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Specification for MHC Power Board

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Change Record

ISSUE	DATE	PAGES CHANGED	COMMENTS
01	16 May 2001	All New	Draft
02	21 June 01	4	P7 pin out corrected
		6	Table 4.1 changed
		6	TBD updated in 4.2
		6	Test in 4.3 and 4.4
		7	Added current monitors in 4.5
03	October 02	All	Complete rework of document

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1 Introduction

This specification is for the DC-DC converter to supply secondary power to the Extreme-ultraviolet Imaging Spectrometer (EIS) Mechanism and Heater Control (MHC) Unit on the Solar-B satellite. The converter will take the spacecraft supply at 28V, switched in the Instrument Control Unit, provide isolation for this from the experiment ground, and supply seven power lines. Total power handling is about 11W, and typical spacecraft environmental conditions apply. The outgassing characteristics of the unit must be suitable for use in proximity to optical systems working at UV wavelengths. The converter mounts as a plug-in board into the MHC Unit.

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 3 dated Feb 01.

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.

3.4 Ref. 4

MHC Backplane Definition MSSL/SLB-EIS/DDnnn.nn

3.5 Ref. 5

MHC PCB Profile. MSSL A1/5275/302-15
(Size: 218.00 * 143.10mm)
(Estimated weight: 0.481kg)

3.6 Ref. 6

MHC PCB Schematic. MSSL A2/5275/007

3.7 Ref.7

Cleanliness Control Plan MSSL/SLB-EIS/PA003.01 22-Jun-00

4 Design and Construction Requirements

Note that Ref. 2 shall be used as the primary basis for component selection. Ref. 4 details the backplane connections. The information relevant to this converter specification from Ref. 1 and Ref. 3 is included in the text.

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

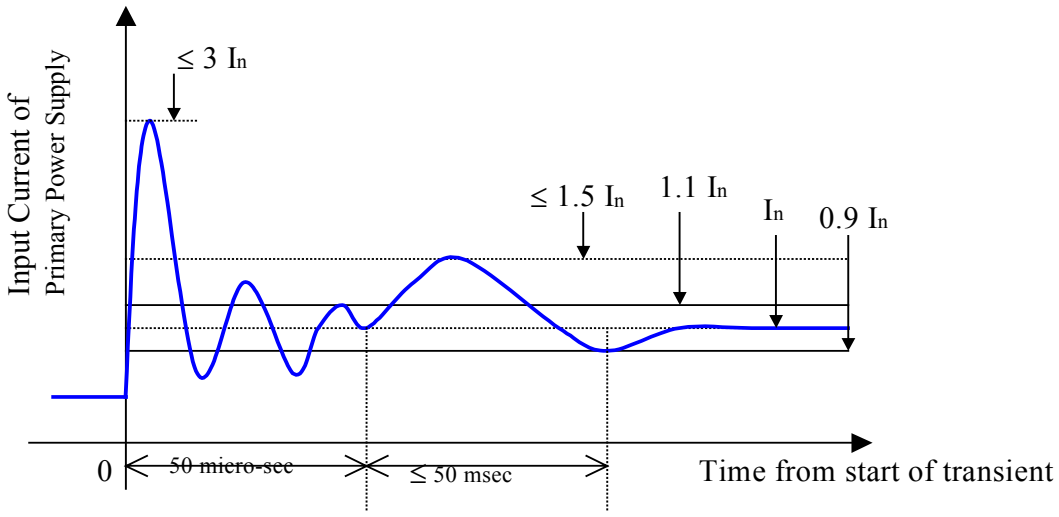
5.1 Input voltage

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 meet the following:
From switch-on to 50µs: <3In.
From 50µs to 50ms: <1.5In, with a rate of change of less than 5 x 10^4 A s^{-1}.
The maximum duration of the inrush peak shall be 50ms.
In = 500mA
Fig.1 illustrates the requirement.

Fig.1



Regulation for transient current on primary power line.

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 to +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

The ICU shall provide this function.

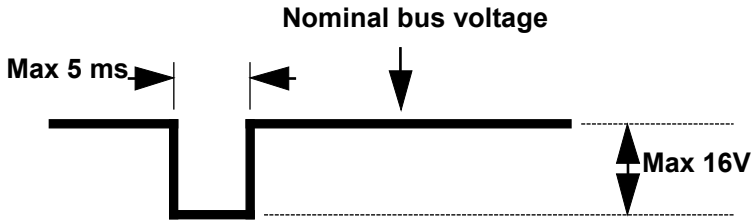
5.6 Input short circuit

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 should not cause the outputs to go out of specification, even at full rated load.

Fig.2



6 Outputs

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

6.1 AGND

6.1.1 Output +15V (MHC +15V Analogue Supply)

6.1.1.1 +15.5V ± 1.0V over full load and environmental conditions.
6.1.1.2 Maximum continuous load: 67mA.
6.1.1.3 Peak load: as maximum continuous load.
6.1.1.4 Minimum load: 20mA.
6.1.1.5 Noise: Less than 5mV pk-pk from dc to 50MHz.

6.1.2 Output -15V (MHC -15V Analogue Supply)

6.1.2.1 -15.5V ±1.0V over full load and environmental conditions.
6.1.2.2 Maximum continuous load: 67mA.
6.1.2.3 Peak load: as maximum continuous load.
6.1.2.4 Minimum load: 20mA.
6.1.2.5 Noise: Less than 5mV pk-pk from dc to 50MHz.

6.1.3 Output +5VA (MHC +5V Analogue Supply)

6.1.3.1 +5.125V ±0.125V over full load and environmental conditions.
6.1.3.2 Maximum continuous load: 16mA.
6.1.3.3 Peak load: as maximum continuous load.
6.1.3.4 Minimum load: 0.2mA.
6.1.3.5 Noise: Less than 5mV pk-pk from dc to 50MHz.

6.1.4 Output -5VA (MHC -5V Analogue Supply

6.1.4.1 -5.125V ±0.125V over full load and environmental conditions.
6.1.4.2 Maximum continuous load: 30mA.
6.1.4.3 Peak load: as maximum continuous load.
6.1.4.4 Minimum load: 0mA.
6.1.4.5 Noise: Less than 5mV pk-pk from dc to 50MHz.

6.1.5 Output +120V (MHC +120V Analogue Supply)

6.1.5.1 +120V ±10.0V over full load and environmental conditions.
6.1.5.2 Maximum continuous load: 20mA.
6.1.5.3 Peak load: as maximum continuous load.
6.1.5.4 Minimum load: 0.3mA.
6.1.5.5 Noise: Less than 50mV pk-pk from dc to 50MHz.

6.2 DGND

6.2.1 Output +5V (MHC +5V Digital Supply)

6.2.1.1 +5.1V ±0.15V over full load and environmental conditions.
6.2.1.2 Maximum continuous load: 440mA.
6.2.1.3 Peak load: as maximum continuous load.
6.2.1.4 Minimum load: 140mA.
6.2.1.5 Noise: Less than 100mV pk-pk from dc to 50MHz.

6.3 +15VMRTN

6.3.1 Output +15VM (MHC +15V Motor Supply)

6.3.1.1 +15V ±0.5V over full load and environmental conditions.
6.3.1.2 Maximum continuous load: 233mA.
6.3.1.3 Peak load: as maximum continuous load.
6.3.1.4 Minimum load: 0mA.
6.3.1.5 Maximum output current with any load: 250mA.
6.3.1.6 Noise: Less than 500mV pk-pk from dc to 50MHz.

7 Outputs - General Information

7.1 Overload

The +/-5VA and +5VD outputs shall withstand a continuous overload or short circuit for at least 24 hours TBC 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 Maximum output currents

+15VM, 420mA +/-50mA
+5VD, 1400mA +/-200mA

7.3 Isolation

The isolation between groups shall be:

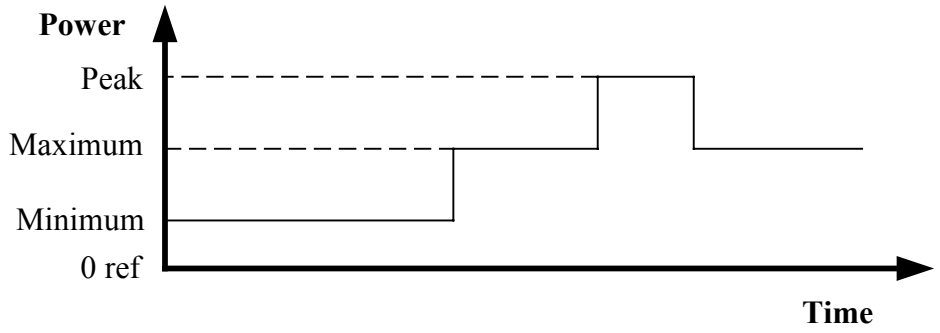
R > 10Mohms
C < 1nF before common mode filter capacitors fitted
V breakdown > 300V

The +15VM and +5VD returns shall be connected together with a wire link.

7.4 Power definitions:

Fig.3 indicates the meanings of the power definitions.

Fig.3



7.5 Absolute Limits

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

7.5.1 +15V (MHC +15V Analogue Supply)
0 –> +16.5.V

7.5.2 -15VA (MHC -15V Analogue Supply)
0 –> -16.5V

7.5.3 +5VA (MHC +5V Analogue Supply)
0 –> +5.5V

7.5.4 -5VA (MHC -5V Analogue Supply)
0 –> -5.5V

7.5.5 +120VA (MHC -5V Analogue Supply)
0 –> +130V

7.5.6 +5VD (MHC +5V Digital Supply)
0 –> +5.25V

7.5.7 +15VA (MHC +15V Motor Supply)
0 –> -+18V

7.6 Noise Specification

7.6.1 Conditions

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

7.6.2 Definitions

All outputs shall have spikes of less than a 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 bandwidth according to the table. This is a frequency domain measurement.

Measurement Bandwidths

Frequency	Bandwidth
30Hz - 10kHz	30Hz
10kHz - 2.5MHz	300Hz
2.5MHz - 25MHz	3kHz
25MHz - 50MHz	30kHz

8 Operating Frequency

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

9 Current Monitoring

Supply current sense resistors in the "high" side of the +5VD line.

Signals are as follows:-

+5VIMON+ Higher voltage side of series resistor in digital +5V line.

+5VIMON- Lower voltage side of series resistor in digital +5V line.

Sense resistor is 0.05R.

10 Current Limiting

The +15VM shall have a latching current limit set to 420mA +/-50mA which is reset by cycling the power to the MHC.

11 Thermal Sensors

There shall be provision for three thermal sensors, T0MON2, T0MON3 and T0MON12.

Temperature Range:

Nominal temperatures at the mounting point:

11.1 Operating

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

11.2 Survival

-30 – +65 C . The converter shall survive switch on with any load inside specification in this range. The outputs shall be inside the absolute limits of section 7.6.

12 Primary Isolation

Primary to structure breakdown voltage:	>100V
Primary to structure resistance:	>10Mohm
Primary to structure capacitance:	<20nF (target), 100nF (max)
Primary to secondary breakdown voltage:	>300V
Primary to secondary resistance:	>10Mohm
Primary to secondary capacitance:	<1nF

13 EMC - Primary Power

All the following parameters apply to ANY combination of load or supply conditions within the nominal specification and apply to the MHC integrated with the ICU.

All frequencies generated shall be necessary for operation of the converter; there shall be no spurious oscillation.

13.1 Conducted Emissions

13.1.1 Differential mode

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

13.1.2 Common mode

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

13.2 Conducted Susceptibility

For all continuous injected signals, the injected current shall be restricted to a maximum of 500mA peak to limit the risk of damage.

The converter shall not go outside specification when subject to any of the following conditions.

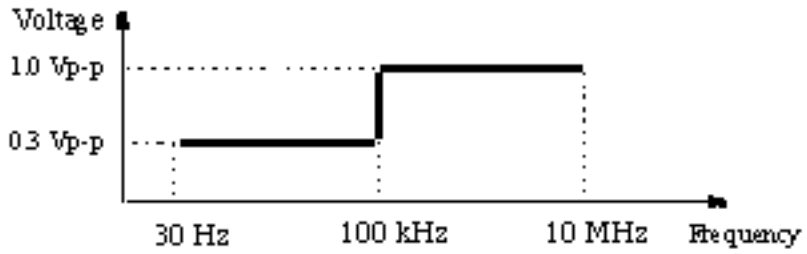
13.2.1 Differential mode

13.2.1.1 Continuous sinewave sweep at 1 octave in 90s from 30Hz to 10MHz.

Signal injection: Main power.

Level: as in Fig.4

Fig.4



13.2.1.2 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

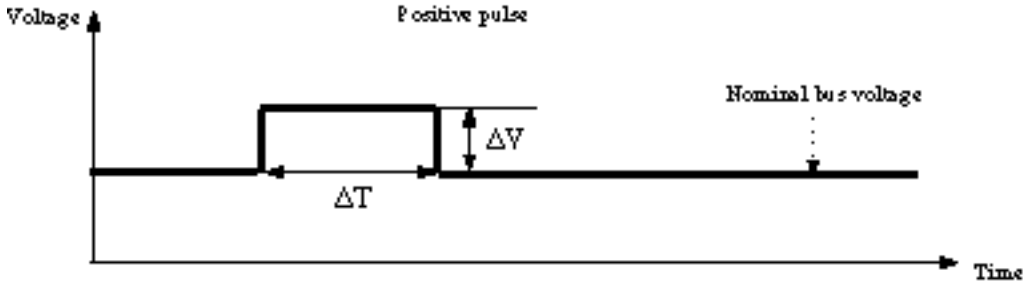
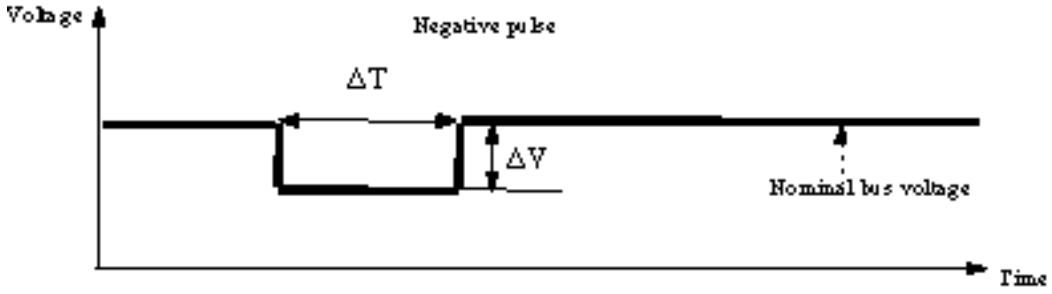


Fig.6



13.2.2 Common mode (TBC)
The noise signal shall be injected between the power return wire and the unit case.

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

13.2.2.2 Voltage transient of square shape as shown in and , 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.

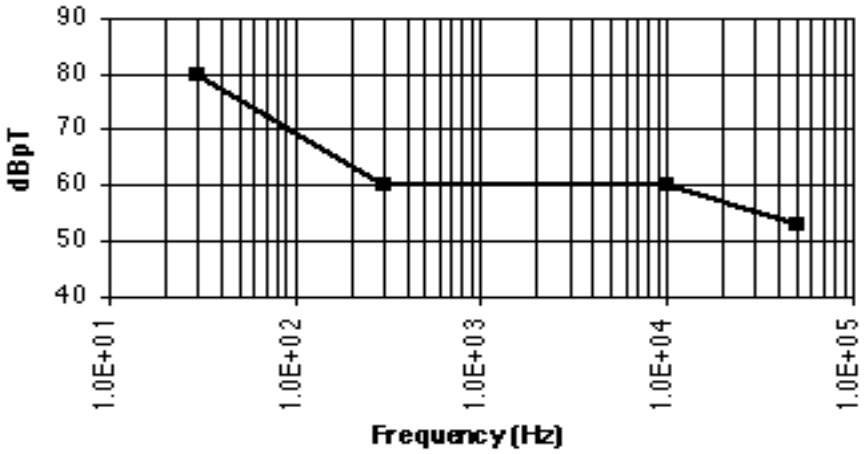
Transient parameters 1:	ΔV = 3V	ΔT = 10ms
Transient parameters 2:	ΔV = 300mV	ΔT = 150ms

13.3 Radiated Emissions

13.3.1 Magnetic field
The emissions shall not exceed the following:

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

Fig.7



13.4 Radiated Susceptibility

13.4.1 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.

14 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.

15 Efficiency

The converter shall operate at a minimum of 65% efficiency with all outputs at maximum load as specified. For minimum converter load as specified in section 6, the efficiency shall be at least 50%.

16 Mechanical Construction

The pcb board size is fixed - see Ref. 5.

The mass of the fully assembled converter shall not exceed 550 g.

17 Qualification

17.1 Prototype Model

The PM shall use extended temperature range vacuum-compatible parts. Tests will include performance, vibration, thermal design and EMC.

17.2 Prototype Flight Model (PFM)

17.2.1 Build standard:

Full flight build standard

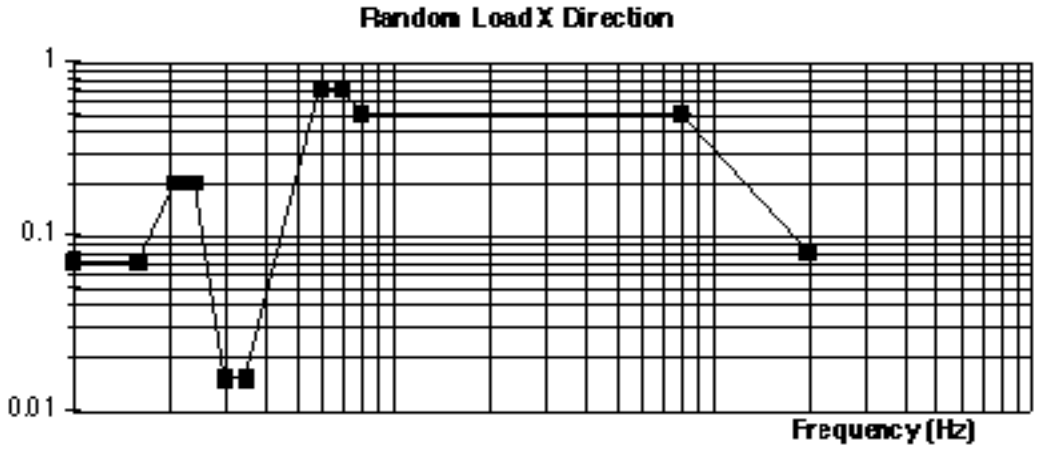
17.2.2 Testing

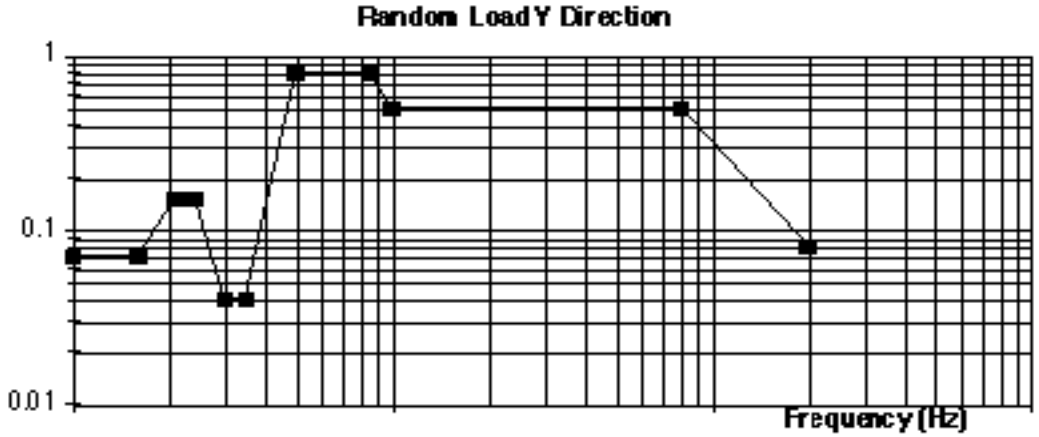
The FM shall meet the qualification level thermal and EMC tests, and the acceptance level tests for vibration.

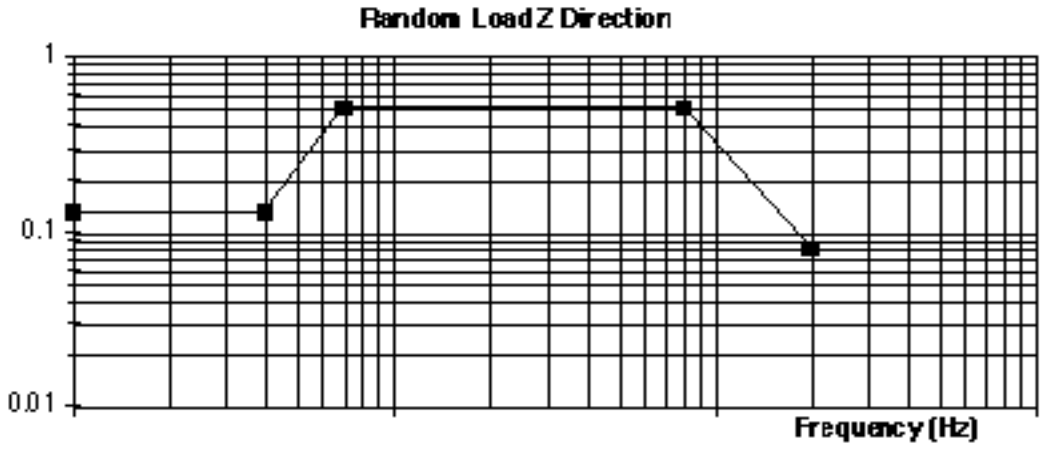
18 Vibration Testing

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

18.1 Random Vibration







Note: PSD(G2/Hz) implies PSD(G^2/Hz) !

18.2 Low Frequency Shock

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

Shock Load Definitions

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

19 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.

20 Cleanliness

Ref 7, Cleanliness Control Plan, specifies the cleanliness requirements .

21 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.

22 Marking

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