TOTAL DOSE STEADY-STATE IRRADIATION

OF

IRFY 9140 (DC 9833A)

P-channel power MOSFET

from

INTERNATIONAL RECTIFIER

Written by	Verified by	Approved by
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Date:	Date:	Date:
Visa:	Visa:	Visa:

CONTENTS

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
IRFY9140CSCS	Detail Specification

II. TEST PLAN

II.1 PARTS REFERENCES

REFERENCES		
TYPE	:	IRFY 9140
MANUFACTURER	:	INTERNATIONAL RECTIFIER
PLACE	:	USA
FUNCTION		
P-channel power MOSFET		
TECHNOLOGY		
HEXFET		
PARTS PROCUREMENT		
ORIGIN	:	METOP
LEVEL	:	MIL Class S
PACKAGING	:	TO257 AA
DATE CODE	:	9833A
F.R. NUMBER	:	98053
WAFER LOT NUMBER	:	246573
NUMBER OF PARTS	:	11 (10 irradiated + 1 ref)
DETAIL SPECIFICATION		
IRFY9140CSCS		

II.2 ELECTRICAL MEASUREMENTS

TEST TYPE		
TYPE	:	Remote electrical measurements done at room temperature

TEST FACILITY		
PLACE	:	MATRA VELIZY
MATERIAL	:	HP 4155 & Programmable Curve Tracer (370A)
CALIBRATION DATE	:	04/98 & (02/98 & 10/98)

TESTED PARAMETERS

Parameter Name	Fig n°	Symbol	Test Conditions	Min	Max	Unit
Gate Voltage threshold	1	Vgs(th)	Vds=Vgs ; Id=-250µA	-4	-2	V
Zero gate Voltage Drain Current	2 & 3	Idss	Vgs=0V ; Vds=-80V	-25		µA
Static Drain-Source ON Resistance	4	Rds ON 1	Vgs=-10V ; Id=-8.2A		0.21	Ohms
Static Drain-Source ON Resistance	5	Rds ON 2	Vgs=-10V ; Id=-13A		0.24	Ohms

Notes:

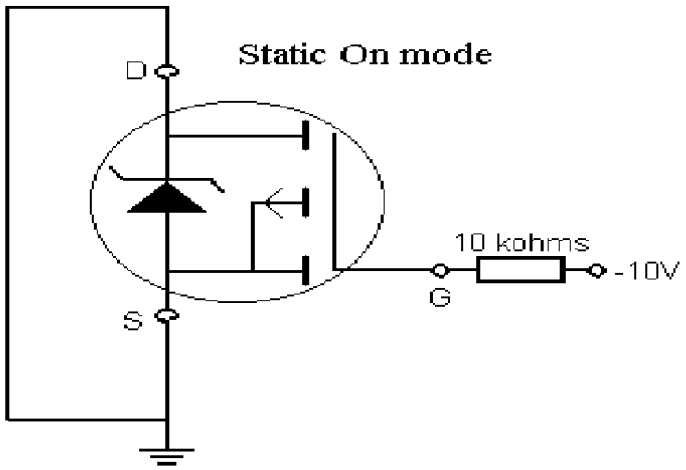
- All electrical measurements were made within one hour of termination of the irradiation step.
- Figure numbers refer to the figures showing variation and values of each parameter with total dose and annealings at the end of this document.

II.3 EXPERIMENTAL CONDITIONS

IRRADIATION FACILITY		
PLACE	:	C.E.A. SACLAY
TYPE	:	COBALT 60 GALAXIE
ACTIVITY	:	330 Rad/h
CALIBRATION DATE	:	At the beginning of irradiation

IRRADIATION FACILITY		
TYPE	:	Multiple Exposures
STEPS	:	9.2 , 22.6 , 30 , 52.6 , 69.4 , 106.7 kRad (Si)

BIASING CONDITIONS



COMMENTS

8 parts were biased in Static On mode, 2 parts were biased in Static Off mode with all pins connected to ground.

III TEST REPORT

III.1 EXPERIMENTAL CONDITIONS

PARTS IDENTIFICATION			
MANUFACTURER MARKING :	Top : I R BeO IRFY9140CSCS Δ 9833		
SAMPLES DESCRIPTION			
SN Manuf.	**SN Irrad.**	**Biasing Mode**	**Comments**
31	**0**	**REF**	
32	**1**	**ON**	
33	**2**	**ON**	
34	**3**	**ON**	
35	**4**	**ON**	
36	**5**	**ON**	
37	**6**	**ON**	
38	**7**	**ON**	
39	**8**	**ON**	
40	**9**	**OFF**	
41	**10**	**OFF**	

IRRADIATION SCHEDULE						
Step N°	Date In / Out	Description	DOSE RATE [kRad(Si) / H]	IRRAD. TIME [H]	DOSE [kRad(Si)]	TOTAL DOSE [kRad(Si)]
0		Initial Measurements			0,00	0,0
1	08/02/99 09/02/99	Irradiation & Measurements	0,33	28,02	9,2	9,2
2	09/02/99 11/02/99	Irradiation & Measurements	0,33	40 ,33	13,4	22,6
3	11/02/99 12/02/99	Irradiation & Measurements	0,33	22,67	7,4	30.
4	12/02/99 15/02/99	Irradiation & Measurements	0,33	68,42	22,6	52,6
5	15/02/99 17/02/99	Irradiation & Measurements	0,33	50,92	16,8	69,4
6	17/02/99 22/02/99	Irradiation & Measurements	0,33	103,5	37,3	106,7
7	22/02/99 23/02/99	Annealing Amb.	0	24	0	106,7
8	23/02/99 02/03/99	Annealing 100°C	0	168	0	106,7

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.

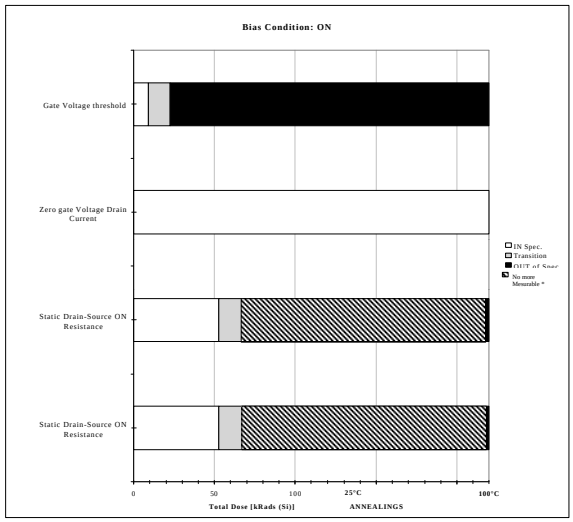
The following tables summarize the evolution of the measured parameters with irradiation and annealings (See next page) for each biasing conditions

In the construction of these charts ,

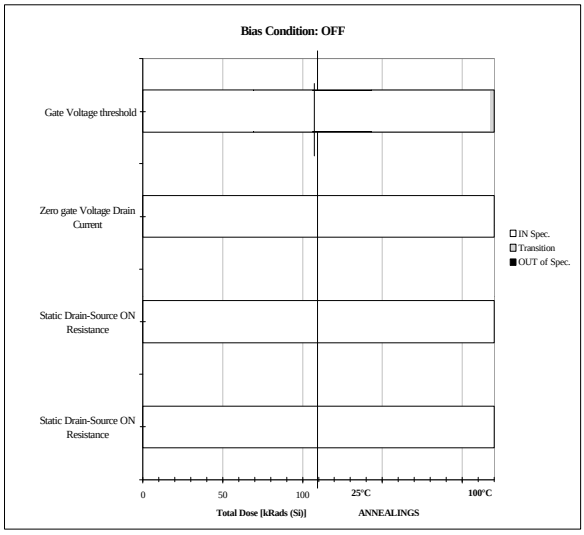
1/ A parameter is considered to be out of specification if the parameter is measured out of specification on one or more devices.

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.



* See III.2.3 Problems encountered / Discussion.



III.2.2.Post irradiation effects.

Step 1.

Temperature : Room Temperature.
Duration : 24 h
Biasing : Parts biased as during irradiation.

Step 2.

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

III.2.3 Problems encountered / Discussion

- Due to deterioration of Vgs(th) (< -7,3V after 69,4 KRad), Rds1(on) is no more measureable with the specified test conditions after 69,4 KRad, for all parts biased in Static On mode.

- Due to deterioration of VGS(th) (< -6,4V after 52,6 KRad), Rds2(on) is no more measureable with the specified test conditions, on 4 parts biased in Static On mode after 52,6 KRad and on 4 parts biased in Static On mode after 69,4 KRad.

- Programmable Curve Tracer (370A) which was calibred in 02/98, was replaced after step 4.

IV CONCLUSION

Total dose steady-state irradiation test using gamma rays from Cobalt 60 has been carried out on 10 parts (8 parts biased in Static On mode and 2 Off) P-channel power MOSFET IRFY 9140 (9833A) from INTERNATIONAL RECTIFIER up to 106,7 KRad test at low dose rate (≤ 360 Rad/h).

The results indicate that :

- All the parameters stay within specification up to 17 Krad.

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

	Tolerance	
Parameter	**Static On**	**Static Off**
Vgs(th)	17 KRad	97 KRad
Rds ON 1	60 KRad	> 106,7 KRad
Rds ON 2	53 KRad	> 106,7 KRad
Drift Vgs(th)	68 mV/KRad	16,5 mV/KRad

- Biasing mode effect :

  - Degradation is more important for parts biased in static On mode during radiation.

- Annealing effect :

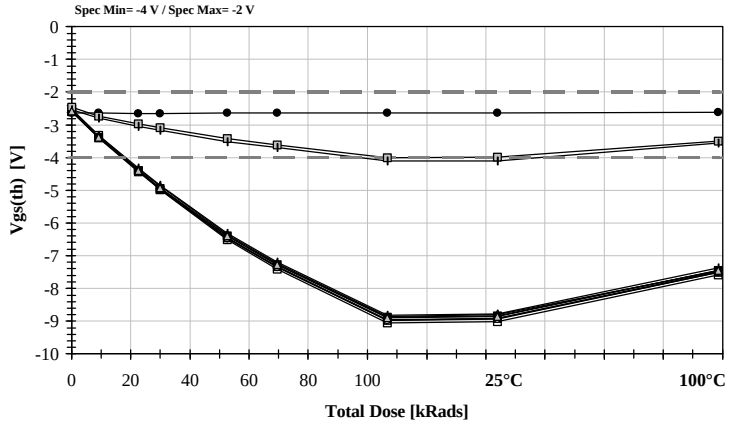
  - No significiant recovery has been observed after the annealing at 100°C.

In the following table, a comparison is made with other date codes from the same manufacturer, already tested :

Date code	**Diffusion lot**	**Tolerance (in kRad)**	**Report ref.**
98833A	246573	17 KRad	NI 9.088
9534C	233080	13,5 KRad	DOF/DEC/GER/ RP6.210

Date :	Device Type :	IRFY 9140	Figure 1

Component	Date Code :	**9833A**	Manufacturer :	INTERNATIONAL RECTIFIER
Irradiation	Dose Rate :	<= 0.33 kRad / h	Conditions :	OFF / ON / REF
Test	Parameter :	**Vgs(th)**	Conditions :	1

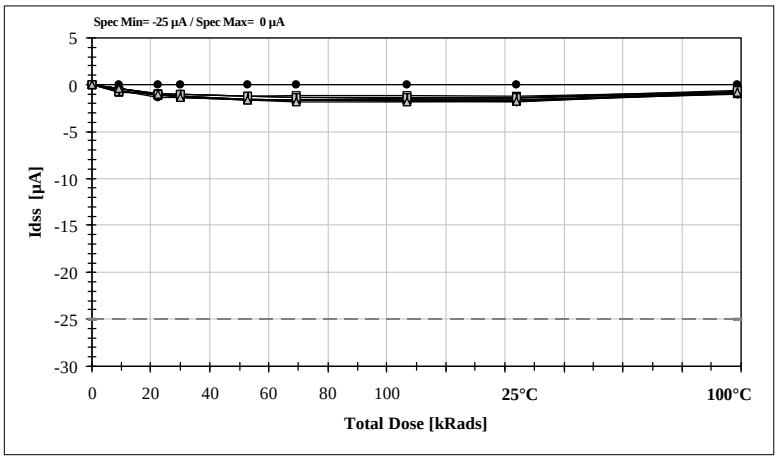


Comments : *The last step correspond to the post annealing measurements*

Total Dose [kRad(Si)]			0	9,2	22,6	30	52,6	69,4	106,7	25°C	100°C
9	OFF	0	-2,53126	-2,79008	-3,044647	-3,169048	-3,504112	-3,698892	**-4,100636**	**-4,094351**	-3,560492
10	OFF	9	-2,46787	-2,72168	-2,962724	-3,085721	-3,417429	-3,612485	-3,998598	-3,989239	-3,488723
1	ON	1	-2,51117	-3,32361	**-4,403969**	**-4,97559**	**-6,514429**	**-7,42085**	**-9,060541**	**-9,009707**	**-7,592202**
2	ON	2	-2,56334	-3,35653	**-4,405339**	**-4,944156**	**-6,453417**	**-7,335473**	**-8,95044**	**-8,906994**	**-7,492486**
3	ON	3	-2,59591	-3,39381	**-4,420855**	**-4,965632**	**-6,440094**	**-7,331547**	**-8,970407**	**-8,925413**	**-7,517581**
4	ON	4	-2,56063	-3,36528	**-4,405341**	**-4,96075**	**-6,467296**	**-7,343867**	**-8,978511**	**-8,933843**	**-7,50511**
5	ON	5	-2,59955	-3,37558	**-4,401875**	**-4,94019**	**-6,389788**	**-7,259922**	**-8,883708**	**-8,838101**	**-7,442985**
6	ON	6	-2,54755	-3,3122	**-4,317372**	**-4,847329**	**-6,313578**	**-7,189909**	**-8,824989**	**-8,775831**	**-7,371895**
7	ON	7	-2,54857	-3,32834	**-4,349825**	**-4,866358**	**-6,35255**	**-7,228142**	**-8,852689**	**-8,804262**	**-7,468468**
8	ON	1	-2,5812	-3,36699	**-4,390448**	**-4,914712**	**-6,381689**	**-7,268756**	**-8,896195**	**-8,850835**	**-7,453342**
0	REF	8	-2,63011	-2,6354	-2,651234	-2,64744	-2,639428	-2,641498	-2,643327	-2,631701	-2,617355

Date :	Device Type :	IRFY 9140	Figure 2

Component	Date Code :	**9833A**	Manufacturer :	INTERNATIONAL RECTIFIER
Irradiation	Dose Rate :	<= 0.33 kRad / h	Conditions :	OFF / ON / REF
Test	Parameter :	**Idss**	Conditions :	2

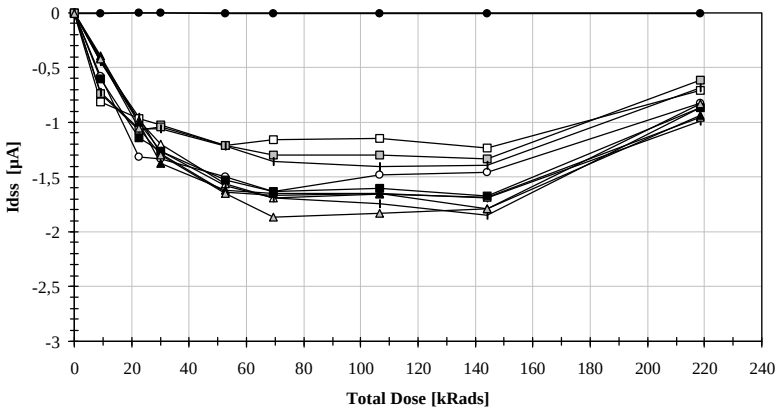


Comments : *The last step correspond to the post annealing measurements*

Total Dose [kRad(Si)]			0	9,2	22,6	30	52,6	69,4	106,7	25°C	100°C
9	OFF	0	-0,0039495	-0,73094	-1,0644	-1,0571	-1,2182	-1,3593	-1,4004	-1,3982	-0,68031
10	OFF	9	-0,0035188	-0,73323	-1,0668	-1,0478	-1,207	-1,2962	-1,2983	-1,335	-0,61179
1	ON	1	-0,0046329	-0,81731	-0,96874	-1,0249	-1,2141	-1,1584	-1,1471	-1,2331	-0,7137
2	ON	2	-0,0042165	-0,44936	-0,95878	-1,287	-1,6363	-1,6697	-1,6492	-1,6894	-0,98719
3	ON	3	-0,0040689	-0,4145	-0,98434	-1,2038	-1,5653	-1,6896	-1,6562	-1,6857	-0,95664
4	ON	4	-0,0030443	-0,58071	-1,3149	-1,3377	-1,4987	-1,6278	-1,4804	-1,4563	-0,82136
5	ON	5	-0,0038744	-0,60956	-1,1388	-1,259	-1,5306	-1,6308	-1,608	-1,6734	-0,86765
6	ON	6	-0,0039425	-0,44865	-0,99828	-1,2602	-1,5795	-1,6954	-1,7488	-1,853	-0,87261
7	ON	7	-0,0042447	-0,39746	-1,0101	-1,3739	-1,6254	-1,6526	-1,6491	-1,7864	-0,93576
8	ON	1	-0,0052627	-0,42415	-1,0562	-1,2941	-1,6486	-1,8716	-1,8324	-1,7898	-0,83413
0	REF	8	-0,0059167	-0,005416	-0,0041643	-0,0043286	-0,0049866	-0,0049104	-0,004698	-0,0049356	-0,0068533

Date :	Device Type :	IRFY 9140	Figure 3

Component	Date Code :	**9833A**	Manufacturer :	INTERNATIONAL RECTIFIER
Irradiation	Dose Rate :	<= 0.33 kRad / h	Conditions :	OFF / ON / REF
Test	Parameter :	**Idss**	Conditions :	2

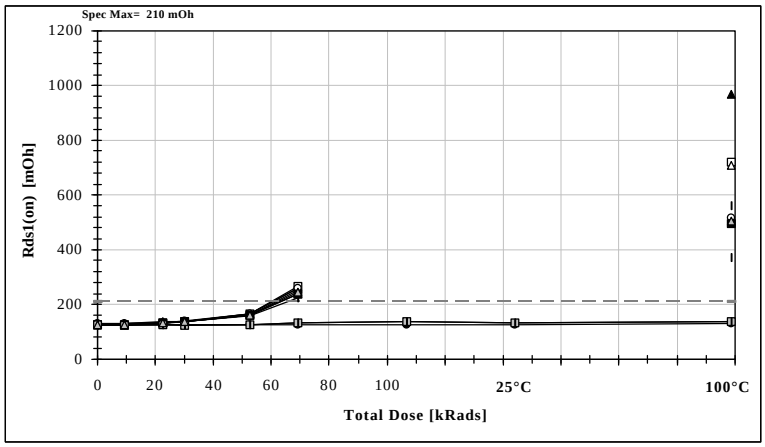


Comments : *The last step correspond to the post annealing measurements*

Total Dose [kRad(Si)]			0	9,2	22,6	30	52,6	69,4	106,7	25°C	100°C
9	OFF	0	-0,0039495	-0,73094	-1,0644	-1,0571	-1,2182	-1,3593	-1,4004	-1,3982	-0,68031
10	OFF	9	-0,0035188	-0,73323	-1,0668	-1,0478	-1,207	-1,2962	-1,2983	-1,335	-0,61179
1	ON	1	-0,0046329	-0,81731	-0,96874	-1,0249	-1,2141	-1,1584	-1,1471	-1,2331	-0,7137
2	ON	2	-0,0042165	-0,44936	-0,95878	-1,287	-1,6363	-1,6697	-1,6492	-1,6894	-0,98719
3	ON	3	-0,0040689	-0,4145	-0,98434	-1,2038	-1,5653	-1,6896	-1,6562	-1,6857	-0,95664
4	ON	4	-0,0030443	-0,58071	-1,3149	-1,3377	-1,4987	-1,6278	-1,4804	-1,4563	-0,82136
5	ON	5	-0,0038744	-0,60956	-1,1388	-1,259	-1,5306	-1,6308	-1,608	-1,6734	-0,86765
6	ON	6	-0,0039425	-0,44865	-0,99828	-1,2602	-1,5795	-1,6954	-1,7488	-1,853	-0,87261
7	ON	7	-0,0042447	-0,39746	-1,0101	-1,3739	-1,6254	-1,6526	-1,6491	-1,7864	-0,93576
8	ON	1	-0,0052627	-0,42415	-1,0562	-1,2941	-1,6486	-1,8716	-1,8324	-1,7898	-0,83413
0	REF	8	-0,0059167	-0,005416	-0,0041643	-0,0043286	-0,0049866	-0,0049104	-0,004698	-0,0049356	-0,0068533

Date :	Device Type :	IRFY 9140	Figure 4

Component	Date Code :	**9833A**	Manufacturer :	INTERNATIONAL RECTIFIER
Irradiation	Dose Rate :	<= 0.33 kRad / h	Conditions :	OFF / ON / REF
Test	Parameter :	**Rds1(on)**	Conditions :	3

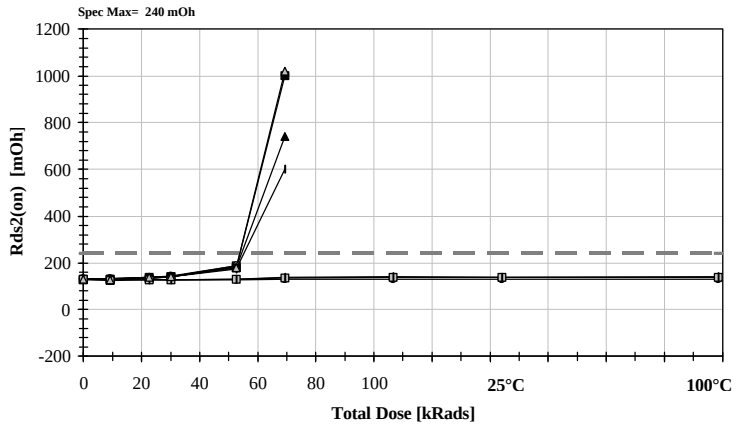


Comments : *The last step correspond to the post annealing measurements*

Total Dose [kRad(Si)]			0	9,2	22,6	30	52,6	69,4	106,7	25°C	100°C
9	OFF	0	126	126	125	125	128	133,5	136,5	135	137
10	OFF	9	126	123	125	124	126	132,5	135,5	134	135,5
1	ON	1	126	128	132	137	164	**266,2**			**720**
2	ON	2	124	126	131	137	162	**251,7**			**563**
3	ON	3	126	128	134	137	164	**260,2**			**708**
4	ON	4	128	130	135	139	165	**259**			**517**
5	ON	5	125	126	134	137	161	**238,2**			**494**
6	ON	6	127	125	132	136	159	**224,2**			**372**
7	ON	7	128	130	137	138	161	**237,7**			**969**
8	ON	1	126	126	133	137	162	**245,5**			**504**
0	REF	8	130	127	126	125	125	126,8	125,6	125	128,3

Date :	Device Type :	IRFY 9140	Figure 5

Component	Date Code :	**9833A**	Manufacturer :	INTERNATIONAL RECTIFIER
Irradiation	Dose Rate :	<= 0.33 kRad / h	Conditions :	OFF / ON / REF
Test	Parameter :	**Rds2(on)**	Conditions :	4



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

Total Dose [kRad(Si)]			0	9,2	22,6	30	52,6	69,4	106,7	25°C	100°C
9	OFF	0	128	128	127	127	130	137	140	138	140,2
10	OFF	9	129	125	128	127	129	136	138	137	138,2
1	ON	1	128	130	134	141	186	#N/A	#N/A	#N/A	#N/A
2	ON	2	129	128	135	141	182	#N/A	#N/A	#N/A	#N/A
3	ON	3	129	131	138	141	184	#N/A	#N/A	#N/A	#N/A
4	ON	4	131	132	138	143	186	#N/A	#N/A	#N/A	#N/A
5	ON	5	127	128	138	142	180	**1001**	#N/A	#N/A	#N/A
6	ON	6	129	127	136	140	175	**600**	#N/A	#N/A	#N/A
7	ON	7	131	132	139	142	178	**741**	#N/A	#N/A	#N/A
8	ON	1	128	128	136	141	180	**1021**	#N/A	#N/A	#N/A
0	REF	8	132	129	128	127	128	129	128,9	128	130,3