HIRDLS

TC-OXF-272

HIGH RESOLUTION DYNAMICS LIMB SOUNDER

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Subject/Title: **HIRDLS IFC Failure Modes Effects Analysis (FMEA)**

Description/Summary/Contents:

A preliminary but complete assessment of the possible failure modes with the In-Flight Calibrator subsystem and their effects and actual response.

Keywords: IFC FMEA

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EOS

IFC FMEA

In Flight Calibrator Failure Modes Effects Analysis

For the purposes of this analysis the IFC is divided into the following functional blocks:

IFCBB Cavity
IFCBB science temperature sensors
IFCBB engineering temperature sensors
IFCBB heater elements

IFCBB-BEU harness

BEU PRT bridge
BEU supply current limiters
BEU IPU interface (including HCW/DRW selector
BEU data acquisition (including latches and ADC & sequencer)
BEU reference resistor temperature sensor
BEU power on reset
BEU IFCBB heater drive
BEU connectors.

The IFC has the following interfaces:
[figure from ICD sp-hir-247]

The IFC is cold redundant - having two identical sides with no cross strapping, everything is repeated between the two sides except for the IFCBB cavity. Side A or B is selected according to the side of the IPU that is selected.

A description of the IFC function is as follows:
Commands sent from the IPU request data to be read back from the IFC or to set the heater level into the IFCBB. Data returned are: PRT values, Reference resistor temperature, supply voltages, side A/B identifier. Heating levels are from 0 to 255 (dec). The IPU supplies a 125 Hz sync clock that is used by the IFC to generate internal timing events that control data acquisition and operation of the PRT bridge.

the IFCBB cavity temperature is determined by sensing the resistance of the PRTs using the BEU bridge, the balance point of the bridge is calibrated against absolute temperature of the PRTs. There are three PRTs per side on the IFCBB cavity, two on the base and one on the wall.

Two AD590 temperature sensors are mounted on the IFCBB aperture plate to provie information on its temperature to be used when scanning the filed of view across the aperture to find the best view of the cavity.

SEVERITY CATEGORY	SEVERITY DEFINITION
1 - Catastrophic	Death or serious personnel injury or vehicle loss
1R - Catastrophic Redundant	Catastrophic due to loss of both primary & redundant functions
1S - Catastrophic Safety	Catastrophic due to loss of hazard monitoring function
2 - Critical	Loss of all (x,y & Z channel) HIRDLS science data
2R - Critical Redundant	Critical due to loss of both primary and redundant functions

3 - Significant	Significant loss of HIRDLS science data or house keeping function
4 - Minor	Minor/No degradation of HIRDLS science data or house keeping function

PROBABILITY CATEGORY	**FREQUENCY DEFINITION**
A-Frequent, 0 - 0.5	Likely to occur at or before HIRDLS launch
B-Probable, 0.5 _ 0.1	Likely to occur shortly after HIRDLS launch.
C-Occasional, 0.1 _ 0.01	Possibly to occur sometime during HIRDLS 5 yr life.
D-Remote,0.001 _ 0.001	Unlikely, but possible to occur during HIRDLS 5 yr life.
E-Improbable, _0.001 _ 0	So unlikely, essentially will not occur during HIRDLS 5 yr life.

See report table

Functional Item	Function	Fail mode	Local Effect (Item)	Next higher effect (IFC)	End effect (on HIRDLS)	Severity	Likelihood	Response	Remarks
IFCBB Cavity	Cavity black surface provides high infra-red emissivity	Paint flaking	Reduced emissivity	Increased uncertainty of emission from the cavity	Reduced radiometric accuracy				Single point failure.
IFCBB Cavity	Cavity black surface	Contamination	Change of emissivity	Increased uncertainty of emission from the cavity	Reduced radiometric accuracy				Degradation - not a failure mechanism
IFCBB Cavity	Cavity aperture plate	Damage to plate deforms aperture	Change of emissivity	Increased uncertainty of emission from the cavity	Reduced radiometric accuracy				Degradation - not a failure mechanism
IFCBB PRTs	PRT sensors provide means of determining the temperature of the cavity	PRT becomes detached from the cavity	Reduced accuracy of temperature measurement from this PRT	Increased uncertainty of emission from the cavity	Negligible for one PRT, greatest for all three PRTs - reduced radiometruc accuracy			Switch to other side	
IFCBB PRTs	PRT sensors	PRT becomes open circuit	Loss of PRT chain	Loss of PRT measurement on the given side				Switch to other side	
IFCBB PRTs	PRT current leads	Supply leads become open circuit	Loss of PRT chain	Loss of PRT measurement on the given side				Switch to other side	
IFCBB PRTs	PRT sense leads								
IFCBB PRTs	PRT side A/B chains	Short Between the two chains.	Loss of both PRT chains	Loss of temperature sensing both sides	Reduced radiometric accuracy				Single point failure.
IFCBB Heater	Heater element provides heating to raise cavity temperature	Open circuit break	No heating	Cavity remains at nominal/ambient temperature.	Loss of information on calibration mirror emissivity & cavity viewing			Switch to other side.	
IFCBB Heater	Heating to cavity	Short to substrate.	No heating - return current to start earth <TBV>	Cavity remains at nominal/ambient temperature.	Loss of information on calibration mirror emissivity & cavity viewing			Switch to other side.	
IFCBB aperture plate	Aperture plate temperature sensors	Open circuit break	Loss of temperature of aperture plate	No information on temperature contrast to cavity.	Increased difficulty in searching the cavity view.			Switch to other side.	
IFCBB aperture plate	Aperture plate temperature sensors	Short to substrate.	Loss of temperature of aperture plate	No information on temperature contrast to cavity.	Increased difficulty in searching the cavity view.			Switch to other side.	
Harness (U15)	Continuity between electronics unit and IFCBB	Adjacent pin short - signal to screen	Loss of PRT signals downstream from the shorted pin.	Reduced knowledge of cavity temperature.	Possible reduced radiometric accuracy.			Switch to other side.	Depends on degree of degradation.
Harness (U15)	Continuity between electronics unit and IFCBB	Adjacent pin short - screen to screen	None	None	None			None	
Harness (U15)	Continuity between electronics unit and IFCBB	Open circuit break - on screen	Possible decreased noise immunity.	Possible increased uncertainty of cavity temperature.	Possible reduced radiometric accuracy.			Switch to other side.	Depends on noise charactersistics.
Harness (U15)	Continuity between electronics unit and IFCBB	Incorrect polarity	None	Lack of function.	n/a			None	Possible only during ground testing.

BEU PRT Bridge.	PRT temperature measurement,	Fails to switch between sensors.	Measurement of one PRT only.	Loss of information on temperatue gradients in the cavitv.	Possible reduced radiometric accuracy.	Switch to other side.	
BEU PRT Bridge.	PRT temperature measurement,	Loss of a winding in the IVD stack.	Decreased bit resolution of bridge at the point of failure.	Possible loss of resolution.	Possible reduced radiometric accuracy.	Switch to other side.	Depends upon which winding is lost.
BEU PRT Bridge.	PRT temperature measurement,	Open circuit break in drive current.	Loss of bridge function.	Loss of temperature.	Reduced radiometric accuracy	Switch to other side.	
BEU Supply current limiters	Limit current drawn in IFC.	Trip current reduced below operating point.	BEU won't power up.	Loss if IFC function.		Switch to other side.	Degradation - not fail mode.
BEU Supply current limiters	Limit current drawn in IFC.	Trip current increased above safe level.	Loss of short circuit protection.	Possible damage to BEU in case of ion impact.		Switch to other side.	Degradation effect. Depends upon sufficient damamge occuring due to ion impact.
BEU Supply current limiters	Limit current drawn in	Open circuit break.	Loss of supply voltage on correspondina rail.	Loss if IFC function.		Switch to other side.	
IPU Interface	RS422 & control word selector	Receiver or driver chip failed.	No IPU control/data interface.	No IPU interface	Loss of subsystem - increase radiometric error.	Switch to other side.	
Data acquisition	Sequencer and latches hold A/D data.	Sequencer clock stops, latches don't latch.	No valid data.	No valid data from IFC.	Loss of subsystem - increase radiometric error.	Switch to other side.	
Reference resistor.	Provides reference for bridge balance point.	Open circuit break.	Bridge does not balance.	No valid PRT data.	Loss of cavity temperature measurement.	Switch to other side.	
Reference resistor.	Provides reference for bridge balance point.	Short circuit break.	Bridge does not balance.	No valid PRT data.	Loss of cavity temperature measurement.	Switch to other side.	
Power on reset	Initialises sequencer and acquisistion during start-up transient.	Timer fails to operate.	No initialisation.	Corrupt data for first data poll.	One set of erroneous data.	Wait for next set of IPU bus transactions.	
IFCBB Heater drive	Converts IPU control word into power level to heater element.	D/A fails to convert.	Fixed or no power into IFCBB heater.	no control of IFCBB cavity temperature.	Loss of information on emissivty and view error into cavitv.	Switch to other side.	
IFCBB Heater drive	Output power stage delivers curent to heater element.	Output stage becomes open circuit.	No heating into IFCBB.	no control of IFCBB cavity temperature.	Loss of information on emissivty and view error into cavitv.	Switch to other side.	
IFCBB Heater drive	Output power stage delivers curent to heater element.	Output stage becomes short circuit across supplv.	Current trip may activate.	Loss if IFC function.	Loss of subsystem - increase radiometric error.	Switch to other side.	
BEU to IFCBB wiring and connectors.	Supply to IFCBB heater, supply and sense for PRTs and AD590s.	Open circuit break.	Loss of corresponding function.	Loss of some IFC function.	Depends on which circuit fails from increased error to loss of informaiton.	Switch to other side.	If open circuit on one PRT sense wires then the toerh two PRTs would still operate