PPM-91-534

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(71)

**UNISYS**

Interoffice Memorandum

To
J. Lohr
Department
Code 311
From
K. Sahu KS
Department
7809
Subject
Radiation Report on ISTP/WAVES
Part No. FRL9130R3

PPM-91-534
Date
August 22, 1991
Location
GSFC
Telephone
731-8954
Location
Lanham
cc
R. Sharma
S. Esmacher

A radiation evaluation was performed on FRL9130 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. Parts were separated into two test groups of five parts each. In each group, four parts were irradiated and one part was used as a control sample. During the radiation testing, Test Group A (TGA) parts were irradiated without bias, while Test Group B (TGB) parts were irradiated under bias (see Figure 1 for bias configuration). The total dose radiation steps were 2.5, 5, 7.5, 10, 15, 20, 30 and 50 krads. After 50 krads, parts were annealed at 25°C for 24 and 168 hours (cumulative), and then irradiation was continued to 100, 200 and 300 krads. The dose rate was between 0.1 - 5.0 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 according to the test conditions and the specification limits listed in Table III.

All (4) parts in Test Group A and three parts in Test Group B passed all tests on irradiation up to 300 krads. However, SN 221 from Test Group B did not initially pass the AC tests (TDon, TDoff, Tr and Tf) after 7.5 krads, but passed these tests on retest, twenty minutes later. The same part was also observed to momentarily fail the AC tests after 50 krads, but again passed on retest. The control samples passed all tests at all radiation and annealing steps. Tables IVA and IVB provide the mean and standard deviation values for each parameter after different radiation exposures and annealing treatments for Test Group A and Test Group B, respectively.

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

TABLE I. Part Information

| | |
|---|---|
| Generic Part Number: | FRL9130 |
| ISTP/WAVES Part Number: | FRL9130R3 |
| ISTP/WAVES Control Number: | 4578 |
| Charge Number: | C14433 |
| Manufacturer: | Harris Corp. |
| Lot Date Code: | 9029 |
| Quantity Tested: | 10 |
| Serial Numbers of Radiation Samples: | 203, 205, 211, 212 (TGA)<br>220, 221, 222, 223 (TGB) |
| Serial Numbers of Control Samples: | 200 (TGA)<br>219 (TGB) |
| Part Function: | P-Channel Power MOSFET |
| Part Technology: | MOSFET |
| Package Style: | TO-205 |
| Test Engineer: | Anh Phung |

TABLE II. Radiation Schedule for TGA and TGB

| EVENTS | DATE |
|---|---|
| 1) Initial Electrical Measurements | 07/09/91 |
| 2) 2.5 krads irradiation @ 125 rads/hr | 07/15/91 |
| Post 2.5 krads Electrical Measurements | 07/16/91 |
| 3) 5 krads irradiation @ 125 rads/hr | 07/16/91 |
| Post 5 krads Electrical Measurements | 07/17/91 |
| 4) 7.5 krads irradiation @ 125 rads/hr | 07/17/91 |
| Post 7.5 krads Electrical Measurements | 07/18/91 |
| 5) 10 krads irradiation @ 125 rads/hr | 07/18/91 |
| Post 10 krads Electrical Measurements | 07/19/91 |
| 6) 15 krads irradiation @ 75 rads/hr | 07/19/91 |
| Post 15 krads Electrical Measurements | 07/22/91 |
| 7) 20 krads irradiation @ 250 rads/hr | 07/22/91 |
| Post 20 krads Electrical Measurements | 07/23/91 |
| 8) 30 krads irradiation @ 500 rads/hr | 07/23/91 |
| Post 30 krads Electrical Measurements | 07/24/91 |
| 9) 50 krads irradiation @ 1000 rads/hr | 07/24/91 |
| Post 50 krads Electrical Measurements | 07/25/91 |
| 10) 24 hour annealing | 07/25/91 |
| Post 24 hr Electrical Measurements | 07/26/91 |
| 11) 168 hour annealing | 07/25/91 |
| Post 168 hr Electrical Measurements | 08/01/91 |
| 12) 100 krads irradiation @ 2500 rads/hr | 08/01/91 |
| Post 100 krads Electrical Measurements | 08/02/91 |
| 13) 200 krads irradiation @ 1470 rads/hr | 08/02/91 |
| Post 200 krads Electrical Measurements | 08/05/91 |
| 14) 300 krads irradiation @ 5000 rads/hr | 08/05/91 |
| Post 300 krads Electrical Measurements | 08/06/91 |

Notes:

- All parts IN TGB were radiated under bias at the cobalt-60 gamma ray facility at GSFC.
- All electrical measurements were performed off-site at 25°C.
- Annealing of parts in TGB performed at 25°C under bias.

Table III. Electrical Characteristics of FRL9130

$T_A = 25°C$ UNLESS OTHERWISE SPECIFIED

| NO. | PARAMETER | TEST CONDITION | MIN | MAX | UNIT | METHOD |
|---|---|---|---|---|---|---|
| 1 | $BV_{DSS}$ | $V_{GS}=0$<br>$I_D=1mA$ | -100 | | V | 3407 |
| 2 | $V_{GS(th)}$ | $V_{DS}=V_{GS}$<br>$I_D=1mA$ | -2 | -4 | V | 3403 |
| 3 | $I_{GSSF}$ | $V_{GS}=-20V$ | | 100 | nA | 3411 |
| 4 | $I_{GSSR}$ | $V_{GS}=+20V$ | | 100 | nA | 3411 |
| 5 | $I_{DSS1}$ | $V_{DS}=-100V$<br>$V_{GS}=0$ | | 1 | mA | 3413 |
| 6 | $I_{DSS2}$ | $V_{DS}=-80V$<br>$V_{GS}=0$ | | 25 | μA | 3413 |
| 7 | $V_{DS(ON)}$ | $V_{GS}=-10V$<br>$I_D=5A$, PULSED* | | -2.89 | V | 3405 |
| 8 | $R_{DS(ON)}$ | $V_{GS}=-10V$<br>$I_D=3A$, PULSED* | | 0.55 | Ω | 3421 |
| 9 | $V_{SD}$ | $V_{GD}=0$<br>$I_D=5A$, PULSED* | -0.6 | -1.8 | V | 4011 |
| 10 | $t_{D(ON)}$ | $V_{DD}=-50V$, PW = 3μS, PER = 300nS<br>$I_D=5A$, $R_{GEN}=25Ω$, $0 \leq V_{GS} \leq -10V$ | | 56 | nS | 3472 |
| 11 | $t_{D(OFF)}$ | 〃 | | 126 | nS | 3472 |
| 12 | $t_r$ | 〃 | | 124 | nS | 3472 |
| 13 | $t_f$ | 〃 | | 78 | nS | 3472 |
| 1 | $I_{DSS3}$ | $V_{DS}=-80V$<br>$V_{GS}=0$, $T_A=125°C$ | | | | 3413 |

DELTA LIMITS : $\Delta I_{GSSFER} = \pm 20nA$ OR ± 100%, WHICHEVER IS GREATER.
$\Delta I_{DSS2} = \pm 15\mu A$ OR ± 100%, WHICHEVER IS GREATER.
$\Delta V_{GS(th)} = \pm 20\%$

* $t_{pulse} = 800\mu S$, DUTY CYCLE = 2% SEE ATTACHED MEMO.

TABLE IVA: Summary of Electrical Measurements
after Total Dose Exposures and Annealing for FRL9130 1/

*Group A - Parts irradiated without bias*

| Parameters | | Spec. Limits min | Spec. Limits max | Initials mean | Initials sd | Total Dose Exposure (krads) 2.5 mean | 2.5 sd | 5 mean | 5 sd | 7.5 mean | 7.5 sd | 10 mean | 10 sd | 15 mean | 15 sd | 20 mean | 20 sd | 30 mean | 30 sd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VBDSS(-) | V | 100 | - | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | |
| VGSth(-) | V | 2 | 4 | 3.4 | .03 | 3.5 | .03 | 3.5 | .02 | 3.5 | .03 | 3.5 | .02 | 3.5 | .02 | 3.5 | .03 | 3.5 | .01 |
| IGSSF | nA | - | 100 | 1.2 | .03 | 1.1 | .03 | 1.2 | .03 | 1.4 | .06 | 1.2 | .04 | 1.6 | .03 | 1.3 | .09 | 1.4 | .1 |
| IGSSR | nA | - | 100 | .4 | .07 | .1 | .04 | .2 | 0 | .4 | .04 | .4 | .06 | .2 | .03 | .3 | .06 | .3 | .06 |
| IDSS1 | mA | - | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IDSS2 | uA | - | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RDS on | mOhm | - | 550 | 249 | 1 | 252 | 4 | 248 | 2 | 247 | 2 | 243 | 3 | 264 | 3 | 258 | 6 | 258 | 1 |
| VDS on(-) | V | - | 2.89 | 2.08 | .01 | 2.11 | .07 | 2.07 | .01 | 2.09 | .01 | 2.05 | .02 | 2.09 | .02 | 2.15 | .04 | 2.18 | .02 |
| VSD (-) | V | .6 | 1.8 | 1.5 | 0 | 1.5 | .04 | 1.4 | .02 | 1.5 | .02 | 1.4 | .02 | 1.57 | .03 | 1.51 | .02 | 1.55 | .03 |
| Tdon | ns | - | 56 | 26 | 0.8 | 27 | 0.8 | 26 | 0.7 | 27 | 0.7 | 28 | 0.8 | 28 | 1 | 28 | 0 | 28 | 0 |
| Tdoff | ns | - | 126 | 19 | 1.5 | 19 | 1 | 14 | 1.1 | 16 | 0.8 | 20 | 1.5 | 17 | 1.3 | 13 | 1.3 | 13 | 1.3 |
| Tr | ns | - | 124 | 49 | 1.8 | 50 | 5.3 | 45 | 2.2 | 41 | 2.2 | 44 | 1.5 | 41 | 1 | 45 | 1 | 46 | 0.5 |
| Td | ns | - | 78 | 12 | 0.4 | 15 | 1.1 | 15 | 1.9 | 13 | 1.3 | 14 | 1.5 | 13 | 0.5 | 13 | 0.7 | 13 | 0.4 |

<Table IVA continued on next page>

TABLE IVA. (continued)

*Group A - Parts irradiated without bias*

| Parameters | | Spec. Limits min | Spec. Limits max | Initials mean | Initials sd | TDE (krads) 50 mean | TDE (krads) 50 sd | Annealing 24 hrs mean | Annealing 24 hrs sd | Annealing 168 hrs mean | Annealing 168 hrs sd | Total Dose (krads) 100 mean | Total Dose (krads) 100 sd | Total Dose (krads) 200 mean | Total Dose (krads) 200 sd | Total Dose (krads) 300 mean | Total Dose (krads) 300 sd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VBDSS(-) | V | 100 | - | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | |
| VGSth(-) | V | 2 | 4 | 3.4 | .03 | 3.5 | .01 | 3.5 | .02 | 3.5 | .01 | 3.5 | .03 | 3.6 | .03 | 3.6 | .03 |
| IGSSF | nA | - | 100 | 1.2 | .03 | 1.5 | .2 | 1.6 | .03 | 1.3 | 0 | 1.5 | .1 | 1.8 | .1 | 1.8 | .1 |
| IGSSR | nA | - | 100 | .4 | .07 | .3 | .06 | .3 | .03 | .3 | .06 | .3 | .06 | .2 | .03 | .3 | .04 |
| IDSS1 | mA | - | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .01 | 0 |
| IDSS2 | uA | - | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RDS on | mOhm | - | 550 | 249 | 1 | 258 | 4 | 250 | 4 | 253 | 2 | 250 | 5 | 250 | 2 | 245 | 3 |
| VDS on(-) | V | - | 2.89 | 2.08 | .01 | 2.13 | .03 | 2.12 | .06 | 2.15 | .01 | 2.10 | .04 | 2.08 | .02 | 2.09 | .03 |
| VSD(-) | V | .6 | 1.8 | 1.5 | 0 | 1.52 | .05 | 1.58 | .03 | 1.55 | .02 | 1.47 | .04 | 1.45 | .02 | 1.48 | .03 |
| Tdon | ns | - | 56 | 26 | 0.8 | 28 | 0.4 | 28 | 0.4 | 28 | 0 | 28 | 0 | 28 | 0 | 28 | 0 |
| Tdoff | ns | - | 126 | 19 | 1.5 | 14 | 0.9 | 14 | 1.1 | 14 | 1.3 | 13 | 1.9 | 13 | 1 | 14 | 0.7 |
| Tr | ns | - | 124 | 49 | 1.8 | 41 | 1 | 43 | 1.7 | 45 | 0.7 | 41 | 0.9 | 44 | 1.6 | 44 | 1.6 |
| Td | ns | - | 78 | 12 | 0.4 | 12 | 0.4 | 12 | 0.4 | 14 | 0.5 | 12 | 1.1 | 13 | 0.8 | 12 | 0.4 |

Note:

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.

TABLE IVB: Summary of Electrical Measurements
after Total Dose Exposures and Annealing for FRL9130 1/, 2/

*Group B - Parts irradiated under bias*

| | | Spec. Limits | | Initials | | Total Dose Exposure (krads) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2.5 | | 5 | | 7.5 | | 10 | | 15 | | 20 | | 30 | |
| Parameters | | min | max | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd |
| VBDSS(-) | V | 100 | - | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | |
| VGSth(-) | V | 2 | 4 | 3.4 | .03 | 3.4 | .03 | 3.4 | .03 | 3.4 | .03 | 3.4 | .03 | 3.4 | .03 | 3.4 | .03 | 3.5 | .03 |
| IGSSF | nA | - | 100 | 1.4 | .06 | 1.3 | .1 | 1.3 | .1 | 1.5 | .03 | 1.1 | .03 | 1.2 | .03 | 1.3 | .03 | 1.3 | .1 |
| IGSSR | nA | - | 100 | .3 | .03 | .4 | .03 | .3 | .05 | .3 | .05 | .4 | .03 | .3 | .06 | .3 | .03 | .3 | .03 |
| IDSS1 | uA | - | 1000 | .8 | .7 | 1.1 | 1.0 | 1.1 | 1.0 | 1.2 | 1.0 | 1.2 | 1.0 | 1.2 | 1.0 | 1.3 | 1.0 | 1.3 | 1.0 |
| IDSS2 | uA | - | 25 | .3 | .3 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 |
| RDS on | mOhm | - | 550 | 243 | 1 | 254 | 4 | 253 | 4 | 256 | 6 | 234 | 2 | 252 | 2 | 266 | 10 | 254 | 3 |
| VDS on(-) | V | - | 2.89 | 2.05 | .01 | 2.15 | .05 | 2.11 | .03 | 2.15 | .05 | 2.05 | .02 | 2.15 | .02 | 2.19 | .04 | 2.15 | .03 |
| VSD(-) | V | .6 | 1.8 | 1.4 | .01 | 1.5 | .04 | 1.5 | .03 | 1.55 | .06 | 1.45 | .02 | 1.50 | .03 | 1.56 | .02 | 1.51 | .03 |
| Tdon 2/ | ns | - | 56 | 26 | 0.7 | 26 | 1.2 | 27 | 0.4 | 26 | 0.9 | 27 | 0.4 | 28 | 0.4 | 28 | 0.4 | 28 | 0.4 |
| Tdoff 2/ | ns | - | 126 | 16 | 0.8 | 17 | 1 | 17 | 0.9 | 16 | 0.8 | 20 | 0 | 18 | 1.9 | 15 | 1.6 | 15 | 1.6 |
| Tr 2/ | ns | - | 124 | 50 | 9.2 | 48 | 5.6 | 44 | 0.8 | 62 | 1.4 | 46 | 3 | 40 | 0.4 | 44 | 2.4 | 43 | 2.1 |
| Td 2/ | ns | - | 78 | 12 | 2.5 | 13 | 1.9 | 13 | 2.6 | 15 | 1.6 | 14 | 0.4 | 11 | 0.8 | 13 | 0.8 | 12 | 0.4 |

<Table IVB continued on next page>

## TABLE IVB. (continued) 1/, 2/

### *Group B - Parts irradiated under bias*

| | | Spec. Limits | | Initials | | TDE (krads) | | Annealing | | | | Total Dose (krads) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 50 | | 24 hrs | | 168 hrs | | 100 | | 200 | | 300 | |
| Parameters | | min | max | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd |
| VBDSS(-) | V | 100 | - | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | | Pass | |
| VGSth(-) | V | 2 | 4 | 3.4 | .03 | 3.5 | .03 | 3.5 | .03 | 3.5 | .03 | 3.5 | .03 | 3.5 | .03 | 3.6 | .03 |
| IGSSF | nA | - | 100 | 1.4 | .06 | 1.5 | .2 | 1.3 | .1 | 1.3 | .1 | 2.2 | .4 | 2.7 | .2 | 3.2 | .03 |
| IGSSR | nA | - | 100 | .3 | .03 | .3 | .05 | .3 | .05 | .3 | .05 | .2 | .03 | .3 | .03 | .2 | .03 |
| IDSS1 | uA | - | 1000 | .8 | .7 | 1.3 | 1.0 | 1.3 | 1.0 | 1.2 | 1.0 | 1.3 | 1.0 | 1.3 | 1.0 | 1.2 | 1.0 |
| IDSS2 | uA | - | 25 | .3 | .3 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 |
| RDS on | mOhm | - | 550 | 243 | 1 | 257 | 7 | 253 | 1 | 263 | 4 | 250 | 2 | 260 | 2 | 252 | 1 |
| VDS on(-) | V | - | 2.89 | 2.05 | .01 | 2.15 | .05 | 2.13 | .01 | 2.27 | .05 | 2.09 | .03 | 2.18 | .03 | 2.14 | .02 |
| VSD(-) | V | .5 | 1.8 | 1.4 | .01 | 1.55 | .04 | 1.53 | .01 | 1.62 | .04 | 1.48 | .02 | 1.53 | .03 | 1.49 | .02 |
| Tdon 2/ | ns | - | 56 | 26 | 0.7 | 28 | 0.5 | 27 | 0.4 | 28 | 0.5 | 28 | 0 | 28 | 0.5 | 28 | 0.4 |
| Tdoff 2/ | ns | - | 126 | 16 | 0.8 | 13 | 1.3 | 16 | 1.8 | 15 | 1.1 | 14 | 0.8 | 15 | 0.5 | 14 | 0.9 |
| Tr 2/ | ns | - | 124 | 50 | 9.2 | 41 | 1 | 41 | 1 | 44 | 2.3 | 41 | 2.2 | 41 | 1 | 44 | 1.3 |
| Td 2/ | ns | - | 78 | 12 | 2.5 | 13 | 0.5 | 12 | 0 | 14 | 0.5 | 12 | 1 | 13 | 0.5 | 13 | 0 |

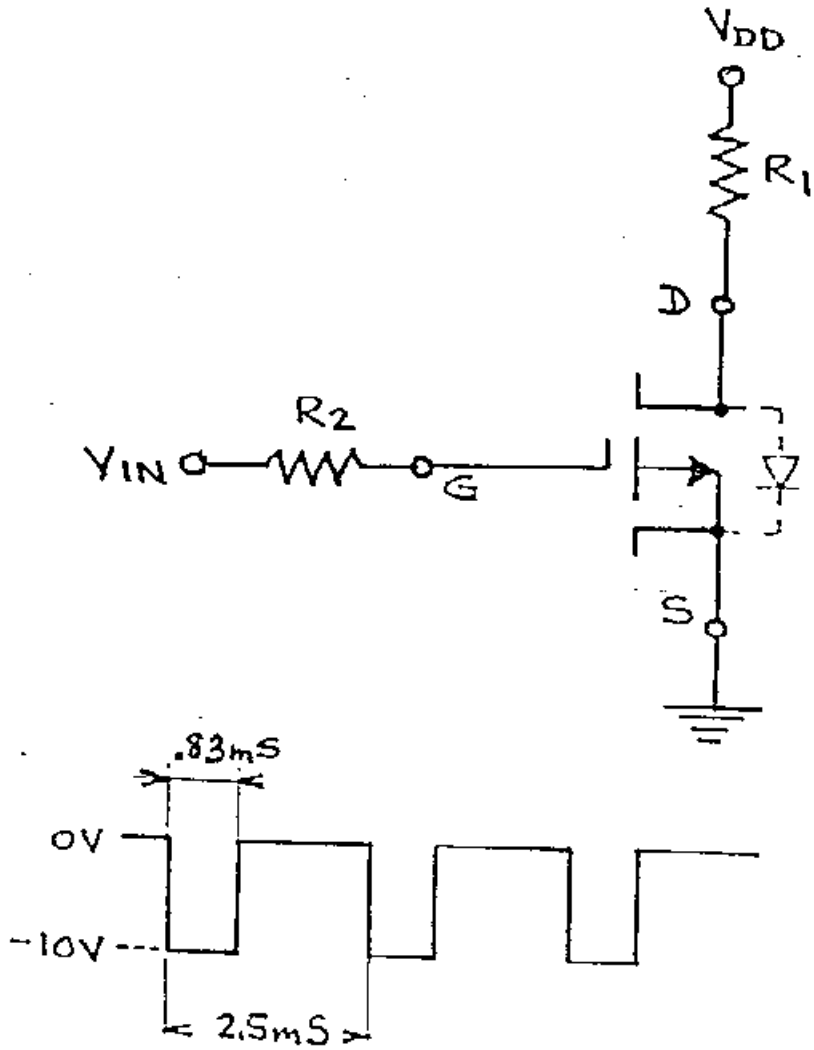
Notes:

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/ SN 221 did not initially pass the AC timing measurements (Tdon, Tdoff, Tr and Tf) after 7.5 krads, but passed twenty minutes later on retest. Also, SN 221 momentarily failed these tests after 50 krads, but again passed on retest. The values in Table IVB for these AC parameters after 7.5 and 50 krads reflect the passing, retested measurements.

Figure 1. Radiation Bias Circuit for FRL9130

(Test Group B only)




$V_{IN}$ = -10V @ f = 400Hz ⇒ T = 2.5mS

$V_{DD}$ = -28 ± .5V

$R_1$ = 1KΩ ±5%, 1W

$R_2$ = 10KΩ ±5%, ¼W

FIG. 1