Government Systems Group

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DATE: April 14, 1995 PPM-95-142
TO: J. Lohr/311
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on: MIC4429
Project: CASSINI/CIRS
Control #: 11820
Job #: EE56098
Project part #: 5962-8877002PA

cc: B. Posey/300.1
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A radiation evaluation was performed on MIC4429 (High Speed, High Current, MOSFET Driver) 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 ^{60}Co 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, 10, 15, 20, 30, 50 and 100 krads* . The dose rate was between 0.08 and 2.94 krads/hour, depending on the total dose level (see Table II for radiation schedule). After the 100 krad irradiation, the parts were annealed for 168 hours at 25°C, after which the parts were annealed for 168 hours at 100°C. After the 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 four functional tests at 50.0 kHz.

All parts passed initial electrical measurements. All irradiated parts passed all functional and parametric tests up to and including the 15 krad irradiation level.

At the 20 krad level, all irradiated parts failed Functional Test # 2, in which Vcc = 4.5 V, Vil = 0.8 V and Vih = 2.4 V. However, all parts passed Functional Test # 1, in which Vcc = 4.5 V, Vil = 0.0 V and Vih = 2.4 V. This indicates that the parts were becoming sensitive to the Vil level. Parts continued to pass both functional tests in which Vcc = 15.0 V. In addition, all irradiated parts failed the VOH45_2 test, in which Vil = 0.8 V, indicating an incorrect output state. However, the parts continued to pass VOH45_1, in which Vil = 0.0 V. At the 30 krad level, the same failures were observed.

At the 50 krad level, all irradiated parts failed Functional Tests # 2 and # 4. In both of these tests, Vil = 0.8 V. Parts continued to pass both Functional Test # 1 and # 3, in which Vil = 0.0 V. The same failures in VOH45_2 continued.

At the 100 krad level, the same failures were observed. All irradiated parts continued to pass all other functional and parametric tests.

After annealing for 168 hours at 25°C, no recovery was observed. In addition, S/N 12 and 13 failed VOH15_2, in which Vil = 0.8 V, indicating an incorrect output state. After annealing for 168 hours at 100°C, no rebound effects were observed.

Table IV provides a summary of the functional test results and the mean and standard deviation values for each parameter after the irradiation exposure and annealing.

* 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.

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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Figure 1. Radiation Bias Circuit for MIC4429

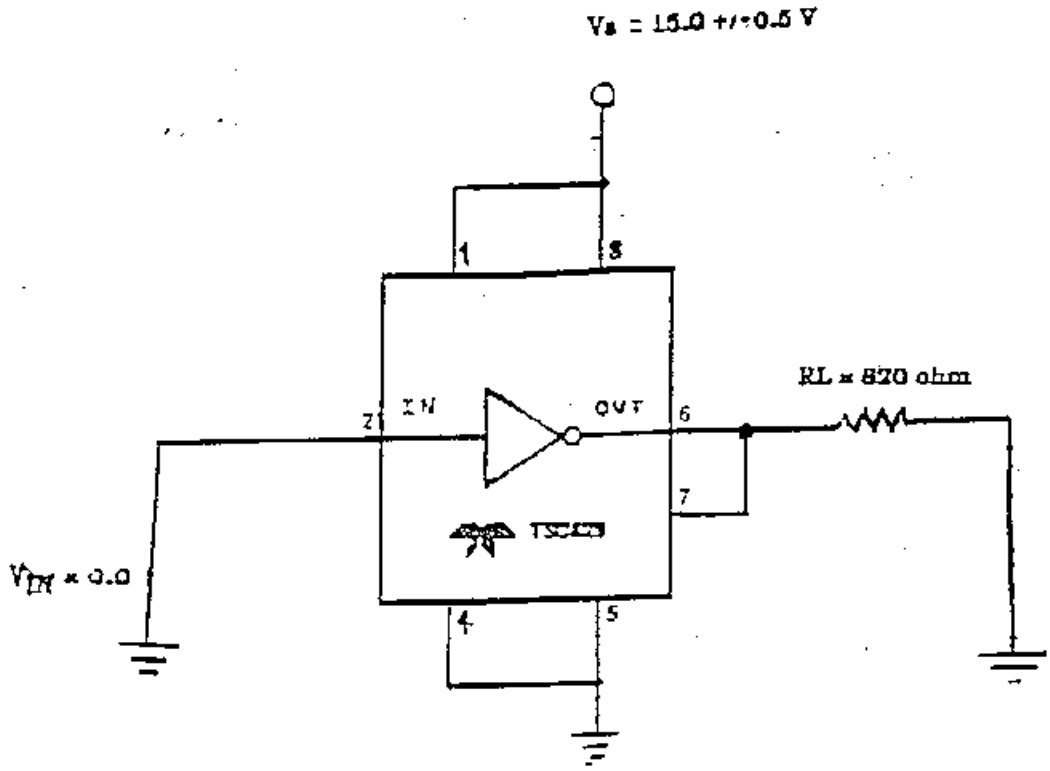

TABLE I. Part Information

Generic Part Number:	MIC4429*
CASSINI/CIRS Part Number	5962-8877002PA
CASSINI/CIRS Control Number:	11820
Charge Number:	EE56098
Manufacturer:	Micrel
Lot Date Code (LDC):	9418
Quantity Tested:	5
Serial Number of Control Samples:	11
Serial Numbers of Radiation Samples:	12, 13, 14, 15
Part Function:	High Speed, High Current MOSFET Driver
Part Technology:	MOSFET
Package Style:	8-pin DIP
Test Equipment:	S-50
Engineer:	T. Mondy

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

TABLE II. Radiation Schedule for MIC4429.

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	02/15/95
2) 2.5 KRAD IRRADIATION (0.16 KRADS/HOUR)	02/21/95
POST-2.5 KRAD ELECTRICAL MEASUREMENT	02/22/95
3) 5 KRAD IRRADIATION (0.16 KRADS/HOUR)	02/22/95
POST-5 KRAD ELECTRICAL MEASUREMENT	02/23/95
4) 10 KRAD IRRADIATION (0.33 KRADS/HOUR)	02/23/95
POST-10 KRAD ELECTRICAL MEASUREMENT	02/24/95
5) 15 KRAD IRRADIATION (0.08 KRADS/HOUR)	02/24/95
POST-15 KRAD ELECTRICAL MEASUREMENT	02/27/95
6) 20 KRAD IRRADIATION (0.33 KRADS/HOUR)	02/27/95
POST-20 KRAD ELECTRICAL MEASUREMENT	02/28/95
7) 30 KRAD IRRADIATION (0.67 KRADS/HOUR)	02/28/95
POST-30 KRAD ELECTRICAL MEASUREMENT	03/08/95
8) 50 KRAD IRRADIATION (1.00 KRAD/HOUR)	03/08/95
POST-50 KRAD ELECTRICAL MEASUREMENT	03/09/95
9) 100 KRAD IRRADIATION (2.94 KRAD/HOUR)	03/09/95
POST-100 KRAD ELECTRICAL MEASUREMENT	03/10/95
10) 168-HOUR ANNEALING @25°C	03/10/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/17/95
11) 168-HOUR ANNEALING @100°C	03/17/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/27/95

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

Table III. Electrical Characteristics of MIC4429

FUNCTIONAL TESTS

Test #	Test Conditions
FUNC1	Vcc=4.5V, Vil=0.0V, Vih=2.4V, Freq.=50.0kHz
FUNC2	Vcc=4.5V, Vil=0.8V, Vih=2.4V, Freq.=50.0kHz
FUNC3	Vcc=15 V, Vil=0.0V, Vih=5.0V, Freq.=50.0kHz
FUNC4	Vcc=15 V, Vil=0.8V, Vih=2.4V, Freq.=50.0kHz

PARAMETRIC TESTS

Test #	Parameter	Units	Test Conditions	Spec. Limits	
				Min	Max
1	IINH1	µA	Vcc=4.5V, Vin=4.5V	-10.0	10.0
2	IINH2	µA	Vcc=15V, Vin=15V	-10.0	10.0
3	IINL1	µA	Vcc=4.5V, Vin=0V	-10.0	10.0
4	IINL2	µA	Vcc=15V, Vin=0V	-10.0	10.0
5	VOH45_1	V	Vil=0.0V, Vih=4.0V, Vcc=4.5V	4.475	-
6	VOH45_2	V	Vil=0.8V, Vih=2.4V, Vcc=4.5V	4.475	-
7	VOH15_1	V	Vil=0.0V, Vih=4.0V, Vcc=15V	14.98	-
8	VOH15_2	V	Vil=0.8V, Vih=2.4V, Vcc=15V	14.98	-
9	VOL45_1	mV	Vil=0.8V, Vih=2.4V, Vcc=4.5V	-	25.00
10	VOL45_2	mV	Vil=0.0V, Vih=4.0V, Vcc=4.5V	-	25.00
11	VOL15_1	mV	Vil=0.0V, Vih=4.0V, Vcc=15V	-	25.00
12	VOL15_2	mV	Vil=0.8V, Vih=2.4V, Vcc=15V	-	25.00
13	ROUT1	Ω	Vil=0.0V, Vih=4.5V, Vcc=15V	-	2.800
14	ROUT0	Ω	Vil=0.0V, Vih=4.5V, Vcc=15V	-	2.500
15	ICC1	mA	Vcc=4.5V, Vin=3.0V	-	1.500
16	ICC0	µA	Vcc=4.5V, Vin=0.0V	-	150.0
17	TD1	ns	Vcc=15V, Cload=2500pF, Vin=0.4, 5.0V	2.000	60.00

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for MIC4429 /1

#	Functional Test /2	Initial	Total Dose Exposure (krads) 2.5	5	10	15	20	30	50	100	Annealing 168 hrs@25°C	168 hrs@100°C
1	Func1, Vcc=4.5V, Vil=0.0V, Vih=2.4V, Freq.=50.0kHz	P	P	P	P	P	P	P	F	F	F	F
2	Func2, Vcc=4.5V, Vil=0.0V, Vih=2.4V, Freq.=50.0kHz	P	P	P	P	P	F	F	F	F	F	F
3	Func3, Vcc=15V, Vil=0.0V, Vih=5.0V, Freq.=50.0kHz	P	P	P	P	P	P	P	P	P	P	P
4	Func4, Vcc=15V, Vil=0.0V, Vih=2.4V, Freq.=50.0kHz	P	P	P	P	P	P	P	F	F	F	F

#	Parameters	Units	Spec. Lim./3 min	Spec. Lim./3 max	Initial mean	Initial sd	2.5 mean	2.5 sd	5 mean	5 sd	10 mean	10 sd	15 mean	15 sd	20 mean	20 sd	30 mean	30 sd	50 mean	50 sd	100 mean	100 sd	168 hrs@25°C mean	168 hrs@25°C sd	168 hrs@100°C mean	168 hrs@100°C sd
1	IINI1	µA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	IINH2	µA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	IINL1	µA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	IINL2	µA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0	-0.01	0	-0.01	0	-0.01	0	-0.02	0	-0.01	0
5	VOH45_1 /4	V	4.475	-											4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	4.50	0
6	VOH45_2 /5	V	4.475	-	4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	F		F		F		F		F		4.50	0
7	VOH15_1 /4	V	14.98	-											15.0	0	15.0	0	15.0	0	15.0	0	15.0	0	15.0	0
8	VOH15_2 /5	V	14.98	-	15.0	0	15.0	0	15.0	0	15.0	0	15.0	0	15.0	0	15.0	0	15.0	0	15.0	0	2P2F		3P1F	
9	VOL45_1	mV	-	25.00	2.01	.09	1.98	.03	1.81	.06	1.81	.06	1.71	.05	1.79	.06	1.94	.11	1.74	.12	1.74	.12	1.89	.08	1.81	.13
10	VOL45_2 /4	mV	-	25.00											1.75	.04	2.00	0	1.70	.04	1.70	.04	1.78	.09	1.84	.10
11	VOL15_1 /4	mV	-	25.00											1.83	.10	1.99	.04	1.81	.06	1.81	.09	1.90	.15	1.89	.13
12	VOL15_2	mV	-	25.00	2.03	.08	1.99	.10	1.81	.07	1.91	.11	1.88	.12	1.88	.06	2.03	.09	1.79	.12	1.80	.10	1.93	.15	1.84	.15
13	ROUT1	Ω	-	2.800	1.48	.03	1.60	.01	1.56	.07	1.65	.12	1.65	.06	1.51	.03	1.71	.01	1.71	.13	2.00	.28	1.87	.14	1.83	.02
14	ROUT0	Ω	-	2.500	2.21	.09	2.11	.04	1.98	.05	2.06	.08	2.07	.08	1.99	.08	2.19	.02	2.15	.06	2.17	.03	2.19	.11	2.15	.11
15	ICC1	mA	-	1.500	0.37	.08	0.24	.07	0.30	.07	0.22	.10	0.14	.13	0.13	.13	0.12	.12	0.12	.11	0.59	.12	0.10	.08	0.20	.06
16	ICC0	µA	-	150.0	65.3	13	59.4	12	53.5	12	40.5	19	26.2	25	24.8	24	22.7	22	20.4	21	193	233	15.4	16	47.2	9.5
17	TD1	ns	2.000	60.00	16.9	.43	16.9	.50	16.7	.45	16.6	.46	16.6	.44	16.5	.45	14.6	.44	14.4	.43	14.5	.50	14.5	.45	15.7	.40

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/ "P" indicates that all parts passed this test at this irradiation or annealing level. "F" indicates that all parts failed this test at this irradiation or annealing level. "nPmF" indicates that n parts passed and m parts failed this test at this irradiation or annealing level.

3/ 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.

4/ These tests were added after the 20 krad irradiation and testing. The purpose of adding these tests was to determine if the parts would pass VOH tests under hard input conditions (Vil = 0.0 V, Vih = 4.0 V), since the parts had started failing VOH45_2 under soft input conditions.

5/ No valid readings could be obtained for failing parts at these irradiation or annealing levels, therefore, data are given as "nPmF", as in Note 2.

Radiation-sensitive parameters: FUNC2, FUNC4, VOH45_1, VOH15_2.