Photometer Calibrator (PCal)

Failure Modes Effects & Criticality Analysis (FMECA) Report

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Date	Version	Remarks
31/08/01	1.0	First Issue for DDR
25/01/02	2.0	First configuration controlled issue

List of Acronyms

Term	Meaning	Term	Meaning
AD	Applicable Document	IR	Infrared
ADC	Analogue to Digital Converter	IRD	Instrument Requirements Document
AIV	Assembly, Integration and Verification	IRTS	Infrared Telescope in Space
AME	Absolute Measurement Error	ISM	Interstellar Medium
AOCS	Attitude and Orbit Control System	JFET	Junction Field Effect Transistor
APART	Arizona's Program for the Analysis of Radiation Transfer	ISO	Infrared Space Observatory
APE	Absolute Pointing Error	LCL	Latching Current Limiter
ASAP	Advanced Systems Analysis Program	LIA	Lock-In Amplifier
ATC	Astronomy Technology Centre, Edinburgh	LVDT	Linear Variable Differential Transformer
AVM	Avionics Model	LWS	Long Wave Spectrometer (an instrument used on ISO)
BDA	Bolometer Detector Array	MAC	Multi Axis Controller
BFL	Back Focal Length	MAIV	Manufacturing, Assembly, Integration and Verification
BRO	Breault Research Organization	MCU	Mechanism Control Unit = HSMCU
BSM	Beam Steering Mirror	MGSE	Mechanical Ground Support Equipment
CBB	Cryogenic Black Body	M-P	Martin-Puplett
CDF	Cardiff, Department of Physics & Astronomy	NEP	Noise Equivalent Power
CDMS	Command and Data Management System	NTD	Neutron Transmutation Doped
CDMU	Command and Data Management Unit	OBS	On-Board Software
CDR	Critical Design Review	OGSE	Optical Ground Support Equipment
CEA	Commissariat a l'Energie Atomique	OMD	Observing Modes Document
CMOS	Complimentary Metal Oxide Silicon	OPD	Optical Path Difference
CoG	Centre of Gravity	PACS	Photodetector Array Camera and Spectrometer
CPU	Central Processing Unit	PCAL	Photometer Calibration source
CQM	Cryogenic Qualification Model	PFM	Proto-Flight Model
CVV	Cryostat Vacuum Vessel	PID	Proportional, Integral and Differential (used in the context of feedback control loop architecture)
DAC	Digital to Analogue Converter	PLW	Photometer, Long Wavelength
DAQ	Data Acquisition	PMW	Photometer, Medium Wavelength
DCU	Detector Control Unit = HSDCU	POF	Photometer Observatory Function
DDR	Detailed Design Review	PROM	Programmable Read Only Memory
DM	Development Model	PSW	Photometer, Short Wavelength
DPU	Digital Processing Unit = HSDPU	PUS	Packet Utilisation Standard
DSP	Digital Signal Processor	RAL	Rutherford Appleton Laboratory,
DQE	Detective Quantum Efficiency	RD	Reference Document
EDAC	Error Detection and Correction	RMS	Root Mean Squared
EGSE	Electrical Ground Support Equipment	SCAL	Spectrometer Calibration Source
EM	Engineering Model	SCUBA	Submillimetre Common User Bolometer Array
EMC	Electro-magnetic Compatibility	SED	Spectral Energy Distribution
EMI	Electro-magnetic Interference	SMEC	Spectrometer Mechanics
ESA	European Space Agency	SMPS	Switch Mode Power Supply
FCU	FCU Control Unit = HSFCU	SOB	SPIRE Optical Bench
FIR	Far Infrared	SOF	Spectrometer Observatory Function
FIRST	Far Infra-Red and Submillimetre Telescope	SPIRE	Spectral and Photometric Imaging Receiver
FOV	Field of View	SRAM	Static Random Access Memory
F-P	Fabry-Perot	SSSD	SubSystem Specification Document
FPGA	Field Programmable Gate Array	STP	Standard Temperature and Pressure
FPU	Focal Plane Unit	SVM	Service Module
FS	Flight Spare	TBC	To Be Confirmed
FTS	Fourier Transform Spectrometer	TBD	To Be Determined
FWHM	Full Width Half maximum	TC	Telecommand
GSFC	Goddard Space Flight Center	URD	User Requirements Document
HK	House Keeping	UV	Ultra Violet
HOB	Herschel Optical Bench	WE	Warm Electronics
HPDU	Herschel Power Distribution Unit	ZPD	Zero Path Difference
HSDCU	Herschel-SPIRE Detector Control Unit		
HSDPU	Herschel-SPIRE Digital Processing Unit		
HSFCU	Herschel-SPIRE FPU Control Unit		
HSO	Herschel Space Observatory		
IF	Interface		
IID-A	Instrument Interface Document - Part A		
IID-B	Instrument Interface Document - Part B		
IMF	Initial Mass Function		

Table of Contents

1. Scope

This document presents the results of the FMECA carried out on the PCAL design.

2. Documents

2.1. Applicable documents

All applicable documents are listed in the AD chapter of the CIDL (HSO-CDF-LI-029).

2.2. Reference documents

3. Details of the analysis

A failure modes effects and criticality analysis has been performed on all functional elements of PCAL (excluding structural elements whose integrity has been assessed with stress analysis and fracture mechanics analysis as necessary) which can cause failure effects within the experiment or cause damage to or interfere with, the proper functioning of the SPIRE instrument or Herschel spacecraft.

Each failure effect identified has been given a criticality category according to the definition below:

- Category 1**:** The failure effect is not confined to the subsystem. When this failure results also in loss or degradation of the instruments function this shall be stated.

- Category 2: The failure results in loss or degradation of the subsystems function but the effect is confined to the subsystem.

- Category 3: Minor internal subsystem failures.

The following attributes have been added to the criticality category as appropriate:

- "R", if the design contains a redundant item which can perform the same function
- "SH", if the failure effect causes a safety hazard
- "SPF" if the failure is caused by a single point failure.

The following failure modes have been considered: -

Premature operation
Failure to operate (at the prescribed time)
Failure to cease operation (at the prescribed time)
Failure during operation
Degradation or out of tolerance operation
For failure at component level e.g. hardware interface
- short circuit
- open circuit
- incorrect function e.g. from single event upset - ex: latch-ups.

Incorrect commands or sequence of commands
Incorrect software functions
Mechanical failure

Design specifications, descriptions functional diagrams etc. used in the preparation of the FMECA shall be attached or referenced.

Table 1 Results of FMECA of the PCal subsystem.

FAILURE MODES EFFECTS AND CRITICALITY ANALYSIS (FMECA)

Product: SPIRE Instrument
Project/Phase: Herschel
System/Subsystem/Equipment: Photometer Calibrator (PCal)
Mission phase/Operational Mode: Space Flight
Prepared by: P.Hargrave
Approved by:
Date: 25/08/01
Document reference:
Issue:

Id number	Item/ block	Function	Failure mode	Failure cause	Failure effects a. Local effects b. End effects	Severity	Failure detection method/ observable symptoms	Compensation provisions	Correction actions	Remarks
000.001	PCAL assembly		Input power short to ground	Connector failure	a. Loss of PCAL b. Modification to observation program – calibrate photometer detectors off astronomical source	2R	Very low voltage drop across PCAL wires (constant current drive)	Switch to redundant side	None	
000.002			Input power open circuit	Connector failure	a. Loss of PCAL b. Modification to observation program – calibrate photometer detectors off astronomical source	2R	No current flow in circuit	Switch to redundant side	None	
001.001	PCAL source	Radiant source	Source support wire breaks	Manufacturing error	a. Loss of PCAL. b. Modification to observation program – calibrate photometer detectors off astronomical source	2(R)	No current flow in circuit	Switch to redundant side.	None	
001.002			Source impedance changes	Ageing effect	a. Modified power dissipation and temperature characteristics. b. Loss off confidence in repeatability of signal. Possibility of increased power dissipation in BSM.	3R	Changed V/I characteristics	Switch to redundant side	Modify drive current to get same source temperature.	
001.003			Mica substrate cracks	Manufacturing error	a. Loss of PCAL. b. Modification to observation program – calibrate photometer detectors off astronomical source	2(R)	No current flow in circuit	Switch to redundant side.	None	

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