

DATE: December 14, 1996  
 TO: J. Lohr/311.1  
 FROM: K. Sohn/300.1 *K. Sohn*  
 SUBJECT: Radiation Report on: DAC87  
           Project: ASTRO-U/XDS  
           Control #: 15405  
           Job #: EE62006

PPM-97-004

cc: A. Sharma/311  
 OFA Library/300.1

A radiation evaluation was performed on DAC87 (12-bit D/A Converter) to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Figure 1 and Tables I through IV.

The total dose testing was performed using a  $\text{Co}^{60}$  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 1, 3, 5, 10, 20, 50 and 100 krad\*. The dose rate was between 30 and 1760 rads/hour, depending on the total dose level (see Table II for radiation schedule). After the final radiation exposures, parts were annealed for 336 hours @ 25°C and for 168 hours @ 100°C. After each radiation exposure and annealing step, parts were electrically tested according to the test conditions and the specification limits\*\* listed in Table III.

All parts passed all initial electrical tests. All parts passed all electrical tests throughout all irradiation steps.

No significant degradation was observed in any parameter throughout all irradiation and annealing steps.

Table IV provides mean and standard deviation values for each parameter initially and after each irradiation exposure.

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

\* The term rads, as used in this document, means rads( $\text{SiO}_2$ ). All consecutive annealing times at the same temperature and 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.

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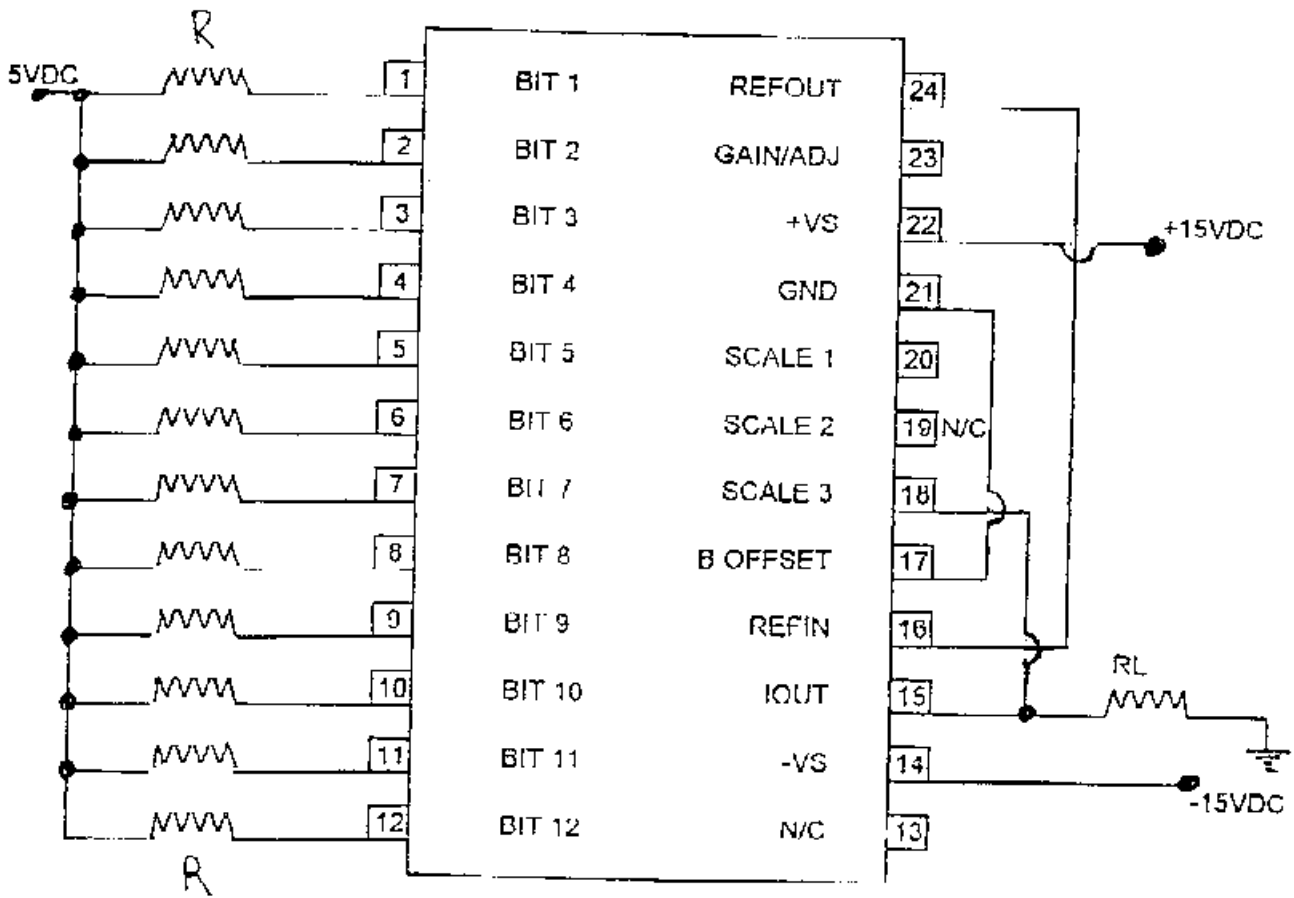
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Figure 1. Radiation Bias Circuit for DAC87

**ADDAC 87**  
**12 BIT D/A CONVERTER**  
**RADIATION BIAS CIRCUIT**



All R's are 10K ohms.  $\frac{1}{4}$ W  
 RL = 5K ohms 5%  $\frac{1}{4}$ W

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TABLE I. Part Information

|                                      |                      |
|--------------------------------------|----------------------|
| Generic Part Numbers:                | DAC87                |
| ASTRO-E/XDS Part Number              | ADDAC87D CBI-V/883   |
| ASTRO-E/XDS Control Number:          | 15405                |
| Charge Number:                       | EE62006              |
| Manufacturer:                        | Analog Devices       |
| Lot Date Code (LDC):                 | 9445L, 9432A         |
| Quantity Tested:                     | 6                    |
| Serial Number of Control Sample:     | 182                  |
| Serial Numbers of Radiation Samples: | 183, 184, 185, 186   |
| Part Function:                       | 12-bit D/A Converter |
| Part Technology:                     | Hybrid               |
| Package Style:                       | 24-pin DIP           |
| Test Equipment:                      | A540                 |
| Engineer:                            | A. Duvalsaint        |

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

TABLE II. Radiation Schedule for DAC87

| EVENT .....   | DATE     |
|---|----------|
| 1) INITIAL ELECTRICAL MEASUREMENTS.....               | 10/22/96 |
| 2) 1 KRAD IRRADIATION* (0.06 KRADS/HOUR).....         | 10/22/96 |
| POST-1 KRAD ELECTRICAL MEASUREMENT .....              | 10/23/96 |
| 3) 3 KRAD IRRADIATION (0.03 KRADS/HOUR).....          | 11/01/96 |
| POST-3 KRAD ELECTRICAL MEASUREMENT.....               | 11/04/96 |
| 4) 5 KRAD IRRADIATION (0.12 KRADS/HOUR).....          | 11/04/96 |
| POST-5 KRAD ELECTRICAL MEASUREMENT.....               | 11/05/96 |
| 5) 10 KRAD IRRADIATION (0.29 KRADS/HOUR).....         | 11/05/96 |
| POST-10 KRAD ELECTRICAL MEASUREMENT.....              | 11/06/96 |
| 6) 144-HOUR ANNEALING @25°C.....                      | 11/06/96 |
| POST-144 HOUR ANNEAL ELECTRICAL MEASUREMENT .....     | 11/12/96 |
| 7) 20 KRAD IRRADIATION (0.59 KRADS/HOUR).....         | 11/12/96 |
| POST-20 KRAD ELECTRICAL MEASUREMENT.....              | 11/13/96 |
| 8) 50 KRAD IRRADIATION (1.76 KRADS/HOUR).....         | 11/13/96 |
| POST-50 KRAD ELECTRICAL MEASUREMENT.....              | 11/14/96 |
| 9) 100 KRAD IRRADIATION (0.56 KRADS/HOUR).....        | 11/14/96 |
| POST-100 KRAD ELECTRICAL MEASUREMENT.....             | 11/18/96 |
| 10) 336 HOURS ANNEALING @25°C.....                    | 11/19/96 |
| POST 336 HOURS ANNEALING ELECTRICAL MEASUREMENT ..... | 12/03/96 |
| 11) 168 HOURS ANNEALING @100°C.....                   | 12/03/96 |
| POST 168 HOURS ANNEALING ELECTRICAL MEASUREMENT ..... | 12/10/96 |

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

Table III. Electrical Characteristics of DAC87

| <b>Unipolar +10V Mode</b>  |                             |              |                     |             |
|----------------------------|-----------------------------|--------------|---------------------|-------------|
|                            | <b>Electrical</b>           |              | <b>Spec. Lim./1</b> |             |
| <b>#</b>                   | <b>Parameters</b>           | <b>Units</b> | <b>min</b>          | <b>max</b>  |
| <b>1</b>                   | <b>I<sub>cc</sub></b>       | <b>mA</b>    | <b>-</b>            | <b>10</b>   |
| <b>2</b>                   | <b>I<sub>ee</sub></b>       | <b>mA</b>    | <b>-20</b>          | <b>-</b>    |
| <b>3</b>                   | <b>V<sub>ref</sub></b>      | <b>V</b>     | <b>6.23</b>         | <b>6.37</b> |
| <b>8</b>                   | <b>I<sub>ih</sub> B1 /2</b> | <b>μA</b>    | <b>-</b>            | <b>250</b>  |
| <b>20</b>                  | <b>I<sub>il</sub> B1 /3</b> | <b>μA</b>    | <b>-100</b>         | <b>-</b>    |
| <b>32</b>                  | <b>Lin_Error</b>            | <b>lsb</b>   | <b>-0.5</b>         | <b>0.5</b>  |
| <b>33</b>                  | <b>Dif_LinErr</b>           | <b>lsb</b>   | <b>-0.5</b>         | <b>0.75</b> |
| <b>Bipolar +/-10V Mode</b> |                             |              |                     |             |
|                            | <b>Electrical</b>           |              | <b>Spec. Lim./1</b> |             |
| <b>#</b>                   | <b>Parameters</b>           | <b>Units</b> | <b>min</b>          | <b>max</b>  |
| <b>34</b>                  | <b>Lin_Error</b>            | <b>lsb</b>   | <b>-0.5</b>         | <b>0.5</b>  |
| <b>35</b>                  | <b>Dif_LinErr</b>           | <b>lsb</b>   | <b>-0.75</b>        | <b>0.75</b> |
|                            |                             |              |                     |             |

**TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for DAC87**

| Unipolar -10V Mode |                       | Total Dose Exposure (krads) |      |      |         |     |       |     |       |     |       |     |       | Annealing |       | Total Dose Exposure (krads) |       |     |       |     |       | Annealing 4/ |       |     |       |     |       |     |                |     |
|--------------------|-----------------------|-----------------------------|------|------|---------|-----|-------|-----|-------|-----|-------|-----|-------|-----------|-------|-----------------------------|-------|-----|-------|-----|-------|--------------|-------|-----|-------|-----|-------|-----|----------------|-----|
| #                  | Electrical Parameters | Units                       | min  | max  | Initial |     |       | 1   |       |     | 3     |     |       | 5         |       |                             | 10    |     |       | 20  |       |              | 50    |     |       | 100 |       |     | 168 hrs @ 25°C |     |
|                    |                       |                             |      |      | mean    | sd  | mean  | sd  | mean  | sd  | mean  | sd  | mean  | sd        | mean  | sd                          | mean  | sd  | mean  | sd  | mean  | sd           | mean  | sd  | mean  | sd  | mean  | sd  | mean           | sd  |
| 1                  | I <sub>cc</sub>       | nA                          | -    | 10   | 5.35    | .09 | -14.1 | .29 | 5.35  | .09 | 5.35  | .09 | 5.35  | .09       | 5.35  | .09                         | 5.35  | .09 | 5.35  | .09 | 5.35  | .09          | 5.35  | .09 | 5.27  | .09 | 5.27  | .09 | 5.2            | .09 |
| 2                  | I <sub>ee</sub>       | nA                          | -20  | -    | -14.1   | .29 | -14.1 | .29 | -14.1 | .29 | -14.1 | .29 | -14.1 | .29       | -14.1 | .29                         | -14.1 | .29 | -14.1 | .29 | -14.1 | .29          | -14.1 | .29 | -13.9 | .29 | -13.9 | .29 | -13.5          | .30 |
| 3                  | V <sub>ref</sub>      | V                           | 6.23 | 6.37 | 6.299   | 0   | 6.299 | 0   | 6.299 | 0   | 6.299 | 0   | 6.299 | 0         | 6.299 | 0                           | 6.299 | 0   | 6.299 | 0   | 6.299 | 0            | 6.299 | 0   | 6.300 | 0   | 6.300 | 0   | 6.295          | .01 |
| 8                  | I <sub>ih</sub> B1/2  | µA                          | -    | 250  | 150     | 4.8 | 4.8   | 150 | 4.8   | 150 | 4.8   | 150 | 4.8   | 150       | 4.8   | 150                         | 4.8   | 150 | 4.8   | 150 | 4.8   | 150          | 4.8   | 150 | 5.2   | 150 | 5.2   | 145 | 4.5            |     |
| 20                 | I <sub>ih</sub> B1/3  | µA                          | -100 | -    | 39.4    | 1.5 | 39.4  | 1.5 | 39.4  | 1.5 | 39.4  | 1.5 | 39.4  | 1.5       | 39.4  | 1.5                         | 39.4  | 1.5 | 39.4  | 1.5 | 39.4  | 1.5          | 39.4  | 1.5 | 38.8  | 1.3 | 38.8  | 1.3 | 38.5           | 1.2 |
| 32                 | I <sub>in</sub> Error | lsb                         | -0.5 | 0.5  | 0.03    | .06 | 0.03  | .06 | 0.03  | .06 | 0.03  | .06 | 0.03  | .06       | 0.03  | .06                         | 0.03  | .06 | 0.03  | .06 | 0.03  | .06          | 0.03  | .06 | 0.05  | .05 | 0.05  | .05 | .06            | .05 |
| 33                 | Dif_LinErr            | lsb                         | -0.5 | 0.75 | -0.08   | .01 | -0.08 | .01 | -0.08 | .01 | -0.08 | .01 | -0.08 | .01       | -0.08 | .01                         | -0.08 | .01 | -0.08 | .01 | -0.08 | .01          | -0.08 | .01 | -0.08 | .01 | -0.08 | .01 | .07            | .01 |

| Bipolar -10V Mode |                       | Total Dose Exposure (krads) |       |      |         |     |       |     |       |     |       |     |       | Annealing |       | Total Dose Exposure (krads) |       |     |       |     |       | Annealing 4/ |       |     |       |     |       |     |                |     |      |     |
|-------------------|-----------------------|-----------------------------|-------|------|---------|-----|-------|-----|-------|-----|-------|-----|-------|-----------|-------|-----------------------------|-------|-----|-------|-----|-------|--------------|-------|-----|-------|-----|-------|-----|----------------|-----|------|-----|
| #                 | Electrical Parameters | Units                       | min   | max  | Initial |     |       | 1   |       |     | 3     |     |       | 5         |       |                             | 10    |     |       | 20  |       |              | 50    |     |       | 100 |       |     | 168 hrs @ 25°C |     |      |     |
|                   |                       |                             |       |      | mean    | sd  | mean  | sd  | mean  | sd  | mean  | sd  | mean  | sd        | mean  | sd                          | mean  | sd  | mean  | sd  | mean  | sd           | mean  | sd  | mean  | sd  | mean  | sd  | mean           | sd  | mean | sd  |
| 34                | I <sub>ih</sub> Error | lsb                         | -0.5  | 0.5  | 0.09    | .04 | 0.09  | .04 | 0.09  | .04 | 0.09  | .04 | 0.09  | .04       | 0.09  | .04                         | 0.09  | .04 | 0.09  | .04 | 0.09  | .04          | 0.09  | .04 | 0.09  | .02 | 0.09  | .02 | .09            | .02 |      |     |
| 35                | Dif_LinErr            | lsb                         | -0.75 | 0.75 | 0.09    | .01 | -0.09 | .01 | -0.09 | .01 | -0.09 | .01 | -0.09 | .01       | -0.09 | .01                         | -0.09 | .01 | -0.09 | .01 | -0.09 | .01          | -0.09 | .01 | -0.09 | .01 | -0.09 | .01 | -0.09          | .01 | .09  | .01 |

Notes:

- 1/ These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.
- 2/ This is a typical reading for all I<sub>ih</sub> tests throughout all irradiation and annealing steps. Detailed data for I<sub>ih</sub> B2 - I<sub>ih</sub> B12 are available on request.
- 3/ This is a typical reading for all I<sub>il</sub> tests throughout all irradiation and annealing steps. Detailed data for I<sub>il</sub> B2 - I<sub>il</sub> B12 are available on request.
- 4/ The test data for all electrical parameters after high temperature annealing was very similar to the measurements after R.T. annealing and is therefore not included in this table. This data is available on request.