



Herschel
DPU/ICU Spacecraft Interface
Test Plan

Ref: CNR.IFSI.2001TR04
Issue: 1.1
Date: 05/09/2002
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Prepared by: Sergio Molinari

Date: 05/09/2002

Approval List:

Institution	Responsible	Signature
ESA	S. Thürey	
IFSI	R. Orfei	
SRON	L. Dubbeldam	
RAL	K. King	
MPE	O. Bauer	



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Document Status Sheet:

Document Title: Herschel DPU/ICU Spacecraft Interface Test Plan			
Issue	Revision	Date	Reason for Change
Draft 0.5		21 June 2001	First draft
1.0		19 September 2002	Officially circulated
	1.1	5 September 2002	TFL tests removed; they will be part of OBS test plans of individual instruments

1 Introduction

1.1 Purpose of the document

This document describes the HW and SW tests that IFSI will carry out, upon delivery to the HERSCHEL instrument Consortia, on the DPU/ICU side of the interface with the HERSCHEL spacecraft.

1.2 Overview and General Statements

The communication between the CDMS and the DPU/ICU is managed according to the MIL-STD-1553B standard defined in AD2, structured according to a multi-layer protocol specified in AD3. According to AD3, the CDMS acts as the BC while the DPU/ICU is an RT. The HW interface to the CDMS will be implemented on the DPU/ICU via a BU-61580 hybrid circuit produced by DDC and described in detail in RD2. In particular, this terminal integrates dual transceivers, protocol, memory management and processor interface logic, 32KB Dual Port RAM and a Time Tag Register. The BU-61580 completely manages the low-level communication protocol as defined in AD2.

AD4, Section 6, recommends that all RTs, then including the DPUs/ICUs, is tested according to the specifications, requirements and procedures contained in RD1. Such requirements and procedures concern the PHL and the DLL and have been reviewed and collected in AD1 (adequately cross-referenced to RD1).

The BU-61580 that will be mounted on the DPU/ICU is provided by DDC and, as such, has been successfully tested by DDC according to RD1. Consequently, and only limited to the PHL and DLL, IFSI will carry out **only** the tests in AD1 that concern features of the BU-61580 that can be affected by the additional ancillary components, cabling, etc.

AD1 also requires an additional series of tests for the TFL, which are not contained in RD1 since the TFL has been specifically developed for the HERSCHEL/Planck missions. The TFL, however, is at the application level and will be tested as part of the On-Board Software Test Plans of the individual instruments.

1.3 Acronyms and Glossary

ACE	Advanced Computing Engine
ATP	Acceptance Test Plan
AVM	Avionic Model
BC	Bus Controller
CDMS	Computer Data Management System
DDC	Data Device Corporation
DLL	Data Link Layer
DPU	Digital Processing Unit
DSP	Digital Signal Processor
ESA	European Space Agency



GUI	Graphical User Interface
HIFI	Heterodyne Instrument for FIRST
HERSCHEL	Herschel Space Observatory
HW	Hardware
ICU	Instrument Control Unit
IFSI	Istituto di Fisica dello Spazio Interplanetario
NA	Not Applicable
OBS	On-Board Software
PACS	Photoconductor Array Camera and Spectrometer
PHL	Physical Layer
RAM	Random Access Memory
RT	Remote Terminal
SPIRE	Spectral and Photometric Imaging Receiver
SA	Sub Address
SW	Software
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TC	Telecommand
TFL	Transfer Layer
TM	Telemetry

2 Document List

2.1 Applicable Documents

Document Reference	Name	Number/version/date
AD1	FIRST-PLANCK CDMS-interface test requirements specifications	SRON-U/HIFI-SP-2000-5 Issue: 1.0 14 June 2001
AD2 AD3	MIL-STD-1553B Packet Structure Interface Control Document	21 September 1978 SCI-PT-ICD-7527 Issue: 1.0 1 September 2000
AD4	Herschel/Planck Instrument Data Rates	H-P-1-ASPI-TN-0204 Issue: 1 15 January 2002

2.2 Reference Documents

Document Reference	Name	Number/version
RD1	MIL-HDBK-1553A	
RD2	Payload and Spacecraft Interface Board Specification	DPU-SP-CGS-002 Issue: 1 11 December 2000



3 Environmental needs

It is planned that tests related to the DDL be also executed with the ESA CDMS Testbed. The functionality required for this Testbed is the ability to send TRANSMIT and RECEIVE messages and mode commands.

For these tests, it is required that the following equipment is available at the test site:

- 1) ESA CDMS Testbed
- 2) DPU
- 3) OBS development system (hosting a licensed copy of the VIRTUOSO operating system)

Based on these needs, the instruments propose that the location for the tests with the ESA CDMS Testbed is IFSI where the OBS is developed and tested. It is then required that the ESA CDMS Testbed is made available in a suitcase for shipping. In case, following the tests with the ESA CDMS Testbed, it is necessary to debug and update the OBS, the instruments anticipate that they will not be able to support such activities on any site other than IFSI.

4 Tests Overview

We will below detail the test procedures that will be carried out for all tests specified in AD1.

4.1 Output characteristics

The testing equipment for these tests will be a DDC BU-61580 board configured as BC and managed through the ACE Manager GUI provided by DDC. The BC shall be connected via transformer-coupled stubs to the DPU/ICU. Only a limited set of the tests specified in AD1, Section 4.2, will be carried out (see Section 1.2).

4.1.1 Amplitude

A valid, legal transmit command shall be sent to the DPU/ICU, requesting the maximum number of words that it is capable of sending. The amplitude of the waveform transmitted by the DPU/ICU shall be measured peak-to-peak. The pass criteria for V_{pp} for transformer coupled stubs shall be 18.0 V minimum, and 27.0 V maximum. The maximum and minimum measured parameters, V_{pp} , shall be recorded.

4.1.2 Rise time/Fall time

A valid, legal transmit command shall be sent to the DPU/ICU, requesting at least one data word. The rise and fall time of the DPU/ICU waveform shall be measured between the 10% and 90% points of the waveform. The measurements shall be taken at both the rising and falling edges of a sync waveform and a data bit waveform. The rise time (T_r) and the fall time (T_f) shall be recorded. The pass criteria shall be $100\text{ns} < T_r < 300\text{ns}$ and $100\text{ns} < T_f < 300\text{ns}$. The measured parameters, T_r and T_f , shall be recorded.

Note: the rise time of the sync waveform shall be measured at the mid-crossing of a data word sync, and the fall time of the sync waveform shall be measured at the mid-crossing of the status word sync.

4.1.3 Distortion, overshoot and ringing

A valid legal transmit command shall be sent to the DPU/ICU requesting it to transmit at least one data word. The distortion of the waveform, distortion voltage (V_D) shall be measured as indicated in Fig. 2 of RD1. Pass criteria shall be $V_D < +900\text{mV}$ peak, line-to-line, for transformer-coupled stubs. The worst measured parameter, V_D , shall be recorded.

4.1.4 Output isolation

A valid, legal transmit command shall be sent to the DPU/ICU, requesting the maximum number of words that it is capable of sending. The voltage of the output waveform transmitted by the DPU/ICU shall be measured on the active and redundant buses. Each data bus shall be alternatively activated and measurements taken. The pass criteria shall be that the ratio in dB between the output peak-to-peak voltage on the active bus and the output peak-to-peak voltage

on all inactive buses shall be greater than or equal to 45 dB. The measured parameters, output isolation, expressed as a ratio in dB, shall be recorded for each bus combination.

4.1.5 Power on/off noise

The DPU/ICU shall limit any spurious differential output during a power-up or power-down sequence. Power shall be applied to the DPU/ICU and any outputs shall be measured. Power shall be removed from the DPU/ICU and any output shall be measured. The test will be repeated ten times. The pass criteria shall be that, for transformer coupled stubs, any spurious noise pulses produced shall be less than or equal to ± 250 mV peak, line-to-line. All measured parameters, output noise amplitudes and pulse widths, shall be recorded.

Note: This test shall be performed using the normal on/off power sequence of the DPU/ICU.

4.2 Input characteristics

None of the tests specified to characterize the input characteristics, reported in AD1 Section 4.3, will be carried out (see Section 1.2).

4.3 Protocol tests

None of the protocol tests specified in AD1 Section 4.4 will be carried out (see Section 1.2).

4.4 Error injection

None of the tests specified in AD1 Section 4.5 will be carried out (see Section 1.2).

4.5 Noise Rejection Test

None of the tests specified in AD1, Section 4.6, will be carried out (see Section 1.2).

4.6 Data Link support

The subsections below map those of AD1, Section 4.7. An external PC equipped with a BU-65549 1553 interface board and the ACE Manager GUI, both provided by DDC, will be used as BC for the tests in this subsection.

4.6.1 Mode commands

Although compliance of 1553 interface on DPU to AD2 concerning mode commands is certified by manufacturer, we will test what we believe are the most critical ones. Pass criteria for tests in this subsection are based on inspection of the Status Word transmitted by the RT in response to any non-broadcast command received from the BC.

4.6.1.1 Transmitter Shutdown/Override



The test procedure and pass criteria are taken from RD1, §100, 5.2.1.5.2.

Step #	Action	Pass Criteria
1	Send a valid legal command to the DPU on channel A	Clear status word
2	Send a valid legal command to the DPU on channel B	Clear status word
3	Send a valid legal transmitter shutdown mode command on channel A	Clear status word
4	Send a valid legal command to the DPU on channel B	No response
5	Send a valid legal command to the DPU on channel A	Clear status word
6	Send a valid legal override transmitter shutdown mode command on channel B	No response
7	Send a valid legal command to the DPU on channel B	No response
8	Send a valid legal override transmitter shutdown mode command on channel A	Clear status word
9	Send a valid legal command to the DPU on channel B	Clear status word
10	Send a valid legal command to the DPU on channel A	Clear status word

4.6.1.2 Synchronize with/without Data Word

The ability of the DPU to correctly react to these mode commands shall be tested as part of the Satellite Data Bus Protocol tests in 1.1.

4.6.1.3 Transmit BIT (Built-In Test) Word

As in RD1, §100, 5.2.2.1.4, a transmit BIT word mode command shall be sent to the DPU. The pass criteria will be a Clear Status Word and a clear BIT word transmitted by the RT.

4.6.1.4 Terminal Flag Bit Inhibit/Override

The test procedure and pass criteria are taken from RD1, §100, 5.2.2.1.6.

Step #	Action	Pass Criteria
1	Send a valid legal receive command to the DPU with at least 1 data word	Clear status word
2	Modify DPU 1553 configuration forcing to 1 the Terminal Flag in the Status Word. Send a valid legal receive command to the DPU with at least 1 data word	Terminal Flag bit set in status word
3	Send a valid legal inhibit terminal flag mode command	Clear status word or Terminal Flag bit set in status word
4	Send a valid legal receive command to the DPU with at least 1 data word	Clear status word
5	Send a valid legal override inhibit terminal flag mode command	Clear status word



		or Terminal Flag bit set in status word
6	Send a valid legal receive command to the DPU with at least 1 data word	Terminal Flag bit set in status word
7	Modify DPU 1553 configuration resetting to 0 the Terminal Flag in the Status Word	
8	Send a valid legal receive command to the DPU with at least 1 data word	Clear status word

4.6.1.5 Transmit Last Command

The test procedure and pass criteria are a subset of those from RD1, §100, 5.2.2.1.8.

Step #	Action	Pass Criteria
1	Send a valid legal receive command to the DPU with at least 1 data word	Clear status word
2	Send a valid legal transmit last command mode command	Clear status word; check that the associated data word matches the command word received in Step 1.
3	Send a valid legal transmit command to the DPU with at least 1 data word	Clear status word
4	Send a valid legal transmit last command mode command	Clear status word; check that the associated data word matches the command word received in Step 3.

4.6.2 Data Wrap-Around

For this test only, the BC functions shall be operated via a dedicated C program compiled with the DDC ACE Runtime Libraries running on a PC with a DDC 1553 card installed and connected to the DPU via a 1553 bus. The test procedure and pass criteria are from RD1, §100, 5.2.1.6.

Step #	Action	Pass Criteria
1	Send a valid legal receive command to the DPU at SA30 with 32 randomly determined data words	Clear status word
2	Send a valid legal transmit command to the DPU at SA30 with 32 data words	Clear status word
3	Compare received and transmitted data words	The two sets of



		data words should be identical
4	Repeat steps 1 to 3 for 10000 times.	

4.6.3 Receive message

Valid receive commands are used to send 32 words to the RT on SAs 11 to 14. The 1553 RAM will be inspected at proper location for these SAs (this information is contained in addresses 0x8F00014B to 0x8F00014E of the 1553 RAM). The contents of these memory areas will be compared with the data words sent by the BC.

4.6.4 Broadcast message

No tests required here because the only broadcast messages received by the RT are the Synchronize with/without Data Word Mode Commands, which will be tested with the TFL as part of the OBS Test Plans.

4.6.5 Transmit message

Valid transmit commands are used to send 32 words to the BC on SAs 11 to 14. The 1553 RAM will be filled with HEX words at proper location for these SAs (this information is contained in addresses 0x8F00016B to 0x8F00016E of the 1553 RAM). The BC stack file will be inspected and the data words received by the BC will be compared with the data words sent by the RT.

4.6.6 Receive low-level command

No tests are required since low-level commanding is only foreseen for non-intelligent RTs.