SYNOPSIS V1.1: HEAVY ION-INDUCED SINGLE EVENT EFFECT MEASUREMENTS ON ADVANCED ANALOG DC/DC CONVERTERS

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TEST DATE : November 8-11, 1997.
December 19, 1997

REPORT DATE: January 30, 1998

I. INTRODUCTION

This study was undertaken to determine the single event effect response of a set of DC/DC converters manufactured by Lambda/Advanced Analog. The converters were interrogated for single event effects (SEE) by exposing them to heavy ion irradiations at Brookhaven National Laboratory's Single Event Upset Test Facility.

II. DEVICES TESTED

Full Single Event Upset (SEU) or Transient (SET) as well as destructive event (Single event Latchup - SEL, Single Event GateRupture - SEGR, and Single Event Burnout - SEB) testing was performed on DUTs 1,2 and 3. Destructive event testing was performed on DUT 4. These DUTs were used in test Series 1.

DUT	Device	LDC	Serial number	DUT Bias	Icc(norm)	Icc (SEL)
1	ASA2805S/CH	9735	9726137-B	28V	48	
2	ASA2805S/ES	9734	9725133-A	28V	48	
3	7804	9713	9720146	28V	63	
4	ASA2805S/ES	9734	9725134	35V	43	100

The following devices were tested at a later test date with varying output loads (test Series 2):

DUT	Device Type	Note
5	ASA2805	180 ohm resistor added internally
6	ASA2805	2K ohm resistor added internally
7	ATW2805	
8	AHF2812	

In addition, samples of the ASA, ATW, and AHF were modified so that the output of the internal analog comparator could be observed.

III TEST FACILITY

Facility: Brookhaven National Laboratory's Single Event Upset Test Facility.
Flux: $1x10^4$ to $1.5x10^5$ particles/cm^2/s.
Maximum fluence: 1.0 x 10^6 to $5.0x10^7$ particles/cm^2.
Ions used during exposures: LET and Range is given for Silicon target.

Ion Species	LET normal to the die surface (MeV-cm^2/mg) for "standard" ion energy	Range (µm)
Au	82.3	27.9
Br	37	39
Ni	26.6	41.9
Ti	18.8	47.5
Cl	11.4	63.5

IV. TEST METHODS

Temperature : 25^o C – No attempt was made to heat or cool the devices.
Hardware : Totalizing oscilloscope and programmable power supply.
Loading : 40 Ω (12.5%) for Series 1, 0-100% for Series
Definition of an SEU : Output voltage monitored for an increase or decease of > 0.3 V.
Definition of an destructive event (SEL,SEGR and SEB) : Supply current monitored for an increase or decease.

V. SUMMARY OF RESULTS

Series 1

None of the devices tested showed radiation induced distructive event (SEL,SEB,SEGR). All DUTs were irradiated with Br ions, LET of 37 MeV–cm^2/mg, to a fluence of at least $1x10^7$ p/cm^2 ions per test run. DUT 1 (ASA2805S/CH) was exposed to $5x10^7$ p/cm^2. LET threshold is between 11 and 13.

SEU testing on DUT 1 (ASA2805S/CH) and DUT 2 (ASA2805S/ES) showed a 10ms dropout or SET in the output voltage. Figure 1 shows a trace of the typical dropout. Figure 2 plots the cross section as a function of LET for DUT 1. The arrows pointing down indicate that the cross section at this LET is less than the plotted value. DUT 2 was only exposed to Br ions, LET=37 MeV–cm^2/mg.

No SEE were observed on DUT 3 (7804). The device were tested up to an LET of 37 MeV–cm^2/mg. The cross section is less than $1x10^{-7}$ cm^{-2}.

Series 2

Series 2 was an attempt to isolate the SET issue noted in Series 1. Analysis was performed at Lambda/AA with an internal analog comparator expected to be the culprit. In addition, a load variance was expected (due to a feedback loop) as to the number and whether dropouts would occur. To this extent, unmodified and modified (resistors added internally in an attempt to mitigate the SETs) devices were tested to determine SET sensitivity when load was varied. Results are tabulated below.

Device	Highest load level to not observe dropout at LET of 26.6
ASA2805	0%
ASA2805 w/180 ohm internal	< 20%
ASA2805 w/ 2K ohm internal	20%<level<50%
ATW2805	70%<level<83%
AHF2812	50%<level<83%

In addition, a SEGR condition was observed on one sample of the ATW with a 28V bias input at the first test run with Au (LET of 82.3). Further testing would be required to determine LET threshold and bias information.

V. RECOMMENDATIONS

We typically categorize devices based on SEE test results into the following four categories:

Category 1 **-** Recommended for usage in all spaceflight applications.
Category 2 **-** Recommended for usage in spaceflight applications, but may require some SEE mitigation techniques.
Category 3 **-** Recommended for usage in some spaceflight applications, but requires extensive SEE mitigation techniques or SEL recovery mode..
Category 4 **-** Not recommended for usage in any spaceflight applications.

I. The ASA, ATW, and AHF series devices from Lambda/Advanced Analog could result in significant need for error detection and mitigation or correction techniques to correct for the 10 ms dropouts. In addition, knowledge of the actual load that will be used in application is required. With these constraints, these devices are placed in Category 3. We would also recommend lot specific tests be performed to verify SET and destructive condition performance.

II. The 7804 series devices from Advanced Analog does not require error detection, and mitigation or correction techniques, i.e. Category 1.

We would also like to note the following two items:

- the ATR series has the same comparator device internally and as such might have the same SEE concerns, and

- Lambda/AA does manufacture devices that are immune to these events: the ART and ARH series of DC-DC converters. We would recommend their usage to most spaceflight projects.

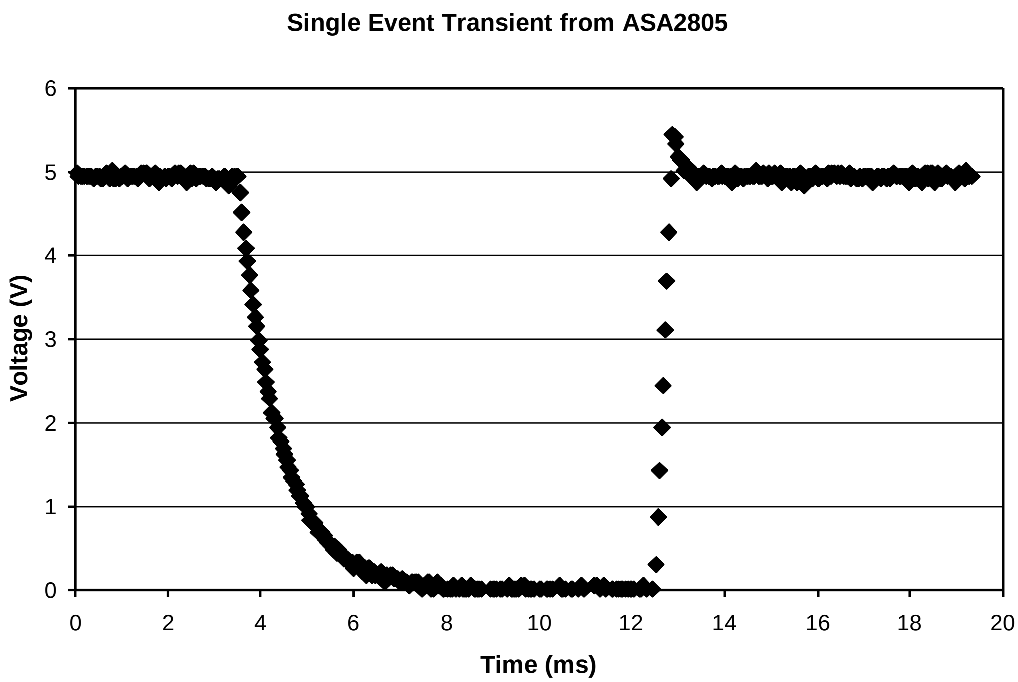

Figure 1. Typical trace of dropout.

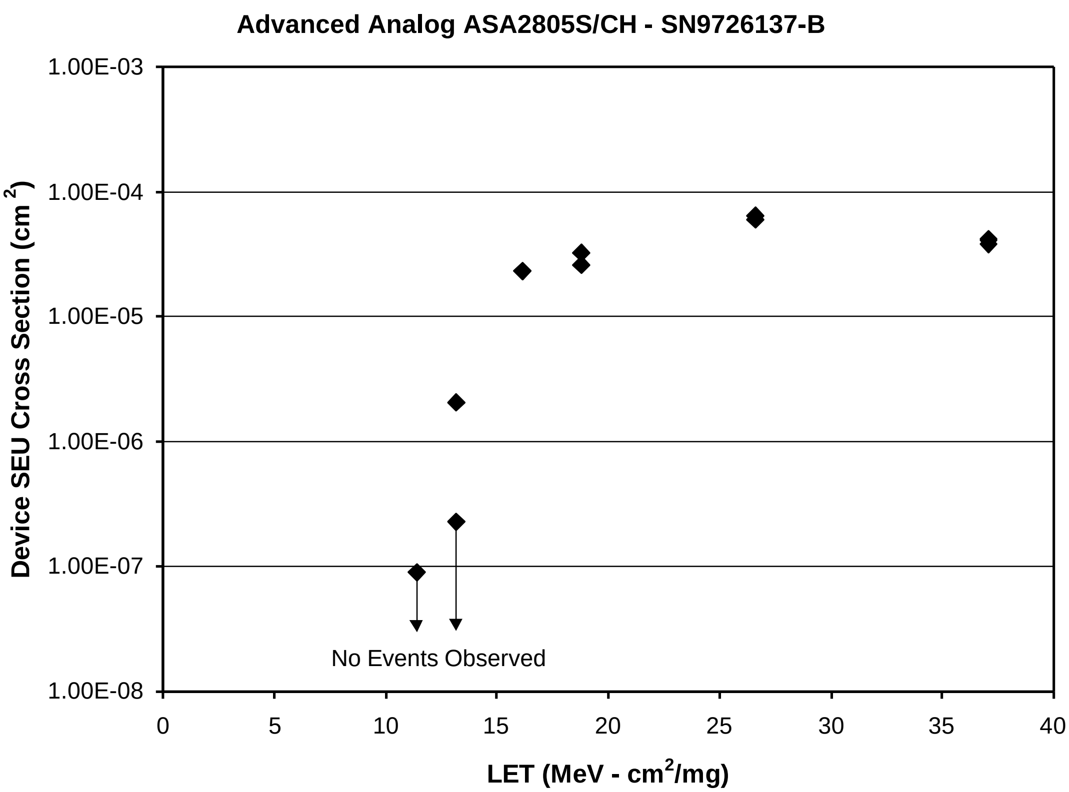

Figure 2. SEU cross section as a function of LET for the ASA2805S/CH