

ESA-QCA0039T-C

CL-HMS-TR-0449*
FILE: 20326

TOTAL DOSE STEADY-STATE IRRADIATION
OF
2N6764 (IRF150) (DC 9803)
N-channel enhancement power Mosfet
from
INTERNATIONAL RECTIFIER

Ford

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CLUSTER II		9 SEP 1998			FILE 221
					CHRONO 2861
JP	CE	MS	ESOC		

Written by	Verified by	Approved by
Name: Ph. DOS SANTOS	Name: B. DOUCIN	Name: Th CARRIERE
Date: 26-06-98	Date: 30-06-98	Date: 30-06-98
Visa: <i>[Signature]</i>	Visa: <i>[Signature]</i>	Visa: <i>[Signature]</i>

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ANNEX.- Plot and values of tested parameters versus total dose and annealings	
Characteristic Log Id =f(Vgs) for Sn 4.	

I. DOCUMENTATION

I.1 APPLICABLE DOCUMENTS:

PRO2. 001 MATRA Procedure for Total Dose Steady-State
Irradiation on Active Devices.

I.2 REFERENCE DOCUMENTS:

MIL STD 883.D, Method 1019-4..... Steady State Irradiation Procedure
ESA/SCC 22900-3 ESA Basic Specification For Total Dose Steady-
State Irradiation
DOF/DEC/TP7.466 Test Plan (modification by Cluster Project People).

II. TEST PLAN

II.1 PARTS REFERENCES

REFERENCES	
TYPE	: 2N6764 (IRF150)
MANUFACTURER	: INTERNATIONAL RECTIFIER
PLACE	: USA
FUNCTION	
N-Channel Enhancement Power Mosfet Transistor	
TECHNOLOGY	
HEXFET III	
PARTS PROCUREMENT	
ORIGIN	: MMS UK (Cluster Project)
PACKAGING	: TO3
DATE CODE	: 9803
WAFER LOT NUMBER	: DC11559/1
NUMBER OF PARTS	: 6 (5 irradiated + 1 ref)
DETAIL SPECIFICATION	
DOF/DEC/RP 8.236 (modified by Cluster Project People)	

MATRA MARCONI SPACE	Groupe Expertise Radiations	Ref : DASTDTR\RP8.236 Issue : 00 Date : 26/06/98 Page : 5 / 12
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II.2 ELECTRICAL MEASUREMENTS

TEST TYPE						
TYPE	:	Remote electrical measurements done at room temperature				
TEST FACILITY						
PLACE	:	MATRA VELIZY				
MATERIAL	:	HP4155A AND CURVE TRACER TEKTRONIX 370A				
CALIBRATION DATE	:	04/98 and 02/98				
TESTED PARAMETERS						
Parameter Name	Fig n°	Symbol	Test Conditions	Min	Max	Unit
Gate Threshold Voltage	1	VGS(th)**	Vds>=Vgs; Id=250 µA	2	4	V
Drain Current	2	Idss**	Vds=80 V; Vgs=0 V	-	25	µA
Drain-Source ON Resistance	3	Rds(On)	Vgs=10 V; Id=24 A * Pw=300 µs, dc<=2 %	-	0.055	ohms
Forward Transconductance	4	Gfs	Vds>=15 V; Id=24 A * Pw=300 µs, dc<=2 %	9	-	S

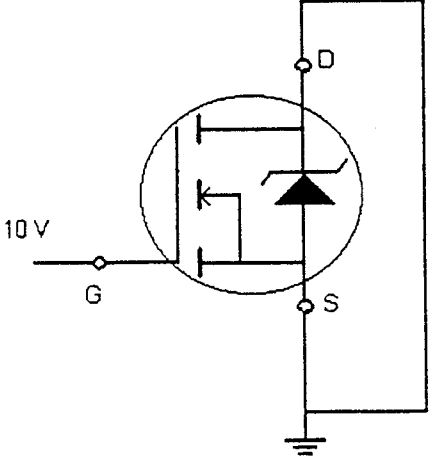
* Due to tester limitation, Rds(on) and Gfs have been tested at 20A instead of 24A.

** In accordance with a fax from Cluster Project People (date : 29 April 98), a modification of the test plan have been performed.

Notes:

- All electrical measurements were made within one hour of termination of the irradiation step.
- Figure numbers refer to the figures showing variation and values of each parameter with total dose and annealings at the end of this document.

II.3 EXPERIMENTAL CONDITIONS

IRRADIATION FACILITY	
PLACE	: MATRA VELIZY (France)
TYPE	: COBALTD 60 MODEL SHEPHERD 484
ACTIVITY	: < 9Curies
CALIBRATION DATE	: January 98.
IRRADIATION FACILITY	
TYPE	: Multiple Exposure
STEPS	: 0, 4.3, 10.5, 25.1, 29, 40.3, 50.6 kRad (Si), 25°C and 100°C Annealing.
BIASING CONDITIONS	
	
FIG. 1	
COMMENTS	
4 parts were biased in static on mode (see fig. 1), 1 part was biased in static off mode with all pins connected to ground.	

III TEST REPORT

III.1 EXPERIMENTAL CONDITIONS

PARTS IDENTIFICATION			
MANUFACTURER MARKING		IR 5205/013-01B 94-5945 Δ 9803	
SAMPLES DESCRIPTION			
SN Manuf.	SN Irrad.	Biassing Mode	Comments
146	0	REF	
147	1	ON	
148	2	ON	
149	3	ON	
246	4	ON	
247	5	OFF	

IRRADIATION SCHEDULE						
Step N°	Date In / Out	Description	DOSE RATE [kRad(Si) / H]	IRRAD. TIME [H]	DOSE [kRad(Si)]	TOTAL DOSE [kRad(Si)]
1	04-05-98	Initial Measurements	0	0	0,00	0,0
2	04-05-98 05-05-98	Irradiation & Measurements	0,15	28,73	4,31	4,3
3	05-05-98 07-05-98	Irradiation & Measurements	0,15	41,15	6,17	10,5
4	07-05-98 11-05-98	Irradiation & Measurements	0,15	97,1	14,57	25,1
5	11-05-98 12-05-98	Irradiation & Measurements	0,158	24,8	3,92	29,0
6	12-05-98 15-05-98	Irradiation & Measurements	0,158	71,48	11,29	40,3
7	15-05-98 18-05-98	Irradiation & Measurements	0,158	65,20	10,30	50,6
8	18-05-98 19-05-98	Annealing Amb.		23,33		
9	19-05-98 26-05-98	Annealing 100°C		167		

III.2 EXPERIMENTAL RESULTS

III.2.1. Parametric tests:

The evolution of each parameter as a function of the total dose and annealings is plotted at the end of the report.

The following tables summarize the evolution of the measured parameters with irradiation and annealings (See next page) for each biasing conditions

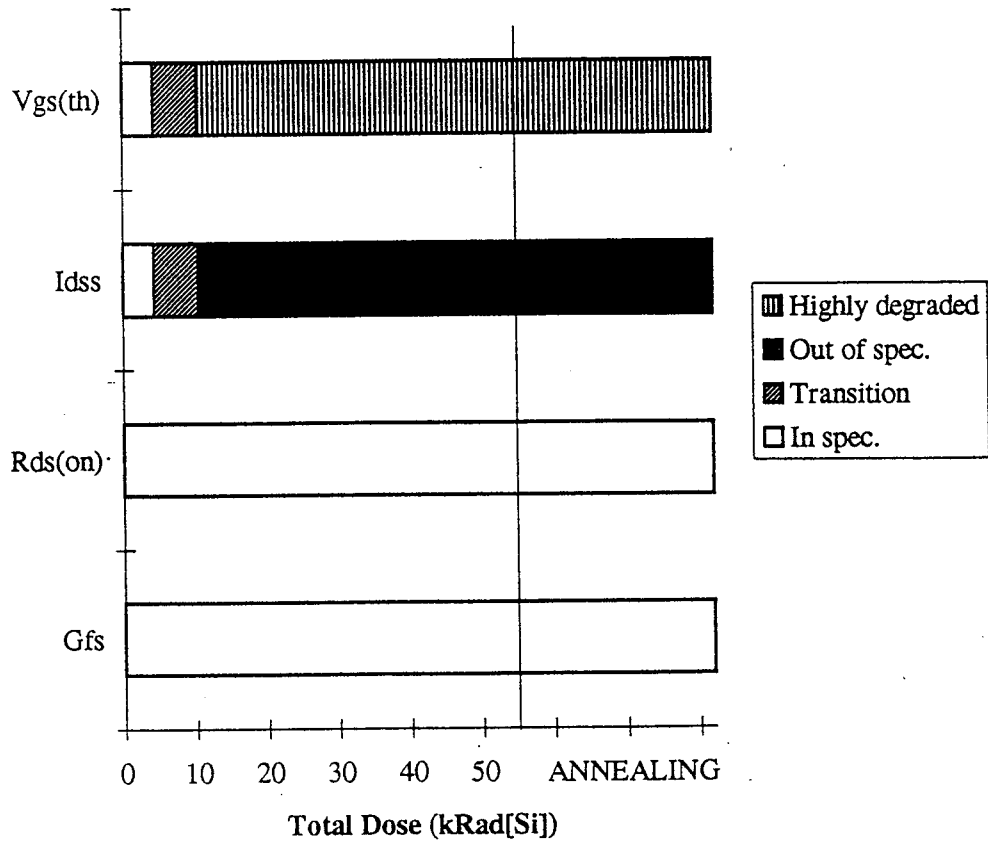
In the construction of these charts ,

1/ A parameter is considered to be out of specification if the parameter is measured out of specification on one or more devices.

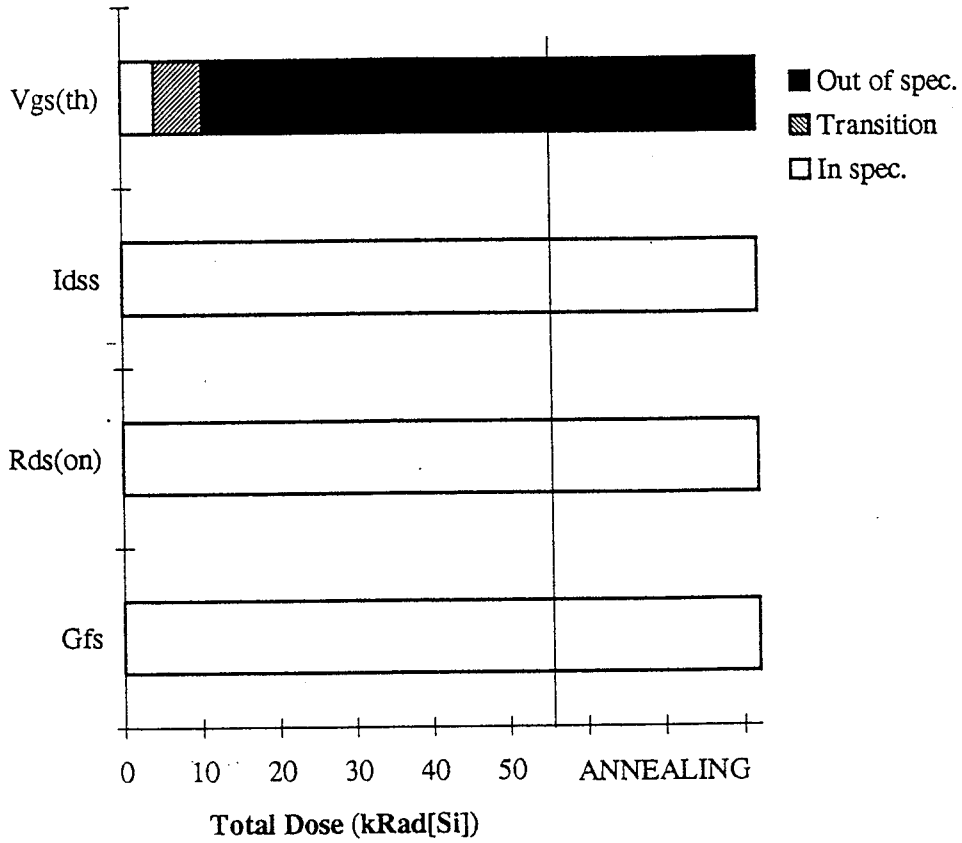
2/ A parameter is considered to be in specification only up to the last step for which all irradiated devices remain inside the parameter specification.

3/ The step during which a parameter goes out of specification (or recovers) is called transition step.

Static On Mode



Static Off Mode



III.2.2. Post irradiation effects.

Step 1.

Temperature : Room Temperature.
Duration : 23,33
Biasing : Parts biased as during irradiation.

Step 2.

Temperature : 100°C.
Duration : 167
Biasing : Parts biased as during irradiation.

Two parts did not recover after annealing, this observation indicates that degradation at a lower dose rate will be the same.

III.2.3 Problems encountered / Discussion

Evolution during irradiation of I_d versus V_{gs} is given in annex for part 4, biased in static On mode. This characterization performed on a HP4155A permits to observe the activation of parasitic MOS transistors. As dose increases, the main parasitic transistor exhibits a strong increase of leakage current, whatever V_{gs} . This phenomenon is related to charge trapping in the thick isolation oxides, allowing a current track around the gate. Therefore, $V_{gs(th)}$ measurement performed at 10.5 kRad is not representative of the real commutation level of the transistor which is lower than the measurement performed.

IV. CONCLUSION

Total dose steady-state irradiation test using gamma rays from Cobalt 60 has been carried out on 6 (5 irradiated + 1 ref) parts (4 parts biased in Static On mode and 1 Off) N-channel enhancement power Mosfet Transistor 2N6764 (IRF150) (9803) from INTERNATIONAL RECTIFIER up to 50.6 kRad at low dose rate (≤ 360 Rad/h).

The following conclusions refers to the specification defined by MMS-uk Cluster Project which is not compliant to the detail spec. SCC5205-013-01B

The results indicate that :

- All the parameters stay within specification up to 4kRad ($V_{gs(th)}$ out of spec. at 4kRad by interpolation) for parts biased in On mode.

The following table shows the tolerance in kRad of parameters affected by irradiation (by interpolation from the figures) :

Parameter	Tolerance	
	Static On	Static Off
$V_{gs(th)}$	4 kRad	9 kRad
I_{dss}	7.5 kRad	> 50.6 kRad

- Biasing mode effect : Parts biased in Static On Mode degrades more than part biased in Static Off mode.
- Annealing effect : An annealing effect has been observed on some parts, but two parts Sn1 and Sn4 did not recover after the 100°C annealing and present the same degradation at 50.6 kRad after 167h at 100°C.
- Degradation and recovery observed on the parts of this test indicates that this lot is not homogeneous.
- No other date code of IRF150 have been previously tested by MMS.

Date : MAY 98

Device Type :

2N6764 (IRF150)

Figure 1

Component Date Code : 9803

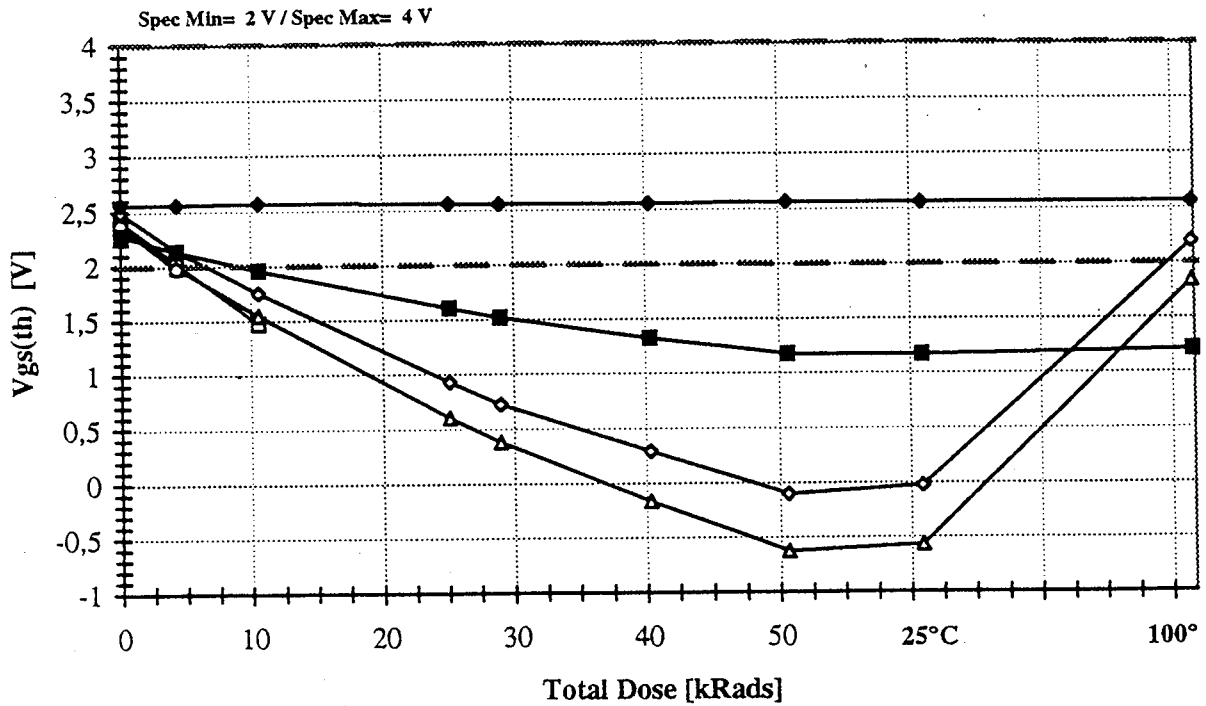
Manufacturer : INTERNATIONAL RECTIFIER

Irradiation Dose Rate : ≤ 0.36 kRad / h

Conditions : OFF / ON / REF

Test Parameter : $V_{gs(th)}$

Conditions : $V_{ds} \geq V_{gs}$; $I_d = 250 \mu A$



Comments : The last step correspond to the post annealing measurements

Total Dose [kRad(SI)]		0	4,3	10,5	25,1	29	40,3	50,6	25°C	100°C	
5	OFF	—■—	2,28	2,132697	1,959365	1,605345	1,519595	1,323811	1,177935	1,17395	1,214995
1	ON	—□—	2,41	2,020772	1,472242						
2	ON	—◇—	2,49	2,140728	1,749496	0,9321368	0,7263053	0,2910276	-0,1025315	-0,02515548	2,190199
3	ON	—△—	2,38	1,989946	1,547268	0,6040882	0,3799646	-0,1648536	-0,6252485	-0,5630146	1,842527
4	ON	—○—	2,37	1,967783							
Avg	REF	—◆—	2,56	2,558435	2,5658285	2,5563185	2,553335	2,551996	2,5611405	2,556787	2,558675

Date : MAY 98

Device Type :

2N6764 (IRF150)

Figure 2

Component

Date Code : 9803

Manufacturer : INTERNATIONAL RECTIFIER

Irradiation

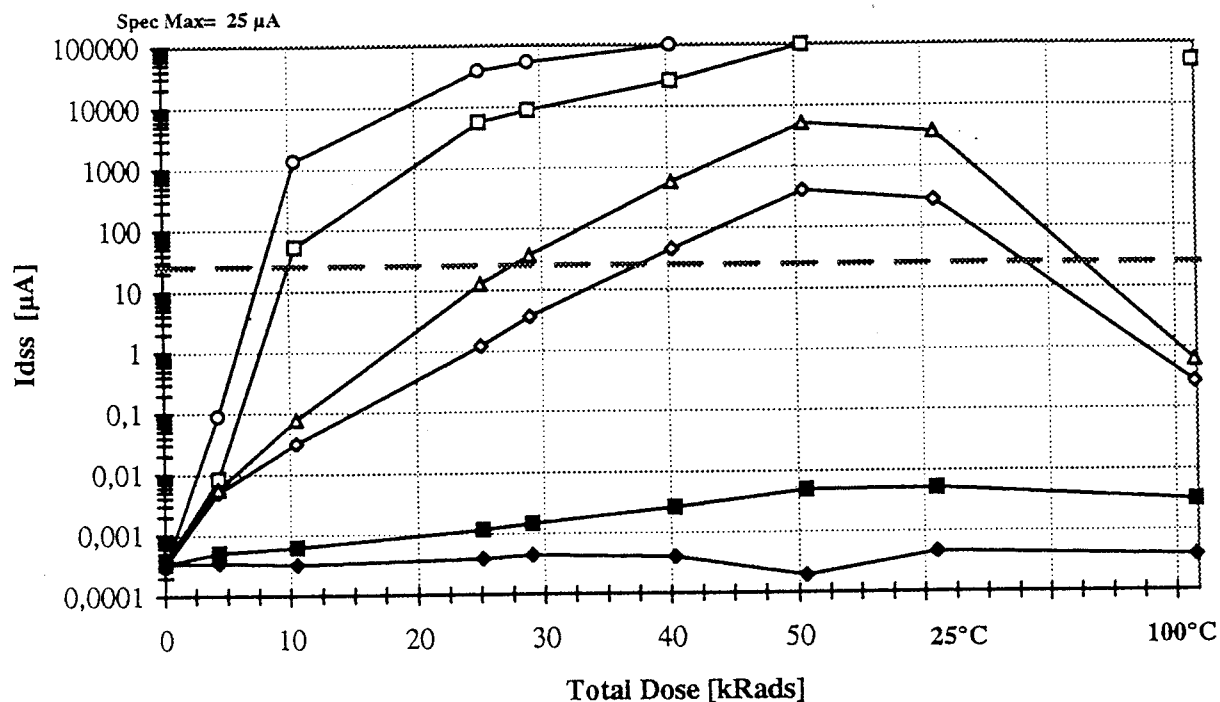
Dose Rate : <= 0.36 kRad / h

Conditions : OFF / ON / REF

Test

Parameter : Idss

Conditions : Vds=80V, Vgs=0V.



Comments : The last step correspond to the post annealing measurements

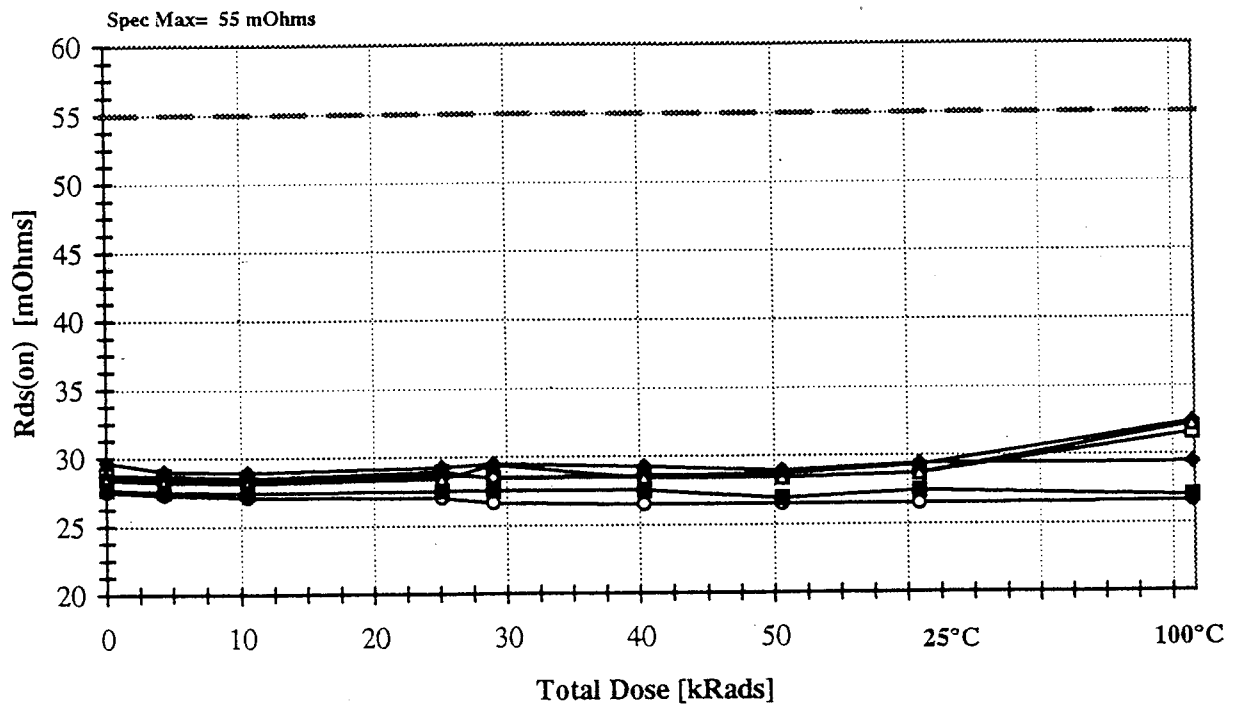
Total Dose [kRad(SI)]		0	4,3	10,5	25,1	29	40,3	50,6	25°C	100°C	
5	OFF	—■—	0,000337	0,000516	0,00062431	0,0011648	0,0014637	0,0025881	0,004888	0,0051774	0,0031851
1	ON	—□—	0,000342	0,008429	53,268	5625,9	8764	26158	99996		51464
2	ON	—◇—	0,000325	0,0049632	0,031881	1,2349	3,6967	45,426	407,97	279,19	0,27262
3	ON	—△—	0,000337	0,0056307	0,079106	12,569	37,087	572,2	5147,2	3688,7	0,614
4	ON	—○—	0,0003	0,088838	1355,3	38276	53745	99999			
Avg	REF	—◆—	0,000337	0,0003483	0,00031967	0,0003923	0,00043654	0,00040085	0,000194	0,0004578	0,00039227

Date : MAY 98 Device Type : **2N6764 (IRF150)** Figure 3

Component Date Code : 9803 Manufacturer : INTERNATIONAL RECTIFIER

Irradiation Dose Rate : <= 0.36 kRad / h Conditions : OFF / ON / REF

Test Parameter : **Rds(on)** Conditions : Vgs=10 V; Id=24 A *Pw=300 μs, dc<=2 %



Comments : *The last step correspond to the post annealing measurements*

Total Dose [kRad(SI)]		0	4,3	10,5	25,1	29	40,3	50,6	25°C	100°C
5	OFF	27,7	27,5	27,4	27,5	27,5	27,5	26,9	27,4	27
1	ON	28,8	28,7	28,5	28,9	28,4	28,5	28,4	28,7	31,6
2	ON	28,6	28,4	28,3	28,7	28,5	28,6	28,7	29,3	32,4
3	ON	28,4	28,2	28,1	28,4	29,4	28,4	28,4	28,7	32,2
4	ON	27,5	27,3	27,1	27	26,6	26,5	26,5	26,5	26,6
Avg	REF	29,65	29	28,9	29,25	29,5	29,25	28,9	29,4	29,45

Date : MAY 98

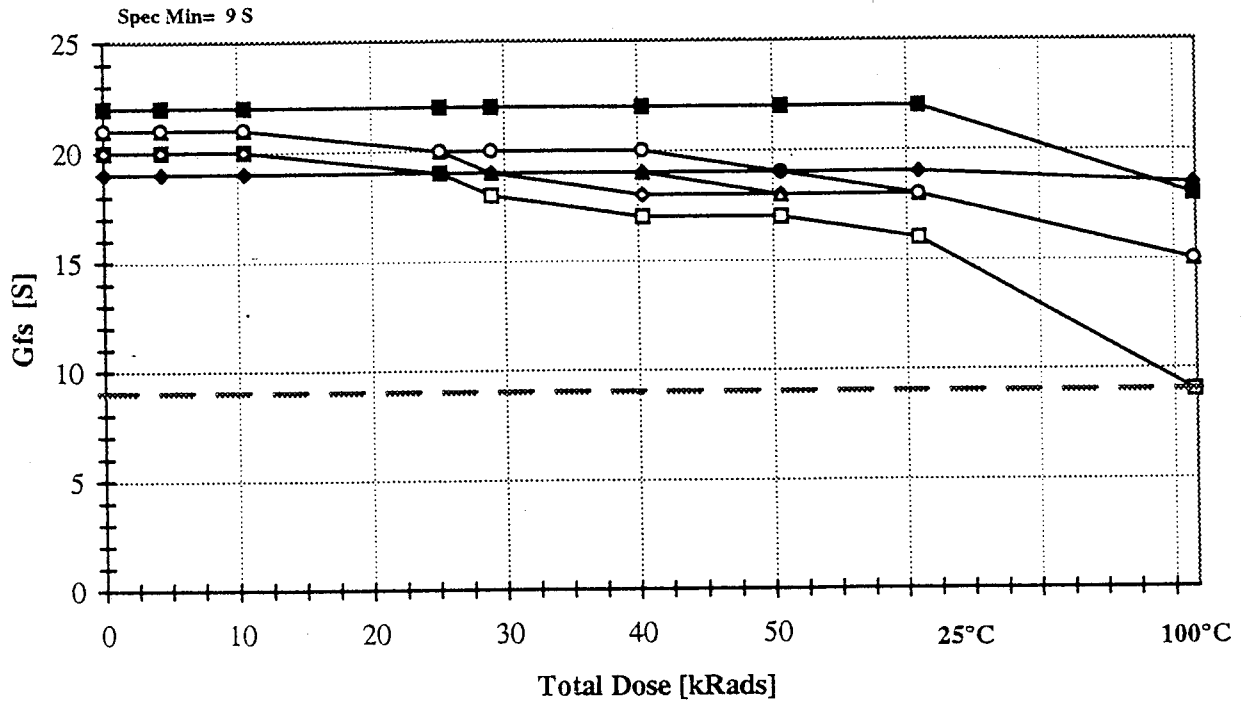
Device Type : **2N6764 (IRF150)**

Figure 4

Component Date Code : 9803 Manufacturer : INTERNATIONAL RECTIFIER

Irradiation Dose Rate : <= 0.36 kRad / h Conditions : OFF / ON / REF

Test Parameter : Gfs Conditions : Vds>=15 V; Id=24 A *Pw=300 μs, dc<=2 %



Comments : The last step correspond to the post annealing measurements

Total Dose [kRad(Si)]			0	4,3	10,5	25,1	29	40,3	50,6	25°C	100°C
5	OFF	■	22	22	22	22	22	22	22	22	18
1	ON	□	20	20	20	19	18	17	17	16	9
2	ON	◇	20	20	20	19	19	18	18	18	15
3	ON	△	21	21	21	20	19	19	18	18	15
4	ON	○	21	21	21	20	20	20	19	18	15
Avg	REF	◆	19	19	19	19	19	19	19	19	18,5

Emetteur	: Ph. DOS SANTOS
Direction ou service	: DTR
Référence	: DAST/DTR/NI 8.242
Date	: 01-07-98
Objet	: Report diffusion

Destinataires : A. STOREY
L. GIRALDOU (MMS-Toulouse)

Please find hereafter a copy of the RVT report for 2N6764 (DC: 9803) from INTERNATIONAL RECTIFIER.

Reference report : DAST/DTR/RP 8.236

Best regards,

PDS