SEE Transient Response of Crane Interpoint Single Output Point of Load DC-DC Converters

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Abstract—**This study was undertaken to determine the single event effect and transient susceptibility of the Crane Interpoint Maximum Flexible Power (MFP) Single Output Point of Load DC/DC Converters, for transient interruptions in the output signal and for destructive and non destructive events induced by exposing it to a heavy ion beam.**

I. Introduction

THE MFP series are a high-reliability, high-efficiency point of load converter for use with a 3.3 VDC input bus or a 5 VDC input bus. The MFP0507S model has the flexibility to be set for any output voltage from 0.64 VDC to 3.5 VDC. The converter operates from an input of 3.0 to 6.0 VIN with an under voltage shutdown (Fig. 1) below 3 volts and an overvoltage shutdown above 6 volts. The converter can withstand up to a 15 V transient for up to 1 second.

The non-isolated, feature-rich MFP uses a Buck converter design with synchronous rectification. The design allows the unit to operate synchronously to no output load, ensuring high efficiency at the lightest loads without switching off the synchronous devices. Important features include a solid state switch, inrush current limiting, synchronization with an external system clock and the ability to current share allowing multiple devices to supply a common load.

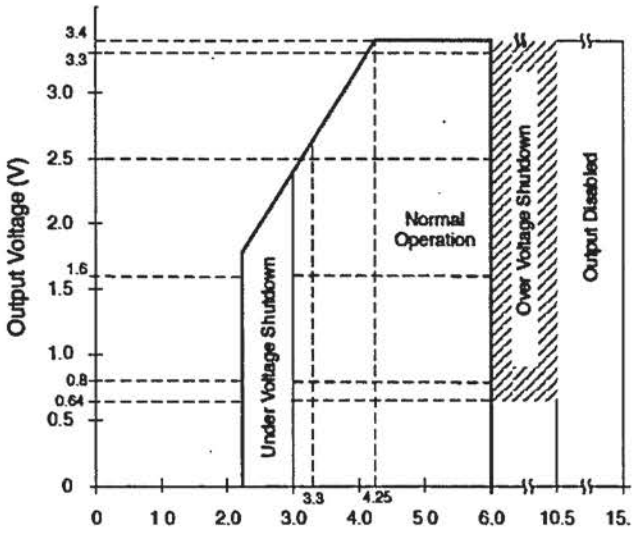

Fig. 1: Input Voltage vs. Maximum Output Voltage

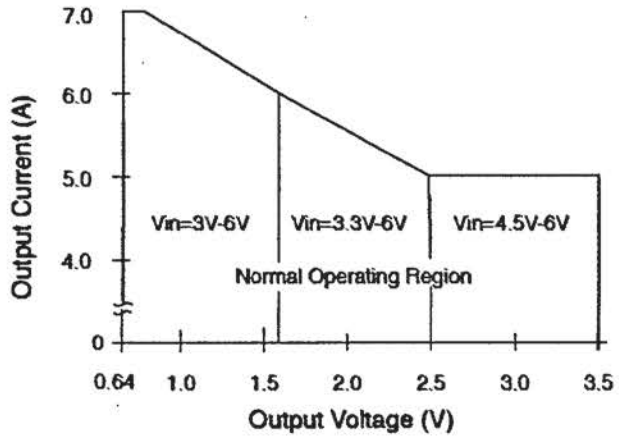

Fig. 2: Maximum Rated Output Current

The MFP includes an internal housekeeping supply that is active at inputs as low as 2 VDC and provides a boosted and regulated voltage supply for internal use. This internal supply is one of the reasons that this product can provide full power at very high efficiency at input voltages as low as 3 VDC. No external power source or external bias is required. The MFP converters are designed for the large, fast transient load currents typical to digital loads.

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The Interpoint MFP0507S is a single output non isolated point of load converter. The MFP will produce any output voltage from 0.8VDC to 3.3VDC. The rated output current is 7Amps at 0.8V and 5Amps at 3.3V. Input voltage range for the MFP is from 3.3V to 6V, however the selected output voltage should not exceed 80% of the input voltage. Any one of four precision output voltage set points can be selected by the combination of open or grounding of the two trim pins. Maximum output power of 16.5W is with output set for 3.3V and 5A. Maximum output power with the output voltage set for 0.8V and 7Amp is 5.6W. They are best suited for high reliability and high radiation assurance requirements with an LET of 80 MeV cm^2/mg for SEU.

II. Experiment

A. Heavy Ion Testing at LBNL

SEE testing was performed at the Lawrence Berkeley Nuclear Laboratory (LBNL) for transient interruptions on the output signal with Ne and Ar for non destructive events. The devices are packaged in a 10-pin lead metal can package and were prepped for test by delidding. These low linear energy transfer (LET) values were used to determine the transient onset threshold for the devices which was $LET_{th} < 3.49$ MeV-cm2/mg. Four devices were exposed to heavy ions at various loading conditions. Table 1, shows the test conditions where tests were conducted for an input nominal voltage of 6V with and without loading and also with loading conditions of 30, 50, 70, and 100% loading with both .8V & 3.3V outputs.

TABLE I: TEST CONDITIONS

	Vsupply (V)	Isupply (A)	Vin (V)	Loading %
DUT 1	+.8V	.121	6V	0
DUT 1	+.8V	.445	6V	30
DUT 1	+.8V	.685	6V	50
DUT 1	+.8V	.947	6V	70
DUT 1	+.8V	1.38	6V	100
DUT 2	+3.3V	.117	6V	0
DUT 2	+3.3V	.997	6V	30
DUT 2	+3.3V	1.60	6V	50
DUT 2	+3.3V	2.22	6V	70
DUT 2	+3.3V	3.17	6V	100
DUT 3	+.8V	.120	6V	0
DUT 3	+.8V	.440	6V	30
DUT 3	+.8V	.680	6V	50
DUT 3	+.8V	.941	6V	70
DUT 3	+.8V	1.375	6V	100
DUT 4	+3.3V	.122	6V	0
DUT 4	+3.3V	.999	6V	30
DUT 4	+3.3V	1.60	6V	50
DUT 4	+3.3V	2.22	6V	70
DUT 4	+3.3V	3.17	6V	100

B. Heavy Ion Testing at TAMU

SEE testing was performed at the Texas A&M University (TAMU) Cyclotron Lawrence Berkeley Nuclear Laboratory for transient interruptions for Xe, Ta, and Au ions in the output signal and for destructive and non destructive events induced by exposure to heavy ions. All test runs were made at normal incidence due to the depth penetration needed to reach the sensitive areas of the embedded power mosfets. [1][2]

Figures 3&4 show the cross sections for .8V and 3.3V outputs respectively vs. effective LET.

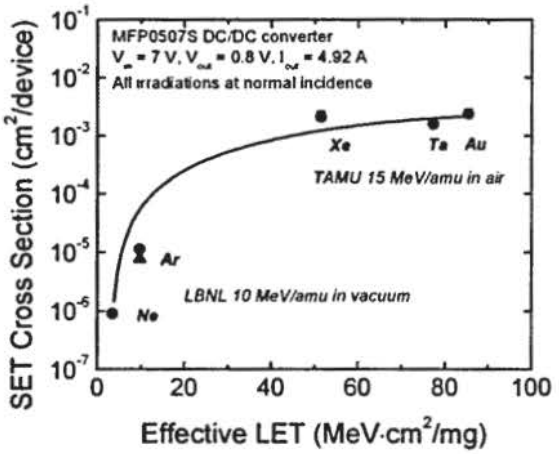

Fig. 3: Output = 0.8V Cross Sections

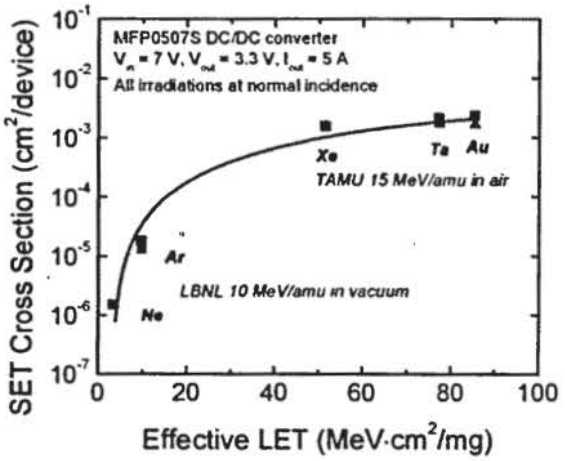

Fig. 4: Output = 3.3V Cross Sections

III. RESULTS

The devices were exposed from a fluence of 1.00×10^3 to 1.00×10^7 particles/cm^2 of the Xenon, Tantalum, and Gold ion beams. Observations for destructive and non-destructive events were for energies up to the maximum LET of 85.4 MeV-cm^2/mg at normal angle of incidence. There were no destructive events observed for the MFP0507S, but the device

was sensitive to SETs and did experience transient events with larger transients occurring at the .8V output greater than 2V and approximately 200us for worse case width. This large spike may need to be mitigated with using the appropriate LC filtering circuitry in conjunction with this DC-DC converter. The 3.3V output transients were <500mV and 100us for worse case width duration. The tests were run with an input of 6V with .8V and 3.3V output configurations at 30%, 50%, 70%, and 100% loading conditions. Fig. 6&7 show typical histograms of amplitude using the absolute values attained. In general most SETs were small for the 3.3V output which is the common use for designers for space flight applications; therefore this device is suitable for space applications.

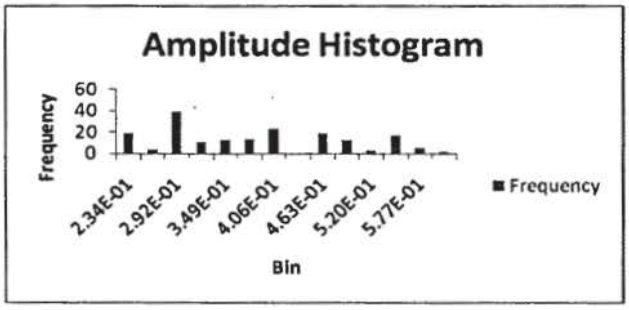

Fig. 6: MFP0507S Amplitude Histogram for 3.3V input

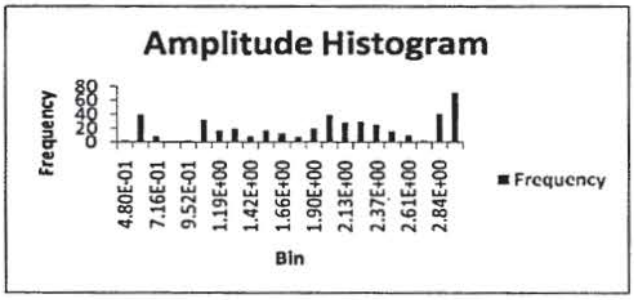

Fig. 7: MFP0507S Amplitude Histogram for 0.8V input

IV. Conclusions

The Crane Interpoint MFP0507S Point of Load (POL) converters have shown resiliency to heavy ions akin to the ISL70001SRH where the device was free of SEL/SEB/SEGR > 85 MeV-cm^2/mg. [3] The transient events are minimal at the 3.3V output but several high peak transients were seen at the 0.8V output that still needs filtering circuitry on the output. Further investigation with the manufacturer is needed to analyze the internal circuitry for the 0.8V output to reduce the transient amplitude.

Acknowledgment

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References

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