SPIRE/Herschel System Interface FMECA

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0 Scope

This document is a hardware/functional Failure Modes and Effects Criticality Analysis conducted during SPIRE Phase C/Herschel System Phase B to ensure compatibility of SPIRE design with system requirements. It is particularly directed towards the interfaces between the instrument and the Herschel system. The detailed failure modes etc of the internal sub-systems within the SPIRE instrument have been dealt with individually in the SPIRE sub-systems FMECAs.

Only those sub-systems with a direct interface to the Herschel system are discussed in this document. Analysis of the critical sub-system level FMECAs (RD3, RD4 and RD5) shows that there are no other identified failure modes that can lead to permanent failure or effects propagation beyond the SPIRE instrument – i.e. apart from those discussed in this document, there are no identified failure modes within the SPIRE instrument which cause effects when the instrument is non-operational. Effects on the system when SPIRE is operational are considered non-permanent and to be dealt with by changes to SPIRE operations; that is, they impair the function of SPIRE only.

This document identifies each interface between SPIRE and the Herschel systems and briefly describes the type of interface. In the IID-B (AD1) there is a detailed description of the design of the interfaces. The analysis presented here covers failures on launch and subsequent flight operations and the effects of any failures on the flight operations of Herschel and/or SPIRE. The likelihood of the failure occurring during launch and flight operations is assessed together with the effects on the system/instrument of identified failures and how the effects will manifest themselves during flight operations. The mitigation of any failures and effects in the design and operation of the instrument are described and a criticality number is computed for each failure mode.

1 Applicable and Reference Documents

1.1 Applicable Documents

AD1 – SPIRE IID-B plus annexes with interface control drawings
AD2 - Space product assurance: Failure modes, effects and criticality analysis (FMECA) – ECSS-Q-30-02A

1.2 Reference Documents

RD1 – Design Description Document - SPIRE-RAL-PRJ-000620
RD2 – SPIRE Block Diagram - SPIRE-RAL-DWG-000646 issue 4.8 30 September 2002
RD3 - DRCU - Architecture and Reliability Analysis Report - SAp-SPIRE-FLo-0039-01
RD4 – SPIRE Structure FMECA - MSSL/SPIRE/PA005.01
RD5 – SPIRE DPU FMECA - SPIRE-IFS-DOC-000785
RD6 – SPIRE Mechanical Interface Control Drawing pack – SPIRE-RAL-DWG-001409 issue 3

2 Document Status

ISSUE	DATE	Comments/Changes
0.1	10 May 2002	New Document – draft for discussion
0.2	21 May 2002	Changed parts level for DPU interfaces from “C” to “B” following comment form Renato Orfei. This version sent to Estec
1.0	1 Nov 2002	Updated following comments from Jan Rautakoski: Added Block diagram issue number Added Mechanical ICD as reference document for design of interfaces Added explanation of use of severity; probability and criticality numbers. Added “R” to criticality of cold redundant interfaces. Reassessed JFET mechanical/thermal interfaces in light of design changes.

3 SPIRE Interfaces to the Herschel System

SPIRE consists of a cold FPU; two cold JFET amplifier boxes and three warm electronics units. The instrument is described in detail in RD1 and the interfaces to the system are described in AD1. The block diagram (RD2) of the instrument shows the following interfaces between the SPIRE instrument and the Herschel system. Here the interfaces are identified and given ID numbers for use later.

3.1 HSFPU mechanical/thermal interfaces:

HSFPU IF1.1, 1.2. 1.3:
3 mechanical attachment points onto the Herschel Optical Bench (HOB) – for design see RD6 drawing A1-5264-300 sheet 4

HSFPU IF 2.1, 2.2, 2.3:
3 “level 0” thermal strap attachment points – for design see RD6 drawing A1-5264-300 sheet 5

HSFPU IF 2.4:
1 “level 1” thermal strap attachment point – for design see RD6 drawing A1-5264-300 sheet 5

HSFPU IF 3.1 - 3.14:
14 cryoharness connections

3.2 JFET Boxes mechanical/thermal interfaces

HSJFP IF 1.1-1.5
5 mechanical attachment points to the HOB with thermally isolating CFRP bushes - for design see RD6 drawing A0-KE-0104-350-C

HSJFP IF 2.1-2.2
1 “level 3” thermal attachment point onto aluminium bar via 2 M4 bolts - see RD6 drawing A0-KE-0104-350-C. System side of interface not yet defined

HSJFP IF 3.1-3.28
28 cryoharness connections

HSJFS IF 1.1-1.4
4 mechanical attachment points to the HOB with thermally isolating CFRP bushes - for design see RD6 drawing A0-KE-0104-360-E

HSJFS IF 2.1-2.2
1 “level 3” thermal attachment point onto aluminium bar via 2 M4 bolts - see RD6 drawing A0-KE-0104-360-E. System side of interface not yet defined

HSJFS IF 3.1-3.10
10 cryoharness connections

3.3 Warm Electronics Mechanical/Electrical Interfaces

HSDCU IF 1.1-1.N
12 Mechanical attachment points to the Herschel SVM with M4 bolts - see RD6 drawing A0-SPIR-MX-5100-000-D

HSDCU IF 2.1-2.28
28 SVM intermediate harness connections (24 non-redundant)

HSDCU IF 3.1-3.4
4 SPIRE warm harness connections (2 data 2 power – 1data 1 power on each of prime and redundant sides)

HSFCU IF 1.1-1.N

12 Mechanical attachment points to the Herschel SVM with M4 bolts - see RD6 drawing A0-SPIR-MX-5200-000-F

HSFCU IF 2.1-2.2

2 connections to S/C primary power (redundant not cross strapped to primary power prime and redundant)

HSFCU IF 3.1-3.16

16 SVM intermediate harness connection (8 on each of prime and redundant sides)

HSFCU IF 4.1-4.6

6 SPIRE warm harness connections (4 data 2 power – 2 data and 1 power on each of prime and redundant sides)

HSDPU IF 1.1-1.6

6 Mechanical attachment points to the Herschel SVM

HSDPU IF 2.1-2.2

2 connections to S/C primary power (redundant not cross strapped to primary power prime and redundant)

HSDPU IF 3.1-3.4

4 data interfaces to the CDMU – one from each of SPIRE prime and redundant side to each of CDMU prime and redundant side

HSDPU IF 4.1-4.6

6 SPIRE warm harness connections (3 data connections on each of prime and redundant sides)

4 FMECA Tables

4.1 Definitions

In the FMECA tables the definitions of Severity Number; Probability Number and Criticality number used are as follows (taken from AD2):

Table 4-1: Definition of Severity Category

Severity category	Failure effect
Catastrophic 1S	Loss of life, life threatening or permanently disabling injury or occupational illness, loss of an element of an interfacing manned flight system.
	Loss of launch site facilities.
	Long-term detrimental environmental effects.
Catastrophic 1	Propagation of failure to other subsystems/assemblies/equipment.
Critical 2S	Temporary disabling but not life threatening injury, or temporary occupational illness.
	Loss of, or major damage to other flight systems, major flight elements, or ground facilities.
	Loss of, or major damage to public or private property.
	Short-term detrimental environmental effects.
Critical 2	Loss of functionality.
Major 3	Degradation of functionality.
Negligible 4	Any other effect.

Table 4-2: Equivalent Severity Number

Severity category	SN
1S, 1 catastrophic	4
2S, 2 critical	3
3 major	2
4 negligible	1

Table 4-3: Probability Number

Level	Limits	PN
Probable	P > 10E—2	4
Occasional	10E--4 < P ≤ 10E—2	3
Remote	10E--5 < P ≤ 10E—4	2
Extremely remote	P ≤ 10E—5	1

For the SPIRE interfaces to the Herschel system considered here there is no risk of personal injury; damage to the launch site or long term environmental effects; severity categories 1S and 2S therefore do not apply. Severity category 1 is considered appropriate to consider as it is possible that failure of a SPIRE interface may propagate to other parts of the system. Severity categories 2,3 and 4 are self explanatory and used as defined in table 4-1.

Whilst the epithets *probable; occasional; remote* and *extremely remote* are used to give a judgement on the likelihood of a failure when determining the criticality of an interface, placing a numerical limit on them as defined in table 4-3 is not realistic as the nature of the interfaces considered does not permit this type of analysis.

The Criticality Number for an interface failure mode is defined in the standard way as SN x PN. Any interface failure mode with a criticality greater than 8 is considered unacceptable to the SPIRE project team. The design of all interfaces has been analysed to ensure that the level criticality is always ≤8. Interfaces that are fully cold redundant are designated with a criticality number #R. Some interfaces, such as the connectors to the JFET units, are partially redundant only so are not designated #R.

Table 4-4: FMECA WorkSheets for SPIRE Interfaces to Herschel

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSFPU	IF1.1-1.3	Mechanical mounting feet	Collapse or breakage due to launch environment	Launch	Loss of SPIRE instrument; possibility of SPIRE hitting other instrument; possible thermal short between thermal levels L0 and L1 and/or L1 and L2	During LEOP large boil off rate detected due to increased loads. Anomalous temperatures on SPIRE straps.	Mitigated by instrument level qualification program and instrument/system level acceptance testing. If failure occurs no recovery is possible.	4	1	4
HSFPU	IF2.1-2.2	Level 0 Thermal Straps to cooler	Breakage of the strap supports due to launch environment. Strap remains connected to tank but may contact HOB or SPIRE instrument box	Launch	Damage to SPIRE cooler Impaired operation of SPIRE instrument Thermal short between L0 and L1 and/or L2	During LEOP large boil off rate detected due to increased loads. Anomalous temperatures on SPIRE straps and/or internal temperature sensors Inability to operate SPIRE cooler	Mitigated by instrument level qualification program and instrument/system level acceptance testing. Depending on precise failure some instrument operation may still be possible with reduced efficiency	4	1	4

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSFPU	IF2.1-2.2	Level 0 Thermal Straps to cooler	Breakage of strap support at light baffle due to launch environment. Strap remains connected to tank but may contact SPIRE instrument box	Launch	Damage to SPIRE cooler Impaired operation of SPIRE instrument Thermal short between L0 and L1	During LEOP increased boil off rate detected due to increased loads. Anomalous temperatures on SPIRE straps and/or internal temperature sensors Inability to operate SPIRE cooler	Mitigated by instrument level qualification program and instrument/system level acceptance testing. Depending on precise failure some instrument operation may still be possible with reduced efficiency	3	1	3
HSFPU	IF2.3	Level 0 Thermal Straps to detector box	Breakage of the strap supports due to launch environment. Strap remains connected to tank but may contact HOB or SPIRE instrument box	Launch	Impaired operation of SPIRE instrument Thermal short between L0 and L1 and/or L2	During LEOP increased boil off rate detected due to increased loads. Anomalous temperatures on SPIRE straps and/or internal temperature sensors	Mitigated by instrument level qualification program and instrument/system level acceptance testing. Depending on precise failure some instrument operation may still be possible with reduced efficiency	3	1	3

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSFPU	IF2.3	Level 0 Thermal Straps to detector box	Breakage of strap support at light baffle due to launch environment. Strap remains connected to tank but may contact SPIRE instrument box	Launch	Impaired operation of SPIRE instrument Thermal short between L0 and L1	During LEOP increased boil off rate detected due to increased loads. Anomalous temperatures on SPIRE straps and/or internal temperature sensors	Mitigated by instrument level qualification program and instrument/system level acceptance testing. Depending on precise failure some instrument operation may still be possible with reduced efficiency	3	1	3
HSFPU	IF2.4	Level 1 Thermal Strap	Strap bolts directly to the SPIRE structure. No reasonable failure mode foreseen on SPIRE side of the interface	N/A	N/A	N/A	N/A	-	-	-
HSFPU	IF3.1-3.14	MDM cryoharness connections at FPU wall	SPIRE side of the interface consists of MDM mounted firmly on FPU wall. System harness may yank on this due to differential movement of harness and FPU interface causing structural failure and possible circuit failure	Launch	Impaired operation of SPIRE instrument.	Inability to operate one or more SPIRE sub-systems – no response from sensors or other equipment.	Mitigated by instrument and system level qualification programmes and instrument/system level acceptance testing. Depending on precise failure only one side of the instrument (P or R) may be affected.	3	2	6

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSFPU	IF3.1-3.14	MDM Cryoharness connections at FPU wall	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument	Inability to operate one or more SPIRE sub-systems – no response from sensors or other equipment.	Mitigated by design and instrument/system level acceptance testing. Depending on precise failure only one side of the instrument (P or R) may be affected.	2	2	4
HSJFP	IF1.1-1.5	Mechanical attachment points to HOB	Collapse or breakage due to launch environment leading to thermal short between JFET box and HOB. (Assume the box remain attached somehow and doesn't destroy the instruments)	Launch	Increased load onto HOB during SPIRE photometer mode operations – temperature of HOB will rise. No effect if SPIRE not operational.	Increased temperature seen on sensor close to HSJFP mounting point.	Mitigated by design and instrument/system level acceptance testing. Operational – use SPIRE photometer mode less or reduce power dissipated from photometer JFETs.	2	1	2
HSJFP	IF2.1-2.2	Level 3 thermal strap interface	Breakage of aluminium bar holding strap leading to poor thermal connection	Launch	Impaired cooling of JFET unit. JFET unit will increase in temperature during operation – possible increase in load to L1 down harness	Decreased power required for JFET operation. Possible increase in SPIRE L1 temperatures. Possible increase in straylight levels due to elevated JFET temperature.	Mitigated by design and instrument/system level acceptance testing. Operational – use SPIRE photometer mode less or reduce power dissipated from photometer JFETs.	2	1	2

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSJFP	IF3.1-3.28	MDM cryoharness connections at JFET box	SPIRE side of the interface consists of MDM mounted firmly on JFET unit wall. System harness may yank on this due to differential movement of harness and JFET box interface causing structural failure and possible circuit failure	Launch	Impaired operation of SPIRE instrument.	Inability to operate one or more JFET unit and/or detector arrays – no response from detectors.	Mitigated by instrument and system level qualification programmes and instrument/system level acceptance testing. Many channels of detectors are present so loss of one JFET modules causes only partial loss of functionality – no recovery possible for loss of JFET module. Bias lines are cold redundant at instrument level.	3	2	6

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSJFS	IF3.1-3.28	MDM cryoharness connections at JFET box	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument.	Inability to operate one or more JFET unit and/or detector arrays – no response from detectors.	Mitigated by design and instrument and system level instrument/system level acceptance testing. Loss of a single JFET module on the spectrometer causes a severe loss of instrument functionality – no recovery possible for loss of JFET module. Bias lines are cold redundant at instrument level.	3	2	6
HSJFS	IF1.1-1.4	Mechanical attachment points to HOB	Collapse or breakage due to launch environment leading to thermal short between JFET box and HOB. (Assume the box remain attached somehow and doesn't destroy the instruments)	Launch	Increased load onto HOB during SPIRE photometer mode operations – temperature of HOB will rise. No effect if SPIRE not operational.	Increased temperature seen on sensor close to HSJFFP mounting point.	Operational – use SPIRE spectrometer mode less or reduce power dissipated from spectrometer JFETs.	2	1	2

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSJFS	IF2.1-2.2	Level 3 thermal strap interface	Breakage of aluminium bar holding strap leading to poor thermal connection	Launch	Impaired cooling of JFET unit. JFET unit will increase in temperature during operation – possible increase in load to L1 down harness	Decreased power required for JFET operation. Possible increase in SPIRE L1 temperatures. Possible increase in straylight levels due to elevated JFET temperature.	Mitigated by design and instrument/system level acceptance testing. Operational – use SPIRE spectrometer mode less or reduce power dissipated from photometer JFETs.	2	1	2
HSJFS	IF3.1-3.10	MDM cryoharness connections at JFET box	SPIRE side of the interface consists of MDM mounted firmly on JFET unit wall. System harness may yank on this due to differential movement of harness and JFET box interface causing structural failure and possible circuit failure	Launch	Impaired operation of SPIRE instrument.	Inability to operate one or more JFET unit and/or detector arrays. No response from detectors.	Mitigated by instrument and system level qualification programmes and instrument/system level acceptance testing. Loss of a single JFET module on the spectrometer causes a severe loss of instrument functionality – no recovery possible for loss of JFET module. Bias lines are cold redundant at instrument level.	3	2	6

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSJFS	IF3.1-3.10	MDM cryoharness connections at JFET box	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument.	Inability to operate one or more JFET unit and/or detector arrays. No response from detectors.	Mitigated by design and instrument and system level instrument/system level acceptance testing. Loss of a single JFET module on the spectrometer causes a severe loss of instrument functionality – no recovery possible for loss of JFET module. Bias lines are cold redundant at instrument level.	3	2	6
HSDCU	IF1.1-1.N	Mechanical attachment point to SVM	Hard bolted to SVM panel according to interface specification. No reasonable failure mode foreseen on SPIRE side of interface.	N/A	N/A	N/A	N/A			

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSDCU	2.1-2.28	D-Type connections to SVM intermediate harness at DCU box	SPIRE side of the interface consists of connector mounted firmly on DCU unit wall. System harness may yank on this due to differential movement of harness and DCU box interface causing structural failure and possible circuit failure	Launch	Impaired operation of SPIRE instrument.	Inability to operate one or more JFET unit and/or detector arrays. No response from detectors.	Mitigated by design and instrument and system level instrument/system level acceptance testing. Loss of a single JFET module on the spectrometer causes a severe loss of instrument functionality less so for loss of photometer JFET module. No recovery possible for loss of JFET module. Bias lines are cold redundant at instrument level.	3	2	6

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSDCU	2.1-2.28	D-Type connections to SVM intermediate harness at DCU box	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument.	Inability to operate one or more JFET unit and/or detector arrays. No response from detectors.	Mitigated by design and instrument and system level instrument/system level acceptance testing. Loss of a single JFET module on the spectrometer causes a severe loss of instrument functionality less so for loss of photometer JFET module. No recovery possible for loss of JFET module. Bias lines are cold redundant at instrument level.	3	2	6
HSDCU	3.1-3.4	D-Type connections to SPIRE warm harness	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument.	Inability to communicate with DCU	Fully cold redundant at instrument level. Switch to redundant side of instrument.	2	2	4R
HSFCU	IF1.1-1.N	Mechanical attachment point to SVM	Hard bolted to SVM panel according to interface specification. No reasonable failure mode foreseen on SPIRE side of interface	N/A	N/A	N/A	N/A			

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSFCU	2.1-2.2	D-Type connections to SVM primary power harness at FCU box	SPIRE side of the interface consists of connector mounted firmly on FCU unit wall. System harness may yank on this due to differential movement of harness and FCU box interface causing structural failure and possible circuit failure	Launch	Impaired operation of SPIRE instrument.	Inability to communicate with FCU or DCU as no power present	Mitigated by and instrument and system level instrument/system level acceptance testing. Instrument is cold redundant so request CDMS to switch to redundant power line.	3	2	6R
HSFCU	2.1-2.2	D-Type connections to SVM primary power harness at FCU box	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument. Primary power LCL will trip and failure does not propagate.	System will detect LCL trip. SPIRE will detect inability to communicate with FCU and DCU.	Mitigated by design and instrument and system level instrument/system level acceptance testing. Instrument is cold redundant so request CDMS to switch to redundant power line.	3	2	6R

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSFCU	2.1-2.2	D-Type connections to SVM primary power harness at FCU box	Circuit failure within FCU causes excessive current demand on primary power line.	Operation	Impaired operation of SPIRE instrument. Primary power LCL will trip and failure does not propagate.	System will detect LCL trip. SPIRE will detect inability to communicate with FCU and DCU.	Mitigated by design (isolated supply and single component failure should not cause this failure); component selection (all interface circuits are level B) and instrument and system level instrument/system level acceptance testing. Instrument is cold redundant so request CDMS to switch to redundant power line.	3	2	6R
HSFCU	3.1-3.16	D-Type connections to SVM intermediate harness at FCU box	SPIRE side of the interface consists of connector mounted firmly on FCU unit wall. System harness may yank on this due to differential movement of harness and FCU box interface causing structural failure and possible circuit failure	Launch	Impaired operation of SPIRE instrument.	Inability to operate one or more sub-systems. No response from a given sub-system.	Mitigated by and instrument and system level instrument/system level acceptance testing. Instrument is cold redundant for all FCU sub-systems so switch to redundant side.	2	2	6R

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSFCU	3.1-3.16	D-Type connections to SVM intermediate harness at FCU box	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument.	Inability to operate one or more sub-systems. No response from a given sub-system.	Mitigated by design and instrument and system level instrument/system level acceptance testing. Instrument is cold redundant for all FCU sub-systems so switch to redundant side.	2	2	4R
HSFCU	4.1-4.6	D-Type connections to SPIRE warm harness	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument.	Inability to communicate with FCU	Fully cold redundant at instrument level. Switch to redundant side of instrument.	2	2	4R
HSDPU	IF1.1-1.6	Mechanical attachment point to SVM	Hard bolted to SVM panel according to interface specification. No reasonable failure mode foreseen.	N/A	N/A	N/A	N/A			
HSDPU	IF2.1-2.2	D-Type connections to SVM primary power harness at DPU box	SPIRE side of the interface consists of connector mounted firmly on FCU unit wall. System harness may yank on this due to differential movement of harness and FCU box interface causing structural failure and possible circuit failure	Launch	No operation of SPIRE instrument.	CDMS cannot communicate with SPIRE instrument as no power present to DPU	Mitigated by instrument and system level instrument/system level acceptance testing. Instrument is cold redundant CDMS will switch to redundant power line.	3	2	6R

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSDPU	IF2.1-2.2	D-Type connections to SVM primary power harness at DPU box	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	No operation of SPIRE instrument. Primary power LCL will trip and failure does not propagate.	System will detect LCL trip. CDMS will detect inability to communicate with SPIRE	Mitigated by design and instrument and system level instrument/system level acceptance testing. Instrument is cold redundant CDMS will switch to redundant power line.	3	2	6R
HSDPU	IF2.1-2.2	D-Type connections to SVM primary power harness at DPU box	Circuit failure within DPU causes excessive current demand on primary power line.	Operation	No operation of SPIRE instrument. Primary power LCL will trip and failure does not propagate.	System will detect LCL trip. CDMS will detect inability to communicate with SPIRE	Mitigated by design (isolated supply and single component failure should not cause this failure); component selection (all interface circuits are level B) and instrument and system level instrument/system level acceptance testing. Instrument is cold redundant CDMS will switch to redundant power line.	3	2	6R

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSDPU	IF3.1-3.4	D-Type connections to CDMS harness at DPU box	SPIRE side of the interface consists of connector mounted firmly on FCU unit wall. System harness may yank on this due to differential movement of harness and FCU box interface causing structural failure and possible circuit failure	Launch	Impaired operation of SPIRE instrument. Effect on 1553 bus?	CDMS cannot communicate with SPIRE instrument or repeated errors in communication.	Mitigated by instrument and system level instrument/system level acceptance testing. Instrument is cold redundant CDMS will switch to redundant 1553.	3	2	6R
HSDPU	IF3.1-3.4	D-Type connections to CDMS harness at DPU box	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument. Effect on 1553 bus?	CDMS cannot communicate with SPIRE instrument or repeated errors in communication.	Mitigated by instrument and system level instrument/system level acceptance testing. Instrument is cold redundant CDMS will switch to redundant 1553.	3	2	6R

Unit	Interface ID	Description	Failure Modes	Mission Phase	Effect at System Level	Failure Detection	Mitigation /Recovery	SN	PN	CN
HSDPU	IF3.1-3.4	D-Type connections to CDMS harness at DPU box	Circuit failure within DPU causes some sort of failure?	Operation	Impaired operation of SPIRE instrument. Effect on 1553 bus?	CDMS cannot communicate with SPIRE instrument or repeated errors in communication.	Mitigated by design (galvanic isolation? and single component failure should not cause this failure); component selection (all interface circuits are level B) and instrument and system level instrument/system level acceptance testing. Instrument is cold redundant CDMS will switch to redundant 1553.	3	2	6R
HSDPU	IF4.1-4.6	D-Type connectors to SPIRE warm harness	Short or open circuit due to debris or poor workmanship under lunch environment	Launch	Impaired operation of SPIRE instrument.	Inability to communicate with one or more sub-systems or repeated failures in communication	Fully cold redundant at instrument level. Switch to redundant side of instrument.	2	2	4R