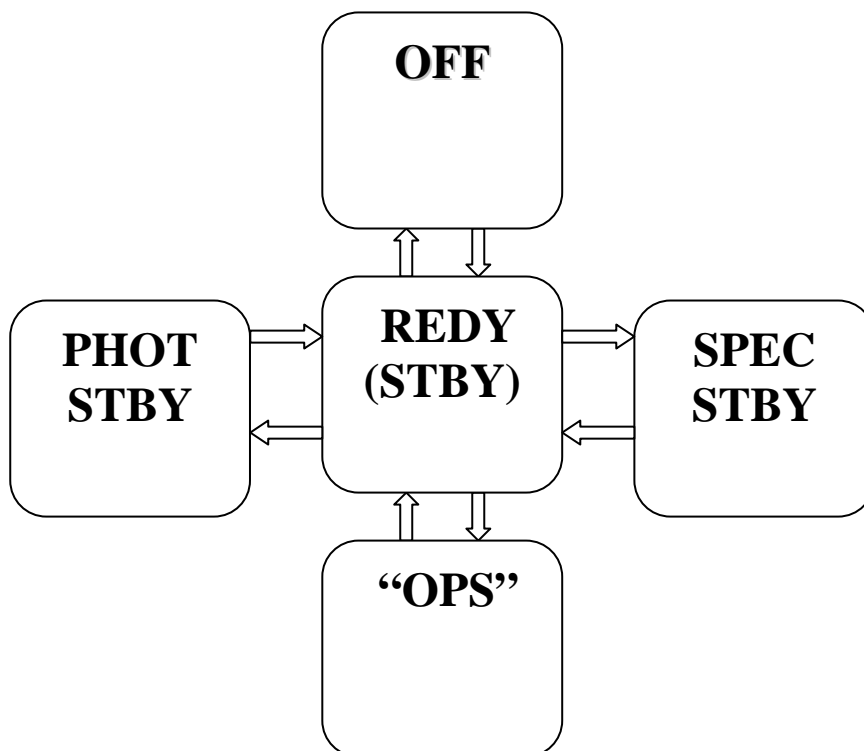# 1. Introduction

This document describes the procedures to be used for IST SAT debugging activities. These procedures are valid for the SPIRE AVM and FM (**before integration of FM DRCU with the FPU**). They allow the SPIRE instrument to be switched between five basic operating modes. To facilitate the debugging activities the following mode transitions are defined:

- **OFF to STBY. Note that the STBY mode is known as REDY mode in SPIRE terminology.** In this mode only SPIRE HK is being generated.
- **STBY to "OPS"**, where "OPS" refers to a dummy mode where SPIRE is Prime Instrument and generating both science and HK data at the nominal data rate.
- **"OPS" to STBY**
- **STBY to PHOTSTBY – SPIRE should be in PHOTSTBY mode prior to execution of the Photometer MTL in the RMS debugging tests.**
- **PHOTSTBY to STBY**
- **STBY to SPECSTBY – SPIRE should be in SPECSTBY mode prior to execution of the Spectrometer MTL in the RMS debugging tests.**
- **SPECSTBY to STBY**
- **STBY to OFF**

For FM these procedures should only be used before integration with the FPU. Since these procedures use standalone TCL scripts they do not require the presence of SPIRE personnel and the I-EGSE will not be used.

1.1 Scope

Unless otherwise indicated, it is assumed that both the FM and AVM procedures are the same. Any differences are noted in the detailed procedures in section 4.

1.2 Applicable Documents

AD#	Title	Reference	Issue#	Date
AD01	SPIRE Functional Test Specification	SPIRE-RAL-DOC-001652	1.4	22/07/2005
AD02	SPIRE ILT Warm Functional Test Procedure	SPIRE-RAL-PRC-002322	1.2	27/01/2006

1.3 Reference Documents

RD#	Title	Reference	Issue#	Date
RD01	SPIRE Instrument User Manual	SPIRE-RAL-PRJ-002395	1.0	08/04/2005
RD02	H/P OBT-UTC Time Synchronisation Technical Note	PT-CMOC-OPS-TN-6604-OPS- OGH	1.3	Sep 2004
RD03	Spire Instrument Block Diagram	SPIRE-RAL-DWG-000646	6.1	
RD04	DRCU Simulator HW/SW User Manual		1.0	26/11/2003

1.4 Change Record

Doc	Issue#	Changes	Date of Change
Issue	1.0	First version prepared for IST SAT debugging activities	02/03/2007
Issue	1.1	Updated to include the Photometer and Spectrometer Standby modes. Statement added restricting use of Procedures to **before** integration with FPU integration, i.e. FM	22/05/2007

		DRCU.	

1.5 Open Issues

There are some known issues with regard to the DRCU simulator behaviour which will be present only on the AVM scenario. For example, the DRCU Simulator does not recognize certain SPIRE Get HK commands contained in both the nominal and critical HK requests. As a result, whenever the OBS is started the HK parameter values relating to these requests enter into their hard limits (red alarms on SCOS), as specified in the SPIRE MIB. These are unavoidable design features of the DRCU simulator that cannot be corrected at this stage. Hence, where applicable, the affected procedures make reference to this 'anomalous' behaviour explicitly.

For the purposes of these debugging activities these OOL conditions can be ignored.

1.6 Constraints

These procedures are only valid for the IST SAT and RMS debugging activities and should not be used after the FPU has been integrated with the FM DRCU.

1.7 List of Acronyms

AND	Alpha Numeric Display
AVM	Avionics Model
BSM	Beam Steering Mirror
CCS	Central Checkout System
CDMU	Command and Data Management Unit
DCU	Detector Control Unit
DPU	Digital Processing Unit
DRCU	Detector Readout and Control Unit
EGSE	Electrical Ground Support Equipment
FM	Integrated System Test
FPU	Focal Plane Unit
I-EGSE	Instrument EGSE
IST	Integrated Systems Test
MCU	Mechanism Control Unit

MTL	Mission Time Line
OBT	On Board Time
OOL	Out Of Limit
RMS	Reference Mission Scenario
SMEC	Spectrometer Mechanism

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2. Test Configuration

The main differences between the AVM and the FM configurations are with respect to the hardware. On the SPIRE AVM hardware the Warm Units and the FPU are substituted by a DRCU simulator.

2.1 FM Test Configuration

This is the required configuration prior to the start of the test:

SPIRE WU:

- The SPIRE FM DRCU should be interconnected with the SPIRE FM DPU, both PRIME and REDUNDANT interfaces.
- The SPIRE FM DRCU NOMINAL and REDUNDANT power interfaces to the Herschel satellite should be connected.
- The SPIRE FM DPU NOMINAL and REDUNDANT 1553 interfaces to the Herschel satellite should be connected.
- The SPIRE FM DPU NOMINAL and REDUNDANT power interfaces to the Herschel satellite should be connected.

HCDMU:

- The Bus list selected on the HCDMU should be as appropriate for the planned activity. If SPIRE is to put into an "Operations" mode then bus list should be for SPIRE Prime Instrument, (i.e., 27 TM slots allocated for SPIRE telemetry). For the NOMINAL side tests the BUS Configuration should be SPIRE Nominal (i.e, RT=21) and for the REDUNDANT side test the BUS Configuration should be SPIRE Redundant (i.e, RT=22).
- The HCDMU and CCS should be interconnected.

CCS:

- The SPIRE MIB should be imported on the CCS.

2.2 AVM Test Configuration

Note: There is no redundancy on the AVM configuration

This is the required configuration prior to the start of the test:

SPIRE WU:

- The SPIRE DRCU Simulator PC should be powered ON and the operating system running.
- The SPIRE DRCU Simulator PC should be interconnected with the SPIRE FM DPU following RD04.
- The SPIRE FM DPU NOMINAL 1553 interface to the Herschel satellite should be connected.
- The SPIRE FM DPU NOMINAL power interface to the Herschel satellite should be connected.

HCDMU:

- The Bus list selected on the HCDMU should be as appropriate for the planned activity. If SPIRE is to be put into "Operations" mode then bus list should be for SPIRE Prime Instrument, (i.e., 27 TM slots allocated for SPIRE telemetry).
- The HCDMU and CCS should be interconnected.

CCS:

- The SPIRE MIB should be imported on the CCS.

3. IST SAT Debugging Procedures Overview

3.1 General instructions for executing the test procedures

- Section 3.2 of this document specifies the sequence to be executed. Each of the steps in the sequence has a detailed specification in section 4.

- The detailed procedures in section 4 include blank boxes where the actual values of parameters can be noted. Based on the comparison with the expected values the success or failure of a step should be recorded in the final column of the table.

- If the tests are to be performed with the FM then the operator has to select either the NOMINAL or REDUNDANT instrument – in such cases these choices are indicated by a switch in Procedure Step Description, e.g. **NOMINAL/REDUNDANT (21/22)**

- The last row in a procedure table should be used to record the overall Pass/Fail result of each test.

- In general any text in boldface in the procedural steps indicates an action which may have to be performed manually by the CCS staff.

3.2 Test Sequences

3.2.1 OPS Test Sequence

This section specifies the sequence to be executed for switching between OFF and OPS modes. Maximum estimated times for executing a test sequence are also given.

Procedure Name	Purpose	Duration
SPIRE-IST-DBG-OFF-TO-STBY	To switch SPIRE from OFF to STBY mode	5 min
SPIRE-IST-DBG-STBY-TO-OPS	To switch SPIRE from STBY to "OPS" mode	5 min
SPIRE-IST-DBG-OPS-TO-STBY	To switch SPIRE from "OPS" to STBY mode	5 min
SPIRE-IST-DBG-STBY-TO-2OFF	To switch SPIRE from STBY to OFF	5 min

Total: ~ 20 min

3.2.2 RMS Photometer MTL Test Sequence

The procedure SPIRE-IST-DBG-STBY-TO-PHOT assumes that SPIRE is in STBY mode and puts it in

PHOTSTBY mode, in readiness for Photometer MTL execution. To return to SPIRE STBY mode the procedure SPIRE-IST-DBG-PHOT-TO-STBY must be executed.

Procedure Name	Purpose	Duration
SPIRE-IST-DBG-STBY-TO-PHOT	To switch SPIRE from OFF to STBY mode	5 min
SPIRE-IST-DBG-PHOT-TO-STBY	To switch SPIRE from STBY to "OPS" mode	5 min

3.2.3 RMS Spectrometer MTL Test Sequence

The procedure SPIRE-IST-DBG-STBY-TO-SPEC assumes that SPIRE is in STBY mode and puts it in SPECSTBY mode, in readiness for Spectrometer MTL execution. To return to SPIRE STBY mode the procedure SPIRE-IST-DBG-SPEC-TO-STBY must be executed.

Procedure Name	Purpose	Duration
SPIRE-IST-DBG-STBY-TO-SPEC	To switch SPIRE from STBY to SPECSTBY mode	5 min
SPIRE-IST-DBG-SPEC-TO-STBY	To switch SPIRE from SPECSTBY to STBY mode	5 min

4. Detailed IST Debugging Procedures

4.1 Procedures

4.1.1 Procedure SPIRE-IST-DBG-OFF-TO-STBY

Version	1.1
Date	22nd May 2007
Purpose	To switch the SPIRE instrument from OFF to STBY mode
Initial configuration	SPIRE DPU and DRCU are switched off
Final configuration	SPIRE is in STBY mode: • SPIRE DPU and DRCU are on • Generating Nominal HK reports at 4 second intervals • Generating Critical HK reports at 2 second intervals
Preconditions	• SPIRE FM DPU and DRCU are electrically integrated with the Herschel Satellite • SPIRE MIB is imported in the CCS database. • CCS is up and running • DPU AND OBS PARAMETERS AND is selected on the CCS • SFT PARAMETERS AND is selected on the CCS
Duration	5 minutes
Pass/Fail criteria	Nominal and Critical HK reports start being generated at their nominal rates of 0.25Hz and 0.5Hz respectively.

Step	Description	Parameter	Expected Values Before/After	Actual Values Before/After	Pass/ Fail
1	**Power ON the SPIRE DPU NOMINAL/REDUNDANT unit using the dedicated spacecraft LCL line and configure 1553 Spacecraft bus for SPIRE DPU (RT = 21/22)**	—	—	—	
2	Wait for the boot software to produce at least 2 event packets (5,1)	—	—	—	
3	Execute TCL script SPIRE-IST-DBG-OFF2DPUON.tcl	—	—	—	
4	Nominal and Critical HK packets should arrive at the CCS for 10 seconds: **SPIRE Nominal HK:** • (type ,subtype) : (3,25) • APID : 0x502/0x503 **SPIRE Critical HK:** • (type ,subtype) : (3,25) • APID: 0x500	—	—	—	
5	For this 10 second period check that TM1N and TM2N parameters incremented as indicated	TM1N TM2N	@ 0.5Hz @ 1Hz	—	
6	After this 10 second interval check that all HK TM reception has stopped	TM1N TM2N	Not incrementing Not incrementing	— —	
7	**Power ON the SPIRE DRCU NOMINAL/REDUNDANT unit using the dedicated spacecraft LCL line.** **For the AVM the DRCU simulator has to be switched on.**	—	—	—	
8	Execute TCL script SPIRE-IST-DBG-DPUON2STBY.tcl	—	—	—	
9	Check that the THSK parameter is refreshing every 4 seconds	THSK	Refreshing @ 0.25Hz	—	

Step	Description	Parameter	Expected Values Before/After	Actual Values Before/After	Pass/ Fail
10	Check that TM1N and TM2N parameters are incrementing as indicated	TM1N	Incrementing by one every 4 seconds	—	
		TM2N	Incrementing by 2 every 4 seconds	—	
11	Check that the DRCU parameters show nominal values.	SCUP5V	$\sim 5.2 \pm 0.5V$		
		SCUP9V	$\sim 9.0 \pm 0.2V$		
		SCUM9V	$\sim -9.0 \pm 0.2V$		
		BIASP5V	$\sim 5.1 \pm 0.5V$		
		BIASP9V	$\sim 9.0 \pm 0.2V$		
		BIASM9V	$\sim -9.0 \pm 0.2V$		
		MCUBITSTAT	0/1		
		MCUP5V	$\sim 5.0 \pm 0.3V$		
		MCUP14V	$\sim 14.0 \pm 0.6V$		
		MCUM14V	$\sim -14..0 \pm 0.6V$		
	Note that for the AVM some parameters will be in hard limits.	MCUP15V	$\sim 15.0 \pm 0.6V$		
		MCUM15V	$\sim -15.0 \pm 0.6V$		
12	Check that SPIRE is in REDY mode	MODE	DRCU_ON/REDY		
Test Result (Pass/Fail):					

4.1.2 Procedure SPIRE-IST-DBG-STBY-TO-OPS

Version	1.0
Date	2nd April 2007
Purpose	To switch SPIRE from STBY to "OPS" mode
Initial configuration	• SPIRE DPU and DRCU are ON • SPIRE is in REDY mode
Final configuration	SPIRE is Prime Instrument and in "OPS" mode: • Generating critical and nominal HK at 0.5Hz and 1Hz respectively • Generating photometer science data at ~ 18 packets/s
Preconditions	• SPIRE MIB is imported in the CCS database. • CCS is up and running • DPU AND OBS PARAMETERS and FUNCTIONAL TEST PARAMETERS ANDs are selected on the CCS
Duration	5 minutes
Pass/Fail criteria	SPIRE is Prime Instrument and in "OPS" mode: • Generating critical and nominal HK at 0.5Hz and 1Hz respectively • Generating Photometer science data at ~ 18 packets/s

Step	Description	Parameter	Expected Values Before/ After	Actual Values Before/After	Success/ Failure
1	Execute TCL script SPIRE-IST-DBG-STBY2OPS.tcl	—	—	—	
2	Check that THSK parameter is refreshing every second	THSK	Refreshing @ 1Hz	—	
3	Check that TM1N and TM2N parameters are incrementing as indicated	TM1N TM2N	@ 0.5Hz @ 1Hz	—	
4	Check that TM3N is incrementing as indicated	TM3N	~18-20 Hz	—	
5	Check that DCUFRAMECNT on the FUNCTIONAL TEST PARAMETERS AND is incrementing as indicated	DCUFRAMECNT	~18-20 Hz	—	
6	Check that the MODE parameter is set to 0xFFFF for the "OPS" mode *Note that "OPS" is a dummy value for the debugging activities – no converted value is defined.*	MODE	REDY/ 0xFFFF		
Test Result (Pass/Fail):					

4.1.3 Procedure SPIRE-IST-DBG-OPS-TO-STBY

Version	1.1
Date	10th May 2007
Purpose	To switch SPIRE from "OPS" to STBY mode
Initial configuration	• SPIRE DPU and DRCU are ON • SPIRE is Prime Instrument • SPIRE is in "OPS" mode and generating photometer science data as well as HK
Final configuration	SPIRE is in STBY mode: • Generating only critical and nominal HK at 0.5Hz and 0.25Hz respectively
Preconditions	• SPIRE MIB is imported in the CCS database. • CCS is up and running • DPU AND OBS PARAMETERS and FUNCTIONAL TEST PARAMETERS ANDs are selected on the CCS
Duration	5 minutes
Pass/Fail criteria	

Step	Description	Parameter	Expected Values Before/After	Actual Values Before/After	Success/ Failure
1	Execute TCL script SPIRE-IST-DBG-OPS2STBY.tcl	—	—	—	
2	Check that the THSK parameter is refreshing every 4 seconds	THSK	Refreshing @ 0.25Hz	—	
3	Check that TM1N and TM2N parameters are incrementing as indicated	TM1N TM2N	Incrementing by one every 4 seconds Incrementing by 2 every 4 seconds	—	
4	Check that TM3N has stopped incrementing	TM3N	—	—	
5	Check that DCUFRAMECNT on the FUNCTIONAL TEST PARAMETERS has stopped incrementing	DCUFRAMECNT	—	—	
6	Check that SPIRE is in REDY mode (RAW 0x200)	MODE	0xFFFF/0x200		
Test Result (Pass/Fail):					

4.1.4 Procedure SPIRE-IST-DBG-STBY-TO-OFF

Version	1.1
Date	9th May 2007
Purpose	To switch SPIRE from "OPS" to STBY mode
Initial configuration	• SPIRE DPU and DRCU are ON • SPIRE is in STBY mode: Generating only critical and nominal HK at 0.5Hz and 0.25Hz respectively
Final configuration	SPIRE is OFF: • DPU and DRCU are both OFF
Preconditions	• SPIRE MIB is imported in the CCS database. • CCS is up and running • DPU AND OBS PARAMETERS is selected on the CCS • SFT PARAMETERS AND is selected on the CCS
Duration	5 minutes
Pass/Fail criteria	SPIRE instrument is OFF

Step	Description	Parameter	Expected Values Before/After	Actual Values Before/After	Success/ Failure
1	Execute TCL script SPIRE-IST-DBG-STBY2OFF.tcl	—	—	—	
2	Check that TM1N and TM2N parameters have both stopped incrementing	TM1N	—	—	
		TM2N	—	—	
3	Check that the MCU has been switched off	MCUBITSTAT	1/0		
4	Check that SPIRE is in DRCU_ON mode	MODE	DRCU_ON		
5	**Power OFF the SPIRE DRCU NOMINAL/REDUNDANT unit.** **For the AVM the DRCU simulator has to be switched off.**	—	—	—	
6	**Power OFF the SPIRE DPU NOMINAL/REDUNDANT unit.**	—	—	—	
Test Result (Pass/Fail):					

NOTE: IF THE DPU IS TO BE POWERED ON AGAIN, PLEASE WAIT ~2 MINUTES AFTER EXECUTION OF SPIRE-IST-DBG-STBY2OFF.

4.1.5 Procedure SPIRE-IST-DBG-STBY-TO-PHOT

Version	1.1
Date	22nd May 2007
Purpose	To switch SPIRE from STBY to PHOTSTBY mode
Initial configuration	• SPIRE DPU and DRCU are ON • SPIRE is in STBY mode: Generating only critical and nominal HK at 0.5Hz and 0.25Hz respectively
Final configuration	SPIRE is in PHOTSTBY mode: • Generating only critical and nominal HK at 0.5Hz and 1Hz respectively • Configured to generate Photometer and BSM science data
Preconditions	• SPIRE MIB is imported in the CCS database. • CCS is up and running • DPU AND OBS PARAMETERS AND is selected on the CCS • MCU PARAMETERS AND is selected on the CCS
Duration	5 minutes
Pass/Fail criteria	SPIRE instrument is in PHOTSTBY mode

Step	Description	Parameter	Expected Values Before/After	Actual Values Before/After	Success/ Failure
1	Execute TCL script SPIRE-IST-DBG-STBY2PHOT.tcl	—	—	—	
2	Check that SPIRE is in PHOTSTBY mode	MODE	PHOTSTBY		
3	Check the value of parameter MCUTM12SAMPLE	MCUTM12SAMPLE	0x25		
Test Result (Pass/Fail):					

4.1.6 Procedure SPIRE-IST-DBG-PHOT-TO-STBY

Version	1.1
Date	22nd May 2007
Purpose	To switch SPIRE from PHOTSTBY to STBY mode
Initial configuration	• SPIRE DPU and DRCU are ON • SPIRE is in PHOTSTBY mode:
Final configuration	SPIRE is in STBY mode: • Generating only critical and nominal HK at 0.5Hz and 0.25Hz respectively
Preconditions	• SPIRE MIB is imported in the CCS database. • CCS is up and running • DPU AND OBS PARAMETERS AND is selected on the CCS
Duration	5 minutes
Pass/Fail criteria	SPIRE instrument is in STBY mode

Step	Description	Parameter	Expected Values Before/After	Actual Values Before/After	Success/ Failure
1	Execute TCL script SPIRE-IST-DBG-PHOT2STBY.tcl	—	—	—	
2	Check that SPIRE is in REDY mode	MODE	REDY		
3	Check that TM1N and TM2N parameters are incrementing as indicated	TM1N	Incrementing by one every 4 seconds	—	
		TM2N	Incrementing by 2 every 4 seconds		

Test Result (Pass/Fail):

4.1.7 Procedure SPIRE-IST-DBG-STBY-TO-SPEC

Version	1.1
Date	22nd May 2007
Purpose	To switch SPIRE from STBY to SPECSTBY mode
Initial configuration	• SPIRE DPU and DRCU are ON • SPIRE is in STBY mode: Generating only critical and nominal HK at 0.5Hz and 0.25Hz respectively
Final configuration	SPIRE is in SPECSTBY mode: • Generating only critical and nominal HK at 0.5Hz and 1Hz respectively • Configured to generate Spectrometer and SMEC science data
Preconditions	• SPIRE MIB is imported in the CCS database. • CCS is up and running • DPU AND OBS PARAMETERS AND is selected on the CCS • MCU PARAMETERS AND is selected on the CCS
Duration	5 minutes
Pass/Fail criteria	SPIRE instrument is in SPECSTBY mode

Step	Description	Parameter	Expected Values Before/After	Actual Values Before/After	Success/ Failure
1	Execute TCL script SPIRE-IST-DBG-STBY2SPEC.tcl	—	—	—	
2	Check that SPIRE is in SPECSTBY mode	MODE	SPECSTBY		
3	Check the value of parameter MCUTM10SAMPLE	MCUTM10SAMPLE	0xA		
Test Result (Pass/Fail):					

4.1.8 Procedure SPIRE-IST-DBG-SPEC-TO-STBY

Version	1.1
Date	22nd May 2007
Purpose	To switch SPIRE from SPECSTBY to STBY mode
Initial configuration	• SPIRE DPU and DRCU are ON • SPIRE is in SPECSTBY mode:
Final configuration	SPIRE is in STBY mode: • Generating only critical and nominal HK at 0.5Hz and 0.25Hz respectively
Preconditions	• SPIRE MIB is imported in the CCS database. • CCS is up and running • DPU AND OBS PARAMETERS AND is selected on the CCS
Duration	5 minutes
Pass/Fail criteria	SPIRE instrument is in STBY mode

Step	Description	Parameter	Expected Values Before/After	Actual Values Before/After	Success/ Failure
1	Execute TCL script SPIRE-IST-DBG-SPEC2STBY.tcl	—	—	—	
2	Check that SPIRE is in REDY mode	MODE	REDY	—	
3	Check that TM1N and TM2N parameters are incrementing as indicated	TM1N	Incrementing by one every 4 seconds	—	
		TM2N	Incrementing by 2 every 4 seconds		
Test Result (Pass/Fail):					