Summary Radiation Test Report

Part Type:	**14 Bit A/D Converter with latchup protection**
Manufacturer:	**Maxwell Technologies**
Part No. :	**9240LP**
Document No. :	**1002545**
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I. Purpose

This report presents a summary of radiation data on the Analog Devices AD9240, 14 Bit CMOS A/D Converter die and Maxwell's LPT ASIC used in Maxwell's 9240LP product. Single Event and Total Dose data summarized are from various sources.

II. Abstract

The MCM 9240LPFP uses an Analog Devices AD9240A, CMOS 14 bit A/D Converter and Maxwell's LPT ASIC to protect the AD9240A from latchups. The AD9240A has a recoverable Single Event Latchup threshold of 16 MeV-cm^2/mg with a saturated cross section of 2 E-4 cm^2. The calculated latchup rate in a geosynchronous orbit is 3.6 E-5 latchups/ day or once every 75 years. The LPT ASIC protecting the AD9240A has an SEL threshold of greater then 116 MeV-cm^2/mg. If a latchup occurs in the AD9240A, the MCM 9240LP will have a functional interrupt that is a result of the part entering into a latchup state. The LPT ASIC detects a latchup, powers down the device and then re-powers the device after the latchup has cleared. After being re-powered, the part will return to normal functionality. The TID level of the 9240LP is greater than 22.5 krad(Si) at the die level. In a RAD-PAK package, the packaged die has a much higher TID tolerance level that is dependent on the radiation environment.

III. Data Summary

Analog Devices AD9240A

Single Event Effects

SEi/Maxwell 8/30/98
SEi/Maxwell tested the AD9240A at Brookhaven National Laboratories on August 30, 1998.

LET MeV-cm^2/mg	SEL Cross section cm^2
26.5	1.6E-6
37	2.2E-5

Table 1. LET levels tested and the SEL cross section for those levels

The test was performed over three LET values; 11, 26.5 and 37.2 MeV-cm^2/mg. The device did not latch at 11 MeV-cm^2/mg, but did latch at 26.5 MeV-cm^2/mg. Therefore, the SEL threshold level is between 11 and 26.5 MeV-cm^2/mg. The particle fluence was around 1E 6 particles/cm^2. The off time required to recover the device was between 32 µs and 512 µs.

Latchup currents ranged from 140 mA to 200 mA. Figure 1. shows the latchup cross section. After each latchup the device returned to complete functionality. At 37 MeV-cm^2/mg, DUT number one had 22 latchups, all recovered successfully to normal operation using Maxwell's latchup protection (LPT™) circuit.

By looking at anomalies in the sine wave, a crude SEU estimate was made. This analysis could only see SEUs in the first 3 bits of data. With this test, the SEU cross-section at 37.2 MeV-cm^2/mg was approximately 1E-5 cm^2 and at 26.5 MeV-cm^2/mg was around 1E-6 cm^2.

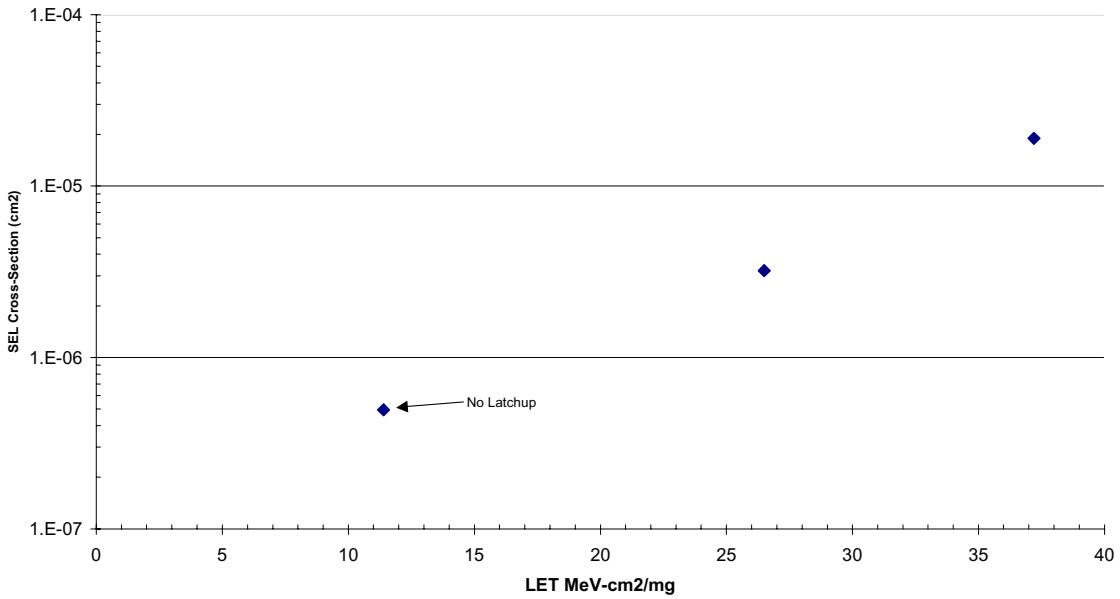

Figure 1. Maxwell SEL Cross-section data.

John Hopkins/2001

John Hopkins tested the Analog Devices AD9240A, lot date code 0021 for SEL effects. The data was reported in IEEE NSREC 2001 data workshop [1].

The test monitored three separate supply pins including $DV_{DD,SS}$, $AV_{DD,SS}$ and $DRV_{DD,SS}$. Greater than 99.5% of all latchup were detected on the $AV_{DD,SS}$ supply the other 0.5% were detected on the DV_{DD} at high LETs. Data shown in Figure 3 illustrates the average cross-section at each LET level. JHU reported Weibull fit parameters σ = 2E-4 cm^2, $L_{threshold}$ = 19 MeV-cm^2/mg, W = 45 MeV-cm^2/mg, S = 1.5.

JPL/Aerospace 2001

This data is from a paper presented at the 2001 IEEE NSREC conference [2]. The paper compared the AD9240A and AD9260 looking for destructive latchup. The AD9240A was tested with Cl, Ni and Xe up to a maximum Let of 43.8 MeV-cm^2/mg at Brookhaven and Texas A&M. Additional testing was performed with Californium. Three different date codes were used (9722, 9910 and 9930). Rapid shutdown was used for this test to prevent destructive burnout. The cross section was found to be higher for ions with longer ranges, see figure 2. The LET threshold was found to be 15 MeV-cm^2/mg. The latchup was found to be strongly dependent on temperature. The AD9240A did not exhibit destructive latchup.

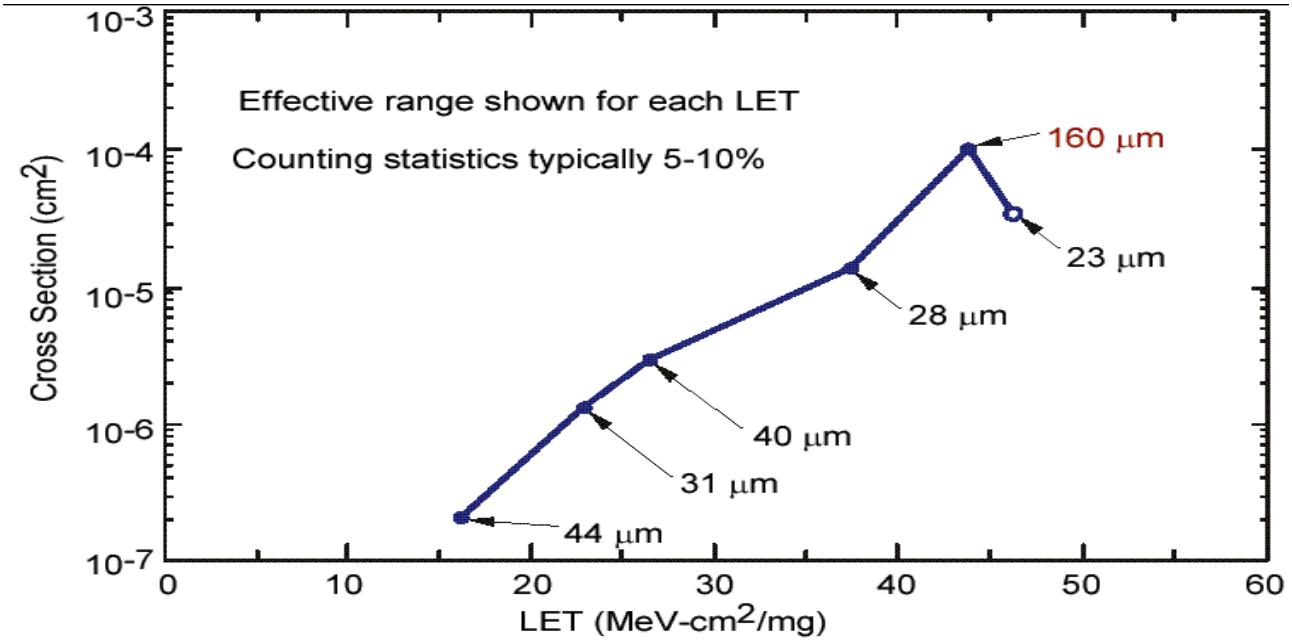

Figure 2. Latchup cross section with penetration range, from JPL report

SEE Summary

Figure 3 shows a plot of all of the three testing organizations data as well as the average and a Weibull plot were the saturated cross-section σ = 2E-4 cm^2, Latchup threshold $L_{threshold}$ = 16 MeV-cm^2/mg, shape parameter W = 50 MeV-cm^2/mg and S = 2.0. The graph shows good agreement between all three tests. The Weibull parameters are close to the John Hopkins data. Using this data and space radiation 4.0 in a Geosynchronous environment, the latchup rate is 3.6 E-5 latchups/day or a latchup every 75 years.

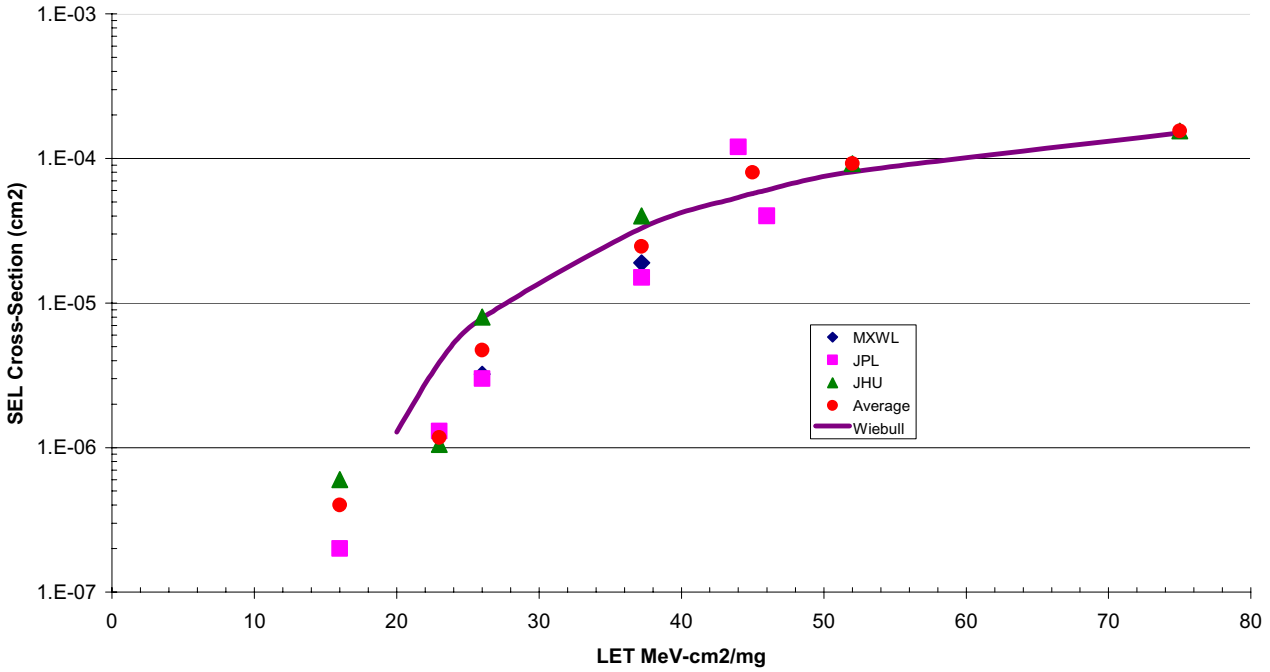

Figure 3. SEL cross-section curves from Maxwell, JHU, JPL including the average for each LET and a Weibull fit curve.

Total Ionizing Dose (TID)

SEI/ Maxwell

SEi/ Maxwell performed the total dose test on its Co-60 irradiator on May 7, 1999 on package date code 9745. All 5 irradiated parts and 1 control part were within parametric specifications and there were no functional failures up to the maximum tested level of 22.5 krad(Si). IDRVDD was the only parameter to shift significantly during the test but it remained within specifications throughout the test.

LPT ASIC radiation Data.

Maxwell uses the AMI 0.6µ CMOS epi foundry process for its LPT ASIC. Die lot A35252.2 was used for both test below.

Single Event Effects

Single Event Effects tests were performed on March 9, 2000 and July 15, 2000. The ASIC was tested inside the MCM package, while protecting the ADS7809D 16 bit AD converter. The test results showed no latchup up to and including a LET (linear energy transfer) of 116 MeV-cm^2/mg. Single Event Transients were observed as low as 11.4 MeV-cm^2/mg. These transients were small in nature, about 70 mA. In addition, these transients had no effects on the device's ability to function properly. The LPT ASIC was able to function properly without interruption throughout all the testing. The 7809LP continued to function properly while the ASIC was under beam up to all LET levels.

TID

A Total Ionizing Dose test was performed on April 10, 2000. The test results showed no

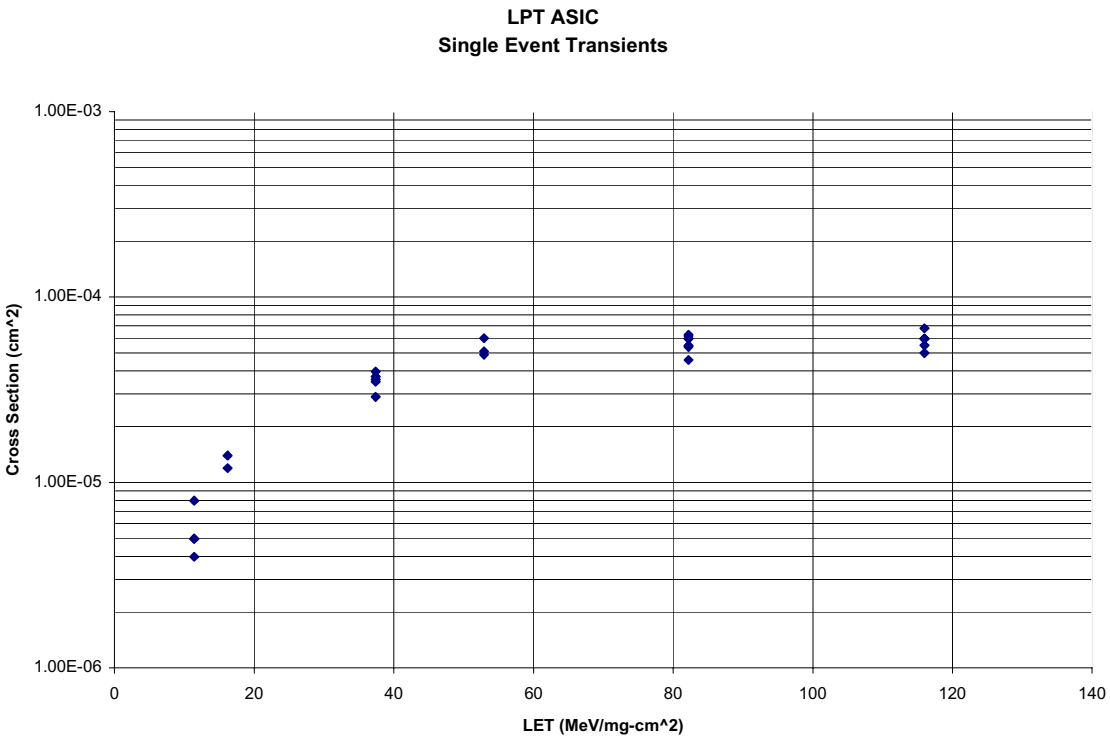

Figure 4. Heavy ion SET Cross-Section for the LPT ASIC

parametric movement up through and including 50 krad(Si). None of the 134 test parameters measured showed any significant degradation.

IV. Conclusion

The MCM 9240LP has a recoverable Single Event Latchup threshold of 16 MeV-cm^2/mg with a saturated cross section of 2 E-4 cm^2. The calculated latchup rate in a geosynchronous orbit is 3.6 E-5 latchups/day or once every 75 years. The LPT ASIC protecting the 9240 has an SEL threshold of greater then 116 MeV-cm^2/mg. If a latchup occurs in the AD9240A the MCM 9240LP will have a functional interrupt that will last until the current drops below the current sense threshold, after which the part will return to normal functionality. The TID level of the 9240LP is greater then 22.5 krad(Si) at the die level.

References.

[1] K. Warren, D. Roth, J. Kinnison, B. Carkuff, "Single Event Latchup and Total Dose Testing in Spacecraft Electronic Components," 2001 IEEE NSREC Radiation Effects Data Workshop, pp. 100 –105, IEEE Doc. No. 01TH8588.

[2] T. Miyahira, A. Johnston, H. Becker, S. LaLumondiere and S. Moss " Catastrophic Latchup in CMOS analog-to Digital Converters," IEEE Trans. Nucl. Sci., VOL. 48, NO. 6, December 2001, pp. 1833 - 1840.