

UNISYS

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PPM-95-170

TO: M. Gates/735.0
FROM: K. Sahu/300.1 *KS*
SUBJECT: Radiation Report on LANDSAT
Part No. IBM0116400J3C
Control No. 13191cc: A. Sharma/311.0
OFA Library/300.1

A radiation evaluation was performed on IBM0116400J3C (DRAM) 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 Co^{60} gamma ray source. During the radiation testing, four parts were irradiated under bias (see Figure 1 for bias configuration), and one part was used as a control sample. The total dose radiation levels were 2.5, 5, 7.5, 10, 15, 20, 30, 50 and 100 krad*. The dose rate was between 0.12 and 1.2 krad/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits** listed in Table III. These tests included six functional tests at 5.0 Mhz, with $V_{cc} = 5.0$ V. For details of the functional tests, refer to Table III.

All parts passed initial electrical measurements. All irradiated parts passed all electrical tests upto and including the 20 krad level. At the 30 krad irradiation level, S/N304 exceeded the maximum specification limit of $\pm 10\mu\text{A}$ for I1H and IOZH with a reading of $11\mu\text{A}$.

At the 50 krad irradiation level, all parts exceeded the maximum specification limit for I1H and IOZH with readings in the range of $14\mu\text{A}$ to $100\mu\text{A}$. In addition SN304 exceeded the maximum specification limit of $\pm 10\mu\text{A}$ for I1L with a reading of $100\mu\text{A}$, all parts except SN303 exceeded the maximum specification limit of 2mA for ICC7 with readings in the range of 2.1mA to 3.1mA, and SN302 marginally exceeded the maximum specification limit of 1mA for ICC5 with a reading of 1.05mA.

At the 75 krad irradiation level, all parts continued to exceed the maximum specification limit for I1H, I1L and IOZH. In addition all parts exceeded the maximum specification of 75mA for ICC1 with readings in the range of 98mA to 128mA, 2mA for ICC2 with readings in the range of 12mA to 16mA, 1mA for ICC5 with readings in the range of 12mA to 16mA, 75mA for ICC6 with readings in the range of 95mA to 128mA, 2mA for ICC7 with readings in the range of 3mA to 51mA respectively. In addition S/N304 failed five functional tests, and exceeded the maximum specification limit of 75mA for ICC3 with a reading of 128mA, $\pm 10\mu\text{A}$ for IOZL with a reading of $11\mu\text{A}$.

At the 100 krad irradiation level, all parts continued to exceed the maximum specification limit for I1H, I1L, IOZH, ICC1, ICC2, ICC3, ICC5, and ICC7. In addition all parts except S/N305 exceeded the maximum specification limit of 65mA for ICC4 with readings in the range of 68mA to 116mA, and S/N303, S/N304 continued to exceed the maximum specification limit of ICC6 with a reading of 128mA. In addition S/N302 and S/N303 failed one functional test.

*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.

**These are manufacturer's pre-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

After annealing for 168 hours at 25°C, all parts continued to exceed the maximum specification limit for I1H, I1L, IOZ11, ICC1, ICC2, ICC3, ICC5, ICC6 and ICC7. All parts failed the functional tests. In addition S/N305 exceeded the maximum specification of 35nS for TAA_HL with a reading of 1mS.

After annealing for 168 hours at 100°C, no rebound effects were observed in the parts.

Table IV provides a summary of the mean and standard deviation values for each parameter after different irradiation exposures and 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.

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TABLE I. Part Information

| | |
|---|--------------------|
| Generic Part Number: | 0116400J3C |
| LANDSAT-7 Part Number: | 0116400J3C |
| LANDSAT-7 Control Number: | 13191 |
| Charge Number: | ERS2821 |
| Manufacturer: | IBM |
| Lot Date Code: | 9314 |
| Quantity Tested: | 5 |
| Serial Number of Control Samples: | 301 |
| Serial Numbers of Radiation Samples: | 302, 303, 304, 305 |
| Part Function: | DRAM |
| Part Technology: | CMOS |
| Package Style: | 24 pin SOJ |
| Test Equipment: | S-50 |
| Test Engineer: | A. Duvalsaint |

* No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

TABLE II. Radiation Schedule for 0116400J3C

| EVENTS | DATE |
|--|----------------------|
| 1) INITIAL ELECTRICAL MEASUREMENTS | 05/19/95 |
| 2) 2.5 KRAD IRRADIATION (0.125 KRADS/HOUR) POST-2.5 KRAD ELECTRICAL MEASUREMENT | 05/22/95 05/23/95 |
| 3) 5 KRAD IRRADIATION (0.125 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT | 05/23/95 05/24/95 |
| 4) 7.5 KRAD IRRADIATION (0.125 KRADS/HOUR) POST-7.5 KRAD ELECTRICAL MEASUREMENT | 05/24/95 05/25/95 |
| 5) 10 KRAD IRRADIATION (0.125 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT | 05/25/95 05/26/95 |
| 6) 15 KRAD IRRADIATION (0.20 KRADS/HOUR) POST-15 KRAD ELECTRICAL MEASUREMENT | 05/30/95 05/31/95 |
| 7) 20 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-20 KRAD ELECTRICAL MEASUREMENT | 05/31/95 06/01/95 |
| 8) 30 KRAD IRRADIATION (0.50 KRADS/HOUR) POST-30 KRAD ELECTRICAL MEASUREMENT | 06/01/95 06/02/95 |
| 9) 50 KRAD IRRADIATION (1.0 KRADS/HOUR) POST-50 KRAD ELECTRICAL MEASUREMENT | 06/02/95 06/08/95 |
| 10) 75 KRAD IRRADIATION (1.25 KRADS/HOUR) POST-75 KRAD ELECTRICAL MEASUREMENT | 06/05/95 06/06/95 |
| 11) 100 KRAD IRRADIATION (1.25 KRADS/HOUR) POST-100 KRAD ELECTRICAL MEASUREMENT | 06/06/95 06/07/95 |
| 12) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT | 06/07/95 06/15/95 |
| 13) 168-HOUR ANNEALING @100°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT | 06/15/95 06/22/95 |

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS; SEE FIGURE 1.

Table III. Electrical Characteristics of IBM0116400AJ3

| FUNCTIONAL TESTS | | | | | | | | | |
|------------------|------|------|------|-----------------|---------|------------|------------|--|--|
| PARAMETER | VCC | VIL | VIH | CONDITIONS | PINS | LIMITS 25C | | | |
| FUNCT # 1 | 5.0V | 0.0V | 5.0V | FREQ = 5.000MHZ | ALL I/O | VOL < 1.0V | VOH > 2.0V | | |
| FUNCT # 2 | 5.0V | 0.0V | 5.0V | FREQ = 5.000MHZ | ALL I/O | VOL < 1.0V | VOH > 2.0V | | |
| FUNCT # 3 | 5.0V | 0.0V | 5.0V | FREQ = 5.000MHZ | ALL I/O | VOL < 1.0V | VOH > 2.0V | | |
| FUNCT # 4 | 5.0V | 0.0V | 5.0V | FREQ = 5.000MHZ | ALL I/O | VOL < 1.0V | VOH > 2.0V | | |
| FUNCT # 5 | 5.0V | 0.0V | 5.0V | FREQ = 5.000MHZ | ALL I/O | VOL < 1.0V | VOH > 2.0V | | |
| FUNCT # 6 | 5.0V | 0.0V | 5.0V | FREQ = 5.000MHZ | ALL I/O | VOL < 1.0V | VOH > 2.0V | | |

(1) FUNCTIONAL TESTS ARE PERFORMED AT VCC = 5.0V ONLY

(2) FUNCTIONAL TESTS CONSIST OF THE FOLLOWING PATTERNS :

- 1 - SIMPLE FUNCTIONAL TEST
- 2 - ALL_ONES
- 3 - ALL_ZEROS
- 4 - CHECKERBOARD & INVERSE CHECKERBOARD
- 5 - COL ADDRESS
- 6 - SURROUND

| DC PARAMETRIC TESTS | | | | | | | | | |
|---------------------|------|------|------|--------------|---------|------------|-----------|--|--|
| PARAMETER | VCC | VIL | VIH | CONDITIONS | PINS | LIMITS 25C | | | |
| VIH_4.5V* | 4.5V | 0.0V | 0.8V | FREQ = 5MHZ | INS | > +0.0V | < +2.4V | | |
| VIH_5.5V* | 5.5V | 0.0V | 0.8V | FREQ = 5MHZ | INS | > +0.0V | < +2.4V | | |
| VIL_4.5V* | 4.5V | 2.4V | 4.5V | FREQ = 5MHZ | INS | > +0.8V | < +4.5V | | |
| VIL_5.5V* | 5.5V | 2.4V | 5.5V | FREQ = 5MHZ | INS | > +0.8V | < +5.5V | | |
| IINH | 5.5V | 0.0V | 5.5V | VIN = 5.8V | INS | > -10.0UA | < +10.0UA | | |
| IIL | 5.5V | 0.0V | 5.5V | VIN = 0.0V | INS | > -10.0UA | < +10.0UA | | |
| IOZH | 5.5V | 0.0V | 5.5V | VOUT = 5.5V | OUTS | > -10.0UA | < +10.0UA | | |
| IOZL | 5.5V | 0.0V | 5.5V | VOUT = 0.0V | OUTS | > -10.0UA | < +10.0UA | | |
| ICC1 | 5.5V | 0.0V | 5.5V | FRQ = 1/TPC | MIN VCC | > 0.0MA | < +75.0MA | | |
| ICC2 | 5.5V | 0.0V | 5.5V | STAND-BY | VCC | > 0.0MA | < +2.0MA | | |
| ICC3 | 5.5V | 0.0V | 5.5V | FRQ = 1/TPC | MIN VCC | > 0.0MA | < +75.0MA | | |
| ICC4 | 5.5V | 0.0V | 5.5V | FRQ = 1/TPC | MIN VCC | > 0.0MA | < +65.0MA | | |
| ICC5 | 5.5V | 0.0V | 5.5V | STAND-BY | VCC | > 0.0MA | < +1.0MA | | |
| ICC6 | 5.5V | 0.0V | 5.5V | FRQ = 1/TRC | MIN VCC | > 0.0MA | < +75.0MA | | |
| ICC7 | 5.5V | 0.2V | 5.5V | FRQ = 1/TRAS | MIN VCC | > 0.0MA | < +2.0MA | | |

| AC PARAMETRIC TESTS | | | | | | | | | |
|---------------------|------|------|------|-------------------------|---------|------------|--------|--|--|
| PARAMETER | VCC | VIL | VIH | CONDITIONS | OUTPINS | LIMITS 25C | | | |
| TAA_LH | 4.5V | 0.0V | 3.0V | F = 5.0MHZ, VCMP = 1.5V | OUTS | > 0NS | < 35NS | | |
| TAA_HL | 4.5V | 0.0V | 3.0V | F = 5.0MHZ, VCMP = 1.5V | OUTS | > 0NS | < 35NS | | |

* VIH_4.5V and VIH_5.5V are shown in the text and in Table IV as VIH_MIN_4.5V and VIH_MIN_5.5V, respectively, to indicate that they are a measurement of the minimum value of VIH necessary to produce the correct output. Similarly, VIL_4.5V and VIL_5.5V are shown as VIL_MAX_4.5V and VIL_MAX_5.5V, respectively, to indicate that they are a measurement of the maximum value of VIL above which the correct output is not seen.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for 0116400J3C /1

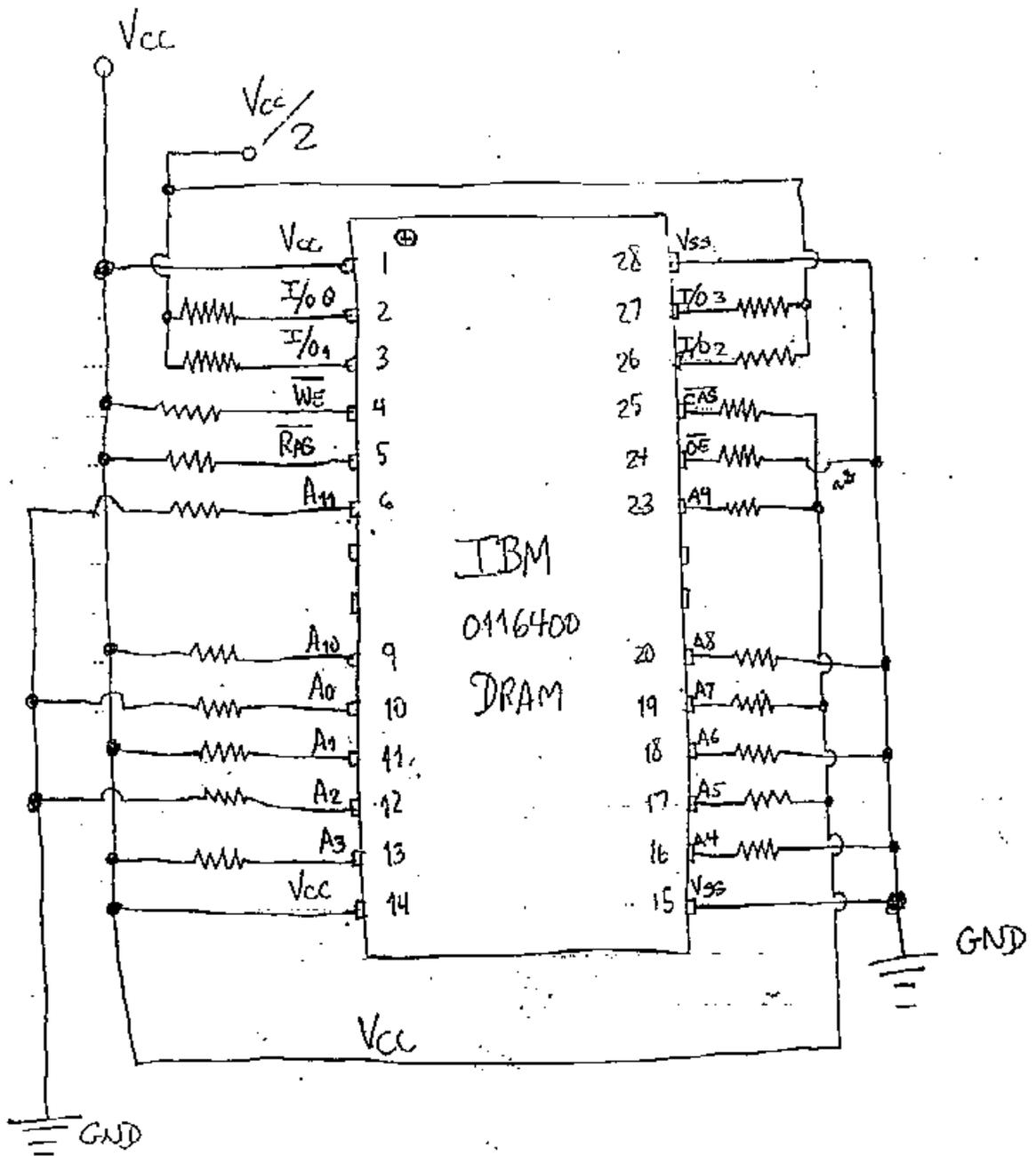
| Test # | Parameter | Units | Spec. Lim./Z | | Total Dose Exposure (krads) | | | | | | | | | | | | | | | | Annealing | | | | | | |
|--------|---------------------------------|-------|--------------|-----|-----------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-----------|-------|---------------|--------|----------------|-------|-----|
| | | | | | Initial | | 5/ 3 | | 10 | | 15 | | 20 | | 30 | | 50 | | 75 | | 100 | | 168 hrs @25°C | | 168 hrs @100°C | | |
| | | | | | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | |
| 1 | V _{IH} 4.5V | V | 0 | 2.4 | 1.70 | 0.0 | 1.73 | 0.04 | 1.70 | 0.0 | 1.73 | 0.04 | 1.73 | 0.04 | 1.70 | 0.0 | 1.75 | 0.02 | 1.81 | 0.04 | 1.77 | 0.06 | 1.50 | 1.21 | 1.77 | 0.04 | |
| 2 | V _{IH} 5.5V | V | 0 | 2.4 | 1.90 | 0.0 | 1.90 | 0.0 | 1.90 | 0.0 | 1.95 | 0.05 | 1.97 | 0.04 | 2.0 | 0.0 | 2.0 | 0.0 | 2.05 | 0.02 | 2.12 | 0.04 | 2.39 | 1.51 | 2.0 | 0.0 | |
| 3 | V _{IL} 4.5V | V | 0.5 | 4.5 | 1.25 | 0.05 | 1.25 | 0.05 | 1.21 | 0.04 | 1.25 | 0.05 | 1.23 | 0.04 | 1.10 | 0.0 | 1.10 | 0.04 | 1.07 | 0.04 | 0.97 | 0.04 | 0.24 | 0.49 | 1.15 | 0.09 | |
| 4 | V _{IL} 5.5V | V | 0.5 | 5.5 | 1.40 | 0.0 | 1.27 | 0.04 | 1.21 | 0.03 | 1.27 | 0.04 | 1.15 | 0.05 | 1.17 | 0.04 | 1.20 | 0.0 | 1.22 | 0.04 | 1.12 | 0.04 | 0.87 | 0.57 | 1.20 | 0.0 | |
| 5 | I _{IH} | uA | -10 | +10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.01 | 0.01 | 0.34 | 2.39 | 7.69 | 20.1 | 89335 | 29928 | 54044 | 13029 | 85766 | 33859 | 24998 | 43297 | |
| 6 | I _{IL} | uA | -10 | +10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3749 | 18994 | 44996 | 49744 | 48745 | 49979 | 1493 | 49932 | -0.05 | 0.26 | |
| 7 | IOZH | uA | -10 | +10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | IOZL | uA | -10 | +10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | ICC1 | mA | 0 | 75 | 46.3 | 0.38 | 50.9 | 0.65 | 36.5 | 14.8 | 51.6 | 0.79 | 82.1 | 0.72 | 59.2 | 0.47 | 59.5 | 1.40 | 106 | 12.9 | 128 | 100 | 120 | 0.75 | 62.7 | 5.39 | |
| 10 | ICC2 | mA | 0 | 2 | 0.09 | 0.0 | 0.09 | 0.0 | 0.09 | 0.0 | 0.09 | 0.0 | 0.09 | 0.0 | 0.12 | 0.01 | 0.27 | 0.26 | 15.1 | 1.49 | 16.0 | 11.0 | 15.9 | 0.0 | 4.90 | 5.35 | |
| 11 | ICC3 | mA | 0 | 75 | 34.2 | 0.43 | 31.5 | 0.59 | 34.7 | 0.35 | 35.8 | 0.46 | 36.1 | 0.56 | 38.7 | 0.56 | 45.8 | 0.66 | 16.3 | 24.1 | 121 | 6.58 | 109 | 26.8 | 43.4 | 6.43 | |
| 12 | ICC4 | mA | 0 | 65 | 3.71 | 2.82 | 7.54 | 0.22 | 4.41 | 3.43 | 4.17 | 3.21 | 11.5 | 11.8 | 9.25 | 8.73 | 9.25 | 0.73 | 34.0 | 15.9 | 79.8 | 21.9 | 41.6 | 14.8 | 13.3 | 5.15 | |
| 13 | ICC5 | mA | 0 | 1 | 0.09 | 0.0 | 0.09 | 0.0 | 0.09 | 0.0 | 0.09 | 0.0 | 0.09 | 0.0 | 0.11 | 0.0 | 0.11 | 0.0 | 15.1 | 1.54 | 16.0 | 0.0 | 15.9 | 0.0 | 4.91 | 5.34 | |
| 14 | ICC6 | mA | 0 | 75 | 46.4 | 0.61 | 51.3 | 0.86 | 36.2 | 14.9 | 51.6 | 0.60 | 81.3 | 0.58 | 53.2 | 0.65 | 53.3 | 0.65 | 187 | 12.4 | 84.5 | 43.4 | 109 | 19.2 | 59.6 | 5.56 | |
| 15 | ICC7 | mA | 0 | 2 | 0.13 | 0.02 | 1.01 | 0.91 | 0.88 | 0.78 | 0.45 | 0.62 | 0.31 | 0.75 | 0.53 | 0.64 | 0.53 | 0.58 | 25.1 | 21.0 | 71.4 | 23.1 | 43.2 | 7.88 | 4.94 | 5.34 | |
| 16 | TAA_LII | nS | 0 | 35 | 14.2 | 0.29 | 14.2 | 0.35 | 14.3 | 0.21 | 14.9 | 1.64 | 15.4 | 1.59 | 17.3 | 0.54 | 17.3 | 0.50 | 18.9 | 0.50 | 62.5 | 0.24 | 14.7 | 3.41 | 15.3 | 0.91 | |
| 17 | TAA_IL | nS | 0 | 35 | 16.3 | 0.62 | 12.6 | 3.05 | 11.8 | 3.16 | 11.7 | 3.06 | 11.5 | 3.04 | 11.7 | 3.15 | 13.2 | 3.15 | 14.0 | 2.19 | 14.1 | 2.89 | 258000 | 433010 | 12.5 | 3.29 | |
| 18 | FUNC_Vcc=5V, Vb=5V, Vb=5V, SMDZ | | | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P |
| 19 | FUNC_Vcc=5V, Vb=5V, Vb=5V, SMDZ | | | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P |
| 21 | FUNC_Vcc=5V, Vb=5V, Vb=5V, SMDZ | | | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P |
| 22 | FUNC_Vcc=5V, Vb=5V, Vb=5V, SMDZ | | | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P |
| 23 | FUNC_Vcc=5V, Vb=5V, Vb=5V, SMDZ | | | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P |
| 24 | FUNC_Vcc=5V, Vb=5V, Vb=5V, SMDZ | | | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P | | P |

Notes:

- 1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing. The control sample remained constant throughout the testing and is not included in this table.
- 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 performed.
- 3/ All parts passed all tests at 2.5 krad and 7.5 krad. Data for these radiation levels are available on request.
- 4/ In the Functional Tests, "P" means that all parts passed this test at this irradiation or annealing level, "F" means that all parts failed this test at this irradiation or annealing level and, "nPmF" means that n parts passed at this level and m parts at this level.

Radiation-sensitive parameters: I_{IH}, I_{IL}, IOZH, IOZL, ICC1, ICC2, ICC3, ICC4, ICC5, ICC6 and ICC7.

Figure 1. Radiation Bias Circuit for 011640013C



$V_{cc} = +5.0 \text{ V} \pm 0.1 \text{ V}$
 $V_{cc}/2 = +2.5 \text{ V} \pm 0.1 \text{ V}$
 $R = 2\text{K} \Omega \pm 10\%$