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A radiation evaluation was performed on the 54AC646LMQB to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through IV and Figure 1.

The total dose testing was performed using a cobalt-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 steps were 10, 20, 30, 50, 75, and 100 krads*. After 100 krads, the parts were annealed under bias at 25°C for 254 hours. After this annealing, the parts were irradiated to 200 and 300 krads (cumulative). Finally, the parts were annealed under bias for 168 hours at 100°C followed by an additional 192 hours without bias at 25°C. The dose rate was between 300 and 6,250 rads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, the parts were electrically tested at 25°C according to the test conditions and the specification limits listed in Table III. These tests included two functional tests at 1 MHz after each radiation and annealing step.

All parts passed both functional tests on irradiation up to 300 krads and on subsequent annealing treatment under bias for 168 hours at 100°C followed by 168 hours without bias at 25°C. Also, all parts stayed within the specification limits for all parameters on irradiation up to 20 krads. However, after radiation exposure to 30 krads, 3 devices exceeded the maximum specification limit of 160 uA for ICCH and ICCZ. These parts had readings ranging from 188 uA to 449 uA. Upon continued exposure to 50 krads, 5 devices were over the limit for ICCH and ICCZ. The readings ranged from 365 uA to 4.5 mA. In addition, one part exceeded the limit of 1 uA for ITH with an actual reading of 8.83 uA. The ICCH, ICCZ and ITH parameters continued to degrade through 100 krads of exposure. After 100 krads, 6 devices were over the limit for ICCH and ICCZ with readings from 1.8 mA to more than 16 mA. Also, 5 of these 6 devices exceeded the ITH limit with readings from 22 uA to 676 uA. The 256 hour annealing step enabled the devices to recover slightly, however, the same 6 parts were outside the specified limits. These 6 parts had readings for ICCH and ICCZ ranging from 0.5 mA to more than 16 mA and ITH decreased to a range of 2.5 uA to 384 uA. Upon further irradiation to 200 krads and then 300 krads, the degradation in the ICCH, ICCZ and ITH
parameters continued. All 8 samples exceeded the limits for these three parameters after 300 krads. Readings for ICCH and ICCZ were in excess of 16 mA. Readings for IIH ranged from slightly over 1 uA to 3.8 mA. The post 300 krads annealing step consisted of 168 hours under bias at 100°C plus an additional 192 hours of unbiased room temperature annealing. This annealing enabled 3 devices to recover enough to be within the limits for ICCH, ICCZ and IIH. The other 5 devices also recovered, but remained outside the specification limits for ICCH, ICCZ and IIH. Readings ranged from 200 uA to 9 mA for ICCH and ICCZ and from 2 uA to 85 uA for IIH.

Table IV provides the mean and standard deviation values for each parameter after each radiation exposure and annealing treatment. It also provides a summary of the functional test results after each radiation/annealing step.

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

In this report, the term rads is used as an abbreviation for rads (Si).
<table>
<thead>
<tr>
<th><strong>Generic Part Number:</strong></th>
<th>54AC646LMQB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SMEX Common Buy Part Number:</strong></td>
<td>5962-89682013A</td>
</tr>
<tr>
<td><strong>SMEX Common Buy Control Number:</strong></td>
<td>1412</td>
</tr>
<tr>
<td><strong>Charge Number:</strong></td>
<td>C90353</td>
</tr>
<tr>
<td><strong>Manufacturer:</strong></td>
<td>National Semiconductor Corp.</td>
</tr>
<tr>
<td><strong>Lot Date Code:</strong></td>
<td>9109A</td>
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<tr>
<td><strong>Quantity Tested:</strong></td>
<td>8</td>
</tr>
<tr>
<td><strong>Serial Numbers of Radiation Samples:</strong></td>
<td>302, 303, 304, 305, 306, 307, 308, 309</td>
</tr>
<tr>
<td><strong>Serial Number of Control Sample:</strong></td>
<td>300, 301</td>
</tr>
<tr>
<td><strong>Part Function:</strong></td>
<td>OCTAL TRANSCEIVER/REGISTER</td>
</tr>
<tr>
<td><strong>Part Technology:</strong></td>
<td>CMOS</td>
</tr>
<tr>
<td><strong>Package Style:</strong></td>
<td>28-pin LCC</td>
</tr>
</tbody>
</table>
TABLE II. Radiation Schedule for 54AC646LMQB

<table>
<thead>
<tr>
<th>EVENTS</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Initial (Pre-Irradiation) Electrical Measurements</td>
<td>11/18/91</td>
</tr>
<tr>
<td>2) 10 KRAD IRRADIATION (500 rads/hour)</td>
<td>12/09/91</td>
</tr>
<tr>
<td>POST 10 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/10/91</td>
</tr>
<tr>
<td>3) 20 KRAD IRRADIATION (500 rads/hour)</td>
<td>12/10/91</td>
</tr>
<tr>
<td>POST 20 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/11/91</td>
</tr>
<tr>
<td>4) 30 KRAD IRRADIATION (525 rads/hour)</td>
<td>12/11/91</td>
</tr>
<tr>
<td>POST 30 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/13/91</td>
</tr>
<tr>
<td>5) 50 KRAD IRRADIATION (300 rads/hour)</td>
<td>12/13/91</td>
</tr>
<tr>
<td>POST 50 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/17/91</td>
</tr>
<tr>
<td>6) 75 KRAD IRRADIATION (1,320 rads/hour)</td>
<td>12/17/91</td>
</tr>
<tr>
<td>POST 75 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/18/91</td>
</tr>
<tr>
<td>7) 100 KRAD IRRADIATION (1,320 rads/hour)</td>
<td>12/18/91</td>
</tr>
<tr>
<td>POST 100 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/19/91</td>
</tr>
<tr>
<td>8) 96 HOURS ANNEALING AT 25°C</td>
<td>12/19/91</td>
</tr>
<tr>
<td>POST 96 HOURS ELECTRICAL MEASUREMENT</td>
<td>12/23/91</td>
</tr>
<tr>
<td>9) 264 HOURS ANNEALING AT 25°C</td>
<td>12/19/91</td>
</tr>
<tr>
<td>POST 264 HOURS ELECTRICAL MEASUREMENT</td>
<td>12/30/91</td>
</tr>
<tr>
<td>10) 200 KRAD IRRADIATION (6,250 rads/hour)</td>
<td>12/30/91</td>
</tr>
<tr>
<td>POST 200 KRAD ELECTRICAL MEASUREMENT</td>
<td>12/31/91</td>
</tr>
<tr>
<td>11) 300 KRAD IRRADIATION (2,130 rads/hour)</td>
<td>12/31/91</td>
</tr>
<tr>
<td>POST 300 KRAD ELECTRICAL MEASUREMENT</td>
<td>01/02/92</td>
</tr>
<tr>
<td>12) 168 HOURS ANNEALING AT +100°C PLUS 192 HOURS AT 25°C WITHOUT BIAS</td>
<td>01/02/92</td>
</tr>
<tr>
<td>POST ANNEALING ELECTRICAL MEASUREMENT</td>
<td>01/18/92</td>
</tr>
</tbody>
</table>

Notes:

- All parts were radiated under bias at the cobalt-60 gamma ray facility at GSFC.
- All electrical measurements were performed off-site at +25°C.
- All Annealing steps were performed under bias except as noted.
# Table III. Electrical Characteristics of 54AC646LMQB

<table>
<thead>
<tr>
<th>Parameter</th>
<th>VCC</th>
<th>VIL</th>
<th>VEH</th>
<th>Conditions</th>
<th>Pins</th>
<th>Limits (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FREQ1</td>
<td>3.0V</td>
<td>0.0V</td>
<td>3.0V</td>
<td>FREQ = 300HZ</td>
<td>ALL 3/8</td>
<td>VCC = 1.5V</td>
</tr>
<tr>
<td>FREQ2</td>
<td>3.5V</td>
<td>0.0V</td>
<td>3.0V</td>
<td>FREQ = 1500HZ</td>
<td>ALL 3/8</td>
<td>VCC = 1.5V</td>
</tr>
</tbody>
</table>

### AC PARAMETRIC TESTS PROPAGATION DELAY TIMING

<table>
<thead>
<tr>
<th>Parameter</th>
<th>VCC</th>
<th>VIL</th>
<th>VEH</th>
<th>Pins</th>
<th>Limits BASE = 55°C, 125°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPLH</td>
<td>4.5V</td>
<td>0.0V</td>
<td>3.0V</td>
<td>OUT 1</td>
<td>10 NSS</td>
</tr>
<tr>
<td>TPLH</td>
<td>4.5V</td>
<td>0.0V</td>
<td>3.0V</td>
<td>OUT 0</td>
<td>12 NSS</td>
</tr>
<tr>
<td>TPLH</td>
<td>4.5V</td>
<td>0.0V</td>
<td>3.0V</td>
<td>OUT 1</td>
<td>12 NSS</td>
</tr>
<tr>
<td>TPLH</td>
<td>4.5V</td>
<td>0.0V</td>
<td>3.0V</td>
<td>OUT 0</td>
<td>12 NSS</td>
</tr>
</tbody>
</table>

### COMMENTS/EXCEPTIONS

1. AC parametric test #6 & 8 as is performed with VIL = TVIS and VEH = TVIS.
2. VIL & VEH are tested going against the AC parametric tests.
3. This program detects improper/out insertion.
4. The following AC exceptions were taken:
   - TPLH O/E TO BUS
   - TPLH O/E TO BUS
   - TPLH O/E TO BUS
   - TPLH O/E TO BUS
   - TPLH O/E TO BUS
   - TPLH O/E TO BUS

5. This program detects improper/out insertion.
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Spec Limits @ 25°C</th>
<th>0 (Pre-Rad)</th>
<th>10</th>
<th>30</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>264 hour @ 25°C</th>
<th>200</th>
<th>300</th>
<th>168 hours @ 100°C &amp; 192 hours @ 25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTC1 1 MHz</td>
<td>min max</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
</tr>
<tr>
<td>FTC2 1 MHz</td>
<td>min max</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
<td>mean sd</td>
</tr>
<tr>
<td>VCH2, 4.5 V</td>
<td>2.9 3.5</td>
<td>0.94%</td>
<td>0.59%</td>
<td>0.23%</td>
<td>0.20%</td>
<td>0.09%</td>
<td>0.007%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
</tr>
<tr>
<td>VCH2, 5.5 V</td>
<td>2.9 3.5</td>
<td>0.94%</td>
<td>0.59%</td>
<td>0.23%</td>
<td>0.20%</td>
<td>0.09%</td>
<td>0.007%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
</tr>
<tr>
<td>VCH4, 2.4 V</td>
<td>2.9 3.5</td>
<td>0.94%</td>
<td>0.59%</td>
<td>0.23%</td>
<td>0.20%</td>
<td>0.09%</td>
<td>0.007%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
</tr>
<tr>
<td>VCH6, 2.4 V</td>
<td>2.9 3.5</td>
<td>0.94%</td>
<td>0.59%</td>
<td>0.23%</td>
<td>0.20%</td>
<td>0.09%</td>
<td>0.007%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
</tr>
<tr>
<td>VCH8, 2.4 V</td>
<td>2.9 3.5</td>
<td>0.94%</td>
<td>0.59%</td>
<td>0.23%</td>
<td>0.20%</td>
<td>0.09%</td>
<td>0.007%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
</tr>
<tr>
<td>VCH10, 2.4 V</td>
<td>2.9 3.5</td>
<td>0.94%</td>
<td>0.59%</td>
<td>0.23%</td>
<td>0.20%</td>
<td>0.09%</td>
<td>0.007%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
<td>0.001%</td>
</tr>
</tbody>
</table>

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54AC646LMQB 1/2/3/4/
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Spec Limits @ 25°C</th>
<th>Total Dose Exposure (TDE) (krads)</th>
<th>Anneal 206 hour @ 25°C</th>
<th>Anneal 206 hour @ 100°C &amp; 124 hour @ 25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPLSEL1A</td>
<td>1.0 12.0</td>
<td>7.93 0.22 6.94 0.38 8.97 0.40</td>
<td>9.32 0.5 9.36 0.56</td>
<td>10.56 0.38 10.52 0.26 9.56 0.21</td>
</tr>
<tr>
<td>TPLSEL1B</td>
<td>1.0 12.0</td>
<td>9.05 0.56 6.26 0.56 7.75 0.56</td>
<td>8.41 0.59 8.47 0.59</td>
<td>8.35 0.53 8.47 0.59 8.34 0.59</td>
</tr>
<tr>
<td>TPLSEL2A</td>
<td>1.0 12.0</td>
<td>7.94 0.59 8.97 0.56 7.75 0.56</td>
<td>10.61 0.71 10.52 0.80</td>
<td>10.59 0.71 10.57 0.84 10.62 0.83</td>
</tr>
<tr>
<td>TPLSEL2B</td>
<td>1.0 12.0</td>
<td>5.15 0.56 6.20 0.56 5.34 0.56</td>
<td>7.25 0.52 7.26 0.52</td>
<td>7.25 0.52 7.26 0.52 7.25 0.52</td>
</tr>
<tr>
<td>TPLSEL3A</td>
<td>1.0 11.5</td>
<td>6.24 0.21 6.64 0.27 6.72 0.23</td>
<td>7.72 0.27 7.72 0.27</td>
<td>7.72 0.27 7.72 0.27 7.72 0.27</td>
</tr>
<tr>
<td>TPLSEL3B</td>
<td>1.0 11.5</td>
<td>7.91 0.29 7.86 0.28 7.55 0.27</td>
<td>8.65 0.24 8.65 0.24</td>
<td>8.65 0.24 8.65 0.24 8.65 0.24</td>
</tr>
<tr>
<td>TPLSEL4A</td>
<td>1.0 11.5</td>
<td>8.99 0.57 8.92 0.52 8.85 0.51</td>
<td>9.25 0.52 9.25 0.52</td>
<td>9.25 0.52 9.25 0.52 9.25 0.52</td>
</tr>
<tr>
<td>TPLSEL4B</td>
<td>1.0 11.5</td>
<td>7.56 0.21 7.86 0.27 7.55 0.27</td>
<td>8.65 0.24 8.65 0.24</td>
<td>8.65 0.24 8.65 0.24 8.65 0.24</td>
</tr>
<tr>
<td>TPLSEL5A</td>
<td>1.0 9.5</td>
<td>6.84 0.72 7.20 0.73 6.74 0.71</td>
<td>7.91 0.14 7.91 0.14</td>
<td>7.91 0.14 7.91 0.14 7.91 0.14</td>
</tr>
<tr>
<td>TPLSEL5B</td>
<td>1.0 9.5</td>
<td>5.82 0.71 7.66 0.69 7.53 0.71</td>
<td>8.65 0.41 8.65 0.41</td>
<td>8.65 0.41 8.65 0.41 8.65 0.41</td>
</tr>
<tr>
<td>TPLSEL6A</td>
<td>1.0 9.5</td>
<td>8.76 0.61 8.88 0.63 8.88 0.63</td>
<td>9.26 1.23 9.26 1.23</td>
<td>9.26 1.23 9.26 1.23 9.26 1.23</td>
</tr>
<tr>
<td>TPLSEL6B</td>
<td>1.0 9.5</td>
<td>5.04 1.40 6.32 0.49 5.51 0.41 5.43 0.42 5.43 0.42 5.43 0.42</td>
<td>7.46 1.44 7.46 1.44</td>
<td>7.46 1.44 7.46 1.44 7.46 1.44</td>
</tr>
</tbody>
</table>

1/ These statistics do not include the control samples which remained constant throughout testing.

2/ The statistics for the post 20 krad and 206 hour annealing steps are available upon request.

3/ It shall be noted that beyond 50 krad of exposure, three devices were reading below the minimum limit for VDH3. This trend was not consistent with some parts passing VDH3 at later radiation steps.

4/ **** - indicates that statistics are not available due to fluctuations with the Automated Test Equipment (ATE).
Figure 1. Radiation Bias Circuit for 54AC646LMQB

\[ V_{CC} = 5.0V \pm 10\% \quad V_{CC/2} = 2.5V \pm 10\% \]

\[ R = 1.0K \text{ Ohm}, 5\% , \frac{1}{4} W \]

\[ T_A = 25^\circ C \]