Solar-B EIS

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Specification for DC-DC Converter

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CHANGE RECORD

File: EIS ICU power converter

ISSUE	DATE	PAGES CHANGED	COMMENTS
1	28 Feb 01	All	New

1 Introduction

This specification is for the DC-DC converter to supply secondary power to the Extreme-ultraviolet Imaging Spectrometer (EIS) instrument on the Solar-B satellite. The converter will take the spacecraft supply at 28V, provide isolation for this from the experiment ground, and supply eight regulated power lines. Total power handling is about 38W, and typical spacecraft environmental conditions apply. The outgassing characteristics of the unit must be suitable for use in proximity to grazing incidence optical systems working at UV wavelengths.

2 General

2.1 Terms

In this document "shall" represents a mandatory requirement, and "should" represents a preferred choice.

2.2 Units

Two units are required: one prototype model (PM) and one proto-flight model (FM). The differences between these are described in the Qualification section.

2.3 Environmental

Most environmental, testing and qualification figures are closely derived from Ref. 3

2.4 Changes

Change bars identify changes from the previous issue.

3 Applicable Documents

3.1 Ref. 1

Solar-B Electrical Design Standard (EDS) SLB-120 Ver 2.1 dated 30 Aug 00.

3.2 Ref. 2

Electronic Component Specification MSSL/SLB-EIS/SP020.01 dated 5 Jul 00.

3.3 Ref. 3

Environmental Conditions for Solar-B, SLB-124 Rev. 2.0 January 2001.

4 Design and Construction Requirements

Note that Ref. 2 shall be used as the primary basis for component selection.

4.1 Workmanship

All designs and manufacturing processes shall comply with space industry standards and practices, and shall comply with MSSL process specifications and standards.

4.2 Failure Propagation

4.2.1 Interface Failure

The equipment shall be designed in such a way that any failure cannot be propagated towards other equipment, through the electrical harness or by thermal or mechanical effects.

4.2.2 Internal Failure

The equipment shall be designed in such a way that any failure cannot be propagated inside the unit.

4.2.3 Single Point Failure

The design shall minimise the number of possible single point failures. If a single point failure exists, it shall be clearly identified together with all the necessary precautions required to minimise its consequences.

5 Input

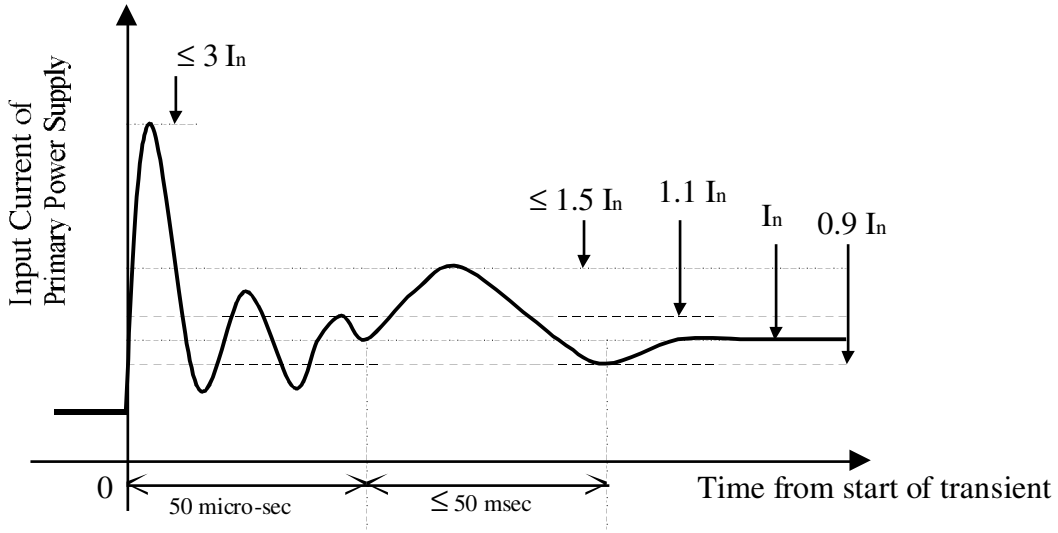
5.1 Input voltage

The converter shall operate within specification over the input voltage range 25.5 - 30.5V.

5.2 Inrush current

Inrush current on switch-on with any load from the specified minimum to full shall be controlled to less than the following:
From switch-on to 50µs: 6.9A.
From 50µs to 50ms: 3.5A, with a rate of change of less than 5×10^4 A s^{-1}.
The maximum duration of the inrush peak shall be 50ms.
Fig.1 illustrates the requirement (I in = 2.3A).

Fig.1



5.3 Input overload - momentary

The unit shall survive a momentary input lasting for up to 1ms of +45V, repeated every 10s, without damage.

5.4 Input overload - long term

The unit shall survive an input voltage of 0 - +35V for at least 24 hours without damage and with the outputs being back in specification within 1 minute of the supply being restored to normal.
No reverse voltage protection is required.

5.5 On-off threshold

There shall be a unit on/off threshold set at 20V ±2V.

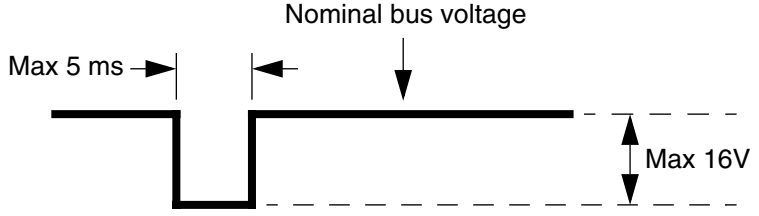
5.6 Input short circuit

The unit shall survive an instantaneous short circuit on the input power line at any time.

5.7 Input hold-up time

An input transient as in Fig.2 shall not cause the outputs to go out of specification, even at full rated load.

Fig.2



6 Outputs

The output lines are divided into five groups which are electrically isolated from each other.

6.1 Ground A

6.1.1 Output +2.5V (ICU Logic Supply)

6.1.1.1 +2.60V ± 0.1V over full load and environmental conditions.

6.1.1.2 Maximum continuous load: 200mA TBC.

6.1.1.3 Peak load: as maximum continuous load.

6.1.1.4 Minimum load: 10mA TBC.

6.1.1.5 Maximum output current with any load: 400mA TBC.

6.1.1.6 Noise: Less than 50 mV rms from dc to 50MHz

6.1.2 Output +5V (ICU Logic Supply)

6.1.2.1 +5.1V ±0.2V over full load and environmental conditions.

6.1.2.2 Maximum continuous load: 1.7A TBC.

6.1.2.3 Peak load: as maximum continuous load.

6.1.2.4 Minimum load: 50mA

6.1.2.5. Maximum output current with any load: 3.4A TBC.

6.1.2.6 Noise: Less than 100mV pk-pk from dc to 50MHz.

6.1.3 Output +Monitor

6.1.3.1 +15.0V ±0.5V over full load and environmental conditions.

6.1.3.2 Maximum continuous load: 50mA TBC

6.1.3.3 Peak load: 120mA TBC for 10ms with 1:100 duty cycle.

6.1.3.4. Minimum load: 10mA TBC

6.1.3.5 Maximum output current with any load: 240mA TBC.

6.1.3.6 Noise: Less than 200mV pk-pk from dc to 50MHz.

6.1.4 Output -Monitor

6.1.4.1 -15.0V ±0.5V over full load and environmental conditions

6.1.4.2 Maximum continuous load: 50mA TBC

6.1.4.3 Peak load: as maximum continuous load.

6.1.4.4 Minimum load: 10mA TBC

6.1.4.5 Maximum output current with any load: TBDmA.

6.1.4.6 Noise: Less than 200mV pk-pk from dc to 50MHz.

6.2 Ground B

6.2.1 Output +7V (CAM Supply)

6.2.1.1 +7.1V ±0.5V over full load and environmental conditions.

6.2.1.2 Maximum continuous load: 200mA TBC

6.2.1.3 Peak load: 250mA for 5ms with 30% duty cycle.

6.2.1.4 Minimum load: zero.

6.2.1.5 Maximum output current with any load: 500mA

6.2.1.6 Noise: Less than 200mV pk-pk from dc to 50MHz.

6.3 Ground C

6.3.1 Output -7V (CAM Supply)

6.3.1.1 -7.1V ±0.5V over full load and environmental conditions.

6.3.1.2 Maximum continuous load: 120mA TBC.

6.3.1.3 Peak load: 150mA for 5ms with 30% duty cycle.

6.3.1.4 Minimum load: zero.

6.3.1.5 Maximum output current with any load: 500mA.

6.3.1.6 Noise: Less than 200mV pk-pk from dc to 50MHz.

6.4 Ground D

6.4.1 Output +15V (CAM supply)

6.4.1.1 +15.2V ±0.5V over full load and environmental conditions.

6.4.1.2 Maximum continuous load: 100mA TBC.

6.4.1.3 Peak load: 240mA for 5ms with 30% duty cycle.

6.4.1.4 Minimum load: zero.

6.4.1.5 Maximum output current with any load: 500mA.

6.4.1.6 Noise: Less than 200mV pk-pk from dc to 50MHz.

6.5 Ground E

6.5.1 Output -12V (CAM supply)

6.5.1.1 -12.2V ±0.5V over full load and environmental conditions.

6.5.1.2 Maximum continuous load: 2.5mA TBC

6.5.1.3 Peak load: 3mA TBC.

6.5.1.4 Minimum load: zero.

6.5.1.5 Maximum output current with any load: 100mA.

6.5.1.6 Noise: Less than 200mV pk-pk from dc to 50MHz.

7 Outputs - General Information

7.1 Overload

All outputs shall withstand a continuous overload or short circuit for at least 24 hours without damage and with the outputs being back in specification within 1 minute of loads being restored to normal. This shall be measured under any combination of specified input voltage, load on another output, or environmental condition.

7.2 Cross Regulation

An excessive load on any combination of outputs shall not cause any other output to go outside the absolute limits.

7.3 Maximum output current

Connection of any load including a short circuit shall not cause more than this current to flow. The only exception is for up to 10ms after application of the load, to allow discharge of output capacitors in the converter. There is no requirement for the converter to be capable of supplying this current - the *peak load* value defines the largest current required.

7.4 Isolation

The isolation between groups shall be:

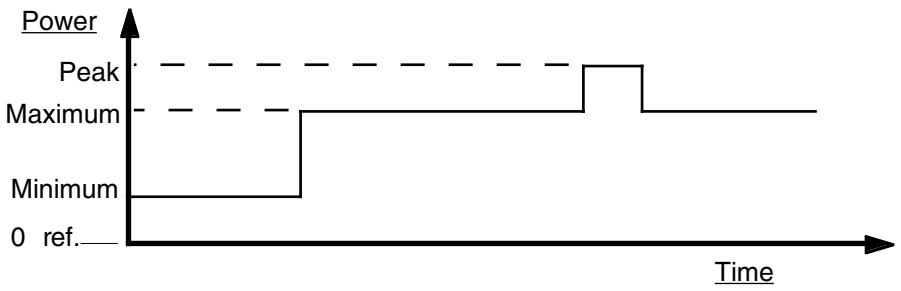
R > 10MΩ
C < 1nF before common mode filter capacitors fitted
V breakdown > 100V

No isolation is required between the output supplies of any one group. There is also no requirement for them to be connected.

7.5 Power definitions:

Fig.3 indicates the meanings of the power definitions.

Fig.3



7.6 Absolute Limits

At no time and under no fault conditions shall the outputs go outside the following ranges (TBC):

7.6.1 +2.5V (ICU Supply)
0 –> +3.0V

7.6.2 +5V (ICU Supply):
0 –> +6.2V

7.6.3 +Monitor
0 –> +17V

7.6.4 -Monitor
0 –> -17V

7.6.5 +7V (CAM supply)
0 –> +8.0V

7.6.6 -7V (CAM supply)
0 –> -8.0V

7.6.7 +15V (CAM supply)
0 –> +17.0V

7.6.8 -12V (CAM supply)
0 –> -13.0V

7.7 Noise Specification

7.7.1 Conditions

All noise figures are measured under any combination of specified input voltage, output load, or environmental condition.

7.7.2 Definitions

All output noise shall have spikes of less than the figures above, and ripple of less than 30mV rms. The definitions of these are:-
Spikes: the maximum allowable amplitude of non-repetitive signals in the frequency range of 100Hz to 10MHz, recorded over a period of at least 10s. This is a time domain measurement.
Ripple: the maximum allowable amplitude of repetitive signals in the frequency range of 100Hz to 50MHz, measured in a 30Hz bandwidth. This is a frequency domain measurement.

8 Operating Frequency

The converter should have a switching frequency between 50kHz and 600kHz (TBC). There is no requirement for external synchronisation.

9 Temperature Range:

Nominal temperatures at the mounting point:

9.1 Operating

-20 – +50 C . The converter shall be to specification in this range.

9.2 Survival

-30 – +65 C .The converter shall survive switch on with any load inside specification in this range.

10 Primary Isolation

Primary to structure breakdown voltage:	>100V
Primary to structure resistance:	>10MΩ
Primary to structure capacitance:	<20nF
Primary to secondary breakdown voltage:	>100V
Primary to secondary resistance:	>10MΩ
Primary to secondary capacitance:	<1nF

11 EMC

All the following parameters apply to ANY combination of load or supply conditions within the nominal specification.
All frequencies generated shall be necessary for operation of the converter; there shall be no spurious oscillation.

11.1 Conducted Emissions

11.1.1 Differential mode

The noise appearing on a primary power or return wire shall not exceed 30mV pk, measured in a 50MHz bandwidth.

11.1.2 Common mode

The noise appearing on the power line together with the return shall not exceed 100µA peak from 30Hz to 50MHz.

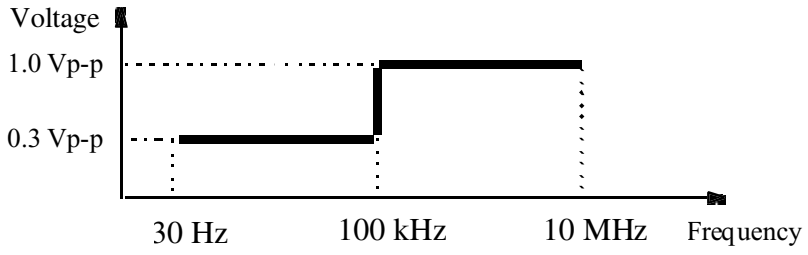
11.2 Conducted Susceptibility

For all continuous injected signals, the injected current shall be restricted to a maximum of 500mA (TBC) peak to limit the risk of damage.
The converter shall not go outside specification when subject to any of the following conditions.

11.2.1 Differential mode

11.2.1.1 Continuous sinewave sweep at 1 octave in 90s from 30Hz to 10MHz.
Signal injection: Main power.
Level: as in Fig.4

Fig.4



11.2.1.2 Voltage transient of square shape as shown in Fig.5 and Fig.6, with rise time < 4µs.
A continuous stream of pulses at 5Hz shall be applied, both positive and negative, and using both parameters 1 and 2, with the supply set to the upper voltage limit (30.5V).
The test shall then be repeated at the lower voltage limit (25.5V).
Signal injection: Main power.
Transient parameters 1: ΔV = 3V ΔT = 10ms
Transient parameters 2: ΔV = 300mV ΔT = 150ms

Fig.5

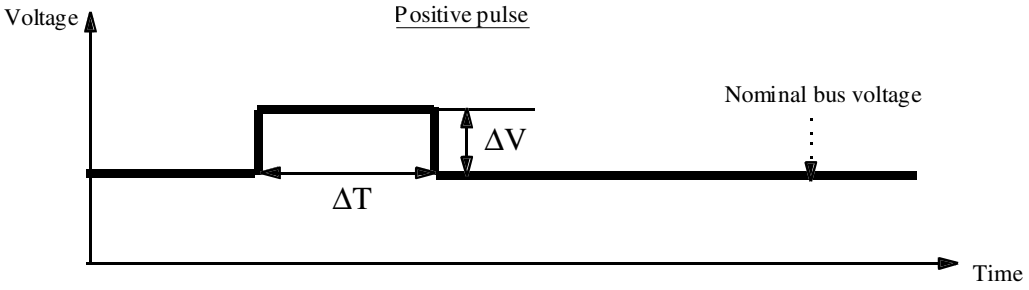
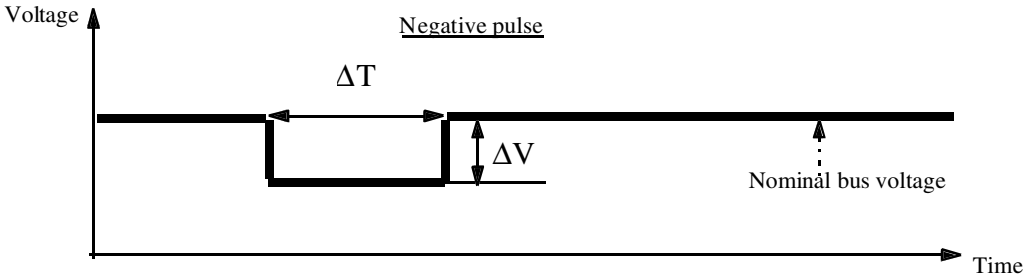


Fig.6



11.2.2 Common mode (TBC)

The noise signal shall be injected between the power return wire and the unit case.

11.2.2.1 Continuous sinewave sweep at 1 octave in 90s from 30Hz to 10MHz.
Signal injection: Main power.
Level: as in Fig.4

11.2.2.2 Voltage transient of square shape as shown in Fig.5 and Fig.6, with rise time < 4µs.
A continuous stream of pulses at 5Hz shall be applied, both positive and negative, and using both parameters 1 and 2, with the supply set to the upper voltage limit (30.5V).
The test shall then be repeated at the lower voltage limit (25.5V).
Signal injection: Main power.
Transient parameters 1: ΔV = 3V ΔT = 10ms
Transient parameters 2: ΔV = 300mV ΔT = 150ms

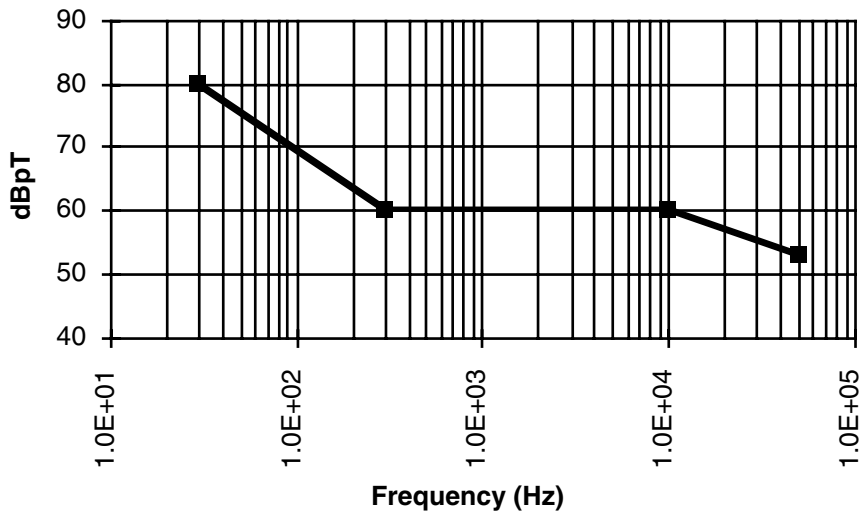
11.3 Radiated Emissions

11.3.1 Magnetic field

The emissions shall not exceed the following:

DC: 106dBpT (200nT) at 1m distance
30Hz to 50kHz: see Fig.7

Fig.7



11.4 Radiated Susceptibility

11.4.1 Magnetic field

The converter shall be inside the specification when subject to:

DC:	170dBpT (300μT)
30Hz to 50kHz:	130dBpT rms

The alternating magnetic field shall be swept at 1 octave in 90s along each orthogonal axis.

12 Radiation

The unit shall remain inside specification for a radiation dose of 30krad spread over 5 years. This figure takes into account shielding due to other instrument and spacecraft parts.

13 Efficiency

The converter shall operate at a minimum of 65% efficiency with all outputs fully loaded to specification. For a total converter load of nominally 30% of specification the efficiency shall be at least 50%. The following currents shall be used to define a nominal 30% load:

Output	Load
+5.10V	500mA
+15V	40mA
-15V	15mA

14 Mechanical Construction

The pcb board size is fixed - see diag <ref>
The mass of the fully assembled converter shall not exceed TBD g.

15 Qualification

15.1 Prototype Model

The PM can use commercial parts. Tests will be limited to performance, basic thermal design and EMC.

15.2 Prototype Flight Model (FM)

15.2.1 Build standard:

Full flight build standard

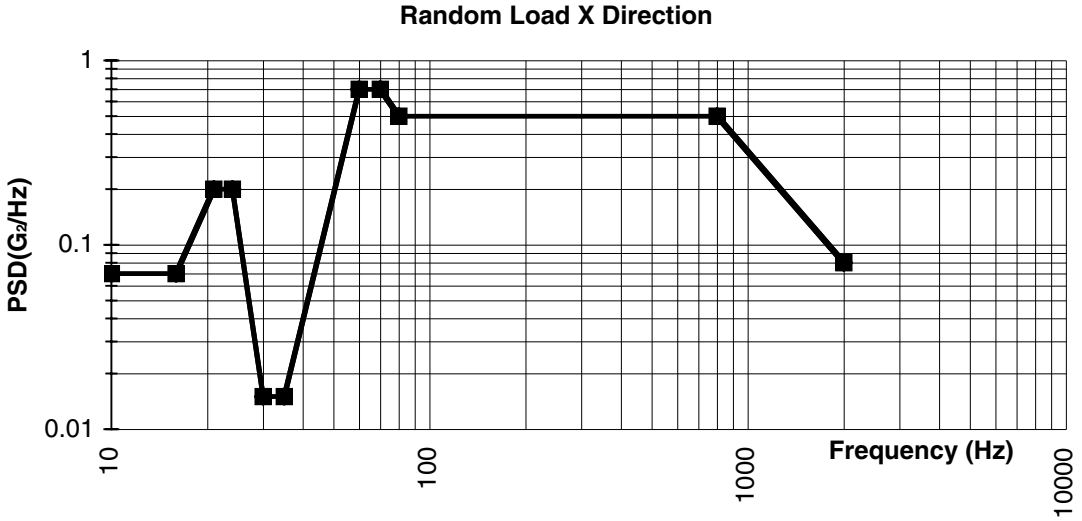
15.2.2 Testing

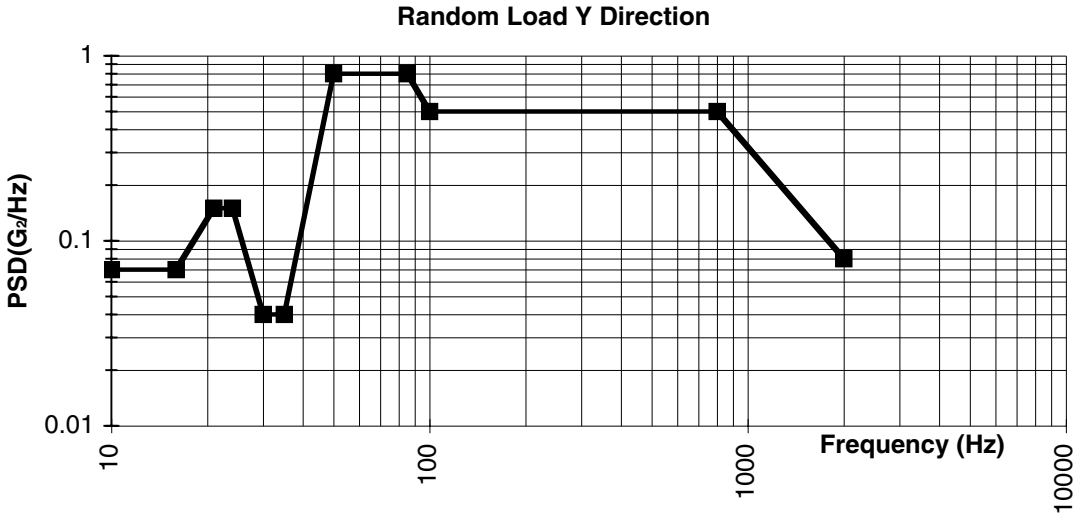
The FM shall meet the qualification level thermal and EMC tests, and the acceptance level tests for vibration..

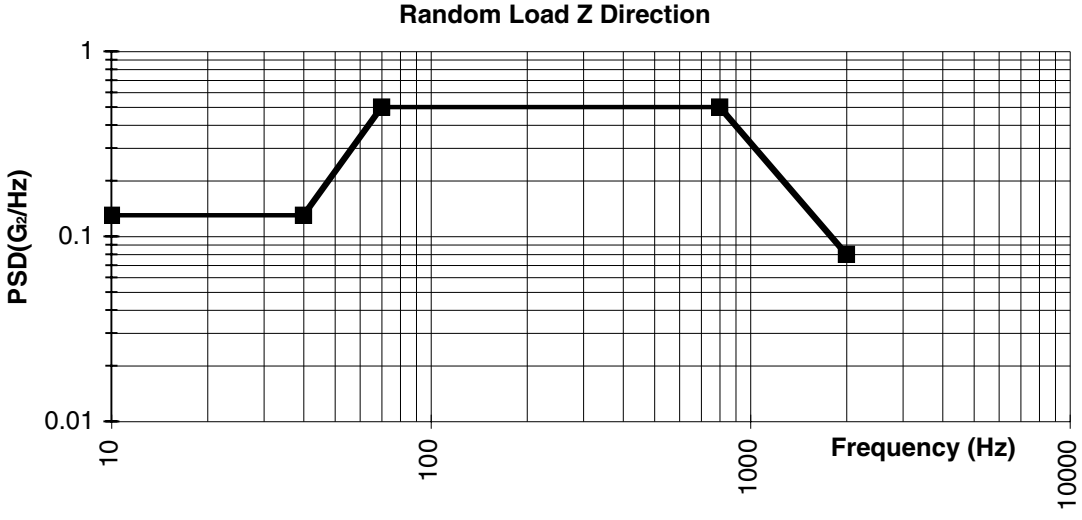
16 Vibration Testing

The unit shall be in specification after the following vibration tests in all three axes:

16.1 Random Vibration







PSD(G_2/Hz) => PSD(G^2/Hz) !

16.2 Low Frequency Shock

Low frequency shock loads of subsystems and components in the Bus structure

Direction	Load
Axis of spacecraft	25g zero - peak x 10ms
lateral to spacecraft	8g zero - peak x 10ms

17 Temperature Cycling

The unit whilst operating and fully loaded shall survive 5 cycles of -30 –> +65˚C at a rate of change of 0.1 -> 1˚C per minute at a pressure less than 1.3×10^{-3} Pa (1.33×10^{-5} mbar), and be within specification whilst in the range -20 –> + 50˚C during the test and afterwards.

18 Cleanliness

A specifically agreed method shall be used for cleaning. All units except the PM shall meet the basic outgassing criteria of TML ≤ 1% and CVCM ≤ 0.1% .

19 Documentation

As a minimum the following shall be supplied with the converters.

Detailed design document with full circuit diagrams including those for any sub-modules or application specific circuits.
Interface control drawings - electrical and thermal.
Declared parts, processes and component lists.
Parts approval documents.
Acceptance test plan and test reports.
Failure modes, effects and criticality analyses.

20 Marking

Each unit shall be marked with at least the name, model type and a serial number.