Application Note - Interpoint

Crane Aerospace & Electronics Power Solutions

Mechanical: Mounting, Vibration and Shock

CRANE
AEROSPACE & ELECTRONICS

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APPLICATION NOTE

Although the concepts stated are universal, this application note was written specifically for Interpoint products.

Handling Precautions

Interpoint metal packaged power converters have compression glass seals around the pins and, as such, should be handled carefully to protect the integrity of the seal. Refer to Figure 1. For example, dropping a part on a pin from only a short distance will almost certainly result in cracking of the glass bead and consequent loss of hermeticity. A significant drop with contact on almost any part of the metal case may result in permanent seal or other type of damage. Anything that bends or twists the pins may fracture the glass, possibly cracking the substrate.

Never cut an unsupported pin with a pair of side cutters or by other means. The resulting shock will crack the glass sealing bead. To cut pins before mounting the part on a PC card or other structure, the pins must be supported. A gauge block or other tool which slips over the pins, and incorporates features similar to those shown in Figure 1, should be used for support. Once this is done, the pins can be cut or sheared with a sharp blade. If the part is mounted and soldered on a PC card before cutting the pins, the solder joints will provide the support for safe cutting.

Mounting on PC Card or Metal Plate

Figure 2 shows a typical metal case configuration used for MTO and some MTR type power converters. There are nine function pins which exit the mounting base through glass sealing and insulating beads, and one case ground pin which is brazed into the mounting base. The mounting base is also the thermal surface from which internally generated heat is intended to be removed by conduction.

The case pin is intended for connection to a ground plane which connects to other components such as the power line filter case pin or case bypass capacitors used for Common Mode noise suppression. If the power converter is mounted on a PC Card with some clearance from the board for cleaning or inspection, then the internally generated heat will be removed mainly by convection not by conduction. For the case example used, the thermal resistance from case to still air will be about 18°C/watt of internally generated heat, and will be dependent on orientation. For operation at 10 watts output power and 80% efficiency, the internal power loss will be 2.5 watts, and the case will rise on the order of 45°C above the ambient air. This may be an inadequate thermal solution, with the removal of some heat by conduction necessary. Mounting on a short thermal ladder using a ceramic or other thermally conductive spacer will help lower the case temperature while still allowing inspection of solder joints.

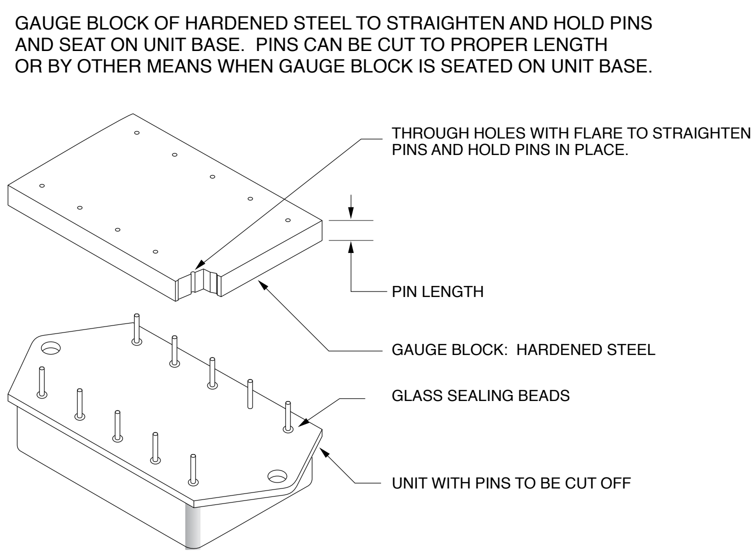

Figure 1: Cutting Pins Sealed With Compression Glass

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Mounting on the core of an aluminum cored PC Card or other metal structure with a thermal pad interface to fill air voids would be a better thermal solution. Painting the case a dull black will take advantage of radiation where convection is ineffective. See our "Thermal Management" application note for more detailed information.

Where vibration and/or shock of significance is a system requirement, some additional precautions might be considered. Use a flange mounted case, and if on a PC or aluminum cored board, mount it as close as possible to the support rails rather than toward the center of the board. This should improve the thermal situation also. Secure to the board with fasteners at the flanges or by other means. Devices which are secured by the pins only, and in particular those with the smaller 0.018 inch diameter pins, can be in danger of having the pins sheared off during vibration. The problem can be reduced by securing the device with epoxy or other means, or by using flying leads for stress relief rather than soldering directly to the PC card. Examples of vibration and shock conditions with comments on how they are tested follow.

Random Vibration

Interpoint power converters are rugged devices which will withstand high levels of vibration and shock, provided the structure to which they are mounted is free of resonances having significant Q's. A high Q indicates a lack of damping, and Q's of 1 or less are desirable, but often hard to realize. Random Vibration is characteristic of real world conditions and is a situation where all frequencies within the vibration bandwidth have an equal probability of being present at any one time, hence the term "Random" to describe the vibration spectrum.

The Random test spectrum is generated from a clipped white noise generator which is followed by a group of band shaping filters and conditioning circuits feeding into a power amplifier which provides the electrical input to the shaker pot armature. A typical vibration spectrum is shown in Figure 3. Here the vertical axis, power spectral density, has units of G^2/Hz. The horizontal axis is Log Frequency, and has units of Hz. The RMS G level of the Random Spectrum over a given bandwidth is found from the square root of the area under the vibration curve over the given bandwidth. For example, the flat spectrum of Figure 4 having a PSD of 0.5 G^2/Hz over the bandwidth of 20 to 2000 Hz, has an RMS level of 31.5 G_{RMS}. This vibration spectrum and level are within what is possible with Interpoint power converters provided the mounting means is free of significant resonances.

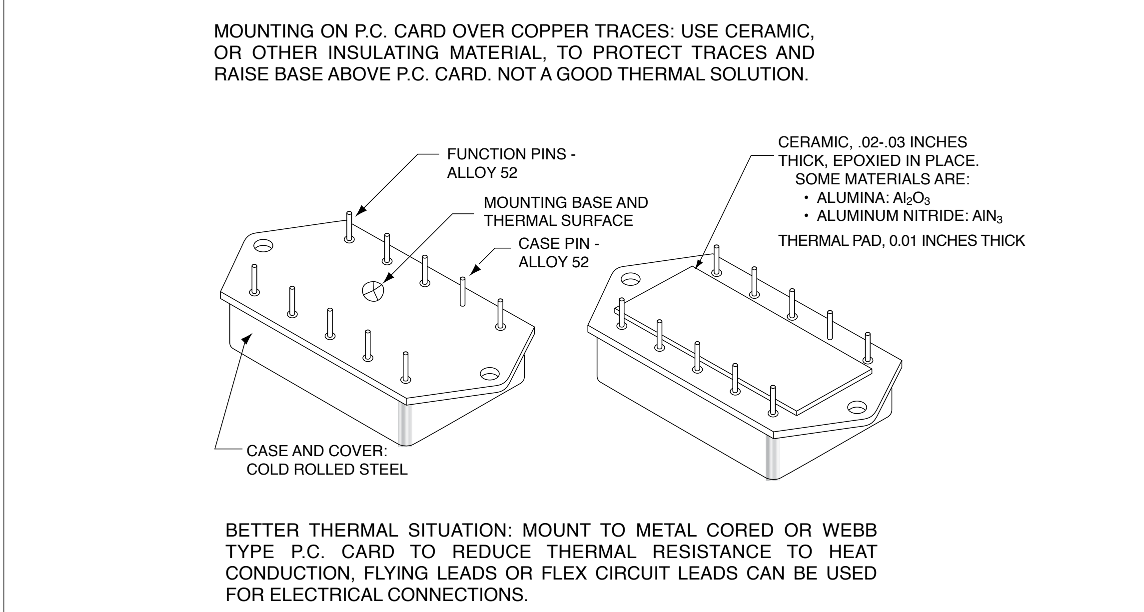

Figure 2: Mounting Power Converter To PC Card

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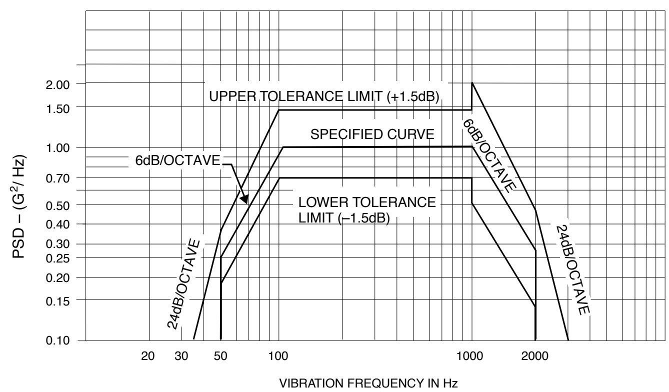

FROM MIL-STD-202

CHARACTERISTICS		
TEST CONDITION LETTER	POWER SPECTRAL DENSITY	OVERALL rms G
A	0.02	5.2
B	0.04	7.3
C	0.06	9.0
D	0.10	11.6
E	0.20	16.4
F	0.30	20.0
G	0.40	23.1
H	0.60	28.4
J	1.00	36.6
K	1.50	44.8

$$dB = 10 \log \frac{G^2 / Hz}{G_r^2 / Hz} = 20 \log \frac{G / \sqrt{Hz}}{G_r / \sqrt{Hz}}$$

THE RMS VALUE OF ACCELERATION WITHIN A FREQUENCY BAND BETWEEN f_1 AND f_2 IS:

$$G_{rms} = \left[\int_{f^1}^{f^2} (G^2 / Hz)\, df \right]^{1/2}$$

WHERE G_r^2 / Hz IS A GIVEN REFERENCE VALUE OF POWER-SPECTRAL DENSITY, USUALLY THE MAXIMUM SPECIFIED VALUE.

Figure 3: Typical Random Vibration Profile

Interpoint does not screen for vibration except on a special order basis. We do however run qualification tests on new parts and, when vibration is included, we make sure that a resonance free mounting means is used. A resonance free means is achieved with an aluminum block, securely mounted to the shaker head, with cavities into which the power converters are inserted and then potted with wax. The vibration test may be run with or without power applied to the test samples.

Interpoint does apply constant acceleration to screened parts, 500 G or 5000 G, depending on the screening level. This is a static test done by centrifuging, and not in any way related to vibration.

Sinusoidal Vibration

Sinusoidal vibration involves one discrete frequency at a time, with the frequency swept back and forth over the defined bandwidth at a predetermined rate. The test vibration is generated by a sine wave sweep generator which drives a power amplifier supplying the electrical signal for the shaker pot armature. Testing for susceptibility to sinusoidal vibration usually involves dwelling at frequencies where structural resonances are discovered. This is a more severe test than Random Vibration where the RMS levels are the same. Figure 5 is taken from MIL-STD-202 and shows examples of different conditions of sinusoidal vibration. The graph has P-P, Double Amplitude, displacement on the vertical axis plotted against Log Frequency on the horizontal axis. The sloping straight lines are of constant acceleration (conditions A through H) and all revert to a horizontal line representing a constant P-P displacement of 0.06 inches at lower frequencies of 60 to 200 Hz, depending on condition. The constant displacement vibration mode at low frequencies is due to the shaker pot armature being displacement limited.

Shock

Examples of shock conditions which Interpoint power converters are capable of surviving are shown in Figure 6. Survival assumes a resonance free mounting means. For shock levels higher than those shown in the example, repeated applications may cause cracking in magnetic components, followed by power train electrical failures. Other mechanical type failures may also occur.

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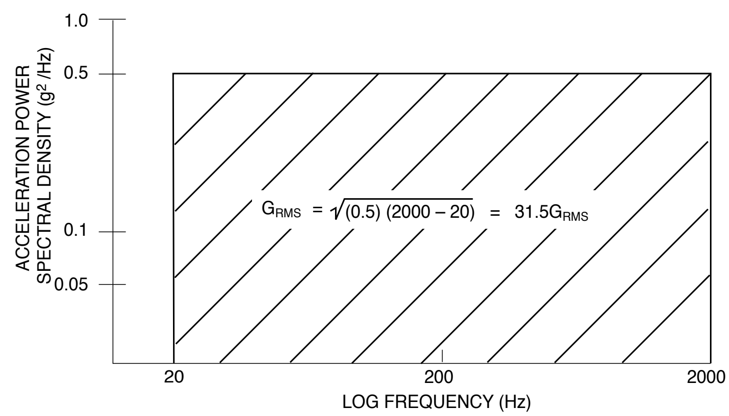

Figure 4: Random Vibration - Flat Spectrum

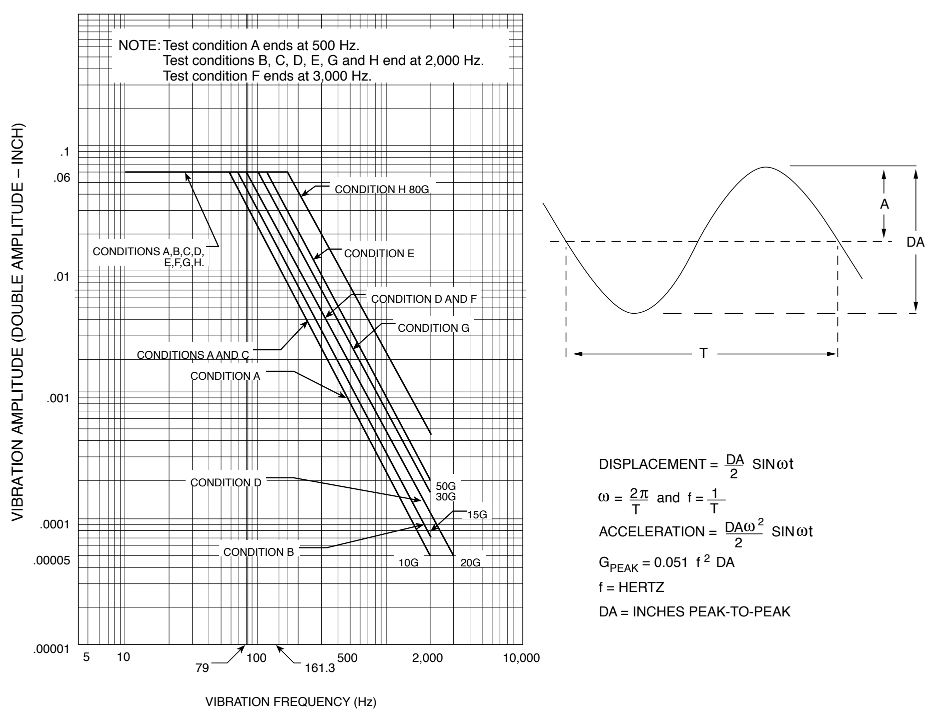

Figure 5: Sine Vibration

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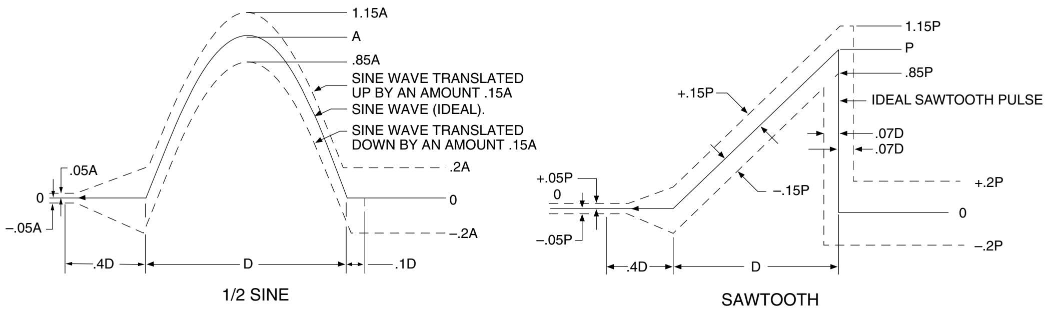

TABLE 213-1. TEST CONDITION VALUES

TEST CONDITION	PEAK VALUES (g's)	NORMAL DURATION (D) (ms)	WAVEFORM
A	50	11	HALF-SINE
B	75	6	HALF-SINE
C	100	6	HALF-SINE
D	500	1	HALF-SINE
E	1,000	0.5	HALF-SINE
F	1,500	0.5	HALF-SINE
G	50	11	SAWTOOTH
H	75	6	SAWTOOTH
I	100	6	SAWTOOTH
J	30	11	HALF-SINE
K	30	11	SAWTOOTH

FIGURE 6: TYPICAL SHOCK CONDITIONS