ESA-QCA0066T-C

Reference: DOF/DEC/RP6.096
Issue: 00
Date: 12/02/96
Page: 1/15

TOTAL DOSE STEADY-STATE IRRADIATION

OF

MBH 473D

"MACS BUS HEAD" HYBRID MICRO-CIRCUIT

from

MMS

Written by	Verified by	Approved by
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Date: 12/02/96	Date: 14/12/96	Date: 15 /02/96
Visa:	Visa:	Visa:

CONTENTS

I. DOCUMENTATION

I.1 APPLICABLE DOCUMENTS:

I. 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	ESA Basic Specification For Total Dose Steady-State Irradiation.
MA 9000/AHA Iss.3	Procurement Specification

II. TEST PLAN

II.1 PARTS REFERENCES

REFERENCES	
Type:	MBH 473D
Manufacturer:	MMS
Place:	France
Packaging:	Hybrid 36pin
FUNCTION	
Hybrid Micro-Circuit	
TECHNOLOGY	
Bipolar	
PARTS PROCUREMENT	
Origin :	MMS-UK
Date Code :	9229 (encapsulation)
Lot Number :	18
Quality Level :	D
Number of Parts :	3 (2 irradiated)
DETAIL SPECIFICATION	
MA9000/AHA Iss.3	

II.2 ELECTRICAL MEASUREMENTS

TEST TYPE	
Type:	Remote electrical measurements done at room temperature

TEST FACILITY	
Place:	MATRA VELIZY
Material:	Banc VXI

TESTED PARAMETERS

Parameter Name	Fig n°	Symbol	Test Conditions	min	max	Unit
Supply Current	1	I_{CC0}	Nominal Load All emitters off	-	60	mA
Supply Current	2 A/B	$I_{CC1\ A/B}$	Nominal Load One emitter active and DOUT is low level	-	170	mA
Supply Current	3 A/B	$I_{CC2\ A/B}$	Nominal Load One emitter active and DOUT is high level	-	75	mA
Clock Receiver						
Differential Input Resistance	4	$R_{DI\ CKA}$	CKB+ to CKB-	100	-	kΩ
	5	$R_{DI\ CKB}$	CKB+ to CKB-	100	-	kΩ
Clock Differential Input Hysteresis Voltage	6	$V_{DI\ CKA}$	$V_{CKB+} - V_{CKB-}$	18	42	mV
	7	$V_{DI\ CKB}$	$V_{CKB+} - V_{CKB-}$	18	42	mV
Propag Delay Time (Clock low to high)	8	t_{PLHCKA}	CL=18pF see spec fig.2	110	250	ns
	9	t_{PLHCKB}	CL=18pF see spec fig.2	110	250	ns
Propag Delay Time (Clock high to low)	10	t_{PHLCKA}	CL=18pF see spec fig.2	180	300	ns
	11	t_{PHLCKB}	CL=18pF see spec fig.2	180	300	ns
Rise Time (Clock Signal)	12	$t_{R\ CK}$	CL=18pF see spec fig.2	-	100	ns
Fall Time (Clock Signal)	13	$t_{F\ CK}$	CL=18pF see spec fig.2	-	50	ns

Parameter Name	Fig n°	Symbol	Test Conditions	min	max	Unit
Clock to Data LH Phase Timing	14	$t_{Phase\ LHA}$	Test 8 - 16	-80	50	ns
	15	$t_{Phase\ LHB}$	Test 12 - 22	-80	50	ns
Clock to Data HL Phase Timing	16	$t_{Phase\ HLA}$	Test 8 - 17	-120	50	ns
	17	$t_{Phase\ HLB}$	Test 12 - 23	-120	50	ns
Data Receiver						
Differential Input Resistance	18	$R_{DI\ REA}$	DBI+ TO DBI-+	100	-	kΩ
	19	$R_{DI\ REB}$	DBI+ TO DBI-+	100	-	kΩ
Clock Differential Input Hysteresis Voltage	20	$V_{DI\ REA}$	$V_{DBI+} - V_{DBI-}$	18	42	mV
	21	$V_{DI\ REB}$	$V_{DBI+} - V_{DBI-}$	18	42	mV
Propag Delay Time (DIN low to high)	22	t_{PLHREA}	CL=18pF see spec fig.2	110	250	ns
	23	t_{PLHREB}	CL=18pF see spec fig.2	110	250	ns
Propag Delay Time (DIN high to low)	24	t_{PHLREA}	CL=18pF see spec fig.2	180	300	ns
	25	t_{PHLREB}	CL=18pF see spec fig.2	180	300	ns
Ouput Enable Time (from RESET OUT)	26	$t_{PZL\ REA}$	CL=18pF V_{ID}=-2V, spec fig.3 Clock retrieval	-	50	ns
	27	$t_{PZL\ REB}$	CL=18pF V_{ID}=-2V, spec fig.3 Clock retrieval	-	50	ns
Ouput Disable Time (from RESET OUT)	28	$t_{PLZ\ REA}$	CL=18pF V_{ID}=-2V, spec fig.3 Clock disappearing	-10	70	ns
	29	$t_{PLZ\ REB}$	CL=18pF V_{ID}=-2V, spec fig.3 Clock disappearing	-10	70	ns
Rise Time (DIN Signal)	30	$t_{R\ DIN}$	CL=18pF Opposite clock bus steady state	-	100	ns
Fall Time (DIN Signal)	31	$t_{F\ DIN}$	CL=18pF Opposite clock bus steady state	-	50	ns

Parameter Name	Fig n°	Symbol	Test Conditions	min	max	Unit
Emitter						
Active differential Output Voltage	32	$V_{OD\ EMA}$	Nominal Load DOUT=0	-	-1.6	V
	33	$V_{OD\ EMB}$	Nominal Load DOUT=0	-	-1.6	V
Short Circuit Output Current	34	$I_{OS\ EMA}$	DOUT=0	-	120	mA
	35	$I_{OS\ EMB}$	DOUT=0	-	120	mA
Propag Delay Time from DOUT to Output	36	t_{PLHEMA}	Nominal Load Clock modulation	60	200	ns
	37	t_{PLHEMB}	Nominal Load Clock modulation	60	200	ns
Propag Delay Time from DOUT to Output	38	t_{PHLEMA}	Nominal Load Clock modulation	25	100	ns
	39	t_{PHLEMB}	Nominal Load Clock modulation	25	100	ns
Ouput Active Time from CMD=0	40	$t_{PZL\ EMA}$	Nominal Load DOUT=0 RESET OUT=1 Clock modulation	-	500	ns
	41	$t_{PZL\ EMB}$	Nominal Load DOUT=0 RESET OUT=1 Clock modulation	-	500	ns
Ouput Disable Time from RESET OUT	42	$t_{PLZ\ EMA}$	Nominal Load DOUT=0 Clock disappearing	-	6	µs
	43	$t_{PLZ\ EMB}$	Nominal Load DOUT=0 Clock disappearing	-	6	µs
Ouput Active Time from CMD=0	44	$t_{R\ EMA}$	Nominal Load Clock modulation DOUT changes from low to high level	-	300	ns
	45	$t_{R\ EMB}$	Nominal Load Clock modulation DOUT changes from low to high level	-	300	ns
Rise Time	46	$t_{F\ EMA}$	Nominal Load Clock modulation DOUT changes from high to low level	-	100	ns

Parameter Name	Fig n°	Symbol	Test Conditions	min	max	Unit
Fall Time	47	$t_{F\ EMB}$	Nominal Load Clock modulation DOUT changes from high to low level	-	100	ns
Clock Detection						
Time to be Active	48	$t_{ACT\ A}$	CL=18pF see spec fig.6	50	350	µs
	49	$t_{ACT\ B}$	CL=18pF see spec fig.6	50	350	µs
Time to be Inactive	50	$t_{INH\ A}$	CL=18pF see spec fig.6	50	350	µs
	51	$t_{INH\ B}$	CL=18pF see spec fig.6	50	350	µs
Rise Time (RESET OUT Signal)	52	$t_{R\ RESET}$	CL=18pF see spec fig.6	-	100	ns
Fall Time (RESET OUT Signal)	53	$t_{F\ RESET}$	CL=18pF see spec fig.6	-	50	ns
Synchro Recovery						
Synchronization Set-Up Time	54	$t_{SYNC\ A}$	CL=18pF see spec fig.7	500	1400	ns
	55	$t_{SYNC\ B}$	CL=18pF see spec fig.7	500	1400	ns
Hold Time	56	$t_{HOLD\ A}$	CL=18pF see spec fig.7	400	1000	ns
	57	$t_{HOLD\ B}$	CL=18pF see spec fig.7	400	1000	ns
Rise Time (SYNC Signal)	58	$t_{R\ SYNC}$	CL=18pF see spec fig.7	-	200	ns
Fall Time (SYNC Signal)	59	$t_{F\ SYNC}$	CL=18pF see spec fig.7	-	50	ns

Notes:

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

II.3 EXPERIMENTAL CONDITIONS

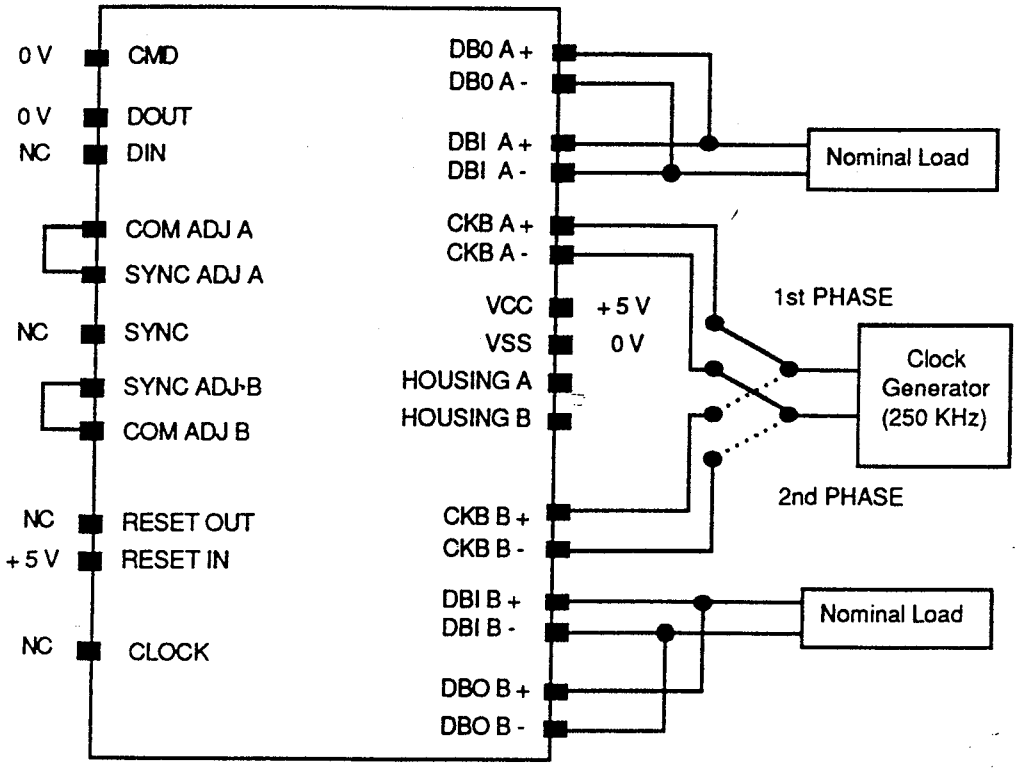
IRRADIATION FACILITY

Place:	MATRA VELIZY (France)
Type:	Cobalt 60 Shepherd 484
Activity:	9 Curies
Calibration Date:	09/09/95

EXPOSURE TYPE

Type:	Multiple Exposures
Steps:	5.2, 11.7, 19.5, 34.6, 50.7, 74.9, 98.7 kRad[Si].

BIASING CONDITIONS



1st phase (interface A)
. Clock A = 250 kHz ± 5%
. Duration = 0,5 ms

2nd phase (interface B)
. Clock B = 250 kHz ± 5%
. Duration = 0,5 ms

COMMENTS

2 parts were biased in the mode described hereabove

III TEST REPORT

III.1 EXPERIMENTAL CONDITIONS

PARTS IDENTIFICATION			
Manufacturer Marking :	MBH-B 473D MA 9000 AHA 922918xx		
Serial Numbers	**Sample Devices**		**Control**
Manuf. Marking	30	43	9
Biasing Mode	On	On	Unbiased

IRRADIATION TEST SEQUENCE

Step n°	Date/Time IN Date/Time OUT		Description	Dose Rate kRad[Si]/h	Exp. Time h	Dose kRad[Si]	Total Dose kRad[Si]
0	16/01/96		Initial Elect. Measurements				
1 1a	16/01/96 17/01/96	19h00 09h25	Irradiation Elec. Measur.	0.36	14.4	5.2	5.2
2 2a	17/01/96 18/01/96	11h30 09h05	Irradiation Elec. Measur.	0.30	21.6	6.5	11.7
3 3a	18/01/96 19/01/96	10h35 09h00	Irradiation Elec. Measur.	0.35	22.4	7.8	19.5
4 4a	19/01/96 22/01/96	10h30 10h35	Irradiation Elec. Measur.	0.21	72.1	15.1	34.6
5 5a	22/01/96 24/01/96	12h15 10h15	Irradiation Elec. Measur.	0.35	46	16.1	50.7
6 6a	24/01/96 29/01/96	12h00 13h00	Irradiation Elec. Measur.	0.205	121	24.2	74.9
7 7a	29/01/96 01/02/96	15h00 16h15	Irradiation Elec. Measur.	0.325	73.25	23.8	98.7
6 6a	01/02/96 02/02/96	17h45 15h45	Anneal room t° Elec. Measur.		22		
7 7a	02/02/96 09/02/96	16h45 16h45	Anneal 100°C Elec. Measur.		168		

III.2 EXPERIMENTAL RESULTS

III.2.1.Parametric tests:

The evolution of each parameter as a function of the total dose is plotted at the end of the report. The two last steps correspond to the 25°C and 100°C post annealing measurements.

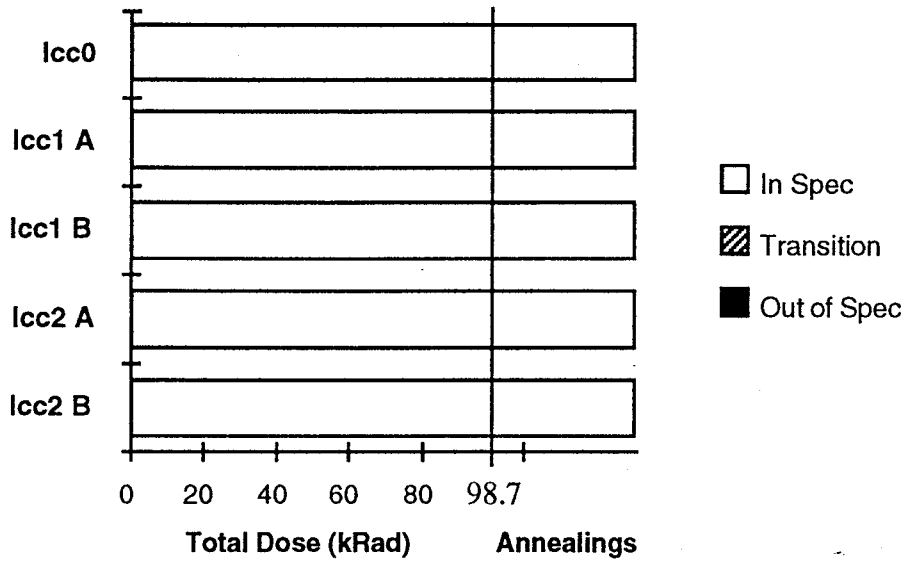
The following tables summarize the evolution of the measured parameters with irradiation and annealings.

In the construction of these charts ,

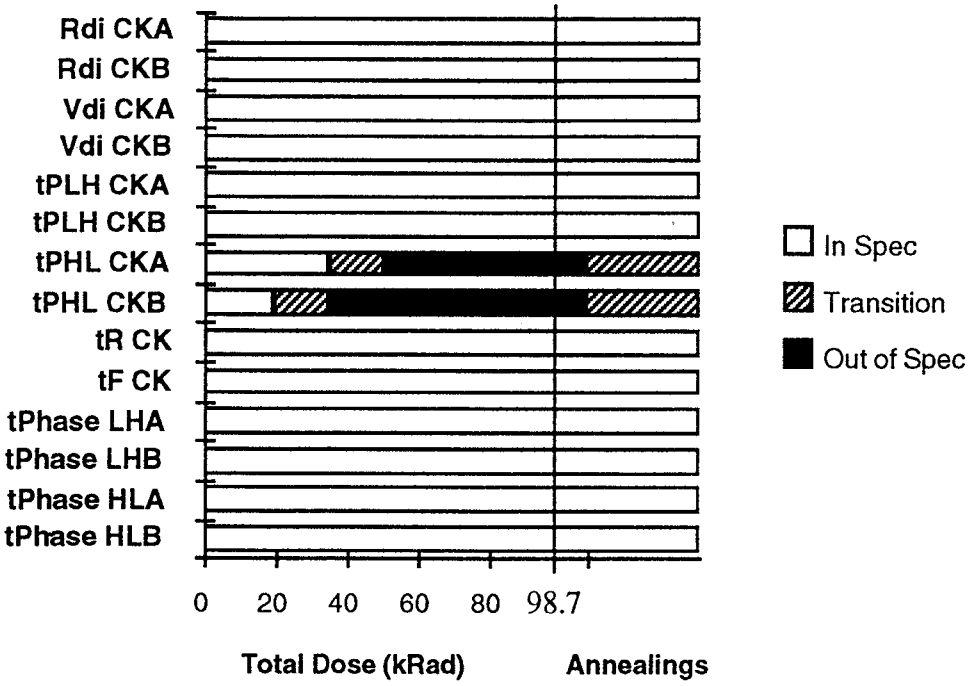
1/ A parameter is considered to be out of specification if the parameter is measured out of specification on one or more devices.

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.

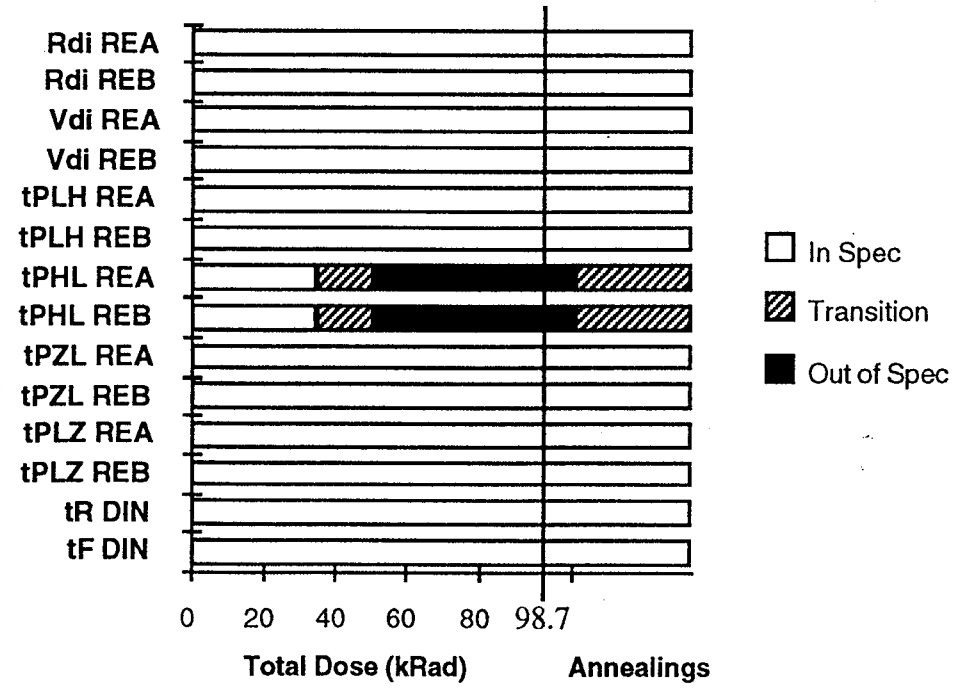
3/ The step during which a parameter goes out of specification (or recovers) is called transition step.



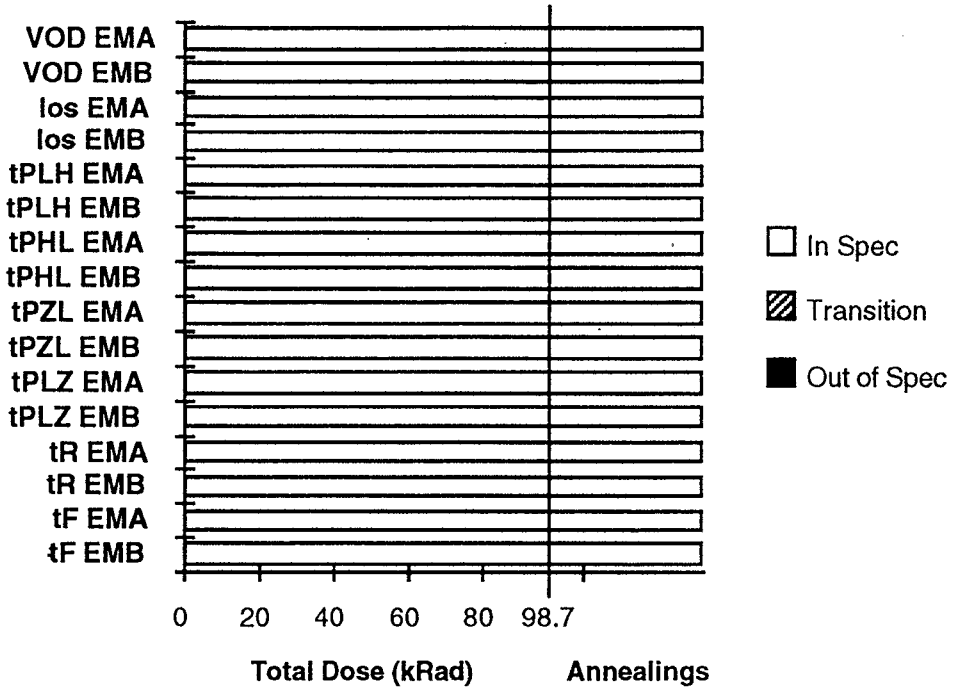
Clock Receiver :



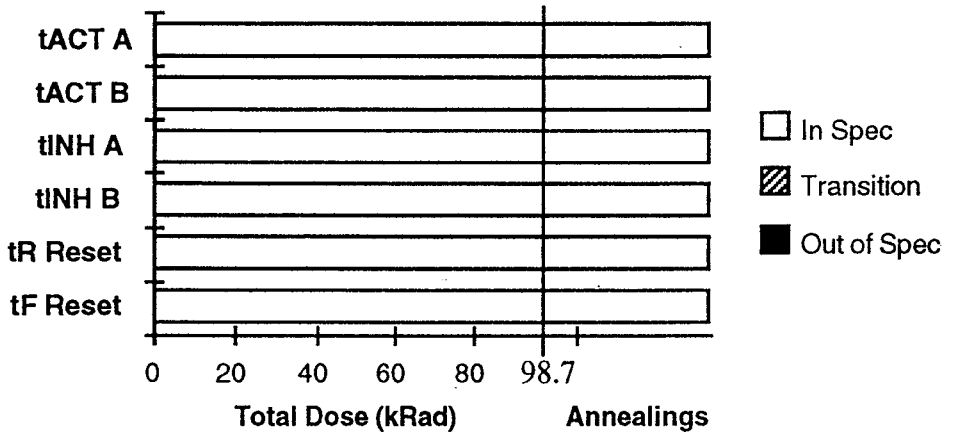
Data Receiver :



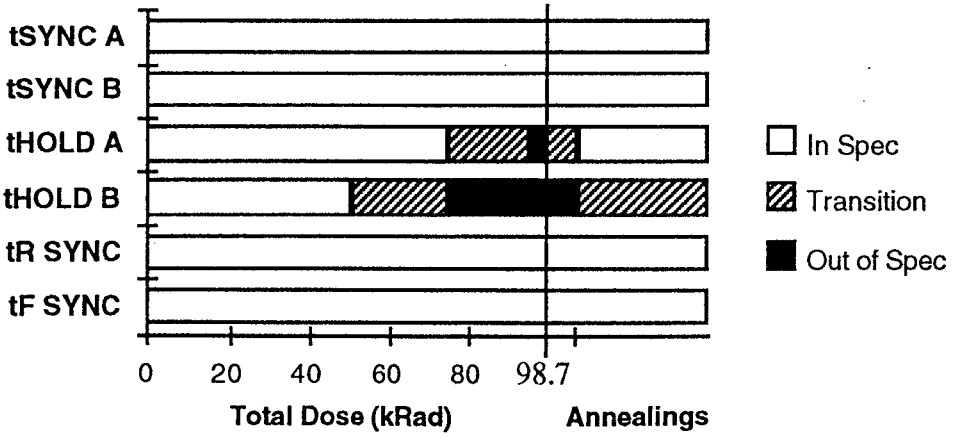
Emitter :



Clock Detection :



Synchro Recovery :



III.2.2.Post irradiation effects.

Step 1.

Temperature: Room Temperature.
Duration: 22h
Biasing: Parts biased as during irradiation.

Step 2.

Temperature: 100°C.
Duration: 168h
Biasing: Parts biased as during irradiation.

An annealing effect has been observed on deteriorated parameters which all recover and come back within specificatiuon after annealing at 100°C.

Important remark: According to some papers published in IEEE Nucl.Science *, 100°C annealing results shall not be taken into account in an attempt to predict the space dose rate behavior of parts.

III.2.3 Problems encountered / Discussion

No specific problem has been encountered during the test.

* "Hardness-Assurance and Testing Issues for bipolar/BiCMOS Devices"
R. NATHAN Nowlin, D.M. Fleetwood, R.D. Schrimpf, R.L. Pease, W.E. Combs
IEEE Transactions on nuclear Science, Vol.40, n°6, p1686, December 93.

IV CONCLUSION

Total dose steady-state irradiation test using gamma rays from Cobalt 60 has been carried out on 2 **Hybrid Micro-circuit "Macs Bus Head" MBH 473D** from **MMS** up to 98.7 kRad[Si] at low dose rate (≤ 360 Rad/h).

The results indicate that:

- All parts stay functional up to the last step of irradiation at 98.7kRad and after annealings.

- All the parameters stay within specification up to **30kRad**[Si] by interpolation from the figure.

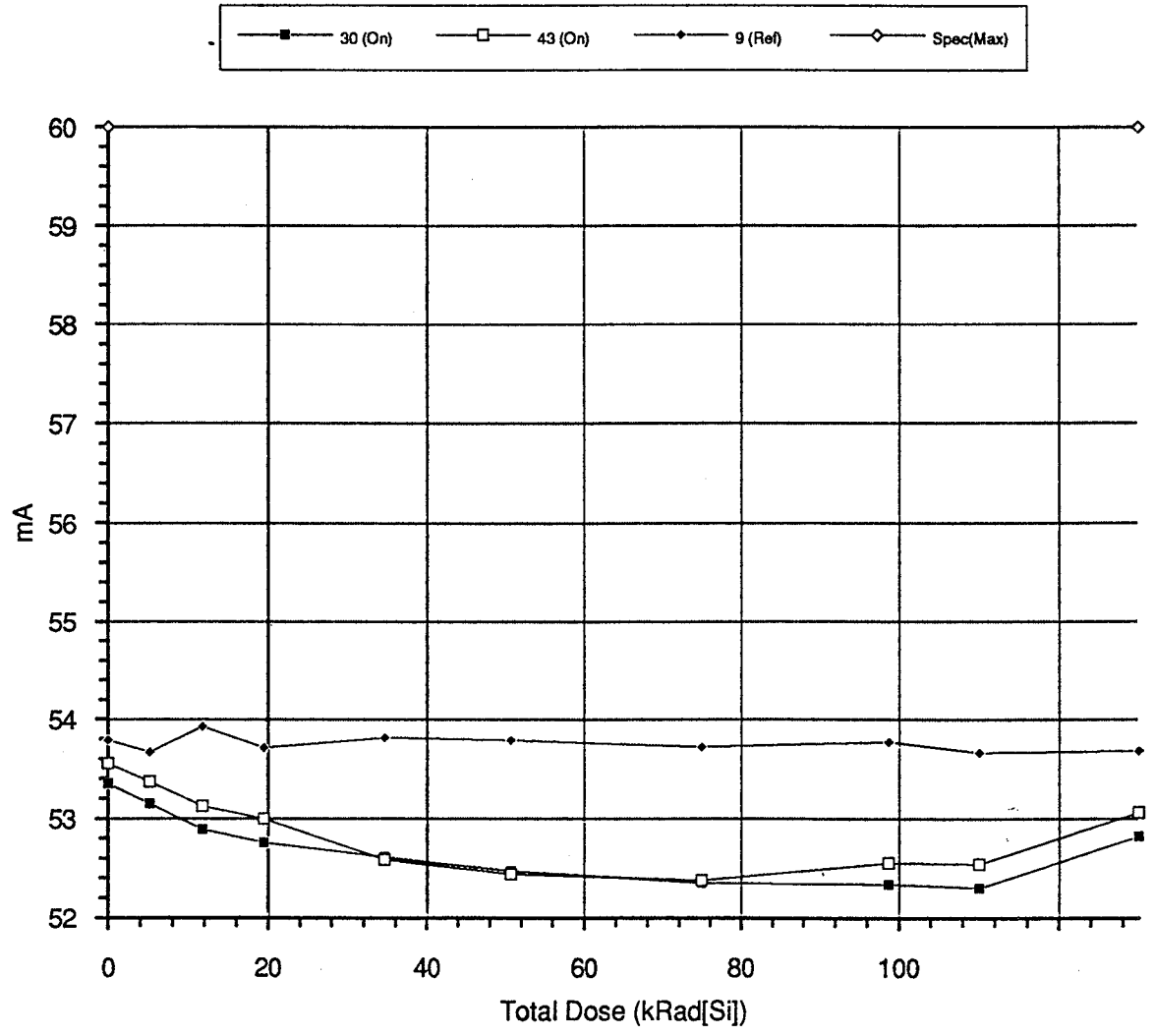
- The parameters which overstep specification during irradiation are :
  - **tPHL** CKA and CKB at 46kRad and 30kRad respectively (by interpolation)
  - **tPHL** REA and REB at 40kRad and 37 kRad (by interpolation)
  - **tHold** A and B at 80kRad and 56kRad (by interpolation)

- All parameters come back within specification after annealing at 100°C.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 1
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **ICC0**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, all emitters Off.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: **2**

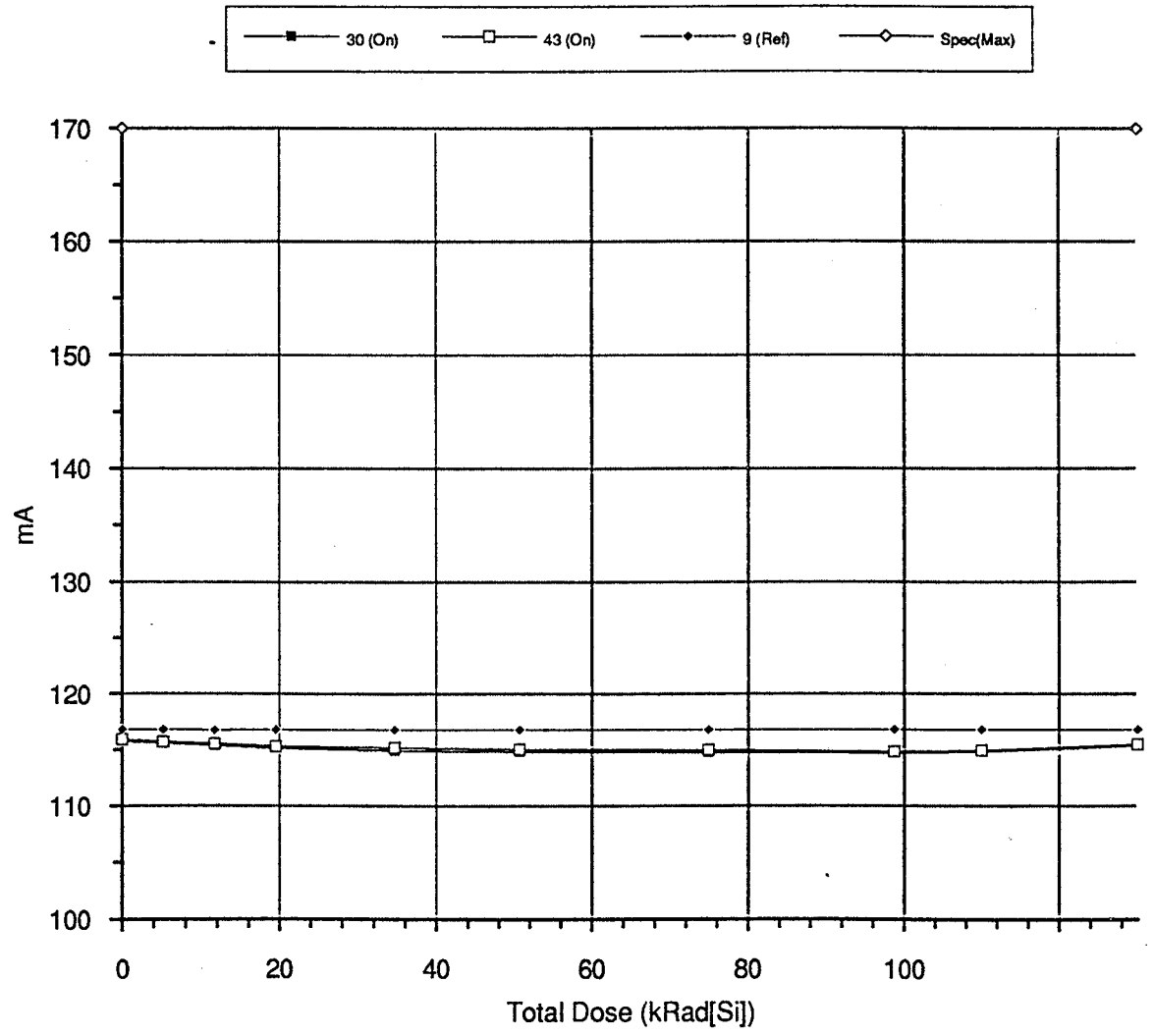


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 2a
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **ICC1_A**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, one emitter active and DOUT is low level.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

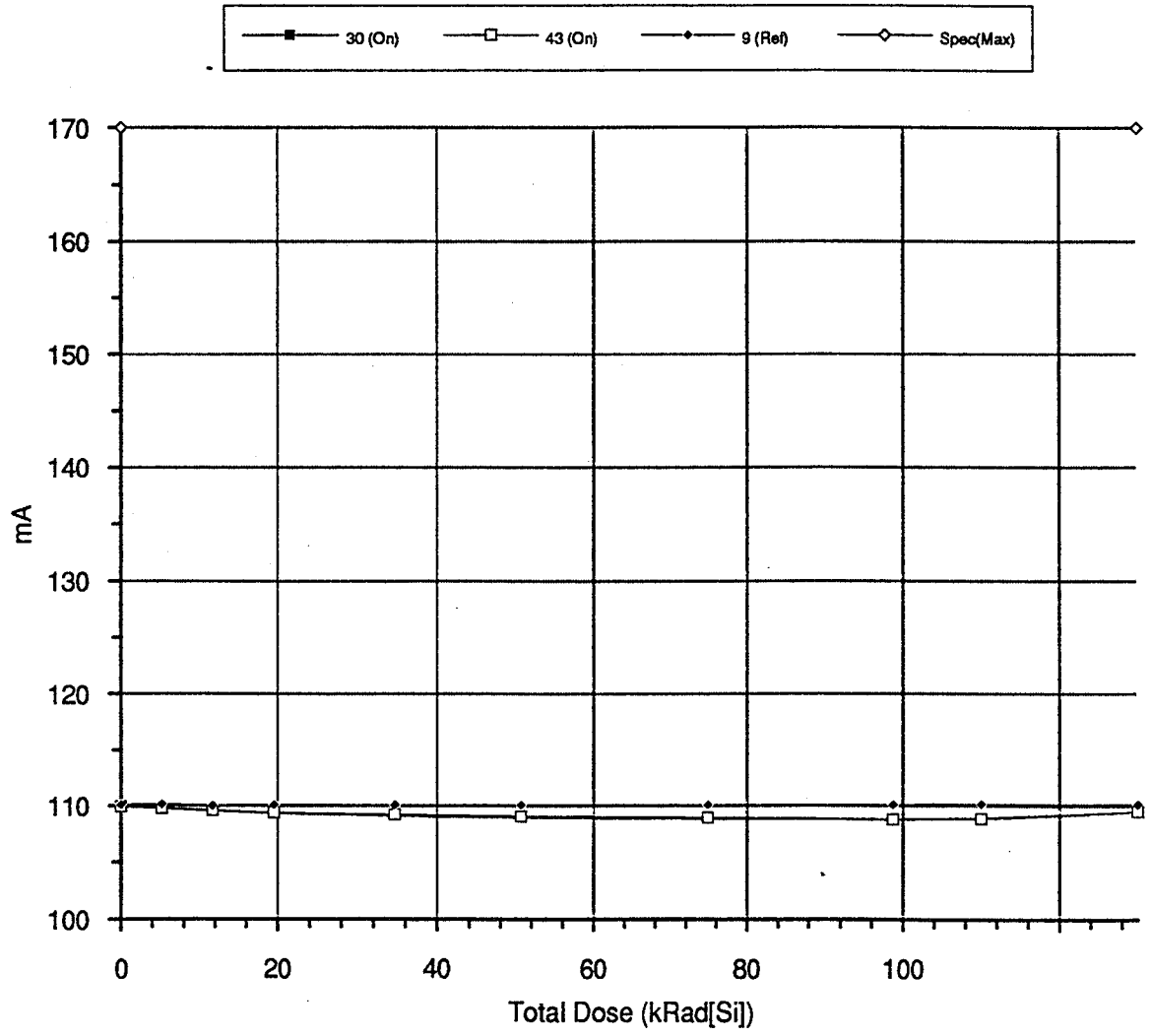


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 2b
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **ICC1_B**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, one emitter active and DOUT is low level.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: **2**

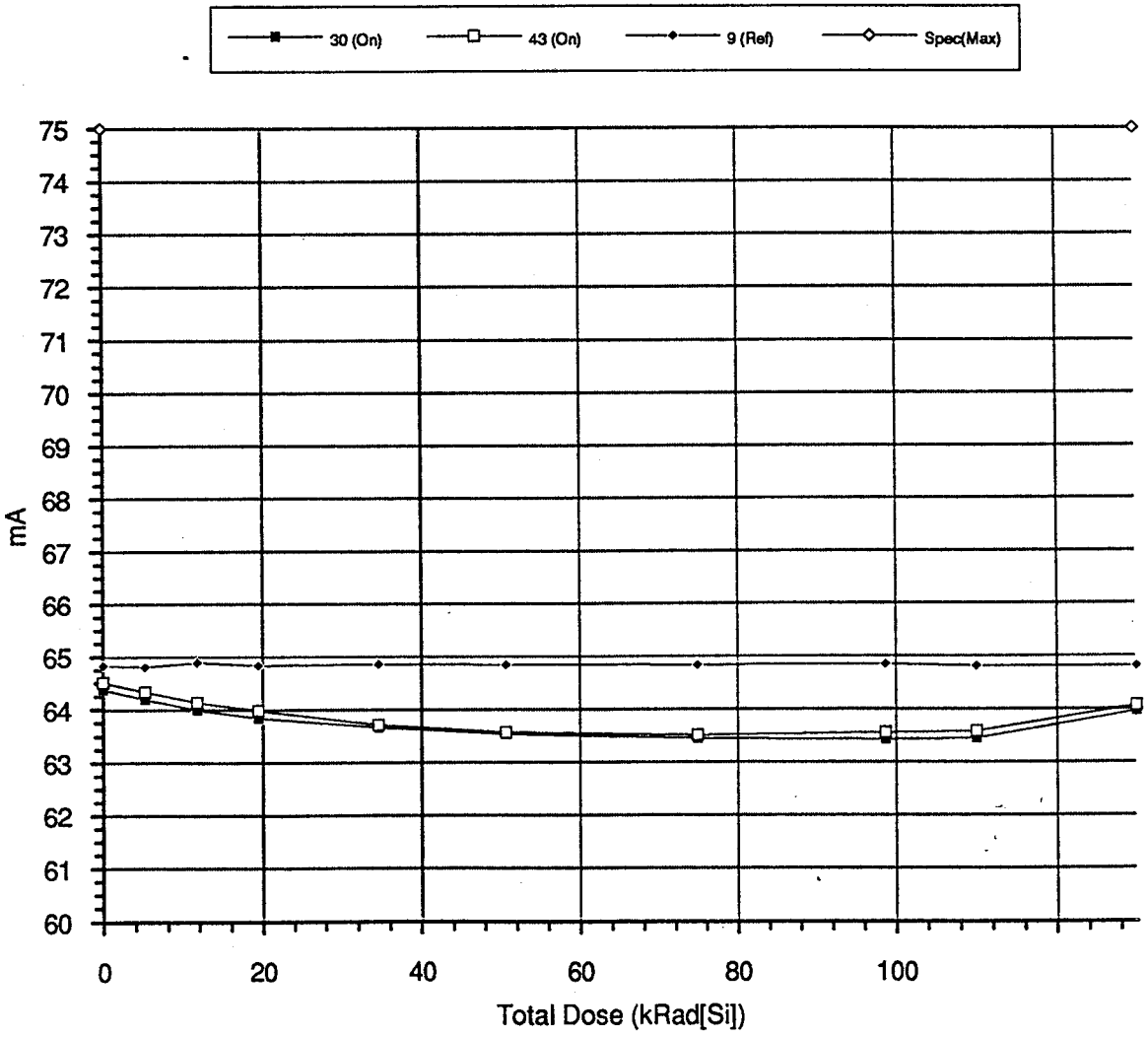


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 3a
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **ICC2_A**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, one emitter active and DOUT is high level.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: *2*

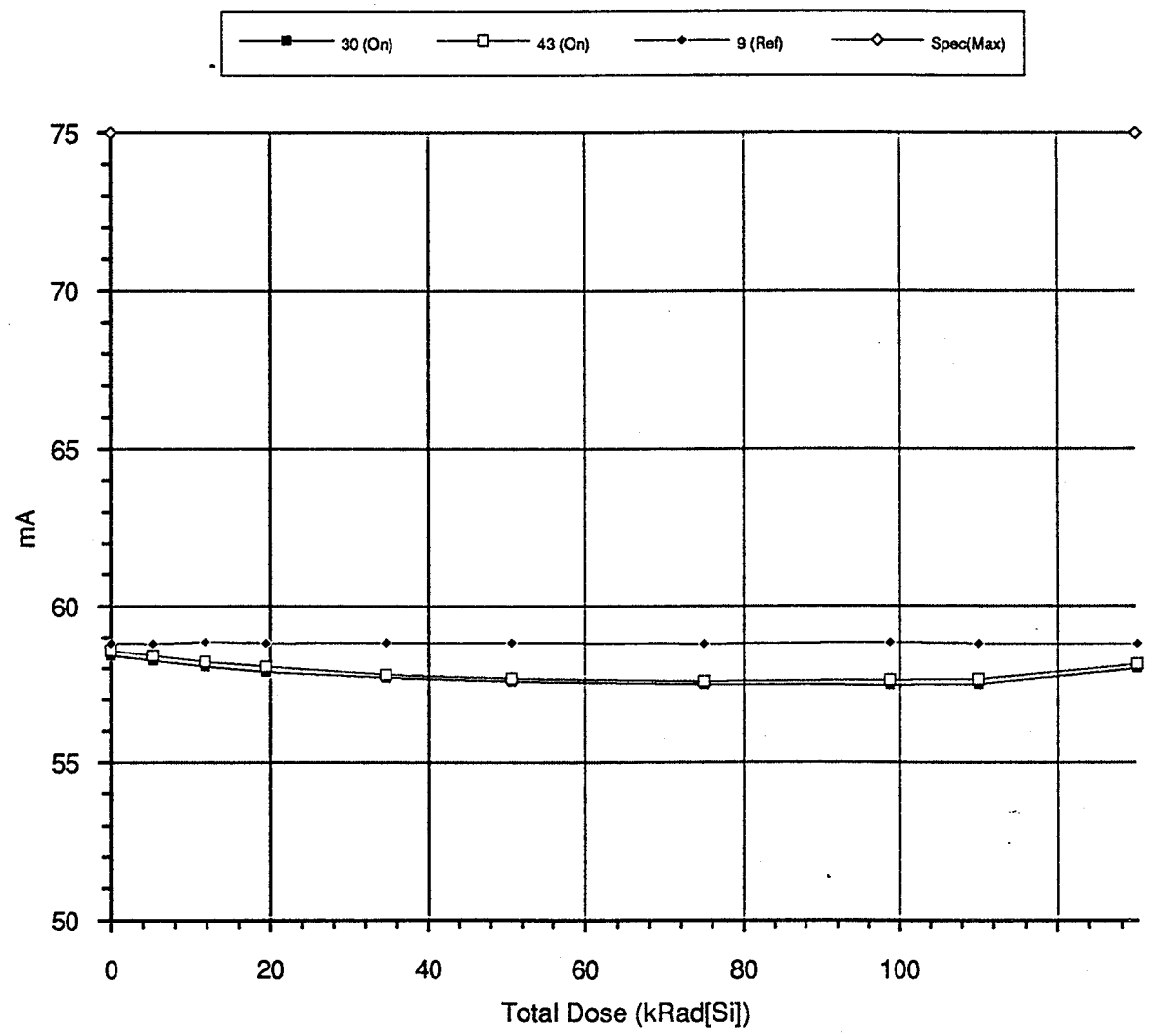


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 3b
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **ICC2_B**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, one emitter active and DOUT is high level.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

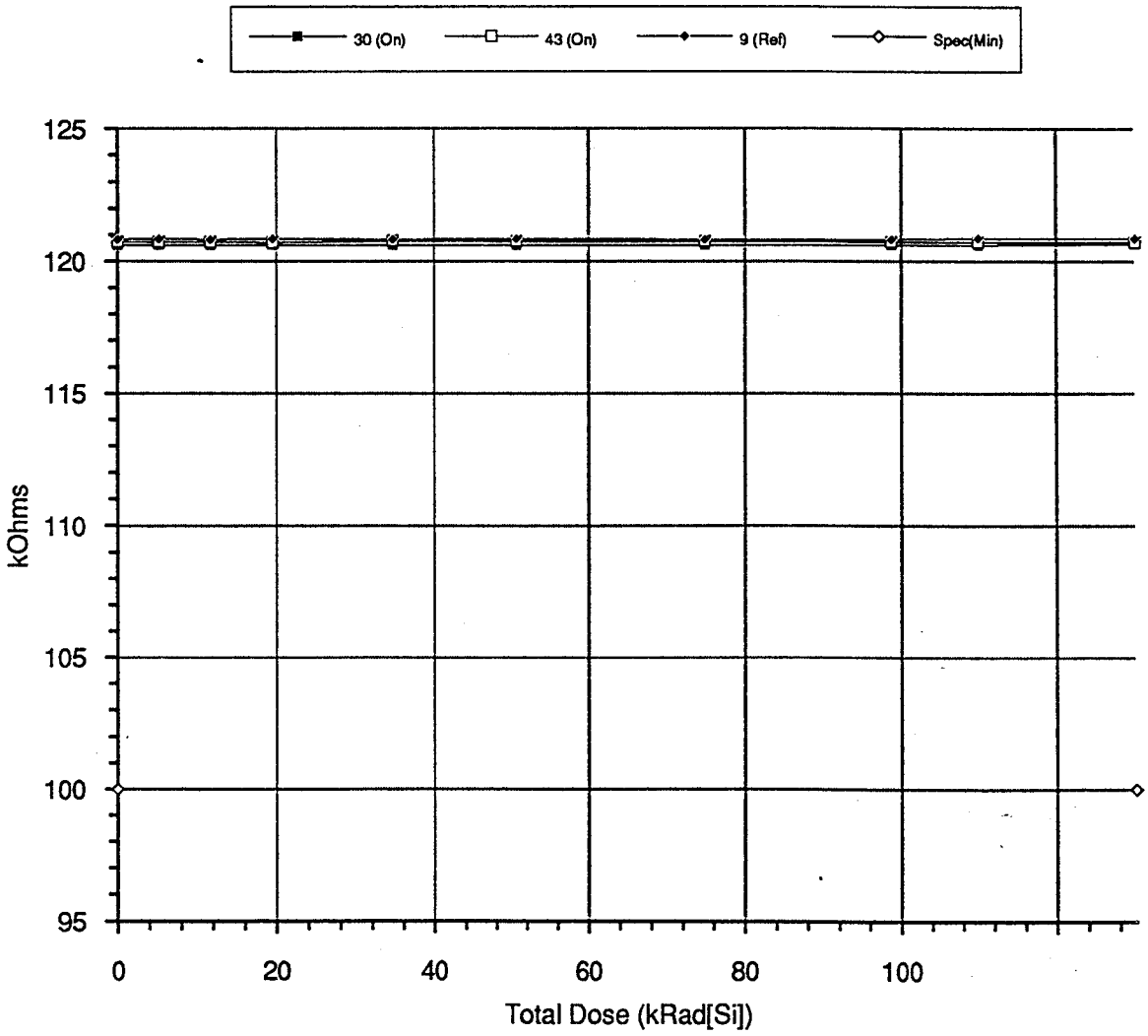


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 4
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **RDI_CKA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **CK8+ to CKB-.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: **2**

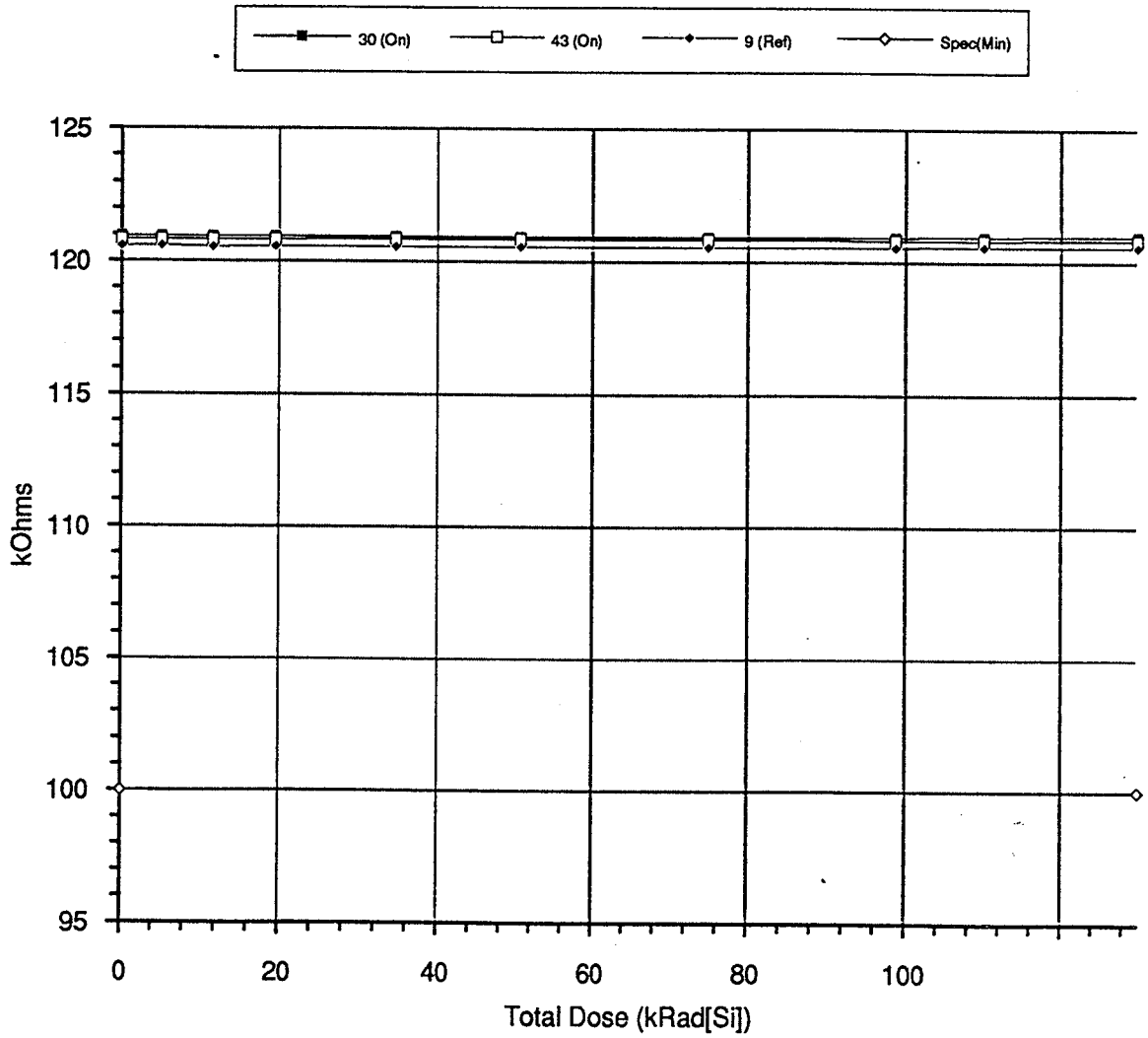


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: January 96.		Fig. 5
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **RDI_CKB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **CKB+ to CKB-.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: **2**

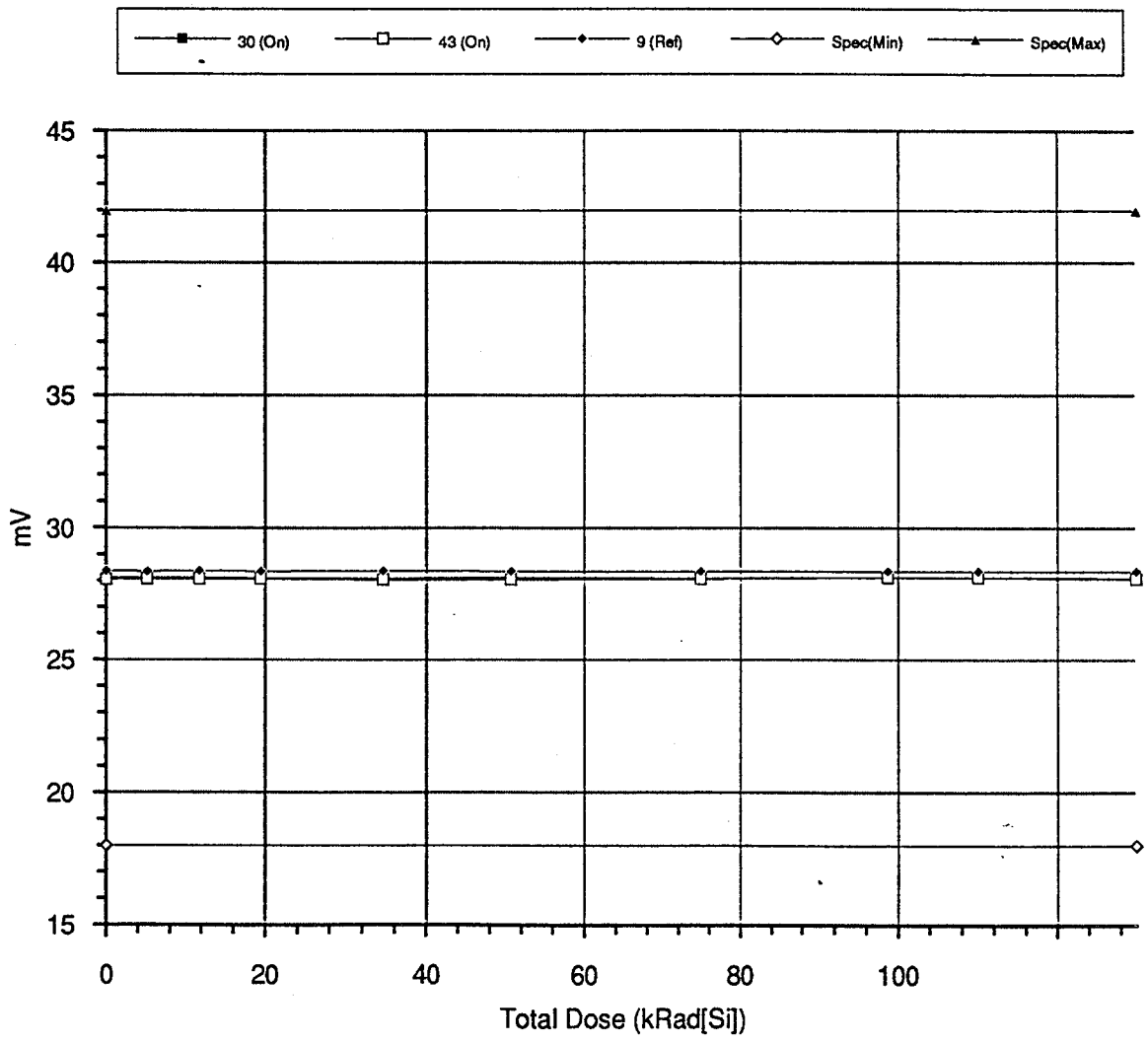


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: January 96.		Fig. 6
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **VDI _CKA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **(VCKA+) - (VCKB-).**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

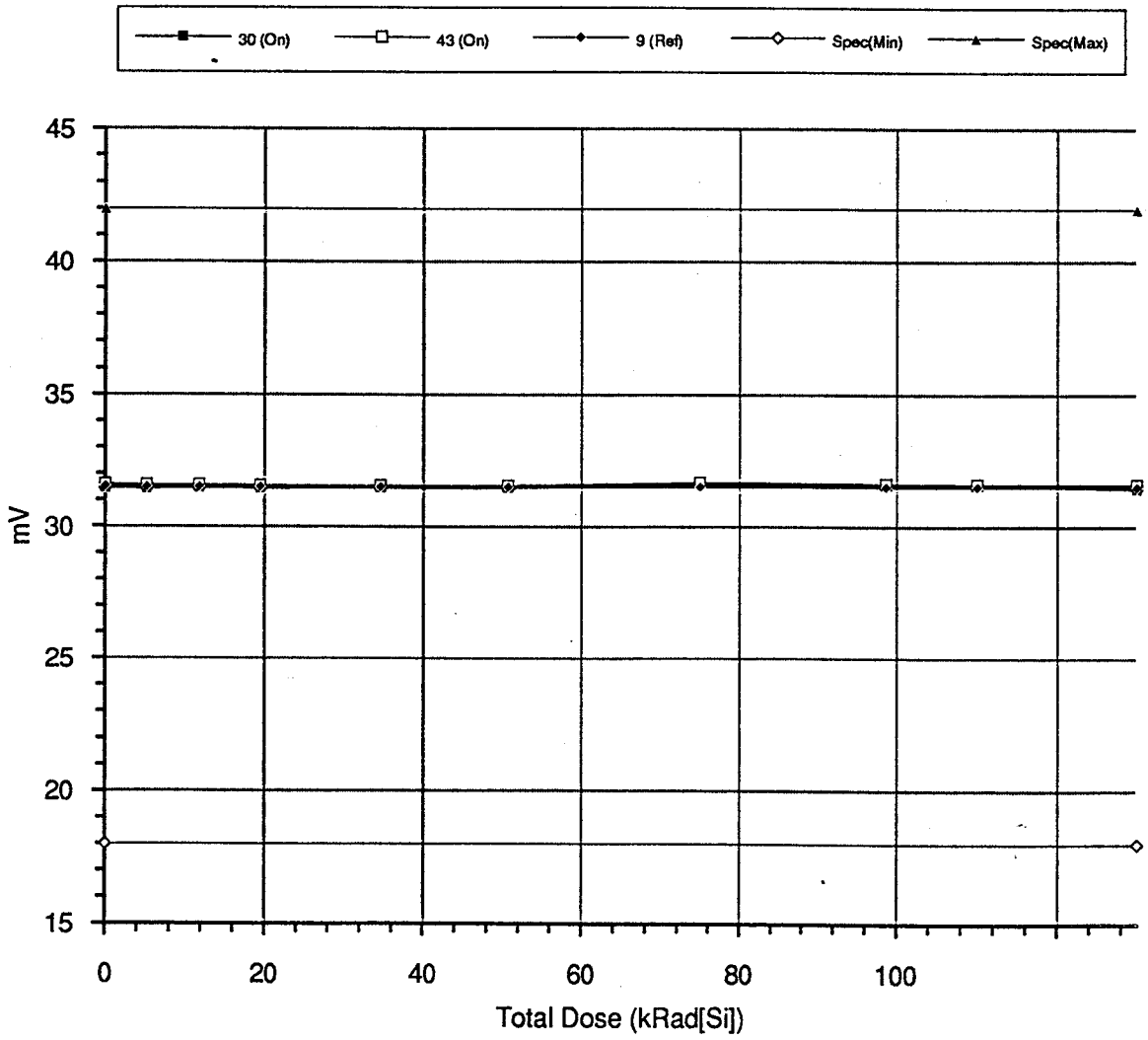


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: January 96.		Fig. 7
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **VDI _CKB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **(VCKB+) - (VCKB-).**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: **2**

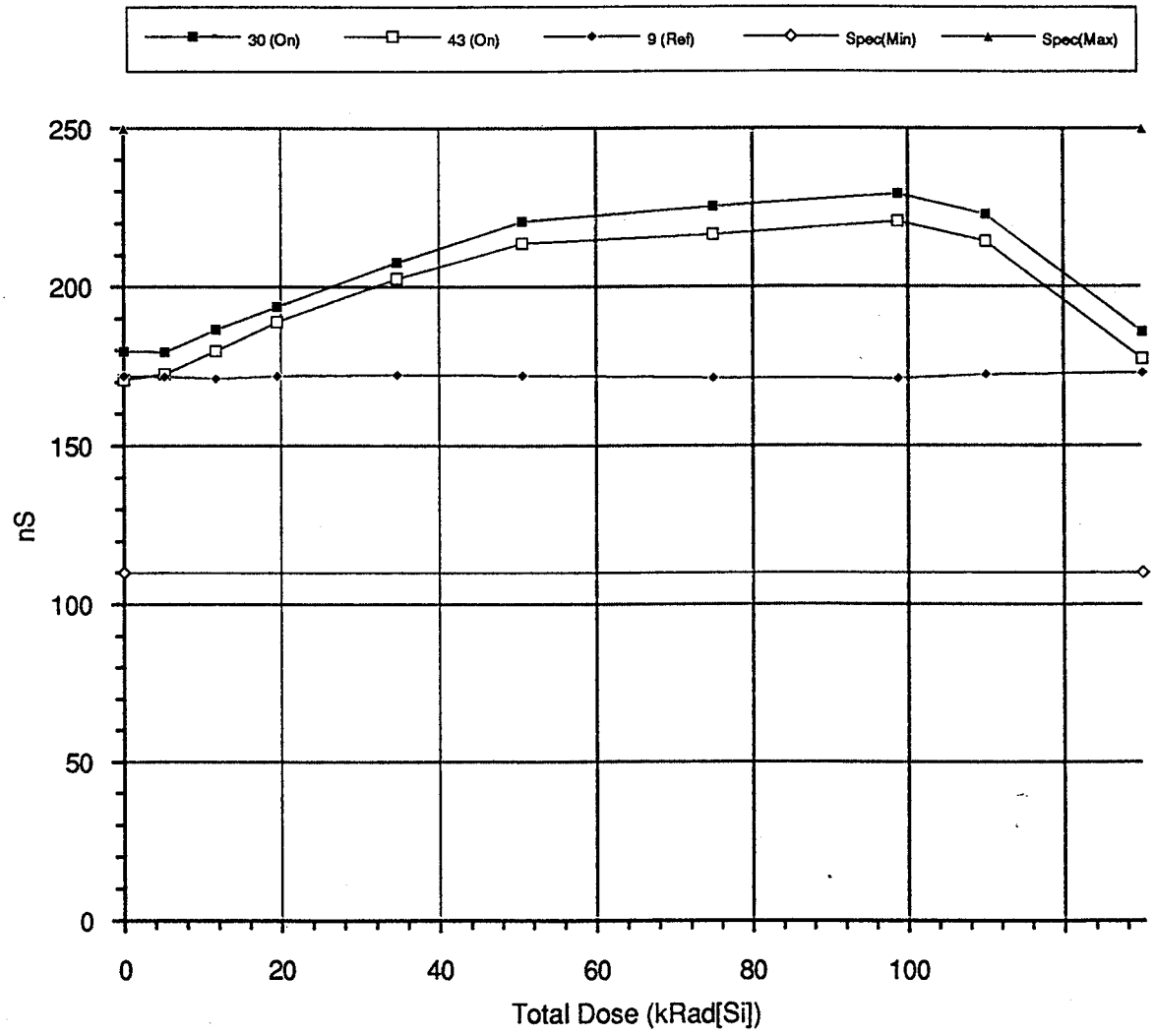


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 8
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLH_CKA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: **2**

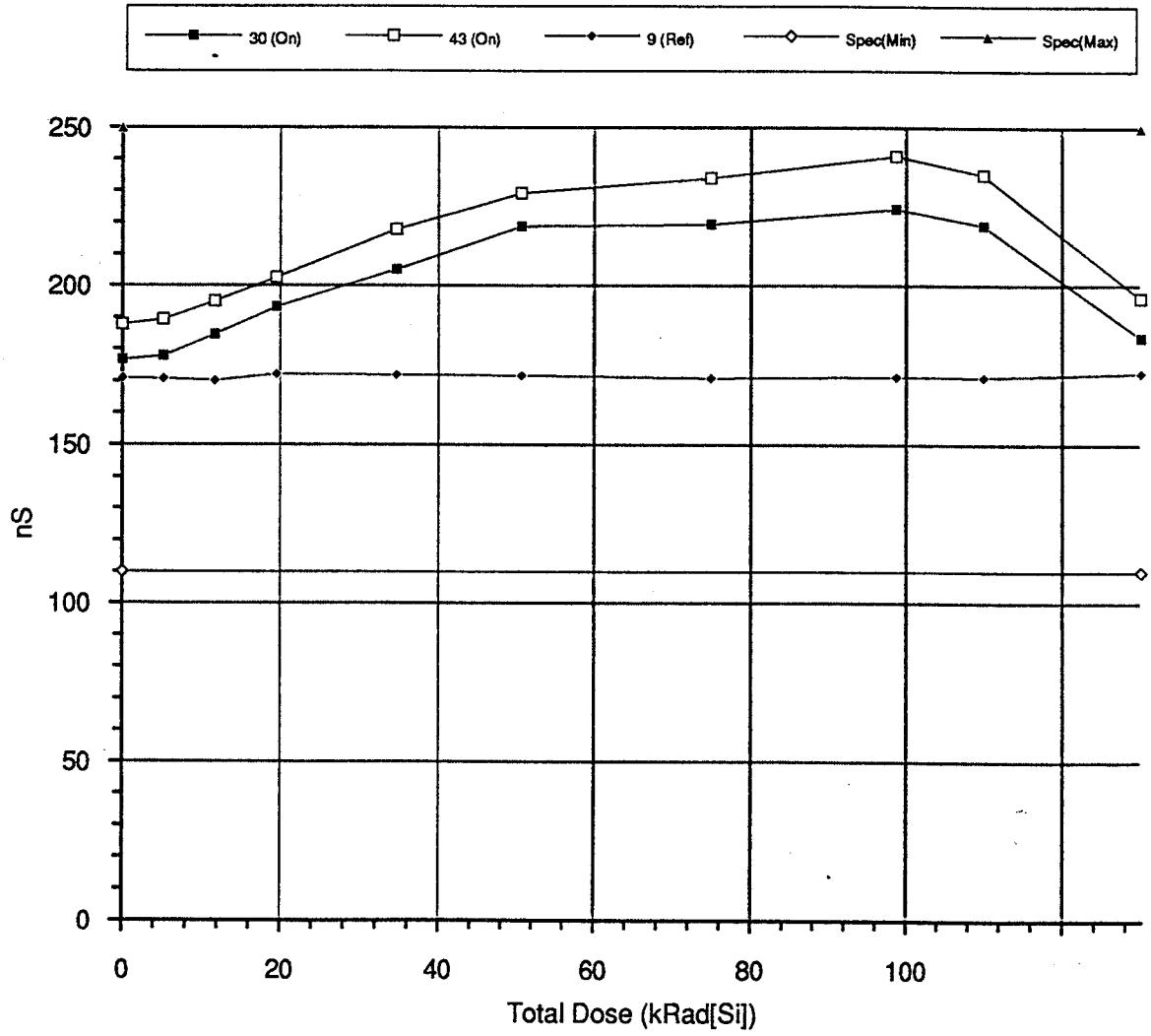


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 9
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLH_CKB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: **2**

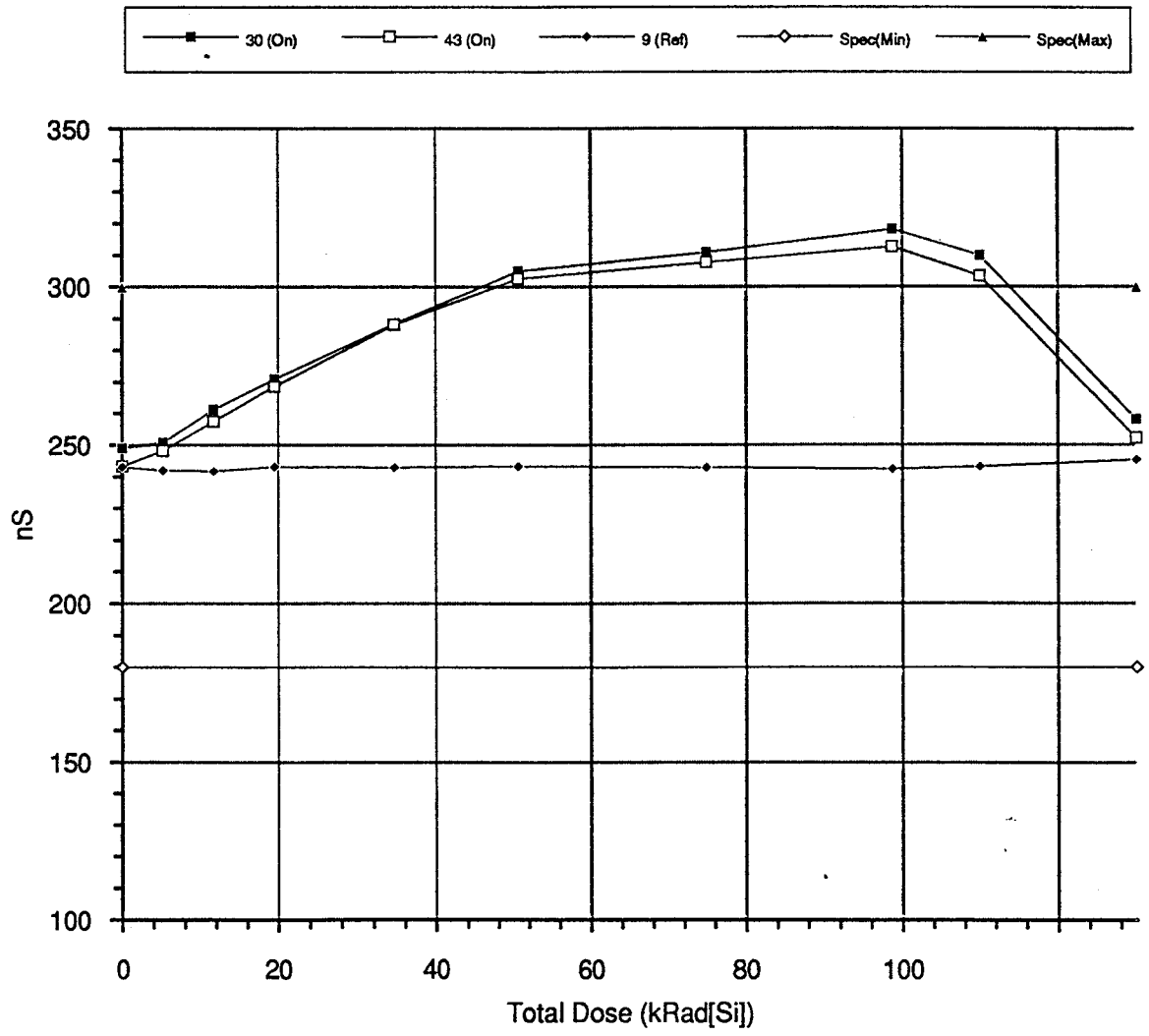


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 10
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPHL_CKA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

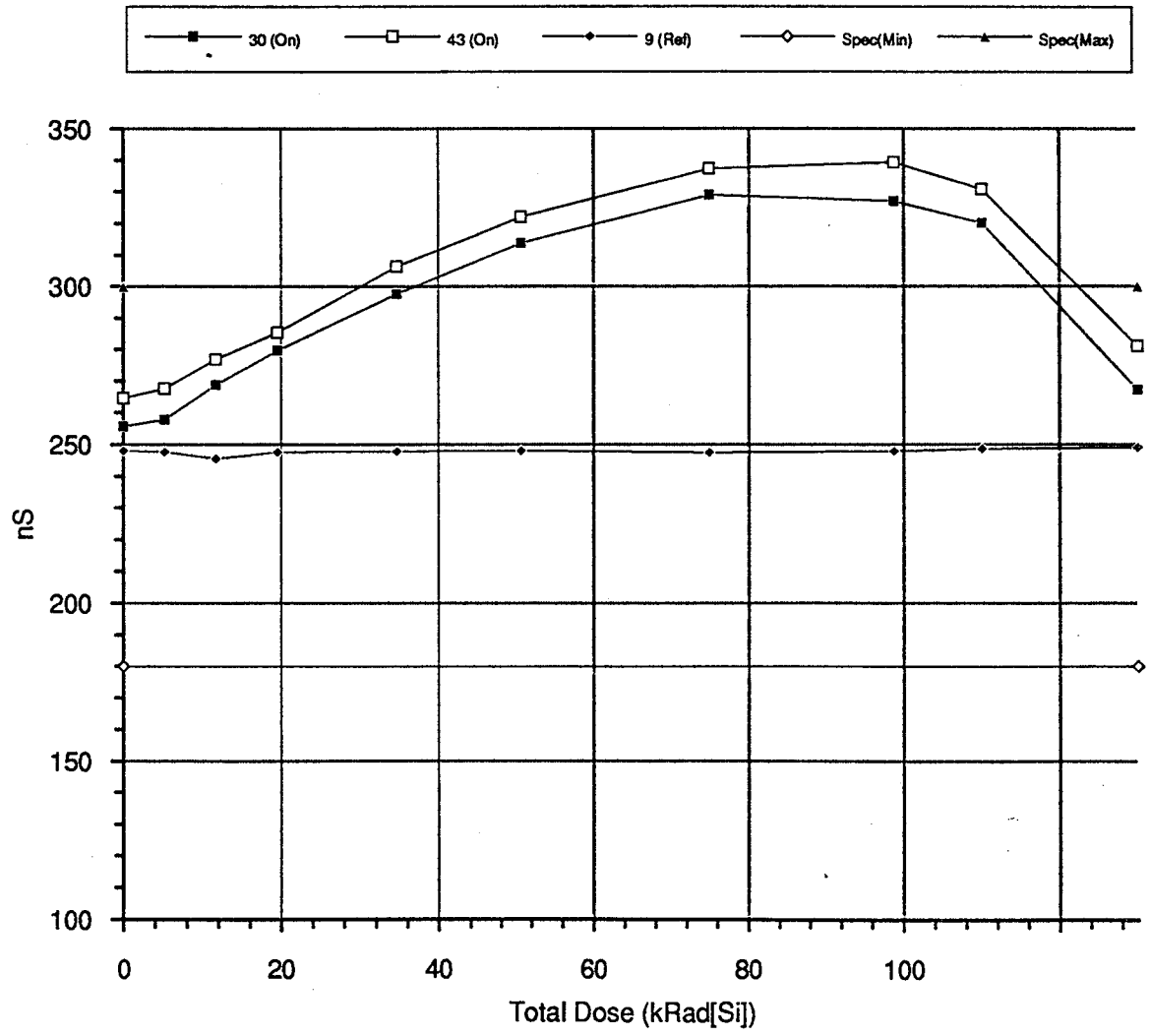


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 11
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPHL_CKB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: **2**

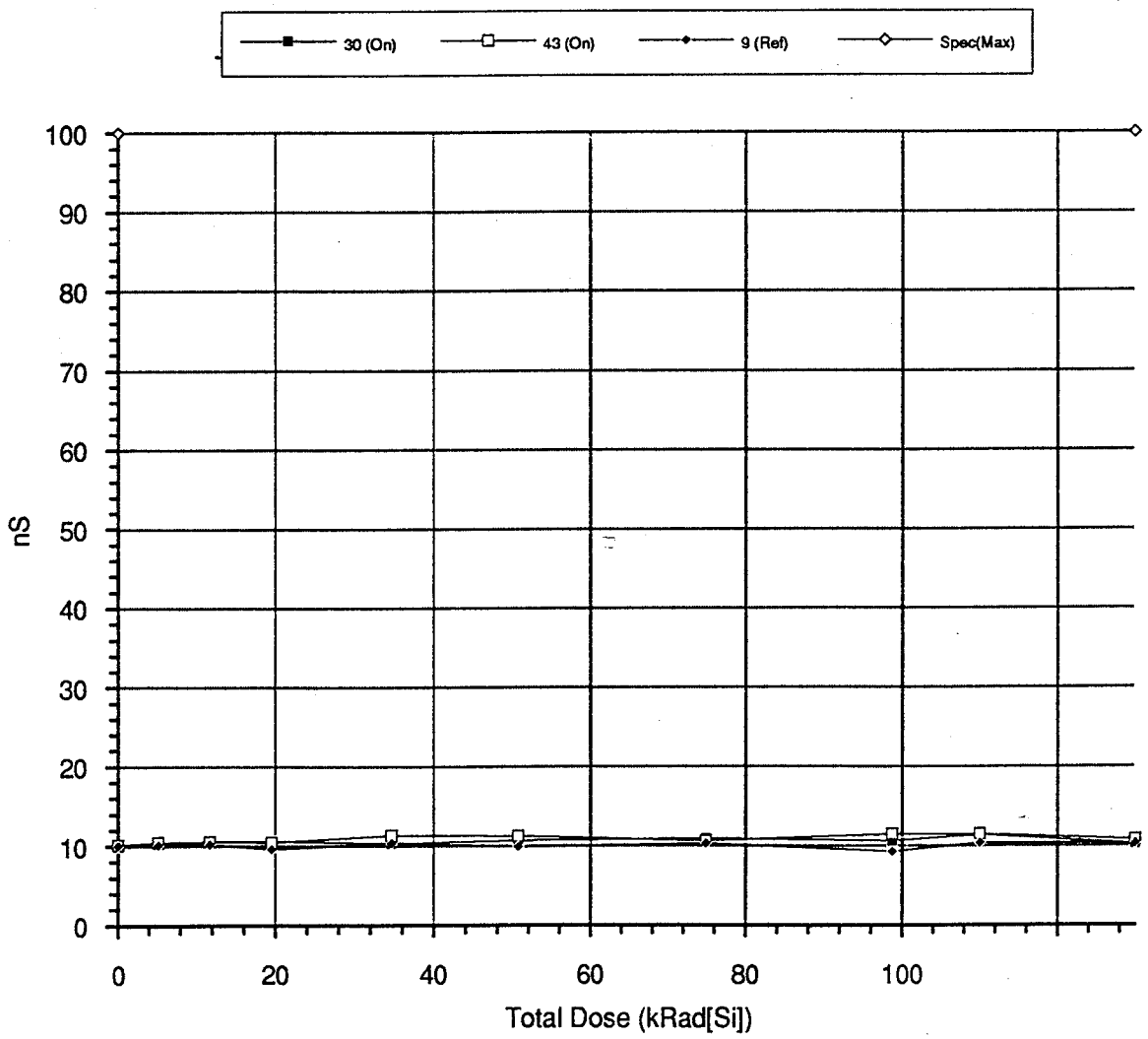


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 12
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TR_CK**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

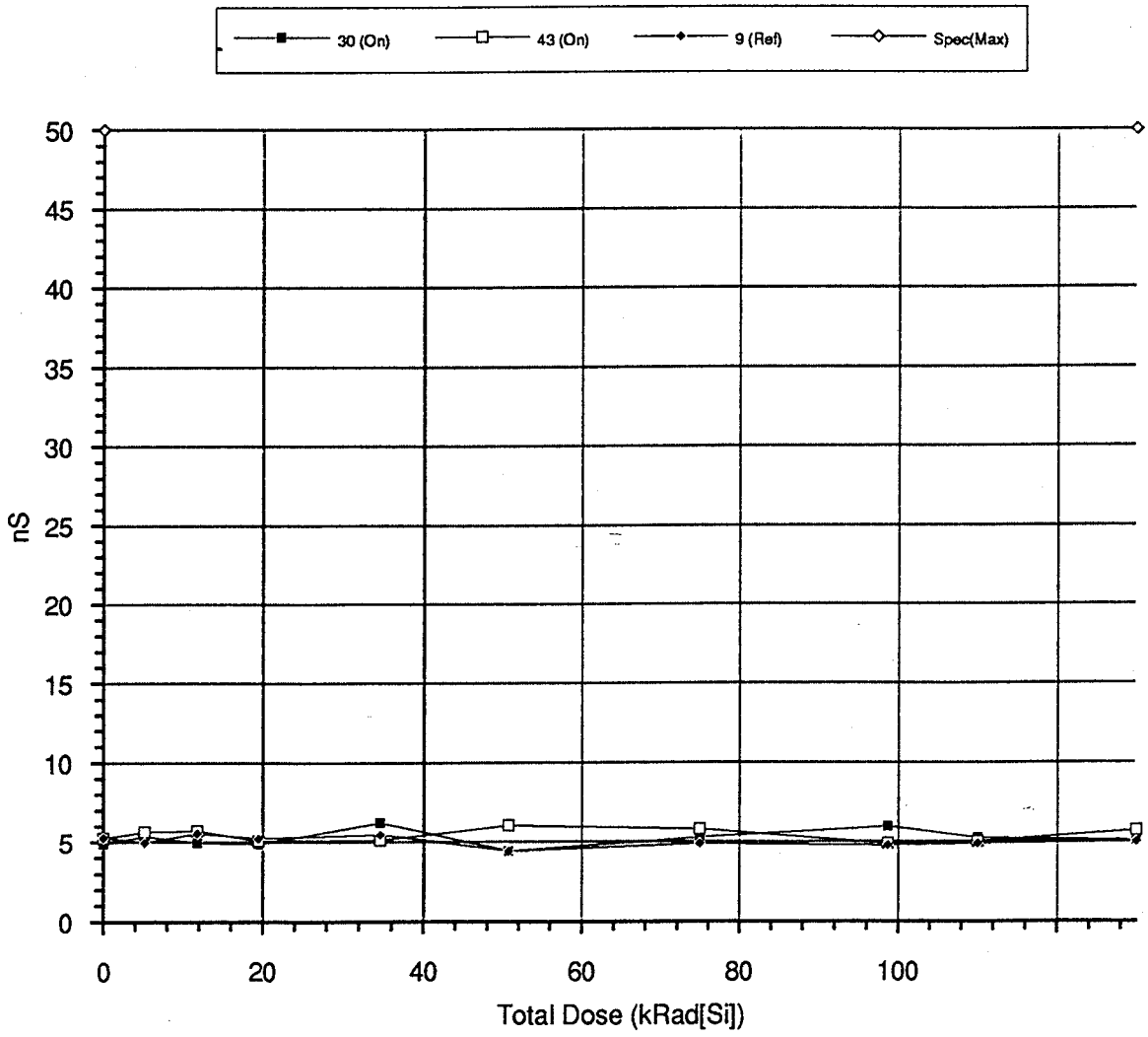


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 13
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TF_CK**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

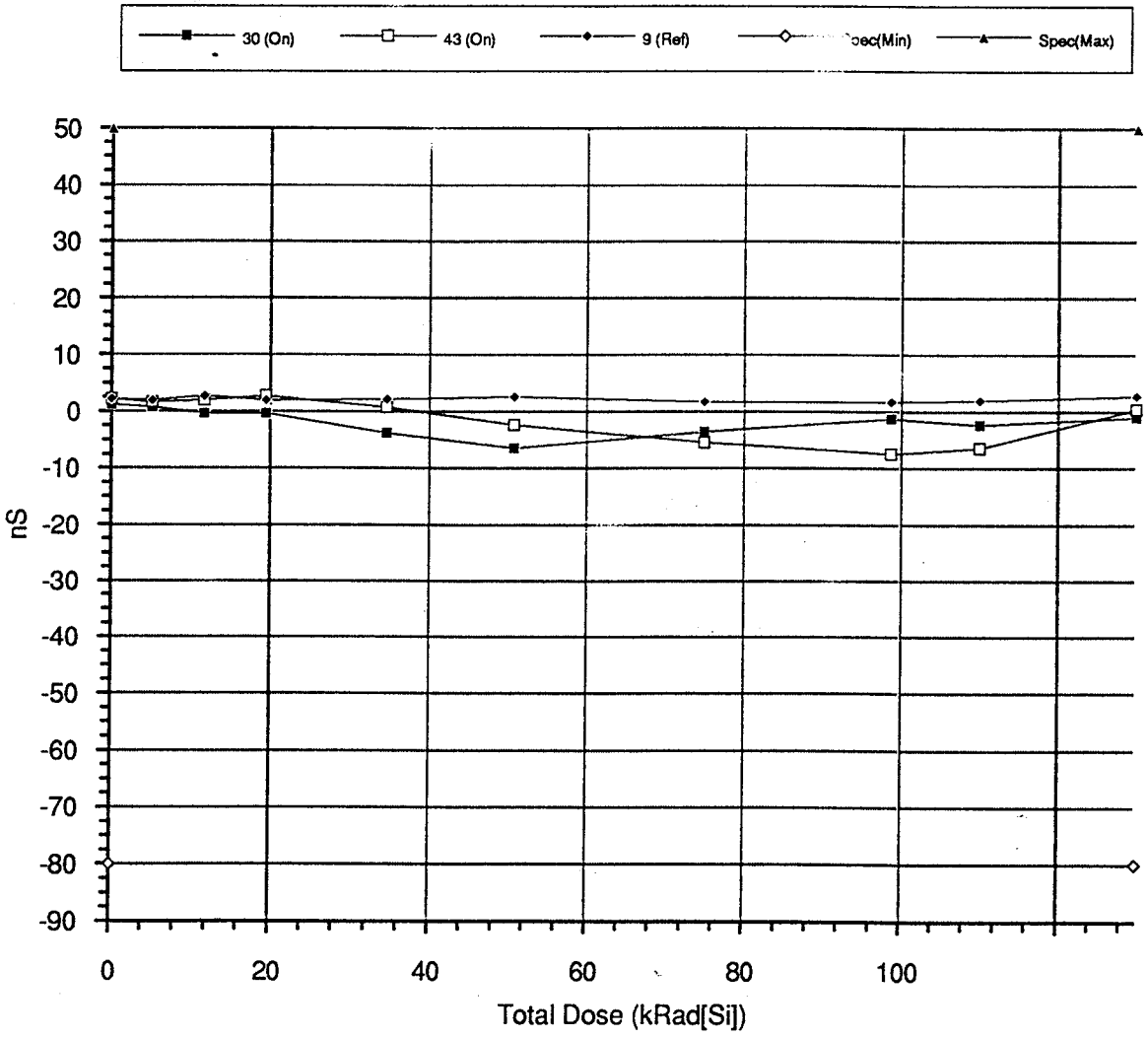


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: January 96.		Fig. 14
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **PhaseLHA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Test 8-16.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

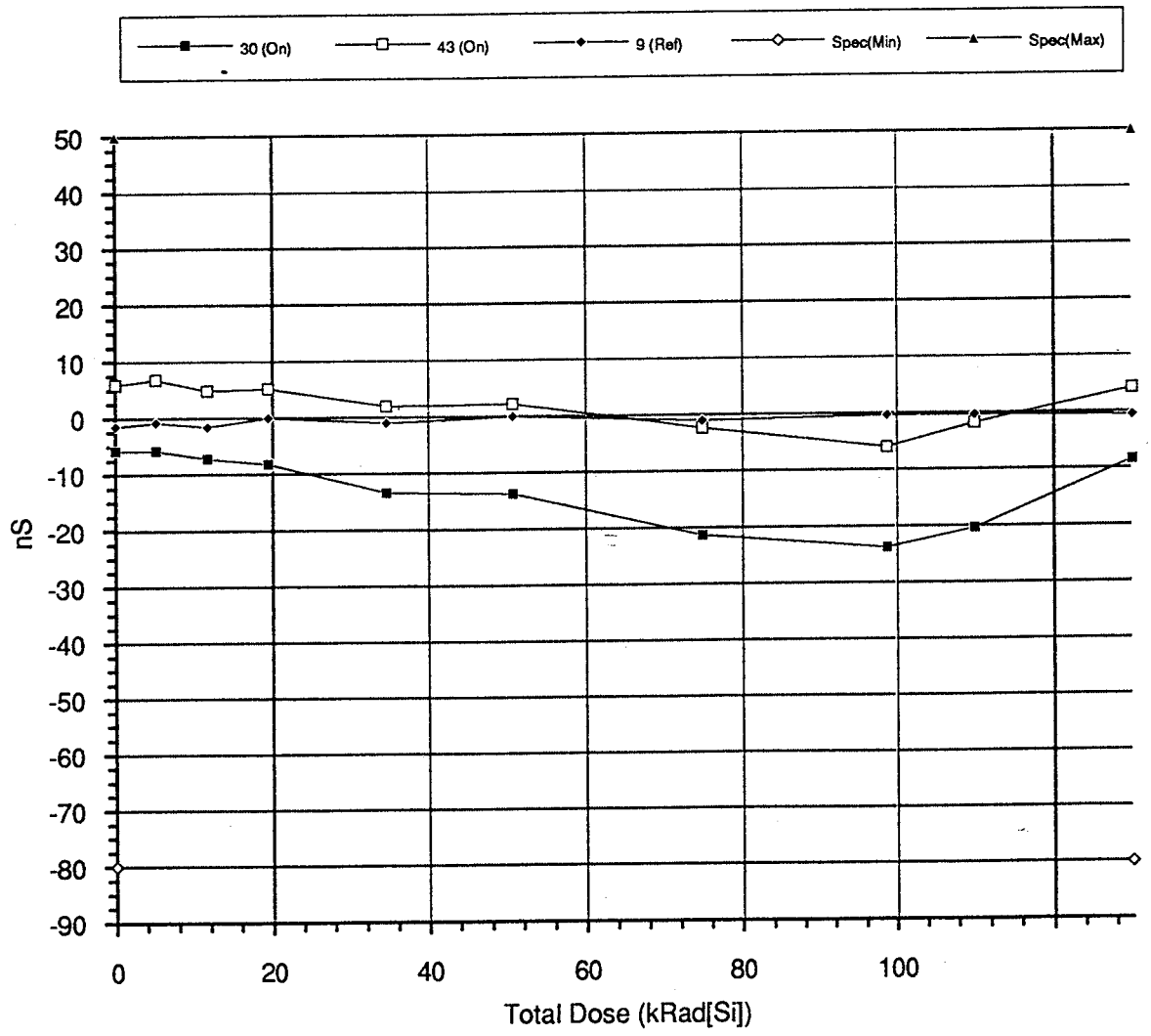


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**			Fig. 15
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**	
Tested Parameter: **PhaseLHB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**	
Test Conditions: **Test 12-22.**			
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2	

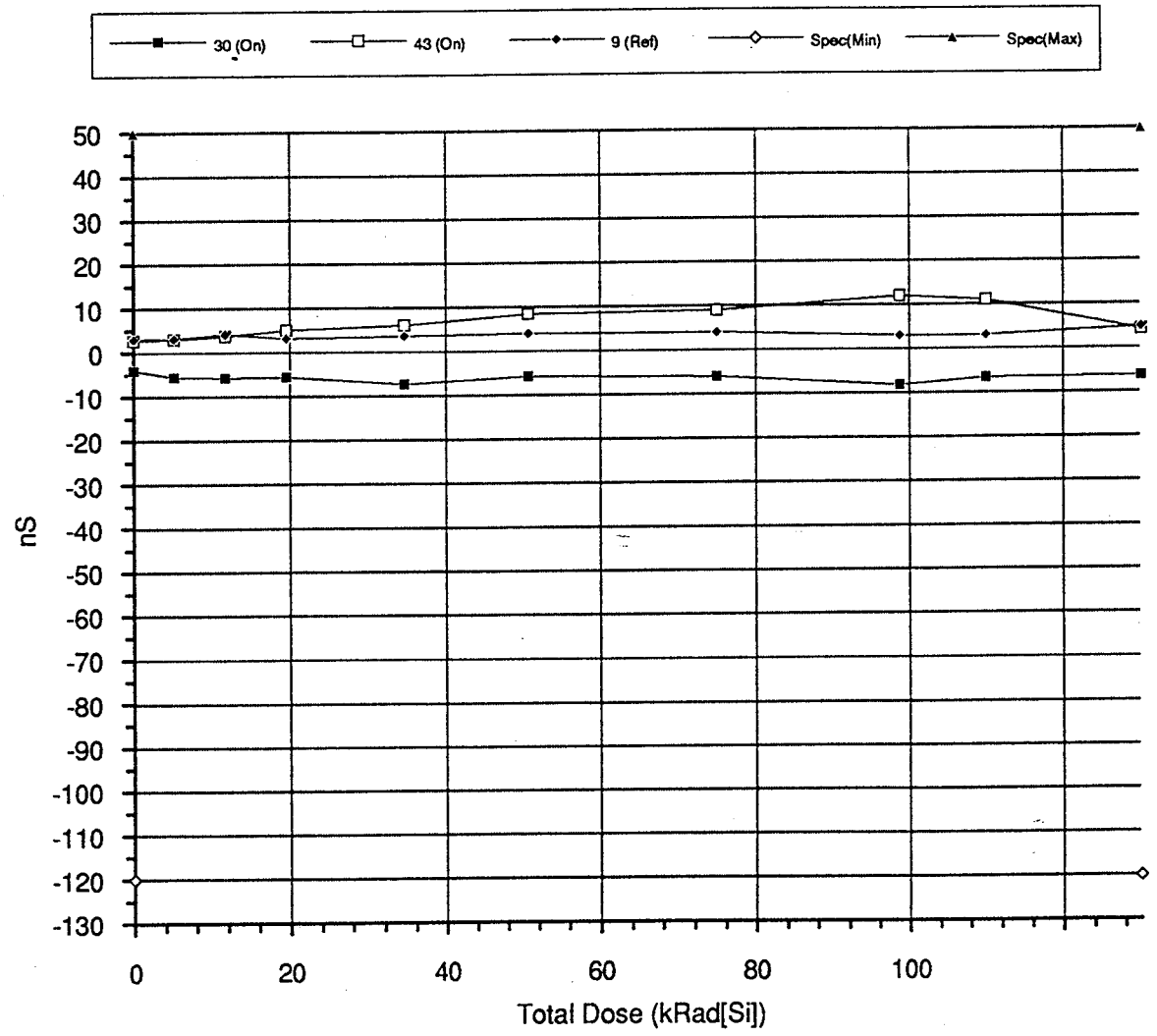


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 16
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **PhaseHLA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Test 8-17.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: **2**

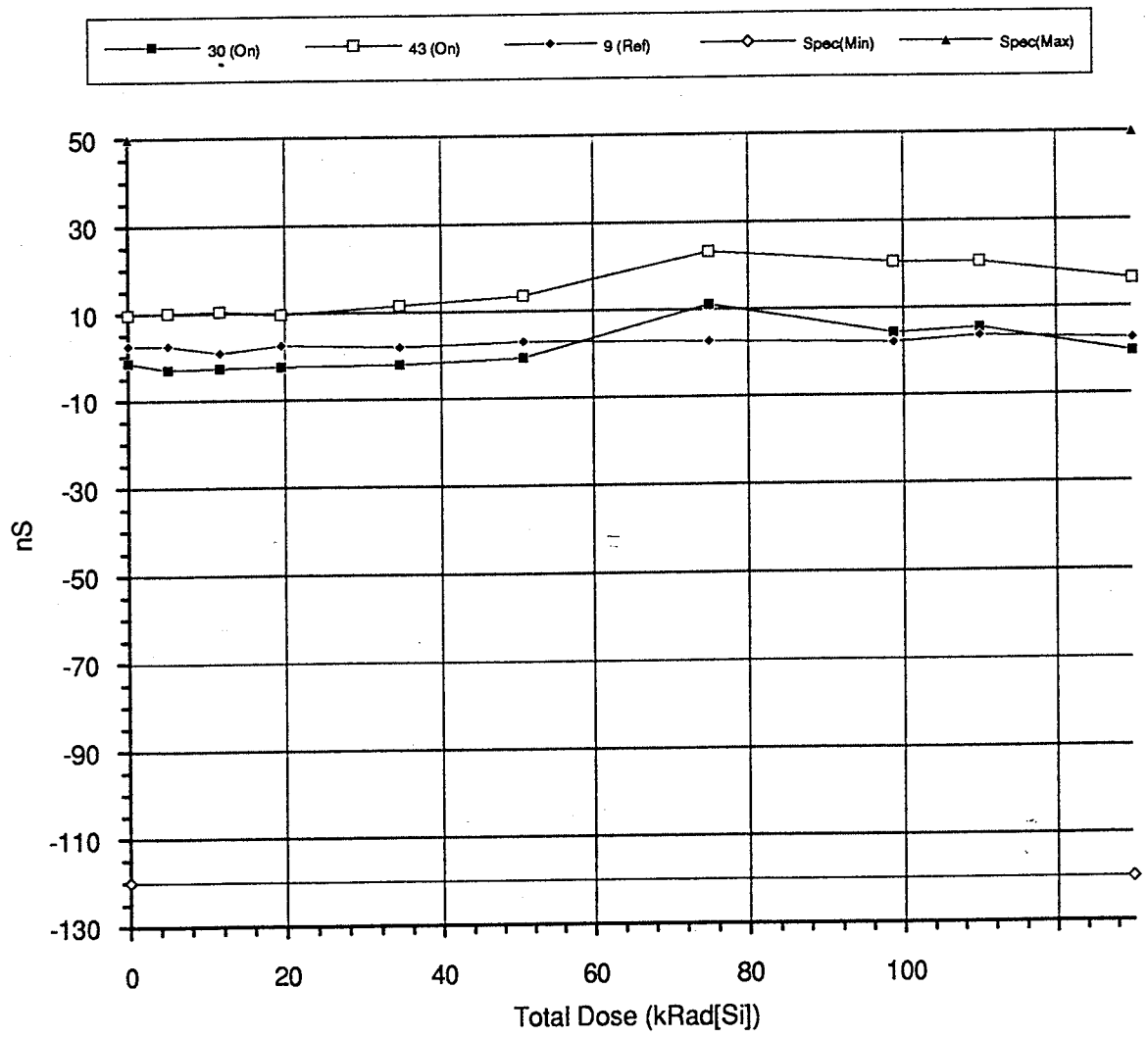


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: January 96.		Fig. 17
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **PhaseHLB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Test 12-23.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

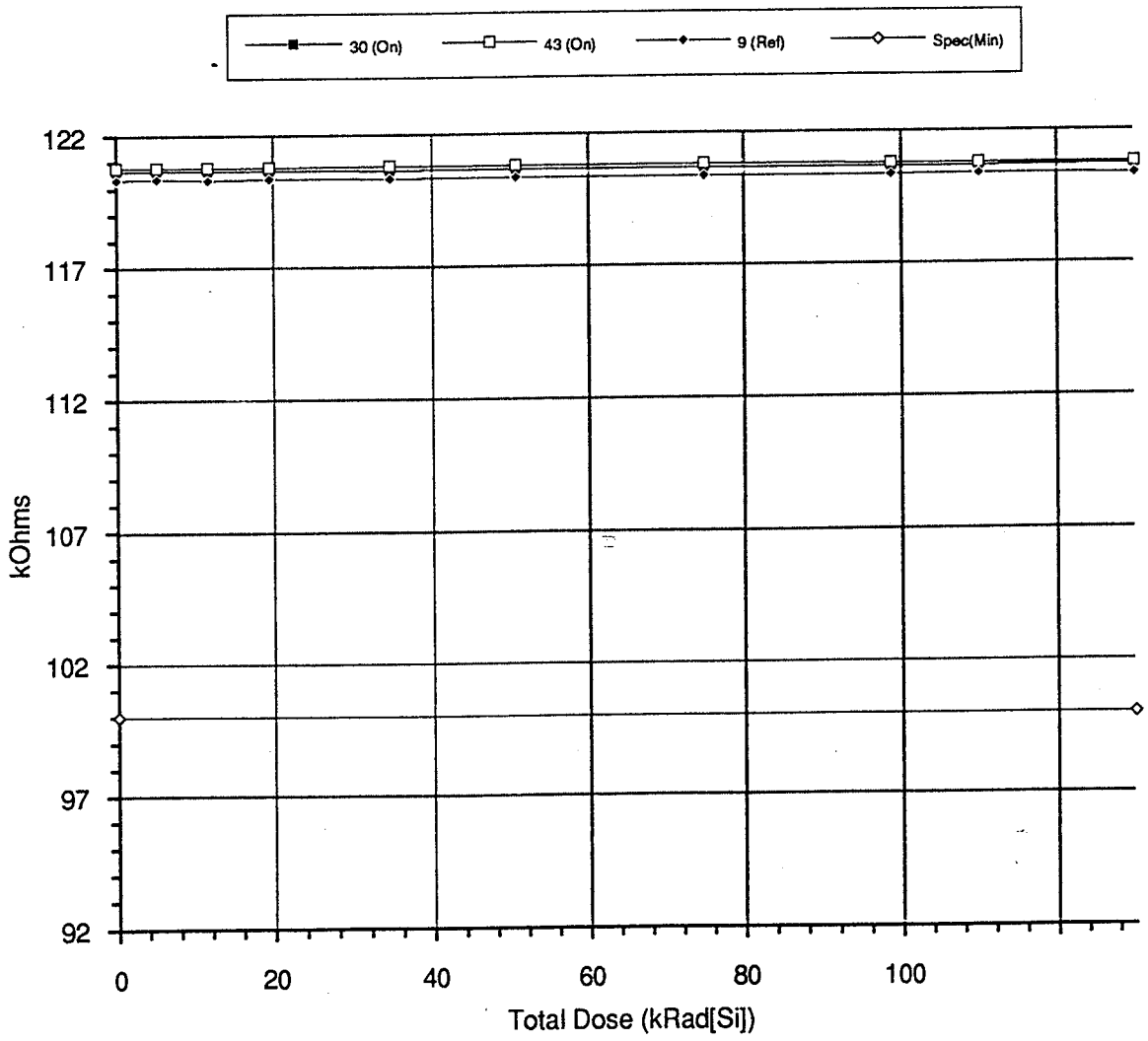


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: January 96.		Fig. 18
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **R_DI_REA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **DBI+ to DBI-.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

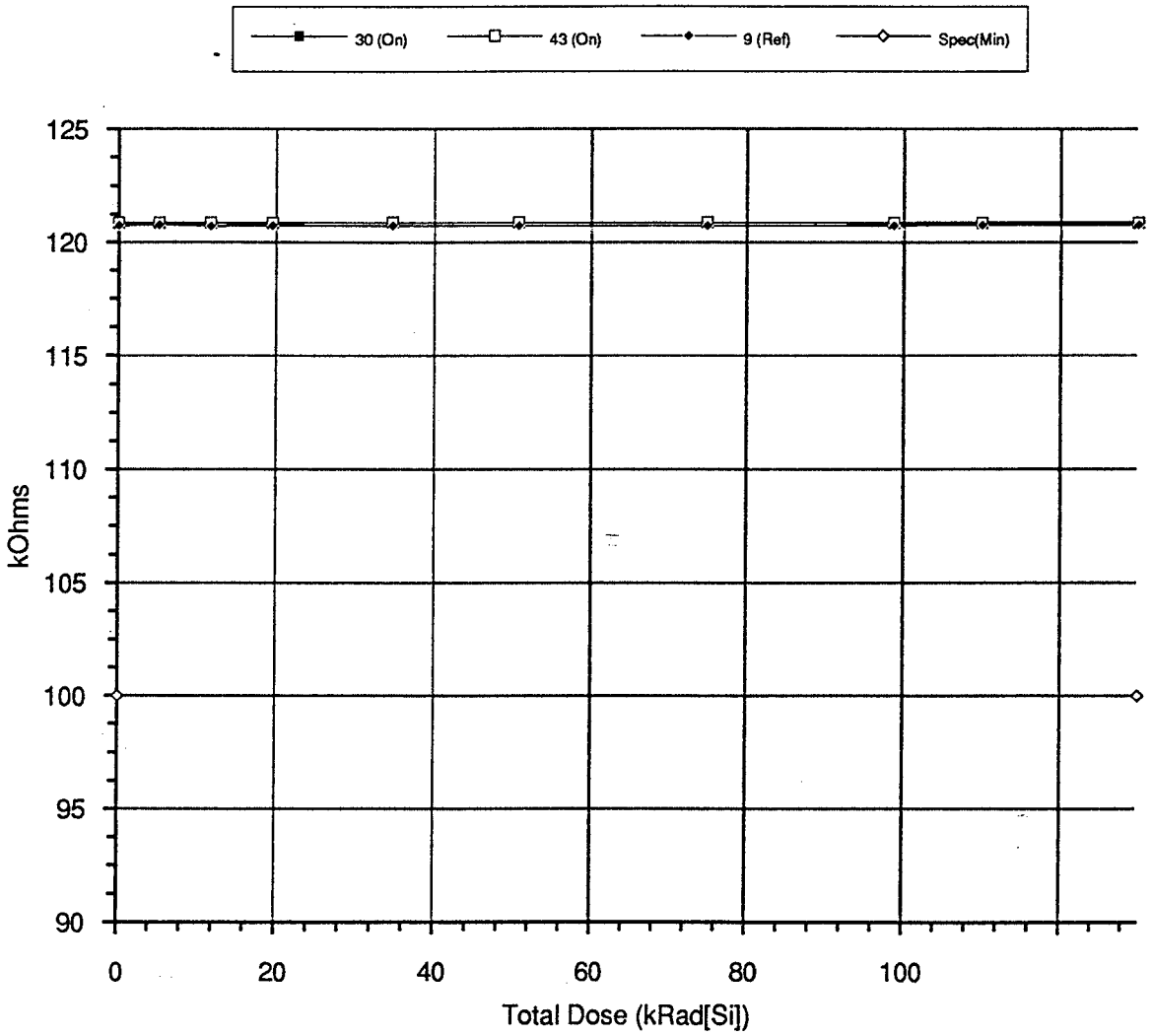


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 19
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **R_DI_REB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **DBI+ to DBI-.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

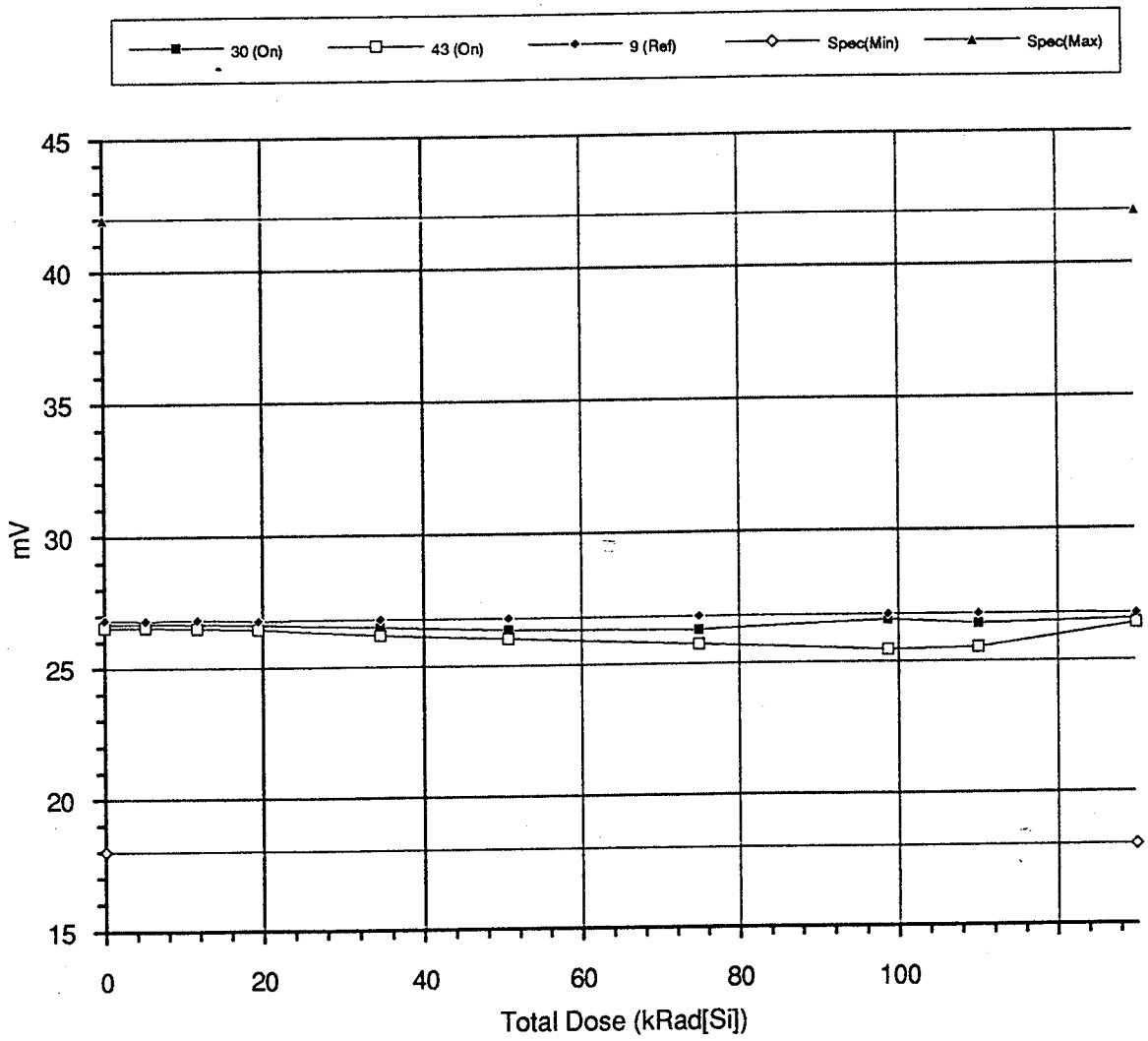


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**			Fig. 20
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**	
Tested Parameter: **V_DI_REA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**	
Test Conditions: **(Vdbi+) - (Vdbi-).**			
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2	

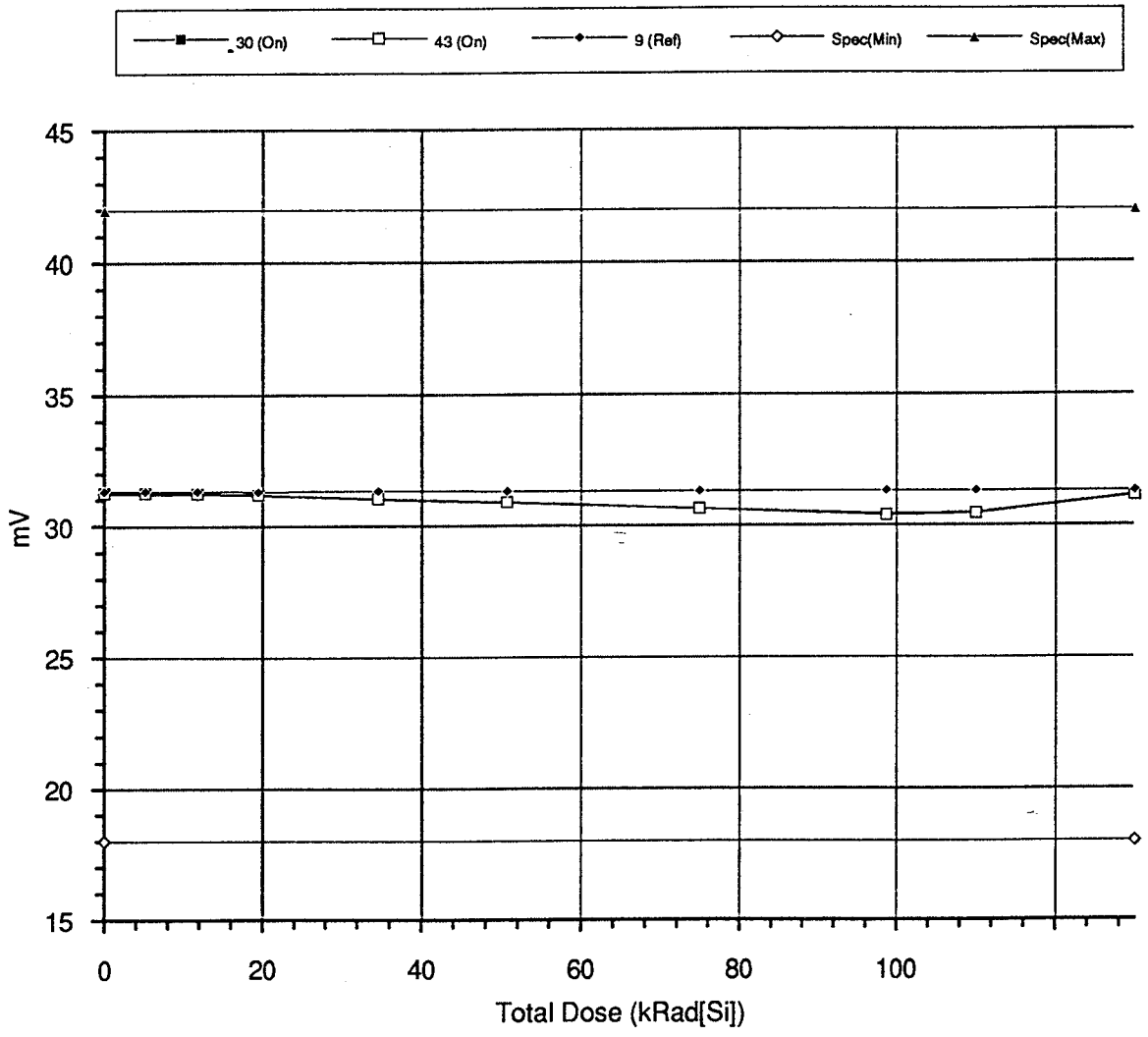


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 21
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **V_DI_REB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **(Vdbi+) - (Vdbi-).**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

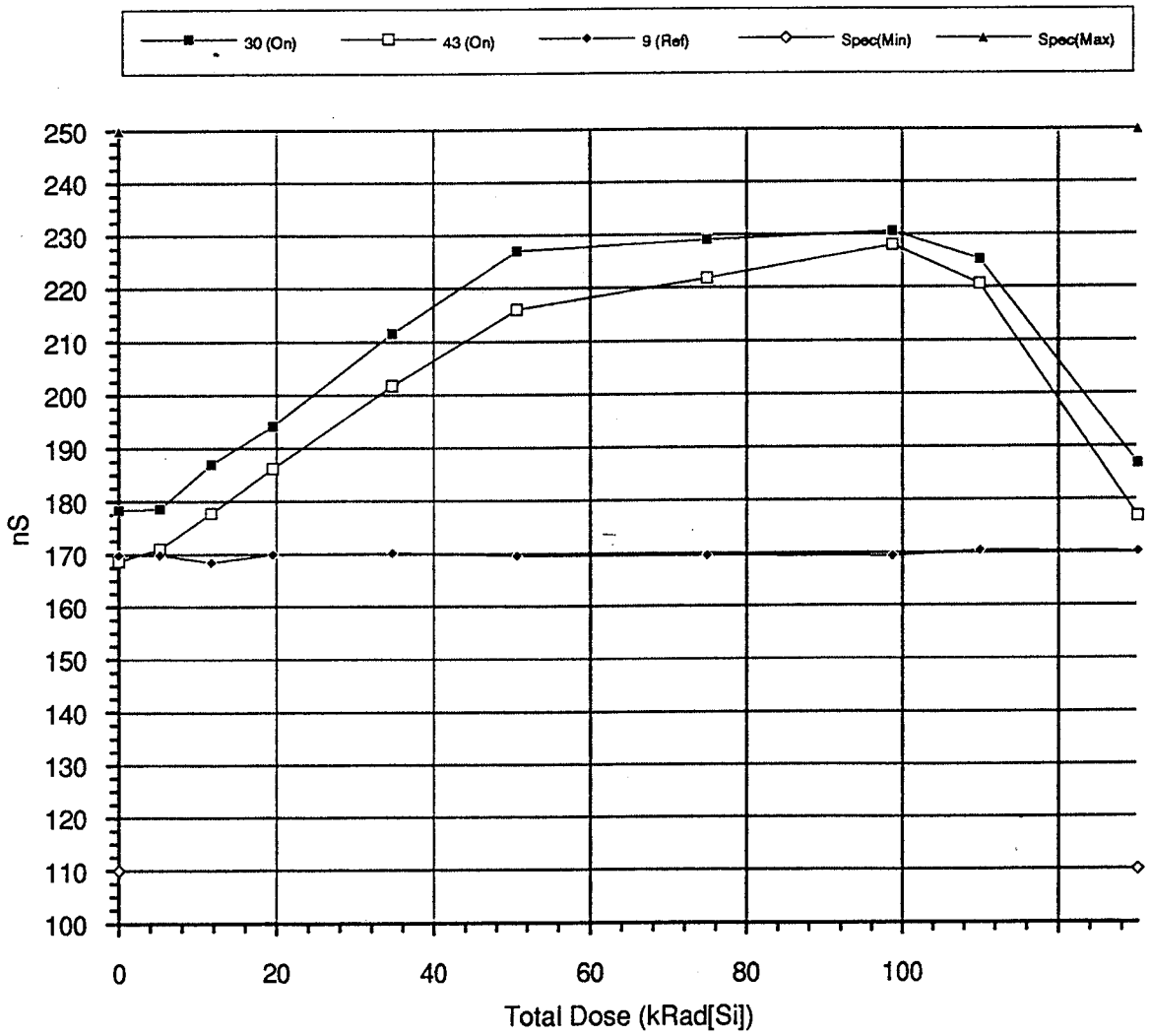


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 22
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLH_REA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

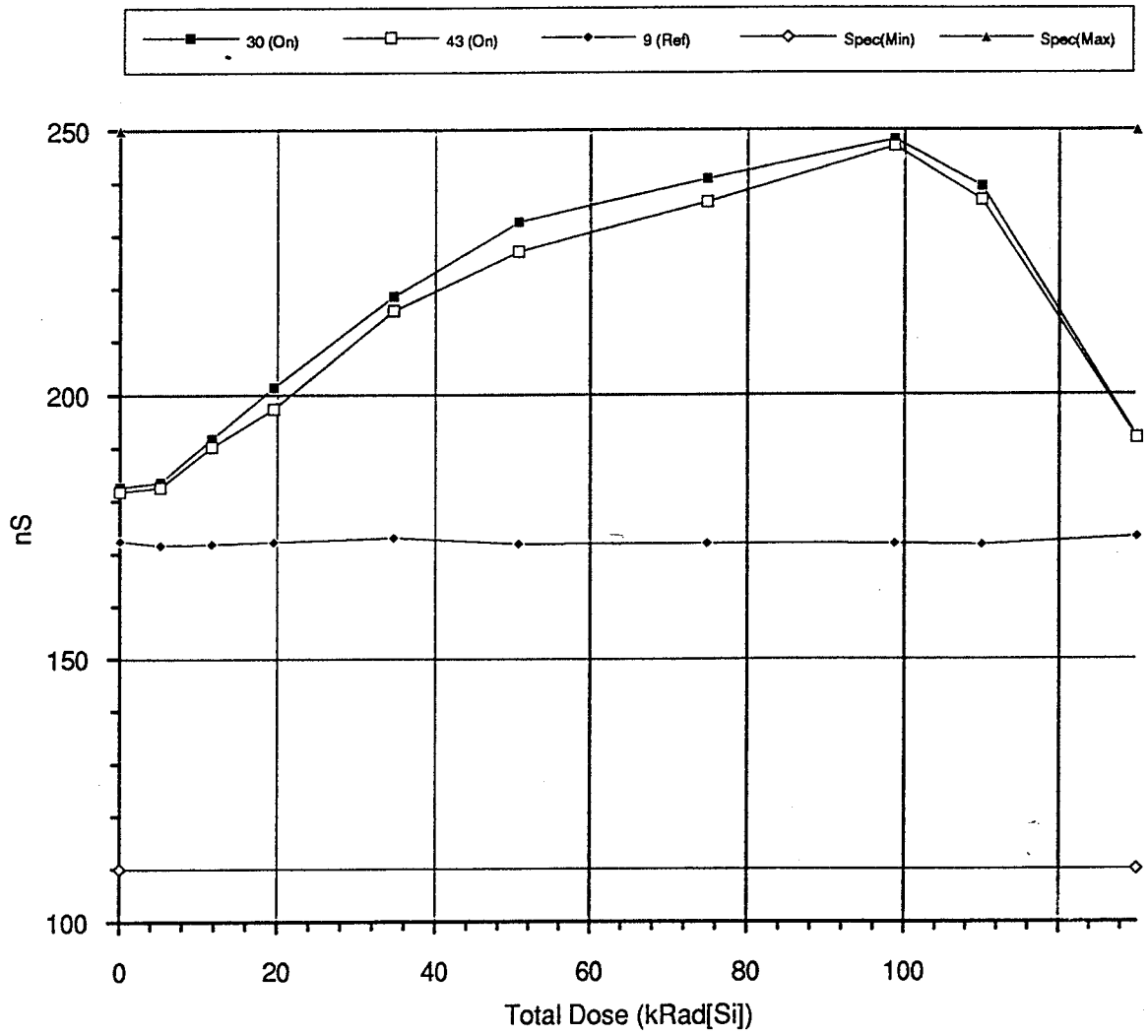


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 23
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLH_REB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

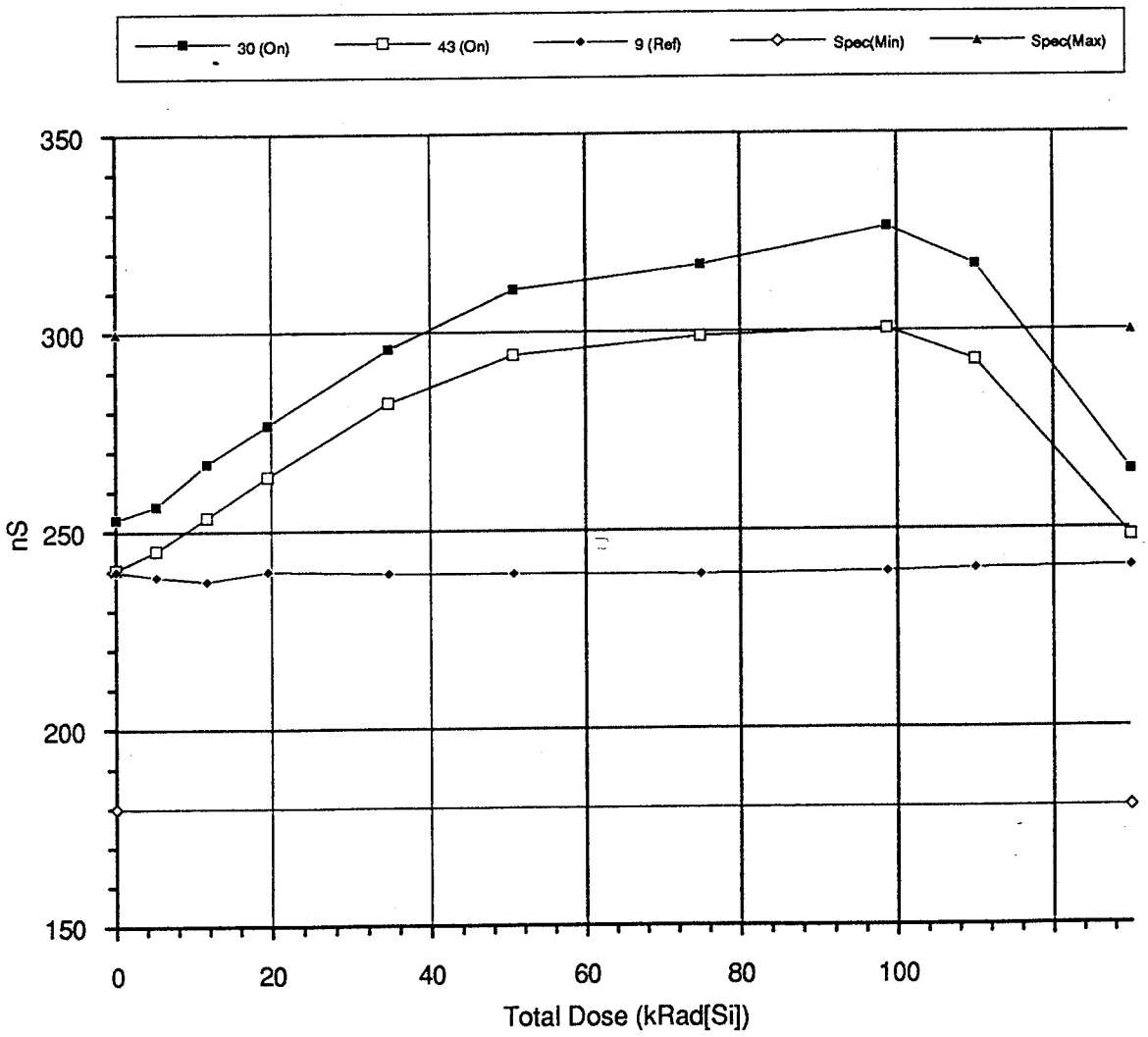


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 24
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPHL_REA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

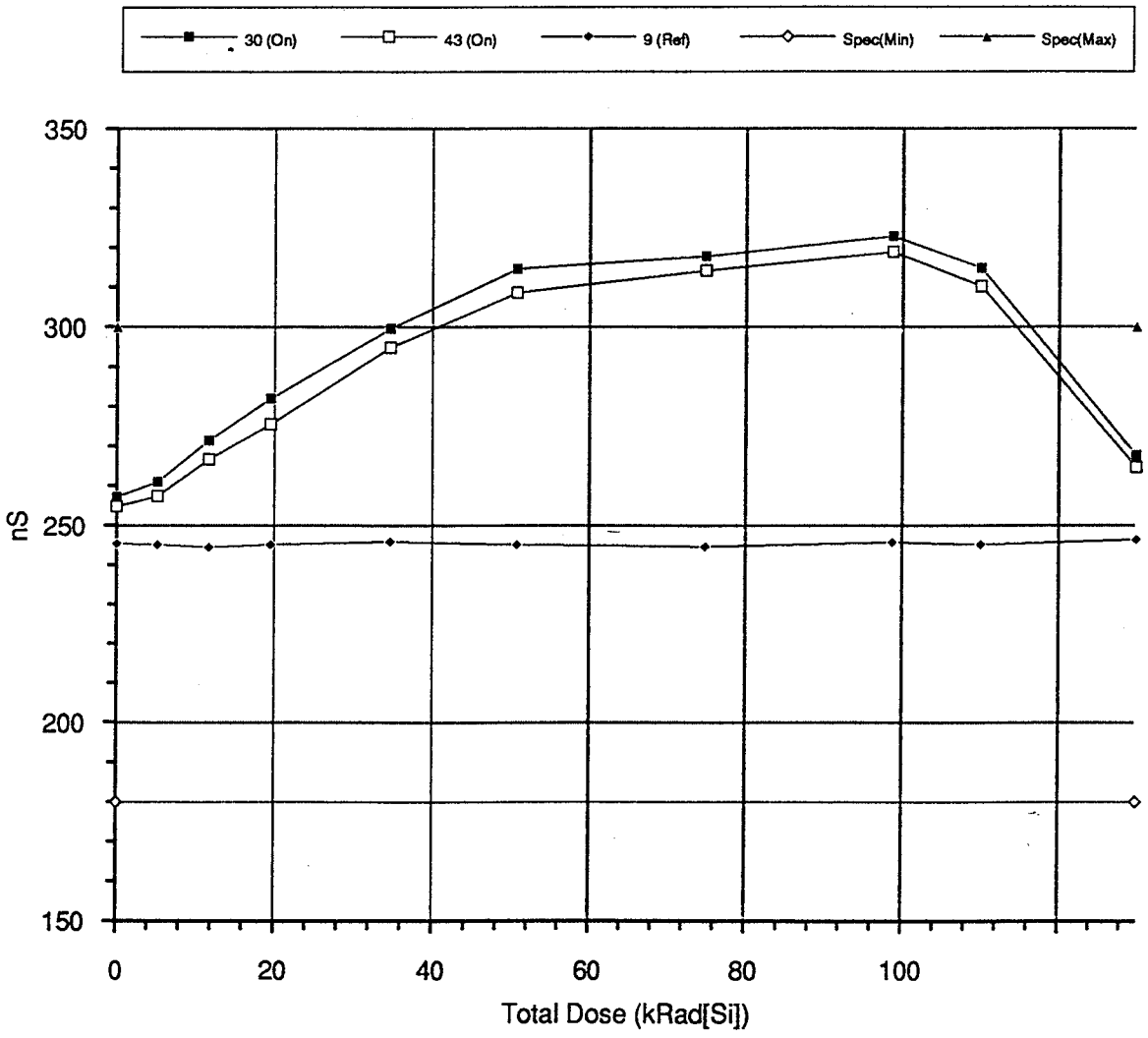


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 25
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPHL_REB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig 2.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

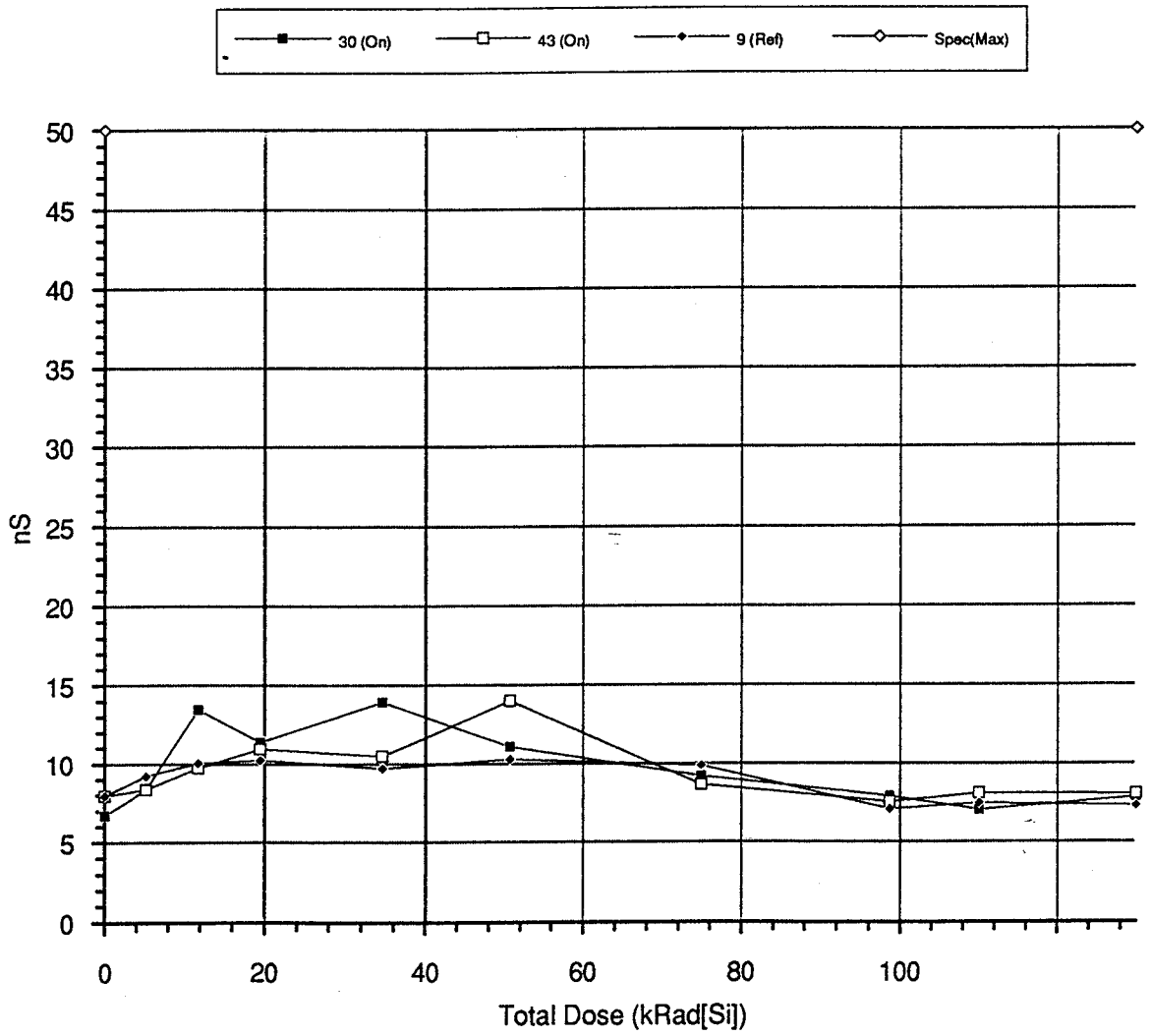


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 26
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPZL_REA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, Vid=-2V, spec. fig 3, Clock retrieval.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2



The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.** Fig. 27

Type:	Date Code:	Manufacturer:
MBH 473D	**9229**	**MMS**

Tested Parameter: **TPZL_REB**

Radiation Source: **Co60**

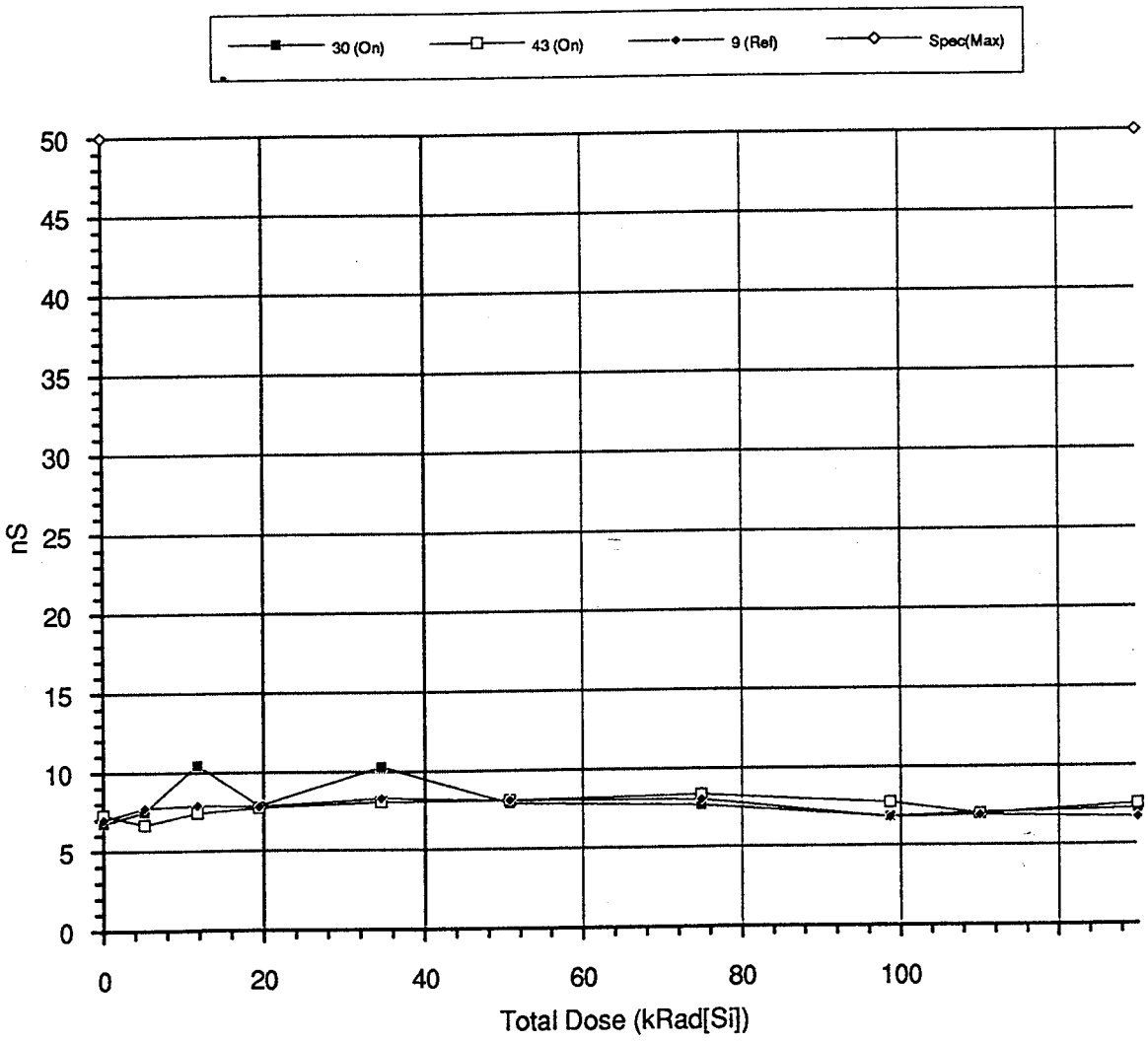
Dose Rate: **<= 0.36 kRad/h.**

Test Conditions:

Cl=18pF, Vid=-2V, spec. fig 3, Clock retrieval

Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**

Number of irradiated devices: 2

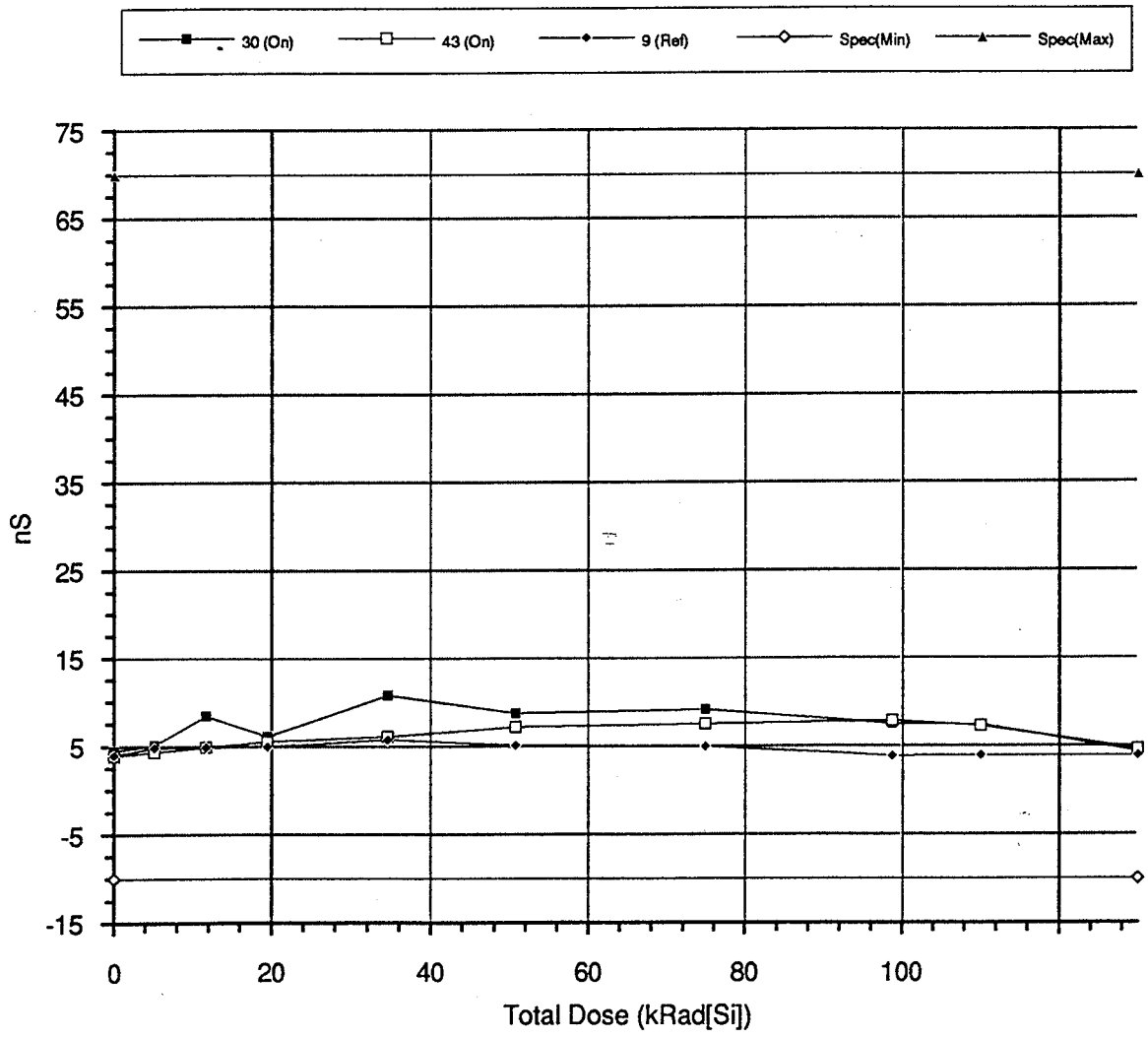


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 28
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLZ_REA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, Vid=-2V, spec. fig 3, Clock disappearing.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

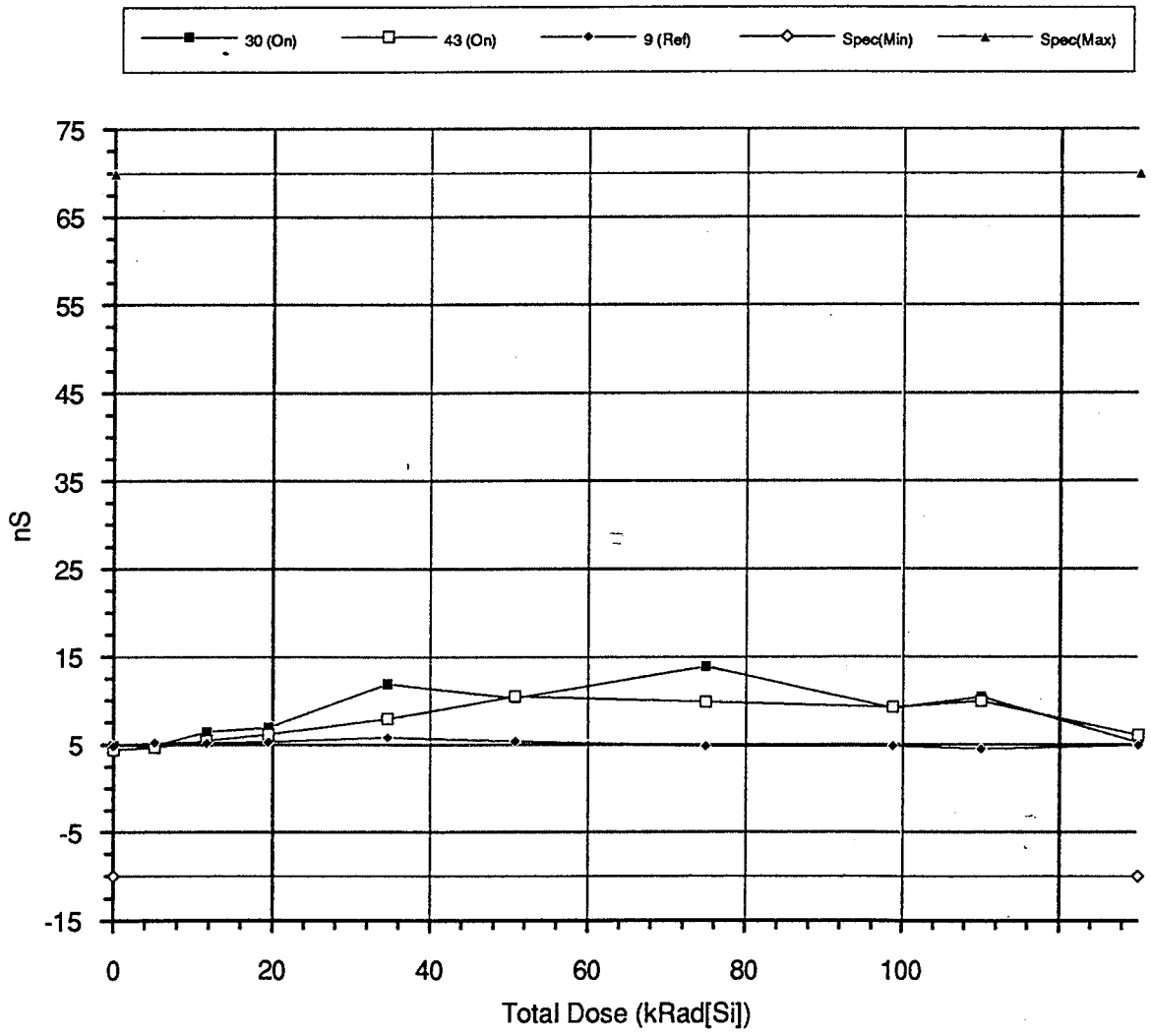


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 29
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLZ_REB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, Vid=-2V, spec. fig 3, Clock disappearing.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

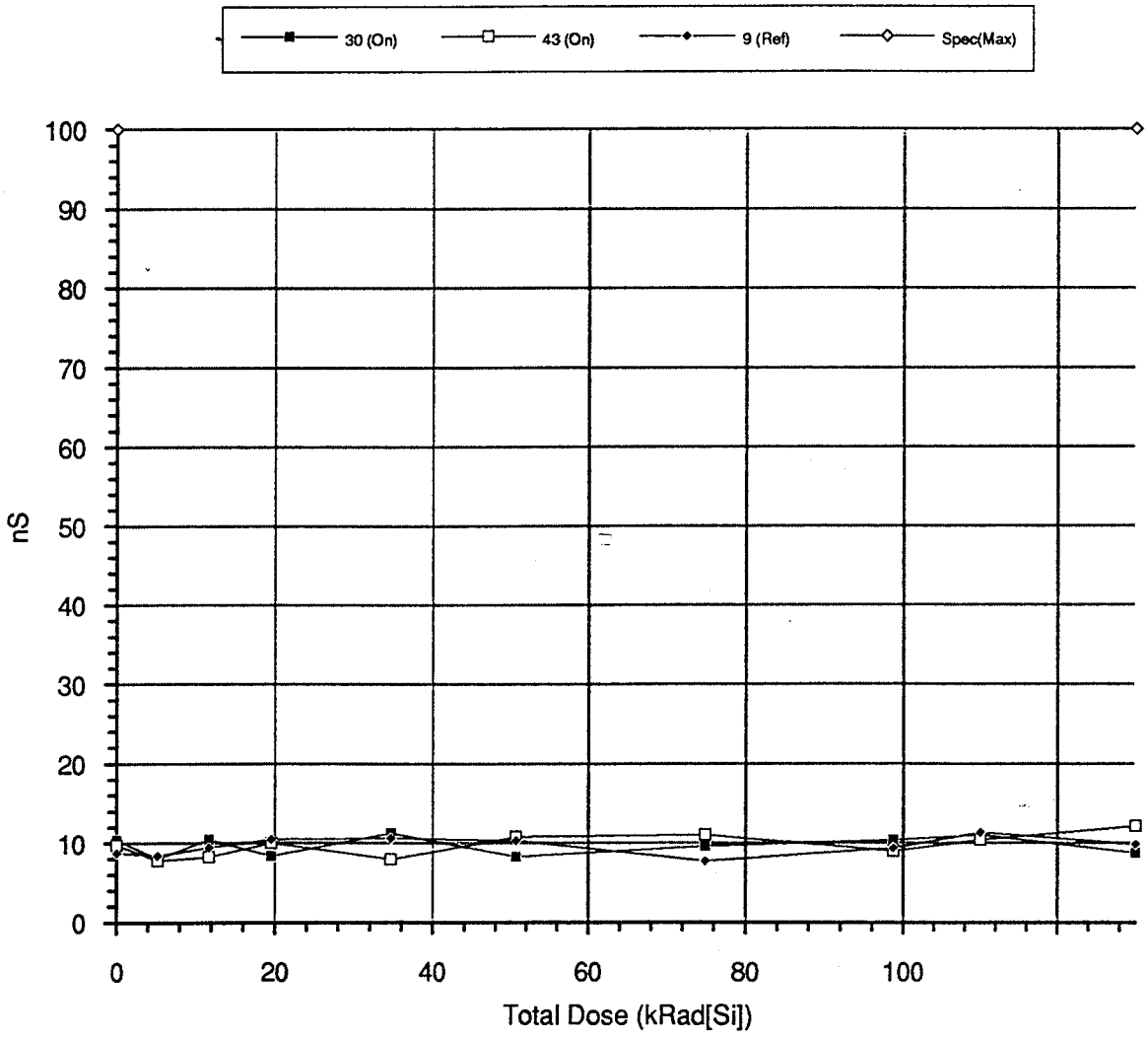


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 30
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TR_DIN**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, Opposite clock bus steady state.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2



The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.** Fig. 31

Type:	Date Code:	Manufacturer:
MBH 473D	**9229**	**MMS**

Tested Parameter: **TF_DIN**

Radiation Source: **Co60**

Dose Rate: **<= 0.36 kRad/h.**

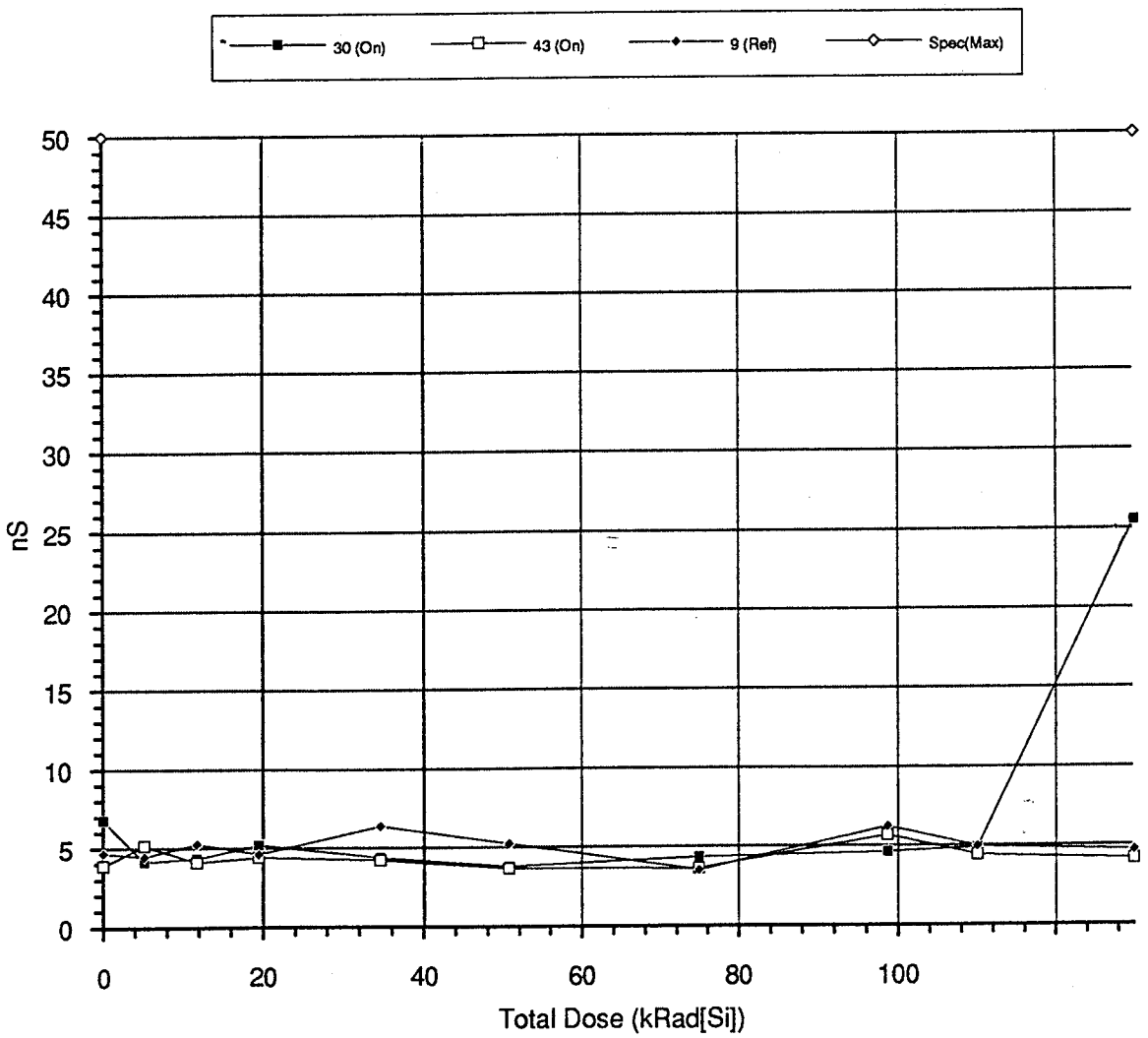
Test Conditions:

Cl=18pF, Opposite clock bus steady state.

Irradiation Conditions:

Dynamic On(Sn30 & Sn43).

Number of irradiated devices: 2

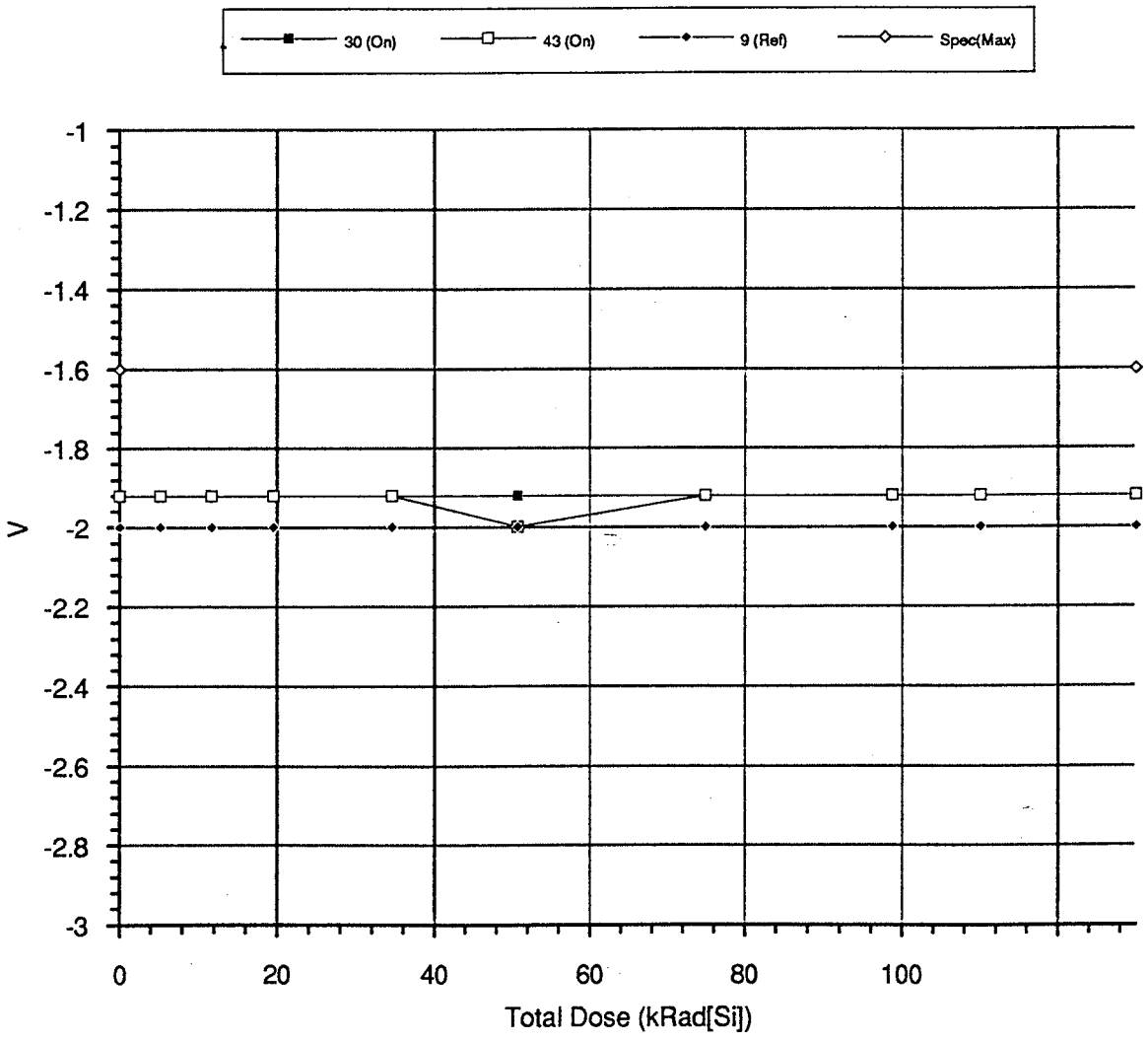


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 32
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **V_OD_EMA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, Dout=0.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

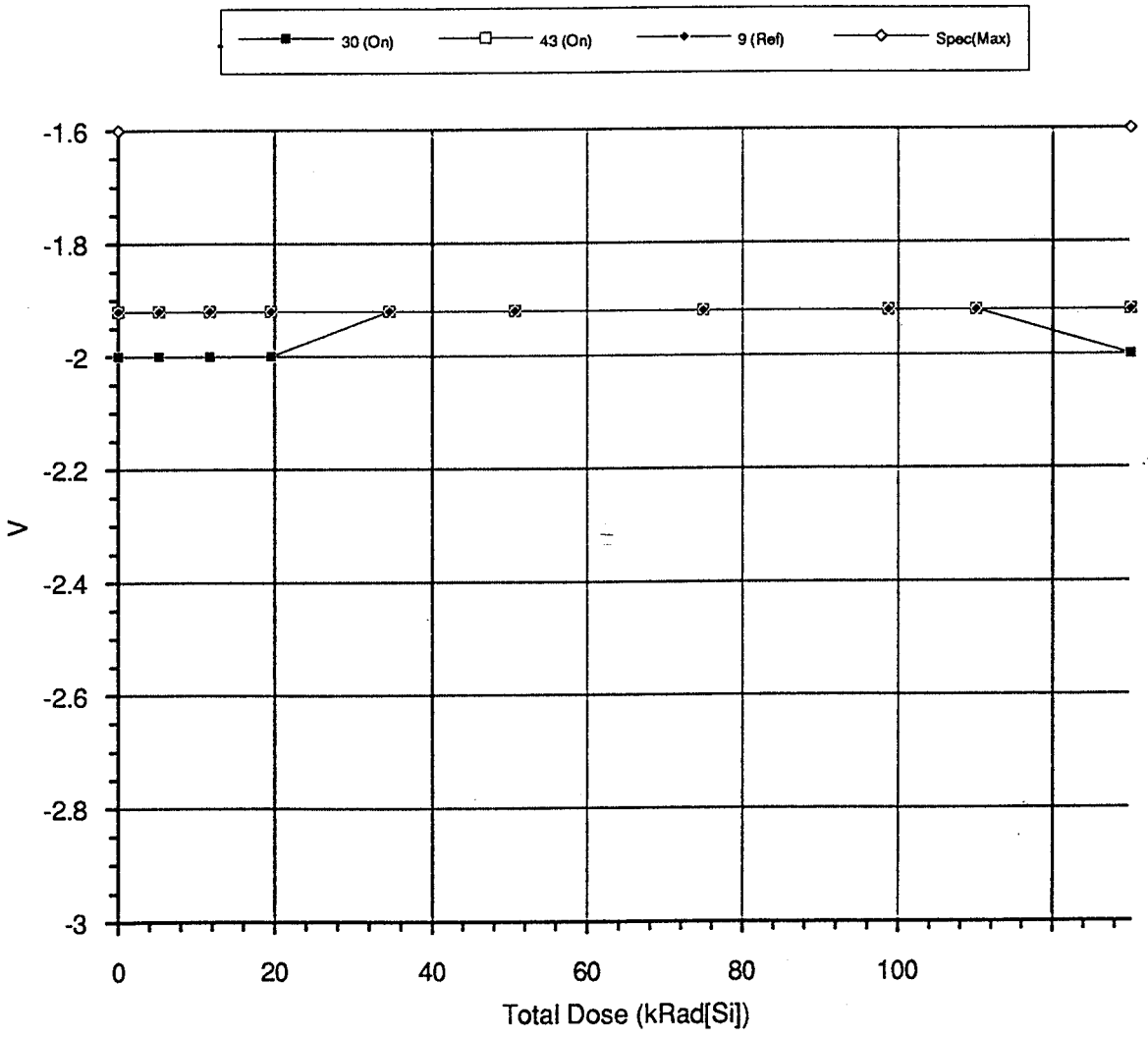


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 33
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **V_OD_EMB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, Dout=0.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

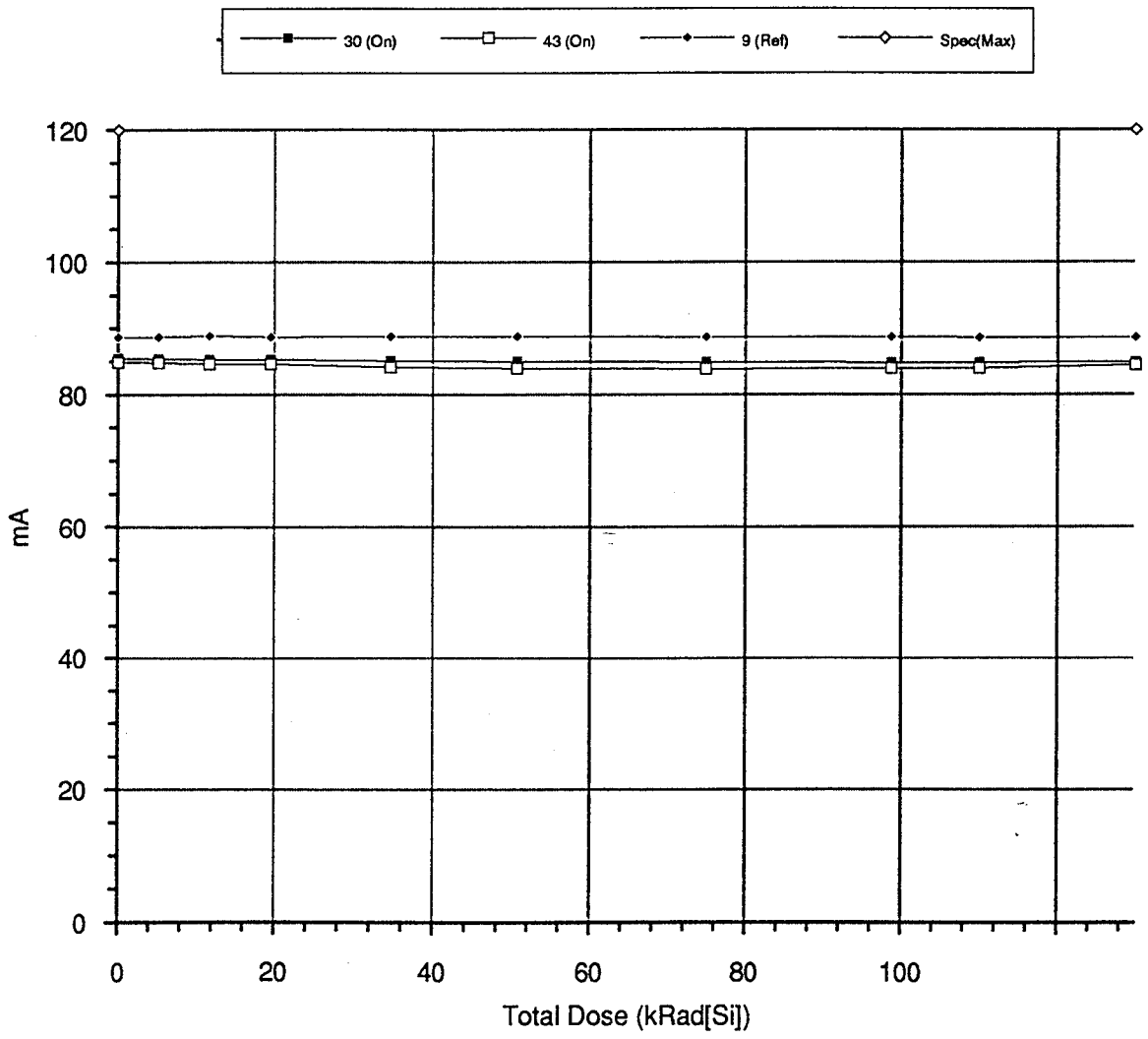


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 34
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **I_OS_EMA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Dout=0.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

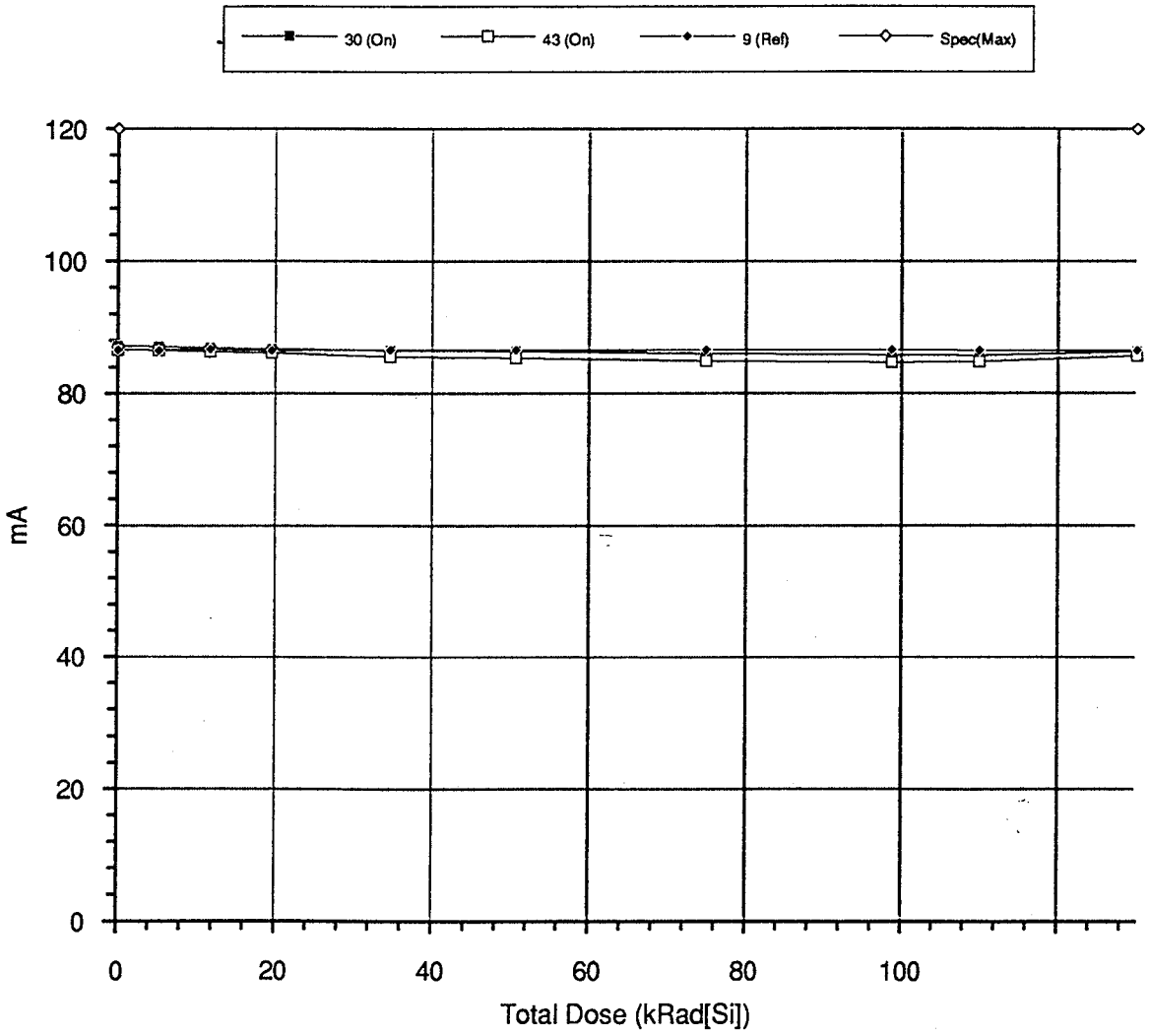


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 35
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **I_OS_EMB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Dout=0.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

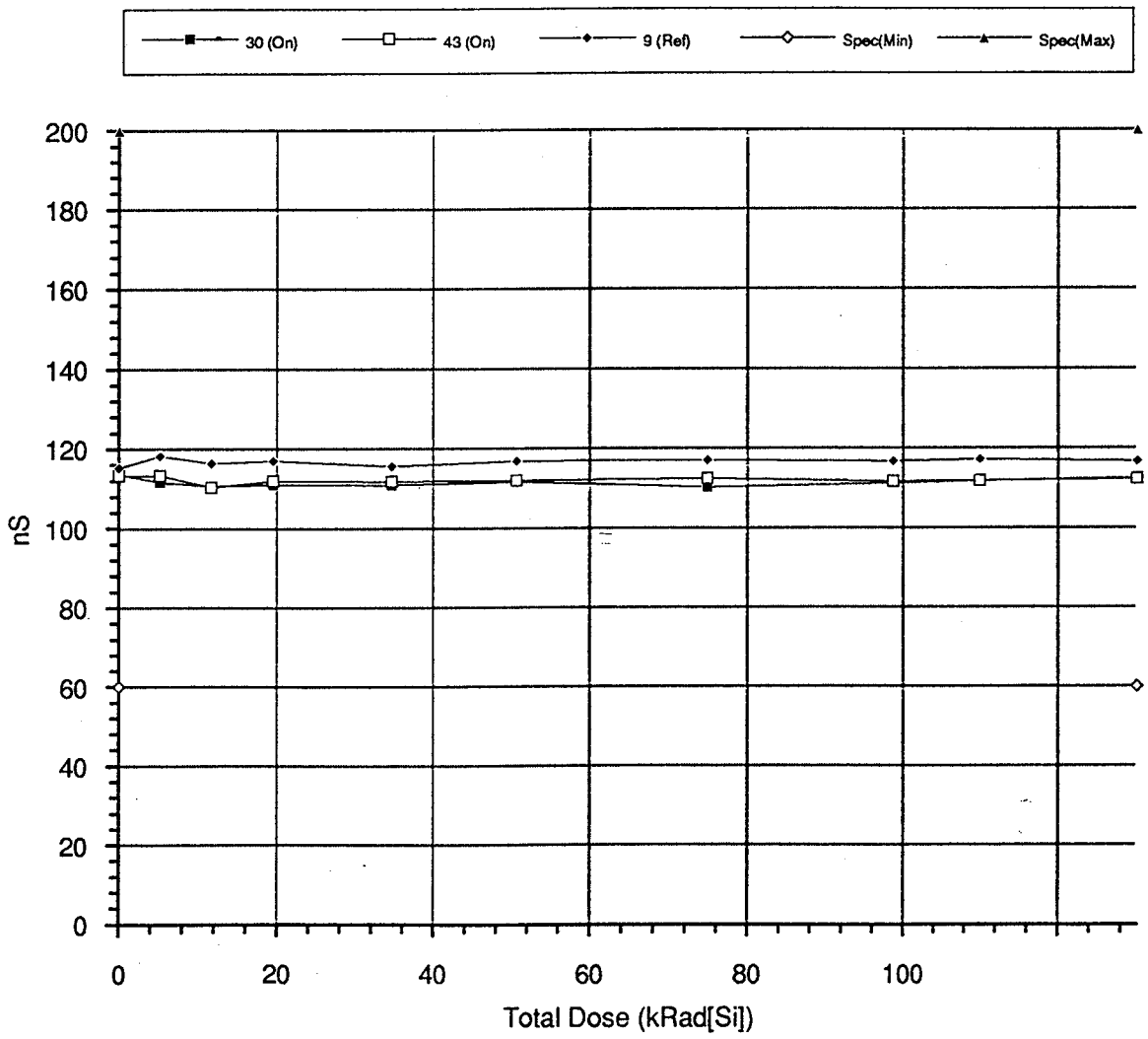


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 36
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLH_EMA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, clock modulation.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

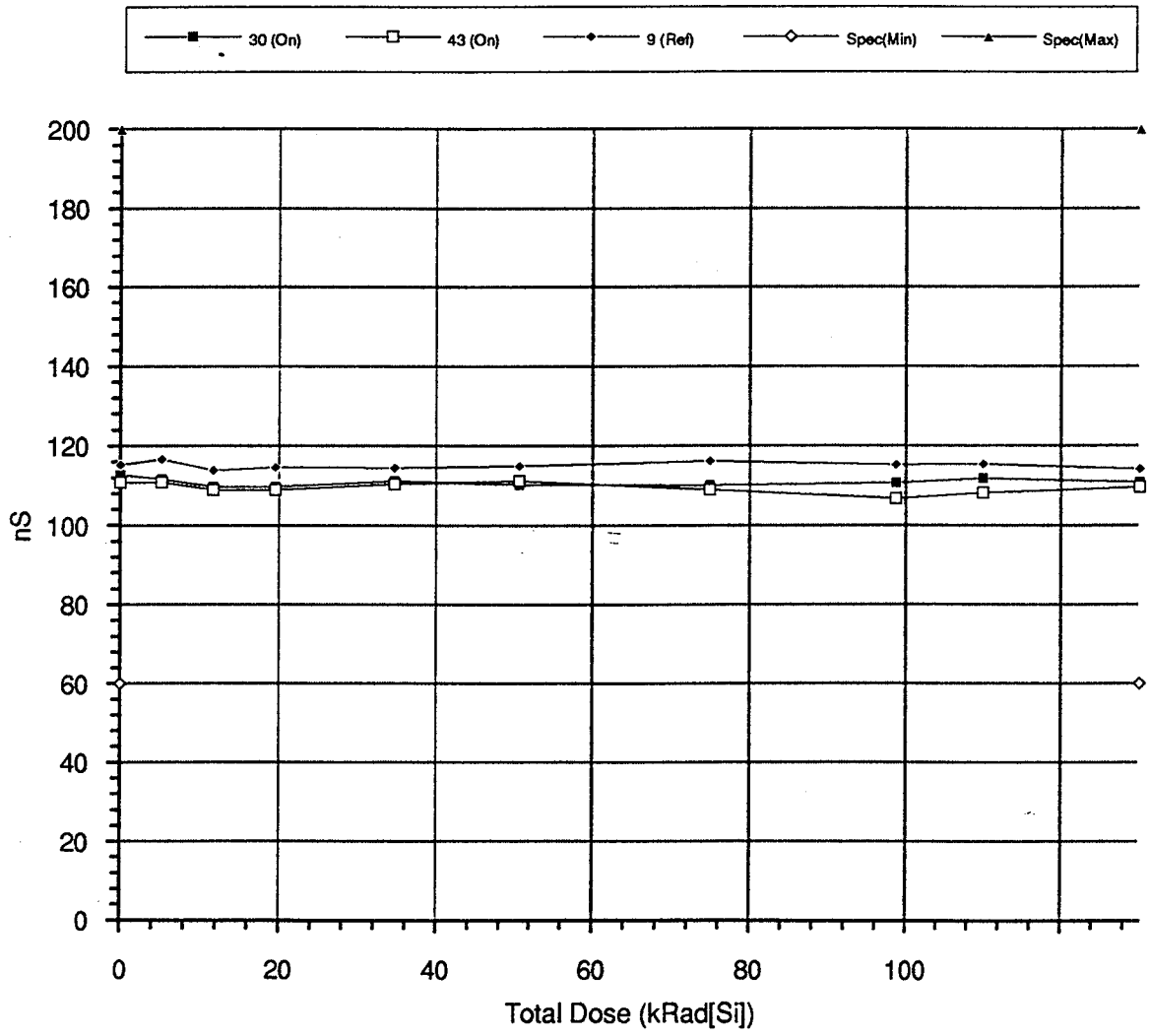


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 37
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLH_EMB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, clock modulation.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

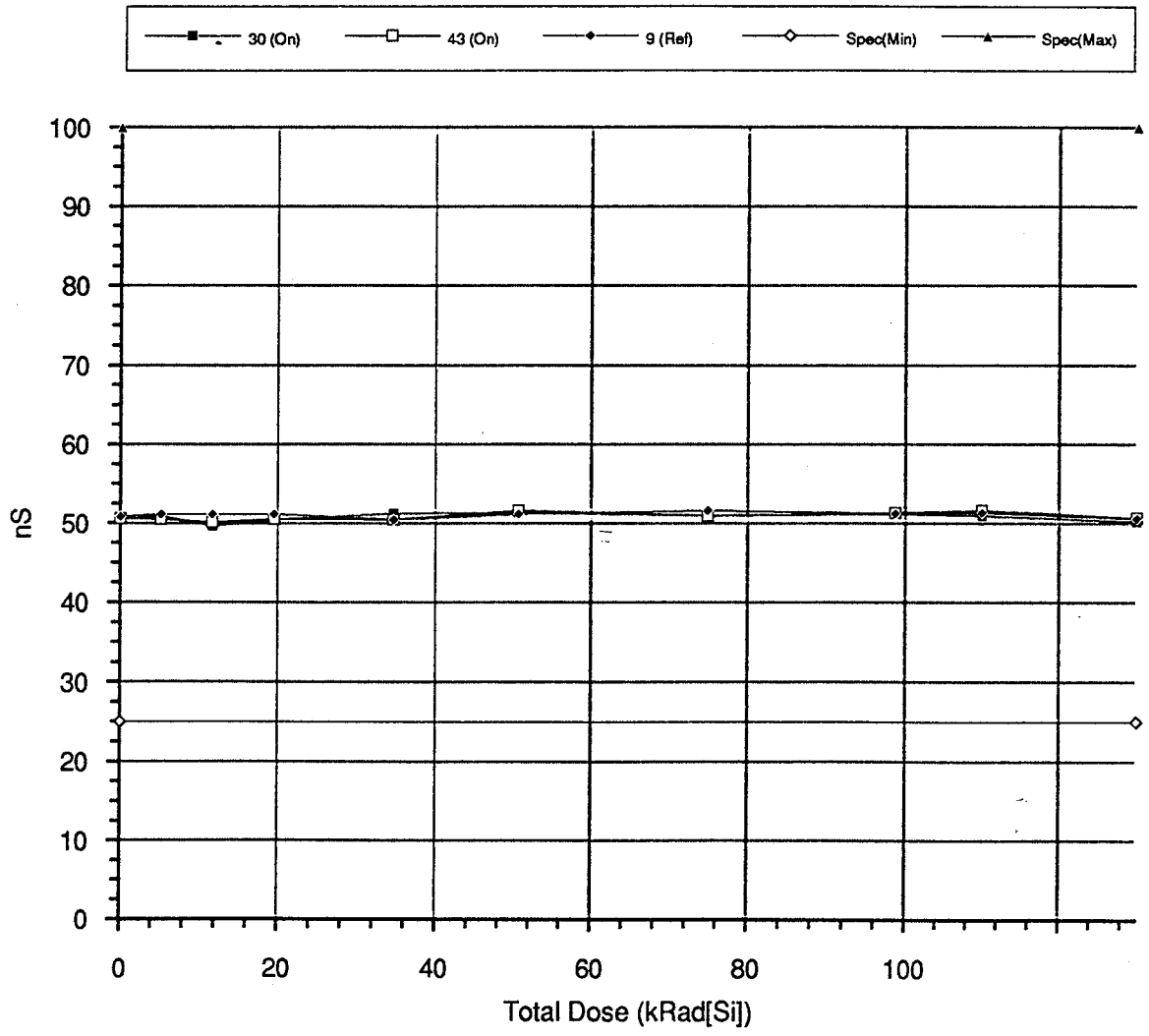


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 38
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPHL_EMA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, clock modulation.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

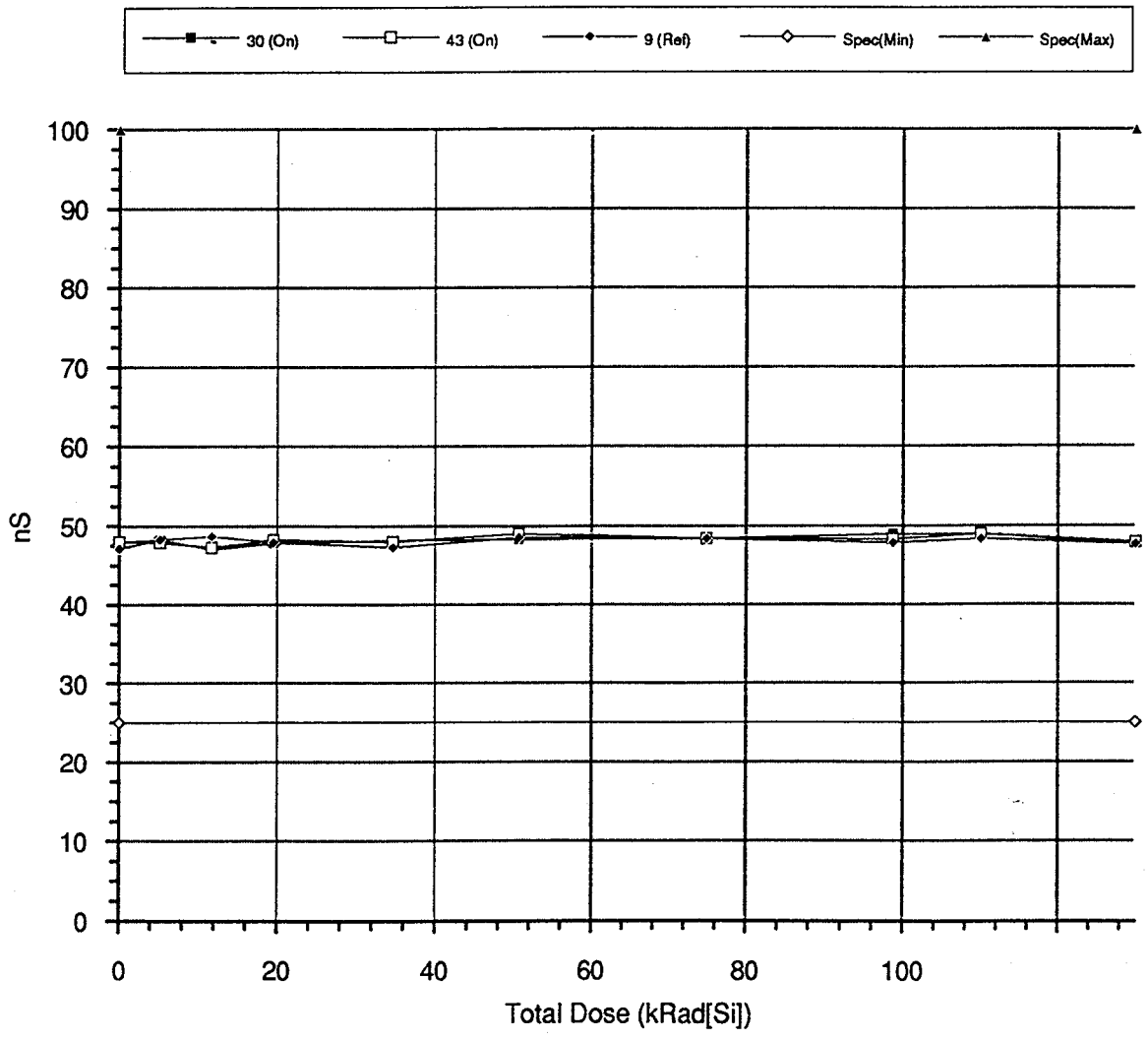


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 39
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPHL_EMB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, clock modulation.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

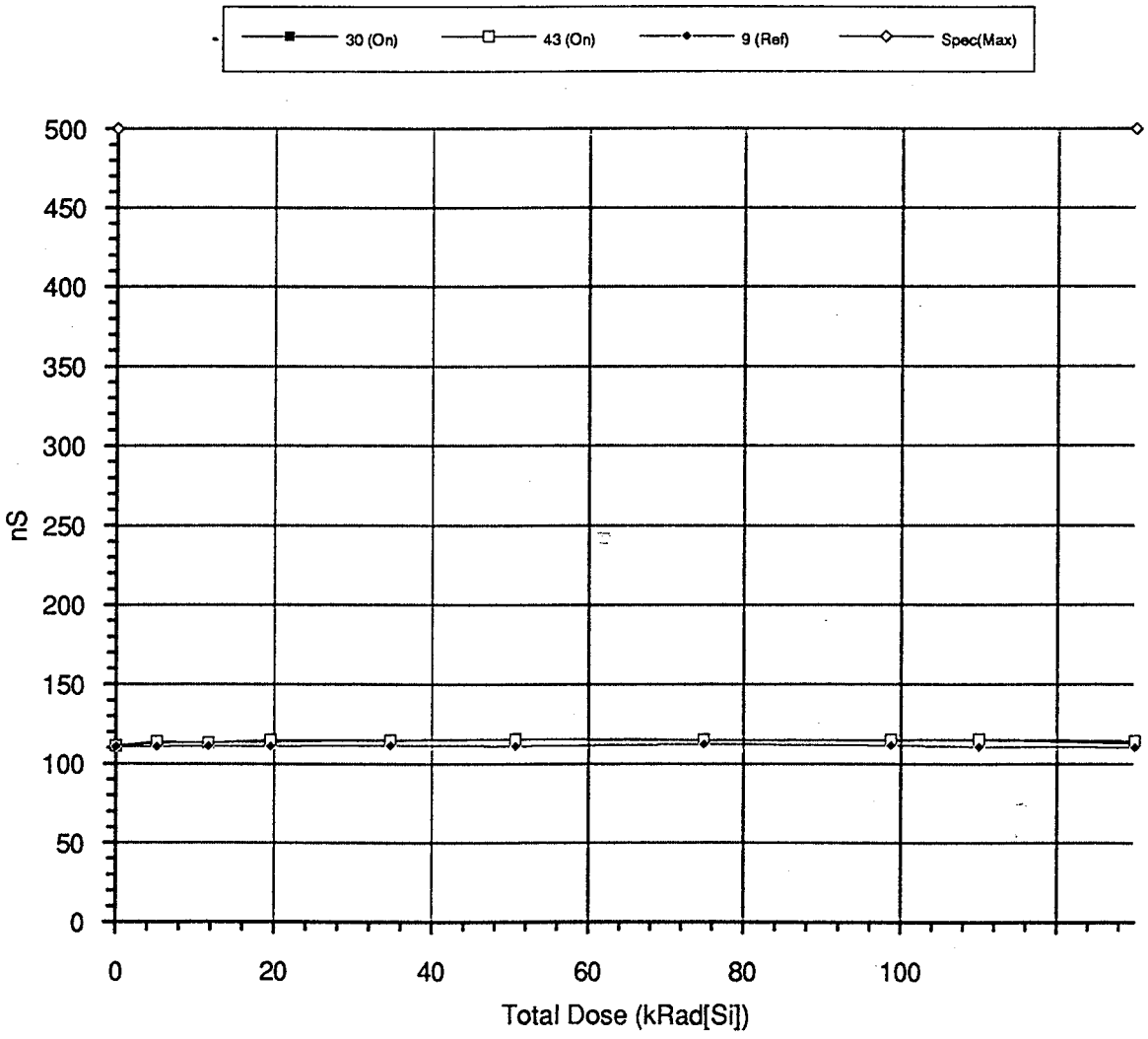


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 40
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPZL_EMA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, Dout=0 , reset out=1, clock modulation.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

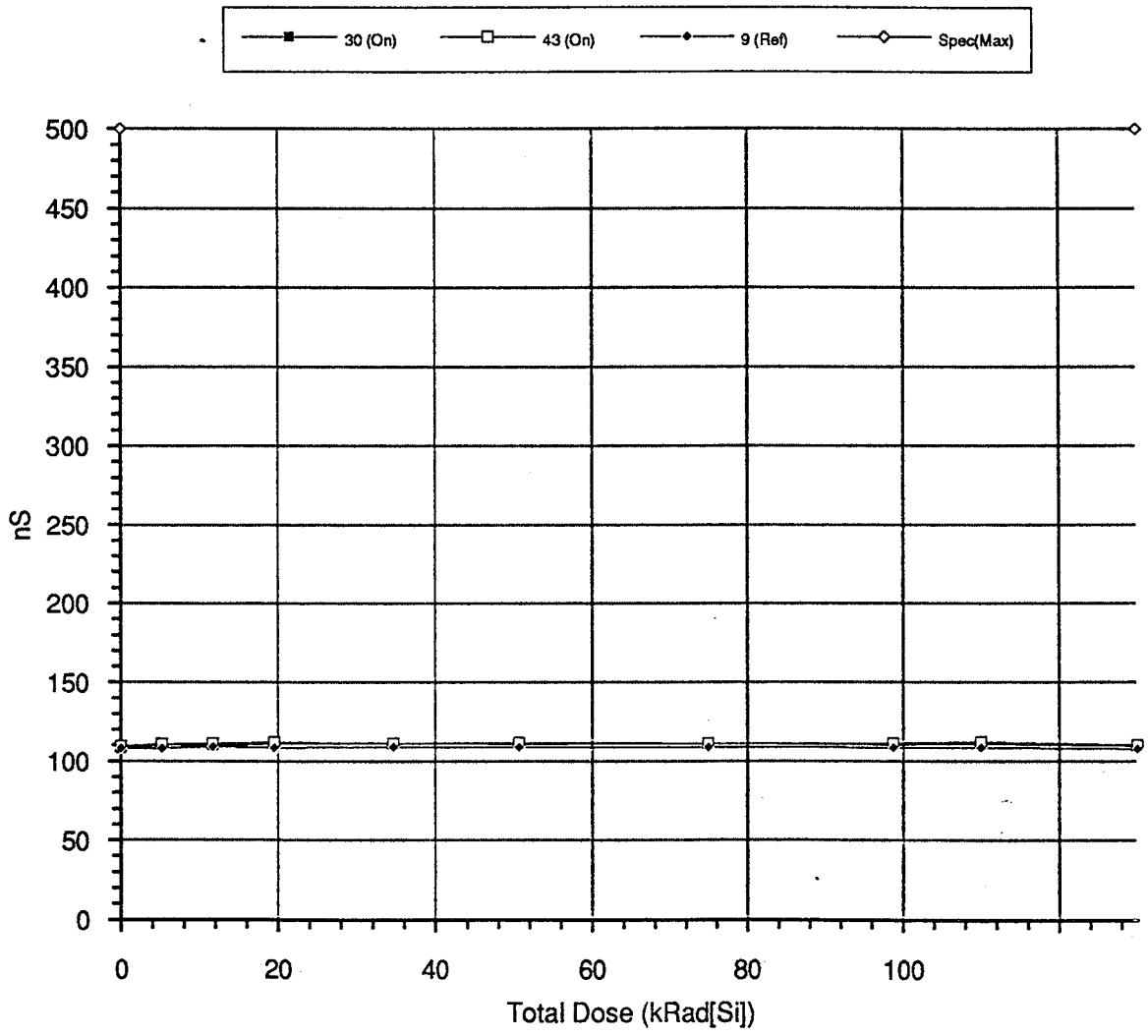


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 41
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPZL_EMB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, Dout=0 , reset out=1, clock modulation.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

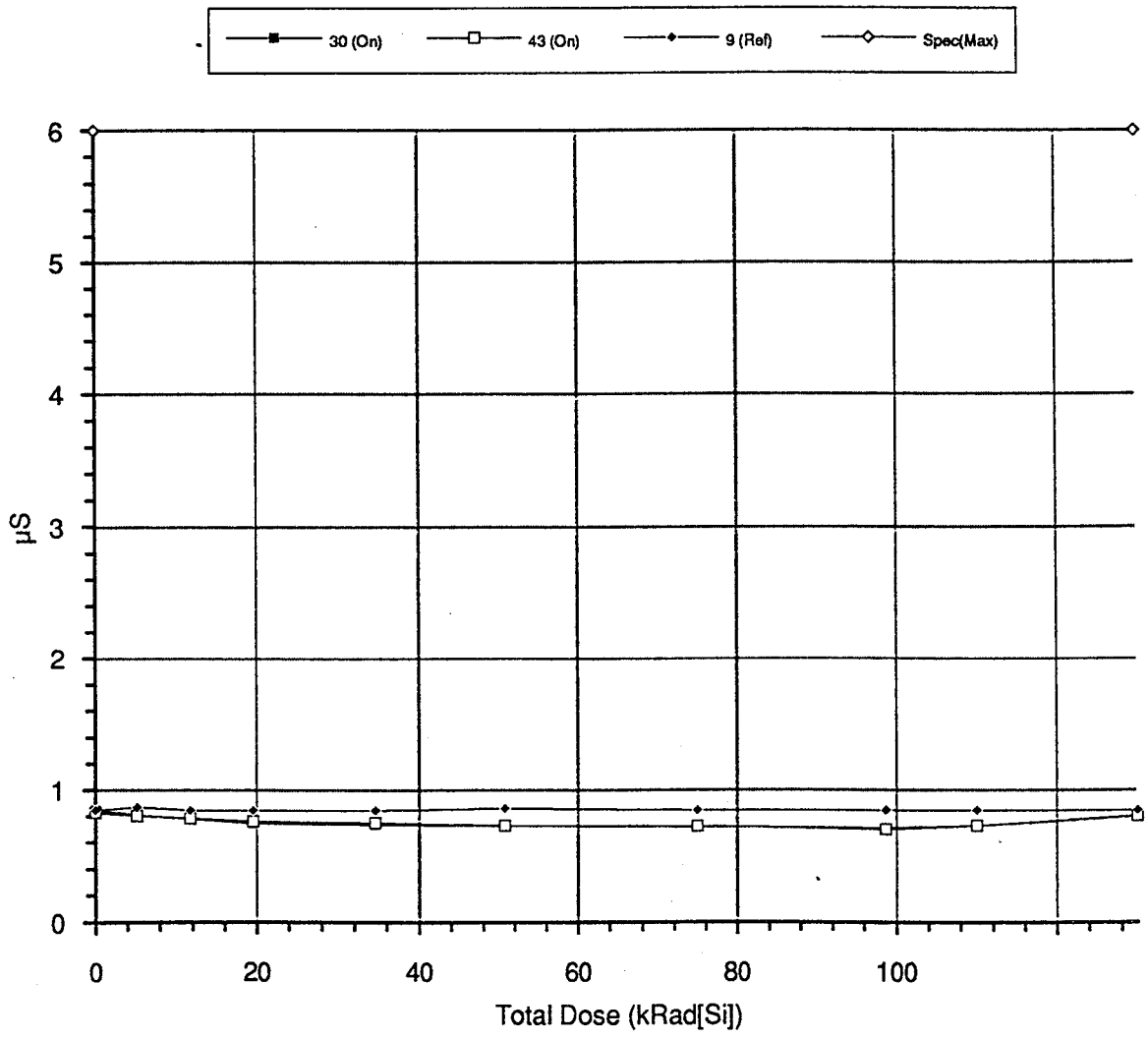


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 42
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLZ_EMA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, Dout=0, clock disappearing.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

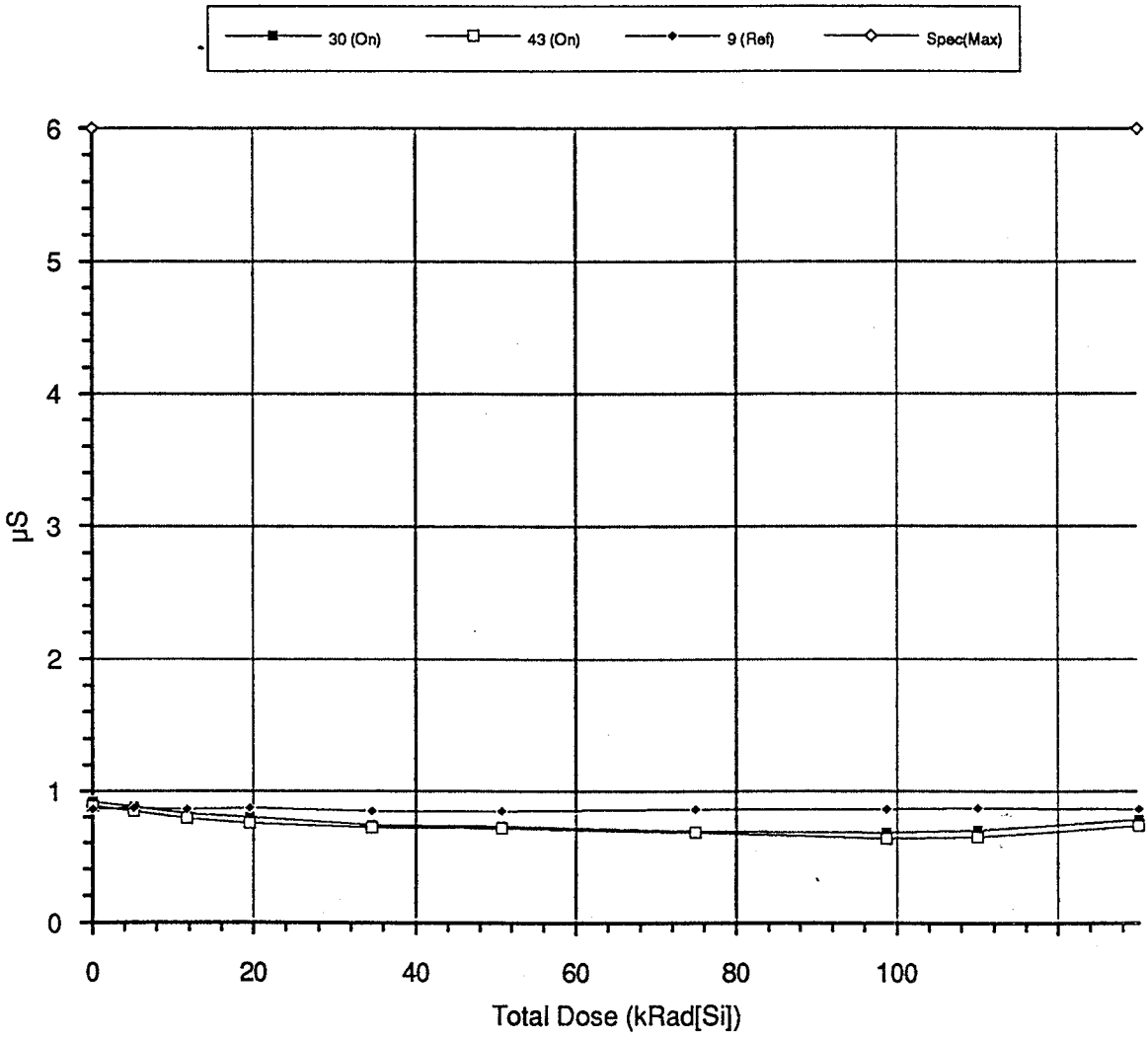


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 43
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TPLZ_EMB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, Dout=0, clock disappearing.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

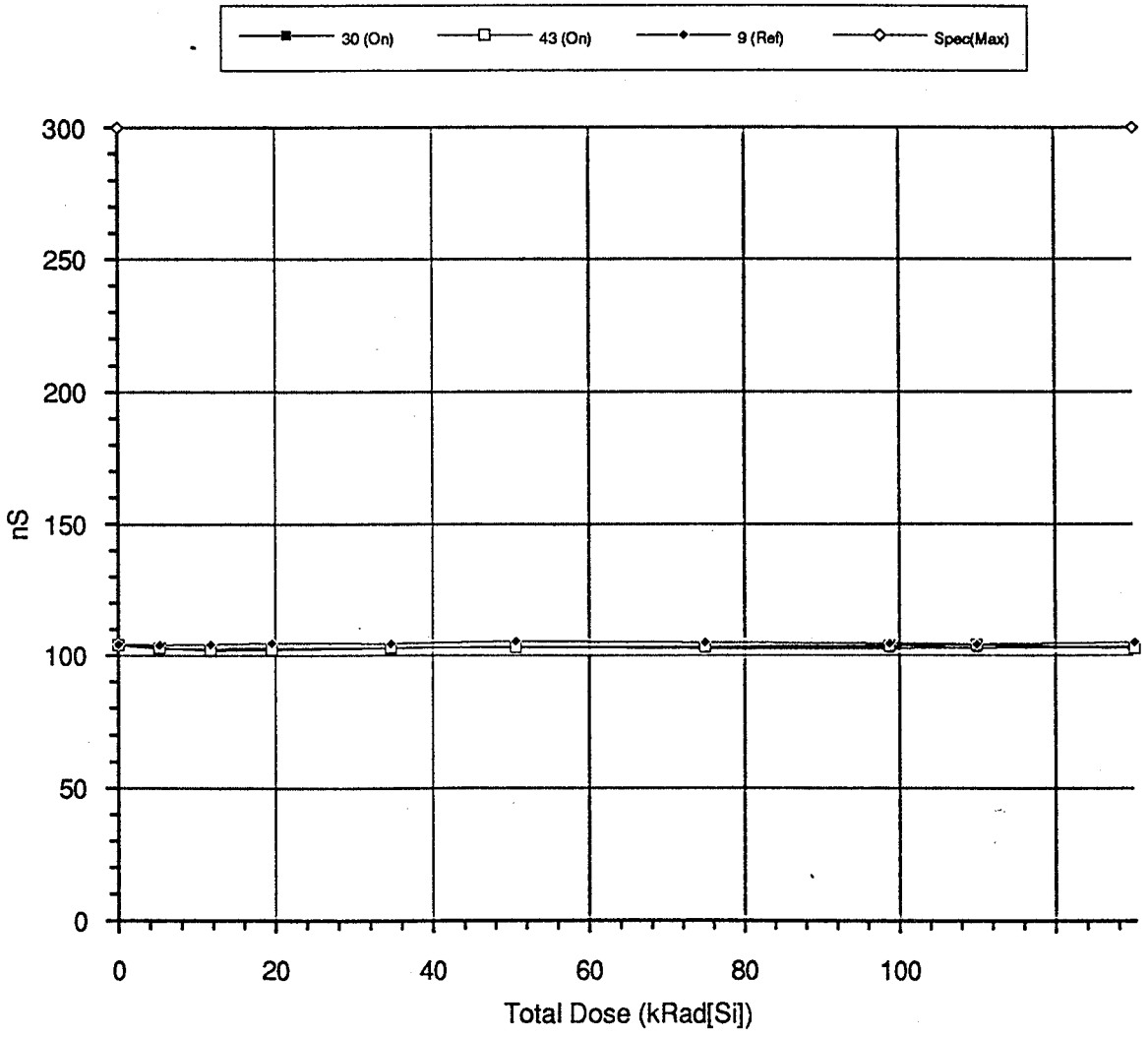


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 44
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TR_EMA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, clock modulation, Dout changes from low to high level.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

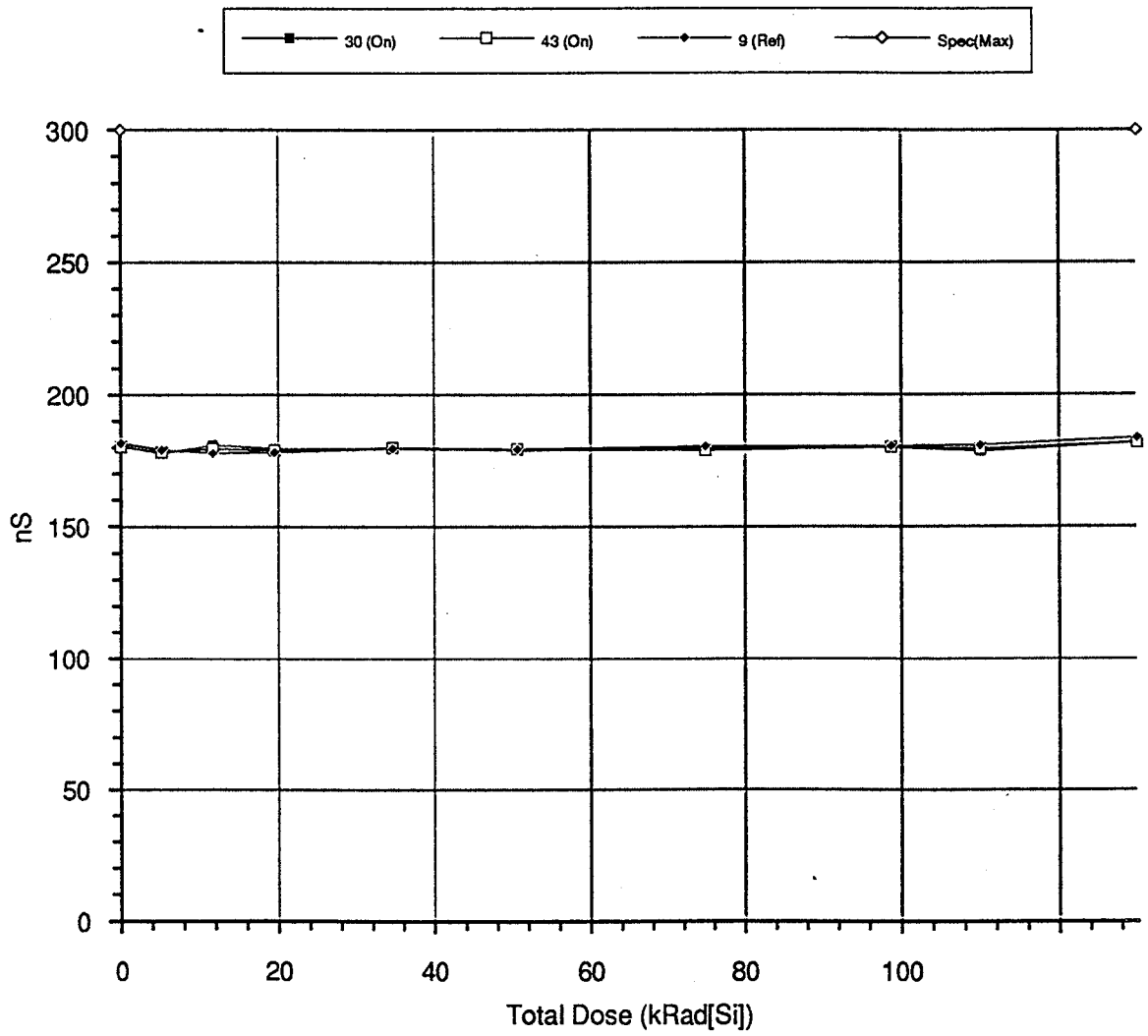


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 45
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TR_EMB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, clock modulation, Dout changes from low to high level.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

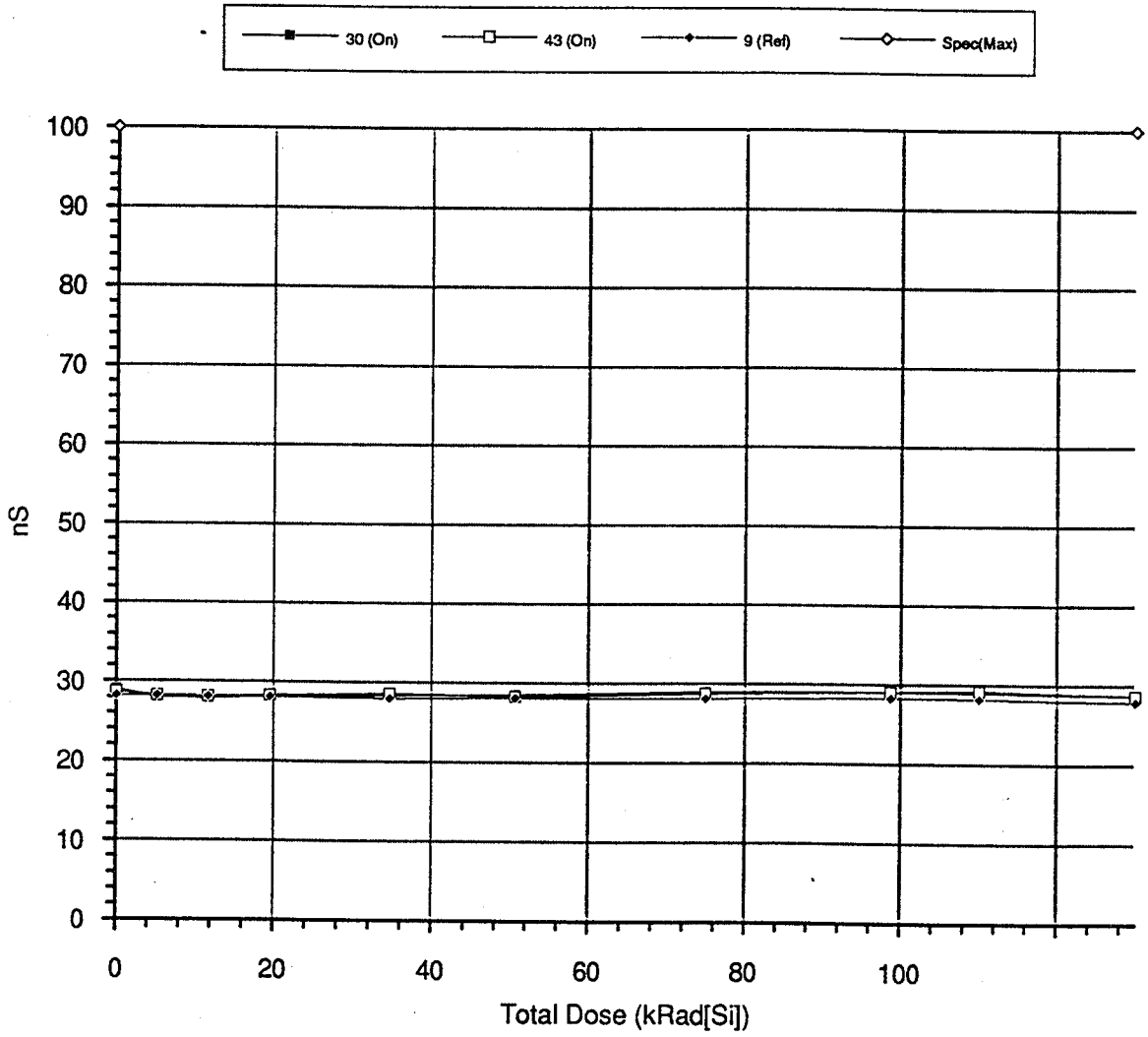


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 46
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TF_EMA**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, clock modulation, Dout changes from high to low level.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

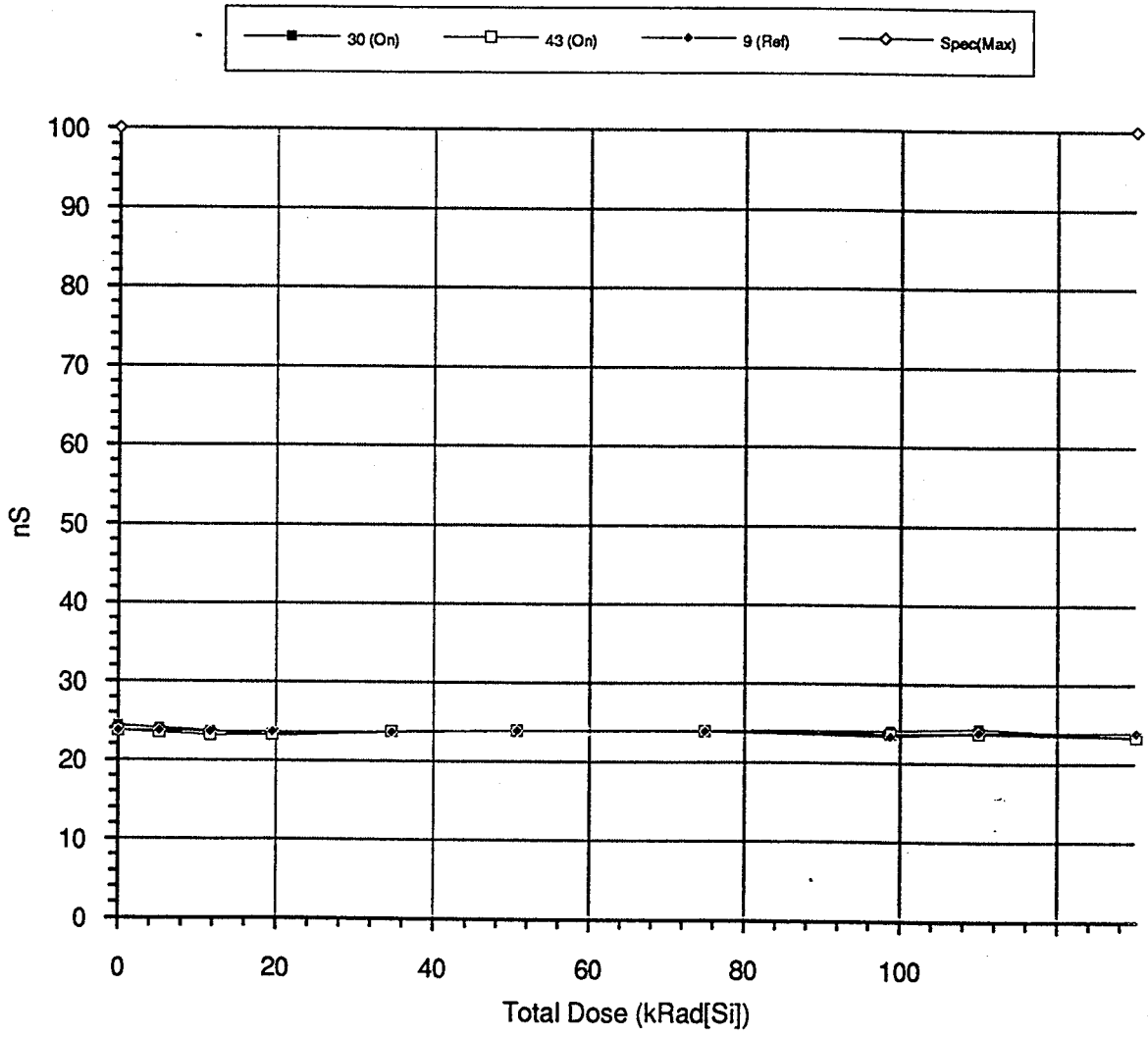


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 47
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TF_EMB**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Nominal load, clock modulation, Dout changes from high to low level.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

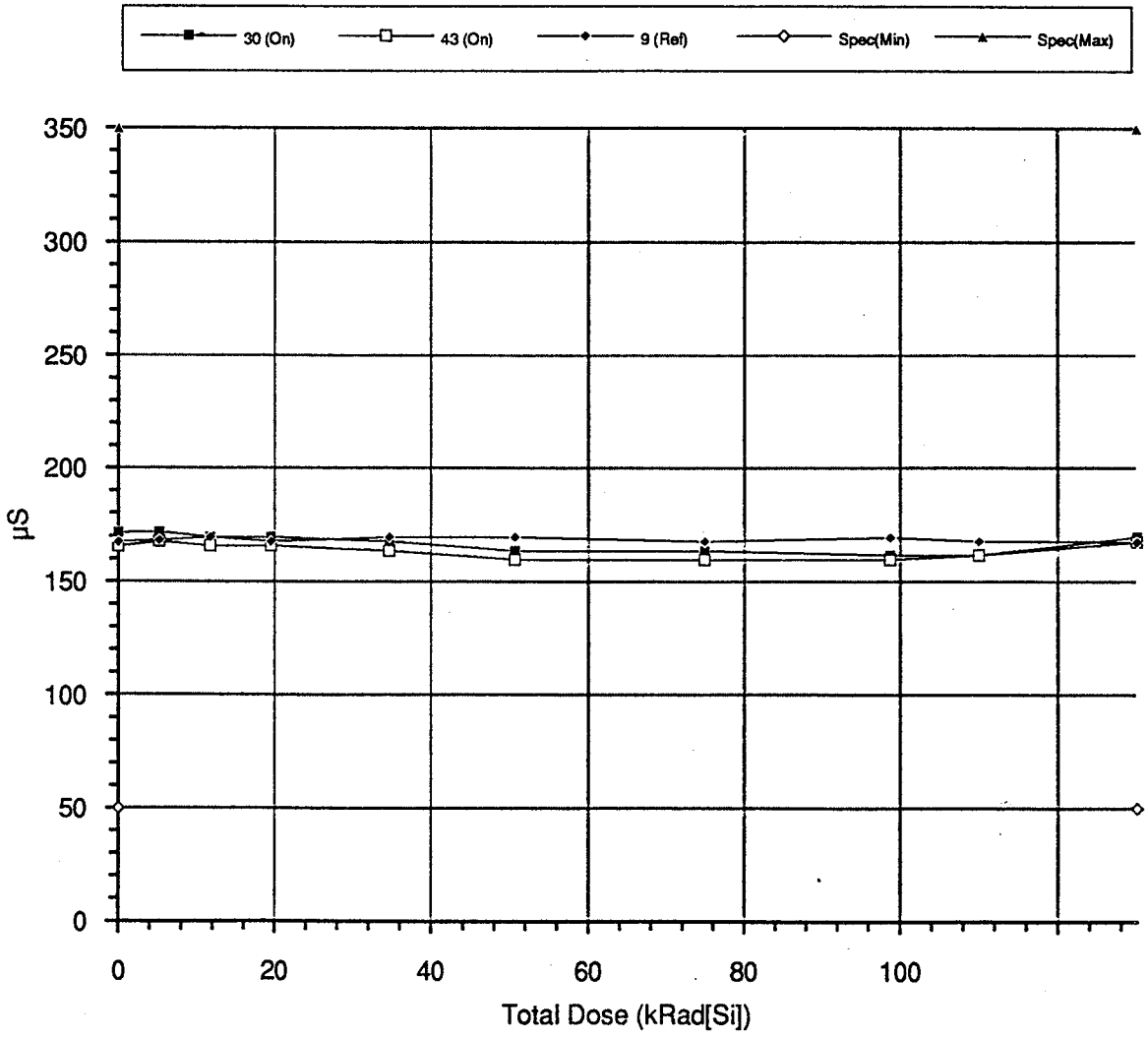


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 48
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **T_ACT_A**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.6.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

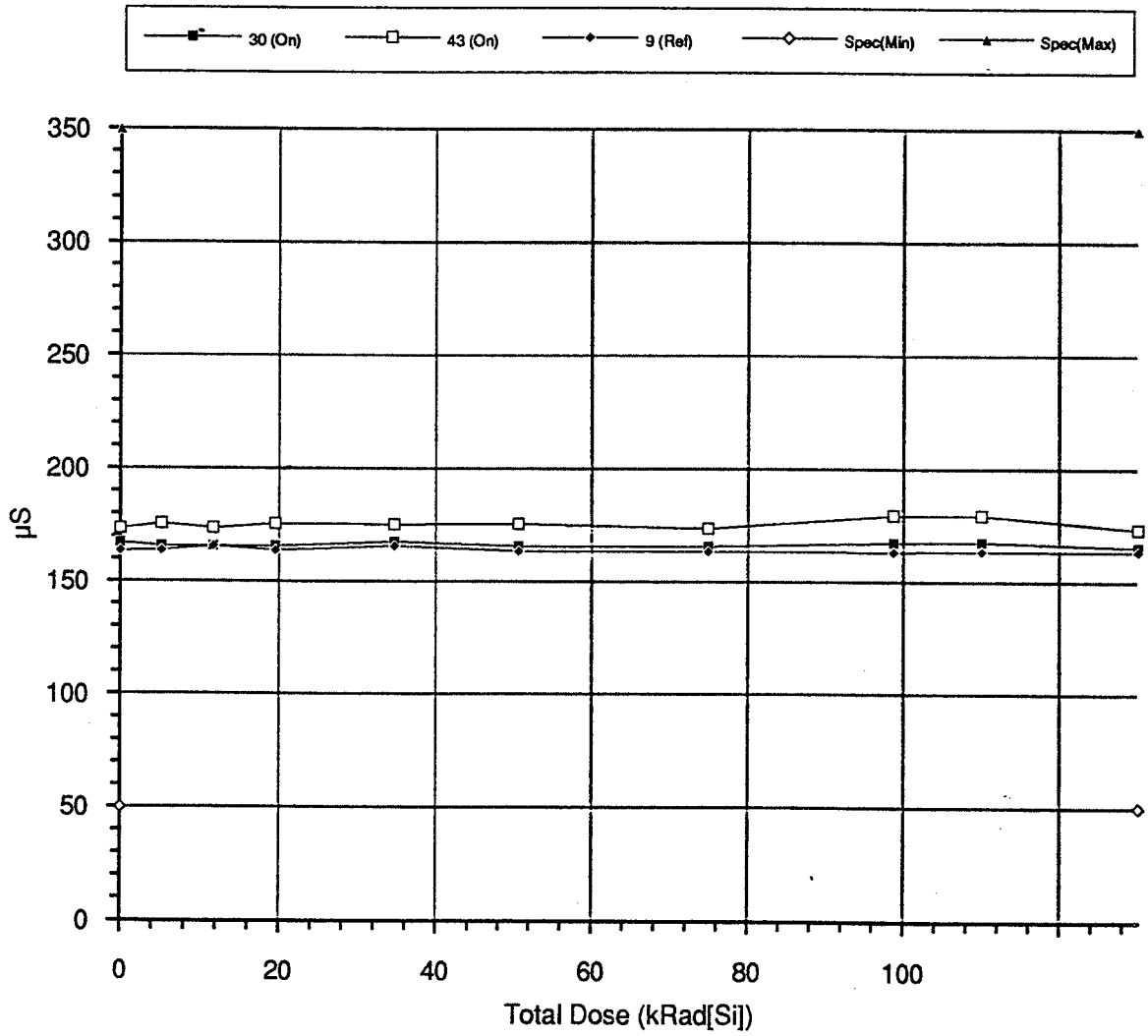


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 49
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **T_ACT_B**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.6.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

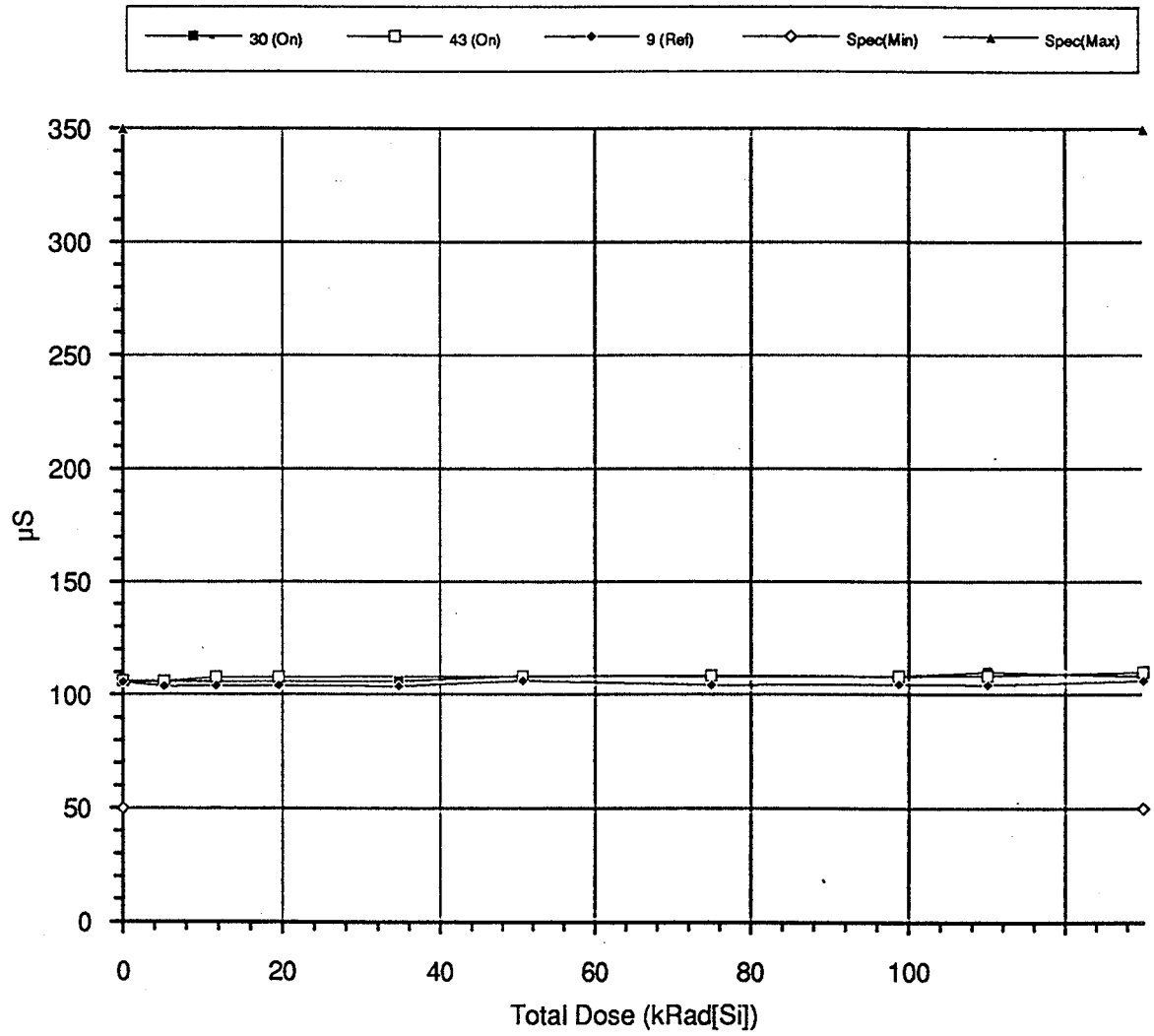


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 50
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **T_INH_A**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.6.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

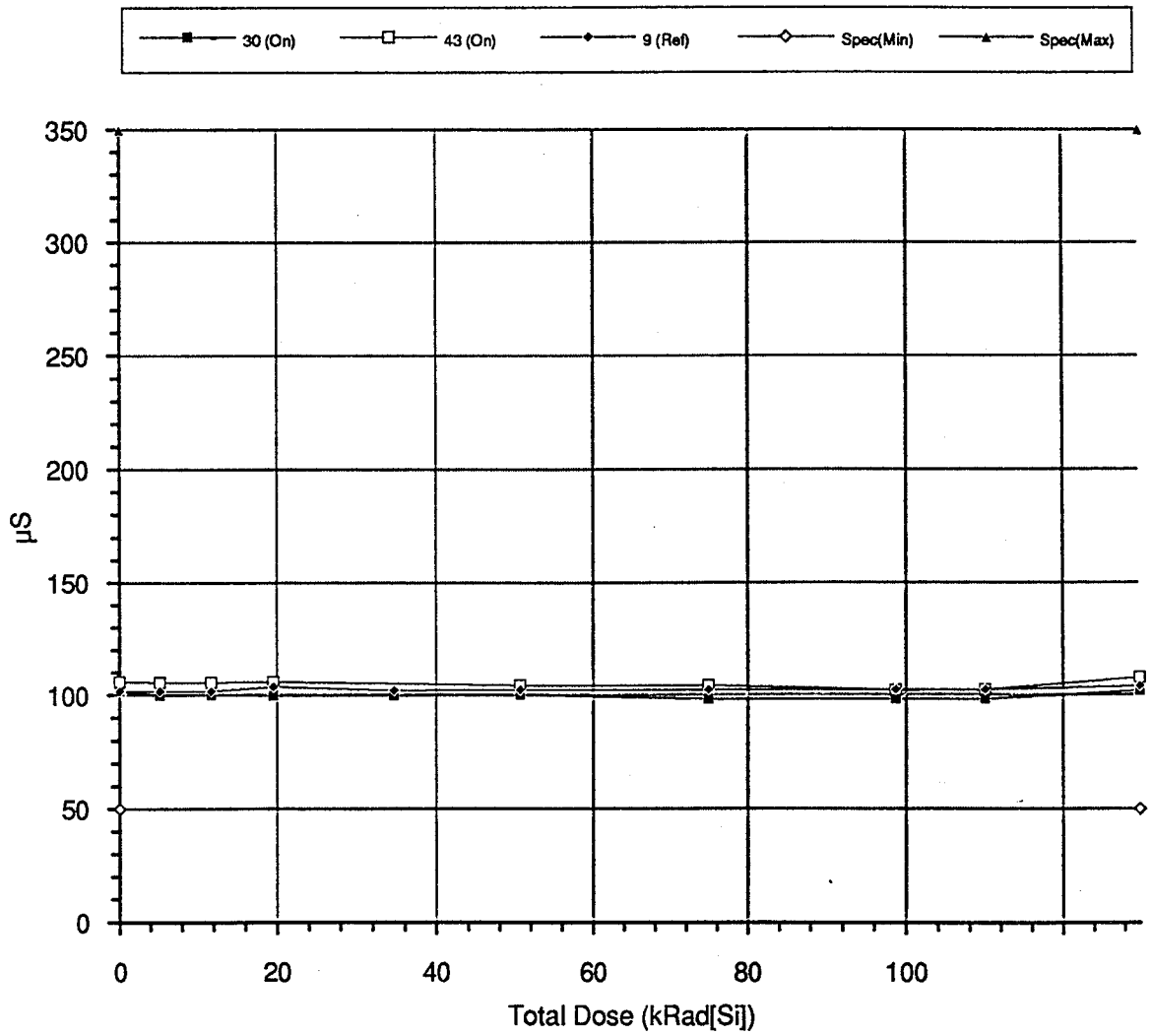


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 51
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **T_INH_B**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.6.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

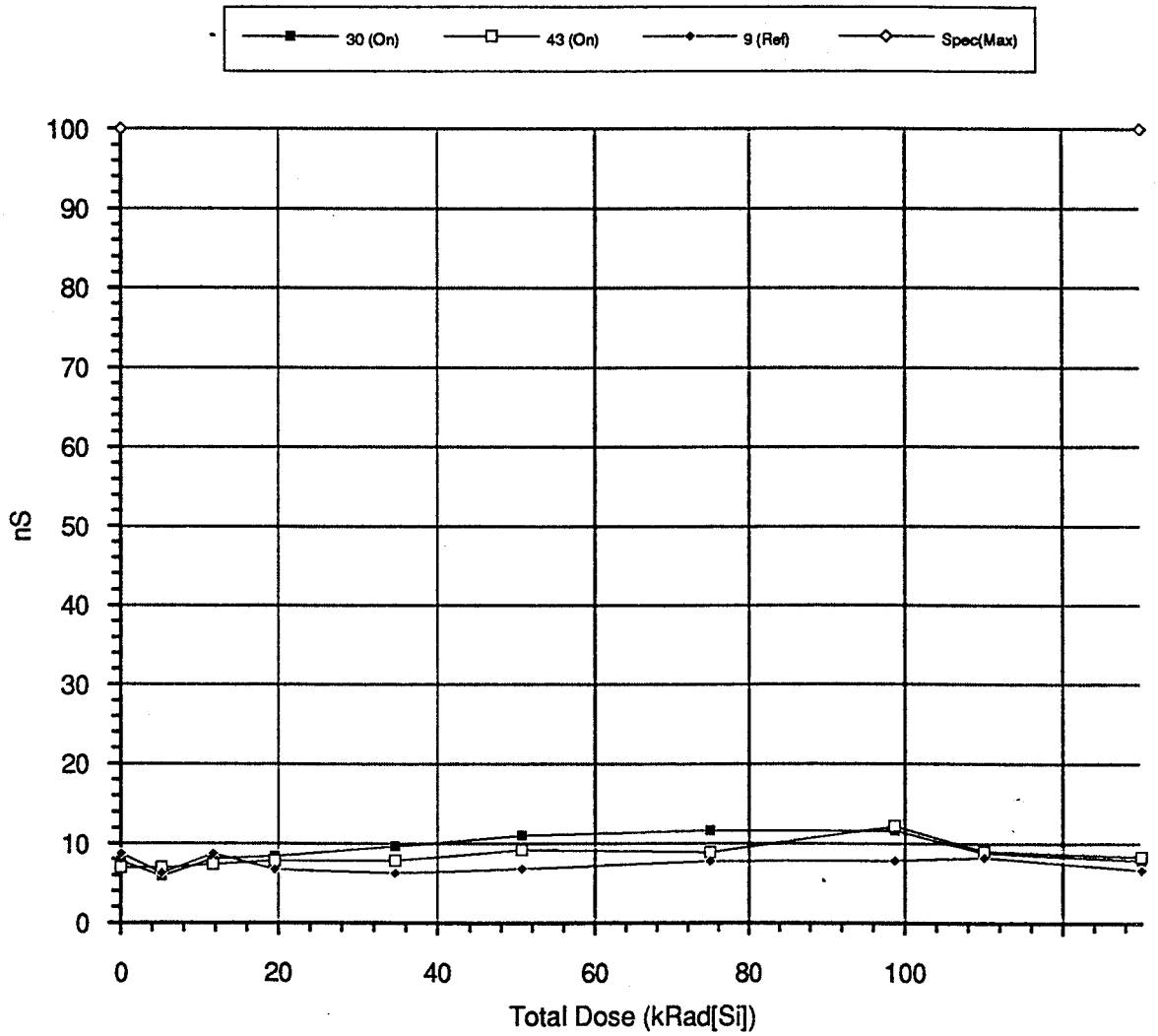


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 52
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TR_RESET**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.6.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

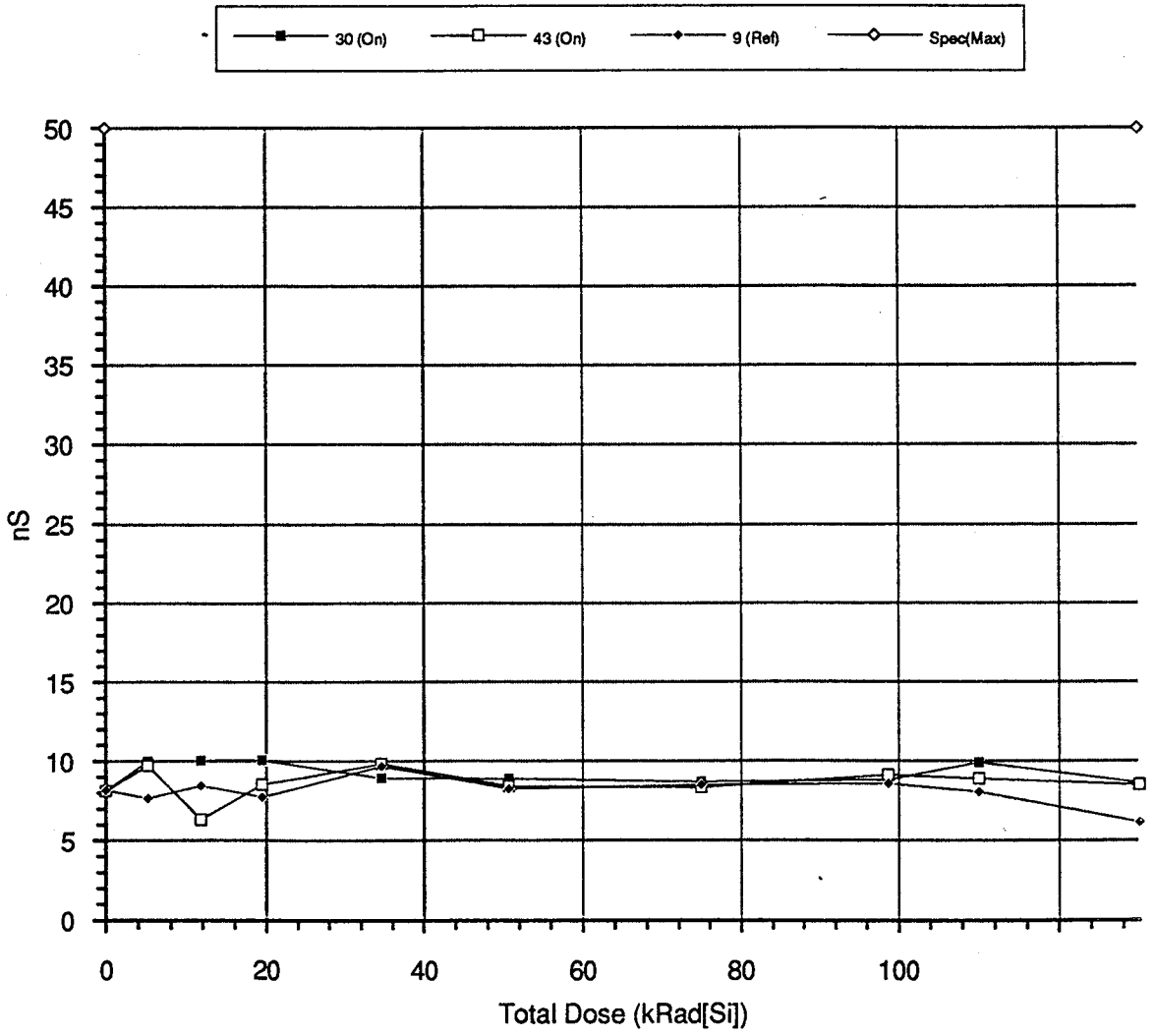


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 53
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TF_RESET**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.6.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

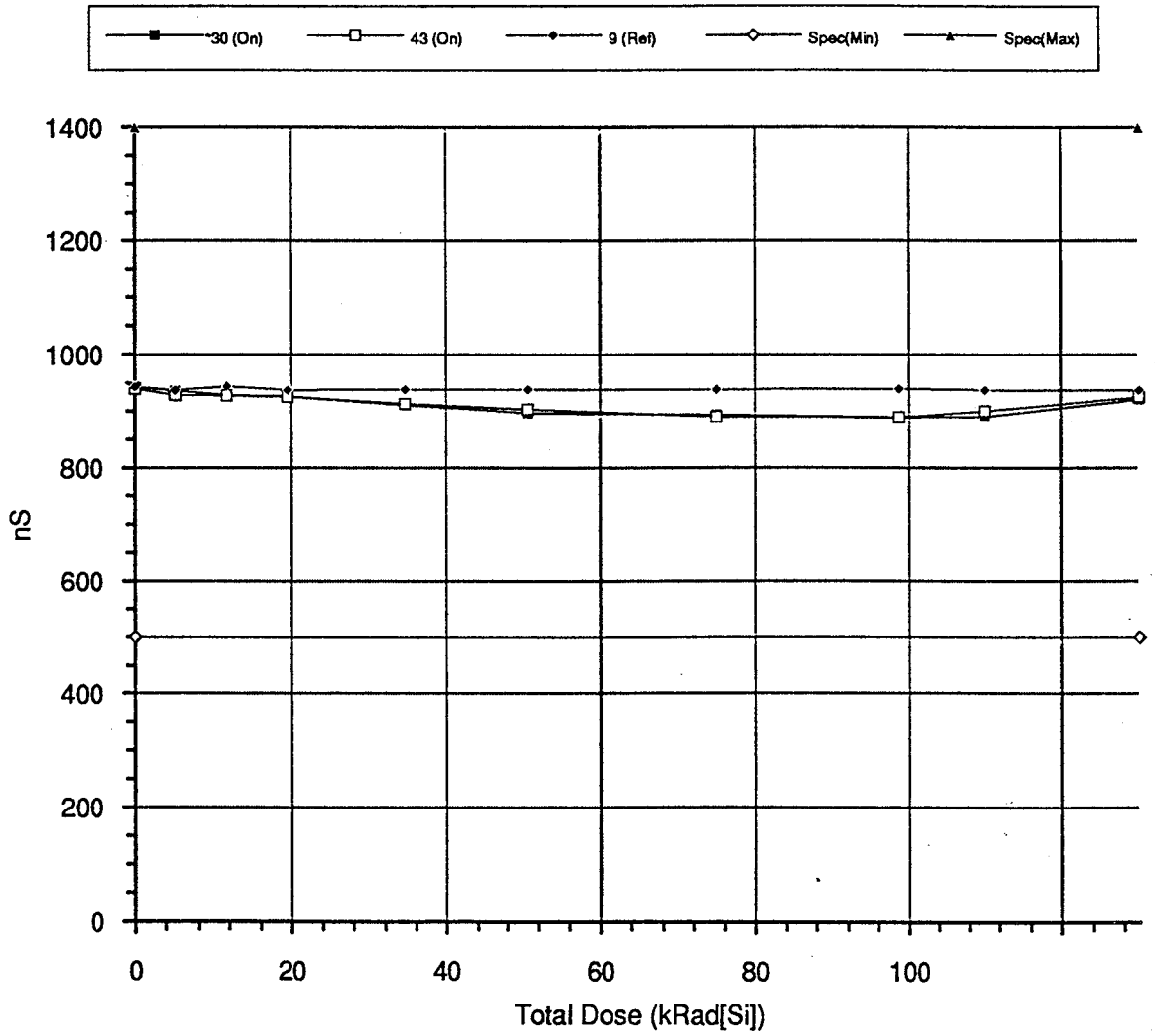


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96**		Fig. 54
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **T_SYNC_A**		Radiation Source: **Co60** Dose Rate: **<= 0.36kRad/h**
Test Conditions: **Cl=18pF, see spec. fig.7.**		
Irradiation Conditions: **Dynamic On (Sn30 & 43)**		Number of irradiated devices: 2

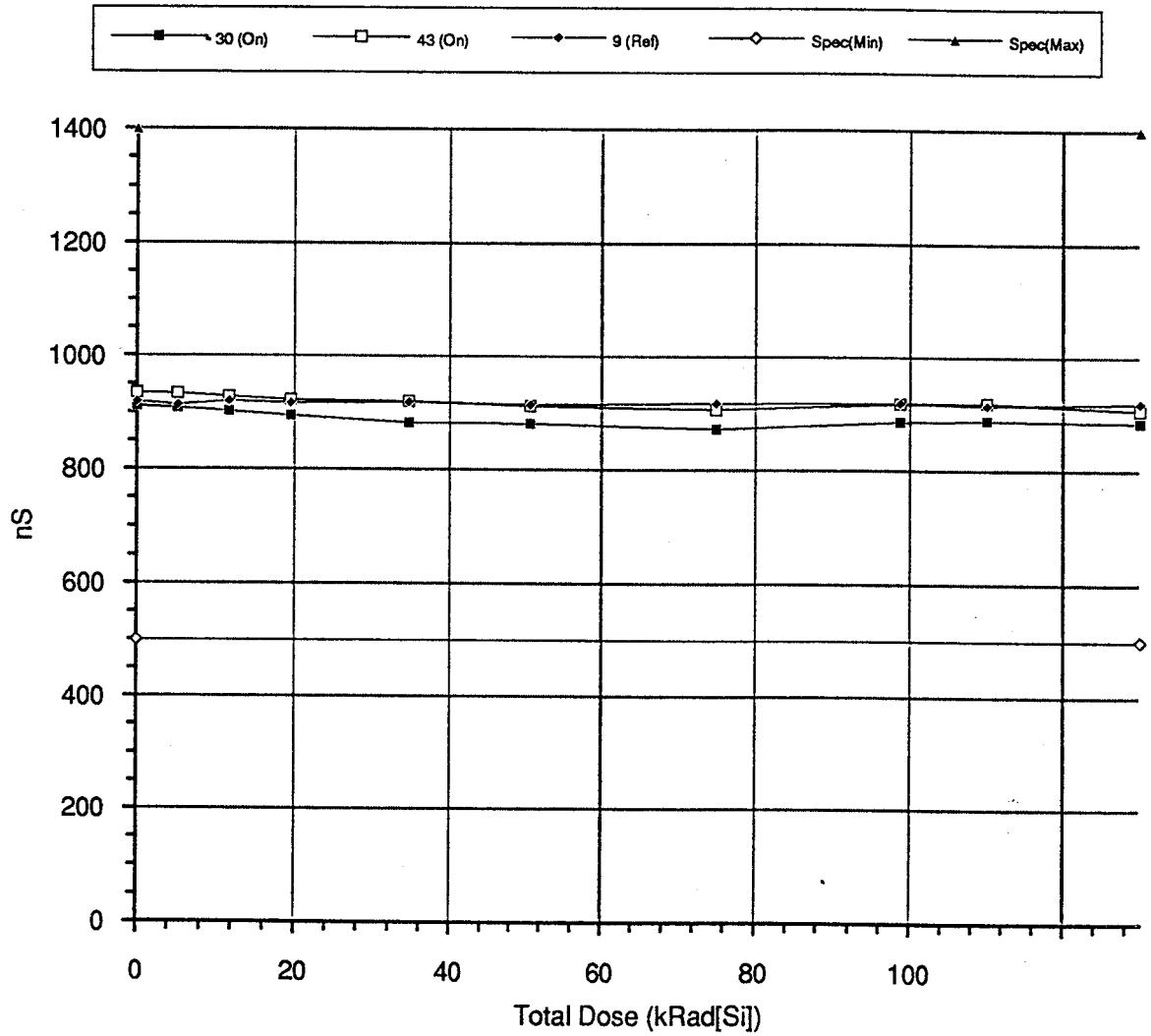


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96**		Fig. 55
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **T_SYNC_B**		Radiation Source: **Co60** Dose Rate: **<= 0.36kRad/h**
Test Conditions: **Cl=18pF, see spec. fig.7**		
Irradiation Conditions: **Dynamic On (Sn30 & 43)**		Number of irradiated devices: 2

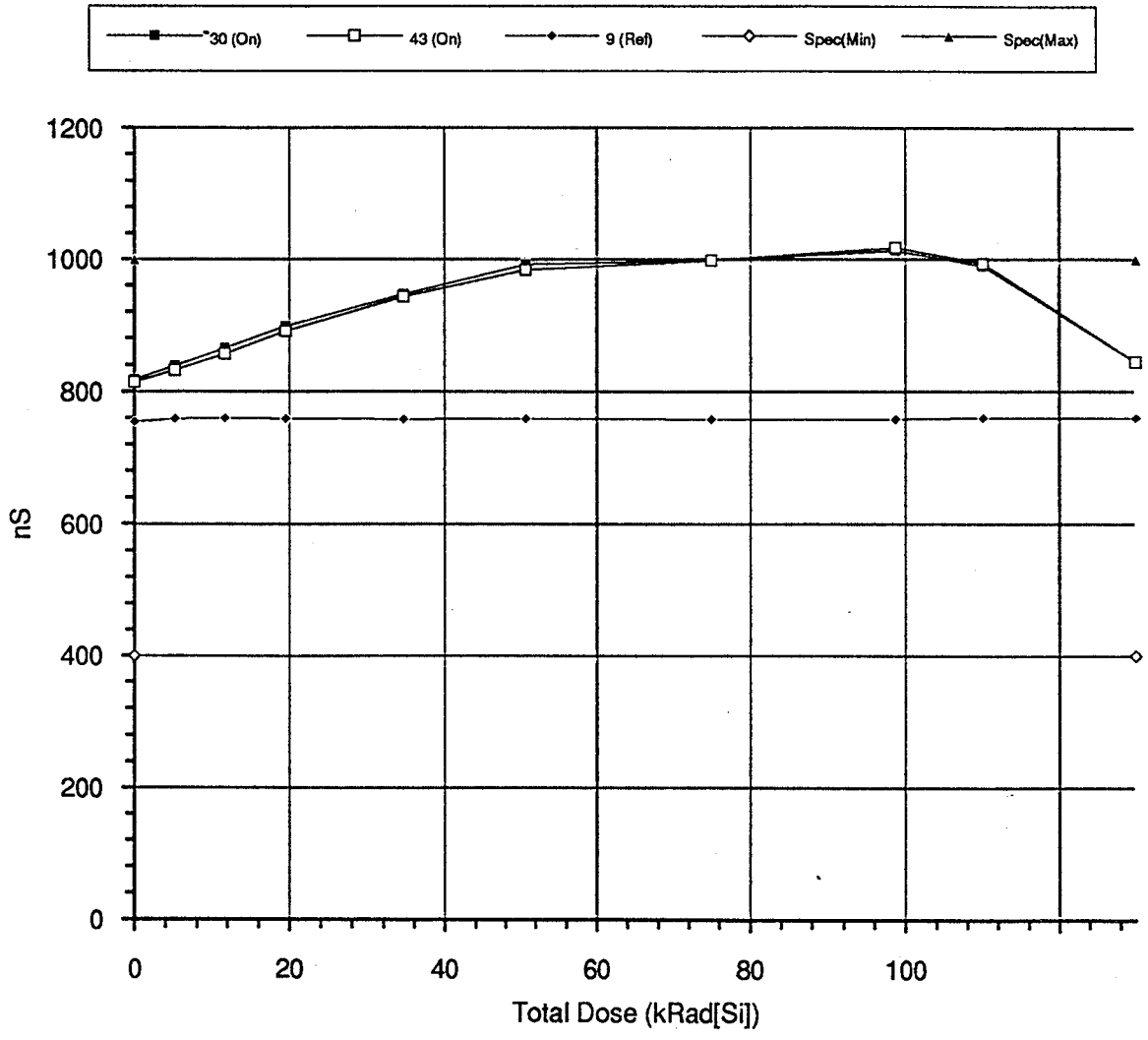


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 56
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **T_HOLD_A**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.7.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

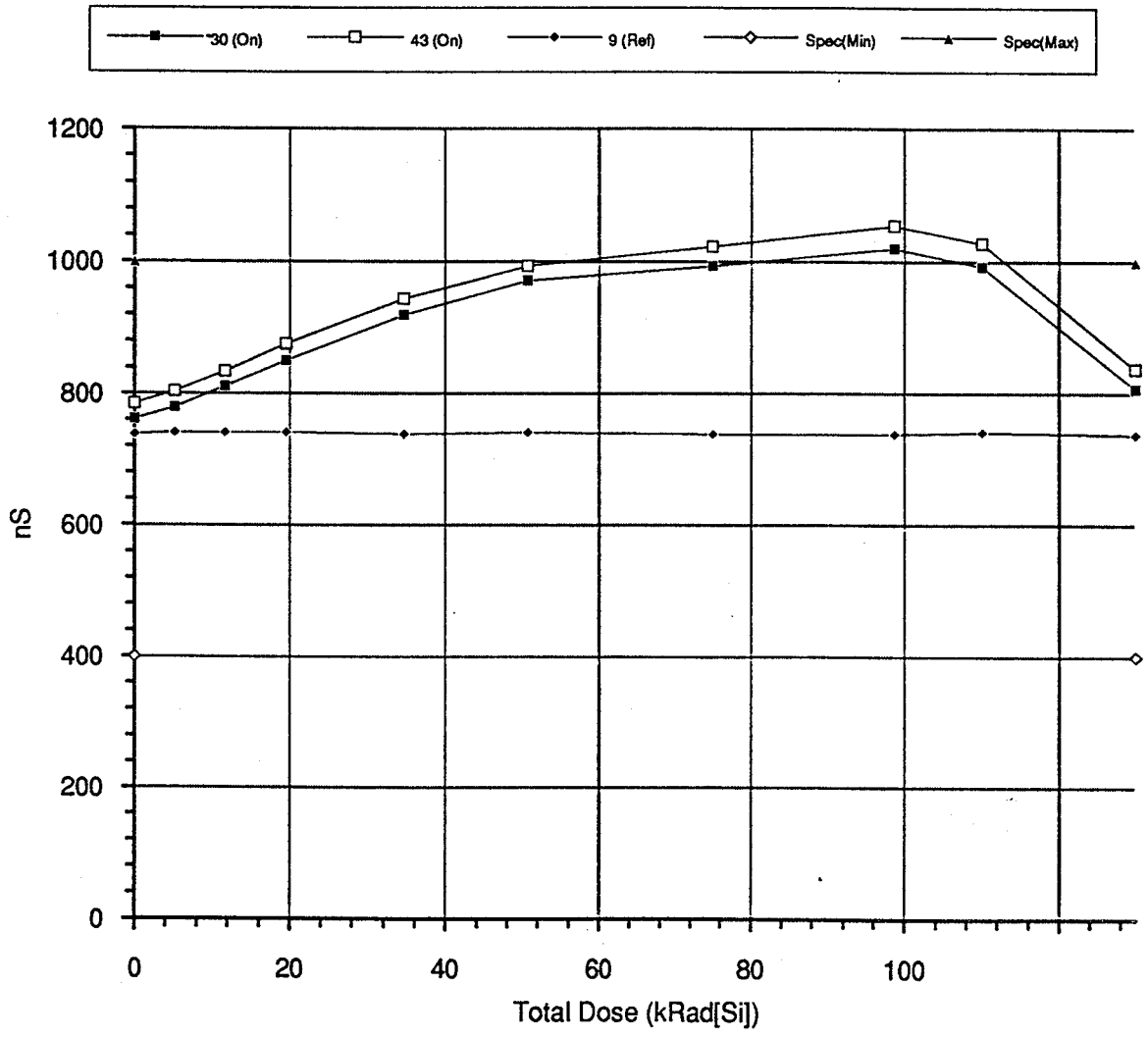


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 57
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **T_HOLD_B**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.7.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

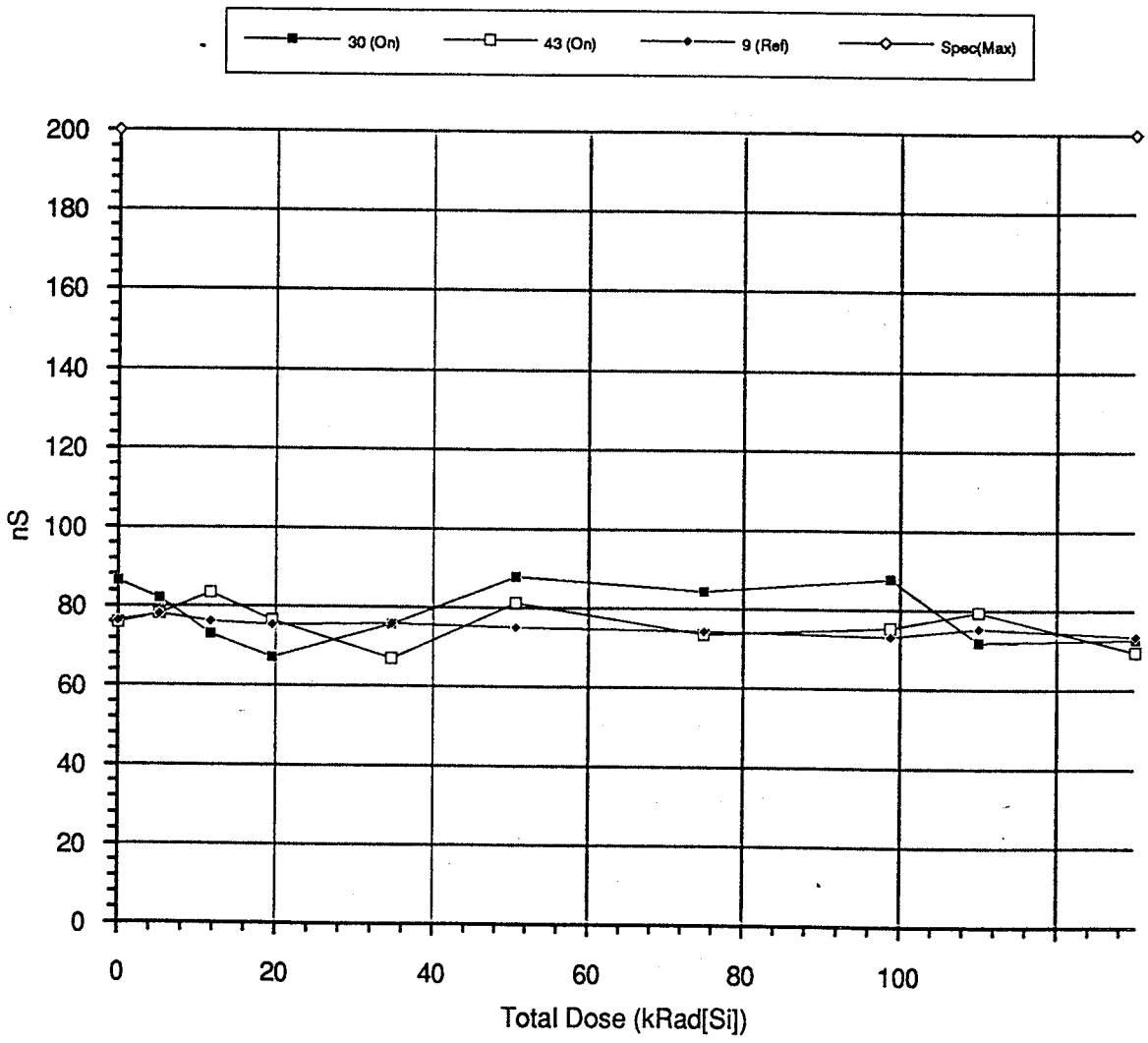


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: **January 96.**		Fig. 58
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TR_SYNC**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.7.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2

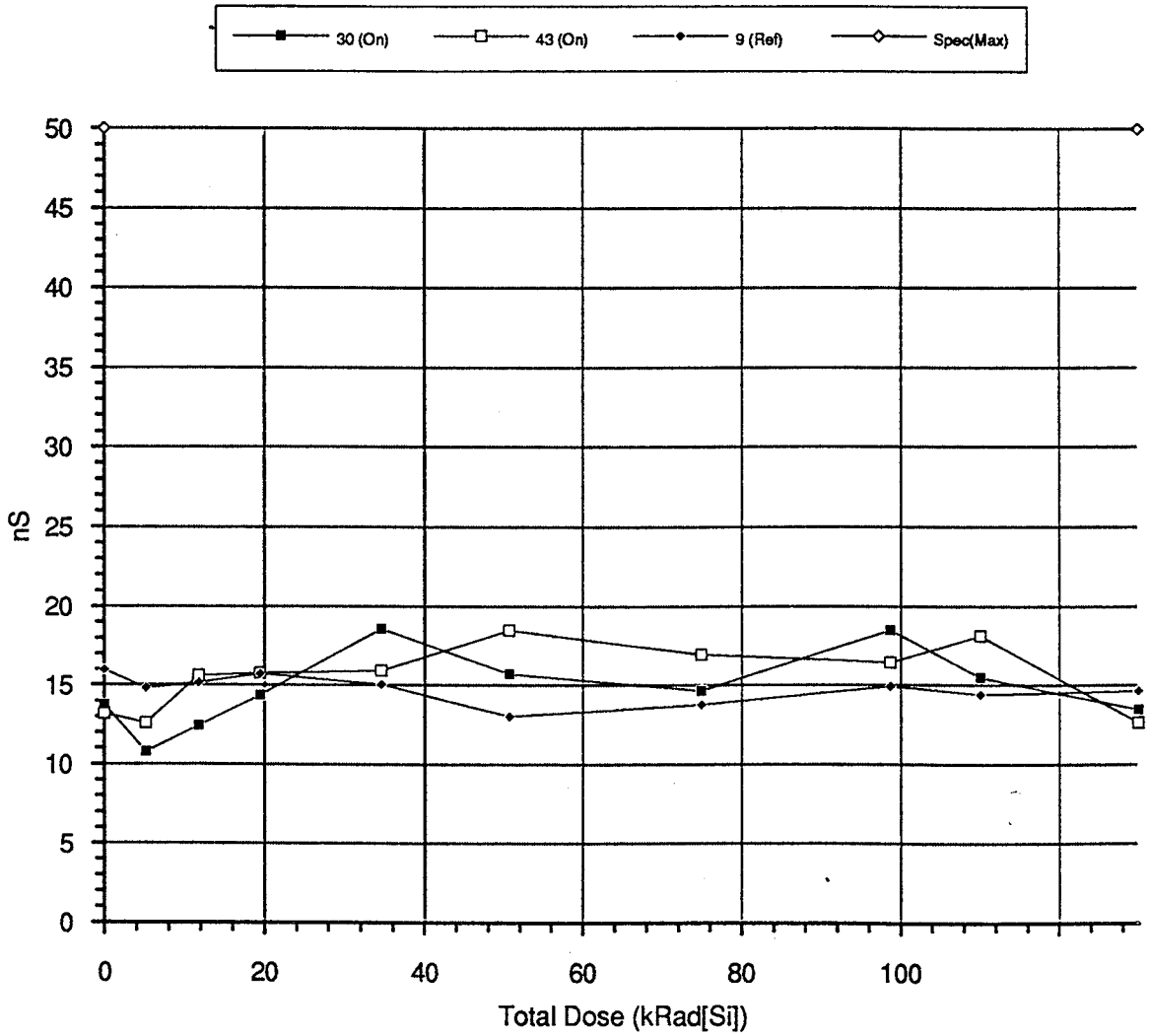


The two last points correspond to the post annealing measurements.

Total Dose Radiation Testing

MATRA MARCONI SPACE

Date: January 96.		Fig. 59
Type: **MBH 473D**	Date Code: **9229**	Manufacturer: **MMS**
Tested Parameter: **TF_SYNC**		Radiation Source: **Co60** Dose Rate: **<= 0.36 kRad/h.**
Test Conditions: **Cl=18pF, see spec. fig.7.**		
Irradiation Conditions: **Dynamic On(Sn30 & Sn43).**		Number of irradiated devices: 2



The two last points correspond to the post annealing measurements.