TOTAL IONIZING DOSE Test Report

BC847 - 100mA NPN Transistor from Infineon

Prepared by **Florian Krimmel**

Reference
Issue/Revision **1.0**
Date of Issue **06/01/2021**
Status **published/authorized**

APPROVAL

Title TID Test Report BJT COTS	
Issue Number 0	**Revision Number** 0
Author Florian Krimmel	**Date** 06/01/2021
Approved By	**Date of Approval**

CHANGE LOG

Reason for change	Issue Nr.	Revision Number	Date

CHANGE RECORD

Issue Number 0	**Revision Number** 0		
Reason for change	**Date**	**Pages**	**Paragraph(s)**

DISTRIBUTION

Name/Organisational Unit

Table of contents:

1 INTRODUCTION 4
2 DOCUMENTS 4
3 PART REFERENCES 4
4 DOSIMETRY AND IRRADIATION FACILITY 4
5 TEST EQUIPMENT 5
6 TEST PARAMETERS 5
7 BIAS CONDITIONS 5
8 TEST RESULTS 6
8.1 hfe @ 0.01 mA 6
8.2 hfe @ 0.1 mA 8
8.3 hfe @ 1 mA 10
8.4 hfe @ 10 mA 12
8.5 hfe @ 100 mA 14
8.6 VCE0 (BR) @ 10mA 16
8.7 VCB0 (BR) @ 10uA 18
8.8 VCE (sat) @ 5mA 100mA 20
9 CONCLUSION 22
10 APPENDIX - EXTRACT FROM THE DATA SHEET 23

1 INTRODUCTION

This report presents the total ionizing dose results of **BC847** a **100mA NPN Transistor from Infineon**.

2 DOCUMENTS

APPLICABLE AND REFERENCE DOCUMENTS
BJTs COTS TID test plan
Datasheet **BC847** from Infineon

3 PART REFERENCES

REFERENCES	
Type:	BC847BE6327HTSA1 and BC847CE6327HTSA1
Manufacturer:	Infineon
Function:	100 mA general-purpose transistors
Technology:	Bipolar NPN Silicon
PARTS PROCUREMENT	
Packaging:	SOT23 (TO-236AB)
Date Code:	batch no. 21: Jan-2020 batch no. 22: Mar-2019 batch no. 24: Jun-2018
Distributor:	batch no. 21: Farnell batch no. 22: RS Components batch no. 24: Mouser
Number of Parts:	3 x 10 irradiated and 3 x 1 ref

4 DOSIMETRY AND IRRADIATION FACILITY

IRRADIATION FACILITY	
Source:	Co60
Localization:	ESTEC, Netherlands
Dosimetry:	FARMER 2670 / 2571

IRRADIATION TIMING	
Total dose limit (krad(Si))	50
Level for measurement (krad(Si))	0, 5, 10, 21, 50
Dose rate (krad(Si)/h)	0.24

ANNEALING TIMING	
Annealing 22°C	24 h
Ageing 100°C	168h

5 TEST EQUIPMENT

PARAMETER	TEST EQUIPMENT
VCE0(BR), VCB0(BR), VCE(sat), hfe (Ic>50mA)	SZ UNIMET M300 Test adapter TA07B.1 SA 07.B.03/1
hfe (Ic<50mA)	Keysight B2912A Precision Source/Measure Unit

6 TEST PARAMETERS

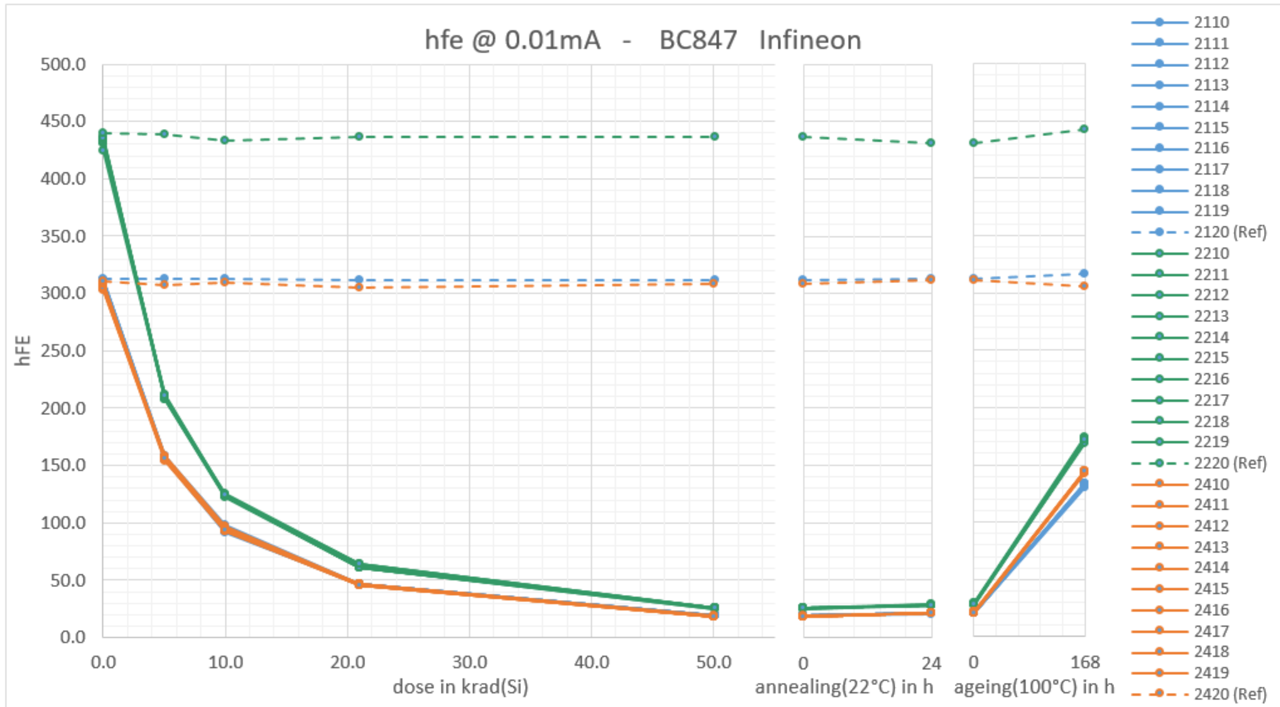
PARAMETERS	SYMBOLS	TEST CONDITIONS
Forward Current Transfer Ratio	hfe1	Ic= 0.01mA, Vce = 1V
	hfe2	Ic= 0.1mA, Vce = 1V
	hfe3	Ic= 1mA, Vce = 1V
	hfe4	Ic= 10mA, Vce = 1V
	hfe5	Ic= 100mA, Vce = 1V
Collector-Emitter Breakdown Voltage	VCE0 (BR)	Ic = 10mA
Collector-Base Breakdown Voltage	VCB0 (BR)	Ic = 10uA
Collector-Emitter Saturation Voltage	VCE (sat)	Ib = 5mA, Ic = 100mA

7 BIAS CONDITIONS

All samples were irradiated in unbiased condition. During the irradiation and during the annealing, a connection of all pins of the transistors was ensured by a conductive foam. During the aging at 100 °C aluminium foil was used to create a connection between all pins.

8 TEST RESULTS

8.1 hfe @ 0.01 mA

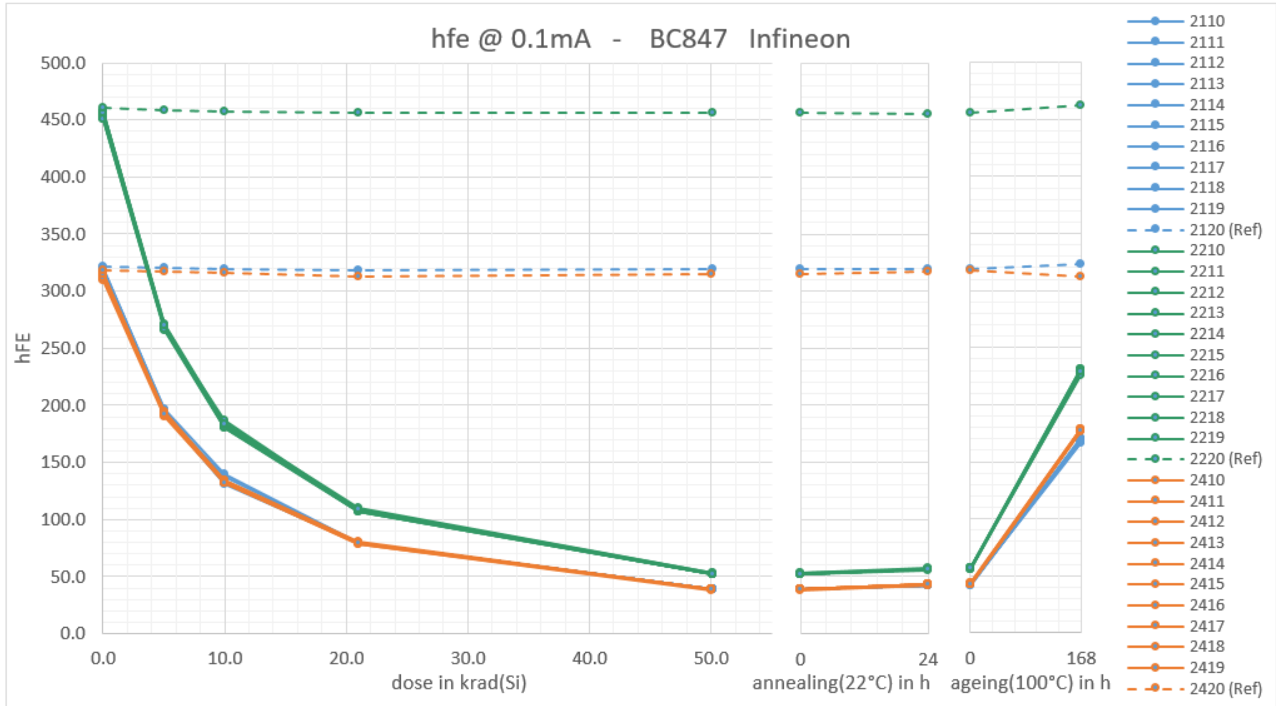


hfe @ 0.01mA	BC847 BE6327HTSA1 Infineon Farnell Jan-2020						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2110	308.0	154.7	96.1	46.7	19.1	21.1	130.4
2111	308.0	155.5	93.5	46.2	19.1	21.1	130.8
2112	310.2	155.6	91.7	46.5	18.9	20.9	133.8
2113	310.5	155.7	92.2	46.8	19.1	21.0	133.2
2114	311.6	157.1	92.4	46.8	19.1	21.1	134.1
2115	311.6	157.8	98.2	46.7	19.1	21.0	132.6
2116	312.1	156.9	92.6	46.1	19.0	21.0	133.6
2117	308.5	155.8	92.2	46.1	19.1	21.0	132.9
2118	310.9	156.4	93.8	46.3	19.1	21.1	132.2
2119	311.4	158.3	93.0	46.5	19.2	21.2	133.2
2120 (Ref)	313.1	312.8	312.4	311.2	311.9	312.6	316.3
Average	310.28	156.37	93.58	46.48	19.10	21.05	132.68
s	1.588	1.151	2.051	0.288	0.072	0.082	1.238
Average+3s	315.04	159.82	99.73	47.35	19.31	21.29	136.39
Average-3s	305.51	152.92	87.42	45.61	18.88	20.80	128.96

hfe @ 0.01mA	BC847 CE6327HTSA1 Infineon RS Mar-2019						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2210	431.2	212.2	124.9	63.0	25.8	28.2	173.3
2211	432.0	208.3	122.9	64.5	25.6	28.1	170.1
2212	433.3	209.6	122.8	60.8	25.4	29.4	171.2
2213	430.8	208.0	121.7	60.4	25.4	27.8	170.3
2214	432.5	210.7	123.7	61.6	25.9	28.5	172.7
2215	437.0	209.4	123.1	60.5	25.2	29.5	173.8
2216	434.0	207.7	123.4	60.4	25.3	28.0	172.0
2217	435.0	210.0	123.5	61.0	25.5	28.4	170.8
2218	424.7	208.5	126.0	63.9	25.6	28.1	169.3
2219	435.2	211.3	124.0	64.1	25.7	28.2	171.9
2220 (Ref)	439.4	439.2	433.6	436.0	436.5	430.8	443.2
Average	432.58	209.57	123.59	62.02	25.54	28.44	171.54
s	3.366	1.481	1.197	1.667	0.233	0.562	1.452
Average+3s	442.68	214.01	127.18	67.03	26.23	30.12	175.90
Average-3s	422.48	205.13	120.00	57.02	24.84	26.75	167.19

hfe @ 0.01mA	BC847 BE6327HTSA1 Infineon Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2410	308.3	156.6	95.0	46.7	18.7	21.3	143.9
2411	303.4	156.5	94.0	46.4	18.6	21.3	143.5
2412	304.5	157.8	94.9	46.7	18.7	21.4	144.5
2413	304.2	154.0	93.1	45.8	18.4	22.0	143.7
2414	308.6	156.4	93.5	46.3	18.5	21.4	143.5
2415	306.5	157.8	96.7	46.7	18.9	21.5	144.3
2416	307.6	156.4	94.5	46.0	18.5	21.3	142.6
2417	307.3	155.3	93.2	45.8	18.4	21.1	143.8
2418	305.0	157.5	94.3	45.9	18.6	21.3	144.9
2419	308.5	156.4	93.5	46.0	18.6	21.3	144.2
2420 (Ref)	311.0	307.0	309.3	304.9	308.7	311.2	305.5
Average	306.39	156.47	94.26	46.24	18.59	21.39	143.90
s	1.955	1.171	1.106	0.373	0.142	0.232	0.645
Average+3s	312.26	159.98	97.57	47.36	19.02	22.09	145.83
Average-3s	300.53	152.96	90.94	45.12	18.16	20.70	141.96

8.2 hfe @ 0.1 mA

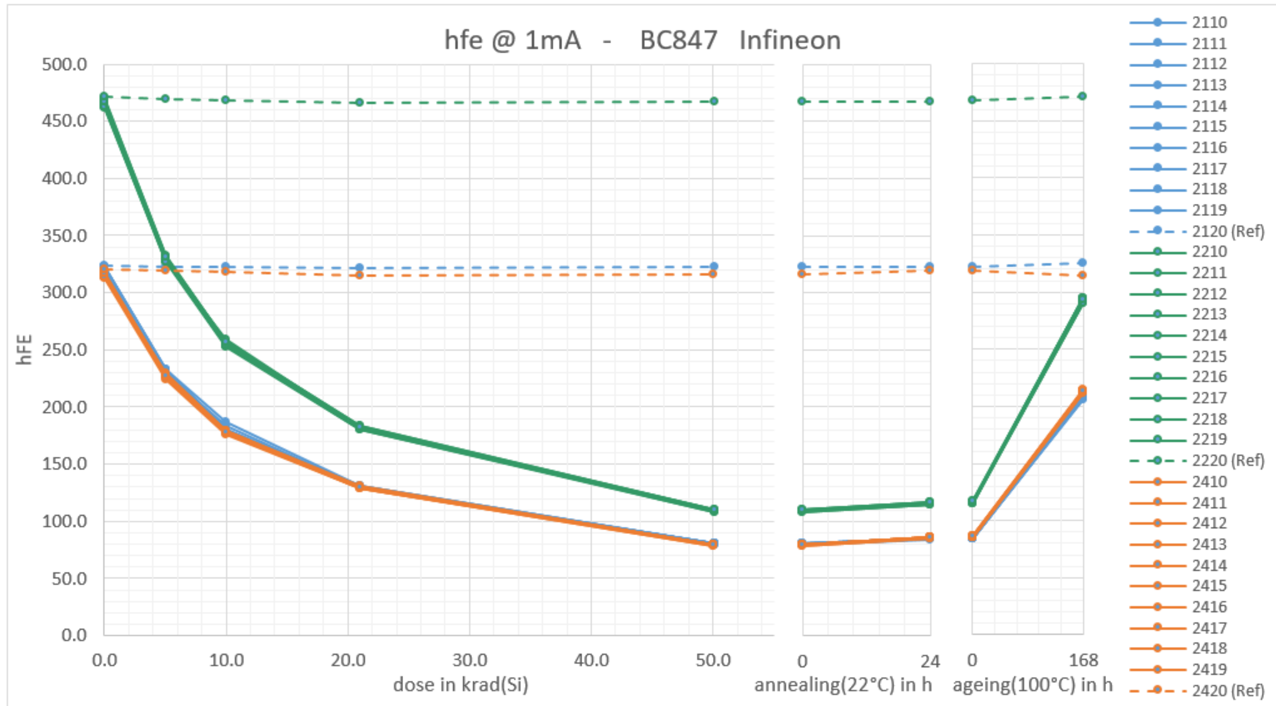


hfe @ 0.1mA	BC847 BE6327HTSA1 Infineon Farnell Jan-2020						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2110	315.7	192.0	137.0	79.8	39.2	42.4	166.6
2111	318.5	192.8	131.6	79.4	39.3	42.5	166.9
2112	318.1	192.7	131.4	79.0	38.8	42.0	169.8
2113	318.7	193.0	132.1	79.4	39.1	42.2	169.7
2114	319.8	195.0	132.6	79.6	39.1	42.3	170.7
2115	319.6	196.1	139.3	79.8	39.1	42.3	168.4
2116	320.0	195.0	132.3	79.2	39.0	42.2	170.0
2117	318.4	193.2	132.1	79.2	39.0	42.2	168.9
2118	318.3	193.8	132.9	79.5	39.1	42.3	168.4
2119	319.7	196.0	132.9	79.7	39.3	42.5	169.6
2120 (Ref)	321.0	319.9	319.7	318.4	319.2	319.1	323.2
Average	318.68	193.97	133.44	79.45	39.10	42.29	168.89
s	1.267	1.471	2.590	0.285	0.140	0.159	1.354
Average+3s	322.48	198.38	141.21	80.30	39.52	42.76	172.96
Average-3s	314.88	189.55	125.67	78.59	38.68	41.81	164.83

hfe @ 0.1mA	BC847 CE6327HTSA1 Infineon RS Mar-2019						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2210	456.8	271.7	184.2	109.7	52.8	57.1	231.0
2211	452.1	267.4	181.4	108.4	52.5	56.9	226.9
2212	453.6	268.1	181.6	107.4	51.9	56.3	228.1
2213	451.2	266.2	180.1	107.0	52.0	56.3	227.0
2214	457.6	270.3	183.3	109.0	53.0	57.4	230.7
2215	457.3	268.8	182.2	107.1	51.7	56.0	231.2
2216	454.6	266.5	180.6	107.0	51.9	56.1	229.0
2217	455.5	268.9	182.6	107.9	52.3	56.8	230.1
2218	450.6	266.8	186.8	107.9	52.3	56.7	226.2
2219	455.8	270.5	183.4	108.7	52.6	57.0	229.2
2220 (Ref)	460.1	458.6	457.7	455.8	456.4	455.5	462.2
Average	454.54	268.52	182.61	108.00	52.32	56.66	228.94
s	2.535	1.862	1.939	0.937	0.430	0.449	1.816
Average+3s	462.14	274.10	188.43	110.81	53.61	58.00	234.39
Average-3s	446.93	262.93	176.80	105.19	51.03	55.31	223.49

hfe @ 0.1mA	BC847 BE6327HTSA1 Infineon Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2410	315.5	192.4	133.5	80.0	38.9	42.9	177.8
2411	311.6	192.4	132.8	79.6	38.7	42.9	177.1
2412	310.9	194.0	133.9	79.6	38.9	43.5	178.6
2413	310.0	189.7	131.7	78.6	38.4	42.9	177.3
2414	315.1	192.2	132.5	79.2	38.8	43.3	177.0
2415	313.9	193.9	134.1	80.3	39.2	43.5	178.2
2416	314.4	192.6	133.0	79.2	38.7	43.1	176.2
2417	314.2	191.1	132.2	78.8	38.5	42.8	177.6
2418	311.9	193.5	133.1	79.3	38.8	43.1	178.6
2419	315.4	192.5	132.5	79.5	38.7	43.2	178.0
2420 (Ref)	318.5	316.7	316.3	313.0	314.5	317.7	312.5
Average	313.30	192.43	132.92	79.42	38.75	43.12	177.64
s	2.009	1.294	0.759	0.489	0.224	0.249	0.781
Average+3s	319.32	196.31	135.20	80.89	39.42	43.86	179.98
Average-3s	307.27	188.55	130.65	77.95	38.08	42.37	175.30

8.3 hfe @ 1 mA

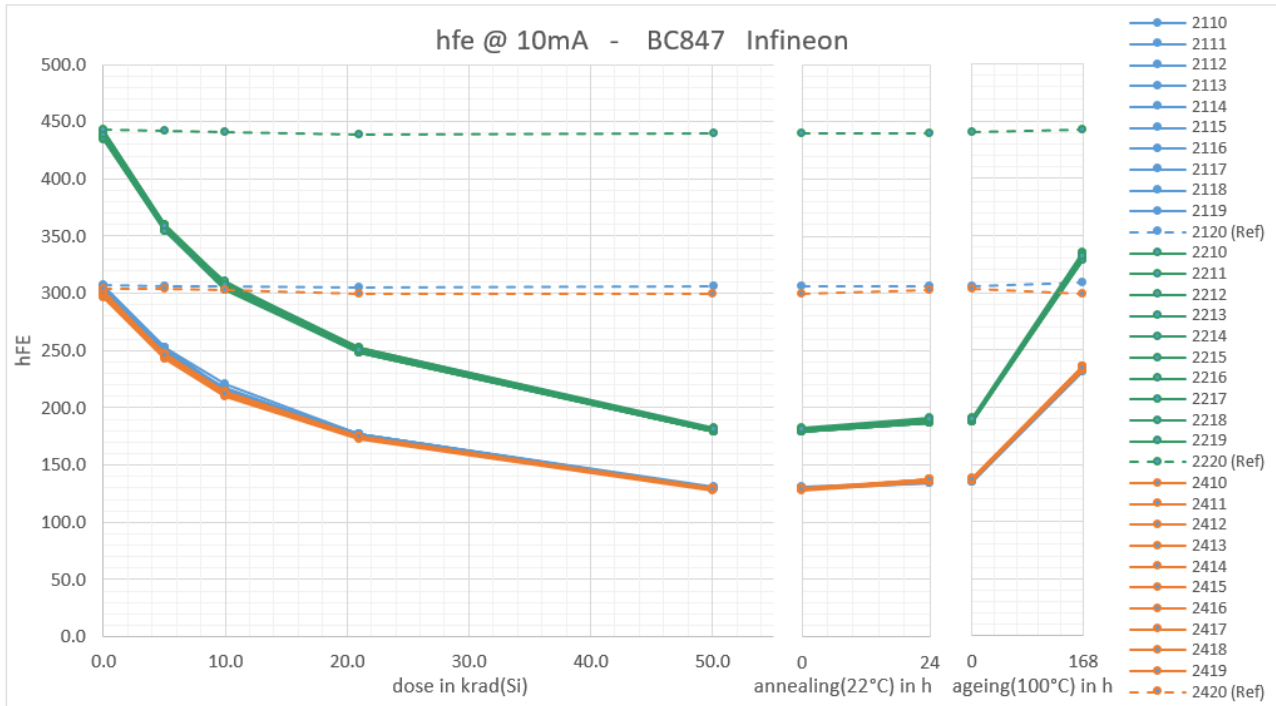


hfe @ 1mA	BC847 BE6327HTSA1 Infineon Farnell Jan-2020						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2110	318.7	229.0	183.8	130.1	80.1	84.7	205.7
2111	321.7	230.1	178.7	130.1	80.1	85.1	206.1
2112	321.2	229.8	178.3	129.5	79.6	84.3	209.0
2113	321.8	230.3	179.0	130.0	80.1	84.7	208.7
2114	322.9	232.2	179.8	130.5	80.2	84.9	209.8
2115	322.7	233.2	186.3	130.7	80.1	84.8	207.4
2116	323.0	232.5	179.6	130.1	79.9	84.6	209.0
2117	321.6	230.4	179.1	130.1	79.9	84.7	208.1
2118	322.1	230.9	180.0	130.3	80.1	84.8	207.3
2119	323.0	232.9	180.1	130.8	80.3	85.2	208.6
2120 (Ref)	323.9	322.8	322.6	321.3	322.1	322.4	325.2
Average	321.87	231.12	180.47	130.22	80.04	84.78	207.97
s	1.281	1.455	2.558	0.371	0.207	0.262	1.316
Average+3s	325.72	235.49	188.14	131.33	80.66	85.57	211.92
Average-3s	318.03	226.76	172.80	129.11	79.42	84.00	204.03

hfe @ 1mA	BC847 CE6327HTSA1 Infineon RS Mar-2019						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2210	469.3	332.7	257.2	183.9	110.2	116.5	295.3
2211	462.5	327.7	253.7	181.9	109.5	115.7	290.6
2212	464.2	328.7	254.0	181.0	108.6	114.7	291.6
2213	461.6	326.5	252.3	180.7	108.7	115.2	290.3
2214	469.9	331.7	256.9	184.0	110.6	117.1	295.3
2215	467.6	329.9	254.6	180.8	108.3	114.6	295.1
2216	465.2	327.8	253.2	180.6	108.5	114.8	292.9
2217	466.1	330.2	255.5	182.0	109.6	115.9	294.3
2218	462.6	327.3	259.5	181.7	109.1	115.9	289.9
2219	466.7	331.6	256.4	182.9	110.1	116.9	293.4
2220 (Ref)	471.1	469.3	468.6	466.2	466.8	467.7	471.5
Average	465.56	329.42	255.32	181.95	109.33	115.73	292.86
s	2.893	2.120	2.182	1.268	0.800	0.896	2.138
Average+3s	474.24	335.78	261.87	185.75	111.73	118.41	299.28
Average-3s	456.88	323.06	248.78	178.15	106.93	113.04	286.45

hfe @ 1mA	BC847 BE6327HTSA1 Infineon Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2410	317.5	227.5	178.6	130.1	79.7	85.8	213.5
2411	313.9	227.4	177.9	129.6	79.5	85.8	212.6
2412	313.7	229.3	179.6	130.0	79.5	86.2	214.0
2413	312.8	224.2	176.4	128.3	78.6	85.1	212.2
2414	316.9	227.3	177.6	129.1	79.4	85.9	212.3
2415	315.8	228.7	179.2	130.5	80.0	86.6	213.6
2416	316.4	227.6	178.1	129.5	79.2	86.0	211.6
2417	316.0	226.1	177.3	128.9	78.9	85.6	213.2
2418	314.3	228.7	178.4	129.6	79.4	86.1	214.2
2419	317.4	227.8	177.9	130.0	79.5	86.0	213.7
2420 (Ref)	320.5	319.8	318.6	315.2	316.2	319.4	314.7
Average	315.46	227.47	178.10	129.57	79.37	85.91	213.10
s	1.677	1.448	0.935	0.646	0.387	0.403	0.866
Average+3s	320.49	231.81	180.91	131.51	80.53	87.12	215.70
Average-3s	310.43	223.12	175.30	127.63	78.21	84.70	210.50

8.4 hfe @ 10 mA

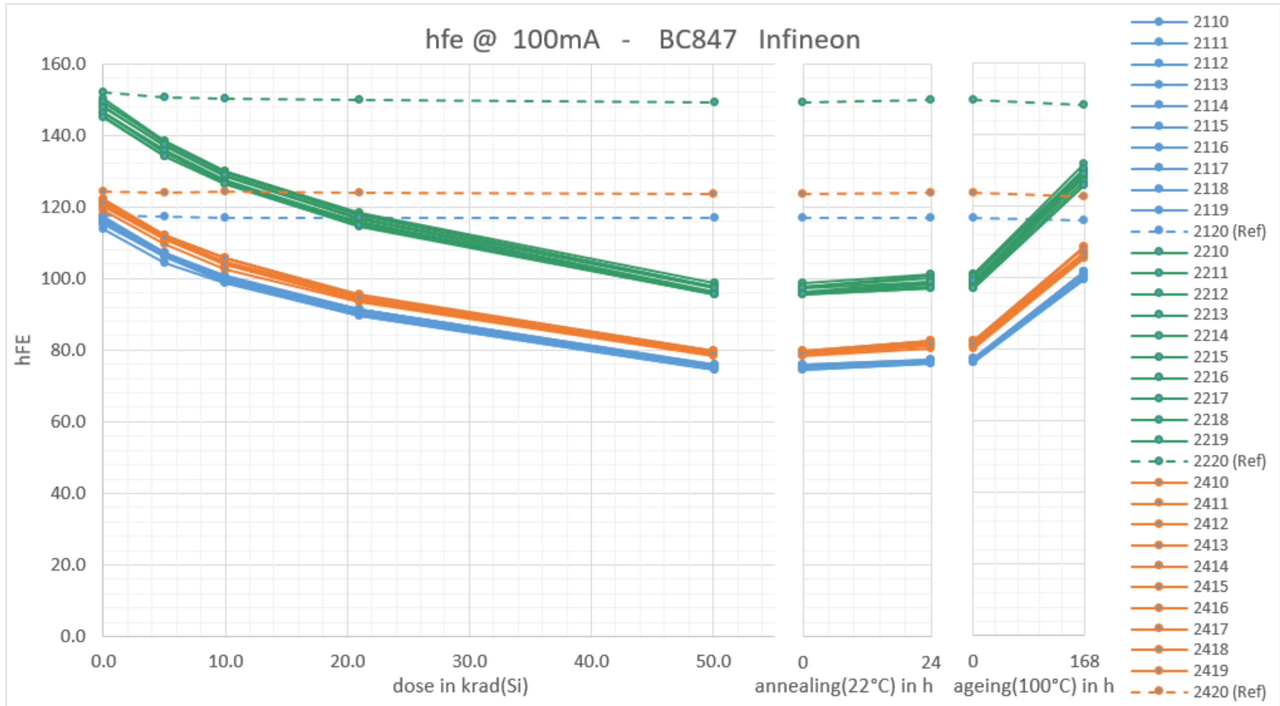


hfe @ 10mA	BC847 BE6327HTSA1 Infineon Farnell Jan-2020						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2110	302.4	247.8	217.7	175.8	129.4	134.8	231.4
2111	305.1	249.3	214.2	176.2	130.4	135.5	231.7
2112	304.7	248.6	213.5	175.5	128.9	134.5	234.0
2113	305.4	249.5	214.6	176.1	129.5	135.4	234.1
2114	306.4	251.6	215.6	176.8	130.0	135.8	235.1
2115	306.2	252.5	220.5	176.9	129.7	135.5	232.6
2116	306.4	252.3	215.1	176.4	129.6	135.4	234.2
2117	305.1	249.5	214.7	176.2	129.4	135.2	233.5
2118	305.5	249.9	215.8	176.4	129.6	135.4	232.4
2119	306.5	252.0	215.4	177.1	130.5	135.9	233.8
2120 (Ref)	307.5	306.4	306.2	305.0	305.7	306.0	308.6
Average	305.38	250.30	215.70	176.35	129.69	135.33	233.28
s	1.246	1.647	2.027	0.509	0.470	0.419	1.197
Average+3s	309.12	255.24	221.79	177.88	131.10	136.59	236.87
Average-3s	301.64	245.36	209.62	174.82	128.28	134.07	229.68

hfe @ 10mA	BC847 CE6327HTSA1 Infineon RS Mar-2019						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2210	441.4	360.1	308.7	252.0	181.6	190.0	333.9
2211	435.0	355.0	304.6	249.1	180.0	188.3	328.4
2212	436.4	356.1	305.0	248.4	179.0	187.2	330.0
2213	434.0	353.9	303.3	247.8	178.9	187.3	328.4
2214	442.1	360.0	309.1	252.5	182.4	190.8	334.9
2215	439.6	358.0	307.3	248.9	179.0	187.3	333.7
2216	437.1	355.4	304.5	248.2	178.8	187.1	331.4
2217	438.4	358.1	307.0	250.1	180.6	189.0	333.6
2218	435.0	354.9	310.3	249.0	179.6	188.4	328.4
2219	438.7	359.1	307.7	250.7	181.1	189.8	332.0
2220 (Ref)	443.2	441.6	440.9	438.9	439.4	440.0	443.2
Average	437.77	357.06	306.75	249.67	180.08	188.52	331.47
s	2.755	2.272	2.286	1.618	1.269	1.321	2.540
Average+3s	446.04	363.87	313.60	254.52	183.89	192.48	339.09
Average-3s	429.51	350.24	299.89	244.81	176.27	184.56	323.85

hfe @ 10mA	BC847 BE6327HTSA1 Infineon Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2410	301.3	245.9	212.8	175.0	128.9	136.1	234.8
2411	297.7	245.5	212.1	174.3	128.5	136.1	233.4
2412	297.6	247.4	213.8	174.8	129.3	137.7	235.4
2413	296.7	242.5	210.2	172.5	127.7	135.9	233.2
2414	300.6	245.6	211.7	174.2	128.8	137.1	233.6
2415	299.7	246.8	213.3	175.2	129.8	137.3	235.1
2416	300.1	246.0	212.4	174.3	128.9	136.7	232.3
2417	299.9	244.7	211.6	173.8	128.5	135.9	234.3
2418	298.3	247.1	212.7	174.8	129.1	136.7	235.6
2419	301.1	246.2	212.3	175.1	129.3	137.3	234.8
2420 (Ref)	304.3	303.6	302.5	299.2	300.1	303.1	298.8
Average	299.31	245.77	212.31	174.39	128.88	136.68	234.25
s	1.618	1.389	0.990	0.789	0.562	0.649	1.095
Average+3s	304.17	249.93	215.28	176.75	130.56	138.63	237.54
Average-3s	294.46	241.60	209.34	172.02	127.19	134.73	230.97

8.5 hfe @ 100 mA

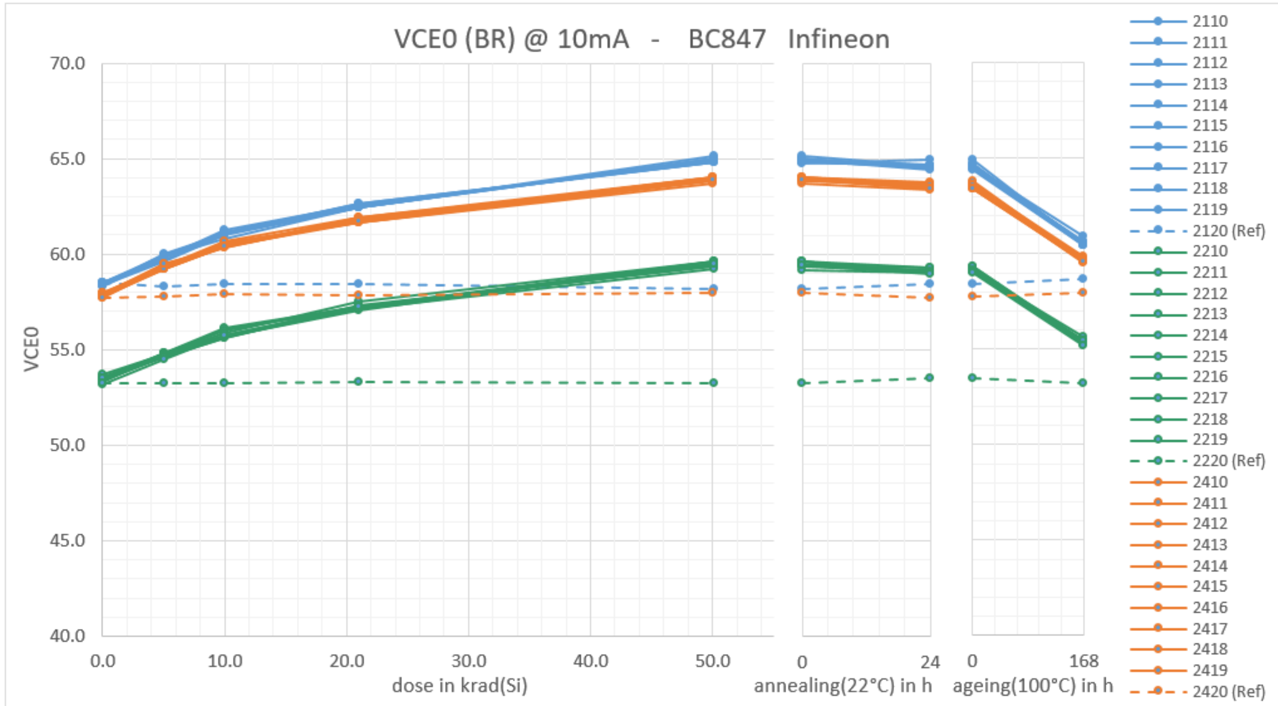


hfe @ 100mA	BC847 BE6327HTSA1 Infineon Farnell Jan-2020						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2110	113.8	104.3	98.7	89.6	74.6	76.3	99.7
2111	115.4	106.0	99.2	90.4	75.4	77.1	99.7
2112	115.3	106.1	99.2	89.6	74.6	76.3	100.2
2113	115.9	106.5	99.7	90.4	75.4	77.1	101.8
2114	117.1	107.0	100.2	91.2	76.0	77.4	101.8
2115	116.5	107.0	100.9	91.2	75.4	77.1	101.4
2116	116.7	107.0	100.1	91.2	75.7	77.1	101.4
2117	115.6	106.5	99.2	90.0	75.2	76.8	101.8
2118	116.2	106.6	99.7	90.8	75.2	77.1	100.2
2119	116.7	107.0	100.1	91.2	76.0	77.4	101.8
2120 (Ref)	117.8	117.2	117.1	116.9	116.8	116.9	116.2
Average	115.93	106.41	99.69	90.58	75.35	76.99	100.95
s	0.961	0.818	0.663	0.658	0.489	0.413	0.924
Average+3s	118.81	108.86	101.68	92.56	76.82	78.23	103.72
Average-3s	113.04	103.95	97.70	88.61	73.88	75.76	98.18

hfe @ 100mA	BC847 CE6327HTSA1 Infineon RS Mar-2019						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2210	150.1	138.3	129.8	118.1	97.8	100.9	131.9
2211	146.4	135.2	126.7	115.7	95.9	98.7	127.9
2212	146.5	135.0	126.9	115.3	95.9	97.8	126.8
2213	145.4	134.2	126.2	114.6	95.5	97.3	125.9
2214	149.2	138.4	129.9	118.4	98.7	101.0	130.3
2215	147.9	137.0	128.3	116.5	96.4	99.2	129.9
2216	146.5	135.8	127.3	115.6	95.9	98.2	128.8
2217	149.0	138.0	129.4	117.5	97.8	100.2	130.4
2218	144.9	134.2	126.4	114.9	95.5	97.3	125.8
2219	147.8	137.3	128.8	117.1	97.3	99.2	129.1
2220 (Ref)	151.9	150.5	150.1	150.0	149.3	149.9	148.4
Average	147.36	136.35	127.97	116.37	96.66	98.97	128.67
s	1.712	1.649	1.452	1.350	1.128	1.378	2.039
Average+3s	152.50	141.29	132.33	120.42	100.05	103.10	134.79
Average-3s	142.23	131.40	123.62	112.32	93.28	94.84	122.55

hfe @ 100mA	BC847 BE6327HTSA1 Infineon Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2410	122.0	112.2	105.7	95.5	79.8	82.4	108.8
2411	121.5	111.6	104.8	95.0	79.2	81.4	107.0
2412	121.9	112.0	105.6	95.0	79.8	82.4	107.0
2413	119.1	109.4	102.6	93.3	78.3	80.5	105.6
2414	120.5	110.8	103.9	94.2	78.9	81.4	106.1
2415	120.9	111.3	104.4	95.0	79.5	81.8	106.5
2416	120.2	110.8	103.9	93.7	78.6	81.1	105.6
2417	121.0	111.3	104.3	94.6	79.2	81.4	108.8
2418	122.1	111.9	105.7	95.0	79.5	82.4	108.4
2419	121.0	111.3	103.9	94.6	78.9	81.4	107.0
2420 (Ref)	124.2	123.9	124.2	123.9	123.6	123.9	122.7
Average	121.03	111.26	104.48	94.60	79.20	81.63	107.08
s	0.935	0.799	0.991	0.680	0.509	0.635	1.225
Average+3s	123.83	113.65	107.45	96.64	80.72	83.54	110.76
Average-3s	118.22	108.86	101.50	92.56	77.67	79.72	103.41

8.6 VCEo (BR) @ 10mA

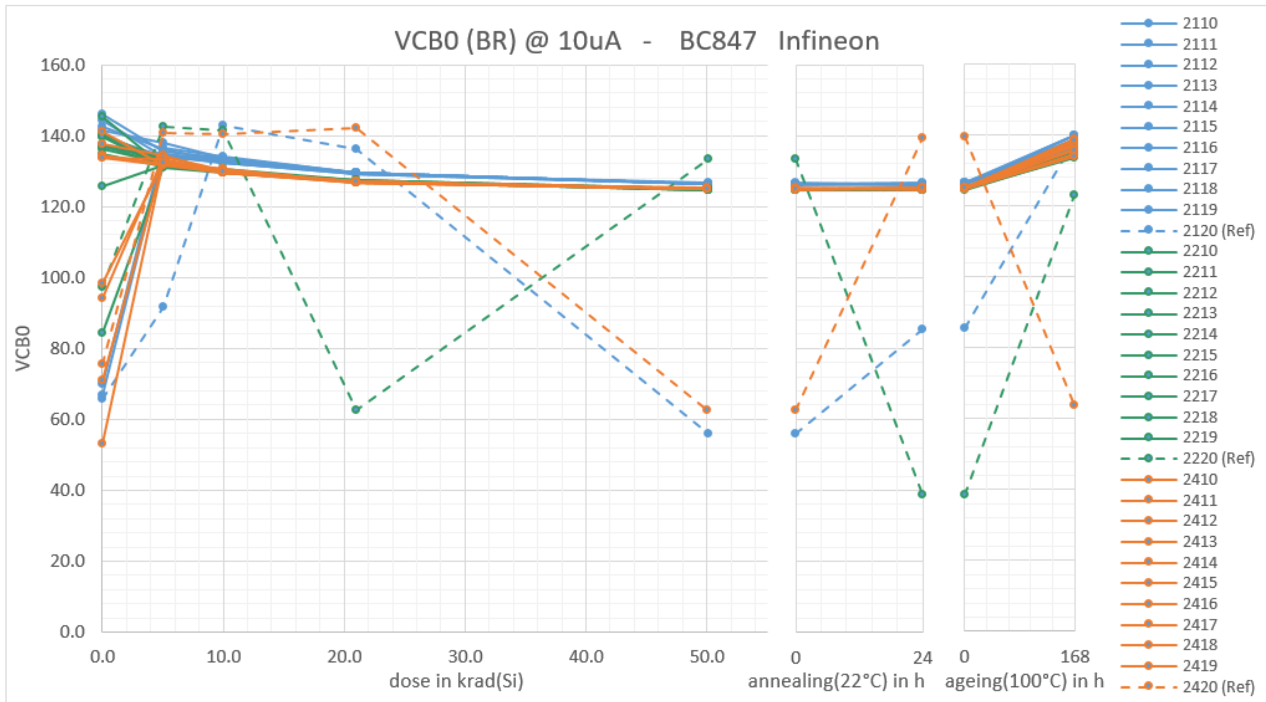


VCE0 (BR) @ 10mA	BC847 BE6327HTSA1 Infineon Farnell Jan-2020						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2110	58.4	59.9	61.1	62.4	65.0	64.4	60.5
2111	58.5	59.8	61.1	62.6	64.8	64.6	60.5
2112	58.5	59.9	61.1	62.4	65.0	64.5	60.6
2113	58.4	60.0	61.0	62.4	65.0	64.5	60.5
2114	58.5	59.8	61.3	62.6	64.9	64.6	60.6
2115	58.3	59.9	61.1	62.6	64.8	64.9	60.4
2116	58.5	59.9	61.1	62.7	64.8	64.6	60.9
2117	58.3	59.6	61.0	62.5	65.1	64.6	60.6
2118	58.5	59.7	61.1	62.6	64.9	64.5	60.6
2119	58.4	59.9	60.8	62.5	64.9	64.7	60.4
2120 (Ref)	58.5	58.3	58.4	58.4	58.2	58.4	58.7
Average	58.43	59.84	61.06	62.52	64.92	64.60	60.55
s	0.082	0.108	0.123	0.090	0.110	0.148	0.136
Average+3s	58.68	60.16	61.43	62.79	65.25	65.04	60.96
Average-3s	58.19	59.52	60.69	62.25	64.59	64.16	60.15

VCE0 (BR) @ 10mA	BC847 CE6327HTSA1 Infineon RS Mar-2019						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2210	53.3	54.7	55.6	57.2	59.6	59.0	55.2
2211	53.6	54.8	56.1	57.2	59.4	59.2	55.4
2212	53.4	54.8	55.8	57.3	59.4	59.3	55.5
2213	53.5	54.8	56.1	57.2	59.4	59.1	55.6
2214	53.4	54.7	55.7	57.1	59.6	59.0	55.3
2215	53.3	54.8	56.0	57.2	59.5	59.1	55.3
2216	53.7	54.8	55.9	57.5	59.6	59.3	55.4
2217	53.5	54.6	55.6	57.4	59.3	59.1	55.5
2218	53.5	54.6	55.7	57.1	59.2	59.0	55.5
2219	53.2	54.5	55.7	57.3	59.5	59.0	55.2
2220 (Ref)	53.2	53.3	53.3	53.3	53.2	53.5	53.2
Average	53.43	54.71	55.81	57.25	59.46	59.13	55.38
s	0.142	0.116	0.194	0.123	0.137	0.114	0.139
Average+3s	53.86	55.05	56.39	57.61	59.87	59.47	55.80
Average-3s	53.01	54.36	55.23	56.88	59.05	58.78	54.97

VCE0 (BR) @ 10mA	BC847 BE6327HTSA1 Infineon Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2410	57.8	59.3	60.6	61.7	63.9	63.5	59.5
2411	57.8	59.2	60.4	61.9	63.9	63.7	59.8
2412	57.9	59.4	60.5	61.6	63.7	63.4	59.6
2413	58.0	59.3	60.7	61.9	64.0	63.6	59.7
2414	58.0	59.3	60.4	61.6	63.8	63.6	59.6
2415	57.9	59.5	60.4	61.8	64.0	63.8	59.7
2416	57.9	59.4	60.4	61.8	63.9	63.6	59.7
2417	57.7	59.4	60.4	61.8	64.0	63.6	59.7
2418	57.9	59.2	60.4	61.8	64.0	63.4	59.7
2419	57.8	59.5	60.4	61.7	63.9	63.4	59.6
2420 (Ref)	57.7	57.8	57.9	57.8	58.0	57.7	57.9
Average	57.88	59.33	60.46	61.77	63.91	63.56	59.66
s	0.078	0.090	0.107	0.101	0.109	0.126	0.080
Average+3s	58.11	59.60	60.78	62.07	64.24	63.94	59.90
Average-3s	57.64	59.06	60.14	61.47	63.58	63.18	59.42

8.7 VCB0 (BR) @ 10uA



VCB0 (BR) @ 10uA	BC847 BE6327HTSA1 Infineon Farnell Jan-2020						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2110	146.2	135.3	133.8	129.6	126.4	126.3	139.8
2111	144.2	134.0	132.6	129.5	126.2	126.3	137.3
2112	139.7	134.1	132.4	129.4	126.5	126.5	137.6
2113	66.7*	134.7	132.4	129.2	126.4	126.4	139.9
2114	136.7	134.3	132.3	129.3	126.5	126.1	135.8
2115	141.4	138.0	133.7	129.4	126.4	126.7	138.9
2116	69.8	136.5	134.1	129.4	126.4	126.5	136.8
2117	142.6	136.3	132.6	129.6	126.3	126.5	139.8
2118	136.9	134.8	133.4	129.1	126.6	126.2	138.2
2119	137.6	133.7	132.9	129.5	126.3	126.5	136.5
2120 (Ref)	65.6*	91.6*	142.8	136.0	55.9*	85.4*	138.5
Average	126.17	135.18	133.02	129.38	126.40	126.41	138.08
s	30.701	1.367	0.666	0.159	0.111	0.179	1.500
Average+3s	218.27	139.29	135.01	129.86	126.74	126.94	142.58
Average-3s	34.07	131.08	131.02	128.91	126.07	125.87	133.58

* Obviously incorrect measurement result, due to the UNIMET M3000 at low currents

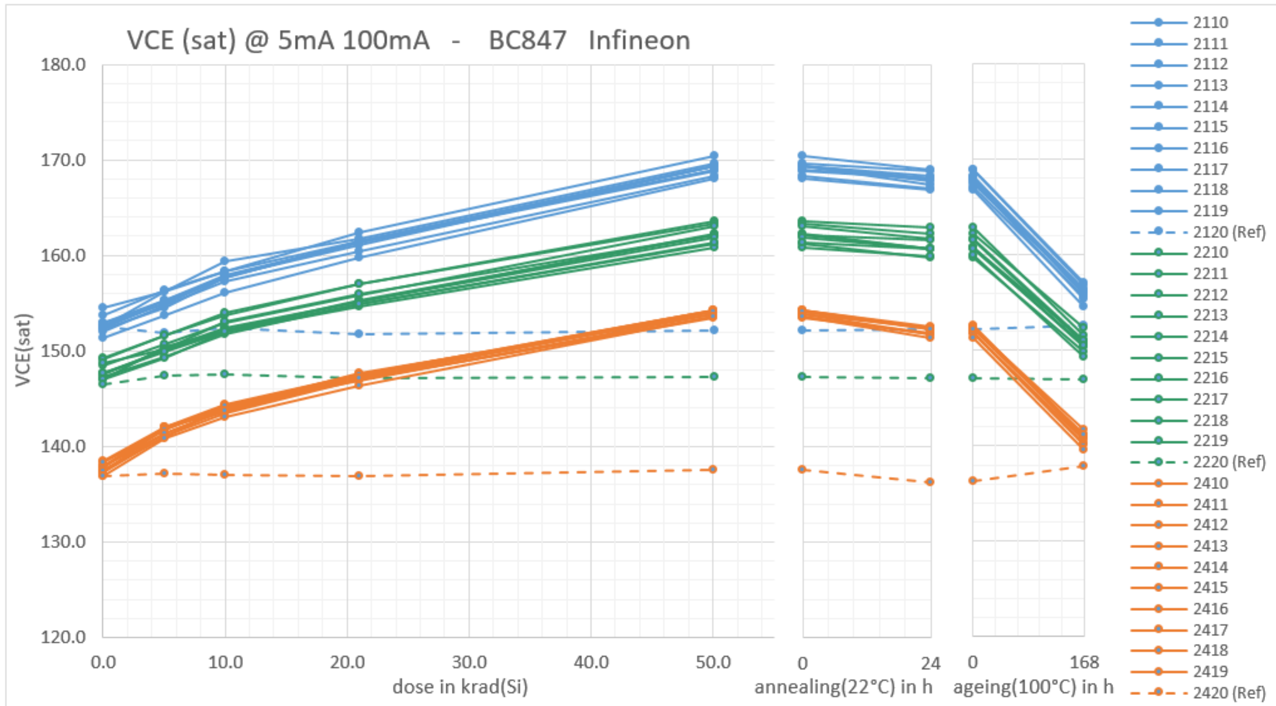
VCB0 (BR) @ 10uA BC847 CE6327HTSA1 Infineon RS Mar-2019							
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2210	84.3*	131.1	129.7	127.3	125.0	125.0	133.5
2211	137.3	132.9	129.8	127.1	125.1	124.7	133.9
2212	125.5	131.5	129.8	127.2	125.0	124.9	134.4
2213	136.0	132.4	130.0	127.3	124.8	124.8	135.2
2214	139.6	131.9	129.8	127.0	124.9	124.7	135.5
2215	137.2	131.6	130.5	127.3	124.9	125.1	135.8
2216	134.9	131.3	130.2	127.0	124.9	125.0	135.6
2217	140.3	133.1	129.8	127.0	124.6	124.7	134.0
2218	139.8	131.0	129.4	127.0	124.6	124.9	135.3
2219	145.2	131.3	129.8	127.1	124.5	124.6	133.9
2220 (Ref)	97.1*	142.4	141.4	62.5*	133.5	38.6*	123.1
Average	132.01	131.83	129.88	127.15	124.83	124.84	134.71
s	17.504	0.748	0.280	0.148	0.192	0.163	0.862
Average+3s	184.52	134.07	130.72	127.59	125.41	125.33	137.30
Average-3s	79.49	129.58	129.04	126.70	124.26	124.36	132.12

* Obviously incorrect measurement result, due to the UNIMET M3000 at low currents

VCB0 (BR) @ 10uA BC847 BE6327HTSA1 Infineon Mouser Jun-2018							
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2410	134.2	132.0	130.4	126.8	125.0	125.0	137.8
2411	133.7	131.5	130.0	126.8	124.9	125.0	136.9
2412	94.2*	134.1	130.3	127.0	124.8	124.9	137.0
2413	53.0*	133.2	129.4	127.1	125.0	124.9	134.5
2414	141.2	131.7	129.4	126.9	125.1	125.2	137.5
2415	71.1*	133.1	129.6	126.9	125.2	124.8	134.0
2416	134.3	132.1	130.6	126.8	125.0	125.0	136.2
2417	137.5	134.3	129.5	127.0	125.0	125.2	135.6
2418	133.9	133.4	129.5	126.8	124.9	125.0	138.8
2419	98.3*	132.5	129.9	127.0	125.0	125.2	138.4
2420 (Ref)	75.6*	140.6	140.2	142.1	62.4*	139.5	63.7*
Average	113.15	132.79	129.85	126.91	124.97	125.02	136.67
s	31.786	0.984	0.462	0.099	0.109	0.140	1.609
Average+3s	208.51	135.74	131.24	127.21	125.30	125.44	141.50
Average-3s	17.79	129.84	128.47	126.61	124.64	124.60	131.84

* Obviously incorrect measurement result, due to the UNIMET M3000 at low currents

8.8 VCE (sat) @ 5mA 100mA



VCE (sat) @ 5mA 100mA	BC847 BE6327HTSA1 Infineon Farnell Jan-2020						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2110	153.7	156.3	158.3	162.4	170.4	169.0	156.8
2111	154.5	156.3	159.3	161.8	169.6	168.9	157.1
2112	152.9	155.3	157.9	161.4	169.4	168.1	156.4
2113	152.6	156.2	158.3	161.5	169.3	168.3	156.1
2114	152.3	154.5	157.7	161.5	169.0	168.0	156.1
2115	151.4	153.7	156.1	159.8	168.0	166.8	154.6
2116	152.0	154.8	157.2	160.5	168.3	167.0	155.7
2117	152.6	155.4	157.7	161.5	169.4	167.8	155.4
2118	152.4	155.1	157.8	161.0	169.4	167.4	156.2
2119	153.0	154.9	157.8	161.3	168.8	168.0	155.9
2120 (Ref)	152.5	151.9	152.4	151.8	152.1	152.2	152.6
Average	152.75	155.23	157.81	161.25	169.15	167.93	156.04
s	0.879	0.851	0.814	0.718	0.661	0.698	0.700
Average+3s	155.38	157.78	160.26	163.41	171.14	170.02	158.14
Average-3s	150.11	152.67	155.37	159.10	167.17	165.83	153.94

VCE (sat) @ 5mA 100mA	BC847 CE6327HTSA1 Infineon RS Mar-2019						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
2210	149.3	151.6	153.8	156.9	163.6	162.9	151.5
2211	147.6	150.2	152.5	155.2	162.3	160.7	150.4
2212	147.0	150.5	152.2	155.3	162.2	160.7	150.6
2213	149.2	151.6	153.9	157.0	163.4	162.2	152.3
2214	147.3	149.4	151.7	154.9	161.2	159.8	149.9
2215	148.4	150.6	152.9	155.8	163.1	161.7	151.0
2216	148.7	150.2	153.1	156.0	162.2	161.6	150.7
2217	147.1	149.2	152.0	154.6	160.8	159.9	149.3
2218	147.7	150.0	152.2	155.2	161.9	160.7	151.0
2219	147.7	149.9	152.1	155.0	161.4	160.6	150.5
2220 (Ref)	146.6	147.4	147.6	147.2	147.2	147.1	147.0
Average	147.99	150.32	152.63	155.59	162.20	161.09	150.72
s	0.853	0.810	0.768	0.834	0.933	1.003	0.840
Average+3s	150.55	152.75	154.93	158.09	165.00	164.10	153.24
Average-3s	145.43	147.89	150.32	153.08	159.40	158.09	148.20

VCE (sat) @ 5mA 100mA	BC847 BE6327HTSA1 Infineon Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2410	137.4	141.1	143.4	147.0	153.6	151.8	140.2
2411	137.6	141.0	144.1	146.9	153.9	151.8	140.2
2412	137.9	141.4	143.9	147.0	153.4	151.8	140.6
2413	138.0	142.0	143.9	147.7	153.9	152.5	141.2
2414	138.5	142.0	144.4	147.6	154.2	152.3	141.6
2415	137.3	142.0	143.6	147.5	154.3	152.6	141.0
2416	137.8	141.8	144.1	147.3	154.1	152.4	141.0
2417	138.3	141.8	144.3	147.5	154.2	152.4	140.9
2418	137.4	141.4	143.7	147.2	154.1	152.2	141.1
2419	136.9	140.8	143.1	146.4	153.6	151.3	139.6
2420 (Ref)	136.8	137.2	137.0	137.0	137.5	136.3	137.8
Average	137.70	141.54	143.85	147.21	153.94	152.10	140.74
s	0.508	0.455	0.399	0.395	0.308	0.402	0.599
Average+3s	139.23	142.91	145.05	148.40	154.86	153.31	142.54
Average-3s	136.18	140.18	142.65	146.03	153.01	150.90	138.95

9 CONCLUSION

The test results of the BC847 from Infineon indicate very similar behaviour for all the 3 different tested date codes, especially if you put the different initial gain value into consideration.

The gain of the transistors decreases continuously with increasing dose. This effect is particularly stronger at the lower collector currents. Whether the transistor can still be used at the maximum tested dose must be carefully considered for the respective application.

A change in the breakdown voltage between the Collector-Emitter and Collector-Base can be determined at the measured operating points, but it is still within the tolerances specified in the data sheet.

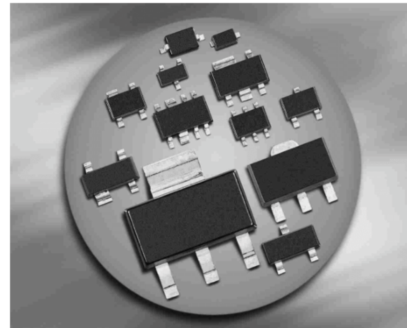
The CE saturation voltage increases slightly over the radiation dose but still stays inside the specification.

10 APPENDIX - EXTRACT FROM THE DATA SHEET

BC847...-BC850...

NPN Silicon AF Transistors

- For AF input stages and driver applications
- High current gain
- Low collector-emitter saturation voltage
- Low noise between 30 Hz and 15 kHz
- Complementary types:
  BC857...-BC860...(PNP)
- Pb-free (RoHS compliant) package
- Qualified according AEC Q101[1)]



[1]BC847BL3 is not qualified according AEC Q101

Type	Marking	Pin Configuration						Package
BC847A	1Es	1=B	2=E	3=C	-	-	-	SOT23
BC847B	1Fs	1=B	2=E	3=C	-	-	-	SOT23
BC847BL3*	1F	1=B	2=E	3=C	-	-	-	TSLP-3-1
BC847BW	1Fs	1=B	2=E	3=C	-	-	-	SOT323
BC847C	1Gs	1=B	2=E	3=C	-	-	-	SOT23
BC847CW	1Gs	1=B	2=E	3=C	-	-	-	SOT323
BC848A	1Js	1=B	2=E	3=C	-	-	-	SOT23
BC848B	1Ks	1=B	2=E	3=C	-	-	-	SOT23
BC848BL3	1K	1=B	2=E	3=C	-	-	-	TSLP-3-1
BC848BW	1Ks	1=B	2=E	3=C	-	-	-	SOT323
BC848C	1Ls	1=B	2=E	3=C	-	-	-	SOT23
BC848CW	1Ls	1=B	2=E	3=C	-	-	-	SOT323
BC849B	2Bs	1=B	2=E	3=C	-	-	-	SOT23
BC849C	2Cs	1=B	2=E	3=C	-	-	-	SOT23
BC849CW	2Cs	1=B	2=E	3=C	-	-	-	SOT323
BC850B	2Fs	1=B	2=E	3=C	-	-	-	SOT23
BC850BW	2Fs	1=B	2=E	3=C	-	-	-	SOT323
BC850C	2Gs	1=B	2=E	3=C	-	-	-	SOT23
BC850CW	2Gs	1=B	2=E	3=C	-	-	-	SOT323

* Not qualified according AEC Q101

1 2011-09-09

BC847...-BC850...

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CEO}		V
BC847..., BC850...		45	
BC848..., BC849...		30	
Collector-emitter voltage	V_{CES}		
BC847..., BC850...		50	
BC848..., BC849...		30	
Collector-base voltage	V_{CBO}		
BC847..., BC850...		50	
BC848..., BC849...		30	
Emitter-base voltage	V_{EBO}		
BC847..., BC850...		6	
BC848..., BC849...		6	
Collector current	I_C	100	mA
Peak collector current, $t_p \leq 10$ ms	I_{CM}	200	
Total power dissipation-	P_{tot}		mW
$T_S \leq 71$ °C, BC847-BC850		330	
$T_S \leq 135$ °C, BC847BL3-BC848BL3		250	
$T_S \leq 124$ °C, BC847W-BC850W		250	
Junction temperature	T_j	150	°C
Storage temperature	T_{stg}	-65 ... 150	

Thermal Resistance

Parameter	Symbol	Value	Unit
Junction - soldering point[1)]	R_{thJS}		K/W
BC847-BC850		≤ 240	
BC847BL3-BC848BL3		≤ 60	
BC847W-BC850W		≤ 105	

[1]For calculation of R_{thJA} please refer to Application Note AN077 (Thermal Resistance Calculation)

2 2011-09-09

BC847...-BC850...

Electrical Characteristics at T_A = 25°C, unless otherwise specified

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
DC Characteristics					
Collector-emitter breakdown voltage	$V_{(BR)CEO}$				V
I_C = 10 mA, I_B = 0 , BC847..., BC850...		45	-	-	
I_C = 10 mA, I_B = 0 , BC848..., BC849...		30	-	-	
Collector-base breakdown voltage	$V_{(BR)CBO}$				
I_C = 10 µA, I_E = 0 , BC847..., BC850...		50	-	-	
I_C = 10 µA, I_E = 0 , BC848..., BC849...		30	-	-	
Emitter-base breakdown voltage	$V_{(BR)EBO}$	-	6	-	
I_E = 0 , I_C = 10 µA					
Collector-base cutoff current	I_{CBO}				µA
V_{CB} = 45 V, I_E = 0		-	0.015	-	
V_{CB} = 30 V, I_E = 0 , T_A = 150 °C		-	5	-	
DC current gain[1]	h_{FE}				-
I_C = 10 µA, V_{CE} = 5 V, h_{FE}-grp.A		-	140	-	
I_C = 10 µA, V_{CE} = 5 V, h_{FE}-grp.B		-	250	-	
I_C = 10 µA, V_{CE} = 5 V, h_{FE}-grp.C		-	480	-	
I_C = 2 mA, V_{CE} = 5 V, h_{FE}-grp.A		110	180	220	
I_C = 2 mA, V_{CE} = 5 V, h_{FE}-grp.B		200	290	450	
I_C = 2 mA, V_{CE} = 5 V, h_{FE}-grp.C		420	520	800	
Collector-emitter saturation voltage[1]	V_{CEsat}				mV
I_C = 10 mA, I_B = 0.5 mA		-	90	250	
I_C = 100 mA, I_B = 5 mA		-	200	600	
Base emitter saturation voltage[1]	V_{BEsat}				
I_C = 10 mA, I_B = 0.5 mA		-	700	-	
I_C = 100 mA, I_B = 5 mA		-	900	-	
Base-emitter voltage[1]	$V_{BE(ON)}$				
I_C = 2 mA, V_{CE} = 5 V		580	660	700	
I_C = 10 mA, V_{CE} = 5 V		-	-	770	

[1]Pulse test: t < 300µs; D < 2%

esa

BC847...-BC850...

Electrical Characteristics at T_A = 25°C, unless otherwise specified

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
AC Characteristics					
Transition frequency I_C = 10 mA, V_{CE} = 5 V, f = 100 MHz	f_T	-	250	-	MHz
Collector-base capacitance V_{CB} = 10 V, f = 1 MHz	C_{cb}	-	0.95	-	pF
Emitter-base capacitance V_{EB} = 0.5 V, f = 1 MHz	C_{eb}	-	9	-	
Short-circuit input impedance	h_{11e}				kΩ
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.A		-	2.7	-	
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.B		-	4.5	-	
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.C		-	8.7	-	
Open-circuit reverse voltage transf. ratio	h_{12e}				10^{-4}
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.A		-	1.5	-	
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.B		-	2	-	
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.C		-	3	-	
Short-circuit forward current transf. ratio	h_{21e}				
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.A		-	200	-	
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.B		-	330	-	
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.C		-	600	-	
Open-circuit output admittance	h_{22e}				µS
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.A		-	18	-	
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.B		-	30	-	
I_C = 2 mA, V_{CE} = 5 V, f = 1 kHz, h_{FE}-grp.C		-	60	-	
Noise figure I_C = 200 µA, V_{CE} = 5 V, f = 1 kHz, Δf = 200 Hz, R_S = 2 kΩ, BC849..., BC850...	F	-	1.2	4	dB
Equivalent noise voltage I_C = 200 µA, V_{CE} = 5 V, R_S = 2 kΩ, f = 10 ... 50 Hz , BC850...	V_n	-	-	0.135	µV

4 2011-09-09