SPIRE

On Board Software

User Requirements Document

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Issue	**Revision**	**Date**	**Reason for Change**
Draft 0		05/11/1999	First draft for each instrument
Draft 1		29/11/1999	Merged the three URD in only one document by IFSI
Draft 2		31/03/2000	Inserted comments from the three consortia
Draft 3.1		13/06/2000	SPIRE section updated. Common section updated in accordance with the new versions of the applicable documents.
Draft 3.2		30/06/2000	PACS section updated.
Draft 4		05/07/2000	HIFI section updated according to the new versions of the applicable documents.
Issue 1.0		28/09/2000	HIFI, PACS and SPIRE comments on draft versions included
Issue 1.1		16/04/2002	Separated documents for the three instruments. Many additions and updates.
Issue 1.2		15/05/2003	Revised with the SPIRE consortium; final update before the SPIRE IHDR

1 Introduction

The astronomical satellite HERSCHEL will host onboard three instruments: HIFI, PACS and SPIRE. The instruments are completely different from each other in many respects, from the optical design to their scientific goals. However some commonalities among them have been identified in order to ease the realisation of the satellite: one of the deepest commonality regards the units responsible for the interface between the spacecraft and each instrument. One only institute (IFSI) is in charge of providing these units, taking care of both the hardware and the software realisation.

This document contains the User Requirements on the SPIRE DPU On-Board Software. The SPIRE instrument can be broken down in sub-units called subsystems. The number and the tasks of each subsystem are described in the appropriate subsection.

1.1 Purpose of the document

The user requirements in a software development lifecycle are the result of the problem-understanding phase and reflect the needs of the "users" who will finally use the software. This document aims at clarifying and at collecting these needs in order to correctly implement them. In our case, the software to be developed will have the main purpose of interfacing with the CDMS and of handling the various subsystems of the instruments that will be part of the payload of the HERSCHEL satellite.

1.2 Acronyms and Abbreviations

1.2.1 Acronyms

AOT	Astronomical Observation Template
APID	Application Identifier
CASE	Computer Aided Software Engineering
CDMS	Command and Data Management System
CNR	Consiglio Nazionale delle Ricerche
CPU	Control Processing Unit
DCU	Detector Control Unit
DPU	Digital Processing Unit
DRCU	Detector Readout and Control Unit
EEPROM	Electrically Erasable Programmable Read Only Memory
FCU	FPU Control Unit
HERSCHEL	Far InfraRed and Submillimeter Telescope
FOV	Field Of View
FPU	Focal Plane Unit
FTS	Fourier Transform Spectrometer
HIFI	Heterodyne Instrument for HERSCHEL
HK	HouseKeeping

[1] The most difficult problem to solve in assessing this commonality has been the choice of the name for these units. And in fact no solution at all has been found: PACS and SPIRE adopted DPU (Digital Processing Unit), while HIFI preferred ICU (Instrument Control Unit). The notation DPU/ICU will be then used throughout this document.

HS	High Speed
HW	HardWare
ICC	Instrument Control Centre
ICS	Instrument Command Sequence
IF	Intermediate Frequency
IFSI	Istituto di Fisica dello Spazio Interplanetario
MCU	Mechanical Control unit
MOC	Mission Operations Centre
OBS	On Board Software
OIRD	Operations Interface Requirements Document
PACS	Photoconductor Array Camera and Spectrometer
PCS	Permanent Command Sequence
PROM	Programmable Read Only Memory
RAM	Random Access Memory
ROM	Read Only Memory
SPIRE	Spectral and Photometric Imaging Receiver
SCU	Subsystem Control Unit
SW	SoftWare
TAI	Temps Atomique International
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TC	TeleCommand
TM	TeleMetry
UART	Universal Asynchronous Receiver Transmitter
UR	User Requirement
URD	UR Document
WE	Warm Electronics

1.2.2 Abbreviations

ID Identification

1.3 References

1.3.1 Applicable Documents

Document Reference	Name	Number
AD1.	FIRST/Planck Instrument Interface Document Part A	PT-IIDA-04624
AD2.	FIRST/Planck Instrument Interface Document Part B Instrument “SPIRE”	SCI-PT-IIDB/SPIRE-02124
AD3.	FIRST/PLANCK Operations Interface Requirements Document	SCI-PT-RS-07360
AD4.	FIRST/PLANCK Packet Structure Interface Control Document	SCI-PT-IF-07527
AD5.	FIRST Instrument Commanding Concepts	
AD6.	Operating Modes for the SPIRE Instruments	SPIRE-RAL-DOC-000320

AD7.	SPIRE Instrument Requirements document	SPIRE/RAL/N/0034
AD8.	FIRST SPIRE Electrical Interface Control Document	SAp-SPIRE-Cca-24-00
AD9.	SPIRE Data ICD	SPIRE-RAL-DOC-001078

1.3.2 Reference Documents

Document Reference	Name	Number
RD1.	Guide to applying the ESA software engineering standards to small software projects	BSSC(96)2
RD2.	FIRST SPIRE DPU subsystem specification document	
RD3.	FIRST SPIRE DPU-DRCU Interfaces	SP-RCI-5.7.00
RD4.	Telemetry and Telecommand Packet Utilisation Standard	ECSS-E-70/41
RD5.	Herschel/Planck Instrument Data Rates	H-P-1-ASPI-TN-0204
RD6.	DPU Switch-on procedure telemetry packet user manual	DPU-MA-CGS-004

1.4 Overview of the document

The DPU/ICU On Board Software User Requirements document is organised as follows:

- Section 1 (this section) contains the introduction, with a brief description of the purpose of the software, providing the "reading tools" (list of acronyms, references and so on).
- Section 2 provides a general description of the world the software operates in.
- Section 3 reports the list of all the requirements upon which the software will be accepted.

2 General Description

2.1 General capabilities

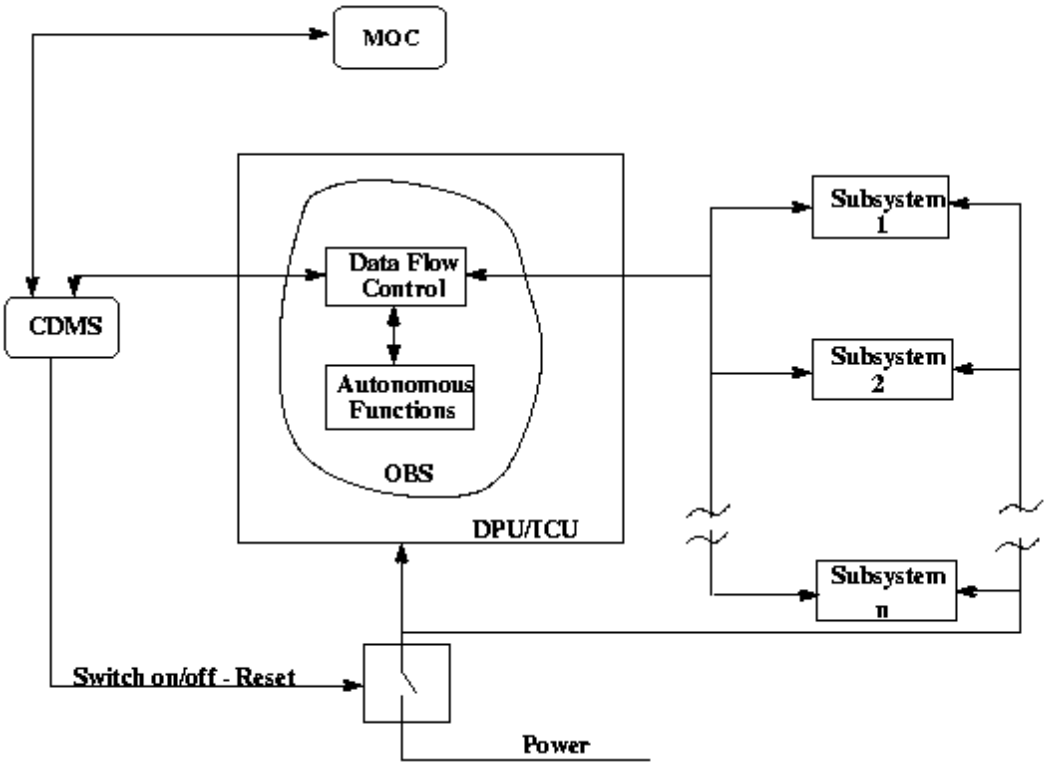

Figure 2-1 *High level functionality of DPU OBS: dialogue with subsystems and check of health status of the instrument (autonomy functions). On the basis of the HK parameters values DPU can ask CDMS to switch off part or the whole instrument.*

Figure 2-1 gives an overview of the activities of OBS. The DPU is the only data interface of the instruments with the satellite, so the main capabilities of OBS will be related with TCs and TM handling. In particular, TCs packets will be received, interpreted according to their priority, translated into the instrument ICS and, when relevant, the appropriate command instructions are sent to the subsystems. The DPU will then receive the science data and all the HK data, part of which will be used for monitoring the instrument behaviour. A check will be performed on some of the parameters and, if the corresponding critical values are reached, the OBS will run the pre-defined autonomy functions in order to prevent any damage to the instrument. Depending on the severity of the detected anomaly, the measurement could even be reset and/or DPU could ask CDMS to set the instrument to stand by mode and/or to switch off the instrument itself or any of its subsystems.

TM will be structured in three types of packets: science, HK and events/reports. Furthermore, the OBS has to manage the uploading and downloading of (part of) the processor memory: this will allow the upgrading of the OBS as well as all the subsystems parameters tables. The OBS will be able to handle the instrument behaviour in all operating modes foreseen for the instrument. The SPIRE observing modes are described in AD2 and AD6.

2.2 User Characteristics

The natural users of the software will be:

- The ICC personnel in charge of the command uplink sequence definition, who will provide the command procedures related to the measurements to be performed;
- The SW engineers, who will perform the testing, maintenance and upgrading of the software all over the satellite lifetime;
- The Ground Test (instrument and system level) Engineers, who will perform the functional and performance test on the instrument before launch;
- The other instrument subsystems developers, who will provide requirements mainly on the software interfaces and performances.

2.3 Operational Environment

2.3.1 Ground Station contact

Ground station contact and real time control will take place during 3 hours per day (AD1 Sect. 4.2). This means that the science operations will be done outside the ground control window. The activities on board will be performed from a schedule, but autonomously. In particular, the instrument will need on board monitoring and autonomy features to recover from non nominal situations: this might imply to request CDMS to switch off parts or the whole instrument. It is decided that while an autonomy function can lead to the switch off of an instrument, the following switch-on can take place only during ground contact.

2.3.2 Interfaces

2.3.2.1 Spacecraft Interface

The DPU will interface with the spacecraft through a serial interface compatible with the MIL-STD-1553B. The main characteristics of this interface are:

- Fundamental unit of data is a 16 bit word;
- This unit of data is encoded into 20 bits on the bus (allowing HW to detect transmission errors);
- The only controller of the bus is the CDMS
- Clock rate is 1MHz.
- Nominal bit rate is 130 kbps, averaged on 24 hours, including HK and events (RD5).
- Standby mode data rate is 2kbps.

2.3.2.2 Subsystem Interface

The only Subsystem interfacing the DPU is the Detector Read Out And Control Unit (DRCU): it is a warm analogue electronics box which contains the circuitry necessary to readout the detectors and to control the various mechanisms. The science data links are three monodirectional fast (1 MHz clock) synchronous serial input interfaces, each of which has an 8 kw 16 Bit FIFO: the data on each line can be received by the DPU at the same time. The housekeeping data link is a serial synchronous bus with a baseline clock speed 312.5 kHz. See

RD2 and RD3 for a description of the transmission protocol. The logical interfaces of the DPU OBS are shown in Figure 2-2

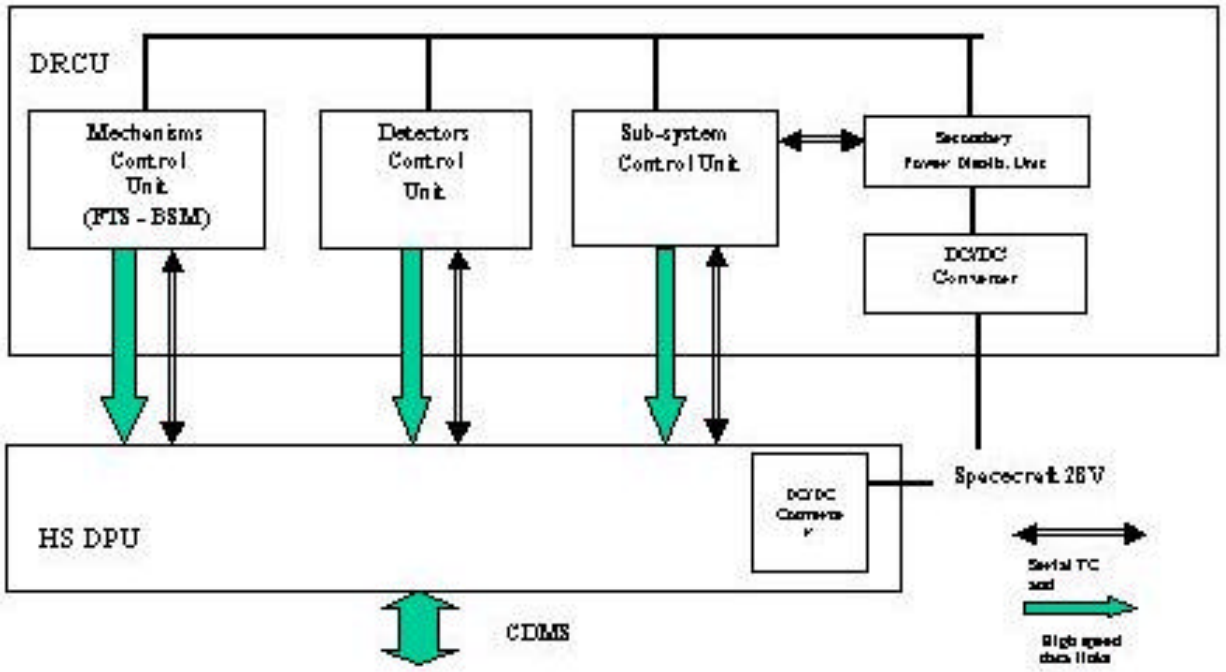

Figure 2-2 SPIRE DPU-DRCU Interface block Diagram

2.3.3 Microprocessor

The microprocessor for the DPU is Analog Devices 21020, developed for space applications by TEMIC, with the following characteristics:

- Program bus: 48 bits
- Data bus: 32 bits
- Memory dimensions:
  - PROM = 32 kB
  - EEPROM = 1 MB
  - Program RAM = 3 MB
  - Data RAM = 2 MB
- Clock speed ≅20 MHz

2.3.4 OBS Development

The OBS will be developed in the following environment:

- Virtuoso [2] as operating system.
- AxiomSys [3] as structured analysis based CASE tool.
- SIGMA[4] 33MHz ADSP 21020 development board for SW testing.

[2] Virtuoso is a trademark of Eonic Systems nv.
[3] AxiomSys is a trademark of Structured Technology Group, Inc.
[4] Sigma board is manufactured by BittWare research systems

3 Requirements

The main functions of the OBS are:

- Acceptance of instrument commands from CDMS;
- Execution of predefined commanding sequences;
- Instrument health/status monitoring;
- Implementation of pre-defined procedures on detection of instrument anomalies: the instrument shall be able to adjust parameters and/or switch operating mode and/or activate subsystem redundancy when an anomaly occurs.
- Active temperature control of the cooler, the 300mK unit and the thermal strap;
- Science data acquisition and packetisation;
- HK data packetisation;
- Transmission of data (science, HK and events) from the instrument to the CDMS;

In addition, the OBS shall provide the following SW oriented functions:

- The ability to load, via TCs, replacement and/or additional SW (patches, tables, command sequences);
- Self test and SW verification facilities;
- Possibility to load and dump part of DPU memory;
- Possibility to write and check EEPROM: possibility to inhibit these functions during flight operations.

The above listed functions all together lead to the definition of the following lists of requirements, which have been classified as: switch on, switch off, TCs handling, TM generation, synchronisation, SW testing and maintenance, autonomy functions, active controls and TM rate. Each requirement is uniquely identified by its ID code according to the following template: **OBS-UR-yyii**. The third token consists of a string (yy) and a two digits progressive index (ii). The string can assume one of the following values:

ON switch on/reset requirements
TC TCs requirements
TM TM generation requirements
SY synchronization requirements
SM OBS testing and maintenance requirements
AF autonomy functions requirements
FU Functional
GE General

Req. ID	Description	Reference
SWITCH-ON REQUIREMENTS		
OBS-UR-ON1	The DPU memory shall be checked as first task after switch on of the instrument. The sequence shall be: 1) check the content of non-volatile memory (EEPROM test first, then PROM test), through checksum; 2)	IFSI

	check the volatile memory, through simple writing/reading operations.	
OBS-UR-ON2	The health of the DPU subsystem shall be checked by comparing a TBD list of HK parameters with pre-defined values.	IFSI
OBS-UR-ON3	An event report shall be generated reporting the results of the two checks performed (see OBS-UR-ON1). In case of any failure this report shall clearly state which test failed and why, according to RD6	IFSI
OBS-UR-ON4	The event report (see OBS-UR-ON3) shall be generated after no more than 10 seconds, otherwise the CDMS shall assume that the DPU did not properly boot.	IFSI
OBS-UR-ON5	In the event of a failed check, the OBS shall enter a mode in which it is possible to load a program and/or data memory (RAM) and start program execution from a given address (it shall be possible to continue with the normal start-up sequence).	
TELECOMMANDS REQUIREMENTS		
OBS-UR-TC1	The OBS shall be able to handle all the instrument commands specified in AD9	AD9
OBS-UR-TC2	The OBS shall be able to: a) Update/add a SW function; b) Update/add a procedure.	AD5 Sect. 3.2.2 AD7 IRD-CMD-R13
OBS-UR-TC3	The OBS shall be able to receive all the instrument commands originated from the CDMS. The commands are issued as TC packets structured following the definition in AD4 according to ESA standards via the S/C interface protocol described in AD4 Appendix 9.	AD3 Sect. 1.5.1 AD4 Appendix 9 AD7 IRD-DATA-R01
OBS-UR-TC4	The OBS shall receive, unpack and process all the uplinked TC packets at the maximum command data rate (2 TC per second, AD1 section 5.11.4), regardless of packet sizes. It is a goal to be able to unpack and process up to 25 TCs per second.	AD3 Sect. 2.1.1 CTRL5, CTRL-6 AD7 IRD-CMD-R01
OBS-UR-TC5	The OBS shall acknowledge, sending TM event packets back to the CDMS, the receipt of the TCs. A specific field in the acknowledgement area (header) will indicate what type of acknowledgement (if any) is needed for each TC. The acknowledge acceptance is mandatory.	AD3 Sect. 3.2 TCV-0 AD4 Sect. 3.1.2.1
OBS-UR-TC6	The OBS shall be able to handle both 'immediate' and ' normal' commands. The only immediate command shall be the 'ABORT MEASUREMENT' command.	SPIRE
OBS-UR-TC7	Immediate commands shall be executed within 100msec of their reception and processing.	SPIRE
OBS-UR-TC8	The OBS shall be able to check the conformity of the received packets to the FIRST/PLANCK Packet	AD5 Sect. 4.3 AD4 Sect. 3.1.2.1

	Structure Interface Control Document (AD4) standard and the validity of the Application Data in order to identify non-valid packets. This includes checking the CRC, APID, packet Type and Subtype and the validity of the Application Data.	AD3 Sect. 3.1 PACK 14 AD7 IRD-CMD-R02
OBS-UR-TC9	The OBS shall be able to check the validity of APIDs, whose structure is defined in AD4.	AD3 Sect. 3.1 PACK 14 AD4 Sect. 3.1.1.1, Appendix 3
OBS-UR-TC10	The OBS shall reject non-valid packets at the earliest possible stage in the on-board acceptance and verification process. The related command sequence shall not be executed at all.	AD3 Sect. 2.1.2 TC7 AD5 Sect. 4.3 AD7 IRD-CMD-R02
OBS-UR-TC11	The OBS shall generate a report indicating the result of the validity check of the received TC packet (see OBS-UR-TC8). In case of invalid packets, this report shall include the reason for not acceptance.	AD3 Sect. 3.2 TCV-1, TCV-2 AD7 IRD-CMD-R04
OBS-UR-TC12	The OBS shall generate the TC verification report within 1 sec from the reception of the TC.	AD3 Sect. 3.2 TCV-7 AD7 IRD-CMD-R04
OBS-UR-TC13	The OBS shall generate a report indicating the result of the verification done to check if the received TCs have illegal or inconsistent Application Data (AD4 Sect. 5.1.2.1, Telecommand Acceptance Report-Failure, Code 5).	AD3 Sect. 3.2 TCV-2 AD4 Sect. 3.1.2.1, Sect. 5.1.2.1 AD5 Sect. 4.3 AD7 IRD-CMD-R04
OBS-UR-TC14	The OBS shall, following successful acceptance of the TC, be able to interpret the contents of the TC, possibly sending instructions to the instrument subsystems.	AD2
OBS-UR-TC15	The OBS shall be able to generate, upon request, a progress report or anomaly report reflecting the completion status (success or failure) of the stages of the TC execution process.	AD3 Sect. 3.2 TCV-3 AD7 IRD-CMD-R03 IRD-CMD-R04
OBS-UR-TC16	The OBS shall generate a TM event packet for unsuccessful command execution.	AD3 Sect. 3.2 TCV-4 AD7 IRD-CMD-R04
OBS-UR-TC17	The OBS shall pack the event reports according to the ESA packet telemetry standards reported in AD4. ~~(via a TBW protocol to adapt AD4 to MIL STD-1553B, AD4 Appendix 9).~~	AD5 Sect. 4.3
OBS-UR-TC18	The OBS shall be able to abort the current command execution whenever a special control TC (the 'ABORT MEASUREMENT' immediate command) is received.	AD5 Sect. 4.1 AD7 IRD-CMD-R10
OBS-UR-TC19	The OBS shall support the possibility of updating, via TCs, all the tables stored on board.	AD3 Sect. 3.2 TC-9 AD7 IRD-CMD-R12
OBS-UR-TC20	The OBS shall interrupt, if requested by CDMS, the transmission to CDMS of TC verification packets.	AD3 sect 3.2 TCV-5
OBS-UR-TC21	The OBS shall identify lost commands (by a jump in the TC packet counter) and report this in an event packet.	SPIRE
OBS-UR-TC22	The OBS shall be able to execute a peak-up	AD2 Sect. 5.12.1

	procedure, interacting with the spacecraft.	
OBS-UR-TC23	The OBS shall support the definition of new operating modes.	SPIRE
TELEMETRY GENERATION REQUIREMENTS		
OBS-UR-TM1	The OBS shall be able to provide all the TM packets identified in AD9	AD7 (WE req)
OBS-UR-TM2	The OBS packetize all data them accordingly to AD4 and AD9, and to transmit them to CDMS following the protocol defined in AD4 Appendix 9.	IFSI AD7 IRD-WE-R03
OBS-UR-TM3	The OBS shall be able to provide time info in the header of all output TM packet. The TM packet time field shall report the instant in time of initiation of packet data assembly from data previously acquired. Any other time, such as the time of data collection, will be specified in the packet data.	AD3 Sect. 2.1.3 TM-17 AD3 Sect. 3.1 PACK-11, PACK-12 AD5 Sect. 4.5
OBS-UR-TM4	All packets shall contain the information needed to identify the observation/step they belong to.	AD7 IRD-CMD-R11 AD7 IRD-TLM-R04
OBS-UR-TM5	The OBS shall be able to buffer 2 seconds worth of maximum size telemetry packets at nominal telemetry rate (i.e. about 52 1024 Byte packets). Overflow on this buffer should be reported as an event.	AD7 IRD-TLM-R02 IFSI & SPIRE
OBS-UR-TM6	The OBS shall be able to support a data rate of up to 50 TM packets per second.	SPIRE
OBS-UR-TM7	The OBS shall be able to support a reduction of the average data rate to CDMS to 20 kbps (e.g. in case of a reduced telemetry downlink rate) by providing degraded science data packets.	AD7 IRD-DATA-R04
OBS-UR-TM8	The OBS shall be able to handle the Commissioning Calibration (COCA), Transparent (TRNS) and TEST data configurations as defined in AD6	AD6 Sect.3.10
OBS-UR-TM9	The OBS shall be able to include any of the HK data provided by instrument subsystems, including the DPU itself, during all nominal modes of the instrument, including any instrument SAFE mode.	AD3 Sect. 2.1.1 CTRL-4 AD7 IRD-TLM-R05 AD7 IRD-WE-R04 AD7 IRD-WE-R17
OBS-UR-TM10	The OBS shall be able to include any software internal parameter used by the OBS in the instrument housekeeping packets.	AD3 Sect. 2.1.3 TM-10
OBS-UR-TM11	The OBS shall record the time of the start of the housekeeping data acquisition as an OBS parameter	SPIRE
OBS-UR-TM12	The OBS shall provide the facility to modify the content of housekeeping packets.	SPIRE
OBS-UR-TM13	The OBS shall provide only actual values of the HK parameters and not changes (or delta values) since the last readout.	AD3 Sect. 2.1.3 TM-11
OBS-UR-TM14	The OBS shall provide two default housekeeping packets (Critical and Nominal), which shall be activated when the OBS starts. The default rate of	

	generation shall be 0.5 Hz and 1 Hz respectively.	
OBS-UR-TM15	The OBS shall be able to provide at least two additional housekeeping packets for diagnostic purposes.	SPIRE
OBS-UR-TM16	It shall be possible to modify the generation rate of any housekeeping packet between 0.1 Hz and 5 Hz.	
OBS-UR-TM17	It shall be possible to include oversampled data (data generated at a higher rate than the packet generation rate) in telemetry packets. The oversampled data shall be sampled at a fixed interval.	
OBS-UR-TM18	The OBS shall be able to pack multiple raw science data frames generate by subsystems into a single packet.	
SYNCHRONISATION REQUIREMENTS		
OBS-UR-SY1	The OBS shall be able to synchronise, with an accuracy of 100us, the DPU internal clock with the CDMS master clock using the timing information provided each second on the 1553 Bus	SPIRE
OBS-UR-SY2	Whenever the time has not yet been synchronised (e.g., after switch on or reset), the OBS shall set to 1 the MSB of the time field in the header of TM packets.	AD4
OBS-UR-SY3	The OBS shall be able to send a synchronisation command to subsystems. The OBS shall record the DPU time when this synchronization command was sent, with an accuracy of better than 5 ms as an OBS parameter.	AD3 Sect. 1.5.8 SPIRE
OBS-UR-SY4	The OBS shall be able to include in the TM packets all the timing info necessary to correlate their source time with TAI (with an accuracy TBD in AD1). In order to monitor DPU drifts in the clock, the instantaneous difference between the internal DPU clock and the S/C clock (updated every second) will be available as a DPU HK parameter.	AD3 Sect. 2.1.4 TIM2
OBS TESTING AND MAINTENANCE REQUIREMENTS		
OBS-UR-SM1	Entering the instruments Test Mode shall not require disabling of fault management (autonomy) functions.	AD3 Sect.2.2.4 INFT-3
OBS-UR-SM2	The OBS shall be able to perform regular self checks (HW and SW).	AD3 Sect. 2.2.1 AUT-10
OBS-UR-SM3	An OBS software verification facility (for PROM, EEPROM, RAM code) shall be provided on board.	AD7 IRD-CMD-R13
OBS-UR-SM4	The OBS shall reside in non-volatile memories: PROM and EEPROM.	AD3 Sect. 3.6 OBSM-1
OBS-UR-SM5	Functionally distinct memory areas shall be assigned on board to the following categories: - program code; - fixed constants; - variables and parameters.	AD3 Sect. 3.5 MM-1 AD1 Sect. 5.13.2
OBS-UR-SM6	It shall be possible to load, dump and check the	AD3 Sect. 3.5 MM-2,

	contents of either a contiguous memory area or of several non-contiguous memory areas. The OBS shall be able to read from, write to and checksum areas of, the DPU EEPROM memory blocks.	MM-3, MM-7, MM-8, MM-10, MM-11 AD7 IRD-CMD-R13
OBS-UR-SM7	The OBS shall be able to detect data corruptions in the loaded memory area.	AD3 Sect.3.5 MM-5 AD5 Sect.4.8
OBS-UR-SM8	The OBS shall be able to provide an answer to an "are you alive" request originating from CDMS for testing the end-to-end connection between ground and DPU.	AD3 Sect. 3.14 FTS-1, FTS-2, FTS-3
OBS-UR-SM9	It shall be possible to stop and start tasks running in the OBS	SPIRE
OBS-UR-SM10	The OBS shall be able to update/add a procedure.	AD5 Sect. 3.2.2 AD7 IRD-CMD-R13
OBS-UR-SM11	The OBS shall be able to update/add a SW function	AD5 Sect. 3.2.2 AD7 IRD-CMD-R13
AUTONOMY FUNCTION REQUIREMENTS		
OBS-UR-AF1	The OBS shall be able to process and analyse any housekeeping parameter, or group of parameters, according to operating mode and limit check criteria, in order to detect anomalies within instrument subsystems.	SPIRE
OBS-UR-AF2	The OBS shall be able to execute pre-defined procedures (health autonomy functions) on detection of DPU and other instrument subsystems anomalies.	AD2 AD5 Sect. 4.6 AD3 Sect. 2.2.1 AUT- 9
OBS-UR-AF3	The OBS shall be able to generate and to transmit (in event packets) reports of failures and/or anomalies detected on board, indicating the level of criticality.	AD3 Sect. 2.2.1 AUT-11 AD3 Sect. 3.4.3 EVRP-1
OBS-UR-AF4	The OBS shall be able to transmit (in event packets) reports of the adopted autonomy functions. It shall provide all the support information necessary for the ground analysis in case of failure/anomaly detection, including the indication of the anomaly time of occurrence.	AD3 Sect. 2.2.1 AUT-11 AUT-12, AUT-15 AD3 Sect. 3.4.3 EVRP-3
OBS-UR-AF5	The OBS shall be able to echo all the relevant inputs actually used during the execution of the autonomy functions. This is to allow a full check of the correctness of the executed actions.	AD3 Sect. 2.1.3 TM-8 AD3 Sect. 3.4.3 EVRP-4
OBS-UR-AF6	The OBS shall provide all the event packets with a counter that permits the unambiguous identification of missing packets.	AD3 Sect. 2.1.3 TM-18
OBS-UR-AF7	The same type of event resulting from, e.g., and out-of-limit parameter, will be reported only once. When the cause for the event generation has disappeared, an event has to be sent signalling that the parameter is back to normal.	~~AD3 Sect. 3.4.3 EVRP-5~~ SPIRE
OBS-UR-AF8	Any control action requiring fast response times shall be handled on board, without any ground intervention.	AD3 Sect. 2.1.1 CTRL-1

OBS-UR-AF9	The OBS shall be able to enable/disable on request (via a dedicated TC) each individual autonomy function.	AD3 Sect. 2.2.1 AUT-15
OBS-UR-AF10	All parameters used for autonomous fault management shall be updateable by TC and available in TM.	AD3 Sect. 2.2.1 AUT-19
OBS-UR-AF11	The OBS shall be able to transmit reports of normal progress of operations/activities generated by any on board function. For long execution processes, the OBS shall report in the output TM the start and the end of the process. In addition, reports of progress either periodically or at predefined steps in the execution shall be provided.	AD3 Sect. 3.4.3 EVRP-8
OBS-UR-AF12	The initialisation of a mode shall include configuration of the necessary HW, activation of a default periodic TM configuration, and all the automatic processes required to achieve the objective of the mode.	AD3 Sect. 2.2.1 AUT-22
OBS-UR-AF13	The OBS shall handle the warm reset of the DPU.	IFSI
OBS-UR-AF14	The OBS shall support the possibility of an arm/fire procedure for critical commands (to be defined in AD9) to be sent to subsystems.	SPIRE
FUNCTIONAL REQUIREMENTS		
OBS-SUR-FU1	The OBS shall be able to support the *Instrument commanding*, as it is defined in AD6 section 4.1 “Instrument Actions definition”.	AD6 section 4.1.
OBS-SUR-FU2	The OBS shall be able to support the *Photometer Detector Control* activity, as it is defined in AD6 section 4.1 “Instrument Actions definition”.	AD6 section 4.1.
OBS-SUR-FU3	The OBS shall be able to support the *Spectrometer Detector Control* Activity, as it is defined in AD6 section 4.1 “Instrument Actions definition”.	AD6 section 4.1
OBS-SUR-FU4	The OBS shall be able to support the *Photometer Calibration Source Control* Activity, as it is defined in AD6 section 4.1 “Instrument Actions definition”.	AD6 section 4.1
OBS-SUR-FU5	The OBS shall be able to support the *Spectrometer Calibration Source Control* Activity, as it is defined in AD6 section 4.1 “Instrument Actions definition”.	AD6 section 4.1
OBS-SUR-FU6	The OBS shall be able to support the *FTS Mechanism Control* Activity, as it is defined in AD6 section 4.1 “Instrument Actions definition”.	AD6 section 4.1
OBS-SUR-FU7	The OBS shall be able to support the *Beam Steering Mirror Control* Activity, as it is defined in AD6 section 4.1 “Instrument Actions definition”.	AD6 section 4.1
OBS-SUR-FU8	The OBS shall be able to support the *Fridge Recycle Control* Activity, as it is defined in AD6 section 4.1 “Instrument Actions definition”.	AD6 section 4.1.
OBS-SUR-FU9	The OBS shall be able to support the *Fridge Heater Control* Activity, as it is defined in AD6 section 4.1	AD6 section 4.1

	"Instrument Actions definition".	
OBS-SUR-FU10	The OBS shall be able to handle both the command and data interfaces between the DPU and the DRCU subsystems. The implemented communication protocols shall be compliant with the description in AD8.	AD8
OBS-SUR-FU11	The OBS shall be able to support the maximum output data rates of the following subsystems: - FTS mechanism controller; - Beam Steering Mirror; - Photometer detector array, - Spectrometer detector array - Sorption cooler.	IFSI
OPERATING MODES REQUIREMENTS		
OBS-SUR-GE1	The OBS shall be able to handle all of the SPIRE Instrument operating modes, described in AD6. In the following, for each one of the operating modes, an indication of the common requirements necessary to that mode is reported. This includes any operations carried out in parallel to the observational mode (e.g. temperature control).	AD7 IRD-MODE-R01 AD7 IRD-WE-R05
OBS-SUR-GE2	The OBS shall be able to handle the Initialise (INIT) mode (the mode entered by the instrument after a power on or reboot). The DPU booting procedure starts with a programme resident in PROMs. The OBS in this situation will support only a limited subset of its regime functionalities, i.e. those necessary to receive TC from CDMS and to perform non-volatile memory checks/updates.	AD6 Sect.3.2
OBS-SUR-GE3	The OBS shall be able to handle the ON mode (the DPU is the only instrument subsystem switched on and initialised). All TC reception and verification requirements applicable (DPU commanding). Full DPU HK data are collected and sent to the CDMS.	AD6 Sect. 3.3, 4.1
OBS-SUR-GE4	The OBS shall be able to handle the Ready (REDY) mode (DPU and DRCU powered on and OBS ready to receive commands). All CUR requirements are applicable (with the HK collection limited to the DRCU data).	AD6 Sect.3.4, 4.1
OBS-SUR-GE5	The OBS shall be able to handle the PHOT and spectrometer Standby modes (PHOT_STBY and SPEC_STBY) mode.	AD6 Sect.3.5, 4.1
OBS-SUR-GE6	The OBS shall be able to handle the Cooler Recycle (CREC) mode. OBS is able to support the *Fridge Recycle Control* Activity	AD6 Sect.3.7, 4.1
OBS-SUR-GE7	The OBS shall be able to handle the SAFE mode: • OBS able to manage unrecoverable anomalies. • OBS able to handle HK data	AD6 Sect.3.8, 4.1 AD3 Sect. 2.1.1 CTRL-4

	OBS able to run under a restricted environment (a restricted set of software stored in ROM, see RD2 for a description of the ROM software functions).	
OBS-SUR-GE8	The OBS shall be able to support the two basic sub-modes for the Observe (OBSV) mode and shall implement the on-board data processing as described in AD7. • Photometer mode: in this mode 9 different observatory functions are foreseen; • Spectrometer mode: in this mode 4 different observatory functions are foreseen.	AD6 Sect.3.6 AD6 Sect. 5 (TBC)
OBS-SUR-GE9	The OBS shall be able to acquire all Photometer detector pixels corresponding to a 4'x8' FOV (288 detectors) at a maximum readout frequency of 16 Hz per frame and 16 bits per sample.	AD6 Sect. 5 (TBC)
OBS-SUR-GE10	The OBS shall be able to acquire all Spectrometer detector pixels corresponding to a 2.6'x2.6' FOV (56 detectors) at a maximum readout frequency of 80 Hz per frame and 16 bits per sample.	AD6 Sect. 5 (TBC)
OBS-SUR-GE11	When the instrument operates in chopped modes, the OBS shall be able to implement a correct synchronisation between BSM movements and detectors sampling. The timing scheme and the subsystems commanding sequence is TBD in AD6.	AD6 Sect. 5 (TBC)
OBS-SUR-GE12	The OBS shall be able to handle transitions between modes as defined in AD6, section 4.5	
OBS-SUR-GE13	The OBS shall be able to handle degraded operations as defined in AD6, section 6	
OBS-SUR-GE14	IT shall be possible to put the OBS into the SAFE mode, from any other mode, by command.	