DATE:  January 03, 2000
TO:    B. Forsbacka/562
FROM:  K. Sahu/S. Kniffin/300.1
SUBJECT: Radiation Report on MX7225UQ/883B (Maxim) (LDC 9321)
PROJECT: HST/COS
cc:    T. Perry/300.1, R. Reed/562, A. Sharma/562, OFA Library/300.1

A radiation evaluation was performed on MX7225UQ/883B Quad 8-Bit CMOS D/A Converter (Maxim) to
determine the total dose tolerance of these parts. The total dose testing was performed using a Co$^{60}$ gamma ray
source. During the radiation testing, eight parts were irradiated under bias (see Figure 1 for bias configuration) and
two parts were used as control samples. The total dose radiation levels were 2.5, 5.0, 10.0, 20.0, and 30.0kRads.
The average dose rate was 0.15kRads/hour (0.04Rads/s). See Table II for the radiation schedule and average dose
rate calculation. After the 30.0kRad irradiation, the parts were annealed under bias at 25°C for 168 hours. After
each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and
the specification limits listed in Table III. An executive summary of the test results is provided below in bold,
followed by a detailed summary of the test results after each radiation level and annealing step.

All parts passed all tests up to 10kRads. After the 20kRad irradiation, some parts showed minor degradation
in IDD_15V and Zero_Code_Error. Four parts showed significant degradation in all NL and RA tests. After
the 30kRad irradiation, there was some increase in the degradation in IDD_15V and Zero_Code_Error. One
part marginally exceeded the specification limit on one Full_Scale_Error test. All parts showed significant
degradation in all NL and RA tests. After annealing the parts at 25°C for 168 hours, the parts showed
significant recovery in IDD_15V, Full_Scale_Error and Zero_Code_Error. No significant recovery was noted
in any NL or RA parameter. See Figures 2 and 3 for further information in NL and RA.

Initial electrical measurements were made on 10 samples. Eight samples (SN’s 50, 52, 53, 54, 55, 57, 58, and 59)
were used as radiation samples while SN’s 51 and 56 were used as control samples. All parts passed all tests during
initial electrical measurements.

All parts passed all tests up to 10.0kRads.

After the 20kRad irradiation, one part exceeded the specification limit of 10.00mA for IDD_15V with a reading of
10.47mA. Three parts marginally exceeded the specification limit of 15.00mV for some of the Zero_Code_Error
tests with readings in the range of 15.63 to 21.52mV. Four parts significantly exceeded the specification limit of
1.00lsb for all NL tests with readings in the range of 85 to 541lsb. Four parts significantly exceeded the
specification limit of 0.05lsb for all RA tests with readings in the range of 78 to 927lsb. All parts passed all other
tests.

After the 30kRad irradiation, six parts exceeded the specification limit for IDD_15V with readings in the range of
10.92 to 14.96mA. One part marginally exceeded the specification limit of 0.50lsb for one Full_Scale_Error test
with a reading of 0.66lsa. All parts significantly exceeded the specification limit for all NL and RA tests with
readings in the range of 214 to 463lsb. All parts passed all other tests.

After annealing the parts for 168 hours at 25°C, the parts showed significant recovery in IDD_15V,
Full_Scale_Error and Zero_Code_Error. No significant recovery was noted in any NL or RA parameter.

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1 The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
2 The temperature 25°C as used in this document implies room temperature.
3 These are manufacturer’s pre-irradiation data specification limits. The manufacturer provided no post-irradiation
   specification limits or radiation tolerance guarantees at the time these tests were performed.
Table IV provides a summary of the test results with the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call us at (301) 731-8954.

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Figure 1. Radiation Bias Circuit for MX7225UQ/883B

Notes:
1. $V_{DD} = +15.0\text{V} \pm 0.5\text{V}$.
2. $V_1 = +5.0\text{V} \pm 0.5\text{V}$.
3. $R = 1k\Omega$, 5%, ½W.
<table>
<thead>
<tr>
<th>TABLE I. Part Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic Part Number: MX7225</td>
</tr>
<tr>
<td>HST/COS Part Number: MX7225UQ/883B</td>
</tr>
<tr>
<td>HST/COS TID Requirement: 10kRads (RDM = 5)</td>
</tr>
<tr>
<td>Charge Number: C00167</td>
</tr>
<tr>
<td>Manufacturer: Maxim</td>
</tr>
<tr>
<td>Lot Date Code (LDC): 9321</td>
</tr>
<tr>
<td>Quantity Tested: 10</td>
</tr>
<tr>
<td>Serial Numbers of Control Samples: 51, 56</td>
</tr>
<tr>
<td>Serial Numbers of Radiation Samples: 50, 52, 53, 54, 55, 57, 58, 59</td>
</tr>
<tr>
<td>Part Function: Quad 8-Bit CMOS D/A Converter</td>
</tr>
<tr>
<td>Part Technology: CMOS</td>
</tr>
<tr>
<td>Package Style: 24 Pin DIP</td>
</tr>
<tr>
<td>Test Equipment: A540</td>
</tr>
<tr>
<td>Test Engineer: S. Archer-Davies</td>
</tr>
</tbody>
</table>

- The manufacturer for this part guaranteed no radiation tolerance/hardness.
TABLE II. Radiation Schedule for MX7225UQ/883B

<table>
<thead>
<tr>
<th>EVENT</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) INITIAL ELECTRICAL MEASUREMENTS</td>
<td>12/02/99</td>
</tr>
<tr>
<td>2) 2.5 KRAD IRRADIATION (0.125 KRADS/HOUR) POST-2.5 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/06/99</td>
</tr>
<tr>
<td>3) 5.0 KRAD IRRADIATION (0.106 KRADS/HOUR) POST-5.0 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/07/99</td>
</tr>
<tr>
<td>4) 10.0 KRAD IRRADIATION (0.125 KRADS/HOUR) POST-10.0 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/08/99</td>
</tr>
<tr>
<td>5) 20.0 KRAD IRRADIATION (0.144 KRADS/HOUR) POST-20.0 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/10/99</td>
</tr>
<tr>
<td>6) 30.0 KRAD IRRADIATION (0.219 KRADS/HOUR) POST-30.0 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/13/99</td>
</tr>
<tr>
<td>7) 168 HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT</td>
<td>12/03/99</td>
</tr>
</tbody>
</table>

Average Dose Rate = 30,000 RADS/196 HOURS=153.1 RADS/HOUR=0.04RADS/SEC

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS, SEE FIGURE 1.
Table III. Electrical Characteristics MX7225UQ/883B (1)

<table>
<thead>
<tr>
<th>Test #</th>
<th>Parameter</th>
<th>Units</th>
<th>Spec. Limit</th>
<th>Test Conditions (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>IDD_15V</td>
<td>mA</td>
<td>0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$V_{DD} = 15V$, outputs unloaded</td>
</tr>
<tr>
<td>11</td>
<td>ISS_-5V</td>
<td>mA</td>
<td>-9.0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$V_{SS} = -5V$, outputs unloaded</td>
</tr>
<tr>
<td>20</td>
<td>Full_Scale_Error_A</td>
<td>lsb</td>
<td>-0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>21</td>
<td>Zero_Code_Error_A</td>
<td>mV</td>
<td>-15</td>
<td>15</td>
</tr>
<tr>
<td>22</td>
<td>Full_Scale_Error_B</td>
<td>lsb</td>
<td>-0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>23</td>
<td>Zero_Code_Error_B</td>
<td>mV</td>
<td>-15</td>
<td>15</td>
</tr>
<tr>
<td>24</td>
<td>Full_Scale_Error_C</td>
<td>lsb</td>
<td>-0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>25</td>
<td>Zero_Code_Error_C</td>
<td>mV</td>
<td>-15</td>
<td>15</td>
</tr>
<tr>
<td>26</td>
<td>Full_Scale_Error_D</td>
<td>lsb</td>
<td>-0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>27</td>
<td>Zero_Code_Error_D</td>
<td>mV</td>
<td>-15</td>
<td>15</td>
</tr>
<tr>
<td>30-41</td>
<td>Iih</td>
<td>nA</td>
<td>-1000</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$V_{IN} = V_{DD}$</td>
</tr>
<tr>
<td>50-61</td>
<td>Iil</td>
<td>nA</td>
<td>-1000</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$V_{IN} = 0V$</td>
</tr>
<tr>
<td>90</td>
<td>NL_A (3)</td>
<td>lsb</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>91</td>
<td>RA_A (3)</td>
<td>lsb</td>
<td>0</td>
<td>0.50</td>
</tr>
<tr>
<td>92</td>
<td>NL_B</td>
<td>lsb</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>93</td>
<td>RA_B</td>
<td>lsb</td>
<td>0</td>
<td>0.50</td>
</tr>
<tr>
<td>94</td>
<td>NL_C</td>
<td>lsb</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>95</td>
<td>RA_C</td>
<td>lsb</td>
<td>0</td>
<td>0.50</td>
</tr>
<tr>
<td>96</td>
<td>NL_D</td>
<td>lsb</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>97</td>
<td>RA_D</td>
<td>lsb</td>
<td>0</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Notes:

(1) These are the manufacturer’s non-irradiated data sheet specification limits. The manufacturer provided no post-irradiation limits at the time the tests were performed.

(2) $V_{DD} = +15V$, $V_{SS} = -5V$, AGND = DGND = 0V, and $V_{REF} = 2.0V$ to $(V_{DD} - 4V)$ unless otherwise noted.

(3) NL = Differential Non-Linearity, RA = Integral Non-Linearity
### LE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for MX7225UQ/883

<table>
<thead>
<tr>
<th>Test #</th>
<th>Parameters</th>
<th>Units</th>
<th>Spec. Lim. (2)</th>
<th>Initial</th>
<th>2.5</th>
<th>5.0</th>
<th>10.0</th>
<th>20.0</th>
<th>30.0</th>
<th>168 hours @25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>mean</td>
<td>sd</td>
<td>mean</td>
<td>sd</td>
<td>mean</td>
<td>sd</td>
<td>mean</td>
</tr>
<tr>
<td>10</td>
<td>IDD_15V mA</td>
<td>0</td>
<td>10.0</td>
<td>7.09</td>
<td>0.33</td>
<td>7.06</td>
<td>0.20</td>
<td>7.25</td>
<td>0.19</td>
<td>7.69</td>
</tr>
<tr>
<td>11</td>
<td>ISS_-5V mA</td>
<td>-9.0</td>
<td>0</td>
<td>-6.03</td>
<td>0.31</td>
<td>-5.99</td>
<td>0.17</td>
<td>-6.09</td>
<td>0.18</td>
<td>-6.26</td>
</tr>
<tr>
<td>20</td>
<td>Full_Scale_Error_/ lsb</td>
<td>-0.50</td>
<td>0.50</td>
<td>-0.02</td>
<td>0.05</td>
<td>-0.03</td>
<td>0.05</td>
<td>-0.02</td>
<td>0.05</td>
<td>-0.03</td>
</tr>
<tr>
<td>21</td>
<td>Zero_Code_Error_/ mV</td>
<td>-15</td>
<td>15</td>
<td>3.91</td>
<td>2.98</td>
<td>4.60</td>
<td>3.13</td>
<td>4.91</td>
<td>3.23</td>
<td>5.40</td>
</tr>
<tr>
<td>22</td>
<td>Full_Scale_Error_/ lsb</td>
<td>-0.50</td>
<td>0.50</td>
<td>-0.03</td>
<td>0.10</td>
<td>-0.02</td>
<td>0.11</td>
<td>-0.03</td>
<td>0.11</td>
<td>-0.05</td>
</tr>
<tr>
<td>23</td>
<td>Zero_Code_Error_/ mV</td>
<td>-15</td>
<td>15</td>
<td>4.52</td>
<td>5.38</td>
<td>4.08</td>
<td>6.14</td>
<td>4.95</td>
<td>6.21</td>
<td>5.77</td>
</tr>
<tr>
<td>24</td>
<td>Full_Scale_Error_/ lsb</td>
<td>-0.50</td>
<td>0.50</td>
<td>-0.03</td>
<td>0.07</td>
<td>-0.03</td>
<td>0.08</td>
<td>-0.05</td>
<td>0.09</td>
<td>-0.08</td>
</tr>
<tr>
<td>26</td>
<td>Full_Scale_Error_/ lsb</td>
<td>-0.50</td>
<td>0.50</td>
<td>-0.05</td>
<td>0.08</td>
<td>-0.04</td>
<td>0.08</td>
<td>-0.03</td>
<td>0.09</td>
<td>-0.07</td>
</tr>
<tr>
<td>27</td>
<td>Zero_Code_Error_/ mV</td>
<td>-15</td>
<td>15</td>
<td>4.92</td>
<td>4.37</td>
<td>4.52</td>
<td>4.73</td>
<td>4.87</td>
<td>4.63</td>
<td>5.96</td>
</tr>
<tr>
<td>30-41</td>
<td>Iih nA</td>
<td>-1000</td>
<td>1000</td>
<td>-720</td>
<td>80</td>
<td>-697</td>
<td>67</td>
<td>-721</td>
<td>65</td>
<td>-714</td>
</tr>
<tr>
<td>50-61</td>
<td>Iil nA</td>
<td>-1000</td>
<td>1000</td>
<td>-739</td>
<td>61</td>
<td>-731</td>
<td>58</td>
<td>-699</td>
<td>30</td>
<td>-794</td>
</tr>
<tr>
<td>90</td>
<td>NL_A (3) lsb</td>
<td>0</td>
<td>1.00</td>
<td>0.16</td>
<td>0.08</td>
<td>0.15</td>
<td>0.08</td>
<td>0.14</td>
<td>0.08</td>
<td>0.15</td>
</tr>
<tr>
<td>91</td>
<td>RA_A lsb</td>
<td>0</td>
<td>0.50</td>
<td>0.33</td>
<td>0.07</td>
<td>0.32</td>
<td>0.07</td>
<td>0.31</td>
<td>0.07</td>
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<td>NL_B lsb</td>
<td>0</td>
<td>1.00</td>
<td>0.12</td>
<td>0.08</td>
<td>0.09</td>
<td>0.05</td>
<td>0.09</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>93</td>
<td>RA_B lsb</td>
<td>0</td>
<td>0.50</td>
<td>0.29</td>
<td>0.08</td>
<td>0.27</td>
<td>0.05</td>
<td>0.27</td>
<td>0.05</td>
<td>0.27</td>
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<tr>
<td>94</td>
<td>NL_C lsb</td>
<td>0</td>
<td>1.00</td>
<td>0.15</td>
<td>0.11</td>
<td>0.11</td>
<td>0.08</td>
<td>0.11</td>
<td>0.09</td>
<td>0.12</td>
</tr>
<tr>
<td>95</td>
<td>RA_C lsb</td>
<td>0</td>
<td>0.50</td>
<td>0.36</td>
<td>0.12</td>
<td>0.29</td>
<td>0.09</td>
<td>0.29</td>
<td>0.09</td>
<td>0.28</td>
</tr>
<tr>
<td>96</td>
<td>NL_D lsb</td>
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<td>1.00</td>
<td>0.11</td>
<td>0.05</td>
<td>0.09</td>
<td>0.04</td>
<td>0.09</td>
<td>0.03</td>
<td>0.09</td>
</tr>
<tr>
<td>97</td>
<td>RA_D lsb</td>
<td>0</td>
<td>0.50</td>
<td>0.28</td>
<td>0.05</td>
<td>0.26</td>
<td>0.04</td>
<td>0.26</td>
<td>0.04</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Notes:
(1) The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout testir
(2) These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were
(3) np/mF implies that n parts passed and m parts failed this test at this level. 8F implies that all parts failed this test at this level.

Radiation sensitive parameters: IDD_15V, Full_Scale_Error, Zero_Code_Error, NL, RA.