Mechanism Control Unit

Failure Mode Effects And Critically Analysis

DRAFT ISSUE TO BE COMPLETED

Prepared by :	Date :
Didier Ferrand	20/09/2001
Checked by :	**Date :**
Dominique Pouliquen	20/09/2001

Centre National de la Recherche Scientifique - Laboratoire Astrophysique de Marseille
BP 8 - 13376. Marseille Cedex 12. Tel. : 33 .4.91.05.59.00 - Fax : 33 .4.91.66.18.62

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Acronyms

AD	Applicable Document
AVM	Avionics Model
BOL	Begin Of Life
BSM	Beam Steering Mirror
CQM	Cryogenic Qualification Model
EGSE	Electrical Ground Support Equipment
EOL	End of Life
ESA	European Space Agency
FIRST	Far Infra Red and Sub-millimeter Telescope
FM	Flight Model
FPU	Focal Plane Unit
FTS	Fourier Transform Spectrometer
FTSE	FTS warm Electronics
FTSP	FTS Preamplifier for the position encoder signals
H/K	House Keeping
H/W	Hardware
I/F	Interface
LAM	Laboratoire Astrophysique de Marseille
MAC	Multi Axes Controller
MCU	Mechanism Control Unit
N/A	Not Applicable
RAL	Rutherford Appleton Laboratory
RD	Reference Document
ROE	Royal Observatory of Edinburgh
S/C	Spacecraft
SM	Spare Model
SMEC	Spectrograph MEChanism
S/W	Software
TBC	To Be Confirmed
TBD	To Be Define
TBW	To Be Written
TC	Tele-Command
TM	TeleMetry
WE	Warm Electronics

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this document is to describe the potential failure effects of the MCU electronics and software.

1.2 APPLICABLE AND REFERENCE DOCUMENTS

1.2.1 Applicable documents

AD1	Operating Modes for the SPIRE Instrument (SPIRE-RAL-DOC-000320)
AD2	FIRST/Planck Packet Structure Interface Control Document (SCI-PT-IF-07527)
AD3	Spire Spectrometer Mirror Mechanism Subsystem Specification (SPIRE-LAM-PRJ-000460)
AD4	FIRST / Planck Instrument Interface Document Part B (SCI-PT-IIDB/SPIRE-02124)
AD5	DRCU Electrical Interface Control Document (SAp-SPIRE-CCa-24-00)
AD6	SPIRE Instrument Requirements Specification (IRD) (SPIRE-RAL-PRJ-000034)

1.2.2 Reference documents

RD1	MCU Design Description

2 SYSTEM OVERVIEW/SCOPE

The **MCU** is part of the **DRCU** and has electrical (Main Power Supplies) and mechanical (Electronics Cabinet) interfaces with it.
The **MCU** is dedicated to the control and monitoring of the following **3 axis** of the SPIRE instrument:

- the Spectrometer Mechanism (**SMEC**). The control is typically based on a scan at a configurable speed, but can be set-up on the basis of a step position control in case of use of the step and integrate mode of the instrument.
- the **Chopper** and **Jiggle** axis of the Beam Steering Mirror subsystem. The control is a position step control pattern.

The MCU control electronics includes:

- the **MAC Board** : common digital control board based on a **21020 DSP** including :
  - 3 DACs for SMECm and BSMm motor control,
  - 1 multiplexed 16 bits ADC for SMEC and BSM analogue signal acquisitions,
  - 8 logical inputs
  - 12 logical outputs.
- **a SMEC Board** : analogue electronics for the power amplification of the actuators and acquisition electronics for sensors pre-amplification and conditioning of the SMEC subsystem
- **a BSM Board** : analogue electronics for the power amplification of the actuators and acquisition electronics for sensors pre-amplification and conditioning of the BSM subsystem

The design is described in the MCU Design Description document (RD1).

3 FMECA

Subsystem/ Component in failure	Failure description	Failure Cause	Identification mean	Failure Effect	Recovering Compensation provision
Interface electronics	No command can be received	Open connection Driver internal failure	the DPU has no command handshake	MCU out of control All motion stopped and the MAC automatically resets after time-out	Switch to redundant
	Bad command/parameter	Glitch on the line Invalid parameter	Checksum/No recognition of a command	None because the command is verified	Stop of the scan Status report Switch to stand-by mode waiting for another control mode operation
DSP and related interface components	Control algorithm diverging	Bad PID parameter configuration	software limits (maximum position error and maximum speed)	Increase of the actuator command up to limitation	Stop of the scan Status report Switch to stand-by mode waiting for another control mode operation
	No control on the DSP	Glitch in the program memory	Watchdog by bus Control FPGA	DSP out of control	Emergency stop on watchdog action and reset by Bus Control FPGA
Motor and related PWR amp	Short cut in the motor coil	Internal Failure	I Motor=Iref=Imeas. Backemf=0	Limitation of current and motion stop after detection	Use of the redundant board + motor coil.
	Motor coil open	Internal failure	Imot=Imeasured=0 Backemf=12V	Motion stopped	Use of the redundant board + motor coil.
	Harness open	Internal failure or no connected	Imot=Imeasured=0 Backemf=0	Motion stopped	Use of the redundant board + motor coil.
	Measure resistance open	Internal failure of V->I Resistance	Imot=0 Imeasured=high Backemf=0	Motion stopped	Use of the redundant board + motor coil.
Optical encoder and related acquisition electronics	Loss of some individual incremental pulses during closed loop operation	Encoder misaligment	Difference between fiducial mark and position counter	Perturbation on the trajectory	Status report Adjust the position counter on next scan or switch to LVDT/Open loop control degraded mode
	Total loss of incremental encoder pulses	Encoder internal failure	id.	Error vs ramp reference increase -> Increase of the actuator command due to integral effect and position ramp increase -> Excessive motion speed up to speed limitation. -> Emergency stop.	Stop of the scan Status report Switch to stand-by mode waiting for another control mode operation
	Glitch on the absolute position counter (decreasing)		Additional position switch on the mechanics	The scan goes to hardware limits	Flyback operation and reset of the absolute position counter

	Glitch on the absolute position counter (increasing)		The scan ends before the nominal scan length parameter, and a difference between fiducial mark and position counter occurs at the end of flyback	The scientific scan is not achieved completely	Status report Readjust the position counter on next scan