SPIRE

SUBJECT: DRCU Simulator User Requirements Document

PREPARED BY: K.J. King

DOCUMENT No: SPIRE-RAL-PRJ-000910

ISSUE: Issue 1.0 **Date:** 29th November 2001

APPROVED BY:

Checking Engineer (SO) **G. Olofsson**	
Project Manager (SO) **H-G Floren**	
Checking Engineer (IFSI) **R. Cerulli**	
Instrument Scientist **B.M. Swinyard**	
Instrument Development Manager **E.C. Sawyer**	

Distribution

K.J. King	RAL
G. Olofsson	Stockholm
H.G. Floren	Stockholm
R. Orfei	IFSI
R, Cerulli	IFSI
S. Molinari	IFSI
B.M. Swinyard	RAL
E.C. Sawyer	RAL
D.L. Smith	RAL

Change Record

ISSUE	DATE	Description of Change
Issue 1.0 (Draft 1)	19th October 2001	First version issued for comments
Issue 1.0	29th October 2001	First Issue

TABLE OF CONTENTS

FIGURES

TABLES

Glossary

AIV	Assembly, Integration and Verification
AVM	Avionics Model
DPU	Digital Processing Unit
DRCU	Detector Readout and Control Unit
EGSE	Electrical Ground Support Equipment
FIRST	The Far-Infrared and Sub-millimetre Telescope
Herschel	The spacecraft formerly known as FIRST
IFSI	Istituto di Fisica dello Spazio Interplanetario, Rome
OBS	On-Board Software
RAL	Rutherford Appleton Laboratory
SPIRE	Spectral and Photometric Imaging Receiver

1. INTRODUCTION

1.1 Purpose

This document provides the top-level user requirements on the DRCU Simulator, a system for simulating the complete SPIRE instrument apart from the digital part of the instrument warm electronics (the DPU).

The DRCU Simulator forms part of the deliverable Avionics Model (AVM) of the instrument (see RD-01), and is also used during the acceptance testing of the DPU at IFSI and RAL. As such it is subject to the product assurance and configuration control requirements applied to all SPIRE deliverable units (see AD-01, AD-02). This document will be used to define the tests to be carried out on the DRCU Simulator in order for it to be accepted for use with the DPU.

1.2 Scope

This document provides the user requirements on the DRCU Simulator both for use as part of the AVM and as EGSE supporting the testing of the DPU data interfaces and the OBS functionality. The simulator is not required to support detailed testing of the DPU interfaces (e.g. w.r.t. signal levels, timing, performance etc.). These will be tested independently by the DPU providers.

As the AVM test plan and Warm Electronics Integration Plan are not yet available, this first version of this document is based on expected tests and experience from previous projects and requirements identified from AD-01.

1.3 References

1.3.1 Applicable Documents

AD-01 SPIRE Product Assurance Plan (SPIRE-RAL-PRJ-000017), Issue 1.0, 11th April 2001

AD-02 SPIRE Configuration Management Plan (SPIRE-RAL-PRJ-000626), Issue 1.0, 12th April 2001

AD-03 SPIRE AVM Test Plan TBW

AD-04 SPIRE Warm electronics Integration Plan TBW

AD-05 SPIRE DPU Interface Control Document (SPIRE-IFS-PRJ-000650) Issue 1.0, 2nd April 2001

AD-06 FIRST/Planck Instrument Interface Document Part A (SCI-PT-IIDA-04624) Issue 2.0, 31st July 2001

AD-07 FIRST/Planck Instrument Interface Document Part B, Instrument SPIRE (SCI-PT-IIDB-02124) Issue 2.0, 31st July 2001

AD-08 Herschel EGSE Packet Router ICD (SRON-G/HIFI/ICD/2001-001) Issue 1.0, 23rd July 2001

1.3.2 Reference Documents

RD-01 SPIRE AVM Definition (SPIRE-RAL-COM-000387), 17th April 2000

1.4 Document Overview

1.4.1 Structure

Section 2 gives a brief overview of the environments in which the simulator will be used and identifies the users of the DRCU and their expectations of the DRCU Simulator

Section 3 forms the bulk of the document and defines the user requirements of the system. These are split into two sections covering the functional (section 3.1) and non-functional (section 3.2) requirements. Individual subsections cover different aspects of the required functionality.

1.4.2 Requirement Identification

Each Requirement is uniquely identified with the following designation:

DRCUS-UR-sss-nnnn

Where:

sss = section name in which it appears
nnnn = a sequence number , unique within the section

2. USER CHARACTERISTICS

2.1 Use of the DRCU Simulator

The different scenarios in which the simulator is used are shown below:

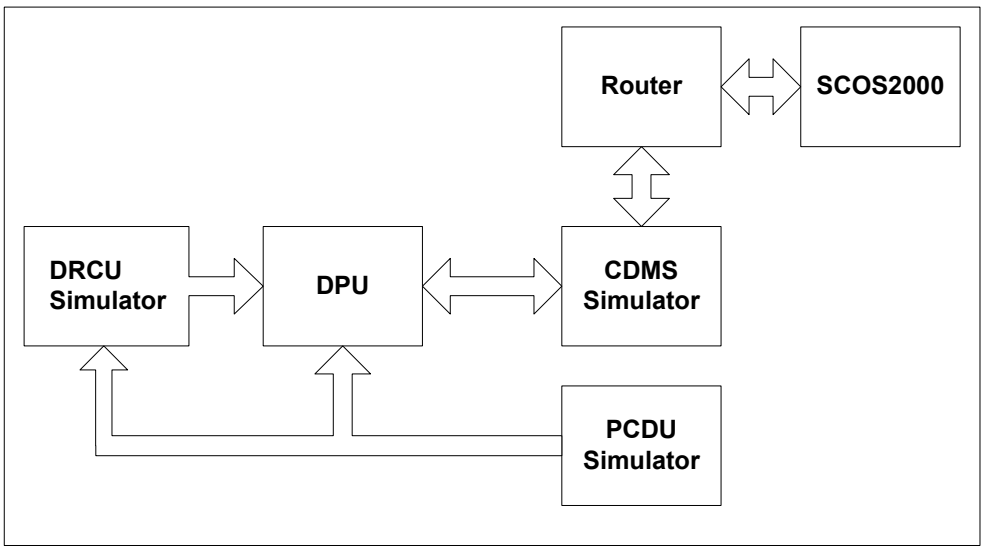

Figure 2-1 Test Setup for DPU and OBS tests at IFSI

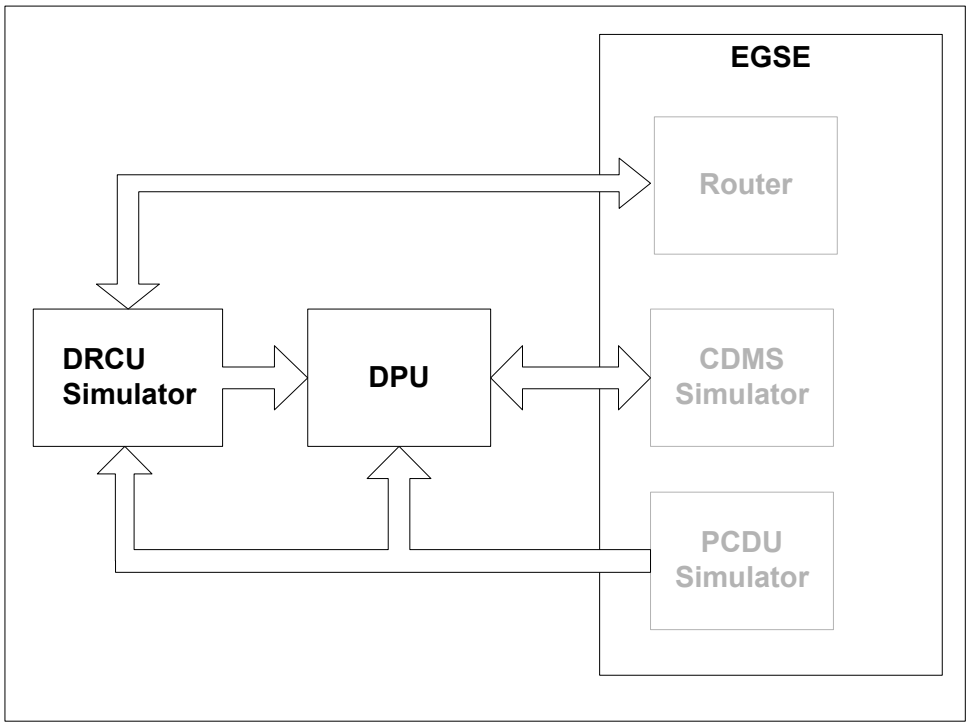

Figure 2-2 Test Setup for Warm Electronics Integration Tests at RAL

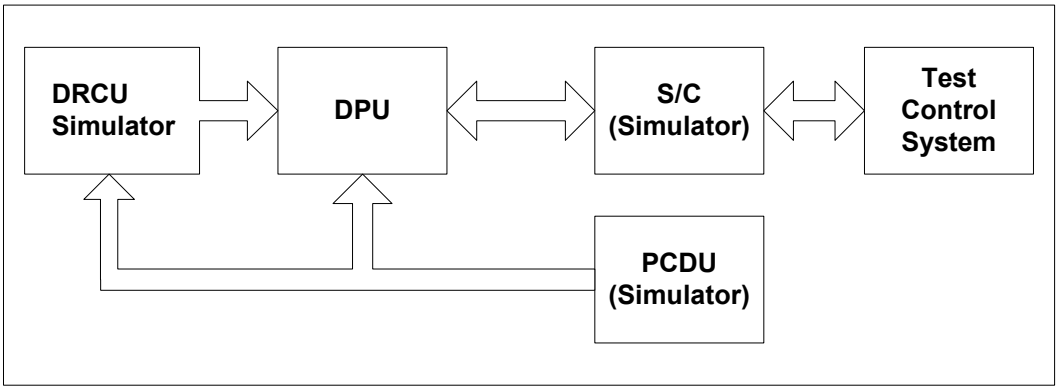

Figure 2-3 Test Setup for AVM Tests at 'ESA'

2.2 Identified Users

2.2.1 DPU Test Engineer

The DPU Test engineer will use the DRCU Simulator to test the low-speed and high-speed interfaces between the DPU and the DRCU Simulator. This will give confidence in their correct operation before integration of the DPU with the DRCU proper. These tests will form part of the acceptance test of the DPU.

2.2.2 OBS Software Developer

The On-Board Software developer will use the DRCU Simulator to test the correct operation of the OBS in all operational modes and in the case of anomalies. The DPU will provide commands to the DRCU Simulator and it will expect to receive data representative of the configuration into which the instrument has been commanded. These tests will form part of the acceptance test of the DPU.

2.2.3 SPIRE Test Engineer

The SPIRE Test Engineer will use the DRCU Simulator to integrate and test the DPU with the SPIRE AIV Facility prior to integrating the rest of the instrument.

2.2.4 ESA AIV Engineer

The ESA AIV engineer will use the DRCU Simulator during integration of the SPIRE warm electronics on to the Herschel SVM, or its simulator, and for performing avionics tests of the complete spacecraft.

3. REQUIREMENTS

3.1 Capability Requirements

3.1.1 General

DRCUS-UR-GEN-0010 The DRCU Simulator simulate the operation of the SPIRE FPU, JFET boxes, Cryoharness and DRCU when operating in their nominal environment
For example, t*here is no need to simulate operation when the FPU is warm*

DRCUS-UR-GEN-0020 The DRCU Simulator shall respond to instrument commands by generating telemetry representative of the instrument in its commanded state
More details about how representative the telemetry should be is contained in the following requirements.

DRCUS-UR-GEN-0040 The DRCU Simulator shall maintain a representation of the current instrument status that shall be modifiable and displayable by the operator
This status will be displayed on the operator screen and will be modified to set up anomalous configurations

DRCUS-UR-GEN-0050 The DRCU Simulator shall be capable of logging all data sent between itself and the DPU for a minimum of 1 hour.
For commands from the DPU, the log should contain at least: the time of arrival of the command; the command received; and the response returned to the DPU.
For telemetry sent to the DPU, the log should contain at least: the time of issue of each frame; and its contents.
If the logged data is not written directly to disk the Simulator should provide the facility to copy the logged data to disk at a later stage.

DRCUS-UR-GEN-0060 The DRCU Simulator shall be capable of storing the data logs for up to 10 days of operation.

DRCUS-UR-GEN-0070 It shall be possible to display and/or print the contents of the data log in human readable form

DRCUS-UR-GEN-0080 The CDMS Simulator shall simulate the DRCU internal 'instrument clock' driven by the 312.5Hz clock signal provided with the low-speed serial interface
This clock is used to time tag all science data frames generated by the simulator

3.1.2 DRCU Commands

DRCUS-UR-CMD-0010 The DRCU Simulator shall respond to the time sync broadcast command by setting the simulated internal 'instrument clock' to zero

DRCUS-UR-CMD-0020 The DRCU Simulator shall respond to commands from the DPU setting or returning the value of the requested parameter held in the current instrument configuration.
The simulator shall respond to all the commands identified in AD-05

3.1.3 Housekeeping Data Generation

DRCUS-UR-HSK-0010 The DRCU Simulator shall be capable of generating housekeeping data based on the current instrument configuration
The simulator will have to maintain its representation of the instrument

configuration at all times in order to respond to requests for housekeeping information at any time from the DPU

DRCUS-UR-HSK-0020 The current instrument configuration shall be updated on receipt of commands from the DPU on the low-speed interface.
The requirement here is to only represent the static configuration of the instrument in the housekeeping data. There is no need to simulate short-term changes (<1 sec) in housekeeping parameters.

DRCUS-UR-HSK-0030 It shall be possible to set the current instrument configuration to a predefined state via the user interface.
It is expected that the instrument configuration for the non-operating modes will be pre defined and one of these configuration may be selected at the start of a test

3.1.4 Science Frame Generation

DRCUS-UR-SCI-0010 The DRCU Simulator shall be capable of generating science data frames in all modes defined by the DPU ICD (AD-05)
It shall be able to provide the defined test pattern data frames as well as data frames containing simulated science data

DRCUS-UR-SCI-0020 The DRCU Simulator shall be capable of generating science data frames with the following characteristics:
1. A fixed value for each parameter contained in the frame
2. A unique value for each parameter contained in the frame
3. Values corresponding to the simulated flux on the detectors at the time of data Generation

DRCUS-UR-SCI-0030 The DRCU Simulator shall be capable of generating detector data frames corresponding to the following source images at the telescope focal plane (assume non-illuminated pixels are set to a 'low' signal level, illuminated pixels to a higher value):
1. A single illuminated pixel
2. A circular array of pixels with equal illumination (a 'top hat')
3. A circular array of pixels with illumination corresponding to a Gaussian profile, with the peak at the centre

It shall be possible to specify the central pixel of each image and the maximum value and width of the circular arrays.

DRCUS-UR-SCI-0040 The detector data frames generated by the simulator shall take account of the position of the BSM mechanism.
The pixel illumination shall take the source image and apply the offset due to the BSM position to calculate the detector signal. It may be assumed that zero BSM offset corresponds to the flux from the central pixel in the telescope focal plane falling completely on the central pixel in the detector array and that any BSM offset will correspond to an exact movement to another pixel in the detector array(TBC) It may be assumed that the BSM move to its commanded position immediatey.l There is no requirement to take into account the telescope pointing.

DRCUS-UR-SCI-0050 The detector data frames generated by the simulator shall take account the time constant of the detector
Thus if the BSM moves the detector signal shall change according to an exponential curve based on the flux change on the detector and the detector time constant (RC Circuit). All detectors may be assumed to have the same time constant.

DRCUS-UR-SCI-0060 It shall be possible to add a noise component (either random or at a given frequency) into the detector data

DRCUS-UR-SCI-0070 The DRCU Simulator shall be capable of generating BSM data frames in all modes defined by the DPU ICD (AD-05)
It shall be able to provide the defined test pattern data frames and trace mode data as well as data frames containing simulated science data

DRCUS-UR-SCI-0080 The CDMS Simulator shall be capable of generating BSM data frames with the following characteristics:
1. A fixed value for each parameter contained in the frame
2. A unique value for each parameter contained in the frame
3. Values corresponding to the simulated position of the BSM at the time of data generation

DRCUS-UR-SCI-0090 The data frames generated by the BSM shall simulate the response of the BSM to changes in position
The response of the BSM position sensors to changes may be approximated by an exponential curve with a fixed time constant.

DRCUS-UR-SCI-0100 The DRCU Simulator shall be capable of generating SMEC data frames in all modes defined by the DPU ICD (AD-05)
It shall be able to provide the defined test pattern data frames and trace mode data as well as data frames containing simulated science data

DRCUS-UR-SCI-0110 The CDMS Simulator shall be capable of generating SMEC data frames with the following characteristics:
1. A fixed value for each parameter contained in the frame
2. A unique value for each parameter contained in the frame
3. Values corresponding to the simulated time of optical encoder pulse

DRCUS-UR-SCI-0120 The data frames generated by the SMEC shall simulate the movement of the SMEC performing a constant velocity scan.
There is no need to simulate velocity errors in the SMEC scanning (TBC)

3.1.5 Interfaces

DRCUS-UR-IF-0010 THE DRCU Simulator shall provide an interface to the operator to allow changes to the current instrument configuration to be made in real time.
The operator will require to make changes to the simulator operation (e.g. to simulate anomalous behaviour) in real time. More details are given in the User Interface section

DRCUS-UR-IF-0020 The DRCU Simulator shall interface with the DPU using the low-speed and high-speed serial interfaces defined in AD-05
This includes any redundancy necessary to operate with the redundant DPU

DRCUS-UR-IF-0030 The DRCU Simulator shall provide an interface to the S/C power subsystem as defined in AD-06
Required for AVM Test Phase only
The DRCU itself takes its power from the spacecraft 28v bus. I must be possible to connect this to the DRCU simulator during AVM tests.

DRCUS-UR-IF-0040 The DRCU Simulator interface to the S/C Power subsystem shall simulate the power dissipation of the DRCU in the SPIRE Operational modes (see AD-07)

Required for AVM Test Phase only
ESA will expect typical power dissipation during AVM testing

DRCUS-UR-IF-0050 The DRCU shall be capable of reacting to the state of the S/C power interface
The simulator should react to commands or generate telecommands until power is supplied to this interface. Note this may be overwritten - see Operational Constraints section

DRCUS-UR-IF-0060 The DRCU Simulator shall provide a 100 Mbps Ethernet interface with TCP/IP protocol.
This will allow remote control of the simulator using VNC or equivalent when the simulator is in a different room or a long way from the operator. It will also allow operation through the router interface of the SPIRE EGSE

DRCUS-UR-IF-0070 The DRCU Simulator shall be capable of operation through the router interface of the SPIRE EGSE.
AD-08 defines this interface which allows the EGSE to send commands to test equipment in the form of Herschel telecommand packets and to receive telemetry packets from the test equipment.

3.1.6 Anomalous Behaviour

DRCUS-UR-ANO-0010 It shall be possible, at any time, to set the values of one or more housekeeping parameters, irrespective of the current instrument configuration using the user interface
This shall be used to simulate anomalous behaviour of subsystems in order to test autonomous actions in the OBS based on the monitoring of instrument housekeeping parameters

DRCUS-UR-ANO-0020 It shall be possible to set the simulator to not supply an acknowledgement to requests from the DPU on the low-speed interface
This will allow testing of the OBS interface functions

DRCUS-UR-ANO-0030 It shall be possible to return an error indication in response to a request from the DPU on the low-speed interface
This will allow testing of the OBS interface functions

DRCUS-UR-ANO-0040 The DRCU Simulator shall be capable of simulating the reset of the DRCU DSP due to watchdog time out

3.1.7 User Interface

DRCUS-UR-IF-0020 The DRCU Simulator shall provide an interface to the operator to allow changes to the internal instrument configuration to be made in real time.
The operator will require to make changes to the simulator operation (e.g. to simulate anomalous behaviour) in real time

DRCUS-UR-UI-0010 The DRCU Simulator shall be capable of displaying the current instrument status continously
It should be possible to display the values of at least 20 parameters associated with the current instrument configuration continuously in one window. More than one window may be displayed at once to allow the display of all the parameters, though these may overlap on the display screen

DRCUS-UR-UI-0020 The DRCU Simulator shall be capable of displaying the command and science frame logs in real time
In practice only the last few entries (e.g. 20) need be displayed.

3.2 Constraint Requirements

3.2.1 Operational Constraints

DRCUS-UR-OPS-0010 It shall be possible to operate the DRCU Simulator with, or without, the spacecraft power applied
The spacecraft power interface will not be used during SPIRE testing. During AVM testing the simulator should react to the spacecraft power being supplied to the DRCU

3.2.2 Performance Constraints

DRCUS-UR-PERF-0010 The DRCU Simulator shall operate apparently in real time
I.e. it shall generate data that is tagged with the times corresponding to the time of commanding. It is acceptable that the data itself is generated with a delay of up to 1 second (TBC).

3.2.3 Reliability, Maintainability and Availability Requirements

DRCUS-UR-REL-0010 The DRCU Simulator shall run on an IBM PC compatible computer (running the Windows operating system (NT or 2000), TBC) with additional interface cards (PCI compatible)

DRCUS-UR-REL-0020 The DRCU Simulator shall not utilise more than 20% of the CPU time, 20% of the memory or 50% of the disk space of the system on which it runs during normal operation.
This is to allow other applications, e.g. to examine logs, to be run concurrent with the simulator operation.

DRCUS-UR-REL-0030 All source code, libraries and development tools shall be provided with the system
It should be possible to regenerate the software on the DRCU Simulator machine. As far as possible the software will be written in a high-level programming language (e.g. C).

3.2.4 Safety Requirements

DRCUS-UR-SAF-0010 The DRCU Simulator shall be designed to protect the DPU from any failure in the DRCU Simulator.
In particular, interface circuitry should be isolated from the main DRCU Simulator power supply in order to prevent the possibility of mains supply voltages being applied to the DPU