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To
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Department
Code 311
From
K. Sahu
Department
7813
Subject
Radiation Report on ISTEP Common
Buy Part No. HS2-3530RH-Q.

PPM-91-003
Date
January 2, 1991
Location
GSFC
Telephone
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A radiation evaluation was performed on HS2-3530RH-Q 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 50 and 100 krads. After 100 krads, parts were annealed at 25°C for 24 and 168 hours, and then the irradiation was continued up to 200 and 300 krads (cumulative). The dose rate was between 2.5-5 krads/hour, depending on the total dose level (see Table I 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.

All parts passed all tests on irradiation up to 50 krads. At 100 krads, two parts marginally exceeded the specification limits on input bias current (Ib+ and Ib-). These two parts were measuring approximately 25 nA, while the specification limit was 20 nA. However, all other parts were well within the specification limits for all tests on irradiation up to 100 krads. On annealing the parts for 24 and 168 hours, the parts showed partial recovery in Ib+ and Ib-.

On continued irradiation to 200 and 300 krads (cumulative), all parts exceeded the specification limits on Ib+, Ib-, and open loop gain (AOL). No significant degradation was observed for any other parameter. Table IV provides a summary of the electrical measurements after total dose exposures and annealing.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at 731-8661.

TABLE I. Part Information

| | |
|---|---|
| Generic Part Number: | HS2-3530RH-Q |
| ISTP Common Buy Part Number: | HS2-3530RH-Q |
| ISTP Common Buy Control Number: | 436 |
| Manufacturer: | Harris |
| Quantity Procured: | 378 |
| Lot, Date Code: | 9010 |
| Quantity Tested: | 10 |
| Serial Numbers of Radiation Samples: | 23,24,25,26,27,28,29,30 |
| Serial Numbers of Control Samples: | 21,22 |
| Part Function: | Low Power Programmable Operational Amplifier |
| Part Technology: | Bipolar, Radiation Hardened |
| Package Style: | TO-99 (radial lead - 8 pin) |

TABLE II. Radiation Schedule

| EVENTS | DOSE RATE | DATE |
|---------------------------------------|--------------|-------|
| 1) Initial Electrical Measurements | | 10/15 |
| 2) 50 krads irradiation | 2.5 krads/hr | 10/15 |
| Post 50krads Electrical Measurements | | 10/16 |
| 3) 100 krads irradiation | 2.5 krads/hr | 10/16 |
| Post 100krads Electrical Measurements | | 10/17 |
| 4) 24 hrs annealing | | |
| Post 24 hr Electrical Measurements | | 10/18 |
| 5) 168 hrs annealing | | |
| Post 168 hr Electrical Measurements | | 10/24 |
| 6) 200 krads irradiation | 5 krads/hr | 10/24 |
| Post 200krads Electrical Measurements | | 10/25 |
| 7) 300 krads irradiation | 5 krads/hr | 10/25 |
| Post 300krads Electrical Measurements | | 10/26 |

All electrical measurements performed at 25°C.
 All parts radiated under bias, see Figure 1.
 Annealing performed at 25°C under bias, see Figure 1.

TABLE III. Electrical Characteristics and Test Specifications for MS2-3530RH-Q 1), 2).

| Parameter | Symbol | BIN#1 | | BIN#3 | | Units |
|------------------------------|--------|-------|-----|-------|-----|-------|
| | | min | max | min | max | |
| Offset Voltage | VOS | | 3 | | 3 | mV |
| Input Bias Current | Ibias | | 20 | | | mV |
| Input Offset Current | IOS | | 5 | | | nA |
| Large Signal Voltage Gain | AOL | 80 | | 65 | | kV/V |
| Common Mode Rejection Ratio | CMRR | 80 | | 80 | | dB |
| Supply Current | ICC | | 150 | | 15 | uA |
| Power Supply Rejection Ratio | PSRR | 80 | | 80 | | dB |
| Output Voltage Swing | VO | ±12.5 | | ±12.5 | | V |

| Parameter | Symbol | BIN#2 | | BIN#4 | | Units |
|------------------------------|--------|-------|-----|-------|-----|-------|
| | | min | max | min | max | |
| Large Signal Voltage Gain | AOL | 25 | | 25 | | kV/V |
| Common Mode Rejection Ratio | CMRR | 80 | | 80 | | dB |
| Supply Current | ICC | | 150 | | 15 | uA |
| Power Supply Rejection Ratio | PSRR | 80 | | 80 | | dB |
| Output Voltage Swing | VO | ±2.0 | | ±2.0 | | V |
| Offset Voltage | VOS | | 3 | | 3 | mV |

Notes:

1) The following nomenclature is used for the test measurements under different conditions:

- BIN#1: $V_s = \pm 15V$, $I_{set} = 15\mu A$
- BIN#2: $V_s = \pm 3V$, $I_{set} = 15\mu A$
- BIN#3: $V_s = \pm 15V$, $I_{set} = 1.5\mu A$
- BIN#4: $V_s = \pm 3V$, $I_{set} = 1.5\mu A$

2) VO measurements at $V_s = \pm 3V$ could not be made reliably because of difficulty with test equipment. These measurements are therefore not included in Table IV.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing, for HS2-3 H-Q 1/, 2/.

BINH1, VS = ±15V, ISET = 15uA

| Parameters | | Spec. Limits | | Initials | Total Dose Exposure (krads) | | | | | | | | | | | | |
|------------|------|--------------|-----|----------|-----------------------------|-------|------|-------|-------------------|-------|----------|-------|------|-------|------|-------|-----|
| | | | | | 50 | | 100 | | Annealing at 25°C | | | | 200 | | 300 | | |
| | | | | | mean | sd | mean | sd | 24 hrs. | | 168 hrs. | | mean | sd | mean | sd | |
| ICC | uA | | 150 | 142.5 | 4.8 | 129.5 | 5.1 | 129.9 | 5.3 | 129.3 | 5.4 | 128.8 | 3.2 | 125 | 5.8 | 125.3 | 4.9 |
| -ICC | uA | -150 | | -126 | 7.6 | -116 | 6.8 | -114 | 5.2 | -115 | 6.7 | -114 | 6.5 | -113 | 5 | -109 | 6.5 |
| VOS1 | mV | | 3.0 | 0.3 | 1.2 | 0.3 | 1.1 | 0.4 | 1.1 | 0.4 | 1.1 | 0.4 | 1.1 | 0.5 | 1.1 | 0.6 | 1.1 |
| IOS | nA | | 5.0 | -0.3 | 0.5 | -0.5 | 0.9 | -0.7 | 1.2 | -0.6 | 1.2 | -0.5 | 1 | -0.8 | 1.5 | -1 | 1.8 |
| Ib+ | nA | | 20 | 9.8 | 1.7 | 13.6 | 2.8 | 19.2 | 3.6 | 18.2 | 3.4 | 17.2 | 3.1 | 32.1 | 6.5 | 39.3 | 7.6 |
| Ib- | nA | | 20 | 10.1 | 1.9 | 14.2 | 2.6 | 19.9 | 3.8 | 18.8 | 3.6 | 17.7 | 3.4 | 33 | 6.4 | 40.1 | 7.7 |
| Ibias | nA | | 20 | 9.9 | 1.8 | 13.9 | 2.6 | 19.6 | 3.6 | 18.4 | 3.4 | 17.4 | 3.2 | 32.6 | 6.4 | 39.6 | 7.5 |
| VOS2 | mV | | 3.0 | 0.3 | 1.2 | 0.3 | 1.1 | 0.2 | 1.1 | 0.4 | 1.1 | 0.4 | 1.1 | 0.5 | 1.1 | 0.6 | 1.1 |
| AOL | kV/V | 80 | | 141.6 | 9 | 110.3 | 6.7 | 94.4 | 6.6 | 97.6 | 7.1 | 101.5 | 7.3 | 75.5 | 6.7 | 64.1 | 6.1 |
| CMRR | dB | 80 | | 96.1 | 3 | 94.4 | 2.4 | 93 | 2.1 | 93.4 | 2.4 | 93.4 | 2.4 | 91.3 | 2 | 90.1 | 1.8 |
| +PSRR | dB | 80 | | 112.4 | 10.7 | 106.1 | 3.9 | 104.3 | 3.6 | 104.3 | 3.1 | 104.6 | 3.7 | 101.6 | 2.7 | 99.8 | 2.2 |
| -PSRR | dB | 80 | | 105.5 | 5.4 | 105.5 | 5.4 | 105.3 | 4.9 | 105.6 | 5.4 | 105.8 | 5.6 | 106.1 | 5.7 | 105.6 | 5.3 |
| +VO | v | 12.5 | | 14.1 | 0 | 14.1 | 0 | 14.1 | 0 | 14.1 | 0 | 14.1 | 0 | 14.1 | 0 | 14.1 | 0 |
| -VO | v | 12.5 | | -13.1 | 0.1 | -13.1 | 0 | -13.1 | 0 | -13.1 | 0 | -13.1 | 0 | -13 | 0 | -13 | 0 |

BINH2, VS = ±3V, ISET = 15uA

| Parameters | | Spec. Limits | | Initials | 50 | | 100 | | 24 hrs. | | 168 hrs. | | 200 | | 300 | | |
|------------|------|--------------|-----|----------|------|-------|------|-------|---------|-------|----------|-------|------|-------|------|-------|-----|
| | | | | | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | |
| ICC | uA | | 150 | 124.1 | 5.8 | 114.5 | 5.4 | 110.6 | 5.8 | 113.8 | 4.7 | 113.8 | 3.5 | 110.9 | 6.4 | 110.5 | 5.6 |
| -ICC | uA | -150 | | -108 | 5.1 | -97 | 4.5 | -98 | 5.6 | -99 | 5.9 | -97.3 | 6.4 | -96.8 | 4.9 | -95.3 | 5 |
| VOS1 | mV | | 3.0 | 0.3 | 1.1 | 0.2 | 1.1 | 0.3 | 1.1 | 0.3 | 1.1 | 0.2 | 1.1 | 0.4 | 1.1 | 0.4 | 1.1 |
| AOL | kV/V | 25 | | 77.1 | 5.6 | 56.8 | 3.5 | 49.1 | 3.8 | 50.9 | 2.7 | 50.1 | 2.6 | 38.6 | 2.5 | 32.9 | 3.2 |
| CMRR | dB | 80 | | 95.1 | 4.8 | 93.3 | 3.4 | 90.9 | 2.4 | 91.1 | 2.5 | 91.5 | 2.7 | 88.3 | 2 | 87.5 | 4.3 |
| +PSRR | dB | 80 | | 102.1 | 4 | 98 | 2.4 | 95.8 | 2.2 | 96.9 | 2 | 96.6 | 1.9 | 94.6 | 1.9 | 93.4 | 1.4 |
| -PSRR | dB | 80 | | 110.3 | 4.8 | 107.9 | 5.4 | 108.8 | 4.7 | 107.1 | 3.7 | 107.8 | 4 | 106.9 | 4.7 | 106.3 | 3.6 |

TABLE IV (Continued).

BIN#3, $V_S = \pm 15V$, $I_{SET} = 1.5\mu A$

| Parameters | Units | Spec. Limits | | Initials | Total Dose Exposure (krads) | | | | | | | | | | | | |
|---------------------|---------|--------------|--|----------|-----------------------------|------|------|------|-------------------|------|----------|------|------|------|------|------|-----|
| | | | | | 50 | | 100 | | Annealing at 25°C | | | | 200 | | 300 | | |
| | | | | | mean | sd | mean | sd | 24 hrs. | | 168 hrs. | | mean | sd | mean | sd | |
| ICC | μA | 15 | | 12.7 | 2.2 | 12.6 | 1.5 | 13.3 | 3.4 | 10.7 | 1.7 | 12.4 | 1.0 | 10.8 | 3.3 | 11.7 | 1.9 |
| -ICC(-) | μA | 15 | | 11.9 | 1.7 | 10.8 | 2.2 | 12.1 | 2.3 | 11.2 | 3.6 | 11.1 | 2.1 | 8.8 | 3.2 | 9.3 | 2.9 |
| VOS1 | mV | 3 | | 0.1 | 1.1 | 0.4 | 1.0 | 0.4 | 1.0 | 0.5 | 1.0 | 0.4 | 1.0 | 0.8 | 0.9 | 0.8 | 1.3 |
| IOS | pA | 5000 | | 8.2 | 67 | -32 | 128 | -67 | 215 | -52 | 205 | -40 | 171 | -125 | 315 | -99 | 520 |
| VOS2 | mV | 3000 | | 0.1 | 1.1 | 0.4 | 1.0 | 0.4 | 1.0 | 0.5 | 1.0 | 0.4 | 1.0 | 0.8 | 0.9 | 0.8 | 1.3 |
| AOL | kV/V | 65 | | 128 | 9 | 92 | 7 | 74 | 7 | 77 | 7 | 80 | 6 | 49 | 7 | 33 | 12 |
| CMRR | dB | 80 | | 95 | 3 | 93 | 2 | 91 | 2 | 91 | 2 | 91 | 2 | 89 | 2 | 97 | 2 |
| +PSRR | dB | 80 | | 109 | 5 | 104 | 4 | 103 | 4 | 103 | 4 | 103 | 3 | 100 | 3 | 96 | 3 |
| -PSRR | dB | 80 | | 104 | 5 | 103 | 5 | 105 | 4 | 104 | 5 | 102 | 4 | 104 | 5 | 105 | 4 |
| +V _O | V | 12.5 | | 14.2 | 0 | 14.2 | 0 | 14.2 | 0 | 14.2 | 0 | 14.2 | 0 | 14.2 | 0 | 14.2 | 0 |
| -V _O (-) | V | 12.5 | | 13.3 | 0 | 13.2 | 0 | 13.2 | 0 | 13.2 | 0 | 13.2 | 0 | 13.2 | 0 | 12.8 | 0.3 |

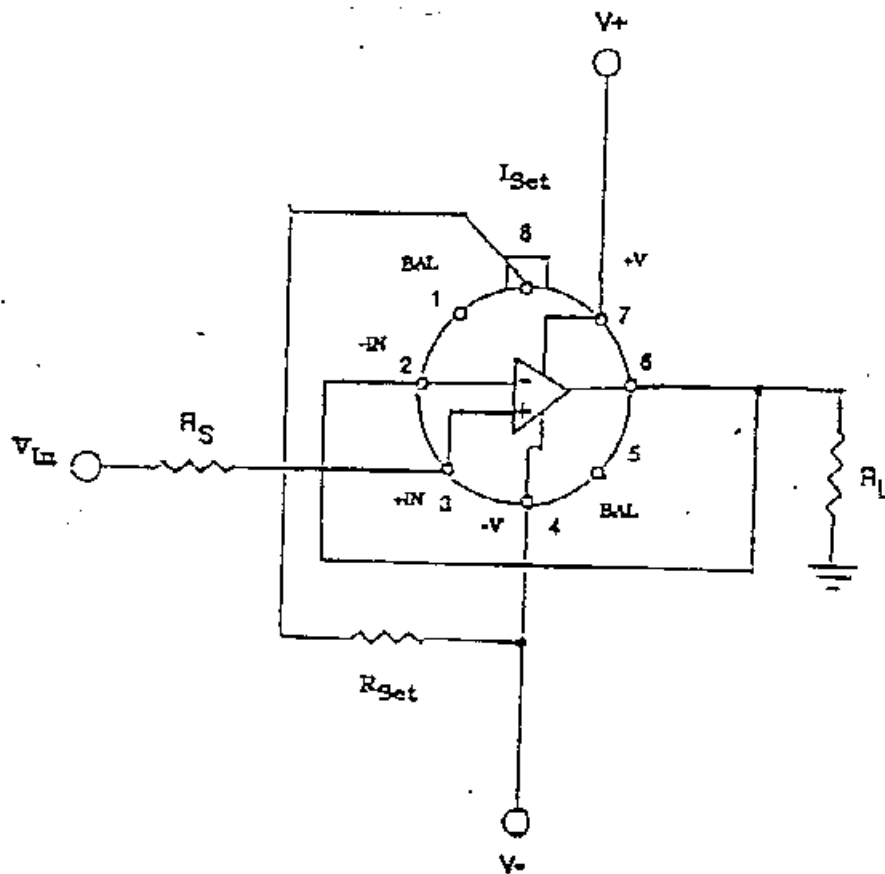
BIN#4, $V_S = \pm 3V$, $I_{SET} = 1.5\mu A$

| Parameters | Spec. Limits | | Initials | 50 | | 100 | | 24 hrs. | | 168 hrs. | | 200 | | 300 | | | |
|------------|--------------|-----|----------|------|-----|------|-----|---------|-----|----------|-----|------|-----|------|-----|------|-----|
| | min | max | | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | | |
| ICC | μA | 15 | | 10.6 | 3.7 | 11.4 | 1.8 | 11.2 | 2.2 | 10.9 | 1.9 | 9.0 | 1.9 | 10.3 | 1.8 | 10.0 | 2.0 |
| -ICC(-) | μA | 15 | | 8.4 | 3.1 | 7.2 | 7.5 | 10.3 | 1.9 | 8.0 | 2.4 | 7.8 | 1.8 | 9.8 | 2.3 | 7.5 | 2.5 |
| VOS1 | mV | 3.0 | | 0.3 | 1.0 | 0.3 | 1.0 | 0.4 | 0.9 | 0.4 | 1.0 | 0.3 | 1.0 | 0.6 | 0.9 | 9.2 | 23 |
| AOL | kV/V | 25 | | 64 | 4 | 47 | 5 | 35 | 3 | 39 | 3 | 40 | 4 | 25 | 4 | 20 | 3 |
| CMRR | dB | 80 | | 91 | 3 | 89 | 2 | 87 | 2 | 87 | 2 | 87 | 2 | 84 | 1 | 82 | 2 |
| +PSRR | dB | 80 | | 100 | 3 | 97 | 2 | 95 | 2 | 96 | 3 | 95 | 2 | 92 | 2 | 91 | 3 |
| -PSRR | dB | 80 | | 109 | 6 | 111 | 5 | 111 | 8 | 109 | 9 | 113 | 9 | 109 | 7 | 105 | 4 |

Notes:

1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

2/ V_O measurements at $V_S = \pm 3V$ could not be made reliably because of difficulty with test equipment; therefore these measurements are not included in Table IV.



Notes:

$V_{IN} = 5 \pm 0.5VDC$

V^+ shall be $15.0 \pm 0.5V$, V^- shall be $-15.0 \pm 0.5V$

R_S shall be 820 Ohm, 0.25 watt $\pm 5\%$

R_L shall be 3.3 kOhm, 0.25 watt $\pm 5\%$

R_{SET} shall be 1 MOhm, 0.25 watt $\pm 5\%$

FIGURE 1. Radiation Bias Circuit