SPACE ACCELERATION MEASUREMENT SYSTEM II

Agreement and Interface Definition Document (AIDD)

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Acronyms & Abbreviations

AIDD	Agreement and Interface Definition Document
C	Celsius
CU	Control Unit
dc	direct current
ECW	Emergency Caution and Warning
EE	Electronics Enclosure
ES	Ethernet Standalone
EXPRESS	EXpedite the PRocessing of Experiments to Space Station
GOE	Ground Operations Equipment
GRC	Glenn Research Center
ICAD	Interface Control and Agreement Document
ICU	Interim Control Unit
IPLAT	ISS Payload Label Approval Team
ISS	International Space Station
ISIS	International Subrack Interface Standards
JSC	Johnson Space Center
LOS	Loss of Signal
mA	milliampere
MOU	Memorandum of Understanding
MSG	Microgravity Science Glovebox
NASA	National Aeronautics and Space Administration
PI	Principal Investigator
PIMS	PI Microgravity Services
RTS	Remote Triaxial Sensor
SAMS	Space Acceleration Measurement Systems
SAMS-II	Space Acceleration Measurement System-II (hardware specific)
SE	Sensor Enclosure
TBD	To Be Determined
TSH	Triaxial Sensor Head

1.0 INTRODUCTION

1.1 Purpose

This Agreement and Interface Definition Document (AIDD) sets forth the physical and operational requirements for the use of a SAMS Remote Triaxial Sensor (RTS) system, in whole or in part, and a SAMS Triaxial Sensor Head – Ethernet Standalone (TSH-ES). An RTS consists of an Electronics Enclosure (EE) and up to two Sensor Enclosures (SEs). The TSH-ES is independent of the RTS. Facility class payloads that wish to provide an acceleration measurement system for their subrack payloads should plan to integrate a complete RTS (an EE and up to two SE's) or TSH-ES into their rack. The SE's/TSH-ES's in this case would then be a facility operated resource and control of the installation and operation of the SE/TSH-ES and its mounting hardware would be under their control. Alternatively, a facility could elect to only provide access to a SAMS managed EE or access to a managed power/ethernet port for a TSH-ES. In that case, each payload would be required to make independent arrangements with the SAMS Project regarding the use of an SE/TSH-ES.

An Interface Control and Agreement Document (ICAD) that defines all of the applicable and non-applicable requirements stated in this AIDD, as well as, any payload unique requirements will be created for each user. Applicable sections of this AIDD may be annotated to meet the needs of a particular user, contingent on the SAMS Project's concurrence.

Section 3.0 provides information on the incorporation of the SAMS equipment into the user's operations, both ground and flight. Sections 4.0 through 6.0 enumerate the specific requirements for the use of an EE, SE, TSH-ES respectively.

1.2 Definitions

For the purposes of this document, the "user" is identified as the agency or project accepting and integrating the SAMS hardware into the payload. The "payload" is identified as the hardware, whether rack, locker, or drawer, that will be onboard the International Space Station (ISS).

SAMS RTS System is considered an EXPRESS Rack payload. It has baselined the EXPRESS Rack interface and verification requirements. This does not preclude the use of the RTS for non-EXPRESS Rack applications. User specific ICADS will reflect non-EXPRESS Rack interface and verification requirements.

SAMS TSH-ES is considered an ISS payload. It will be baselined to the ISS interface and verification requirements as per SSP 57000. User specific ICADS will reflect any deviations from the ISS requirements, as well as, additional requirements specific to the user.

1.3 Responsibilities

The SAMS Project will provide functionally tested hardware to the designated users. Once the hardware has been turned over to the user, it is the user's responsibility to ensure safekeeping. SAMS will supply verification documentation for the user's safety review packages, as requested. The SAMS Project will develop the user-unique ICAD.

The user shall provide all information necessary to develop an ICAD.

1.4 Request For Support

The SAMS Project will provide the appropriate hardware items to designated users. The process for requesting SAMS hardware is to contact the SAMS Project Manager. (See Section 1.6)

1.5 Document Configuration Control

The SAMS Project will maintain configuration control of this document in accordance with SAMS-PLN-001, SAMS Configuration Management Plan.

1.6 Contacts

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2.0 APPLICABLE DOCUMENTS

The following documents form a part of this document to the extent specified herein. If no date is given, the current revision of the document should be used. In the event of conflict between the project documents referenced and the contents of this document, the contents of this document shall be considered a superseding requirement.

NASA or ISS Documents

NSTS 1700.7B	Safety Policy and Requirements for Payloads Using the Space Transportation System, January 1989
NSTS 1700.7B ISS Addendum	Safety Policy and Requirements for Payloads Using the International Space Station
SSP 30237	Space Station Electromagnetic Emission and Susceptibility Requirements
SSP 30238	Space Station Electromagnetic Techniques, General Vol.1; Vol. 2, Requirements and Procedures
SSP 52000-IDD-ERP	EXPRESS Interface Definition Document
SSP 52000-PVP-ERP	EXPRESS Payload Verification Plan
SSP 57000	Pressurized Payloads Interface Requirements Document

Project Documents

SAMS-PLN-000	SAMS Project Plan
SAMS-PLN-001	SAMS Configuration Management Plan
SAMS-PLN-002	SAMS Product Assurance Plan
SAMS-SPC-001	SAMS System Specifications Document
SAMS-PLN-xxx	SAMS Verification Plan
SAMS-II-007	SAMS-II System Verification Plan
SAMS-II-013	SAMS RTS Phase III Flight Safety Compliance Data Package
SAMS-II-200	SAMS Safety Critical Structures Package
SAMS-II-400	SAMS Data & Command Format Definition Document
SAMS-II-609	RTS Functional Acceptance Test
SAMS-II-612	RTS Thermal Test Plan & Procedure
SAMS-II-627	Sine Sweep & Random Vibration Qualification Test Plan (RTS Hardware)

Industry Documents

IEEE 802.3 (ISO/IEC 8802-3)	INTERNATIONAL STANDARD

3.0 INTEGRATION & OPERATIONS

3.1 Hardware Overview

3.1.1 SAMS RTS System

The RTS is an assembly consisting of an Electronics Enclosure (EE) and one or two Sensor Enclosures (SE), all designed for use in the International Space Station environment.

The SEs interface with the EE and the EE interfaces with either the Interim Control Unit (ICU) or the Control Unit (CU). The SE is an acceleration-measuring package made up of acceleration transducers, temperature transducers, and required circuitry for output of digital acceleration data. The EE is a data processing and measurement support package made up of power distribution circuitry for the attached SEs, network interface circuitry, and circuitry to acquire acceleration data from each attached SE. It compensates for temperature and SE bias effects and then transmits the data via the ISS payload Ethernet to the ICU/CU. The ICU/CU collects, processes, stores and downlinks acceleration and housekeeping data from the RTS system, and controls SE operations. Figure 1 contains a picture of a SAMS RTS EE, two RTS SEs and a SAMS RTS Cable. Figure 2 contains a picture of the SAMS ICU.

Figure 1 - SAMS Electronics Enclosure and Sensor Enclosure

Figure 2 - SAMS Interim Control Unit

3.1.2 SAMS TSH-ES

The Trixial Sensor Head -Ethernet Standalone (TSH-ES) has internal processing capabilities, which allows it to interface directly with the SAMS ICU (or CU). Similar to the SE, each TSH-ES will include three analog accelerometers and three temperature sensors. The TSH-ES will sense acceleration and provide a digital signal to the ICU via ethernet. The TSH-ES will provide network data flow control and will also perform data processing for temperature compensation and axial misalignment of the data. Control signals from the ICU to the various TSH-ES units will take place over the reverse path, using the corresponding protocols. Reference Section 6.0 for a picture of the TSH-ES.

3.2 Integration

3.2.1 Drawings

The SAMS Project will provide to the user drawings indicating the appropriate interfaces and the geometric configurations of the components. The user shall supply to the SAMS Project drawings defining all SAMS/user interfaces.

3.2.2 Coordinates & Alignment

The user shall supply the SAMS Project with the orientation of each SE/TSH-ES. An engineering drawing is preferred. It is desired that one axis of each SE/TSH-ES be parallel with one axis of the module (US Lab, COF, etc) or station. The user shall supply the module coordinates of each SE/TSH-ES reference point

(Figure 12). The alignment of the SE/TSH-ES axes with the module axes can be critical if a payload has a specific science constraint, such as directional sensitivity. If this criticality exists, the user shall also provide the SAMS Project with the rotational angles between the SE/TSH-ES and the module coordinate systems so that the data can be compensated correctly.

3.2.3 RTS/TSH-ES Cable Routing

The user shall provide the cable routing within their experiment envelope. It is the user's option to install the cable either prior to launch or on-orbit.

3.2.4 Testing

3.2.4.1 User Development Testing

Physical mock-ups of the SAMS hardware are available to assist the user in performing hardware fit checks. Functional simulators are available for software interface testing. Engineering hardware is available for hardware and software interface testing. The SAMS Project will supply mock-ups, functional simulators and engineering units at the request of the user.

3.2.4.2 Pre-Integration Flight Verification Testing

The SAMS Project will perform all verification testing, except for integrator verifications, prior to delivery of the hardware (reference EE Section 4.5, SE Section 5.5, and TSH-ES Section 6.5). The SAMS Project will perform a functional test of the hardware prior to shipment to the user and after shipment but prior to formal hand over of the hardware to the user.

The user shall inform the SAMS Project of any planned environmental testing of the payload that may affect the hardware, such as thermal cycling, vibration testing and EMI testing. Based on the test parameters, the SAMS Project may require a functional test of the SAMS hardware to be performed after the environmental testing.

All testing performed on the SAMS hardware after shipment to the user shall be recorded on log sheets as per those provided in Appendix D.

3.2.4.3 Post-Integration Flight Verification Testing

The user shall perform all hardware related integrator verification testing prior to hardware turnover at KSC (reference EE Section 4.5.2, SE Section 5.5.2 and ES Section 6.5.2). The SAMS Project personnel, or a designated KSC representative, will perform a functional test of the hardware following shipment to KSC. The SAMS Project will also assist KSC in performing pre-launch verification testing.

3.2.5 Acceptance Data Package

An Acceptance Data Package (ADP) will be provided with each hardware delivery. The content of the ADP is derived from SSP 30695, Revision A, Acceptance Data Package Requirements Specification. It will include a DD1149, engineering drawings, verification certifications, planned work, a brief historical log, and identification of non-flight hardware.

3.2.6 Hardware Shipping

The SAMS Project is responsible for shipping any hardware to the user. Once the hardware has been turned over to the user, the user is responsible for shipping the SAMS hardware within the constraints defined by the EXPRESS Rack IDD (SSP 52000-IDD-ERP, Sections 4.9.1 and 4.9.2). Shipment of all hardware shall be documented on the applicable logsheets as provided in Appendix D. All SAMS hardware will be shipped in non-flight approved ESD bags.

3.2.7 Stowage

3.2.7.1 Launch & Landing

The SAMS hardware has been qualified for the random vibration environments detailed in Appendix B. If the random vibration environment at the intended installation location exceed these levels, the SAMS hardware (EE, SE or TSH-ES) shall be stowed for launch and/or landing. The user is responsible for supporting this activity including, but not limited to, weight, space and crew resource issues. If the SAMS hardware is stowed, it must be placed in a flight approved ESD bag before the flight.

3.2.7.2 On-Orbit

On-orbit stowage required for the SAMS hardware shall be arranged by the user and come out of their allocation. The return of the SAMS hardware will be negotiated between the SAMS Project and the user, based on the amount of time remaining in the calibration cycle. The SAMS Project may request that the SAMS hardware be disconnected from the user's hardware and officially transferred over to the SAMS Project. In this case, the SAMS Project will assume responsibility for the stowage of that item from that point forward. Otherwise, the user will be responsible for manifesting the return of the hardware to the SAMS Project at GRC.

3.2.8 Crew Procedures

The SAMS Project has baseline procedures to perform standard activities such as activations, deactivations, malfunctions, corrections, and alternates. There are two methods of utilizing these procedures. The chosen method will be documented in the user's ICAD. In one method, the SAMS Project writes custom procedures and the user links to them from the appropriate steps in the user's procedures according to PODF standards. In the second method, the user incorporates the required SAMS steps into their own crew procedures. In either case, the user shall ensure that the SAMS Project is on the Mandatory Evaluators List for the procedure review, baselining and change processes.

3.2.9 Crew Training

The SAMS Project will provide crew training involving all standard nominal and malfunction procedures relating specifically to the SAMS hardware and software. These 'standard procedures' will include activation, deactivation, display manipulation, and mounting of SEs on simple structures. If a complex attachment is required (mounting fixture, cable routing, etc), the training will be considered user specific and charged against the users' allotted training time. The SAMS Project will support training session(s) if requested.

3.2.10 Mission Planning

The SAMS Project has created Public Service sequences in iURC, the current ISS Mission Planning Tool. These Public Services will ensure that the SAMS system is collecting data during the requisite portions of the user's timeline. The user shall either incorporate the existing generic sequences into their payload sequences or request that the SAMS Project create a specific sequence to address their requirements.

3.2.11 Labels

The content and placement of the labeling on an RTS System have been approved by the ISS Payload Label Approval Team (IPLAT). The TSH-ES labels are still in development. No other labels shall be placed on the hardware without approval from the SAMS Project. Inventory Management System (IMS) labels and numbers shall be provided by the SAMS Project.

3.3 Operations

3.3.1 Resource Allocation

The responsibility for required resources is outlined in Table 1.

Table 1 – Resource Allocation Matrix

	EE	SE	TSH-ES	RTS/ TSH-ES Cables	EE to Rack Data and Power Cables
Power	User (Section 4.2)	User (Section 5.2)	User (Section 6.2)	N/A	N/A
Thermal	User (Section 4.1.6)	User (Section 5.1.6)	User (Section 6.1.6)	N/A	N/A
Mass	User (Section 4.1.3)	User (Section 5.1.3)	User (Section 6.1.3)	Users of SE/TSH-ES	Users of EE
Command and Data	SAMS	SAMS	SAMS	N/A	N/A
Crew Time (inc. mounting & moving)	User if needed	User if needed	User if needed	User if needed	User if needed
Stowage	User if needed	User if needed (Section 3.3.2)	User if needed (Section 3.3.2)	User if needed	User if needed

3.3.2 SE/TSH-ES Reconfiguration

An SE/TSH-ES can be repositioned on-orbit to meet the science objectives of the user. Once the SE/TSH-ES has been installed in its new location, the crew will voice down that location and will update the onboard SAMS display. They will also videotape the SE/TSH-ES in the new location. This video will be downlinked to the SAMS Project to verify the proper positioning of the SE/TSH-ES.

3.3.3 Calibration Requirements

In order to ensure the SAMS Project requirements for acceleration data accuracy are met, the EE, SE and TSH-ES need to be calibrated periodically. The SE/TSH-ES requires a calibration once every 2 years and the EE requires a calibration once every 10 years. All calibrations are performed by the SAMS Project.

3.3.4 Health & Status

For RTS System:
The EE generates two different health and status packets that are available to any user that makes a TCP/IP socket connection to the EE. The first health and status packet follows the packet definition defined in SSP 52000-IDD-ERP (EXPRESS formatted H&S packet). This packet contains an EXPRESS header, an Emergency Caution & Warning (ECW) word, a cyclical counter, unit ID and the baseplate temperature of the EE. The ECW word is set to different values that define the status of the EE. When the baseplate temperature rises above its warning limit (typically 42 degrees C), the ECW is set to 0x01 hex signaling the EE is operating hotter than expected. When the baseplate temperature rises above its caution limit

(typically 62 degrees C), the ECW is set to 0x052 hex signaling the need for the integrator to cut the power to the EE.

The other health and status packet is defined in the SAMS-II-400 document (Housekeeping data). It contains a SAMS header, unit ID, and baseplate temperature. This packet is sent to the SAMS operations on the ground for monitoring purposes.

Both packets are generated at a rate of 1 Hz. Specifics details on how to obtain and interpret these health and status packets are defined in the SAMS-II-400 document.

For TSH-ES:
TBD

From Facilities:
If the user is a facility, then the SAMS project shall be informed of the MSID of the appropriate facility functions, such as, SAMS power port activity and SAMS Ethernet port activity.

3.3.5 Timing

For RTS System:
The SAMS control unit obtains its time from the ISS EXPRESS rack in which it is located. All EEs synch their internal clocks to the control unit's clock by means of the unix protocol xntp. This synchronization requires that the EE can communicate with the control unit via the ISS Payload Ethernet. The EEs internal clock provides the time stamp for the SE's acceleration data.

For TSH-ES:
TBD

3.4 Ground Operations

3.4.1 Data Flow

Analysis and interpretation of the SAMS acceleration data is performed by the Principal Investigator (PI) Microgravity Services (PIMS) group. The PIMS group, located at the GRC TSC, receives the SAMS acceleration data packets and writes them to a database in near real-time. PIMS will also put acceleration data received from Loss Of Signal (LOS) periods into the database, resulting in a complete set of SAMS acceleration data. PIMS display generation software will then extract data from the database, decommutate the data, and display the data on PIMS Ground Operations Equipment (GOE), all in near real-time. Periodic electronic snapshots of these plotted images will be obtained and made available to the science community via the PIMS ISS web page.

3.4.2 Commanding

Users will be able to control the data collection parameters of the SEs/TSH-ESs assigned to them via commands originating on the ground or onboard. Users can start or stop the data collection, change the frequency range of the data and/or change the units of the data. The SEs can collect data in the following frequency ranges: 0-25 Hz, 0-50 Hz, 0-100 Hz, 0-200 Hz or 0-400 Hz. The TSH-ES can collect data in the following ranges: 0-3 Hz, 0-5 Hz, 0-10 Hz, 0-20 Hz, 0-45 Hz, 0-95 Hz, 0-185 Hz or 0-375 Hz. The acceleration data can have units of micro-g's or volts. Ground commanding is accomplished by contacting the SAMS ground operations team with a command request. Onboard commanding requires the user to make a TCP/IP socket connection to the SAMS control unit and issuing SAMS formatted commands as described in SAMS-II-400 for the RTS System and SAMS-XXX-XXX for the TSH-ES.

3.4.3 On Console Support

The SAMS Project will provide operational support on an as needed basis. SAMS personnel will be on-call via pagers and a group email account. The LIS has a full list of the current contact numbers and emails. SAMS will be on console for planned activities such as sensor relocations or activations. The SAMS Coord voice loop is available to users for discussions concerning both data analysis and operations. This loop should be requested through the PDL Ground Services Data Set.

3.4.4 Facility and Subrack Payload Interactions

It is imperative that a facility which hosts the SAMS hardware informs the SAMS project of its subrack payloads that desire to use the SAMS hardware. Communication between SAMS/PIMS and the subrack payloads is necessary in order to obtain the commanding parameters and data collection information specific to their needs.

3.4.5 Precedence of Users

SAMS has been designed so that multiple SEs/TSH-ESs can function simultaneously and independently. If, however, a resource conflict does develop it will be resolved by the SAMS Project Manager.

4.0 ELECTRONICS ENCLOSURE

4.1 Physical

4.1.1 General

An EE has four electrical connectors that provide interfaces to rack power, rack Ethernet network and each of two SEs (via EE channels A and B), as shown in Figure 3. The EE connectors have plastic dust caps for shipping. All cables supplied by the SAMS Project will utilize tethered caps. Accessibility to the EE is needed for on-orbit off-nominal operations such as resetting the power switch (circuit breaker) and replacement of the unit.

Figure 3 - Remote Triaxial Sensor – Electronics Enclosure

4.1.2 Dimensions

The EE dimensions are 237 mm (9.3 in) in width, 118.8 mm (4.7 in) in height and 230 mm (9.1 in) in length. These dimensions do not include interface cabling with appropriate bend radii. Cable backshells will require additional space. Dimensioned drawings of the EE and interface cabling are shown in Figures 4 through 7.

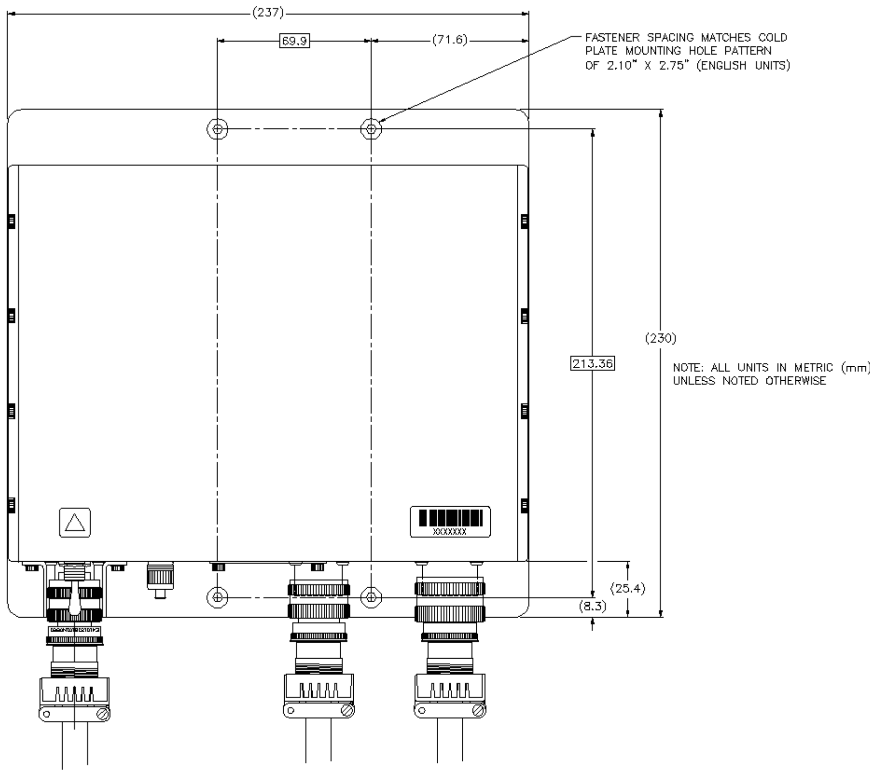

Figure 4 - Top View of EE With Straight Backshell

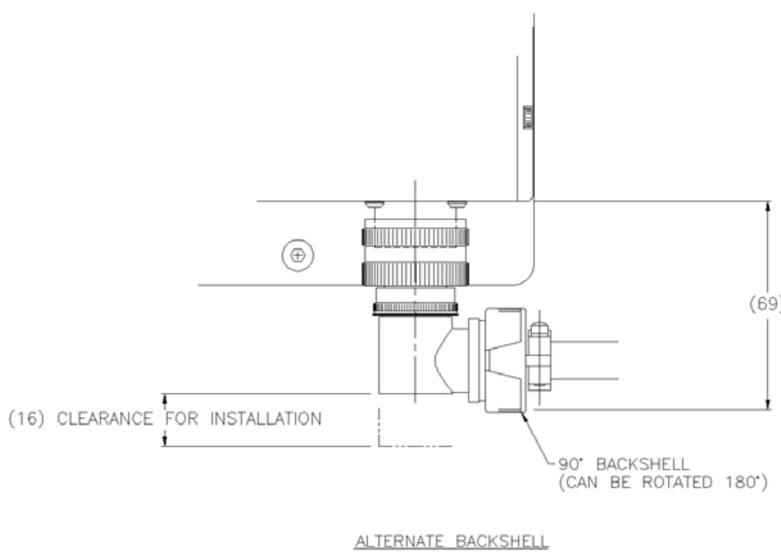

Figure 5 - EE 90 Degree Backshell

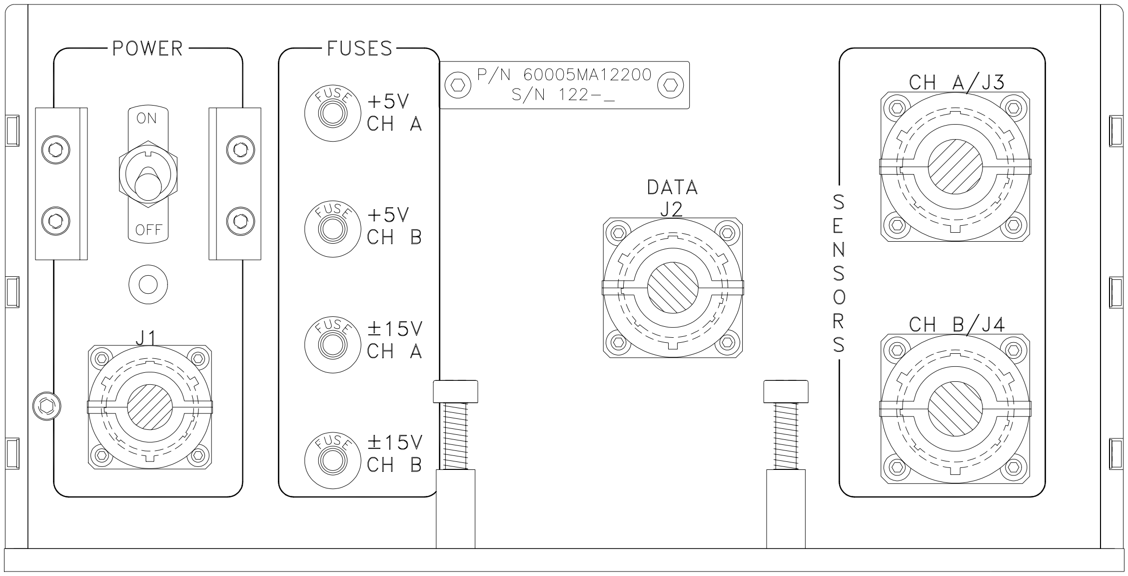

Figure 6 – Front View of EE

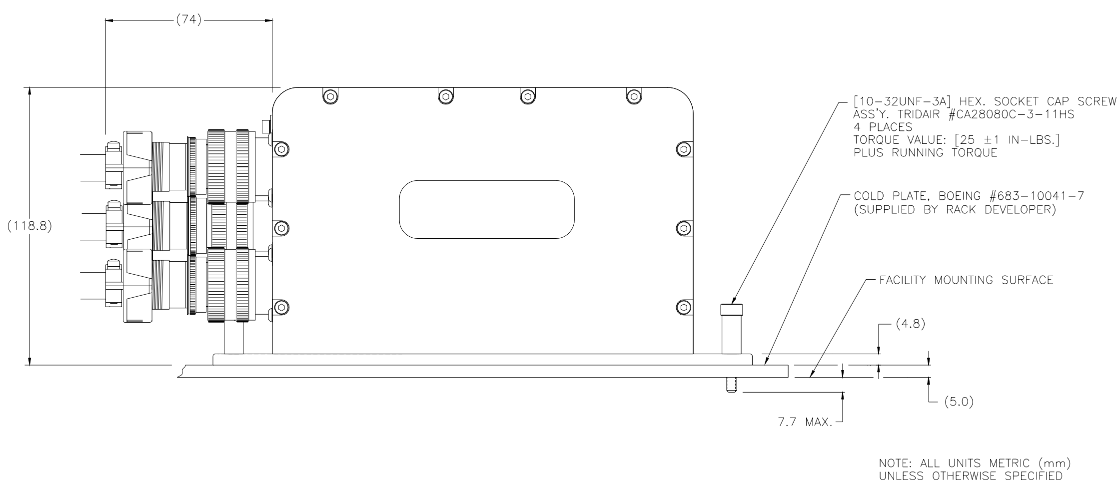

Figure 7 - Side View of EE

4.1.3 Mass

The EE has a mass of approximately 5 kg (11 lbs). Individual units may vary slightly, due to performance upgrades and parts tolerance. The mass will be provided for a specific unit by the SAMS Project upon request.

4.1.4 Center Of Mass

An example of the mass center information for an EE is provided in Table 2. The reference coordinate system is shown in Figure 8. The center of mass will be provided for a specific unit by the SAMS Project upon request.

Table 2 - EE Center of Mass Example

MASS	CENTER OF MASS		
	X-AXIS	**Y-AXIS**	**Z-AXIS**
5.09 kg (11.2 lbs)	107.4 mm (4.23 in)	114.6 mm (4.51 in)	60.7 mm (2.39 in)

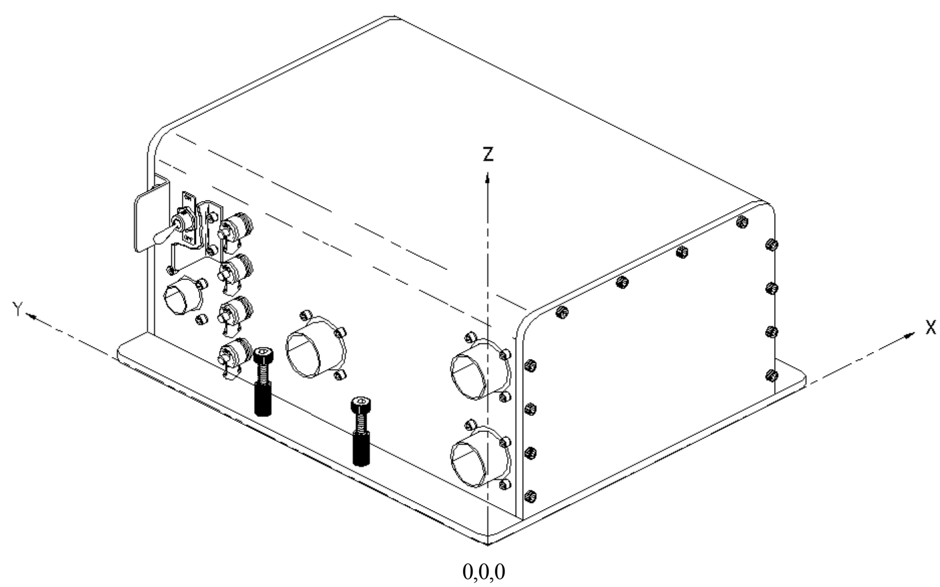

Figure 8 - EE Center of Mass Reference

4.1.5 Mounting

The EE is attached using four Tridair CA28080C-3-11HS fully retracting spring-loaded captive screw assemblies with nut retainers, shown in Figure 7. All four fasteners must be used to provide a fail-safe condition. Each fastener has a hex socket recess for tool installation. All the tools necessary to perform SAMS hardware mounting are available from the ISS IVA Toolkit. The fasteners are sized for cold plate applications (0.688 inch depth of thread); spacers may be required for other applications. SAMS-II drawing #60005MA12212 (EE Base Detail) shows the bolt hole pattern for the EE interface. The torque requirement for mounting an EE into Cres stainless steel inserts is 25 ± 1 in-lbs plus running torque except that for the EE's mounted in all EXPRESS racks the torque is 20 ± 1 in-lbs plus running torque. A minimum thread engagement of 0.31 inches is required. Planned mounting of the EE into any other material requires specific review and approval by the SAMS-Project.

4.1.6 Thermal

Each EE undergoes thermal acceptance testing over an operating temperature range of 0º to 50 °C. The heat dissipation of an EE is approximately 10 watts. The external surface temperature of an EE under nominal operating conditions is typically no more than 2 °C higher than the surface upon which it is mounted, therefore an EE mounted in crew accessible locations is restricted to an operating thermal environment of 0º to 45°C.

The EE will monitor its internal temperature using data from a temperature sensor mounted on the inside base of the EE. The averaged base temperature is included in both health and status packets generated by the EE (see section 3.3.4 Health and Status for more information on these packets). If the baseplate temperature of an EE exceeds the caution limit (currently 62 °C), the SAMS Project requests that the user removes power from the EE, in effect, shutting down the EE. In an over temperature situation, the EE cannot automatically remove power from itself. If the user has a requirement to shut down the EE at its caution temperature, then it is the user's responsibility to remove the power from the EE when its temperature goes above the caution limit. Section 3.3.4 describes how to monitor either of the health and status packets produced by the EE to determine when the caution limit has been exceeded.

4.1.7 Pressure Environment

The EE can operate at pressures ranging from 10.0 to 16.0 psia.

4.1.8 Humidity

The EE can operate in a 20% - 80% non-condensing relative humidity environment.

4.1.9 Ground Storage Environment

All SAMS hardware shall be stored in a controlled access area with the following environmental restrictions:

	Requirement
Temperature	0 - 70°C
Humidity	20% - 80%

4.2 Power

4.2.1 Electrical Power Characteristics

The EE shall be powered by 28Vdc from a cable provided by the user (reference section 4.2.3 Power Cable). The EE is functionally verified to an input voltage range of 25 – 29.5Vdc. The average electrical power is approximately 10 watts.

4.2.2 Current Characteristics With Power On

Figure 9 displays the current waveform of an EE supplied with 28±0.1Vdc and with two SEs attached to channel A and channel B.

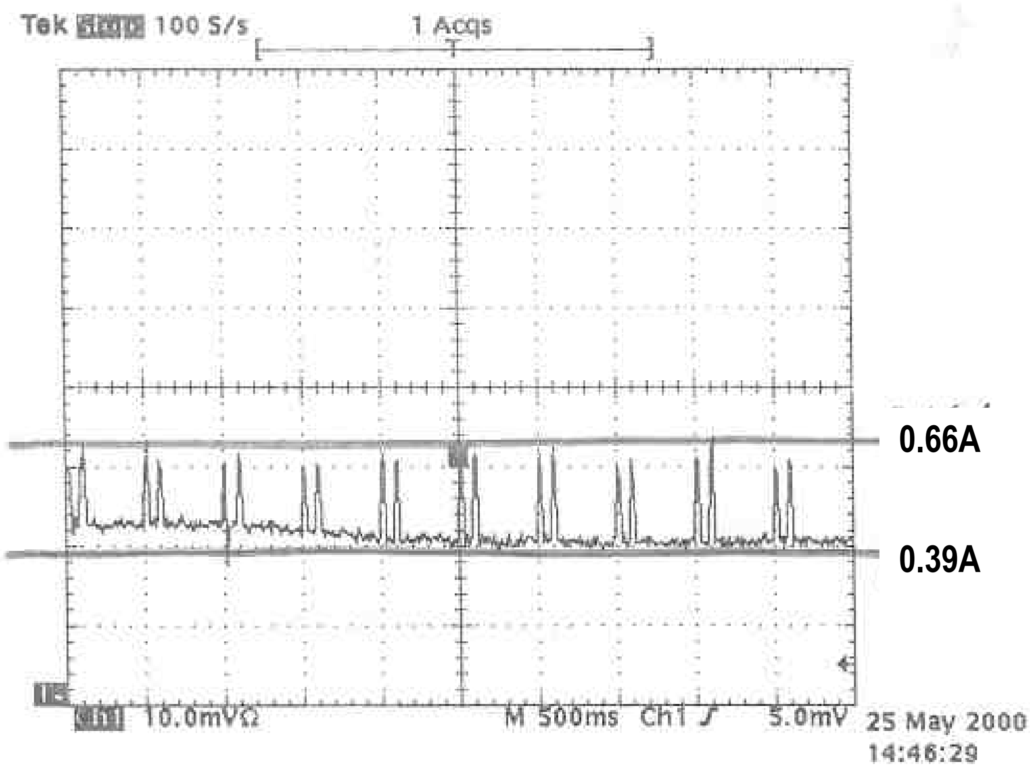

Figure 9 - Power On Current Requirements

4.2.3 Power Cable

The power cable shall be provided by the user, and shall comply with the pinout as shown in Table 3 and Figure 10. It shall use 20 AWG size wire and be terminated with an MS27467T11F4S connector. The chassis connector on the EE is an MS27656T11F4P connector. If 20 AWG size wire is too small for the user, it is the user's responsibility to appropriately increase the wire size as per the wire derating requirements of NSTS 18798, TA-92-038. The user shall verify cable functionality and shall meet the safety and carrier related requirements of the power cable.

Table 3 - Power Cable Pinout

Power Connector Pin	Purpose
A	28 Vdc
B	28 Vdc return
C	Chassis ground
D	No connection

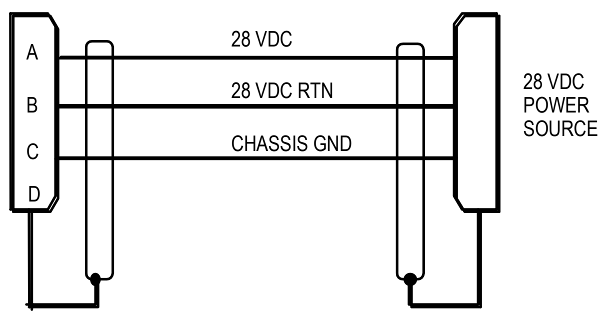

Figure 10 - DC Power Cable

4.3 Communications

4.3.1 Network Interface

The user shall provide the EE with Ethernet access to the SAMS control unit. If the EE is located outside of the EXPRESS rack housing the SAMS control unit, then the user shall provide the EE with access to the ISS Payload Ethernet network. The Ethernet access to the EE shall be via the data cable described in section 4.3.3. The user shall also configure its internal network (including any hubs/bridges) to allow TCP/IP messages between the EE and the SAMS control unit to pass through. The EE interface to the Ethernet, including the data cable described in section 4.3.3 Data Cable, shall be 802.3 compliant.

4.3.2 Health & Status

See section 3.3.4 Health and Status for details about the health and status data produced by an EE.

Additional information on establishing a connection and interpreting the health and status packet is provided in SAMS-II-400, SAMS Data & Command Format Definition Document.

4.3.3 Data Cable

The user shall supply the Ethernet cable for the EE, utilizing the pinout schedule shown below (Table 4). The cable shall be compatible with the IEEE 802.3 standard for Ethernet communications. Table 5 specifies the connectors that shall be utilized. The user shall verify cable functionality and shall meet the safety and carrier related requirements of the data cable.

Table 4 - Data Cable Pinout

Communications Cable Pinout		
SAMS GENERATED SIGNAL	**SAMS PIN**	**User's Ethernet Port ***
Rx+	F	Tx+
Rx-	G	Tx-
Tx+	D	Rx+
Tx-	E	Rx-

* If the user's Ethernet hub does not cross the Rx and Tx lines, the user shall ensure that the SAMS Ethernet signals get mapped as defined in table 3 (Rx+ to Tx+, Rx- to Tx-, etc) before it reaches its destination.

Table 5 - Data Cable Connector

EE Chassis	Cable Termination
MS27656T13F98P	MS27467T13F98S

4.4 Fire Detection & Suppression

The EE is designed to minimize the occurrence of fire. The EE design includes NASA approved materials, appropriate electrical inhibits, and appropriate wire sizing. The EE consumes low power (~ 10 W) and is constructed with the electronics enclosed within an aluminum housing and base. In addition, the EE incorporates a temperature sensor that detects overheating and automatically notifies the user via the health and status data (reference Section 4.1.6).

The EE does not have the capability to detect or suppress fire; therefore, the user shall provide provisions for fire detection and suppression within the environment of the EE.

4.5 Verification

4.5.1 SAMS Verification

The SAMS Project will perform the EE quality assurance, performance, interface, and safety verifications specified in SAMS-II-007, SAMS-II System Verification Plan, and the RTS Phase III Flight Safety Hazard Reports. Verification Tracking Logs will be included in the Acceptance Data Package supplied with each EE. The results of these analyses, tests and inspections will be made available upon request.

4.5.2 User Verification

4.5.2.1 Interface Verifications

The EE user shall perform all interface verifications based upon the user's carrier requirements. For example, a user that mounts the EE in an EXPRESS Rack shall meet the applicable EXPRESS Rack interface verification requirements and a user that mounts the EE in the Microgravity Science Glovebox (MSG) shall meet the applicable MSG interface verification requirements.

4.5.2.2 Safety Verifications

The EE user safety verification requirements originate from the ISS payload safety process. The verification methods are taken directly from the approved Phase III Payload Hazard Reports and are detailed in sections 4.5.2.2.1 through 4.5.2.2.5. The user shall provide the safety verification closure data to the SAMS project. Table 11 of Appendix C lists data due dates based on hardware launch.

4.5.2.2.1 Bonding

The user shall perform a ground-based certification test using EE flight hardware along with the planned on-orbit installation operations, to ensure that there is a bond between the EE and the user's hardware that meets the requirements of SSP 30245 (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-04, Verification 1.4.2).

4.5.2.2.2 Structural/Mechanical

The EE is considered a sealed container for structural analyses.

A baseline quasi-static load environment for the EE is defined in SAMS-II-200C. This environment provides positive margins of safety based on factors of safety of 2.0 for ultimate and 1.25 for yield, and on crew induced loads of 125 pounds over a 4 x 4 inch area. The user shall provide a structural configuration for the EE that maintains these positive margins of safety, and shall verify this by analysis (ref. SAMS-II-013, Hazard Report SAMSII--RTS-02, Verification 1.1.4).

A baseline random vibration environment for the EE is defined in Appendix B. The user shall ensure the EE's environment will not exceed these levels, and verify this by analysis and/or test (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-02, Verification 1.1.5).

The user shall provide self-locking nuts/nut plates for EE captive fastener mounting if the fasteners are used for securing hardware during Orbiter launch or landing, and verify this by independent inspection (ref. SAMS-II-013, Hazard Report SAMSII--RTS-02, Verification 5.1.1). The user shall perform an analysis, test and/or inspection to verify the integrity of the nut/nut plates used for the EE captive fasteners (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-02, Verification 5.2.1).

4.5.2.2.3 Thermal

The user shall perform an analysis and/or test to verify that the thermal environment specified in section 4.1.6, Thermal, has been provided (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-03, Verification 1.2.1).

If the user utilizes an active thermal management device to provide the referenced thermal environment, the design of this device must be single failure tolerant. The user shall perform an analysis and/or test to verify the adequacy and functionality of this device (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-03, Verification 1.2.2).

4.5.2.2.4 Electrical

The user shall perform testing to verify that the maximum voltage supplied to the EE is no greater than 32 V (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-04, Verification 1.1.2).

The user shall provide an inhibit, verifiable at the time of insertion, that removes voltage to the EE. The user shall perform testing to demonstrate the functionality and verifiability of this inhibit (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-04, Verification 1.1.1).

4.5.2.2.5 Installation & Removal

Details pertaining to the installation of an EE into the user's hardware shall be defined in the user's ICAD. For all installation and removal operations involving an EE, either prior to launch or on-orbit, the user shall include steps utilizing all four captive fasteners for each EE and applying the proper torque to the captive fasteners (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-02, Verification 4.2.1) and inserting a verifiable inhibit to remove power to the EE (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-04, Verification 2.1).

5.0 SENSOR ENCLOSURE

5.1 Physical

5.1.1 General

The SAMS hardware senses microgravity acceleration using the three orthogonal accelerometers mounted in an RTS Sensor Enclosure (SE), as shown in Figure 11. The SE draws power from the EE and has a hardwired data interface with the EE. Specific details of the cabling layout will be dependent on the particular rack configuration, which will be defined in conjunction with the user. The SE connector will have a tethered cap.

Figure 11 - Remote Triaxial Sensor - Sensor Enclosure

5.1.2 Dimensions

The SE dimensions, exclusive of connectors and cables, are 137.9 mm (5.4 in.) in width, 87.4 mm (3.4 in.) in height and 107.2 mm (4.2 in.) in length, as shown in Figure 12. For straight and 90° backshell dimensions, see Figures 4 and 5, respectively.

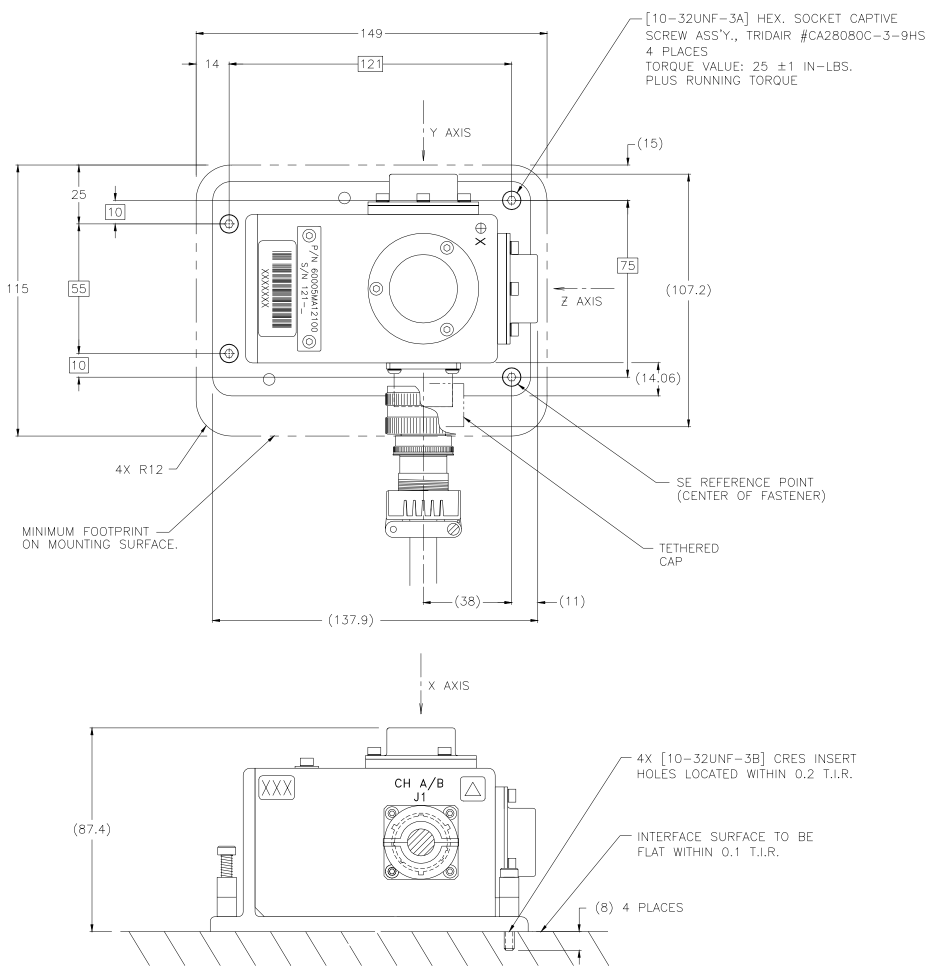

Figure 12 - Sensor Enclosure and Base

5.1.3 Mass

The SE has a mass of approximately 1.13 kg (2.5 lbs). Individual units will vary slightly due to performance upgrades and part tolerances.

5.1.4 Center Of Mass

An example of the mass center information for an SE is provided in Table 6. The reference coordinate system shown is in Figure 13. The center of mass will be provided for a specific unit by the SAMS Project upon request.

Table 6 - SE Center of Mass Example

MASS	CENTER OF MASS		
	X-AXIS	**Y-AXIS**	**Z-AXIS**
1.12 kg (2.46 lbs)	50 mm (1.97 in)	62.5 mm (2.46 in)	40.6 mm (1.6 in)

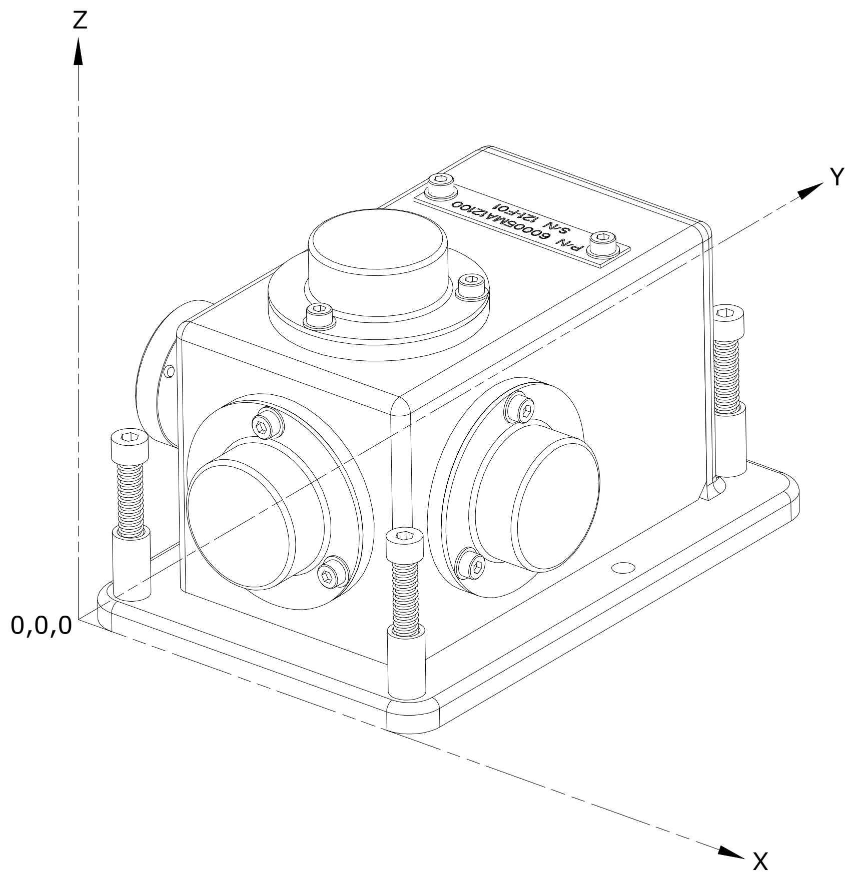

Figure 13 - SE Center of Mass Reference

5.1.5 Mounting

5.1.5.1 Mounting Structure

To provide useful acceleration measurements, that which has not been attenuated and/or amplified, the structural transmission path between the SE and the experimental payload (e.g. science test chamber) should contain no structural resonance below 1.5 times the maximum frequency of vibrations that the experiment is interested in measuring to assess effects on science investigation results. Example: the maximum selectable frequency for the SAMS SE's is 400 Hz and therefore, if one is interested in this full bandwidth the minimum natural frequency between the sensor and the location of interest must be no less than 600 Hz.

5.1.5.2 Attachment

The SE is attached using four integral Tridair CA28080C-3-9HS fully retracting spring-loaded captive screw assemblies with nut retainers, as shown in Figure 12. All four fasteners must be used. Each fastener has a hex socket recess for tool installation. All the tools necessary to perform SAMS hardware mounting are available from the ISS IVA Toolkit. SAMS-II drawing #60005MD12111 (RTS-SE Base Detail) shows the bolt hole pattern for the SE interface. The torque requirement for mounting an SE into 303 Cres stainless steel inserts is 25 ± 1 in-lbs plus running torque. A minimum thread engagement of 0.31 inches is required. Threadlock compound should not be used on these fasteners due to their planned removal for calibration purposes. Planned mounting of the SE into any other material requires specific review and approval by the SAMS Project.

5.1.5.2 Mounting Clearance

The SE shall have at least 1 inch clearance from all surfaces of its housing. This is to ensure clearance for removal.

5.1.6 Thermal

Each SE undergoes thermal acceptance testing over an operating temperature range of 0º to 50 °C. The heat dissipation of an SE is approximately 2.5 watts. The external surface temperature of an SE under nominal operating conditions is typically no more than 2 °C higher than the surface upon which it is mounted, therefore an SE mounted in crew accessible locations is restricted to an operating thermal environment of 0º to 45°C.

5.1.7 Pressure Environment

The SE operates at pressures ranging from 10.0 to 16.0 psia.

5.1.8 Humidity

The SE can operate in a 20% - 80% non-condensing relative humidity environment.

5.1.9 Ground Storage Environment

All SAMS hardware shall be stored in a controlled access area with the following environmental restrictions:

	Requirement
Temperature	0 - 70°C
Humidity	20% - 80%

5.2 Power

The SE receives power from the EE and therefore has no individual power requirements.

5.3 RTS Cable

Certified RTS cable(s) will be furnished by the SAMS Project. Maximum length of an RTS cable is 10 meters. The cable bend radius should be five inches, however radii down to 3 inches are acceptable. The SAMS Project will provide final cable drawings to the user. The user shall define to the SAMS Project back-shell type (right angle or straight), orientation, and length of cable.

Figure 14 illustrates two possible SE mounting configurations: internal and external. The actual configuration shall be defined by the user. All cables shall utilize connector caps unless otherwise specified in the ICAD. All cable connectors without tethered caps will have plastic dust caps for shipping & storage.

The SAMS Project will inform the user as to which EE channel (A or B) the user's SE will be connected. The user shall avoid clearance conflicts with the connector not being utilized.

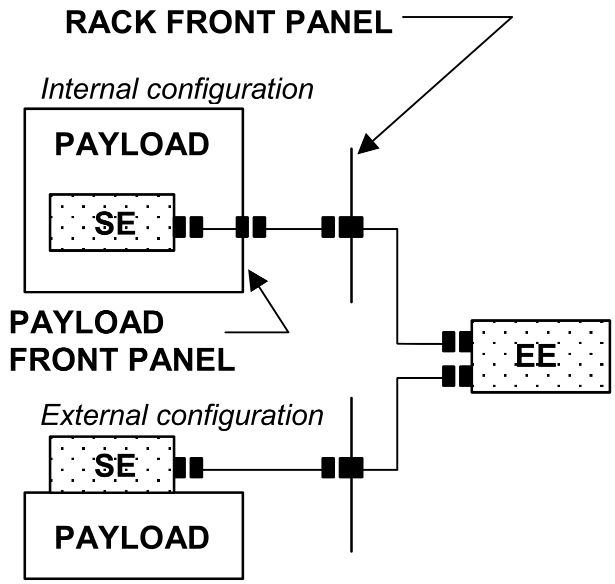

Figure 14 - Examples of SE Interfacing

5.4 Fire Detection & Suppression

The SE is designed to minimize the occurrence of fire. The SE design includes NASA approved materials, appropriate electrical inhibits, and appropriate wire sizing. The SE consumes low power (~ 2.25 W) and is constructed with the electronics enclosed within an aluminum housing and base.

5.5 Verification

5.5.1 SAMS Verification

The SAMS Project will perform the SE quality assurance, performance, interface, and safety verifications specified in SAMS-II-007, SAMS-II System Verification Plan, and the RTS Phase III Flight Safety Hazard Reports. Verification Tracking Logs will be included in the Acceptance Data Package supplied with each SE. The results of these analyses, tests and inspections will be made available upon request.

5.5.2 User Verification

5.5.2.1 Interface Verifications

The SE user shall perform all interface verifications based upon the user's carrier requirements. For example, a user that mounts the SE in an EXPRESS Rack shall meet the applicable EXPRESS Rack interface verification requirements and a user that mounts the SE in the Microgravity Science Glovebox (MSG) shall meet the applicable MSG interface verification requirements.

5.5.2.2 Safety Verifications

The SE user safety verification requirements originate from the ISS payload safety process. The verification methods are taken directly from the approved Phase III Payload Hazard Reports and are detailed in sections 5.5.2.2.1 through 5.5.2.2.5. The user shall provide the safety verification closure data to the SAMS project. Table 11 of Appendix C lists data due dates based on hardware launch.

5.5.2.2.1 Bonding

The user shall perform a ground-based certification test using SE flight hardware along with the planned on-orbit installation operations, to ensure that there is a bond between the SE and the user's hardware that meets the requirements of SSP 30245 (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-04, Verification 1.4.2).

5.5.2.2.2 Structural/Mechanical (for launch configurations only)

The SE is considered a vented container for structural analyses.

A baseline quasi-static load environment for the SE is defined in SAMS-II-200C. This environment provides positive margins of safety based on factors of safety of 2.0 for ultimate and 1.25 for yield, and on crew induced loads of 125 pounds over a 4 x 4 inch area. The user shall provide a structural configuration for the SE that maintains these positive margins of safety, and shall verify this by analysis (ref. SAMS-013, Hazard Report SAMS-II-RTS-02, Verification 1.1.4)

A baseline random vibration environment for the SE is defined in Appendix B. The user shall ensure the SE's environment will not exceed these levels, and verify this by analysis and/or test (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-02, Verification 1.1.5).

The user shall provide self-locking nuts/nut plates or tapped holes for SE captive fastener mounting if the fasteners are used for securing hardware during Orbiter launch or landing, and verify this by independent inspection (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-02, Verification 5.1.1). The user shall perform an analysis, test and/or inspection to verify the integrity of the nuts/nut plates used for the SE (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-02, Verification 5.2.1).

5.5.2.2.3 Thermal

The user shall perform an analysis and/or test to verify that the thermal environment specified in section 5.1.6, Thermal, has been provided (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-03, Verification 1.2.1).

If the user utilizes an active thermal management device to provide the referenced thermal environment, the design of this device must be single failure tolerant. The user shall perform an analysis and/or test to verify the adequacy and functionality of this device (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-03, Verification 1.2.2).

5.5.2.2.4 Electrical

The SE user is not responsible for verification of power removal to the SE. The user of the EE that the SE is connected to shall provide an inhibit, verifiable at the time of insertion, that removes power to both the EE and its associated SEs (ref. Section 4.6.2.4).

5.5.2.2.5 Installation & Removal

Details pertaining to the installation of an SE into the user's hardware shall be defined in the user's ICAD. For all installation and removal operations involving an SE, either prior to launch or on-orbit, the user shall include steps utilizing all four captive fasteners for each SE and applying the proper torque to the captive fasteners (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-02, Verification 4.2.1) and inserting a verifiable inhibit to remove power to the EE (ref. SAMS-II-013, Hazard Report SAMS-II-RTS-04, Verification 2.1).

6.0 TRIAXIAL SENSOR HEAD-ETHERNET STANDALONE (TSH-ES)

6.1 Physical

6.1.1 General

The SAMS-ES hardware senses microgravity acceleration using the three orthogonal accelerometers mounted in an enclosure, as shown in Figure 15. The TSH-ES draws power from a 15 VDC supply source and has an ethernet data interface directly with the ICU. Specific details of the cabling layout will be dependent on the particular rack configuration, which will be defined in conjunction with the user. The TSH-ES connector will have a tethered cap.

Figure 15 – Triaxial Sensor Head—Ethernet Standalone

6.1.2 Dimensions

The TSH-ES dimensions, exclusive of connectors and cables, are 87.6 mm (3.45 in.) in width, 89.66 mm (3.53 in.) in height and 91.0 mm (3.58 in.) in length, as shown in Figure 16. For straight and 90° backshell dimensions, see Figures 17 and 18, respectively.

TBD

Figure 16 - Sensor Enclosure and Base

TBD

Figure 17 – TSH-ES Dimensions with Straight Backshell

TBD

Figure 18 – TSH-ES Dimensions with a 90 degree Backshell

6.1.4 Mass

The TSH-ES has a mass of approximately 0.5 kg (1.27 lbs). Individual units will vary slightly due to performance upgrades and part tolerances.

6.1.5 Center Of Mass

An example of the mass center information for a TSH-ES is provided in Table 8. The reference coordinate system shown is in Figure 19. The center of mass will be provided for a specific unit by the SAMS Project upon request.

Table 7 – TSH-ES Center of Mass Example

MASS	CENTER OF MASS		
	X-AXIS	**Y-AXIS**	**Z-AXIS**
0.5 kg (1.27 lbs)	tbd	tbd	tbd

TBD

Figure 19 – TSH-ES Center of Mass Reference

6.1.6 Mounting

6.1.6.1 Mounting Structure

To provide useful acceleration measurements, that which has not been attenuated and/or amplified, the structural transmission path between the TSH-ES and the experimental payload (e.g. science test chamber) should contain no structural resonance below 1.5 times the maximum passband frequency that the experiment is interested in measuring to assess effects on science investigation results. Example: the maximum selectable frequency for the SAMS TSH-ES is 375 Hz and therefore, if one is interested in this full bandwidth the minimum natural frequency between the sensor and the location of interest must be no less than 562.5 Hz.

6.1.6.2 Attachment

The TSH-ES is attached using four integral Tridair CA28080-08-7HS fully retracting spring-loaded captive screw assemblies with nut retainers, as shown in Figure 12. All four fasteners must be used. Each fastener has a hex socket recess for tool installation. All the tools necessary to perform SAMS hardware mounting are available from the ISS IVA Toolkit. SAMS drawing tbd shows the bolt hole pattern for the TSH-ES interface. The torque requirement for mounting a TSH-ES into A286 CRES stainless steel inserts is 20 in-lbs plus running torque. A minimum thread engagement of 0.25 inches is required. Threadlock compound should not be used on these fasteners due to their planned removal for calibration purposes. Planned mounting of the TSH-ES into any other material requires specific review and approval by the SAMS Project.

6.1.6.3 Mounting Location

When mounting, the TSH-ES shall have at least 1 inch clearance from all surrounding objects. This is to ensure clearance for removal. The mounting location shall be in agreement with all egress requirements as per SSP 57000.

6.2 Environment

6.2.1 Thermal

Thermal control will be provided by conduction through the base. Therefore, the TSH-ES must be mounted on a thermally conductive surface, capable of removing sufficient heat to maintain internal electronics within specification.

Each TSH-ES undergoes thermal acceptance testing over an operating temperature range of 0º to 50 °C. The heat dissipation of a TSH-ES is ≤ 5 watts. The external surface temperature of a TSH-ES under nominal operating conditions is typically no more than 2 °C higher than the surface upon which it is mounted, therefore a TSH-ES mounted in crew accessible locations is restricted to an operating thermal environment of 0º to 45°C.

6.2.2 Pressure Environment

The TSH-ES operates at pressures ranging from tbd to 16.0 psia.

6.2.3 Humidity

The TSH-ES can operate in a 20% - 80% non-condensing relative humidity environment.

6.2.4 Loads

TBD until structural analysis is completed. If user cannot meet the loads requirement during launch, then the TSH-ES shall be stowed.

6.2.5 Repress/Depress

TBD until structural analysis is completed.

6.2.6 Ground Storage Environment

All SAMS hardware shall be stored in a controlled access area with the following environmental restrictions:

	Requirement
Temperature	0 - 70°C
Humidity	20% - 80%

6.3 Performance

The TSH-ES will meet the following performance requirements as per SAMS-SPC-001:

> The system shall provide measurements in three axes of the microgravity acceleration where the noise level for each axis is 10dB below the curve defined by: 1.8 ugrms for data from 0.01 Hz to 0.1 Hz, 18 ugrms x frequency for data from 0.1 to 100 Hz, 1.8mgrms for data from 100Hz to 300 Hz.
>
> The system shall provide acceleration measurements in which the maximum error is less than 10% of the measured value for measurements that exceed the system noise floor requirement (reference above) across the frequency range of 0.01Hz to 300 Hz.

6.4 Power

The TSH-ES uses 4.58 W of power and receives power from the user or rack with a requirement of +/- 15VDC. A TSH-ES power conversion unit will be available to convert a facility's +28 VDC line to ± 15 VDC. The need for the TSH-ES power conversion unit will be captured in the user's ICAD.

6.5 Ethernet Connection

It is preferred that the user provides an ISS Ethernet connection to the TSH-ES for data communication to the SAMS control unit within ISS. The signal characteristic of the TSH-ES Ethernet will comply with the IEEE 802.3 (ISO/IEC 8802-3) standard as per SSP 57000. The communication interface is TCP-IP socket connections.

6.6 TSH-ES Cable

It is preferred that the SAMS Project furnishes the certified TSH-ES cable(s). This cable will connect the TSH-ES to the facility and will contain all power and data connections. Maximum length of a TSH-ES cable is tbd meters. The cable bend radius should be tbd, however radii down to tbd inches are acceptable. The SAMS Project will provide final cable drawings to the user. The user shall define to the SAMS Project back-shell type (right angle or straight), back-shell orientation, length of cable, pinout of user's end, and manufacturer and part number of connector on user's end.

Figure 20 illustrates two possible TSH-ES mounting configurations: internal and external. The actual configuration shall be defined by the user. All cables shall utilize connector caps unless otherwise specified in the ICAD. All cable connectors without tethered caps will have plastic dust caps for shipping & storage.

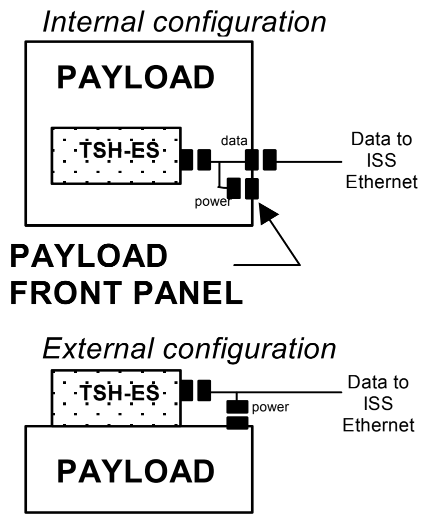

Figure 20 - Examples of TSH-ES Interfacing

6.7 Grounding

The TSH-ES will meet the grounding requirements of SSP 30243. There will be no ground to chassis within the TSH-ES.

6.8 Electromagnetic Interference

Electromagnetic interference will be performed as per SSP 57000. Since SSP 57000 is written for racks interfacing to space station, the power requirements are based on a much higher scale than the TSH-ES's needs. Therefore, several of the EMI tests are affected based on input power used. In this case, EXPRESS Rack Interface Definition Document, SSP 52000-IDD-ERP will be utilized.

6.9 Fire Detection & Suppression

The TSH-ES is designed to minimize the occurrence of fire. The TSH-ES design includes NASA approved materials, appropriate electrical inhibits, and appropriate wire sizing. The TSH-ES consumes low power (≤ 5.0 W) and is constructed with the electronics enclosed within an aluminum housing and base.

6.10 Verification

6.10.1 SAMS Verification

The SAMS Project will perform the TSH-ES quality assurance, performance, interface, and safety verifications specified in SAMS-PLN-xxx, SAMS Verification Plan. Verification Tracking Logs will be included in the Acceptance Data Package supplied with each TSH-ES. The results of these analyses, tests and inspections will be made available upon request.

6.10.2 User Verification

6.10.2.1 Interface Verifications

TBD – dependent on verification plan.

6.10.2.2 Safety Verifications

The TSH-ES user safety verification requirements originate from the ISS payload safety process. Since the ISS payload safety process has not been completed on the TSH-ES design these verifications are TBD.

6.10.2.2.1 Bonding

TBD – dependent on verification plan.

6.10.2.2.2 Structural/Mechanical (for launch configurations only)

TBD – dependent on verification plan.

6.10.2.2.3 Thermal

TBD – dependent on verification plan.

6.10.2.2.4 Electrical

TBD – dependent on verification plan.

6.10.2.2.5 Installation & Removal

TBD – dependent on verification plan.

APPENDIX A - STANDARD RTS FLIGHT CONFIGURATION

In the complete configuration, an RTS system is composed of one EE, two SEs, one power cable from a 28 VDC supply to the EE, one communications cable from the ISS's Payload Ethernet to the EE, and an RTS cable from the EE to each SE. The TSH-ES system is composed of one TSH-ES and once TSH-ES Cable from the TSH-ES to the user.

Table 8 - Standard Assembly

Item	Part Number
EE	60005MA12200
EE power cable	User-specified
EE data cable	User-specified
SE (channel A or channel B)	60005MA12100
SE Cable (channel A or channel B)	60005EA123xx*
TSH-ES	50000
TSH-ES Cable	xx*

* xx = specific to user

APPENDIX B - RTS RANDOM VIBRATION PARAMETERS

Table 9 - Maximum Allowable EE Random Vibration Levels
(Reference SAMS-II-629)

Frequency (Hz)	PSD level (g^2/Hz)
20	0.01
20 - 70	+3.3 dB/octave
70 - 500	0.04
500 - 2000	-3.0 dB/octave
2000	0.01
Composite	**6.8 g_{rms}**

Table 10 - Maximum Allowable SE Random Levels
(Reference SAMS-II-629)

Frequency (Hz)	PSD level (g^2/Hz)
20	0.01
20 - 70	+3.3 dB/octave
70 - 340	0.04
340 – 2000	-3.9 dB/octave
2000	0.004
Composite	**5.55 g_{rms}**

APPENDIX C – INTEGRATOR SAFETY VERIFICATIONS

Table 11 - Integrator EE Safety Verifications

Log No.	Hazard Report Number	Safety Verification Number	Safety Verification Method	Ground Operation(s) Constrained	Independent Verification Required	Due Date (Launch minus months)
16	02	1.1.4 (I)	Facility/rack/integrator perform structural analysis to demonstrate positive margins of safety for RTS hardware configuration as specified in SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS". Analysis may demonstrate load environment encompassed by baseline environment.	No	No	L-5
17	02	1.1.5 (I)	Facility/rack/integrator will perform analysis/test to demonstrate RTS hardware will survive random vibration environment as specified in SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS." Analysis may demonstrate random vibration environment encompassed by baseline vibration environment.	No	No	L-5
23	02	4.2.1 (I)	Facility/rack/payload integrator review its pre-launch procedures and/or crew procedures documented in accordance with SSP 52000-PDS for the installation and removal of RTS hardware including specifications for applying the proper torque to the captive fasteners and require that all four captive fasteners be utilized if the captive fasteners are used to secure RTS hardware during Shuttle launch and landing. If all four captive fasteners can not or were not planned to be used to secure RTS hardware for return on the Shuttle, crew procedures will be reviewed for specifications for the RTS hardware to be returned in a safe stowage configuration. The requirement for review of these procedures is specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	No	No	L-5
25	02	5.1.1 (I)	Facility/rack/payload integrator perform a QA inspection of the flight hardware to ensure self-locking nuts/nut plates for RTS captive fasteners are used if fasteners are used for securing hardware during Orbiter launch or landing in accordance with approved drawings and parts lists as specified in the SAMS-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	No	No	L-5
27	02	5.2.1 (I)	Facility/rack/payload integrator perform analysis/testing/inspection to verify the integrity of the nuts/nut plates used for RTS captive fasteners as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	No	No	L-5
32	03	1.2.1 (I)	Facility/rack/payload integrator of RTS hardware perform thermal analysis or testing to verify RTS hardware surfaces remain below 49ºC for all crew accessible operations as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS." Verification may include demonstration that thermal environment is within SAMS-II defined thermal environment envelope.	No	No	L-5
33	03	1.2.2 (I)	Facility/rack/payload integrator of RTS hardware perform analysis/test of active thermal management devices if required to verify adequacy and functionality of single failure tolerant design as specified in SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	No	No	L-5
34	04	1.1.1 (I)	Facility/rack/payload integrator perform testing to demonstrate that there is an inhibit that removes voltage to the RTS-EE and is verifiable at the time of inhibit insertion as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS." (Applicable only to integrator of a RTS-EE).	No	No	L-5

Log No.	Hazard Report Number	Safety Verification Number	Safety Verification Method	Ground Operation(s) Constrained	Independent Verification Required	Due Date (Launch minus months)
35	04	1.1.2 (I)	Facility/rack/payload integrator perform testing to verify that the maximum voltage supplied to the RTS-EE is no greater than 32 volts as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS." (Applicable only to an integrator of a RTS-EE).	No	No	L-5
40	04	1.4.2 (I)	Facility/rack/payload integrator perform a ground based certification test utilizing RTS flight hardware (which may not be specific RTS flight hardware unit) or flight-like RTS hardware and the planned on-orbit installation operations to ensure there is a bond between the RTS hardware and the hardware of the facility/rack/payload integrator which meets the requirements of SSP 30245 as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS".	No	No	L-5
41	04	2.1 (I)	Facility/rack/payload integrator review the crew procedures documented in accordance with SSP 52000-PDS for RTS installation and removal operations including steps to insert a verifiable inhibit to remove power to the RTS-EE as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	No	No	L-5

Table 12 - Integrator SE Safety Verifications

Log No.	Hazard Report Number	Safety Verification Number	Safety Verification Method	Ground Operation(s) Constrained	Independent Verification Required	Due Date (Launch minus months)
16	02	1.1.4 (I)	Facility/rack/integrator perform structural analysis to demonstrate positive margins of safety for RTS hardware configuration as specified in SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS". Analysis may demonstrate load environment encompassed by baseline environment.	No	No	L-5
17	02	1.1.5 (I)	Facility/rack/integrator will perform analysis/test to demonstrate RTS hardware will survive random vibration environment as specified in SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS." Analysis may demonstrate random vibration environment encompassed by baseline vibration environment.	N/A	N/A	L-5
23	02	4.2.1 (I)	Facility/rack/payload integrator review its pre-launch procedures and/or crew procedures documented in accordance with SSP 52000-PDS for the installation and removal of RTS hardware including specifications for applying the proper torque to the captive fasteners and require that all four captive fasteners be utilized if the captive fasteners are used to secure RTS hardware during Shuttle launch and landing. If all four captive fasteners can not or were not planned to be used to secure RTS hardware for return on the Shuttle, crew procedures will be reviewed for specifications for the RTS hardware to be returned in a safe stowage configuration. The requirement for review of these procedures is specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	No	No	L-5
25	02	5.1.1 (I)	Facility/rack/payload integrator perform a QA inspection of the flight hardware to ensure self-locking nuts/nut plates for RTS captive fasteners are used if fasteners are used for securing hardware during Orbiter launch or landing in accordance with approved drawings and parts lists as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	N/A	N/A	L-5
27	02	5.2.1 (I)	Facility/rack/payload integrator perform analysis/testing/inspection to verify the integrity of the nuts/nut plates used for RTS captive fasteners as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	No	No	L-5
32	03	1.2.1 (I)	Facility/rack/payload integrator of RTS hardware perform thermal analysis or testing to verify RTS hardware surfaces remain below 49ºC for all crew accessible operations as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS." Verification may include demonstration that thermal environment is within SAMS-II defined thermal environment envelope.	No	No	L-5
33	03	1.2.2 (I)	Facility/rack/payload integrator of RTS hardware perform analysis/test of active thermal management devices if required to verify adequacy and functionality of single failure tolerant design as specified in SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	No	No	L-5

Log No.	Hazard Report Number	Safety Verification Number	Safety Verification Method	Ground Operation(s) Constrained	Independent Verification Required	Due Date (Launch minus months)
40	04	1.4.2 (I)	Facility/rack/payload integrator perform a ground based certification test utilizing RTS flight hardware (which may not be specific RTS flight hardware unit) or flight-like RTS hardware and the planned on-orbit installation operations to ensure there is a bond between the RTS hardware and the hardware of the facility/rack/payload integrator which meets the requirements of SSP 30245 as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS".	No	No	L-5
41	04	2.1 (I)	Facility/rack/payload integrator review the crew procedures documented in accordance with SSP 52000-PDS for RTS installation and removal operations including steps to insert a verifiable inhibit to remove power to the RTS-EE as specified in the SAMS-II-100, "ISS Rack/Payload Interface Definition Document for the SAMS-II RTS."	N/A	N/A	L-5

APPENDIX D – PROCEDURE HISTORY / LOG SHEET

PROCEDURE HISTORY/LOG SHEET

NASA-GRC MICROGRAVITY SCIENCE DIVISION – ZIN TECHNOLOGIES

PART/ASSY NAME:

PART NUMBER: | **SERIAL NUMBER:** | **PAGE:**

ENTRY NO.	DESCRIPTION OF ACTION	INITIALS	DATE

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