



RADIATION TEST SUMMARY

PART TYPE : IRFY9140

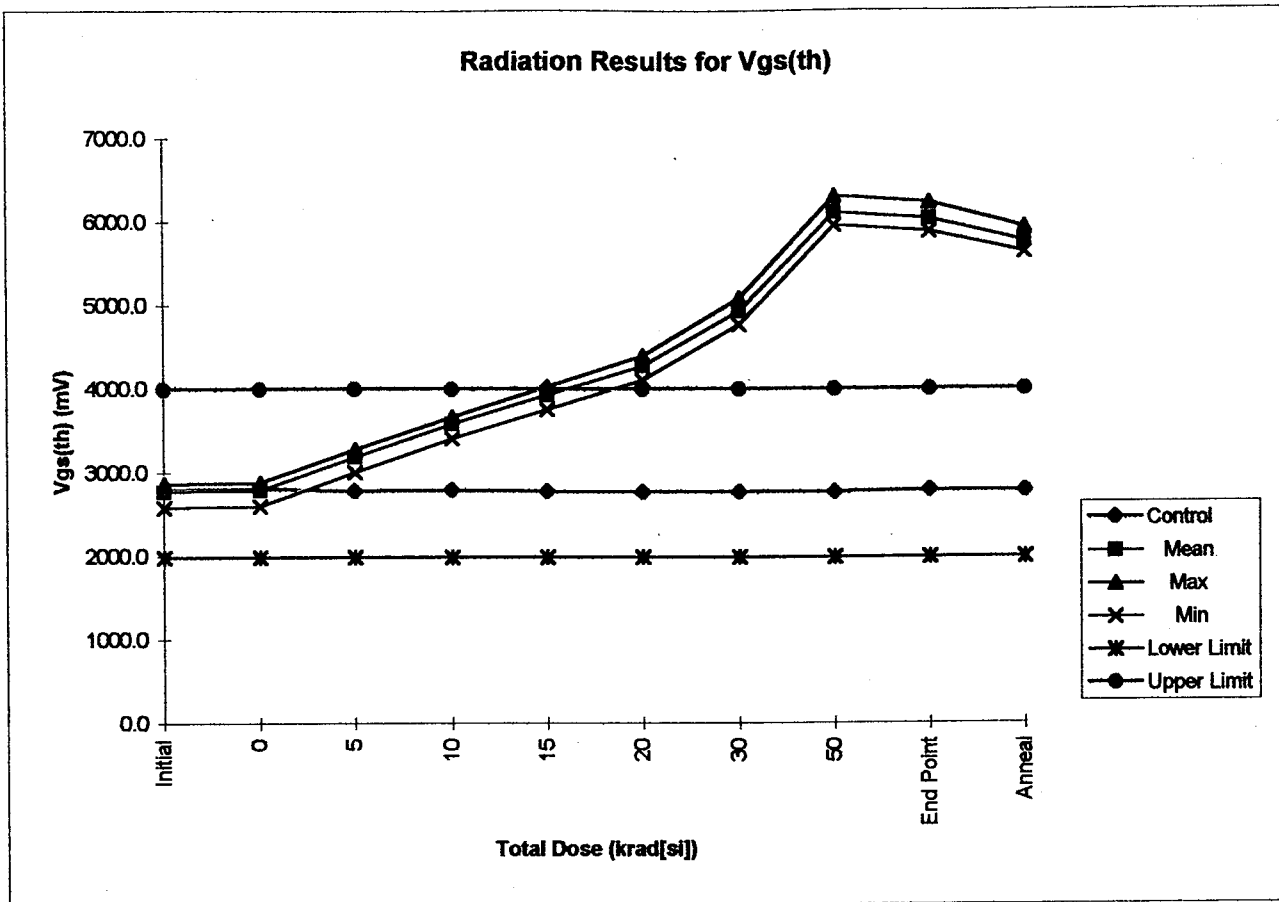
DESCRIPTION : P-CHANNEL POWER MOSFET

REPORT NO. : RD 248

PARAMETERS PLOTTED :

VGS(th)
RDSon

NOTE : The results for the remaining parameters showed no significant change and hence plots were not considered necessary.

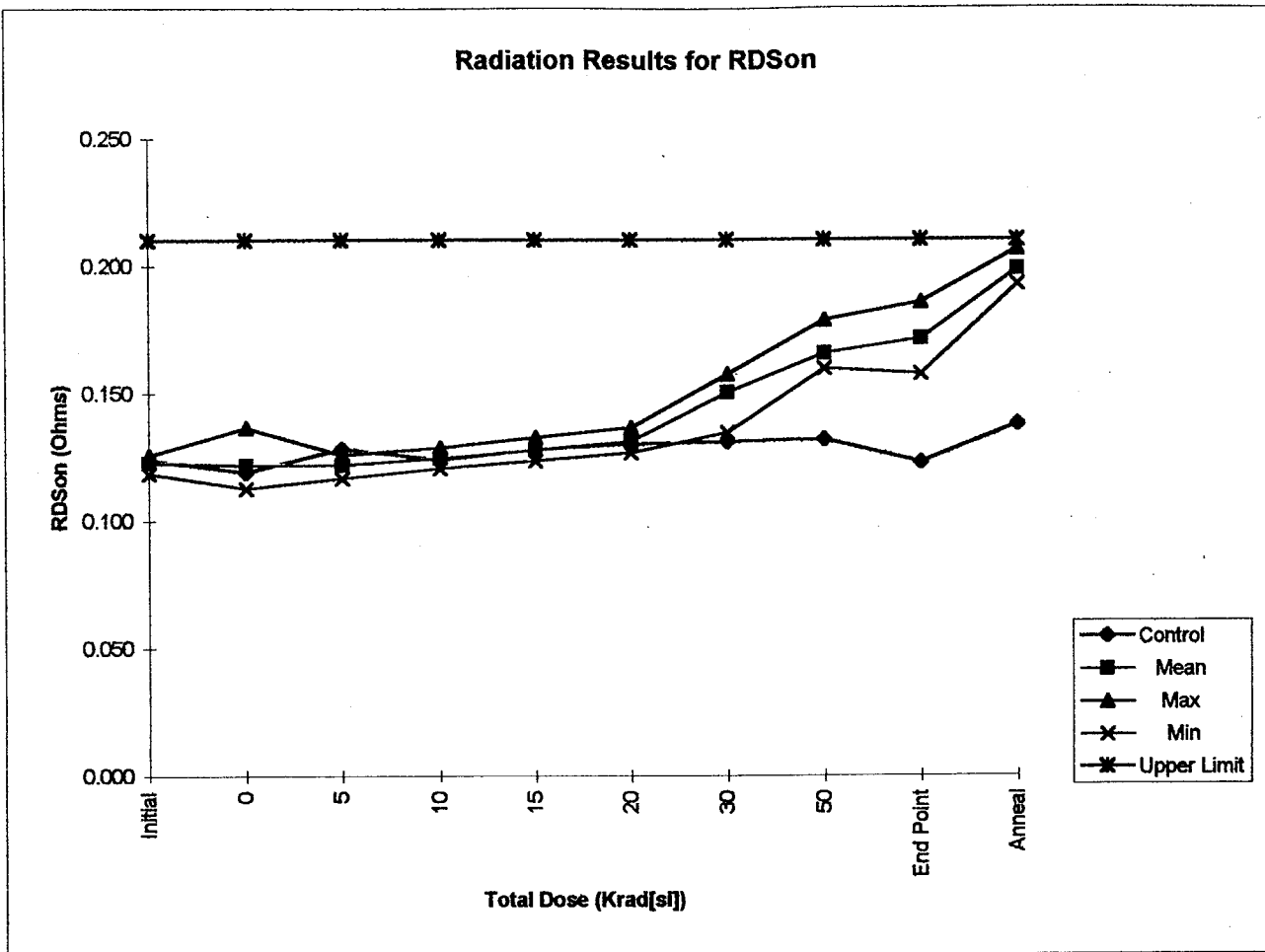


Dose (kRad)	Control (mV)	Mean (mV)	Max (mV)	Min (mV)	Lower Limit (mV)	Upper Limit (mV)	Std.Dev.
Initial	2787.3	2782.8	2875.1	2590.1	2000	4000	130.03
0	2804.3	2799.7	2891.3	2604.7	2000	4000	131.36
5	2773.9	3198.4	3285.6	3011.2	2000	4000	127.11
10	2788.0	3593.2	3676.3	3413.1	2000	4000	123.01
15	2774.9	3943.2	4041.8	3766.9	2000	4000	123.01
20	2765.1	4287.2	4404.3	4121.1	2000	4000	120.76
30	2766.6	4944.4	5090.2	4779.4	2000	4000	128.79
50	2764.2	6116.6	6312.2	5961.7	2000	4000	145.63
End Point	2791.8	6041.3	6240.3	5889.3	2000	4000	146.10
Anneal	2783.7	5770.5	5936.5	5645.8	2000	4000	125.63

Note : Results for both control samples (biased and unbiased) similar therefore average plotted.

Lot size for statistics : 4 devices

RD 248 Date code 9730



Dose (kRad)	Control (Ohms)	Mean (Ohms)	Max (Ohms)	Min (Ohms)	Upper Limit (Ohms)	Lower Limit (Ohms)	Std.Dev.
Initial	0.124	0.123	0.126	0.119	0.210	-	0.00
0	0.119	0.122	0.137	0.113	0.210	-	0.01
5	0.128	0.122	0.126	0.117	0.210	-	0.00
10	0.124	0.125	0.129	0.121	0.210	-	0.00
15	0.128	0.128	0.133	0.124	0.210	-	0.00
20	0.130	0.132	0.137	0.127	0.210	-	0.00
30	0.131	0.151	0.158	0.135	0.210	-	0.01
50	0.132	0.166	0.179	0.160	0.210	-	0.01
End Point	0.123	0.172	0.186	0.158	0.210	-	0.01
Anneal	0.138	0.199	0.207	0.193	0.210	-	0.01

Note : Results for both control samples (biased and unbiased) similar therefore average plotted.

ENVISAT-1

RIR 79604

RD 248

IRRADIATION TEST PLAN NO.

PO-PL-IGG-PL-0017

Issue No. 2
Date: OCTOBER 1995
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Rev. NA
Date: NA

1

2

Component No.
POIG003003B

3

Component Designation: TRANSISTOR,
MOSFET, P-CHANNEL, POWER TYPE
IRFY9140

4

Irradiation Spec No. NA

Iss. Rev.

5

Specifications

Generic ESA/SCC 5000 Iss. 7 Rev. B
Detail PO-PS-IGG-PL-0030 Iss. 3

6

Acceptance

Evaluation _____
Element _____
Diffusion _____
Lot X

7

Electrical
Measurements

In-situ _____
Remote X

8

Project/Programme

ENVISAT-1

9

Manufacturer: Name: Int. Rectifier
Address: Hurst Green, Oxted
Surrey,
England

10

Test Facility: Name: ERA
Address: LEATHERHEAD, SURREY
ENGLAND

11

Originator: IGG CT
Name: S THACKER

12

Radiation Source

COBALT 60

13

Sample Size: 4

Control Device: 1
(Each Test)

14

Exposure

Single _____
Multiple X

15

Annealing Test

YES X NO _____

16

Radiation Level:

See Below

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Single Exposure
Dose [Krad(Si)]
Dose Rate [rad(Si)/s]
Exposure Time

Not applicable

18

Multiple Exposure:

Irradiation Steps

Dose [Krad(Si)]

Dose Rate [rad(Si)/s]

Exposure Time(s)

In accordance with the applicable
Appendix to this Plan for each
test.

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Bias Requirements: During and after Exposure (for remote Electrical Measurements): YES

Bias Conditions:

Test Circuits: The Electrical Bias circuit is given in Figure 1 in the applicable Appendix to this Plan.

Shielding:

Shielding is required to minimize dose enhancement effects caused by low energy, scattered radiation. The test units shall be enclosed in a Pb/Al container of Pb 1.5mm minimum, surrounding on inner shield of 0.7 to 1.0mm Al.

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Irradiation Test Sequence(applied for each radiation test per the applicable Appendix to this plan).

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Test Step	Description	Requirements
1	Irradiation Test Samples Selection	Quantity 5 devices shall be selected from the lot delivered to IGG.
2	Serialisation	Serialisation - (if the devices are not already serialised) Test units shall be serialised 1 to 4 and the control unit shall be 5.
3	Initial Electrical Measurements (at IGG)	Per Table A herein - (Read-and-Record) - on all 5 parts at IGG. (See Remarks 1 and 2).
4	Initial Electrical Measurements (at ERA)	Per Table A herein - (Read-and-Record) - on all 5 parts at ERA. (See Remarks 1 and 2).
5	Set-up of Test	Verify Bias Circuit and Voltages (In-situ) for 4 test units.

Irradiation Test Sequence (Cont.)

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Test Step	Description	Requirements
6	Irradiation Exposure	Verify radiation dose rate and position in the chamber to achieve required dose. Verify and witness duration of exposure to achieve required dose.
7	Intermediate Electrical Measurement (at ERA)	Bias to be maintained until test is performed. Test per Table A herein - (Read-and-Record) - on all 5 parts. Test to be performed immediately upon removal from chamber (less than 10 mins interval). Upon completion of test 4 test units shall be replaced in bias circuit and returned to chamber. Maximum interval between two consecutive exposures to be 30 mins. (See Remark 2).
8 to 7 + 3n	Repeat Set-up/Exposure/Test sequence upto a Final Total Dose as per the applicable Appendix	Repeat Steps 5, 6, 7 for a total of n cycles (see applicable Appendix). (See Remark 3)
8 + 3n	End Point Electrical Measurements (at IGG)	Per Table A herein - (Read-and-Record) - on all 5 parts at IGG. (See Remarks 2 and 4).
9 + 3n	Annealing	Bias shall be maintained during Annealing for 4 test units. Annealing shall be at room temperature for 168 hours.
10 + 3n	Final Electrical Measurements (at IGG)	Per Table A herein - (Read-and-Record) - on all 5 parts at IGG (See Remark 2).
11 + 3n	Total Dose Irradiation Test Report	ESA/SCC No. 22900

Remarks

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- The initial electrical measurements performed at IGG (Test Step 3) shall be performed within 24 hours of the initial electrical measurements at ERA (Test Step 4).
- All electrical testing shall be performed on the same set of equipment in order to achieve correlation of results both at IGG and ERA. All results plus details of any failures shall be advised to Project.
- The set-up/exposure/test sequence shall be stopped for any device that exhibits repeated functional failure.
- The End Point electrical measurements (Test Step 8 + 3n) performed at IGG shall be performed within 24 hours of the last electrical measurement at ERA (Test Step 7 + 3n).

TABLE A - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - $T_{amb} = +25 \pm 5^{\circ}\text{C}$ BEFORE, AT INTERMEDIATE POINTS, AND ON COMPLETION OF IRRADIATION.

NO.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN.	MAX.	
1	Breakdown Voltage Drain to Source	BV_{DSS}	3407 Bias Cond. C	$I_D = -0.25\text{mA dc}$ $V_{GS} = 0$	-100	-	Vdc
2	Gate Threshold Voltage	$V_{GS(th)}$	3403	$V_{DS} = V_{GS}$ $I_D = -1.0\text{mA dc}$	-2.0	-4.0	Vdc
3	Gate Current	I_{GSS}	3411 Bias Cond. C	$V_{GS} = -20\text{V dc}$ $V_{DS} = 0$	-	-100	nAdc
4	Drain Current	I_{DSS}	3413 Bias Cond C	$V_{DS} = -100\text{V dc}$ $V_{GS} = 0$	-	-0.25	mAdc
5	Drain Source ON Resistance	$r_{DS(ON)}$	3421	$V_{GS} = -10\text{V dc}$ $I_D = -10\text{A dc}$ (Notes 2 and 3)	-	0.21	Ω

NOTES

- The limits specified in this Table only apply to the first intermediate electrical measurements at dose 5Krad(Si). For all other intermediate, end point and final electrical measurements, these limits shall not apply but the tests shall be performed and the result recorded for information and characterisation purposes.

Parametric failures to the limits given in this Table could possibly occur at any irradiation level greater than 5Krad(Si).

- Pulsed: Pulse Width $\leq 300\mu\text{s}$, Duty Cycle $\leq 2\%$.
- Measured within 2mm of case.

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IRRADIATION TEST PLAN NO.

PO-PL-IGG-PL-0017

Issue No. 2

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Rev. NA

Date: NA

APPENDIX: 1

COMPONENT TYPE: IRFY9140

This appendix defines the specific radiation test requirements applicable to the following ENVISAT-1 user(s):-

USER CODE	USER COMMENT
MEICSA, MEVECI, SRDSSA, MPPSCO, SRICCR	Ref. PO-DAS-1365/95

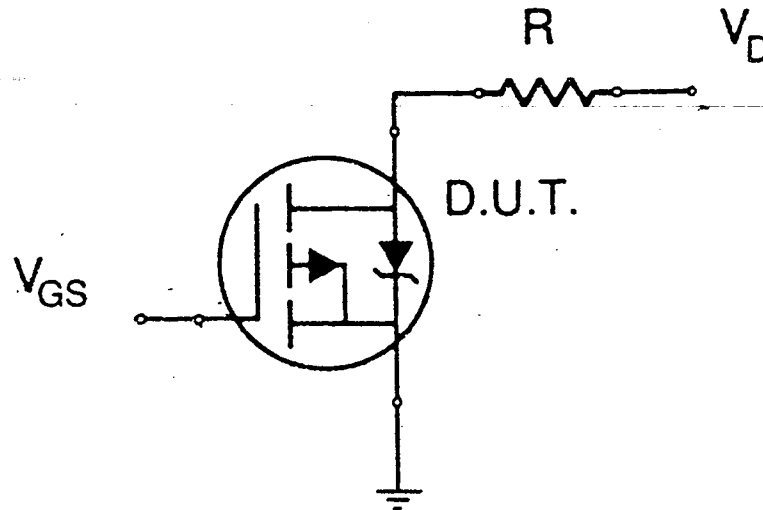
The following specific requirements shall apply:-

a) MULTIPLE EXPOSURE/IRRADIATION STEPS:

Irradiation Steps (n)	1	2	3	4	5	6
Dose [Krad(Si)]	5	5	5	5	10	20
Accumulated Dose[Krad(Si)]	5	10	15	20	30	50
Dose Rate [rad(Si)/s] (See note)	3	3	3	3	3	3
Exposure Time(s) (See note)	1667	1667	1667	1667	3333	6667

Note: The dose rates and exposure times given are nominal conditions and may be adjusted during irradiation testing to achieve convenient test points. The actual dose rate shall not exceed 3rad(Si)/s. The dose rates and exposure times used during the testing shall be recorded for each test step.

b) ELECTRICAL BIAS CIRCUIT FOR IRRADIATION TESTING:-



- NOTES:**
- i) Bias conditions $V_{GS} = -10V_{dc}$, $V_D = -30V_{dc}$
 - ii) $R = 300\Omega \pm 1\%$ to give $I_D = -100mA_{dc}$

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD248_IRFY9140_INIT_EMS@IG6 / V1.0 15/1/96 SMR

=====
Results file : RD248_IRFY9140_INIT_EMS@IG6 from: 11.11.97 / 09:45:23
Operator : PAUL RUSSELL
Part number : IRFY9140
Lot number : RD248
Order number : D/C 9730
Vendor : IR
: CONTROLS: 443(UNBIASED), 445(BIASED) ; 446,447,449,450
: INITIAL EMS @ IG6
: IRFY9140 PO-PL-IG6-PL-0017 ISS.2 / V1.0 15/1/96 SMR
=====

Test steps

1. -VGS	2000.0	...	4000.0	mV
2. -IGSS (FWD)	(0.0)	...	100.0	nA
3. -IGSS (REV)	(0.0)	...	100.0	nA
4. -IDSS	(0)	...	250	uA
5. RDS on	(0.000)	...	0.210	Ohm
6. -V(BR)DSS	100.0	...	700.0	V

	443	445	446	447	449	450
1.1 [mV]	2795.6	2778.9	2875.1	2836.2	2590.1	2829.9
2.1 [nA]	1.5	1.5	1.4	1.6	1.5	1.6
3.1 [nA]	1.4	1.5	1.5	1.6	1.5	1.5
4.1 [uA]	0	0	0	0	0	0
5.1 [Ohm]	0.124	0.123	0.126	0.123	0.119	0.125
6.1 [V]	125.0	124.5	118.7	121.1	121.2	124.6

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD248_IRFY9140_INIT_EMS@_ERA / V1.0 15/1/96 SMR

Results file : RD248_IRFY9140_INIT_EMS@_ERA from: 12.11.97 / 10:23:23
Operator : PAUL RUSSELL
Part number : IRFY9140
Lot number : RD248
Order number : D/C 9730
Vendor : IR
: CONTROLS: 443<UNBIASED>, 445<BIASED> ; RAD 446,447,449,450
: INITIAL EMS @ ERA
: IRFY9140 PO-PL-IG6-PL-0017 ISS.2 / V1.0 15/1/96 SMR

Test steps

1. -VGS	2000.0	...	4000.0	mV
2. -IGSS (FWD)	(0.0)	...	100.0	nA
3. -IGSS (REV)	(0.0)	...	100.0	nA
4. -IDSS	(0)	...	250	uA
5. RDS on	(0.000)	...	0.210	Ohm
6. -V(BR)DSS	100.0	...	700.0	V

	443	445	446	447	449	450
1.1 [mV]	2813.6	2795.0	2891.3	2853.4	2604.7	2849.4
2.1 [nA]	1.2	1.2	1.2	1.2	1.3	1.3
3.1 [nA]	1.2	1.3	1.3	1.3	1.3	1.4
4.1 [uA]	0	0	0	0	0	0
5.1 [Ohm]	0.119	0.119	0.137	0.121	0.113	0.118
6.1 [V]	124.4	123.7	118.2	120.6	120.4	124.0

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD248_IRFY9140_EMS_@_5_KRAD / V1.0 15/1/96 SMR

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=====
Results file   : RD248_IRFY9140_EMS_@_5_KRAD   from: 12.11.97 / 10:44:24
Operator      : PAUL RUSSELL
Part number   : IRFY9140
Lot number    : RD248
Order number  : D/C 9730
Vendor        : IR
               : CONTROLS: 443<UNBIASED>, 445<BIASED> ; RAD 446,447,449,450
               : EMS @ 5 KRAD
               : IRFY9140 PO-PL-IG6-PL-0017 ISS.2 / V1.0 15/1/96 SMR
=====

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Test steps

1. -VGS	2000.0	...	4000.0	mV
2. -IGSS (FWD)	(0.0)	...	100.0	nA
3. -IGSS (REV)	(0.0)	...	100.0	nA
4. -IDSS	(0)	...	250	uA
5. RDS on	(0.000)	...	0.210	Ohm
6. -V(BR)DSS	100.0	...	700.0	V

	443	445	446	447	449	450
1.1 [mV]	2805.3	2742.4	3295.6	3228.3	3011.2	3268.6
2.1 [nA]	1.6	1.5	1.6	1.4	1.3	1.4
3.1 [nA]	1.6	1.5	1.6	1.4	1.3	1.5
4.1 [uA]	0	0	0	0	0	0
5.1 [Ohm]	0.121	0.134	0.122	0.126	0.117	0.124
6.1 [V]	124.7	125.9	117.9	121.4	120.9	124.7

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD248_IRFY9140_EMS_@_10_KRAD / V1.0 15/1/96 SMR

=====
Results file : RD248_IRFY9140_EMS_@_10_KRAD from: 12.11.97 / 11:37:49
Operator : PAUL RUSSELL
Part number : IRFY9140
Lot number : RD248
Order number :
Vendor :
: EMS @ 10 KRAD
:

Test steps

1. -VGS	2000.0	...	4000.0	mV
2. -IGSS (FWD)	(0.0)	...	100.0	nA
3. -IGSS (REV)	(0.0)	...	100.0	nA
4. -IDSS	(0)	...	250	uA
5. RDS on	(0.000)	...	0.210	Ohm
6. -V(BR)DSS	100.0	...	700.0	V

	443	445	446	447	449	450
1.1 [mV]	2800.3	2775.6	3667.6	3615.9	3413.1	3678.3
2.1 [nA]	1.4	1.4	1.5	1.5	1.5	1.9
3.1 [nA]	1.4	1.4	1.4	1.5	1.5	1.6
4.1 [uA]	0	0	0	0	1	1
5.1 [Ohm]	0.123	0.124	0.124	0.126	0.121	0.129
6.1 [V]	124.9	124.3	117.7	121.1	121.2	124.7

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD248_IRFY9140_EMS_@_15_KRAD / V1.0 15/1/98 SMR

Results file : RD248_IRFY9140_EMS_@_15_KRAD from: 12.11.97 / 11:53:33
Operator : PAUL RUSSELL
Part number : IRFY9140
Lot number : RD248
Order number :
Vendor :
: EMS @ 15 KRAD
:

Test steps

1. -VGS	2000.0	...	4000.0	mV
2. -IGSS (FWD)	(0.0)	...	100.0	nA
3. -IGSS (REV)	(0.0)	...	100.0	nA
4. -IDSS	(0)	...	250	uA
5. RDS on	(0.000)	...	0.210	Ohm
6. -V(BR)DSS	100.0	...	700.0	V

	443	445	446	447	449	450
1.1 [mV]	2796.9	2752.9	4010.1 F	3953.8	3766.9	4041.8 F
2.1 [nA]	1.7	1.6	1.6	1.8	1.7	1.7
3.1 [nA]	1.7	1.6	1.6	1.7	1.6	1.6
4.1 [uA]	0	0	1	1	1	1
5.1 [Ohm]	0.124	0.131	0.126	0.129	0.124	0.133
6.1 [V]	125.1	125.3	117.8	121.1	121.1	124.9

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD240_IRFY9140_EMS @ 20_KRAD / V1.0 15/1/96 SMR

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Results file : RD240_IRFY9140_EMS @ 20_KRAD from: 12.11.97 / 12:11:54
Operator : PAUL RUSSELL
Part number : IRFY9140
Lot number : RD240
Order number :
Vendor :
: EMS @ 20 KRAD
:

Test steps

1. -VGS	2000.0	...	4000.0	mV
2. -IGSS (FWD)	(0.0)	...	100.0	nA
3. -IGSS (REV)	(0.0)	...	100.0	nA
4. -IDSS	(0)	...	250	uA
5. RDS on	(0.000)	...	0.210	Ohm
6. -V(BR)DSS	100.0	...	700.0	V

	443	445	446	447	449	450
1.1 [mV]	2793.4	2736.8	4336.7	4286.5	4121.1	4404.3
2.1 [nA]	2.2	2.4	2.3	2.3	2.3	2.4
3.1 [nA]	2.1	2.2	2.1	2.2	2.1	2.2
4.1 [uA]	0	0	1	1	2	2
5.1 [Ohm]	0.125	0.135	0.129	0.133	0.127	0.137
6.1 [V]	125.3	125.9	118.2	121.1	121.0	125.0

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD248_IRFY9140_EMS_@_30_KRAD / V1.0 15/1/96 SMR

=====
Results file : RD248_IRFY9140_EMS_@_30_KRAD from: 12.11.97 / 13:32:00
Operator : PAUL RUSSELL
Part number : IRFY9140
Lot number : RD248
Order number :
Vendor :
: EMS @ 30 KRAD
:

Test steps

1. -V6S	2000.0	...	4000.0	mV
2. -I6SS (FWD)	(0.0)	...	100.0	nA
3. -I6SS (REV)	(0.0)	...	100.0	nA
4. -IDSS	(0)	...	250	uA
5. RDS on	(0.000)	...	0.210	Ohm
6. -V(BR)DSS	100.0	...	700.0	V

	443	445	446	447	449	450
1.1 [mV]	2789.3	2743.9	4977.3	4930.5	4779.4	5090.2
2.1 [nA]	2.5	2.5	2.5	2.6	2.6	2.7
3.1 [nA]	2.3	2.4	2.3	2.4	2.4	2.3
4.1 [uA]	0	0	1	2	3	2
5.1 [Ohm]	0.126	0.135	0.155	0.158	0.135	0.155
6.1 [V]	125.4	125.8	118.1	121.3	121.4	125.1

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD248_IRFY9140_EMS @ 50_KRAD / VI.0 15/1/96 SMR

=====
Results file : RD248_IRFY9140_EMS @ 50_KRAD from: 12.11.97 / 14:14:42
Operator : PAUL RUSSELL
Part number : IRFY9140
Lot number : RD248
Order number :
Vendor :
: EMS @ 50 KRAD
:

Test steps

1. -VGS	2000.0	...	4000.0	mV
2. -IGSS (FWD)	(0.0)	...	100.0	nA
3. -IGSS (REV)	(0.0)	...	100.0	nA
4. -IDSS	(0)	...	250	uA
5. RDS on	(0.000)	...	0.210	Ohm
6. -V(BR)DSS	100.0	...	700.0	V

	443	445	446	447	449	450
1.1 [mV]	2789.2	2739.1	8112.6	8079.8	5981.7	8312.2
2.1 [nA]	2.6	2.6	3.0	3.2	2.7	3.3
3.1 [nA]	2.4	2.4	2.4	2.4	2.4	2.4
4.1 [uA]	0	0	2	3	4	3
5.1 [Ohm]	0.126	0.138	0.160	0.164	0.161	0.179
6.1 [V]	125.4	125.9	118.1	121.1	121.1	125.2

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD248_IRFY9140_END_POINT_EMS / V1.0 15/1/96 SMR

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=====
Results file   : RD248_IRFY9140_END_POINT_EMS   from: 13.11.97 / 13:36:35
Operator      : PAUL RUSSELL
Part number   : IRFY9140
Lot number    : RD248
Order number  :
Vendor        :
              :
              : END POINT EMS
              :
=====

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Test steps

1. -VGS	2000.0	...	4000.0	mV
2. -IGSS (FWD)	(0.0)	...	100.0	nA
3. -IGSS (REV)	(0.0)	...	100.0	nA
4. -IDSS	(0)	...	250	uA
5. RDS on	(0.000)	...	0.210	Ohm
6. -V(BR)DSS	100.0	...	700.0	V

	443	445	446	447	449	450
1.1 [mV]	2800.2	2793.4	6028.2 F	6007.2 F	5889.3 F	6240.3 F
2.1 [nA]	2.3	2.3	2.6	2.7	2.4	2.8
3.1 [nA]	2.2	2.2	2.1	2.2	2.2	2.2
4.1 [uA]	0	0	3	3	3	3
5.1 [Ohm]	0.123	0.122	0.172	0.171	0.158	0.198
6.1 [V]	124.9	124.2	118.7	121.3	121.2	124.9

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD248_IRFY9140_FINAL_EMS / V1.0 15/1/96 SMR

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=====
Results file   : RD248_IRFY9140_FINAL_EMS   from: 21.11.97 / 10:17:44
Operator      : PAUL RUSSELL
Part number   : IRFY9140
Lot number    : RD248
Order number  : D/C 9730
Vendor        : IR
               : CONTROLS: 443(UNBIASED), 445(BIASED) ; RAD 446,447,449,450
               : FINAL EMS
               : IRFY9140 PO-PL-IG6-PL-0017 ISS.2 / V1.0 15/1/96 SMR
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Test steps

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1. -VGS           2000.0   ...   4000.0   mV
2. -IGSS (FWD)   (  0.0 )...   100.0   nA
3. -IGSS (REV)   (  0.0 )...   100.0   nA
4. -IDSS         (  0   )...   250     uA
5. RDS on        ( 0.000 )...   0.210  Ohm
6. -V(BR)DSS     100.0   ...   700.0   V
-----

```

	443	445	446	447	449	450
1.1 [mV]	2795.8	2771.5	5791.0	5708.7	5645.8	5936.5
2.1 [nA]	1.8	1.8	2.0	2.1	1.8	2.1
3.1 [nA]	1.7	1.7	1.7	1.7	1.7	1.7
4.1 [uA]	0	0	3	2	3	2
5.1 [Ohm]	0.149	0.127	0.198	0.207	0.193	0.198
6.1 [V]	125.3	124.7	118.8	121.3	121.1	125.0

