





**DISPLACEMENT DAMAGE
TEST REPORT
No. ATN-RR-333**

Issue/Rev: 1

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Date: 2015/05/28

R.L: 2015010918

Component No CS249/L2S Option 20		Component Designation: CS249	Irradiation Spec. No.: ESA/SCC 22900 Iss. 4
Gen. Spec.: MIL-PRF-19500 Det. Spec.: DWG CS249/L2S Amend.: N/A		Evaluation: X Acceptance Wafer: - Acceptance Lot: -	Project/Programme: CU1
Family: 18	Group: 01	Functional Assignment: CERAMIC HERMETICALLY SEALED, RADIATION HARD TRANSISTOR OPTOCOUPLER	Package: DIL-6
Manuf.Name: ISOCOM LIMITED Address: GREAT BRITAIN		Test House: ATN Address: SEVILLA (SPAIN)	Facility Name: UCL Address: LOUVAIN LA NEUVE (BELGIUM)
Radiation Test Plan No.: ATN-RP 170 Iss.1		Sample Size: 5 Irradiation Devices: 4 Control Devices: 1	Date Code: 1508 Assembly Lot: I3053 Diffusion Run: 84609021073/3821D061111
Beam Energy: 60 MeV Flux: 1E8 [p/s cm ²]		Interest level: N/Av	Maximum Test Level: 8E11 p/cm ²
Irradiation Conditions: Biased: N/A Unbiased: 4 samples Test Circuit: Figure 1		Irradiation Measurements Interval: Remote test: X In situ Test: --	Annealing Tests: N/A Biased: N/A Unbiased: N/A Test Circuit: N/A
Remark: The results obtained during the irradiation test process show that the samples are sensitive to the cumulative fluence when are tested at a beam energy of 60 MeV up to an accumulated fluence of 8E11 p/cm ² . The IC/IF ₁ , IC/IF ₂ , IC/IF ₃ , IC/IF ₄ , IC/IF ₅ , IC/IF ₆ and V _{CE(SAT)} are the most affected parameters. Only the V _F , I _R , I _{CEO} , IC/IF ₃ and IC/IF ₅ remain within limits during the whole irradiation test.			
Prepared by.: José Joaquín González Date: 2015/05/28 Signature: 		Approved by.: Eugenio Muñoz Date: 2015/05/28 Signature: 	



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DOCUMENT CHANGE CONTROL

Edition / Revision	Date	Affected Edition / Revision	Affected Paragraph / Modification
ATN-RR-333 Iss.1	2015/05/28	--	First edition of this document.

ATNF141.C

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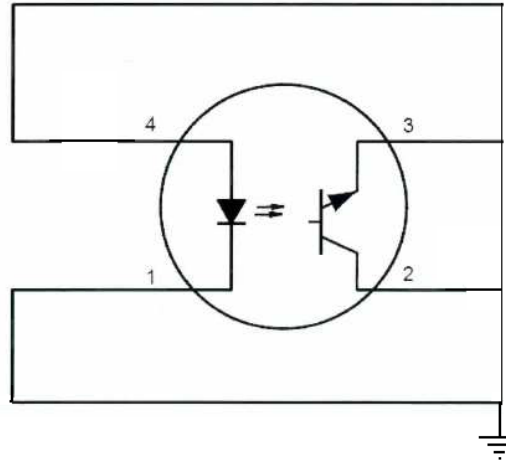


FIGURE 1.-RADIATION BIAS CIRCUIT

Note:

The samples were exposed to the proton beam in one biasing mode: the pins were short circuited and connected to ground.



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SUMMARY

A proton irradiation test has been carried out on a CS249, a CERAMIC HERMETICALLY SEALED, RADIATION HARD TRANSISTOR OPTOCOUPLER, manufactured by ISOCOM LIMITED in order to evaluate displacement damage effect under proton irradiation of this component. The test was performed until a cumulative fluence of $8E11$ p/cm² of 60MeV protons energy in accordance with the test plan.

No incident during the test was noticed.

The serial numbers of the samples used are indicated below:

Test S/N	MFR S/N	Usage
R1	23	CONTROL
R2	28	Radiated/Bias OFF
R3	3	
R4	7	
R5	10	

DEVIATION TO PLAN

Due to the degradation observed in the first irradiation step ($1E11$ p/cm²), an additional step was included at $2E11$ p/cm² of cumulative fluence in order to obtain more data about the behaviour of the samples.



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RESULTS

The next table shows a summary of the irradiation test results.

	INITIAL	1E11 p/cm ²	2E11 p/cm ²	4E11 p/cm ²	6E11 p/cm ²	8E11 p/cm ²
V _F	PASS	PASS	PASS	PASS	PASS	PASS
I _R	PASS	PASS	PASS	PASS	PASS	PASS
I _{CEO}	PASS	PASS	PASS	PASS	PASS	PASS
IC/IF ₁	PASS	PASS	NOTE 1	NOTE 1	NOTE 1	NOTE 1
IC/IF ₂	PASS	PASS	PASS	NOTE 1	NOTE 1	NOTE 1
IC/IF ₃	PASS	PASS	PASS	PASS	PASS	PASS
IC/IF ₄	PASS	PASS	PASS	NOTE 1	NOTE 1	NOTE 1
IC/IF ₅	PASS	PASS	PASS	PASS	PASS	PASS
IC/IF ₆	PASS	PASS	NOTE 1	NOTE 1	NOTE 1	NOTE 1
V _{CE(SAT)}	PASS	PASS	PASS	PASS	NOTE 1	NOTE 1

The values measured and graphs with the evolution of the previous parameters during the irradiation are available in ANNEX.

NOTE 1: Out of limits.



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CONCLUSION

The results obtained during the irradiation test process show that the samples are sensitive to the cumulative fluence when are tested at a beam energy of 60 MeV up to an accumulated fluence of $8E11$ p/cm². The IC/IF₁, IC/IF₂, IC/IF₃, IC/IF₄, IC/IF₅, IC/IF₆ and V_{CE(SAT)} are the most affected parameters. The deviation of these parameters shows an uniform increase trend until the end of the test for the case of V_{CE(SAT)}; and an uniform decrease trend for the case of IC/IF₁, IC/IF₂, IC/IF₃, IC/IF₄, IC/IF₅, and IC/IF₆.

The I_R parameter starts to show an increase trend between $2E11$ p/cm² and $4E11$ p/cm² but is not a significant deviation.

The samples starts to be out of limits between $1E11$ p/cm² and $2E11$ p/cm² in the case of the IC/IF₁ and IC/IF₆ parameters; between $2E11$ p/cm² and $4E11$ p/cm² in the case of IC/IF₂ and IC/IF₄, and between $4E11$ p/cm² and $6E11$ p/cm² in the case of V_{CE(SAT)} parameter.

As it can be seen in the above summary table, only the V_F, I_R, I_{CEO}, IC/IF₃ and IC/IF₅ remain within limits during the whole irradiation test.

These results are in accordance what it was expected by Alter based on the data provided by previous radiation campaign where it was observed a degradation in the IC/IF's and V_{CE(SAT)} parameters.

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SCHEDULE

DATE	EXPOSURE TIME (sec)	ENERGY (MEV)	CUMULATIVE FLUENCE (p/cm ²)	FLUENCE (p/cm ²)	MEAN FLUX (p/s cm ²)
24/03/2015	823	59.9	9.96E+10	9.96E+10	1.21E+08
24/03/2015	1086	59.9	2.00E+11	1.00E+11	9.21E+07
24/03/2015	1908	59.9	4.00E+11	2.00E+11	1.05E+08
24/03/2015	1887	59.9	6.00E+11	2.00E+11	1.06E+08
24/03/2015	1922	59.9	8.00E+11	2.00E+11	1.04E+08

ELECTRICAL MEASUREMENTS EQUIPMENT LIST

REF INVENT	DESCRIPTION	CALIBRATION EXPIRE DATE	USAGE
LE0723.000	SEMICONDUCTOR PARAMETER ANALYZER	2017/10/13	Initial, 1E11, 2E11, 4E11, 6E11 and 8E11 p/cm ²
ATN-TJ-EM-162	TEST JIG	--	Initial, 1E11, 2E11, 4E11, 6E11 and 8E11 p/cm ²
ATN-EM-SW-1082	PROGRAM REFERENCE	--	Initial, 1E11, 2E11, 4E11, 6E11 and 8E11 p/cm ²



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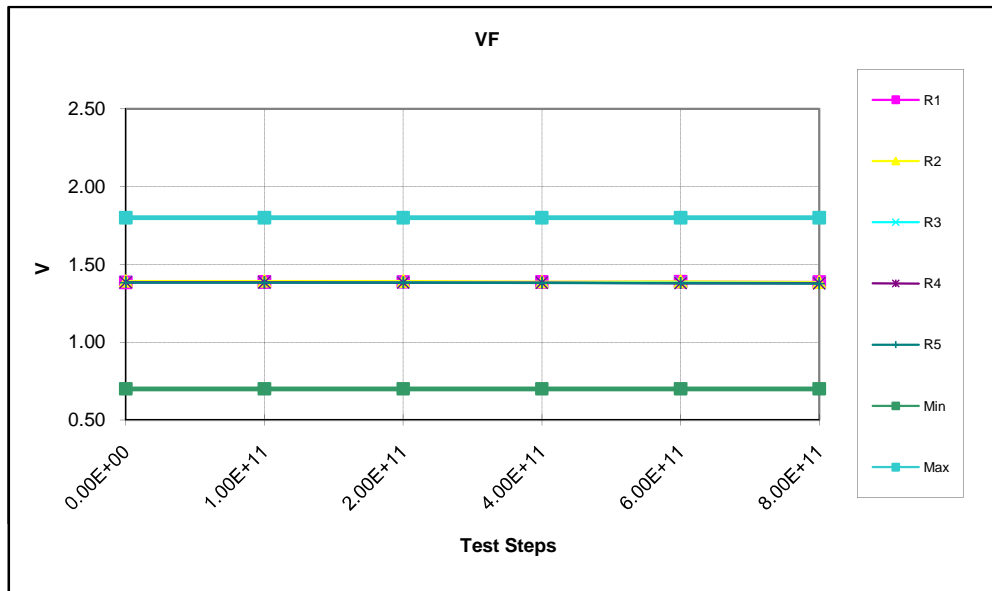
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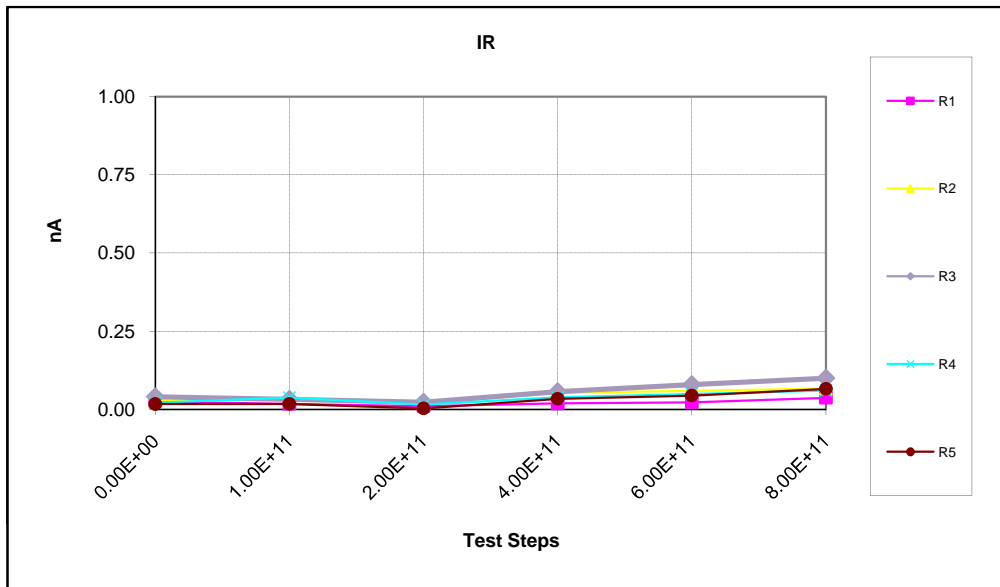
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ANNEX

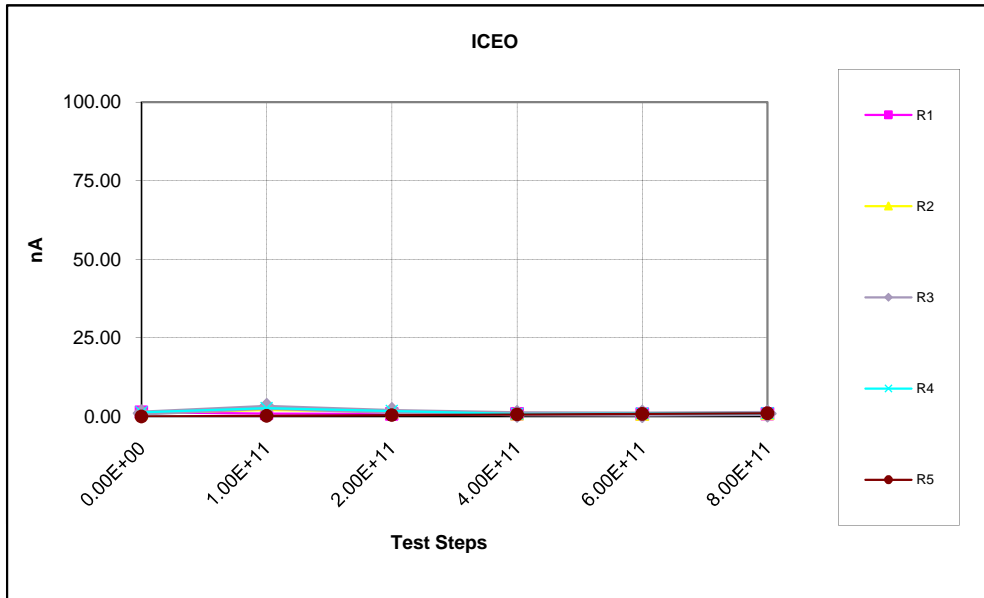
ELECTRICAL MEASUREMENTS GRAPHS



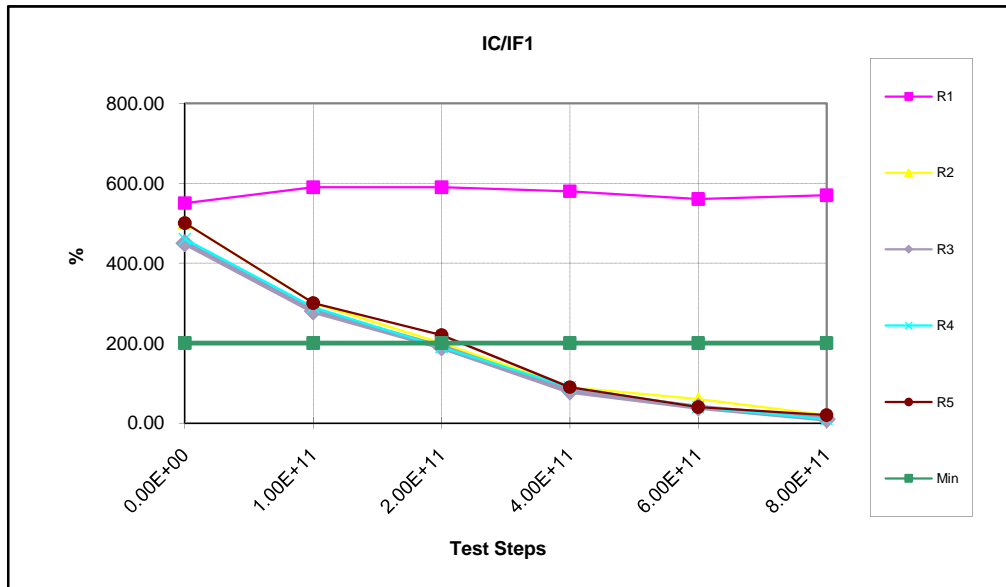
VF	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	0.7	0.7	0.7	0.7	0.7	0.7
Max	1.8	1.8	1.8	1.8	1.8	1.8
Unit	V	V	V	V	V	V
Control Results						
R1	1.385	1.387	1.388	1.387	1.389	1.388
Bias OFF Results						
R2	1.394	1.394	1.393	1.390	1.391	1.387
R3	1.387	1.384	1.385	1.384	1.383	1.380
R4	1.385	1.385	1.384	1.383	1.379	1.379
R5	1.384	1.383	1.383	1.382	1.379	1.377
Statistics bias OFF						
min result	1.384	1.383	1.383	1.382	1.379	1.377
max result	1.394	1.394	1.393	1.390	1.391	1.387
average	1.387	1.386	1.386	1.385	1.383	1.381
sigma	0.005	0.005	0.005	0.004	0.005	0.004



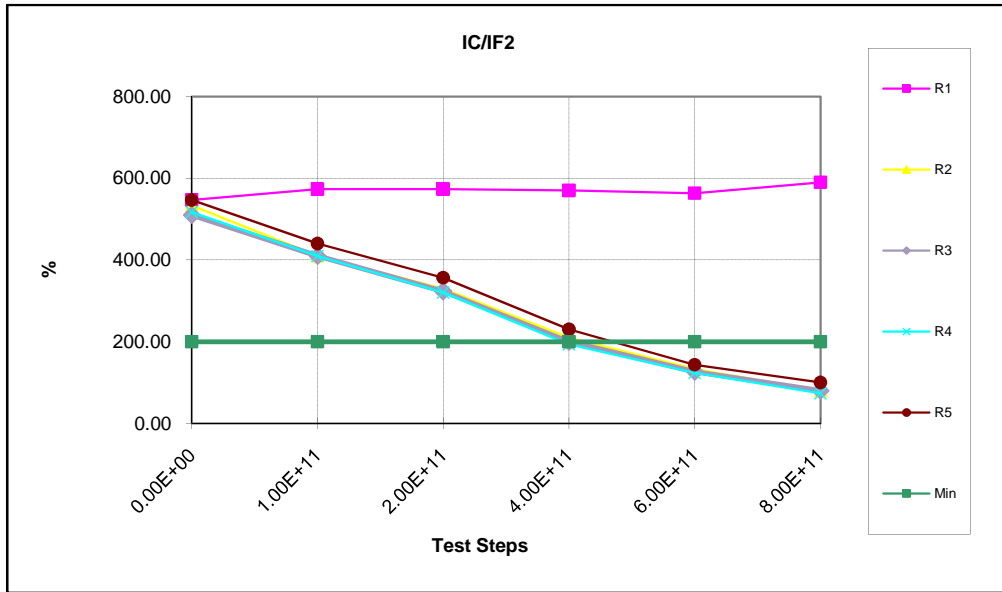
IR	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	-	-	-	-	-	-
Max	100000.000	100000.000	100000.000	100000.000	100000.000	100000.000
Unit	nA	nA	nA	nA	nA	nA
Control Results						
R1	0.026	0.017	0.010	0.019	0.022	0.037
Bias OFF Results						
R2	0.028	0.029	0.019	0.053	0.059	0.066
R3	0.040	0.032	0.023	0.057	0.079	0.100
R4	0.021	0.038	0.015	0.039	0.048	0.060
R5	0.017	0.017	0.003	0.033	0.044	0.065
Statistics bias OFF						
min result	0.017	0.017	0.003	0.033	0.044	0.060
max result	0.040	0.038	0.023	0.057	0.079	0.100
average	0.026	0.029	0.015	0.045	0.058	0.073
sigma	0.010	0.009	0.009	0.011	0.016	0.018



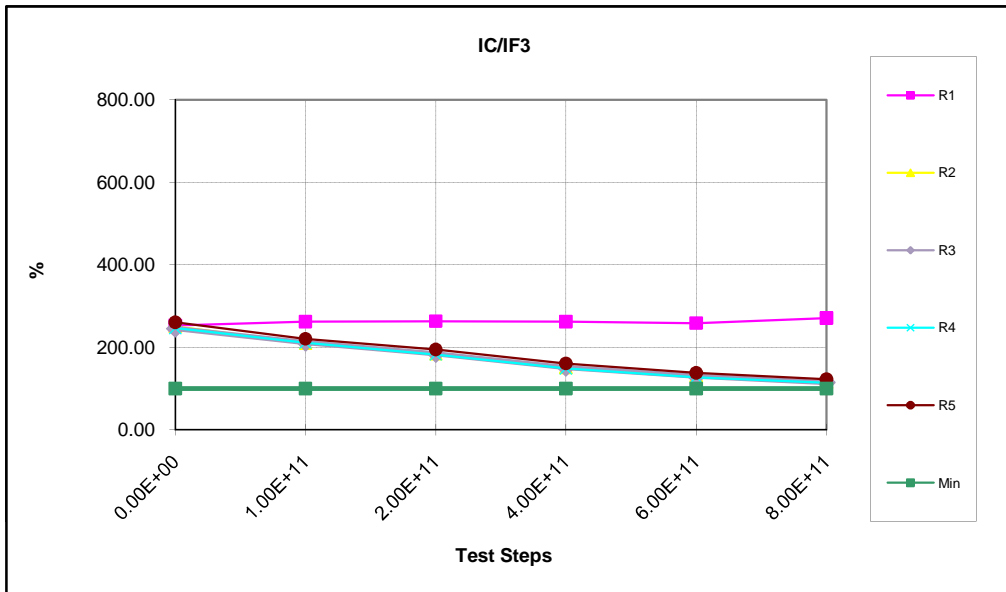
ICEO	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	-	-	-	-	-	-
Max	100000.000	100000.000	100000.000	100000.000	100000.000	100000.000
Unit	nA	nA	nA	nA	nA	nA
Control Results						
R1	1.304	0.974	0.808	0.836	0.748	0.842
Bias OFF Results						
R2	1.157	2.085	1.533	0.886	0.763	0.988
R3	1.052	2.937	1.640	0.840	0.780	0.980
R4	1.317	2.638	1.709	0.877	0.958	1.074
R5	0.008	0.209	0.435	0.631	0.781	1.004
Statistics bias OFF						
min result	0.008	0.209	0.435	0.631	0.763	0.980
max result	1.317	2.937	1.709	0.886	0.958	1.074
average	0.883	1.967	1.329	0.808	0.821	1.011
sigma	0.593	1.224	0.600	0.120	0.092	0.043



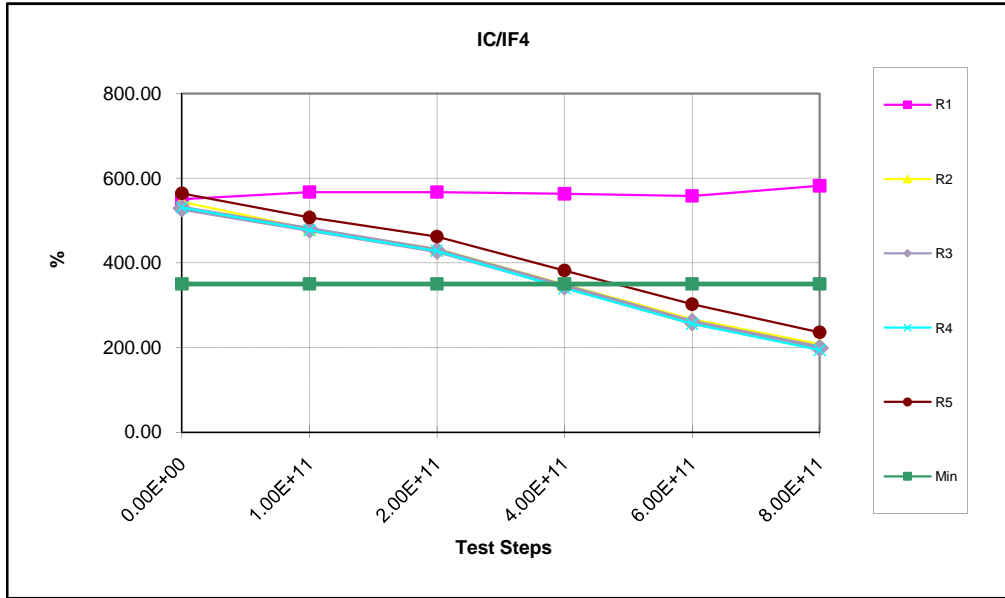
IC/IF1	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	200	200	200	200	200	200
Max	--	--	--	--	--	--
Unit	%	%	%	%	%	%
Control Results						
R1	550.0	590.0	590.0	580.0	560.0	570.0
Bias OFF Results						
R2	500.0	300.0	200.0	90.0	60.0	20.0
R3	450.0	280.0	190.0	80.0	40.0	10.0
R4	460.0	290.0	190.0	90.0	40.0	10.0
R5	500.0	300.0	220.0	90.0	40.0	20.0
Statistics bias OFF						
min result	450.0	280.0	190.0	80.0	40.0	10.0
max result	500.0	300.0	220.0	90.0	60.0	20.0
average	477.5	292.5	200.0	87.5	45.0	15.0
sigma	26.3	9.6	14.1	5.0	10.0	5.8



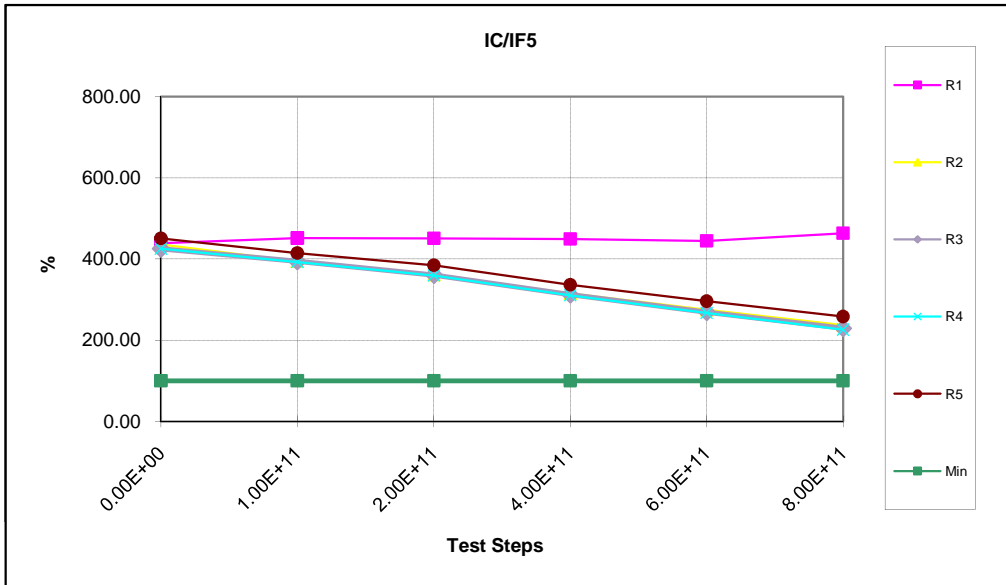
IC/IF2	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	200	200	200	200	200	200
Max	--	--	--	--	--	--
Unit	%	%	%	%	%	%
Control Results						
R1	546.7	573.3	573.3	570.0	563.3	590.0
Bias ON Results						
R2	533.3	410.0	330.0	210.0	133.3	80.0
R3	510.0	410.0	323.3	200.0	126.7	80.0
R4	516.7	410.0	320.0	193.3	123.3	73.3
R5	546.7	440.0	356.7	230.0	143.3	100.0
Statistics bias OFF						
min result	510.000	410.000	320.000	193.333	123.333	73.333
max result	546.667	440.000	356.667	230.000	143.333	100.000
average	526.667	417.500	332.500	208.333	131.667	83.333
sigma	16.555	15.000	16.639	15.986	8.819	11.547



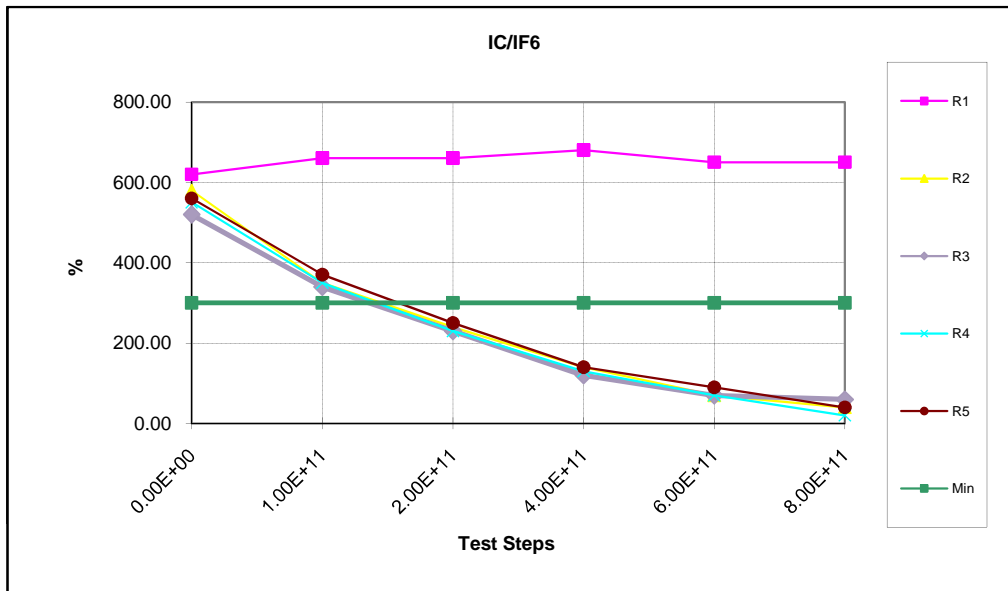
IC/IF3	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	100	100	100	100	100	100
Max	--	--	--	--	--	--
Unit	%	%	%	%	%	%
Control Results						
R1	253.3	262.0	263.3	262.0	258.7	270.7
Bias OFF Results						
R2	250.7	210.0	184.7	151.3	131.3	116.0
R3	245.3	211.3	184.7	151.3	130.0	114.7
R4	246.7	211.3	182.7	148.7	127.3	114.0
R5	260.7	220.7	194.7	160.7	138.0	122.7
Statistics bias OFF						
min result	245.333	210.000	182.667	148.667	127.333	114.000
max result	260.667	220.667	194.667	160.667	138.000	122.667
average	250.833	213.333	186.667	153.000	131.667	116.833
sigma	6.936	4.929	5.416	5.263	4.538	3.977



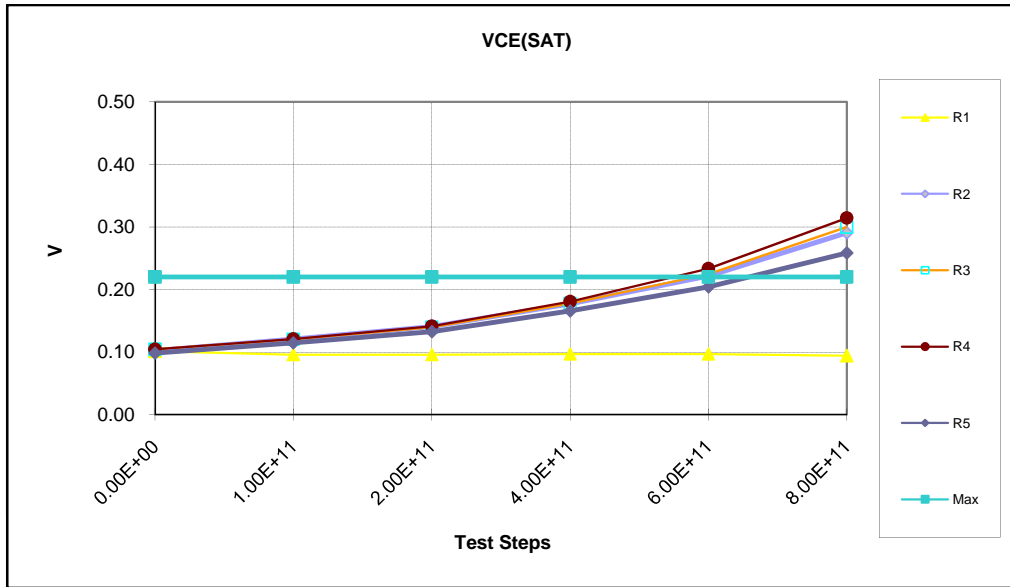
IC/IF4	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	350	350	350	350	350	350
Max	--	--	--	--	--	--
Unit	%	%	%	%	%	%
Control Results						
R1	550.0	567.0	567.0	563.0	558.0	582.0
Bias OFF Results						
R2	544.0	480.0	433.0	349.0	267.0	208.0
R3	529.0	479.0	429.0	344.0	260.0	199.0
R4	531.0	477.0	428.0	340.0	256.0	194.0
R5	564.0	507.0	462.0	382.0	302.0	236.0
Statistics bias OFF						
min result	529.000	477.000	428.000	340.000	256.000	194.000
max result	564.000	507.000	462.000	382.000	302.000	236.000
average	542.000	485.750	438.000	353.750	271.250	209.250
sigma	16.104	14.221	16.145	19.190	20.998	18.751



IC/IF5	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	100	100	100	100	100	100
Max	--	--	--	--	--	--
Unit	%	%	%	%	%	%
Control Results						
R1	438.7	451.3	450.7	449.3	444.7	463.3
Bias OFF Results						
R2	435.3	394.0	361.3	315.3	274.7	236.7
R3	425.3	394.0	360.7	312.0	269.3	229.3
R4	425.3	392.7	359.3	310.7	267.3	226.0
R5	450.7	414.7	384.7	336.7	296.0	258.0
Statistics bias OFF						
min result	425.333	392.667	359.333	310.667	267.333	226.000
max result	450.667	414.667	384.667	336.667	296.000	258.000
average	434.167	398.833	366.500	318.667	276.833	237.500
sigma	11.968	10.574	12.140	12.159	13.147	14.375



IC/IF6	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	300	300	300	300	300	300
Max	--	--	--	--	--	--
Unit	%	%	%	%	%	%
Control Results						
R1	620.0	660.0	660.0	680.0	650.0	650.0
Bias OFF Results						
R2	580.0	350.0	240.0	140.0	70.0	40.0
R3	520.0	340.0	230.0	120.0	70.0	60.0
R4	550.0	350.0	230.0	130.0	70.0	20.0
R5	560.0	370.0	250.0	140.0	90.0	40.0
Statistics bias OFF						
min result	520.000	340.000	230.000	120.000	70.000	20.000
max result	580.000	370.000	250.000	140.000	90.000	60.000
average	552.500	352.500	237.500	132.500	75.000	40.000
sigma	25.000	12.583	9.574	9.574	10.000	16.330



VCE(SAT)	0.00E+00	1.00E+11	2.00E+11	4.00E+11	6.00E+11	8.00E+11
Min	--	--	--	--	--	--
Max	0.22	0.22	0.22	0.22	0.22	0.22
Unit	V	V	V	V	V	V
Control Results						
R1	0.101	0.096	0.096	0.097	0.097	0.094
Bias OFF Results						
R2	0.102	0.121	0.141	0.177	0.222	0.291
R3	0.104	0.121	0.140	0.178	0.225	0.300
R4	0.104	0.121	0.141	0.181	0.233	0.314
R5	0.098	0.115	0.133	0.166	0.204	0.259
Statistics bias OFF						
min result	0.098	0.115	0.133	0.166	0.204	0.259
max result	0.104	0.121	0.141	0.181	0.233	0.314
average	0.102	0.119	0.139	0.175	0.221	0.291
sigma	0.003	0.003	0.004	0.006	0.012	0.024