TOTAL IONIZING DOSE Test Report

BC857BLT1G - 100mA PNP Transistor from ON-Semiconductor

Prepared by **Florian Krimmel**

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

European Space Agency
Agence spatiale européenne

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

This report presents the total ionizing dose results of **BC857BLT1G** a **100mA PNP Transistor from ON-Semiconductor**.

2 DOCUMENTS

APPLICABLE AND REFERENCE DOCUMENTS
BJTs COTS TID test plan
Datasheet **BC857** from ON-Semiconductor

3 PART REFERENCES

REFERENCES	
Type:	BC857BLT1G
Manufacturer:	ON-Semiconductor
Function:	100 mA general-purpose transistors
Technology:	Bipolar PNP Silicon
PARTS PROCUREMENT	
Packaging:	SOT23 (TO-236AB)
Date Code:	batch no. 29: Dec even years batch no. 30: Feb odd years batch no. 32: Nov even years
Distributor:	batch no. 29: Farnell batch no. 30: RS Components batch no. 32: Mouser
Number of Parts: 3 x 10 irradiated and 3 x 1 ref	

4 DOSIMETRY AND IRRADIATION FACILITY

IRRADIATION FACILITY	
Source:	C060
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
VCEo(BR), VCBo(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

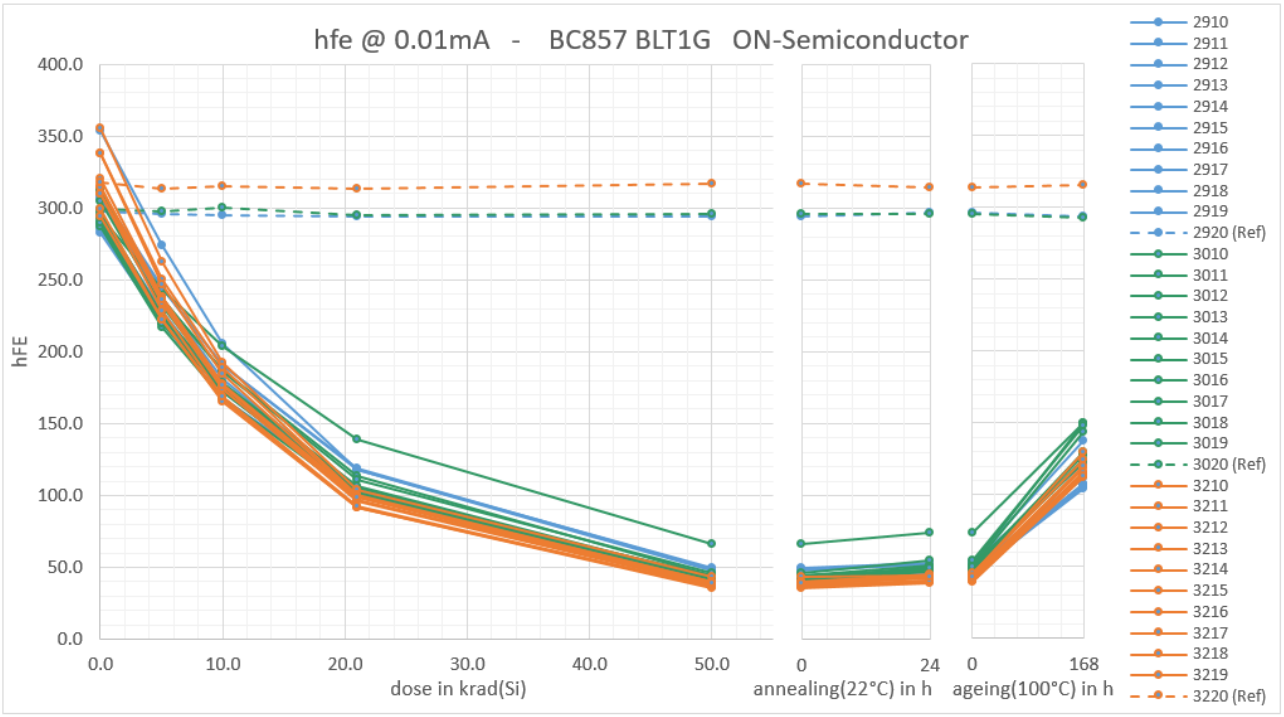
PARAMETERS	SYMBOLS	TEST CONDITIONS
Forward Current Transfer Ratio	hfe1	Ic= 0.01mA, Vce = 1V
	hfe2	Ic= 0.1mA, Vce = 1V
	hfe3	Ic= 1mA, Vce = 1V
	hfe4	Ic= 10mA, Vce = 1V
	hfe5	Ic= 100mA, Vce = 1V
Collector-Emitter Breakdown Voltage	VCEo (BR)	Ic = 10mA
Collector-Base Breakdown Voltage	VCBo (BR)	Ic = 10uA
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

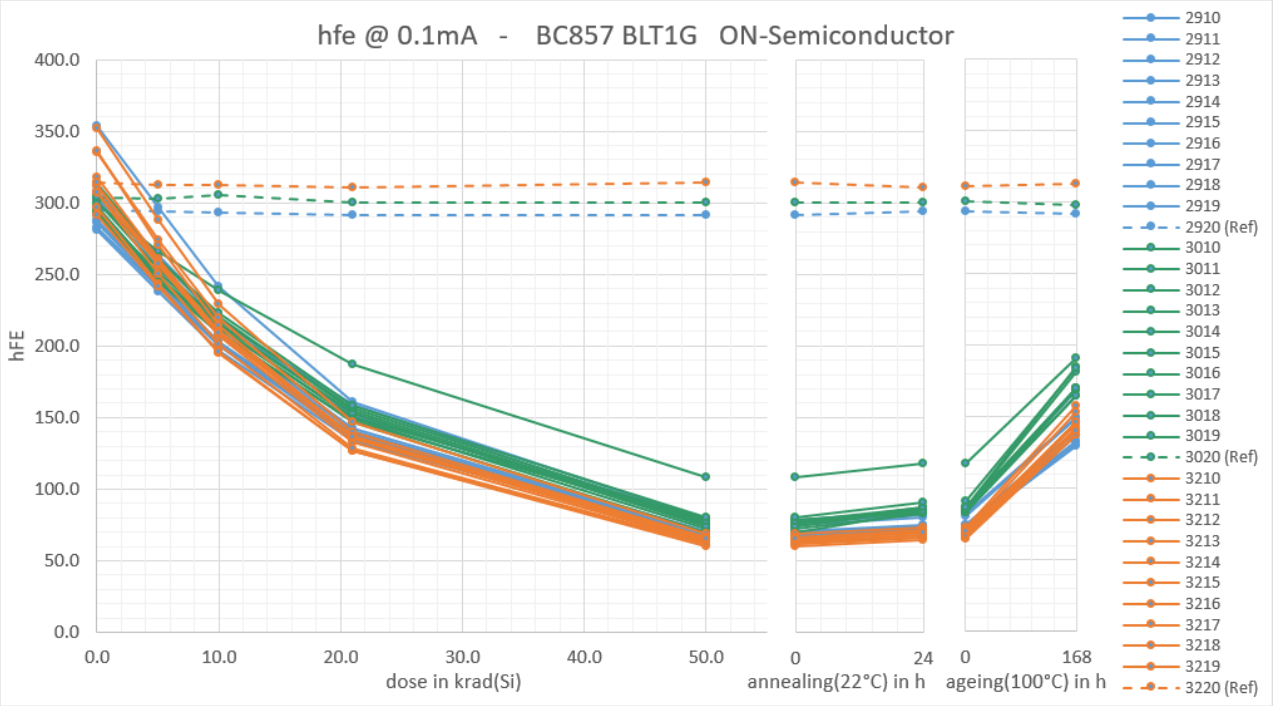


hfe @ 0.01mA	BC857 BLT1G ON-Semiconductor Farnell Dec. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2910	353.9	274.3	205.7	118.0	49.9	53.4	138.1
2911	306.8	244.2	190.9	118.9	48.7	52.3	122.1
2912	305.0	235.5	177.8	103.2	42.3	46.8	112.4
2913	288.2	224.2	172.6	102.4	42.0	45.7	108.1
2914	290.4	225.6	173.2	101.9	41.8	45.9	106.8
2915	308.8	237.2	181.3	104.8	42.8	46.9	114.2
2916	294.2	228.7	174.1	102.4	41.9	45.8	112.0
2917	311.1	244.6	190.9	118.0	47.9	52.1	122.5
2918	284.8	222.4	173.8	100.8	41.4	45.1	104.9
2919	283.0	220.5	168.2	102.7	40.9	44.7	104.4
2920 (Ref)	297.6	296.1	295.3	293.9	294.0	296.4	294.1
Average	302.62	235.71	180.85	107.32	43.97	47.86	114.55
s	20.788	16.101	11.591	7.665	3.435	3.333	10.444
Average+3s	364.99	284.01	215.63	130.31	54.28	57.86	145.88
Average-3s	240.26	187.40	146.08	84.32	33.67	37.86	83.22

hfe @ 0.01mA	BC857 BLT1G ON-Semiconductor RS Feb. odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3010	289.9	219.4	176.0	101.9	39.8	47.7	128.3
3011	287.4	216.8	168.2	99.3	43.2	47.4	124.7
3012	304.9	231.5	177.8	105.7	41.7	50.3	143.8
3013	312.8	236.3	187.0	113.7	44.4	51.5	149.8
3014	293.0	220.7	172.6	101.3	44.2	48.6	129.8
3015	289.7	224.1	175.2	103.5	40.9	49.4	128.3
3016	293.2	219.1	173.4	99.7	37.5	48.3	123.0
3017	293.8	242.9	203.8	138.8	66.1	74.0	150.1
3018	296.3	225.6	178.8	106.6	42.9	49.9	127.9
3019	312.2	236.7	186.1	110.9	45.9	54.6	148.5
3020 (Ref)	299.5	297.8	300.4	294.9	295.6	295.6	293.0
Average	297.32	227.33	179.88	108.15	44.67	52.18	135.42
s	9.291	9.003	10.197	11.743	7.928	7.943	11.173
Average+3s	325.20	254.34	210.48	143.38	68.45	76.01	168.93
Average-3s	269.45	200.32	149.29	72.93	20.88	28.35	101.90

hfe @ 0.01mA	BC857 BLT1G ON-Semiconductor Mouser Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3210	315.3	233.6	173.6	95.7	37.2	41.3	114.8
3211	299.5	222.0	166.7	91.3	35.5	39.4	112.5
3212	320.0	238.2	176.5	97.2	38.3	42.9	118.7
3213	355.6	262.7	192.0	104.2	43.4	44.7	129.7
3214	313.7	238.2	177.8	99.5	39.9	44.0	119.7
3215	294.3	222.2	165.0	91.9	36.4	40.2	113.1
3216	309.6	228.5	168.4	92.4	36.4	40.2	115.0
3217	337.9	250.2	188.6	100.5	39.6	45.7	124.7
3218	337.9	246.5	184.4	99.8	37.5	41.0	115.5
3219	309.6	236.2	176.4	99.0	39.3	43.3	113.5
3220 (Ref)	317.5	313.6	314.9	313.3	317.1	313.9	315.7
Average	319.34	237.84	176.93	97.15	38.36	42.26	117.71
s	19.052	12.699	9.136	4.261	2.313	2.135	5.635
Average+3s	376.49	275.94	204.34	109.93	45.30	48.66	134.61
Average-3s	262.18	199.75	149.52	84.37	31.42	35.85	100.81

8.2 hfe @ 0.1 mA

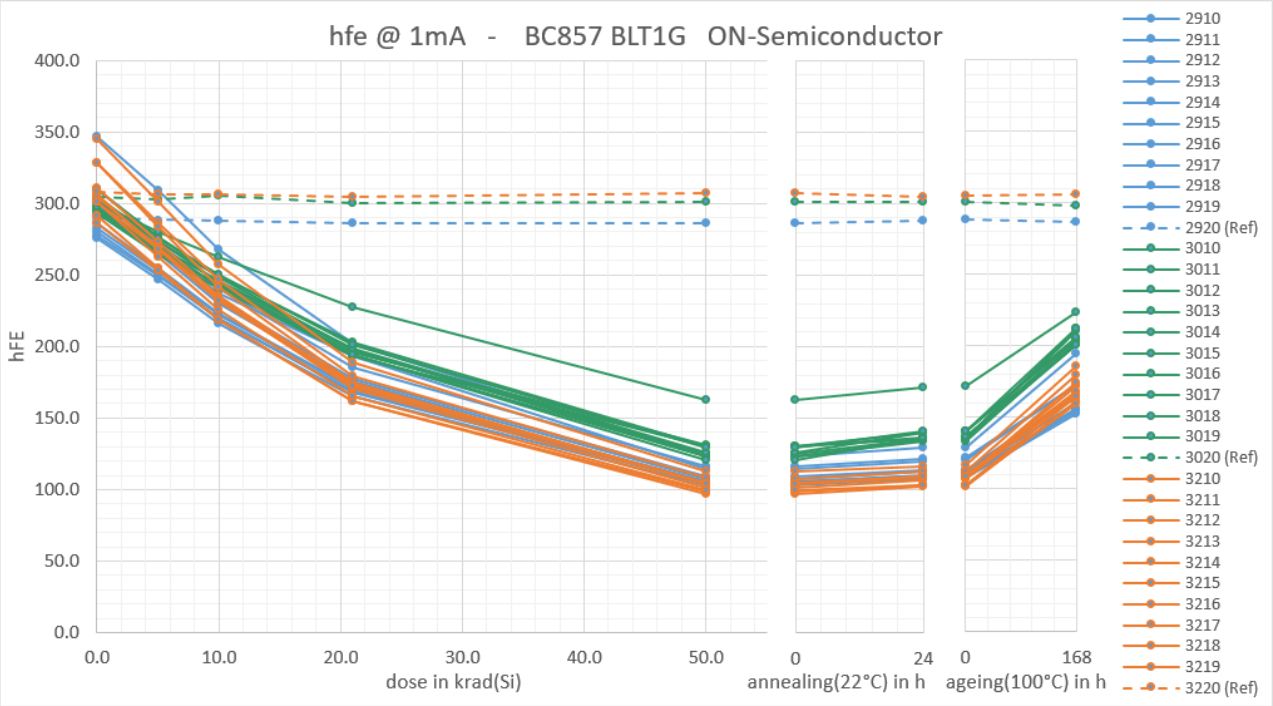


hfe @ 0.1mA	BC857 BLT1G ON-Semiconductor Farnell Dec. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2910	353.4	297.0	241.3	160.9	78.9	84.8	167.9
2911	304.4	261.9	217.4	159.0	75.3	80.5	149.1
2912	302.7	254.9	208.5	140.8	69.5	74.3	139.5
2913	285.7	241.7	200.9	137.3	68.6	73.0	133.3
2914	288.1	243.7	202.0	137.7	68.5	73.0	132.5
2915	306.2	257.1	210.8	142.2	70.3	74.9	141.0
2916	291.6	245.9	203.1	138.5	68.8	73.1	137.1
2917	308.2	263.2	220.0	151.3	76.4	82.3	149.5
2918	282.7	240.4	200.2	135.5	67.9	72.3	130.9
2919	280.8	238.2	196.8	133.8	66.9	71.5	129.8
2920 (Ref)	295.0	293.8	293.5	291.4	291.5	293.8	292.0
Average	300.38	254.41	210.09	143.70	71.13	75.96	141.05
s	21.239	17.529	13.346	9.802	4.167	4.726	11.749
Average+3s	364.09	307.00	250.13	173.10	83.63	90.14	176.30
Average-3s	236.66	201.83	170.05	114.29	58.62	61.79	105.80

hfe @ 0.1mA	BC857 BLT1G ON-Semiconductor RS Feb. odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3010	293.9	246.6	213.6	149.8	72.5	83.0	168.8
3011	292.1	245.1	208.8	147.6	77.8	83.5	164.6
3012	306.4	257.3	215.6	153.3	74.1	85.7	181.2
3013	313.5	260.9	220.7	154.5	75.8	86.9	185.2
3014	296.7	248.2	212.9	150.3	78.9	84.9	170.2
3015	294.3	251.3	215.1	152.6	74.4	86.6	170.0
3016	297.5	248.1	210.2	146.8	69.6	84.7	165.0
3017	299.1	265.6	238.8	187.3	108.6	117.5	191.4
3018	301.2	253.8	219.1	156.6	77.3	87.0	170.5
3019	313.1	260.4	222.7	158.2	80.0	91.2	184.4
3020 (Ref)	304.0	302.6	305.2	299.8	300.5	300.6	298.1
Average	300.78	253.74	217.75	155.70	78.91	89.11	175.12
s	7.735	7.009	8.606	11.699	10.887	10.250	9.520
Average+3s	323.98	274.77	243.57	190.80	111.57	119.86	203.68
Average-3s	277.57	232.72	191.94	120.61	46.24	58.36	146.56

hfe @ 0.1mA	BC857 BLT1G ON-Semiconductor Mouser Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3210	312.8	256.1	207.3	132.9	62.7	67.8	142.0
3211	296.9	243.5	194.9	126.3	60.1	64.8	137.6
3212	317.3	260.8	209.8	135.6	64.5	69.5	146.3
3213	352.2	287.5	229.3	146.5	69.2	73.0	157.6
3214	311.1	258.7	210.4	137.4	66.1	70.6	144.3
3215	291.8	241.6	195.9	127.0	61.6	65.9	137.2
3216	307.3	250.6	201.1	128.8	61.7	65.9	141.1
3217	334.8	273.7	219.9	140.0	66.5	71.4	153.2
3218	335.7	270.4	214.3	135.4	63.5	67.7	146.2
3219	307.1	257.2	208.8	136.3	65.5	70.1	140.2
3220 (Ref)	314.5	312.4	312.3	310.5	314.1	311.1	313.0
Average	316.70	260.01	209.17	134.63	64.14	68.68	144.57
s	18.832	14.053	10.525	6.202	2.748	2.674	6.592
Average+3s	373.19	302.17	240.75	153.24	72.38	76.71	164.35
Average-3s	260.20	217.85	177.60	116.03	55.89	60.66	124.80

8.3 hfe @ 1 mA

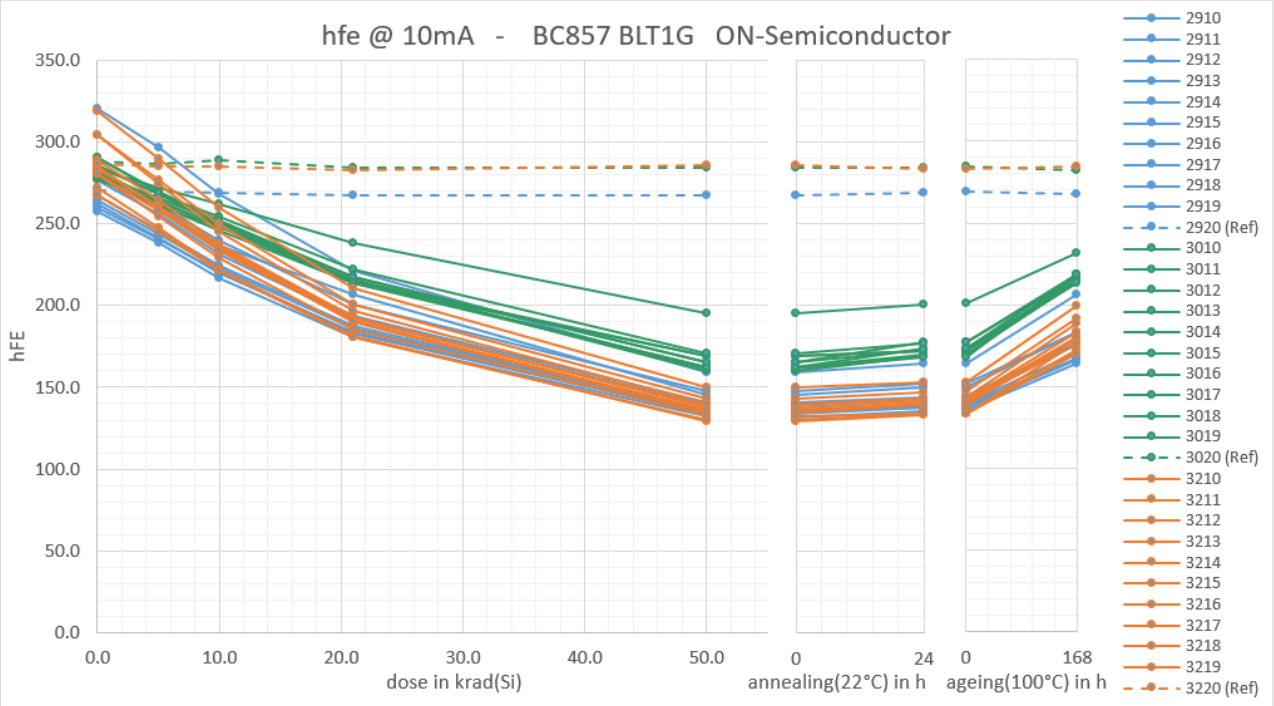


hfe @ 1mA	BC857 BLT1G ON-Semiconductor Farnell Dec. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2910	346.1	309.0	267.6	201.6	123.1	129.2	194.9
2911	298.4	270.7	237.2	193.4	114.4	119.7	172.5
2912	296.8	264.8	230.2	175.7	107.8	112.5	163.9
2913	280.3	250.0	219.7	169.2	105.2	109.4	156.1
2914	282.6	252.6	221.9	170.4	105.3	109.6	155.8
2915	300.4	267.4	232.8	177.1	108.9	113.4	165.3
2916	286.1	254.8	223.1	171.4	105.9	110.1	160.1
2917	302.1	271.7	240.5	185.1	116.1	121.9	173.0
2918	277.4	249.1	219.7	167.7	104.5	109.0	154.4
2919	275.5	246.8	215.9	165.4	102.9	107.5	152.8
2920 (Ref)	289.5	288.3	288.0	285.7	286.0	288.1	286.4
Average	294.58	263.69	230.85	177.69	109.40	114.24	164.88
s	20.674	18.460	15.288	12.002	6.457	7.077	12.747
Average+3s	356.60	319.07	276.72	213.70	128.78	135.47	203.12
Average-3s	232.56	208.31	184.99	141.69	90.03	93.01	126.64

hfe @ 1mA	BC857 BLT1G ON-Semiconductor RS Feb. odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3010	293.9	264.7	243.4	194.3	122.8	133.6	202.4
3011	292.9	264.2	240.3	193.4	129.8	135.1	200.5
3012	304.2	274.2	245.1	197.5	122.9	134.9	210.2
3013	310.0	276.6	248.9	197.6	124.9	135.1	212.3
3014	296.4	267.0	243.6	196.0	130.6	136.1	204.0
3015	294.7	269.7	245.5	198.5	125.9	140.2	205.2
3016	297.9	267.5	242.0	194.5	120.9	136.4	200.9
3017	299.8	279.6	262.8	227.2	163.0	171.6	223.5
3018	301.6	272.6	249.7	202.9	130.5	140.0	206.3
3019	309.9	275.9	249.9	201.2	129.4	140.5	211.7
3020 (Ref)	304.4	303.0	305.7	300.1	300.9	300.8	298.5
Average	300.13	271.21	247.12	200.32	130.07	140.35	207.71
s	6.248	5.352	6.400	9.901	12.102	11.271	7.010
Average+3s	318.88	287.27	266.32	230.02	166.37	174.16	228.74
Average-3s	281.39	255.16	227.92	170.61	93.76	106.54	186.68

hfe @ 1mA	BC857 BLT1G ON-Semiconductor Mouser Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3210	306.5	268.0	232.5	170.3	101.5	106.6	166.8
3211	291.4	254.7	218.3	161.9	97.1	102.1	161.0
3212	311.0	273.0	235.1	173.5	104.1	108.8	171.5
3213	344.4	300.9	257.5	189.1	112.6	116.2	186.3
3214	304.9	269.8	234.0	173.9	105.1	109.5	168.7
3215	286.1	252.5	218.6	161.8	98.2	102.9	159.5
3216	301.1	262.6	225.7	165.5	99.6	102.9	165.1
3217	327.8	286.4	246.4	179.4	107.9	112.5	179.3
3218	328.5	283.9	241.5	175.1	104.3	108.4	174.8
3219	301.0	267.9	232.1	172.3	103.9	108.8	164.4
3220 (Ref)	308.1	306.3	306.1	304.1	307.4	304.6	306.4
Average	310.27	271.97	234.16	172.28	103.44	107.86	169.73
s	18.143	14.877	12.124	8.268	4.618	4.476	8.400
Average+3s	364.70	316.60	270.53	197.08	117.30	121.28	194.93
Average-3s	255.84	227.34	197.78	147.47	89.59	94.43	144.53

8.4 hfe @ 10 mA

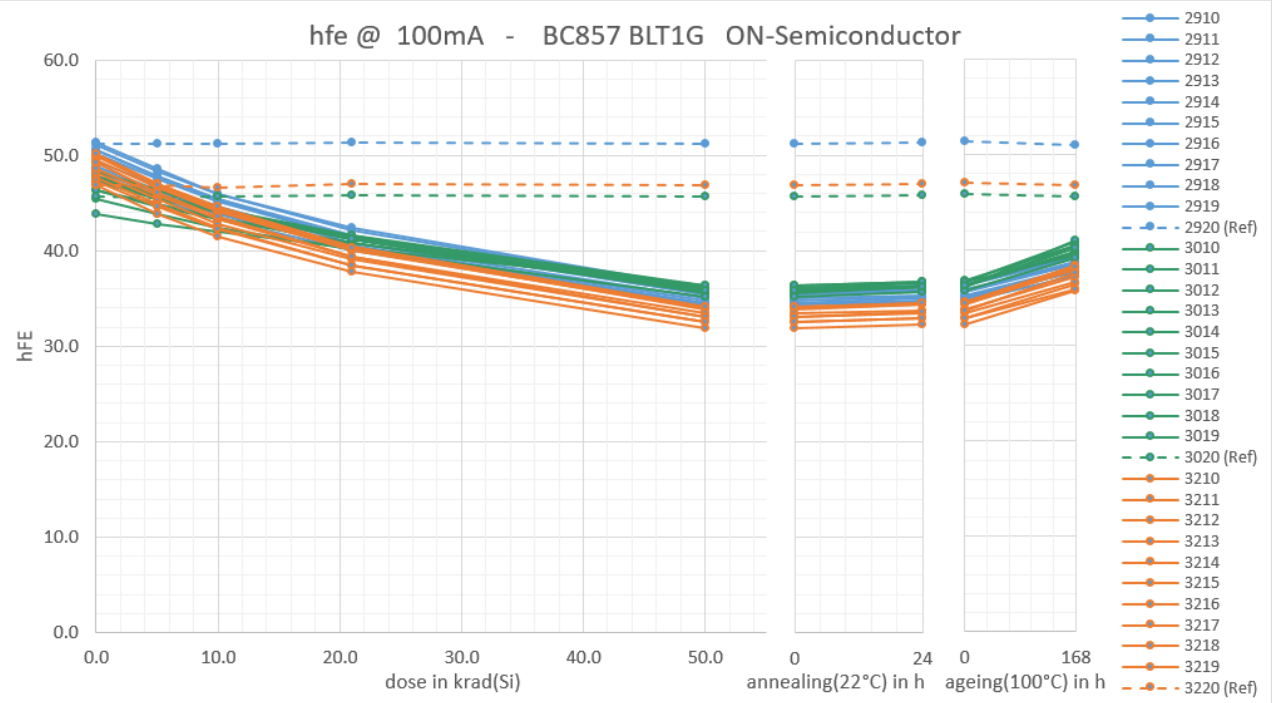


hfe @ 10mA	BC857 BLT1G ON-Semiconductor Farnell Dec. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2910	320.4	296.4	268.0	220.9	159.2	164.2	206.6
2911	278.4	260.4	236.7	206.7	145.4	149.6	183.2
2912	276.5	255.3	231.2	192.4	139.0	142.9	175.9
2913	261.7	240.9	219.8	183.8	134.3	137.6	167.4
2914	263.9	243.7	222.4	185.8	135.1	138.5	167.6
2915	279.9	257.9	233.8	193.8	140.5	144.0	177.3
2916	267.1	246.0	223.9	187.1	136.1	139.4	171.4
2917	281.9	261.3	239.9	200.3	147.3	152.0	183.6
2918	259.3	240.5	220.1	182.9	134.0	137.6	166.2
2919	257.5	238.3	216.7	180.5	131.9	135.7	164.5
2920 (Ref)	270.2	269.4	269.1	267.2	267.4	269.1	267.6
Average	274.66	254.08	231.25	193.42	140.28	144.15	176.39
s	18.435	17.271	15.135	12.683	8.340	8.865	12.662
Average+3s	329.96	305.89	276.66	231.47	165.30	170.74	214.37
Average-3s	219.35	202.27	185.85	155.38	115.26	117.55	138.40

hfe @ 10mA	BC857 BLT1G ON-Semiconductor RS Feb. odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3010	277.7	260.6	247.8	213.4	161.9	169.8	213.8
3011	277.4	260.8	245.5	213.2	168.8	171.9	213.2
3012	285.4	268.3	248.5	215.6	160.3	169.2	218.0
3013	290.1	269.8	251.5	214.9	161.3	168.3	218.8
3014	280.1	262.9	248.4	215.2	169.0	172.3	215.2
3015	278.9	265.3	250.0	217.6	165.6	177.4	217.1
3016	281.7	264.2	247.9	215.3	162.0	173.4	213.7
3017	283.4	271.9	261.6	238.0	194.9	200.8	231.3
3018	284.9	268.1	253.9	221.8	170.6	177.0	218.5
3019	290.0	268.8	251.8	217.6	165.5	173.1	218.2
3020 (Ref)	287.6	286.4	288.5	283.9	284.5	284.4	282.4
Average	282.95	266.07	250.70	218.27	167.98	175.31	217.78
s	4.658	3.878	4.512	7.364	10.120	9.428	5.216
Average+3s	296.92	277.70	264.24	240.37	198.33	203.60	233.43
Average-3s	268.98	254.43	237.16	196.18	137.62	147.03	202.13

hfe @ 10mA	BC857 BLT1G ON-Semiconductor Mouser Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3210	285.1	259.2	235.2	190.0	134.9	139.2	179.1
3211	271.7	247.0	221.9	181.1	129.1	133.5	172.7
3212	289.0	263.8	237.5	193.1	138.0	141.7	183.5
3213	318.4	289.5	259.8	210.7	149.9	152.9	199.5
3214	283.6	260.1	235.5	192.1	138.1	141.4	180.4
3215	267.3	245.0	221.5	180.4	130.0	133.7	170.7
3216	280.1	254.3	229.0	185.3	132.7	133.7	177.0
3217	303.8	276.3	249.2	200.2	143.2	146.9	191.5
3218	304.3	274.3	245.0	196.6	139.8	143.2	188.4
3219	280.0	258.2	233.3	190.2	136.4	140.3	176.3
3220 (Ref)	286.3	284.8	284.6	282.9	285.6	283.3	284.7
Average	288.33	262.78	236.79	191.96	137.20	140.63	181.90
s	15.927	13.773	11.952	9.085	6.233	6.222	8.965
Average+3s	336.11	304.10	272.65	219.22	155.89	159.30	208.80
Average-3s	240.55	221.46	200.94	164.71	118.50	121.97	155.01

8.5 hfe @ 100 mA

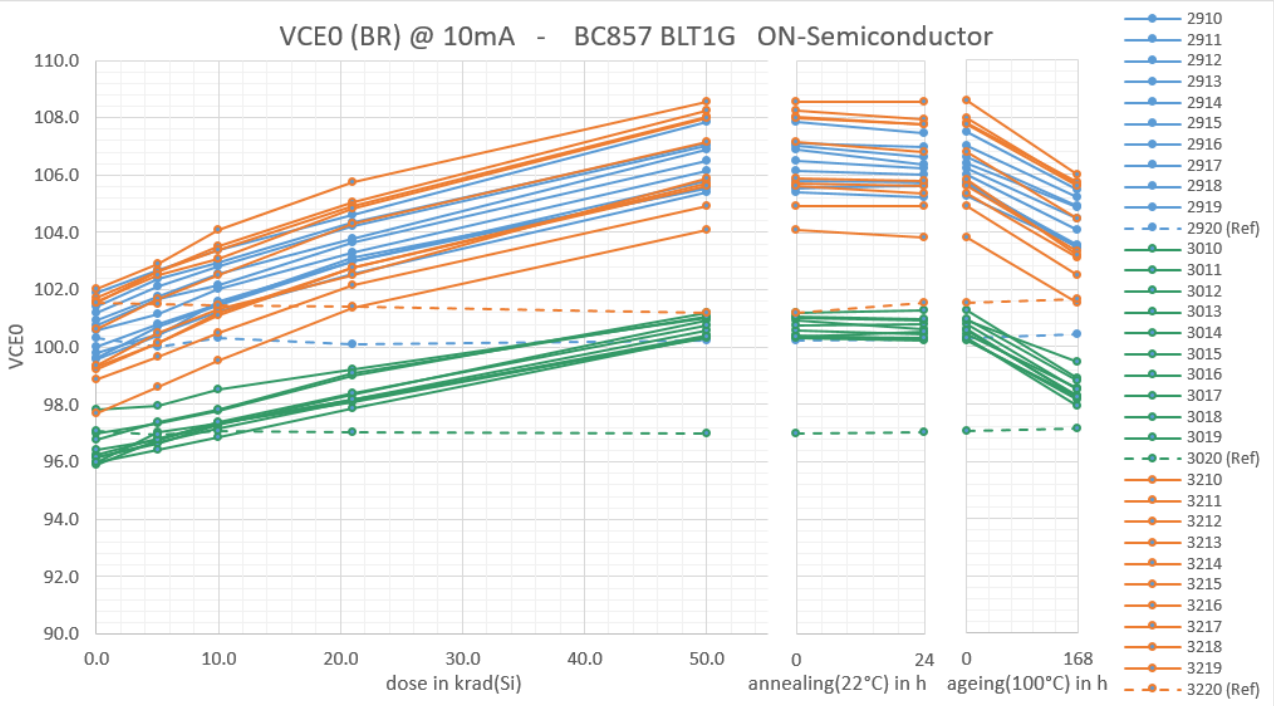


hfe @ 100mA	BC857 BLT1G ON-Semiconductor Farnell Dec. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2910	48.6	46.1	43.8	40.3	34.4	34.7	38.2
2911	47.8	45.5	43.3	40.0	34.4	34.6	37.4
2912	50.5	47.8	45.4	41.2	35.4	35.8	38.8
2913	48.8	46.4	44.1	40.4	34.6	35.0	37.8
2914	50.5	47.8	45.5	41.7	35.6	36.0	38.5
2915	51.3	48.6	46.0	42.4	36.0	36.4	39.3
2916	50.1	47.5	45.2	41.3	35.4	35.6	38.5
2917	48.4	46.0	44.0	40.5	34.8	35.2	37.7
2918	49.4	46.9	44.6	40.8	35.0	35.3	38.1
2919	51.0	48.4	46.0	42.1	36.0	36.3	39.2
2920 (Ref)	51.1	51.1	51.1	51.4	51.1	51.4	51.0
Average	49.64	47.08	44.77	41.08	35.15	35.49	38.35
s	1.208	1.077	0.938	0.791	0.613	0.625	0.649
Average+3s	53.26	50.31	47.59	43.45	36.99	37.36	40.30
Average-3s	46.02	43.85	41.96	38.71	33.31	33.61	36.41

hfe @ 100mA	BC857 BLT1G ON-Semiconductor RS Feb. odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3010	47.4	45.8	44.2	41.5	36.2	36.7	40.9
3011	46.4	44.9	43.4	40.8	35.9	36.3	39.7
3012	47.8	45.8	44.1	41.2	35.6	36.2	40.5
3013	48.2	46.3	44.4	41.2	35.7	36.2	41.0
3014	47.5	45.7	44.4	41.7	36.4	36.8	40.5
3015	46.3	44.6	43.3	40.8	35.8	36.3	39.8
3016	47.2	45.5	44.1	41.2	36.1	36.3	39.9
3017	43.8	42.8	42.0	40.3	36.4	36.7	39.5
3018	45.4	43.9	42.4	40.1	35.2	35.7	39.2
3019	47.8	45.9	44.1	41.2	35.8	36.3	40.3
3020 (Ref)	45.7	45.6	45.7	45.9	45.7	45.9	45.6
Average	46.77	45.09	43.64	41.01	35.90	36.35	40.13
s	1.353	1.074	0.834	0.505	0.372	0.318	0.611
Average+3s	50.83	48.32	46.14	42.52	37.02	37.31	41.96
Average-3s	42.71	41.87	41.13	39.49	34.78	35.40	38.29

hfe @ 100mA	BC857 BLT1G ON-Semiconductor Mouser Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3210	49.9	46.8	44.3	40.2	33.9	34.4	38.0
3211	47.7	44.9	42.4	38.5	32.5	32.9	36.5
3212	49.5	46.6	44.1	40.0	33.9	34.3	38.0
3213	50.0	47.0	44.4	40.4	34.1	34.6	38.4
3214	48.1	45.4	42.8	39.0	33.1	33.4	36.7
3215	48.6	45.9	43.3	39.3	33.4	33.8	37.3
3216	46.8	43.9	41.5	37.8	31.9	32.3	35.7
3217	50.1	47.0	44.6	40.4	34.2	34.5	38.2
3218	49.2	46.1	43.5	39.3	33.1	33.6	37.5
3219	47.2	44.7	42.3	38.5	32.6	32.9	35.9
3220 (Ref)	46.8	46.8	46.6	47.0	46.9	47.0	46.8
Average	48.72	45.82	43.31	39.33	33.28	33.67	37.22
s	1.209	1.090	1.038	0.903	0.760	0.793	0.968
Average+3s	52.35	49.09	46.43	42.04	35.56	36.05	40.12
Average-3s	45.09	42.55	40.20	36.62	31.00	31.29	34.31

8.6 VCEo (BR) @ 10mA

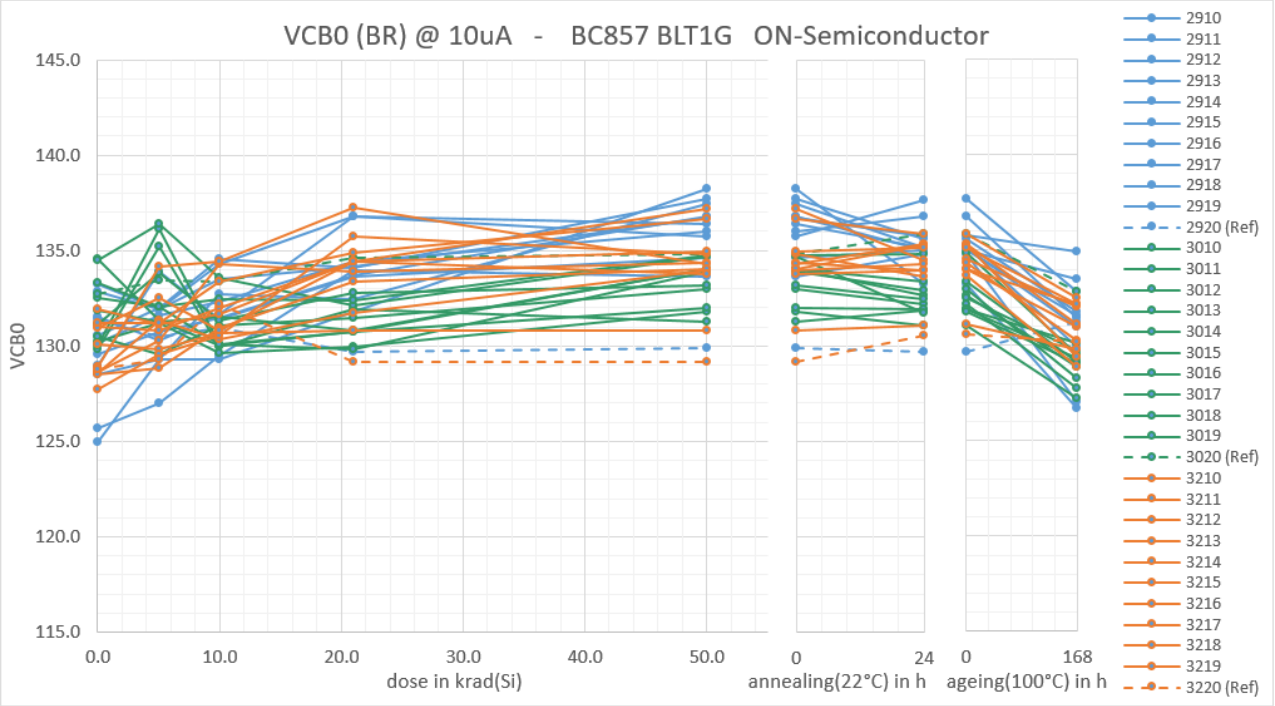


VCE0 (BR) @ 10mA	BC857 BLT1G ON-Semiconductor Farnell Dec. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2910	99.6	100.7	101.4	103.0	105.8	105.7	103.5
2911	101.9	102.7	103.4	104.6	107.8	107.5	105.5
2912	99.6	100.4	101.6	103.0	105.6	105.6	103.5
2913	101.2	102.1	102.8	104.2	107.0	106.6	104.9
2914	100.6	101.1	102.0	103.3	106.1	106.0	104.0
2915	99.8	100.4	101.3	102.6	105.4	105.2	103.5
2916	100.8	101.7	102.1	103.6	106.5	106.2	104.5
2917	101.4	102.4	103.0	104.4	107.1	107.0	105.2
2918	100.9	101.8	102.5	103.8	106.9	106.4	104.9
2919	100.0	100.8	101.5	103.1	105.6	105.6	103.5
2920 (Ref)	100.3	100.0	100.3	100.1	100.2	100.3	100.4
Average	100.58	101.41	102.16	103.56	106.38	106.19	104.29
s	0.800	0.824	0.729	0.674	0.817	0.687	0.791
Average+3s	102.98	103.88	104.35	105.58	108.83	108.26	106.67
Average-3s	98.17	98.94	99.98	101.54	103.93	104.13	101.92

VCE0 (BR) @ 10mA BC857 BLT1G ON-Semiconductor RS Feb. odd years							
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3010	96.1	96.7	97.2	98.1	100.4	100.3	98.2
3011	96.3	96.8	97.4	98.2	100.6	100.4	98.5
3012	96.2	96.7	97.3	98.3	100.9	100.6	98.3
3013	96.0	97.0	97.4	98.1	100.4	100.6	98.3
3014	95.9	96.8	97.3	98.2	100.3	100.2	98.2
3015	97.0	97.3	97.8	99.0	101.2	101.3	98.9
3016	96.4	96.8	97.4	98.4	100.8	100.8	98.5
3017	97.8	98.0	98.5	99.2	101.0	100.9	99.5
3018	96.8	97.4	97.8	99.1	101.1	101.0	98.8
3019	96.0	96.4	96.9	97.9	100.4	100.3	97.9
3020 (Ref)	97.1	96.9	97.1	97.0	97.0	97.0	97.2
Average	96.44	96.98	97.49	98.44	100.70	100.64	98.51
s	0.596	0.453	0.458	0.474	0.336	0.349	0.454
Average+3s	98.23	98.34	98.87	99.87	101.71	101.68	99.87
Average-3s	94.65	95.63	96.12	97.02	99.70	99.59	97.15

VCE0 (BR) @ 10mA BC857 BLT1G ON-Semiconductor Mouser Nov. even years							
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3210	99.3	100.1	101.2	102.8	105.7	105.6	103.3
3211	101.7	102.6	103.5	105.1	108.2	108.0	105.6
3212	99.2	100.1	101.1	102.8	105.6	105.4	103.1
3213	97.7	98.6	99.6	101.4	104.1	103.8	101.5
3214	100.6	101.7	102.5	104.3	107.2	106.8	104.5
3215	101.6	102.6	103.4	104.9	108.0	107.8	105.7
3216	102.0	102.9	104.1	105.8	108.5	108.6	106.0
3217	98.9	99.7	100.5	102.2	104.9	104.9	102.5
3218	99.4	100.5	101.3	102.5	105.9	105.8	103.2
3219	101.6	102.5	103.1	104.8	108.0	107.8	105.6
3220 (Ref)	101.6	101.5	101.4	101.4	101.2	101.5	101.6
Average	100.20	101.14	102.03	103.65	106.62	106.44	104.11
s	1.489	1.516	1.499	1.500	1.569	1.559	1.584
Average+3s	104.67	105.68	106.53	108.15	111.33	111.11	108.86
Average-3s	95.73	96.59	97.54	99.15	101.92	101.76	99.36

8.7 VCB0 (BR) @ 10uA

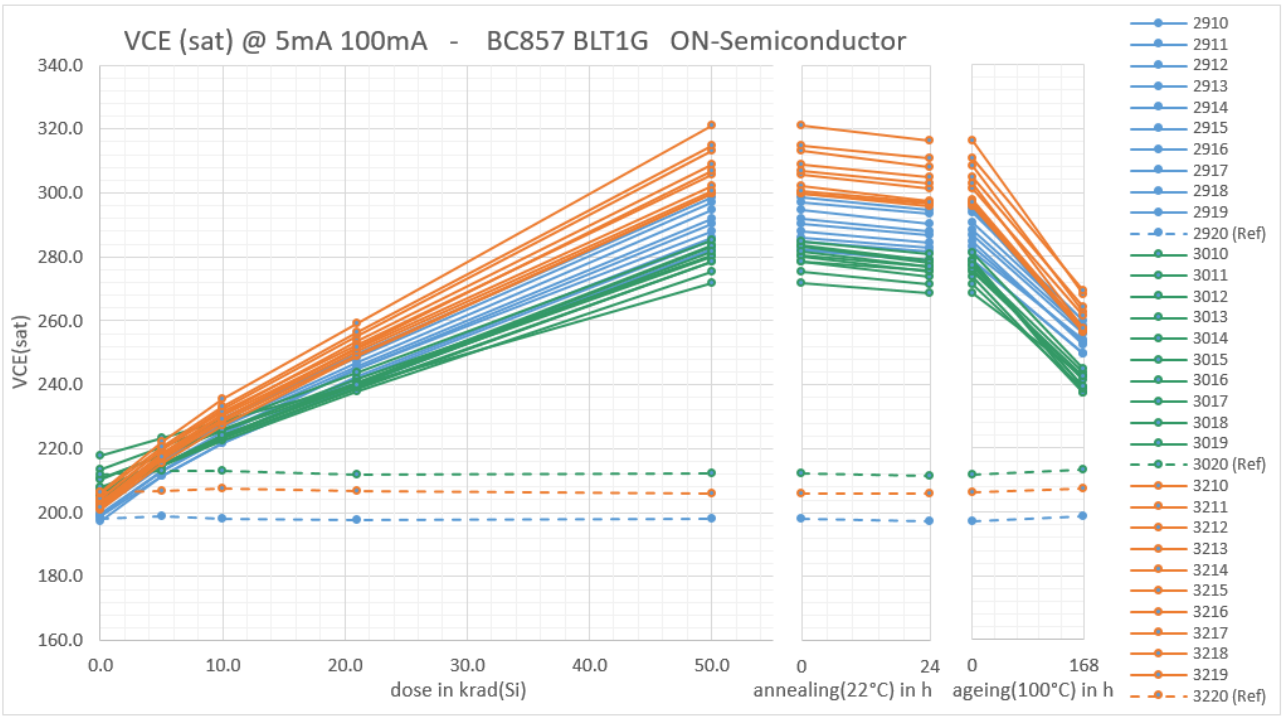


VCB0 (BR) @ 10uA	BC857 BLT1G ON-Semiconductor Farnell Dec. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2910	128.5	129.3	132.7	132.5	137.5	135.2	129.9
2911	125.7	127.0	129.5	134.0	133.6	134.8	127.1
2912	129.6	130.8	131.5	133.7	136.8	135.0	133.5
2913	133.3	131.9	133.5	134.2	136.7	135.8	134.9
2914	130.5	132.0	134.6	134.1	137.7	135.6	131.7
2915	131.5	130.3	131.7	136.8	136.4	135.1	131.0
2916	130.1	131.6	132.3	134.4	136.0	136.8	131.4
2917	124.9	129.3	129.3	131.8	138.2	133.2	126.7
2918	132.8	131.9	134.3	136.8	135.7	137.7	132.8
2919	128.9	133.9	131.4	133.7	134.6	135.0	131.6
2920 (Ref)	131.4	130.5	130.9	129.7	129.9	129.7	131.3
Average	129.60	130.80	132.08	134.19	136.33	135.42	131.06
s	2.741	1.922	1.798	1.601	1.405	1.190	2.598
Average+3s	137.82	136.57	137.47	138.99	140.54	138.99	138.85
Average-3s	121.37	125.03	126.69	129.38	132.12	131.85	123.26

VCB0 (BR) @ 10uA	BC857 BLT1G ON-Semiconductor RS Feb. odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3010	129.8	135.2	129.9	131.9	131.3	131.9	130.1
3011	130.2	131.2	129.6	129.9	131.8	131.1	127.3
3012	130.0	136.1	130.1	130.8	134.0	132.6	128.8
3013	131.9	131.3	131.6	130.8	134.0	133.3	129.1
3014	130.5	129.6	131.1	131.5	133.0	132.2	127.7
3015	134.5	131.3	130.0	130.8	132.0	131.9	129.3
3016	131.1	133.8	131.3	132.8	133.2	132.5	129.7
3017	134.5	136.4	133.6	132.1	134.7	131.7	129.0
3018	133.3	132.1	130.1	129.8	133.9	132.9	128.3
3019	132.5	132.1	132.5	132.4	134.8	134.8	129.5
3020 (Ref)	132.7	133.4	133.3	134.6	134.8	135.9	132.8
Average	131.84	132.90	130.98	131.28	133.26	132.50	128.90
s	1.806	2.346	1.282	1.006	1.239	1.045	0.899
Average+3s	137.25	139.94	134.82	134.30	136.98	135.63	131.59
Average-3s	126.42	125.86	127.13	128.26	129.54	129.36	126.20

VCB0 (BR) @ 10uA	BC857 BLT1G ON-Semiconductor Mouser Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3210	131.0	130.8	132.0	134.4	137.2	134.5	132.0
3211	128.6	131.4	130.3	131.7	133.9	134.3	130.2
3212	128.7	130.3	134.3	133.9	134.4	134.0	131.0
3213	130.1	129.9	130.7	130.8	130.8	131.1	129.8
3214	128.9	134.2	134.4	137.2	134.3	135.3	131.1
3215	127.7	129.6	130.6	135.7	134.8	133.7	128.9
3216	128.5	128.9	130.9	133.4	134.0	135.3	129.4
3217	131.0	132.5	130.8	134.4	133.8	134.0	132.2
3218	131.9	131.1	131.7	134.4	135.0	135.1	132.1
3219	131.2	131.2	133.4	134.9	136.7	135.8	132.5
3220 (Ref)	128.8	129.3	132.2	129.1	129.1	130.6	130.2
Average	129.75	130.97	131.91	134.10	134.49	134.31	130.92
s	1.447	1.523	1.572	1.840	1.721	1.331	1.295
Average+3s	134.09	135.54	136.63	139.62	139.65	138.30	134.81
Average-3s	125.41	126.41	127.19	128.58	129.33	130.32	127.03

8.8 VCE (sat) @ 5mA 100mA



VCE (sat) @ 5mA 100mA	BC857 BLT1G ON-Semiconductor Farnell Dec. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2910	203.9	217.9	229.2	249.5	298.4	294.8	256.0
2911	204.4	217.9	229.6	248.6	296.9	293.7	259.7
2912	199.7	213.1	224.4	245.1	288.0	284.6	252.4
2913	202.3	216.5	227.7	247.2	294.6	290.5	258.3
2914	199.4	213.2	223.3	241.8	285.0	281.6	253.8
2915	197.4	211.5	221.8	239.8	282.3	278.9	249.6
2916	199.3	213.1	223.5	242.5	285.9	283.0	252.9
2917	202.6	216.2	226.8	245.7	291.7	288.1	257.2
2918	201.1	214.6	225.2	244.8	290.5	286.8	255.8
2919	198.9	211.5	221.7	239.9	282.0	278.8	249.6
2920 (Ref)	198.0	198.9	198.0	197.5	198.2	197.2	198.6
Average	200.90	214.55	225.32	244.49	289.54	286.06	254.53
s	2.327	2.456	2.877	3.418	5.880	5.722	3.474
Average+3s	207.88	221.91	233.95	254.74	307.18	303.22	264.95
Average-3s	193.91	207.18	216.69	234.23	271.90	268.89	244.11

VCE (sat) @ 5mA 100mA	BC857 BLT1G ON-Semiconductor RS Feb. odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3010	207.7	215.2	223.3	238.5	278.5	273.7	237.3
3011	210.7	217.9	226.0	241.7	280.4	277.1	243.6
3012	206.0	215.2	224.1	240.7	283.7	278.8	238.8
3013	204.8	214.5	224.2	240.3	283.1	278.2	237.5
3014	206.8	214.8	222.7	237.9	275.3	271.3	238.4
3015	210.3	218.0	225.7	240.8	280.3	275.3	242.4
3016	207.8	215.2	223.1	238.9	278.4	275.9	241.2
3017	217.6	223.1	228.7	239.9	271.7	268.5	242.4
3018	213.3	220.4	228.2	243.8	285.0	280.9	244.7
3019	205.5	214.8	224.2	240.0	281.6	277.1	239.4
3020 (Ref)	211.8	213.0	212.9	212.0	212.3	211.5	213.1
Average	209.04	216.92	225.04	240.26	279.78	275.69	240.56
s	4.003	2.905	2.080	1.670	4.033	3.694	2.633
Average+3s	221.05	225.64	231.28	245.27	291.88	286.77	248.46
Average-3s	197.03	208.21	218.80	235.25	267.69	264.61	232.66

VCE (sat) @ 5mA 100mA	BC857 BLT1G ON-Semiconductor Mouser Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
3210	201.0	215.5	227.4	248.9	299.7	295.7	256.1
3211	204.2	219.9	232.4	255.3	313.4	308.2	262.8
3212	201.3	216.4	228.3	249.3	299.9	296.5	256.7
3213	203.0	217.9	230.4	251.2	302.0	297.5	256.9
3214	203.3	218.5	230.9	253.6	308.8	304.8	264.1
3215	204.4	219.7	231.7	252.7	305.7	301.4	261.2
3216	206.6	222.2	235.4	259.2	321.1	316.2	268.1
3217	202.3	217.4	229.2	250.6	300.7	297.0	256.9
3218	201.5	217.3	229.0	251.5	306.9	303.0	257.3
3219	206.0	220.7	233.3	256.4	315.0	310.8	269.2
3220 (Ref)	206.5	206.8	207.7	206.6	206.1	206.1	207.4
Average	203.35	218.56	230.80	252.87	307.31	303.11	260.92
s	1.918	2.058	2.482	3.290	7.266	6.906	4.935
Average+3s	209.10	224.73	238.25	262.74	329.10	323.83	275.72
Average-3s	197.60	212.39	223.36	243.00	285.51	282.40	246.11

9 CONCLUSION

The test results of the BC857BLT1G from ON-Semiconductor 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

BC856ALT1G Series

General Purpose Transistors

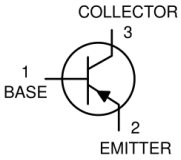
PNP Silicon

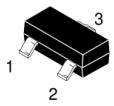
Features

- S and NSV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

ON Semiconductor®

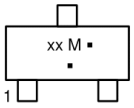
http://onsemi.com





SOT−23 (TO−236AB)
CASE 318
STYLE 6

MARKING DIAGRAM



xx = Device Code
xx = (Refer to page 6)
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*Date Code orientation and/or overbar may vary depending upon manufacturing location.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage BC856, SBC856 BC857, SBC857 BC858, NSVBC858, BC859	V_{CEO}	 −65 −45 −30	V
Collector-Base Voltage BC856, SBC856 BC857, SBC857 BC858, NSVBC858, BC859	V_{CBO}	 −80 −50 −30	V
Emitter−Base Voltage	V_{EBO}	−5.0	V
Collector Current − Continuous	I_C	−100	mAdc
Collector Current − Peak	I_C	−200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR−5 Board, (Note 1) T_A = 25°C Derate above 25°C	P_D	 225 1.8	 mW mW/°C
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (Note 2) T_A = 25°C Derate above 25°C	P_D	 300 2.4	 mW mW/°C
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. FR−5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in 99.5% alumina.

March, 2014 − Rev. 14

Publication Order Number:
BC856ALT1/D

BC856ALT1G Series

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –10 mA) BC856, SBC856 Series	$V_{(BR)CEO}$	–65	–	–	V
BC857, SBC857 Series		–45	–	–	
BC858, NSBVC858 BC859 Series		–30	–	–	
Collector–Emitter Breakdown Voltage (I_C = –10 μA, V_{EB} = 0) BC856 S, SBC856eries	$V_{(BR)CES}$	–80	–	–	V
BC857A, SBC857A, BC857B, SBC857B Only		–50	–	–	
BC858, NSVB858, BC859 Series		–30	–	–	
Collector–Base Breakdown Voltage (I_C = –10 μA) BC856, SBC856 Series	$V_{(BR)CBO}$	–80	–	–	V
BC857, SBC857 Series		–50	–	–	
BC858, NSVBC858, BC859 Series		–30	–	–	
Emitter–Base Breakdown Voltage (I_E = –1.0 μA) BC856, SBC856 Series	$V_{(BR)EBO}$	–5.0	–	–	V
BC857, SBC857 Series		–5.0	–	–	
BC858, NSVBC858, BC859 Series		–5.0	–	–	
Collector Cutoff Current (V_{CB} = –30 V)	I_{CBO}	–	–	–15	nA
(V_{CB} = –30 V, T_A = 150°C)		–	–	–4.0	μA
ON CHARACTERISTICS					
DC Current Gain BC856A, SBC856A, BC857A, SBC857A, BC858A	h_{FE}	–	90	–	–
(I_C = –10 μA, V_{CE} = –5.0 V) BC856B, SBC856B, BC857B, SBC857B, BC858B, NSVBC858B		–	150	–	
BC857C, SBC857C BC858C		–	270	–	
(I_C = –2.0 mA, V_{CE} = –5.0 V) BC856A, SBC856A, BC857A, SBC857A, BC858A		125	180	250	
BC856B, SBC856B, BC857B, SBC857B, BC858B, NSVBC858B, BC859B		220	290	475	
BC857C, SBC857C, BC858C, BC859C		420	520	800	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$				V
(I_C = –10 mA, I_B = –0.5 mA)		–	–	–0.3	
(I_C = –100 mA, I_B = –5.0 mA)		–	–	–0.65	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$				V
(I_C = –10 mA, I_B = –0.5 mA)		–	–0.7	–	
(I_C = –100 mA, I_B = –5.0 mA)		–	–0.9	–	
Base–Emitter On Voltage	$V_{BE(on)}$				V
(I_C = –2.0 mA, V_{CE} = –5.0 V)		–0.6	–	–0.75	
(I_C = –10 mA, V_{CE} = –5.0 V)		–	–	–0.82	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = –10 mA, V_{CE} = –5.0 Vdc, f = 100 MHz)	f_T	100	–	–	MHz
Output Capacitance (V_{CB} = –10 V, f = 1.0 MHz)	C_{ob}	–	–	4.5	pF
Noise Figure	NF				dB
(I_C = –0.2 mA, V_{CE} = –5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)					
BC856, SBC856, BC857, SBC857, BC858, NSVBC858 Series		–	–	10	
BC859 Series		–	–	4.0	