Radiation Test Summary

Part Type:	**14 Bit A/D Converter**
Manufacturer:	**Maxwell Technologies**
Part No.:	**7872**
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Table of Contents

Purpose

This report presents a summary of radiation data on the BiCMOS Analog Devices AD7872, 14 Bit Analog to Digital converter used in Maxwell's 7872RP product. Single Event and Total Dose data from various sources are summarized below.

Abstract

The 7872 has a single event latchup threshold of 104 MeV-cm^2/mg, and SEU threshold of 1.4 MeV-cm^2/mg with a saturated cross section of 1E-3 cm^2/device. Three different total dose tests performed by Maxwell show a variation in TID tolerance that appear to depend on dose rate and/or die lot. The die level total dose tolerance varied between 5 and 20 krad(Si). Typical space environment rates range from 1 E-4 to less then 1 E-5 rad(Si)/sec, (not counting solar flares), so the lower dose rate test more accurately predicts the space environment. The lower dose rate test shows a die tolerance of between 15 and 20 krad(Si).

Data Summary

Single Event Effects

JPL June 1992

JPL reported on its Website the SEE test conducted on June 29, 1992 at BNL. SEL was tested at room temperature and 85 ºC with a fluence of 5E6 ions/cm^2. The ions used for SEU testing were; 337 MeV I, 255 MeV Ni, 120 MeV Cl, 50 MeV F, 32 MeV C, and 99 MeV C. The SEU cross section shows a linear increase from LET=1.4 to highest LET test ion = 60 MeV-cm^2/mg the saturated cross section is approximately is 10E-3 cm2 per device. The test program included an AC sawtooth input and several DC inputs leading to all 1's, all 0's and checkerboard outputs. JPL reported no difference in response of the different test conditions.

Total Ionizing Dose (TID)

Maxwell performed three TID tests using a MCT-2000 Digital IC tester and a bench test for integral linearity testing. Testing was to the data sheet parameters. The bias board is shown in Figure 1.

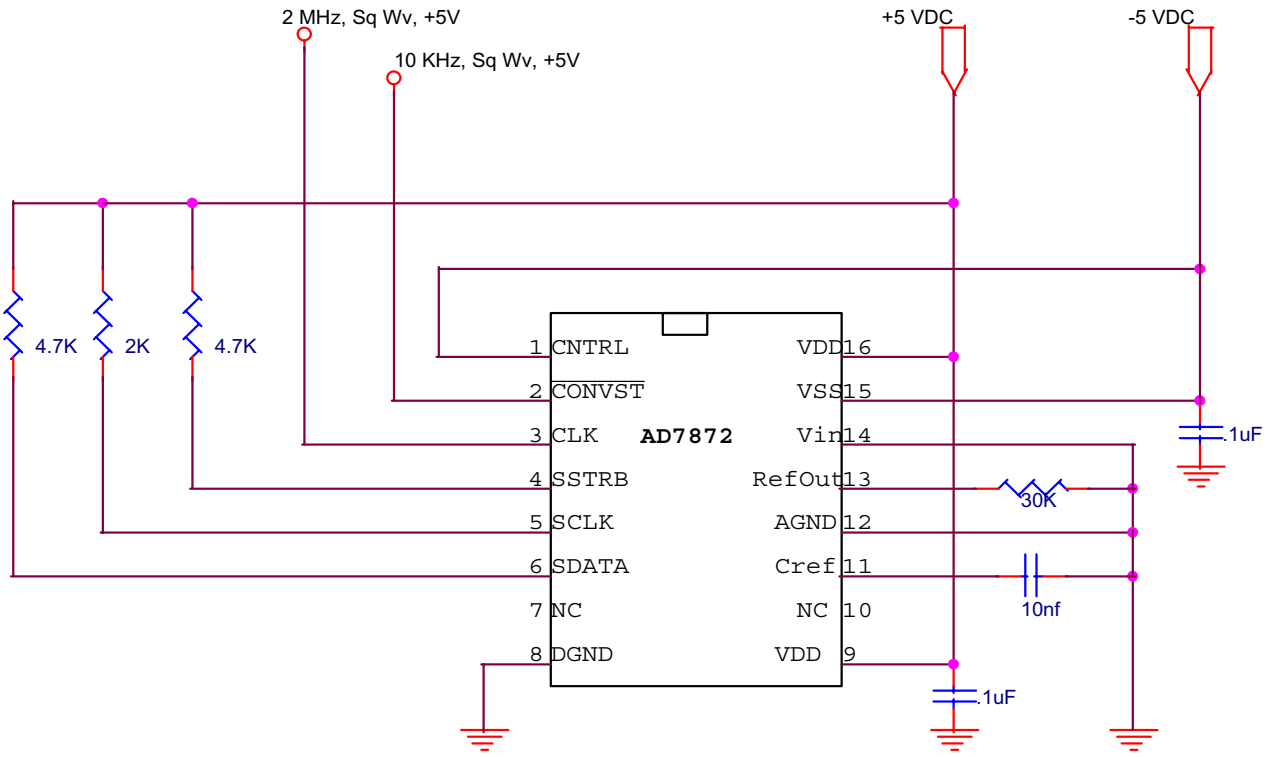

Figure 1. TID bias circuit

Maxwell May, 1999

Maxwell tested fives devices (4 + 1 control) from die lot A44220.2 in May of 1999 at a dose rate of 3.4 rad(Si)/sec. The discrete test levels were 2 krads(Si), 5.3 krads (Si), 7 krads (Si), 10.06 krads(Si), 15.2 krads(Si), and 20 krads(Si). All devices were functionally operative and remained within the parametric test specifications up to the highest level tested of 20 krad(Si).

Maxwell February, 2000

Maxwell tested fives devices (4 + 1 control) from die lot 40019-01 in February of 2000 at a dose rate of 4.5 rad(Si)/sec. The discrete test levels were 2 krad(Si), 5 krads(Si), 7 krads(Si), and 10 krads(Si). All parts passed all tests at 2 and 5 krad(Si).

At 7krad(Si), High Output Current (I_{OH}) exceeded the maximum test limit. The worst-case value recorded was 185.1uA on three parts. Bipolar Zero Error went out of specification with a maximum of 118.5 LSB for two parts. Positive and Negative Integral Non-Linearity and Negative and positive Bipolar Gain also went out of specification.

At 10Krads(Si) the DUTs were functionally inoperative. The parts went into a 50 hour room temperature anneal. Three of the four DUTs recovered functionality, and passed all test

parameters within manufacturers' test specifications. The remaining part could not be tested because of a broken pin.

Maxwell June 2000

Maxwell tested nine devices (8 + 1 control) in June of 2000 at a dose rate of 0.063 rad(Si)/sec. The discrete test levels were 7 krads (Si), 11 krads (Si), 15 krads (Si), and 20 krads(Si) and then a 168 hour, 100º C anneal test.

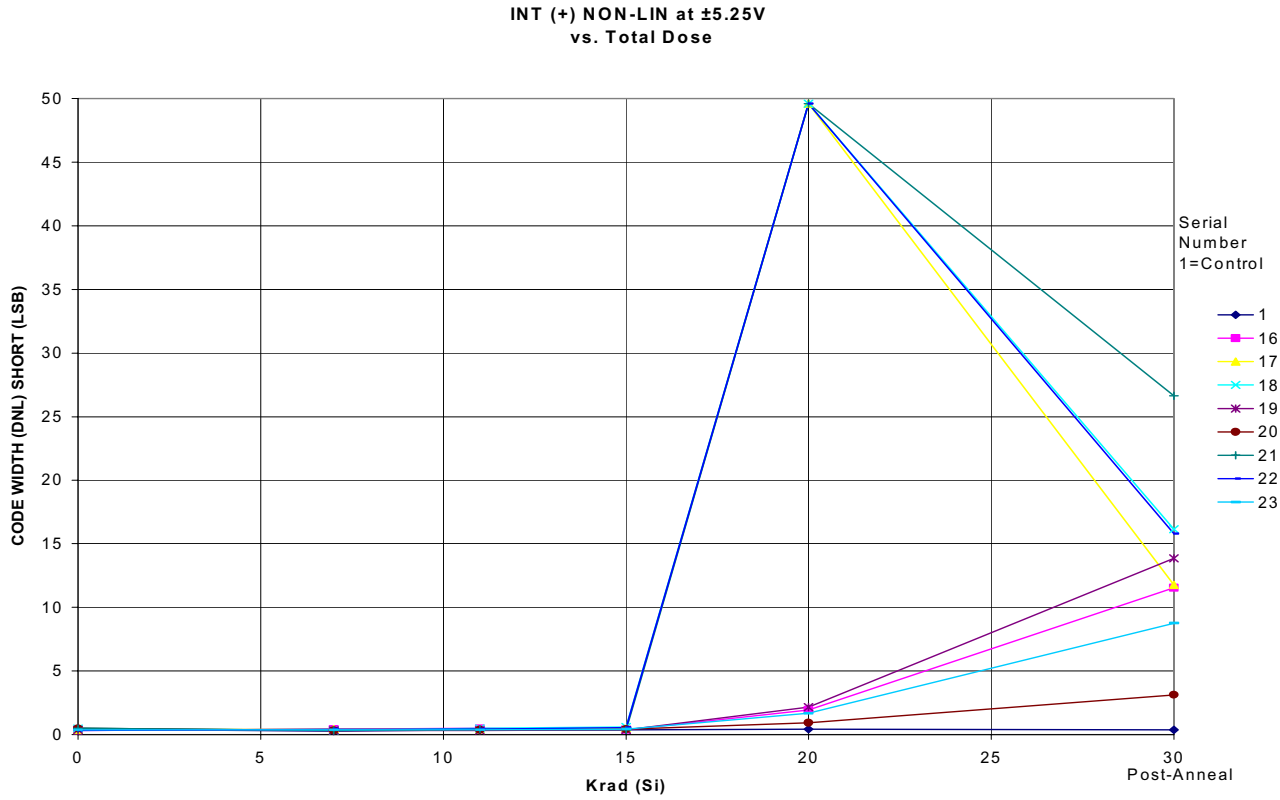

Figure 2. June 2000 Test. Positive Integral nonlinearity vs. total Dose. Values after 20 krad(Si) correspond to the 168 hour, 100º C anneal.

All eight irradiated devices were functionally operative and remained within the parametric test specifications up through the 15krad(Si) dose level. At the 20krad(Si) dose level, only one part passed all parametric tests. Three devices had only bit errors while four devices had bit errors and IOH parametric failures. Figure 2 shows the Positive Integral Nonlinearity.

After high temperature annealing, IOH returned within specification for all devices, however DNL did not return within specification in fact it got worse (see Figure 3).

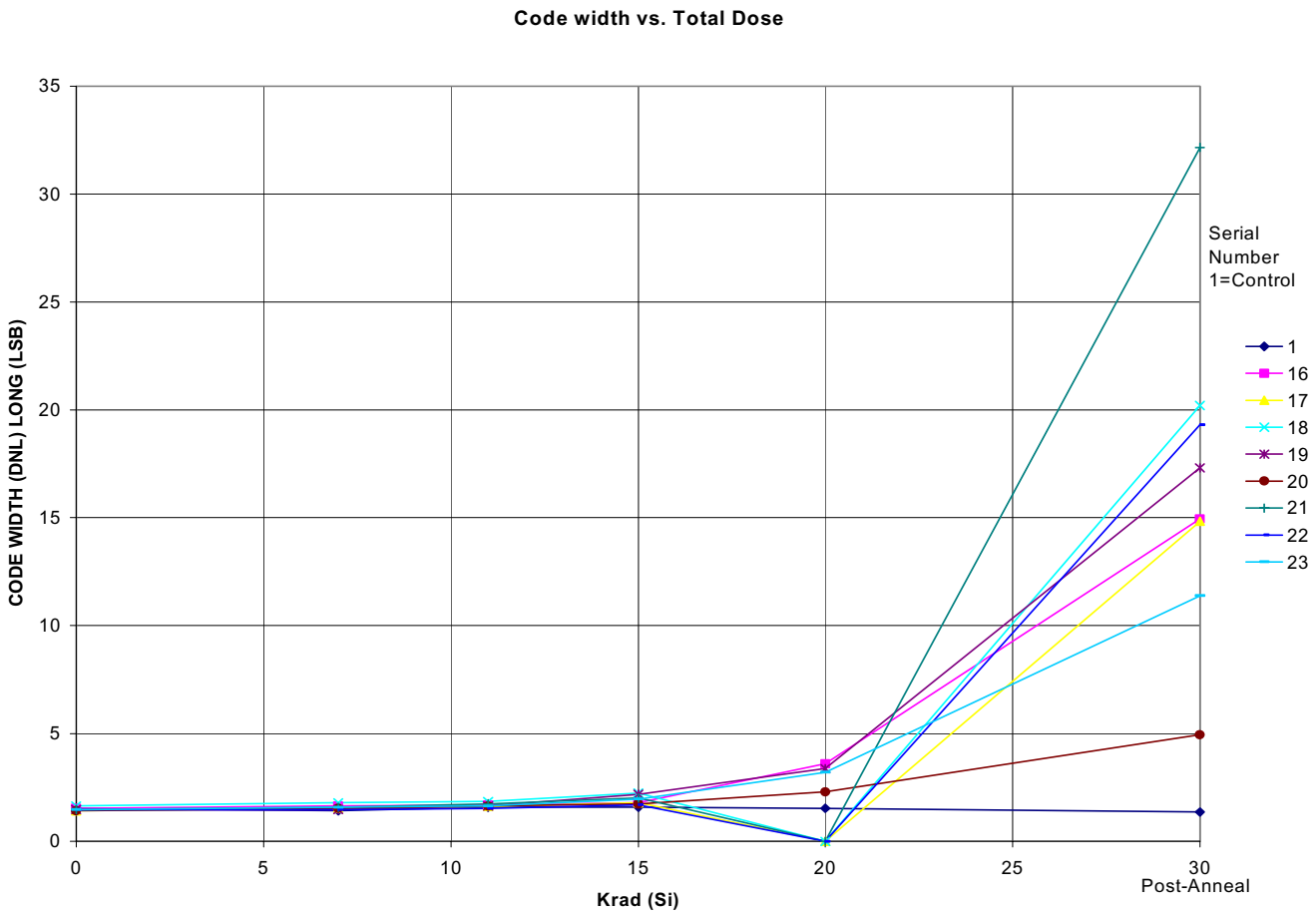

Figure 3. June 2000 test. Code Width (DNL) vs. total Dose. Values after 20 krad(Si) correspond to the 168 hour, 100º C anneal

Conclusion

The 7872 has a single event latchup threshold of 104 MeV-cm^2/mg, and SEU threshold of 1.4 MeV-cm^2/mg with a saturated cross section of 1E-3 cm^2/device. The die level total dose tolerance varies with die lot and dose rate. The three tests show a tolerance variance between 5 and 20 krad(Si). Typical space environment rates range from 1 E-4 to less then 1 E-5 rad(Si)/sec, (not counting solar flares), so the lower dose rate test more accurately predicts the space environment. The lower dose rate test shows a die tolerance of between 15 and 20 krad(Si).