Lander in real time / RF link test

- Interference tests with:
  - Orbiter instruments
  - Orbiter S/S and especially AOCMS, TxRx and Whell, ESS TxRx
  - Lander instrument and S/S

- Consert validation
  - UFTO, UFL, PPT
  - FOP validation in case of CDMS SW realise

In order to secure the synchronization of both Orbiter and Lander electronics turn on, on have to have some statitics on the synchronization delay. The absolute time tagged command test and the RF test have to be re-play several times.

3.1.3 *Swingbys*

The Earth Swingby 3 is an opportunity to have a test of the Consert vsynchronization in realistic contition by regards to the orbitography.

3.1.4 *Asteroid Flybys*

No science expected for asteroid FB's.
Calibration test need during lutetia

3.1.5 *Hybernation and commissioning post-hybernation*

Both Consert instruments are designed to survive the deep space hibernation period without being activated. In consequence, we can assess that there is no specific risk to go in this phase.

A careful thermal check will be done before wake, especially on the Lander in order to avoid boot problems.

After wake up, a complete commissioning will be done based on procedures used for passive PC: CN-SEQ-300 (UFTO), LN-SEQ-310 (UFTL) & CN-SEQ-320 (PPT) and on the contingency recovery procedures: CN-CRP-301 (OCN) & LN-CRP-311 (LCN).

This test will be completed by tests in condition representative of the comet conditions as described for active PC: long poing pong test, absolute time tagged test & RF link test.

3.2 Comet Operation

3.2.1 *Concept*

Each scientific measurement sequence (called scanning sequence) involves the Orbiter instrument and the Lander instrument. The duration of this Scan sequence is related to the duration of the orbit of the Rosetta Spacecraft relatively to the Lander on the rotating comet nucleus. This duration is typically of the order of one revolution around the nucleus. These orbits dedicated to consert are named Consert Orbits.
During this scan sequence, about 12000 individual measurements, called soundings are taken. The individual duration of this sounding is less than one second.

As previously explain, this scanning sequence starts with the synchronization of baoth electronic with an accuracy better of 10 seconds and is follow by a period 10 minutes of visibility in order to allow tunning and the start of the soudings. The scanning sequence ends with 5 minutes of sounding in visibility in order to improve the orbitography restitution.

A complete scanning during the Lander flyby doesn't concern the nucleus radio tomography. In the other hand, this data could be relevant to inverse orbitography and to model gravitation and non-gravitation strengths.

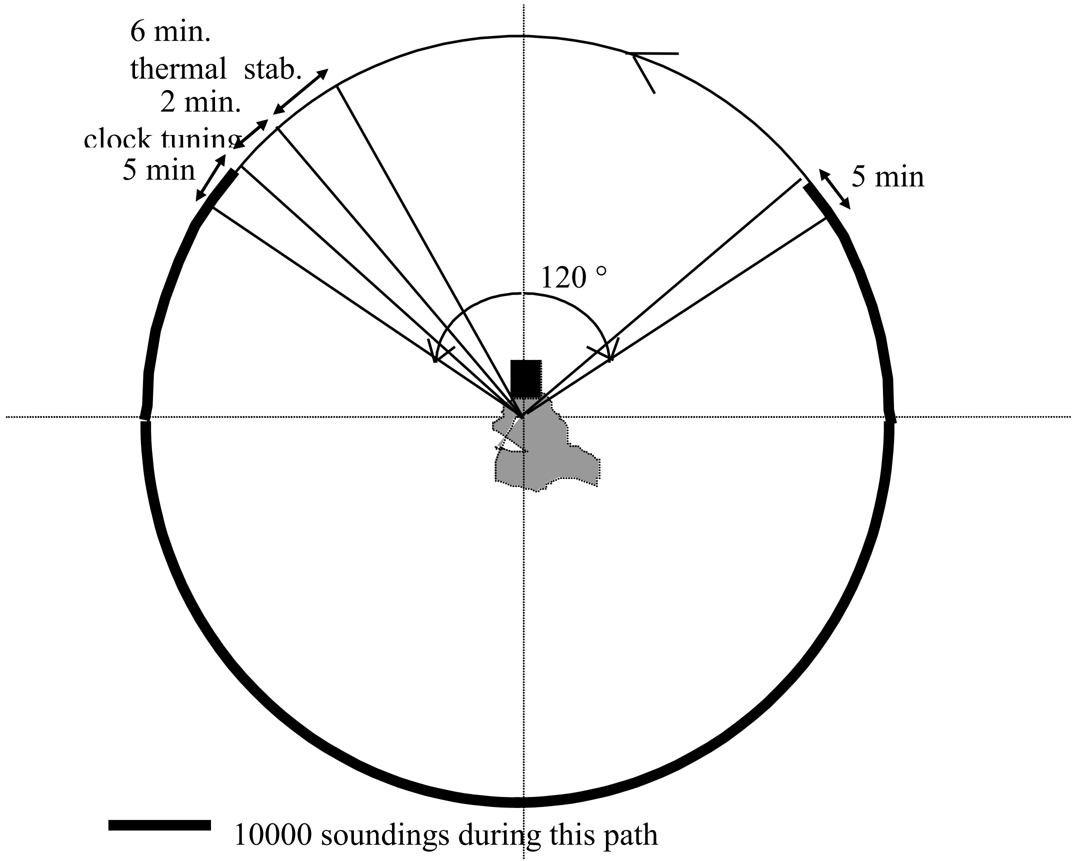


Figure 6 : Consert scanning sequence

3.2.2 *CONSERT Operationnal Requirements*

Preliminary remark: actual operation constraints interaction with Rosetta and Philae operation teams have been summarized in [AD 10]. The [AD 10] document reading is highly recommended.

3.2.3 *Mission table and budgets*

The general structure of the CONSERT operational scenario is not dependant on the comet type that will be explored during the Rosetta mission. But a certain amount of the parameters of the mission table and especially the scanning sequence duration are dependant of the shape and size of the comet nucleus and of the orbit of the spacecraft and nucleus rotation. These values have to be calculated before the Consert orbit from knowledge of nucleus, the selected landed site and the orbitography constraints.

In a theoretical point of view, the sampling rate has to respect the nyquits condition in space domaine at the surface of the nucleus to allow a complete rebuilt of the field inside the nucleus. That means a sounding every meter on nucleus surface (i.e. projection of the spacecraft position on the nucleus surface following the direction of the Lander).

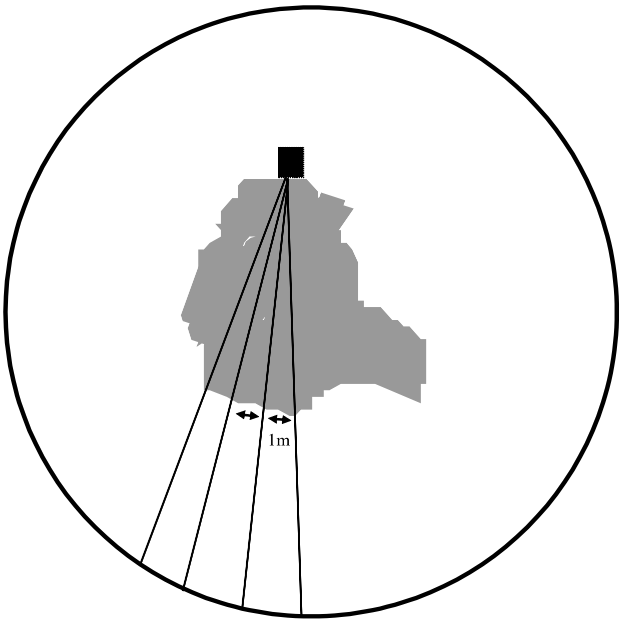


Figure 7 : Sampling rate at the nucleus surface

For a circular nucleus and a circular orbit with a constant velicity by regards to the surface:

	Typical	Mininum	Maximum
Comet radius (m)	2000	1000	3000
Number of sounding	12600	6300	18900
Orbit Duration (h)	12	3	30
Deltatic (s)	3.4 s	1 s (*)	17 s

Table 6 : Typical parameters for a spheric nucleus and circular orbit
(*) The minimum value is 1s by construction.
For a 3h orbit, 1 s is compatible with a radius lower than 1.7 km.

In practice the spacecraft notion by regards to the nucleus surface would be complexe, without a constant velocity. The Rosetta "ground track" would be more complex than a simple circle. The constraint concerns the velocity of the spacecraft ground track.

During the whole Consert Orbit, the delta_tic has to be lower than the time to cover 1 meter on the surface nucleus.

The number of souding could be consequently significantly larger than the values presented in **Table 6*****. The following table proposes strawman cases:***

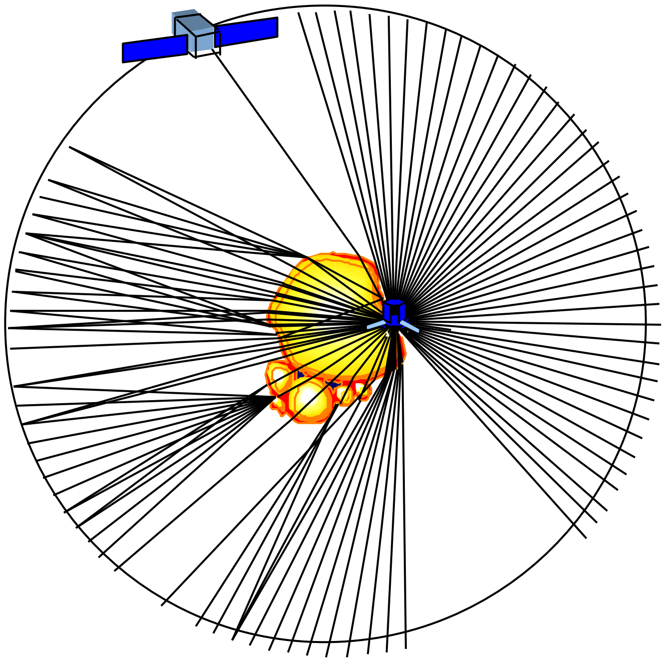
	Typical	Fast	Slow
Number of sounding	25000	25000	35000
Deltatic	1.7 s	1.0 s	3 s
Orbit Duration	12 h	7.2 h	30 h
Orbiter			
HK (Kbytes)	800	800	1 000
Sci (Kbytes)	25 600	25 600	36 000
Other (Kbytes)	< 10	< 10	< 10
Total (Kbytes)	26 500	26 500	37 000
Power Mean (W)	4.4	5.4	3.8
Power Max (W)	10.9	10.9	10.9
Total Power (Wh)	53	39	112
Lander *			
Sci Number	110 000	110 000	150 000
Sci (Kbytes)	7500	7500	10 000
Power Mean (W)	5.6	7.2	4.5
Power Max (W)	9.4	9.4	9.4
Total Power (Wh)	67	53	136

Table 7 : strawman cases: parameters and budgets
(*)assuming FIOV = 5 and -40°c (power budget worst cas)

3.2.4 *Full Orbit Tomography (FOT)*

It is the 'nominal' CONSERT configuration with operation from a Lander visibility slot to the following one.
During this orbit, the Orbiter has to move on the opposite side of the nucleus (opposite side by regards to Philae)

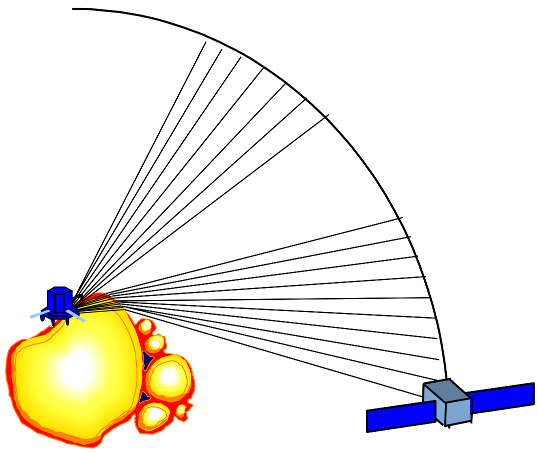
This sequence is the way to measure the mean permittivity throughout the nucleus, to quantify its homogeneity and to characterize the typical heterogeneity scale inside the nucleus. With a sufficient number of full orbits, it will be possible to obtain many cuts of the interior of the comet and therefore to build up a tomographic image of the nucleus (several orbits not in the same plane).



3.2.5 *Orbiter Going Under Philae's Horizon (GUH)*

After a period of visibility during which a reference signal is recorded, when Rosetta goes down to the horizon, it is possible to study the signal extinction to retrieve the near surface stratigraphy (100 m) in the vicinity of the landing site. The data inversion method is similar to that used for planetary atmospheres by studying the solar light extinction.

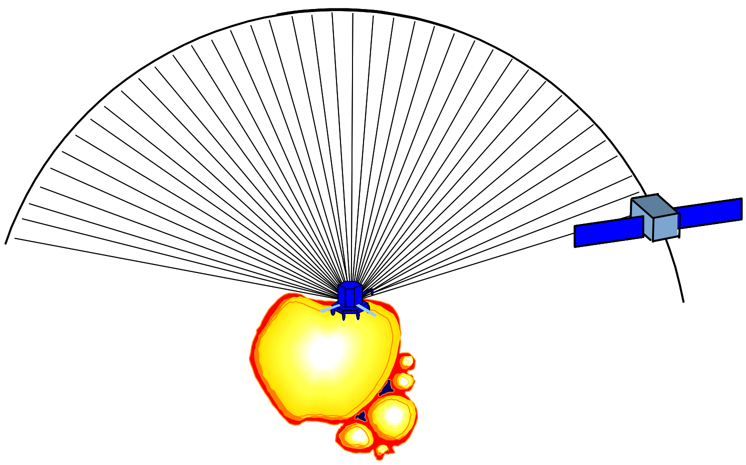
This sequence can be done as a part of a full orbit but can also be envisaged as a separated sequence corresponding to ~20 % of a full orbit. In this case, the spatial resolution (data sampling) can be increased to improve the quality of data taking and processing.



3.2.6 *Lander Fly Over (FOL)*

The Philae Fly Over gives an opportunity to monitor the gravitational and non gravitational forces in the vicinity of Philae and to monitor their temporal variations.
Consert geometry permits measurements of the range in time between the Orbiter and a reference point (Lander position) on the nucleus surface. This measurement will be done with a limited resolution (3m).

As for GUH, this sequence can be done as a part of the full orbit or as a specific sequence.

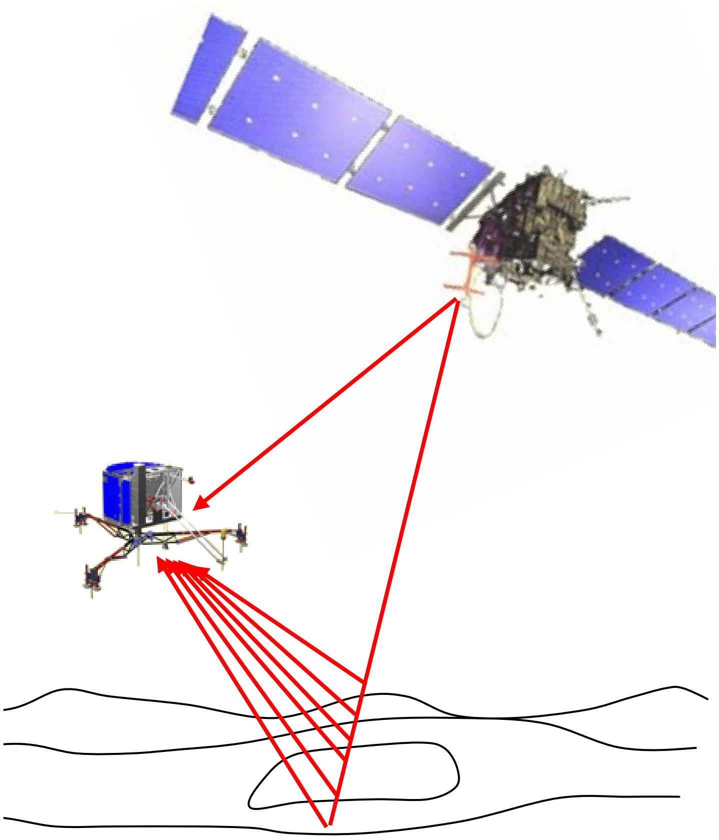


3.2.7 *Lander Descent (SDL)*

During the descent, Consert will perform

- Characterization of the surface and near subsurface in terms of roughness (surface diffusion), stratification (internal reflexions) and homogeneity (volume diffusion).
- The surface / Lander and Lander / Orbiter distance measurement is also the only way to monitor the Lander dynamics during descent.

Between SDL and First Science Sequence phases, CONSERT shall stop its transmission, but keep the clock synchronization between OCN and LCN. To do so a specific stop & start procedure has been defined, please refer to [AD 11].



3.2.8 *CONSERT save mode*

3.2.8.1 Rationale

In case of Orbiter save mode during SDL&FSS, Consert orbiter will be turn off while Consert lander will continue to operate during SDL and FSS.

RMOC asked Consert Team to propose an OCN commanding allowing to detect LCN signal and to demonstrate that the lander is in good shape, especially in case of no Rosetta /Philae RF link.

We have developed a new Consert mode using stroboscopic sampling to bypass tuning constraint and to allow one signal acquisition every 2 minutes:
- 6 percent of sounding are well-synchronized and useful for both science and operation while 94% are noise measurement without any interest.
- The instrument performances are nominal in term of sensitivity: SNR and lander/orbiter distance measurement.
- The spatial sampling is degraded with one measurement of interest every 2 minutes.

Considering the fact that the lander resources will be engaged, this mode would allow saving a part of the Consert science during FSS bloc 1 in case of save mode. **For this reason, even if not needed for operational purpose, Consert team asks RMOC to implement this mode in any case of save mode during SDL & FSS and to maintain it up to the end Consert FSS (lander event: AORF2 @ 5:32)**.

3.2.8.2 Mode description

3.2.8.2.1 Concept

During the tuning both OCN and LCN are synchronized in frequency and in time. After tuning both electronics run separately and automatically.

1/ A PLL locks the orbiter clock frequency to the lander one: this is to limit the drift of the LCN calendar versus OCN one during the whole measurement sequence.

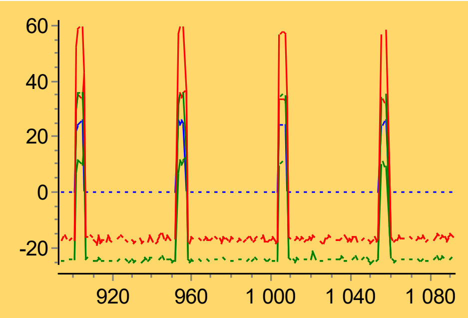
2/ After PLL convergence, the end of the LCN carrier transmission is detected to have the same t0 on both e-box and to run the mission tables in a synchronized way. The accuracy of this synchronization is ~1 ms. Without this synchronization, the OCN is receiving out of the LCN Tx slots and vice et versa.

The first step can be easily bypassed due to the predictability of the clock behavior: the OCN OCXO frequency was quasi-constant from integration to now: OCXO command word = 129 or 130 dec. This command word can be send by TC after the tuning phase (8 minutes after OCN on).

The second step is not possible to bypass in the normal mode. The idea of this degraded mode is to have different sounding intervals (delta tic) on the lander and on the orbiter in order to have a drift of the OCN sounding time by regard to the lander one. So by stroboscopic effect, OCN will by synchronized with LCN from time to time, with a given periodicity.

In the proposed commanding, OCN deltatic = 1494 (2.448 s) while LCN deltatic = 1526 (2.5s), we will have 3 synchronized sounding every 48 soundings (2 minutes).

Typical cycling with stroboscopic effect (measured power during lab test):



3.2.8.2.2 Operation

```
T0 :  ACNS401A
VCNA040 = 1494 dec  (2.448s) :  time step in TIC
VCNA050 =  30000 dec  :  total sounding number. (20h30 operation)

T0 + 20h30 : ACNS401B
```

3.2.9 *Attitude and orbitography constraints*

A summary of geometric constraints can be found in [AD 10].

3.2.9.1 Metric restitution of the Consert Orbit.

The Consert orbit has to be chosen in order to provide restitution accuracy equal to a few meters. Drastic S/C manoeuvres during Consert orbit could degrade this accuracy *[RD 5].*

3.2.9.2 SC speed by regards to the nucleus surface

Velocity of the S/C footprint on the NUCLEUS SURFACE has to be lower than 1 m/s at all the moments during Consert Orbit. The maximum sounding repetition is close to 1 sounding per second and a higher velocity doesn't allow to respect the Nyquist condition at nucleus surface. The S/C footprint is the projection of the S/C position at the nucleus surface along the line between the spacecraft and the nucleus centre of mass [RD 5].

3.2.9.3 SC altitude

The Orbiter has to be as close as possible to the comet nucleus during Consert operations. The altitude decrease induces a better signal to noise ratio on the conserts signal. That induces also a better spreading of the signal of interest along the orbit and consequently an easier data interpretation. Altitude higher than 20 kilometres would degrade significantly the link budget and the instrument sensitivity (Maximum limit 30 km) *[RD 5].*

The lower SC altitude seems the better for Consert.

The impact of the altitude decarese on the orbit stability, orbit a posterior restitution and ground track complexity is under analysis.

3.2.9.4 <u>SC attitude</u>

S/C +Z axis should be pointed to the centre of the comet nucleus with an accuracy of +/- 2° during Consert operation in order to maintain the nucleus inside the Consert antenna pattern *[RD 5].*

3.2.9.5 <u>Tuning Consert</u>

Rosetta and Philae has to be in visibility during tuning. The success of the Tuning depends in the accuracy of the Turn-On as previously explained.

The tuning duration is coded to 60 seconds (36621 TIC units) in the Lander Flight Software.

3.3 Comet science scenarios

3.3.1 *Landing phase*

3.3.1.1 <u>Objectives</u>

During the descent phase, the signal reflected at the surface and by sub-surface layers will be measured. The strength of the signal and its form will permit to derive the dielectric constant of the surface layers and the sub-surface structure. The crust and the subsurface layering will be detected. This measurement is a major scientific objective of the mission.

The use of CONSERT can measure veolcity and acceleration of the lander which can be used to estimate the gravitational and non-gravitational forces in the vicinity of the landing site (one measurement ranges the distance between the orbiter to lander every 1 second; expected precision of the ranging is about 3 m). This is the complementary to the RSI measurements as we are giving the small scale variations of gravity field when RSI gives the global results.

3.3.1.2 <u>Landing Scenario</u>

Measurement during the whole descent

Ref : ROS-PHI-CON-SDL-001 and ROS-PHI-CON-SDL-001

Between SDL and First Science Sequence phases, CONSERT shall stop its transmission, but keep the clock synchronization between OCN and LCN. To do so a specific stop & start procedure has been defined, please refer to [AD 11].

3.3.2 *First Philae phase*

3.3.2.1 <u>*Objectives*</u>

The CONSERT measurements provide the real and imaginary parts of the dielectric permittivity of the cometary material inside the nucleus. The permittivity of the material is linked with the density and composition of the material and further analyzes with suitable experimental simulations will help constraining the density, composition of the material and inhomogeneities inside the nucleus of the comet.

During the eclipse of the lander by the comet, the near-surface properties of the comet are probed by CONSERT grazing extinction sounding. This type of measurements provides information on the structure and dielectric properties of this material vs depth. In fact for each orbit of our measurements we will have this information. It will be possible to plan only experiments for these measurements with a shorter duration (scenario #2) .

During the flight-by of Philae by Rosetta, the use of CONSERT can measure veolcity and acceleration of the lander which can be used to estimate the gravitational and non-gravitational forces in the vicinity of the landing site (one measurement ranges the distance between the orbiter to lander every 1 second; expected precision of the ranging is about 3 m). This is the complementary to the RSI measurements as we are giving the small scale variations of gravity field when RSI gives the global results. This acquisition can be done in the continuity of a whole scaning sequence or not (scenario #3).

Between SDL and First Science Sequence phases, CONSERT shall stop its transmission, but keep the clock synchronization between OCN and LCN. To do so a specific stop & start procedure has been defined, please refer to [AD 11].

3.3.2.2 <u>*Scenario #1*</u>

Complete consert orbit measurement from a visibility period to another one.
10 minutes of visibility required before extinction
Typical duration 3 to 30 hours.

We need the maximum orbit as possible in order to build the good image of the interior.

Ref : ROS-PHI-CON-FSS-001 and ROS-PHI-CON-FSS-002

3.3.2.3 <u>*Scenario #2*</u>

In case of measurement separated from scenario#1: 10 minutes of visibility and 1 hours off visibility.

Ref : ROS-PHI-CON-FSS-003

3.3.2.4 Scenario #3

In case of measurement separated from scenario#1: measurement during the whole visibility

Ref : ROS-PHI-CON-FSS-004

3.3.3 *Escort phase*

3.3.3.1 Objectives

Similar to the first science sequence:
- the increase of the number of measurement sequence will allow us to rebuilt a complete image of the internal structure of the nucleus.
- The long term survey of the rosetta Flight-by will allow to follow the evolution of the non gravitational strength and so the nucleus activity during the extended Philae mission.

3.3.3.2 Scenario #1

Complete consert orbit measurement from a visibility period to another one.
10 minutes of visibility required before extinction
Typical duration 3 to 30 hours.

We need the maximum orbit as possible in order to build the good image of the interior.

Ref : ROS-PHI-CON-LST-001 and ROS-PHI-CON-LST-002

3.3.3.3 Scenario #2

In case of measurement separated from scenario#1: 10 minutes of visibility and 1 hours off visibility.

Ref : ROS-PHI-CON-LST-003

3.3.3.4 Scenario #3

In case of measurement separated from scenario#1: measurement during the whole visibility

Ref : ROS-PHI-CON-LST-004

4 ORBITER

4.1 Experiment configuration

4.1.1 *Physical*

The consert experiment on board of the orbiter consists in an electyronics box, an antenna deployed during sc commitioning (10/03/2004) and a Harness.

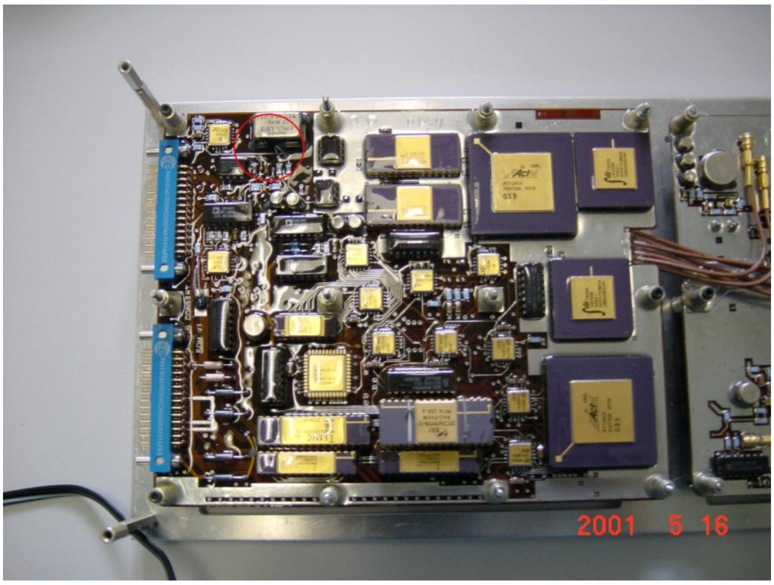


Figure 8 : Thermistor position inside OCN Ebox (OCXO Temperature from consert TM HK)

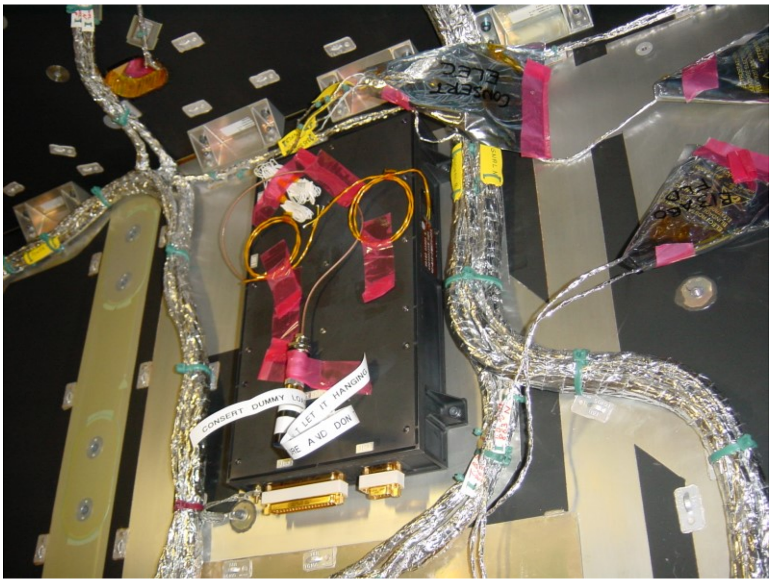


Figure 9 : Thermistor on the consert Ebox (Temperature from S/C TM HK)

4.1.2 *Electrical*

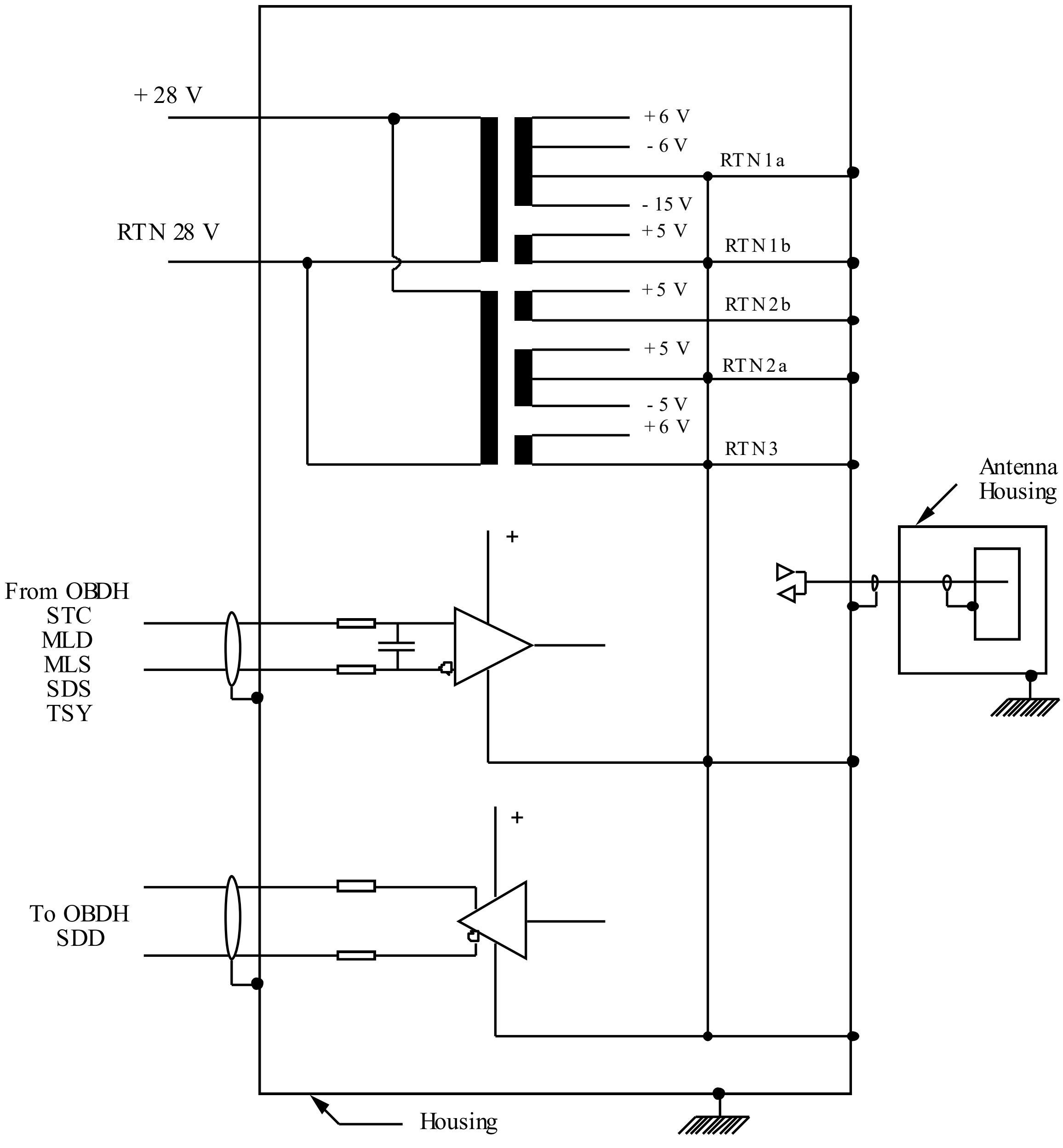


Figure 10 : Orbiter Consert Grounding Diagram

4.1.3 *SW*

TBW

4.1.4 *Power Budget*

Experiment phase	Orbiter Power Usage	Typical Duration
Init	4.5 W tbc	60 s
Wait mission table	2.9 W	60 s
Wait tuning	2.9 W	200 s
Tuning	6.2 W	60 s
Wait Sounding	2.9 W	60 s
Sounding	3.4 W Peak 10.9 W	duration 2 to 20 hours, comet type dependant
End Sounding	2.9 W	Wait for switch-off

Table 8 : Orbiter : Phase power budget summary @-20°c (Worst Case)

The consert orbiter primary currents measured at -20°c on 28 V are:

<table>
<tr><td>sandby phase</td><td colspan="3">105 mA (2.9 W)</td></tr>
<tr><td>tuning phase</td><td colspan="3">220 mA (6.2 W)</td></tr>
<tr><td rowspan="5">sounding phase
(see figure)</td><td>Waiting Tx</td><td>105 mA (2.9 W)</td><td></td></tr>
<tr><td>Tx</td><td>390 mA (10.9 W)</td><td>200 ms</td></tr>
<tr><td>Wainting Rx</td><td>200mA (5.6 W)</td><td>200 ms</td></tr>
<tr><td>Rx</td><td>275 mA (7.7 W)</td><td>25 msec</td></tr>
<tr><td>Repporting</td><td>220 mA (6.1 W)</td><td>75 ms</td></tr>
</table>

Table 9 : Orbiter current during one sounding

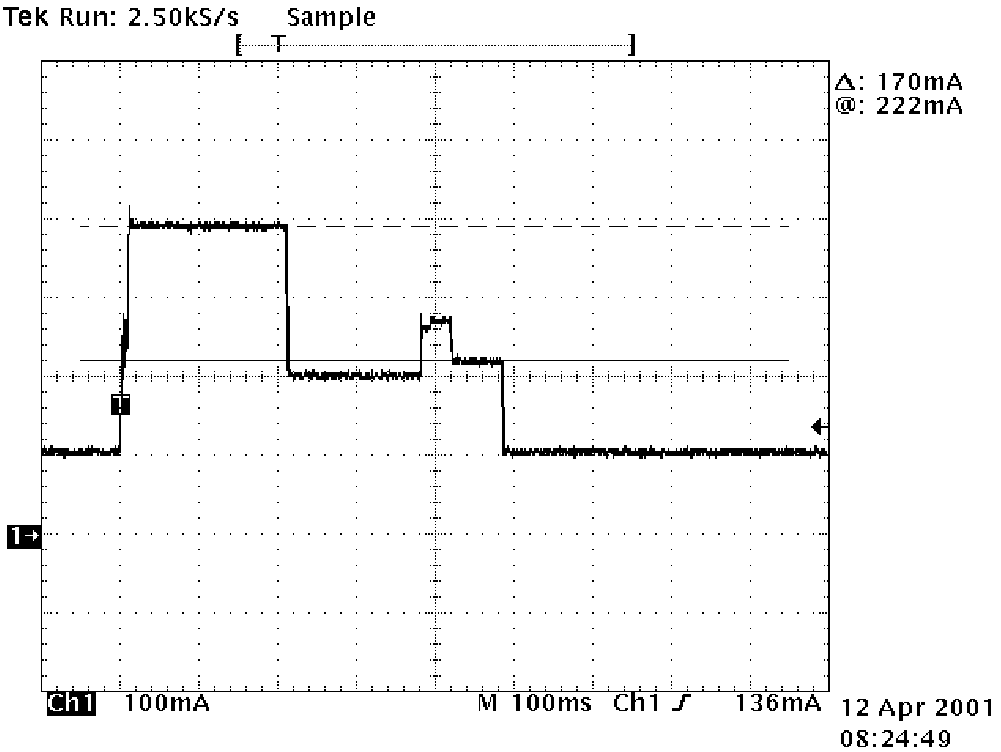


Figure 11 : Consert Orbiter current during a sounding (-20°c / 28V)

With a sounding every ΔTic, the power average during sounding is:
Pav = 0.2/ΔTic*10.9 + 0.2/ΔTic*5.6 + 0.025/ΔTic*7.7 + 0.075/ΔTic*6.1 + (ΔTic-0.5)/ΔTic*2.9

Pav = 2.9 + 2.5 / ΔTic

The power average is 3.4 W for ΔTic = 4.95 s as used for flight tests.

4.1.5 *Model (Rosetta PFM, Rosetta EQM and CNOT lab's)*

The Flight Model Orbiter (FMO) is on board of Rosetta PFM

The Flight Spare Orbiter (FSO) is on board of Rosetta EQM located at ESOC. This model is a carbon copy of the FMO including internal SW.

The Electrical Qualification Model Orbiter (EMO) is on the LPG (CNOT lab). This model is not representative of the FMO in therm of SW version (SW ???) , interfaces and maybe FPGA. A major difference has been observed for the time update during PFM commissioning.

The qualification model Orbiter (QMO) is a model intern to CNOT and is expected to be similar to the FMO.

4.2 Telecommands

Packet category is #12 for all TCs

Sub Type	Database TC Name	Service Request (TC)	Usage / remark
SERVICE 3			
5	ZCN00305	Enable HK Report	
6	ZCN00306	Disable HK Report	Not to be used in nominal obs.
SERVICE 6			
2	ZCN00602	Load Memory by absolute add (patch)	Response: ACK
5	ZCN00605	Memory Dump request by absolute add	Response: ACK + YCN00606
9	ZCN00609	Memory check request by absolute add	Response: ACK + YCN00610
SERVICE 9			
1	ZCN00901	Accept time update	**To be sent only once per scanning sequence, after instrument switch-on**
SERVICE 17			
1	ZCN01701	Connection Test Request	YCN01702
SERVICE 20			
1	ZCN02001	Enable Science Report (RTU)	
2	ZCN02002	Disable Science Report (RTU)	Not to be used in nominal obs.
SERVICE 192			
1	ZCN19201	Mission table Uplink	To be sent only once per scanning sequence, after instrument switch-on and time update Reponse : ACK
2	ZCN19202	Direct TC	For test purposes only
SERVICE 255			
1	ZCN25501	Reset TM buffer	Reset internal Consert FIFO (8kbytes for TM output)

Hereafter is the detail of the Consert TC including the description as extracted from the RSDB from [AD 5] Consert_cmds.edf Revision .

4.2.1 *Mission table*

ZCN19201 / MISSION_TABLE

The mission table defines all the Consert operation and has to be sent in the 60s after instrument trun on

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Version=0			1	1	Process ID = 59							Packet Category = 12			
1	1	1	Source Sequence Count													
2	Packet Length = 25															
3	PUS			Chk	Spare				Packet Service type = 192							
4	Packet Service subtype = 1								PAD Field							
5	Mission Table index =1								PAD Field = 0							
6	Start TIC for Tuning phase MSW (= 65536 Tics = 107 sec)															
7	Start TIC for Tuning phase LSW (= 7706 Tics = 13 sec)															
8	Start TIC for Soundings MSW (= 0 Tics = 0 sec)															
9	Start TIC for Soundings LSW (= 48218 Tics = 79 sec)															
10	Time step in TIC (= 3052 Tics = 5 sec)															
11	Total number of soundings (= 1000)															
12	Clock Initial Frequency Setting (= 127) + Mode Byte Setting (= 0)															
13	Minimum (= 0) + Maximum (= 31) Attenuation															
14	NBL AGC Level (=180) + NBL Zero Level (=120)															
15	Packet Error Control (Not tested by Consert)															

Parameter	*Structure*	
PCNDA011	1 Bytes	TAB_INDEX : mission table index
PCNDA012	1 Bytes	PAD : Used by Consert Lander
PCNGA020	4 Bytes	TAB_TUNETIC B3 to B0 (MSB to lsb) Start of tuning
PCNGA030	4 Bytes	TAB_STARTTIC B3 to B0 (MSB to lsb) Start of Sounding
PCNGA040	2 Bytes	TAB_DELTATIC B1 ; B0 (MSB ; lsb) Time step in TIC
PCNGA050	2 Bytes	TAB_NBSOUND B1; B0 : Total number of soundings
PCNDA061	1 Byte	TAB_INITFREQ : clock initial frequency setting
PCNDA062	1 Byte	TAB_MODE : mode Byte setting
PCNDA071	1 Byte	TAB_MINATT : minimum GCW (attenuation)
PCNDA072	1 Byte	TAB_MAXATT : maximum GCW (attenuation)
PCNDA081	1 Byte	TAB_NBL_LEVEL : level to be reached during NBL AGC
PCNDA082	1 Byte	TAB_NBL_ZERO : level to be detected during NBL zero detection

Mode Byte bit pattern definition:
Bit 0 (lsb) = DataSource 0 = FPGA 1 = Simulated data
Bit 1 to Bit 7 : not used

```
Action: ZCN19201 "Mission Table Update"
Action_type: COMMAND
Action_parameters: \
   PCNDA011 \                  # Mission_Table_Index
   PCNDA012 \                  # Pad_used_by_Consert_La
   PCNGA020 \                  # Start_TIC_for_Tuning_Pha
   PCNGA030 \                  # Start_TIC_for_Soundings
   PCNGA040 \                  # Time_Step_in_TIC
   PCNGA050 \                  # Total_Number_of_Sounding
   PCNDA061 \                  # Clock_Initial_Frequency
   PCNDA062 \                  # Mode_Setting
   PCNDA071 \                  # Minimum_GCW_Attenuation
   PCNDA072 \                  # Maximum_GCW_Attenuation
   PCNDA081 \                  # TAB_NBL_LEVEL
   PCNDA082                    # TAB_NBL_ZERO
```

4.2.2 *Direct Telecommand*

ZCN19202 / DIRECT_TC

The direct TC modifies the Consert parameters. Only the modification of the OCXO DAC can be used in flight while the other parameters correspond in ground test.

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="3">Version=0</td><td>1</td><td>1</td><td colspan="7">Process ID = 59</td><td colspan="4">Packet Category = 12</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td colspan="14">Source Sequence Count</td></tr>
<tr><td>2</td><td colspan="16">Packet Length = 7</td></tr>
<tr><td>3</td><td colspan="3">PUS</td><td>Chk</td><td colspan="4">Spare</td><td colspan="8">Packet Service type = 192</td></tr>
<tr><td>4</td><td colspan="8">Packet Service subtype = 2</td><td colspan="8">PAD Field</td></tr>
<tr><td>5</td><td colspan="8">DIR_COMMAND</td><td colspan="8">DIR_PARAM</td></tr>
<tr><td>6</td><td colspan="16">Packet Error Control (Not tested by Consert)</td></tr>
</table>

Parameter	*Structure*	
PCNDB011	1 Byte	DIR_COMMAND : see note 4
PCNDB012	1 Byte	DIR_PARAM : see note 4

```
Action: ZCN19202 "Direct TC"
Action_type: COMMAND
Action_parameters: \
    PCNDB011 \                  # Command
    PCNDB012                    # Parameter
```

DIR COMMAND	DIR PARAM	Action	Remarks
5	x	Set clock DAC to x	
6	0	CLEAR TXPON	
6	1	SET TXPON	
7	0	CLEAR RXPON	
7	1	SET RXPON	
8	0	CLEAR TRCOM	
8	1	SET TRCOM	
9	0	CLEAR TUNING COM	
9	1	SET TUNING COM	
A	0	CLEAR TRPON	
A	1	SET TRPON	
B	0	SWITCHSEQ OFF	MESCOM is OFF
B	1	SWITCHSEQ ON	FPGA is in reset state all time, MESCOM is ON
E	x	set Gain (GCW) to X	
F	0	Set_BYPASS OFF (measurement)	
F	1	Set_BYPASS ON (Tuning)	
10	n (0 to 2)	Lander Only	

4.2.3 *Load memory (Patch)*

ZCN00602 / CON_MEMO_PATCH

A Consert patch adress one memory block. This block can not exceed XXX word length.

	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Version=0			1	1	Process ID = 59							Packet Category = 12			
1	1	1	Source Sequence Count													
2	Packet Length = 13+2n															
3	PUS			Chk	Spare				Packet Service type = 6							
4	Packet Service subtype = 2								PAD Field							
5	Consert Memory ID = 60 (dec)								**Number of Memory Blocks = 1**							
6	Start address MSB = 0001															
7	Start address lsb															
8	Number of word to be patched (n)															
9	First word to be patched															
	…															
8+n	Last word to be patched															
9+n	Packet Error Control (Not tested by Consert)															

Parameter	*Structure*	
PCNG0600 Memory_ID	1 Byte	**Consert Memory ID = 60 (dec) / 3C (hex)**
PCNG0601 number of blocks	1 Byte	number memory of blocks **: Always 1 for Consert**
PCNG0610 Start Address	4 Bytes	MSB to lsb , the first word is always 0001 (TBC & justification)
PCNG0620 Block length = n	2 Bytes	MSB lsb, length in 16 bit words = n
PCNG0630 Data	2n Bytes	Data to be written in memory

```
Action: ZCN00602 "Load Memory"
Action_type: COMMAND
Action_parameters: \
    PCNG0600 \                  # Memory_block
    PCNG0601 \                  # N
    PCNG0610 \                  # MemStart
    PCNG0620 \                  # MemLength
    PCNG0630                    # MemData
```

4.2.4 *Dump request*

ZCN00605 / CON_MEMO_DUMP_RQ

A Consert dump request adresses one memory block. This block can not exceed 512 (dec) word length.

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="3">Version=0</td><td>1</td><td>1</td><td colspan="7">Process ID = 59</td><td colspan="4">Packet Category = 12</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td colspan="14">Source Sequence Count</td></tr>
<tr><td>2</td><td colspan="16">Packet Length = 13</td></tr>
<tr><td>3</td><td colspan="3">PUS</td><td>Chk</td><td colspan="4">Spare</td><td colspan="8">Packet Service type = 6</td></tr>
<tr><td>4</td><td colspan="8">Packet Service subtype = 5</td><td colspan="8">PAD Field</td></tr>
<tr><td>5</td><td colspan="8">Consert Memory ID = 60 (dec)</td><td colspan="8">Number of Memory Blocks = 1</td></tr>
<tr><td>6</td><td colspan="16">Start address MSB = 0001</td></tr>
<tr><td>7</td><td colspan="16">Start address lsb</td></tr>
<tr><td>8</td><td colspan="16">Number of word to be patched (n)</td></tr>
<tr><td>9</td><td colspan="16">Packet Error Control (Not tested by Consert)</td></tr>
</table>

Parameter	*Structure*	
PCNG0600 Memory_ID	1 Byte	**Consert Memory ID = 60 (dec) / 3C (hex)**
PCNG0601 number of blocks	1 Byte	number memory of blocks **: Always 1 for Consert**
PCNG0610 Start Address	4 Bytes	MSB to lsb , the first word is always 0001 (TBC & justification)
PCNG0620 Block length = n	2 Bytes	MSB lsb, length in 16 bit words = n

```
1BBC C000 000D 1106 0500 3C01 0000 500F 0010 3F2B
          Leng Type Subt bloc  address  size checksum
```

```
Action: ZCN00605 "Dump Memory"
Action_type: COMMAND
Action_parameters: \
   PCNG0600 \                 # Memory_block
   PCNG0601 \                 # N
   PCNG0610 \                 # MemStart
   PCNG0620                   # MemLength
```

4.2.5 *Memory check request*

ZCN00609 / CON_MEMO_CHECK_RQ

A Consert check memory calculates the CRC of the adrresed memory block. The length of this memory block is not limited.

	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Version=0			1	1	Process ID = 59							Packet Category = 12			
1	1	1	Source Sequence Count													
2	Packet Length = 13															
3	PUS			Chk	Spare				Packet Service type = 6							
4	Packet Service subtype = 9								PAD Field							
5	Consert Memory ID = 60 (dec)								Number of Memory Blocks = 1							
6	Start address MSB = 0001															
7	Start address lsb															
8	Number of word to be patched (n)															
9	Packet Error Control (Not tested by Consert)															

Parameter	*Structure*	
Data field Header	4 Bytes	as per EID A
PCNG0600 Memory_ID	1 Byte	**Consert Memory ID = 60 (dec) / 3C (hex)**
PCNG0601 number of blocks	1 Byte	number memory of blocks **: Always 1 for Consert**
PCNG0610 Start Address	4 Bytes	MSB to lsb , the first word is always 0001 (TBC & justification)
PCNG0620 Block length = n	2 Bytes	MSB lsb, length in 16 bit words = n

```
Ne pas utiliser 3FFF on ner sait pas se qure l'on check.

1BBC C000 000D 1106 0900 3C01 0000 0000 3FFF 3FD3
          Leng Type Subt bloc  address  size checksum


   Action: ZCN00609 "Check Memory"
   Action_type: COMMAND
   Action_parameters: \
      PCNG0600 \                 # Memory_block
      PCNG0601 \                 # N
      PCNG0610 \                 # MemStart
      PCNG0620                   # MemLength
```

4.2.6 *Test response – Ping*

ZCN01701 / PING_TEST

	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Version=0			1	1	Process ID = 59							Packet Category = 12			
1	1	1	Source Sequence Count													
2	Packet Length = 5															
3	PUS			Chk	Spare				Packet Service type = **17**							
4	Packet Service subtype = **1**								PAD Field							
5	**Packet Error Control** (Not tested by Consert)															

```
Action: ZCN01701 "Connection Test Request"
Action_type: COMMAND
```

On board the connectivity test has to be done using the command ZDMD0012.

4.2.7 *Other Consert'TC*

The other TC's from the RSDB [AD 5]

```
Action: ZCN00305 "Enable HK Report"
Action_type: COMMAND
Action_parameters: \
   PCND0311 [FIXED] \           # HK_PAD
   PCND0312                     # HK_SID

Action: ZCN00306 "Disable HK Report"
Action_type: COMMAND
Action_parameters: \
   PCND0311 [FIXED] \           # HK_PAD
   PCND0312                     # HK_SID

Action: ZCN00901 "Accept Time Update"
Action_type: COMMAND
Action_parameters: \
   PCNG0901                     # SCET

Action: ZCN02001 "Enable Science Report"
Action_type: COMMAND
Action_parameters: \
   PCND2011 [FIXED] \           # SC_PAD
   PCND2012                     # SC_PID

Action: ZCN02002 "Disable Science Report"
Action_type: COMMAND
Action_parameters: \
   PCND2011 [FIXED] \           # SC_PAD
   PCND2012                     # SC_PID

Action: ZCN25501 "Reset TM Output Buffer"
Action_type: COMMAND
```

4.2.8 *Platform'TC's relevant to Consert*

```
Action: ZDM10163 "Add APID to Packets Store Definition"
Action_type: COMMAND
Action_parameters: \
   FDM10142 \                   # Store_File_Name
   FDM10175                     # Application_Process_ID

Action: ZDM10164 "Remove APID from Packets Store Def"
Action_type: COMMAND
Action_parameters: \
   FDM10142 \                   # Store_File_Name
   FDM10175                     # Application_Process_ID

Action: ZDMX0041 "Define Nom/Red branch for CONSERT"
Action_type: COMMAND
Action_parameters: \
   FDM30029                     # Nom_Red_Branch

Action: ZDMX0052 "Enable/Disable TM polling from CONSERT"
Action_type: COMMAND
Action_parameters: \
   FDM30030                     # TM_Polling

Action: ZDMX0063 "Enable/Disable TC sending to CONSERT"
Action_type: COMMAND
Action_parameters: \
   FDM30031                     # TC_Sending

Action: ZDMX0215 "Send Time to CONSERT 59"
Action_type: COMMAND
Action_parameters: \
   FDMX0015                     # Update_Period_for_CONSER

Action: ZDMX0226 "Stop Time Update to CONSERT 59"
Action_type: COMMAND

Action: ZDMD0012 "Request Connection Test to CONSERT 59"
Action_type: COMMAND
```

```
Action: ZPWMA111 "CONSERT PS 1, PL-LCL 52A ON-A"
Action_type: COMMAND
Action_parameters: \
   FPWM0100 [FIXED] \          # PAD
   FPWM0101 [FIXED] \          # N
   FPWM0200 [FIXED] \          # R
   FPWM0208 [FIXED] \          # Destination_PDU_P_L_A
   FPWM0201 [FIXED] \          # Delayed_ML
   FPWM0202 [FIXED] \          # Peripheral_Address
   FPWM0203 [FIXED] \          # ML_Address
   FPWM0212 [FIXED] \          # MLC_Data_PDU_All_
   FPWM0300 [FIXED] \          # R
   FPWM0301 [FIXED] \          # Destination_PAD_
   FPWM0302 [FIXED] \          # Delayed_ML
   FPWM0303 [FIXED] \          # Peripheral_Address
   FPWM0307 [FIXED] \          # ML_Address_PDU_P_L_A
   FPWMA111 [FIXED]            # CONSERT_PS_1

Action: ZPWMA112 "CONSERT PS 1, PL-LCL 52A OFF-A"
Action_type: COMMAND
Action_parameters: \
   FPWM0100 [FIXED] \          # PAD
   FPWM0101 [FIXED] \          # N
   FPWM0200 [FIXED] \          # R
   FPWM0208 [FIXED] \          # Destination_PDU_P_L_A
   FPWM0201 [FIXED] \          # Delayed_ML
   FPWM0202 [FIXED] \          # Peripheral_Address
   FPWM0203 [FIXED] \          # ML_Address
   FPWM0212 [FIXED] \          # MLC_Data_PDU_All_
   FPWM0300 [FIXED] \          # R
   FPWM0301 [FIXED] \          # Destination_PAD_
   FPWM0302 [FIXED] \          # Delayed_ML
   FPWM0303 [FIXED] \          # Peripheral_Address
   FPWM0307 [FIXED] \          # ML_Address_PDU_P_L_A
   FPWMA112 [FIXED]            # CONSERT_PS_1
```

4.3 OBCP

The Consert OBCP's are defined in [AD 4] Consert OBCP user requirement - RO-ESC-RS-5630_CONSERT_OBCP_URD.

4.3.1 *Power-On OBCP*

OBCP Title: PL_OBCP_5_CN.1
RSDB Name : KCNR8021

Objective :

- Turn Consert ON,
- Enable HK and SC reporting
- Time Update

Remark:

- Stop Time Update at the end of the procedure
- Send Mission Table has been remove from this OBCP

OBCP Call:

```
Action: ZSKA8021 "START CONSERT ON OBCP"
Action_type: COMMAND
Action_parameters: \
   FSK08021 [FIXED] \           # OBCP_ID_CONSERT_On_
   FSK02001 [FIXED] \           # OBCP_Offset_0_within_TM
   FSK02005 [FIXED] \           # OBCP_Length_of_TC_parame
   FSKD1000 \                   # Used_LCL_nominal_redu
   FSKD1001 [FIXED]             # SPARE
```

Main procedure

Step P1: Verify pre-conditions

KCNR8021.D010

Step 010 IF CONSERT LCL A not OFF THEN
Step 020 event 6
Step 030 abort OBCP
END IF
Step 040 IF CONSERT LCL B not OFF THEN
Step 050 event 7
Step 060 abort OBCP
END IF

Note: Monitoring of CONSERT temperature sensors is performed by TCS.Check / surveillance of available S/C power is considered a system task and shall not be part of each P/L OBCP.

Step 070 deleted

Step P2: Switch-on LCL

KCNR8021.D020

Step 005 Wait 5 sec *(to ensure that enough time elapsed after last switch-off)*
Step 010 Switch CONSERT LCL PAR1 ON using I/O A
(PAR1 is an invocation parameter)
Step 015 Switch CONSERT LCL PAR1 ON using I/O B
Step 020 Wait 8 sec *(TM update cycle)*
Step 030 IF CONSERT LCL PAR1 not ON THEN
Step 040 Switch CONSERT LCL PAR1 ON using I/O A
Step 045 Switch CONSERT LCL PAR1 ON using I/O B
Step 050 Wait 8 sec *(TM update cycle)*
Step 060 IF CONSERT LCL PAR1 not ON THEN
Step 070 event 8
END IF
END IF
Step 090 IF CONSERT LCL PAR1 current < 0.08 A **OR >** 0.600 A THEN
(demand at switch-on is 150 mA, after 20 sec it falls to 95 mA;
at tuning start it rises to 201 mA: inrush current is appr. 450 or 600 mA)
Step 100 event 9
Step 110 switch CONSERT LCL PAR1 OFF via I/O A
Step 120 switch CONSERT LCL PAR1 OFF via I/O B
Step 130 Wait 8 sec *(TM update cycle)*
Step 140 IF CONSERT LCL PAR1 not OFF THEN
Step 150 switch CONSERT LCL PAR1 OFF via I/O A
Step 160 switch CONSERT LCL PAR1 OFF via I/O B
Step 170 Wait 8 sec
Step 180 IF CONSERT LCL PAR1 not OFF THEN
Step 190 event 10
END IF
END IF
Step 200 abort OBCP
END IF
Step 210 deleted

Note: *At this position it could be possible to include commands which start OCN on the Lander (to cope with 10 sec. synch. Req. between OCN-O and OCN-SSP); e.g. "start transponder"-TC). Currently control via mission timeline is preferred.*

Step P3: Enable CONSERT TM acquisition and commanding

KCNR8021.D030

Step 010 not used

Step 020 Enable TM polling from CONSERT
Step 030-040 not used
Step 050 Enable TC sending to CONSERT
Step 060 deleted

Step P4: Synchronise CONSERT with SCET

KCNR8021.D040

Step 010 Wait time 12 sec

Note: *wait time increased from 7 to 12 seconds after in-flight anomaly*

Note: *According to CONSERT User Manual (Chap. 4.2, p26) the time update shall be initiated only after DMS has received an event report notifying the correct H/W initialization for CONSERT. As events are not defined to be of type (5,4) this cannot be done on-board. As well, bench test and UFT procedures according to the User Manual (p30/31) do not respect this requirement, but instead define a waiting time of 30 sec only. According to a private communication of J.P. Goutail (last iteration at 28.6.2001) at this step 010 of the ON_OBCP a waiting time of 7 sec is acceptable. This time sums up with the LCL_ON waiting time of 8 sec (step P2.020) to a total of at least 15 sec which is in line with the allowed max. time between power-on and time up-date and in line with instrument performance.*

Step 020 Request DMS to send time packet to CONSERT with acceptance and execution acknowledgments

Note: *TC (9,2), no update necessary, i.e. update period is indefinite if possible; updateonly once per switch-on; user CONSERT, ZG00902 with parameter PID=59,causing DMS to send the command ZCN00901 to CONSERT. If possible at the end of the ON_OBCP the stop time update to OCN TC shall be sent as OCN does not need time updates.*

Note: *TC(9,2) acc+exe acks requested to get more information on timing; added after in-flight anomaly*

Step 030 Wait time 20 seconds.

Note: this wait time guarantees that the time synchronisation pulse has been received by CONSERT before starting housekeeping generation.

Step 040 Enable CONSERT HK report generation

Note: *defined by service (3,5); TC name is ZCN00305*

Step 050 Enable CONSERT Science packet generation

Note: *defined by service (20,1); Enable Science Report via RTU; TC name is ZCN02001*

Step 060 deleted

Step P5: Request Connection Test

KCNR8021.D050

Step 010 Send TC “Request connection test” with execution acknowledge
Step 020 IF execution not successful THEN
Step 030 event 11
Step 040 END IF

Note: *Verify Experiment Status (First HK Packet) is not necessary to be performed for CONSERT.*

Step P6: Stop Time Update

All steps related to “Send Mission Table to Consert” have been removed.

Note:*On p36, chap. 5.2 of Experiment User Man. CONSERT requires that the mission table CON_MISSION_TABLE has to be sent as a* ***predefined*** *TC. However, the final TC will be defined just prior to the actual measurements (i.e. some weeks in advance to comet or asteroid measurements). This is in contradiction with the fact that the OBCP will be defined prior to launch. Solution can be to upload to the S/C a dedicated Science_ON_OBCP prior to (each) measurement. If possible, alternatively the TC could be placed in the data pool and called up from there by the OBCP. In this case only*

the TC needs to be uploaded to S/C and not a complete new OBCP when the TC needs to be changed! This version of the OBCP does not include the mission table TC!
Mission table TC shall be sent separately between 1 and 4 min. after the ON_OBCP has started. The TC is the same as the one used in the CONSERT IST.

KCNR8021.D060
Step 10-60 deleted
Step 70 (moved to Step 85)
Step 80 Send stop time update TC (9,3)
Note: *CONSERT does not need periodic time update. If possible to stop time update as long as a unit is powered on than this shall be done here.*
Step 85 event 54 (end OBCP)
Step 90 end OBCP

4.3.2 *Power-Off OBCP*

The Consert OBCP's are defined in [AD 4] Consert OBCP user requirement - RO-ESC-RS-5630_CONSERT_OBCP_URD.

OBCP Title: PL_OBCP_5_CN.2
RSDB Name : KCNR8022

Objective :
- Turn Consert OFF,
- Do a check memory 20s before turn off

Check Memory as describe in §2.3.2 p26 :
- address of the memory segment checked 00 01 0C 21
- the length 15 42
- The retrun value 27 DC

OBCP Call:

```
Action: ZSKA8022 "START CONSERT OFF OBCP"
Action_type: COMMAND
Action_parameters: \
   FSK08022 [FIXED] \           # OBCP_ID_CONSERT_Off_
   FSK02001 [FIXED] \           # OBCP_Offset_0_within_TM
   FSK02004 [FIXED]             # OBCP_Length_of_TC_parame
```

Main procedure

Step P0: Check CONSERT Memory

KCNR8022.D001

Step 010 Send TC Check Memory
Step 020 Wait time 20 sec

Step P1: Disable CONSERT TM acquisition / commanding

KCNR8022.D010

Step 004 Disable CONSERT HK report generation
Step 008 Disable CONSERT science packet generation
Step 010 disable TM polling from CONSERT
Step 020 not used
Step 030 disable TC sending to CONSERT
Step 040 deleted

Note:*The command “*send Stop CONSERT Time Update TC (9,3)” *is not necessary here if it has been already implemented at the end of the ON_OBCP .*

Step 044 (moved to Step 004)
Step 045 (moved to Step 008)
Step 050 deleted

Step P2: Switch OFF CONSERT LCL

KCNR8022.D020

Step 010 send TC CONSERT LCL A OFF via I/O A
Step 020 send TC CONSERT LCL A OFF via I/O B
Step 030 send TC CONSERT LCL B OFF via I/O A
Step 040 send TC CONSERT LCL B OFF via I/O B
Step 050 wait time 8 sec
Step 060 IF CONSERT LCL A not OFF THEN
Step 070 send TC CONSERT LCL A OFF via I/O A
Step 080 send TC CONSERT LCL A OFF via I/O B
Step 090 wait time 8 sec
Step 100 IF CONSERT LCL A not OFF THEN
Step 110 event 1
END IF
END IF
Step 120 IF CONSERT LCL B not OFF THEN
Step 130 send TC CONSERT LCL B OFF via I/O A
Step 140 send TC CONSERT LCL B OFF via I/O B
Step 150 wait time 8 sec
Step 160 IF CONSERT LCL B not OFF THEN
Step 170 event 2
END IF
END IF
Step 180 event 51
Step 190 end OBCP

4.4 Telemetry

There are three different times for CONSERT:

- Rebuilt Time on ground : SCET Time (in SFDU Header)
- On-Board Set Time : OBT time
- CONSERT own Time: counter in TIC
  sets to zero when Consert is turned on and resets to zero after tuning phase,
  allows the precise synchronization between CONSERT Orbiter and CON. Lander

All TMs were dated with OBT time (standard TM format). HK and SCI TMs were dated with TIC.

Process Id	**Packet cat**	**APID dec**	**Packet Service Type dec**	**Packet Service SubType dec**	Database TM Name	
59	1	945	1	1	YCNST001	Acceptance Acknowledge - Success
59	1	945	1	2	YCNST002 to YCNST007	Acceptance Acknowledge - Failure
59	4	948	3	25	YCN00325	Housekeeping reports from Consert
59	7	951	5	1	YCN0A501 to YCN0D501	Normal progress report
59	7	951	5	2	YCN00502	Anomalous Event report
59	7	951	6	10	YCN00610	Memory Check by absolute add
59	7	951	17	2	YCN01702	Connection Test Report
59	9	953	6	6	YCN00606	Memory Dump from Consert
59	12	956	20	3	YCN02003	Science Reporting from Consert

4.4.1 *Acknowledgment 59, 1*

YCNST001 / CON_ACC_ACK_SUCCESS

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="3">Version=0</td><td>0</td><td>1</td><td colspan="7">Process ID = 59</td><td colspan="4">Packet Category = 1</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td colspan="14">Source Sequence Count</td></tr>
<tr><td>2</td><td colspan="16">Packet Length = 13</td></tr>
<tr><td>3</td><td colspan="16">OBT Time (Seconds)</td></tr>
<tr><td>4</td><td colspan="16">OBT Time (seconds)</td></tr>
<tr><td>5</td><td colspan="16">OBT Time (fractional seconds)</td></tr>
<tr><td>6</td><td colspan="3">PUS</td><td>Chk</td><td colspan="4">Spare</td><td colspan="8">Packet Service type = 1</td></tr>
<tr><td>7</td><td colspan="8">Packet Service subtype = 1</td><td colspan="8">PAD Field</td></tr>
<tr><td>8</td><td colspan="16">TC Packet ID</td></tr>
<tr><td>9</td><td colspan="16">TC Sequence Control</td></tr>
</table>

Parameter	*Structure*	
NCNAST01 TC packet ID	2 Bytes	MSB, lsb
NCNAST02 TC Seq. control	2 Bytes	MSB , lsb

YCNST002 to YCNST009/ CON_ACK_FAILURE

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Version=0			0	1	Process ID = 59							Packet Category = 1			
1	1	1	Source Sequence Count													
2	Packet Length = 21															
3	OBT Time (Seconds)															
4	OBT Time (seconds)															
5	OBT Time (fractional seconds)															
6	PUS			Chk	Spare				Packet Service type = 1							
7	Packet Service subtype = 2								PAD Field = 0							
8	TC Packet ID															
9	TC Sequence Control															
10	Failure Code															
11	Parameter 1								Parameter 2							
12	Parameter 3															
13	Parameter 4															

Parameter	*Structure*	
NCNAST01 TC packet ID	2 Bytes	MSB, lsb
NCNAST02 TC Seq. control	2 Bytes	MSB , lsb
NCNAST03 Failure Code	2 Bytes	MSB , lsb , see note 1

YCNST001	AcceptSuccess	
YCNST002	IncompletePacket	Acceptance Failure Report: Failure Code 1. Incomplete Packet within time-out
YCNST003	ADC Reading Timeout	Acceptance Failure Report: Failure Code 7.
YCNST004	Incorrect APID	Acceptance Failure Report: Failure Code 3. Incorrect APID
YCNST005	InvalidCmdCode	Acceptance Failure Report: Failure Code 4. Invalid Command Code.
YCNST006	PbExecTime	Acceptance Failure Report: Failure Code 5. Command can not be executed at this time (2 missions Table)
YCNST007	DataFieldInconsistent	Acceptance Failure Report: Failure Code 6. Data Field Inconsistent (Unknown TC_DIRECT)
YCNST008	WRONG CRC	Acceptance Failure Report: Failure Code 2. WRONG CRC
YCNST009	Unsucces Time Update	Acceptance Failure Report: Failure Code 8. Time out during Time Update process

Failure code and parameter values:

Failure Code	Failure name	Failure Reason	Param. 1 Byte	Param. 2 Byte	Par. 3 2 Bytes	Par 4 2 Byte
1	ERR_TC_TIMEOUT	TC packet not complete after 2 seconds	TC packet Type	TC packet SubType	Nbr of expect Bytes (from TC Hd)	Nb of Bytes in 2 s
2	ERR_TYPE_WRONG CRC	Calculated CRC is not egal to CRC at end of TC packet	TC packet Type	TC packet SubType	CRC as read from packet datafield	CRC as calculated using TC data
3	ERR_TYPE_WRONGAPID	TC packet has wrong APID (ID # 59 or Cat #12)	TC packet Type	TC packet SubType	0	0
4	ERR_TC_TYPE_UNKNOWN	TC packet has unknown Type or Subtype	TC packet Type	TC packet SubType	0	0
5	ERR_TWO_MISS_TAB	TC with mission table received and other table already received	TC packet Type	TC packet SubType	0	0
6	ERR_TC_DIRECT_UNKNOWN	Direct TC of unknown type received	TC packet Type	TC packet SubType	Direct TC value	0

NCNAST01	TMGS	N	Global PID
NCNAST02	TMGS	N	Sequence Control
NCNAST03	TMGS	N	FailureCode
NCNAST04	TMGS	N	Packet Service Info
NCNAST10	TMGS	N	Length in TC header
NCNAST11	TMGS	N	Nb of received bytes
NCNAST12	TMGS	N	FC41007_Par3
NCNAST13	TMGS	N	FC41007_Par4
NCNAST14	TMGS	N	FC4_Par3
NCNAST15	TMGS	N	FC4_Par4
NCNAST20	TMGS	N	InconsistentPar

4.4.2 *Housekeeping 59, 4*

Every time the instrument is switched-on, and if the Housekeeping Report generation is not Disabled (via Service #3, sub type # 2), the instrument will generate a housekeeping report on a regular basis as defined in the mission table.
The first HK report is sent one minute (60 seconds) after switch-on and the HK periodicity is15s before reception of the mission table

YCN00325/ CON_HK_REP

	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Version=0			0	1	Process ID = 59							Packet Category = 4			
1	1	1	Source Sequence Count													
2	Packet Length = 21															
3	OBT Time (Seconds)															
4	OBT Time (seconds)															
5	OBT Time (fractional seconds)															
6	PUS			Chk	Spare				Packet Service type = 3							
7	Packet Service subtype = 25								PAD Field = 0							
8	PAD Field = 0								Structure ID = 1							
9	On-Board Time in TICs MSW (65536 Tics = 107 sec)															
10	On-Board Time in TICs LSW (7706 Tics = 13 sec)															
11	Init OK	Mission Table OK	Tuning OK	Sounding Started	Sounding Finished	HK Rep Enab	SC Rep Enab	LOBT Received	OCXO Temperature							
12	Digital Board Temperature								NBL Level Acquisition							
13	TMIX Level Acquisition								OCXO Frequency Setting							

```
0BB4 C00D 0015 0000 00D4 A000 4003 1900 0001 0001 C504 C7 AB AD 80
12 50
          Len        Time          Type            OBT     St   Temp
```

Parameter	*Structure*	
NCNA0320	4 Bytes	HK_TIC : packet TIC Value
NCNA0330	2 Bytes	Status Byte + OCXO Tmp
NCNA0340	2 Bytes	DIGI Board Tmp + NBL Level Acq
NCNA0350	2 Bytes	TMIX Level Acq + OCXO Freq Setting
HK_PARAMETERS		
NCND0339	1 Byte	HK_TEMP_OCXO : OCXO Temperature
NCND0341	1 Byte	HK_TEMP_DIGI : digital board temperature
NCND0342	1 Byte	HK_ADC_NBL : NBL level acquisition
NCND0351	1 Byte	HK_ADC_TMIX : TMIX level acquisition
NCND0352	1 Byte	HK_OCXO_SETTING : OCXO frequency setting
HK_STATUS : Instrument Status Byte		
NCND0331	1 Bit	STAT_BIT_INIT_OK (Init Performed)
NCND0332	1 Bit	STAT_BIT_MISS_TAB_OK (Mission Table Received)
NCND0333	1 Bit	STAT_BIT_TUNING_OK (Tuning performed)
NCND0334	1 Bit	STAT_BIT_SOUNDING (Sounding started)
NCND0335	1 Bit	STAT_BIT_END (Souding Finished)
NCND0336	1 Bit	STAT_BIT_HKREP (HK reporting enabled)
NCND0337	1 Bit	STAT_BIT_SCREP (Sceince reporting enabled)
NCND0338	1 Bit	STAT_BIT_LOBT (Time received)

4.4.3 *Progress report 59, 7*

An event packet is generated at achievement of each major step in the mode transitions:

- Hardware init performed
- Instrument Tuned
- Sounding mode started
- Sounding mode finished

In flight, the first progress report (hardware init) is send before time-update and miss-dated. The date reconstructed by the groind segment is generally delayed of a few hours and this TM is definitively out of the normal data flow.

Anomaly report event are only anomaly reports, no action has to be taken by S/C or ground on reception of these reports

YCN0A501 to YCN0D501/ CON_PROGRESS_REP

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="3">Version=0</td><td>0</td><td>1</td><td colspan="7">Process ID = 59</td><td colspan="4">Packet Category = 7</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td colspan="14">Source Sequence Count</td></tr>
<tr><td>2</td><td colspan="16">Packet Length = 17</td></tr>
<tr><td>3</td><td colspan="16">OBT Time (Seconds)</td></tr>
<tr><td>4</td><td colspan="16">OBT Time (seconds)</td></tr>
<tr><td>5</td><td colspan="16">OBT Time (fractional seconds)</td></tr>
<tr><td>6</td><td colspan="3">PUS</td><td>Chk</td><td colspan="4">Spare</td><td colspan="8">Packet Service type = 5</td></tr>
<tr><td>7</td><td colspan="8">Packet Service subtype = 1</td><td colspan="8">PAD Field</td></tr>
<tr><td>8</td><td colspan="16">Event ID (41002 = Tuning OK, 41003 = Sounding started, 41004 = Sounding finished)</td></tr>
<tr><td>9</td><td colspan="8">Clock Frequency (or 0)</td><td colspan="8">Intercatille (or 0)</td></tr>
<tr><td>10</td><td colspan="8">Tuning phase GCW</td><td colspan="8">Level GCW</td></tr>
<tr><td>11</td><td colspan="8">Level Zero</td><td colspan="8">PAD Field (= 0)</td></tr>
</table>

```
0BB7 C005 0011 0000 00D4 A000 4005 0100 A02B DC08 0081 8100
          Len       Time             Type   EID#
```

YCN00502, YCNA0502 & YCNB0502/ CON_ANO_EVENT

	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Version=0			0	1	Process ID = 59							Packet Category = 7			
1	1	1	Source Sequence Count													
2	Packet Length = 17															
3	OBT Time (Seconds)															
4	OBT Time (seconds)															
5	OBT Time (fractional seconds)															
6	PUS			Chk	Spare				Packet Service type = 5							
7	Packet Service subtype = 2								PAD Field							
8	Event ID (41007 = Timeout AGC, 41008 = Timeout Data, 41020 = Tuning Pb)															
9	Clock Frequency (or 0)								Intercatille (or 0)							
10	Tuning phase GCW								Level GCW							
11	Level Zero								PAD Field (= 0)							

Parameter (TM names)	*Structure*	
NCNA0EID	2 Bytes	Event ID : EID number from 41001 to 41004 (success) Or from 41007 to 41020 (anomalous)
Event ID		
NCNA0505 (YCN0D501)	2 Bytes	Initialized : after completion of hardware init Event ID = 41001
NCNA0510 (YCN0A501)	2 Bytes	Tuning OK : after completion of Tuning phase Evend ID = 41002
NCNA0520 (YCN0B501)	2 Bytes	Sounding Started : at start of sounding phase Evend ID = 41003
NCNA0530 (YCN0C501)	2 Bytes	Sounding Completed : at end of sounding phase Evend ID = 41004
xx (YCN0A502)	2 Bytes	Agc Timeout : FPGA reset due to timeout during AGC phase Evend ID = 41007
xx (YCN0B502)	2 Bytes	Data Timeout : FPGA reset due to timeout during data transfer phase Evend ID = 41008
NCNA0540 (YCN00502)	2 Bytes	No Tuning : Tuning phase algorithm has not converged Evend ID = 41020
Event Parameters		
NCND0511	1 Byte	OCXO_freq at end of tuning phase
NCND0512	1 Byte	tuning_inter : confidence indicator of tuning phase or 1 : good confidence grater : bad S:N ratio
NCND0513	1 Byte	Tuning phase GCW
NCND0514	1 Byte	level GCW : ADC level achieved on NBL signal at end of tuning phase AGC
NCND0515	1 Byte	level_zero : ADC level achieved on NBL signal at end of tuning phase, zero detection

4.4.4 *Memory Check 59, 7*

YCN00610 / CON_MEM_CHECK

	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Version=0			0	1	Process ID = 59							Packet Category = 7			
1	1	1	Source Sequence Count													
2	Packet Length = 19															
3	OBT Time (Seconds)															
4	OBT Time (seconds)															
5	OBT Time (fractional seconds)															
6	PUS			Chk	Spare				Packet Service type = 6							
7	Packet Service subtype = 10								PAD Field							
8	60 (dec) = 3C (hex)								Number of Blocks (=1)							
9	Start address MSW (=0)															
10	Start address LSW															
11	Block Length (in 16 bits words)															
12	CRC16 Value of the Designated Memory Area															

	Field Structure	NCND0600 Memory_ID
NCND0600 Memory_ID	1 Byte	**Always 60 (dec) – 3C (hex) for Consert Memory**
NCND0610 number of blocks	1 Byte	**Always 1 for Consert**
NCNA0610 Start Address	4 Bytes	MSB to lsb , the two first bytes are always 00 (only64k octet mem)
NCNA0620 Block length = n	2 Bytes	MSB lsb, length in 16 bit words = n
YCN00610 CRC	2 Bytes	CRC16 value of the designated memory area

4.4.5 *Ping Test 59, 7*

YCN01702 / CON_TEST_RESP

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="3">Version=0</td><td>0</td><td>1</td><td colspan="7">Process ID = 59</td><td colspan="4">Packet Category = 7</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td colspan="14">Source Sequence Count</td></tr>
<tr><td>2</td><td colspan="16">Packet Length = 9</td></tr>
<tr><td>3</td><td colspan="16">OBT Time (Seconds)</td></tr>
<tr><td>4</td><td colspan="16">OBT Time (seconds)</td></tr>
<tr><td>5</td><td colspan="16">OBT Time (fractional seconds)</td></tr>
<tr><td>6</td><td colspan="3">PUS</td><td>Chk</td><td colspan="4">Spare</td><td colspan="8">Packet Service type = 17</td></tr>
<tr><td>7</td><td colspan="8">Packet Service subtype = 2</td><td colspan="8">PAD Field</td></tr>
</table>

4.4.6 *Memory Dump 59, 9*

YCN00606 / CON_MEM_DUMP

	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Version=0			0	1	Process ID = 59							Packet Category = 9			
1	1	1	Source Sequence Count													
2	Packet Length =															
3	OBT Time (Seconds)															
4	OBT Time (seconds)															
5	OBT Time (fractional seconds)															
6	PUS			Chk	Spare				Packet Service type = 6							
7	Packet Service subtype = 6								PAD Field							
8	60 (dec) = 3C (hex)								Number of Blocks (=1)							
9	Start address MSW (=0)															
10	Start address LSW															
11	Block Length (in 16 bits words)															
12	Dumped Memory															
..																
?																

Parameter	*Structure*	
NCND0600 Memory_ID	1 Byte	**Consert Memory ID = 60 (dec) / 3C (hex)**
NCND0601 number of blocks	1 Byte	number memory of blocks **: Always 1 for Consert**
NCNA0610 Start Address	4 Bytes	MSB to lsb , the two first bytes are always 00 (only 64k octet mem)
NCNA0620 Block length = n	2 Bytes	MSB lsb, length in 16 bit words = n
NCNA0630 Data	2n Bytes	Dumped memory

4.4.7 *Science report 59, 12*

YCN02003/ CON_SCI_REP

While the instrument is in sounding mode and if the Science Report generation is not disabled (Service 20, 2), the instrument generates a Science Report every sonding.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Version=0			0	1	Process ID = 59							Packet Category = 12			
1	1	1	Source Sequence Count													
2	Packet Length = 1041															
3	OBT Time (Seconds)															
4	OBT Time (seconds)															
5	OBT Time (fractional seconds)															
6	PUS			Chk	Spare				Packet Service type = 20							
7	Packet Service subtype = 3								PAD Field							
8	Sounding Start TIC (MSW)															
9	Sounding Start TIC (LSW)															
10	OCXO Temperature								DIGI Board Temperature							
11	Present Sounding Number															
12	Present Gain Control Word								OCXO Frequency							
13	Signal I Channel 0															
14	Signal I Channel 1															
-																
267	Signal I Channel 254															
268	Signal Q Channel 0															
269	Signal Q Channel 1															
-																
522	Signal Q Channel 254															
523	0															

```
0BBC C007 0411 0000 00D4 A000 0014 0300 0000 D69A AAAC ............
          Len       Time           Type      sndstrt    Temp
```

Parameter	*Structure*	
Parameter 1	4 Bytes	SC_TIC B3 to B0: sounding start TIC MSB to lsb
Parameter 2	1 Byte	SC_TEMP_OCXO : OCXO Temperature
Parameter 3	1 Byte	SC_TEMP_DIGI : digital board temperature
Parameter 4	2 Byte	SC_SOUNDING_N B1; B0: sounding nb MSB to lsb
Parameter 5	1 Byte	SC_GCW : Gain control word of this sounding
Parameter 6	1 Byte	SC_OCXO_SETTING : OCXO frequency setting Byte
Parameter 7	510 Bytes	SC_SIGNAL_I (MSB ; lsb) for position 0 to 254
Parameter 8	510 Bytes	SC_SIGNAL_Q (MSB ; lsb) for position 0 to 254
Parameter 9	2 Bytes	Spare bytes

4.5 Telemetry Analysis

4.5.1 *TM Budget*

Experiment phase	Orbiter Data Rate (Kbit/sec)	Typical Duration
Init	1 EVT	60 s
Wait mission table	1 HK / 15 s	60 s
Wait tuning	1 ACK 1 HK / ΔTic(4.95 s)	200 s
Tuning		60 s
Wait Sounding	1 EVT 1 HK / ΔTic(4.95 s)	60 s
Sounding	1 EVT 1 HK / ΔTic (4.95 s) 1 SC / ΔTic (4.95 s)	duration 2 to 20 hours, comet type dependant
End Sounding	1 EVT 1 HK / ΔTic (4.95 s)	Wait for switch-off

Table 10 : Orbiter TM rates

Orbiter:

APID	ACK	HK	EVT	EVT Ping	SCI
TM size (bytes)	17	28	24	18	1048
Number of TM	**1**	**(TO-120)/ΔTic**	**4**	**1**	**NS**
Data Volume (Bytes)	17		98	18	
Data Volumes (Kbytes)	0.02		0.10	0.02	

Table 11 : Orbiter TM budget

ΔTic : time interval between sounding
TO : total operation time from turn on to turn off
NS : number of sounding

4.5.2 *Memory Check before Switch-off*

There is no switch off condition for Consert orbiter and lander. In order to easily check the data integrity, a specific TC is send before turn off and the corresponding TM has to be received.

On the Orbiter: Check memory sent 20 seconds before turn-off. The address of the memory segment checked is Ox00 01 0C 21, the length is Ox 15 42. The return value (checksum) is 27 DC

4.5.3 *CSA*

See §12.4.3CSA parameter

CSA is not relevant for Consert Orbiter operating alone (CSA = ~ -26s).
CSA is not relevant before tuning (CSA = ~ -420 s)
CSA is not relevant when a Time update is happened after tuning (CSA= ~ -420s).

4.5.4 *MDR and CRP*

See annex

5 LANDER

5.1 Experiment configuration

5.1.1 *Physical*

The consert experiment on board of the lander consists in an electyronics box, an antenna to be deployed during landing and a Harness.

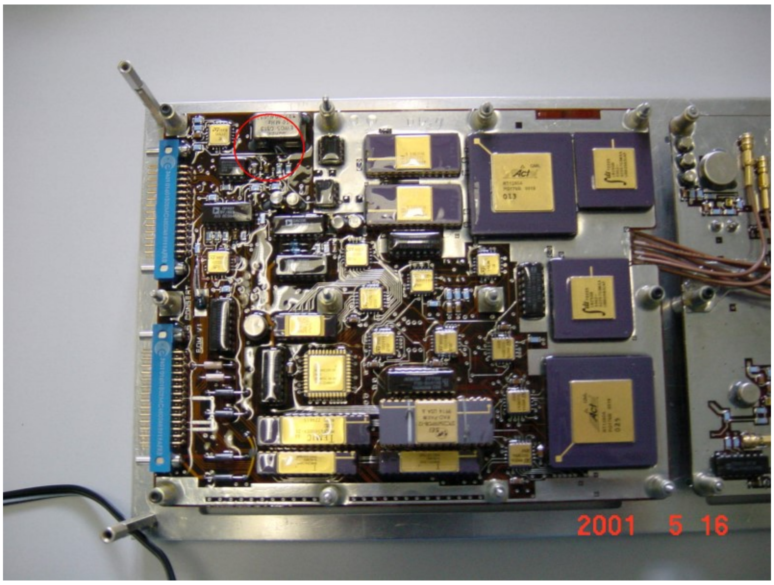


Figure 12 : Thermistor position inside OCN Ebox (OCXO Temperature from consert TM HK)

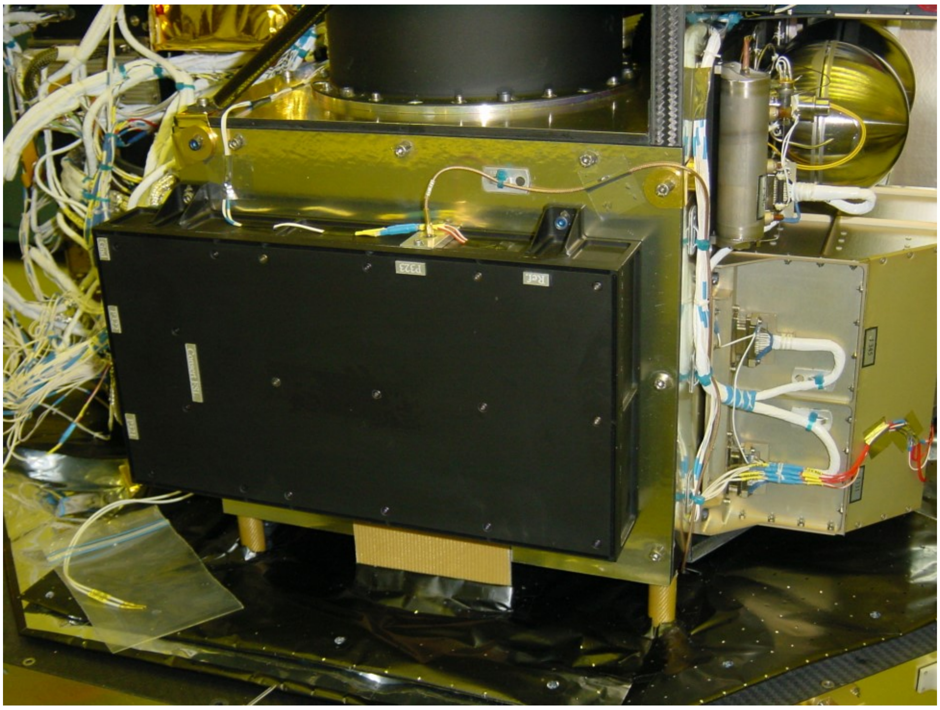


Figure 13 : Thermistor on the consert Ebox (Temperature from Philae TM HK)

5.1.2 *Electrical*

TBAdded : Specificity of the lander CONSERT databus

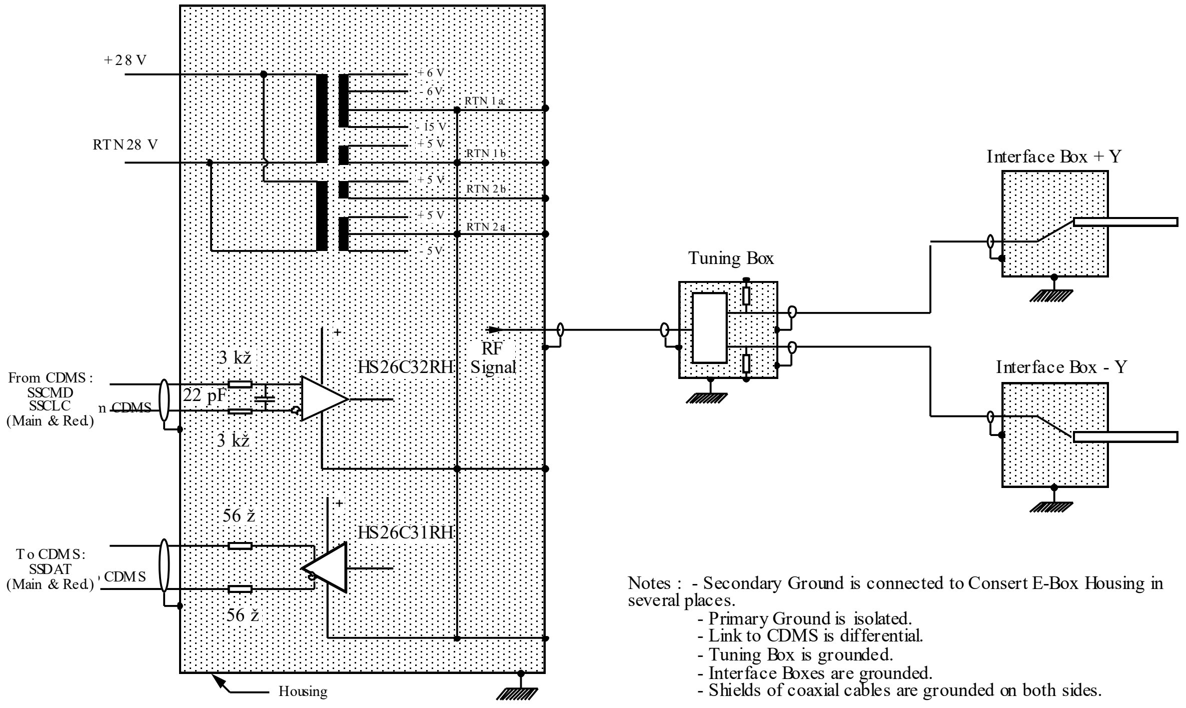


Figure 14 : Lander Consert Grounding Diagram

5.1.3 *SW*

TBW

5.1.4 *Power Budget*

Experiment phase	Lander Power Usage	Typical Duration
Init	4.5 W	60 s
Wait mission table	3.2 W	60 s
Wait tuning	3.2 W	200 s
Tuning	9.4 W	60 s
Wait Sounding	3.2 W	60 s
Sounding	4 W Peak 9.4 W	duration 2 to 20 hours, comet type dependant
End Sounding	3.2 W	Wait for switch-off

Table 12 : Lander phase budget summary @-40°c (Worst Case)

The consert orbiter primary courants measred at -40°c on 28 V on the FML are:

sandby phase	116 mA (3.2 W)		
tuning phase	336 mA (9.4 W)		
sounding phase (see figure)	Standby	116 mA (3.2 W)	
	Waiting Rx	230 mA (6.4 W)	90 ms
	Rx	310 mA (8.7 W)	25 ms
	Processing	250 mA (7.0 W)	180 ms
	Tx	335 mA (9.4 W)	210 ms
	Repporting	200 mA (5.6 W)	30 ms

Table 13 : Lancer current during one sounding

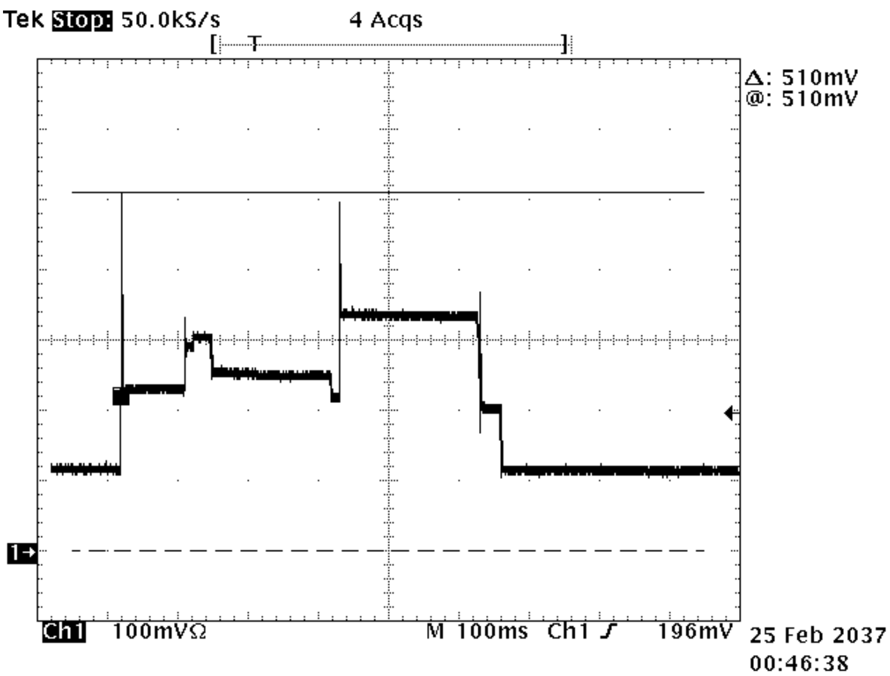


Figure 15 : Consert Lander current during a sounding (-40°c / 28V)

With a sounding every ΔTic, the power average during sounding is :
Pav = 0.09/ΔTic*6.4 + 0.025/ΔTic*8.7 + 0.180/ΔTic*7.0 + 0.210/ΔTic*9.4 + 0.030/ΔTic*5.6 + (ΔTic -0.535)/ΔTic*3.2

Pav = 3.2 + 4 / ΔTic

The power average is 4 W for ΔTic = 4.95 s as used for flight tests. **This value is a worst case corresponding to -40°c**

5.1.5 *Model (Philae, GRM and CNOT lab's)*

The Flight Spare Lander (FSL) is on Philae on board of Rosetta PFM.

The Flight Spare Lander (FML) is on board of Philae GRM located at LCC. This model is a carbon copy of the FML including internal SW.

The Electrical Qualification Model Lander (EML) is on the LPG (CNOT lab). This model is not representative of the FSL in therm of SW version (V12 versus V15), and maybe interfaces and FPGA.

The qualification model Lander (QML) is a model intern to CNOT and is expected to be similar to the FSL.

5.1.6 *Quiet Mode*

A cdms quiet mode has been developed during Philae design and has been validated during during in Philae commissioning. During quiet phase, the cdms is turn off to limit the emc pollution for lander consert.

Considering the limited sensitivity improvement for consert lander, the associated risk in term of operation and the resources limitation for cdms S, this mode has been removed form the following CDMS S/W versions.

5.2 Telecomand Format - LCN / Philae level

A Telecommand to Consert is a message of a Length up to 32 words sent from the CDMS. The first byte (index 0) of each TC message is the TC type.

Four types of TCs are handled by Consert: These commands are used for direct test of individual Hardware interfaces and sent via APID 112,12

TC TYPE value	TC_TYPE	Usage
1	TC_TYPE_DIRECT	TC with direct effect on Hardware.
2	TC_TYPE_PATCH	Update of flight software
3	TC_TYPE_MISS_TAB	Mission table definition
4	TC_TYPE_DUMP	dump a segment of Flight Software

5.2.1 *Direct Telecommand – Type 1*

The direct TC modifies the Consert parameters. Only the modification of the OCXO DAC can be used in flight while the other parameters correspond in ground test.

Direct TC length in words = 2 :

- Word 0 : MSB = TC_TYPE_DIRECT = 1
  LSB = 0 (not used)
- Word 1 : MSB = Direct TC type (see table)
  LSB = Direct TC parameter (see table)

TC type hexa	TC para	Action	TM contents
3	0	LED ON	
3	1	LED OFF	
5	x	Set clock DAC to x	
6	0	CLEAR TXPON	
6	1	SET TXPON	
7	0	CLEAR RXPON	
7	1	SET RXPON	
8	0	CLEAR TRCOM	
8	1	SET TRCOM	
9	0	CLEAR TUNING COM	
9	1	SET TUNING COM	
A	0	CLEAR TRPON	
A	1	SET TRPON	
B	0	SWITCHSEQ OFF	MESCOM is OFF
B	1	SWITCHSEQ ON	FPGA is in reset state all time, MESCOM is ON
E	x	set Gain (GCW) to X	
F	0	Set_BYPASS OFF (measurement)	
F	1	Set_BYPASS ON (Tuning)	
10	n (0 to 2)	Set code source (FPGA, +,-)	0 = Code from FPGA, Nothing if FPGA OFF 1 = Delta 312 2= CW (sinus)

Ex : 01 00 05 AA (OCXO dac @ AA)

5.2.2 *Patch TC – Type 2*

The maximum length to be patched is 60 bytes or 30 Word

Patch TC length in words = 2 + (patch_length_in_bytes)/2.

Word 0 : MSB = TC_TYPE_PATCH = 2
LSB = number of bytes to be patched (max. is 60)

Word 1 : start address of segment to be patched

Word 2 : First word to be

Word i : Last word to be patched

i max is 31.

Ex: 0201 6098 0400 (to put the parameter BYTE_MODE at the value 4)

5.2.3 *Mission table – Type 3*

Length of a Mission Table TC in words = 10.

Index (bytes)	Index names	Description	Associated global variable
0	TAB_HEADER	always 3 for mission table	none
1	TAB_index	any reference number	none
2	TAB_TUNETIC_B3	Time to start the tuning phase after instrument switch On, in TICs	tuneTIC
3	TAB_TUNETIC_B2		
4	TAB_TUNETIC_B1		
5	TAB_TUNETIC_B0		
6	TAB_STARTTIC_B3	Time to start the first sounding, after completion of tuning phase, in TIC	startTIC
7	TAB_STARTTIC_B2		
8	TAB_STARTTIC_B1		
9	TAB_STARTTIC_B0		
10	TAB_DELTATIC_B1	Time period between each sounding start, in TIC	deltaTIC
11	TAB_DELTATIC_B0		
12	TAB_NBSOUND_B1	Total number of soundings in the observation	total_soundings
13	TAB_NBSOUND_B0		
14	TAB_INITFREQ	frequency of the Sorep OCXO	OCXO_freq
15	TAB_FIOW_RATIO	Period of Full response (0 means never a full response)	FIOW_ratio
16	TAB_MODE	mode byte, see definition below	mode_byte
17	TAB_MINATT	Minimum allowed attenuation	mini_att
18	TAB_MAXATT	Maximum allowed attenuation	max_att
19	Spare	spare	Spare

Ex: 0301 0003 5A4F 0000 8F0D 0BCD 0938 8305 0000 1F00

Bit pos	Bit name	Bit definition	Bit value	Bit value name	Effect
0	MODE_BIT_DATA	Mode bit position to define the data source			
			0	DATA_FPGA	Data source = FPGA
			1	DATA_SIMU	Data source = Simulated data; ie in tab[] static
1	MODE_BIT_FIOW	Mode bit position to define type of data sent in FIOW response			
			0	FIOW_SIGNAL	FIOW standard = Signal I & Q on 16 bits each
			1	FIOW_FULL	FIOW full = Standard + Signal I & Q framed 8 bits + correl I & Q
2	MODE_BIT_BLOCK	Mode bit position to define the block structure (1 x 32 words or 4 x 32 words			
			0	TM_1_BLOCK	1 time 32 word block. Flight Configuration
			1	TM_4_BLOCKS	1 time 4 x 32 word block. Ground test Configuration

Table 14: Definition of the mode byte bit pattern

5.2.4 *Dump request TC – Type 4*

Check dump result in the TM Report packet generated. Instead of the copy of this TC, the packet will contain the memory content of the dumped area.

The maximum length to be dumped is 64 bytes.

Dump request TC length in words = 2:

Word 0 : MSB = TC_TYPE_DUMP = 4
LSB = number of bytes to be dumped (max. is 64)
Word 1 : MSB = MSB of start address of segment to be dumped
LSB = LSB of start address of segment to be dumped

Ex: 043C 0000 (to dump 60 octets (3Ch) adresse 0000)
Ex: 0402 6098 (to read the value of the parameters "BYTE_MODE")

5.3 Telecomand Format – Philae/Rosetta/RSDB level

At the S/C and Philae level, the consert TC are manipulated in a generic container (ZLN00112) with a versatile format allowing different command modes: directe execution, absolute time taggued commands,…

At the RSDB level, this container is declinated in different specific TC for DIRECT COMMAND used (TC scheduled by the orbiter) in order to increase the lisibility of the sequence. So each consert TC type can be send using two different TC at the RSDB level; the generic container or the dedicated TC.

5.3.1 *Consert TC Container ZNL00112*

The other TC's from the RSDB [AD 5]

```
Action: ZLN00112 "CONSERT TC"
  Action_type: COMMAND
  Action_parameters: \
     PLND0001 \                   # CONS_TC_Protection_Flag
     PLND0002 \                   # CONS_TC_Extension_Flag
     PLND0003 \                   # CONS_TC_Visible_Flag
     PLND0012 \                   # CONS_TC_Presep_Flag
     PLND0004 \                   # CONS_TC_Unused_Bit
     PLND0011 \                   # CONS_TC_SafeMess_Flag
     PLND0013 \                   # CONS_TC_SSIFSelect
     PLND0005 \                   # CONS_TC_ActionCode
     PLND0006 \                   # CONS_TC_DescriptorWrdCnt
     PLND0007 \                   # CONS_TC_Mask_Full_Flag
     PLND0008 \                   # CONS_TC_Transp_Std_Flag
     PLND0009 \                   # CONS_TC_UsrCmdWrdCnt
     PLND0010 \                   # CONS_TC_TIMH
     PLNG0002 \                   # CONSERT_TC_Parameter_2
     PLNG0003 \                   # CONSERT_TC_Parameter_3
     PLNG0004 \                   # CONSERT_TC_Parameter_4
     PLNG0005 \                   # CONSERT_TC_Parameter_5
     PLNG0006 \                   # CONSERT_TC_Parameter_6
     PLNG0007 \                   # CONSERT_TC_Parameter_7
     PLNG0008 \                   # CONSERT_TC_Parameter_8
     PLNG0009 \                   # CONSERT_TC_Parameter_9
     PLNG0010 \                   # CONSERT_TC_Parameter_10
     PLNG0011 \                   # CONSERT_TC_Parameter_11
     PLNG0012 \                   # CONSERT_TC_Parameter_12
     PLNG0013 \                   # CONSERT_TC_Parameter_13
     PLNG0014 \                   # CONSERT_TC_Parameter_14
     PLNG0015 \                   # CONSERT_TC_Parameter_15
     PLNG0016 \                   # CONSERT_TC_Parameter_16
     PLNG0017 \                   # CONSERT_TC_Parameter_17
     PLNG0018 \                   # CONSERT_TC_Parameter_18
     PLNG0019 \                   # CONSERT_TC_Parameter_19
     PLNG0020                     # CONSERT_TC_Parameter_20
```

5.3.2 *Consert Direct TC ZNL00102*

5.3.3 *Consert Patch TC ZNL00140*

5.3.4 *Consert Mission Table ZNL00160*

5.3.5 *Consert Dump TC ZNL00130*

5.3.6 *ZLN70000*

```
Action: ZLN70000 "CONSERT Patch"
```

In practice I do!
I patch 1 word in LN (SEQ131, 132 & 133, and CRP311) using ZLN112.
For orbiter, 1-word-long patches are autorized by ESOC without a specific ground procedure.
and so CN-SEQ-230 is also limitated to 1 word

I'm going to note ZLN70000 in the user manuel without detail and as obsolet
have good week end

Brigitte Pätz a écrit :

Hi Alain,

first of all, I've checked back with Michael, in dead, there is no description of ZLN70000 in the LUM.

For your information I have extracted both TCs (ZLN70000 and ZLN00112) from the RSDB to show the structure.
ZLN00112 - PLNG0001 is divided into 13 detailed parameters ->PLND00XX
ZLN70000 - PLNG7001 is NOT divided into detailed parameters

LN70000 is an empty CONSERT Lander TC-Container, nothing is hardcoded in the TC, there are even no detailed parameters. That is the only difference, there is no byte shift... Let me emphasize again, this format is only used for SW Patch/Upload, not during 'nominal' operations, here only ZLN00112 applies.
All this is mainly for historical reasons from the beginning of the Mission, not necessarily useful, if you know what I mean....

All in all, if you do not plan to patch CONSERT SW, you can even forget about the existence of this TC.

I hope, that I did not confuse you too much...

Cheers, Brigitte

5.3.7 *Platform'TC's relevant to Consert*

5.3.7.1 ZLC19265

```
Action: ZLC19265 "Executing an AMST"
  Action_type: COMMAND
  Action_parameters: \
     PLCDH001 \                 # _192_65_ProtectionFlag
     PLCDH002 \                 # _192_65_Extension_Flag
     PLCDH003 \                 # _192_65_Visible_Flag
     PLCDH012 \                 # _192_65_Presep_Flag
     PLCDH004 \                 # _192_65_Unused_Bit
     PLCDH011 \                 # _192_65_SafeMess_Flag
     PLCDH013 \                 # _192_65_SSIFSelect
     PLCDH005 \                 # _192_65_ActionCode
     PLCDH006 \                 # _192_65_DescriptorWrdCn
     PLCDH007 \                 # _192_65_Mask_Full_Flag
     PLCDH008 \                 # _192_65_Transp_Std_Flag
     PLCDH009 \                 # _192_65_UsrCmdWrdCnt
     PLCDH010 \                 # _192_65_TIMH
     PLCGH002 \                 # LC_TC_192_65_Par2
     PLCGH003 \                 # LC_TC_192_65_Par3
     PLCGH004 \                 # LC_TC_192_65_Par4
     PLCGH005 \                 # LC_TC_192_65_Par5
     PLCGH006 \                 # LC_TC_192_65_Par6
     PLCGH007 \                 # LC_TC_192_65_Par7
     PLCGH008 \                 # LC_TC_192_65_Par8
     PLCGH009 \                 # LC_TC_192_65_Par9
     PLCGH010 \                 # LC_TC_192_65_Par10
     PLCGH011 \                 # LC_TC_192_65_Par11
     PLCGH012 \                 # LC_TC_192_65_Par12
     PLCGH013 \                 # LC_TC_192_65_Par13
     PLCGH014 \                 # LC_TC_192_65_Par14
     PLCGH015 \                 # LC_TC_192_65_Par15
     PLCGH016 \                 # LC_TC_192_65_Par16
     PLCGH017 \                 # LC_TC_192_65_Par17
     PLCGH018 \                 # LC_TC_192_65_Par18
     PLCGH019 \                 # LC_TC_192_65_Par19
     PLCGH020                   # LC_TC_192_65_Par20
```

5.3.7.2 ZLC90000

```
Action: ZLC90000 "Lander to Normal Mode"
Action_type: COMMAND
```

5.3.7.3 ZLC90003

```
Action: ZLC90003 "Swith ON CONSERT"
Action_type: COMMAND
```

5.4 AMDT

```
ZLC90003 Switch ON CONSERT Start AMST 003 (003 hex) Fixed 192 65 impl.
ZLC90103 Start CONSERT CV Seq Start AMST 103 (067 hex) Fixed 192 65 impl.
ZLC90203 Start CONSERT TC Verification Start AMST 203 (0CB hex) Fixed 192 65
impl.
ZLC90303 Start CONSERT Patch & Dump Start AMST 303 (12F hex) Fixed 192 65 impl.
ZLC90403 Start CONSERT Interference Test Start AMST 403 (193 hex) Fixed 192 65
impl.
ZLN00112 CONSERT TC Parameter 192 128 impl.
ZLN70000 CONSERT SW Patch TC Like ZLN00112 but no det. params for CONSERT SW
Patch only Parameter 192 128 impl.

ZLC90040 Execute Extended AFT Start AMST 040 (028 hex) Fixed 192 65 DCR
```

Table du LUM

5.4.1 *AMDT 003 (0x0003)*

Consert switch on

Call

```
   Action: ZLC90003 "Swith ON CONSERT"
   Action_type: COMMAND
```

5.4.2 *AMDT 103 (0x0067)*

Send Consert mission table (100 soundings)

```
00:00:02:00 TCOffset    0x0000
      TC Length    0x000A
      TC     0301 0003 5A4F 0000 8F0D 0BCD 0064 8305 0000 1F00
```

Call:

```
   Action: ZLC90103 "Start CONSERT CV Sequence"
   Action_type: COMMAND
```

5.4.3 *AMDT 203 (0x00CB)*

Send mission table and changes twice OCXO value

```
00:00:02:00 TCOffset    0x0000
      TC Length    0x000A
      TC     0301 0003 5A4F 0000 8F0D 0BCD 0064 8305 0000 1F00
00:00:08:30 TCOffset    0x000A
      TC Length    0x0002
      TC     0100 0555
00:00:08:45 TCOffset    0x000C
      TC Length    0x0002
      TC     0100 0583
```

Call:

```
Action: ZLC90203 "Start CONSERT TC Verification"
Action_type: COMMAND
```

5.4.4 *AMDT 303 (0x012F)*

Test Patch and dump and send mission table

```
00:00:00:30 TCOffset    0x000E
      TC Length   0x0005
      TC    0206 8000 AAAA 1234 5678
00:00:00:40 TCOffset    0x0013
      TC Length   0x0002
      TC    0406 8000
00:00:02:00 TCOffset    0x0000
      TC Length   0x000A
      TC    0301 0003 5A4F 0000 8F0D 0BCD 0064 8305 0000 1F00
```

Call:

```
Action: ZLC90303 "Start CONSERT Patch & Dump"
Action_type: COMMAND
```

5.4.5 *AMDT 403 (0x0193)*

Send mission table (2360 soundings)

```
00:00:02:00 TCOffset    0x0015
      TC Length   0x000A
      TC    0301 0003 5A4F 0000 8F0D 0BCD 0938 8305 0000 1F00
```

Call:

```
Action: ZLC90403 "Start CONSERT Interference Test"
Action_type:COMMAND
```

5.4.6 *AMST 40 and AMDT42*

Abreged Functional Test Philae
During the Philae UFT, Consert is turn on and so turn off after several minutes.
No Tc are sent to consert during this test.

Call: ZLC90040

5.5 Telemetry Consert

15 seconds after switch-on, the instrument sends a STANDARD TM packet (type 1). Every 15 seconds, a STANDARD TM packet is sent until the Mission Table is received. This repetition rate is modified when the Mission Table is received (typicaly 5 seconds). This packet contains housekeeping information and some science data from the instrument.

After reception of each TC, a REPORT TM is generated (type 2) with the copy or the result of the received TC.

During sounding activities, the complete received signal is transmitted from time to time.
Every TAB_FIOW_RATIO period, the STANDARD TM packet is followed by the Science signal (type 3) or the FULL_DATA report (type 4). The selection between the two report types is performed within the Mission Table Mode byte (bit number1). The description of these two TM packet types is given below. The FULL_DATA report is intended for FPGA validation only and is not intended for use in flight due to the large amount of TM generated.

All TMs are dated OBT by CDMS Lander and all packets are dated TIC by CONSERT. The numbering of TM packet number is continuous, independently of the packet type. TMs are described for Software Lander 15 corresponding in the QML, FML and FSL.

5.5.1 *TM_TYPE_STANDARD Type 1*

1 Block

	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	TM Packet Number															
1	On-Board Time in TICs MSW (= 65536 Tics = 107 sec)															
2	On-Board Time in TICs LSW (= 7706 Tics = 13 sec)															
	Data Type (= 1)								Instrument Status							
3	0	0	0	0	0	0	0	1	Init OK	Mission Table OK	Tuning OK	Sounding Started	Sounding Finished	0	0	0
4	OCXO Temperature								DIGI Board Temperature							
5	Narrow Band Level Signal								Mixer Signal Output							
6	OCXO Frequency								Tuning Phase Info							
7	Total Error Count								Last Error Code							
8	Present Sounding Number															
9	Present Gain Control Word								FPGA Framing Info							
10	Position of Correlation Modulus Maximum								0	0	0	0	0	0	0	0
11	Signal I at position -10								Signal Q at position -10							
12	Signal I at Position -9								Signal Q at Position -9							
13	Signal I at Position -8								Signal Q at Position -8							
14	Signal I at Position -7								Signal Q at Position -7							
15	Signal I at Position -6								Signal Q at Position -6							
16	Signal I at Position -5								Signal Q at Position -5							
17	Signal I at Position -4								Signal Q at Position -4							
18	Signal I at Position -3								Signal Q at Position -3							
19	Signal I at Position -2								Signal Q at Position -2							
20	Signal I at Position -1								Signal Q at Position -1							
21	Signal I at Center Position								Signal Q at Center Position							
22	Signal I at Position +1								Signal Q at Position +1							
23	Signal I at Position +2								Signal Q at Position +2							
24	Signal I at Position +3								Signal Q at Position +3							
25	Signal I at Position +4								Signal Q at Position +4							
26	Signal I at Position +5								Signal Q at Position +5							
27	Signal I at Position +6								Signal Q at Position +6							
28	Signal I at Position+7								Signal Q at Position+7							
29	Signal I at Position +8								Signal Q at Position +8							
30	Signal I at Position +9								Signal Q at Position +9							
31	Signal I at Position + 10								Signal Q at Position + 10							

From Init to the start of the souding phase, this bloc is HouseKeeping only and the words from 8 to 31 are equal to zero.

During souding phase, this block is housekeeping and science data. Onboard Software formats short signal in two types with data= I2+Q2 on 16 bits for Software Lander 15 or with data= I on 8bits_and Q on 8 bits for Software Lander 12 (EML).

After souding completion, this block is housekeeping only. The words from 8 to 31 repeat the values of the last sounding bloc.

Instrument status

Bit number Msbit = 7	Information	Name
7	0 = Init not performed 1 = init OK	`STAT_BIT_INIT_OK`
6	0 = Mission table not received 1 = Mission table received	`STAT_BIT_MISS_TAB_OK`
5	0 = Tuning not performed 1 = Tuning performed	`STAT_BIT_TUNING_OK`
4	0 = Not in sounding mode 1 = In sounding mode	`STAT_BIT_SOUNDING`
3	0 = Sounding not finished yet 1 = Sounding finished	`STAT_BIT_END`

Error codes

Value (in hex)	Description	Effect	Name
0	No error occurred since last TM packet		
1	Received a TC message with wrong address, TC rejected,	FIFO reset	ERR_ WRONG_ADDR
0x80 & CDMS error code	Received a TC message with CDMS error notification, bits 5 to 0, contain copy of CDMS error code	FIFO reset	ERR_ CDMS_RERC
3	Received a TC with a mission table, while a first mission table has already been received, New table is ignored		ERR_ TWO_MISS_TAB
4	Received a TC of unknown type, ignored		ERR_ TC_TYPE_UNKNOWN
5	A time-out occurred in the low-level TC acquisition loop	FIFO reset	ERR_ TC_TIMEOUT
6	A timeout occurred in the low-level slow ADC read-out	ADC read-out set to 0	ERR_ ADC_TIMEOUT
7	A direct command with unidentified type has been received	none	ERR_ TC_DIRECT_UNKNOWN
8	A timeout occurred during the FPGA AGC phase	Next Sounding info may be corrupted	ERR_ TIMEOUT_AGC
9	A timeout occurred during the FPGA data transfer phase	Next Sounding info may be corrupted	ERR_ TIMEOUT_DATA

The framing information is composed of two 4 bits codes : Code Cor & Code Sig; and :
framing = Code Cor * 16 + Code Sig

Signal Framer (coherent addition) :

Code Sig (dec)	Code Sig (hex)	Higher Non Zero Bit position	Right shift factor in bits	Multiplier factor
15	F	Impossible	Impossible	Impossible
14	E	16	10	1024
13	D	15	10	1024
12	C	14	8	256
11	B	13	8	256
10	A	12	6	64
9	9	11	6	64
8	8	10	4	16
7	7	9	4	16
6	6	8	2	4
5	5	7	2	4
4	4	Impossible	Impossible	Impossible
3	3	Impossible	Impossible	Impossible
2	2	Impossible	Impossible	Impossible
1	1	Impossible	Impossible	Impossible
0	0	6 to 0	0	1

Correlation framer

Code Cor (dec)	Code Cor (Sig)	Higher Non Zero Bit position	right shift factor in bits	multiplier factor
15	F	15	Impossible	Impossible
14	E	14	8	256
13	D	13	7	128
12	C	12	6	64
11	B	11	5	32
10	A	10	4	16
9	9	9	3	8
8	8	8	2	4
7	7	7	1	2
0	0	6 to 0	0	1

5.5.2 *TM_TYPE_REPORT Type 2*

2 blocks

The first block is only a hard-copy of the last standard TM without new data while :

- The TM packet Number is incremented
- The Consert Time Tic is updated
- In case of sounding mode, the sounding is incremented but does not correspond to an existing sounding

This 1st block has not to be taken into account in the science data analysis.

The second block is the result of the TC as follow:

- Mission Table : Copy of the TC
- Direct TC : Copy of the TC
- Patch : Copy of the TC
- Dump : dumped value of the memory

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	TM Packet Number															
1	On-Board Time in TICs MSW (= 65536 Tics = 107 sec)															
2	On-Board Time in TICs LSW (= 7706 Tics = 13 sec)															
	Data Type (= 2)								Instrument Status							
3	0	0	0	0	0	0	1	0	Init OK	Mission Table OK	Tuning OK	Sounding Started	Sounding Finished	0	0	0
4	OCXO Temperature								DIGI Board Temperature							
5	Narrow Band Level Signal								Mixer Signal Output							
6	OCXO Frequency								Tuning Phase Info							
7	Total Error Count								Last Error Code							
8	Present Sounding Number															
9	Present Gain Control Word								FPGA Framing Info							
10	Position of Correlation Modulus Maximum								0	0	0	0	0	0	0	0
11	Signal I at position -10								Signal Q at position -10							
---	---								---							
31	Signal I at Position + 10								Signal Q at Position + 10							
32	Copy of Received Telecommand Or Memory dump															

63																

5.5.3 *TM_TYPE_SCIENCE Type 3*

17 blocks

The first block is the housekeeping and science bloc for the corresponding date. It has to be taken into account in the science data analysis.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	TM Packet Number															
1	On-Board Time in TICs MSW (= 65536 Tics = 107 sec)															
2	On-Board Time in TICs LSW (= 7706 Tics = 13 sec)															
	Data Type (= 3)								Instrument Status							
3	0	0	0	0	0	0	1	1	Init OK	Mission Table OK	Tuning OK	Sounding Started	Sounding Finished	0	0	0
4	OCXO Temperature								DIGI Board Temperature							
5	Narrow Band Level Signal								Mixer Signal Output							
6	OCXO Frequency								Tuning Phase Info							
7	Total Error Count								Last Error Code							
8	Present Sounding Number															
9	Present Gain Control Word								FPGA Framing Info							
10	Position of Correlation Modulus Maximum								0	0	0	0	0	0	0	0
11	Signal I and Q at Position ± 10 from Peak position (Byte 22 to 63) (21 Words)															
--																
31																
32	Signal I (255 x 16 bits) (Byte 64 to 573)															
--																
286																
287	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
288	Signal Q (255 x 16 bits) (Byte 576 to 1085)															
--																
542																
543	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

5.5.4 *TM_TYPE_FULL_DATA Type 4*

This format is a test mode used in CRP procedure (LN-CRP-311) and in LN-SEQ-133.

	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	TM Packet Number															
1	On-Board Time in TICs MSW (= 65536 Tics = 107 sec)															
2	On-Board Time in TICs LSW (= 7706 Tics = 13 sec)															
	Data Type (= 4)								Instrument Status							
3	0	0	0	0	0	1	0	0	Init OK	Mission Table OK	Tuning OK	Sounding Started	Sounding Finished	0	0	0
4	OCXO Temperature								DIGI Board Temperature							
5	Narrow Band Level Signal								Mixer Signal Output							
6	OCXO Frequency								Tuning Phase Info							
7	Total Error Count								Last Error Code							
8	Present Sounding Number															
9	Present Gain Control Word								FPGA Framing Info							
10	Position of Correlation Modulus Maximum								0	0	0	0	0	0	0	0
11																
--	Signal I and Q at Position ± 10 from Peak position (Byte 22 to 63) (21 Words)															
31																
32																
--	Signal I (255 x 16 bits) (Byte 64 to 573)															
286																
287	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
288																
--	Signal Q (255 x 16 bits) (Byte 576 to 1085)															
542																
543	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
544																
--	Framed Signal I (255 Bytes) (Byte 1088 to 1342)															
671									0	0	0	0	0	0	0	0
672																
--	Framed Signal Q (255 Bytes) (Byte 1344 to 1598)															
799									0	0	0	0	0	0	0	0
800																
--	Correlation I (255 Bytes) (Byte 1600 to 1854)															
927									0	0	0	0	0	0	0	0
928																
--	Correlation I (255 Bytes) (Byte 1856 to 2110)															
1055									0	0	0	0	0	0	0	0

5.6 CDMS Telemetry Handling

Consert generates TM packets which are formated by the CDMS to be sent at the orbiter:

- The Lander CDMS generates TM compliant with the orbiter general format with a fixed length: 127 word for the source data. The only consert lander apid is 1804 = 112,12 corresponding in a science format.

- The Consert TM's are reformatted to fit with this format and cut in 32-word blocks.
    - 1 block per TM type 1
    - 2 blocks per TM type 2
    - 17 blocks per TM type 3
    - 33 blocks per TM type 4

Each TM could also be completed with nulls before reception of the mission table or when setting MODE_BIT_BLOCK in the Mission Table.

- The Lander CDMS groups the 32-word blocks 4 by 4 to constitute a final TM sent to the orbiter during normal operation. Due to this concatenation, a loss of 0 to 3 blocks may occur at the beginning of the CDMS Quiet Mode and at the end of each Consert run (problem corrected at PC8: zero completion for the last TM).

Conserning the Consert TM packet numbering:
- The numbering of packet produced by the Consert instrument is continuous, independantly of the TM type. This numbering is reset when consert turned off/on.
- The numbering of the Consert telemetry written by the Lander CDMS in the the main Header of the final TM is not reset when Consert is turn off / turn on.

5.6.1 *Lander CDMS TM format 112,12*

Structure of the Telemetry as generated by the CDMS:

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Version=0			0	1	Process ID = 112							Packet Category = 12			
1	1	1	Source Sequence Count													
2	Packet Length = 269															
3	OBT Time (Seconds)															
4	OBT Time (seconds)															
5	OBT Time (fractional seconds)															
6	PUS			Chk	Spare				Packet Service type = 20							
7	Packet Service subtype = 3								PAD Field = 0							
8	PAD Field = 0								Structure ID = 0							
9 - 40	1st data block															
41 - 72	2nd data block															
73 - 104	3rd data block															
105 - 136	4th data block															
137	CheckSum															

5.6.2 *Lander acknowledgment 112,1*

The APID 1793 is generated by the Lander to acknowledge the TC sent to Consert. The TCs, when received and accepted by Consert, are also acknowledged via a type 2 telemetry of APID 1804.

YLN11000	N	CONSERT ACCEPT SUCCESS REP	7	ETM00101TCAS
YLN12001	N	CONSERT INCOMPLETE PKT	7	ETM00102TCAF
YLN12002	N	CONSERT INCORRECT CRC	7	ETM00102TCAF
YLN12003	N	CONSERT INCORRECT APID	7	ETM00102TCAF
YLN12004	N	CONSERT INVALID TYPE / SUBTYPE	7	ETM00102TCAF

5.7 Telemetry analysis

5.7.1 *Telemetry Budget*

Experiment phase	Lander Data Rate	Typical Duration
Init	Type 1 / 15s	60 s
Wait mission table	Type 1 / 15s	60 s
Wait tuning	Type 1 / ∆T	200 s
Tuning	0	60 s
Wait Sounding	Type 1 / ∆∆∆	60 s
Sounding	Type 1 / ∆ + Type 3 / (FIOW.∆Tic)	duration 2 to 20 hours, comet type dependant
End Sounding	Type 1 / ∆Tic	Wait for switch-off

Table 15 : Lander TM rates

Lander:

TM type	Type 1 (before MT)	Type 1	Type 2	Type 3
Number of blocs	1 + 3	1	2	17
Number of TM	**4**	**(TO-120) / ∆Tic**	**1**	**NS / FIOV**

Table 16 : Lander TM budgets

∆Tic : time interval between sounding
TO : total operation time from turn on to turn off
NS : number of sounding
FIOV ratio = 5

5.7.2 *Switch-off dump*

There is no switch off condition for Consert orbiter and lander. In order to easily check the data integrity, a specific TC is send before turn off and the corresponding TM has to be received.

On the Lander: a dump memory sent 40 seconds before turn-off. The address of the memory segment is Ox 0C1A, the length is 64 bytes. The return values are:

```
12 0F 1B 75 2C 07 90 60 52 E0 FF 12 12 73 90 60
52 EF F0 12 1D B0 12 10 07 90 50 15 E0 FC A3 E0
FD A3 E0 FE A3 E0 FF 90 50 0B E0 F8 A3 E0 F9 A3
E0 FA A3 E0 FB 74 03 12 00 C4 70 D7 90 50 09 E0
```

5.7.3 *Memory Dump and CRP*

See annex

6 FOP

The consert fop has been revisited in Jannuary-March 0_ in the frame of PC8. The new sequences are summarized in the following table and are organized as follow:

- Basic sequences for LCN, OCN and for Turn on/off: each sequence corresponds in a unique action implemented as one or a small number of TC. This Basic Sequences are used to built complexe sequences

- Fixed sequences with predefined parameters, duration and data volume. These stand-alone sequences are used for unit test during passive PC or active PC: unit functional test orbiter, unit functional test Lander, ping pong functional test. The CRP are also prepared for instrument commissioning or detailed investigations.

- Open sequences with versatiles parameters allow complexe operations like interference test, long pingpong, etc. The sequence CN-SEQ-320 is aloso prepared to be used possibly used on the comet.

Some SEQ have to be added after PC8, especially some Lander basic sequences and also the open seq for ping pong.

Basic Sequences

	Formal Name	name	Comments	Version
LANDER	LN-SEQ100	Concert Lander Direct TC	general TC for consert	V7 - 09/10/03
LANDER	LN-SEQ101	Concert Lander OCXO Change	Direct TC with 1° param = 5	
LANDER	LN-SEQ130	Concert Lander Patch	Patch	
LANDER	LN-SEQ131	Concert Lander Change Mode Byte		V2 - 27/03/08
LANDER	LN-SEQ132	Concert Lander Change Flow Ratio		V2 - 27/03/08
LANDER	LN-SEQ133	Concert Lander Load Full signal		V2 - 27/03/08
LANDER	LN-SEQ140	Concert Lander Dump	Dump	
LANDER	LN-SEQ141	Concert Lander Swip	Dump SW internal parameters	V2 - 27/03/08
LANDER	LN-SEQ143	Concert Lander Dump before off	Dumpused before turn off	V2 - 27/03/08
ORBITER	CN-SEQ200	Consert Orbiter Direct TC	general TC for consert	V2 - 04/03/08
ORBITER	CN-SEQ201	Consert Orbiter OCXO Change	Direct TC with 1° param = 5	V2 - 04/03/08
ORBITER	CN-SEQ210	Consert Orbiter Ping		V2 - 04/03/08
ORBITER	CN-SEQ220	Consert Orbiter Memory Check		V2 - 04/03/08
ORBITER	CN-SEQ230	Consert Orbiter Memory Patch	Patch 1 word	V2 - 04/03/08
ORBITER	CN-SEQ240	Consert Orbiter Memory Dump		V2 - 29/02/08
ORBITER	CN-SEQ241	Consert Orbiter Swip dump	Dump SW internal parameters	V2 - 29/02/08
ORBITER	CN-SEQ242	Consert Orbiter dump CSA	Dump Consert Synchro Accracy Parmeter	V2 - 29/02/08
ORBITER	CN-SEQ250	Consert Orbiter Time Update		V2 - 29/02/08
ORBITER	CN-SEQ260	Consert Orbiter Mission Table		V2 - 27/03/08
LANDER	LN-SEQ900	Concert Lander ON by AMST		V3 - 27/03/08
ORBITER	CN-SEQ950	Consert Orbiter ON by TC		V3 - 05/03/08
ORBITER	CN-SEQ960	Consert Orbiter On by OBCP	nominal seq	V3 - 05/03/08
ORBITER	CN-SEQ970	Consert Orbiter OFF by TC		V4 - 07/03/08
ORBITER	CN-SEQ980	Consert Orbiter OFF by OBCP	nominal seq	V4 - 07/03/08

Fixed SEQ (predefined parameter; On et OFF inside SEQ)

ORBITER	CN-SEQ300	Consert Orbiter UFT	Unit Function Test (noise level)	V2 - 27/03/08
ORBITER	CN-CRP301	Consert Orbiter ExFT	CRP (contengency recovery procedure)	V4 - 02/04/08
LANDER	LN-SEQ310	Consert Lander UFT	Unit Function Test (noise level)	V2 - 26/03/08
LANDER	LN-CRP311	Consert Lander ExFUT L	CRP (contengency recovery procedure)	V3 - 01/04/08
O+L	CN-SEQ320	Consert O+L Ping Pong FT	Classical Ping Pong	V2 - 31/03/08

Open SEQ (versatil paramater and duration)

ORBITER	CN-SEQ400A	Consert Orbiter Long test	long term test with OCN only On and MT	V2 - 26/03/08
	CN-SEQ400B		long term test with OCN only Off	V2 - 26/03/08
LANDER	LN-SEQ410A	Consert Lander Long test	long term test with LCN only On and MT	V5 - 03/04/08
	LN-SEQ410B		long term test with LCN only OFF	V5 - 03/04/08
O+L	CN-SEQ420A	Consert O+L Direct Command Ping-pong	long term Ping Pong (Ombilical) ON & MT	V5 - 03/04/08
	CN-SEQ420B		long term Ping Pong (Ombilical) OFF	V5 - 03/04/08
O+L	CN-SEQ430	Consert O+L ATTC Ping Pong	long term Ping Pong (ATTC) etc…	

Table 17 :FOP 10th March 08

6.1 FOP summary and philosophy

TBW

6.2 Predefine sequences

The nominal operation during fligth check out consists in a unit Functionnal test orbiter, a unit functional test lander and a ping-pong test with lander and orbiter.

6.2.1 *Unit Functional Test Orbiter*

MTUFTO : Orbiter Mission Table for Functional Test (10 16bits Words)		
Parameter #	**TC Data Word (Hex)**	**Signification**
PCNGA010	**0100**	Mission table index & Spare
PCNGA020	**00038C60**	TUNETIC = 232544 Tics (381 seconds)
PCNGA030	**00008FOD**	STARTTIC = 36621 Tics (60 seconds)
PCNGA040	**0BCD**	DELTATIC = 3021 Tics (4.95 seconds)
PCNGA050	**0078**	NBSOUNDING (= 120)
PCNGA060	**8000**	INIT FREQ =128 & Mode byte setting
PCNGA070	**001F**	MIN ATT = 0 & MAX ATT = 31
PCNGA080	**9585**	NBL Level = 149 & NBL zero = 133

Total duration of this mode : circa 22 minutes

Orbiter TM Budget :

APID	ACK	HK	EVT	EVT Ping	SCI	total
TM size (bytes)	17	28	24	18	1048	
Number of TM	**1**	**200**	**6**	**1**	**120**	328
Data Volume (Bytes)	17	5600	144	18	125760	131539
Data Volumes (Kbytes)	0.02	5.47	0.14	0.02	122.81	128.46

The corresponding procedure is given in annex

6.2.2 *Unit Functional Test Lander*

Mission Table

MTUFTL : Lander Mission Table for Functional Test (10 16bits Words)		
Parameter #	**TC Data Word (Hex)**	**Signification**
1	**0301**	Mission table indicator & table index
2	**0003**	TUNETIC (B3 & B2) = 219727 Tics (360 seconds)
3	**5A4F**	TUNETIC (B1 & B0)
4	**0000**	STARTTIC (B3 & B2) = 36621 Tics (60 seconds)
5	**8F0D**	STARTTIC (B1 & B0)
6	**0BCD**	DELTATIC = 3021 Tics (4.95 seconds)
7	**0064**	NBSOUNDING = 100
8	**8305**	INIT FREQ (=131) & FIOW RATIO (=5)
9	**0000**	MODE BYTE (= 0) & MIN ATT (= 0)
10	**1F00**	MAX ATT (= 0) & PAD Field (=0)

Total duration of this mode: circa 16 minutes

TM Budget
Lander :

Type	**Start**	**ACK**	**Soundings**	**Full signals**	**End**	**Total**
Numbers of TM blocks	**70**	**1**	**100**	**320**	**40**	531
Data Volumes (Kbytes)						36

FIOV ratio = 5

The corresponding procedure is given in annex

6.2.3 *Ping pong Test*

Mission Table

MTPPTO : Orbiter Mission Table for Ping Pong Test (10 16bits Words)		
Parameter #	**TC Data Word (Hex)**	**Signification**
PCNGA010	**0100**	Mission table index & Spare
PCNGA020	**00038C60**	TUNETIC = 232544 Tics (381 seconds)
PCNGA030	**00008FOD**	STARTTIC = 36621 Tics (60 seconds)
PCNGA040	**0BCD**	DELTATIC = 3021 Tics (4.95 seconds)
PCNGA050	**0078**	NBSOUNDING (= 120)
PCNGA060	**8000**	INIT FREQ =128 & Mode byte setting
PCNGA070	**001F**	MIN ATT = 0 & MAX ATT = 31
PCNGA080	**9585**	NBL Level = 149 & NBL zero = 133

Total duration of this mode : circa 18 minutes

MTPPTL : Lander Mission Table for PingPong Test (10 16bits Words)		
Parameter #	**TC Data Word (Hex)**	**Signification**
1	**0301**	Mission table indicator & table index
2	**0003**	TUNETIC (B3 & B2) = 219727 Tics (360 seconds)
3	**5A4F**	TUNETIC (B1 & B0)
4	**0000**	STARTTIC(B3 & B2) = 36621 Tics (60 seconds)
5	**8F0D**	STARTTIC(B1 & B0)
6	**0BCD**	DELTATIC = 3021 Tics (4.95 seconds)
7	**0064**	NBSOUNDING = 100
8	**8305**	INIT FREQ (=131) & FlOW RATIO (=5)
9	**0000**	MODE BYTE (= 0) & MIN ATT (= 0)
10	**1F00**	MAX ATT (= 0) & PAD Field (=0)

Total duration of this mode : circa 16 minutes (+ 2 minutes waiting for Orbiter to finish)

TM Budget
Orbiter:

APID	ACK	HK	EVT	EVT Ping	SCI	total
TM size (bytes)	17	28	24	18	1048	
Number of TM	**1**	**200**	**6**	**1**	**120**	328
Data Volume (Bytes)	17	5600	144	18	125760	131539
Data Volumes (Kbytes)	0.02	5.47	0.14	0.02	122.81	128.46

Lander :

Type	Start	ACK	Soundings	Full signals	End	Total
Numbers of TM blocks	**70**	**1**	**100**	**320**	**40**	531
Data Volumes (Kbytes)						36

FIOV ratio = 5

The corresponding procedure is given in annex

6.3 Open sequences

6.4 CRP

6.5 Memory Dump

6.5.1 *Orbiter : Memory Dump Request (MDR)*

There is one MDR predefine for consert. This file dump the S/W memory of OCN (ROM and RAM).

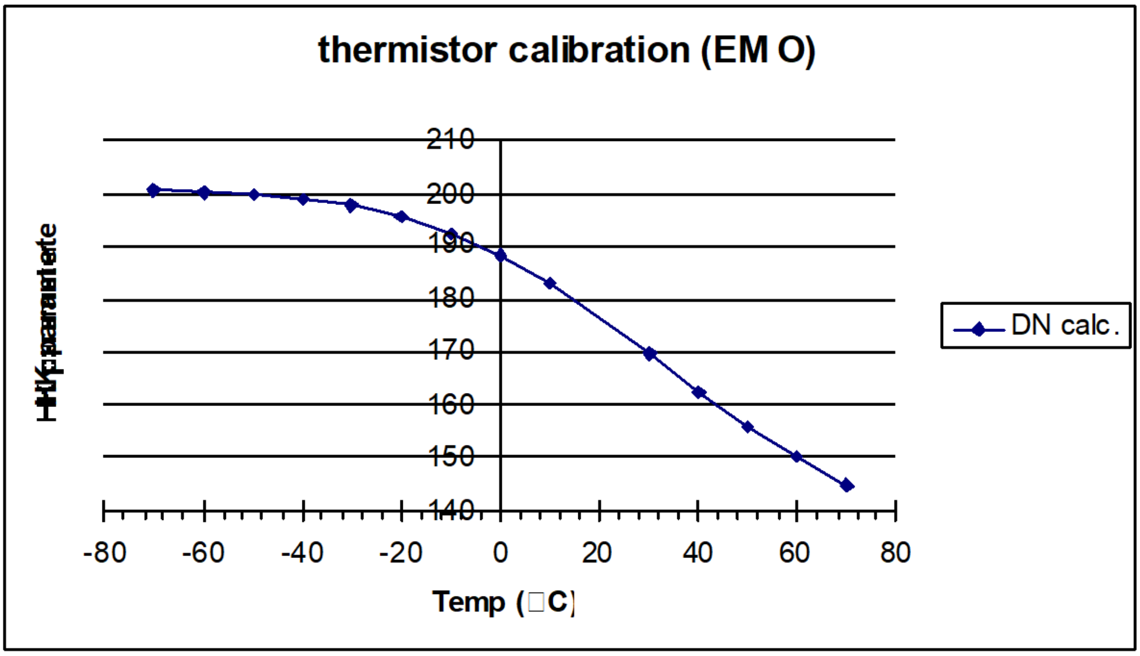
6.5.2 *Lander : Memory Dump Request (MDR)*

7 ANNEX

7.1 Thermistor calibration curves

Calibration curve has been established for the Orbiter Engineering Model (EMO).
It is valid for every model.

T (°C)	Thermistor read-out
-70	201
-60	200
-50	199
-40	198
-30	197
-20	195
-10	192
0	188
10	183
30	170
40	163
50	156
60	150
70	145



The polynom that represents the best this curve is :
TEMP = -0.001866*HK^3 + 0.934* HK ^2 - 156.52* HK + 8815

7.2 Operation Handbook

7.3 Software Handbook

7.4 Annex C : FOP Change Request Log

RO-OCN-TN-3826 CUM - Annex C FOP Change Request Log.xls

7.5 Annex D : OIOR Change Request Log

RO-OCN-TN-3827 CUM - Annex D OIOR Change Request Log.xls

7.6 Annex E : LIOR Change Request Log

RO-OCN-TN-3828 CUM - Annex E LIOR Change Request Log.xls

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