ICS Radiation Test Results

F2812 DSP
Texas Instruments

=================================================================
TI P.O. Number 4500023746

DEVICE TYPE: F2812 DSP (TI)
RADIATION SOURCE: Neeley Nuclear Research Center
Georgia Institute of Technology
Atlanta, GA
Co60 1.25MeV

D/C Unknown || PACKAGE Unknown || LOT# Unknown
LOG# 1308 || TEST DATE 01/08/04 || RTP# 539

Test Conductor: Hal Anthony
Test Administrator: Michael K. Gauthier

ICS RADIATION TECHNOLOGIES, INC.
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Downey, CA 90240-3949

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FAX: 562-923-3609
INTERNET e-mail: support@icsrad.com
www.icsrad.com
Device Type: F2812 DSP
Manufacturer: Texas Instruments
Lot No: Date Code:
Package Type:
No. of Devices Supplied: 8
No. of Devices to be tested: 7

=================================================================
RADIATION CONDITIONS:

TOTAL DOSE: MIL-STD-883E, Method 1019.6
Facility Co60 Room Source, Georgia Institute of Technology
Energy: 1.25 MeV

<table>
<thead>
<tr>
<th>Total Dose krad(Si)</th>
<th>40</th>
<th>85</th>
<th>125</th>
<th>170</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Dose Rate rad(Si)/s</th>
<th>Less than 20</th>
</tr>
</thead>
</table>

BIAS CONDITIONS DURING IRRADIATION:

Total Dose Irradiation:

Name  Voltage

PS1  1.8 Volts
PS2  3.3 Volts
Ground  Ground

Attachment A of TI Spec. SM/SMJ320F2812HFG
Connect all “CLK” resistors to 3.3 Volts
Connect all BOLD resistors to Ground

Irradiation Notes:
1. Irradiate one device till ICC indicates possible device failure.
2. Irradiate 2 devices to each irradiation level, based on the failure point of step 1.
3. Package devices in Dry Ice for delivery to TI for testing.
4. TI to supply ICS with copies all test data so ICS can write a test report.
Co$^{60}$ Irradiation of Texas Instruments
F2812 DSP
at The Neeley Nuclear Research Center
Georgia Institute of Technology, Atlanta, Georgia

On January 8 2004, ICS irradiated 7 F2812 DSP ICs (Log #1308) manufactured by Texas Instruments, Sherman, Texas. The irradiation was of four groups of one or two device units each (7 devices units). The Texas Instruments purchase order number is 4500023746. The ICS Task number is 624. The Radiation Test Procedure (RTP) is No. 539 dated November 17, 2003.

The irradiator used was the “Hot Cell” room source at The Neeley Nuclear Research Center (NNRC) on the campus of Georgia Institute of Technology in Atlanta, Georgia. Dose rate calculation was provided by the Neeley Nuclear Research Center Staff.

The setup consisted of:

- 7 pieces plus 1 control, TI F2812 DSP
- 1 Bias board (TI supplied 8 position burn in board)
- 1 Fluke Model 8010A DMM (Current monitor) Serial# 3520136.
- 1 Fluke Model 8050A DMM (Current monitor) Serial# 2210301.
- 2 GW Laboratory DC Power supply Model GPS-1850D, Serial# C880876 & C880880 [3.3 & 1.8 Volts to Bias Board]
- 1 LND Ionization Probe, Model# 52120
- NNRC Hot Cell for Co$^{60}$ exposures.

The TI- F2812 DSP were irradiated to total dose exposures of 40, 85, 125, or 170krads(Si), one level for each group of Units Under Test (UUT) (serialized) at a dose rate of 18.95 rad(Si)/second [1137 rad(Si)/minute]. The UUT were placed in a TI supplied burn-in/bias board and the board was set to a distance of 15cm from the Co$^{60}$ source. The dose rate of 18.95 rad(Si)/second was measured at the surface of the burn-in/bias board using a LND Ionization Probe, Model# 52120 which was calibrated to NiST traceable standards. The board was positioned to uniformly expose the entire bias board area. This provided for a dose rate of 18.95 rads(Si)/second to each UUT.

UUTs Current and Voltages were monitored and recorded at the start, during and end of exposure periods. See Exposure Activity log for details. All Test equipment property of ICS with the exception of the NNRC Hot Cell and the UUTs.

NOTE: Each UUT was immediately placed in a chilled dry ice environment after it attained its respective TID exposure level.

The exposure groups by serial # and actual exposure level are as follows (See Figure2 for exposure timeline):

<table>
<thead>
<tr>
<th>Serial #</th>
<th>Exposure Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>TID —S.N. 1.</td>
</tr>
</tbody>
</table>
| 85       | TID —S.N. 2 & 3.
| 125      | TID —S.N. 4 & 5.
| 170      | TID —S.N. 6 & 7. |

Several more samples were available but were not exposed to Co$^{60}$ radiation

Power supply current and voltage levels were monitored and recorded during exposure. Very little bias current change on either PS1 or PS2 was observed during radiation exposure and is shown in Figure 1. Power supply bias currents are shown in the exposure activity log, Table 1. See figure 2 for activity timeline. No unusual events were observed during the radiation exposure of the TI F2812 DSPs.

Test Engineer: Hal Anthony
If you have any questions, please contact me directly.

ICS RADIATION TECHNOLOGIES, INC.

Dr. Michael K. Gauthier, P.E., President
# Exposure Activity log

**TI F2818 DSP**

**Thursday 8 January 2004**

<table>
<thead>
<tr>
<th>Time</th>
<th>3.3Vps mA</th>
<th>1.8Vps mA</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>951</td>
<td>5.97</td>
<td>43.8</td>
<td>Beam on</td>
</tr>
<tr>
<td>953</td>
<td>5.783</td>
<td>43.8</td>
<td></td>
</tr>
<tr>
<td>1002</td>
<td>5.773</td>
<td>43.8</td>
<td>1 piece</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>sn 1</td>
</tr>
<tr>
<td>1004</td>
<td>5.77</td>
<td>43.8</td>
<td></td>
</tr>
<tr>
<td>1005</td>
<td>5.769</td>
<td>43.8</td>
<td></td>
</tr>
<tr>
<td>1006</td>
<td>5.764</td>
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</tr>
<tr>
<td>1010</td>
<td>5.756</td>
<td>43.8</td>
<td></td>
</tr>
<tr>
<td>1020</td>
<td>5.747</td>
<td>43.8</td>
<td></td>
</tr>
<tr>
<td>1030</td>
<td>5.74</td>
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<td>1040</td>
<td>5.733</td>
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<tr>
<td>1050</td>
<td>5.727</td>
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<td></td>
</tr>
<tr>
<td>1100</td>
<td>5.722</td>
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</tr>
<tr>
<td>1120</td>
<td>5.717</td>
<td>43.8</td>
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<tr>
<td>1130</td>
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<td>1140</td>
<td>5.712</td>
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</tr>
<tr>
<td>1142</td>
<td>5.709</td>
<td>43.8</td>
<td>Beam off</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>3.3Vps mA</th>
<th>1.8Vps mA</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1157</td>
<td>34.19</td>
<td>49.66</td>
<td>Beam on</td>
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<tr>
<td>1210</td>
<td>34.06</td>
<td>49.63</td>
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<tr>
<td>1215</td>
<td>33.98</td>
<td>49.62</td>
<td>6 pieces</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>sn 2, 3, 4, 5, 6, 7</td>
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<tr>
<td>1220</td>
<td>33.85</td>
<td>49.47</td>
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<td>1225</td>
<td>33.81</td>
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<td></td>
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<tr>
<td>1234</td>
<td>33.8</td>
<td>49.48</td>
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<td>1243</td>
<td>23.03</td>
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<td>1245</td>
<td>23</td>
<td>46.34</td>
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<tr>
<td>1250</td>
<td>22.97</td>
<td>46.35</td>
<td>4 pieces</td>
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<td>sn 4, 5, 6, 7</td>
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<tr>
<td>1300</td>
<td>22.94</td>
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<td>22.92</td>
<td>46.4</td>
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<tr>
<td>1320</td>
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<tr>
<td>1333</td>
<td>11.085</td>
<td>35.68</td>
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<td>1334</td>
<td>11.079</td>
<td>35.68</td>
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<tr>
<td>1340</td>
<td>11.071</td>
<td>35.69</td>
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<tr>
<td>1350</td>
<td>11.064</td>
<td>35.68</td>
<td>2 pieces</td>
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<td>sn 6, 7</td>
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<td>1400</td>
<td>11.06</td>
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<td>1415</td>
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<td>11.08</td>
<td>35.72</td>
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<td>11.097</td>
<td>35.74</td>
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<tr>
<td>1430</td>
<td>11.155</td>
<td>35.87</td>
<td></td>
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<tr>
<td>1447</td>
<td>11.168</td>
<td>35.77</td>
<td>Beam off</td>
</tr>
</tbody>
</table>

Table 1 Exposure Activity Log
Figure 1. Bias Current During Exposure Plot

Figure 2. Exposure Activity timeline

NOTE: See Appendix A for test setup and facility photos.
Device Type: F2812 DSP
Manufacturer: Texas Instruments
Lot No: Date Code:
Package Type:
No. of Devices Supplied: 8
No. of Devices to be tested: 7

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BIAS CONDITIONS DURING IRRADIATION:

Total Dose Irradiation:

Name Voltage

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PS2 3.3 Volts
Ground Ground

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ICS Radiation Test Results
Log # 1308 01/08/04

NEELEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)

F2812 DSP (TI)

PS / SUPPLY PINOS / VDD_OS - PIN VDD1 (uA)

MINIMUM

MEAN

MAXIMUM

NIELEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)
<table>
<thead>
<tr>
<th></th>
<th>PS / SUPPLYPINOS / VDD_OS - PIN AVDDREFBG (uA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINIMUM</td>
<td>-6.00E+00</td>
</tr>
<tr>
<td>MEAN</td>
<td>-5.00E+00</td>
</tr>
<tr>
<td>MAXIMUM</td>
<td>-4.00E+00</td>
</tr>
</tbody>
</table>

Neeley Nuclear Research Center: Georgia Institute of Technology (Co60 1.25MeV)

**Diagram Description:**
- **PS / SUPPLYPINOS / VDD_OS - PIN AVDDREFBG (uA)**
- **X-axis:** Initial, 42, 84, 126, 168
- **Y-axis:** Minimum (-6.00E+00), Mean (-5.00E+00), Maximum (-4.00E+00)
- Legend:
  - MINIMUM
  - MEAN
  - MAXIMUM

**Graph Details:**
- The graph shows the radiation test results for the F2812 DSP (TI) device.
- The data points are plotted for different radiation levels, indicating the performance of the device under varying conditions.
F2812 DSP (TI)
IC S Radiation Test Results  Log # 1308 01/08/04

FREQUENCY / PLLmax / revC_ratio4 (MHz)

MINIMUM
MEAN
MAXIMUM

NEELEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)
F2812 DSP (TI)

IC S Radiation Test Results  Log # 1308 01/08/04

<table>
<thead>
<tr>
<th>MINIMUM</th>
<th>MEAN</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPMU / Leakage_Test / TriLo1 / PIN XHOLDAn (pA)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NEELEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)
IC S Radiation Test Results
Log # 1308 01/08/04

PPMU / Leakage_Test / TriLo1 / PIN XCLKOUT (pA)

F2812 DSP (TI)

Initial 42 84 126 168

Neely Nuclear Research Center: Georgia Institute of Technology (Co60 1.25MeV)
<table>
<thead>
<tr>
<th>PPMU / Leakage_Test / TriLo2 / - WORST CASE (pA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINIMUM</td>
</tr>
<tr>
<td>MEAN</td>
</tr>
<tr>
<td>MAXIMUM</td>
</tr>
</tbody>
</table>

### F2812 DSP (TI)

IC S Radiation Test Results  
Log # 1308 01/08/04

**NEELEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)**

- **MINIMUM**
- **MEAN**
- **MAXIMUM**
F2812 DSP (TI)
ICS Radiation Test Results Log # 1308 01/08/04

MINIMUM MEAN MAXIMUM

PPMU / Leakage_Test / TriLo2 / PIN X1 (pA)

NEELEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)
F2812 DSP (TI)

IC S Radiation Test Results Log # 1308 01/08/04

NECTEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)

PPMU / Leakage Test / TriLo3 (nA)

MINIMUM

MEAN

MAXIMUM

NEELEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)
F2812 DSP (TI)

I C S Radiation Test Results  Log # 1308 01/08/04

<table>
<thead>
<tr>
<th>PPMU / Leakage_Test / TriPUPDa / PIN EMU0 (uA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INITIAL</td>
</tr>
<tr>
<td>MINIMUM</td>
</tr>
<tr>
<td>MEAN</td>
</tr>
<tr>
<td>MAXIMUM</td>
</tr>
</tbody>
</table>

NEELEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)

MINIMUM  MEAN  MAXIMUM
F2812 DSP (TI)
ICS Radiation Test Results Log # 1308 01/08/04

NEELEY NUCLEAR RESEARCH CENTER: GEORGIA INSTITUTE OF TECHNOLOGY (Co60 1.25MeV)

MINIMUM  MEAN  MAXIMUM
ANOMALY REPORT

F2812 DSP

Texas Instruments

Date Code Unknown, Lot: Unknown
Log# 1308, Test Date 01-08-04
P.O.# 4500023746

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ANOMALY: FAILED Devices, Missing Data Points.

The Texas Instruments F2812 DSP was tested per RTP 539 dated November 17, 2003. The devices were initially tested by TI and sent to ICS for irradiation. ICS irradiated and returned the devices, packed in dry ice, to TI via overnight express. TI tested the devices and supplied the raw test data to ICS for this report.

During this test the first failures were noted at 84krad(Si). Serial number 4 failed IDDQ on several of the PMExits parameters, exceeding the manufacturer's limits at 84krad(Si). No data for functional testing was supplied with the raw data, but an attached note from TI stated that serial numbers 6 failed the functional test and a number of other parameters at 168krad(Si). Serial number 7 failed IDQQ on all PMExits parameters at 168krad(Si). In the case of frequency measurements, all measurements after the initials for both the irradiated devices and the controls was "0", indicating the devices were not measured for those parameters.

If you should require any further clarification on this matter, please contact me directly:
TEL-562-923-1837, FAX-562-923-3609, or E-Mail mike@icsrad.com.

Dr. Michael K. Gauthier, P.E.
President
ICS Radiation Technologies, Inc.
February 23, 2004
---F2812 in test chamber at NNRC, Georgia Tech, Atlanta, GA, 7 Jan 2004---

---View into test chamber at NNRC---
Boot shape in upper left is Co60 transfer tube. F2812 bias board is the vertical structure right low of center.

---Power supply and DMM setup outside of test chamber at NNRC, Georgia Tech, Atlanta, GA, 7 Jan 2004---

---User area outside of test chamber at NNRC---

---NNRC building at Georgia Tech, Atlanta, GA, 7 Jan 2004---