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Goddard Space Flight Center
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National Aeronautics and
Space Administration

Change History Log

Revision	Effective Date	Description of Changes (Reference the CCR & CCB/ERB Approve Date)
Rev -	12/15/2010	Initial release per CCR 472-CCR-10-0022 (12/15/2010)
Rev A	04/05/2011	Removed ITAR banner from cover page and footer of document per CCR 472-CCR-11-0072.

TBx list for GIID sections 1, 3, and 4

SECTION	REQ ID	TBx ITEM	ACTIONEE
1.3	Figure	Figure 1.3-1. JPSS Documentation Tree [TBS]	NASA
3.1.4.3	IF230275	In the event of a failure, the spacecraft shall minimize exposure of the instruments to solar input onto sensitive surfaces, to the extent feasible, with a sun exposure duration not exceeding TBD.	BATC
3.2.4.2.3.3.5.3	IF230795	For JPSS-2 and subsequent, the Spacecraft Attitude Control Rate Error during any orbit, excluding effects due to jitter, shall be less than 50 arcsec/sec TBR (3 sigma) during all mission data collection periods.	NASA
3.2.4.3.1.5.2.2.1	IF231000	The instrument shall limit the operational power bus turn-on inrush current transient rate of change to less than 1A per microsecond (TBR).	BATC
3.2.4.3.1.5.2.2.1	IF231025	The instrument operational bus turn-on transient shall be limited by the instrument to be no more than 25 A (TBR).	BATC
3.2.4.3.1.5.2.2.1	IF231030	The operational bus, instrument inrush current shall decay to within 10% of the instrument orbit averaged maximum steady-state current in less than 50 milliseconds (TBR).	BATC
3.2.4.3.1.5.4	IF231105	The spacecraft power bus impedance at the interface between the instrument and the spacecraft harness, looking back toward the spacecraft source, shall be equivalent to a resistance of 100 milliohms (TBR) in series with a 5 microHenry inductance.	BATC
3.2.4.8	IF232021	Instruments shall comply with the command and telemetry formats as specified in TBS, JPSS Command and Telemetry Handbook and the Mission Data Format Control Book (MDFCB).	NASA
3.2.6.1.1	IF232760	In cases where it is not possible to perform the test at a low dose rate, a ratio of the degradation from low dose rate to high dose rate (MIL standard specified dose rates) shall be calculated based on published literature and used to further derate the parts that are tested at the MIL standard dose rates. (This approach is only acceptable for devices that have been previously characterized at low dose rates.) Radiation design margin (RDM) is defined as the ratio of the derated hardness capability of the part to the estimated dose at the part location. TBR - [Entire RDM/RLAT under review by NASA JPSS]	NASA
3.2.6.1.3	Section	3.2.6.1.3 Meteoroid and Debris Environments[TBR NASA JPSS]	NASA

3.2.6.2.1.2	IF232911	The instrument shall be capable of withstanding the worst-case free molecular heating transient provided in Figure 3.2.6.2.1.2-1. (TBR)	NASA
3.3.2.2.5.2	Table	Table 3.3.2.2.5.2-1. Unintentional Radiated Electric Field Emissions, 10 kHz to 18 GHz TBR	NASA
3.3.2.2.5.2	Table	Table 3.3.2.2.5.2-2. Unintentional Radiated Electric Field Emissions, 18 to 200 GHz TBR	NASA
3.3.11.2	IF233765	Commanding of the instrument shall be from the spacecraft electrical GSE, through the spacecraft C&DH subsystem.Note: In lieu of ECLIPSE workstation, ProcPad will be provided to the instrument contractor to generate and verify ATSs. [TBD]	NASA
3.3.12.8	IF234080	The remnant uncompensated magnetic moment of an instrument shall not exceed 0.031 ampere-turn-meter-square (31 pole-cm) per kilogram [TBR] of instrument mass.	NASA
3.3.12.8	IF234081	The stray uncompensated magnetic moment of an instrument shall not exceed 0.0106 ampere-turn-meter-square (10.6 pole-cm) TBR per watt of instrument average operational power.	NASA

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1 SCOPE

1.1 IDENTIFICATION

This JPSS General Instrument Interface Document (GIID) sets forth the general, common interface requirements imposed on both the instruments and spacecraft for the Joint Polar Satellite System (JPSS). This interface document is intended to define and control requirements generally at the interface between the instrument and the satellite (bus plus payloads). However, it must be understood that for interfaces such as EMI, contamination, etc., the “interface” extends further into the instrument.

The extent of applicability of the GIID to the JPSS spacecraft provider is identified in Appendix A.

1.2 TERMINOLOGY

Throughout this document the following definitions are used:

The term *spacecraft* is interchangeable with spacecraft bus or bus, and refers to all parts of the space segment that are not the instruments.

The term *satellite* refers to the fully or partially integrated system, including the spacecraft and one or more instruments. This term is used mainly in reference to testing to differentiate between the spacecraft bus without instruments, and the integrated satellite with instruments.

The term *instrument provider* refers to the organization / company delivering the instruments for integration on the spacecraft. The term is used interchangeably with the instrument contractor or sensor subcontractor with respect to JPSS. For the purposes of this document, the instrument provider is treated as a single entity, although in reality, the integrating team will probably include representatives from many organizations.

The term "(TBD)" , which means "to be determined", applied to a missing requirement means that the instrument/spacecraft contractor should determine the missing requirement in coordination with NASA JPSS.

The term "(TBS)", which means "to be specified", means that NASA JPSS will supply the missing information in the course of the contract. These serve as a placeholder for future requirements. The instrument and spacecraft contractors are not liable for compliance with these "placeholder" requirements, as insufficient information is provided on which to base a design.

The term "(TBR)", which means "to be refined/reviewed", means that the requirement is subject to review for appropriateness by the instrument/spacecraft contractors,as well as NASA JPSS, and subject to revision. The instrument/spacecraft contractor is liable for compliance with the requirement as if the "TBR" notation did not exist. The "TBR" merely provides an indication that

the value is more likely to change in a future modification than requirements not accompanied by a "TBR".

The term "Instrument", rather than "Sensor", is used within this document. "Instrument" is used as a more general descriptor, on the assumption that all sensors are instruments, but not all instruments are sensors (Search and Rescue, for example). Requirements within this GIID apply to the instrument as a whole, unless noted otherwise (e.g., "all separately mountable components").

1.3 DOCUMENT OVERVIEW

The JPSS interfaces between the instrument and spacecraft are controlled through the use of three documents. In hierarchical order, these are:

- Unique instrument Interface Control Document (ICD) (one per instrument) - see text
- Mechanical ICD (one per instrument) – see text (same priority as the ICD)
- General Instrument Interface Document (GIID) (this document)

The GIID is imposed on both the instrument contractor and the spacecraft contractor. It specifies the general instrument interface requirements and defines the general environments to which the satellite will be subjected.

The GIID is controlled and maintained by NASA JPSS. Changes to Notes and associated Figures and Tables may be approved by the JPSS Flight Project Configuration Control Board provided that the affected parties agree that such changes have no cost, technical, or schedule impacts.

The unique instrument interface control document (ICD) complements the GIID by defining the interface requirements for a given instrument. The ICD defines specific resource allocations, documents exceptions to the general GIID requirements, defines instrument-specific interface conditions and constraints, and defines special requirements not specifically covered in the GIID. In addition, the mechanical ICD (MICD) defines instrument-spacecraft requirements that are more readily shown in a drawing than in a text document. The combination of the GIID/ICD/MICD fully document the instrument/spacecraft interfacesThe relationship between the GIID, the JPSS specifications, the MICD’s and ICDs is depicted in Figure 1.3-1.

Figure 1.3-1. JPSS Documentation Tree [TBS]

1.4 CONFLICTS

In the event of conflict between the referenced documents (other than the ICD and the 1394 system IRD) and the contents of this specification, the contents of this specification shall be the superseding requirements.

In the event of a conflict involving the external interface requirements, or in the event of any other unresolved conflict, the NASA JPSS contracting officer shall determine the order of precedence .

This requirement is not meant to imply that the order of precedence of the ICD over the GIID can be reversed.

1.5 REQUIREMENT WEIGHTING FACTORS

The requirements stated in this specification are not of equal importance or weight. The following four paragraphs define the weighting factors incorporated in this specification.

a. ***Shall*** designates the most important weighting level; that is, mandatory. Any deviations from these contractually imposed mandatory requirements require the approval of NASA JPSS.

b. ***Should*** designates suggestions that are requested, but are not mandatory. Unless required by other contract provisions, noncompliance with the *should* paragraphs does not require approval of the contracting officer, but does require technical substantiation.

c. ***May*** designates the lowest weighting level. These *may* statements designate intent and are often stated as examples of acceptable designs, items, and practices. Unless required by other contract provisions, noncompliance with the *may* paragraphs does not require approval of the contracting officer and does not require documented technical substantiation.

In the remainder of this document, those paragraphs which are intended for information or clarification, but do not represent requirements, will be shown in italics. Following such introductory text, it is possible that the same basic information may exist as a requirement, but it will be properly numbered as a requirement. For convenience and tracking, all statements other than notes, figures, and tables are assigned requirement identifiers.

2 APPLICABLE DOCUMENTS

It is understood that some of the documents below are not the most recent revision as of the date of issue of the GIID, and that some have been superseded or cancelled. However, the documents listed still apply to the JPSS program. Tailoring of documents in this section is permitted by mutual agreement of the parties.

2.1 GOVERNMENT REQUIREMENT DOCUMENTS

The following documents of the exact issue shown form a part of this document to the extent specified herein.

SPECIFICATIONS:

NASA

472-00015	1553 Interface Requirements Document
472-00016	FT1394 System Interface Requirements Document
472-00017	FT1394 S100 Technology Interface Requirements Document
TBS	JPSS Command and Telemetry Handbook.
TBS	Mission Data Format Control Book

STANDARDS:

NASA

NASA-STD-5017 6-Jun-06	NASA-STD-5017, DESIGN AND DEVELOPMENT REQUIREMENTS FOR MECHANISMS

Military

MIL-STD-461E Aug 20, 1999	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-1540C Sep 94	Test Requirements for Launch, Upper Stage, and Space Vehicles
MIL-STD-1541A Dec 87	Electromagnetic Compatibility Requirements for Space Systems
MIL-STD-1553B Notice 2	Military Standard Digital Time Division Command/Response multiplex Data Bus

OTHER PUBLICATIONS:

Regulations

USAF EWR AFS PCMAN91-710	Air Force Space Command Range Safety Policies and Procedures

(Contractors requiring copies of specifications, standards, handbooks, drawings, and publications in connection with specified acquisition functions may obtain them from the contracting activity or as directed by the contracting officer.)

2.2 NON-GOVERNMENT REQUIREMENT DOCUMENTS

The following documents of the exact issue shown form a part of this document to the extent specified herein.

TBS BATC	Electrical Ground Support Equipment to Sensor Ground Support Equipment ICD

(Technical society and technical association specifications and standards are generally available from reference libraries. They are also available in technical groups and using federal agencies. Contact the contracting officer regarding any referenced document not readily available from other sources.)

2.3 REFERENCE DOCUMENTS

The following documents are for reference only and compliance with these documents is not a requirement imposed by this GIID.

SPECIFICATIONS:

AIAA S114-2005	Moving Mechanical Assemblies for Space and Launch Vehicles

STANDARDS:

MIL-STD-1576 Sep 1992	Electroexplosive Subsystem Safety Requirements and Test Methods for Space Systems
MIL-STD-2401 Jan 11, 1994	Department of Defense World Geodetic System (WGS)

Other

NIMATR 8350.2	World Geodetic System 1984, Its Definition and Relationship with Local Geodetic Systems

3 REQUIREMENTS

3.1 GENERAL

3.1.1 Reserved

3.1.2 Reserved

3.1.3 Instrument Modes/functionalities

IF230000 The instrument shall implement the following modes and functionalities, as appropriate, with the mode characterizations shown in Table 3.1.3-1.

Note that the first four modes/functionalities follow a normal transition from full off to full operational mode. The next three represent modes for abnormal conditions. The final one represents the ability to continue providing science data without ground commanding. The requirement is that the instrument provide the functionalities described in the following paragraphs. They do not have to be separate and distinct commandable modes.

IF230005 OFF Mode

IF230010 ACTIVATION (functionality)

IF230015 EARLY ORBIT CHECKOUT (functionality)

IF230020 OPERATIONAL Mode

IF230025 DIAGNOSTIC Mode

IF230030 SAFE Mode

IF230035 SURVIVAL Mode

IF230055 Each instrument shall be separately commandable into any of the above conditions which represent distinct modes.

IF230060 Although preferred sequences may be defined, the instrument shall cause no damage to any instrument or the spacecraft when transitioning from any mode to any other mode.

Table 3.1.3-1. Mode Characterization

	OFF	ACTIVATION	CHECKOUT	OPERATION	DIAG.	SAFE	SURVIVAL
Operational Power		Y	Y	Y	Y	Y	
Survival Power		*	*	*	*	*	Y
Safety Bus Power		Y					
Commanding		Y	Y	Y	Y	Y	
Telemetry		Y	Y	Y	Y	Y	
Functional Performance				Y	Y**		

Y= capability pertains to that mode/functionality
* = survival heater bus enabled in survival mode. May or may not be enabled in other modes
**Functional performance in Diagnostic mode is not precluded, but is not required

3.1.3.1 OFF Mode

IF230065 In the Instrument OFF mode, the instrument shall receive no external power, including survival heater power and operational power.

Instrument OFF mode may be used for ground storage & transportation, launch, and spacecraft power crisis situations.

IF230070 The instrument shall be capable of withstanding, without damage, the sudden entry into the OFF mode. This refers specifically to the sudden removal of operational power without first going through an orderly shut-down sequence.

3.1.3.2 ACTIVATION

ACTIVATION refers to instrument turn-on, and subsequent instrument component warm up, or cool down, to the operating temperatures. ACTIVATION terminates when all instrument temperatures, biases, and currents have stabilized within specified operational limits. For some instruments, this may refer to a period of time, rather than a different state of the instrument. ACTIVATION also includes any deployments and opening of covers or shutters.

IF230090 During power up, the instrument shall enable the command and telemetry functions, and provide for orderly turn-on (channel enable, scan motor turn-on, etc.) based on commands to the instrument.

3.1.3.3 EARLY ORBIT CHECKOUT

The initial on-orbit period is devoted to a complete spacecraft checkout and the calibration and performance verifications of the payloads. The spacecraft and payload performance verification tests may be repeated at appropriate times during the operational phase of the mission.

EARLY ORBIT CHECKOUT is a test period in which the instrument collects data to verify that performance complies with design and meets requirements. This may be regarded as a submode of the DIAGNOSTIC Mode.

IF230095 To support early orbit checkout, and for anomaly resolution, the instrument contractor shall provide the capability to selectively disable any on-orbit processing operation that combines or compresses raw data in any manner.

This requirement may not apply to every instrument, depending on the type of data produced.

Examples of such processing operations are: spatial aggregation of pixel samples; temporal aggregation of pixel samples; averaging of pixel data acquired while viewing calibration sources; averaging of calibration instrumentation data such as source temperature measurements; and data compression.

During this mode, instrument peak data rate must still be observed. The instrument contractor may maintain the data rate within requirements in this mode by limiting the portion of the swath or number of bands for which data are transmitted, or by any other means consistent with providing maximum flexibility and utility for performing diagnostics.

3.1.3.4 OPERATIONAL Mode

IF230100 In the OPERATIONAL mode the instrument shall be fully functional, providing all data originating within the instrument, necessary to produce the raw data records used to create the specified EDRs for that instrument.

For instruments which are not associated with EDRs, OPERATIONAL mode means the instrument is to provide normal mission data, housekeeping telemetry, and periodic calibration information, as required

IF230105 All allocated spacecraft resources shall be available to the instrument in OPERATIONAL mode.

IF230110 Instruments shall be capable of remaining in normal operational mode and meeting all performance requirements without damage while the spacecraft performs orbit correction.

Note: Any exceptions to this requirement will be documented in the ICD.

3.1.3.5 DIAGNOSTIC Mode

IF230115 The instrument DIAGNOSTIC mode shall support housekeeping and software updates.

3.1.3.6 SAFE Modes

In the event of certain in-orbit spacecraft bus subsystem anomalies, the instrument must be properly configured to protect against prolonged exposure to abnormal environments such as those caused by abnormal pointing of the spacecraft. When possible, the spacecraft will send pre-defined reconfiguration commands to the instrument. In addition, the instrument must put itself into a SAFE mode upon detection of an internal anomaly which could be detrimental to the instrument or any other part of the satellite.

3.1.3.6.1 INSTRUMENT SAFE Mode

IF230125 For instances of an instrument-detected on-orbit failure, where failure to take prompt corrective action could result in damage to the instrument, the instrument shall place itself into a SAFE mode.

IF230140 In Instrument Safe mode, health and status data shall continue to be collected and transmitted, but not mission or calibration data.

IF230145 The instrument shall configure itself such that no damage will occur if the next action from the spacecraft is to turn off the instrument, even though that may not be the normal flow.

The instrument may, by choice, utilize this mode as an intermediate state between OPERATIONAL and OFF, or OPERATIONAL and SURVIVAL modes.

IF230150 The instrument shall also enter SAFE mode upon receipt of a SAFE mode command from the spacecraft.

This could be a forwarded ground command, or could be generated by the spacecraft in response to a power system anomaly, for example. It could also mean that the spacecraft has either lost lock on the Earth and will be transitioning to Sun pointing orientation ,or that the spacecraft is about to enable thrusters for attitude control or momentum unloading. The instrument may elect to be commanded to enter INSTRUMENT SAFE Mode when the Spacecraft is performing scheduled thruster activity, such as for orbit maintenance.

IF230155 The instrument shall autonomously configure to its SAFE mode within 45 seconds after entry into SAFE mode is initiated.

IF230165 The command from the spacecraft for the instrument to enter SAFE mode (i.e., "forcing" instrument safe mode) shall not be inhibitable by the instrument.

IF230170 The instrument shall not autonomously transition from INSTRUMENT SAFE mode to any other mode.

3.1.3.6.2 SPACECRAFT SAFE Mode

In the event of certain anomalous conditions, as determined by the spacecraft, the spacecraft will place itself, and the instruments, into a total SPACECRAFT SAFE mode. Power system anomalies and attitude system anomalies are examples of conditions which could result in the entry into the SPACECRAFT SAFE mode. This mode could involve abnormal attitude of the spacecraft. This is an emergency mode, and as such is a power conservation mode.

IF230175 As part of the process of entering a complete SPACECRAFT SAFE mode, the spacecraft shall initiate the INSTRUMENT SAFE mode described above, and may also turn off the instrument, while ensuring the survival heater bus is enabled. (see SURVIVAL Mode).

It is intended that, whenever possible, the instrument will be permitted to undergo an orderly shut-down prior to removal of operational power.

From the perspective of an individual instrument, SPACECRAFT SAFE mode will involve INSTRUMENT SAFE mode, SURVIVAL mode, or in extreme situations, OFF mode, all of which are defined elsewhere.

IF230180 As part of SPACECRAFT SAFE mode, the instrument shall enter SAFE mode upon: a) receipt of a spacecraft command to enter SAFE mode

IF230185 As part of SPACECRAFT SAFE mode, the instrument shall enter SAFE mode upon: b) failing to receive twelve (12) consecutive time code data packets from the spacecraft.

IF230190 The number of missed time code packets which result in SAFE mode shall be alterable on-orbit over the range of 8 up to a maximum of 63 consecutive time code data packets.

3.1.3.7 SURVIVAL Mode

SURVIVAL mode is entered when a critical power shortage has been identified by the spacecraft. SURVIVAL mode is a low power mode from which the satellite can eventually recover to full operational status. Only those functions required for satellite safety, diagnostics and recovery will be powered. Instrument operational power will be off and instrument survival power will be enabled, if sufficient power is available (instrument in SURVIVAL mode).

IF230195 The spacecraft shall place the instrument into SURVIVAL mode in the event of a severe spacecraft emergency.

This may be the end state of the SPACECRAFT SAFE mode described above. The intent is that all instruments on the spacecraft will be reactivated by ground command upon spacecraft recovery.

IF230285 In SURVIVAL mode, the instrument shall be able to survive indefinitely while the spacecraft is in a sun-pointing attitude.

Definition of Sun-Pointing Attitude. As part of entry into the SURVIVAL mode, the Spacecraft transitions from earth-pointing to a sun-pointing attitude. The sun-pointing attitude results from pointing the solar array normal to the sun and slowly rotating the spacecraft about the sunline at approximately 2 rev/orbit.

The solar array configuration for each spacecraft is specifically tailored to the satellite orbital nodal crossing to maximize the operational solar illumination. A typical spacecraft configuration for the JPSS 1330 nodal crossingwhile in operational earth-point attitude is shown in Figure 3.1.3.7-1. The solar array rotation axis is aligned with the spacecraft -Y axis and a fixed cant angle is built into the array. The cant angle is 0 deg for JPSS. The survival sun-pointing configuration is depicted in Figure 3.1.3.7-2. The solar array is indexed and fixed to a position relative to the spacecraft in which the cells are nominally facing in the -X direction. The spacecraft points the solar array normal to the sun and rotates slowly about the sunline.

IF230200 Initiation of SURVIVAL mode shall not require commands to the instrument.

Due to the emergency nature of the situation, ideally no instrument reconfiguration should be necessary before operating power is cut off by the spacecraft, although a recommended command sequence may be provided by the instrument contractor . The command to go to INSTRUMENT SAFE mode could be used as the precursor. The purpose of the re-configuration is to protect the instrument against potential prolonged exposure to abnormal environments such as those caused by abnormal pointing of the spacecraft while in the SURVIVAL mode.

IF230205 As part of entry into the SURVIVAL mode, the Spacecraft may, if time permits, issue the instrument-defined command or sequence of commands to each instrument to transition the instrument into its SURVIVAL mode.

The intent is for the spacecraft to issue the instrument-defined sequence, but the instrument design can not depend on that having been done.

IF230210 The spacecraft shall remove instrument operational power during SURVIVAL mode.

IF230215 The spacecraft shall ensure instrument survival heater power is enabled during SURVIVAL mode.

Note: if survival heater power consumption threatens survival of the satellite, the spacecraft may turn off the survival heaters. At that point, the instrument is in the OFF mode, rather than the SURVIVAL mode

IF230220 In those cases where an agreed-upon sequence of commands is sent to the instrument prior to removing instrument operational power, the instrument shall transition into its SURVIVAL mode within 45 seconds after initiation of that command sequence.

IF230225 In SURVIVAL mode, the spacecraft shall be responsible for sampling critical instrument temperatures via the instrument passive analog temperature sensors (normal instrument telemetry is not available with operational power off).

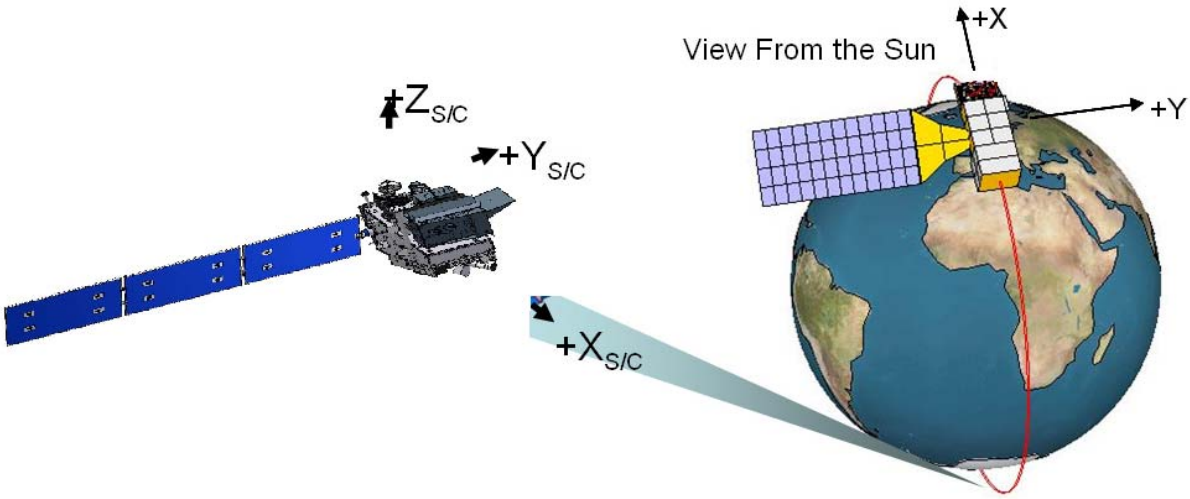


Figure 3.1.3.7-1. Typical Spacecraft Configuration for the JPSS 1330 Nodal Crossings Operational Earth-Point Mode

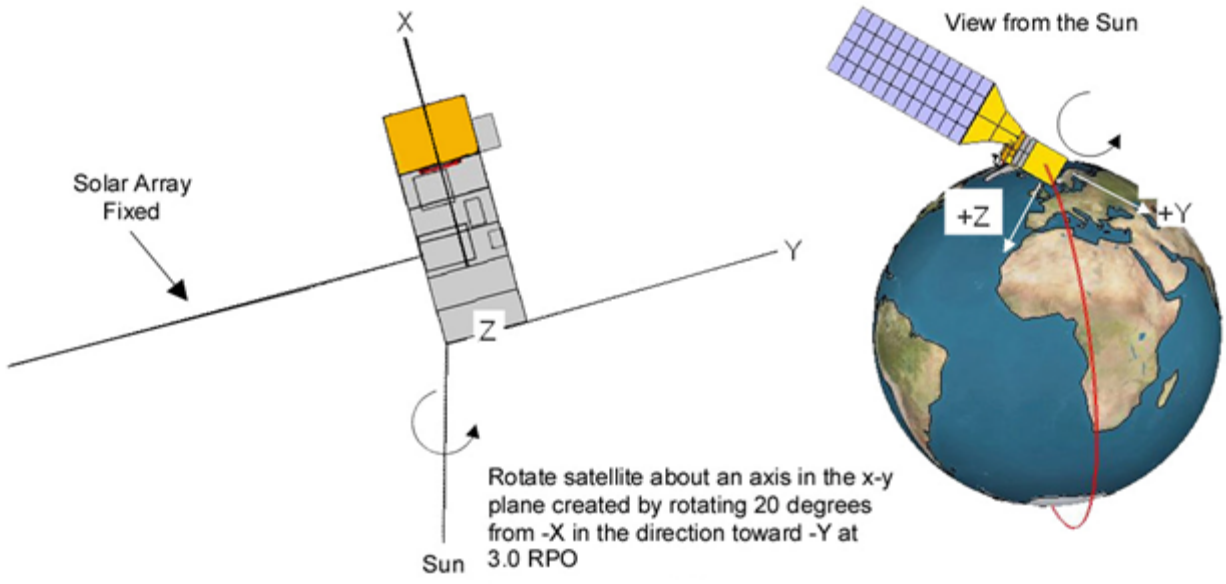


Figure 3.1.3.7-2. Typical Spacecraft Configuration for the JPSS 1330 Nodal Crossings Survival Sun-Point Mode

3.1.4 Operational Concept

3.1.4.1 Pre-launch

The satellite will be transported to the launch site where final vehicle preparations and checkout will be accomplished. Final inter-segment and system verification tests will be accomplished prior to launch.

3.1.4.2 Launch and Injection

During launch and injection to the operational orbit, the various spacecraft subsystems may be powered on or turned off in order to provide protection from the launch and injection environments or to comply with other specified requirements. Spacecraft telemetry to monitor vehicle status may be provided during launch and injection. Transmission of launch vehicle telemetry may satisfy this requirement during the launch phase. Spacecraft telemetry transmission to ground monitoring stations would be used to the extent practicable during the injection phase. After insertion into its operational orbit and separation from the launch vehicle, appropriate deployments would be initiated by memory command, if not pre-empted by the ground. Early orbit check-out will be conducted through the control center for the JPSS satellite.

IF230255 The mode of an instrument at the time of launch shall be OFF.

3.1.4.3 On-orbit Operational Concept

The JPSS satellites will operate in a sun synchronous, near circular, frozen orbit with a nominal altitude of 824 km +/- 17 km, an ascending node of 13:30 pm +/- 10 min, a ground track repeatability of +/- 20 km at all latitudes, and a repeat cycle of less than 20 days.

IF230270 The spacecraft shall, in the absence of failure, remain oriented so as to keep direct sunlight off the "cold" side of the instrument.

IF230275 In the event of a failure, the spacecraft shall minimize exposure of the instruments to solar input onto sensitive surfaces, to the extent feasible, with a sun exposure duration not exceeding TBD.

3.2 INTERFACE CHARACTERISTICS

3.2.1 General

IF230295 The uncertainty values specified in this document are one sigma unless specified otherwise.

In addition to uncertainty values, repeatability and variation values specified herein shall be considered one sigma unless specified otherwise. Ranges of values are considered not-to-exceed ranges. All other specification limits are not-to-exceed values unless specified otherwise.

3.2.2 Reserved

3.2.3 Reserved

3.2.4 Physical and Interface Characteristics

3.2.4.1 Mass Properties

Throughout the remainder of this document, the expression 'separately-mounted instrument components' refers to each part of an instrument which is separately mounted onto the spacecraft by the spacecraft contractor. An example would be a scan head and an electronics box which are purposefully separated. Where an instrument is divided into multiple pieces, but is mounted onto the spacecraft via a single baseplate, that is not considered 'separately-mounted' instrument components in this document.

In the paragraphs below, the term "actual" refers to values which apply to a given serial number. As indicated below, these are generally provided in a data package associated with delivery of each individual serial numbered instrument.

The terms "typical" and "predicted" are used to document a nominal value in the ICD. These may be the result of calculations or measurements on a non-flight unit which is expected to be representative of the value for a flight unit.

3.2.4.1.1 Instrument Mass Properties Documentation

IF230320 The mass of the instrument shall be measured to ± 0.1 kg.

3.2.4.1.2 Instrument Mass Variability Documentation

3.2.4.1.3 Center of Mass

3.2.4.1.3.1 Center of Mass Location

IF230340 The actual stowed (launch configuration) and deployed (on-orbit configuration) centers of mass of each separately-mounted instrument component shall be measured by the instrument contractor, reported to ± 6 mm (not-to-exceed), referenced to the instrument coordinate axes and documented in the data package for that serial number instrument.

IF230350 The instrument coordinate axes shall be defined to be in the same orientation as the spacecraft axes (refer to section 3.2.4.2.2), but not the same origin.

3.2.4.1.4 Moments and Products of Inertia

3.2.4.1.4.1 Moments and Products of Inertia Measurement

IF230355 The moments and products of inertia shall be measured or calculated for each separately-mounted instrument component, using coordinates based on the spacecraft axes (refer to section 3.2.4.2.2) but passing through the instrument component center of mass.

3.2.4.1.4.2 Moments and Products of Inertia Accuracy

IF230360 Moments and products of inertia values shall be accurate to within ± 5 % for calculated values, and the greater of 5% or 300 kg-cm² for measured values.

3.2.4.1.4.3 Reserved

3.2.4.1.4.4 Reserved

3.2.4.2 Mechanical Requirements

IF230395 All mechanical requirements specified shall be met at the mechanical interface, the surface(s) of the spacecraft where the instrument is in contact with the spacecraft, unless otherwise specifically indicated.

Where kinematic mounts are used, the mechanical interface is the surface of the mount that contacts the spacecraft.

3.2.4.2.1 Dimensions

IF230400 All interface documents shall provide units in metric and English. An exception is allowed for interface documents in native English units. The primary (as-designed) units shall be displayed above the converted units with the latter in parentheses.

IF230405 All interfaces shall be specified in the international system of units, System Internationale (SI), unless design heritage precludes this, and concurrence exists between the spacecraft contractor, the instrument contractor, and NASA JPSS.

IF230410 Regardless of the selection of units, both the primary (as-designed) units and converted units shall be shown on all drawings as either Primary/Converted or Primary (Converted).

IF230415 Dimensioning shall be in the as-designed units, and identified when other than SI.

Analysis results produced by existing software tools may be in heritage units.

3.2.4.2.2 Spacecraft Body Frame

IF230430 A right-hand, orthogonal, body-fixed XYZ coordinate system shall be used, as shown in Figure 3.2.4.2.2-1.

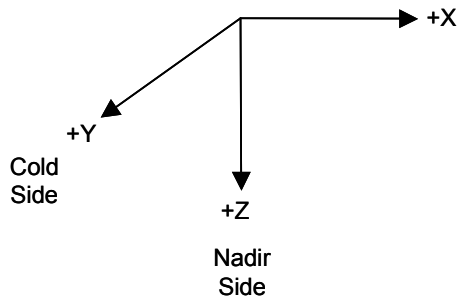


Figure 3.2.4.2.2-1. Spacecraft Body Frame

3.2.4.2.3 Physical Interface

The responsibilities for providing interface hardware are shown below.

HARDWARE	PROVIDER
Standard mounting hardware (e.g., std. fasteners)	Spacecraft
Special mounting hardware (instrument-unique)	Instrument
Mounts (e.g., kinematic, flexure, etc.)	Instrument
Optically aligned component drill template	Instrument
Non-optically aligned component drill template	Instrument
Instrument optical alignment target /cube and cover	Instrument
Holding and lifting fixtures	Instrument
Test and alignment hardware	Instrument
GSE - special, electrical and mechanical	Instrument
GSE - general, electrical and mechanical	Spacecraft
Shipping containers	Instrument

3.2.4.2.3.1 Stowed and Critical Clearances

Both the spacecraft contractor and the instrument contractor must work together to ensure that the stowed, deploying, and final deployed positions of the instrument will clear all obstacles, including obstacles on the spacecraft, other instruments, and the launch vehicle.

IF230435 The spacecraft contractor shall position the instruments on the spacecraft so the following are achieved:

a) the instrument envelopes are maintained

b) the instrument fields of view are maintained

c) the spacecraft, with instruments mounted, fits within the envelope of the launch vehicle's fairing.

IF230445 The spacecraft contractor shall lay out the instruments on the spacecraft so as to maintain adequate clearance between the instrument and surrounding structures, in order to provide access to instrument mounting hardware, access to instrument connectors, and space for instrument interfacing harness service loops.

3.2.4.2.3.1.1 Instrument Envelope Documentation

3.2.4.2.3.2 Mounting Provisions

3.2.4.2.3.2.1 Mounting Method

IF230475 The mounting method shall accommodate manufacturing tolerance, structural distortion, thermal distortions, and alignment requirements.

The spacecraft to instrument mounting interface will be established by the spacecraft contractor from the instrument provided drill template as described in section 3.2.4.2.3.2.3.1 and shown in the MICD. This process aligns the instrument mechanical datums to the spacecraft body frame within the spacecraft alignment control allocation precluding the need to shim or correct the instrument orientation at instrument installation.

If required, the spacecraft contractor will provide contingency shims to correct instrument alignment control error at installation. Shim capability for out of plane rotations (spacecraft X & Y axis) will be limited by pin / bolt clearance. There is no adjustment capability for in plane rotation (about spacecraft Z axis) where close fit pins are used.

Potential mounting interface gaps (prior to fastener full preload) will be managed through instrument, spacecraft, and drill template flatness and / or co-planarity requirements to preclude the need to shim for gaps at installation.

If required, the spacecraft contractor will provide contingency shims to close gaps at installation. Shim capability will be limited by pin / bolt clearances and access required to inspect or perform gap measurements.

IF230485 The instrument mounting method shall not require access from inside the spacecraft.

3.2.4.2.3.2.2 Mounting Interface

3.2.4.2.3.2.2.1 Reserved

3.2.4.2.3.2.2.2 Reserved

3.2.4.2.3.2.3 Drill Templates

3.2.4.2.3.2.3.1 Drill Template Usage

The drill template is used during the manufacturing of the spacecraft bus to establish instrument interface features. The drill template is supported from a gantry (mechanical ground support equipment). The template/instrument mounting datum features are aligned to the spacecraft body frame with laser tracker and/or thedolite measurements. With the template properly aligned, spacecraft secondary structure is matched to the template through a combination of drill, bolt, and bonding processes as required.

The drill template may also be used for interface and alignment verification during the spacecraft manufacturing and AI&T phases.

IF230505 If templates are used, then instrument equipment, spacecraft, and test fixture interfaces shall be established using the same templates (i.e. face to face master).

3.2.4.2.3.2.3.2 Reserved

3.2.4.2.3.2.4 Reserved

3.2.4.2.3.2.5 Reserved

3.2.4.2.3.2.6 Special Mounts

IF230630 Instrument components shall be mounted using kinematic mounts unless the instrument contractor determines that kinematic mounts are not required.

3.2.4.2.3.3 Pointing and Alignment

Pointing: The process of controlling the location or direction of a Line of Sight with respect to an intended target location or direction.

Instrument Interface: The mechanical interface and associated datum(s) at the location where the instrument attaches to the spacecraft.

Jitter: Rotations due to elastic as well as rigid body vibrations caused by disturbance sources such as reaction wheels, solar array drive assemblies and instrument mechanisms.

Spacecraft Attitude Determination Frame: The right-handed orthogonal reference frame which approximates the Spacecraft Body Frame and of which the Attitude Determination System on board the spacecraft determines inertial attitude.The Spacecraft Attitude Determination Frame is defined by the

relative orientation of these datums with respect to the Spacecraft Body Frame, as established by measurements during installation alignment or on-orbit calibration.

Spacecraft Target Frame: The right-handed, orthogonal reference frame that, at any time, is the target attitude of the Spacecraft Attitude Determination Frame.

3 Sigma: A set of values is considered to meet a 3 sigma requirement if no fewer than 99.73% of the values are within the specified limits of the requirement.

Root Sum Square (RSS): The square root of the sum of the squares of components of error or uncertainty.

Alignment: The relative orientation of 2 reference frames.

Installation Alignment: The process of setting, measuring and/or adjusting the relative orientation of an instrument or hardware reference frame with respect to another reference frame in order to satisfy required alignment criteria.

Alignment Shift: A change in the alignment between 2 reference frames that occurs over one finite, defined, period of time, typically prior to and not changing significantly during normal on-orbit operations. For the alignment of the instruments relative to the spacecraft, alignment shifts arise from structural distortion effects such as launch loads, moisture out-gassing and the relief of gravity loads.

Alignment Drift: Changes in the alignment between 2 reference frames that occur during normal on-orbit operations, excluding effects due to jitter. For the alignment of instruments relative to the spacecraft, one source of drift is structural distortions arising from orbital and seasonal changes in thermal conditions.

Alignment Knowledge: The estimate of the relative orientation between 2 reference frames.

Alignment Knowledge Uncertainty: The uncertainty in the knowledge of the relative orientation between 2 reference frames.

Boresight Alignment Knowledge Uncertainty: For a specific instrument, the uncertainty in the knowledge of the relative orientation between its Instrument Boresight and the Spacecraft Attitude Determination Frame. This uncertainty will be considered to be composed of the following factors:

- *Static (not changing significantly during normal on orbit operations)*
  - *-- Measurement uncertainty during installation alignment.*
  - *-- Alignment Shifts.*
- *Dynamic (changing significantly during normal on orbit operations)*
  - *-- Alignment Drifts.*
  - *-- Jitter.*

Alignment Control: The process of controlling the maximum difference between the actual orientation of a reference frame and its nominal orientation.

Alignment Control Error: The maximum difference between the actual orientation of a reference frame and its nominal orientation.

Boresight Alignment Control Error: For a specific instrument, the maximum difference between the actual and the nominal orientation of its Instrument Boresight relative to the Spacecraft Attitude Determination Frame. This error will be considered to be composed of the following factors:

- *Static (not changing significantly during normal on orbit operations)*
  - *Measurement uncertainty during installation alignment.*
  - *Limitations associated with fabrication and installation.*
  - *Alignment Shifts.*
- *Dynamic (changing significantly during normal on orbit operations)*
  - *Alignment Drifts.*
  - *Jitter.*

Figure 3.2.4.2.3.3-1 illustrates a framework for representing the train of components of Knowledge Uncertainty (Figure 3.2.4.2.3.3-2) and Control Error (Figure 3.2.4.2.3.3-3) between an Instrument Boresight and inertial references. Please note the following acronyms: Earth Centered Inertial (ECI) (J2000.0), Spacecraft Target Frame (STF), Spacecraft Attitude Determination Frame (SADF), Spacecraft Attitude Determination Reference (SADR), Spacecraft Attitude Reference (SAR), Spacecraft Body Frame (SBF), Instrument Attitude Reference (IAR), Spacecraft (SC). Spacecraft factors are indicated by solid arrows (←→) and instrument factors are indicated by dashed arrows (← - - - →).

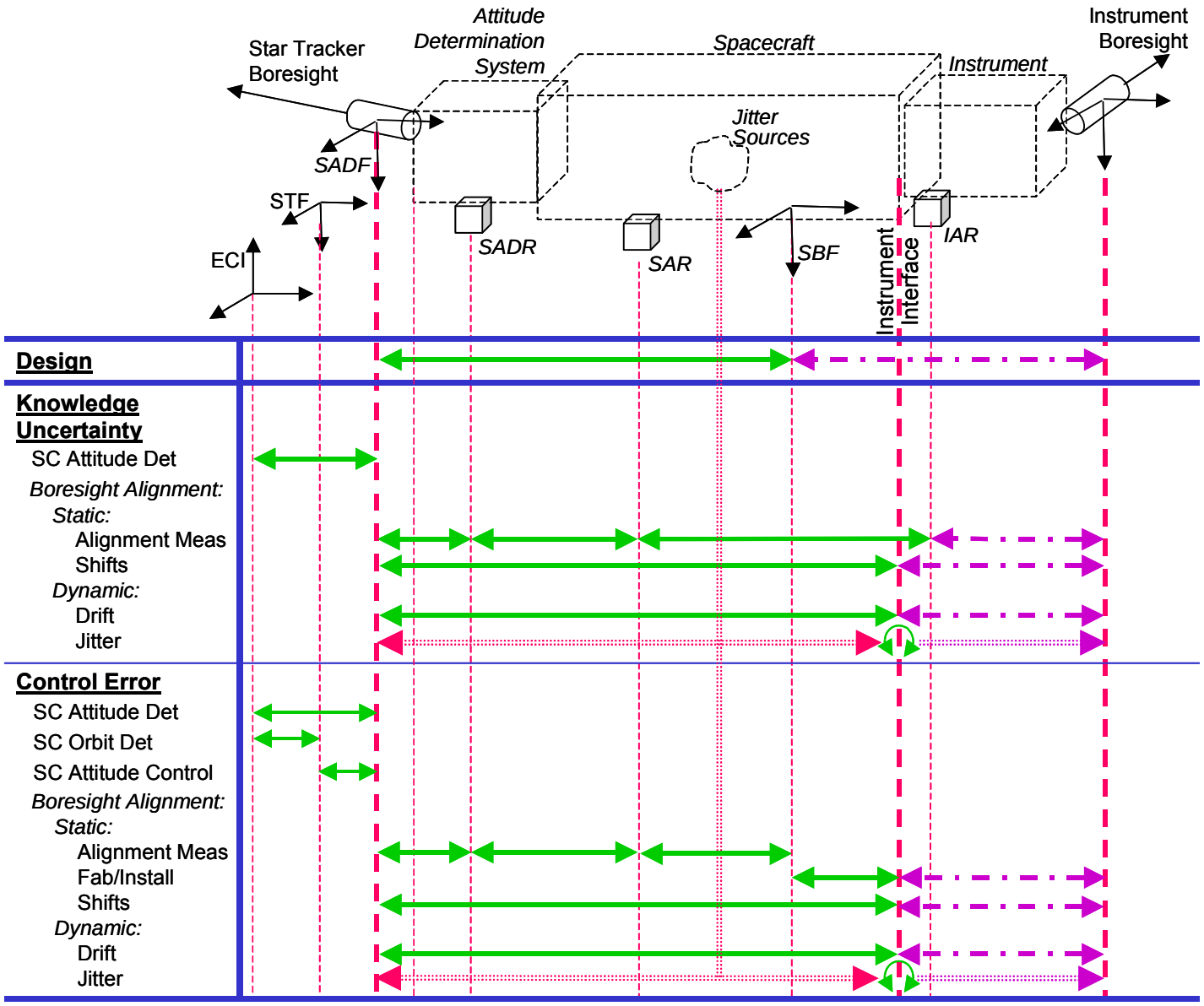


Figure 3.2.4.2.3.3-1. Spacecraft/Instrument Allocation of Knowledge and Control

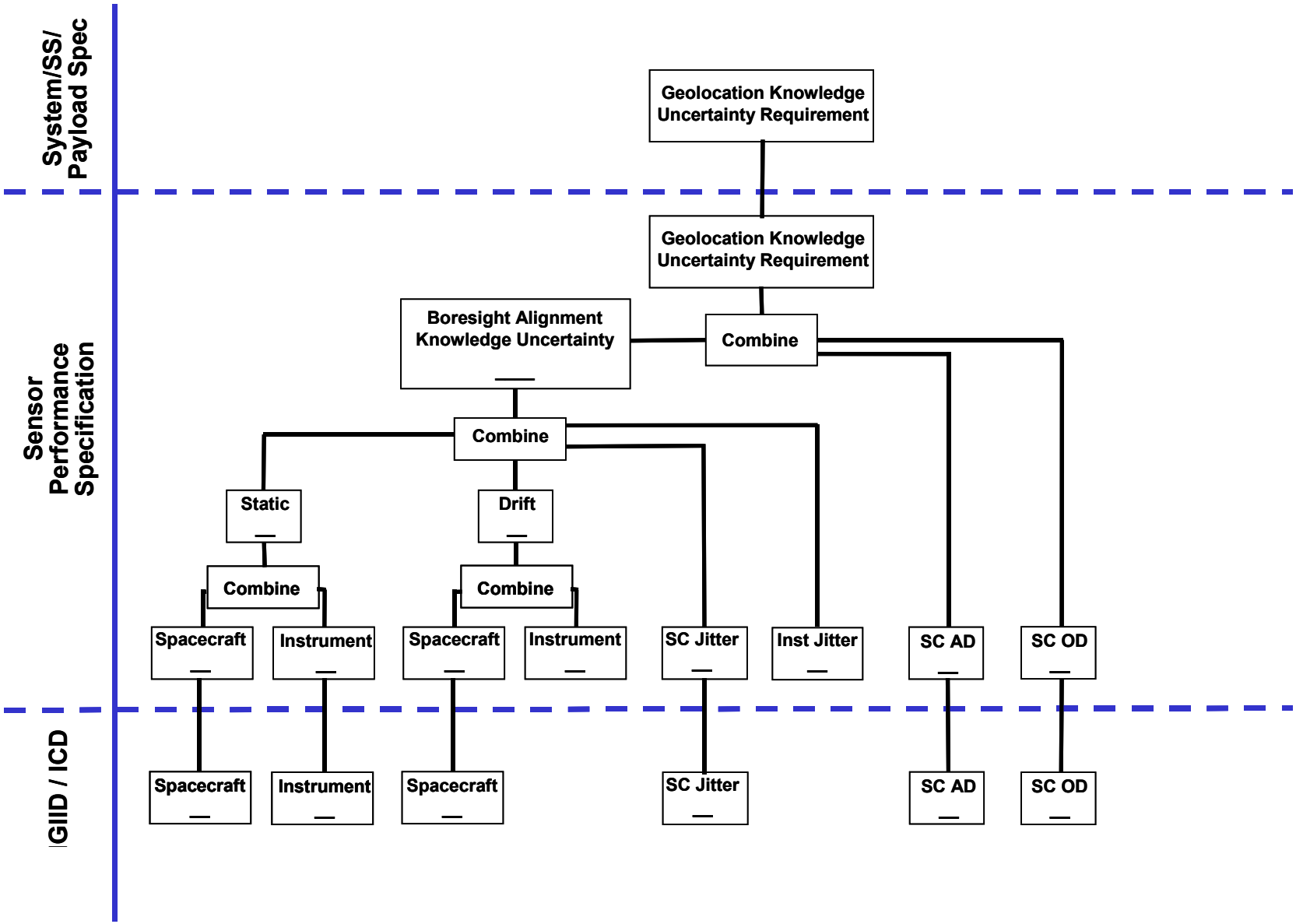


Figure 3.2.4.2.3.3-2. Spacecraft / Instrument Allocation of Geolocation Knowledge Uncertainty

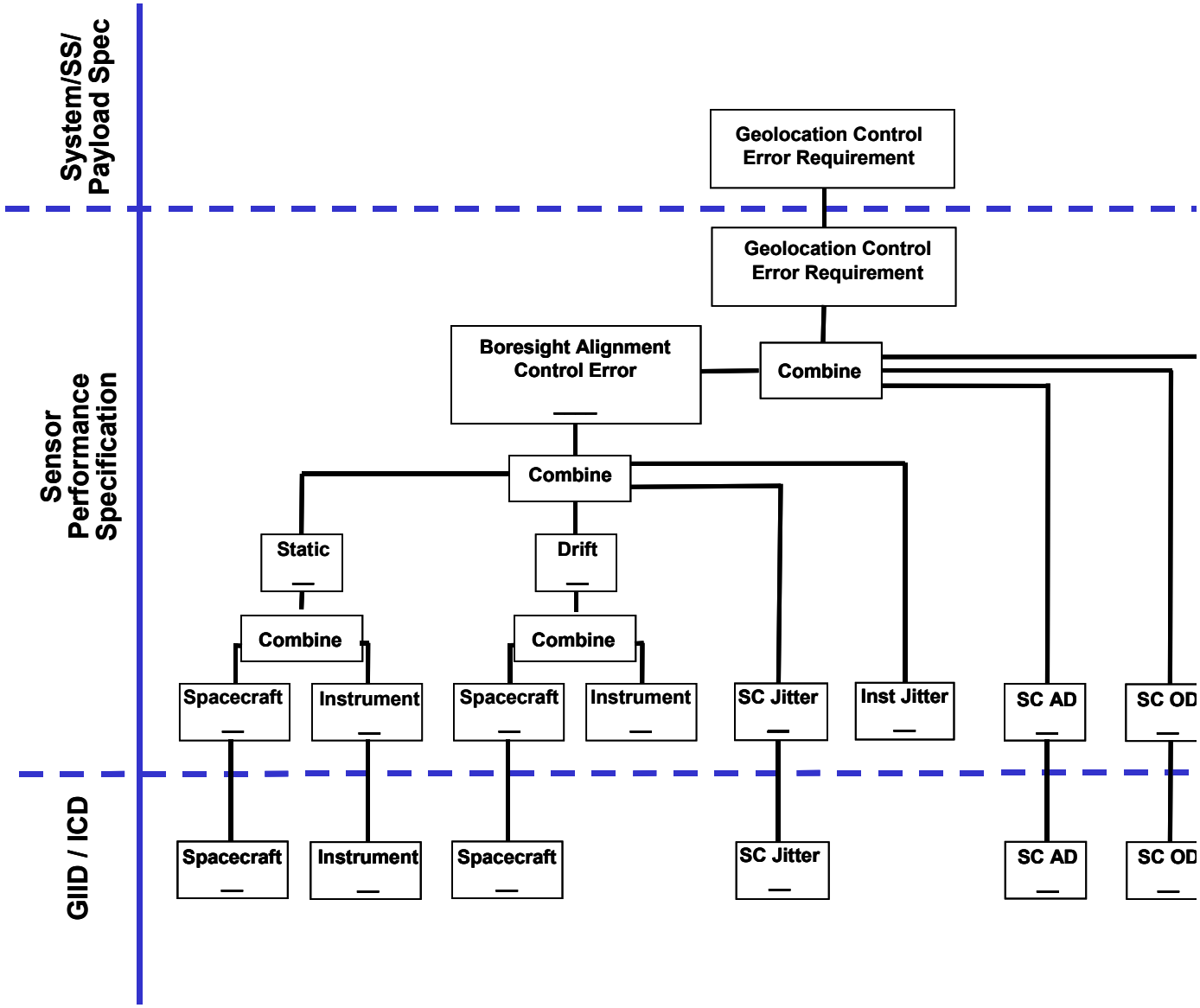


Figure 3.2.4.2.3.3-3. Spacecraft / Instrument Allocation of Geolocation Control Error

3.2.4.2.3.3.1 Reserved

3.2.4.2.3.3.2 Installation Alignment References

IF230690 The Instrument Alignment References shall be viewable from two orthogonal directions when integrated to the satellite.

IF230705 Optical targets or cubes shall have a per-face surface area of at least 360 mm^2.

IF230710 At least two viewing surfaces of the optical alignment target or cube shall be orthogonal to within ± 3 arcsec, 3 sigma.

IF230715 All optical targets or cubes shall have a minimum reflectance of 80%, surface figure of ¼ wave peak value at 0.63 microns, and a surface quality of 80/50 scratch/dig or better.

IF230720 Each optical target or cube shall be covered with a flight quality (and flight capable) cover, provided by the instrument contractor.

IF230725 The cover shall be removable during Integration and test.

IF230730 While on orbit, the cover shall provide protection against optical reflections onto any light-sensitive surface.

IF230735 The cover shall provide captive hardware to prevent loose pieces if the cube comes loose.

3.2.4.2.3.3.3 Alignment Knowledge

All components of Boresight Alignment Knowledge Uncertainty between the Spacecraft Attitude Determination Frame and the Instrument Interface (mounting surface datums) are allocated to the spacecraft.

All components of Boresight Alignment Knowledge Uncertainty between the Instrument Interface (mounting surface datums) and the Instrument Boresight are allocated to the instrument.

Components of Boresight Alignment Knowledge Uncertainty resulting from alignment shifts allowed by clearances across the mounting interface (pin/fastener to hole tolerance) at the Instrument Interface (mounting surface datums) are allocated to the instrument.

IF230755 The RSS of all sources of Boresight Alignment Knowledge Uncertainty between the Spacecraft Attitude Determination Frame and the Instrument Interface due to alignment shifts, as well as the Alignment Knowledge Uncertainty associated with the alignment measurements during Installation Alignment shall be less than 75 arcsec (3 sigma) per axis.

IF230760 The RSS of all sources of Boresight Alignment Knowledge Uncertainty between the Spacecraft Attitude Determination Frame and the Instrument Interface due to alignment drifts shall be less than 30 arcsec (3 sigma) per axis over any orbit.

3.2.4.2.3.3.4 Alignment Control

All components of Boresight Alignment Control Error between the Spacecraft Attitude Determination Frame and the Instrument Interface (mounting surface datums) are allocated to the spacecraft

For each instrument, the Boresight Alignment Control Error are controlled by an allocation from the Instrument Boresight to the Instrument Interface mechanical datums, as well as an allocation from the Instrument Interface mechanical datums to the Spacecraft Attitude Determination Frame.

All components of Boresight Alignment Control Error between the Instrument Boresight and the Instrument Interface (mounting surface datums) are allocated to the instrument.

Components of Boresight Alignment Control Error resulting from alignment shifts allowed by clearances across the mounting interface (pin/fastener to hole tolerance) at the Instrument Interface (mounting surface datums) are allocated to the instrument.

IF230677 The RSS of all sources of Boresight Alignment Control Error between the Spacecraft Attitude Determination Frame and the Instrument Interface due to alignment drifts shall be less than 30 arcsec (3 sigma) per axis over any orbit.

3.2.4.2.3.3.5 Spacecraft Pointing

Reference Ellipsoid: The WGS 84 reference ellipsoid as defined by NIMA TR8350.2.

Geodetic Nadir: Defined at any point in the orbit as the direction perpendicular to the Reference Ellipsoid.

Inertial Velocity: The velocity relative to the ECI (J2000.0) reference frame.

Orbital Reference Frame: A right-handed, orthogonal, XYZ coordinate system defined such that the origin is at the spacecraft center of mass (CM), the +Z axis points toward Geodetic Nadir, the +X axis is coplanar with both the +Z axis and the spacecraft inertial velocity vector (and is in the general direction of the spacecraft inertial velocity vector), and the +Y axis completes the right-handed, orthogonal coordinate system as shown in Figure 3.2.4.2.3.3.5-1.

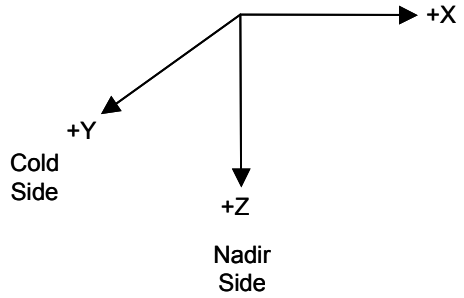


Figure 3.2.4.2.3.3.5-1 Orbital Reference Frame

3.2.4.2.3.3.5.1 Spacecraft Attitude Knowledge

IF230780 The spacecraft-supplied estimate of the inertial attitude of the Spacecraft Attitude Determination Frame shall be in the J2000.0 frame, be time-tagged and have an error during any orbit of less than 30 arcsec (3 sigma) per axis.

3.2.4.2.3.3.5.2 Reserved

3.2.4.2.3.3.5.3 Spacecraft Attitude Control

During normal operation, the Spacecraft Attitude Control Error is the difference between the orientation of the Spacecraft Target Frame and the orientation of the Spacecraft Attitude Determination Frame.

During normal operation, the Spacecraft Attitude Control Rate Error is the difference between the angular rate of the Spacecraft Target Frame and the angular rate of the Spacecraft Attitude Determination Frame.

IF230685 During normal operation, the Spacecraft Target Frame shall be aligned with the Orbital Reference Frame for orbits having an LTAN between noon and midnight, or rotated 180 degrees about the Z axis relative to the Orbital Reference Frame for orbits having an LTAN between midnight and noon.

IF230790 For JPSS-2 and subsequent, the Spacecraft Attitude Control Error during any orbit, excluding the effects due to jitter, shall be less than 50 arcsec (3 sigma) per axis during all mission data collection periods.

IF230795 For JPSS-2 and subsequent, the Spacecraft Attitude Control Rate Error during any orbit, excluding effects due to jitter, shall be less than 50 arcsec/sec TBR (3 sigma) during all mission data collection periods.

IF230796 For JPSS-1, the Spacecraft Attitude Control Error during any orbit, excluding the effects due to jitter, shall be less than 108 arcsec (3 sigma) per axis during all mission data collection periods.

IF230797 For JPSS-1, the Spacecraft Attitude Control Rate Error during any orbit, excluding effects due to jitter, shall be less than 108 arcsec/sec (3 sigma) during all mission data collection periods.

3.2.4.2.3.3.6 Spacecraft Position Knowledge

IF230802 The spacecraft- supplied estimate of Spacecraft Position shall be that of the origin of the Spacecraft Body Frame relative to the WGS 84 Earth Centered Earth Fixed (ECEF) frame used by the GPS OCS at the time of the estimate, be time-tagged and have an error during any orbit of less than 75/75/75 meters (3 sigma) for radial/in-track/cross-track components.

3.2.4.2.3.4 Reserved

3.2.4.3 Power

3.2.4.3.1 Power Bus Requirements

3.2.4.3.1.1 Electrical Interface Definitions

Electrical Interface Location: All requirements apply at the electrical interface, which is at the instrument end of the instrument-to-spacecraft bus harness connector mating surfaces.

Operational Power: Operational power is used for instrument operational modes such as Science Data Collection, Calibration, and Standby.

Peak Operational Power: Peak power is the maximum power required by an instrument. Peak power does not include transients with a duration less than 20 milliseconds.

Average Operational Power: The one-orbit average power is the average power utilized by an instrument over any one-orbit period commencing with the crossing of the night-to-day terminator. The two-orbit average power is the average power utilized by an instrument over any two-orbit period commencing with the crossing of the night-to-day terminator.

Survival-Mode Power: Survival-mode power is power required by the instrument in Survival Mode, in order to operate survival heaters.

Safe-Mode Power: Safe-mode power is the power required by the instrument in instrument safe mode.

Launch-Phase Power: Launch-phase power is the power required by the instrument in launch phase.

1394 Power 1394 power is the power required by the 1394 data bus physical layer.

3.2.4.3.1.2 Power Allocation

This section specifies the characteristics, connections, and control of the Spacecraft power provided to the instrument and requirements at this interface.

3.2.4.3.1.2.1 Instrument Power Allocations

3.2.4.3.1.2.1.1 Reserved

3.2.4.3.1.2.1.2 Survival Power Allocation

IF230836 The instrument survival heaters shall be sized using an assumed minimum spacecraft bus voltage of 25 V.

3.2.4.3.1.2.1.3 Reserved

3.2.4.3.1.2.1.4 Reserved

3.2.4.3.1.3 Power Control

3.2.4.3.1.3.1 Power Connections

IF230890 Each power interface shall consist of a primary and a redundant power feeds routed via two separate connectors. These connections are designated as power feeds A and B.

IF230900 The ON/OFF state of primary and redundant power supply during normal operations shall be identified in the instrument telemetry.

If the power configuration is totally under the control of the spacecraft, no additional power status telemetry is needed from the instrument.

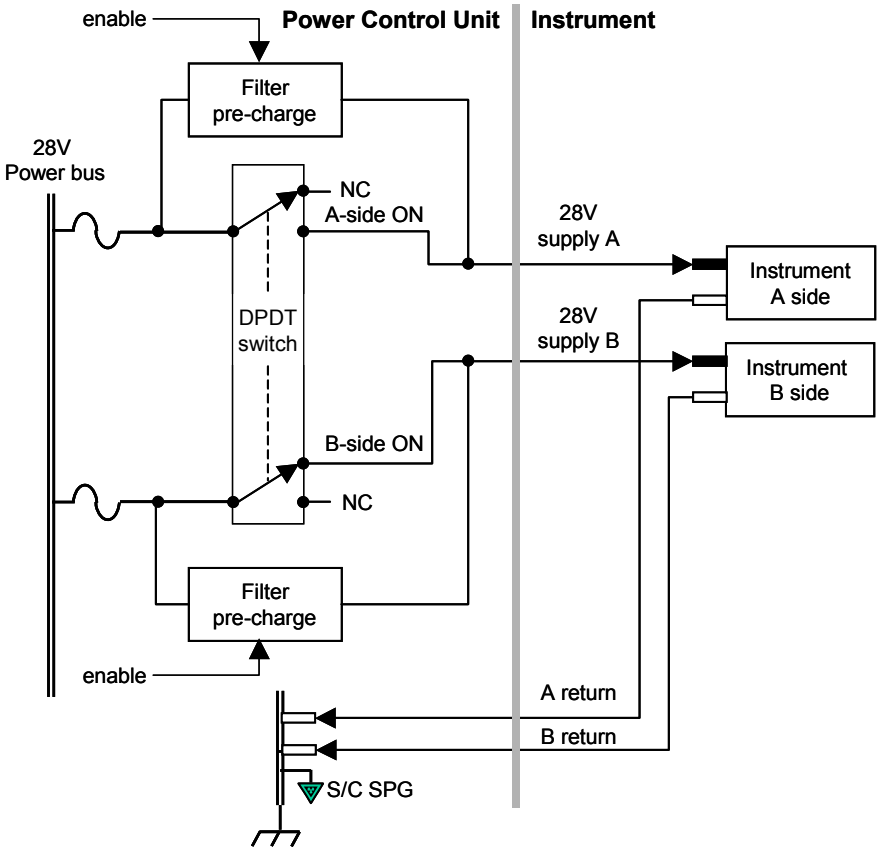


Figure 3.2.4.3.1.3.1-1. Operational Power Interface Circuit

3.2.4.3.1.4 Power Application

IF230905 The spacecraft shall have an interlock to prevent the simultaneous application of power to both power feeds.

3.2.4.3.1.4.1 Power Fault Tolerance

IF230910 The instrument and spacecraft shall not propagate a single fault occurring on either the A or B power interface circuit, on either side of the interface, to the redundant interface or instrument.

3.2.4.3.1.4.2 Instrument Heater Power Separation

IF230915 Instrument operational heaters shall maintain instrument temperatures without the use of survival heaters

IF230916 Instrument operational heaters shall be powered from the instrument operational power supplies

IF230917 Survival heaters shall be switched independently of instrumnent operational power.

3.2.4.3.1.4.3 Reserved

3.2.4.3.1.4.4 Instrument External (Spacecraft) Power

IF230930 Instruments shall be designed to operate from a 28 +6, -6 volt dc, negative ground, unregulated power subsystem.

IF230935 The spacecraft shall be able to remove bus power to all instruments if the spacecraft power system indicates an emergency energy imbalance.

This (removal of power) will not apply to survival heaters unless survival of the spacecraft is at stake.

IF230940 All instrument components shall remain undamaged when subjected to gradual ramp up monotonically (as low as 1 volt per minute) of voltage in the range from 0-22 volts, for a duration not exceeding 10 seconds.

IF233565 Paraffin and other non-explosive actuators shall use the operational bus for actuating power.

3.2.4.3.1.5 Electrical Power Interface Requirements

3.2.4.3.1.5.1 Ripple

3.2.4.3.1.5.1.1 Voltage Ripple

IF330945 Under nominal conditions (no fault clearing), the spacecraft power source-generated ripple, including repetitive spikes, shall not exceed 1.0 volts peak-to-peak as measured over the bandwidth of 30 Hz to 1.0 kHz, decreasing log-linearly to 0.5 volts peak-to-peak at 10 kHz and continuing at 0.5 volts peak to peak from 10.0 kHz to 10 MHz when measured at the power distribution unit.

IF330950 The instrument shall operate within specified performance under nominal conditions (no fault clearing) when the combined differential instrument-induced ripple from all payload instruments at the system level, as seen at the individual instrument, between the power and return lines on the operational power buses (not the survival heater bus), including repetitive spikes, does not exceed 1.0 volts peak-to-peak as measured over the bandwidth of 30 Hz to 1.0 kHz, decreasing log-linearly to 0.5 volts peak-to-peak at 10 kHz and continuing at 0.5 volts peak to peak from 10.0 kHz to 10 MHz when the power system is delivering the maximum rated current into the instrument, and the power-to-return-line impedance is as specified in this JGIID.

3.2.4.3.1.5.1.2 Reflected Ripple

IF230955 Instruments shall not produce reflected ripple greater than the CE101 limits shown in Figure 3.2.4.3.1.5.1.2-1 and CE102 limits shown in Figure 3.2.4.3.1.5.1.2-2.

CE101 and the CE102 maximum levels apply to loads that are 15 amps/450 watts and greater.

IF230960 The maximum conducted emissions, CE101 and CE102, shall be reduced by 1 dB microampere or 1 dB microvolt for each dB ampere reduction in the average load current below 15 amperes.

IF230964 Using the frequencies and limits of Figure 3.2.4.3.1.5.1.2-2. Power Lead Conducted Emissions (CE102), a frequency domain Conducted Emissions (CE) current test to control Common Mode Noise (CMN) shall be performed on all non-passive components which receive or generate spacecraft primary power.

IF230965 Measurements shall be made at the instrument interface.

The test method is as defined in MIL-STD-461E CE101 and CE102 test. The CMN test procedure is the same as CE102 except that the current probe is placed around both the plus and return primary wires together.

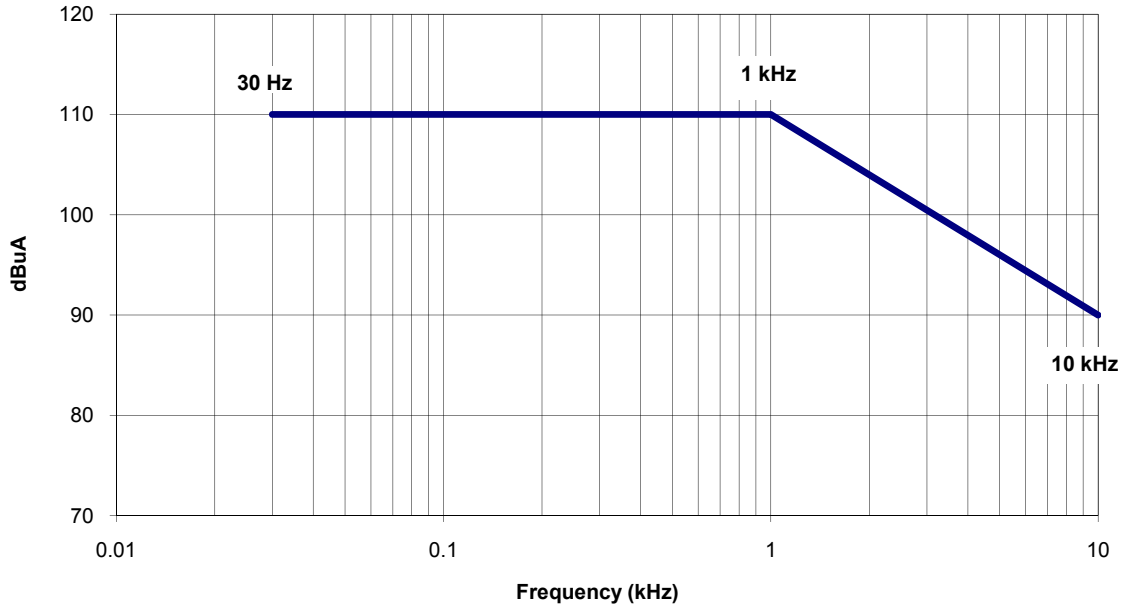


Figure 3.2.4.3.1.5.1.2-1. Power Lead Conducted Emissions (CE101)

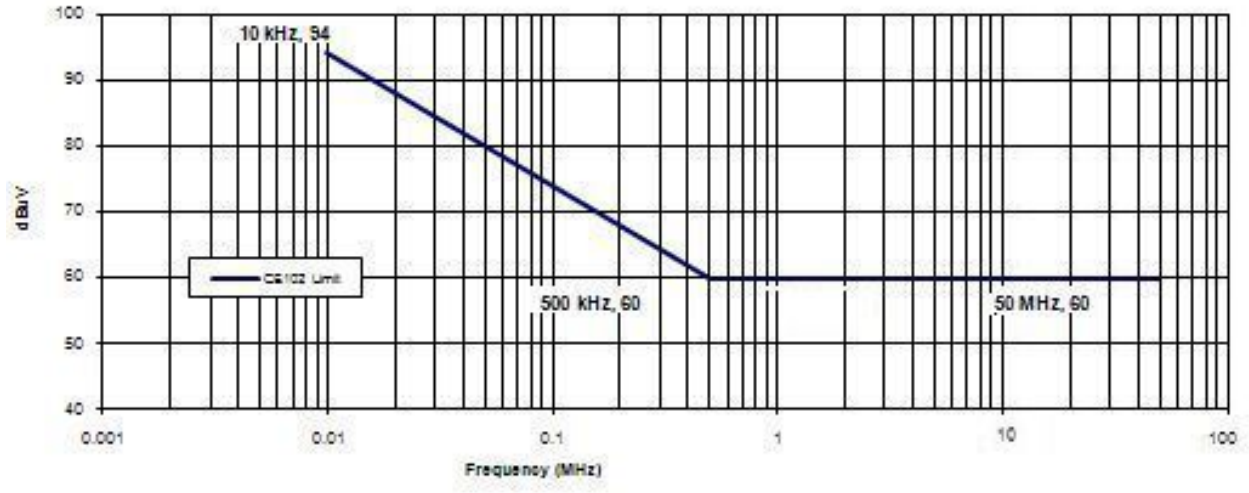


Figure 3.2.4.3.1.5.1.2-2. Power Lead Conducted Emissions (CE102)

3.2.4.3.1.5.2 Transients

3.2.4.3.1.5.2.1 Voltage Transients

IF230975 Positive and negative voltage surges from the spacecraft shall decay to within steady state limits in less than 5 and 100 milliseconds, respectively.

IF230985 All the instrument components shall remain undamaged when subjected to step changes of the input voltage from +28 Vdc to +39 Vdc (100% to 140% of nominal +28 Vdc load voltage) for 10 milliseconds.

IF230986 All the instrument components shall remain undamaged when subjected to step changes of the input voltage from +34 Vdc to 0 Vdc (125% to 0% of nominal +28 VDC load voltage) for 100 milliseconds.

The step changes, exclusive of spikes, are the instantaneous surge amplitudes produced by load switching and the clearing of faults on the space-vehicle power bus.

3.2.4.3.1.5.2.2 Current Transients

IF230990 The instrument shall not generate net negative back current into the spacecraft during any operating mode.

IF230995 When the spacecraft removes power from the instrument, the spacecraft shall not be required to discharge the power bus at the instrument.

3.2.4.3.1.5.2.2.1 Instrument Turn-on Transients

Inrush current requirements apply to the operational power bus with a 10% to 90% voltage risetime of no less than one millisecond.

IF231000 The instrument shall limit the operational power bus turn-on inrush current transient rate of change to less than 1A per microsecond (TBR).

IF231025 The instrument operational bus turn-on transient shall be limited by the instrument to be no more than 25 A (TBR).

IF231030 The operational bus, instrument inrush current shall decay to within 10% of the instrument orbit averaged maximum steady-state current in less than 50 milliseconds (TBR).

3.2.4.3.1.5.2.2.2 Instrument Turn-off Transients

IF231050 All instruments shall use suppression devices, such as diodes, located at the source of the inductive transient, across all filter inductors, relay coils, or other energy sources, which could induce transients on the power lines during turn-off.

IF231065 In remote solenoid valve applications, where diode suppression components cannot be applied directly across the solenoid coil or transient source, the suppression components shall be applied at the valve driving signal source.

IF231070 The instrument shall limit the absolute range of peak voltage of transients generated on the instrument side of the power relay caused by inductive effects of the load to the range of -2 Vdc to +45 Vdc differentially between power and return.

3.2.4.3.1.5.2.2.3 Instrument Operational Transients

IF231075 The instrument shall limit operational bus transients to less than 125 percent of the maximum operational current during any nominal mode of operation (non-fault).

Nominal modes of operation include the modes defined in Section 3.1.3 and instrument specific modes such as calibration and science.

IF231085 During normal operations the instrument shall limit current transient rate of change to no greater than 20 milliamps per microsecond.

3.2.4.3.1.5.3 Abnormal Operation Voltage Limits

IF231101 The instruments shall survive, without permanent degradation, overvoltages of 68 V for 10 microseconds

IF231100 The instruments shall survive, without permanent degradation, voltages in the range of 0 to 50 Vdc for 100 milliseconds.

This voltage and duration is intended to reflect conditions which could exist on the 28 volt bus as the result of a failure and switchover to the redundant side of a spacecraft power system component.

3.2.4.3.1.5.4 Impedance

IF231105 The spacecraft power bus impedance at the interface between the instrument and the spacecraft harness, looking back toward the spacecraft source, shall be equivalent to a resistance of 100 milliohms (TBR) in series with a 5 microHenry inductance.

3.2.4.3.1.5.5 Survival Heater Bus

IF231115 The spacecraft shall provide to the instruments power for survival heaters, meeting the same voltage range requirements as the main 28 volt bus.

IF231120 Instrument design shall be such that having both primary and redundant survival heater circuits enabled does not violate any thermal or power requirement.

It should be clarified that just because both survival circuits are enabled, this does not mean that both circuits should be drawing current. Since either circuit has to be able to meet the thermal requirements, if both circuits are drawing current, the instantaneous power drawn would exceed the allowed maximum by a factor of 2.

IF231125 Survival power shall be used within the instrument only for resistive heaters (and associated thermal control device).

The purpose of the survival heaters is to maintain the instrument at minimum turn-on temperature when the main power bus is disconnected from the instrument.

Note: "minimum turn-on" refers to the temperature at which the instrument can be sustained indefinitely without degradation in performance, once operational power has been restored and a turn-on sequence followed. The initial application of operational power by the spacecraft (turn-on) can be made at this 'minimum turn-on' temperature. Restoration of full operational status will likely involve a sequence of events following that initial turn-on, and may involve intermediate temperature constraints which must be observed.

IF231130 Survival power required by radiatively-cooled components of the instrument shall be no more than 30% of the lowest-power operational mode.

The "30%" relates to the multi-orbit average power consumed. Where spacecraft accommodation constraints require the use of a nadir radiator for the component and the 30% is exceeded, the instrument contractor and the spacecraft contractor will consult to minimize usage of survival heater power.

IF231140 The instrument shall provide thermal control of the survival heaters which is single-fault tolerant against both excessive and insufficient application of heat.

The thermal control arrangement is intended to protect the spacecraft from excessive current drain by the instrument if the control fails ON, and to protect the instrument from becoming too cold if the control fails

OFF. Whether parallel redundancy, series redundancy, or both is needed depends on the current drain, allowable instrument temperatures, and other factors.

IF231155 Survival heater power buses shall be electrically isolated from each other, from other instrument thermal control, from chassis, and shall have independent power returns.

IF231160 The spacecraft shall ensure that both the primary and redundant survival heater circuits are normally enabled on-orbit when an instrument is off.

However, even the survival heaters may be turned off in the event of an emergency where the survival of the spacecraft is in jeopardy.

3.2.4.3.1.5.6 Safety Bus Operation

The spacecraft will turn on the safety bus during those periods where it is intended to be used for safety critical activities. The primary and redundant safety bus power may or may not be on at the same time, depending on spacecraft operations.

IF231165 The instrument design shall not rely on presence of the Safety Bus at any time other than for initial activation of safety-critical items.

3.2.4.3.1.5.7 Overcurrent Protection Device Size

IF231185 Spacecraft power supply output capability shall be adequate to clear the selected size fuse (or equivalent) in addition to providing full rated load to the satellite.

IF231190 Instruments shall not contain fuses.

IF231195 Capability shall be provided by the instrument for external override (reset) of any non-fuse overcurrent protection device (such as electronic circuit breakers) within the instrument.

IF231200 The instrument design shall be such that twice the maximum transient current load can be sustained for 200 ms without propagating damage to the redundant portion of the instrument.

3.2.4.3.1.6 Unannounced Removal of Power

IF231205 Excluding the thermal effects of removing instrument power, unannounced removal of power shall not cause damage or degraded performance (following re-application of power) to the instrument.

The exclusion refers specifically to the fact that unannounced removal of ALL power (operational and survival) for an indefinite period could have permanent detrimental thermal effects.

3.2.4.3.1.7 Instrument High-Voltage Restriction

IF231210 To allow ambient testing, instrument high-voltage supplies (>50 V) shall be capable of being operated at atmospheric pressure.

IF231215 Output of any instrument power supply of 50V or greater shall be decoupled from the ground plane or current limited to prevent discharge damage to spacecraft interfaces or other instruments in the event of single point failures within the instrument.

IF231220 If an instrument high-voltage supply cannot be operated at atmospheric pressure, it shall be disabled by manual means to allow ambient testing.

3.2.4.3.2 Grounds, Returns, and References

3.2.4.3.2.1 Grounding Responsibility

IF231230 Systems shall employ a single-point-ground configuration.

IF231235 Primary power grounding shall be as depicted in Figure 3.2.4.3.2.1-1.

3.2.4.3.2.2 General

IF231240 Instrument pulse command returns shall have their returns referenced at the signal source side of the interface.

IF231250 Instrument passive analog telemetry returns shall be isolated from all other grounds within the instrument by greater than 1 megohm.

Note: the passive analog telemetry returns will be referenced appropriately on the spacecraft, but are to be isolated, as required above, within the instrument itself.

IF231260 Bilevel telemetry returns shall have their returns referenced at the telemetry source side of the interface.

3.2.4.3.2.3 Power Returns

IF231265 Each instrument primary power lead shall have a distinct, separate, and isolated return with power on feed A returned only on return A and power on feed B returned only on return B.

IF231270 Prime power and return shall be isolated, within the instrument, from the instrument chassis and structure by more than 1 megohm.

IF231275 The prime power return shall be tied to the spacecraft single-point ground.

This will be performed by the spacecraft contractor.

The single-point ground is the spacecraft conducting plate or other structure to which all ground planes are connected.

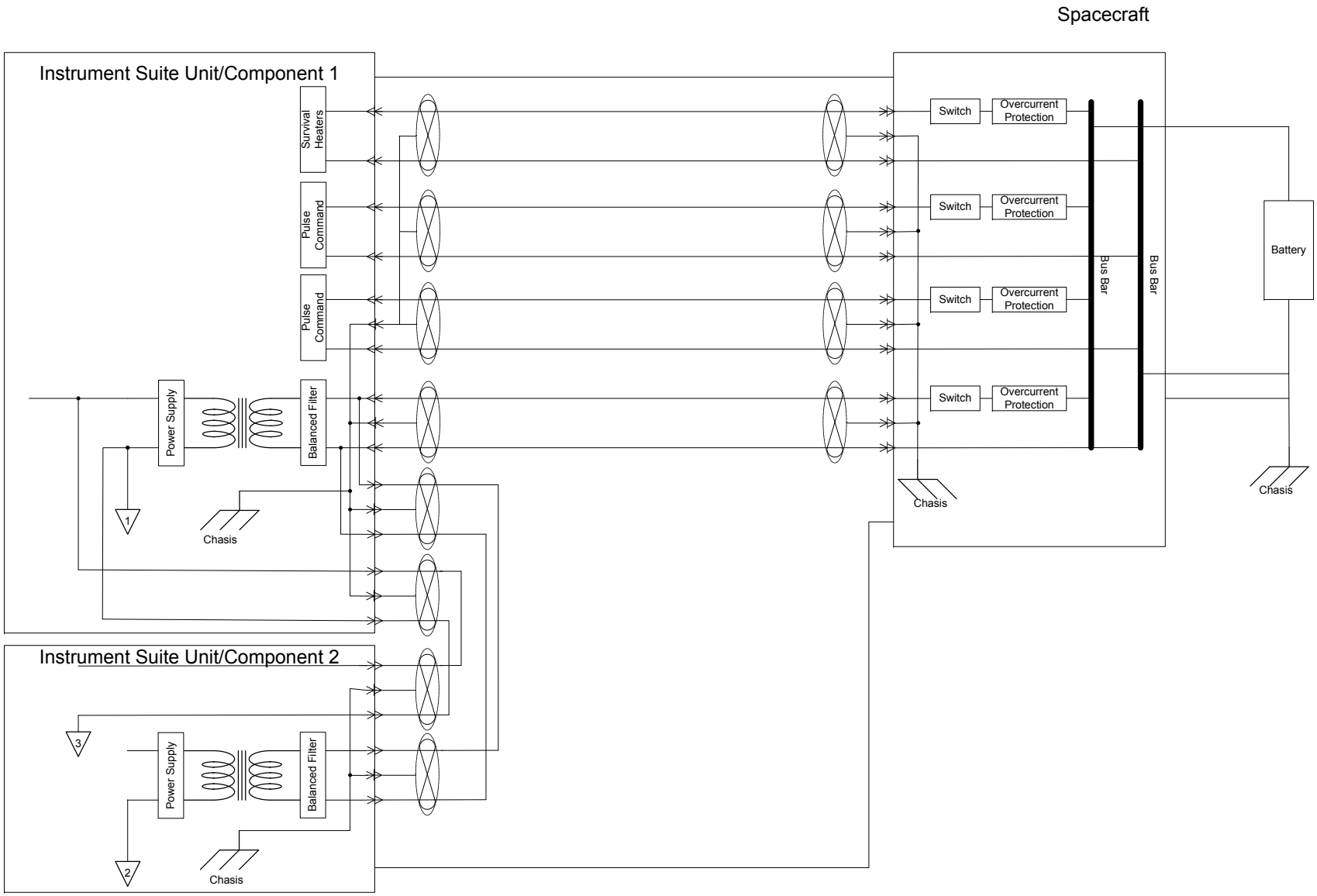


Figure 3.2.4.3.2-1. Spacecraft Grounding Scheme

IF231285 Secondary power returns shall be connected at a single point referred to as the Instrument Secondary Power Reference.

IF231290 The delivery of instrument power by the Spacecraft Contractor shall be through twisted, shielded, conductor (pair, quad, etc.) cables to reduce the electromagnetic interference.

IF231295 The instrument shall bond the Secondary Power Reference to the chassis reference.

IF231305 Secondary power isolated returns shall be referenced to chassis ground through a resistive impedance, the value of which shall be selected by the instrument contractor, but which shall be less than 1 megohm.

IF231310 The DC resistance between a connector shell and the connector mounting panel shall not exceed 2.5 milliohm for multi-pin connectors and RF type connectors and 10.0 milliohm from the mated harness connector case to the connector mounting panel.

3.2.4.3.2.4 Signal Reference

IF231320 The instrument shall be designed such that the Secondary Power Reference and the signal reference for Spacecraft interface circuits are electrically the same point, except for the 1394 and 1553 data buses.

IF231330 Signal ground shall not be used as a power return.

IF231335 The spacecraft contractor shall electrically connect the instrument ground interconnection to the spacecraft single-point ground.

3.2.4.3.2.5 Chassis Ground

IF231345 The spacecraft contractor shall provide a common electrically conductive ground “plane” or bond straps to which all instrument chassis shall be electrically connected by the spacecraft contractor.

IF231350 The instrument shall provide a designated chassis ground terminal on each separately-mounted component, as close to all electrical connectors as feasible, for connection to the spacecraft ground.

IF231355 The spacecraft shall provide a low impedance (10 milli-ohms or less) electrical connection between the instrument chassis ground terminal of each separately-mounted instrument component and the common spacecraft ground point.

IF231365 Electrical bonding shall be maintained across all thermally isolated joints.

IF231370 Electrical bonding shall be achieved by direct metal-to-metal contact over the entire bonding surfaces.

IF231375 The electrical bonding surfaces shall be held in mechanical contact to achieve the lowest possible impedance across each mechanical discontinuity.

IF231380 Electrical bonding of metallic conduits, and other tubular conducting members not inherently bonded, shall be accomplished by a plain metallic clamp, or equivalent design, without crimping or damaging the conduit.

IF231385 Electrical bonding shall be required for metallic parts fastened with non-conductive adhesives (e.g., face plates and edge members of honeycomb panels).

IF231390 A bond strap or jumper shall be provided around hinges, which do not provide a satisfactory low impedance path. General usage requires a bond strap where short circuit currents may be expected to flow, and a jumper where electrostatic grounding is the forcing requirement.

IF231400 The DC resistance from unit chassis to the ground plane shall be less than 2.5 milliohm as verified by actual measurement.

IF231405 All electrical connector receptacle shells shall be bonded to the equipment case or structure on which they are installed.

(Note where a washer is placed between the connector and chassis the 2.5 milliohm impedance shall apply to the chassis to washer and to the washer to the connector)

3.2.4.3.2.6 External Ground Tie Point

IF231410 Each instrument shall provide an external chassis ground tie point to be used for external connections while the instrument is being moved.

This point may be the same point used as the connection point to the spacecraft common ground path.

3.2.4.3.2.7 Thermal Blanket Grounding

IF231420 All thermal blanket conductive layers shall be grounded.

3.2.4.3.3 Harnesses

3.2.4.3.3.1 Electrical Connectors

3.2.4.3.3.1.1 General Considerations

IF231445 Primary and redundant connectors shall be differentiated by clearly marking all boxes and cables.

IF231465 The connector half which sources operational power and/or survival heater power shall be the most protected half of the connector.

This generally means the half with socket contacts.

IF231470 Connectors shall be capable of being mated and demated without the use of special tools.

IF231475 For instrument connections to the spacecraft harness there shall be no need for "blind mate/demates" or a need for removing adjacent instruments in order to mate or demate a harness connection.

Provision of clearance around the outside of connectors is the responsibility of the spacecraft contractor.

IF231485 All connectors that are not used for flight or for EMI/EMC testing shall be covered with EMI tight covers.

3.2.4.3.3.1.2 Connector Location and Types

IF231490 Connectors shall be located on the anti-cold-space side (sun side) of the instrument.

3.2.4.3.3.1.3 Reserved

3.2.4.3.3.1.4 Flight Plugs

"Flight plugs" are plugs with jumper connections, typically used for address plugs, safe/arm plugs, etc.

IF231505 Flight plugs requiring installation prior to launch shall be capable of being installed at the Spacecraft level.

3.2.4.3.3.1.5 Reserved

3.2.4.3.3.1.6 Buffer Connectors and Connector Savers

IF231530 Instrument buffer connectors and connector savers shall be utilized prior to spacecraft-level system tests.

IF231535 Instrument buffer connectors and connector savers shall be provided by the instrument contractor.

3.2.4.3.3.1.7 Test Connectors

Test points for use at the Spacecraft Integration level are discouraged except as expressly approved and documented in the ICD. However, if test points from the instrument to the Spacecraft Ground Support Equipment (GSE) are used, the following requirements apply:

IF231545 All test points shall be brought out to a separate, keyed connector(s) which shall be easily accessible.

IF231550 All test points shall be on the most protective half (male or female side driven by the connector series used) of the connector.

IF231555 Operational instrument circuitry shall not be powered through a test point, or any pin on a test connector, from an external power supply, during any qualification or acceptance test, or at any time while mounted on the spacecraft

IF231560 Test point interface circuitry shall not compromise instrument-grounding requirements.

IF231565 Test point interface circuit and equipment failures shall not be capable of propagating failures into the instrument. This includes credible failures in GSE connected externally to the test point interface connectors.

IF231570 The instrument shall operate within specification in the event that any test point is shorted to ground or to another test point on that same connector, regardless of whether or not the test connector is connected to its normal external source/sink of signals.

IF231575 Test points shall not be used for acceptance or qualification verification of the instrument performance requirements.

IF231580 Captive flight quality and flight capable test connector covers shall be installed whenever the test connector is not in use.

3.2.4.3.3.2 Wiring

IF231590 The spacecraft shall route each instrument primary power return conductor in an electrically shielded harness with the primary power supply lead.

3.2.4.3.3.2.1 Reserved

3.2.4.3.3.2.2 Harness Documentation

3.2.4.3.3.2.3 Harness Wiring Requirements

IF231630 Wires carrying in excess of 0.25 amperes shall be treated as power lines, not signal lines, regardless of the intended function, as regards harnessing and use of single point ground.

IF231655 Interface power and signal circuits shall utilize separate connectors.

IF231670 RF signals shall be transmitted on coax cable and terminated using EMI tight RF connectors.

IF231675 High rate digital (for example 1553, 1394A, and sync signals) shall be transmitted on shielded, twisted-pair cable.

IF231680 EED signals shall be distributed on twisted-pair, double-shielded wire.

IF231690 Spacecraft to instrument wire shields shall be grounded to the unit chassis at both ends and also at each intermediate mechanical discontinuity of the shield.

IF231695 Multi-pin connector shield terminations shall be terminated with 360 deg circumferential contact.

3.2.4.3.3.2.4 Reserved

3.2.4.3.3.2.5 Reserved

3.2.4.4 Reserved

3.2.4.5 Parts, Materials, and Processes

IF231720 For life-limited items, instrument design, qualification and verification shall account for multiple activation during spacecraft level tests.

IF231725 After delivery of instruments, no sanding/scribing/shaving/machining of any beryllium material shall be allowed.

3.2.4.6 Reserved

3.2.4.7 Thermal

3.2.4.7.1 General

IF231790 The operating and survival temperatures, as well as the thermal isolation requirements specified in this section shall be met at the mechanical interface between the spacecraft and the instrument.

Note: The passive analog SURVIVAL temperature sensors described later, may indicate temperatures at other, critical, locations within the instrument, and do not necessarily represent interface temperatures.

IF231795 The instrument contractor shall be responsible for the thermal design of the instrument, maintaining the instrument within operating and survival temperature limits.

IF231800 The instrument thermal design shall provide for utilizing spacecraft survival bus power for maintaining the instrument at or above the minimum survival temperature when the instrument is off and at or above the minimum turn-on temperature before the instrument is activated.

IF231805 The spacecraft shall not be used as a heat source or sink in the instrument thermal design.

(Note: does not apply to coldplate provided by the spacecraft contractor for instrument remote heat rejection).

IF231810 Instrument thermal control devices, including electronic circuitry and all active and passive devices shall be mounted to the instrument (within the defined instrument envelope).

3.2.4.7.2 Thermal Recovery

IF231815 The instrument shall take no more than 60 minutes to return from SAFE mode (Section 3.1.3.6) to a temperature condition capable of normal operation, assuming no anomalies.

This time limitation does not include passive radiative detector coolers.

IF231820 The instrument shall take no more than 102 minutes to return from SURVIVAL mode (Section 3.1.3.7) to a temperature condition capable of normal operation, after spacecraft application of operational power.

This time limitation does not include passive radiative detector coolers.

3.2.4.7.3 Heat Transfer

3.2.4.7.3.1 Heat Transfer to Spacecraft

IF231825 The instrument modules shall be thermally isolated to the maximum extent possible to minimize heat transfer to the spacecraft and other adjacent instruments.

To maintain flexibility in the placement of instrument modules on the spacecraft, it is necessary to limit the total heat transfer (conduction and radiation) to the spacecraft and other instruments. The thermal isolation is accomplished by minimizing thermal conduction and radiation using low thermal conductivity mechanical interface mounts and low effective emissivity MLI blankets at all non-radiator instrument surfaces. Radiation to the earth or to cold space is intended to be the primary means of dissipating waste heat from the instrument. Heat transfer to the spacecraft for dissipation via a spacecraft-provided coldplate can be used,if called out in the ICD.

IF231840 The total orbit-average heat transfer rate (conducted and radiated) between the instrument and the spacecraft shall not exceed 10 watts into or out of the instrument mounting surface.

This includes heat conducted through the harness and ground straps.

IF231850 Each instrument module total orbit average heat transfer rate (conducted and radiated) between the instrument and the spacecraft, divided by the footprint area, shall not exceed 15 watts per square meter into or out of the instrument.

This includes heat conducted through the harness and ground straps.

Note: The term 'footprint area" as used in this requirement means the area under the instrument module, projected onto the spacecraft. It does not refer to the area of the footprint of the kinematic mounts.

3.2.4.7.3.2 Integrated Instrument Thermal Environments

IF231865 The spacecraft contractor shall provide the calculated absorbed on-orbit thermal environment (direct and indirect solar, albedo and earth IR) and spacecraft IR backload heat fluxes for all instrument external surfaces.

This data will be used by the instrument contractor to perform detailed thermal analysis of the instrument. Alternatively, with agreement among NASA JPSS, the spacecraft contractor and the instrument contractor, radiation exchange factors (Rad K's) between the instrument and the spacecraft, and between the instrument and other instruments, along with associated temperatures, could replace the IR backload data exchange.

3.2.4.7.3.2.1 Environmental Heat Flux

IF231880 The thermal environment parameters for worst hot and cold cases are shown in Table 3.2.4.7.3.2.1-1. The given parameter values shall be used by both the spacecraft and instrument contractors in their respective thermal analyses.

Table 3.2.4.7.3.2.1-1. Worst-Case Hot and Cold Thermal Environment Parameters

Parameter	Hot Case	Cold Case
Solar Constant, W/m^2	1400	1308
Earth IR Constant, W/m^2	262	222
Albedo (ratio)	0.387	0.275

3.2.4.7.3.2.2 Spacecraft IR Backload Heat Flux

IF231870 The instrument absorbed cold and hot case environmental heat fluxes shall be defined as a result of the integrated overall spacecraft thermal analysis.

IF231875 The integrated spacecraft IR backload heat fluxes absorbed on instrument external surfaces for the cold, hot, and survival cases shall be defined as a result of the integrated overall spacecraft thermal analysis.

The total IR backload on an instrument external surface, i, is given by

$$Q_{IR-Backload,i} = \sum_{j=1}^{J} \sigma A_i \Im_{ij} T_j^4$$

where $j = 1 \rightarrow J$ represents all surfaces radiatively coupled to surface i.

The IR backload can be segregated into spacecraft and instrument contributions

$$Q_{IR-Backload,i} = \sum_{n=1}^{N} \sigma A_i \Im_{in} T_n^4 + \sum_{k=1}^{K} \sigma A_i \Im_{ik} T_k^4$$

where $n = 1 \rightarrow N$ represents all non-instrument surfaces (spacecraft and other instruments), and $k = 1 \rightarrow K$ represents all surfaces of the instrument.

3.2.4.7.4 Temperature

3.2.4.7.4.1 Spacecraft Mounting Interface Temperature Requirements

IF231885 In normal operational mode, the spacecraft shall maintain the temperature of the mechanical instrument-to-spacecraft mounting surface within the range of -10 deg C and +40 deg C so long as the instrument does not exceed the allowed heat transfer between the instrument and the spacecraft. This temperature range includes analytical uncertainty in the spacecraft prediction.

IF231890 The instrument shall meet all specified performance requirements when the temperature of the mechanical instrument-to-spacecraft mounting surface is in the normal operating range.

IF231891 In survival mode, the spacecraft shall maintain the temperature of the mechanical instrument-to-spacecraft mounting surface within the range of -30 deg C and +60

deg C so long as the instrument does not exceed the allowed heat transfer between the instrument and the spacecraft. This temperature range includes analytical uncertainty in the spacecraft prediction.

IF231895 The instrument temperatures shall stay within the survival limits when the temperature of the mechanical instrument-to-spacecraft mounting surface is in the survival range and return to normal operations after the instrument temperature returns to the normal operating range.

3.2.4.7.4.2 Thermal Uncertainty Margins

IF231915 Thermal uncertainty margins used during the design and validation shall be applied to determine acceptance ranges

a. Acceptance test levels are determined by adding a thermal uncertainty margin of 10 deg C to the analytically determined extreme temperatures predicted from thermal models.
b. If heaters are employed, 25% heater control authority (demonstrated by measurement) can be used in place of the uncertainty margin.
c. Protoflight ranges are calculated by adding additional margins of ± 5 deg C.

3.2.4.7.5 Temperature Monitoring

3.2.4.7.5.1 Mechanical Mounting Interface Temperature Monitoring

IF231920 The spacecraft shall monitor and report the temperatures of the spacecraft at the instrument mechanical mounting interfaces in the spacecraft telemetry.

3.2.4.7.5.2 Instrument Temperature Monitoring

IF231925 All critical instrument temperatures shall be reported by the instrument in the health and status telemetry data.

3.2.4.7.5.3 Reserved

3.2.4.7.6 Thermal Control Design

IF232010 The instrument thermal-control subsystem shall be designed to minimize heater power requirements.

IF232015 Use of passive thermal control techniques shall be maximized.

3.2.4.7.6.1 Thermal Control Hardware

IF231945 The responsibility for providing the thermal control hardware shall be as defined in Table 3.2.4.7.6.1-1.

Table 3.2.4.7.6.1-1. Thermal Control Hardware Responsibility

Hardware	Responsibility
Survival heaters	Instrument Contractor
Instrument thermal control hardware, including blankets, louvers, and heat pipes	Instrument Contractor
Instrument-to-spacecraft interface operational and survival heaters, thermistors, thermostats	Spacecraft Contractor
Thermal close-out blankets to interface between the instrument thermal blankets and the spacecraft thermal blankets	Spacecraft Contractor
Instrument-to spacecraft interface MLI blankets	Spacecraft Contractor

3.2.4.7.6.2 Survival Heaters

IF231950 Instruments shall utilize survival heaters to maintain temperatures at or above minimum survival limits, when the operational power bus has been disconnected from the instrument.

IF231955 When the instrument operational power bus is active, operational heaters located inside the instrument, and controlled by the instrument, shall be used for normal thermal control.

IF231960 Survival heaters shall not be required to provide heat when the operational bus is active to the instrument.

IF231965 The spacecraft contractor may elect to leave the survival heater bus powered during the initial phase of warm-up upon exit from SURVIVAL mode, but the instrument shall be capable of achieving thermal control, once the operational power bus is activated, without use of the survival heaters.

3.2.4.7.6.3 Reserved

3.2.4.7.6.4 Other Considerations

IF231995 Instrument heat pipes shall function with a 1g field in a direction compatible with spacecraft thermal vacuum testing.

3.2.4.7.6.5 Ambient Tests

IF232000 The instrument shall be capable of being functionally tested in an ambient environment, to the maximum extent possible.

3.2.4.8 Command and Data Handling

IF232020 Unless specified otherwise, the requirements in this section shall apply to all Command and Data Handling (C&DH) interfaces.

IF232021 Instruments shall comply with the command and telemetry formats as specified in TBS, JPSS Command and Telemetry Handbook and the Mission Data Format Control Book (MDFCB).

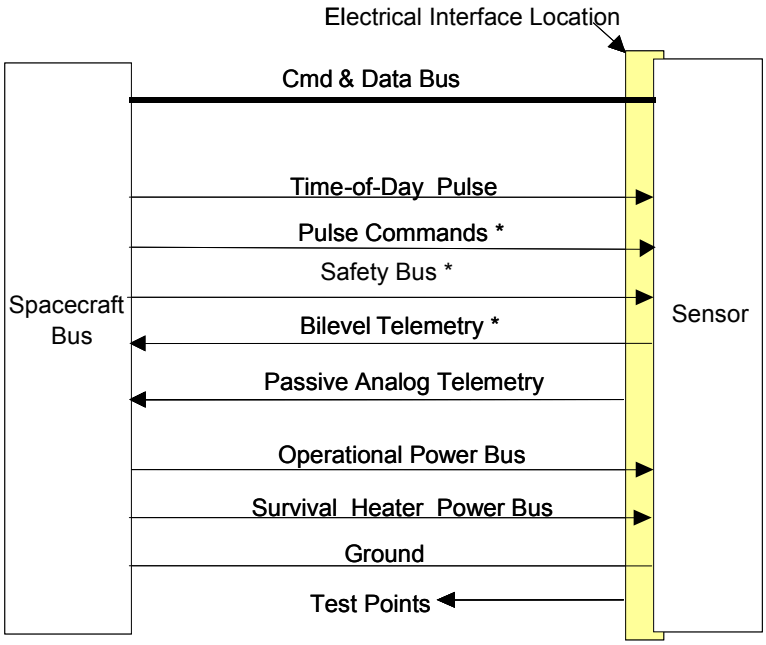
3.2.4.8.1 Common Electrical Interface

IF232025 All electrical interfaces except test point interfaces shall be functionally redundant.

The electrical interfaces (see Figure 3.2.4.8.1-1) include the following. The requirements for each interface are identified later in Section 3.2.4.8:

- Command and Data Bus
- CrIMSS Synchronization (ATMS and CrIS only)
- Time of Day Pulse
- Pulse Command Interface *
- Safety Bus *
- Bilevel Telemetry Interface *
- Passive Analog Telemetry Interface
- Operational Power Bus
- Survival Heater Power Bus
- Grounding Interface
- Test Point Interface.

* = minimal usage



* = minimal usage

Figure 3.2.4.8.1-1. Spacecraft-Instrument Electrical Interfaces

3.2.4.8.1.1 Interface Conductors

IF232030 All signal interface wiring shall use shielded conductors.

3.2.4.8.1.2 Interface Circuitry Isolation

IF232035 The instrument shall maintain electrical isolation of greater than 100 kohm between the primary and redundant interface circuitry to the spacecraft.

3.2.4.8.1.3 Reserved

3.2.4.8.2 Data Bus Requirements

3.2.4.8.2.1 Bus Functions

IF232050 Instruments shall interface to either Mil-STD-1553 or FT1394 data bus as called out in Table 3.2.4.8.2.1-1, complying with 472-00015, 472-00016, 472-00017, as applicable.

Table 3.2.4.8.2.1-1. Instrument Data Bus Assignment

Instrument	Data Bus
VIIRS	1394
CrIS	1394
OMPS	1553
CERES/ERBS	1553
TSIS	1553
SEM	1553
A-DCS	1553
ATMS	1553

The following functions (see Figure 3.2.4.8.2-1), where appropriate, are to be provided between the spacecraft and the instruments.

IF232060 a) Spacecraft to instrument transfers consisting of:

- real-time ground commands
- stored commands
- memory loads
- state of health indications
- auxiliary data (e.g., time code, satellite ephemeris)

IF232065 b) Instrument to spacecraft transfers consisting of:

- mission data, including auxiliary data received from spacecraft
- instrument health and status telemetry
- instrument transition to safe mode indicator
- instrument diagnostic data
- memory dumps
- survival mode temperatures (not part of the data bus)

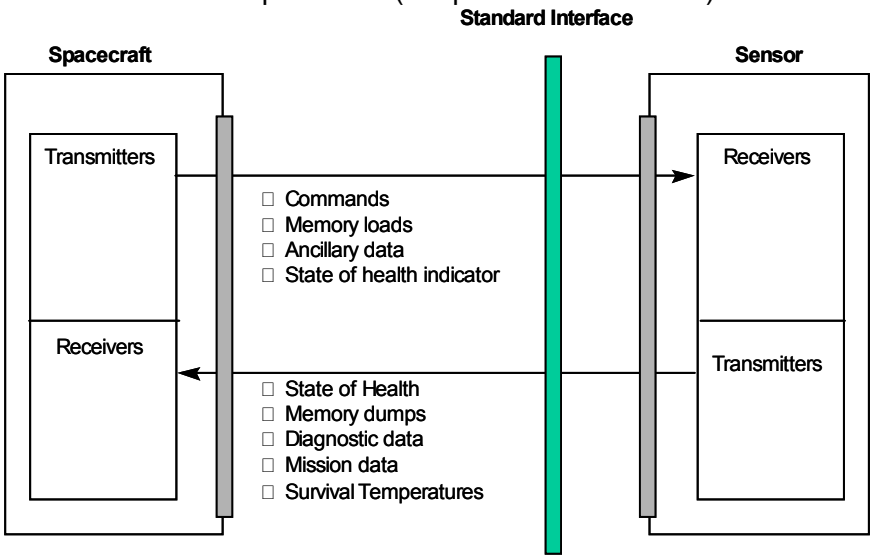


Figure 3.2.4.8.2-1. Data Transfer Interface

3.2.4.8.3 Interface Characteristics

3.2.4.8.3.1 Reserved

3.2.4.8.3.2 IEEE 1394a Interface Characteristics

NASA JPSS will resolve 1394 interface implementation issues not defined here, or in the referenced documents.

IF232080 The interface shall comply with the requirements of 472-00016 and 472-00017

3.2.4.8.3.3 Pulse Commands

IF232095 Pulse commands from the spacecraft shall not be used for functions which could be accomplished by the instrument itself, or by command from the spacecraft via the data bus.

The primary means of commanding the instrument is through the command & data interface. If necessary, and as approved by NASA JPSS and documented in the ICD, selected commands may utilize pulse (relay driving) commands, having the characteristics given below.

IF232100 Instrument discrete pulse commands shall have redundant interfaces per function, one primary, and one redundant, each controlled by one wire pair (command/return).

IF232105 The pulse command characteristics shall be as follows:

IF232110	a. Logic 0:	-2.0 to 4.0 VDC @ 4 microamps load source current
IF232115	b. Logic 1:	22 VDC to bus voltage @ 350 ma load sink current
IF232120	c. Load Impedance:	97 ohms minimum
IF232125	d. Pulse Width:	70 ± 10 milliseconds
IF232130	e. Voltage Rise Time:	4 msec maximum
IF232135	f. Voltage Fall Time:	6 msec maximum

IF232145 g. No contact chatter allowed when subjected to vibration environment specified in this GIID.

Note: This requirement (g.) only applies to functions which will be powered during the vibration environment, and where a change in state of the relay would affect instrument status or performance.

IF232150 The Instrument shall provide series redundant suppression diodes in parallel with all inductive loads.

IF232155 The spacecraft shall not issue pulse commands to the instrument spaced more closely than two times the pulse width (i.e., one pulse width between the end of one command and the start of the next command).

3.2.4.8.3.4 Time of Day Pulse

IF232160 The spacecraft shall provide a 1 Hz Time of Day pulse to indicate the point in time at which to apply the time code which was previously transmitted over the data bus.

See 472-00015 or 472-00016 as applicable.

IF232165 The instrument shall utilize the rising edge of the Time of Day pulse, together with the time code data, in order to establish the time reference for instrument data.

IF232170 The Time-of-Day pulse shall utilize an EIA RS-422 interface circuit, with the following characteristics:

IF232175	Termination impedance:	120 +/- 10 ohms center-tapped to ground via a 0.001 microfarad capacitor
IF232180	Harness:	shielded twisted pair. Shield terminated in connector to chassis ground
IF232185	Rise time:	Less than 1 microsecond
IF232190	Pulse width:	Greater than 10 microseconds

IF232195 The spacecraft shall issue the Time of Day pulse rising edge (non-inverting side of differential interface) within 5 microseconds of each spacecraft 1-second time occurrence.

3.2.4.8.3.5 Synchronization

IF232200 Where instruments require synchronization to each other, the spacecraft shall provide a means whereby synchronization can be accomplished via the data bus interface.

IF232205 If synchronization accuracy requirements cannot be met using the data bus alone, the spacecraft shall provide a synchronization pulse using the electrical characteristics of an EIA RS-422 interface.

IF232210 Where the synchronization period is integer multiples of seconds, the rising edge of the EIA RS-422 Time-of-Day pulse shall be used as the synchronization signal described above, with the data bus indicating which Time-of-Day pulse is the synchronization signal.

3.2.4.8.4 Instrument Commands and Data Load

The spacecraft, through the Mil-STD-1553 bus will deliver the instrument command and data load to the specified instrument RT-receive address/sub-address by conducting BC-to-RT Transfers or RT-to-RT

Transfers (from a spacecraft RT to an instrument RT). Command and data load through the IEEE-1394a will be performed as specified in the ICD.

The spacecraft will provide discrete commands for instrument operational and survival heater power switching, fault recovery, and squib functions as necessary. The spacecraft will provide time synchronization and Time-of-day pulses. The spacecraft will provide auxiliary data and spacecraft ephemeris, where appropriate.

IF232220 The standard means of transmitting commands and data loads from the spacecraft to the instrument shall be via the data bus.

3.2.4.8.4.1 Commands

3.2.4.8.4.1.1 Real-time Ground Commands

IF232225 The instrument shall accept and execute all valid commands issued to the instrument by the Mission Management Center (MMC) via the spacecraft command system.

3.2.4.8.4.1.2 Stored Commands

IF232240 The spacecraft time tag for stored commands shall have a resolution of 1 second or finer.

3.2.4.8.4.1.3 Command Uniqueness

IF232250 Each command shall be unique and have the same effect in all instrument modes for which the command is applicable.

3.2.4.8.4.1.4 Command Sequence

IF232255 The instrument shall be designed such that commands, including test-only commands, may be sent or executed in any sequence, in any mode, without damage to the instrument.

A test-only command is any decodable bit sequence, some of which are used for special testing and others that may be residual, as they were not specifically excluded by the design.

3.2.4.8.4.1.5 Command Restraints

IF232260 No state-dependent or "toggle" commands shall be allowed.

This means that the same command (all bits being the same values) shall not cause different effects depending on the previous state of the item being commanded.

IF232265 For any command, the command format shall be identical for every mission phase and every instrument mode for which the command is applicable.

IF232275 Within commands that control multiple discrete conditions, each controlled function shall have an enabling bit (or a unique code) which shall be able to be changed individually or in any combination.

IF232280 Instrument mechanisms which require uncaging and/or caging on-orbit shall be capable of being caged and uncaged by command.

IF232285 Commands shall be available to disable or override all automatically triggered instrument functions that change the configuration or operational state of the instrument, including instrument-induced transition to instrument safe mode.

3.2.4.8.4.2 Command and Data Load Packets

IF232290 All non-discrete commands (serial bus commands) and all memory loads delivered to the instrument shall be formatted in accordance with 472-00015 or 472-00016 as applicable.

IF232300 Instrument data bus command and memory load source packets shall be decrypted by the spacecraft before transmission to the instruments in clear text.

IF232305 Instrument data bus command and memory load source packets shall be transmitted to their destination according with their APID (Application Process Identifier).

IF235261 The instrument shall be capable of functional operation while having no more than one upload per day

3.2.4.8.4.3 Reserved

3.2.4.8.4.4 Reserved

3.2.4.8.4.5 Critical Command

IF232315 Initiation of critical or hazardous functions shall use, as a minimum, separate enable and execute command sequences to the commanded unit, to prevent inadvertent execution of critical commands.

IF232320 Enables shall be disabled by the instrument after the critical function is commanded, or after 30 seconds have elapsed following receipt of the enable, if the command itself has not been received.

3.2.4.8.4.6 Release Mechanism Commands

Instruments are discouraged from utilizing pyrotechnic devices for release mechanisms.

IF232330 Instrument non-explosive release mechanisms shall be functionally single fault tolerant.

IF232335 Instrument non-explosive release mechanisms shall meet range safety requirements of USAF EWR AFS PCMAN91-710.

3.2.4.8.4.7 Reserved

3.2.4.8.5 Instrument Health and Status Telemetry

IF232475 Instrument health and status telemetry packet shall include housekeeping data required for instrument status and health monitoring.

IF232480 Instrument health and status telemetry includes:

IF232485 a. Instrument mode and configuration,

IF232490 b. Instrument temperatures,

IF232495 c. Instrument internal (converter) power supply voltage,

IF232500 d. Relay status, scan mirror rotation, and other rotating mechanism rates,

IF232505 e. Verification of commands received and commands executed,

IF232510 f. Other telemetry data required to support instrument performance evaluation

IF232520 The same instrument telemetry stream format shall be usable on-orbit as well as for I&T activities.

IF232525 All telemetry used for determining instrument configuration shall be invariant to instrument mode.

IF232530 Instrument health and status telemetry stream packetization shall be as specified in paragraphs of section 3.2.4.8.7.

IF232535 No single point failure shall prevent spacecraft access to critical telemetry points.

3.2.4.8.5.1 Telemetry Diagnostic Data

IF232345 The instrument shall provide sufficient telemetry to diagnose failures to the lowest switchable level, and to track variations in performance of critical functions.

IF232350 During instrument anomaly resolution, the instrument shall have the capability to dwell (multiple samples per second) on particular telemetry measurands, as required to support ground diagnostic investigations.

IF232360 Telemetry dwell shall be in response to a ground-initiated process.

IF232365 The diagnostic telemetry shall be placed within selected packets, identified with a unique packet APID.

3.2.4.8.5.2 Point-to-Point Telemetry

Point-to-point telemetry is intended to represent "static" information (for example: relay status associated with pulse commands where knowledge of the relay position is required even when the instrument is off) such that sampling rates in the seconds, or tens of seconds, is adequate.

IF232370 The instrument shall provide as a minimum the following telemetry to the spacecraft via the point-to-point telemetry interfaces:

IF232375 a. Status of functions commanded via point-to-point interfaces,

IF232380 b. Telemetry for the determination of instrument health and safety not otherwise attainable via the command and data bus, such as telemetry that is required to be available when the operational power is off (goal is none).

IF232390 Each instrument shall provide redundant passive analog temperature sensors sufficient to determine the thermal state of the instrument when unpowered. Use of more than five redundant pairs requires approval by NASA JPSS.

Redundancy may be accomplished by thermally overlapping regions for non-critical measurements. These analog lines are separate and in addition to any state of health (SOH) input being transmitted over the command and data interface and are intended to provide insight during periods when the instrument operational power is not present; therefore, excitation of the passive analog temperature measurement devices is provided by the spacecraft.

IF232395 Electrical connections to these dedicated passive analog temperature measurement devices shall be made only through an electrical connector interfacing the instrument with the spacecraft.

IF232400 The electrical connection between these passive analog temperature measurement devices and any instrument electronics, chassis, or ground shall be isolated to at least 1 megohm.

IF232405 Characteristics of the spacecraft-excited passive analog temperature interface shall be as follows at the instrument connector:

IF232410	Sense Current During Sample :	1 mA ± 5%
IF232415	Instrument Resistance Range:	100 ohms to 5 kilo-ohms
IF232420	Capacitance:	<200 picofarads instrument capacitance

IF232425 The instrument shall provide relay contact closure (wire pair) to indicate bi-level point-to-point telemetry status.

This requirement refers to telemetry associated with pulse commands, not to internal discrete telemetry, which comes over the data bus.

IF232426 Open contact resistance shall be > 100K ohms.

IF232427 Closed contact resistance shall be < 100 ohms.

IF232428 Appropriate ground referencing shall be provided by the spacecraft.

3.2.4.8.5.3 Command Verification

IF232430 Receipt of individual commands via the Command & Data bus shall be verifiable via instrument Health and Status telemetry.

IF232435 Execution of serial commands (data bus) shall be verifiable via instrument Health and Status telemetry.

IF232445 Execution of discrete commands shall be verified via discrete instrument telemetry points sampled by the spacecraft.

3.2.4.8.5.4 Instrument Memory Dump

IF232450 Instrument Memory Dump data shall be transferred to the spacecraft C&DH via the data bus.

IF232455 Instrument Memory Dump data shall span one or more telemetry packets.

IF232460 Instrument Memory Dump packetization shall be as specified in section 3.2.4.8.7

3.2.4.8.5.5 Telemetry Monitor

The Spacecraft Telemetry Monitor (TMON) function performs limit checking on specific data items and is capable of activating a stored command sequence when errors are detected. Group and Logic Tables are used to define the data thresholds. The ground is capable of modifying any of the TMON tables via a Memory Load operation. The TMON function compares the collected data with the predefined limits defined in the tables.

Any payload telemetry parameter that requires monitoring by the spacecraft must be placed in a TMON packet message. The format description of this TMON packet is defined in the 1394 IRD and the 1553 IRD, respectively. Payload telemetry sent in LEO&A and Housekeeping packets simply goes to the ground without spacecraft monitoring.

3.2.4.8.6 Mission Data

IF232545 Instrument Mission Data shall be transferred to the spacecraft C&DH via the Command & Data Interface.

IF232550 Instrument Mission Data packetization shall be as specified in section 3.2.4.8.7

IF232560 The instrument shall not be required to produce a constant data rate over any one second period (i.e., no requirement for "fill" data).

3.2.4.8.7 Data Packetization

The spacecraft C&DH Subsystem collects instrument Health & Status Telemetry, instrument Memory Dump, and Mission Data packets through the Command & Data interface. The C&DH Subsystem multiplexes these packets and attaches appropriate protocol for downlink and storage.

IF232565 All instrument Health & Status telemetry, instrument Memory Dump, and Mission Data shall be packetized in accordance with 472-00015 , 472-00016 or 472-00017, as applicable.

IF232566 Memory loads shall use the format described generally in Table 3.2.4.8.7-1 and specifically in Figure 3.2.4.8.7-1.

This XML file format is the preferred format for binary data intended for uplink to the spacecraft. Any binary data that needs to be uplinked to the spacecraft or sensors should use this format so that Satellite operations can readily generate the appropriate commands to uplink the data, and so Mission

Management can schedule the uplink. This binary can include a variety of data types, from calibration tables to flight software patches.

Table 3.2.4.8.7-1. General Description of the Data Elements of the XML File

Field Name	Data Type	Description
Author	String	For reference, author or source of load. Mandatory
spacecraft	String	Mnemonic for spacecraft. Mandatory.
destination	String	Mnemonic for destination subsystem. This would be instrument name for sensor loads. Mandatory. Defaults to spacecraft.
dateCreated	dateTime	YYYY-MM-DDTHH:MM:SSZ Date of data file creation. Mandatory. dateTime is a predefined XML field that requires correct date and time formatting. Correctly identifying the type as dateTime will also eliminate the need for specifying how to build the date string.
uplinkInterval	ComplexType	The range of effectivity in which the data is still valid to use for an uplink.
uplinkInterval:startInterval	dateTime	YYYY-MM-DDTHH:MM:SSZ The range of effectivity in which the data is still valid to use for an uplink. dateTime is a predefined XML field that requires correct date and time formatting. Correctly identifying the type as dateTime will also eliminate the need for specifying how to build the date string.
uplinkInterval:endInterval	dateTime	YYYY-MM-DDTHH:MM:SSZ The range of effectivity in which the data is still valid to use for an uplink.. dateTime is a predefined XML field that requires correct date and time formatting. Correctly identifying the type as dateTime will also eliminate the need for specifying how to build the date string.
sizeInBytes	Integer	Total size of load, in bytes. Includes all memory blocks in the load.
MemBlock	ComplexType	Consists of addressing information and binary data. There can be N memory blocks in a load, allowing loading of non-contiguous memory regions in a single load.
memBlock:startAddress	String	Hex address to load memory block to. Either startAddress or tableAddr must be provided.
memBlock:tableAddr	ComplexType	The combination of tableId and tableOffset and sizeInBytes. Choice
memBlock:tableAddr:tableId	Integer	Table Id. Number identifier of table to which the memory block should be loaded. Choice
memBlock:tableAddr:tableOffset	Integer	The offset in bytes or (blocks of bytes for some large tables) for the load. Table identifiers are Mandatory.
memBlock:sizeInBytes	Integer	Size, in bytes, of this memory block. Mandatory.
memBlock:data	String	The binary data, in ASCII hex representation. Mandatory. This is the actual data being uploaded. As long as the lines contain valid hexadecimal representation of data, will read as much data as is available on each line and form a single "string" of the data to be loaded.

```
<?xml version="1.0" encoding="utf-8"?>
<!--        === Example Memory Load Input XML ===

<memoryLoadInput xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:noNamespaceSchemaLocation="memoryLoadInput.xsd">
                        –          <spacecraft>NPP</spacecraft>

    <destination>CDH</destination>
    <dateCreated>2000-03-06T21:00:00Z</dateCreated>
    <uplinkInterval>
        <startInterval>2000-06-06T21:00:00Z</startInterval>
        <endInterval>2000-09-06T21:00:00Z</endInterval>
    </uplinkInterval>
    <sizeInBytes>256</sizeInBytes>
    <memBlock>
        <tableId>105</tableId>
        <tableOffset>120</tableOffset>
        <sizeInBytes>32</sizeInBytes>
        <data>
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
        </data>
    </memBlock>
    <memBlock>
        <tableId>105</tableId>
        <tableOffset>360</tableOffset>
        <sizeInBytes>224</sizeInBytes>
        <data>
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
0A0E0A0E0A0E0A0E0A0E0A0E0A0E0A0E
        </data>
    </memBlock>
</memoryLoadInput>

    === End Example Memory Load XML ===
-->

<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">

  <xsd:simpleType name="spacecraftType">

<xsd:element name="uplinkInterval">

    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="startInterval" type="xsd:dateTime"
minOccurs="1" maxOccurs="1"/>
        <xsd:element name="endInterval" type="xsd:dateTime"
minOccurs="1" maxOccurs="1"/>
      </xsd:sequence>
    </xsd:complexType>

  </xsd:element>

  <xsd:group name="tableAddr">

    <xsd:sequence>
      <xsd:element name="tableId" type="xsd:integer" minOccurs="1"
maxOccurs="1"/>
      <xsd:element name="tableOffset" type="xsd:integer"
minOccurs="1" maxOccurs="1"/>
    </xsd:sequence>

  </xsd:group>

  <xsd:element name="memBlock">

    <xsd:complexType>
      <xsd:sequence>
        <xsd:choice>
          <xsd:element name="startAddress" type="xsd:string"
minOccurs="1" maxOccurs="1"/>
            <xsd:group ref="tableAddr"/>
        </xsd:choice>
        <xsd:element name="sizeInBytes" type="xsd:integer"
minOccurs="1" maxOccurs="1"/>
        <xsd:element name="data" type="xsd:string" minOccurs="1"
maxOccurs="unbounded"/>
      </xsd:sequence>
    </xsd:complexType>

  </xsd:element>

  <xsd:element name="memoryLoadInput">

    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="spacecraft" type="spacecraftType"
minOccurs="1" maxOccurs="1"/>
        <xsd:element name="destination" type="xsd:string" minOccurs="1"
maxOccurs="1"/>
        <xsd:element name="dateCreated" type="xsd:dateTime"
minOccurs="1" maxOccurs="1"/>
```

```
    <xsd:restriction base="xsd:string">
      <xsd:enumeration value="NPP" />
      <xsd:enumeration value="N01" />
      <xsd:enumeration value="N02" />
      <xsd:enumeration value="N03" />
    </xsd:restriction>
  </xsd:simpleType>
```

```
      <xsd:element ref="uplinkInterval" minOccurs="0" maxOccurs="1"/>
      <xsd:element name="sizeInBytes" minOccurs="1"
maxOccurs="1"/>
      <xsd:element ref="memBlock" minOccurs="1"
maxOccurs="unbounded"/>
    </xsd:sequence>
  </xsd:complexType>

 </xsd:element>
</xsd:schema>
```

Figure 3.2.4.8.7-1. Sample Memory Load Data Format

IF232570 All instrument Health & Status telemetry, instrument Memory Dump, and Mission Data source packets (CP_PDU) shall contain the appropriate APID (Application Process Identifier).

IF232575 The instrument shall provide the capability, through APID assignment, to support the selection of source packets, as necessary, by the Spacecraft.

This is intended to support selective data denial, and routing of various types of data to different links on the spacecraft.

IF232580 The same data shall have unique APIDs for non-compressed packets and packets compressed by lossless or lossy methods, or any other such unique applied algorithm information necessary to process the data.

IF232585 APIDs not used for a specific spacecraft configuration shall not be reassigned to another use unless the original assignment is permanently retired.

IF232590 The instrument shall correlate the time code, contained within packets generated by the instrument, to the time of sampling data with sufficient accuracy to enable the government to produce the desired Environmental Data Record performance.

IF232600 If the instrument contractor provides “science code” (i.e., starting point algorithms) to JPSS, the instrument contractor shall include in the algorithms for EDR performance, the RDR packet loss effects, based on the instrument contractor’s selection for packet size, applied against the total 10E-8 Bit Error Rate in a CCSDS CP-PDU system. The 10E-8 BER includes the effects of RS and convolutional coding. Packet level encryption by the spacecraft can be assumed.

IF232610 The data commutation scheme for Health and Status telemetry shall be identical for each packet of the same APID.

3.2.4.8.8 Command & Data Interface Test Packets

IF232620 The instrument shall be capable of generating and transmitting, on command, a continuous sequence of packets containing a fixed data pattern.

IF232625 The fixed data pattern shall be repeated within each packet or repeated over an integral number of packets.

IF232630 The test packet(s) shall consist of a fixed packet header and a fixed data pattern within the data zone.

IF232635 The packet header shall contain a fixed bit sequence.

IF232640 The packet header "type" bit shall be set to logical zero.

IF232645 Each test packet type shall be identified with a unique APID.

IF232650 Instrument test packets shall have a unique APID

IF232621 The instrument shall be capable of producing a test packet in each mode in which operational power is enabled.

3.2.5 Instrument Quality Factors

3.2.5.1 Reliability

Reliability is defined as the probability that an item can perform its intended function for a specified interval under stated conditions.

IF232730 The instrument's total system reliability at the end of the on-orbit design life shall be no less than 0.86.

IF232735 The instrument shall be operational 24 hours per day.

3.2.5.1.1 Operational Service Life

IF232660 The on-orbit design life of the instrument shall be no less than 7 years.

IF232665 The design of the instrument shall be such that instrument storage, under controlled conditions, may be planned for as long as 8 years, including up to 3 years for intermittent testing, for a total equivalent of one year of on-ground testing.

The above two requirements mean that the design service life of the instrument needs to be at least 15 years. This includes the time allowed for test, storage, prelaunch checkout, launch and injection, on-orbit, recovery, and contingency time.

IF232670 The instrument shall be capable of undergoing testing at periodic intervals (e.g., 6-month periods) while remaining on the spacecraft.

IF232675 The instrument shall be capable of undergoing the periodic testing described above while oriented with gravity in any direction

3.2.5.1.2 Maintainability

IF232680 The instrument designs shall include maintainability features, if applicable, to ensure timely replacement or test of instrument subsystems or modules prior to launch.

IF232685 Only remove-and-replace maintenance actions shall be performed on the satellite and instruments after delivery.

IF232690 Except for software updates, the payload shall not require maintenance or repair on-orbit.

IF232710 The instrument shall be capable of delivering sensor data on orbit within 45 days of its launch.

3.2.6 Environmental Conditions

3.2.6.1 Natural Environment Characteristics

Specified below are natural environment characteristics in the presence of which the spacecraft and the sensor modules (referred to as space equipment in this section) must meet all other requirements.

IF232740 The space equipment shall be compatible with the natural radiation environments for their operational orbits.

3.2.6.1.1 Total Ionizing Dose Environment

IF232745 The space equipment shall be capable of meeting all performance requirements at the total ionizing dose levels given in Figure 3.2.6.1.1-1 (data provided in Table 3.2.6.1.1-1) and the trapped proton and electron fluxes provided in Figure 3.2.6.1.1-2 (Table 3.2.6.1.1-2) and Figure 3.2.6.1.1-3 (Table 3.2.6.1.1-3).

The total ionizing dose is due to trapped electrons (AE8MAX) and protons (AP8MIN) and solar flare protons (80% JPL).

IF232755 Linear bipolar and BiCMOS device types that are known to be, or potentially susceptible to Enhanced Low Dose Rate Sensitivity (ELDRS) for total ionizing dose shall be evaluated using test data at a low dose rate not to exceed 0.01 rad/sec in accordance with Test Method 1019.6 (Condition D) in Notice 5 of MIL-STD-883E for all bias cases to be used in the spacecraft equipment (i.e., biased and unbiased), unless existing data shows that a lower dose rate is required to manifest the ELDRS effect. However, testing at TID levels above 35 krads may use a higher dose rate (e.g., >10 rads/sec) for the irradiation steps above 35 krads.

IF232760 In cases where it is not possible to perform the test at a low dose rate, a ratio of the degradation from low dose rate to high dose rate (MIL standard specified dose rates) shall be calculated based on published literature and used to further derate the parts that are tested at the MIL standard dose rates. (This approach is

only acceptable for devices that have been previously characterized at low dose rates.)

Radiation design margin (RDM) is defined as the ratio of the derated hardness capability of the part to the estimated dose at the part location. TBR - [Entire RDM/RLAT under review by NASA JPSS]

IF232765 Parts with an RDM of 3 or greater shall not require radiation lot acceptance testing (RLAT).

IF232770 Parts with an RDM less than 3 but greater than or equal to 2 are of marginal hardness and shall require RLAT.

IF232775 Parts with an RDM less than 2 shall not be used.

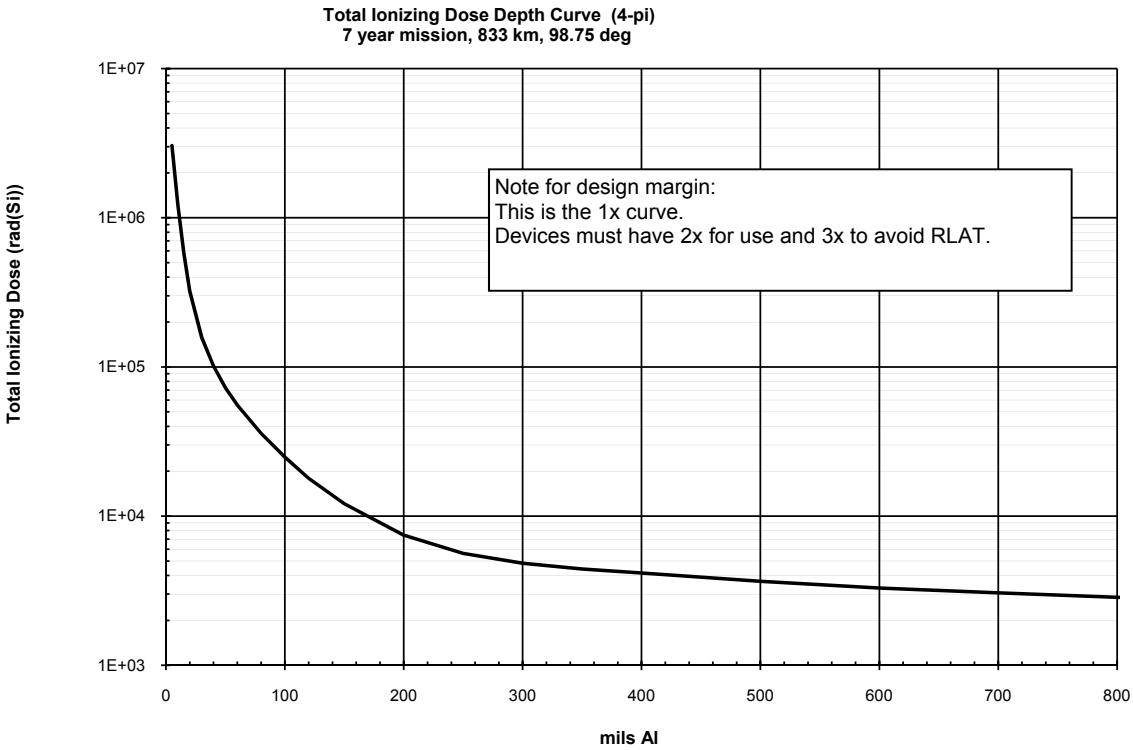


Figure 3.2.6.1.1-1. JPSS Total Ionizing Dose

Table 3.2.6.1.1-1. JPSS Total Ionizing Dose

Shielding mils Al	Total Ionizing Dose (1x) Z(g/cm^2)	rad(Si)	Shielding mils Al	Total Ionizing Dose (1x) Z(g/cm^2)	rad(Si)
5	0.034	3.04E+06	200	1.372	7.45E+03
10	0.069	1.22E+06	250	1.715	5.62E+03
15	0.103	5.82E+05	300	2.057	4.84E+03
20	0.137	3.24E+05	350	2.4	4.43E+03
30	0.206	1.58E+05	400	2.743	4.16E+03

Shielding mils Al	Total Ionizing Dose (1x) Z(g/cm^2)	rad(Si)	Shielding mils Al	Total Ionizing Dose (1x) Z(g/cm^2)	rad(Si)
40	0.274	1.01E+05	450	3.086	3.89E+03
50	0.343	7.26E+04	500	3.429	3.65E+03
60	0.411	5.55E+04	600	4.115	3.29E+03
80	0.549	3.59E+04	700	4.801	3.06E+03
100	0.686	2.48E+04	800	5.486	2.86E+03
120	0.823	1.79E+04	1000	6.858	2.52E+03
150	1.029	1.21E+04			

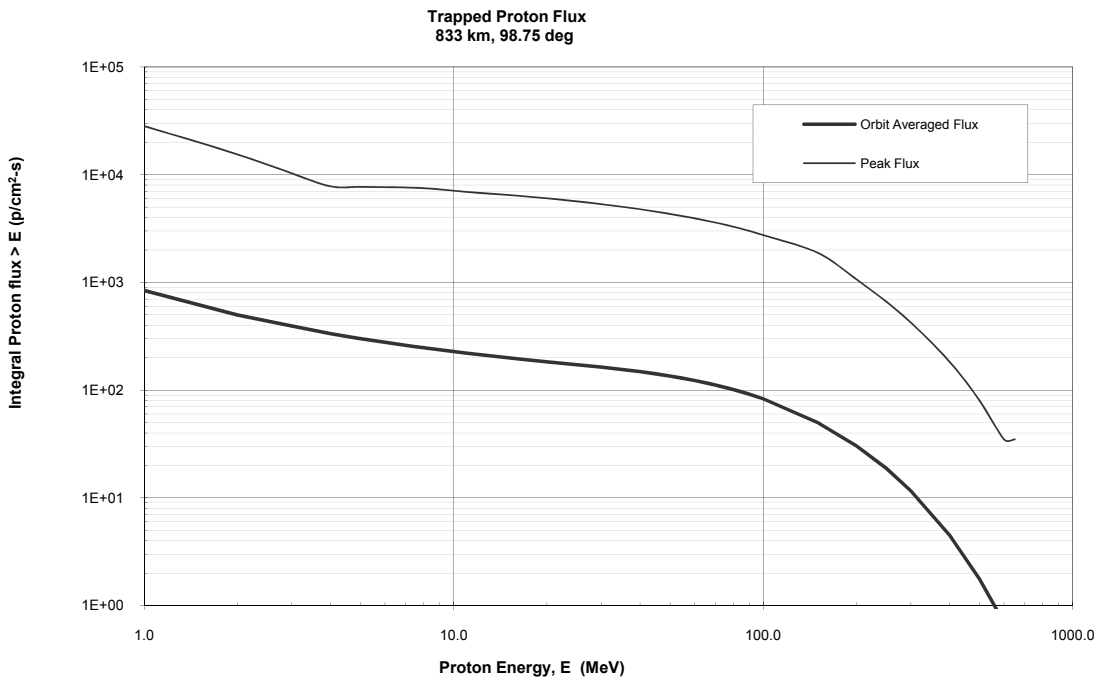


Figure 3.2.6.1.1-2. Integral Trapped Proton Flux

Table 3.2.6.1.1-2. JPSS Trapped Proton Flux

Energy (MeV)	Trapped Proton Flux (p/cm^2-s) Orbit Averaged	Peak	Energy (MeV)	Trapped Proton Flux (p/cm^2-s) Orbit Averaged	Peak
1	8.40E+02	2.82E+04	70	1.12E+02	3.60E+03
2	4.99E+02	1.55E+04	80	1.01E+02	3.29E+03
3	3.94E+02	1.02E+04	90	9.18E+01	3.01E+03
4	3.34E+02	7.79E+03	100	8.32E+01	2.75E+03
5	3.01E+02	7.69E+03	150	5.00E+01	1.88E+03
7	2.60E+02	7.60E+03	200	3.05E+01	1.07E+03
9	2.36E+02	7.33E+03	250	1.88E+01	6.61E+02

10	2.28E+02	7.08E+03	300	1.16E+01	4.24E+02
20	1.83E+02	6.04E+03	400	4.50E+00	1.84E+02
30	1.63E+02	5.31E+03	500	1.77E+00	8.00E+01
40	1.48E+02	4.78E+03	600	6.96E-01	3.50E+01
50	1.35E+02	4.31E+03	650	4.37E-01	3.50E+01
60	1.23E+02	3.94E+03			

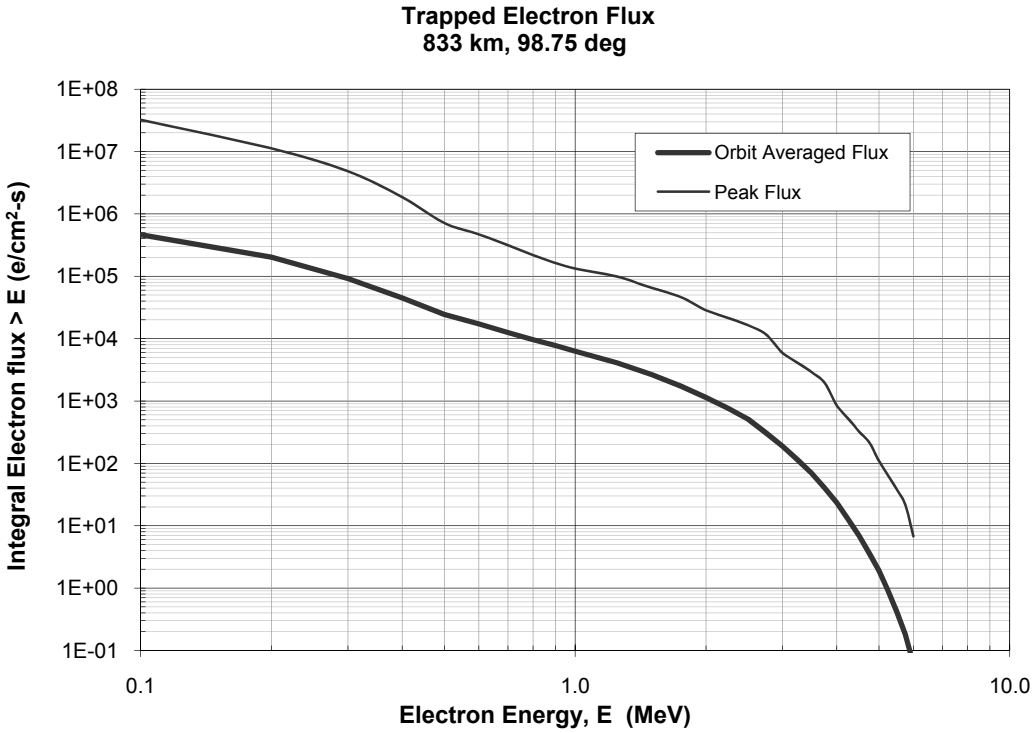


Figure 3.2.6.1.1-3. Integral Electron Flux

Table 3.2.6.1.1-3. Integral Electron Flux

Energy (MeV)	Trapped Electron Flux (e/cm^2-s) Orbit Averaged	Peak	Energy (MeV)	Trapped Electron Flux (e/cm^2-s) Orbit Averaged	Peak
0.10	4.64E+05	3.24E+07	2.50	5.11E+02	1.63E+04
0.20	2.03E+05	1.13E+07	2.75	3.07E+02	1.17E+04
0.30	9.20E+04	4.84E+06	3.00	1.88E+02	5.89E+03
0.40	4.49E+04	1.86E+06	3.25	1.14E+02	4.13E+03
0.50	2.44E+04	7.16E+05	3.50	6.98E+01	2.89E+03
0.60	1.73E+04	4.75E+05	3.75	4.02E+01	1.96E+03
0.70	1.25E+04	3.14E+05	4.00	2.33E+01	8.45E+02
0.80	9.64E+03	2.21E+05	4.25	1.26E+01	5.22E+02
0.90	7.77E+03	1.64E+05	4.50	6.90E+00	3.23E+02
1.00	6.30E+03	1.33E+05	4.75	3.60E+00	2.17E+02
1.25	4.07E+03	9.90E+04	5.00	1.90E+00	1.09E+02

Energy (MeV)	Trapped Electron Flux (e/cm^2-s) Orbit Averaged	Peak	Energy (MeV)	Trapped Electron Flux (e/cm^2-s) Orbit Averaged	Peak
1.50	2.66E+03	6.53E+04	5.25	8.99E-01	6.41E+01
1.75	1.74E+03	4.66E+04	5.50	4.15E-01	3.77E+01
2.00	1.14E+03	2.85E+04	5.75	1.81E-01	2.16E+01
2.25	7.62E+02	2.16E+04	6.00	6.13E-02	6.78E+00

3.2.6.1.2 Cosmic Ray and High Energy Proton Environment

3.2.6.1.2.1 Single Events Radiation Environment

IF232780 The space equipment shall be capable of meeting all performance requirements in the heavy ion and proton environments specified in paragraphs 3.2.6.1.2.1.1 and 3.2.6.1.2.1.2.

IF232785 Predictions of single events (i.e., single event latch-up, single event upset, single-event functional interrupt, single-event gate rupture, and single event burn-out) induced by heavy ions and high energy protons shall be performed separately and the results combined.

IF232790 The space equipment design shall be such that single event phenomena associated with the specified cosmic particle and proton environment does not result in damage or non-recoverable upset to the spacecraft.

IF232795 Part types that are susceptible to destructive SEL shall not be used.

Latchup susceptibility will be evaluated using test data obtained on at least three samples at maximum specified device operating temperature and maximum specified device operating voltage(s) and using at least 10^7 ions/cm^2 with ions of sufficient energy to meet the LET requirement of >75 MeV-cm^2/mg throughout the active charge-collection depth of the device.

IF232800 For nondestructive latchup, the probability of SEL occurrence shall be sufficiently low that spacecraft reliability or availability is not adversely impacted.

Parts believed to latch nondestructively will be latchup-tested in a flight-configuration circuit and examined microscopically after latchup testing to ensure that they have no latent damage, such as molten metallization, voids in circuit metallizations, etc. Devices that utilize latchup circumvention circuitry will require extensive testing and post-test microscopic examination to prove that no latent damage occurs. All latchup-susceptible parts will be identified, and a reliability analysis must be performed prior to Parts Control Board (PCB) approval.

IF232805 Part types that are susceptible to single-event gate rupture (SEGR)) shall not be used at a level higher than 75% of the maximum survivable voltage as determined by SEGR testing.

IF232806 Power MOSFETs shall be derated to 75% of their maximum survival voltage as determined by SEGR testing at the worst-case circuit-application gate-source

turnoff voltage, unless the worst-case application drain-source voltage is no more than 30 V, and the device is rated to at least 100 V.

IF232807 The survival voltage (VDS) shall be established from exposure to a minimum fluence of 1E6 ions/cm^2 with a minimum LET of 37 MeV-cm^2/mg throughout the sensitive charge-collection region of the device.

IF232808 Table 3.2.6.1.2.1-1 provides the ion range requirements that shall be met as a function of device voltage rating for SEGR testing.

IF232809 Testing shall be performed at normal beam incidence and at room ambient temperature.

IF232810 Part types that are susceptible to single-event burnout (SEB) shall not be used at a level higher than 75% of the maximum survivable voltage as determined in SEB testing.

Table 3.2.6.1.2.1-1, which is applicable for MOSFETs, may be used as a guide for bipolar transistors. Test requirements for single-event burnout are similar to those for SEGR, except that the drain current (or collector current for bipolar transistors) must be measured to determine if burnout occurs.

IF232811 The survival voltage (VCE or VDS) shall be established from exposure (at normal beam incidence) to a minimum fluence of 1E^6 ions/cm^2 of an ion with a minimum or average LET of 37 MeV-cm^2/mg throughout the depletion depth of the device at its maximum voltage.

Table 3.2.6.1.2.1-1. Ion Range Requirements for SEGR Testing

Maximum Rated Drain-Source Voltage	Minimum Ion Range (microns)
≤100	30
100 to 250	40
250 to 400	80
400 to 1000	200

3.2.6.1.2.1.1 Galactic Cosmic Ray (GCR) Linear Energy Transfer (LET) Spectrum

IF232815 The integral GCR (and solar) heavy ion linear energy transfer spectrum in Figure 3.2.6.1.2.1.1-1 and Table 3.2.6.1.2.1.1-1 shall be used for prediction of heavy ion-induced single event effects.

IF232820 The space equipment shall be capable of meeting all performance requirements in the background (90% worst case) environment.

IF232825 The space equipment shall survive the heavy ion peak fluxes from a large solar flare (CREME96 Peak).

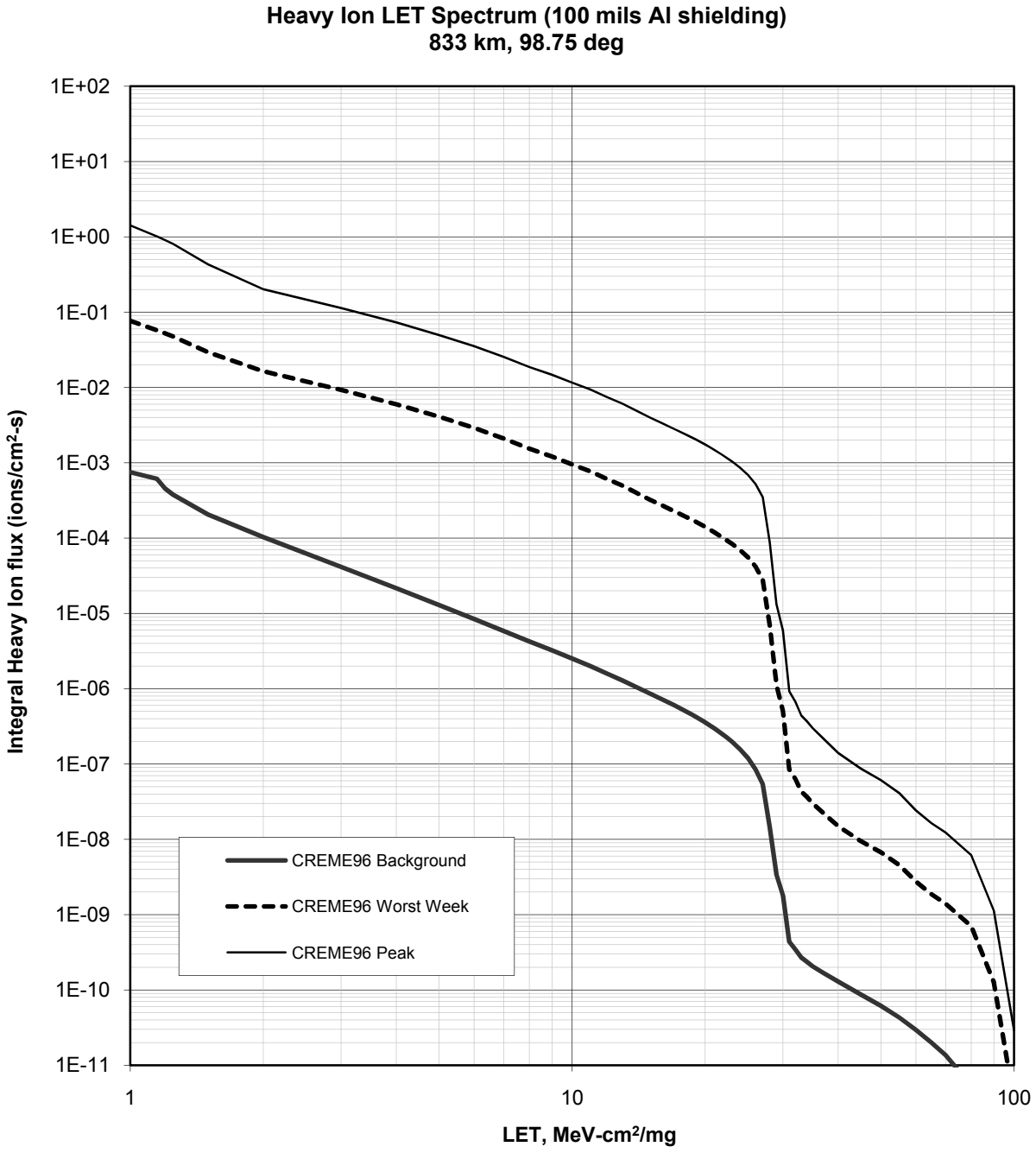


Figure 3.2.6.1.2.1.1-1. Integral GCR and Solar Heavy Ion Linear Energy Transfer Spectrum

Table 3.2.6.1.2.1.1-1. Integral GCR and Solar Heavy Ion Linear Energy Transfer Spectrum

LET	Integral Flux (100 mils Al), ions/cm^2-s			LET	Integral Flux (100 mils Al), ions/cm^2-s		
MeV-cm^2/mg	Background	Worst Week	Peak	MeV-cm^2/mg	Background	Worst Week	Peak
1	7.50E-04	7.68E-02	1.42E+00	22	2.43E-07	9.99E-05	1.24E-03
1.15	6.12E-04	5.75E-02	1.01E+00	23	1.98E-07	8.39E-05	1.04E-03
1.2	4.55E-04	5.23E-02	9.05E-01	24	1.56E-07	6.91E-05	8.61E-04
1.25	3.78E-04	4.76E-02	8.08E-01	25	1.20E-07	5.54E-05	6.90E-04
1.5	2.06E-04	2.94E-02	4.33E-01	26	8.51E-08	4.19E-05	5.22E-04
2	1.03E-04	1.64E-02	2.02E-01	27	5.42E-08	2.81E-05	3.50E-04
3	4.14E-05	9.32E-03	1.13E-01	28	1.45E-08	6.98E-06	8.63E-05
4	2.16E-05	6.00E-03	7.31E-02	29	3.38E-09	1.11E-06	1.33E-05
5	1.29E-05	4.09E-03	4.97E-02	30	1.78E-09	5.03E-07	5.93E-06
6	8.41E-06	2.91E-03	3.54E-02	31	4.38E-10	8.51E-08	9.24E-07
7	5.84E-06	2.10E-03	2.55E-02	32	3.44E-10	6.32E-08	6.72E-07
8	4.25E-06	1.54E-03	1.87E-02	33	2.70E-10	4.30E-08	4.40E-07
9	3.24E-06	1.21E-03	1.48E-02	34	2.36E-10	3.64E-08	3.69E-07
10	2.52E-06	9.53E-04	1.16E-02	35	2.06E-10	3.01E-08	3.00E-07
11	1.99E-06	7.67E-04	9.38E-03	37	1.69E-10	2.25E-08	2.19E-07
12	1.58E-06	6.09E-04	7.45E-03	40	1.29E-10	1.49E-08	1.40E-07
13	1.28E-06	4.97E-04	6.10E-03	45	8.71E-11	9.49E-09	8.68E-08
14	1.05E-06	3.98E-04	4.89E-03	50	6.14E-11	6.70E-09	6.11E-08
15	8.62E-07	3.23E-04	3.98E-03	55	4.29E-11	4.55E-09	4.10E-08
16	7.21E-07	2.72E-04	3.36E-03	60	2.94E-11	2.75E-09	2.42E-08
17	6.05E-07	2.28E-04	2.81E-03	65	2.00E-11	1.87E-09	1.64E-08
18	5.09E-07	1.95E-04	2.41E-03	70	1.36E-11	1.40E-09	1.23E-08
19	4.28E-07	1.66E-04	2.06E-03	80	5.37E-12	7.01E-10	6.19E-09
20	3.58E-07	1.41E-04	1.76E-03	90	6.68E-13	1.27E-10	1.12E-09
21	2.96E-07	1.19E-04	1.48E-03	100	4.04E-14	3.29E-12	2.91E-11

3.2.6.1.2.1.2 High Energy Proton Fluence

The integral proton flux is provided in Figure 3.2.6.1.2.1.2-1 and Table 3.2.6.1.2.1.2-1 for the background environment (trapped protons plus 90% worst case galactic cosmic ray protons) and the peak flux of a large solar flare.

IF232830 Fluxes in Figure 3.2.6.1.2.1.2-1 and Table 3.2.6.1.2.1.2-1 shall be used to determine the proton-induced single event rates for the background environment (trapped protons plus galactic cosmic ray protons) and during a flare.

Analytical techniques may be used for many part types to predict proton SEU rates derived from the heavy ion SEU predictions, but actual proton SEU data are preferred whenever possible.

IF232835 The space equipment shall meet all performance requirements for the background environment.

IF232840 The space equipment shall survive the peak proton flux of the solar flare.

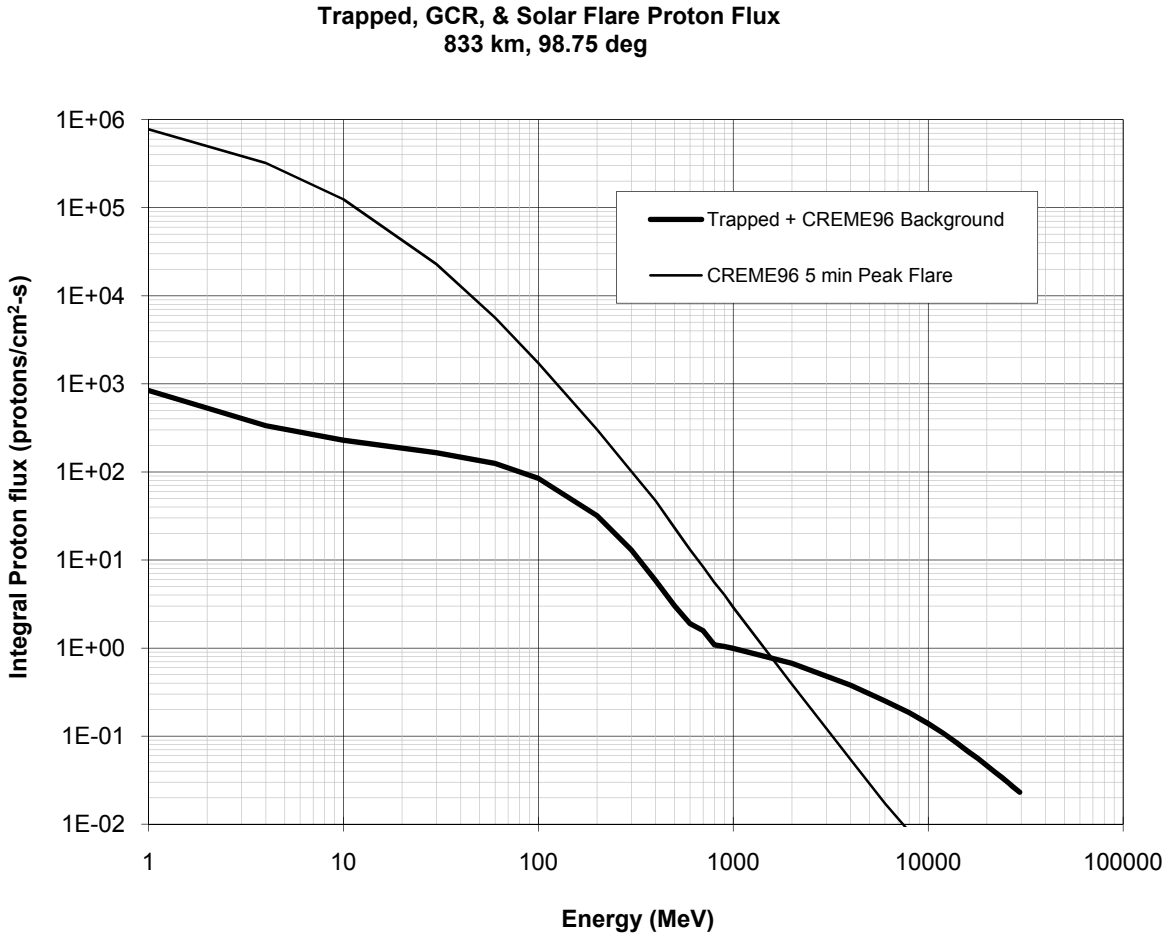


Figure 3.2.6.1.2.1.2-1. Integral Trapped, GCR, and Solar Flare Proton Flux

Table 3.2.6.1.2.1.2-1. Integral Trapped, GCR, and Solar Flare Proton Flux

Energy	Integral Proton Flux (p/cm^2-s)		Energy	Integral Proton Flux (p/cm^2-s)	
(MeV)	Trapped GCR	Peak Flare	(MeV)	Trapped GCR	Peak Flare
1	8.42E+02	7.78E+05	2000	6.70E-01	3.88E-01
4	3.35E+02	3.21E+05	4000	3.78E-01	5.41E-02
10	2.29E+02	1.24E+05	6000	2.50E-01	1.73E-02
30	1.65E+02	2.28E+04	8000	1.85E-01	8.28E-03
60	1.25E+02	5.63E+03	10000	1.39E-01	4.43E-03
100	8.46E+01	1.72E+03	12000	1.07E-01	2.61E-03
200	3.19E+01	3.02E+02	14000	8.42E-02	1.62E-03
300	1.30E+01	1.02E+02	16000	6.72E-02	1.05E-03
400	5.82E+00	4.70E+01	18000	5.58E-02	7.42E-04
500	3.02E+00	2.31E+01	20000	4.62E-02	5.24E-04
600	1.89E+00	1.31E+01	22000	3.91E-02	3.86E-04
700	1.58E+00	8.37E+00	24000	3.37E-02	2.97E-04
800	1.09E+00	5.56E+00	26000	2.90E-02	2.28E-04
900	1.04E+00	4.02E+00	27000	2.69E-02	2.00E-04
1000	9.94E-01	2.90E+00	29500	2.31E-02	1.53E-04

IF232845 The total number of proton-induced single events shall be determined from the total proton fluence as provided in Figure 3.2.6.1.2.1.2-2 and Table 3.2.6.1.2.1.2-2, which combine the trapped, galactic cosmic ray, and flare total fluences.

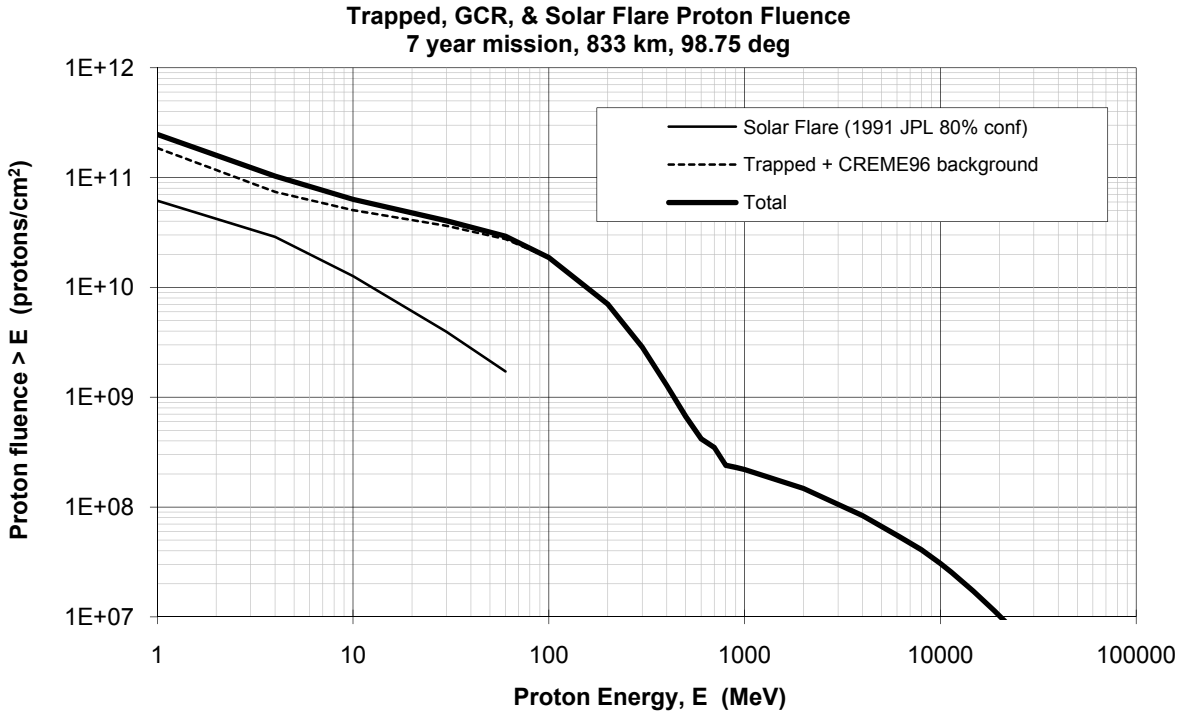


Figure 3.2.6.1.2.1.2-2. Total Integral Proton Fluence

Table 3.2.6.1.2.1.2-2. Total Integral Proton Fluence

Energy	Integral Proton Fluence (protons/cm^2/7 yr)			Energy	Integral Proton Fluence (protons/cm^2/7 yr)		
(MeV)	Solar Flare (1991 JPL 80%)	Trapped +GCR	Total Integral Fluence	(MeV)	Solar Flare (1991 JPL 80%)	Trapped +GCR	Total Integral Fluence
1	6.16E+10	1.86E+11	2.48E+11	2000		1.48E+08	1.48E+08
4	2.88E+10	7.40E+10	1.03E+11	4000		8.36E+07	8.36E+07
10	1.27E+10	5.06E+10	6.32E+10	6000		5.52E+07	5.52E+07
30	3.95E+09	3.64E+10	4.04E+10	8000		4.08E+07	4.08E+07
60	1.72E+09	2.75E+10	2.92E+10	10000		3.06E+07	3.06E+07
100		1.87E+10	1.87E+10	12000		2.37E+07	2.37E+07
200		7.04E+09	7.04E+09	14000		1.86E+07	1.86E+07
300		2.87E+09	2.87E+09	16000		1.48E+07	1.48E+07
400		1.29E+09	1.29E+09	18000		1.23E+07	1.23E+07
500		6.67E+08	6.67E+08	20000		1.02E+07	1.02E+07
600		4.18E+08	4.18E+08	22000		8.63E+06	8.63E+06
700		3.49E+08	3.49E+08	24000		7.45E+06	7.45E+06
800		2.40E+08	2.40E+08	26000		6.41E+06	6.41E+06
900		2.30E+08	2.30E+08	27000		5.94E+06	5.94E+06
1000		2.19E+08	2.19E+08	29500		5.09E+06	5.09E+06

3.2.6.1.2.1.3 Reserved

3.2.6.1.2.2 Displacement Damage

Displacement damage for electronics due to protons and electrons is defined here in terms of an equivalent fluence of 1-MeV neutrons.

IF232860 For part types sensitive to displacement damage degradation (e.g., linear ICs, bipolar technologies, crystal oscillators, and power devices),shall be selected such that the assembly meets all performance requirements at the RDM specified in IF232870. The 1-MeV-equivalent neutron fluence as a function of shielding due to the trapped protons, trapped electrons, and solar flare protons is shown in Figure 3.2.6.1.2.2-1 and Table 3.2.6.1.2.2-1.

For optical sensors (e.g. CCDs) it is more common to define proton displacement damage in terms of displacement damage dose (non ionizing energy loss in units of MeV/gram).

IF232865 When optical detectors are used, the design shall incorporate features that minimize the effects of displacement damage. The displacement damage dose as a function of shielding thickness is provided in Table 3.2.6.1.2.2-1

IF232870 The RDM and RLAT requirements given in Section 3.2.6.1.1 shall also apply to displacement damage.

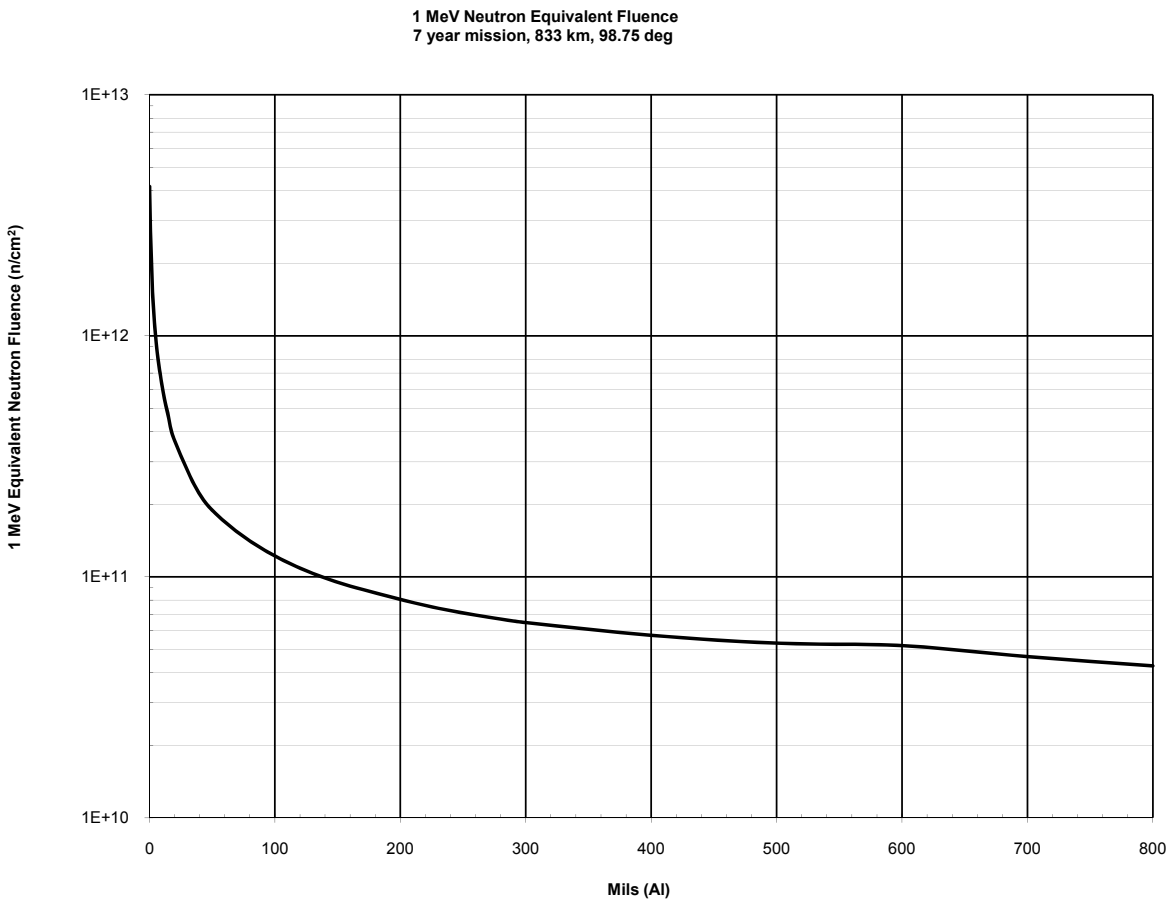


Figure 3.2.6.1.2.2-1. JPSS 1-MeV Neutron Equivalent Fluence (for Si)

Table 3.2.6.1.2.2-1. NPOESS Non-Ionizing Energy Loss

Shielding	1-MeV-Equivalent Neutron Fluence	Displacement Damage Dose	Shielding	1-MeV-Equivalent Neutron Fluence	Displacement Damage Dose
mils (Al)	(n/cm^2)	(MeV/g)	mils (Al)	(n/cm^2)	(MeV/g)
0.1	4.16E+12	8.40E+09	140	9.88E+10	1.99E+08
0.2	3.81E+12	7.69E+09	160	9.15E+10	1.85E+08
0.5	3.27E+12	6.60E+09	180	8.59E+10	1.73E+08
1	2.38E+12	4.81E+09	200	8.05E+10	1.62E+08
2	1.70E+12	3.43E+09	220	7.61E+10	1.53E+08
5	9.65E+11	1.95E+09	240	7.24E+10	1.46E+08
10	6.21E+11	1.25E+09	260	6.94E+10	1.40E+08
15	4.63E+11	9.35E+08	280	6.68E+10	1.35E+08
20	3.67E+11	7.41E+08	300	6.46E+10	1.30E+08
40	2.20E+11	4.43E+08	400	5.72E+10	1.15E+08
60	1.69E+11	3.42E+08	500	5.30E+10	1.07E+08
80	1.41E+11	2.84E+08	600	5.18E+10	1.05E+08
100	1.22E+11	2.46E+08	700	4.67E+10	9.42E+07
120	1.09E+11	2.19E+08	800	4.27E+10	8.62E+07

3.2.6.1.3 Meteoroid and Debris Environments[TBR NASA JPSS]

IF232895 Equipment and materials that are directly exposed to free space, such as cables, propulsion lines, pressurized tanks, and sensor optics, shall be designed to meet reliability requirements to remain operable within their performance specifications over the mission lifetime in the meteoroid and space debris environments defined in Figures 3.2.6.1.3-1 (Table 3.2.6.1.3-1) and Figure 3.2.6.1.3-2 (Table 3.2.6.1.3-2) respectively.

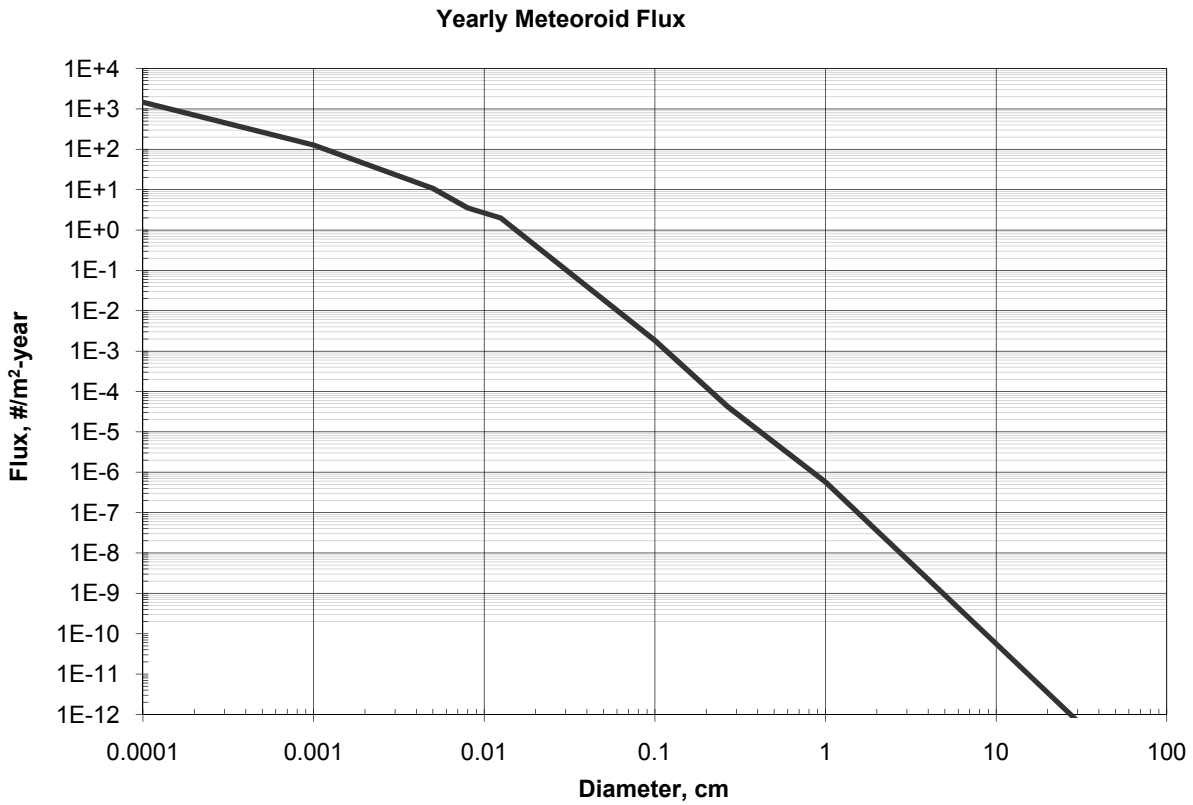


Figure 3.2.6.1.3-1. Meteoroid Flux vs. Size

Table 3.2.6.1.3-1. Meteoroid Flux Environment

Diameter (cm)	Density (g/cm^3)	Mass (gm)	Meteoroid Flux ($\#/m^2$-year)	Diameter (cm)	Density (g/cm^3)	Mass (gm)	Meteoroid Flux ($\#/m^2$-year)
100	0.5	2.62E+05	5.39E-15	0.008	2	5.36E-07	3.52E+00
10	0.5	2.62E+02	5.63E-11	0.005	2	1.31E-07	1.07E+01
1	0.5	2.62E-01	5.68E-07	0.001	2	1.05E-09	1.27E+02
0.267	1	9.97E-03	4.21E-05	0.0001	2	1.05E-12	1.46E+03
0.1	1	5.24E-04	1.84E-03	0.00001	2	1.05E-15	4.43E+04
0.0125	1	1.02E-06	1.99E+00				

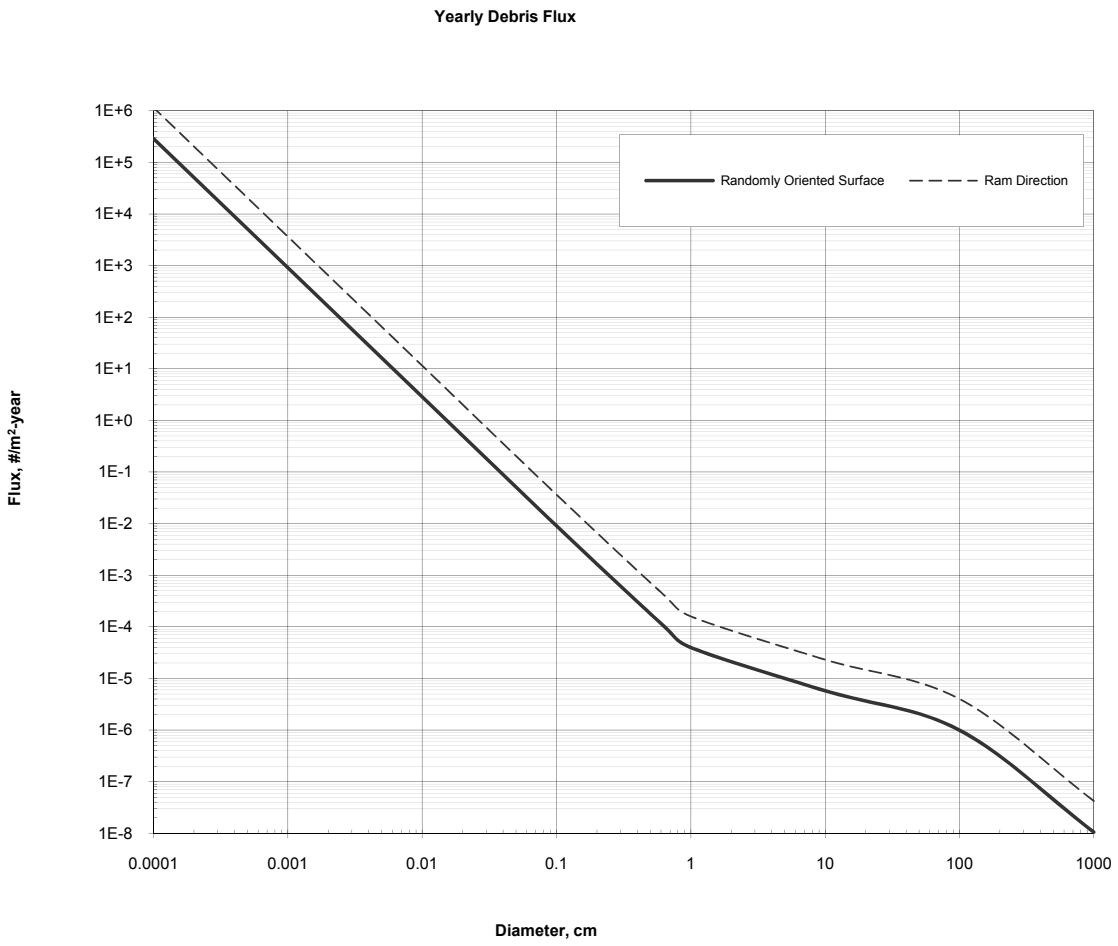


Figure 3.2.6.1.3-2. Debris Flux vs. Size

Table 3.2.6.1.3-2. Debris Flux Environment

Diameter (cm)	Density (g/cm^3)	Mass (gm)	Debris Flux ($\#/m^2$-year)	
			Randomly Oriented Surface	Ram Direction
1000	0.02	8.83E+06	1.06E-08	4.22E-08
100	0.09	4.85E+04	1.00E-06	4.01E-06
10	0.51	2.67E+02	5.78E-06	2.31E-05
1	2.80	1.47E+00	3.99E-05	1.59E-04
0.62	3.99	4.98E-01	1.08E-04	4.30E-04
0.1	4.0	2.09E-03	9.08E-03	3.63E-02
0.01	4.0	2.09E-06	2.87E+00	1.15E+01
0.001	4.0	2.09E-09	9.07E+02	3.63E+03
0.0001	4.0	2.09E-12	2.87E+05	1.15E+06
1.00E-05	4.0	2.09E-15	9.07E+07	3.63E+08
1.00E-06	4.0	2.09E-18	2.87E+10	1.15E+11
1.00E-07	4.0	2.09E-21	9.07E+12	3.63E+13

3.2.6.1.4 Reserved

3.2.6.1.5 Spacecraft Magnetic Fields

IF236055 The instruments shall not exhibit any malfunction, degradation of performance or deviation from the specified indications beyond the tolerances indicated in their individual equipment specifications as a result of being exposed to the DC levels not exceeding 0.001 T.

3.2.6.1.6 Atomic Oxygen

IF232880 The space equipment shall meet performance requirements during exposure to atomic oxygen (AO) experienced during a 833 km polar orbit for seven years. Atomic oxygen fluence is shown in Figure 3.2.6.1.6-1 and Table 3.2.6.1.6-1.

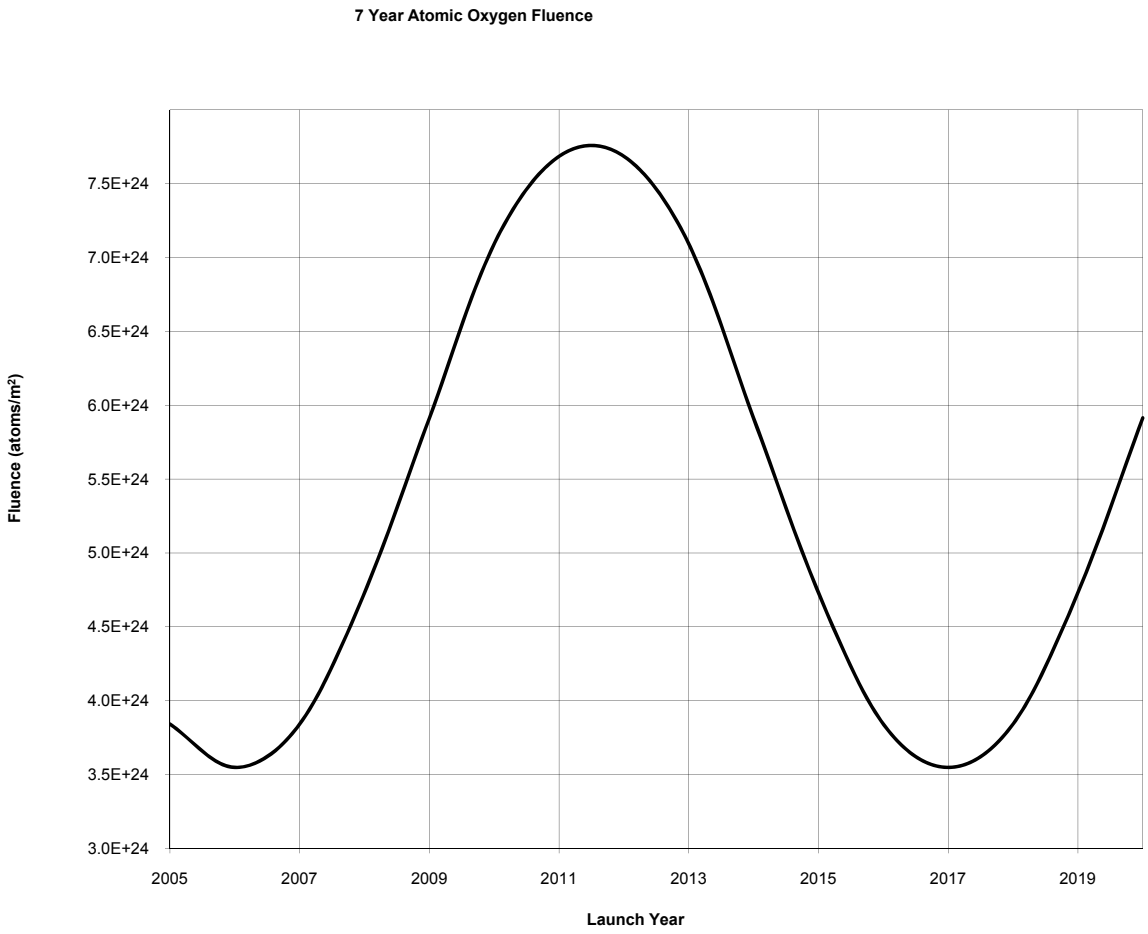


Figure 3.2.6.1.6-1. Atomic Oxygen Fluence

Table 3.2.6.1.6-1. Atomic Oxygen Fluence

Launch Year	Mission Atomic Oxygen Fluence (atoms/m^2)	Launch Year	Mission Atomic Oxygen Fluence (atoms/m^2)
2005	3.84E+24	2013	7.09E+24
2006	3.55E+24	2014	5.91E+24
2007	3.84E+24	2015	4.73E+24
2008	4.73E+24	2016	3.84E+24
2009	5.91E+24	2017	3.55E+24
2010	7.09E+24	2018	3.84E+24
2011	7.69E+24	2019	4.73E+24
2012	7.69E+24	2020	5.91E+24

3.2.6.1.7 Spacecraft Charging from All Sources

IF231735 Instrument external surfaces, if required, shall have special coatings for electrostatic discharge suppression in the plasma environment (except where such coatings degrade performance).

IF232885 The instruments shall operate without performance degradation due to the surface charging, bulk charging, and deep charging environment. The plasma environment is shown in Table 3.2.6.1.7-1.

Table 3.2.6.1.7-1. Plasma Environment

Particle	Density	Temperature
Ambient electrons	10E3 to 2 x 10E6 cm^{-3}	0.1 - 0.39 eV
Ambient positive ions	10E3 to 2 x 10E6 cm^{-3}	0.07 - 0.34 eV
High energy electron flux*	10E8 to 10E10 cm^{-2} sec^{-1} sr^{-1}	14 - 30 keV

* Note: This occurs during periods of auroral arcs. The spacecraft is exposed to auroral environments for < 30 seconds per encounter

IF233295 No floating wires shall be allowed greater than 25 cm length.

IF233300 The design shall provide electrostatic grounding connections between all conductive elements greater than 3 square cm and exposed to an orbit average electron flux greater than 10 femtoamps/sq cm.

IF233310 Metallic tapes of surface area > 25 cm^2 shall be grounded.

IF233315 The resistance between any point on the metallic tape and the ground plane shall not exceed 100 ohm DC.

IF233320 Metallic dielectric tapes shall have the metallic layer grounded to the ground plane.

IF233325 The DC resistance between any point on the metallized layer and the ground plane shall not exceed 100 ohm DC.

IF233330 Electrical continuity of less than 100 ohm DC shall exist between the joints of glass fiber-reinforced polymer (GFRP) components.

IF233335 The resistance of the farthest point on a GFRP structure and the ground plane shall not exceed 1000 ohm DC.

IF233340 GFRP surface areas >25cm^2 shall be grounded.

IF233301 Instrument thermal blankets with exposed areas exceeding 25 cm2 shall use dielectric films which are metallized on the back side and grounded.

IF233302 Instrument thermal insulation blankets shall be connected to chassis ground with a resistance of less than 100 ohm DC.

IF233303 All instrument thermal insulation blankets shall be designed with metallized and conductive layers electrically interconnected such that the resistance between layers is less than 100 ohm DC.

IF233304 The thermal insulation blankets which are used for closeout between the instrument blanket and the spacecraft blanket shall be electrically grounded with a resistance of less than 100 ohm DC.

IF233306 The number of required ground straps for instrument thermal blankets shall be as shown in Table 3.2.6.1.7-2.

Table 3.2.6.1.7-2. Thermal Blanket Ground Straps Requirement

Blanket Surface Area (cm^2)	Number of Required Straps
< 25	0
25 - 100	2
100 - 900	2
900 - 8000	3
8000 - 16000	4
Each additional 8000	1 additional strap

The ground straps should be spaced evenly (approximately) around the perimeter of the blanket.

3.2.6.2 Launch Environment

3.2.6.2.1 Thermal

3.2.6.2.1.1. Temperatures

The worst case effective internal environment in the satellite compartment within the fairing during ascent is defined in Figure 3.2.6.2.1.1-1. The surfaces seen by the satellite will generally fall into one of two categories: surfaces with low emissivity ($\varepsilon \leq 0.3$) and those of higher emissivity ($\varepsilon \leq 0.9$). Maximum temperatures as a function of the time from launch, 150 C for a surface emissivity of 0.3 and 93 C for a surface emissivity of 0.9, are shown in the plot. The exact configuration and percentages of each type of surface is both mission specific and Launch Vehicle specific.

IF232905 Temperatures may exceed those shown below, but in no case shall the total integrated thermal energy imparted to the spacecraft exceed the maximum total integrated energy indicated by the temperature profile shown in Figure 3.2.6.2.1.1-1.

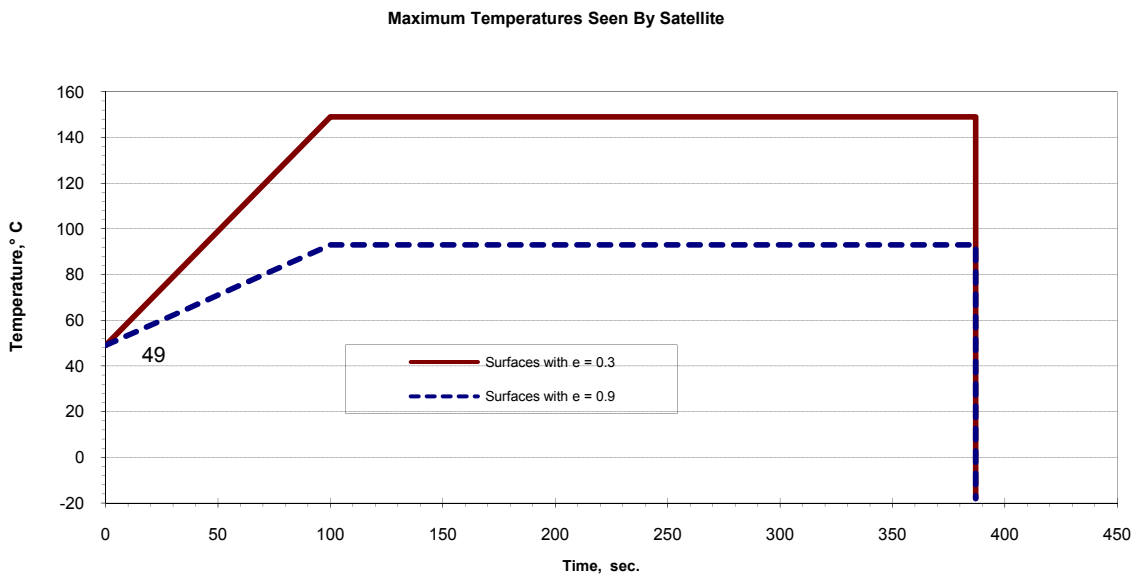


Figure 3.2.6.2.1.1-1. Maximum PLF Inner Temperature

3.2.6.2.1.2 Free Molecular Heating

IF232910 The instrument shall be designed to withstand a maximum, instantaneous, 3-sigma free molecular heating on instrument surfaces perpendicular to the velocity vector at the time of fairing separation of 1135 watts/m^2 (360 Btu/hr-ft^2).

IF232911 The instrument shall be capable of withstanding the worst-case free molecular heating transient provided in Figure 3.2.6.2.1.2-1. (TBR)

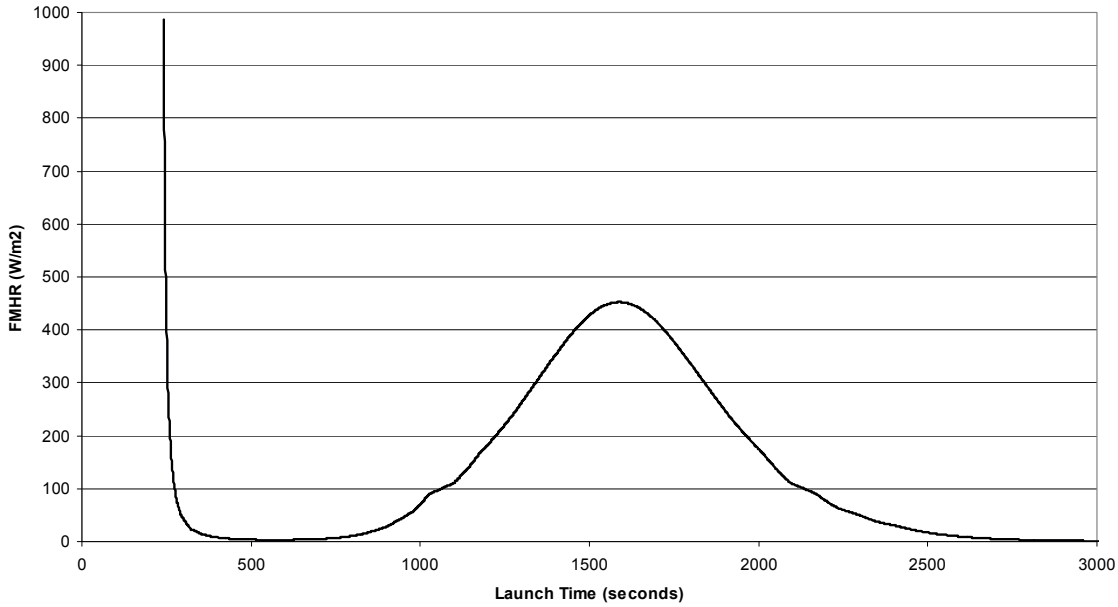


Figure 3.2.6.2.1.2-1. JPSS Free Molecular Heating Transient

3.2.6.2.2 Shock

Figure 3.2.6.2.2-1 and Table 3.2.6.2.2-1 present an envelope of the maximum predicted environments (P95/50 resonant amplification factor, Q=10) at the Space Vehicle to Launch Vehicle Interface Plane. This environment includes Launch Vehicle Stage and Payload Fairing Separations events.

Location of the instrument on the spacecraft, as well as spacecraft structure design will affect the shock level seen at the instrument mounting location.

IF232930 The Instrument shall be capable of surviving, without degradation, shock resulting from self-induced events, such as deployments and other pyrotechnic devices initiated during its life.

The number of shock events to which each unit is exposed while mounted on the spacecraft will be assumed to be four in each of 3 mutually orthogonal axes, for both spacecraft separation and deployments.

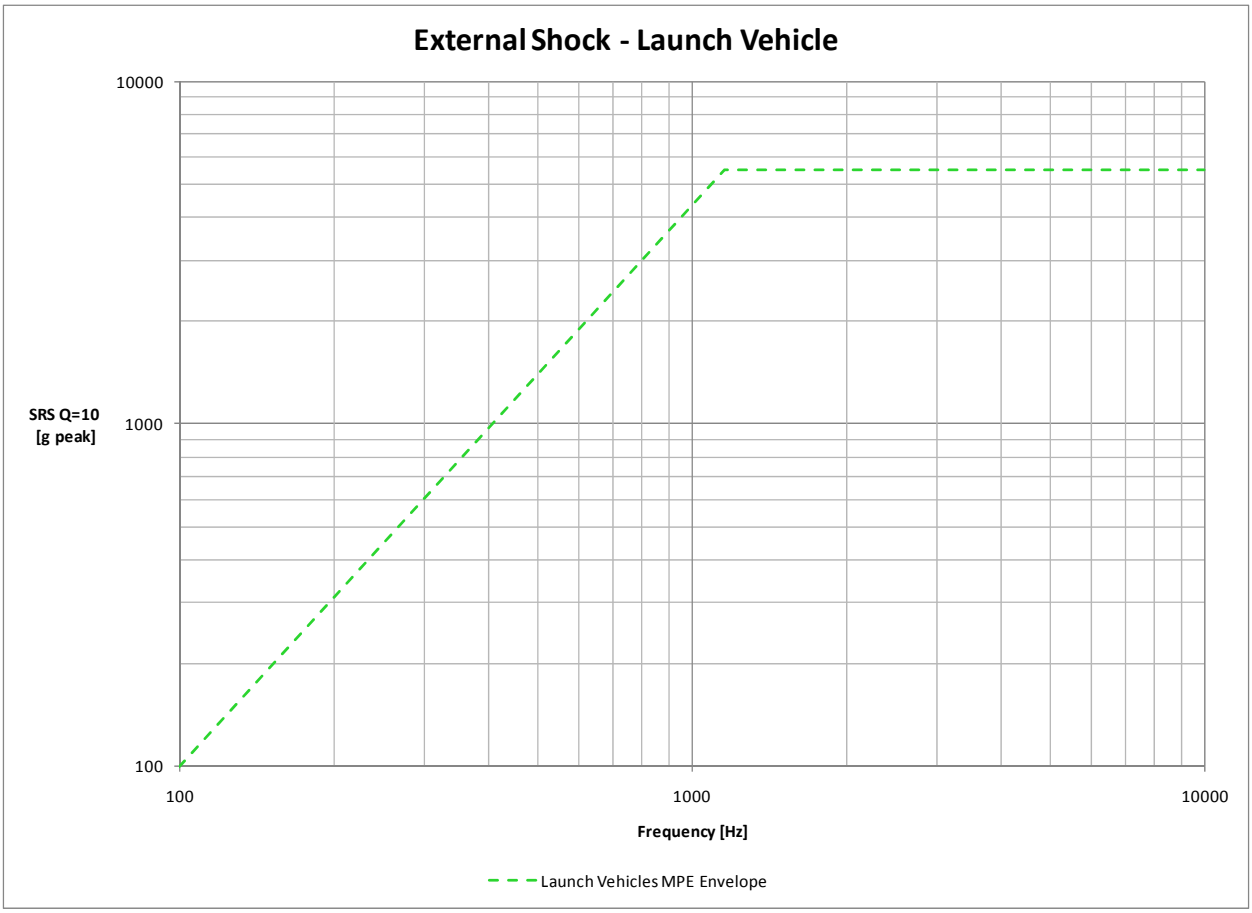


Figure 3.2.6.2.2-1. EELV Shock at SV/LV Interface

Table 3.2.6.2.2-1. EELV Shock at SV/LV Interface

Frequency [Hz]	SRS [g]
100	100
1160	5500
10000	5500

3.2.6.2.3 Reserved

3.2.6.2.4 Vibration

Until such time as Launch Vehicle and Spacecraft-specific information is provided, instrument design shall be performed using an envelope of Expendable Evolved Launch Vehicles (EELV) maximum predicted environments (provided in the next section).

3.2.6.2.5 Acoustics

IF232940 The instrument shall be designed to survive a launch acoustic environment specified in Table 3.2.6.2.5-1.

Table 3.2.6.2.5-1. Maximum Predicted Acoustic Environment (P95/50)

One Third Octave Center Frequency (Hz)	Sound Pressure Level [dB] ref: 20µPa
25	122.2
32	124.1
40	128.5
50	126.5
63	128.0
80	130.0
100	130.0
125	130.1
160	131.5
200	131.5
250	132.5
315	131.5
400	128.0
500	125.7
630	123.5
800	122.8
1000	121.4
1250	118.5
1600	117.0
2000	116.0
2500	115.0
3150	113.5
4000	111.4
5000	108.6
6300	106.8
8000	105.5
10000	105.1
Overall SPL [dB]	141.2

IF232945 The instruments shall be designed to withstand the acoustic tests described in section 4.2.7 of this document.

3.2.6.2.6 Launch Pressure Decay

IF232950 The instrument shall be designed to withstand a payload fairing internal pressure decay rate of 0.4 psi/second (2.76 kPa/second), with a single brief excursion (not exceeding 5 seconds) to 0.9 psi/second (6.21 kPa/second).

3.2.6.2.7 Reserved

3.2.6.3 On-orbit environment

3.2.6.3.1 Acceleration

IF232960 While on orbit, instruments shall be designed to suffer no performance degradation when operating at the maximum accelerations (per axis at the Instrument Interface) listed in Table 3.2.6.3.1-1.

The on-orbit acceleration and jitter environment is characterized by translational accelerations, as well as angular rotations and rates caused by vibrational disturbances.

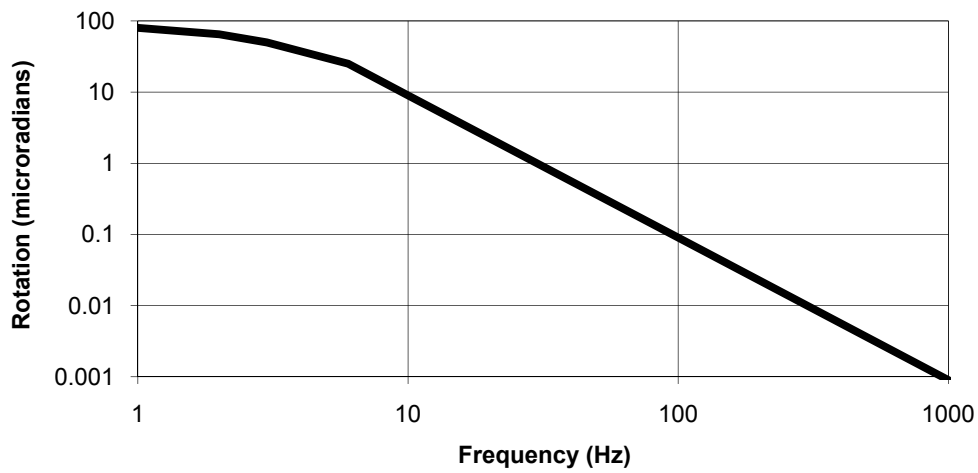
Table 3.2.6.3.1-1. Spacecraft Acceleration Environment

1 Hz to 10 Hz	20 mg
10 Hz and 20 Hz	Ramp up from 20 mg to 50 mg
20 Hz to 100 Hz	50 mg
100 Hz to 1000 Hz	Ramp down from 50 mg to 10 mg
beyond 1000 Hz	10 mg

3.2.6.3.2 Rotation

IF230805 For instruments directly attached to the spacecraft structure, the maximum zero to peak rotation of the Instrument Interface due to jitter shall be less than 20 arcsec (3 sigma) per axis over any orbit and be less than the values specified in Figure 3.2.6.3.2-1 per axis (3 sigma) for any given frequency.

Rotational rates at the instrument interface due to jitter consistent with Figure 3.2.6.3.2-1 on a frequency-by-frequency basis will be considered in the design and performance evaluation of the instrument.



The breakpoints are:

Frequency (Hz)	Rotation (μradians)
1	80
2	65
3	50
4	37.5
5	30
6	25
>6	falls off as $1/f^2$

Note that in the graph above the rotation amplitude is specified as zero-to-peak.

Figure 3.2.6.3.2-1. Zero-to-Peak rotations at the Instrument Interface

3.2.6.4 Reserved

3.2.7 Transportability

IF232975 The payload instruments and support equipment that is to be transported with the instruments shall be designed for ground and air transportation in accordance with best commercial or military practices, as applicable to the mode(s) of transportation to be implemented.

3.2.8 Flexibility and Expansion

3.2.8.1 Operational Computer Resource Reserves

3.2.8.1.1 Reserved

3.2.8.1.1.1 Reserved

3.2.8.1.1.2 Reserved

3.2.8.1.1.3 Reserved

3.2.8.1.1.4 Reserved

3.2.8.1.1.5 Data Processing Software/Firmware

IF233030 Any hardware augmentations necessary to meet the expansion requirements shall, where practical, be designed so that the software and firmware in the data processing subsystems of the space elements are upward compatible with the implementation of those augmentations.

3.3 DESIGN AND CONSTRUCTION

3.3.1 Reserved

3.3.2 Electromagnetic Radiation

3.3.2.1 Electromagnetic Interference (EMI) Filtering of Spacecraft Power

IF233120 The instrument EMI input filters, if required, shall be installed on the instrument side of the power interface.

3.3.2.2 Electromagnetic Compatibility (EMC)

This section, together with the corresponding ICD section, contains all instrument-related EMC requirements, and a minimal set for the spacecraft. Additional spacecraft component and satellite-level EMC requirements may be contained in the JPSS spacecraft contractor's EMC documentation. Appendix B provides additional information that may be useful to the instrument and spacecraft contractors in understanding the EMC requirements. Please see Table B-1 for the JPSS transmitters and B-2 through B-8 for the instrument and spacecraft receiver sensitivities used to derive the requirements in this section.

3.3.2.2.1 Scope

EMC is necessary in each of the following areas:

- *Self-compatibility of an instrument to itself*

- *Compatibility between an instrument and all internal sources and receivers on the satellite (other instruments and the spacecraft bus)*
- *Compatibility between an instrument and all external sources and receivers "visible" on the ground, on the launch vehicle, and on-orbit*

The electromagnetic radiation environment on the JPSS-1 satellite could differ from the environment on JPSS-2, or any JPSS "free-flyer" . For example, the EMI-sensitive SARR, SARP, ADCS, and GPSOS instruments will not fly on the JPSS-1 spacecraft, but may on JPSS-2. Instruments which are common to JPSS-1 and JPSS-2 must satisfy overall JPSS EMI requirements, although waivers can be granted for non-compliance under conditions where the non-compliance is immaterial.

The JPSS instruments are identified in Table 3.3.2.2.1-1. The table identified which instruments are transmit (Tx) or receive (Rx) radio frequency (RF) signals. The table also indicates the satellites (JPSS 1 or 2) on which the instruments comprise the payloads. Table 3.3.2.2.1-2 identifies some common terms and acronyms used in this section.

Table 3.3.2.2.1-1. JPSS Instruments

Instrument	RF Instrument	Satellite Installed
A-DCS	Tx, Rx	Free-Flyer, JPSS-2
ATMS	Rx	JPSS-1, JPSS-2
CERES/ERBS	Not RF	JPSS-1, JPSS-2
CrIS	Not RF	JPSS-1, JPSS-2
OMPS	Not RF	JPSS-1, JPSS-2
SARP	Rx	Free-Flyer, JPSS-2
SARR	Tx, Rx	Free-Flyer, JPSS-2
SEM	Not RF	JPSS-2 (objective)
VIIRS	Not RF	JPSS-1, JPSS-2
TSIS	Not RF	Free-Flyer

Table 3.3.2.2.1-2. Commonly Used Terms

Term	Definition
Bond	A low-impedance electrical connection between two conductive elements
CE101	Conducted emissions, power leads, 30 Hz to 10 kHz
CE102	Conducted emissions, power leads, 10 kHz to 10 MHz
CE106	Conducted emissions, antenna terminals 10 kHz to 40 GHz
Chassis reference	The point within a component at which signal reference and secondary power return leads are referenced to the component chassis
Component	A generic term used to describe independently packaged electronics
Chassis	The metal enclosure which shields electronic circuits
CS101	Conducted susceptibility, power leads, 30 Hz to 150 kHz
CS114	Conducted susceptibility, bulk cable injection, 10 kHz to 200 MHz
CS103	Conducted susceptibility, antenna port, intermodulation, 15 kHz to 10 GHz
CS104	Conducted susceptibility, antenna port, rejection of undesired signals, 30 Hz to 20 GHz
CS105	Conducted susceptibility, antenna port, cross modulation, 30 Hz to 20 GHz
CS115	Conducted susceptibility, bulk cable injection, impulse excitation
CS116	Conducted susceptibility, damped sinusoidal transients, cables and power leads, 10 kHz to 100 MHz
Instrument chassis	The metal enclosure which shields the instrument's electronics
EMC	Electromagnetic Compatibility

Term	Definition
EMCWG	EMC Working Group
Equipment/unit	A generic term used to describe independently packaged components and subsystems. A group of components which work together and whose operation is interrelated are also categorized as equipment
EMI/EMS	Electromagnetic interference/electromagnetic susceptibility
Equipment chassis	The metal enclosure which shields the equipment's electronics
Equipment panel ground plane	The spacecraft conducting plate or other structure to which all ground planes are connected
Ground plane	The local electrically conductive surface to which a component is bonded
Intentional emissions	The signal or spectrum of emitted energy which is the fundamental purpose of operation. Example: the RF output of a transmitter is an intentional emissions at the transmitting antenna, while leakage of the transmitter output from the case of the transmitter is an unintentional emission (see unintentional emission)
PIM	Passive Intermodulation. The unintentional production of frequency cross products of multiple transmit signals mixing together in unshielded intentional nonlinear devices or unintentional nonlinear devices created incidentally by the random contact of conductive and semi-conductive materials on the spacecraft and payloads
Primary power reference	The point on the spacecraft where all primary power returns are referenced. The primary power reference is the reference point for spacecraft voltage control
Primary power return	The isolated 28 V current return lead from the component primary power dc-to-dc converter input back to the spacecraft primary power distribution point
RE101	Radiated emissions, magnetic field, 30 Hz to 100 kHz
RE102	Radiated emissions, electric field, 10 kHz to 18 GHz
RFI	Radio Frequency Interference to on-board receivers due to on-board transmitters
RF signal	RF signals are those which required coaxial cable and connections. RF signals typically have fundamental components above 4 MHz
RS103	Radiated susceptibility, electric field, 2 MHz to 40 GHz
Secondary power	Power which has been derived and isolated from primary power typically by a dc-to-dc converter, and used to power spacecraft interface to other circuits
Secondary power reference	The point within the component where all current returns from the secondary power circuits are referenced
Signal reference	The reference within the component for digital and analog signals
Signal return	The wire which carries the current of a digital or analog signal back to its source
Unintentional emissions	The signal or spectrum of emitted energy which is by-product of operation. Internally generated signals which are necessary for operation of a device but are not the specified and desired output are unintentional emissions (see intentional emissions)

3.3.2.2.2 Baseline Requirements

3.3.2.2.2.1 General

The EMC requirements detailed in this section apply to the instruments. The spacecraft EMI requirements are covered in a separate EMI/EMC plan.

The EMC performance requirements are a tailored version of the MIL-STD-461E requirements.

IF233245 While operating in the configurations necessary for transport, test, launch, separation and on-orbit mission activities, the spacecraft bus, instruments, ground support equipment, and test equipment shall operate together without

performance degradation due to EMI from each other, or the external environment, and without interfering with equipment in the external environment. However, see Para. 3.3.2.2.3.1.

3.3.2.2.2.2 Interface Margins

IF233265 Shielding of all EED circuitry and interface cabling up to an EED, including safe/arm EED cabling shall be designed to provide maximum continuous shielding effectiveness in order to ensure compliance with the 20 dB EMISM requirements of MIL-STD-1576.

3.3.2.2.3 External Environment

"External" means external to the satellite, hence, from another source, either on the earth, in space, or from the launch vehicle.

3.3.2.2.3.1 External RF Environment

IF233270 For the instruments, if the irradiated RF electric field frequency is within the passband of an instrument, the instrument shall automatically recover from, and operate without performance degradation after experiencing the field while in the intended operational mode for the respective phase of operation defined in Table 3.3.2.2.3.1-1.

(For example, if the system is normally powered off during ascent and is then powered on when on-orbit, it must operate properly when turned on after being exposed to 200V/m from 1-10GHz while off. Also, while performing its mission on-orbit, it must be able to withstand 110V/m at 5-10GHz without damage, and, at a minimum, automatically return to normal operational status and capabilities after the RFI stimulus is removed.)

Ideally, the upper limit would be 2 times the maximum frequency used. 18 GHz is used as a practical upper limit for testing.

Table 3.3.2.2.3.1-1 contains an on-orbit column for values due to external (non-satellite generated) RF fields that may be seen occasionally. The last column of the table reflects the RS103 requirement of 20 V/m that must be met at all times and any satellite generated RF fields, which includes on-orbit levels defined in the 1.7 GHz to 1.8 GHz and 7 GHz to 8 GHz frequency ranges. These levels are due to on-board spacecraft transmissions from the LRD and HRD transmitters. These are on at all times.

The test method is as defined in MIL-STD-461E RS103 test.

Table 3.3.2.2.3.1-1. Radiated Susceptibility Levels Due to Factory/Transport, Launch Site, Launch Vehicle, Ascent, and On-Orbit Phases

Frequency (Hz)	Factory/Transport (V/m)	Launch Site (V/m)	Ascent (V/m)	On Orbit External (V/m)	On Orbit Steady State* (V/m)
10 k - 100 M	20	20	20	20	20
100 M - 200 M	20	20	100	20	20
200 M - 1 G	20	20	100	20	30
1 G - 1.7 G	100	100	200	30	30

Frequency (Hz)	Factory/Transport (V/m)	Launch Site (V/m)	Ascent (V/m)	On Orbit External (V/m)	On Orbit Steady State* (V/m)
1.7 G - 1.8 G	100	100	200	30	20
1.8 G - 5 G	100	100	200	30	20
5 G - 7 G	100	100	200	110	20
7 G - 8 G	100	100	200	110	40
8 G - 10 G	100	100	200	110	20
10 G - 20 G	20	20	20	20	30
20 G - 40 G	20	20	20	20	20

* Note: The On Orbit Steady State (RS103) values are the maximum levels at any instrument and include 6 dB EMI susceptibiiity margin. Values that exceed 20 V/m are due to the local transmitters the frequencies of which are listed in Table C-1. Individual instrument environments may be lower. See the respective ICDs.
Note: the large values (100-200 V/m) do not apply across the entire frequency ranges shown, but at discrete frequencies within those bands. The specific frequencies are classified and can be requested via NASA JPSS. The 'Factory/Transport' and 'Launch Site' environments may be reduced by any combination of procedures, facility shielding, or shipping container shielding.

IF233290 If the irradiated RF electric field frequency is outside the passbands of an instrument, the instrument shall operate without performance degradation while exposed to the field while in the intended operational mode for the respective phase of operation defined in Table 3.3.2.2.3.1-1.

3.3.2.2.3.2 Spacecraft Charging from All Sources

3.3.2.2.4 Wiring

Refer to section 3.2.4.3.3.2.

3.3.2.2.5 Conducted and Radiated Interface Requirements

IF233355 The interfaces shall meet the requirements (except for CS 109 and RS105) of MIL-STD-461E as tailored by the intent of MIL-STD-1541A. CS114, CS 115 and CS116 apply to power cables only.

3.3.2.2.5.1 Magnetic Field Radiated Emissions, RE101

IF233370 The radiated ac magnetic field levels from the instruments shall be in accordance with MIL-STD-461E, except that only the Navy requirements (Figure RE101-2) shall apply, making appropriate allowance for power mains frequencies and harmonics.

IF233371 Radiated magnetic field emissions from the instruments shall not exceed the levels shown in Figure 3.3.2.2.5.1-1 at a distance of 7 cm.

The test method is as defined in MIL-STD-461E RE101 test.

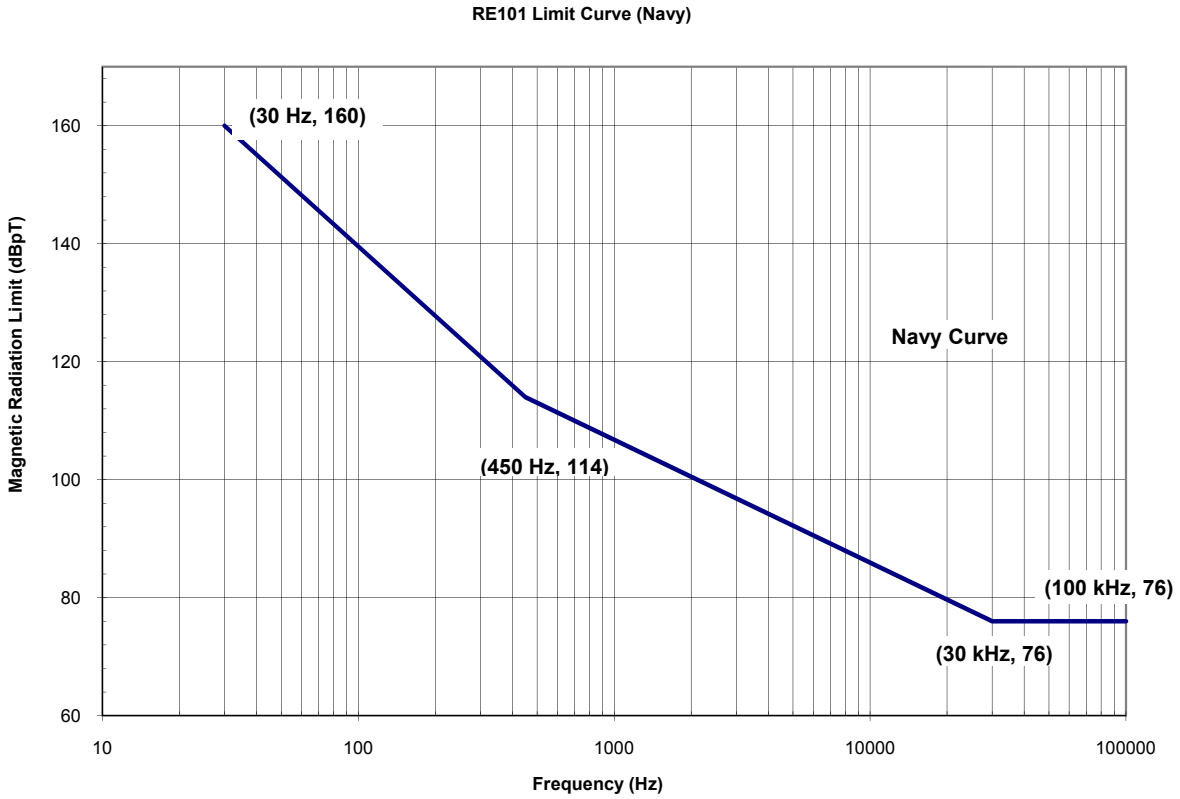


Figure 3.3.2.2.5.1-1. Radiated Emissions, Magnetic Field (RE101) Electric Field Radiated Emissions, RE102

3.3.2.2.5.2 Electric Field Radiated Emissions, RE102

IF233375 The intentional radiated emissions from the spacecraft bus or payload transmitters shall be below 134 dBμV/m (5 V/m) at the interface between the transmitter and any EMI sensitive unit (spacecraft unit or instrument) up to 18 GHz.

IF233380 RF instruments shall not generate conducted emissions at the antenna ports in excess of the levels shown below.

a) Receivers: 34dBμV

b) Transmitters and amplifiers (standby mode): 34 dBμV

c) Transmitters and amplifiers (transmit mode): Harmonics, except the second and third, and all other spurious emissions shall be at least 80 dB down from the level at the fundamental. The second and third harmonics shall be suppressed 50 + 10 log p (where p = peak power output in watts, at the fundamental) or 80 dB, whichever requires less suppression.

Requirement RE103 applies when conducted emissions and harmonics cannot be measured due to inaccessibility of antenna terminals. The test method is as defined in MIL-STD-461E CE106 test.

IF233390 Unintentional radiated electric field emissions from the instruments shall not exceed the levels shown in Table 3.3.2.2.5.2-1.

IF233455 The requirements specified elsewhere in this document apply to continuous emissions. Transient or pulse noise shall be considered on a case-by-case basis, but shall not in any way detrimentally affect the normal operation of the SAR or ADCS subsystems – specifically, the SARR, SARP and ADCS requirements shown in the RE102 limit curves.

IF233470 Selected units that contain noise sources above 5 GHz may require testing above 18 GHz.

This includes ATMS.

IF233475 Units that contain noise sources above 5 GHz shall meet the radiated emissions requirements shown in Table 3.3.2.2.5.2-2.

The test method is as defined in the MIL-STD-461E RE102 test. However, in the frequency notches, lower bandwidths may be used than specified in test method RE102 in order to achieve the test levels.

Table 3.3.2.2.5.2-1. Unintentional Radiated Electric Field Emissions, 10 kHz to 18 GHz TBR

Frequency (MHz)	Limit Level (dBμV/m)	Receiver Protected	Frequency (MHz)	Limit Level (dBμV/m)	Receiver Protected	Frequency (MHz)	Limit Level (dBμV/m)	Receiver Protected
0.01	56		425	28	SARR			
385	56		425	56				
385	28	SARR	1207	56				
396	28	SARR	1207	25	GPS			
396	22	A-DCS	1250	25	GPS			
399.9	22	A-DCS	1250	56				
399.9	-17	A-DCS	1550	56				
400.05	-17	A-DCS	1550	27	GPS			
400.05	22	A-DCS	1600	27	GPS			
401	22	A-DCS	1600	56				
401	-17	A-DCS	2000	56				
403	-17	A-DCS	2063	56				
403	3	SARR	2063	20	CMD			
405.9	3	SARR	2071	20	CMD			
405.9	-17	(SARR/SARP)	2071	56				
406.2	-17	(SARR/SARP)						
406.2	3	SARR						
411	3	SARR						
411	28	SARR						

Table 3.3.2.2.5.2-2. Unintentional Radiated Electric Field Emissions, 18 to 200 GHz TBR

Frequency (GHz)	Limit Level (dBμV/m)	Receiver Protected	Frequency (GHz)	Limit Level (dBμV/m)	Receiver Protected	Frequency (GHz)	Limit Level (dBμV/m)	Receiver Protected
			56.9	50.98	ATMS			
			57.7	50.98	ATMS			
			57.7	56				

Note: Notches above 18 GHz are Table B-7 (ATMS) in-band levels.

3.3.2.2.5.3 Radiated Susceptibility, RS101

IF233480 The instrument shall meet the requirements of MIL-STD-461E, except that RS101 shall apply, but only the Navy requirement (Figure RS101-1) shall apply.

IF233481 The instruments shall not exhibit any malfunction, degradation of performance or deviation from the specified indications beyond the tolerances indicated in their individual specifications as a result of being irradiated with the magnetic field levels shown in Figure 3.3.2.2.5.3-1.

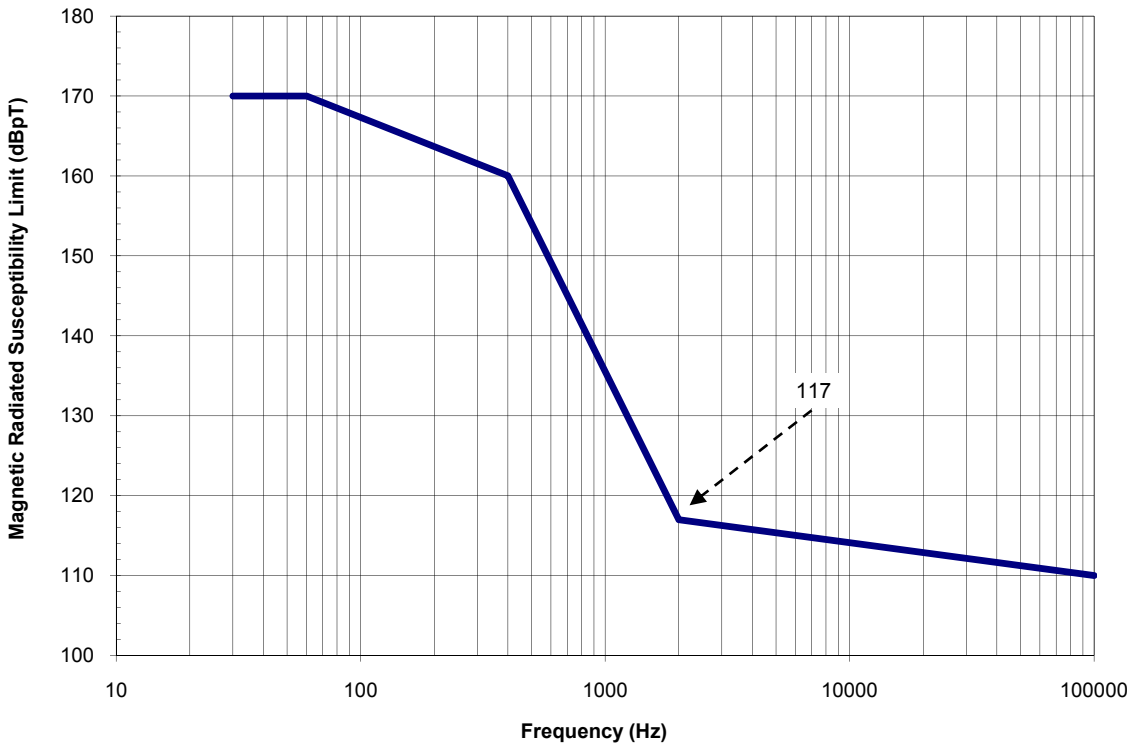


Figure 3.3.2.2.5.3-1. AC Magnetic Field Radiated Susceptibility Limit (RS101)

3.3.2.2.5.4 Radiated Susceptibility RS103

(Note: This paragraph specifically covers susceptibility to emissions from equipment on the JPSS satellite. Susceptibility to emissions from external transmitters, and general RF susceptibility, is covered in paragraphs under and including paragraph 3.3.2.2.3.1.)

IF233485 The instrument shall operate without degradation when exposed to levels shown in the on-orbit column of Table 3.3.2.2.3.1-1 at the frequencies outside its passband.

3.3.2.2.5.5 Conducted Emission (CE)

See Section 3.2.4.3.1.5.1.2

3.3.2.2.5.6 Conducted Susceptibility (CS)

IF233360 The instruments shall not exhibit any malfunction, degradation of performance, or deviation from the specified indications beyond the tolerances indicated in the individual equipment or subsystem specification, when power leads are subjected to the limits shown in Figure 3.3.2.2.5.6-1.

The test method is as defined in the MIL-STD-461E, CS101 test. This requirement is satisfied under conditions where the peak excursions of the voltage applied to the equipment (e.g., dc plus/minus peak ac) are respectively equal to the maximum and the minimum voltage limits specified for the load equipment under steady-state operating conditions.

IF233140 The instruments shall not exhibit any malfunction, degradation of performance, or deviation from the specified indications beyond the tolerances indicated in the individual equipment or subsystem specification, when power leads are subjected to the limits shown in Figure 3.3.2.2.5.6-2.

The test method is as defined in the MIL-STD-461E, CS114 test.

IF233365 The instruments using primary power shall not exhibit any malfunction, degradation of performance, or deviation from the specified indications beyond the tolerances indicated in the individual equipment or subsystem specification, when power leads are subjected to a signal having the waveform shown in Figure 3.3.2.2.5.6-3 and the amplitude or Imax for the curve shown in Figure 3.3.2.2.5.6-4.

The test method is as defined in the MIL-STD-461E, CS116 test.

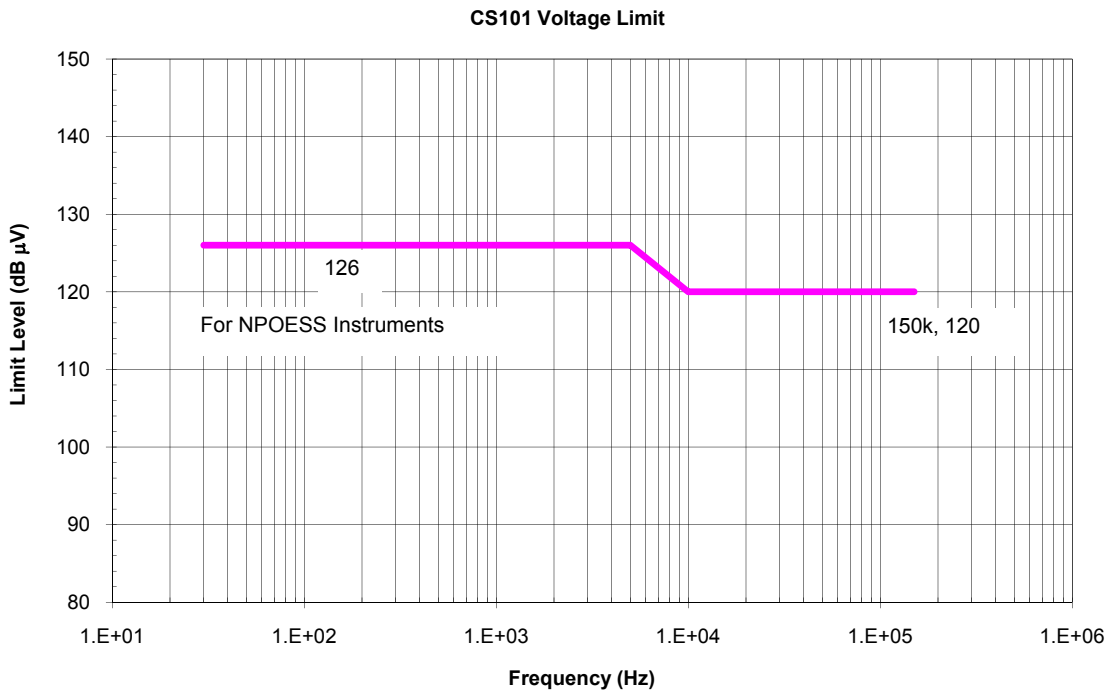


Figure 3.3.2.2.5.6-1. Instrument Power Lead Conducted Susceptibility (CS101)

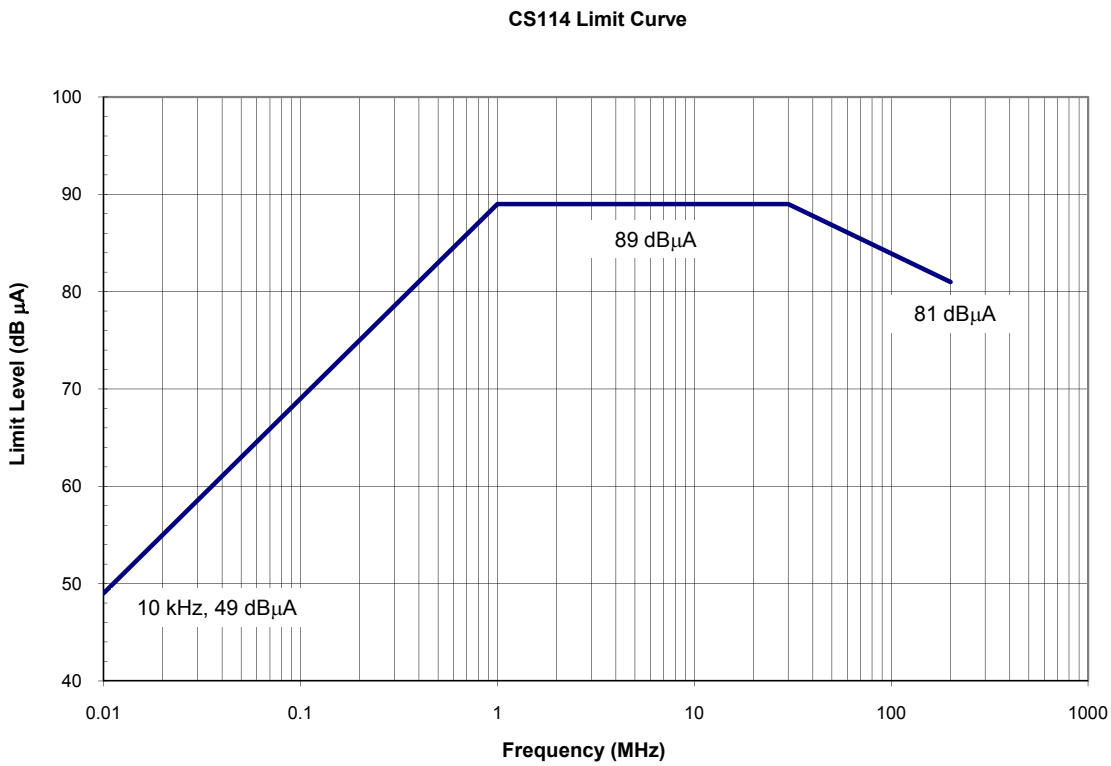
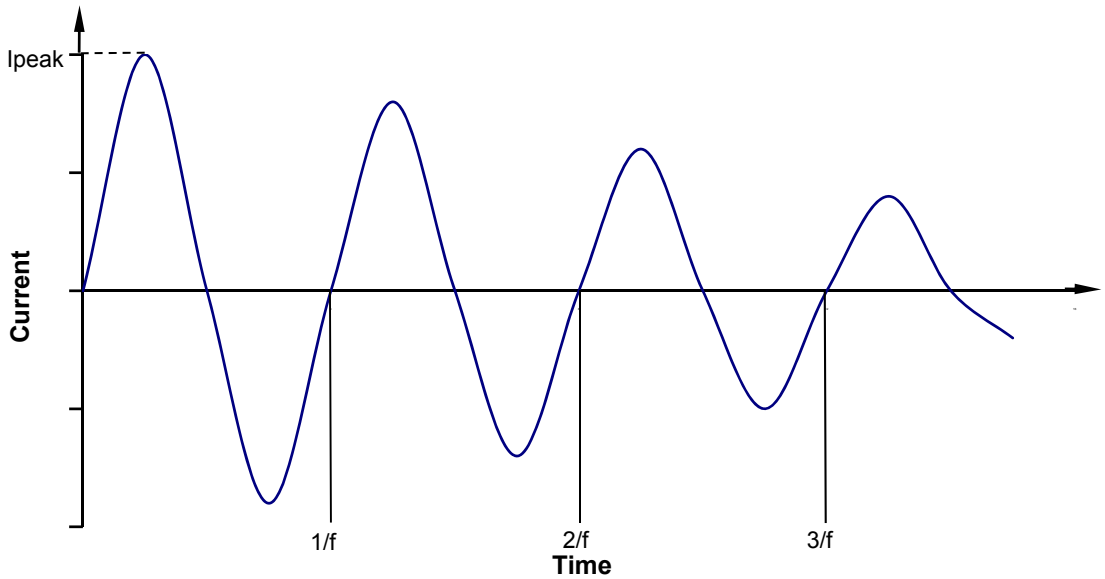


Figure 3.3.2.2.5.6-2. Conducted Susceptibility, Bulk Cable Injection (CS114)



NOTES:

1. Normalized waveform: $e^{-(\pi ft)/Q}\sin(2\pi ft)$

   Where:

   f = Frequency (Hz)

   t = Time (sec)

Q = Damping factor, 15 ± 5

2. Damping factor (Q) shall be determined as follows:

$$Q = \frac{\pi(N-1)}{\ln(I_P/I_N)}$$

Where:

Q = Damping factor
N = Cycle number (i.e. N = 2, 3, 4, 5, ...)
I_P = Peak current at 1st cycle
I_N = Peak current at cycle closest to 50% decay
ln = Natural log

3. I_P as specified in the graph above

Figure 3.3.2.2.5.6-3. Conducted Susceptibility, Damped Sinusoidal Transient Limit (CS116)

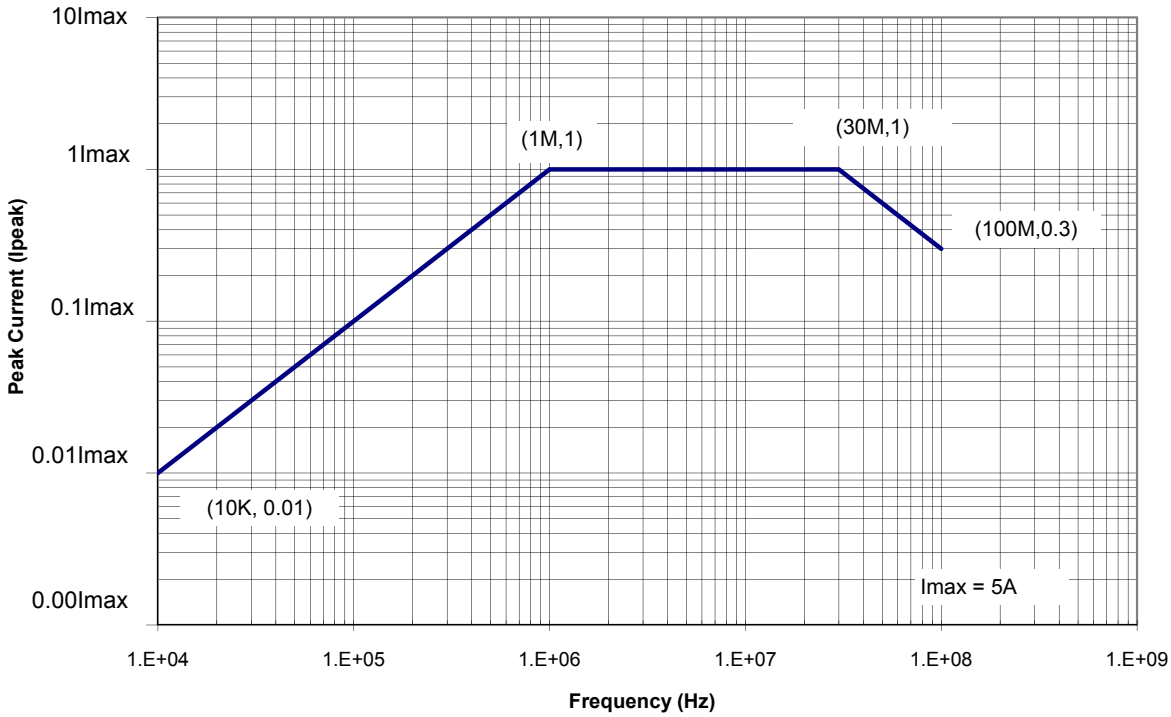


Figure 3.3.2.2.5.6-4. Instrument Conducted Transient Susceptibility (CS116)

3.3.2.3 Reserved

3.3.3 Reserved

3.3.4 Reserved

3.3.5 Reserved

3.3.6 Safety Requirements

3.3.6.1 Design Safety Criteria

IF233545 Space debris shall not be generated.

IF233555 Non-explosive actuators shall be preferred over pyrotechnic devices wherever practicable in order to minimize shock loads. A fast release requirement can preclude this design option (paraffin actuators are slow to release.)

IF233595 Actuating circuitry for safety-related non-explosive actuators shall be two-fault tolerant to unanticipated deployment or release.

This requires three electrical/mechanical interlocks, but does not require all three interlocks to be different for each actuating device.

3.3.7 Reserved

3.3.8 Reserved

3.3.9 Security

3.3.9.1 Communications Security

IF233690 The instrument shall check for invalid commands and execute only valid commands

IF233695 Invalid commands shall be reported in telemetry.

3.3.9.2 Reserved

3.3.10 Reserved

3.3.11 Computer Resources

Computer resources include all computer software and the associated computational equipment included within the instrument.

3.3.11.1 Operational Computer Resources

3.3.11.1.1 Operational Computational Equipment

The computational equipment includes processing units; special-purpose computational devices; main storage; peripheral data storage; input and output units.

3.3.11.1.2 Reserved

3.3.11.1.3 Operating Systems Used in Operational Computers

3.3.11.1.3.1 Instruments Flight Software Requirements

3.3.11.1.3.1.1 Reserved

3.3.11.1.3.1.2 Instrument Flight Software Load

IF233715 Following power-up, the instrument shall be functional without requiring a software or data upload.

3.3.11.1.3.1.3 Instrument Flight Software On-Orbit Installation and Verification

IF233725 Flight software shall be designed so that complete or partial revisions can be installed and verified on-orbit, consistent with operations constraints.

This means, for example, that loads may occur over multiple ground contacts. As such, active memory must not be altered until the complete load is received and verified, at which time the newly uplinked information can be utilized.

3.3.11.1.3.2 Reserved

3.3.11.1.3.2.1 Reserved

3.3.11.1.4 Software Coding Conventions

IF233735 Code shall be written such that no code is modified during execution.

3.3.11.2 Instrument GSE to Spacecraft I&T GSE Interface

IF233755 The interface of deliverable instrument EGSE to the spacecraft EGSE shall be via a local area network during spacecraft level testing.

IF233760 The deliverable instrument EGSE shall be capable of receiving the instrument SMD packets at least 20 times the average data rate of the instrument.

IF233765 Commanding of the instrument shall be from the spacecraft electrical GSE, through the spacecraft C&DH subsystem.

Note: In lieu of ECLIPSE workstation, ProcPad will be provided to the instrument contractor to generate and verify ATSs. [TBD]

IF235041 The deliverable instrument EGSE shall be capable of receiving and displaying the instrument real-time science data (HRD and/or LRD packets).

IF235061 The deliverable instrument EGSE shall be capable of archiving and processing science telemetry (SMD, HRD, and/or LRD packets).

IF235341 After the instrument is integrated onto the spacecraft, the IGSE shall not command the instrument.

Note: Commands shall only be sent thru spacecraft I/F not from any test port

IF333765 At satellite I&T, the instrument contractor shall use the spacecraft command and telemetry system to perform microprocessor and/or memory loads.

3.3.12 Instrument Design Requirements

The spacecraft and instruments must survive the critical loading conditions that exist within the envelope of handling, launch environment, and mission requirements. The detailed requirements are provided in the following sections.

3.3.12.1 Structural Analyses

The launch vehicle/spacecraft coupled loads analysis will be performed by the launch vehicle contractors.

3.3.12.2 Strength Requirements

Limit load is defined as the highest expected load, including environmental effects.

3.3.12.2.1 Reserved

3.3.12.2.2 Reserved

3.3.12.3 Stiffness Requirements

3.3.12.3.1 Reserved

3.3.12.3.2 Reserved

3.3.12.3.3 Component Stiffness

IF233825 Each separately-mounted instrument component, configured for launch, shall have a fixed-base fundamental resonant mode frequency of greater than 50 Hz.

Fixed-base is defined as follows: Each mounting point shall be constrained in those translational degrees of freedom which are rigidly attached to the spacecraft and shall be free in those translational degrees of freedom for which kinematic mounts or flexures provide flexibility.

IF233845 The fundamental resonant mode frequency for an instrument in its on-orbit configuration shall be 6 Hz or greater.

3.3.12.4 Structural Factors of Safety

The factor of safety of the structure is the ratio of the maximum stress that a structural part or other piece of material can withstand to the maximum stress estimated for it in the use for which it is designed (limit load).

3.3.12.4.1 Flight Limit Loads

IF233885 The load factors given in the mass-acceleration curve shown in Figure 3.3.12.4-1 shall be applied in each individual axis.

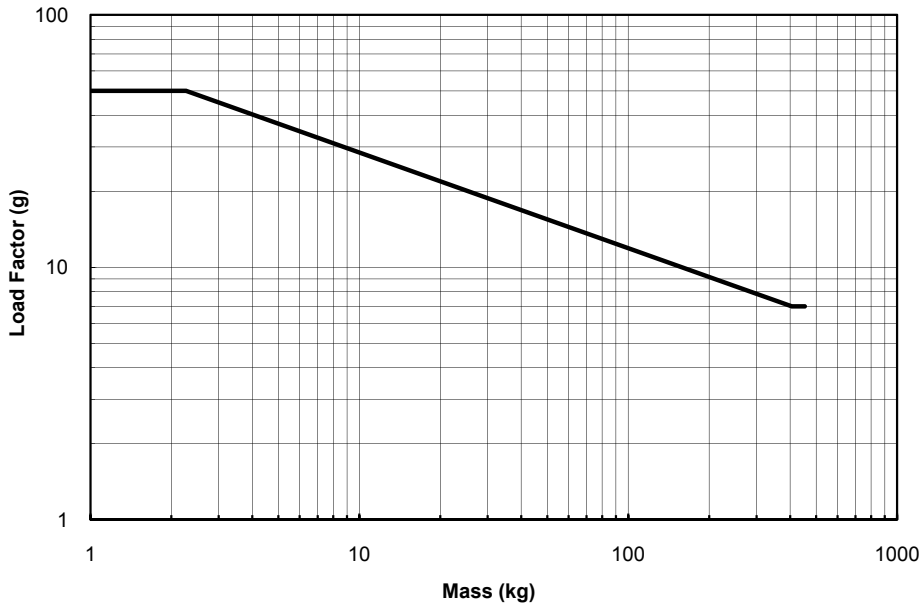


Figure 3.3.13.4-1. Acceleration Load Factors (Limit)

3.3.12.4.2 Pressure Loads

IF233910 Factors of safety for pressure loads shall be determined individually for each pressure vessel, based on tests to establish material characteristics and an analysis of life requirements and other environmental exposure.

3.3.12.5 Reserved

3.3.12.6 Reserved

3.3.12.7 Moving Mechanical Assemblies

3.3.12.7.1 Actuating Devices

See section 3.3.6.1

3.3.12.7.2 Reserved

3.3.12.7.3 Instrument Mechanisms

IF234000 All instrument mechanisms which require restraint during launch shall be caged during launch without requiring power to maintain the caged condition.

IF234005 Instrument mechanisms which require caging and/or uncaging during test and launch site operations shall be capable of being caged or uncaged by command and by manual actuation of accessible locking/unlocking devices.

IF234010 Instrument mechanisms which require uncaging and/or caging on-orbit shall be capable of being caged and uncaged by command.

3.3.12.7.4 Uncompensated Momentum

IF234015 Each instrument having movable components shall not exceed an uncompensated momentum contribution of +/- 0.5 N-m-sec per axis.

3.3.12.7.5 Instrument Disturbance Allocations

3.3.12.7.5.1 Periodic Disturbance Torque Limits

IF234030 The magnitude of the periodic disturbance torque, including the torque resulting from linear forces reacting from the instrument to the spacecraft) shall be in the acceptable range of Figure 3.3.12.7.5.1-1 for all frequencies.

The transition points for Figure 3.3.12.7.5.1-1 are shown in Table 3.3.12.7.5.1-1, for clarity.

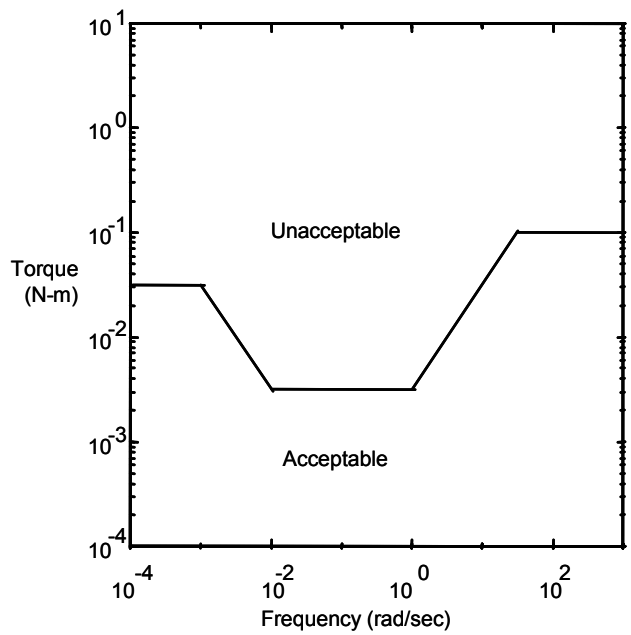


Figure 3.3.12.7.5.1-1. Allowed Transmitted Torque

Table 3.3.12.7.5.1-1. Allowable Transmitted Torque Transition Points

Frequency (rad/sec)	Torque (N-m)
< 0.001	0.03
0.01	0.003
1.0	0.003
> 33.3	0.1

3.3.12.7.5.2 Constant Disturbance Torque Limits

IF234040 Instrument-induced constant disturbances of the same polarity, separated by more than 200 seconds, shall not exceed the torque limit defined in Figure 3.3.12.7.5.2-1 if the duration of application is in excess of 10 seconds. For constant torques of 10 seconds duration or less, the impulse limit is 0.04 N-m-s.

For constant torques of 400 seconds duration or more, the torque limit is maintained at the 400 second limit shown in Figure 3.3.12.7.5.2-1.

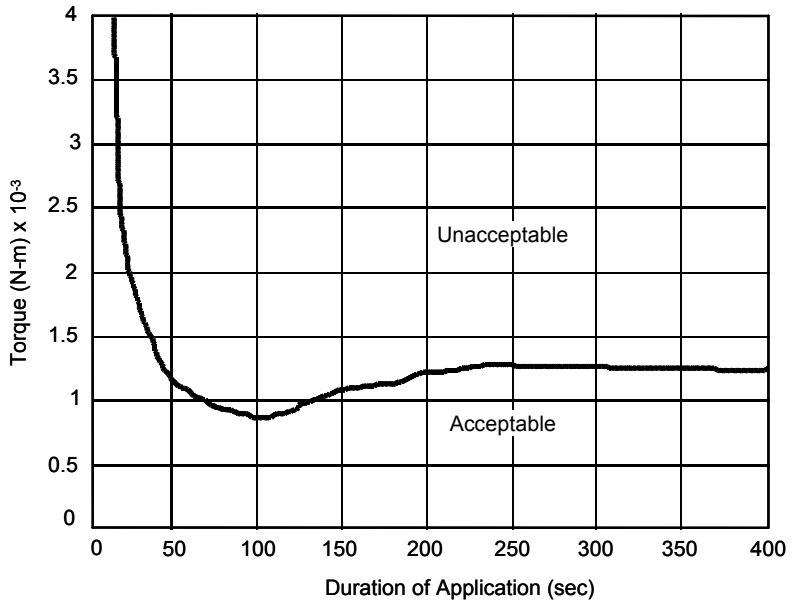


Figure 3.3.12.7.5.2-1. Constant Torque vs. Duration of Application

3.3.12.7.5.3 Disturbance Torque Limits for Linear Forces

IF234045 The same requirements specified above for constant and periodic torques shall apply when linear forces are converted to torques, assuming a moment arm of 2 m for motion along the pitch or yaw axes and 3 m for motion along the roll axis.

3.3.12.7.5.4 Spacecraft Non-Operational Deployment Disturbance

IF234055 The on-orbit non-operational Spacecraft disturbances produced by the uncaging or deployment of any mechanism or device shall be less than 158 N-m at the point of attachment.

3.3.12.7.5.5 Reserved

3.3.12.7.5.6 Reserved

3.3.12.8 Magnetics

IF234080 The remnant uncompensated magnetic moment of an instrument shall not exceed 0.031 ampere-turn-meter-square (31 pole-cm) per kilogram [TBR] of instrument mass.

IF234081 The stray uncompensated magnetic moment of an instrument shall not exceed 0.0106 ampere-turn-meter-square (10.6 pole-cm) TBR per watt of instrument average operational power.

3.3.12.9 Reserved

3.3.12.9.1 Reserved

3.3.12.9.2 General Access

IF234095 All items to be installed, removed, or replaced at the spacecraft level shall be accessible without disassembly of the unit.

3.3.12.10 Mounting/Handling

3.3.12.10.1 Reserved

3.3.12.10.2 Mounting Orientation

IF234125 Instrument design shall be such that the instrument is capable of being mounted to the spacecraft with the spacecraft interface in the horizontal position.

3.3.12.10.3 Instrument-to-Spacecraft Integration and Test Mounting

(The requirements in this section apply to both the instrument contractor and the spacecraft contractor, and requires close co-ordination between the two.)

IF234130 Each separately-mountable instrument component shall be capable of being installed and removed in any order.

IF234133 The spacecraft contractor shall provide access to allow installation and removal of each separately mounted instrument component without removal of other instruments or subsystems, and without demating or removal of harness (including coax) other than for the unit being removed.

IF234135 The spacecraft contractor shall provide connector access for removal and reassembly of an instrument without requiring removal of any equipment.

IF234140 Access for and installation of Instrument mounting hardware shall be exclusively from the instrument side of the spacecraft - instrument mechanical interface.

IF234145 Installation/removal of any separately-mountable instrument component shall not require rotation of the instrument or the spacecraft during installation/removal.

3.3.12.10.4 Reserved

3.3.12.11 Venting

IF234160 The instrument shall limit continuous venting forces to <4.4482E-05 N.

IF234165 The instrument shall limit random venting impulses to <0.1245 Newton-seconds per orbit.

3.3.13 Reserved

3.3.14 Ground Support Equipment

IF234185 All instrument electrical ground support equipment (IEGSE) shall have separate and isolated grounds for DC power, telemetry, and facility AC power.

This requirement only applies to GSE that is used post-shipment of the instrument..

IF234190 IEGSE chassis shall be grounded to facility AC power ground.

IF235150 If the instrument or instrument GSE employs high voltage (>50 VDC), kill (emergency off) switches on the GSE shall be provided.

IF235155 GSE which is used in a clean room shall be class 10,000 clean room compatible.

IF235160 GSE shall be designed for a seismic loading of 0.5g lateral.

IF235170 All red tag/green tag items for an instrument shall be accomplished before encapsulation.

IF235175 The instrument shall be capable of being 'aliveness' tested within the fairing with only "fairing air".

IF236165 Instrument design shall be such that no testing is required at the launch site other than 'aliveness' testing.

IF236205 The instrument shall have the capability of being externally tested, while in storage and on the launch pad, to verify limited functionality.

Although limited functional performance may be the "norm" during storage and at the pad, the goal is to allow the maximum amount of testing "in-place", rather than requiring removal and return of the instruments to the instrument contractor, wherever feasible.

IF236081 IGSE shall have the following dimension requirements:

- Not greater than 79 in. high (without eye-bolts)
- Not greater than 48 in. wide
- Not greater than 35in. deep
- Standard forklift tracks
- Casters greater than or equal to 5 in.
- Cable(s) type, lengths, connector requirements, wire gauge(s)
- When used (ambient observatory testing, BAT testing, TV, EMC, etc.)
- Where used (EGSE to IGSE, IGSE to targets, inside TV, TV port plate, test points, etc.)
- Contamination requirements (TV cables)
- Wirelist

IF236141 All equipment including shipping containers shall be capable of entering through high bay roll up door (minimum door clearances at the spacecraft contractor: 20’ W X 25’ H).

IF236206 Shipping containers for the sensors and GSE shall have features that permit the use of a forklift.

IF236221 An instrument lifting fixture shall be used to transfer the instrument from the instrument shipping container to the spacecraft during instrument installation.

IF236241 The fixture attaches to the instrument and permits instrument lifting/lowering operations along the Spacecraft +Z axis; when the lifting fixture is used, the spacecraft +Z axis shall be vertical and up.

IF236280 MGSE installed on instruments shall have common ground with instrument and S/C via mounting hardware or ground straps.

IF237240 IGSE shall be capable of providing quick look determination on instrument state of health and performance data.

IF237270 Sensor IGSE shall have a configurable IP address.

3.3.15 General Construction Requirements

IF234210 All items to be installed, removed, or replaced at the instrument or spacecraft level shall utilize captive hardware, except instrument mounting hardware.

3.3.15.1 Reserved

3.3.15.1.1 Reserved

3.3.15.1.2 Reserved

3.3.15.1.3 Reserved

3.4 RESERVED

3.5 LOGISTICS

3.5.1 Reserved

3.5.2 Reserved

3.5.3 Packaging, Handling, Storage, and Transportation (PHS&T)

IF221842 The satellite (spacecraft plus instruments) shall not be damaged by being stored in any position, with the deployables stowed.

IF236235 All deliverable items with sensitivity to shock, temperature, and moisture shall include positive means to verify compliance with shock, temperature, and moisture requirements during shipping/handling.

3.6 RESERVED

4 TESTING REQUIREMENTS

4.1 RESERVED

4.2 TESTING

See Section 3.3.14 for ground support equipment requirements

4.2.1 Reserved

4.2.2 Reserved

4.2.3 Reserved

4.2.4 Reserved

4.2.5 Reserved

4.2.6 Reserved

4.2.7 Acceptance and Protoflight Testing

The requirements in sections 4.2.7, 4.2.8, and 4.2.9 are considered verifiable requirements. Verification can be by submission of as-run test procedures.

A comprehensive instrument test program, as defined by MIL-STD-1540C, as tailored for the JPSS program, is to be conducted in conjunction with the spacecraft test program. This will demonstrate that the instrument can meet its performance requirements and will ensure that all interface requirements are satisfied. These interface requirements will include interface structural and thermal loads, electrical power, electrical signals, and other interface performance characteristics for ground handling, launch, deployment (where applicable), and on-orbit operations as well as for worst case systems tests conducted after delivery of the instrument. All of the tests will be conducted by the instrument contractor before delivery of the instruments. Additional tests will be conducted at the satellite level after integration of the instrument onto the spacecraft.

The allocation of tests between the instrument developer and the spacecraft contractor will be coordinated by NASA JPSS as part of the interface control function. Coordination of testing includes such items as sequence of tests, primary test responsibility, test levels, repetition of tests, duration of tests and test location.

The types of testing to be performed by the spacecraft contractor include:

a. *Thermal vacuum and thermal cycling*

b. *EMI/EMC characterization to understand and measure radiative and conductive emissions and susceptibility*

c. *Static and dynamic structural testing (including pressure vessel and ordnance testing)*

d. *Electrical and mechanical functional testing to demonstrate performance*

IF235970 All instrument protoflight and acceptance shall be done in accordance with MIL-STD-1540C unless specified otherwise in this document.

IF235975 All instrument protoflight tests shall be conducted with hardware of the final design that has passed the in-process production screens.

IF235980 The instrument contractor shall perform comprehensive radiometric/geometric calibration at multiple levels of assembly as approved by NASA JPSS.

IF235985 Instruments shall be thermally baked out in one of three methods:

1) During normal thermal-vacuum multi-cycle functional testing at < 1E-5 torr where the last temperature soak cycle is at the high temperature limit followed by ambient temperature at test end and where demonstration that the material from the instrument outgassed sufficiently is given by using a Thermal Quartz Crystal Microbalance (TQCM) to monitor the out-gassing rate during the bake out;

2) by an un-powered thermal vacuum bake-out at 65 deg C for 168 hours and at < 1E-5 torr; or

3) by a thermal vacuum bake out of the instrument at 95 deg C for 72 hours at < 1E-5 torr.

IF235990 Bakeout shall be done prior to delivery, such that contamination is minimized prior to delivery to the spacecraft facility, and to other contamination sensitive components/subsystems on the space vehicle during storage and on orbit.

IF235995 MLI blankets, harnesses and cables, and electronic boxes/modules to be included in thermal-vacuum testing shall be baked out separately from the instrument.

4.2.7.1 Random Vibration Testing

The random vibration test levels are dependent on the payload fairing internal acoustic environment and design of the spacecraft bus.

4.2.7.1.1 Acceptance Level Random Vibration Testing

The test levels currently found in Table 4.2.7.1.1 and Figure 4.2.7.1.1 are considered a conservative estimate of the random vibration environment on a representative spacecraft bus and are the minimum test levels recommended to detect workmanship defects. These values are intended for use until selection of a spacecraft, launch vehicle, fairing, etc. permit more accurate determination, and revision of the table.

IF235785 The test duration shall be 1 minute per axis for acceptance level testing.

IF235790 In no case shall the acceptance test levels for any separately-mountable instrument component be less than those shown in Table 4.2.7.1.1.

Table 4.2.7.1.1-1. Random Vibration - Acceptance Test Levels

Frequency	Acceleration Spectral Density (g^2/Hz)
20	0.01
20 to 160	+3 dB/oct
160 to 250	0.08
250 to 2000	-3 dB/oct
2000	0.01
Overall	7.4 g_{rms}

The plateau acceleration spectral density (ASD) level may be reduced for components between 25 kg and 200 kg according to the component weight (W) up to a maximum of 9 dB as follows:

dB reduction = 10 LOG(W/25)

$ASD_{(plateau)}$ level = 0.08 x (25/W)

where: W = component weight in kg.

IF235795 The sloped portions of the spectrum shall be maintained at ± 3 dB/oct. Therefore, the lower and upper break points, or frequencies at the ends of the plateau become: FL = 160 (25/W) FL = frequency break point low end of plateau, FH = 250 (W/25) FH = frequency break point high end of plateau

IF235800 The test spectrum shall not go below 0.01 g2/Hz. For components whose weight is greater than 200 kg, the workmanship test spectrum is 0.01 g2/Hz from 20 to 2000 Hz with an overall level of 4.4 grms.

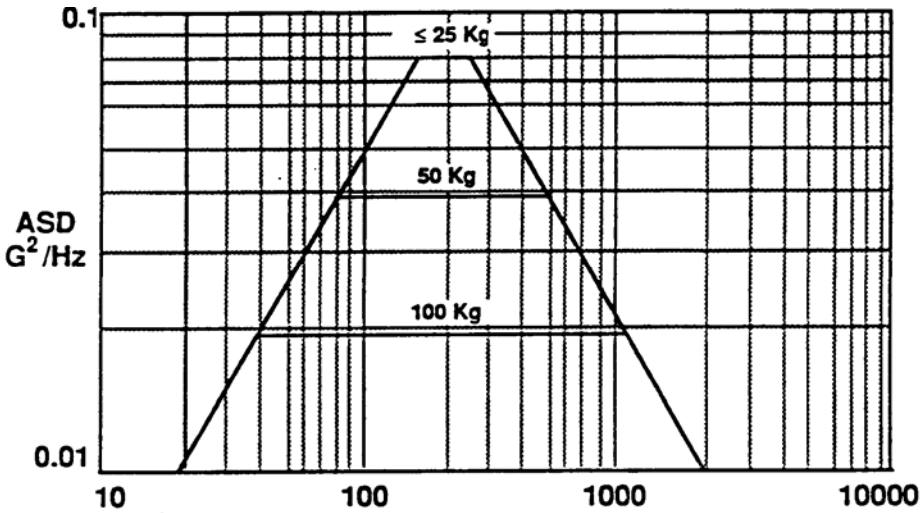


Figure 4.2.7.1.1-1. Random Vibration - Acceptance Levels

4.2.7.1.2 Protoflight Level Random Vibration Testing

The test levels currently found in Table 4.2.7.1.2-1 and Figure 4.2.7.1.2-1 are considered a conservative estimate of the random vibration environment on a representative spacecraft bus and are the minimum test levels recommended to detect workmanship defects, subject to revision after design of the JPSS spacecraft and selection of a launch vehicle contractor.

IF235805 The protoflight test duration shall be 1 minute per axis.

IF235810 In no case shall the protoflight test levels for the any separately-mountable instrument component be less than those shown in Table 4.2.7.1.2-1.

Table 4.2.7.1.2-1. Random Vibration - Protoflight Levels

Frequency	Acceleration Spectral Density (g^2/Hz)
20	0.026
20 to 50	+6 dB/oct
50 to 800	0.16
800 to 2000	-6 dB/oct
2000	0.026
Overall	14.1 g_{rms}

The acceleration spectral density (ASD) level may be reduced for components more than 25 kg according to:

dB reduction = 10 LOG(W/25)

ASD(25 to 400) = 0.16 x (25/W)

where: W = component mass in kg.

IF235815 The slope shall be maintained at ± 6 dB/oct for components up to 65 kg.

IF235820 Above 65 kg, the slopes shall be adjusted to maintain an ASD level of 0.01 g²/Hz at 20 and 200 Hz.

IF235825 For components over 200 kg, the test specification shall be maintained at the level for 200 kg.

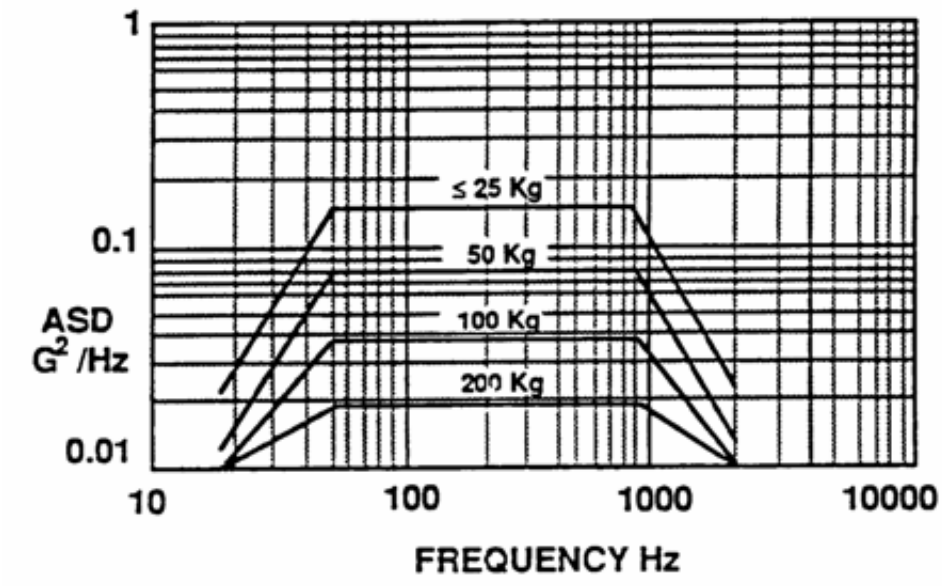


Figure 4.2.7.1.2-1. Random Vibration - Protoflight Levels

4.2.7.1.3 Random Vibration After Rework

IF235827 Instruments that have been taken apart and reassembled shall, as a minimum, be subjected to a single axis workmanship random vibration test to the levels specified in Table 4.2.7.1.3-1, where the actual levels to be used have NASA JPSS FRB concurrence.

The determination of axis shall be made based on the direction necessary to provide the highest excitation of the reworked area. Testing may be required in more than one axis if a single axis test cannot be shown to adequately test all of the reworked area. If the amount of rework or disassembly required is significant, then 3-axis testing to acceptance levels may be necessary if they are higher than workmanship levels.

Frequency (Hz)	ASD Level (g^2/Hz)
20	0.01
20-80	+3 dB/oct
80-500	0.04
500-2000	-3 dB/oct
2000	0.01
Overall	6.8 g_{rms}

The plateau acceleration spectral density level (ASD) may be reduced for components weighing between 45.4 and 182 kg, or 100 and 400 pounds according to the component weight (W) up to a maximum of 6 dB as follows:

		Weight in kg	Weight in lb
dB reduction	=	10 log(W/45.4)	10 log(W/100)
$ASD_{(plateau)}$ level	=	0.04•(45.4/W)	0.04•(100/W)

The sloped portions of the spectrum shall be maintained at plus and minus 3 dB/oct. Therefore, the lower and upper break points, or frequencies at the ends of the plateau become:

F_L = 80 (45.4/W) [kg] = 80 (100/W) [lb] — F_L = frequency break point low end of plateau

F_H = 500 (W/45.4) [kg] = 500 (W/100) [lb] — F_H = frequency break point high end of plateau

The test spectrum shall not go below 0.01 g^2/Hz. For components whose weight is greater than 182-kg or 400 pounds, the workmanship test spectrum is 0.01 g^2/Hz from 20 to 2000 Hz with an overall level of 4.4 g_{rms}.

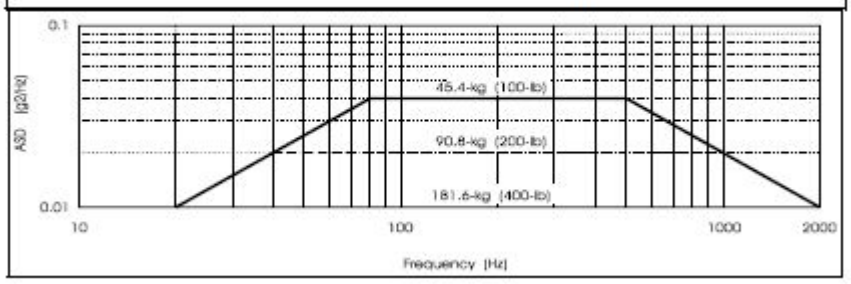


Figure 4.2.7.1.3-1. Random Vibration - Rework MinimumLevels

4.2.7.2 Sine Vibration Testing

IF235880 This test shall be conducted with the instrument in the launch configuration.

IF235885 There shall be one sweep from 5 Hz to 60 Hz for each axis.

IF235887 Requests for tailoring/notching shall be submitted to NASA JPSS for approval prior to testing.

4.2.7.2.1 Acceptance Level Sine Vibration Testing

IF235830 The instrument shall be acceptance tested to the sine vibration test levels specified in Table 4.2.7.2.2-1 and in Figure 4.2.7.2.2-1 in each of three orthogonal axes.

IF235835 The acceptance test sweep rate shall be 4 oct/min.

4.2.7.2.2 Protoflight Level Sine Vibration Testing

IF235840 For protoflight testing, the sine vibration levels shall be the same as the acceptance test levels specified in Table 4.2.7.2.2-1 in each of three orthogonal axes.

Table 4.2.7.2.2-1. Sinusoidal Test Levels

Frequency	Amplitude/Acceleration
6.3 to 17.7 Hz	Displacement = 12.5 mm (double amplitude)
17.7 to 60 Hz	8 g peak

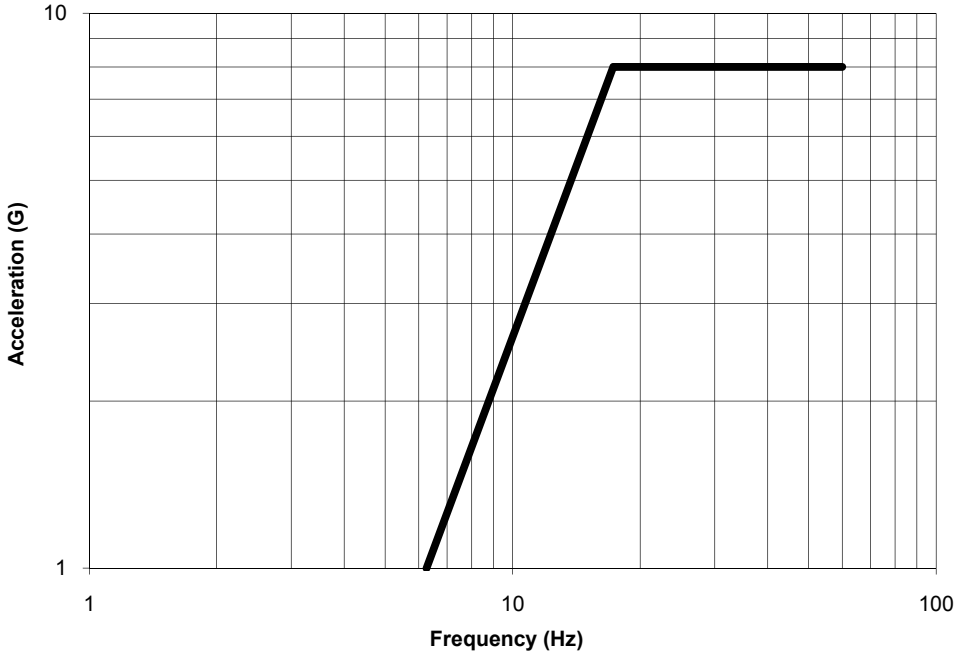


Figure 4.2.7.2.2-1. Sinusoidal Test Levels

4.2.7.2.3 Design Strength Testing

IF235845 Instruments whose fundamental structural modes of vibration are demonstrated by test to be above 50 Hz shall be tested in each of three axes to loads generated by applying the test factors given in Table 3.3.12.4.1-1.

IF235850 Instruments with fundamental modes of vibration below 50 Hz shall apply an additional factor of 1.5 to portions of the structure whose motion in the mode of vibration exceeds the motion of the centroid.

The factor of 1.5 may be linearly varied (reduced) along the structure to 1.0 at the centroid. The loads may be applied by acceleration testing, static load testing, or vibration testing.

IF235855 When a coupled loads analysis of the flight configuration is available, it shall be verified that the predicted loads times the test factor given in Table 3.3.12.4.1-1 are within the tested loads.

IF235860 The analysis shall be based upon test-verified dynamic models of the instrument for any instruments whose fundamental modes of vibration fall below 50 Hz.

4.2.7.3 Reserved

4.2.7.4 Shock Testing

Testing for externally induced shocks (spacecraft separation, solar array deployment, etc.) is typically accomplished at the spacecraft level.

4.2.7.4.1 General

Shock testing will be performed at the spacecraft level for payload attach fitting separation shocks, solar array deployment shocks, appendage deployment shocks, and instrument-induced shocks - if any. However, if an instrument has pyrotechnic devices onboard, then shock testing is also to be performed at the instrument level prior to delivery for integration with the spacecraft.

IF235895 Instruments shall be tested on the spacecraft for externally induced shocks .

4.2.7.4.2 Instrument Level Self-Induced Shock Testing

IF235910 Instrument self-induced shock testing shall be accomplished by two actuations at the instrument level for each self-induced shock source (in order to account for the scatter associated with the actuation of the device), for the first flight unit, and a single actuation on subsequent units.

4.2.7.5 Acoustic Testing

IF235935 Instrument acoustic testing shall be performed for instruments with large surfaces (units with surface-to-mass ratio greater than 2333 cm^2/kg (150 in^2/lb)), which could be excited by the acoustic field directly and for instruments greater than 180 kg.

4.2.7.5.1 Acceptance Level Acoustic Testing

IF235915 The acceptance test acoustics levels shall be as defined in Table 3.2.6.2.5-1.

IF235920 The acceptance test duration shall be one minute.

4.2.7.5.2 ProtoflightLevel Acoustic Testing

IF235925 The protoflight test levels shall be the levels shown in Table 3.2.6.2.5-1 increased by 3 dB.

IF235930 The protoflight test duration shall be one minute.

4.2.7.6 Thermal Testing

IF235940 Thermal vacuum testing shall be performed in accordance with MIL-STD-1540C using the environmental temperature ranges specified in Section 3.2.4.7.4.

IF235945 Thermal cycle testing shall be performed in accordance with MIL-STD-1540C using the environmental temperature ranges specified in Section 3.2.4.7.4.

IF235950 Thermal balance testing shall be performed on the first production unit in accordance with MIL-STD-1540C using the environmental temperature ranges specified in Section 3.2.4.7.4.

This requirement is not applicable if a test-verified thermal model is delivered.

4.2.8 EMC/EMI Testing

IF236005 Electromagnetic verification testing shall be conducted in accordance with MIL-STD-461E, except that CS109, CS115 and RS105 do not apply.

IF236070 For conducted emissions testing, the line impedance stabilization network in MIL-STD-461E shall be tailored, as necessary, to be more representative of the satellite power bus impedance.

IF236075 The radiated emission measurement bandwidths and frequency steps in MIL-STD-461E shall be reduced as necessary to show compliance with the search and rescue receiver notches

IF236080 The instrument contractor shall perform electromagnetic testing to verify that the instrument operates properly if subjected to conducted or radiated emissions from maximum expected sources both internal and external to the satellite, and to verify that the design of the instrument does not result in deleterious conducted or radiated signals that might affect other mission elements. Instruments that fail to meet all MIL-STD-461E requirements may be suitable for flight if detailed analysis and system-level EMI/EMC testing shows no impact on mission operations.

IF236085 The instrument contractor shall perform conducted and radiated tests on the instrument, operating with expected power levels, current, and data rates.

IF236090 Compliance with the EMC performance and design requirements of this document shall be demonstrated by utilizing one or any combination of the verification methods described in the following paragraphs.

IF236095 System level analyses shall be performed during phases of the program to support design development, verification, and pre-launch processing controls, and launch criteria.

IF236100 Instrument charging verification shall be conducted in accordance with MIL-STD-1541A, as tailored.

IF236105 The instrument contractor shall verify that their instrument does not impact the Search and Rescue mission during any mode by verifying that the requirements of Tables of Tables B-3, B-4, and B-5 of Appendix B are met.

IF236110 Unintentional radiated emission measurements in the SAR and ADCS receiver bands shall be made in accordance with MIL-STD-461E RE102 with the EMI meter replaced by a spectrum analyzer preceded by a low-noise preamplifier such that the test system noise figure is ≤ 3 dB.

IF236010 The instrument under test and associated clock and control signals shall have power applied and the difference in the spectrum analyzer levels shall be noted for both white noise and spurious signals.

IF236015 The spectrum analyzer shall be tuned to the center of each of the frequency bands specified in Section 3.3.2.2.5.2

IF236025 The noise floor of the measuring equipment shall be verified to be lower than the specified maximum signal level in a 100 Hz resolution bandwidth.

IF236030 Radiated emissions testing, RE102, shall be from 10 kHz to 18 GHz .

IF236050 For radiated susceptibility measurements, the test shall demonstrate the spacecraft and components can meet their performance objectives while exposed to the specified levels. Modulation of the applied susceptibility signal is required, simulating as closely as possible the modulation characteristics of the known emitter.

IF236060 If the appropriate modulation has not been established by hardware design or mission scenario, the test method of MIL-STD-461E RS103 shall be used.

IF236065 The EMI test levels and frequency range shall be increased if it is known that onboard telemetry systems or other signals in space, such as ground based radars (which are known to produce signals in space in excess of 2 V/m at frequencies at least as low as 400 MHz), could expose the spacecraft and instruments to higher levels than the standard tests.

4.2.9 Current Margin Testing

IF236115 For deployment circuits, the spacecraft contractor shall demonstrate that electrical current margins on non-explosive initiator circuits will be met.

4.2.10 Deployment Testing

IF236120 Mechanisms and deployment and latching devices shall be tested to demonstrate adequate functioning following exposure to the environments in this document, following NASA STD 5017.

AIAA S114-2005 should be used as a guide.

4.2.11 Reserved

4.2.12 Reserved

4.2.13 Reserved

4.2.14 Reserved

4.3 RESERVED

4.3.1 Reserved

4.3.2 Reserved

4.4 VERIFICATION CROSS REFERENCE

The applicability (to instrument/spacecraft/satellite) and verification method for each requirement, starting with section 3, is specified in the GIID Verification Matrix which is part of each individual instrument ICD.

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5 APPENDICES

APPENDIX A. Spacecraft-Satellite Applicability

Paragraph	Title	Reqt. ID	S/C or Satellite Applicable	Comment
3.5.3	Packaging, Handling, Storage, and Transportation (PHS&T)	IF221842	NA	
3.1.3	Instrument Modes/functionalities	IF230000	NA	
3.1.3	Instrument Modes/functionalities	IF230005	NA	
3.1.3	Instrument Modes/functionalities	IF230010	NA	
3.1.3	Instrument Modes/functionalities	IF230015	NA	
3.1.3	Instrument Modes/functionalities	IF230020	NA	
3.1.3	Instrument Modes/functionalities	IF230025	NA	
3.1.3	Instrument Modes/functionalities	IF230030	NA	
3.1.3	Instrument Modes/functionalities	IF230035	NA	
3.1.3	Instrument Modes/functionalities	IF230055	NA	
3.1.3	Instrument Modes/functionalities	IF230060	NA	Needs to be verified by Instrument prior to delivery
3.1.3.1	OFF Mode	IF230065	applicable	
3.1.3.1	OFF Mode	IF230070	NA	
3.1.3.2	Activation	IF230090	NA	
3.1.3.3	EARLY ORBIT CHECKOUT	IF230095	NA	
3.1.3.4	OPERATIONAL Mode	IF230100	NA	
3.1.3.4	OPERATIONAL Mode	IF230105	applicable	
3.1.3.4	OPERATIONAL Mode	IF230110	NA	
3.1.3.5	DIAGNOSTIC Mode	IF230115	NA	
3.1.3.6.1	INSTRUMENT SAFE Mode	IF230125	NA	
3.1.3.6.1	INSTRUMENT SAFE Mode	IF230140	NA	
3.1.3.6.1	INSTRUMENT SAFE Mode	IF230145	NA	
3.1.3.6.1	INSTRUMENT SAFE Mode	IF230150	NA	Requirement is covered for S/C by IF230175
3.1.3.6.1	INSTRUMENT SAFE Mode	IF230155	NA	
3.1.3.6.1	INSTRUMENT SAFE Mode	IF230165	NA	
3.1.3.6.1	INSTRUMENT SAFE Mode	IF230170	NA	
3.1.3.6.2	SPACECRAFT SAFE Mode	IF230175	applicable	
3.1.3.6.2	SPACECRAFT SAFE Mode	IF230180	NA	

3.1.3.6.2	SPACECRAFT SAFE Mode	IF230185	NA	
			NA	
			NA	
			NA	
			NA	
3.1.3.6.2	SPACECRAFT SAFE Mode	IF230190	NA	
3.1.3.7	SURVIVAL Mode	IF230195	applicable	
3.1.3.7	SURVIVAL Mode	IF230200	NA	
3.1.3.7	SURVIVAL Mode	IF230205	applicable	
3.1.3.7	SURVIVAL Mode	IF230210	applicable	
3.1.3.7	SURVIVAL Mode	IF230215	applicable	
3.1.3.7	SURVIVAL Mode	IF230220	NA	
3.1.3.7	SURVIVAL Mode	IF230225	applicable	
3.1.4.2	Launch and Injection	IF230255	applicable	
3.1.4.3	On-orbit Operational Concept	IF230270	applicable	
3.1.4.3	On-orbit Operational Concept	IF230275	applicable	
3.1.3.7	SURVIVAL Mode	IF230285	NA	
3.2.1	General	IF230295	NA	
3.2.4.1.1	Instrument Mass Properties Documentation	IF230320	NA	
3.2.4.1.3.1	Center of Mass Location	IF230340	NA	
3.2.4.1.3.1	Center of Mass Location	IF230350	NA	
3.2.4.1.4.1	Moments and Products of Inertia Measurement	IF230355	NA	
3.2.4.1.4.2	Moments and Products of Inertia Accuracy	IF230360	NA	
3.2.4.2	Mechanical Requirements	IF230395	applicable	
3.2.4.2.1	Dimensions	IF230400	applicable	
3.2.4.2.1	Dimensions	IF230405	applicable	
3.2.4.2.1	Dimensions	IF230410	applicable	
3.2.4.2.1	Dimensions	IF230415	applicable	
3.2.4.2.2	Spacecraft Body Frame	IF230430	NA	Covered in SRS for S/C
3.2.4.2.3.1	Stowed and Critical Clearances	IF230435	applicable	New requirement on S/C vs. NPP
3.2.4.2.3.1	Stowed and Critical Clearances	IF230445	applicable	
3.2.4.2.3.2.1	Mounting Method	IF230475	applicable	
3.2.4.2.3.2.1	Mounting Method	IF230485	NA	
3.2.4.2.3.2.3.1	Drill Template Usage	IF230505	applicable	
3.2.4.2.3.2.6	Special Mounts	IF230630	NA	

3.2.4.2.3.3.4	Alignment Control	IF230677	applicable	
3.2.4.2.3.3.5.3	Spacecraft Attitude Control	IF230685	applicable	
3.2.4.2.3.3.2	Installation Alignment References	IF230690	NA	
3.2.4.2.3.3.2	Installation Alignment References	IF230705	NA	
3.2.4.2.3.3.2	Installation Alignment References	IF230710	NA	
3.2.4.2.3.3.2	Installation Alignment References	IF230715	NA	
3.2.4.2.3.3.2	Installation Alignment References	IF230720	NA	
3.2.4.2.3.3.2	Installation Alignment References	IF230725	NA	
3.2.4.2.3.3.2	Installation Alignment References	IF230730	NA	
3.2.4.2.3.3.2	Installation Alignment References	IF230735	NA	
3.2.4.2.3.3.3	Alignment Knowledge	IF230755	applicable	
3.2.4.2.3.3.3	Alignment Knowledge	IF230760	applicable	
3.2.4.2.3.3.5.1	Spacecraft Attitude Knowledge	IF230780	applicable	
3.2.4.2.3.3.5.3	Spacecraft Attitude Control	IF230790	NA	
3.2.4.2.3.3.5.3	Spacecraft Attitude Control	IF230795	NA	
3.2.4.2.3.3.5.3	Spacecraft Attitude Control	IF230796	applicable	
3.2.4.2.3.3.5.3	Spacecraft Attitude Control	IF230797	applicable	
3.2.4.2.3.3.6	Spacecraft Position Knowledge	IF230802	applicable	
3.2.6.3.2	Rotation	IF230805	applicable	
3.2.4.3.1.2.1.2	Survival Power Allocation	IF230836	NA	
3.2.4.3.1.3.1	Power Connections	IF230890	applicable	
3.2.4.3.1.3.1	Power Connections	IF230900	NA	
3.2.4.3.1.4	Power Application	IF230905	applicable	
3.2.4.3.1.4.1	Power Fault Tolerance	IF230910	applicable	
3.2.4.3.1.4.2	Instrument Heater Power Separation	IF230915	NA	
3.2.4.3.1.4.2	Instrument Heater Power Separation	IF230916	NA	
3.2.4.3.1.4.2	Instrument Heater Power Separation	IF230917	applicable	
3.2.4.3.1.4.4	Instrument External (Spacecraft) Power	IF230930	NA	
3.2.4.3.1.4.4	Instrument External (Spacecraft) Power	IF230935	applicable	
3.2.4.3.1.4.4	Instrument External (Spacecraft) Power	IF230940	NA	
3.2.4.3.1.5.1.2	Reflected Ripple	IF230955	NA	
3.2.4.3.1.5.1.2	Reflected Ripple	IF230960	NA	
3.2.4.3.1.5.1.2	Reflected Ripple	IF230964	applicable	To be verified at unit level (PCDU). Don't want to break connection during system level EMI/EMC.
3.2.4.3.1.5.1.2	Reflected Ripple	IF230965	NA	

3.2.4.3.1.5.2.1	Voltage Transients	IF230975	applicable	
3.2.4.3.1.5.2.1	Voltage Transients	IF230985	NA	
3.2.4.3.1.5.2.1	Voltage Transients	IF230986	NA	
3.2.4.3.1.5.2.2	Current Transients	IF230990	NA	
3.2.4.3.1.5.2.2	Current Transients	IF230995	NA	
3.2.4.3.1.5.2.2.1	Instrument Turn-on Transients	IF231000	NA	
3.2.4.3.1.5.2.2.1	Instrument Turn-on Transients	IF231025	NA	
3.2.4.3.1.5.2.2.1	Instrument Turn-on Transients	IF231030	NA	
3.2.4.3.1.5.2.2.2	Instrument Turn-off Transients	IF231050	NA	
3.2.4.3.1.5.2.2.2	Instrument Turn-off Transients	IF231065	NA	
3.2.4.3.1.5.2.2.2	Instrument Turn-off Transients	IF231070	NA	
3.2.4.3.1.5.2.2.3	Instrument Operational Transients	IF231075	NA	
3.2.4.3.1.5.2.2.3	Instrument Operational Transients	IF231085	NA	
3.2.4.3.1.5.3	Abnormal Operation Voltage Limits	IF231100	NA	
3.2.4.3.1.5.3	Abnormal Operation Voltage Limits	IF231101	NA	
3.2.4.3.1.5.4	Impedance	IF231105	applicable	
3.2.4.3.1.5.5	Survival Heater Bus	IF231115	applicable	
3.2.4.3.1.5.5	Survival Heater Bus	IF231120	NA	
3.2.4.3.1.5.5	Survival Heater Bus	IF231125	NA	
3.2.4.3.1.5.5	Survival Heater Bus	IF231130	NA	
3.2.4.3.1.5.5	Survival Heater Bus	IF231140	NA	
3.2.4.3.1.5.5	Survival Heater Bus	IF231155	NA	
3.2.4.3.1.5.5	Survival Heater Bus	IF231160	applicable	
3.2.4.3.1.5.6	Safety Bus Operation	IF231165	NA	
3.2.4.3.1.5.7	Overcurrent Protection Device Size	IF231185	applicable	
3.2.4.3.1.5.7	Overcurrent Protection Device Size	IF231190	NA	
3.2.4.3.1.5.7	Overcurrent Protection Device Size	IF231195	NA	
3.2.4.3.1.5.7	Overcurrent Protection Device Size	IF231200	NA	
3.2.4.3.1.6	Unannounced Removal of Power	IF231205	applicable	Applicable only for demonstration at satellite level--not a S/C requirement.
3.2.4.3.1.7	Instrument High-Voltage Restriction	IF231210	NA	
3.2.4.3.1.7	Instrument High-Voltage Restriction	IF231215	NA	
3.2.4.3.1.7	Instrument High-Voltage Restriction	IF231220	NA	
3.2.4.3.2.1	Grounding Responsibility	IF231230	applicable	
3.2.4.3.2.1	Grounding Responsibility	IF231235	applicable	
3.2.4.3.2.2	General	IF231240	applicable	
3.2.4.3.2.2	General	IF231250	NA	

3.2.4.3.2.2	General	IF231260	applicable	Some tailoring expected in Instrument ICDs.
3.2.4.3.2.3	Power Returns	IF231265	NA	
3.2.4.3.2.3	Power Returns	IF231270	NA	
3.2.4.3.2.3	Power Returns	IF231275	applicable	
3.2.4.3.2.3	Power Returns	IF231285	NA	
3.2.4.3.2.3	Power Returns	IF231290	applicable	
3.2.4.3.2.3	Power Returns	IF231295	NA	
3.2.4.3.2.3	Power Returns	IF231305	NA	
3.2.4.3.2.3	Power Returns	IF231310	applicable	
3.2.4.3.2.4	Signal Reference	IF231320	NA	
3.2.4.3.2.4	Signal Reference	IF231330	NA	
3.2.4.3.2.4	Signal Reference	IF231335	applicable	
3.2.4.3.2.5	Chassis Ground	IF231345	applicable	
3.2.4.3.2.5	Chassis Ground	IF231350	NA	
3.2.4.3.2.5	Chassis Ground	IF231355	applicable	
3.2.4.3.2.5	Chassis Ground	IF231365	NA	NA because S/C bonding requirements are documented in EMI/EMC control plan, 549553
3.2.4.3.2.5	Chassis Grounding	IF231370	NA	NA because S/C bonding requirements are documented in EMI/EMC control plan, 549553
3.2.4.3.2.5	Chassis Grounding	IF231375	NA	NA because S/C bonding requirements are documented in EMI/EMC control plan, 549553

3.2.4.3.2.5	Chassis Grounding	IF231380	NA	NA because S/C bonding requirements are documented in EMI/EMC control plan, 549553
3.2.4.3.2.5	Chassis Grounding	IF231385	NA	NA because S/C bonding requirements are documented in EMI/EMC control plan, 549553
3.2.4.3.2.5	Chassis Ground	IF231390	NA	NA because S/C bonding requirements are documented in EMI/EMC control plan, 549553
3.2.4.3.2.5	Chassis Ground	IF231400	NA	NA because S/C bonding requirements are documented in EMI/EMC control plan, 549553
3.2.4.3.2.5	Chassis Ground	IF231405	NA	NA because S/C bonding requirements are documented in EMI/EMC control plan, 549553
3.2.4.3.2.6	External Ground Tie Point	IF231410	NA	
3.2.4.3.2.7	Thermal Blanket Grounding	IF231420	NA	NA because this requirement is flowed to the S/C in the SRS (3.2.19)
3.2.4.3.3.1.1	General Considerations	IF231445	applicable	
3.2.4.3.3.1.1	General Considerations	IF231465	applicable	
3.2.4.3.3.1.1	General Considerations	IF231470	applicable	
3.2.4.3.3.1.1	General Considerations	IF231475	NA	
3.2.4.3.3.1.1	General Considerations	IF231485	applicable	
3.2.4.3.3.1.2	Connector Location and Types	IF231490	NA	

3.2.4.3.3.1.4	Flight Plugs	IF231505	NA	
3.2.4.3.3.1.6	Buffer Connectors and Connector Savers	IF231530	NA	
3.2.4.3.3.1.6	Buffer Connectors and Connector Savers	IF231535	NA	
3.2.4.3.3.1.7	Test Connectors	IF231545	NA	
3.2.4.3.3.1.7	Test Connectors	IF231550	NA	
3.2.4.3.3.1.7	Test Connectors	IF231555	applicable	
3.2.4.3.3.1.7	Test Connectors	IF231560	NA	
3.2.4.3.3.1.7	Test Connectors	IF231565	NA	
3.2.4.3.3.1.7	Test Connectors	IF231570	NA	
3.2.4.3.3.1.7	Test Connectors	IF231575	NA	
3.2.4.3.3.1.7	Test Connectors	IF231580	NA	
3.2.4.3.3.2	Wiring	IF231590	applicable	
3.2.4.3.3.2.3	Harness Wiring Requirements	IF231630	applicable	
3.2.4.3.3.2.3	Harness Wiring Requirements	IF231655	applicable	
3.2.4.3.3.2.3	Harness Wiring Requirements	IF231670	applicable	
3.2.4.3.3.2.3	Harness Wiring Requirements	IF231675	applicable	
3.2.4.3.3.2.3	Harness Wiring Requirements	IF231680	applicable	
3.2.4.3.3.2.3	Harness Wiring Requirements	IF231690	applicable	
3.2.4.3.3.2.3	Harness Wiring Requirements	IF231695	applicable	
3.2.4.5	Parts, Materials, and Processes	IF231720	NA	
3.2.4.5	Parts, Materials, and Processes	IF231725	NA	NA because S/C has no beryllium.
3.2.6.1.7	Orbital Spacecraft Charging	IF231735	NA	NA because S/C charging requirements are in SRS.
3.2.4.7.1	General	IF231790	applicable	
3.2.4.7.1	General	IF231795	NA	
3.2.4.7.1	General	IF231800	NA	
3.2.4.7.1	General	IF231805	NA	
3.2.4.7.1	General	IF231810	NA	
3.2.4.7.2	Thermal Recovery	IF231815	NA	
3.2.4.7.2	Thermal Recovery	IF231820	NA	
3.2.4.7.3.1	Heat Transfer To Spacecraft	IF231825	applicable	
3.2.4.7.3.1	Heat Transfer To Spacecraft	IF231840	NA	
3.2.4.7.3.1	Heat Transfer To Spacecraft	IF231850	NA	

3.2.4.7.3.2	Integrated Instrument Thermal Environments	IF231865	applicable	
3.2.4.7.3.2.2	Environmental Heat Flux	IF231870	applicable	
3.2.4.7.3.2.2	Spacecraft IR Backload Heat Flux	IF231875	applicable	
3.2.4.7.3.2.1	Environmental Heat Flux	IF231880	applicable	
3.2.4.7.4.1	Interface Temperature Range	IF231885	applicable	
3.2.4.7.4.1	Interface Temperature Range	IF231890	NA	
3.2.4.7.4.1	Interface Temperature Range	IF231891	applicable	
3.2.4.7.4.1	Interface Temperature Range	IF231895	NA	
3.2.4.7.4.2	Thermal Uncertainty Margins	IF231915	NA	These requirements are flowed to the S/C via MAR/GEVS
3.2.4.7.5.1	Mechanical Mounting Interface Temperature Monitoring	IF231920	applicable	
3.2.4.7.5.2	Instrument Temperature Monitoring	IF231925	NA	
3.2.4.7.6.1	Thermal Control Hardware	IF231945	applicable	
3.2.4.7.6.2	Survival Heaters	IF231950	NA	
3.2.4.7.6.2	Survival Heaters	IF231955	NA	
3.2.4.7.6.2	Survival Heaters	IF231960	NA	
3.2.4.7.6.2	Survival Heaters	IF231965	NA	
3.2.4.7.6.4	Other Considerations	IF231995	NA	
3.2.4.7.6.5	Ambient Tests	IF232000	NA	
3.2.4.7.6	Thermal Control Design	IF232010	NA	
3.2.4.7.6	Thermal Control Design	IF232015	NA	
3.2.4.8	Command and Data Handling	IF232020	NA	
3.2.4.8	Command and Data Handling	IF232021	NA	
3.2.4.8.1	Common Electrical Interface	IF232025	applicable	
3.2.4.8.1.1	Interface Conductors	IF232030	NA	Covered for S/C in EMC/Control Plan
3.2.4.8.1.2	Interface Circuitry Isolation	IF232035	NA	
3.2.4.8.2.1	Bus Functions	IF232050	NA	
3.2.4.8.2.1	Bus Functions	IF232060	applicable	
3.2.4.8.2.1	Bus Functions	IF232065	applicable	
3.2.4.8.3.2	IEEE 1394a Interface Characteristics	IF232080	applicable	
3.2.4.8.3.3	Pulse Commands	IF232095	NA	
3.2.4.8.3.3	Pulse Commands	IF232100	NA	
3.2.4.8.3.3	Pulse Commands	IF232105	NA	Not a stand-alone requirement, only says to comply

				with following requirements.
3.2.4.8.3.3	Pulse Commands	IF232110	applicable	
3.2.4.8.3.3	Pulse Commands	IF232115	applicable	
3.2.4.8.3.3	Pulse Commands	IF232120	applicable	
3.2.4.8.3.3	Pulse Commands	IF232125	applicable	
3.2.4.8.3.3	Pulse Commands	IF232130	applicable	
3.2.4.8.3.3	Pulse Commands	IF232135	applicable	
3.2.4.8.3.3	Pulse Commands	IF232145	NA	Intent of this is covered by SRS for S/C.
3.2.4.8.3.3	Pulse Commands	IF232150	NA	
3.2.4.8.3.3	Pulse Commands	IF232155	NA	NPP Waiver--no S/C capability to meet this requirement--needs Ops constraint.
3.2.4.8.3.4	Time of Day Pulse	IF232160	applicable	
3.2.4.8.3.4	Time of Day Pulse	IF232165	NA	
3.2.4.8.3.4	Time of Day Pulse	IF232170	applicable	
3.2.4.8.3.4	Time of Day Pulse	IF232175	applicable	
3.2.4.8.3.4	Time of Day Pulse	IF232180	applicable	
3.2.4.8.3.4	Time of Day Pulse	IF232185	applicable	
3.2.4.8.3.4	Time of Day Pulse	IF232190	applicable	
3.2.4.8.3.4	Time of Day Pulse	IF232195	applicable	
3.2.4.8.3.5	Synchronization	IF232200	NA	NA for NPP, data bus synchronization not used. Synchronization is performed only by use of RS-422 synch pulses (see IF232205)
3.2.4.8.3.5	Synchronization	IF232205	applicable	Sync pulse requirement applies, like NPP

3.2.4.8.3.5	Synchronization	IF232210	NA	Not a requirement for NPP, data bus synchronization not used.
3.2.4.8.4	Instrument Commands and Data Load	IF232220	NA	
3.2.4.8.4.1.1	Real-time Ground Commands	IF232225	NA	
3.2.4.8.4.1.2	Stored Commands	IF232240	applicable	
3.2.4.8.4.1.3	Command Uniqueness	IF232250	NA	
3.2.4.8.4.1.4	Command Sequence	IF232255	NA	
3.2.4.8.4.1.5	Command Restraints	IF232260	NA	
3.2.4.8.4.1.5	Command Restraints	IF232265	NA	
3.2.4.8.4.1.5	Command Restraints	IF232275	NA	
3.2.4.8.4.1.5	Command Restraints	IF232280	NA	
3.2.4.8.4.1.5	Command Restraints	IF232285	NA	
3.2.4.8.4.2	Command and Data Load Packets	IF232290	applicable	
3.2.4.8.4.2	Command and Data Load Packets	IF232300	applicable	
3.2.4.8.4.2	Command and Data Load Packets	IF232305	applicable	
3.2.4.8.4.5	Critical Command	IF232315	applicable	
3.2.4.8.4.5	Critical Command	IF232320	NA	
3.2.4.8.4.6	Squib Commands	IF232330	NA	
3.2.4.8.4.6	Squib Commands	IF232335	NA	
3.2.4.8.5.1	Telemetry Diagnostic Data	IF232345	NA	
3.2.4.8.5.1	Telemetry Diagnostic Data	IF232350	NA	
3.2.4.8.5.1	Telemetry Diagnostic Data	IF232360	NA	
3.2.4.8.5.1	Telemetry Diagnostic Data	IF232365	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232370	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232375	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232380	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232390	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232395	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232400	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232405	NA	
			NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232410	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232415	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232420	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232425	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232426	NA	
3.2.4.8.5.2	Point-to-Point Telemetry	IF232427	NA	

3.2.4.8.5.2	Point-to-Point Telemetry	IF232428	applicable	
3.2.4.8.5.3	Command Verification	IF232430	NA	
3.2.4.8.5.3	Command Verification	IF232435	NA	
3.2.4.8.5.3	Command Verification	IF232445	applicable	
3.2.4.8.5.4	Instrument Memory Dump	IF232450	NA	
3.2.4.8.5.4	Instrument Memory Dump	IF232455	NA	
3.2.4.8.5.4	Instrument Memory Dump	IF232460	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232475	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232480	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232485	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232490	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232495	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232500	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232505	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232510	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232520	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232525	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232530	NA	
3.2.4.8.5	Instrument Health and Status Telemetry	IF232535	NA	
3.2.4.8.6	Mission Data	IF232545	NA	
3.2.4.8.6	Mission Data	IF232550	NA	
3.2.4.8.6	Mission Data	IF232560	NA	
3.2.4.8.7	Data Packetization	IF232565	NA	
3.2.4.8.7	Data Packetization	IF232566	NA	
3.2.4.8.7	Data Packetization	IF232570	NA	
3.2.4.8.7	Data Packetization	IF232575	NA	
3.2.4.8.7	Data Packetization	IF232580	NA	
3.2.4.8.7	Data Packetization	IF232585	applicable	
3.2.4.8.7	Data Packetization	IF232590	NA	
3.2.4.8.7	Data Packetization	IF232600	NA	
3.2.4.8.7	Data Packetization	IF232610	NA	
3.2.4.8.8	Command & Data Interface Test Packets	IF232620	NA	
3.2.4.8.8	Command & Data Interface Test Packets	IF232621	NA	

3.2.4.8.8	Command & Data Interface Test Packets	IF232625	NA	
3.2.4.8.8	Command & Data Interface Test Packets	IF232630	NA	
3.2.4.8.8	Command & Data Interface Test Packets	IF232635	NA	
3.2.4.8.8	Command & Data Interface Test Packets	IF232640	NA	
3.2.4.8.8	Command & Data Interface Test Packets	IF232645	NA	
3.2.4.8.8	Command & Data Interface Test Packets	IF232650	NA	
3.2.5.1.1	Operational Service Life	IF232660	NA	
3.2.5.1.1	Operational Service Life	IF232665	NA	
3.2.5.1.1	Operational Service Life	IF232670	NA	
3.2.5.1.1	Operational Service Life	IF232675	NA	
3.2.5.1.2	Maintainability	IF232680	NA	
3.2.5.1.2	Maintainability	IF232685	NA	
3.2.5.1.2	Maintainability	IF232690	NA	
3.2.5.1.2	Maintainability	IF232710	NA	
3.2.5.1	Reliability	IF232730	NA	
3.2.5.1	Reliability	IF232735	NA	
3.2.6.1	Natural Environment Characteristics	IF232740	NA	
3.2.6.1.1	Total Ionizing Dose Environment	IF232745	NA	
3.2.6.1.1	Total Ionizing Dose Environment	IF232755	NA	
3.2.6.1.1	Total Ionizing Dose Environment	IF232760	NA	
3.2.6.1.1	Total Ionizing Dose Environment	IF232765	NA	
3.2.6.1.1	Total Ionizing Dose Environment	IF232770	NA	
3.2.6.1.1	Total Ionizing Dose Environment	IF232775	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232780	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232785	NA	

3.2.6.1.2.1	Single Events Radiation Environment	IF232790	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232795	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232800	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232805	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232806	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232807	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232808	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232809	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232810	NA	
3.2.6.1.2.1	Single Events Radiation Environment	IF232811	NA	
3.2.6.1.2.1.1	Galactic Cosmic Ray (GCR) Linear Energy Transfer (LET) Spectrum	IF232815	NA	
3.2.6.1.2.1.1	Galactic Cosmic Ray (GCR) Linear Energy Transfer (LET) Spectrum	IF232820	NA	
3.2.6.1.2.1.1	Galactic Cosmic Ray (GCR) Linear Energy Transfer (LET) Spectrum	IF232825	NA	
3.2.6.1.2.1.2	High Energy Proton Fluence	IF232830	NA	
3.2.6.1.2.1.2	High Energy Proton Fluence	IF232835	NA	
3.2.6.1.2.1.2	High Energy Proton Fluence	IF232840	NA	
3.2.6.1.2.1.2	High Energy Proton Fluence	IF232845	NA	
3.2.6.1.2.2	Displacement Damage	IF232860	NA	
3.2.6.1.2.2	Displacement Damage	IF232865	NA	
3.2.6.1.2.2	Displacement Damage	IF232870	NA	
3.2.6.1.6	Atomic Oxygen	IF232880	NA	
3.2.6.1.7	Orbital Spacecraft Charging	IF232885	NA	
3.2.6.1.3	Meteoroid and Debris Environments	IF232895	NA	
3.2.6.2.1.1	Temperatures	IF232905	applicable	
3.2.6.2.1.2	Free Molecular Heating	IF232910	NA	
3.2.6.2.1.2	Free Molecular Heating	IF232911	NA	
3.2.6.2.2	Shock	IF232930	NA	
3.2.6.2.5	Acoustics	IF232940	NA	
3.2.6.2.6	Launch Pressure Decay	IF232950	NA	
3.2.6.3.1	Acceleration	IF232960	NA	
3.2.7	Transportability	IF232975	NA	
3.2.8.1.1.5	Data Processing Software/Firmware	IF233030	NA	Covered for S/C in MAR/Gold Rules.
3.3.2.1	Electromagnetic Interference (EMI) Filtering of Spacecraft Power	IF233120	NA	
3.3.2.2.5.6	Conducted Susceptibility (CS)	IF233140	NA	

3.3.2.2.2.1	General	IF233245	NA	Covered for S/C in EMC/Control Plan
			NA	
3.3.2.2.2.2	Interface Margins	IF233265	NA	NA, because there are no EEDs on the S/C
3.3.2.2.3.1	External RF Environment	IF233270	NA	
3.3.2.2.3.1	External RF Environment	IF233290	NA	
3.2.6.1.7	Orbital Spacecraft Charging	IF233300	NA	
3.2.6.1.7	Orbital Spacecraft Charging	IF233301	NA	
3.2.6.1.7	Orbital Spacecraft Charging	IF233302	NA	
3.2.6.1.7	Orbital Spacecraft Charging	IF233303	NA	
3.2.6.1.7	Orbital Spacecraft Charging	IF233304	NA	Covered for S/C in SRS 3.2.19.
3.2.6.1.7	Orbital Spacecraft Charging	IF233306	NA	
3.2.6.1.7	Orbital Spacecraft Charging	IF233310	NA	Covered for S/C in SRS 3.2.19.
3.2.6.1.7	Orbital Spacecraft Charging	IF233315	NA	Covered for S/C in SRS 3.2.19.
3.2.6.1.7	Orbital Spacecraft Charging	IF233320	NA	Covered for S/C in SRS 3.2.19.
3.2.6.1.7	Orbital Spacecraft Charging	IF233325	NA	Covered for S/C in SRS 3.2.19.
3.2.6.1.7	Orbital Spacecraft Charging	IF233330	NA	Covered for S/C in SRS 3.2.19.
3.2.6.1.7	Orbital Spacecraft Charging	IF233335	NA	Covered for S/C in SRS 3.2.19.
3.2.6.1.7	Orbital Spacecraft Charging	IF233340	NA	Covered for S/C in SRS 3.2.19.
3.3.2.2.5	Conducted and Radiated Interface Requirements	IF233355	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
3.3.2.2.5.6	Conducted Susceptibility (CS)	IF233360	NA	
3.3.2.2.5.6	Conducted Susceptibility (CS)	IF233365	NA	
3.3.2.2.5.1	Magnetic Fields (RE101)	IF233370	NA	
3.3.2.2.5.1	Magnetic Fields (RE101)	IF233371	NA	

3.3.2.2.5.2	Electric Field Radiated Emissions, RE102	IF233375	applicable	NPP Waiver NPP003A. BATC will need same waiver/ exception.
3.3.2.2.5.2	Electric Field Radiated Emissions, RE102	IF233380	NA	
3.3.2.2.5.2	Electric Field Radiated Emissions, RE102	IF233390	NA	
3.3.2.2.5.2	Electric Field Radiated Emissions, RE102	IF233455	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
3.3.2.2.5.2	Electric Field Radiated Emissions, RE102	IF233470	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
3.3.2.2.5.2	Electric Field Radiated Emissions, RE102	IF233475	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
3.3.2.2.5.3	Radiated Susceptibility, RS101	IF233480	NA	
3.3.2.2.5.3	Radiated Susceptibility, RS101	IF233481	NA	
3.3.2.2.5.4	Radiated Susceptibility RS103	IF233485	NA	
3.3.6.1	Design Safety Criteria	IF233545	applicable	
3.3.6.1	Design Safety Criteria	IF233555	applicable	
3.2.4.3.1.4.4	Design Safety Criteria	IF233565	applicable	
3.3.6.1	Design Safety Criteria	IF233595	applicable	
3.3.9.1	Communications Security (COMSEC)	IF233690	NA	
3.3.9.1	Communications Security (COMSEC)	IF233695	NA	
3.3.11.1.3.1.2	Instrument Flight Software Load	IF233715	NA	
3.3.11.1.3.1.3	Instrument Flight Software On-Orbit Installation and Verification	IF233725	NA	
3.3.11.1.4	Software Coding Conventions	IF233735	NA	
3.3.11.2	Instrument GSE to Spacecraft I&T GSE Interface	IF233755	NA	
3.3.11.2	Instrument GSE to Spacecraft I&T GSE Interface	IF233760	NA	
3.3.11.2	Instrument GSE to Spacecraft I&T GSE Interface	IF233765	applicable	
3.3.12.3.3	Component Stiffness	IF233825	NA	

3.3.12.3.3	Component Stiffness	IF233845	NA	
3.3.12.4.1	Flight Limit Loads	IF233885	NA	
3.3.12.4.2	Pressure Loads	IF233910	NA	
3.3.12.7.3	Instrument Mechanisms	IF234000	NA	
3.3.12.7.3	Instrument Mechanisms	IF234005	NA	
3.3.12.7.3	Instrument Mechanisms	IF234010	NA	
3.3.12.7.4	Uncompensated Momentum	IF234015	NA	
3.3.12.7.5.1	Periodic Disturbance Torque Limits	IF234030	NA	
3.3.12.7.5.2	Constant Disturbance Torque Limits	IF234040	NA	
3.3.12.7.5.3	Disturbance Torque Limits for Linear Forces	IF234045	NA	
3.3.12.7.5.4	Spacecraft Non-Operational Deployment Disturbance	IF234055	NA	
3.3.12.8	Magnetics	IF234080	NA	
3.3.12.8	Magnetics	IF234081	NA	
3.3.12.9.2	General Access	IF234095	NA	
3.3.12.10.2	Mounting Orientation	IF234125	NA	
3.3.12.10.3	Instrument-to-Spacecraft Integration and Test Mounting	IF234130	NA	
3.3.12.10.3	Instrument-to-Spacecraft Integration and Test Mounting	IF234133	applicable	Possible exception for one instrument.
3.3.12.10.3	Instrument-to-Spacecraft Integration and Test Mounting	IF234135	applicable	
3.3.12.10.3	Instrument-to-Spacecraft Integration and Test Mounting	IF234140	NA	
3.3.12.10.3	Instrument-to-Spacecraft Integration and Test Mounting	IF234145	NA	
3.3.12.11	Venting	IF234160	NA	
3.3.12.11	Venting	IF234165	NA	
3.3.14	Ground support equipment	IF234185	NA	
3.3.14	Ground support equipment	IF234190	NA	
3.3.15	General Construction Requirements	IF234210	applicable	
3.3.11.2	Instrument GSE to Spacecraft I&T GSE Interface	IF235041	NA	
3.3.11.2	Instrument GSE to Spacecraft I&T GSE Interface	IF235061	NA	
3.3.14	Ground support equipment	IF235150	NA	
3.3.14	Ground support equipment	IF235155	NA	
3.3.14	Ground support equipment	IF235160	NA	
3.3.14	Ground support equipment	IF235170	NA	
3.3.14	Ground support equipment	IF235175	NA	

3.2.4.8.4.2	Command and Data Load Packets	IF235261	NA	
3.3.11.2	Instrument GSE to Spacecraft I&T GSE Interface	IF235341	NA	
4.2.7.1.1	Acceptance Level Random Vibration Testing	IF235785	NA	
4.2.7.1.1	Acceptance Level Random Vibration Testing	IF235790	NA	
4.2.7.1.1	Acceptance Level Random Vibration Testing	IF235795	NA	
4.2.7.1.1	Acceptance Level Random Vibration Testing	IF235800	NA	
4.2.7.1.2	Protoqualification Level Random Vibration Testing	IF235805	NA	
4.2.7.1.2	Protoqualification Level Random Vibration Testing	IF235815	NA	
4.2.7.1.2	Protoqualification Level Random Vibration Testing	IF235820	NA	
4.2.7.1.2	Protoqualification Level Random Vibration Testing	IF235825	NA	
4.2.7.1.3	Random Vibration After Rework	IF235827	NA	
4.2.7.2.1	Acceptance Level Sine Vibration Testing	IF235830	NA	
4.2.7.2.1	Acceptance Level Sine Vibration Testing	IF235835	NA	
4.2.7.2.2	Protoqualification Level Sine Vibration Testing	IF235840	NA	
4.2.7.2.3	Design Strength Testing	IF235845	NA	
4.2.7.2.3	Design Strength Testing	IF235850	NA	
4.2.7.2.3	Design Strength Testing	IF235855	NA	
4.2.7.2.3	Design Strength Testing	IF235860	NA	
4.2.7.2	Sine Vibration Testing	IF235880	NA	
4.2.7.2	Sine Vibration Testing	IF235885	NA	
4.2.7.2	Sine Vibration Testing	IF235887	NA	
4.2.7.4.1	General	IF235895	applicable	
4.2.7.4.2	Protoqualification Level Instrument Shock Testing	IF235910	NA	
4.2.7.5.1	Acceptance Level Acoustic Testing	IF235915	NA	
4.2.7.5.1	Acceptance Level Acoustic Testing	IF235920	NA	
4.2.7.5.2	Protoqualification Level Acoustic Testing	IF235925	NA	
4.2.7.5.2	Protoqualification Level Acoustic Testing	IF235930	NA	
4.2.7.5	Acoustic Testing	IF235935	NA	
4.2.7.6	Thermal Testing	IF235940	NA	
4.2.7.6	Thermal Testing	IF235945	NA	
4.2.7.6	Thermal Testing	IF235950	NA	

4.2.7	Acceptance and Protoqualification Testing	IF235970	NA	
4.2.7	Acceptance and Protoqualification Testing	IF235975	NA	
4.2.7	Acceptance and Protoqualification Testing	IF235980	NA	
4.2.7	Acceptance and Protoqualification Testing	IF235985	NA	
4.2.7	Acceptance and Protoqualification Testing	IF235990	NA	
4.2.7	Acceptance and Protoqualification Testing	IF235995	NA	
4.2.8	EMC/EMI Testing	IF236005	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
4.2.8	EMC/EMI Testing	IF236010	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
4.2.8	EMC/EMI Testing	IF236015	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
4.2.8	EMC/EMI Testing	IF236025	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
4.2.8	EMC/EMI Testing	IF236030	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
4.2.8	EMC/EMI Testing	IF236050	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.

3.2.6.1.5	Spacecraft Magnetic Fields	IF236055	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
4.2.8	EMC/EMI Testing	IF236060	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
4.2.8	EMC/EMI Testing	IF236065	NA	S/C EMI requirements are documented in the EMI/EMC Control Plan.
4.2.8	EMC/EMI Testing	IF236070	NA	
4.2.8	EMC/EMI Testing	IF236075	NA	
4.2.8	EMC/EMI Testing	IF236080	NA	
3.3.14	Ground Support Equipment	IF236081	NA	
4.2.8	EMC/EMI Testing	IF236085	NA	
4.2.8	EMC/EMI Testing	IF236090	NA	
4.2.8	EMC/EMI Testing	IF236095	NA	
4.2.8	EMC/EMI Testing	IF236100	NA	
4.2.8	EMC/EMI Testing	IF236105	NA	
4.2.8	EMC/EMI Testing	IF236110	NA	
4.2.9	Current Margin Testing	IF236115	applicable	
4.2.10	Deployment Testing	IF236120	NA	Covered for S/C in MAR/GEVS
3.3.14	Ground Support Equipment	IF236141	NA	
3.3.14	Ground support equipment	IF236165	NA	
3.3.14	Ground support equipment	IF236205	NA	
3.3.14	Ground support equipment	IF236206	NA	
3.3.14	Ground support equipment	IF236221	applicable	
3.5.3	Packaging, Handling, Storage, and Transportation (PHS&T)	IF236235	applicable	Shock monitoring only applies to Satellite shipping/handling from BATC to launch facility.
3.3.14	Ground support equipment	IF236241	NA	

3.3.14	Ground support equipment	IF236280	applicable	
3.3.14	Ground support equipment	IF237240	NA	
3.3.14	Ground support equipment	IF237270	NA	
3.2.4.3.1.5.1.1	Voltage Ripple	IF330945	applicable	
3.2.4.3.1.5.1.1	Voltage Ripple	IF330950	NA	
3.3.11.2	Instrument GSE to Spacecraft I&T GSE Interface	IF333765	applicable	

APPENDIX B. NPOESS SATELLITE TRANSMITTERS AND RECEIVERS

Table B-1. JPSS Onboard Transmitters

Transmitter	Transmitting Antenna	Frequency (MHz)	Bandwidth	Transmitting Power (W)*	Spacecraft
A-DCS	A-DCS earth coverage	465.9875	20 kHz	15 (11.12)	Free-Flyer, JPSS-2
SARR	SARR earth coverage	1,544.50	0.4 MHz	10 (5.6)	Free-flyer, JPSS-2
LRD	LRD earth coverage	1,707.0	6.0 MHz	35 (12.8)	Free-flyer, JPSS-2
Tlm Tx	Nadir Omni hemispherical Coverage	2,247.5	6 MHz	10	JPSS-1, JPSS-2
Tlm Tx	Zenith Omni hemispherical Coverage	2,247.5	6 MHz	10	JPSS-1, JPSS-2
HRD	HRD Iso-flux earth coverage	7,812	30 MHz	10 to 15	JPSS-1, JPSS-2
SMD	SMD Iso-flux earth coverage	8,212.5	300 MHz	10 to 15	JPSS-1, JPSS-2

*These are maximum powers levels at transmitters' outputs (i.e., prior to any circuit losses). Transmitter output power levels shown are from equipment specs. Numbers in parentheses are power levels at the antenna terminals; these levels include cable insertion loss. The insertion loss numbers are either from spec, if defined, or calculated from actual cable lengths at the specified frequency.).

Table B-2. JPSS Onboard Receivers

Receiver	Receive Antenna	Frequency (MHz)	BW (MHz)	Spacecraft
A-DCS	A-DCS Common Rx Ant	399.975, 402	See Table C-3	– Free-flyer
SARP/SARR	A-DCS Common Rx Ant	406.050	See Tables C-4 & C-5	Free-flyer
CMD	Nadir & Zenith Omnis	2,067.300	up to 0.256	JPSS-1, JPSS-2
GPS	GPS	1,227.600	See Table 3.3.2.2.5.2-1	JPSS-1, JPSS-2
GPS	GPS	1,575.420	See Table 3.3.2.2.5.2-1	JPSS-1, JPSS-2
ATMS	ATMS Instrument	21300 to 186810	See Table C-7	JPSS-1, JPSS-2

Table B-3. A-DCS Receive Sensitivity

Frequency (MHz) A-DCS			Maximum Signal Level (dBm)	Note
1	-	15	0	(1)
15	-	375	-20	(1)
375	-	385	-60	(1)
385	-	396	-80	(1)
396	-	399.9	-105	(1)
399.9	-	400.05	-145	(2)
400.05	-	401.	-105	(1)
401	-	403	-145	(2)
403	-	406	-105	(1)
406	-	411	-80	(1)
411	-	425	-60	(1)
425	-	1000	-25	(1)
1000	-	20000	-25	(1)

Notes:

(1) The maximum signal level includes all discrete signals and broadband noise in any 1000 Hz bandwidth within the specified band.

(2) The maximum signal level includes all discrete signals in any 100 Hz bandwidth within the specified band and excludes broadband noise.

Table B-4. SARP Receive Sensitivity

Frequency (MHz) SARP-3			Maximum Signal Level (dBm)
1	-	15	0 [1]
15	-	375	-20 [1]
375	-	385	-60 [1]
385	-	401	-85 [1]
401	-	405.9	-115 [1]
405.9	-	406.2	-145 [2]
406.2	-	411	-115 [1]
411	-	25	-85 [1]
425	-	435	-60 [1]
435	-	1000	-25 [1]
1000	-	20000	-25 [1]

Notes:
1. The maximum signal level includes all discrete signals and broadband noise in any 1000 Hz bandwidth within the specified band.
2. The maximum signal level includes all discrete signals in any 100 Hz bandwidth within the specified band and excludes broadband noise.

Table B-5. SARR Receive Sensitivity

Frequency (MHz)			Maximum Narrowband Signal Level (dBM)	
1.0	-	15.0	0	(1)
15.0	-	375.0	-20	(1)
375.0	-	385.0	-60	(1)
385.0	-	401.0	-100	(1)
401.0	-	405.9	-125	(1)
405.9	-	406.2	-145	(2)
406.2	-	411.0	-125	(1)
411.0	-	425.0	-100	(1)
425.0	-	435.0	-60	(1)
435.0	-	1000.0	-20	(1)
1000.0	-	10000.0	0	(1)

Notes:
1. The maximum signal level includes all discrete signals and broadband noise in any 1000 Hz bandwidth within the specified band.
2. The maximum signal level includes all discrete signals in any 100 Hz bandwidth within the specified band and excludes broadband noise.

Table B-6. RESERVED

Table B-7. ATMS Receive Sensitivity

Channel	Center Frequency	Max. Bandwidth	Frequency Range		EMI Sensitivity
	MHz	MHz	From (MHz)	To (MHz)	dBm
1	23800	270	21300.000	22800.000	-51
			22800.000	23567.250	-91
			23567.250	24032.750	-131
			24032.750	24800.000	-91
			24800.000	26300.000	-51
2	31400	180	28900.000	30400.000	-53
			30400.000	31241.500	-93
			31241.500	31558.500	-133
			31558.500	32400.000	-93
			32400.000	33900.000	-53
3	50300	180	47641.500	49300.000	-53
			49300.000	50141.500	-93
			50141.500	50458.500	-133
			50458.500	51300.000	-93
			51300.000	52800.000	-53
4	51760	400	49260.000	50760.000	-53
			50760.000	51425.000	-93
			51425.000	52095.000	-133
			52095.000	52760.000	-93
			52760.000	54260.000	-53
5	52800	400	50300.000	51800.000	-49
			51800.000	52465.000	-89
			52465.000	53135.000	-129
			53135.000	53800.000	-89
			53800.000	55300.000	-49
6	53596 ± 115	170	51096.000	52596.000	-49
			52596.000	53316.000	-89
			53316.000	53446.000	-129
			53446.000	53746.000	-89
			53746.000	53876.000	-129
			53876.000	54596.000	-89
			54596.000	56096.000	-49
7	54400	400	51900.000	53400.000	-49
			53400.000	54065.000	-89
			54065.000	54735.000	-129
			54735.000	55400.000	-89
			55400.000	56900.000	-49
8	54940	400	52440.000	53940.000	-49
			53940.000	54605.000	-89
			54605.000	55275.000	-129
			55275.000	55940.000	-89
			55940.000	57440.000	-49
9	55500	330	53000.000	54500.000	-50
			54500.000	55217.750	-90
			55217.750	55782.250	-130
			55782.250	56500.000	-90

Channel	Center Frequency	Max. Bandwidth	Frequency Range		EMI Sensitivity
	MHz	MHz	From (MHz)	To (MHz)	dBm
			56500.000	58000.000	-50
10	57290.344	330	54790.344	56290.344	-50
			56290.344	57017.594	-90
			57017.594	57563.094	-130
			57563.094	58290.344	-90
			58290.344	59790.344	-50
11	57290.344 ± 217	78	54790.344	56290.344	-53
			56290.344	57008.404	-93
			57008.404	57138.194	-133
			57138.194	57442.494	-93
			57442.494	57572.194	-133
			57572.194	58290.344	-93
			58290.344	59790.344	-53
12	57290.344 ± 322.2 ± 48	36	54790.344	56290.344	-53
			56290.344	56889.224	-93
			56889.224	56951.024	-133
			56951.024	56985.224	-93
			56985.224	57047.024	-133
			57047.024	57533.664	-93
			57533.664	57595.464	-133
			57595.464	57629.664	-93
			57629.664	57691.464	-133
			57691.464	58290.344	-93
			58290.344	59790.344	-53
13	57290.344 ± 322.2 ± 22	16	54790.344	56290.344	-57
			56290.344	56931.724	-97
			56931.724	56960.524	-137
			56960.524	56975.724	-97
			56975.724	57004.524	-137
			57004.524	57576.164	-97
			57576.164	57604.964	-137
			57604.964	57620.164	-97
			57620.164	57648.964	-137
			57648.964	58290.344	-97
			58290.344	59790.344	-57
14	57290.344 ± 322.2 ± 10	8	54790.344	56290.344	-60
			56290.344	56951.024	-100
			56951.024	56965.224	-140
			56965.224	56971.024	-100
			56971.024	56985.224	-140
			56985.224	57595.464	-100
			57595.464	57609.664	-140
			57609.664	57615.464	-100
			57615.464	57629.664	-140
			57629.664	58290.344	-100
			58290.344	59790.344	-60
15	57290.344 ± 322.2 ± 4.5	3	54790.344	56290.344	-64

Channel	Center Frequency	Max. Bandwidth	Frequency Range		EMI Sensitivity
	MHz	MHz	From (MHz)	To (MHz)	dBm
			56290.344	56960.649	-104
			56960.649	56966.599	-144
			56966.599	56969.649	-104
			56969.649	56975.599	-144
			56975.599	57605.089	-104
			57605.089	57611.039	-144
			57611.039	57614.089	-104
			57614.089	57620.039	-144
			57620.039	58290.344	-104
			58290.344	59790.344	-64
16	87000 - 91900	2000	84500.000	86000.000	-42
			86000.000	86665.000	-82
			86665.000	92235.000	-122
			92235.000	92900.000	-82
			92900.000	94400.000	-42
17	164000 - 167000	3000	161500.000	163000.000	-57
			163000.000	163665.000	-97
			163665.000	167335.000	-137
			167335.000	168000.000	-97
			168000.000	169500.000	-57
18	183310±7000	2000	173810.000	175310.000	-60
			175310.000	176028.060	-100
			176028.060	176157.850	-140
			176157.850	190462.150	-100
			190462.150	190591.850	-140
			190591.850	191310.000	-100
			191310.000	192810.000	-60
19	183310±4500	2000	176310.000	177810.000	-60
			177810.000	178489.305	-100
			178489.305	178495.255	-140
			178495.255	188124.745	-100
			188124.745	188130.695	-140
			188130.695	188810.000	-100
			188810.000	190310.000	-60
20	183310±3000	1000	177810.000	179310.000	-60
			179310.000	179989.305	-100
			179989.305	179995.255	-140
			179995.255	186624.745	-100
			186624.745	186630.695	-140
			186630.695	187310.000	-100
			187310.000	188810.000	-60
21	183310±1800	1000	179010.000	180510.000	-60
			180510.000	181190.680	-100
			181190.680	181204.880	-140
			181204.880	185415.120	-100
			185415.120	185429.320	-140
			185429.320	186110.000	-100

Channel	Center Frequency	Max. Bandwidth	Frequency Range		EMI Sensitivity
	MHz	MHz	From (MHz)	To (MHz)	dBm
			186110.000	187610.000	-60
22	183310±1000	500	179810.000	181310.000	-60
			181310.000	181990.680	-100
			181990.680	182004.880	-140
			182004.880	184615.120	-100
			184615.120	184629.320	-140
			184629.320	185310.000	-100
			185310.000	186810.000	-60

These items will be used in an analysis to set the actual levels at the inputs to the sensors. The analysis will be completed in time for the JPSS Spacecraft PDA.

APPENDIX C. Applicability of Specific Requirements

The requirements in this appendix apply to the extent noted in the individual ICDs.

C1 - "SOW" ITEMS

The spacecraft contractor will provide the mass model simulators.

IF231510 Flight plugs, if required, that mate directly to an instrument connector, shall be provided by the instrument contractor.

IF231520 Intra-instrument test tees, interrupt boxes, and breakout boxes shall be provided by the instrument contractor.

IF231525 Test-tees, interrupt boxes, and breakout boxes for instrument-to-spacecraft interfaces shall be provided by spacecraft contractor.

IF231595 All harnessing used on the spacecraft to connect the spacecraft to the instrument shall be provided by the spacecraft contractor (but using connectors provided by the instrument contractor).

IF231600 Intra-instrument harnessing, exterior to the instrument housing and connecting different parts of a single-unit instrument, or different parts of a multiple-assembly instrument mounted on a single baseplate, shall be provided by the instrument contractor.

IF231610 Instrument-level testing shall be done using flight-design harness, manufactured by the manufacturer of the flight harness, between components of an instrument suite.

Computer Resource Reserves for Operational Space Elements

For the purposes of this specification, the data processing subsystems of the operational instrument are defined to comprise all computer hardware and software.

IF232980 The data processing subsystems of the instrument shall have 100 percent growth margin (relative to usage predicted at CDR) while meeting the original functional and performance computational requirements, including timing. This requirement allows the growth margin to be used if additional requirements are added.

Data Processing Processor Reserves

IF232995 Within the processing environment of the data processing subsystems of the space elements, each processor shall have an instruction execution rate sufficient to process a workload that is 100 percent greater than the worst case processor utilization workload predicted at the time of the CDR.

Data Processing Primary Memory Reserves

IF233000 Within the environment of the data processing subsystems of the space elements, the primary memory for each processor shall have 100 percent greater memory capacity than the worst case memory size requirement for that primary memory component, if operating under a non-virtual operating system, at the time of delivery of the first unit.

IF233005 Within the environment of the data processing subsystems of the space elements, the primary memory for each processor shall have, or be capable of having, memory added (through modification, addition, or replacement) to attain a 200 percent greater memory capacity than the worst case predicted memory size requirement for that primary memory component at the time of CDR.

Data Processing Data Transmission Media

IF233020 Within the environment of the data processing subsystems of the space elements, each data transmission medium shall have sufficient capacity to support data throughput that is 50 percent greater than the worst case data throughput that could load that data transmission medium predicted at CDR.

IF233025 Within the environment of the data processing subsystems of the space elements, each data transmission medium shall have, or be capable of being augmented (through modification, addition, or replacement) to have sufficient capacity to support data throughput that is 200 percent greater than the worst case data throughput that could load that data transmission medium predicted at CDR.

IF234895 The instrument contractor shall be responsible for documenting the functional and physical requirements for the instruments in a hierarchical set of specifications, comprising instrument, subsystem, and component levels.

MIL-STD-961D, Notice 1 provides guidance on hierarchical specifications. Lower level specifications may be used to define requirements for software or individual units.

IF234910 Equipment designed for the instrument shall be documented in drawings and associated lists.

Software (Including Databases)

IF234920 Instrument software and databases should be developed and managed in accordance with EIA/IEEE J-STD-016 and NOAA S24.806 software standards. EIA/IEEE J-STD-016 will take precedence.

Technical Manuals

IF234925 Technical manuals should meet the requirements of NOAA Standards S24.801, S24.806, and S24.809 (TM 86-01).

Data Package

IF234930 Each instrument delivered shall have a data package that includes, at a minimum, the following items:

IF234935 Build & test documentation including all discrepancy reports shall be made available for review byNASA JPSS.

IF234940 Test, handling, and operational constraints

IF234945 Operational Time Summary

IF234950 Materials & Processes List

IF234955 Contamination Report

IF234960 Mass property report

IF234965 Instrument serial-number-unique data bases

IF234970 Prior to the delivery of the first instrument, the instrument contractor shall furnish the following:

IF234975 Procedures, drawings, and generic data bases

IF234980 Command and telemetry handbook

IF234985 User’s manual showing:

IF234990 Operations

IF234995 Conditions and limitations

IF235000 Operational procedures

Documentation Delivery Format

IF235005 The format/ content/ structure of deliverable documentation shall be identified in the ICD. In the absence of other definition, Microsoft Word format will be used.

IF235010 Ground test equipment items delivered shall have inspection records and test records maintained by serial number, for the service life of the item, and provided by the instrument contractor in Microsoft Word format, to the content and structure defined in the ICD. Manual records will utilize captured PDF.

PERSONNEL AND TRAINING

IF235060 Personnel supporting integration and test of the instrument shall be trained for working in or with the following, as required

IF235050 1. ESD sensitive devices

IF235040 2. Clean-room

IF235055 3. Confined spaces

IF235045 4. Oxygen deficient environments

IF235065 5. Specific hazards identified in the spacecraft safety plan.

IF233745 Validated procedures and tables willı be delivered.

IF233750 The instrument contractor will deliver a Software Development Plan (SDP) three months after contract award.

The SDP will specify the instrument contractor's processes for developing both instrument and algorithm software. These processes will reflect the complete software development life cycle (i.e., from the generation of software requirements through the verification test of delivered functionality), including all supporting activities (e.g., planning and oversight, software quality assurance, configuration management) and a description of all documentation generated.

IF230265 The ground-based processing of instrument data shall utilize the WGS84 reference geoid defined in MIL-STD-2401 and NIMATR 8350.2.

IF230615 The instrument contractor shall support the spacecraft contractor in determining the location of the instrument on the spacecraft.

IF231700 The provider and the locations of harness tie points shall be an agreement between the instrument contractor and the spacecraft contractor, as required.

IF230305 The instrument contractor shall provide, to JPSS, periodic reports containing the actual mass, center of mass, moments of inertia, products of inertia, uncompensated momentum and relevant alignment measurements for each separately-mounted component of the instrument, for each delivered unit, as well a composite total, where applicable.

IF230310 If the instrument contains movable masses, expendable masses, or deployables, the respective variations shall be documented in the report delivered to JPSS.

IF230325 The (not-to-exceed) instrument mass variation among production units shall be within 2% or 1kg, whichever is larger.

IF230345 The measured or calculated instrument center-of-mass shall be repeatable across all production units within 2% of A, or 12mm, whichever is larger. (where A= the X dimension of the instrument for the X-axis CG location; A=Y dim for the Y-axis CG location; A=Z dimension for the Z axis CG location. X, Y & Z are the dimensions of the instrument's "minimum volumetric parallelepiped").

IF230375 The measured or calculated instrument moments and products of inertia shall be repeatable across all production units within the tolerance allocation specified in Section 3.2.4.1.4.2.

IF230390 If the instrument contains movable masses, expendable masses, or deployable items, the respective measured or calculated moments and products of inertia shall be repeatable across all production units within the tolerance specified in Section 3.2.4.1.4.2.

IF230450 The spacecraft contractor shall conduct an analysis to ensure critical instrument-to-spacecraft, and critical instrument-to-fairing clearances are not violated.

Mounting Hardware

Mounting Hardware Provider

IF230560 The instrument contractor shall provide all unique instrument mounting hardware (e.g., bolts, washers, etc. which have limited-off-the-shelf availability or require a special fabrication lot).

IF230565 The spacecraft contractor shall provide all standard instrument mounting hardware (e.g., bolts, washers, etc. which are procurable off-the-shelf from multiple hardware vendors).

IF230570 Mounting bolts shall be per NASM 1515.

Mounting Hardware Documentation

IF230575 Instrument mounting hardware shall be defined and documented in the MICD, including indication of the source of the hardware (spacecraft or instrument).

Mounting Hardware Delivery

IF230580 Delivery of mounting hardware with the instrument shall be accomplished with each separately-mounted or attached element to be separately kitted.

IF230585 Each unique mounting hardware type or size shall be separately packaged and clearly identified with its relationship to the instrument top assembly drawing.

Mounting Surface Requirements

IF230590 Finish requirements for the mounting surfaces shall be specified by the spacecraft contractor and documented in the MICD.

IF230595 The spacecraft mounting surface flatness shall be as documented in the MICD.

IF230600 The instrument mounting surface flatness shall be as documented in the MICD.

IF230605 The Spacecraft mounting surface planarity shall be as documented in the MICD.

IF230610 The instrument mounting surface planarity shall be as documented in the MICD.

IF230670 The instrument contractor shall provide an Instrument Alignment Reference(s) composed of an alignment target or cube with associated alignment data relative to the Instrument Boresight and the mounting surface datum(s) associated with the instrument.

IF230680 The spacecraft contractor shall provide a Spacecraft Alignment Reference(s) composed of an alignment target or cube with associated alignment data relative to the Spacecraft Body Frame.

IF230645 The alignment data for the Instrument Boresight relative to the Instrument Alignment Reference(s) shall be provided to the spacecraft contractor 6 months prior to the delivery of the instrument.

IF230650 During instrument installation, the spacecraft contractor shall bolt the instrument to the previously established Instrument Interface defined by the drill template to preclude the need to shim for alignment at installation.

IF230660 The spacecraft contractor shall provide contingency shims as required for out of plane rotations (about the spacecraft X- and Y-axes).

IF230750 The spacecraft contractor shall measure the alignment between the Instrument Alignment Reference and the Spacecraft Alignment Reference.

IF230765 All production units of the instrument shall be installed using the same drill template, without requiring any modifications to the drill template (i.e. any instrument can be installed on any spacecraft).

IF230775 The spacecraft shall supply to the ground an estimate of the inertial attitude of the Spacecraft Attitude Determination Frame for ground processing.

IF230800 The spacecraft shall supply to the ground an estimate of Spacecraft Position for ground processing.

IF230820 The Spacecraft shall provide power harnesses to support the allocated power levels specified at the instrument interface.

IF230370 The moments and products of inertia of each separately-mounted instrument component shall be measured or calculated, referenced to the instrument coordinate axes, and documented in the delivered instrument data package.

IF230385 If an instrument contains movable masses or deployable items, the respective moments and products of inertia variations shall be measured or calculated and documented in the delivered data package.

IF230635 The instrument contractor shall provide all kinematic mounts (where used) including those required for the EDU.

IF230640 The instrument shall be delivered to the spacecraft contractor with the flight kinematic mount installed.

IF230636 Sensors with installed kinematic mounts shall provide a set of MGSE mounts to support SC Structural Testing (mass model simulator interfaces)

IF231360 The use of bond straps across structural electrical discontinuities shall be coordinated with EMC.

IF231450 The instrument contractor shall provide two sets of mated pairs of interface connectors for each instrument.

IF231455 The instrument contractor shall provide static-discharging connector covers, delivered in-place with the instrument.

IF231480 Captive covers shall be provided by the instrument contractor for all instrument connectors that are not mated to harnesses or flight plugs.

IF232955 It is the responsibility of the spacecraft contractor to ensure that none of the instruments protrude into the dynamic envelope stay-out zones as defined in the Satellite to Launch Vehicle ICD.

IF233505 In order to expedite maintenance and repair, all instruments shall be configured so as to facilitate modular replacement.

IF233510 All components, assemblies, subassemblies, and modules that are identical with respect to fit, form, and function shall be interchangeable.

IF233515 Parts that are not functionally, electrically, and dimensionally interchangeable shall have different part numbers.

IF233656 During prelaunch and prerelease checkout, sensitive detectors and hardware may require special procedures to protect them from the damage of high-level radiated emissions. If such procedures are needed, they should also be applied during EMC testing. Operational control procedures should also be instituted for

EMC testing during prerelease checkout to minimize interference with the orbiter and other payloads as appropriate.

IF233658 Spurious signals that lie above specified testing limits shall be eliminated.

IF233659 Spurious signals that are below specified limits shall be analyzed to determine if a subsequent change in frequency or amplitude is possible under expected mission conditions.

IF233661 Spurious signals that passed the initial test, but could, under the analyzed conditions, exceed the test limit shall be eliminated to protect payload and instruments from the possibility of interference, and retested to verify that intended solution was effective.

IF235021 The deliverable instrument EGSE shall be capable of performing the stand-alone Bench Acceptance Test (BAT) when the instrument arrives at the spacecraft contractor.

IF235022 The deliverable instrument EGSE shall be capable of supporting science telemetry (SMD, HRD, and/or LRD packets) analysis during spacecraft system level tests.

Note: Examples of Analysis to be performed: limit checking (temp/voltage/current), error checking, packet completeness, packet counts, trending, ..etc.

IF335100 Once integrated onto the spacecraft the instrument contractor shall monitor the S-Band houskeeping telemetry on the Sensor dedicated [TBD] user terminal.

IF235121 The deliverable instrument EGSE shall be capable of providing quick look evaluation of instrument state of health and science telemetry (SMD, HRD, and/or LRD).

Note: Examples of quick look evaluation to be performed: limit checking (temp/voltage/current), error checking, packet completeness, packet counts, ..etc.

IF235141 The deliverable instrument EGSE shall be capable of continuous operation with loss of real time telemetry data up to 15 minutes without requiring restart.

IF235161 Instrument internal software initialization and system self check shall take no more than 10 minutes following a reset or power up.

IF335180 The spacecraft contractor-provided [TBD] IUT (a dedicated workstation) shall be used by the instrument contractor to command and monitor test progress via the STC.

IF335200 The instrument contractor shall provide S-Band housekeeping telemetry mnemonics and layouts for the [TBD] display pages.

IF335220 The IUT shall also provide instrument engineering/state-of-health telemetry page displays whose layout is determined by the instrument contractor.

IF235241 The instrument contractor shall provide instrument test plans, procedures, and flight database to be used for the JPSS test bed, and for I&T integration.

IF335300 The STC shall house all the spacecraft procedures and databases including those provided by the instrument.

IF335320 The STC shall archive all instrument commands, housekeeping telemetry, engineering, and science data.

IF235381 Commands that can potentially damage the spacecraft, instrument or cause injury to personnel shall be identified by the instrument contractor.

IF233770 The spacecraft contractor shall be responsible for providing the results of the launch vehicle/spacecraft coupled loads analysis in a standard format to the instrument contractors.

IF233775 The spacecraft contractor shall provide mission-specific information for maximum equivalent loads to the instrument contractor for static loads analyses.

IF233780 The instrument contractor and spacecraft contractor shall coordinate on analyses.

The two parties should reach an agreement about assumptions and model development either by test or by close coordination between the two structural analysis groups.

IF233785 The spacecraft contractor shall be responsible for the combined structural dynamics analysis of the spacecraft bus and the instruments.

IF233790 The spacecraft contractor shall provide the combined structural dynamics analysis results to the instrument contractors.

IF233795 A structural analysis using maximum equivalent loads shall be conducted on the instrument.

IF233835 A test-verified (refer to paragraph 4.2.4.1.5) detailed finite element model shall be provided if the instrument exceeds 23 kilograms and the fundamental resonant mode frequency is less than 50 Hz, as shown by analysis.

IF233840 The spacecraft shall provide an installation frequency of $\geq$ 35 Hz for all components $\leq$ 23 kg (components is assumed rigid with the same attachment envelope).

IF233875 The instrument contractor shall perform a structural analysis on each separately-mounted instrument component.

IF233880 The structural analysis documentation shall be available for review by the spacecraft contractor.

IF233985 System level test impacts shall be considered in the instrument design; for example, gimballing in a 1 ‘g’ environment, momentum compensation, and the use of GSE.

IF237120 Actuators, radiators, rotating assemblies and louvers (if required) shall be operable in any spacecraft orientation.

IF234025 The instrument contractor shall provide, in electronic format, time/magnitude plots of their disturbances, for decomposition by the spacecraft contractor, of the sum of the instrument-induced periodic disturbance torques, in order to produce the corresponding magnitude spectrum.

IF234075 If magnets are inherent to the instrument design, early estimates of magnetic fields and residual magnetic dipole moments will be provided to the spacecraft contractor.

IF234085 If the requirement is exceeded, a full magnetic survey shall be conducted and corrective action taken.

IF234082 In cases where the magnetic properties of the hardware need to be controlled, the dc magnetics testing should be performed after vibration testing.

This provides an opportunity to correct for any magnetization of the flight hardware caused by fields associated with the vibration test equipment.

IF234105 The instrument contractor shall provide proof-tested handling fixtures for each subsystem for each separately mountable unit with a mass in excess of 20 kilograms, or which has special handling restrictions due to surfaces or delicate mechanisms.

IF234110 Documentation of the fixture certification shall be delivered with the fixture.

IF233990 The instrument contractor shall provide analysis and test data that will allow the spacecraft contractor to ensure that the "swept" or deployed volume is verified, accounting for all distortions and misalignments.

IF233995 Early estimates of gimbaled masses, inertia’s, and cg’s shall be provided to the spacecraft contractor to permit sizing the control components to meet pointing and stability requirements.

IF334146 Instrument providers shall bring their own tools and other equipment as needed for use by the instrument provider to support JPSS test bed operations as well as satellite integration and test.

IF234175 The Spacecraft Contractor shall place the instrument such that the contamination products from the vents of one instrument will not directly impinge on another instrument's contamination-sensitive surface nor directly enter another instrument's aperture unless it can be shown by analysis (by the spacecraft contractor) that the performance of the instrument will not be degraded.

IF235180 The instrument contractor shall identify all constraints, including commands, that pertain to each test environment, including testing while encapsulated at the launch pad.

IF235185 The instrument shall have internal checks for "go/no-go" determination during the aliveness test while on the launch pad.

IF335000 The instrument contractor shall provide Automated Test Scripts (ATSs) written in the CECIL [TBD] language using ProcPad [TBD] to verify syntax, telemetry and command mnemonics.

IF236101 For cables to be provided by the spacecraft contractor, the instrument contractor shall provide detailed cable specifications that include:

IF236121 The instrument contractor shall provide the following information regarding IGSE:

- Number of Racks
- Location of racks
- What phase of I&T shall the test racks be required
- Deltas from IGSE used during the JPSS test bed - EDU interface test
- Power requirements

IF236300 Instrument contractor provided MGSE shall include all items necessary for deploying, stowing, and protecting the instrument.

IF236400 The instrument contractor is responsible for all special equipment needed to test the sensor during TV.

This includes non-standard port plate feed throughs, 50 ft. internal cables, 50 ft. external cables, targets, target controllers, etc).

IF236420 The instrument contractor shall be responsible for maintenance of all instrument GSE.

IF237180 The instrument contractor shall use a configuration management process to document any IGSE modifications that take place during instrument BAT or satellite level testing.

IF237210 IGSE Problem Reports shall be tracked in the NASA JPSS CM process. after sensor delivery.

IF234900 After award of the spacecraft integration contract, each instrument developer and the spacecraft contractor shall participate with NASA JPSS to jointly write an Instrument-to-spacecraft Interface Control Document (ICD) which defines the details of the instrument-to-spacecraft interface and instrument accommodation information.

The instrument-unique ICD, together with the general interface information contained within this document constitute the interface control documentation between the instrument and the spacecraft for JPSS. Except as noted in Section 1, both documents are under the configuration control of NASA JPSS.

IF235020 The instrument contractor shall submit all maintenance procedures for approval.

IF235025 The ground support equipment delivered for use with the spacecraft shall be maintained by the instrument contractor.

IF235035 The instrument contractor shall provide a PHS&T plan by PDR which covers all PHS&T issues for the instrument.

IF236230 The instrument contractor shall provide access provisions for inspection and handling for all deliverable items.

IF236240 Instrument shipping containers shall be designed using non-contaminating materials or must be painted or coated with non-shedding paint.

IF236245 The instrument contractor shall mark deliverable units in accordance with ASTM D3951 as appropriate for the item being prepared.

IF236250 Nameplates for hardware shall contain the item or configuration item number, serial number, lot number (or contract number), manufacturer, and nomenclature.

IF236255 Software media shall be marked to display software configuration item number, serial number, contract number, manufacturer, and nomenclature.

IF235075 The instrument contractor shall document the results of all tests and analyses.

IF235196 JPSS test strategy is as follows (exceptions are to be brought to the attention of NASA JPSS):

1. One flight unit subjected to protoflight-level testing; subsequent flight units acceptance-level tested.
2. Instrument ”tested as flown”
3. No instrument GSE electrically connected to spacecraft or instrument during spacecraft test.
4. When instruments are installed on the spacecraft, all instrument tests are run from spacecraft GSE.
5. No open fluids allowed during test.
6. Spacecraft powered and under test for many extended periods of time.

IF235200 Tests and evaluations of the space equipment may be conducted at in-plant test facilities, which may include subcontractor's facilities and/or at a government-approved test facility. Tests of parts, materials, software units, ground equipment, and computer software may also take place at in-plant test facilities, (including subcontractor's facilities or at a government-approved test bed).

IF335210 The EDU shall be an engineering model with flight-like processor (hosting the flight software) and spacecraft electrical interfaces, and the science gathering portion of the payload provided by flight-like electronics or a simulator.

IF335211 The EDU shall be at fidelity level to meet the electrical integration test objectives at theJPSS test bed.

The EDU will be integrated with the Spacecraft C&DH and EPS Engineering Model (EM) units at the JPSS test bed to form a satellite level testbed. The electrical integration test objectives are:
1. Early checkout of individual spacecraft to sensor interface,
2. Satellite level compatibility checkout among spacecraft subsystems and all sensors,
3. Validated sensor test products and test equipments to be used during I&T,
4. Validated test procedures, automated test scripts (ATSs), C&T Database,
5. Early checkout of interfaces between EGSE and IGSE, and
6. Science data telemetry stream distribution from EGSE to IGSE.

IF335212 The EDU shall be identical to (or flight-like for) the respective requirements in specific sections of this GIID according to Table 4.2.3.1-1 (completed table to appear in the individual ICDs).

The instrument contractor will provide inputs to document the differences between the instrument and the EDU for each requirement section of this ICD using Table 4.2.3.1-1 as an outline.
The instrument contractor will also provide supporting data with the EDU similar to the flight article showing the electrical and mechanical differences between the instrument and the EDU: these documents can be flight documents (electrical schematics, pinouts, MICD, etc) redlined to show the EDU configuration.

Table EDU to Flight Sensor Comparison

Section	Title	Difference	Performance Impacts [1]
3.1.3	Instrument Modes/functionalities		
3.1.3.1	OFF Mode		
3.1.3.2	ACTIVATION		
3.1.3.4	OPERATIONAL Mode		
3.1.3.5	DIAGNOSTIC Mode		
3.1.3.6	SAFE Modes		

Section	Title	Difference	Performance Impacts [1]
3.1.3.6.1	INSTRUMENT SAFE Mode		
3.1.3.6.2	SPACECRAFT SAFE Mode		
3.1.3.7	SURVIVAL Mode		
3.1.3.8	AUTONOMOUS		
3.1.4	Operational Concept		
3.1.4.1	Pre-launch		
3.1.4.2	Launch and Injection		
3.1.4.3	On-orbit Operational Concept		
3.2.4.2.3	Physical Interface		
3.2.4.2.3.1	Stowed and Critical Clearances		
3.2.4.2.3.1.1	Instrument Envelope Documentation		
3.2.4.2.3.2	Mounting Provisions		
3.2.4.2.3.2.1	Mounting Method		
3.2.4.2.3.2.2	Mounting Interface		
3.2.4.2.3.2.2.1	Mounting Interface Documentation		
3.2.4.2.3.2.2.2	Mounting Hole Coordinates and Dimensions		
3.2.4.2.3.2.3	Drill Templates		
3.2.4.2.3.2.3.3	Drill Template Provider		
3.2.4.2.3.2.4	Mounting Hardware		
3.2.4.2.3.2.4.4	Mounting Surface Requirements		
3.2.4.2.3.2.5	Mounting Location and Documentation		
3.2.4.2.3.2.6	Special Mounts		
3.2.4.2.3.4	Structural Support		
3.2.4.3	Power		
3.2.4.3.1	Power Bus Requirements		
3.2.4.3.1.1	Electrical Interface Definitions	NONE	
3.2.4.3.1.2	Power Allocation		
3.2.4.3.1.2.1	Instrument Power Allocations	NONE	
3.2.4.3.1.2.1.1	Operational Power Allocation		
3.2.4.3.1.2.1.2	Survival Power Allocation		
3.2.4.3.1.2.1.3	Launch-phase Power Allocation	NONE	
3.2.4.3.1.2.1.4	Power Interface Allocation		
3.2.4.3.1.2.1.5	1394 Power Allocation		
3.2.4.3.1.3.1	Power Connections		
3.2.4.3.1.4	Power Application		
3.2.4.3.1.4.1	Power Fault Tolerance		
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3.2.4.3.1.4.4	Instrument External (Spacecraft) Power		
3.2.4.3.1.5.1	Ripple		
3.2.4.3.1.5.1.1	Voltage Ripple		
3.2.4.3.1.5.1.2	Reflected Ripple		
3.2.4.3.1.5.2.2	Current Transients		
3.2.4.3.1.5.2.2.1	Instrument Turn-on Transients		
3.2.4.3.1.5.2.2.2	Instrument Turn-off Transients		
3.2.4.3.1.5.2.2.3	Instrument Operational Transients		
3.2.4.3.1.5.3	Abnormal Operation Voltage Limits		
3.2.4.3.1.5.4	Impedance		

Section	Title	Difference	Performance Impacts [1]
3.2.4.3.1.5.5	Survival Heater Bus		
3.2.4.3.1.5.6	Safety Bus Operation		
3.2.4.3.1.5.7	Overcurrent Protection Device Size		
3.2.4.3.1.6	Unannounced Removal of Power		
3.2.4.3.1.7	Instrument High-Voltage Restriction	NONE	
3.2.4.3.2.1	Grounding Responsibility		
3.2.4.3.2.2	General		
3.2.4.3.2.3	Power Returns		
3.2.4.3.2.4	Signal Reference		
3.2.4.3.2.5	Chassis Ground		
3.2.4.3.2.6	External Ground Tie Point		
3.2.4.3.3.1.1	General Considerations		
3.2.4.3.3.1.2	Connector Location and Types		
3.2.4.3.3.1.3	Keying		
3.2.4.3.3.1.4	Flight Plugs		
3.2.4.3.3.1.5	Breakout Boxes	NONE	
3.2.4.3.3.1.6	Buffer Connectors and Connector Savers	NONE	
3.2.4.3.3.1.7	Test Connectors		
3.2.4.3.3.2.1	Harnesses Provider		
3.2.4.3.3.2.2	Harness Documentation		
3.2.4.3.3.2.3	Harness Wiring Requirements		
3.2.4.7.3.1	Heat Transfer to Spacecraft		
3.2.4.7.4	Temperature		
3.2.4.7.6.5	Ambient Tests		
3.2.4.8.1	Common Electrical Interface		
3.2.4.8.1.1	Interface Conductors	NONE	
3.2.4.8.1.2	Interface Circuitry Isolation	NONE	
3.2.4.8.1.3	Interface Fault Tolerance	NONE	
3.2.4.8.1.4	Power Bus	NONE	
3.2.4.8.2	Data Bus Requirements	NONE	
3.2.4.8.2.1	Bus Functions	NONE	
3.2.4.8.3	Interface Characteristics	NONE	
3.2.4.8.3.1	MIL-STD-1553 Characteristics	NONE	
3.2.4.8.3.1.1	Electrical Interface	NONE	
3.2.4.8.3.2	IEEE 1394a Interface Characteristics		
3.2.4.8.3.3	Pulse Commands	NONE	
3.2.4.8.3.4	Time of Day Pulse	NONE	
3.2.4.8.3.5	Synchronization	NONE	
3.2.4.8.4	Instrument Commands and Data Load		
3.2.4.8.4.1.1	Real-time Ground Commands		
3.2.4.8.4.1.2	Stored Commands	NONE	
3.2.4.8.4.1.3	Command Uniqueness	NONE	
3.2.4.8.4.1.4	Command Sequence		
3.2.4.8.4.1.5	Command Restraints		
3.2.4.8.4.2	Command and Data Load Packet		
3.2.4.8.4.5	Critical Command		
3.2.4.8.4.7	Documentation		
3.2.4.8.5	Instrument Health and Status Telemetry		

Section	Title	Difference	Performance Impacts [1]
3.2.4.8.5.1	Telemetry Diagnostic Data		
3.2.4.8.5.2	Point-to-Point Telemetry		
3.2.4.8.5.3	Command Verification		
3.2.4.8.5.4	Instrument Memory Dump		
3.2.4.8.5.5	Telemetry Monitor		
3.2.4.8.6	Mission Data		
3.2.4.8.7	Data Packetization		
3.2.4.8.8	Command & Data Interface Test Packets		
3.2.6.4	Test Environments		
3.2.7	Transportability		
3.2.8	Flexibility and Expansion		
3.2.8.1	Operational Computer Resource Reserves		
3.2.8.1.1	Computer Resource Reserves for Operational Space Elements		
3.2.8.1.1.1	Data Processing Processor Reserves		
3.2.8.1.1.2	Data Processing Primary Memory Reserves		
3.2.8.1.1.3	Data Processing Peripheral Data Storage (Secondary Memory) Reserves		
3.2.8.1.1.4	Data Processing Data Transmission Media		
3.2.8.1.1.5	Data Processing Software/Firmware		
3.3.8	Nuclear Control		
3.3.9	Security		
3.3.9.1	Communications Security (COMSEC)		
3.3.9.2	Computer Security (COMPUSEC)		
3.3.11	Computer Resources		
3.3.11.1	Operational Computer Resources		
3.3.11.1.1	Operational Computational Equipment		
3.3.11.1.3	Operating Systems Used in Operational Computers		
3.3.11.1.3.1	Instruments Flight Software Requirements		
3.3.11.1.3.1.1	Instrument Flight Software Version Control		
3.3.11.1.3.1.2	Instrument Flight Software Load		
3.3.11.1.3.1.3	Instrument Flight Software On-Orbit Installation and Verification		
3.3.11.1.3.2	Programming Language		
3.3.11.1.3.2.1	Language Standards		
3.3.11.1.4	Software Coding Conventions		
3.3.11.2	Instrument GSE to Spacecraft I&T GSE Interface		
3.3.14	Ground Support Equipment		
3.3.15.1.2	Contamination		
3.3.15.1.2.1	Contamination Control Requirements		
3.3.15.1.2.2	Facility Environmental Requirements		
3.3.15.1.2.2.1	Ground Support Equipment (GSE) Cleanliness Requirements		
3.3.15.1.2.3	Instrument Inspection and Cleaning During I&T		
3.3.15.1.2.4	Instrument Purge Requirements		
3.3.15.1.2.5	Fabrication and Handling		
3.3.15.1.2.6	Device Cleanliness		
3.3.15.1.3	Electrostatic Discharge		
3.4.1	Specifications		

Section	Title	Difference	Performance Impacts [1]
3.4.3	Drawings and Associated Lists		
4.1	QUALITY ASSURANCE		
4.1.1	Special Tests and Examinations		
4.1.1.1	Inspections and Tests of the Instrument		
4.1.1.1.1	Instrument Parts, Materials, and Process Controls		
4.1.1.1.2	Instrument Records		
4.2.3	Physical Models		
4.2.3.1	Engineering Development Unit (EDU)		

Note
1. The Performance Impacts column should document performance information due to differences (i.e. No impact, verified by comprehensive EDU tests).

The interface requirements for the mathematical models are defined in this section.

Thermal, structural and dynamic models are required for the spacecraft and each of the mission instruments to accurately define the thermal, structural, and dynamic loads at each instrument/spacecraft interface.

IF235770 All models shall be exchanged in formats that are compatible with those used by the spacecraft contractor.

IF235775 Sufficient model documentation shall be provided to describe how the significant thermal and structural characteristics are modeled.

Nodal number ranges and element number ranges should be defined for the individual components that make up the model.

Finite Element Model

These models are to be used to analyze the structural and dynamic characteristics of each instrument. The models will be used to determine the instrument structural adequacy to withstand transportation, launch, and on-orbit loads. Also, they will be used to predict instrument structural resonant frequencies. The satellite/launch vehicle loads analysis will be used in the development and definition of the instrument/spacecraft interface loads.

IF235430 A structural Finite Element Model, using NASTRAN, shall be provided for each separately-mounted instrument component regardless of mass or resonant frequency.

Model Representation

IF235225 Components having fixed base frequencies greater than 100 Hz shall be represented as rigid masses.

Finite Element Model (FEM) Requirements

IF235230 The FEM shall meet the following requirements (a through j):

IF235235 a. NASTRAN format.

IF235240 b. The model, used for dynamic analysis rather than stress analysis, therefore will be as small as possible. Models will be 'full" models with no symmetry assumptions made to reduce model size. "Super elements" will not be used.

IF235245 c. Model will adequately represent all dynamic modes up to 100 Hz when rigidly supported at the interface.

IF235250 d. The local coordinate system will be rectangular with the same orientation as the Spacecraft coordinate system. Coordinate cards will be provided to establish the local system. The origin of the local coordinate system will be documented in the ICD.

IF235255 e. All constraints internal to instruments and output will be in the local coordinate system. There will be no constraints external to the model upon submittal.

IF235260 f. The bulk data deck will not contain BAROR, GRDSET, PARAM K6ROT or PARAM AUTOSPC NASTRAN cards.

IF235265 g. The specification of vector components for element coordinate system definition will be used in lieu of referenced grid (i.e., CBAR, CBEAM).

IF235270 h. The System Internationale (SI) units will be used unless another consistent system of units is approved by NASA JPSS.

IF235275 i. An instrument-unique numbering system for all NASTRAN model identification numbers will be used (for grids, coordinates systems, elements, property and material IDs, as well as constraint and loading IDs). This number will be of the form XXX001 through XXX999, where XXX is the instrument identification number provided by the spacecraft contractor. All instrument components which are physically separate units will be modeled separately with unique identification numbers within the unique XXX instrument number allocation. No ID number duplications will be allowed.

IF235280 j. The NASTRAN model will be capable of representing different dynamic response characteristics (if any) resulting from planned configuration changes between launch and deployment.

Deliverable NASTRAN Model Data

IF235285 The following data and information shall be supplied in fulfillment of the requirement of a deliverable NASTRAN math model (a through j):

IF235290 a. NASTRAN structural math model of the instrument which is able to:

IF235295 1. Define the loads at the instrument/support structure interface due to gravity loads and structural element temperature changes.

IF235300 2. Be of sufficient detail to accurately represent the dynamic behavior of the instrument up to 100 Hz. In general, no more degrees-of-freedom than necessary should be used. Models which employ static or dynamic reduction techniques should refer to the validation requirements in section 4.2.4.1.4.

IF235305 b. The method of data transfer is electronic, or by other means agreed-upon with the spacecraft contractor.

IF235310 c. Description of the model, any special modeling features used, and rationale for the modeling methodology.

IF235315 d. List of all material properties used in the model.

IF235320 e. Copy of the mass and stiffness calculations used in generating the input data for the model and a description of how the masses were distributed throughout the structure.

IF235325 f. A description of the dynamic ASET degrees-of-freedom.

IF235330 g. Detailed plots of the NASTRAN model clearly showing all grid points, element numbers, and element types. Hardcopy plots showing element connectivity will also be supplied. Identify clearly all Spacecraft attachment points with respective degrees-of-freedom.

IF235335 h. Mechanical and functional description of all mechanisms in the instrument, whether they are modeled or not.

IF235340 i. Mode plots of the first three significant modes.

IF235345 j. The following are to be delivered with the test verified model: Design drawings of the instrument to manufacturing standards. Copy of the stress analysis (input and output) of all loading combinations performed on the detailed model, with cross references to the NASTRAN model and drawing numbers. All fracture critical parts must be clearly labeled as such.

(The drawings referred to are intended to mean drawings already in existence and in use by the instrument contractor, not new drawings generated specifically to meet this requirement.)

Deliverable Model Validity Checks

IF235350 The following computer runs and data checks shall be made to confirm the mathematical validity of the model (a through j):

IF235355 a. Static analysis for unit gravity loading in each of the three axis directions. Reaction forces given by this analysis will equal the weight of the structure as

given by the grid-point weight generator (using PARAM WTMASS card). No large displacements or forces will be generated.

IF235360 b. Eigenvalue analysis for modes up to 100 Hz with the instrument constrained at the instrument/support structure interface. Only those degrees-of-freedom actually used to attach the instrument to the support will be constrained in this analysis.

IF235365 c. Eigenvalue analysis for the modes up to 100 Hz of the instrument in the free-free (unconstrained) condition. This analysis will be made both with and without the SUPORT NASTRAN bulk-data card. The rigid body modes from the analysis without the SUPORT card should yield frequencies less than 0.01 Hz.

IF235370 d. Static analysis with unit-enforced displacements in all six degrees-of-freedom at one grid point. This analysis will yield equivalent unit values of displacement for all grid points whose displacement coordinate system is defined as being parallel to the input coordinate system of the referenced point. In addition, no element forces greater than 0.05 kg or moments greater than 0.1 N-M will be observed. A grid-point force balance will reveal no significant forces on any point in the model.

IF235375 e. Grid-point weight generator (using PARAM WTMASS card) will yield correct weight, center-of-mass location, and moments of inertia.

IF235380 f. Use of case-control command "SPCFORCES=ALL" will reveal no constraint forces at points other than legitimate boundary condition constraint points.

IF235385 g. "Epsilon Sub E" error check for each static subcase will be less than 10^{-11}.

IF235390 h. Static analysis with a unit temperature increase from ambient. The model will contain a stress-free boundary condition, (i.e., kinematic mount or single constrained grid point), with all the thermal expansion coefficients changed to simulate identical materials. The grid-point force balance will reveal no force greater than 0.005 kg. Care will be taken to ensure that rigid elements do not constrain thermal expansion.

IF235395 i. A rigid-body or stiffness-equilibrium check will be performed. Terms should be less than 10^{-5}.

IF235400 j. Modal results for reduced models will agree with full-up model as follows:

IF235405 1. Fundamental frequency should agree to 3%.

IF235410 2. All remaining modes to 100 Hz should have frequencies to within 5%.

IF235415 3. Cross orthogonality check with full-up model must have diagonal terms greater than 0.95 and off-diagonal terms less than 0.05.

NASTRAN Model Verification

IF235420 If either analysis or a frequency verification test show any significant mode below 50 Hz, (in a fixed base configuration) these modes shall be verified in accordance with Section 4.2.7.2.3.

IF235425 The analytical frequency predictions shall agree with dynamic test data to within 5 percent for the fundamental mode and to within 10 percent for all remaining significant modes to 50 Hz.

A cross orthogonality check between test and analytical mode shapes should have diagonal terms above 0.9 and off diagonal terms below 0.1 for all significant modes up to 50 Hz.

Thermal Math Models

IF235745 The instrument contractor shall provide two instrument reduced thermal models (an instrument reduced surface (geometry) model and a thermal (temperature) model) which will be used by the spacecraft contractor for integrated thermal analysis.

The instrument reduced surface (geometry) model will be integrated in the spacecraft overall surface model. The integrated surface model will be used to calculate radiation exchange factors and environmental heating rates (solar, albedo and earth Infrared) during various phases of the mission including launch, transfer orbit and on-orbit operation. The integrated surface model will also be modified and used to simulate the thermal environments during the spacecraft system level test.

IF235746 The instrument reduced thermal (temperature) model shall be integrated in the spacecraft overall thermal model.

The integrated model will be used to study thermal response of the spacecraft for all spacecraft states and instrument modes over the entire length of the mission.

IF235747 The calculated integrated on-orbit thermal environments and spacecraft IR backloads for all instrument external surfaces shall be provided to the instrument contractor for their stand-alone thermal analyses using detailed instrument thermal models. The instrument-to-spacecraft interface conductance (radiative and conductive) will also be provided to the instrument contractor if the mounting hardware is the responsibility of the spacecraft contractor. Detailed thermal math models of the instrument are developed by the instrument contractor with the

objective of demonstrating that all internal instrument critical components meet the thermal requirements during operation and testing.

IF235750 Although the detailed thermal model itself is not a deliverable item, a nodal description and the results of the analysis in terms of correlation between the detailed and reduced thermal model predictions shall be delivered to the spacecraft contractor as a test of the adequacy of the reduced node thermal model in evaluating the critical component temperature predicts against the recommended limits (temperature margins) and a means of making flight instrument predictions.

IF235755 The Instrument contractor shall use the detailed thermal model to predict and analyze the results of the instrument level thermal balance test, resulting in a validation of the math model.

As a goal, correlation of test results to the thermal model predictions should be within ± 3 C.

Instrument Reduced Thermal Math Model Requirements

IF235440 Mathematical models shall be provided by the instrument contractor, to be used by the spacecraft contractor in defining each instrument/spacecraft thermal interface.

IF235445 All models shall be fully documented to permit ease of use by other contractors as deemed appropriate by the spacecraft contractor.

IF235470 The thermal models shall include an adequate level of detail to predict, under worst case hot and cold conditions, all critical temperatures, including those that drive operational and survival temperature limits and heater power. Worst-case conditions will include variations in season, orbit selection, orbital time, and environmental flux parameters (seasonal and spatial) and a rational combination of the effects of design tolerances, fabrication uncertainties, material differences, and degradation due to aging. See Table 3.2.4.7.3.2-1 for cold and hot worst-case environmental parameters.

IF235455 Models shall use conservative property values for conduction, absorption, emission, and MLI effective emittance, and consider contact resistance. Analyses should consider beginning-of-life and end-of-life properties for external coatings.

IF235475 The Instrument contractor shall construct and deliver two math models relating to the thermal design and analysis of the instrument:

IF235480 1. Reduced TRASYS22 or TSS (Thermal Synthesizer System) surface model,

IF235485 2. Reduced SINDA85 or GSINDA thermal model

The reduced surface and thermal models will be incorporated into the respective spacecraft overall models for integrated spacecraft thermal analysis.

These models will be updated as necessary to reflect significant design changes during the design phase of the instrument, and the final model will be required after thermal balance testing of the instrument has been completed.

Reduced Surface Model Requirements

IF235495 The surface model shall be developed in a Thermal Radiation Analyzer System (TRASYS22) or Thermal Synthesizer System (TSS) format.

IF235500 The surface model shall be as small as is reasonably possible. The total number of surfaces is dependent on geometric complexity, but will not exceed 100 surfaces unless coordinated with the spacecraft contractor.

IF235505 The surface model shall form a completely closed volume. Even the surface area which is used for mechanical attachment to the spacecraft will be represented by a surface. For example, a simple rectangular electronics package is represented by six rectangles.

IF235510 In general, each external node of the instrument reduced node thermal model and detailed thermal model shall be represented by a surface or set of surfaces in the surface model. Any surface of special interest (i.e., an aperture or a radiator) will be modeled separately.

IF235515 The local coordinate system shall be rectangular with the same orientation as the spacecraft coordinate system. The origin of the local coordinate system will be documented in the ICD. For each surface in the model, sufficient information will be provided to relate each corner of the surface to the coordinate system.

IF235520 All length dimensions shall be input in cm, and time units in seconds.

IF235525 An instrument-unique numbering system for all surface model identification numbers shall be used. This number will be provided by the spacecraft contractor and documented in the ICD. All instrument components which are physically separate units will be modeled separately with unique identification numbers within the unique instrument number allocation. There will be no ID number duplications allowed.

IF235530 The following information and data shall be supplied in fulfillment of the requirement of a deliverable reduced TRASYS or TSS surface model (a through d):

IF235535 a. A table will be supplied which lists each surface with:

IF235540 1. A brief description.

IF235545 2. The node number in the model.

IF235550 3. The area in cm^2.

IF235555 4. The predominant surface materials.

IF235560 5. The beginning-of-life and end-of-life values of solar absorptivity and IR emissivity of the surface materials including thermal blanket outer layers. The values of the thermo-optical properties will include tolerances for uncertainties and degradation.

IF235565 b. A sample run of the TRASYS surface model of the instrument will be supplied, assuming the worst EOL hot case with the instrument operational. The surface model input deck will be provided in ASCII format, and sent electronically to the spacecraft contractor at the time of delivery.

IF235570 c. Description of the model, any special modeling features used, and the rationale for the modeling methodology.

IF235575 d. Detailed plots of the surface model clearly showing all nodes and node numbers. The coordinate axes will be clearly marked.

Reduced Node Thermal Model Requirements

IF235580 A reduced node thermal model shall be delivered which is a reduced version of the detailed thermal model. It will provide similar results to the detailed model in the areas of interface heat flow (both radiation and conduction) and average internal temperatures of major instrument components (a through j below).

IF235585 a. The reduced node thermal model will be developed in a Systems Improved Numerical Differencing Analyzer (SINDA) SINDA85 or GSINDA format.

IF235590 b. The model will be capable of steady-state and transient analysis.

IF235595 c. The model will be as small as is reasonably possible and will not exceed 250 nodes, unless coordinated with the spacecraft contractor.

IF235600 d. All length dimensions will be input in cm. All heat energy data will be input in watts. Time units will be in seconds. The Celsius temperature scale will be used.

IF235605 e. The reduced model predictions of internal temperatures for critical instrument components will agree with the detailed model predictions within ±5°C.

IF235610 f. The reduced model predictions of heat flow between the instrument and spacecraft interface will agree with the detailed model predictions to within ±5%.

IF235615 g. For each flight temperature sensor a reduced thermal model node will be identified that corresponds to the sensor location and a temperature correction will be provided.

IF235620 h. Power distribution and time-lines will be provided for each expected mode of the mission and for ground testing.

IF235625 i. Each external node of the reduced node thermal model will have a one-to-one correspondence with a surface or group of surfaces from the surface model.

IF235630 j. Required deliverable reduced node thermal model documentation.

IF235635 The following information and data shall be supplied in fulfillment of the requirement of a deliverable reduced SINDA thermal model (a through k below):

IF235640 a. A table will be supplied which lists the following information for each surface modeled in the surface model that appears in the thermal model:

IF235655 1. A brief description.

IF235660 2. The node number in the model.

IF235665 3. The area in cm^2.

IF235670 4. The predominant surface materials.

IF235675 5. The beginning-of-life and end-of-life values of solar absorptivity and IR emissivity of the surface materials including thermal blanket outer layers. The values of the thermo-optical properties will include tolerances for uncertainties and degradation.

IF235680 b. A table will be provided which lists the node number, a brief description, the mass (kg), the specific heat (J/kg/°C), and the relationship to flight temperature sensors. All tables and lists of data will have units clearly stated.

IF235685 c. Reserved

IF235690 d. Maximum and minimum electrical power consumed and thermal dissipation, if different. Electrical heat dissipation for each node for all operating modes including survival and duty cycle (if applicable). Effects of bus voltage variations should be included.

IF235695 e. The following information relating to instrument thermal control heaters will be supplied.

IF235700 1. Type of control (i.e., on/off ground command, thermostatic or proportional).

IF235705 2. Nodes where heat is dissipated.

IF235710 3. The node used for control.

IF235715 4. Operating temperature limits.

IF235720 5. Rated power at instrument voltage.

IF235725 f. A table will be provided listing the relationship between the external nodes of the reduced node thermal model and the surfaces of the surface model.

IF235730 g. Any engineering assumptions made to reduce the model's complexity or to enhance the accuracy will be stated. Any nodes using adiabatic surfaces or arithmetic nodes (zero mass nodes) will be noted.

IF235735 h. A table will be provided which lists the maximum and minimum temperatures for each node for normal operating conditions, standby mode and survival.

IF235740 i. A sample run with an appropriate orbital environment will be supplied to provide a set of reference temperatures that can be compared with the model as it will be used in the Spacecraft model. In the sample run, the instrument will be modeled as at normal operation under hot case end-of-life and worst case orbital conditions.

IF235645 j. All calculations necessary to analytically verify that the design satisfies the thermal requirements must be included. Any assumptions that must be made to facilitate the analysis shall be clearly stated. A written report including an abstract and a statement of conclusions and/or recommendations should accompany these calculations.

IF235650 k. The SINDA input deck used for the sample run will be provided in ASCII format, and sent electronically to the spacecraft contractor at the time of delivery.

IF235965 Instrument protoflight level testing shall be required for one flight unit and its subsystems, with acceptance level testing for all remaining flight units and their subsystems.

IF235905 The spacecraft contractor shall provide to the instrument contractor, analytical shock profiles.

IF235955 An assessment on the need for Solar Simulation testing shall be accomplished and the result presented to NASA JPSS for concurrence.

IF235960 If significant thermal backloading (energy from some other part of the satellite) on the instrument is produced by the spacecraft, the instrument-level thermal

balance and thermal vacuum testing conditions shall account for that backloading.

IF236135 Items that incorporate extensive changes in design, manufacturing processing, environmental levels, or performance requirements shall be requalified.

However, methodology from MIL-HDBK-340 may be used to show that existing designs or items (previously qualified for other applications) have adequately demonstrated compliance to all qualification requirements for the new designs. Deficiencies in meeting some requirements may be fulfilled by supplementing existing data with new test data.

IF236140 Qualification by similarity shall be permitted only with the concurrence of the government contracting officer.

IF236145 Waiver of qualification or requalification requirements shall be approved by NASA JPSS.

IF233030 Any hardware augmentations necessary to meet the expansion requirements shall, where practical, be designed so that the software and firmware in the data processing subsystems of the space elements are upward compatible with the implementation of those augmentations.

C2 - “MAR/IMAR” ITEMS

IF232695 The instrument shall have no undocumented single-point failures.

Materials

IF233035 Unless otherwise specified, the parts, materials, and processes shall be selected and controlled in accordance with instrument-contractor documented procedures to satisfy the specified requirements (reference MIL-STD-1543B).

MIL-STD-1522A should be used as a guide for design and test of all pressurized systems.

Toxic Products and Formulations

IF233040 The use of combustible materials or materials that can generate toxic outgassing or toxic products of combustion shall be compliant with applicable federal, state, and local laws and regulations.

Parts Selection

Care should be exercised in the selection of materials and processes for the instrument to avoid stress corrosion cracking in highly stressed parts and to preclude failures induced by hydrogen embrittlement.

Parts, materials, and processes should be selected to ensure that any damage or deterioration from storage or the space environment or the outgassing effects in the space environment would not reduce the performance of the instrument beyond the specified limits.

IF233045 Parts for space usage shall be chosen to meet the reliability and operational service life requirements.

IF233050 Parts shall be selected in accordance with the contractor’s Parts Management Plan.

IF233055 The instrument and spacecraft contractors shall demonstrate via design and test or analysis that all parts meet the reliability and operational service life requirements.

Material Selection

IF233060 Materials for the space equipment shall be selected for low outgassing, using NASA SP-R-0 022A (NASA JSC) as a guide, and for resistance to the effects of incident radiation.

IF233065 Materials shall be selected that have demonstrated their suitability for the intended application.

IF233070 Materials shall be corrosion resistant or be suitably treated to resist corrosion when subjected to the specified environments.

IF233075 Where practicable, fungus inert materials shall be used.

IF233080 A-basis material allowables shall be used for design of metallic elements per MIL-HDBK-5. An A-basis allowable is defined as a value where 99 percent of a population of values is expected to equal or exceed the allowable, with a confidence of 95 percent.

IF233085 Class I Ozone Depleting Substances (ODS) shall not be part of the delivered instrument.

IF233090 Use of Class II ODS and Emergency Planning and Community Right to Know Act (EPCRA) Section 313 chemicals shall be identified and either eliminated or minimized, justified, and controlled.

A Hazardous Materials Management Program will be developed in accordance with NAS 411.

IF233100 B-basis material allowables shall be used for design of composite structures. A B-basis allowable is defined as a value where 90 % of a population of values is expected to equal or exceed the allowable, with a confidence of 95%.

IF233105 Black kapton shall not be used in any instrument design unless permitted in the ICD.

IF233110 Materials with radioactivity > 1 microcurie shall not be used in any instrument design.

IF233115 If the instrument design uses the material beryllium, the design shall have no exposed sharp beryllium edges.

IF231435 The electrical connectors shall be MIL-C-38999 or MIL-C-24308 connectors, or other connectors allowed by NASA JPSS approved parts list, using MIL-STD-975 and MIL-HDBK-1547A as guides.

Processes and Controls for Space Equipment

Acceptance and flight certification of space equipment is based primarily on an evaluation of data from the manufacturing process.

IF234225 The manufacturing process for instrument equipment shall be accomplished in accordance with documented procedures and process controls which assure the reliability and quality required for the mission.

IF234230 These manufacturing procedures and process controls shall be documented to give visibility to the procedures and specifications by which all processes, operations, inspections, and tests are to be accomplished by the instrument contractor.

IF234235 Each lot shall be manufactured, tested, and stored with sequential lot numbers that indicate the date of manufacture assigned to each lot. (Typically, use three digits for the day of the year and two digits for the year.)

IF234240 Contractor documentation shall include each material required.

IF234245 Contractor documentation shall include the point each material enters the manufacturing flow.

IF234250 Contractor documentation shall include the controlling specification or drawing.

IF234255 The documentation shall indicate required tooling corresponding to each applicable process or material listed.

IF234260 The documentation shall indicate facilities and test equipment corresponding to each applicable process or material listed.

IF234265 The documentation shall indicate the manufacturing check points corresponding to each applicable process or material listed.

IF234270 The documentation shall indicate the quality assurance verification points corresponding to each applicable process or material listed.

IF234275 The documentation shall indicate the verification procedures corresponding to each applicable process or material listed.

IF234280 The specifications, procedures, drawings, and supporting documentation shall reflect the specific revisions in effect at the time the items were produced.

IF234285 Flow charts and the referenced specifications, procedures, drawings, and supporting documentation become the manufacturing process control baseline and shall be retained by the instrument contractor for reference.

IF234290 All changes to the baseline processes used, or the baseline documents used shall be recorded by the instrument contractor following the establishment of the manufacturing baseline. It is recognized that many factors may warrant making changes to this documented baseline; however, these changes provide the basis for flight accreditation of manufactured or of subsequent flight items.

IF234295 The manufacturing process and control documents for instrument equipment shall provide an instrument contractor-controlled baseline that assures that any subsequent failure or discrepancy analysis that may be required can identify the specific manufacturing materials and processes that were used for each item. In that way, changes can be incorporated to a known baseline to correct the problems.

Assembly Lots

IF234300 To the extent practicable, parts for use in instrument equipment shall be grouped together in individual assembly lots during the various stages of their manufacture to assure that all devices assembled during the same time period use the same materials, tools, methods, and controls.

IF234305 Parts and devices for instrument equipment that cannot be tested adequately after assembly without destruction of the item, such as explosive ordnance devices, some propulsion components, and complex electronics, shall have lot controls implemented during their manufacture to assure a uniform quality and reliability level of the entire lot.

IF231180 Harness wire sizes shall be consistent with overcurrent protection device sizes.

IF231440 The contractor (instrument and spacecraft) shall derate electrical connectors, using MIL-HDBK-1547A as a guide.

IF231500 Connectors shall be different sizes, different types, different orientation, color coded or uniquely keyed to prevent improper connection.

This is the recommended order of preference.

IF231620 Instrument power harnesses, within the instrument and within the spacecraft harness, shall be appropriately sized to support the peak allocated power levels and spacecraft fusing.

IF231710 The provider of any harness shall bake out the harness prior to delivery.

Protective Coatings and Finishes

IF231730 The finishes used shall ensure that completed devices are resistant to degradation caused by environmental conditions and galvanic action.

IF231740 The instruments shall not use materials or coating known to flake or outgas, such as cadmium or zinc platings.

IF231745 Pure tin or tin alloy (less than 3 % lead) plating shall not be used on electrical devices and hardware. The guiding document for this prohibition is MIL-HDBK-1547A, "Electronic Parts, Materials, and Processes for Space and Launch Vehicles."

IF231750 Both metallic and insulating surfaces in electronic boxes, such as printed wiring assemblies, where contamination could cause electrical malfunction shall be conformally coated unless otherwise insulated or hermetically sealed.

IF231755 The use of conformal coatings shall apply to electrical components in instruments and their associated ground equipment. MIL-I-46058, or equivalent can be used in selection of conformal coatings and their thicknesses.

IF231760 The use of conformal coatings shall neither lessen the dielectric strength, nor cause deterioration of any electronic components to the extent of affecting top level performance.

IF231765 Unjacketed flexible shielded cable and ground straps shall be specifically excluded from this conformal coating requirement.

IF231770 Certain components suffer significant performance degradation if conformally coated. In these situations, non-use of conformal coatings on electrical components and hardware shall be supported by a thorough analysis and be subject to MRB approval.

IF231775 There shall be no destructive corrosion of the completed devices if exposed to environments normally associated with manufacture, test, transportation, and launch.

IF231780 Nickel Plating shall not be used (unless an electroless process is employed or as underplate for Level 1 IEEE piece parts) in any instrument design.

IF231785 Dissimilar materials defined in MIL-STD-889 shall not be used in direct contact.

IF231970 The spacecraft contractor shall be responsible for approving the Multilayer Insulation (MLI) selection in the Parts, Materials and Processes Control Board (PMPCB) review process.

IF231975 MLI used in thermal control design shall have the following provisions: venting, interfacing with spacecraft thermal control surfaces, and electrical grounding to prevent Electro-Static Discharge (ESD).

IF231990 Any sealed or closed system such as heat pipes, thermal control enclosures, or fluid loops shall not have safety hazards.

IF232040 A single fault on either the spacecraft side of the interface or the instrument side of the interface shall not prevent the full and complete digital data transfer needed to fulfill mission requirements.

IF232042 The instrument and spacecraft shall not propagate a single fault occurring on one interface or instrument, on either side of the interface, to the redundant interface or instrument.

IF233550 Interfaces shall be designed in accordance with the safety requirements in USAF EWR AFS PCMAN91-710.

IF233495 Critical steps of fabrication that are item-peculiar shall be detailed in drawing notes and figures which include appropriate workmanship criteria.

IF233500 Workmanship relating to all other aspects of fabrication shall be in accordance with the Quality Control Plan approved for each manufacturing facility.

IF233520 Hazards to personnel, hardware, or the environment during design, test, manufacture, integration and assembly, handling, transportation, and operations of the instrument shall be identified and controlled or eliminated.

IF233525 Design and operational safety requirements shall be developed and implemented to eliminate or control personnel, hardware, or environmental hazards.

IF233530 Instruments and deliverable support equipment developed for this program shall comply with USAF EWR AFS PCMAN91-710 in the areas of design safety, launch integration, and ground operations.

IF233535 Software controlling hazardous systems or operations (e.g., electro-explosive devices, electromechanical release devices, etc.) shall be assessed for hazard severity and probability in accordance with AFM 91-201 and using MIL-STD-882D as a guide.

IF233540 An instrument safety program shall be established and maintained, using MIL-STD-882D as a guide.

IF233675 Provisions shall be made for the control of all nuclear materials, such as radioactive sources, if used in manufacturing, calibration, and checkout of mission instruments.

IF233705 All software and firmware shall be implemented with an internal identifier (embedded in the executable program) that can be included in the instrument engineering data.

IF233710 This identifier shall be keyed to the configuration management process so that the exact version of software and firmware residing in the instrument can be determined at any time.

IF233730 System and application software developed for JPSS, except where implemented on digital signal processing hardware, shall be implemented in widely used programming languages governed by published government and/or ISO, ANSI, or IEEE standards, unless otherwise approved by the Government.

IF335380 Commands that can potentially damage the spacecraft, instrument or cause injury to personnel shall require NASA JPSS authorization prior to being sent to the instrument for execution.

IF233800 The structure shall be designed to have sufficient strength to withstand simultaneously the yield loads, applied temperature, and other accompanying environmental phenomena for each design condition without experiencing yielding or detrimental deformation.

IF233805 The structure shall be designed to withstand simultaneously the ultimate loads, applied temperature, and other accompanying environmental phenomena without failure.

IF233810 The structural dynamic properties of the equipment shall be such that its interaction with the instrument control subsystem does not result in unacceptable degradation of performance.

IF233815 Stiffness of the structure and its attachments shall be controlled by the equipment performance requirements and by consideration of the handling and launch environments.

IF233820 Special stowage provisions shall be used, if required, to prevent excessive dynamic amplification during transient flight events.

IF233855 Limit loads shall be applied through the center of mass (CM) of the instrument, configured for launch, to design the mounting interface.

IF233860 The loads shall be applied simultaneously using combination of +/- loads in such a way as to produce the maximum stresses.

IF233865 The minimum design factors of safety of Table 3.3.12.4.1-1 below, for the selected option, shall be applied to all loading conditions.

The factors of safety shown above are in addition to contractor-determined margins. The standard definitions apply, namely, no detrimental deformation at the yield value, and no failures at the ultimate value.

Type	Static	Sine	Random/Acoustic[4]
Metallic Yield	1.25[3]	1.25	1.6
Metallic Ultimate	1.4[3]	1.4	1.8
Stability Ultimate	1.4	1.4	1.8
Beryllium & AlBeMetYield	1.4	1.4	1.8
Beryllium & AlBeMet Ultimate	1.6	1.6	2.0
Composite Ultimate	1.5	1.5	1.9
Bonded Inserts/Joints Ultimate	1.5	1.5	1.9

1 – Factors of safety for pressurized systems to be compliant with section 3.3.12.4.2

2 – Factors of safety for glass and structural glass bonds specified in NASA-STD-5001

3 – If qualified by analysis only (i.e., no test), positive margin must be shown for factors of safety of 2.0 on yield and 2.6 on ultimate. Beryllium and composite materials cannot be qualified by analysis alone.

4 – Factors shown should be applied to statistically derived peak response based on RMS level. As a minimum, the peak response shall be calculated as a 3-sigma value.

IF233867 The minimum test factors shall be as shown in Table 3.3.12.4.1-2

Table 3.3.12.4.1-2. Structural Test Factors

Design/Test Options	Test Level Factors
1. Dedicated test article	1.25
2. Test on 1st flight article	1.25
3. Proof test each flight article	1.00
4. Beryllium structure	1.40

IF233895 Positive structural margins of safety shall be maintained so that the instrument can meet all design requirements after being subjected to the worst-case load combinations.

IF233905 Instruments with pressurized systems shall follow the requirements in accordance with USAF EWR AFS PCMAN91-710for the design of pressurized systems and using MIL-STD-1522A for guidance.

IF233915 Proof and burst pressure factors shall be established at levels that ensure structural integrity, structural life, and safety throughout all phases, using the values listed in Table 3.3.12.4.2-1 as limiting lower bounds.

Table 3.3.12.4.2-1. Factors of Safety for Pressurized Components

Component	Design (Ultimate)	Acceptance (Proof)	Qualification (Burst)
Pneumatic Vessels (SVE) [a]	2.00	1.50b	2.00b
Pneumatic Vessels (GSE) [a]	4.00	2.00[b]	4.00
Lines, Fittings, and Hoses			
Less than 3.81 cm diameter	4.00	2.00b	4.00b
3.81 cm diameter and larger	1.50	1.10b	1.50b
Other Pressurized Components	2.50	2.00b	2.50b

Notes:

a Factors of safety shown are minimum values applicable to metallic pressure vessels for which ductile fracture mode is predicted via a combination of stress and fracture mechanics analyses. Design of metallic pressure vessels for which brittle fracture mode is predicted by these analyses should be in accordance with fracture mechanics methodology, wherein the proof factor as well as the design ultimate factor of safety are established to provide a minimum of four times the specified service life against mission requirements. In addition, a fracture control program should be established to prevent structural failure due to the initiation or propagation of flaws or crack-like defects during fabrication, testing, and service life.

b No measurable yielding is permitted at acceptance (proof) test pressure and no rupture at qualification pressure.

IF233920 The instrument equipment shall be capable of withstanding all design load conditions to which it is exposed in all mission phases, as applicable: ground, prelaunch, erection, post-launch, boost, and orbit.

IF233925 During the orbit phase, all of the following shall be considered: maneuvering loads, vehicle spin, meteoroid environment, radiation environment, and other environmental factors, such as thermal effects due to internal heating, solar heating, eclipses, and extreme cold due to ambient space environment.

IF233930 Tubing design shall incorporate provisions for cleaning and to allow proof testing.

Separable Fittings

IF233935 Separable fittings shall have redundant sealing surfaces, such as double "O" rings, and be of the "parallel loaded" type.

“Parallel loaded” means that the fitting contains a compressed element which exerts outward pressure on the other elements of the fitting such that both seals are maintained even if relaxation occurs.

IF233940 Separable fittings shall have provisions for locking.

IF233945 Separable fittings shall be accessible for leak tests and for torque checks.

IF233950 Separable fittings shall not be designed or assembled with lubricants or fluids that could cause contamination or could mask leakage of a poor assembly.

IF233955 Separable fluid fittings shall not use "B" nuts, unless specifically allowed in the ICD.

IF233960 Separable fluid fittings shall be comprised of one or more compressed or internally pressure-energized members which maintain a seal even if stress relaxation occurs in any of the other components.

IF233965 Separable fluid fittings shall have redundant seals in series.

IF233970 Separable fluid fittings shall be lockwired to prevent any rotation between the fitting and the nut.

IF233975 The instrument shall have no open fluid reservoirs at the time of delivery.

IF233980 Deployment mechanisms, instrument mechanisms, pointing mechanisms, drive mechanisms, de-spin mechanisms, separation mechanisms, and other moving mechanical assemblies on instruments should be in accordance with MIL-A-83577B in order to increase reliability of Moving Mechanical Assemblies (MMAs) and facilitate integration and test activities.

The spacecraft contractor will provide estimates of allowable disturbance torque, vibration, and end-of-travel or latch-up loads to the instrument contractor. The design will be an iterative process to accommodate the requirements of both the spacecraft contractor and instrument contractor.

IF234115 Instrument handling fixtures shall be designed to five times limit load for ultimate and three times limit load for yield.

IF234120 Instrument handling fixtures shall be tested to two times working load.

IF234200 Instrument mechanical ground support equipment (IMGSE) shall be painted with non-shedding paint. Metal surfaces may be painted or coated.

IF234205 Large lifting slings shall have grounding capability.

IF235190 Mechanical GSE shall have a 5X design safety factor.

IF235195 All MGSE shall have been proof loaded to 2 times the lifting load within 1 year of its usage.

IF236140 Qualification by similarity shall be permitted only with the concurrence of the government contracting officer.

IF234870 Appropriate provisions shall be made to avoid and to protect against the effects of static electricity generation and discharge in areas containing electrostatic sensitive devices such as microcircuits, initiators, explosive bolts, or any loaded explosive device. DOD-HDBK-263 provides examples of appropriate provisions.

IF234875 There shall be a capability to ground both equipment and personnel working on and around the instrument, subsystems, and components.

All support facilities, including test facilities and launch base facilities, should comply with the grounding requirements of MIL-STD-1542B and NOAA S24.809.

IF234880 All personnel working on or near instruments shall have ESD training.

IF234885 All personnel working on or around the instrument and GSE shall wear ground straps in accordance with an established ESD plan.

IF234890 Equipment used in the vicinity of the instrument shall be grounded.

IF236220 Deliverable items shall be packed and handled by the instrument contractor so as to protect them against vibrations, shocks, moisture, electrostatic charge, and contamination associated with ground or air transport such that calibrations, alignment and performance are not degraded.

IF235070 The instrument contractor shall ensure that quality assurance requirements flow down to all subcontractors.

Inspections and Tests of the Instrument

Instrument Parts, Materials, and Process Controls

IF235080 Parts, materials, and process controls shall be applied during production of all items to ensure that a reliable instrument is fabricated, including use of a material review board (MRB) and test/failure review board (TRB/FRB).

IF235085 The tools, processes, parts, and materials used in the fabrication of the instrument shall be controlled and inspected to ensure compliance with approved manufacturing processes and controls.

Instrument Records

IF235090 The instrument contractor shall maintain records documenting the status of the instrument following assignment of serial numbers.

IF235095 Each instrument item shall have inspection records and test records, maintained by serial number, to provide traceability from instrument usage to production lot data for the devices.

IF235100 The instrument contractor shall maintain complete records for the instrument items and have them available for review during the service life of the instrument.

IF235105 The records shall indicate all relevant test data; all rework or modifications; and all installations and removals for whatever reason.

IF235110 Ground test equipment items shall have inspection records and test records, maintained by serial number, for the service life of the item.

Instrument Manufacturing Screens

IF235115 The instrument contractor shall subject each level of assembly to in-process manufacturing and assembly screens to ensure compliance with the specified requirements to the extent practicable.

IF235120 At each level of assembly, the instrument contractor shall subject each completed unit to visual inspection to ensure that it is free of obvious defects and is meeting specified physical limits.

Non-conforming Material

IF235125 The instrument contractor shall reject all material, components, or assemblies that do not meet the established tolerance limits set for the acceptance limits in the in-process screens.

IF235130 The instrument contractor shall only permit "use-as-is" status on out-of-tolerance parts that have been proven by analysis and/or test to satisfy the total system requirements per the instrument contractor's material review board (MRB).

Any rejected material, component, or assembly may be reworked and re-screened in accordance with established procedures, if the rework is not so extensive as to jeopardize the lot identity of the material or assembled unit. If the reworked material or assembled unit subsequently passes the in-process screens, it can again be considered part of the lot.

IF235135 MRB items shall be made available to NASA JPSS for approval.

IF235140 Reassignment of assembled units to a different lot shall not be made.

Instrument Design Verification Tests

IF235145 The instrument contractor shall perform design verification testing to demonstrate that new or modified designs comply with the specified performance margins.

IF235220 The electrical interface between the spacecraft bus and the instrument shall be checked out prior to instrument delivery to the spacecraft using an electrical interface simulator provided by the spacecraft contractor.

IF235870 Instrument static loads test shall be conducted in accordance with MIL-STD-1540C on the first production instrument if the loads predicted by the model exceed the maximum equivalent flight values.

IF236130 Outgassing evaluation tests shall be conducted for materials, components, and sub systems whose properties are not known.

IF236150 The instrument contractor shall furnish NASA JPSS with a list of age sensitive parts used in the instruments.

IF236155 Lifetime testing shall be conducted in accordance with a tailored MIL-STD-1540C.

IF236160 Explosive ordnance devices and other components whose performance may degrade with time shall have life extensions based on tests made on other devices from the same lot, at the time the extension is requested/necessary.

IF233870 All composite structures and structural bonded joints shall be proof tested, regardless of safety factor.

C3 - THE FOLLOWING REQUIREMENTS APPLY TO DRILL TEMPLATES, IF PROVIDED BY THE INSTRUMENT PROVIDER

IF230509 Drill template design features shall be mutually agreed upon between the instrument and spacecraft contractors, and documented in the MICD.

IF230510 The following requirements shall apply to drill template fabrication by the instrument contractor:

IF230515 a. The material shall be aluminum (preferred), steel or other suitable material.

IF230516 b. The minimum thickness of the drill template shall be in accordance with Table 3.2.4.2.3.2.3.2-1.

To minimize perpendicularity error of the datum feature bushings, local areas around the bushings may be pocketed or the template otherwise reduced in thickness.

IF230520 c. All instrument mounting and datum holes shall be provided with steel drill and liner bushings.

IF230521 d. Liner bushings shall be dimensioned for the appropriate English sized bolt.IF230522 e. Drill and liner bushing IDs and ODs shall be mutually agreed upon and documented in the MICD.

IF230526 f. Liner bushings for datum holes shall be sized to accommodate an instrument compatible drill bushing along with a laser tracker retro-reflector compatible drill bushing.

IF230527 g. Laser tracker retro-reflector compatible drill bushing requirements (IDs) shall be as specified in the MICD.

IF230528 h. Laser tracker retro-reflector compatible drill bushings shall be accessible from the instrument side of the template for the nesting of the retro-reflector.

IF230529 i. There shall be a 44 mm (1.7 inch) diameter minimum clearance around each datum hole.

IF230525 j. The surface flatness shall be less than or equal to 1 mm (0.04 inch) peak-to peak.

IF230517 k. Interface surfaces shall be co-planar to within MICD requirements.

IF230530 l. Surface finish shall be better than 3.2 micrometers (125 microinches) root mean square (RMS).

IF230518 m. The template surface treatment shall be oxidation resistant (Aluminum-chem film per MIL-C-5541, Steel-epoxy polyamide primer per Mil-P-23377)

IF230519 n. The drill template shall be fabricated and suitable for use at 21 ± 1 deg C (70 ± 2 deg F).

IF230523 o. Templates over 9.1 kg (20 lb) shall be supplied with 3 or 4 swivel lifting rings or equivalent.

IF230531 p. The swivel lifting rings/template assembly shall be designed with a 5X factor-of-safety and static proof tested to 2X the lifting load for 3 min.

IF230532 q. The template shall include 4 patterns of 2 each ¼ inch-20 threaded inserts (Keenserts or equivalent) for support of the template during spacecraft bus manufacturing (gantry I/F).

IF230533 r. Locations of the threaded inserts shall be as shown on the MICD.

IF230535 s. The drill template shall be marked with the following:

1. The spacecraft / instrument reference coordinate frame
2. Template orientation and side to be used for spacecraft or instrument drilling
3. Template weight
4. Template part number (on all components including alignment target/cube protective cover).

IF230540 t. Drill templates for each components that which requires alignment shall include an optical alignment target or cube bonded to the template.

IF230541 u. Optical alignment target / cube nominal location and orientation with respect to mounting datum(s) shall be as shown on MICD; should be similar to instrument.

IF230542 v. Drill template optical alignment targets or cubes shall have a removable protective cover

IF230545 w. The size of the drill template shall not exceed the instrument envelope.

IF230550 x. The drill template shall be received in a suitable, clean room compatible container that is labeled and contains all related hardware and documentation. Non-wood containers preferred, untreated / unpainted wood containers not acceptable.

Table 3.2.4.2.3.2.3.2-1. Drill Template Thickness

Longest Overall Dimension		Template Thickness	
Mm	**(inch)**	**mm**	**(inch)**
<381	(<15)	12.7	(0.5)
381-762	(15-30)	25.4	(1.0)
>762	(>30)	50.8	(2.0)

IF230555 The instrument contractor shall provide the spacecraft contractor with the drill template containing appropriate alignment, orientation, and location reference information.

C4 - THE FOLLOWING CONTAMINATION REQUIREMENTS APPLY TO THE EXTENT IDENTIFIED IN THE ICD

Contamination

IF234310 An instrument-level contamination control program shall be developed and implemented.

IF234335 The contamination interface requirements shall be provided for inclusion in the ICD.

This includes contamination sensitivity of the instrument, as well as identification and characterization of all sources of contamination that can be emitted from the instrument.

IF234345 A system-level contamination control plan (CCP) shall be developed by the spacecraft contractor, taking into consideration instrument and other instrument equipment and facility contamination and cleanliness requirements, along with the spacecraft requirements, and the resulting contamination budget provided to each instrument contractor.

IF234340 Contamination control implementation for the instrument shall be performed in accordance with the instrument CCP at the instrument contractor's facility and the spacecraft contractor's CCP at the spacecraft contractor's facility.

IF234350 As part of the contamination control analysis development, the spacecraft contractor shall perform a particulate and molecular plume flowfield analysis for all spacecraft thrusters, vents and outgassing surfaces, providing molecular flux quantities into instrument apertures at the time they are opened on-orbit and total predicted depositions at end-of-life (EOL) onto all sensitive surfaces.

IF234355 This spacecraft contractor's particulate and molecular plume flowfield analysis includes a plume flowfield analysis for all thrusters and any launch vehicle stages which fire after the payload fairing is jettisoned. The flowfield analysis shall include:

a. Identity and quantity of each chemical species emitted,
b. Density as a function of spatial position, including the "backflow region" at angles > 90 degrees from the plume centerline,
c. Velocity or flux as a function of spatial position, including the backflow region,
d. An equation or group of equations describing the plume.

IF234360 The spacecraft contractor shall apply margin for an additional contribution from the payload fairing and launch vehicle thrusters fired after the payload fairing has been jettisoned.

IF234365 The spacecraft and instrument contractors shall identify and characterize all sources of contamination, particulate or molecular, that can be emitted.

IF234370 At a minimum, the characterization of molecular and particulate contamination shall include the material name, the amount, the emission rate, and its location.

IF234375 Non-metallic materials used in the construction of the instrument shall not suffer a total mass loss of greater than 1.0 percent and a volatile condensable material mass gain of greater than 0.1 percent when tested in accordance with the Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment, ASTM E595-93.

IF234380 The out-gassing chemical species and any tendency to photodeposit in a UV or energetic particle radiation environment shall be identified and quantified.

IF234385 All instrument deployable systems shall be designed to minimize particle release that may compromise mission performance.

IF234390 The spacecraft contractor shall perform a total spacecraft contamination analysis of all contributing deployment devices on all sensitive surfaces and document the results to the instrument contractor.

IF234395 The Instrument contractor shall specify, for documentation in the ICD, if and when protective covers (such as bags, draping materials, or hard covers), or purging, are required to keep the instrument clean during I&T, including during shipping and storage.

IF234400 The instrument contractor shall deliver the instrument to the spacecraft contractor double-bagged.

IF234405 Only packaging/cover materials which have been approved by NASA JPSS shall be used on the instrument.

IF234410 Packaging/cover materials to be used for launch site activities shall have passed the tests for Electrostatic Discharge (ESD) per KSC/MMA-1985-79; Flammability per NASA-STD-6001 and Hypergolic Ignition (for hydrazine only) per KSC/MTB-175-88.

IF234415 Packaging/cover materials to be used during spacecraft Integration and Test (I&T) activities shall have passed the tests for Electrostatic Discharge (ESD) per KSC/MMA-1985-79; and Flammability per NASA-STD-6001.

IF234420 The Instrument contractor shall provide instrument protective covers that protect fragile components from minor impact as well as contamination.

IF234425 The instrument contractor shall specify procedures for use of the protective covers.

IF234430 The spacecraft contractor shall ensure sensitive instrument surfaces are covered during spacecraft I&T, shipment, and launch site processing.

Contamination Control Requirements

IF234435 The instrument contractor and the spacecraft contractor shall perform independent contamination analyses per the instrument CCP using "MOLFLUX" (or similar analytical program), to identify, locate and size components sensitive to contamination and assess, calculate or measure the maximum allowable particulate and molecular film (nonvolatile residue, or NVR) contamination consistent with top level mission performance and lifetime specifications.

IF234440 The spacecraft contractor shall perform a Contamination Sources and Effects Analysis using "MOLFLUX" (or similar analytical program), to identify, locate and size components sensitive to contamination and assess, calculate, or measure the maximum allowable particulate and molecular film (non-volatile residue (NVR)) contamination consistent with top level mission performance and lifetime expectations.

IF234445 The spacecraft contractor shall provide the instrument contractor with the analysis results as documented in the JPSS Contamination Sources and Effects Analysis.

IF234450 The instrument contractor shall provide contamination requirements limits for documentation in the ICD.

IF234455 The instrument contractor shall document procedures for all contamination protection measures to be taken after delivery of the instrument.

Facility Environmental Requirements

IF234465 The spacecraft contractor shall integrate the instrument with the spacecraft in a Class 10,000 cleanroom environment and maintain that environment as much as possible during the integration and test flow.

IF234470 Instruments shall be covered and purged whenever exposed to an environment worse than Class 10,000, if so indicated in the ICD.

IF234475 The instrument contractor shall describe the required integration and test environments in accordance with the definitions of FED-STD-209E or ISO/TC 209.

IF234480 Instrument and spacecraft contractor facility requirements shall be documented and shall include, as appropriate, air cleanliness, air flow and recirculation rates, temperature and humidity, and tolerance for out-of-spec conditions (i.e., intermittent spikes) as a minimum. Particle fallout data shall also be provided.

IF234485 In order to maintain the lowest possible relative humidity when the instrument is not being worked on, the instrument shall be enclosed in a tent or bag fabricated of approved antistatic plastic film as specified in the instrument CCP.

IF234500 Receipt and handling shall be in accordance with instrument contractor, Handling and Transportation Procedure

IF234505 During satellite transportation, the ambient air temperature shall be maintained and monitored at 20 +/- 4 °C and the relative humidity at < 50%.

IF234510 The cleanliness shall be a Class 10,000 or better per FED-STD-209E during transport.

IF234515 Any required spacecraft witness samples shall be in place during the move.

IF234520 The interior of the shipping container shall be designed and fabricated out of low outgassing, low shedding materials compatible with Class 10,000 requirements.

IF234525 The interior of the shipping container shall be cleaned to a level 600A or better per IEST-STD-CC1246D prior to its use.

IF234530 The instrument shall be covered during transport.

IF234535 The instrument and spacecraft shall be packaged and purged during transport.

IF234545 Requirements shall include verification by standard testing methods to be performed at regular, specified intervals.

Ground Support Equipment (GSE) Cleanliness Requirements

Ground support equipment (GSE) is defined as those items which are required for the assembly, handling, functional evaluation, design verification, performance testing, transportation shipping and storage of the instrument.

IF234550 Any GSE that accompanies the instrument into a cleanroom area or vacuum chamber shall meet the following requirements (rest of section 3.3.15.1.2.2.1):

IF237000 Design GSE to eliminate/mitigate contamination (i.e., use low outgassing, non-shedding materials, enclose moving parts to prevent particulate release into the environment surrounding the satellite, use labyrinth seals to isolate lubricated surfaces).

IF237005 Inspect MGSE and clean as required.

IF237010 Bag MGSE used over the satellite to prevent contaminants from falling onto the satellite.

IF237015 Vacuum bake out GSE used within the thermal vacuum test chamber prior to use.

IF237020 Pre-clean and package mating gas and liquid lines as well as electrical connectors to ensure that contaminants are not transferred to the payload hardware.

IF237025 Fabricate out of open cross section structural members (i.e. I-beams or C-channels)

IF237030 No cadmium, zinc plating or tin plating (unless it is re-flowed) without approval from Contamination Control Engineer.

IF237035 No polyvinyl chloride (PVC) or tygon tubing shall be utilized in the GSE fabrication.

IF237040 No highly volatile compounds (lubricants, greases, cutting fluids) shall be used without prior approval from Contamination Engineering.

IF237045 Use only low outgassing, durable (chip & solvent resistant) paint.

IF237050 Any GSE which does not meet the above requirements shall be bagged, sealed and approved for use in the clean room by the Contamination Control Engineer or designated representative.

IF237055 Electronic test equipment employing blowers or fans shall be compatible with Class 10,000 clean room environments.

IF234555 All GSE, including cables, used inside thermal/vacuum chambers shall be cleaned and verified as vacuum compatible.

IF237006 Instrument GSE entering the satellite integration cleanrooms shall be visibly clean (Level 500A or better).

Instrument Inspection and Cleaning During I&T

IF234560 Instrument contractor inspection, cleaning, and access requirements during Integration, test and launch operations (ITL) shall be coordinated and defined in the ICD.

IF234320 The instrument provider shall supply the shipping container for instrument transportation and any hardware associated with gas purge.

IF234325 The instrument provider shall be responsible for the cleanliness of the instrument until delivery to the spacecraft contractor.

IF234330 The spacecraft contractor shall be responsible for cleanliness after delivery of the instrument to the spacecraft contractor.

IF234565 Instrument contractors should consider having defined "pass/fail" criteria consistent with top level mission performance and lifetime specifications and the derived contamination budget for that I&T milestone.

The instrument-lifting fixture is used to transfer the instrument from the instrument shipping container to the spacecraft during instrument installation.

IF234590 Witness sample materials shall be provided by instrument contractor.

IF234595 Cleanliness monitoring of the instrument during testing, storage, transportation and integration shall take place using witness plates.

IF234600 The instrument contractor shall supply descriptions of the witness samples for documentation in the ICD.

IF234605 The instrument shall be installed on the spacecraft clean.

IF234610 Installation induced contamination shall be removed as generated.

IF234615 At the system level, removal of contaminants shall be accomplished using only the following methods: solvent wiping, vacuum cleaning, gas purging and CO2 jet spray .

IF234620 Special cleaning techniques such as tape lift cleaning shall be used only when approved by NASA JPSS.

IF234625 A NASA JPSS representative shall approve materials used for cleaning for compatibility with facility safety requirements and S/C materials and mechanisms.

IF234630 The instrument shall be configured such that it can be stored, integrated with the spacecraft, and operated in a Class 10,000 or better (per FED-STD-209E) cleanroom environment for extended periods of time.

IF234635 The spacecraft contractor shall monitor air cleanliness continuously.

IF234640 Nonvolatile Residue (NVR) and particle fallout witness plates shall be changed out monthly, or at key events in the I&T flow (i.e., a change in environment).

Instrument Purge Requirements

IF234645 Instrument purge requirements, including type of purge gas (e.g., dry air or GN2), flow rate, gas purity specifications, filtration and desiccant requirements, and the tolerance for purge interruption, shall be provided for documentation in the ICD.

IF234670 Internal instrument purge hoses and fittings shall be flight compatible.

Internal instrument purge hoses will not be removed prior to flight.

Fabrication and Handling

IF234675 Fabrication and handling of instrument equipment shall be accomplished in a clean environment.

IF234680 Conformal coating or other protective mechanism shall be used where contamination could cause electrical malfunction.

IF234685 Attention shall be given to avoiding non-particulate (chemical) as well as particulate air contamination.

IF234690 To avoid safety and contamination problems, the use of liquids should be minimized in areas where initiators, explosive bolts, or any loaded explosive devices are exposed.

IF234695 Materials and coatings known to flake or outgas (at levels which exceed those levels identified in the instrument contractor's contamination control plan), such as cadmium and zinc plating, shall not be used.

Device Cleanliness

IF234700 The particulate cleanliness of internal moving subassemblies shall be maintained to at least level 500, as defined in IEST-STD-CC1246D, or "visibly clean", as required by the ICD.

IF234705 External surfaces shall be visibly clean.

IF234710 The instrument contractor shall verify the cleanliness of the instrument interior and exterior surfaces prior to shipment to the spacecraft contractor.

IF234715 The results of these tests shall be documented by the instrument contractor and provided to NASA JPSS.

IF234720 The instrument contractor Pre-ship Review Package shall include documentation verifying that during the last hot cycle of the instrument level thermal vacuum testing, the instrument demonstrated that it does not outgas at a rate greater than specified in the ICD.

IF234725 Materials used in the fabrication of radiator surfaces shall be documented in the instrument CCP.

IF234730 The cleanliness criteria shall have been verified using the deposition rates experienced by a Temperature Controlled Quartz Crystal Microbalance (TQCM) maintained at -20 deg C and positioned in a location representative of the effluent flux.

Note: The TQCM variation will be defined in the responsible party's CCP.

IF234721 Outgassing rate shall be measured at a pressure of 1.0 E-5 torr or less by a -20 C (or colder) TQCM placed near an instrument vent while the instrument is at the hot qualification temperature. Rate must be obtained for at least 6 consecutive hours.

IF234735 The location of the TQCM in the thermal vacuum chamber shall be approved by NASA JPSS.

IF234740 At launch external surfaces shall meet Level 600A per IEST-STD-CC1246D.

IF234745 At the beginning of life (BOL) external surfaces shall meet Level 650B per IEST-STD-CC1246D.

IF234750 The flux (out gassing and plume) of molecular contaminants into the instrument apertures shall not exceed the amount specified in the ICD.

IF234755 The instrument shall be designed to function in the spacecraft contamination environment.

IF234760 The spacecraft contractor Contamination Control Specialist shall perform external surface cleanliness inspection and verification.

IF234765 The instrument shall be capable of being cleaned with isopropyl alcohol, and carbon dioxide "snow" unless otherwise specified in ICD.

IF234770 At the request of the S/C provider, the instrument contractor shall perform instrument contamination control surveillance during S/C I&T and launch operations.

IF234775 All inspection and cleaning operations shall be performed in accordance with the instrument CCP.

IF234780 Specific cleaning requirements for thermal control surfaces shall be specified as indicated in the instrument CCP.

IF234785 Blanket material shall be cleaned and baked prior to installation onto the instrument.

IF234790 Blankets shall be fabricated in a Class 100,000 environment and then cleaned to a visibly clean level prior to entry into a Class 10,000 cleanroom.

IF234795 Cabling/harnessing shall be cleaned and baked prior to installation onto the spacecraft.

Instrument Sources of Contamination

IF234800 The spacecraft contractor shall coordinate handling of the issue of material outgassing.

IF234805 The instrument contamination budget, as defined in the instrument CCP, will take in to consideration launch and payload separation contamination contributions.

IF234810 Instrument contractors shall identify and characterize all sources of contamination, particulate and molecular, that can be emitted from the instrument.

IF234815 At a minimum, the characterization of particulate and molecular contamination shall include the material name, the amount, the emission rate, and its location.

IF234820 Vents and outgassing paths shall be controlled to minimize the extent to which molecular outgassing products have access to exterior surfaces.

IF234830 Vent locations shall be reviewed by the spacecraft contractor contamination control personnel to ensure that the JPSS spacecraft, the instrument and other instrument critical surfaces or apertures are not affected.

IF234835 If percent total mass loss (%TML) and percent collected volatile condensable material (%CVCM) data is unavailable, the material shall be tested, per ASTM E -1559, or ASTM E 595.

Materials with the following properties are recommended: Total Mass Loss (TML) less than 1.0 %; production of Collected Volatile Condensable Material (CVCM) less than 0.1 % when tested under conditions of ASTM E595-93 or equivalent.

IF234840 The outgassing chemical species and any tendency to photodeposit in an ultraviolet (UV) or energetic particle radiation environment shall be identified and quantified.

IF234845 The instrument contractors shall consider effects on materials due to the planned space environment, including radiation, vacuum, thermal cycles, and atomic oxygen.

IF234850 If voltage over 100 V are present, the design shall be protected (e.g., potting, pressure vessel) against arcing, and thus, from arcing contamination.

IF234855 Items that might otherwise produce deleterious outgassing while on-orbit, such as composite structures, shall be baked for a sufficient time to drive out all but an acceptable level of outgassing products prior to installation within or on the instrument.

Atomic Oxygen Contamination

IF234860 Instrument materials selection shall minimize the generation of particulate and molecular film contamination via interaction with atomic oxygen (AO).

IF234865 Instrument contractors shall consider the effects of atomic oxygen in the space environment.

IF231980 Thermal control surfaces shall be cleanable to visibly clean or better.

IF231985 Thermal blankets shall be cleaned and baked prior to installation.

C5 - THE FOLLOWING ITEMS, AS A MINIMUM, ARE TO BE INCLUDED IN THE INSTRUMENT-SPECIFIC ICD

IF234150 The instrument contractor shall provide information on all items to be installed or removed prior to flight, for identification in the ICD.

IF230045 Additional modes shall be defined, as required, by the instrument contractor for documentation in the ICD.

IF230050 All instrument commands, and command functions performed by the spacecraft on behalf of the instrument, shall be defined in the ICD.

IF230075 Any special sequences required to re-configure from sudden entry into OFF mode, shall be documented in the ICD.

IF230085 The instrument contractor shall define, for documentation in the ICD, what activation sequences / events are required, where they are necessary, and specific spacecraft control requirements, including appropriate algorithms to be implemented.

IF230120 The DIAGNOSTIC mode shall support trouble shooting, allowing different sampling of telemetry as documented in the ICD.

IF230130 If so indicated in the ICD, the instrument shall notify the spacecraft that it has placed itself into the Instrument SAFE Mode and then await specific further commands via the spacecraft.

IF230135 The conditions monitored by the instrument to go into safe mode, and associated instrument responses, shall be documented in the ICD to ensure that the response is not detrimental to the spacecraft as a whole (such as a sudden momentum shift).

IF230160 Autonomous INSTRUMENT SAFE-mode entry initiation, by the instrument, shall be inhibitable by command from the spacecraft or by other mechanism documented in the ICD.

IF230250 Instrument testing and inspection to be accomplished at the launch site shall be documented in the ICD.

IF230260 The instrument contractor shall identify for documentation in the ICD the required sequences leading up to the pre-launch OFF mode.

IF230280 The instrument's ability to survive, without permanent performance degradation, arbitrary pointing conditions, due to a spacecraft failure, shall be documented in the ICD.

IF230290 Instruments shall provide the necessary observed science data to meet specified EDR performance at any equatorial nodal crossing time, except as explicitly contractually limited, so long as the spacecraft attitude remains in control, and the spacecraft does not permit the sun to shine on the "cold side" of the instrument.

IF230315 The instrument mass shall be less than or equal to that specified in the unique spacecraft-to-sensor ICD.

IF230330 Instrument mass expulsion rates and substances, if any, and any other variability of the mass of the instrument over the mission life shall not exceed the values allocated by the ICD.

IF230335 The launch and on-orbit center of mass of each separately mounted instrument component shall be documented in the MICD, referenced to the instrument coordinate axes.

IF230365 The moments and products of inertia of each separately-mounted instrument component, referenced to the instrument coordinate axes, shall be provided by the instrument contractor for documentation in the MICD.

IF230380 If the instrument contains movable masses, expendable masses, or deployables, the respective moments and products of inertia variations shall be provided by the instrument contractor for documentation in the MICD.

IF230430 A right-hand, orthogonal, body-fixed XYZ coordinate system shall be used, as shown in Figure 3.2.4.2.2-1. The associated mechanical datums and origin are described in the MICD.

IF230440 Instrument components in all configurations shall be contained within the instrument envelopes as allocated within the MICD, but different envelopes may be defined for launch configuration, on-orbit (deployed) configuration, and during deployment.

The defined not-to-exceed envelope includes, but is not limited to, the basic instrument structure, instrument-unique mounts (including kinematic mounts, where used), instrument-unique mounting hardware, mounting feet, thermal blankets (including billowing during launch and ascent), connectors (instrument-side only), and intra-instrument harness (with connectors), as well as any other items that constitute any part of a deliverable instrument.

The intent of this requirement is that everything provided as part of a deliverable instrument, including the items identified above, be allocated against the instrument size and weight allocations, and that everything provided by the spacecraft contractor be held against the spacecraft allocation.

IF230455 The instrument contractor shall provide to JPSS information on the instrument subsystem envelope (including thermal blankets, instrument connectors, mounting feet, instrument-supplied harnesses, and unique mounts) for documentation in the MICD.

Documentation is to be in the form of engineering drawings with a set of "not to exceed" dimensions for the launch, deployed on-orbit, and installation envelopes. The instrument installation envelope is defined as the volume of the instrument including the attached lifting sling.

IF230465 All instrument fields of view, including, where applicable, optical, glint, thermal cryo-radiator, electronics radiator, and solar diffuser fields of view, shall be documented in the MICD.

IF230470 The instrument contractor shall provide, for documentation in the MICD, information on field-of-view-related issues such as clearances, multi-path tolerances, indirect effects such as glint and allowable secondary radiation, and percent interference allowed.

IF230490 Specific requirements for pinning the instrument, if required, shall be documented in the MICD.

IF230495 The spacecraft mounting interface requirements for each separately-mountable instrument component shall be defined in the MICD.

IF230620 The instrument contractor shall provide necessary mounting information to the spacecraft contractor for documentation in the MICD.

IF230625 The instrument mounting location shall be documented in the MICD.

IF230655 The process for verifying gaps shall be mutually agreed upon between the instrument and spacecraft contractors, and documented in the MICD.

IF230695 The type, location, and orientation of the Instrument Alignment References shall be mutually agreed upon between the instrument contractor and the spacecraft contractor, and documented in the MICD.

IF230745 For each instrument, the Boresight Alignment Control Error allocations shall be documented in the instrument ICD.

IF230825 The worst case average power consumed in any operational mode over the life of the instrument shall be less than or equal to the average power allocated in the ICD.

IF230830 The peak power consumed in any operational mode over the life of the instrument shall be less than or equal to the peak power allocated in the ICD.

IF230835 The instrument power consumed in survival mode shall be less than or equal to the worst case life cycle survival power allocated in the ICD.

IF230840 The instrument power consumed in launch phase shall be less than or equal to the launch-phase power allocated in the ICD.

IF230845 The number of power interfaces used by an instrument shall be consistent with the number allocated in the ICD.

IF230850 Power Bus connections and power profiles for all instrument modes shall be provided by the instrument contractor and documented in the ICD.

IF230855 If the instrument power requirements vary as a function of orbit position, that duty cycle shall be supplied by the instrument contractor and documented in the ICD.

IF231135 The instrument contractor shall identify (for documentation in the ICD) if more than 2 circuits are required (1 primary and 1 redundant).

IF231145 Survival heater circuit impedance shall be documented in the ICD.

IF231175 The sizes of the overcurrent protection devices for each instrument shall be documented in the IF231225 Instruments high-voltage restrictions shall be specified in the ICD.

IF231460 The instrument interface mating connectors dimensions and locations shall be documented in the ICD.

IF231495 Connector locations, types, and orientations shall be documented in the ICD.

IF231515 Flight plugs and their locations shall be documented in the ICD.

IF231585 Test connectors and their locations shall be documented in the ICD.

IF231615 Harnesses, connectors, ground straps, and associated service loops shall be documented in the ICD, including all requirements for harness construction, pin-to-pin wiring, cable type, etc.

IF231705 The provider and the locations of tie points shall be documented in the ICD.

IF231720 For life-limited items, instrument design, qualification and verification shall account for multiple activation during spacecraft level tests.

IF231905 Temperature limits for instrument components during ground test and orbital operations shall be provided for documentation in the ICD.

IF231910 Turn-on temperature requirements, relative to the passive analog temperature sensors, shall be provided for documentation in the ICD.

IF231930 The location of the spacecraft-provided interface temperature monitoring sensors shall be shown in the MICD.

IF231935 The location of all instrument contractor-supplied temperature sensors and calibration data shall be provided for documentation in the ICD.

The calibration data is instrument serial number specific.

IF231940 The instrument contractor shall provide information on instrument-provided thermal control hardware for documentation in the ICD

IF232005 Constraints related to this testing capability shall be provided for documentation in the ICD.

IF232215 All commands to be transferred to the instrument via the point-to-point (discrete) command interfaces and the command and telemetry bus, shall be documented in the ICD.

IF232230 The spacecraft memory required by the instrument for stored commands shall be documented in the ICD.

IF232235 Instrument commands which should not be allowed as stored commands (i.e., real-time only), if any, shall be documented in the ICD.

IF232245 Spacecraft stored commands shall be sent to the instrument within 1 second after the instant when the command time tag and spacecraft time are equal, but not at a rate exceeding the normal instrument command rate as documented in the ICD.

IF232270 All commands that will be accepted as valid shall be documented in the ICD along with the result of the command, and the telemetry indicator that can be used to verify execution.

IF232295 Instrument data bus command and memory load source packet length shall be specified in the ICD.

IF232310 The APIDs shall be as documented in the ICD.

IF232325 Commands which involve critical or hazardous functions, or which create critical or hazardous conditions, shall be identified in the ICD.

IF232340 All instrument commands and data load descriptions shall be documented in the ICD.

IF232515 Instruments shall provide Health and Status telemetry packets in format(s) and data rates specified in the ICD.

IF232355 All diagnostic dwell data required to diagnose failures and track variations in performance shall be documented in the ICD along with the required sampling rates and a definition of how the data is to be used.

IF232385 All spacecraft-instrument point-to-point telemetry interfaces shall be documented in the ICD.

IF232440 The instrument's method for verifying each command shall be documented in the ICD.

IF232465 Any requirement for the spacecraft to monitor selected telemetry points (including telemetry from the command and telemetry bus and point-to-point interfaces) and initiate action to the instrument based upon a pre-determined telemetry state shall be negotiated with the spacecraft contractor and documented in the ICD.

IF232470 All instrument telemetry points to be monitored by the spacecraft, for spacecraft action, shall be documented in the ICD, along with the action to be taken and the algorithm for such action, as specified by the instrument contractor.

IF232540 The combined output rate of science data, engineering data and diagnostic data shall not exceed the data rate allocation in the ICD, including all CCSDS packetization overhead.

IF232555 Unless fixed continuous output packet data rate is provided, the instrument mission data packet profile over a periodic period shall be provided and specified in the ICD

IF232595 The time correlation accuracy shall be specified in the ICD.

IF232605 Instrument Health & Status telemetry, instrument Memory Dump, and Mission Data packet length and descriptions shall be documented in the ICD.

IF232655 Test Packet APIDs, patterns and lengths shall be documented in the ICD.

IF232915 Based on launch vehicle and spacecraft inputs, and spacecraft structure, the spacecraft contractor shall document in the ICD the shock level that can appear at the interface to the instrument.

IF232920 The instrument shall be designed to meet performance requirements following exposure to the externally induced shock environment documented in the ICD.

IF232925 Instruments shall be designed to survive without performance degradation the peak shocks defined in the ICD.

IF233285 The spacecraft contractor has control of some of the factors which determine the levels in Table 3.3.2.2.3.1-1. The spacecraft contractor shall document in the ICD

if the environment to be experienced by an instrument has been reduced or increased from the levels given above.

IF233150 RF instruments shall not exhibit any intermodulation products from two signals, beyond those permitted in the individual equipment specification, when subjected to the CS103 test levels defined in the ICD.

IF233155 RF instruments shall not exhibit any undesired response when subjected to the CS104 test levels defined in the ICD.

IF233160 RF instruments shall not exhibit any undesired response when subjected to the CS105 test levels defined in the ICD.

IF233560 Non explosive release devices shall be activated (commanded) as described in the ICD.

IF233570 Electro-explosive devices, where required, shall be activated (commanded) as described in the ICD.

IF233720 After power up, the instrument shall be capable of accepting software uploads and/or table uploads, as required, where the size and frequency of the uploads is identified in the ICD.

IF234020 The typical uncompensated momentum contribution of the instrument shall be documented in the instrument ICD.

IF234035 The instrument ICD shall specify the predicted disturbance torque contributions to the spacecraft, if any.

IF234050 The torques about the spacecraft CM resulting from instrument linear forces shall be documented in the instrument ICD.

IF234060 The instrument contractor shall provide the typical instrument torque versus time profile for documentation in the ICD.

IF234065 The instrument contractor shall provide the magnitude and direction of net thrust, timing of expulsion events, and expulsion material resulting from the expulsion of expendables by the instrument, for documentation in the ICD.

IF234090 The instrument contractor shall provide access requirements for documentation in the MICD.

IF234155 Instrument contractors shall provide the location, size, path, and operation time of vents in the instruments for inclusion in the ICD.

IF234180 All requirements for GSE delivered to the spacecraft contractor shall be documented in the ICD. This documentation includes, but is not limited to, to

following: power, weight, cooling requirements (if necessary), dimensions, and any special moving requirements.

IF235165 The instrument shall be able to perform a comprehensive performance test (CPT) on the spacecraft at the launch site payload processing facility (PPF) in ambient conditions, with limitations documented in the ICD

Although limited functional testing may be the normal extent of instrument testing after shipment to the launch facility, this present requirement is intended to provide flexibility in the event of an extended period at the launch facility, or other abnormal situation. The goal is to prevent having to return the satellite or instruments to the manufacturing facility unnecessarily.

IF236201 The instrument vertical lifting fixture and frame shall be as shown in the MICD.

IF234915 Drawings defining/documenting the interface between the instrument and the spacecraft which are not otherwise included in the ICD will be contained in an MICD controlled by NASA JPSS.