RADIATION TEST SUMMARY

PART TYPE : 2N6782

DESCRIPTION : N-CHANNEL MOSFET

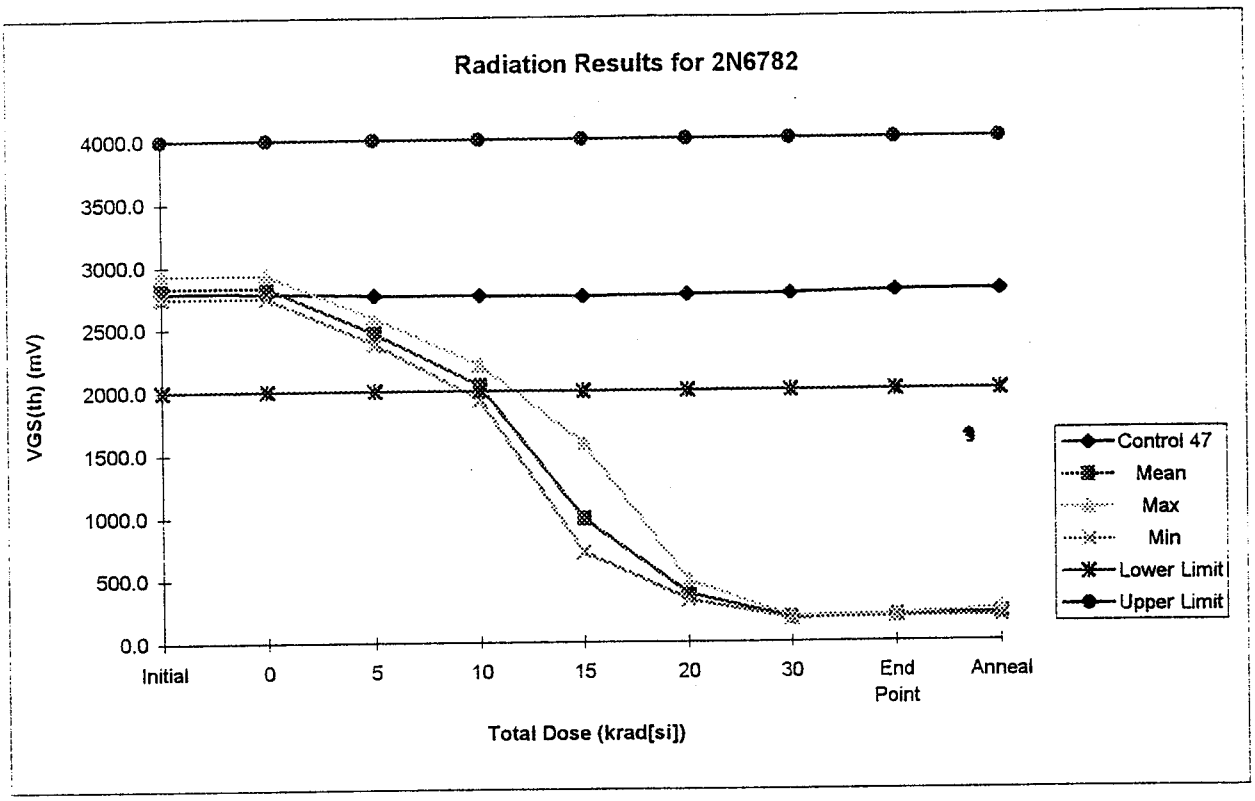
REPORT NO. : RD204

PARAMETERS PLOTTED :

VGS(th)
Idss
BVdss

NOTE :

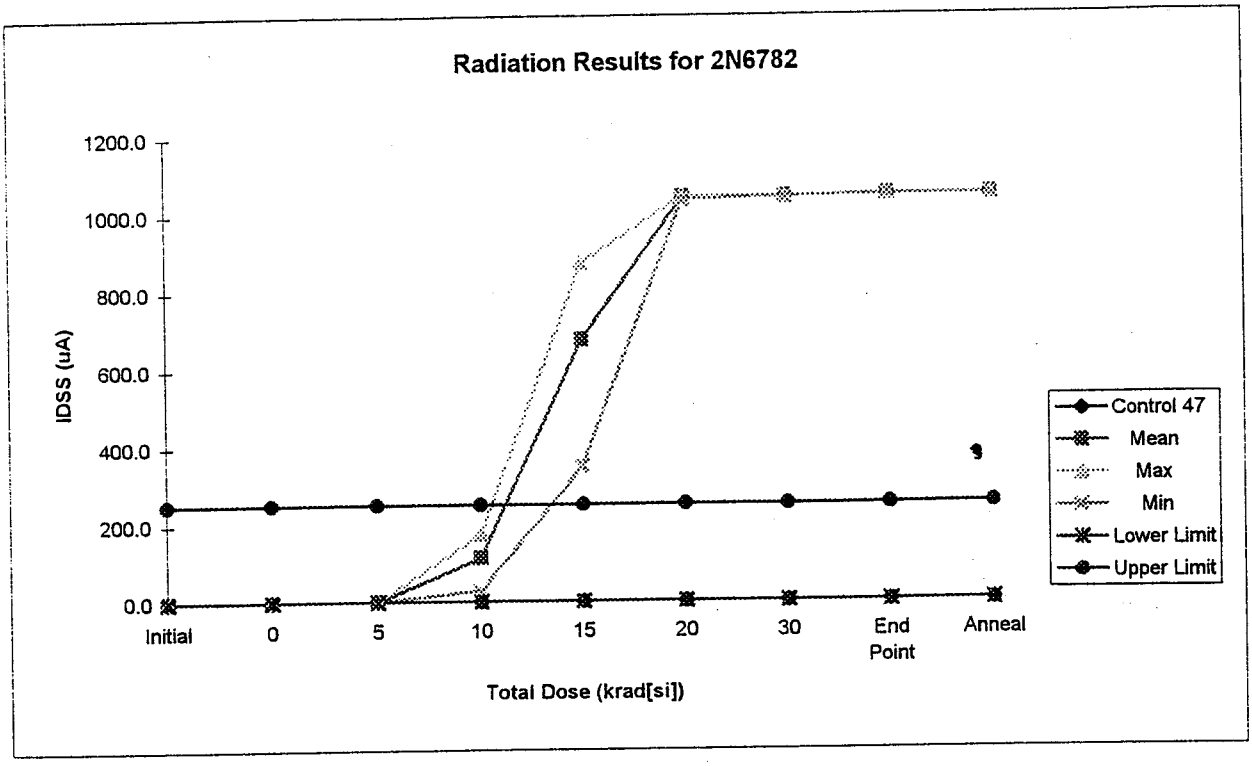
The results for Igss and RDS(on) showed no significant change and hence plots were not considered necessary.



Dose (kRad)	Control 47	Mean	Max	Min	Lower Limit	Upper Limit	Std.Dev.
	(mV)	(mV)	(mV)	(mV)	(mV)	(mV)	
Initial	2791.8	2828.3	2933.3	2748.7	2000	4000	80.76
0	2780.8	2828.5	2930.0	2746.3	2000	4000	77.67
5	2761.1	2461.3	2577.9	2373.3	2000	4000	90.03
10	2756.7	2038.6	2203.0	1930.6	2000	4000	120.39
15	2753.2	983.5	1584.9	714.3	2000	4000	411.52
20	2764.7	384.4	484.0	332.2	2000	4000	69.55
30	2766.9	190.5	198.7	180.9	2000	4000	8.22
End Point	2785.3	200.9	207.6	192.2	2000	4000	6.96
Anneal	2787.8	221.6	254.1	201.5	2000	4000	24.88

Lot size for statistics : 4 devices

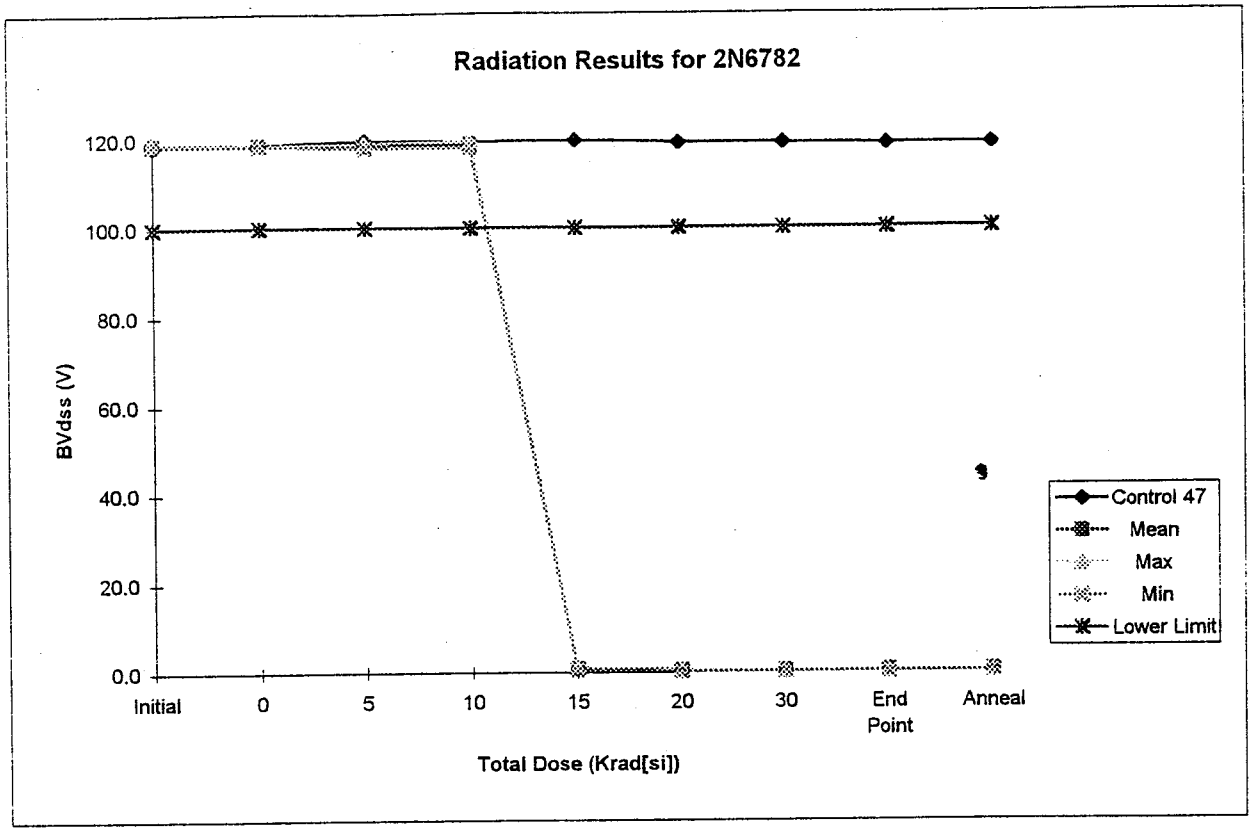
RD 204 Date Code: 9527D



Dose (kRad)	Control 47	Mean	Max	Min	Lower Limit	Upper Limit	Std.Dev.
	(uA)	(uA)	(uA)	(uA)	(uA)	(uA)	
Initial	0.0	0.0	0.0	0.0	0.0	250.0	0.0
0	0.0	0.0	0.0	0.0	0.0	250.0	0.0
5	0.0	0.0	0.0	0.0	0.0	250.0	0.0
10	0.0	112.8	173.0	28.0	0.0	250.0	62.6
15	0.0	675.3	872.0	348.0	0.0	250.0	236.8
20	0.0	1041.3	1043.0	1036.0	0.0	250.0	3.5
30	0.0	1042.0	1042.0	1042.0	0.0	250.0	0.0
End Point	0.0	1047.0	1047.0	1047.0	0.0	250.0	0.0
Anneal	0.0	1046.0	1046.0	1046.0	0.0	250.0	0.0

Lot size for statistics : 4 devices

RD 204 Date Code: 9527D



Dose (kRad)	Control 47	Mean	Max	Min	Lower Limit	Upper Limit	Std.Dev.
	(V)	(V)	(V)	(V)	(V)	(V)	
Initial	118.5	118.9	119.2	118.7	100.0	700.0	0.2
0	118.8	118.7	118.8	118.5	100.0	700.0	0.1
5	119.7	118.6	119.1	118.0	100.0	700.0	0.5
10	119.4	118.9	119.5	118.3	100.0	700.0	0.6
15	119.7	0.7	1.1	0.6	100.0	700.0	0.3
20	119.2	0.4	0.6	0.3	100.0	700.0	0.2
30	119.2	0.3	0.3	0.2	100.0	700.0	0.1
End Point	118.8	0.4	0.4	0.2	100.0	700.0	0.1
Anneal	118.9	0.3	0.4	0.3	100.0	700.0	0.1

Lot size for statistics : 4 devices

RD 204 Date Code: 9527D

********** -COMM. JOURNAL- ******** DATE 15-NOV-1996 ***** TIME 14:51 ****** P.1

MODE=TRANSMISSION START=15-NOV 14:42 END=15-NOV 14:51

FILE NO.= 113

NO.	COM	ABBR.NO.	STATION NAME/ TELEPHONE NO.	PAGES	PRG.NO.	PROGRAM NAME
01	OK		90049754582620	012/012		
02	OK		90031715656040	012/012		

-IGG -

********** -IGG CT LTD - ***** - 01329 829312- **********

ENVISAT-1 RD204 RIR 72398	IRRADIATION TEST PLAN NO. PO-PL-IGG-PL-0010 1	Issue No. 2 Date: OCTOBER 1995 Page: 1/4	Rev. NA Date: NA 2

Component No. 520501401B 3	Component Designation: TRANSISTOR, MOSFET, N-CHANNEL, POWER TYPE 2N6782 4	Irradiation Spec No. NA Iss. Rev. 5

Specifications	Acceptance	Electrical Measurements	Project/Programme
Generic ESA/SCC 5000 Iss. 7 Rev. B Detail ESA/SCC 5205/014 Iss. 1 Rev. D 6	Evaluation ___ Element Diffusion ___ Lot X 7	In-situ ___ Remote X 8	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	Sample Size: 4	Exposure	Annealing Test	Radiation Level:
COBALT 60 13	Control Device: 1 (Each Test) 14	Single ___ Multiple X 15	YES X NO ___ 16	See Below 17

Single Exposure Dose [Krad(Si)] Dose Rate [rad(Si)/s] Exposure Time Not applicable 18	Multiple Exposure:		
	Irradiation Steps	In accordance with the applicable Appendix to this Plan for each test.	19
	Dose [Krad(Si)]		
	Dose Rate [rad(Si)/s]		
	Exposure Time(s)		

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. 20

Irradiation Test Sequence(applied for each radiation test per the applicable Appendix to this plan). 21

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.

S.T.

Irradiation Test Sequence (Cont.) 21

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 22

1. 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).
2. 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.
3. The set-up/exposure/test sequence shall be stopped for any device that exhibits repeated functional failure.
4. 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 ±5°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 = 0.25mAdc V_{GS} = 0	100	-	Vdc
2	Gate Threshold Voltage	$V_{GS(th)}$	3403	V_{DS} = V_{GS} I_D = 0.5mAdc	2.0	4.0	Vdc
3	Gate Current	I_{GSS}	3411 Bias Cond. C	V_{GS} = 20Vdc V_{DS} = 0	-	100	nAdc
4	Drain Current	I_{DSS}	3413 Bias Cond C	V_{DS} = 100Vdc V_{GS} = 0	-	0.25	mAdc
5	Drain Source ON Resistance	$r_{DS(ON)}$	3421	V_{GS} = 10Vdc I_D = 2.25Adc (Notes 2 and 3)	-	0.6	Ω

NOTES

1. 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).

2. Pulsed: Pulse Width ≤ 300uS, Duty Cycle ≤2%.

3. Measured within 2mm of case.

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

USER CODE	USER COMMENT
SRAPCR	Ref. N/A

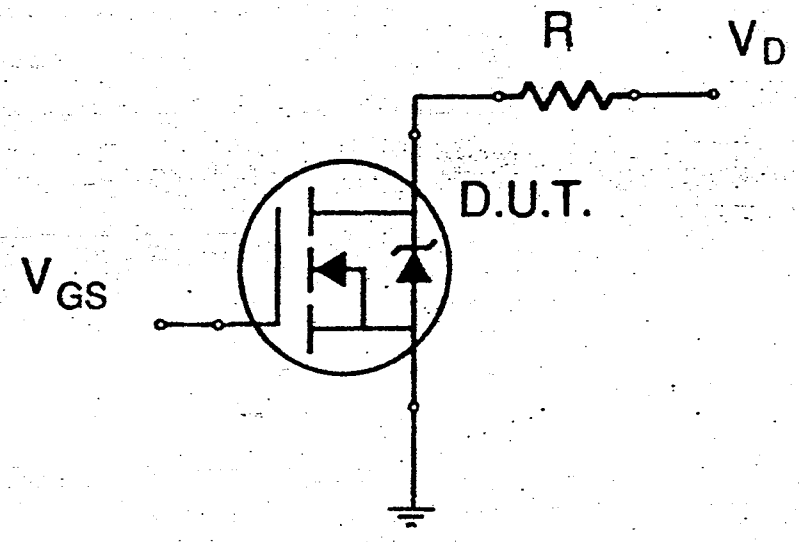
The following specific requirements shall apply:-

a) MULTIPLE EXPOSURE/IRRADIATION STEPS:

Irradiation Steps (n)	1	2	3	4	5
Dose [Krad(Si)]	5	5	5	5	10
Accumulated Dose[Krad(Si)]	5	10	15	20	30
Dose Rate [rad(Si)/s] (See note)	3	3	3	3	3
Exposure Time(s) (See note)	~~2500~~ 1667	~~2500~~ 1667	~~2500~~ 1667	~~2500~~ 1667	~~5000~~ 3333

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} = 10Vdc, V_D = 30Vdc

ii) R = 300Ω ± 1% to give I_D = 100mAdc

ESA-QCA9924T-C

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD204_2N6782_INIT_EMS_@_IGG / V1.0 15/8/96 PAR

Results file : RD204_2N6782_INIT_EMS_@_IGG from: 19.08.96 / 11:47:15
Operator : PAUL RUSSELL
Part number : 2N6782
Lot number : RD204
Order number : D/C 9527D
Vendor : IR
: CONTROL S/No 47 ; RAD SAMPLE S/NoS 53,55,64,70.
: INITIAL EMS @ IGG
: 2N6782 PO-PL-IGG-PL-0010 ISS 2 / V1.0 15/8/96 PAR

Test steps

1.	-V(BR)DSS		100.0	...	700.0	V
2.	VGS		2000.0	...	4000.0	mV
3.	IGSS (FWD)	(	0.0	)...	100.0	nA
4.	IGSS (REV)	(	0.0	)...	100.0	nA
5.	IDSS	(	0	)...	250	uA
6.	RDS on	(	0.000	)...	0.600	Ohm

TK

	47	53	56	64	70
1.1 [V]	118.5	118.7	119.0	118.7	119.2
2.1 [mV]	2791.8	2933.3	2846.3	2748.7	2784.9
3.1 [nA]	0.4	0.4	0.4	0.4	0.4
4.1 [nA]	0.2	0.2	0.2	0.2	0.2
5.1 [uA]	0	0	0	0	0
6.1 [Ohm]	0.430	0.438	0.434	0.428	0.434

SZ-TESTSYSTEME Statistics 05 Vers. 2.15 for TA07F
RD204_2N6782_INIT_EMS_@_ERA / V1.0 15/8/96 PAR

Results file : RD204_2N6782_INIT_EMS_@_ERA from: 20.08.96 / 10:34:05
Operator : PAUL RUSSELL
Part number : 2N6782
Lot number : RD204
Order number : D/C 9527D
Vendor : IR
: CONTROL S/No 47 ; RAD SAMPLE S/NoS 53,56,64,70.
: INITIAL EMS @ ERA
: 2N6782 PO-PL-IGG-PL-0010 ISS 2 / V1.0 15/8/96 PAR

Test steps

1.	-V(BR)DSS		100.0 ...	700.0	V
2.	VGS		2000.0 ...	4000.0	mV
3.	IGSS (FWD)	(	0.0)...	100.0	nA
4.	IGSS (REV)	(	0.0)...	100.0	nA
5.	IDSS	(	0)...	250	uA
6.	RDS on	(	0.000)...	0.600	Ohm

	47	53	56	64	70
1.1 [V]	118.8	118.5	118.8	118.7	118.6
2.1 [mV]	2780.8	2930.0	2839.5	2746.3	2798.2
3.1 [nA]	1.0	0.9	1.0	0.9	1.0
4.1 [nA]	1.7	2.0	2.0	1.9	2.0
5.1 [uA]	0	0	0	0	0
6.1 [Ohm]	0.438	0.439	0.437	0.430	0.428

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD204_2N6782_EMS_@_5_KRAD / V1.0 15/8/96 PAR

Results file : RD204_2N6782_EMS_@_5_KRAD from: 20.08.96 / 10:45:45
Operator : PAUL RUSSELL
Part number : 2N6782
Lot number : RD204
Order number : D/C 9527D
Vendor : IR
: CONTROL S/No 47 ; RAD SAMPLE S/NoS 53,56,64,70.
: EMS @ 5 KRAD
: 2N6782 PO-PL-IGG-PL-0010 ISS 2 / V1.0 15/8/96 PAR

Test steps

1.	-V(BR)DSS		100.0	...	700.0	V
2.	VGS		2000.0	...	4000.0	mV
3.	IGSS (FWD)	(	0.0	)...	100.0	nA
4.	IGSS (REV)	(	0.0	)...	100.0	nA
5.	IDSS	(	0	)...	250	uA
6.	RDS on	(	0.000	)...	0.600	Ohm

	47	53	56	64	70
1.1 [V]	119.7	118.0	118.7	119.1	118.5
2.1 [mV]	2761.1	2577.9	2482.7	2373.3	2411.1
3.1 [mA]	0.7	0.8	0.8	0.7	0.8
4.1 [mA]	1.1	1.2	1.2	1.2	1.3
5.1 [uA]	0	0	0	0	0
6.1 [Ohm]	0.450	0.433	0.431	0.431	0.431

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD204_2N6782_EMS_@_10_KRAD / V1.0 15/8/96 PAR

Results file : RD204_2N6782_EMS_@_10_KRAD from: 20.08.96 / 11:15:00
Operator : PAUL RUSSELL
Part number : 2N6782
Lot number : RD204
Order number : D/C 9527D
Vendor : IR
: CONTROL S/No 47 ; RAD SAMPLE S/NoS 53,56,64,70.
: EMS @ 10 KRAD
: 2N6782 PO-PL-I66-PL-0010 ISS 2 / V1.0 15/8/96 PAR

Test steps

1.	-V(BR)DSS		100.0	...	700.0	V
2.	VGS		2000.0	...	4000.0	mV
3.	IGSS (FWD)	(	0.0	)...	100.0	nA
4.	IGSS (REV)	(	0.0	)...	100.0	nA
5.	IDSS	(	0	)...	250	uA
6.	RDS on	(	0.000	)...	0.600	Ohm

	47	53	56	64	70
1.1 [V]	119.4	118.3	118.4	119.5	119.2
2.1 [mV]	2756.7	2203.0	2050.5	1930.6 F	1970.4 F
3.1 [nA]	0.6	0.6	0.6	0.6	0.6
4.1 [nA]	0.7	0.7	0.7	0.8	0.8
5.1 [uA]	0	28	107	173	143
6.1 [Ohm]	0.452	0.430	0.432	0.427	0.426

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD204_2N6782_EMS_@_15_KRAD / V1.0 15/8/96 PAR

Results file : RD204_2N6782_EMS_@_15_KRAD from: 20.08.96 / 11:44:54
Operator : PAUL RUSSELL
Part number : 2N6782
Lot number : RD204
Order number : D/C 9527D
Vendor : IR
: CONTROL S/No 47 ; RAD SAMPLE S/NoS 53,56,64,70.
: EMS @ 15 KRAD
: 2N6782 PO-PL-IG6-PL-0010 ISS 2 / V1.0 15/8/96 PAR

Test steps

1.	-V(BR)DSS		100.0 ...	700.0	V
2.	VGS		2000.0 ...	4000.0	mV
3.	IGSS (FWD)	(	0.0)...	100.0	nA
4.	IGSS (REV)	(	0.0)...	100.0	nA
5.	IDSS	(	0)...	250	uA
6.	RDS on	(	0.000)...	0.600	Ohm

	47	53	56	64	70
1.1 [V]	119.7	1.1 F	0.6 F	0.6 F	0.6 F
2.1 [mV]	2753.2	1584.9 F	914.3 F	714.3 F	720.6 F
3.1 [nA]	0.6	0.5	0.5	0.5	0.5
4.1 [nA]	0.6	0.6	0.6	0.6	0.6
5.1 [uA]	0	348 F	657 F	872 F	824 F
6.1 [Ohm]	0.451	0.427	0.428	0.423	0.425

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD204_2N6782_EMS_@_20_KRAD / V1.0 15/8/96 PAR

Results file : RD204_2N6782_EMS_@_20_KRAD from: 20.08.96 / 12:15:14
Operator : PAUL RUSSELL
Part number : 2N6782
Lot number : RD204
Order number : D/C 9527D
Vendor : IR
: CONTROL S/No 47 ; RAD SAMPLE S/NoS 53,56,64,70.
: EMS @ 20 KRAD
: 2N6782 PD-PL-IGG-PL-0010 ISS 2 / V1.0 15/8/96 PAR

Test steps

1.	-V(BR)DSS		100.0	...	700.0	V
2.	VGS		2000.0	...	4000.0	mV
3.	IGSS (FWD)	(	0.0	)...	100.0	nA
4.	IGSS (REV)	(	0.0	)...	100.0	nA
5.	IDSS	(	0	)...	250	uA
6.	RDS on	(	0.000	)...	0.600	Ohm

	47	53	56	64	70
1.1 [V]	119.2	0.6 F	0.3 F	0.5 F	0.3 F
2.1 [mV]	2764.7	484.0 F	380.0 F	341.4 F	332.2 F
3.1 [nA]	0.7	0.6	0.6	0.6	0.6
4.1 [nA]	0.8	0.8	0.8	0.8	0.9
5.1 [uA]	0	1036 F	1043 F	1043 F	1043 F
6.1 [Ohm]	0.449	0.424	0.422	0.419	0.420

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD204_2N6782_EMS_@_30_KRAD / V1.0 15/8/96 PAR

Results file : RD204_2N6782_EMS_@_30_KRAD from: 20.08.96 / 12:45:27
Operator : PAUL RUSSELL
Part number : 2N6782
Lot number : RD204
Order number : D/C 9527D
Vendor : IR
: CONTROL S/No 47 ; RAD SAMPLE S/NoS 53,56,64,70.
: EMS @ 30 KRAD
: 2N6782 PO-PL-IGG-PL-0010 ISS 2 / V1.0 15/8/96 PAR

Test steps

1.	-V(BR)DSS		100.0	...	700.0	V
2.	VGS		2000.0	...	4000.0	mV
3.	IGSS (FWD)	(	0.0	)...	100.0	nA
4.	IGSS (REV)	(	0.0	)...	100.0	nA
5.	IDSS	(	0	)...	250	uA
6.	RDS on	(	0.000	)...	0.600	Ohm

	47	53	56	64	70
1.1 [V]	119.2	0.3 F	0.2 F	0.2 F	0.3 F
2.1 [mV]	2766.9	198.7 F	195.8 F	186.6 F	180.9 F
3.1 [nA]	0.8	0.6	0.6	0.6	0.6
4.1 [nA]	0.9	0.9	1.0	1.0	1.1
5.1 [uA]	0	1042 F	1042 F	1042 F	1042 F
6.1 [Ohm]	0.446	0.416	0.414	0.409	0.409

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD204_2N6782_END_POINT_EMS / V1.0 15/8/96 PAR

Results file : RD204_2N6782_END_POINT_EMS from: 21.08.96 / 10:29:23
Operator : PAUL RUSSELL
Part number : 2N6782
Lot number : RD204
Order number : D/C 9527D
Vendor : IR
: CONTROL S/No 47 ; RAD SAMPLE S/NoS 53,56,64,70.
: END POINT EMS
: 2N6782 PO-PL-IGG-PL-0010 ISS 2 / V1.0 15/8/96 PAR

Test steps

1.	-V(BR)DSS	100.0	...	700.0	V
2.	VGS	2000.0	...	4000.0	mV
3.	IGSS (FWD)	(0.0	)...	100.0	nA
4.	IGSS (REV)	(0.0	)...	100.0	nA
5.	IDSS	(0	)...	250	uA
6.	RDS on	(0.000	)...	0.600	Ohm

	47	53	56	64	70
1.1 [V]	118.8	0.4 F	0.4 F	0.4 F	0.2 F
2.1 [mV]	2785.3	207.6 F	205.3 F	198.6 F	192.2 F
3.1 [nA]	0.7	0.6	0.6	0.6	0.5
4.1 [nA]	0.6	0.6	0.6	0.6	0.6
5.1 [uA]	0	1047 F	1047 F	1047 F	1047 F
6.1 [Ohm]	0.436	0.421	0.422	0.417	0.418

SZ-TESTSYSTEME Statistics 03 Vers. 2.15 for TA07F
RD204_2N6782_POST_ANNEAL_EMS / V1.0 15/8/96 PAR

Results file : RD204_2N6782_POST_ANNEAL_EMS from: 29.08.96 ✓ 13:21:20
Operator : PAUL RUSSELL
Part number : 2N6782
Lot number : RD204
Order number : D/C 9527D
Vendor : IR
: CONTROL S/No 47 ; RAD SAMPLE S/NoS 53,56,64,70.
: POST ANNEAL EMS
: 2N6782 PO-PL-IGG-PL-0010 ISS 2 / V1.0 15/8/96 PAR

Test steps

1.	-V(BR)DSS		100.0	...	700.0	V
2.	VGS		2000.0	...	4000.0	mV
3.	IGSS (FWD)	(	0.0	)...	100.0	nA
4.	IGSS (REV)	(	0.0	)...	100.0	nA
5.	IDSS	(	0	)...	250	uA
6.	RDS on	(	0.000	)...	0.600	Ohm

	47	53	56	64	70
1.1 [V]	118.9	0.3 F	0.3 F	0.3 F	0.4 F
2.1 [mV]	2787.8	254.1 F	227.9 F	202.7 F	201.5 F
3.1 [nA]	0.5	0.5	0.5	0.5	0.4
4.1 [nA]	0.3	0.3	0.3	0.3	0.3
5.1 [uA]	0	1046 F	1046 F	1046 F	1046 F
6.1 [Ohm]	0.433	0.422	0.419	0.415	0.415