ExP IDD Errata 4/20/99

The errata listed herein defines the required changes to the ExP IDD as known at 4/20/99. The following sections are free of errata (as of 4/20/99): Sections 1, 2, 10, 11, 12, 13, 14, and 15.

Section 3 Errata:

1) Revise section 3 to add the following sentence to the end of the first paragraph of section 3.4.3.2: "The use titanium fasteners by payloads shall be subject to the criteria of MSFC-STD-557."

2) Table 3-II will be modified as shown below:

ISS COORDINATE SYSTEM	EXP ISS LOCATION NADIR INBOARD inches	NADIR INBOARD meters	NADIR OUTBOARD inches	NADIR OUTBOARD meters	ZENITH INBOARD inches	ZENITH INBOARD meters	ZENITH OUTBOARD inches	ZENITH OUTBOARD meters
ExP Structural Coordinate System	X_{ExP} = TBD#3-03 Y_{ExP} = TBD#3-03 Z_{ExP} = TBD#3-03	X_{ExP} = TBD#3-03 Y_{ExP} = TBD#3-03 Z_{ExP} = TBD#3-03	X_{ExP} = TBD#3-03 Y_{ExP} = TBD#3-03 Z_{ExP} = TBD#3-03	X_{ExP} = TBD#3-03 Y_{ExP} = TBD#3-03 Z_{ExP} = TBD#3-03	X_{ExP} = TBD#3-03 Y_{ExP} = TBD#3-03 Z_{ExP} = TBD#3-03	X_{ExP} = TBD#3-03 Y_{ExP} = TBD#3-03 Z_{ExP} = TBD#3-03	X_{ExP} = TBD#3-03 Y_{ExP} = TBD#3-03 Z_{ExP} = TBD#3-03	X_{ExP} = TBD#3-03 Y_{ExP} = TBD#3-03 Z_{ExP} = TBD#3-03
ITS S3 Coordinate System	X_{S3} = 2.200 Y_{S3} = 169.880 Z_{S3} = 79.700	X_{S3} = 0.056 Y_{S3} = 4.315 Z_{S3} = 2.024	X_{S3} = 2.200 Y_{S3} = 285.260 Z_{S3} = 79.700	X_{S3} = 0.056 Y_{S3} = 7.246 Z_{S3} = 2.024	X_{S3} = 2.200 Y_{S3} = 121.073 Z_{S3} = -79.700	X_{S3} = 0.056 Y_{S3} = 3.075 Z_{S3} = -2.024	X_{S3} = 2.200 Y_{S3} = 234.443 Z_{S3} = -79.700	X_{S3} = 0.056 Y_{S3} = 5.955 Z_{S3} = -2.024
ISS Reference Coordinate System	X_R = -~~97.800~~ 102.200 Y_R = 869.680 Z_R = -~~20.300~~ 179.700	X_R = ~~-2.484~~ 2.596 Y_R = 22.090 Z_R = ~~-0.516~~ 4.564	X_R = ~~-97.800~~ 102.200 Y_R = 985.060 Z_R = ~~-20.300~~ 179.700	X_R = ~~-2.484~~ 2.596 Y_R = 25.021 Z_R = ~~-0.516~~ 4.564	X_R = -~~97.800~~ 102.200 Y_R = 820.873 Z_R = -~~179.700~~ 20.300	X_R = -~~2.484~~ 2.596 Y_R = 20.850 Z_R = -~~4.564~~ 0.516	X_R = ~~-97.800~~ 102.200 Y_R = 934.243 Z_R = -~~179.700~~ 20.300	X_R = ~~-2.484~~ 2.596 Y_R = 23.730 Z_R = ~~-4.564~~ 0.516

Section 4 Errata:

1) Revise section 4.6.4 from:

ExP payload shall meet interface requirements specified herein when applicable thermal effects as described in paragraph 5.3.4 are combined with induced static and dynamic loads, including thermally induced structural interface loads.

To:
ExP payload shall meet interface requirements specified herein when applicable thermal effects as described in paragraph 5.3.4 are combined with induced static and dynamic loads. Thermally induced structural interface loads **shall also be considered when meeting this interface requirement. These loads can be caused by differential expansion of similar materials under a temperature gradient or by differential expansion of dissimilar materials at a constant temperature.**

2) Delete the words “PD provided” from shipping container requirements in Paragraphs 4.10, 4.10.1, and 4.10.2.

3) Add section 4.6.5.4 and Table 4-VI as follows:

4.6.5.4 On-Orbit Random Vibration Loads
Payloads shall be designed to withstand the on-orbit random vibration levels specified in Table 4-VI.

TABLE 4-VI. ON-ORBIT RANDOM VIBRATION ENVIRONMENT

Frequency (Hz)	Level
10-50	0.0005 g^2/Hz
50-100	+3 dB/Octave
100-1000	0.01 g^2/Hz
1000-2000	–3 dB/Octave
2000	0.0005 g^2/Hz
Composite	1.3 grms
Duration	10 hours/Year

Note: Three mutually perpendicular axes.

Section 5 Errata:

1) Add the following sentence to section 5.4.1:

The ISS flight attitudes are defined in Section 3.2.5, Table XXII of S683-29523, United States Laboratory Specification.

2) Make the following changes to Appendix C:

a) Add Introduction, Use of MERAT data, Figure 1, Figure 2, Figure 3, and Table C-2 to Appendix C (as contained on the following pages).

b) Change the title of Table C-1 to "List of Preliminary MERAT Cases".

INTRODUCTION

Many factors affect the overall thermal environment for an object in low earth orbit. Accurate thermal analysis of an external payload in orbit requires a good simulation of the natural environmental conditions (solar flux, albedo, and earth IR) as well as the associated effects from the geometry of other orbital elements. Due to the large size of the International Space Station (ISS) and complex articulation of the solar arrays and thermal radiators, payload experiment developers (PD) must include a vast number of external surfaces and logic in their thermal models or attempt to simulate the overall effects of these complex geometries with a relatively simple representation. The first case can lead to excessive run times if the PD does not have access to supercomputer type performance while the second case may lead to inaccurate results or possibly over conservatism which may be used to compensate for the unknowns of the simplified model. In both cases, the PD must spend many hours trying to accurately model the factors, which will influence their payload's thermal design. Ideally, the experiment developer should minimize this time so that more emphasis can be put on the payload model.

In order to help the PD overcome these problems, a method which simplifies modeling the effects of these complex external factors has been developed. Using an integrated thermal model which contains representations of all the significant external geometries, the environment for a given experiment surface can be summarized into just three values. These values are an absorbed heat flux which includes all solar, albedo, earth IR, and energy from other external surfaces, a Mean Effective RAdiation Temperature (MERAT) which represents the effective sink temperature seen by the given surface, and a radiation conductor (RADK) which defines the thermal link between the experiment surface and the MERAT sink temperature node. A schematic illustrating this concept is shown in Figure C-1. This type of data and analysis methodology has been used by payload developers on the Space Shuttle program for more than 10 years and has proven to be simple to use in all cases and more accurate in cases where the user had limited computer resources.

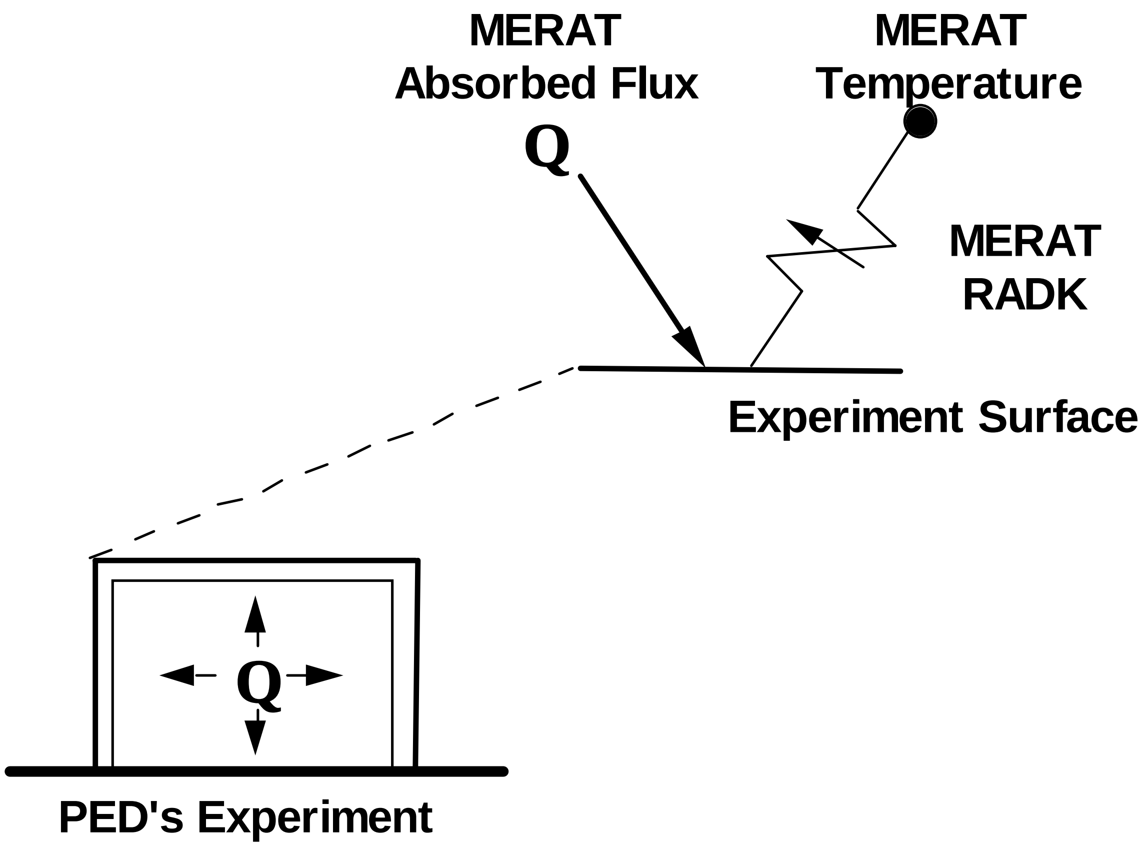

FIGURE 1. EXPERIMENT ENVIRONMENTAL BOUNDARIES SCHEMATIC

The following equations define the calculation methodology used to generate MERAT data:

MERAT Flux:

Computed in TRASYS (Radiation interchange and orbital heating calculation program) using solar, albedo, earth IR, and flux components reflected and emitted from other external surfaces.

MERAT RADK:

Calculated by summing TRASYS radiation conductors from node i to n nodes.

$$G_m = \sum_{j=1}^{n} G_{i-j}$$

MERAT Boundary Temperature:

Computed in thermal analyzer program (e.g. SINDA) based on RADKs and computed temperatures for connected surfaces. Refer to Appendix B for a detailed derivation of this general equation.

$$T_m = \sqrt[4]{\frac{\sum_{j=1}^{n}(G_{i-j}T_j^4)}{\sum_{j=1}^{n}G_{i-j}}}$$

USE OF MERAT DATA

Using this information, the PD does not have to model any element external to the experiment envelope since all the associated effects of the environment are accounted for in the MERAT data. The only addition to the PD model would be the MERAT heat flux, MERAT boundary temperature, and the MERAT RADK connecting the payload surface to the MERAT temperature. The corresponding MERAT data would be input for each external surface in the PD's model.

An integrated thermal model, including all significant station elements as well as solar array and radiator articulations, has been developed for the EXPRESS Pallet(ExP). Figure C-2 shows the S3 truss model segment with the 4 EXPRESS pallets attached. The payload portion of each pallet uses flat rectangular surfaces to simulate the envelopes of the six payload locations. Using this information the user can make some modifications to the existing data to correct for differences in the size and solar absorptivity between the actual experiment and the assumed parameters. In order to make an area change, the MERAT flux and the MERAT RADK should be multiplied by the ratio of the new area to the assumed area (i.e. $Q_{new} = Q_{MERAT} * A_{new} / A_{MERAT}$). Differences in solar absorptivity can be approximated, but the user should be aware that there will be some error introduced since the absorbed flux is a combination of solar and IR wavelengths. In most cases the solar part of the total is much larger than the IR portion so this change can be made with only a minimal error; however, the user should evaluate the location of their experiment to determine if the modification is appropriate. This change is made by simply multiplying the MERAT flux by the ratio of the new absorptivity to the assumed value ($Q_{new} = Q_{MERAT} * \alpha_{new} / \alpha_{MERAT}$). The other MERAT values should remain unchanged.

The preliminary MERAT data cases are listed in Table C-1. These data are for an orbital average environmental condition as well as for transient conditions in an orbit. The orbital average data are generated from data at 12 points for orbits that do not cross into the earth's shadow and 16 points for those that intersect the shadow. Currently, the ISS model uses either the station complete configuration or the UF-3 configuration. In the UF-3 cases, only an ExP at the Nadir-Outboard location is modeled. In the Station Complete cases, all four ExP locations are modeled. Both orbital average and transient data are available for each case defined below. When the STS is docked, there is an ExP modeled in the cargo bay.

A tabulation of orbital parameters used in the MERAT Data cases is given in Table C-2.

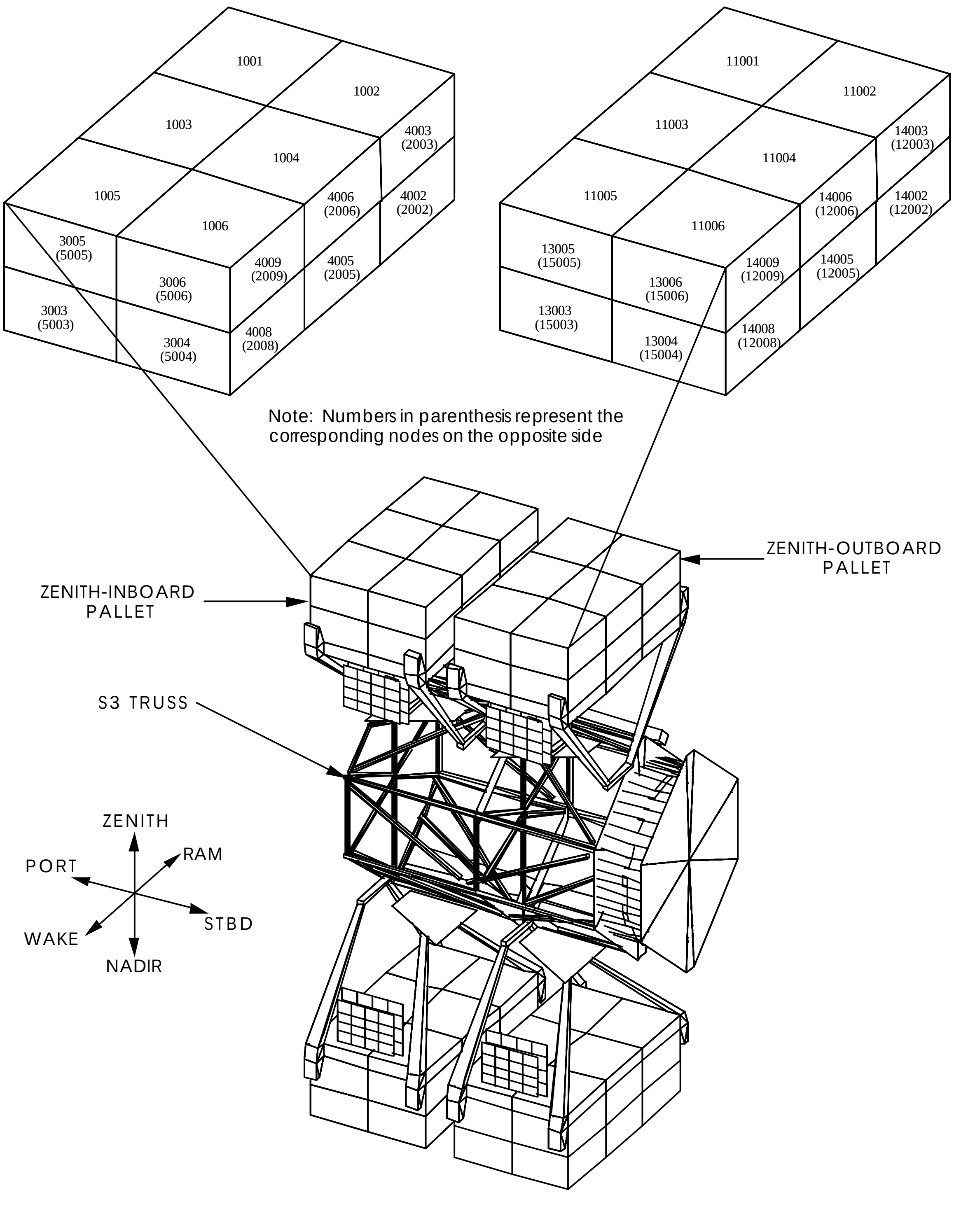

FIGURE2. EXPERIMENT ENVELOPE SURFACE LOCATIONS (SHEET 1 OF 2)

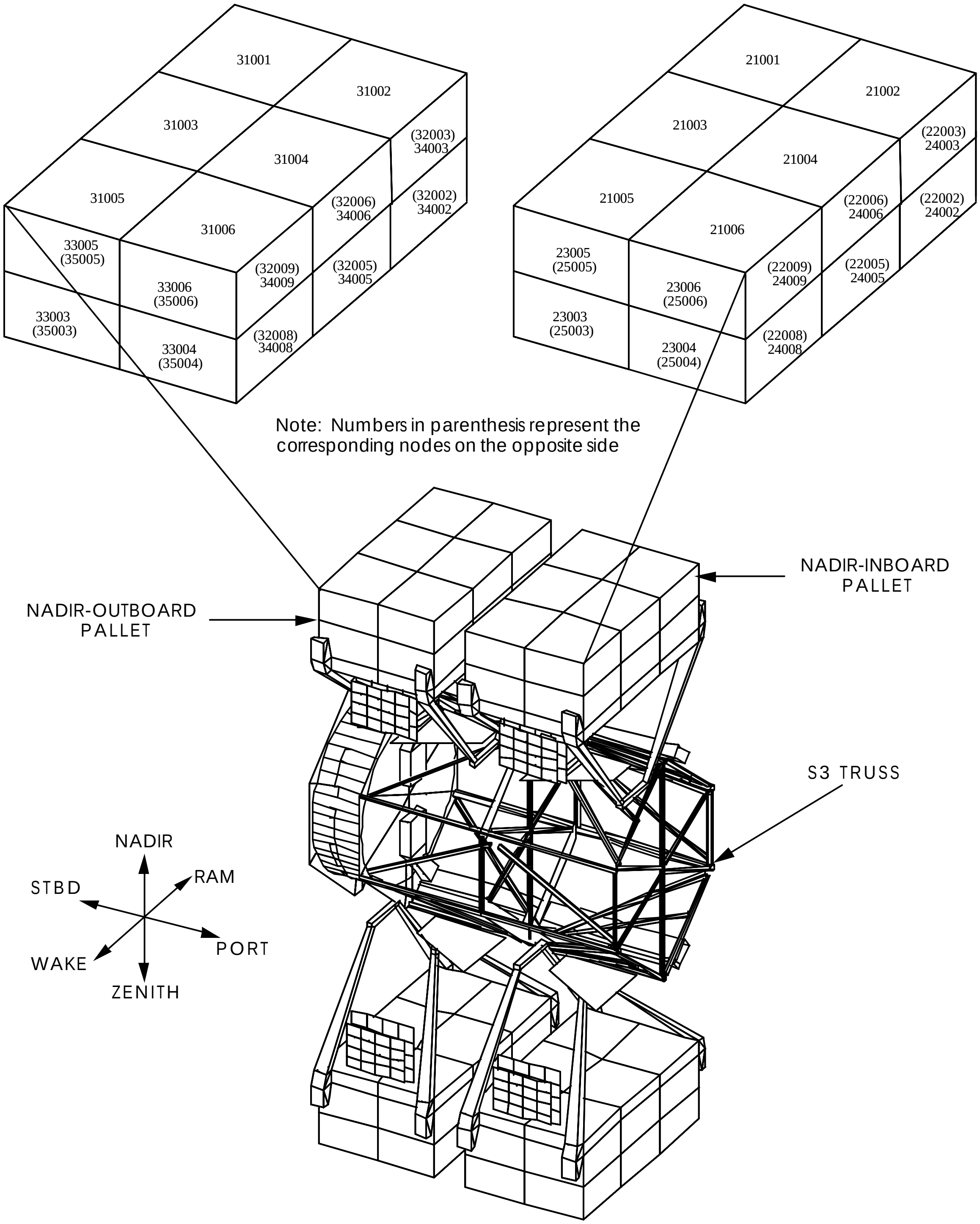

FIGURE 2. EXPERIMENT ENVELOPE SURFACE LOCATIONS (SHEET 2 OF 2)

Table C-2 Orbital Parameters Used in MERAT Data Cases

Parameter	Hot Cases	Cold Cases
Altitude (nmi)	270	180
Solar Constant (W/m^2)	1321	1423
Earth IR (W/m^2)	0.20	0.40
Albedo	206	286
Payload Surface Optical Properties (α/ε)	0.30/0.90	0.30/0.90

Section 6 Errata:

1) Revise Para 6.6 Title as follows:

From:
PAYLOAD POWER ALLOCATION

To:
PAYLOAD POWER **CAPABILITY**

2) Revise Table 6-IV title as follows:

From:
PAYLOAD MAXIMUM POWER AVAILABILITY

To:
PAYLOAD MAXIMUM POWER **CAPABILITY**

3) Revise Table 6-IV column title as follows:

From:
POWER ALLOCATION

To:
POWER **CAPABILITY**

Section 7 Errata:

1) Replace Table 7-I contents with contents from Table 3.2.1.1-1 of SSP 30242:

From:

TABLE 7-I CIRCUIT EMC CLASSIFICATIONS

FREQ. OF RISE AND/OR FALL TIME	SOURCE IMPEDANCE (ohms)	LOAD IMPEDANCE (ohms)	VOLTAGE SENSITIVITY	CIRCUIT CLASSIFI-CATION[4]	WIRE TYPE REQD	SHIELD GROUNDING REQMTS
Analog Alternating or Direct Current	<100	<100 - 600 k 0 - 200 0 - 200	>100 mV to <6 V >6 V to ≤40 V >40 V	ML HO EO	TWS TW TW	SPG[2] None None
	≤2.5 k	<100 - 600 k >600 k	<100 mV	ML	TWS TWDS	SPG SPG
	<200	≥200 ≥200 ≥200 V	>100 mV to <6 V >6 V to ≤40 V >40 V	Ml HO EO	TWS TW TW	SPG None None
<50 kHz or Rise and Fall Time >10 µs	<100	<10 k 0 - 200 0 - 200	≤6 V >6 V to ≤40 V >40 V	ML HO EO	TWS TW TW	SPG None None
	≤2.5 k	<100 - 600 k >600 k	<100 mV	ML	TWS TWDS	SPG SPG
	<200	≥200 ≥200 ≥200 V	>100 mV to <6 V >6 V to ≤40 V >40 V	ML HO EO	TWS TW TW	SPG[2] None None
<50 kHz or Rise and Fall Time ≤10 µs ≤1.024 MHz	All	All All	≤100 mV >100 mV to ≤6 V	RF RF	TWDS[1] TWS	MPG MPG
		<1000 ≥1000	>6 V	RF	TWDS[1] TWS	MPG MPG
>1.024 MHz	All	All	All	RF	COAX	MPG

Symbols Used

AF - Audio Frequency
Coax - Coaxial
k - Kilo
kHz - Kilohertz
MHz - Megahertz
MPG - Multiple Point Ground
RF - Radio Frequency
SPG - Single Point Ground

TSP - Twisted Shielded Pair
TW - Twisted
TWDS - Twisted Double Shielded
TWS - Twisted Shielded
V - Volts (dc)

mV - Millivolts (dc)
µs - microseconds
< - less than
≤ - less than or equal to
≥ - greater than or equal

NOTES:

1. If the capacitance per foot is critical, controlled-impedance wiring, special-shielded-twisted pair cables (nominal 75 ohms) should be used.

2. If circuit is balanced by transformer, differential or optical, the shield shall be multi-point grounded to structure.
3. Distance between shield grounds shall not exceed 18 m.
4. The symbols ML, HO, and EO are arbitrary nomenclature to define circuit classification and have no meaning.

To:

TABLE 7-I CIRCUIT EMC CLASSIFICATIONS

FREQ. OF RISE AND/OR FALL TIME	VOLTAGE SENSITIVITY	LOAD IMPEDANCE (ohms)	CIRCUIT CLASSIFI-CATION[4]	WIRE TYPE REQD	SHIELD GROUND[1]
Analog Alternating or Direct Current f<=50 kHz, Rise and Fall Time >10 µs	≤100 mV ≤100 mV <6V 6V – 40V >40V	<600k ≥600k All All All	ML ML ML HO EO	TWS TWDS TWS TW TW	MPG MPG MPG None None
50 kHz>f<=4MhZ, Rise and Fall Time ≤10 µs	<100 mV >100 mV	All All	RF RF	TWDS TWS	MPG MPG
f>4MHz[1]	All	All	RF	TWS, Coax, or Twin-ax	MPG
Fiber Optics	N/A	N/A	FO	Fiber Optics	N/A

Symbols Used:

TW	-	Twisted	TSP	-	Twisted Shielded Pair
TWDS	-	Twisted Double Shielded	TWS	-	Twisted Shielded
mV	-	Millivolts (dc)	V	-	Volts
Coax	-	Coaxial	Twin-ax	-	Twinaxial
µs	-	microseconds	k	-	Kilo
kHz	-	Kilohertz	MHz	-	Megahertz
MPG	-	Multiple Point Ground	N/A	-	Not Applicable
RF	-	Radio Frequency	SPG	-	Single Point Ground
f	-	Frequency	FO	-	Fiber Optic

ML, HO, EO, MO Arbitrary Nomenclature to define circuit classification

NOTES:
1. Shield grounding shall be compatible with the circuit application.
2. The length of termination-to-ground lead for all circuits shall be the minimum length practical.
3. The preferred method is to connect the shield peripherally to the back shell of the connector with a continuous impedance electrical both path through both halves of the connector shell and the connector-to-mounting surface interface.
4. Digital signals shall be classified as RF (and routed as wire type called out in this table).

2) Replace Table 7-VI contents with contents of Table 3.2.2.1.2-1 of SSP 30237:

From:

TABLE 7-VI CS01 LIMITS

FREQUENCY	VOLTAGE
30 Hz - 2 kHz	0.7 Vrms
2 kHz - 50 kHz	Decreasing log-linearly from 0.7 Vrms at 2 kHz to 0.28 Vrms at 50 kHz

To:

TABLE 7-VI CS01 LIMITS

FREQUENCY	VOLTAGE
30 Hz - 2 kHz	5V root mean square (rms) or 10 percent of the supply voltage, whichever is less
2 kHz - 50 kHz	Decreasing log-linearly with increasing frequency from 5 Vrms, or the supply voltage whichever is less, to either 1 Vrms or 1 percent of the supply voltage, whichever is less

Section 8 Errata:

Revise section 8.2 as follows:

From:
It is the intent that all electrical interface connectors be supplied by the ExP facility. If an ExP payload element chooses to supply electrical connectors and connector contacts that interface with the ExP, they shall be compatible NASA Threaded Coupling (NATC) connectors per SSQ 21635 and shall be intermateable with the connector receptacles indicated in Table 8-I.

To:
Payload cables that mate with the ExPA connector provisions shall be compatible with NASA Threaded Coupling (NATC) connectors per SSQ 21635 and shall be mateable with the connector receptacles indicated in Table 8-I.

<u>Section 9 Errata:</u>

1) Revise section 9.2.1 as follows:

From:
Payloads interfacing with the ExPCA shall meet the requirements and signal characteristics of ISO/IEC 8802-3 (10BASE-T section).

To:
Payloads interfacing with the ExPCA shall meet the requirements and signal characteristics of ISO/IEC 8802-3 (10BASE-T section) **for transformer coupled stubs.**

2) Revise section 9.2.2 as follows:

From:
Payloads communicating with the ExPCA via Ethernet shall use software protocol Transmission Control Protocol/Internet Protocol (TCP/IP).

To:
Payloads communicating with the ExPCA via Ethernet shall use software protocol **per SSP 52050, section 3.3 (excluding paragraphs 3.3.2, 3.3.3.5, 3.3.3.6).**

3) Revise section 9.3.1 as follows:

From:
An analog signal to the ExPCA shall (1) be a +/-5 Vdc output signal. The dc input impedance shall (2) be greater than or equal to 1 megaohm.

To:
The temperature signal input to the ExPCA, excited by a 1 mA excitation signal from the ExPCA, shall (1) be +/- 5 Vdc maximum from the payload-provided RTD. Temperature input range will be +/- 500 mVdc for a typical 1kOhm RTD. The dc input impedance shall (2) be greater than or equal to 1 megaohm **(pin-to-pin).**

4) Revise section 9.3.3 as follows:

From:
An analog input to the ExPCA shall (1) be a <u>+/-</u> 5 Vdc ….. The dc input impedance shall (2) be greater than or equal to 1 megaohm.

To:
An analog input to the ExPCA shall (1) be a <u>+/-</u> 5 Vdc ….. The dc input impedance shall (2) be greater than or equal to 1 megaohm **(pin-to-pin).**