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# DOCUMENT

## RA0617 CO60 TID Test Results on Part Type BFY640B

RA0617


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# APPROVAL

<b>Title</b> RA0617 CO60 TID Test Results on Part Type BFY640B	
<b>Issue 1</b>	<b>Revision 1</b>
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# CHANGE LOG

Reason for change	Issue	Revision	Date
Draft release	1	0	10 January 2013
Final release	1	1	25 February 2013

# CHANGE RECORD

Issue 1	Revision 1		
Reason for change	Date	Pages	Paragraph(s)
Statement that tested parts were previously un-screened	19 February	4	5.2.1

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**1 ACRONYMS**

TID Total Irradiation Dose

**2 REFERENCES**

- REF1 ESA/SCC 22900 “Total Dose Steady-State Irradiation Test Method”, issue 3
- REF2 IFX Detail SpecificationA63500-T1580B-D11E
- REF3 IFX Detail SpecificationA63500-T580B-D11E
- REF4 IFX Detail SpecificationA63500-T1592B-D11E

**3 PURPOSE**

The purpose of this test report is to describe the TID test performed according to REF1 on the devices below specified.

**4 SCOPE**

This documents reports the test results obtained on Silicon-Germanium RF transistors, based on part type BFY650B, manufactured by Infineon.

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## 5 TEST DESCRIPTION

### 5.1 Facility and Dosimetry

The ESTEC Co-60 facility comprises of a Nordion Gammabeam 150C irradiator containing a nominal 85.2 TBq (2300 Ci) Co-60 source at the last reload date in October 2011. the irradiation room is monitored for temperature, relative humidity and pressure.

The dosimetry system is based on Farmer type 2571A 0.6 cc air ionisation chambers linked to Farmer 2670 electrometer. The dosimetry system is compensated against temperature and pressure environmental fluctuations.

All irradiations and measurements were performed at room temperature ( $22.5 \pm 3$  °C).

### 5.2 Devices Under Test

A total of twenty one devices, were received from Infineon Germany. A test fixture for the DC measurements to be performed, was also received from the manufacturer.

#### 5.2.1 Part description

Manufacturer	Infineon - Hired Discrete & MW Semiconductor
Family	RF NPN transistor
Group	Silicon-Germanium
Package	$\mu$ X
Component Designation	BFY640B Variant 01-04
Component Specification	ESCC 5611/010
Part Identification Number	BFY640B(SAM)
Diffusion Lot	4331/12
Delivery Lot	1226.52
Device serial numbers	from 1 to 11 (identified by the individual position in the primary package).

All received devices were not preliminary submitted to any screening by the manufacturer but just measured before the delivery for the TID test campaign.

The devices from s/n 6 to s/n 10 were irradiated with bias applied according to the schematic in Figure 1 .

The devices from s/n's: 1 to 5 were irradiated with all the pins grounded (un-biased). The device s/n 11 was retained as control sample and measured at the completion of each irradiation step.

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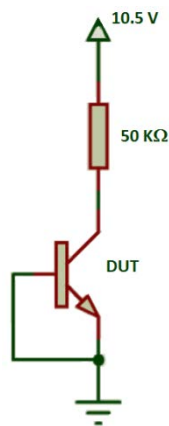
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Table 1 summarize the sample usage

**Table 1 received samples and their usage.**

S/n's	Description
<b>1, 2, 3, 4 and 5</b>	Unbiased during <sup>60</sup> Co irradiation, anneal and ageing
<b>6, 7, 8, 9 and 10</b>	Biased during <sup>60</sup> Co irradiation, anneal and ageing
<b>11</b>	Reference device (not irradiated) - Electrically tested before and after each intermediate measurement run at irradiation step completion.
<b>12, 13, 14, 15, 16, 17, 18, 19, 20</b>	Nor Irradiated/kept for future use.



**Figure 1 Biasing circuit**

### 5.3 Radiation Test Plan

The actual radiation test steps are reported in Table 2.

**Table 2 Irradiation Test Plan**

Step	Step Dose krad (to water)	Total Dose krad (to water)	Dose Rate rad/min (to water)
<b>(Pre irradiation) 0</b>	==		==
<b>Irradiation step # 1</b>	47.75	47.75	6.62
<b>Irradiation step # 2</b>	63.88	111.6	6.54
<b>Irradiation step # 3</b>	83.54	195.2	6.53
<b>Irradiation step # 4</b>	166.9	362.1	6.50

At the completion of each of the above irradiation steps, intermediate electrical measurements were carried out according to the next paragraph.



At the end of the final irradiation run, all devices were electrically measured and annealed for 45 hours at room temperature and subsequently aged at 100°C (for 168 hrs in total), maintaining the same bias conditions applied during the TID test. Table 3 reports the annealing/ageing sequence detail.

**Table 3 Anneal/ageing sequence**

Step	Temperature	Duration
Anneal	Room temperature	45 hours
Ageing	100 °C	168 hours

Again, at the completion of each anneal/ageing step, all devices were electrically tested.

## 5.4 Measurement Set-up

No in-situ measurements were performed during irradiation. Electrical measurements were performed according to Table 2 of the relevant detail specification.

In the following, the Table 2 from the detail specification is reported.

**Table 4 Measured Parameters, Min-Max Limits and Test conditions**

**BFY640B (Var01-04) and BFY650B (Var11) – DC Parameters from Table 2 of ESCC 5611/010:**

No	CHARACTERISTIC	SYMB	TEST FIG.	TEST CONDITION	LIMITS		UNIT
					MIN.	MAX.	
1	Collector Cut-off Current, Base shorted (high voltage)	$I_{CESH}$	4(a)	$V_{CE} = 13 \text{ V}, V_{BE} = 0 \text{ V}$	-	10	$\mu\text{A}$
2	Collector Cut-off Current, Base shorted (medium voltage)	$I_{CESM}$	4(a)	$V_{CE} = 10.5 \text{ V}, V_{BE} = 0 \text{ V}$	-	5	$\mu\text{A}$
3	Emitter Cut-off Current (high voltage)	$I_{EBOH}$	4(a)	$V_{EB} = 1.2 \text{ V}, I_C = 0 \text{ mA}$ Variant 01-04: Variant 11:	-	5 15	$\mu\text{A}$
4	Collector-Emitter Cut-off Current (high voltage)	$I_{CEXH}$	4(a)	$V_{CE} = 4 \text{ V}, I_B = 100 \text{ nA}$ (Note 1)	20	100	$\mu\text{A}$

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No	CHARACTERISTIC	SYMB	TEST FIG.	TEST CONDITION	LIMITS		UNIT
5	DC Forward Current Transfer Ratio (medium current)	$h_{FE}$	4(a)	$V_{CE} = 3\text{ V}$ Variant 01-04, $I_C = 30\text{ mA}$ : Variant 11, $I_C = 80\text{ mA}$ :	135 100	250 250	
6	Base-Emitter Forward Voltage	$V_{FBE}$	4(a)	$I_B = 12\text{ mA}$ , $I_C = 0$ (Note 2)	-	0.96	V
10	Collector Cut-off Current, Base shorted (low voltage)	$I_{CESL}$	4(a)	$V_{CE} = 5\text{ V}$ , $V_{BE} = 0\text{ V}$	-	2	$\mu\text{A}$
11	Emitter Cut-off Current (low voltage)	$I_{EBOL}$	4(a)	$V_{EB} = 0.5\text{ V}$ , $I_C = 0\text{ mA}$	-	100	nA
12	DC Forward Current Transfer Ratio (low current)	$h_{FEL}$	4(a)	$V_{CE} = 3\text{ V}$ , $I_C = 20\text{ }\mu\text{A}$ Variant 01-04: Variant 11:	190 190	600 530	

**NOTES:**

- Regarding upper limit, this is an alternative method of establishing  $V_{(BR)CEO}$  and assures that  $V_{(BR)CEO}$  is  $> 4\text{ V}$ , if the stated base current is not exceeded. Lower limits result from current gain at low  $I_B$ .
- Pulsed measurement: Pulse Duration  $< 1$  second. For the purpose of  $V_{FBE}$  measurement,  $I_{B,max}$  may be exceeded during a pulsed measurement provided that the pulse length duration  $< 1$  second and  $I_C = 0\text{ mA}$ .

All the above parameters have been measured by using the following equipment:

DC Source Monitor Unit: Keithley model KE2612A s/n1259457.  
 Test Jig: Infineon proprietary  
 Test Program: CLY\_inf.vi (Labview<sup>©</sup> based sw)

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## 5.5 Measurement Set-up Calibration

After the test campaign, the DC source monitor was sent out for calibration. According to the calibration certificate (number NL000161 from Fluke Nederland B.V. dated 28 Nov 2012), the current measurements taken on channel A (connected to DUT collector) on ranges:

- a)  $0.101\mu\text{A} - 1.02\mu\text{A}$
- b)  $1.01\mu\text{A} - 10.1\mu\text{A}$

were affected by a systematic error of  $15.7\text{nA}$  for  $I_C$  values ranging from  $0.1\mu\text{A}$  to  $19\mu\text{A}$ .

In particular, all the reported collector current measurements falling in the above range, must be corrected by increasing the figures accordingly.

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## **6 TEST RESULTS**

### **6.1 BFY640B test results**

All measurement results are reported from Table 5 to Table 13. Test ended with a registered Total Dose of 362.1 krad(water).

At the end of the last irradiation step, electrical measurements were performed. The devices were tested again after 45 hours annealing at room temperature.

After the annealing, the samples went through accelerated ageing, with final measurement performed after 168 hrs at 100°C.

During the entire annealing/ageing, the irradiated devices were biased employing the same test board.

Electrical Measurement uncertainty values, reported in the relevant table header, were estimated by combining the instrument uncertainty for the measured parameter (from the manufacturer specification) and the variations of the same parameter in the reference device (s/n 11), observed during the entire test campaign.

Significant data from tables have also been plotted from Figure 2 to Figure 10.

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**Table 5 Collector cut-off current, base shorted (high voltage) - I<sub>CESH</sub>**

	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
1	0.00	0.29	0.56	0.72	0.87	0.85	0.49
2	0.00	0.42	0.83	1.12	1.45	1.44	0.67
3	0.00	0.23	0.43	0.58	0.71	0.71	0.44
4	0.00	0.30	0.55	0.73	0.93	0.93	0.47
5	0.00	0.37	0.68	0.88	1.10	1.12	0.51
6	0.00	0.39	0.82	5.07	(*) >10.00	(*) >10.00	3.97
7	0.00	0.18	0.38	2.00	2.62	2.43	0.88
8	0.00	0.22	0.49	3.04	4.43	4.47	2.06
9	0.00	0.49	0.77	4.42	6.39	6.34	2.31
10	0.00	0.27	0.44	1.38	1.63	1.61	1.02
11	70.15pA	70.42pA	72.07pA	78.46pA	73.47pA	72.11pA	68.41pA

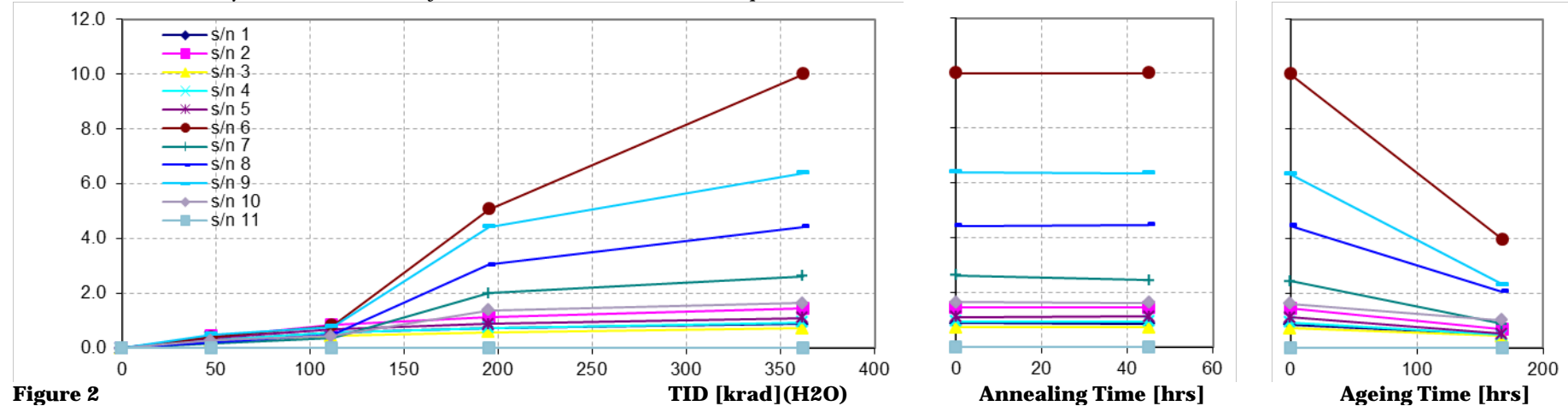
**Part type: BFY640B**

limits		
min:	max:	unit
-	10	uA

Expanded uncertainty (k=2) 3.4 %

Note: All values are in  $\mu\text{A}$  unless differently noted (in red, values outside spec. limits)

(\*) out of range



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**Table 6 Collector Cut-off Current, Base shorted (medium voltage) - ICESM**

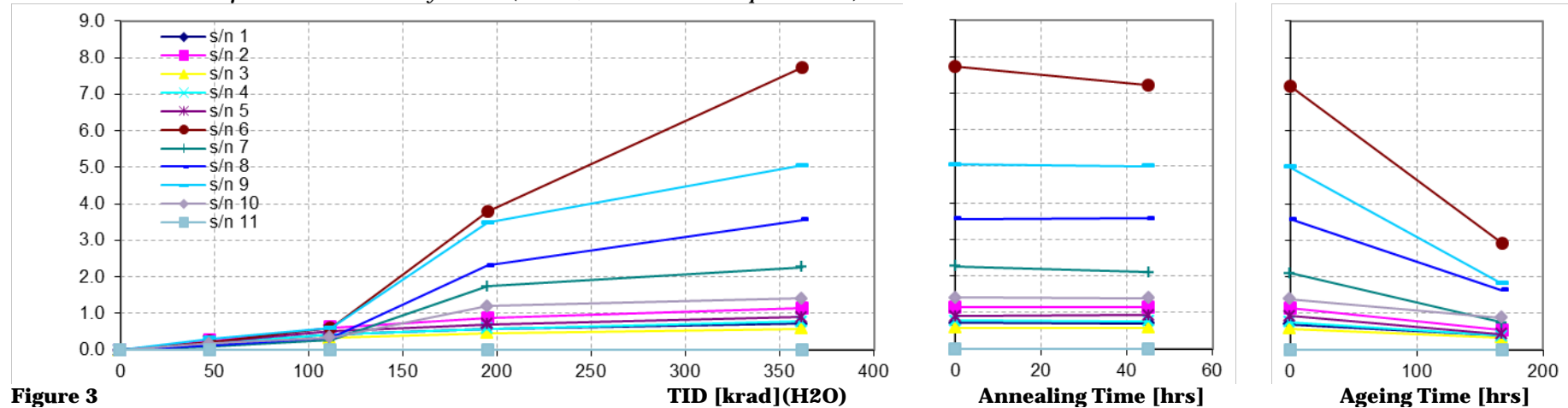
	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
1	0.00	0.17	0.42	0.58	0.72	0.71	0.40
2	0.00	0.25	0.61	0.87	1.15	1.14	0.53
3	0.00	0.14	0.32	0.46	0.58	0.58	0.35
4	0.00	0.18	0.42	0.58	0.77	0.76	0.38
5	0.00	0.22	0.51	0.71	0.90	0.92	0.43
6	0.00	0.21	0.60	3.78	<b>7.73</b>	<b>7.21</b>	2.91
7	0.00	0.10	0.27	1.73	2.27	2.10	0.75
8	0.00	0.12	0.34	2.31	3.56	3.57	1.63
9	0.00	0.32	0.59	3.49	<b>5.05</b>	<b>5.01</b>	1.81
10	0.00	0.18	0.33	1.20	1.41	1.39	0.88
11	22.65pA	22.54pA	23.46pA	26.87pA	24.63pA	23.19pA	20.18pA

Part type: **BFY640B**

limits		
min:	max:	unit
-	5	uA

Expanded uncertainty (k=2) 6.7 %

Note: All values are in  $\mu\text{A}$  unless differently noted (in red, values outside spec. limits)



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**Table 7 Emitter Cut-off Current(high voltage) -  $I_{EBOH}$**

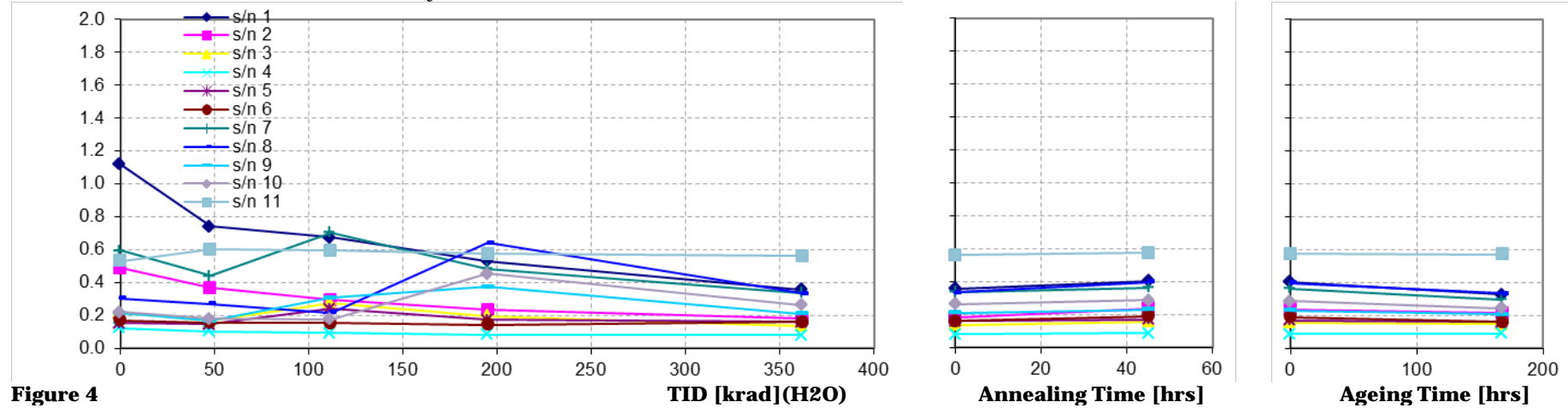
	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
1	1.12	0.74	0.67	0.53	0.36	0.40	0.33
2	0.49	0.37	0.29	0.23	0.18	0.24	0.21
3	0.21	0.17	0.28	0.19	0.14	0.16	0.15
4	0.12	0.10	0.09	0.08	0.08	0.09	0.09
5	0.15	0.15	0.24	0.17	0.16	0.17	0.16
6	0.17	0.16	0.15	0.14	0.16	0.19	0.16
7	0.59	0.44	0.70	0.48	0.34	0.36	0.30
8	0.30	0.27	0.22	0.64	0.33	0.40	0.33
9	0.21	0.16	0.31	0.37	0.21	0.23	0.21
10	0.22	0.18	0.18	0.45	0.26	0.29	0.24
11	529.7pA	599.4pA	594.1pA	574.2pA	559.4pA	572.4pA	568.7pA

**Part type: BFY640B**

limits		
min:	max:	unit
-	5000	nA

Expanded uncertainty (k=2) 3.1 %

Note: All values are in nA unless differently noted



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**Table 8 Collector-Emitter Cut-off Current (high voltage) - I<sub>CEXH</sub>**

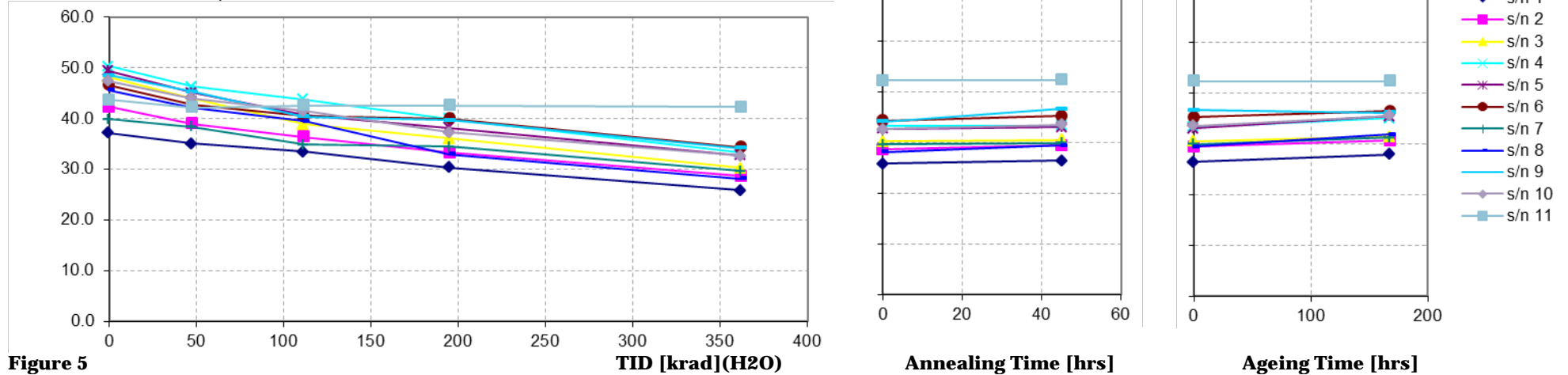
	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
1	37.20	35.04	33.42	30.34	25.79	26.48	27.98
2	42.23	38.99	36.39	33.27	28.68	29.39	30.64
3	48.21	43.84	38.82	36.01	30.23	30.58	31.44
4	50.32	46.31	43.79	39.97	33.27	33.37	35.05
5	49.42	45.05	40.63	38.18	32.77	33.02	35.46
6	46.61	42.70	40.43	39.98	34.39	35.28	36.44
7	39.87	38.37	34.84	34.44	29.59	29.91	31.24
8	45.60	42.11	39.42	32.96	28.11	29.46	31.89
9	48.44	45.27	40.34	39.63	34.15	36.68	36.19
10	47.40	44.02	41.51	37.24	32.67	33.55	35.52
11	43.65	42.16	42.57	42.57	42.23	42.35	42.37

**Part type: BFY640B**

limits		
min:	max:	unit
20	100	µA

Expanded uncertainty (k=2) 0.9 %

Note: All values are in µA



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**Table 9 DC Forward Current Transfer Ratio (medium current) -  $h_{FE}$**

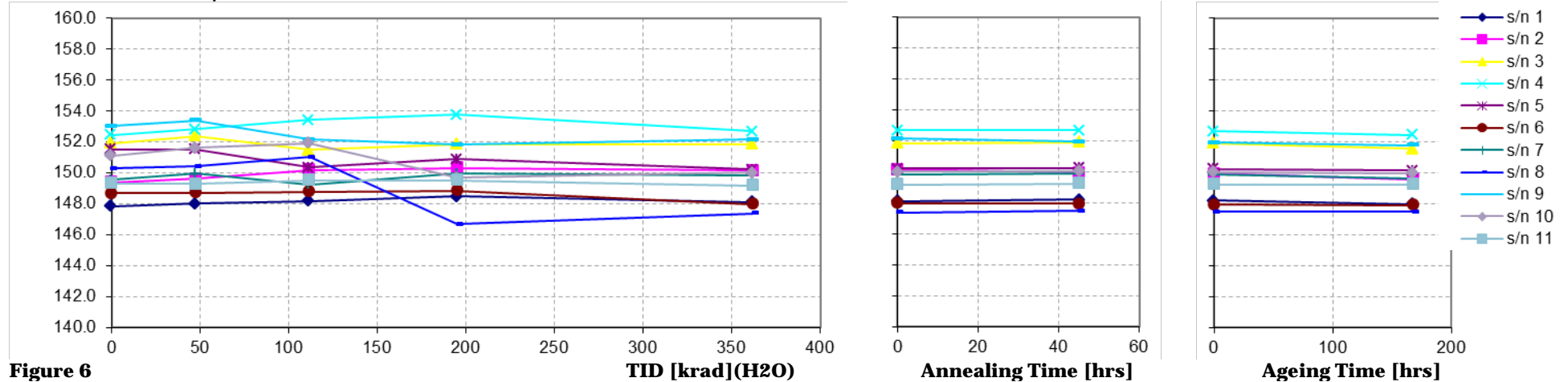
	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
1	147.84	148.02	148.18	148.47	148.12	148.20	147.97
2	149.37	149.60	150.19	150.30	150.14	149.96	149.58
3	151.90	152.39	151.48	151.84	151.86	151.91	151.54
4	152.47	152.81	153.41	153.74	152.67	152.69	152.46
5	151.51	151.52	150.33	150.87	150.22	150.26	150.14
6	148.67	148.71	148.76	148.84	147.98	147.94	147.90
7	149.54	149.94	149.25	149.94	149.85	149.88	149.62
8	150.27	150.41	151.00	146.66	147.36	147.47	147.47
9	153.02	153.37	152.14	151.81	152.15	151.94	151.79
10	151.11	151.60	151.92	149.69	150.02	150.03	149.98
11	149.31	149.29	149.50	149.52	149.19	149.23	149.24

**Part type: BFY640B**

limits		
min:	max:	unit
135	250	-

Expanded uncertainty (k=2) 0.8 %

Note: All values are in  $\mu A$



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**Table 10 Base-Emitter Forward Voltage -  $V_{FBE}$**

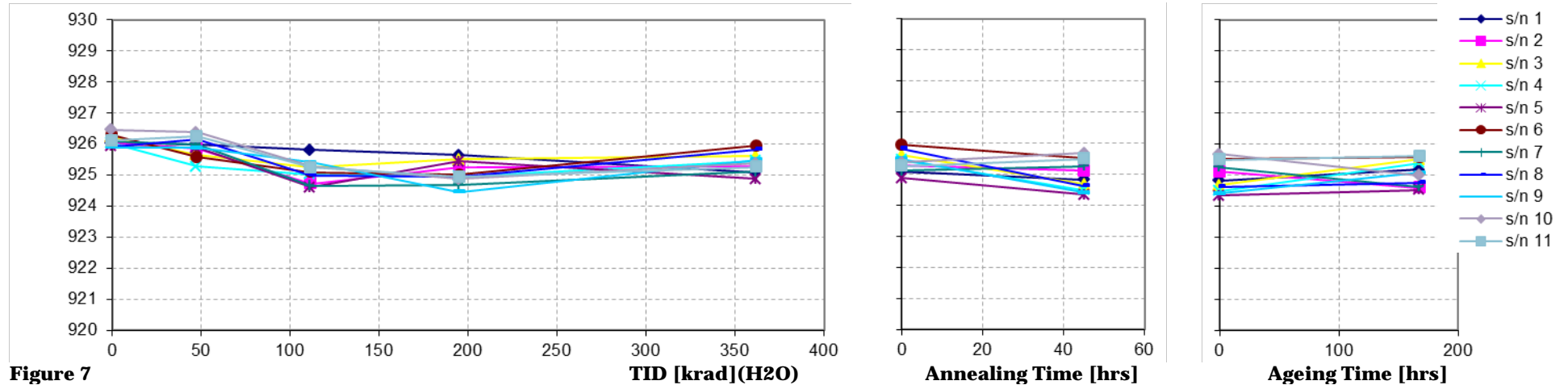
	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
1	926.03	926.00	925.81	925.64	925.08	924.82	925.17
2	926.05	925.86	924.73	925.24	925.30	925.11	924.59
3	926.23	925.65	925.25	925.50	925.61	924.68	925.52
4	926.02	925.28	925.02	924.95	925.46	924.49	925.39
5	925.92	925.87	924.61	925.44	924.87	924.34	924.52
6	926.29	925.57	925.09	925.00	925.95	925.52	925.58
7	926.08	925.99	924.66	924.69	925.10	925.26	924.63
8	925.92	926.15	924.98	924.96	925.83	924.62	924.76
9	925.90	925.87	925.40	924.45	925.49	924.40	925.08
10	926.46	926.37	925.27	924.87	925.37	925.68	924.99
11	926.11	926.25	925.24	924.94	925.27	925.49	925.61

**Part type: BFY640B**

limits		
min:	max:	unit
-	960	mV

Expanded uncertainty (k=2) 0.1 %

Note: All values are in mV



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**Table 11 Collector Cut-off Current, Base shorted (low voltage) - ICESL**

	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
1	0.01	12.01	153.21	275.12	410.83	398.38	207.19
2	0.01	11.71	224.17	398.90	607.51	597.13	276.23
3	0.01	11.63	120.78	216.49	326.42	321.25	169.29
4	0.01	11.37	158.08	281.01	436.83	428.60	203.31
5	0.01	12.33	192.18	341.41	519.50	520.73	240.95
6	0.01	13.73	183.87	<b>2 186.86</b>	<b>3 010.18</b>	<b>2 760.44</b>	1 456.85
7	0.01	10.70	84.63	1 106.00	1 326.82	1 254.66	497.47
8	0.01	11.44	105.14	1 171.68	1 630.46	1 646.29	878.25
9	0.01	62.50	232.31	1 915.14	<b>2 331.41</b>	<b>2 370.96</b>	1 006.51
10	0.01	33.65	131.08	841.94	910.35	910.78	616.98
11	13.03pA	13.02pA	13.67pA	15.18pA	14.82pA	13.48pA	11.78pA

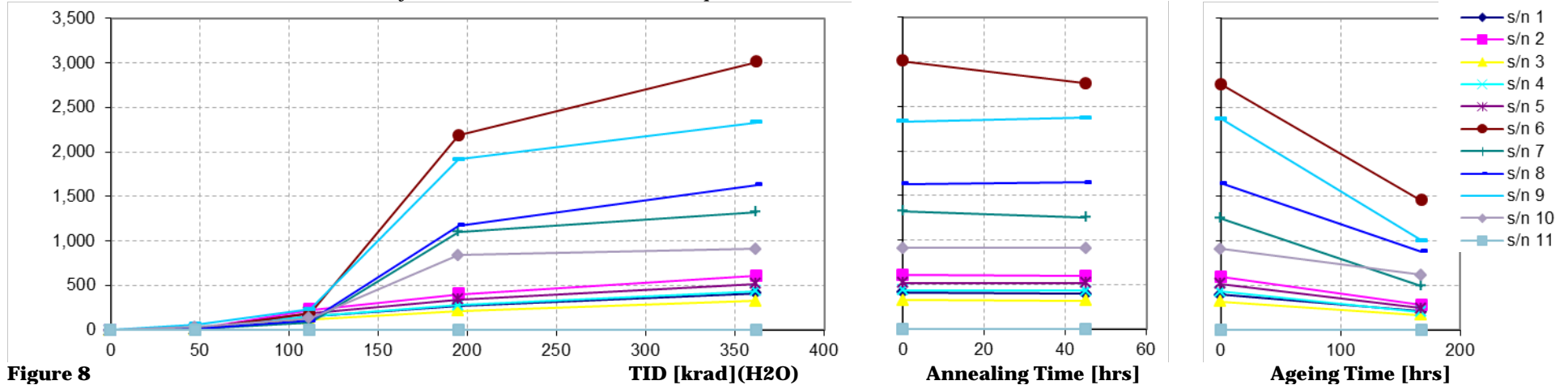
Part type: **BFY640B**

limits		
min:	max:	unit
-	2000	nA

Expanded uncertainty (k=2) 6.4 %

*This parameter is the most sensitive to TID*

Note: All values are in nA unless differently noted (in red, values outside spec. limits)



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**Table 12 Emitter Cut-off Current (low voltage) - I<sub>EBOL</sub>**

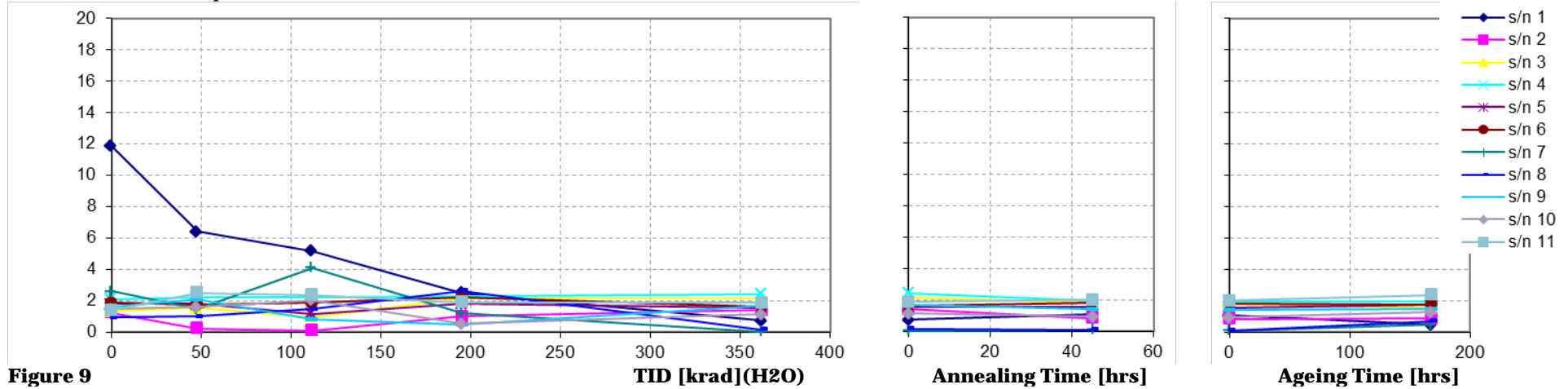
	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
1	11.86	6.41	5.17	2.49	0.73	1.07	0.44
2	1.24	0.23	0.08	0.98	1.38	0.82	0.86
3	1.32	1.53	0.97	2.12	2.13	1.82	1.53
4	2.11	2.19	2.19	2.26	2.42	1.96	1.94
5	1.80	1.80	1.16	1.79	1.54	1.56	1.74
6	1.85	1.76	1.87	2.22	1.63	1.82	1.75
7	2.60	1.44	4.11	1.19	0.02	0.10	0.44
8	0.93	1.00	1.47	2.63	0.15	0.08	0.68
9	1.59	2.06	0.77	0.45	1.66	1.41	1.45
10	1.45	1.59	2.03	0.51	1.13	0.93	1.25
11	1.39	2.48	2.35	1.90	1.87	2.00	2.35

**Part type: BFY640B**

limits		
min:	max:	unit
-	100	nA

Expanded uncertainty (k=2)	13.9 %
----------------------------	--------

Note: All values are in pA



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**Table 13 DC Forward Current Transfer Ratio (low current) - hfEL**

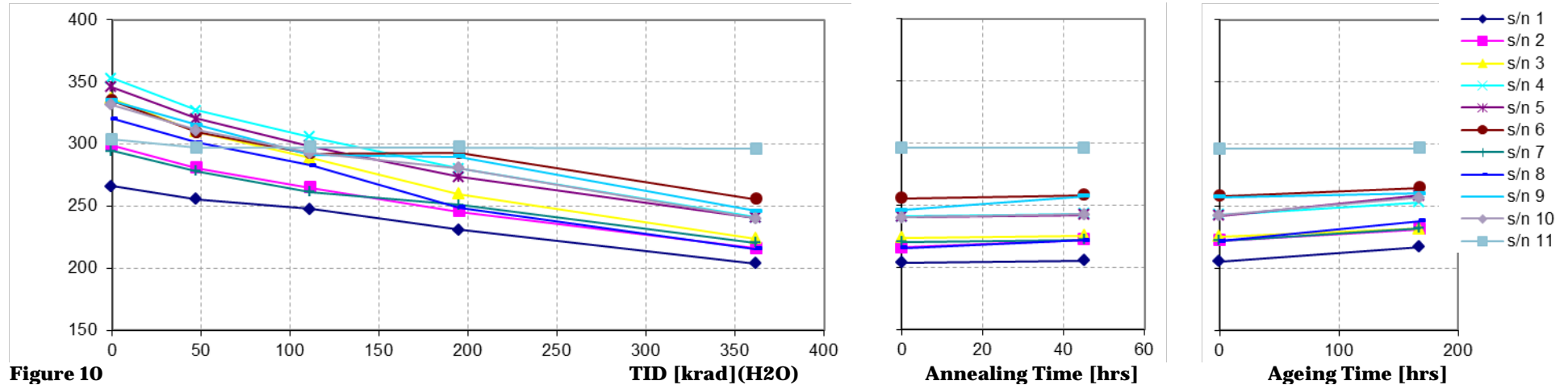
	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
1	265.90	255.63	247.39	231.00	203.55	205.54	217.00
2	298.92	280.78	264.68	245.45	215.83	222.28	231.38
3	336.64	309.77	288.43	259.83	223.94	225.56	231.76
4	352.94	326.78	305.47	280.26	240.79	243.08	253.10
5	345.57	320.07	298.04	273.49	240.53	242.37	258.26
6	334.87	309.57	292.18	292.79	255.39	258.16	264.76
7	294.44	277.95	261.39	251.00	220.36	222.26	232.12
8	320.09	300.87	282.49	248.96	215.26	221.90	238.12
9	334.82	315.24	291.43	289.62	245.87	257.16	259.99
10	331.49	310.93	292.84	280.40	240.17	242.56	256.69
11	303.72	296.76	297.34	297.10	296.03	296.00	296.53

**Part type: BFY640B**

limits		
min:	max:	unit
190	600	-

Expanded uncertainty (k=2)	0.8 %
----------------------------	-------

Note: -



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## 6.2 SUMMARY of result and conclusion on BFY640B

No catastrophic failures were observed during the entire test.  
The parameter degradations induced by gamma radiation is summarized in: Table 14, Table 15 and Table 16.

Table 14 reports the total doses, recorded before and after the parameter *out of limit* per applied bias condition.

**Table 14** TID levels, in [krad(H<sub>2</sub>O)], before and after the parameter out of limit, per different BIAS conditions

nr.	Parameter	Unbiased		Biased	
		<i>pass</i>	<i>fail</i>	<i>Pass</i>	<i>fail</i>
1	<b>ICESH</b>	362	-	195	362
2	<b>ICESM</b>	362	-	195	362
3	<b>IEBOH</b>	362	-	362	-
4	<b>ICEXH</b>	362	-	362	-
5	<b>hFE</b>	362	-	362	-
6	<b>VFBE</b>	362	-	362	-
7	<b>ICESL</b>	362	-	<b>110</b>	-
8	<b>IEBOL</b>	362	-	362	-
9	<b>hFEL</b>	362	-	362	-

**Table 15** Detail of Failures

nr.	Parameter	Bias conditions	Remarks	Ref. to
1	<b>ICESH</b>	Biased	S/n 06 pass up to 195krad(H <sub>2</sub> O) and failed at 362 krad(H <sub>2</sub> O). Failure recovered after 168 hrs H.T. ageing.	Table 5
2	<b>ICESM</b>	Biased	S/n's 06 and 09 pass up to 195krad(H <sub>2</sub> O) and failed after at 362 krad(H <sub>2</sub> O). Failures recovered after 168 hrs H.T. ageing.	Table 6
7	<b>ICESL</b>	Biased	S/n 06 pass up to 110krad(H <sub>2</sub> O) and failed at 195 krad(H <sub>2</sub> O) and after. S/n 06 failure recovered after 168 hrs H.T. ageing. S/n 09 pass up to 195krad(H <sub>2</sub> O) and failed at 362 krad(H <sub>2</sub> O). S/n 09 failure recovered after 168 hrs H.T. ageing.	Table 11

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**Table 16 Summary of TID test results**

nr.	Parameter	Remarks	Ref. to
1	<b>ICESH</b>	More sensitive to TID when biased.	Table 5
2	<b>ICESM</b>	More sensitive to TID when biased.	Table 6
3	<b>IEBOH</b>	Not significantly sensitive to TID up to 300krad (H <sub>2</sub> O). No evidence of bias dependence.	Table 7
4	<b>ICEXH</b>	Sensitive to TID. No evidence of bias dependence.	Table 8
5	<b>h<sub>FE</sub></b>	Not significantly sensitive to TID up to 300krad (H <sub>2</sub> O). No evidence of bias dependence.	Table 9
6	<b>V<sub>FB</sub></b>	Not significantly sensitive to TID up to 300krad (H <sub>2</sub> O). No evidence of bias dependence.	Table 10
7	<b>ICESL</b>	More sensitive to TID when biased. This parameter has been selected for the worst case estimation.	Table 11
8	<b>IEBOL</b>	Not significantly sensitive to TID up to 300krad (H <sub>2</sub> O). No evidence of bias dependence.	Table 12
9	<b>h<sub>FEL</sub></b>	Sensitive to TID. No evidence of bias dependence.	Table 13

The worse performances were observed on biased devices. Biased devices showed also significant parameter spreads versus TID. The parameter **ICESL** has been selected as representative of worst case parameter performance shown in **Table 17**.

**NOTE that the remarks on the test equipment calibration status, (see chapter 5.5) did not substantially change the TID test report results.**

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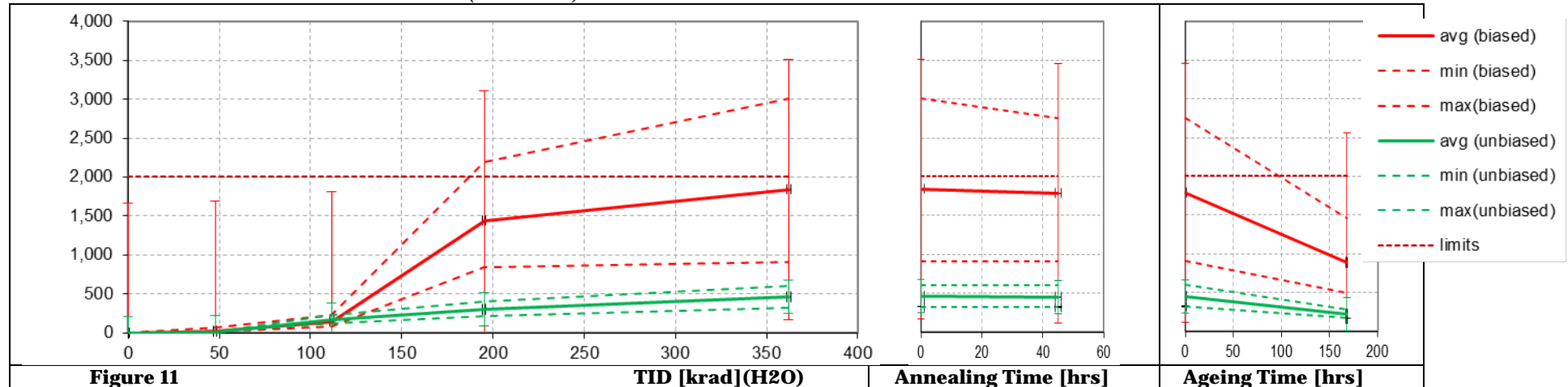


**Table 17 Collector Cut-off Current, Base shorted (low voltage) - ICESL - STATISTICS**

	Pre-irradiation	47.5 [krad]	111.6 [krad]	195.2 [krad]	362.1 [krad]	Anneal @R.T. 45 h	Ageing @100°C 168 h
Unbiased devices							
avg	0.0	11.8	169.7	302.6	460.2	453.2	219.4
min	0.0	11.4	120.8	216.5	326.4	321.3	169.3
max	0.0	12.3	224.2	398.9	607.5	597.1	276.2
$\sigma$	0.0	0.4	39.6	69.7	107.4	107.6	40.7
Biased devices							
avg	0.0	26.4	147.4	1,444.3	1,841.8	1,788.6	891.2
min	0.0	10.7	84.6	841.9	910.4	910.8	497.5
max	0.0	62.5	232.3	<b>2,186.9</b>	<b>3,010.2</b>	<b>2,760.4</b>	1,456.9
$\sigma$	0.0	22.3	60.3	575.5	834.0	768.0	375.4

Part type: BFY640B

Note: all values are in nA. Error bars ->  $\pm 2 \sigma$  (362.1krad)



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# APPENDIX A RADIATION SUMMARY



## ESTEC <sup>60</sup>Co Facility

Keplerlaan, 1 2200AG Noordwijk ZH (NL)



### RADIATION TEST SUMMARY

Irradiation Test Report Number : 20184 Date : 04-10-2012

Test Requester :	Name	Infineon Technologies AG
	Address	Am Campeon 1-12 85579 Neubiberg Germany
	Personnel present :	M Muschitiello, B Nickson
	Project/Cost Code :	ECI
	Devices/Components irradiated :	SiGe Transistors
	Device/Component details : (conditions and identification)	BFY650B, BFY640B, BFY640 & BFY740B

Dosimetry Chain used : C  
 Dosimeter : Farmer model 2680 – s/n 491  
 Gas Ionisation Chamber : NE Type 2571 – s/n 3611

Measured Dosimetry : Total Ionising Dose in [Gy] (water)

Dosimetry Procedure : ESCC 22900 section 4.1.1  
 TEC-QEC/PR001 - Appendix D  
 (Total Ionising Dose accredited by RvA according to ISO/IEC 17025.2005 Certificate No. L517)

(With the exception of the above specified dosimetry equipment, ESTEC <sup>60</sup>Co Facility does not assume any liability for the calibration status of any other equipment lent to the requester )

### Irradiation Test Campaign Details

Source Activity : 75.3 TBq on date : 26-07-2012

	units	Min.	Max.	Time-weighted Average	Dosimeter position relative to <sup>60</sup> Co source		
Temperature	°C	25.2	26.0	25.74	X	cm	-28.0
Pressure	mbar	1000.7	1027.5	1014.22	Y	cm	225.0
Relative Humidity	%	33.7	45.4	41.02	Z	cm	5.0

Run	Start Date & Time (CET)	End Date & Time (CET)	Total Ionising Dose [Gy] (water)	Dose Rate [Gy/h] (water)
1	26/07/2012 13:32	31/07/2012 13:41	477.49	3.97
2	31/07/2012 16:31	06/08/2012 09:16	536.83	3.93
3	06/08/2012 10:56	07/08/2012 12:53	101.92	3.93
4	07/08/2012 15:54	16/08/2012 13:01	835.39	3.92

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**ESTEC <sup>60</sup>Co Facility**

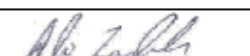
Keplerlaan, 1 2200AG Noordwijk Zh (NL)

Run	Start Date & Time (CET)	End Date & Time (CET)	Total Ionising Dose [Gy] (water)	Dose Rate [Gy/h] (water)
5	16/08/2012 15:49	17/08/2012 10:21	70.97	3.91
6	17/08/2012 10:36	22/08/2012 10:48	467.44	3.89
7	22/08/2012 10:53	22/08/2012 14:48	15.29	3.90
8	22/08/2012 14:52	24/08/2012 14:11	184.42	3.90
9	24/08/2012 14:16	03/09/2012 12:59	931.41	3.90

*Note: The uncertainty budgets (according to TEC-QEC/PR001 section 12) are: 4.2% (k=2) for absorbed dose to water and 4.4% (k=2) for absorbed dose rate to water*

Notes: no remarks.

  
 Bob Nickson/Michele Muschitiello  
 (TEC-QEC Radiation Test Engineer)

  
 Ali Zadeh  
 (TEC-QEC Section Head)

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Irradiation Test Report nr. 20184

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