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DATE: June 22, 1992  
TO: S. Pszcolka/311 KS  
FROM: K. Sahu/7809  
SUBJECT: Radiation Report CDS/CS2 Project  
Part No. JTX2N6786 (Control No. 5109)

PPM-92-191

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A radiation evaluation was performed on the JTX2N6786 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, five 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, 15, 20, 30, 40 and 50 krads\*. After 50 krads, the parts were annealed at 25°C for 168 hours. The dose rate was between 53 and 500 rads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, the parts were electrically tested at 25°C according to the test conditions and the specification limits listed in Table III.

All parts passed all initial electrical measurements. However, the data for the Turn Off Delay Time (T<sub>doff</sub>) were very close to the maximum limit of 35 nS for each part. After 5 krads of exposure, one part failed catastrophically and was removed from further testing. The remaining four parts all marginally exceeded the specified limits for the T<sub>doff</sub> parameter with readings as high as 37.7 nS. Radiation testing continued with these four parts. The T<sub>doff</sub> parameter continued to degrade throughout the testing with the post 50 krads readings as high as 54.5 nS. Also, all parts showed significant degradation in the V<sub>gs(th)1</sub> test. Initial V<sub>gs(th)1</sub> readings averaged 3.22 V against the specification limits of 2 V minimum and 4 V maximum. After 5 krads the average decreased to 2.52 V. After 15 krads one part was marginally below the specification limit of 2 V while the other three were marginally above this limit. After 20 krads all four parts were below the specified 2 V limit (average = 1.86 V). The V<sub>gs(th)1</sub> parameter continued to degrade throughout exposure to 50 krads (average = 1.07 V). The T<sub>doff</sub> and V<sub>gs(th)1</sub> parameters showed no significant recovery after the 168 hour annealing step.

Table IV provides the mean and standard deviation values for each parameter after each radiation exposure and annealing treatment. Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

\* In this report, the term "rads" is used as an abbreviation for rads (Si).

TABLE 1. Part Information

Generic Part Number:	2N6786
CDS/CS2 Part Number:	JTX2N6786
Control Number:	5109
Charge Number:	C23796
Manufacturer:	Harris Corp.
Lot Date Code:	9202
Quantity Tested:	7
Serial Numbers of Radiation Samples:	253, 254, 255, 256, 257
Serial Number of Control Samples:	251, 252
Part Function:	N-Channel Power MOSFET
Part Technology:	N-Channel Power MOSFET
Package Style:	TO-205AF (formerly TO-39)
Test Engineer:	C. Nguyen

TABLE II. Radiation Schedule for JTX2N6786

EVENTS	DATE
1) INITIAL (PRE-IRRADIATION) ELECTRICAL MEASUREMENT	04/28/92
2) 5 KRAD IRRADIATION (53 rads/hour)* POST 5 KRAD ELECTRICAL MEASUREMENT	05/22/92 05/26/92
3) 10 KRAD IRRADIATION (250 rads/hour) POST 10 KRAD ELECTRICAL MEASUREMENT	05/26/92 05/27/92
4) 15 KRAD IRRADIATION (250 rads/hour) POST 15 KRAD ELECTRICAL MEASUREMENT	05/27/92 05/28/92
5) 20 KRAD IRRADIATION (250 rads/hour) POST 20 KRAD ELECTRICAL MEASUREMENT	05/28/92 05/29/92
6) 30 KRAD IRRADIATION (138 rads/hour) POST 30 KRAD ELECTRICAL MEASUREMENT	05/29/92 06/01/92
7) 40 KRAD IRRADIATION (500 rads/hour) POST 40 KRAD ELECTRICAL MEASUREMENT	06/01/92 06/02/92
8) 50 KRAD IRRADIATION (500 rads/hour) POST 50 KRAD ELECTRICAL MEASUREMENT	06/02/92 06/03/92
9) 168 HOURS ANNEALING AT 25°C POST 168 HOURS ELECTRICAL MEASUREMENT	06/03/92 06/10/92

\* Anomalous Event: After 5 krads of exposure, S/N 256 failed catastrophically and was removed from further testing. No failure analysis was performed to determine the cause of failure.

Notes:

- All parts were radiated under bias at the cobalt-60 gamma ray facility at GSFC.
- All electrical measurements were performed off-site at +25°C.
- All annealing steps were performed under bias.

Table III. Electrical Characteristics of JTX2N6786

$T_a = 25^\circ\text{C}$ , Unless otherwise specified.

NO.	PARAMETER	TEST CONDITION	MIN.	MAX.	UNIT	METHOD
1	$V_{BRdss}$	$I_d = 1 \text{ mA} ; V_{gs} = 0 ; \text{COND. C}$	400		V	3407
2	$V_{gs(th)1}$	$V_{ds} > V_{gs} ; I_d = 0.25 \text{ mA}$	2	4	V	3403
3	$I_{gss1}$	$V_{ds} = 0 ; V_{gs} = \pm 20 \text{ V} ; \text{COND. C}$		+/- 100	nA	3411
4	$I_{dss1}$	$V_{ds} = 320 \text{ V} ; V_{gs} = 0 ; \text{COND. C}$		25	mA	3413
5	$R_{ds(on)1}$	$V_{gs} = 10 \text{ V} ; I_d = 0.8 \text{ A} ; \text{PULSED}$		3.60	Ohms	4321
6	$V_{ds(on)}$	$V_{gs} = 10 \text{ V} ; I_d = 1.25 \text{ A} ; \text{PULSED}$		4.50	V	3405
7	$V_{sd}$	$I_s = 1.25 \text{ A} ; \text{PULSED}$	0.60	1.40	V	4011
8	$G_{fs}$	$I_d = 0.80 \text{ A} ; \text{PULSED}$	0.70	2.10	S	3475
9	$T_d(on)$	$I_d = 0.80 \text{ A} ; V_{gs} = 10 \text{ V} ; V_{dd} = 170 \text{ V}$		15	nS	3472
10	$T_r$	Gate drive impedance = 7.5 Ohm		20	nS	3472
11	$T_d(off)$	TEST #9, 10, 11, 12 ON THE BENCH		35	nS	3472
12	$T_f$	$\text{PULSED}$		20	nS	3472

**PULSED** Pulse width = 800  $\mu\text{S}$   
Duty cycle = 2 %

TABLE IV: Summary of Electrical Measurements After  
Total Dose Exposures and Annealing for JTX2N6786 1/, 2/

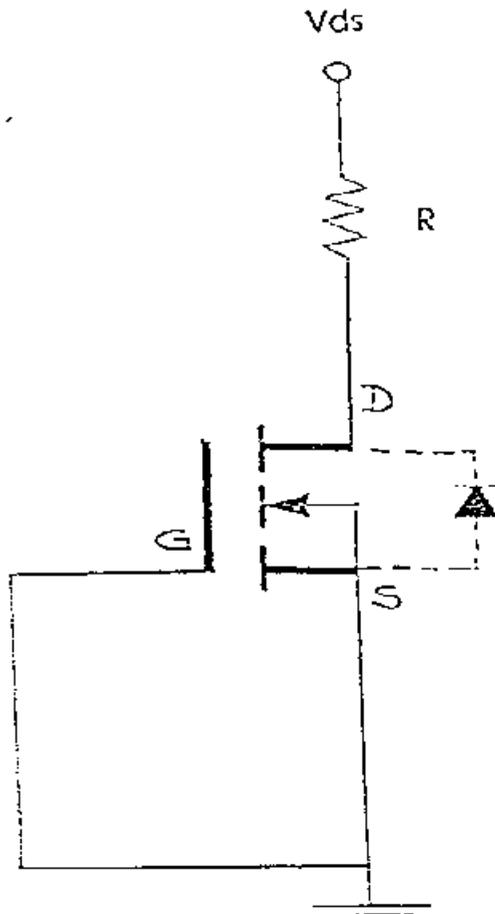
Parameters	Spec Limits @ 25°C min max	Total Dose Exposure (TDE) (krads)																		Anneal @ 25°C 168 hours	
		0 (Pre-Rad)		5		10		15		20		30		40		50		mean sd		mean sd	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
VBRdss	V	400		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass	
Vgs(th)1	V	2	4	3.22	0.06	2.52	0.06	2.28	0.06	2.06	0.06	1.86	0.05	1.50	0.05	1.26	0.05	1.07	0.04	1.08	0.04
Igssl	nA		100	0.58	0.08	0.70	0.14	0.75	0.31	0.63	0.10	0.63	0.05	0.53	0.10	0.78	0.22	0.70	0.00	0.60	0.12
Igsslr	nA		100	0.82	0.13	0.90	0.12	0.88	0.13	0.90	0.08	0.93	0.22	0.75	0.13	0.85	0.21	0.83	0.05	0.95	0.06
IGssl	uA		25	0.05	0.01	0.04	0.03	0.03	0.02	0.13	0.06	0.12	0.06	0.03	0.03	0.07	0.09	0.02	0.01	0.11	0.11
Rds(on)1	Ohms		3.6	3.00	0.10	2.97	0.04	2.99	0.06	3.00	0.08	3.08	0.06	2.99	0.05	3.05	0.06	3.00	0.04	3.02	0.04
Vds(on)	V		4.5	4.02	0.14	3.99	0.06	4.01	0.09	4.02	0.10	4.11	0.07	4.02	0.08	4.08	0.08	4.02	0.07	4.03	0.07
Vad	V	0.6	1.4	0.88	0.00	0.88	0.01	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.01	0.87	0.00	0.87	0.00
Gfs	S	0.7	2.1	1.14	0.01	1.14	0.01	1.13	0.02	0.97	0.12	0.91	0.03	0.92	0.01	1.65	1.50	0.87	0.01	0.88	0.02
Td(on)	ns		15	10.74	1.41	7.80	0.90	7.38	1.21	6.20	0.81	7.28	1.30	5.03	0.25	7.38	1.45	7.75	0.78	7.60	0.72
Tt	ns		20	13.24	1.59	12.78	2.25	12.55	2.60	13.23	1.49	12.10	2.62	14.33	0.86	10.20	1.35	9.58	1.48	9.63	1.07
Td(off)	ns		35	33.66	0.83	36.03	1.18	40.63	0.90	42.58	1.75	44.95	0.34	46.85	2.06	51.70	0.75	53.65	0.81	52.63	0.75
Tf	ns		30	14.08	1.46	13.93	2.48	14.08	1.57	13.43	2.64	12.50	0.91	14.80	3.20	11.95	0.17	13.20	1.76	13.60	1.85

1/ These statistics do not include the control samples which remained constant throughout testing.

2/ The statistics for the initial electrical measurements are computed using all five radiation samples. All other statistics are computed using serial numbers 253, 254, 255, and 257. Serial Number 256 was removed after the 5 krad step because it failed catastrophically at this point of the evaluation.

Figure 1. Radiation Bias Circuit for JTX2N6786

N - CHANNEL. POWER MOSFET



Pin 1 - Source  
 Pin 2 - Gate  
 Pin 3 - Drain

- $V_{ds}$  = <sup>50 to max  $V_{ds}$</sup>  320 V during irradiation, ~~30~~ 60 V during transport, at pin 1 - Source
- $V_{gs}$  = 0
- $R$  = 10 kohms  $\pm 5\%$  @  $\frac{1}{4}$  W
- $T_a$  = 25 °C
- $t$  = 168 Hrs for annealing