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Memorandum

**PARAMAX**  
A Unisys Company

PPM-93-035

DATE: Feb. 23, 1993  
TO: B. Fafaul/311  
FROM: K. Sahu/300.1 KS  
SUBJECT: Radiation Report on FAST/MUE  
Part No. REF 05 AJ/883 C (REF 05)  
Control No. 6138

cc: R. Kolecki/740.4  
T. Miccolis/300.1  
A. Sharma/311  
Library/300.1 ✓  
L. Cusick/740.4  
SMEX, PPM File

A radiation evaluation was performed on REF 05 (Voltage Regulator) 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 5, 10, 20, 40 and 60 krads\*. After 60 krads, parts were annealed at +25°C for 168 hours. The irradiation was then continued to 100 krads (cumulative). The dose rate was between 0.08 and 2 krads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested at 25°C according to the test conditions and the specification limits\*\* listed in Table III.

All ten parts passed initial (pre-rad) electrical tests. All eight irradiated parts passed all electrical tests up to the 10-krad level.

After the 10-krad irradiation, all parts except SN 249 passed all electrical tests. SN 249 exceeded the maximum specification limit of -300 uA for Isink, with a reading of 2.908 mA. All other parts passed this test with readings ranging from -511.44 to -418.84 uA.

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\*The term rads, as used in this document, means rads(silicon).

\*\*These are manufacturers' non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

All irradiated parts passed all electrical tests at the 20- and 40-krad levels.

After the 60-krad irradiation, Seven parts (SN 242, 243, 244, 245, 246, 248 and 249) exceeded the maximum specification limit of 10m%/V for LN reg, with readings ranging from 10.55 to 11.68m%/V. One part (SN 246) also fell below the minimum specification limit of 10 mA for LD current with a reading of 5.04 mA.

After annealing for 168 hours at 25°C, all irradiated parts except SN 244 recovered to within specification limits for all test parameters. SN 244 exceeded the maximum specification limit of -300 uA for Isink, with a reading of 2.72 mA. SN 244 also exceeded the maximum specification limit of 10 %/A for LD reg, with a reading of 27.83 %/A, and exceeded the maximum specification limit of 5.015 V for Vout, with a reading of 5.026 V.

After irradiation to 100 krads (cumulative), all eight irradiated parts exceeded the maximum specification limit of 10 m%/V for LN reg, with readings ranging from 11.78 to 13.96 m%/V. One part (SN 244) also exceeded the maximum specification limit of -300 uA for Isink, with a reading of 2.95 mA.

After a final annealing for 168 hours at 100°C no rebound effects were observed.

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

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:	REF 05
Part Number:	REF 05 AJ/883C
FAST/MUE Control Number:	6138
Charge Number:	C33051
Manufacturer:	Analog Devices
Lot Date Code:	9119A, 9119, 9029
Quantity Tested:	10
Serial Numbers of Radiation Samples:	242, 243, 244, 245, 246, 247, 248, 249
Serial Numbers of Control Samples:	240, 241
Part Function:	Voltage Regulator
Part Technology:	Bipolar
Package Style:	8-lead TOx package
Test Equipment:	Auto-Bench
Test Engineer:	A. Phung

TABLE II. Radiation Schedule for REF 05

EVENTS	DATE
1) Initial Electrical Measurements	01/04/93
2) 5 KRAD IRRADIATION (0.26 krads/hour) POST-5 KRAD ELECTRICAL MEASUREMENT	01/07/93 01/08/93
3) 10 KRAD IRRADIATION (0.76 krads/hour) POST-10 KRAD ELECTRICAL MEASUREMENT	01/08/93 01/11/93
4) 20 KRAD IRRADIATION (0.53 krads/hour) POST-20 KRAD ELECTRICAL MEASUREMENT	01/11/93 01/12/93
5) 40 KRAD IRRADIATION (1.0 KRAD/HOUR) POST-40 KRAD ELECTRICAL MEASUREMENT	01/12/93 01/13/93
6) 60 KRAD IRRADIATION (1.05 KRADS/HOUR) POST-60 KRAD ELECTRICAL MEASUREMENT	01/13/93 01/14/93
7) 168 HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	01/14/93 02/21/93
8) 100 KRAD IRRADIATION (2.0 KRADS/HOUR) POST-100 KRAD ELECTRICAL MEASUREMENT	01/21/93 01/22/93
9) 168 HOUR ANNEALING @100°C* POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	01/22/93 01/29/93

ALL ELECTRICAL MEASUREMENTS WERE PERFORMED AT 25°C.

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

\*High temperature annealing is performed to accelerate long term time dependent effects (TDE), namely, the "rebound" effect due to the growth of interface states after the radiation exposure. For more information on the need to perform this test, refer to MIL-STD-883D, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of REF 05

Test	Units	Specification Limits		Conditions (Vin = 15V, except where otherwise noted.)
		Min	Max	
Vout	V	4.985	5.015	Il = 0
I <sub>sy</sub>	mA	-	1.40	No Load
V <sub>trimMeasHigh</sub> *	V	-	-	R <sub>p</sub> = 10 Kohms
V <sub>trimCalcHigh</sub> *	%	-	-3.0	"
V <sub>trimMeasLow</sub> *	V	-	-	"
V <sub>trimCalcLow</sub> *	%	3.0	-	"
I <sub>os</sub>	mA	15.0	60.0	V <sub>o</sub> = 0
I <sub>sink</sub>	uA	-	-300	Vout = 5.015 V
L <sub>d</sub> current	mA	10.0	-	Il = 0 mA to 10 mA
L <sub>d</sub> reg	%/A	-	10.0	"
LN reg	m%/V	-	10.0	Vin = 0V to 33V

\*V<sub>trimCalc</sub>(High or Low) is the actual test parameter measured, to which the specification limits apply. V<sub>trimMeas</sub>(High or Low) is the measurement made in order to make the calculation. V<sub>trimMeasHigh</sub> is made with the trim pin (#5) to high (Vin) and V<sub>trimMeasLow</sub> is made with the trim pin to ground.

$$V_{trimCalc} = [(V_{trim} - V_{out})/V_{out}] \times 100.$$

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing Steps for REF 05 1/

Parameters	Spec. Lim./2 min max	Total Dose Exposure (TDE) (krads)												Anneal		TDE		Anneal		
		0		5		10		20		40		60		168 hrs @25°C		100 krad/s		168 hrs @+100°C		
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
Vc1t	5.985	5.015	4.995	.004	4.995	.004	4.995	.003	4.999	.002	5.000	.001	5.000	.001	5.000	.008	5.002	.004		
Isy	-	1.40	1.06	.07	1.06	.07	1.06	.07	1.06	.07	1.06	.07	1.06	.07	1.06	.06	1.06	.06		
VtrimMeasHigh V	-	-	4.12	.01	4.12	.01	4.12	.01	4.12	.01	4.12	.02	4.13	.02	4.13	.01	4.13	.01		
VtrimCalcHigh %	-	-3.0	17.5	.32	17.5	.32	17.5	.32	17.5	.32	17.5	.32	17.5	.32	17.5	.32	17.5	.32		
VtrimMeasLow V	-	-	5.37	.01	5.37	.01	5.37	.01	5.37	.01	5.37	.01	5.37	.01	5.37	.02	5.38	.02		
VtrimCalcLow %	3.0	-	7.51	.18	7.51	.18	7.51	.18	7.51	.18	7.49	.17	7.48	.17	7.48	.18	7.50	.18		
IOS	5.0	60.0	20.5	.51	20.5	.51	20.5	.51	20.5	.51	20.4	.50	20.3	.49	20.3	.49	21.0	.52		
Isink/3, /4 uA	-	-300	414	20	-	456	28	506	40	505	46	513	46	505	49	511	46	485	46	
Ld current mA	10.0	-	20.9	1.1	20.1	1.4	18.2	3.9	21.1	.42	21.3	.42	18.4	5.7	21.3	.49	20.7	.76	22.5	0.6
Ld reg/3 %/A	-	10.0	5.61	1.3	-	-	7.01	.96	5.95	1.8	5.83	2.4	5.43	2.5	8.03	8.2	1.92	1.0	2.53	.82
LN reg m%/V	-	10.0	1.42	.15	2.13	0.2	3.25	.49	5.76	0.8	5.12	1.1	11.01	0.8	7.48	2.1	13.0	.76	3.70	.32

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/ These are Manufacturers' non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.
- 3/ Data for these parameters at the 5-krad level were invalid due to intermittent contact problems.
- 4/ Values for this parameter at the 10-krad level do not include SN 249, which read 2.908 mA, and at the 168-hour anneal and 100-krad irradiation level, do not include SN 244, which read 2.720 mA after the 168-hour anneal, and 2.945 mA after the 100-krad irradiation.

Radiation-sensitive parameters were: LN reg, Ld current and Isink.

Figure 1. Radiation Bias Circuit for REF 05

