TOTAL IONIZING DOSE Test Report

BC847BLT3G - 100mA NPN Transistor from ON-Semiconductor

Prepared by **Florian Krimmel**

Reference
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APPROVAL

Title TID Test Report BJT COTS	
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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

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1 INTRODUCTION

This report presents the total ionizing dose results of **BC847BLT3G** a **100mA NPN Transistor from ON-Semiconductor**.

2 DOCUMENTS

APPLICABLE AND REFERENCE DOCUMENTS
BJTs COTS TID test plan
Datasheet **BC847** from ON-Semiconductor

3 PART REFERENCES

REFERENCES	
Type:	BC847BLT3G
Manufacturer:	ON-Semiconductor
Function:	100 mA general-purpose transistors
Technology:	Bipolar NPN Silicon
PARTS PROCUREMENT	
Packaging:	SOT23 (TO-236AB)
Date Code:	batch no. 17: Nov even years batch no. 18: Apr odd years batch no. 20: Oct even years
Distributor:	batch no. 17: Farnell batch no. 18: RS Components batch no. 20: 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

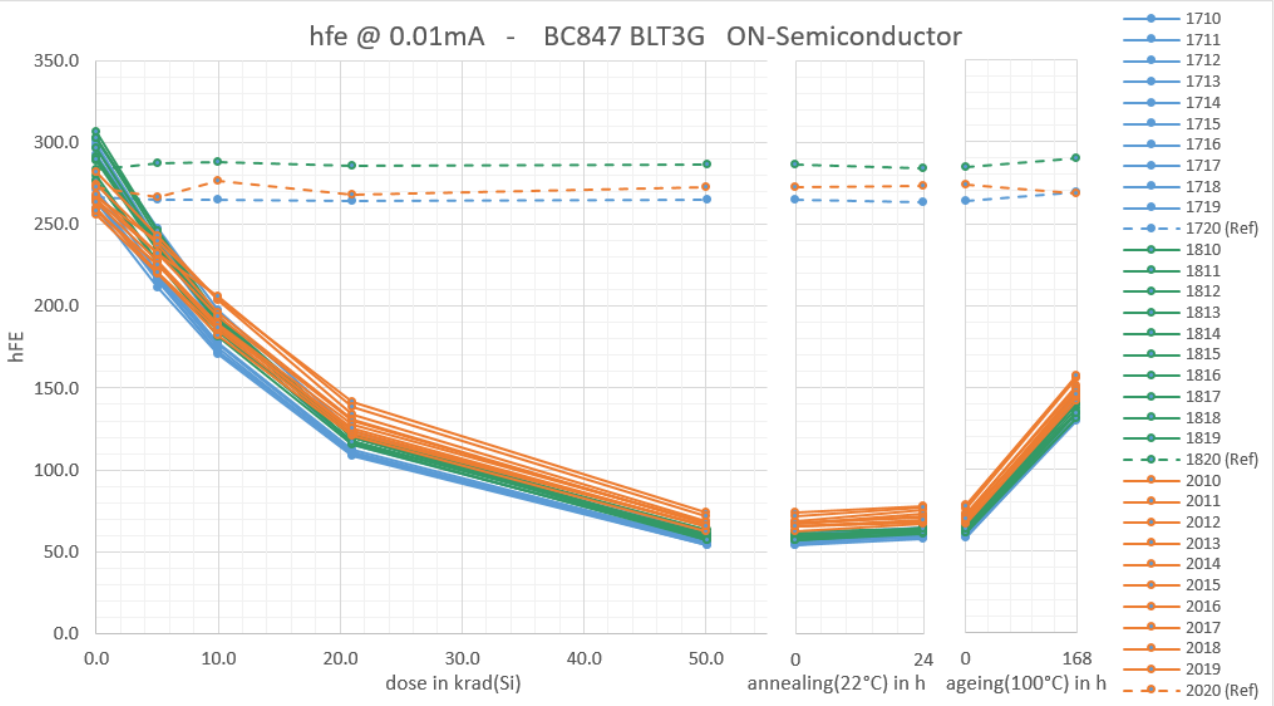
PARAMETERS	SYMBOLS	TEST CONDITIONS
Forward Current Transfer Ratio	hfe1	Ic= 0.01mA, Vce = 1V
	hfe2	Ic= 0.1mA, Vce = 1V
	hfe3	Ic= 1mA, Vce = 1V
	hfe4	Ic= 10mA, Vce = 1V
	hfe5	Ic= 100mA, Vce = 1V
Collector-Emitter Breakdown Voltage	VCEo (BR)	Ic = 10mA
Collector-Base Breakdown Voltage	VCBo (BR)	Ic = 10uA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

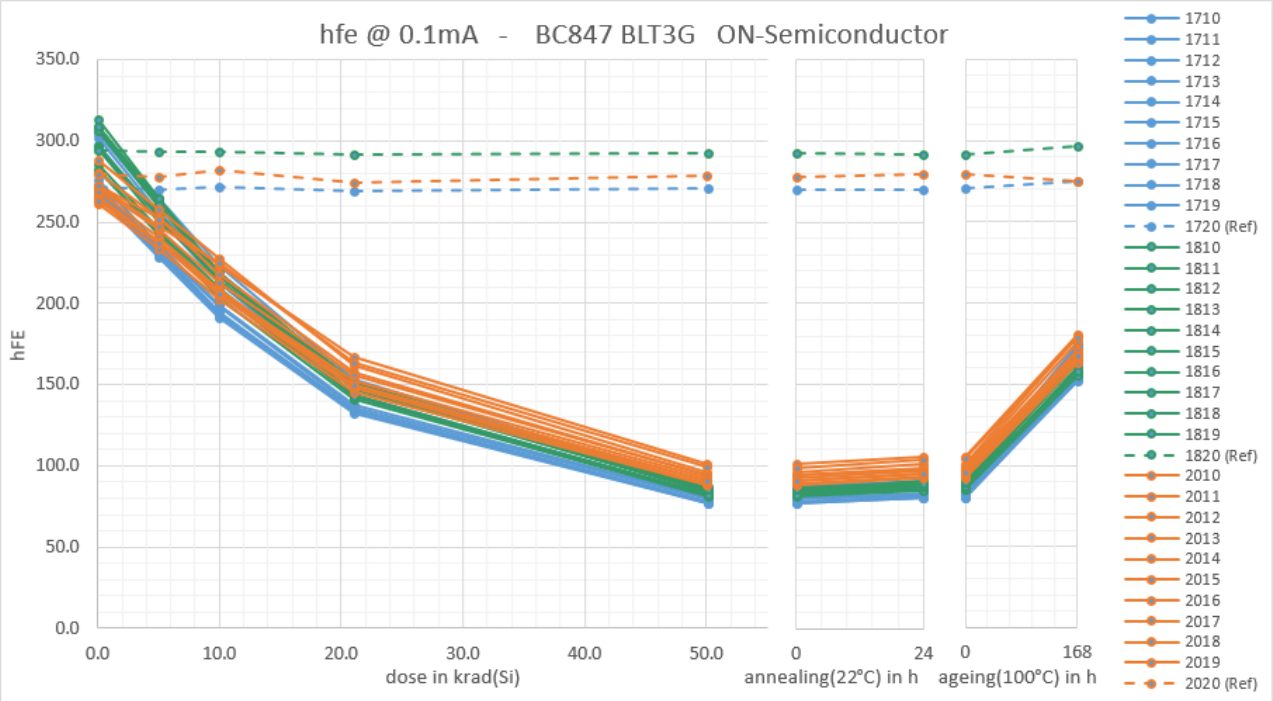


hfe @ 0.01mA	BC847 BLT3G ON-Semiconductor Farnell Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1710	259.7	211.0	170.6	108.8	54.1	57.9	130.5
1711	265.9	216.6	172.5	110.3	54.5	61.5	131.2
1712	270.7	220.6	177.8	112.3	56.6	60.4	132.1
1713	264.4	215.0	171.8	110.7	54.7	59.4	129.3
1714	298.5	239.3	193.7	121.5	59.8	64.0	146.3
1715	292.1	235.5	187.5	115.7	58.3	63.9	142.8
1716	265.5	218.8	174.1	108.9	57.1	58.8	131.2
1717	301.1	247.4	197.8	123.5	60.9	65.0	147.1
1718	263.6	217.2	176.7	110.6	55.9	62.6	131.4
1719	296.5	235.3	193.8	119.9	58.9	63.0	145.7
1720 (Ref)	266.8	265.2	264.9	264.3	265.3	263.7	268.9
Average	277.82	225.69	181.64	114.22	57.07	61.65	136.76
s	16.923	12.472	10.458	5.539	2.362	2.419	7.627
Average+3s	328.59	263.11	213.01	130.84	64.16	68.91	159.64
Average-3s	227.05	188.27	150.26	97.61	49.99	54.39	113.88

hfe @ 0.01mA	BC847 BLT3G ON-Semiconductor RS April odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1810	302.5	245.6	193.5	121.7	59.8	63.8	141.1
1811	290.7	235.9	189.5	120.0	59.3	63.6	137.1
1812	296.7	238.2	191.7	120.0	58.9	63.7	139.9
1813	279.5	226.2	184.7	117.5	59.2	63.7	133.9
1814	302.4	242.8	192.4	120.4	58.7	65.1	140.5
1815	288.9	233.6	194.0	116.1	56.9	64.1	135.1
1816	276.1	226.2	181.6	115.1	57.6	61.3	131.4
1817	306.3	245.6	191.5	120.0	57.3	61.8	141.1
1818	276.1	226.1	185.6	116.7	60.9	61.6	133.9
1819	289.5	236.5	189.5	121.2	62.9	64.0	140.1
1820 (Ref)	283.6	287.3	287.8	285.3	286.6	284.4	290.2
Average	290.86	235.68	189.41	118.86	59.15	63.28	137.40
s	11.124	7.670	4.136	2.328	1.798	1.256	3.599
Average+3s	324.23	258.69	201.82	125.85	64.55	67.05	148.20
Average-3s	257.49	212.67	177.00	111.88	53.76	59.51	126.61

hfe @ 0.01mA	BC847 BLT3G ON-Semiconductor Mouser Oct. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2010	281.7	242.4	203.4	134.0	68.9	75.6	155.7
2011	273.9	237.5	195.8	130.5	67.2	72.1	151.0
2012	266.8	239.5	204.3	141.5	74.1	78.3	156.3
2013	255.8	220.0	182.5	121.0	62.2	67.0	141.9
2014	259.8	220.7	185.0	122.5	65.5	67.7	144.0
2015	265.0	232.0	193.7	129.9	67.4	73.0	149.3
2016	263.1	227.7	188.3	123.9	65.5	68.8	148.2
2017	257.9	225.0	188.8	127.6	68.0	71.3	144.9
2018	257.9	224.7	186.5	125.2	65.3	69.8	146.0
2019	268.1	232.3	206.0	138.1	72.0	77.3	157.4
2020 (Ref)	272.9	266.1	276.2	268.3	272.7	273.6	268.7
Average	265.00	230.17	193.43	129.41	67.62	72.10	149.47
s	8.081	7.862	8.629	6.793	3.457	3.942	5.509
Average+3s	289.25	253.76	219.31	149.79	77.99	83.92	166.00
Average-3s	240.76	206.58	167.54	109.03	57.25	60.27	132.95

8.2 hfe @ 0.1 mA

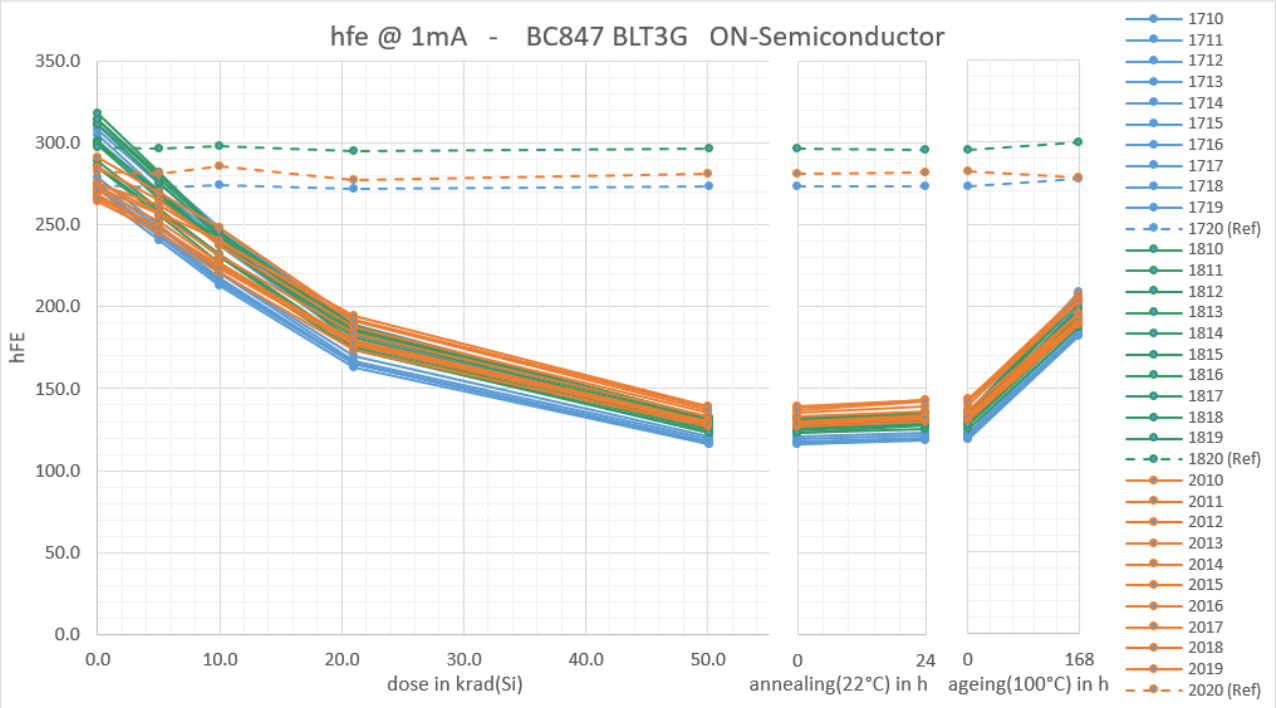


hfe @ 0.1mA	BC847 BLT3G ON-Semiconductor Farnell Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1710	266.7	228.5	190.9	132.6	76.9	80.4	152.6
1711	271.0	231.5	193.8	134.4	77.8	81.3	154.0
1712	276.0	236.6	199.3	137.9	80.3	83.6	156.2
1713	269.5	230.4	192.9	134.3	77.6	80.9	152.2
1714	304.7	260.5	218.6	150.5	86.2	89.8	173.3
1715	297.9	252.7	212.7	143.9	82.6	86.0	168.6
1716	270.4	233.4	195.0	133.9	76.8	80.3	153.6
1717	307.4	265.1	223.2	152.8	87.2	91.1	174.4
1718	272.4	234.8	198.4	135.7	79.4	82.6	154.5
1719	302.1	255.8	218.3	148.2	84.7	88.6	171.5
1720 (Ref)	271.7	270.2	271.5	269.4	270.5	270.4	274.8
Average	283.80	242.94	204.30	140.42	80.95	84.45	161.10
s	16.860	13.973	12.435	7.690	3.970	4.125	9.513
Average+3s	334.38	284.85	241.60	163.49	92.86	96.83	189.63
Average-3s	233.22	201.02	167.00	117.35	69.04	72.08	132.56

hfe @ 0.1mA	BC847 BLT3G ON-Semiconductor RS April odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1810	309.2	264.0	219.3	151.1	86.5	90.1	169.2
1811	297.0	253.2	213.6	147.0	84.2	87.8	163.2
1812	306.1	259.8	216.9	148.9	85.0	88.8	167.3
1813	285.2	245.4	209.2	143.0	82.4	87.7	158.5
1814	309.3	261.6	217.3	149.7	85.2	91.2	168.2
1815	294.7	250.3	218.8	143.7	82.2	85.5	160.8
1816	281.7	242.0	203.5	141.2	81.7	85.0	155.7
1817	313.5	264.8	217.8	148.8	84.0	87.8	168.9
1818	281.7	244.4	207.0	142.7	82.2	87.2	158.0
1819	295.5	255.2	214.6	149.2	85.9	89.4	166.0
1820 (Ref)	294.0	293.3	293.5	291.5	292.8	291.6	296.3
Average	297.38	254.07	213.80	146.52	83.93	88.06	163.59
s	11.861	8.390	5.456	3.509	1.724	1.919	5.028
Average+3s	332.97	279.24	230.17	157.05	89.11	93.81	178.67
Average-3s	261.80	228.90	197.43	136.00	78.76	82.30	148.50

hfe @ 0.1mA	BC847 BLT3G ON-Semiconductor Mouser Oct. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2010	288.4	258.1	227.9	161.7	96.4	101.1	180.1
2011	280.8	252.9	217.7	157.4	94.4	98.9	176.3
2012	272.7	252.2	222.9	167.0	101.1	105.5	180.3
2013	261.4	234.0	202.4	145.6	88.1	92.5	163.6
2014	265.4	237.6	205.0	148.2	89.2	93.7	166.0
2015	270.6	245.5	213.3	155.5	94.3	98.3	171.5
2016	268.7	240.8	208.5	149.8	90.6	95.0	170.6
2017	264.3	238.3	208.0	152.3	92.5	97.1	167.2
2018	263.4	237.4	206.2	149.9	91.0	95.5	167.6
2019	272.5	247.7	225.2	163.7	99.1	104.2	179.2
2020 (Ref)	279.1	277.8	282.3	274.1	278.3	279.4	275.1
Average	270.82	244.46	213.70	155.10	93.68	98.18	172.22
s	8.395	8.083	9.156	7.178	4.235	4.348	6.285
Average+3s	296.01	268.70	241.17	176.64	106.39	111.22	191.08
Average-3s	245.63	220.21	186.23	133.57	80.98	85.13	153.37

8.3 hfe @ 1 mA

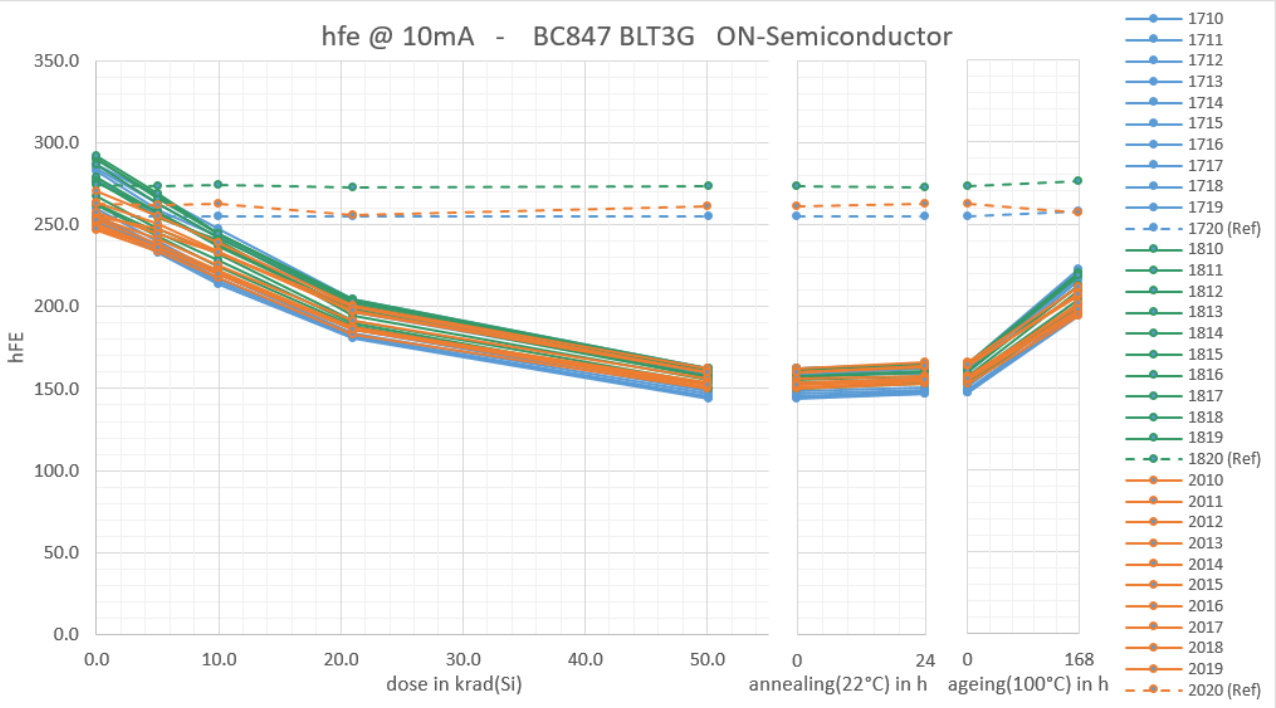


hfe @ 1mA	BC847 BLT3G ON-Semiconductor Farnell Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1710	268.9	240.6	212.5	163.3	115.9	118.6	181.5
1711	273.5	244.3	215.6	165.5	117.5	120.4	183.9
1712	278.7	249.5	221.2	169.5	120.8	122.9	186.8
1713	272.1	242.7	214.4	165.4	117.2	119.3	182.2
1714	307.6	274.8	243.4	186.1	130.9	133.5	206.6
1715	300.6	267.1	237.0	179.1	126.4	129.0	201.3
1716	272.7	245.8	217.3	165.0	116.1	119.0	183.7
1717	310.6	280.1	247.9	188.7	131.9	135.2	208.3
1718	275.0	248.0	220.1	167.0	119.6	121.5	184.7
1719	305.0	270.6	242.5	183.1	128.6	132.0	204.2
1720 (Ref)	274.2	272.9	274.3	272.1	273.2	273.1	277.8
Average	286.47	256.34	227.19	173.28	122.48	125.13	192.31
s	17.115	15.025	13.825	9.860	6.326	6.561	11.240
Average+3s	337.81	301.42	268.66	202.87	141.46	144.82	226.03
Average-3s	235.12	211.26	185.71	143.70	103.50	105.45	158.59

hfe @ 1mA	BC847 BLT3G ON-Semiconductor RS April odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1810	313.8	280.2	245.7	187.9	132.3	134.9	204.9
1811	301.0	268.8	238.4	181.7	128.0	130.5	197.1
1812	311.2	275.6	243.0	185.3	130.6	133.2	202.5
1813	288.7	259.4	232.1	176.4	124.6	128.5	190.7
1814	314.0	278.2	244.8	186.5	130.9	135.3	203.7
1815	299.0	265.9	241.8	178.4	125.9	127.9	194.4
1816	285.2	255.7	226.8	173.8	122.8	125.3	187.4
1817	317.9	282.1	245.1	186.4	130.7	133.3	204.6
1818	285.4	258.3	230.5	175.2	123.3	127.4	189.3
1819	299.0	270.4	239.1	183.4	129.1	131.7	198.8
1820 (Ref)	297.3	296.7	297.7	295.1	296.3	295.3	299.6
Average	301.51	269.44	238.74	181.50	127.81	130.80	197.33
s	12.356	9.535	6.724	5.202	3.452	3.423	6.622
Average+3s	338.58	298.05	258.91	197.10	138.17	141.07	217.19
Average-3s	264.44	240.84	218.56	165.89	117.46	120.53	177.46

hfe @ 1mA	BC847 BLT3G ON-Semiconductor Mouser Oct. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2010	291.2	269.6	247.8	192.4	138.7	142.8	207.1
2011	284.5	265.0	237.5	187.7	135.7	139.6	203.0
2012	275.0	262.0	239.6	194.1	139.5	143.4	203.7
2013	264.5	244.9	220.6	173.9	126.6	130.3	188.4
2014	267.7	248.1	223.3	176.4	128.2	131.9	190.6
2015	272.8	256.2	231.4	183.8	132.9	136.4	195.8
2016	270.8	251.6	226.3	177.9	129.6	133.4	195.0
2017	266.4	248.0	224.8	179.8	130.0	134.0	190.7
2018	265.9	248.2	223.4	177.4	128.8	132.6	191.7
2019	276.0	257.2	240.7	191.3	137.2	141.9	202.8
2020 (Ref)	282.2	281.0	285.5	277.0	281.1	282.1	278.1
Average	273.48	255.07	231.54	183.48	132.71	136.64	196.88
s	8.661	8.329	9.284	7.415	4.735	4.895	6.709
Average+3s	299.47	280.06	259.39	205.73	146.91	151.32	217.00
Average-3s	247.50	230.09	203.68	161.24	118.50	121.95	176.75

8.4 hfe @ 10 mA

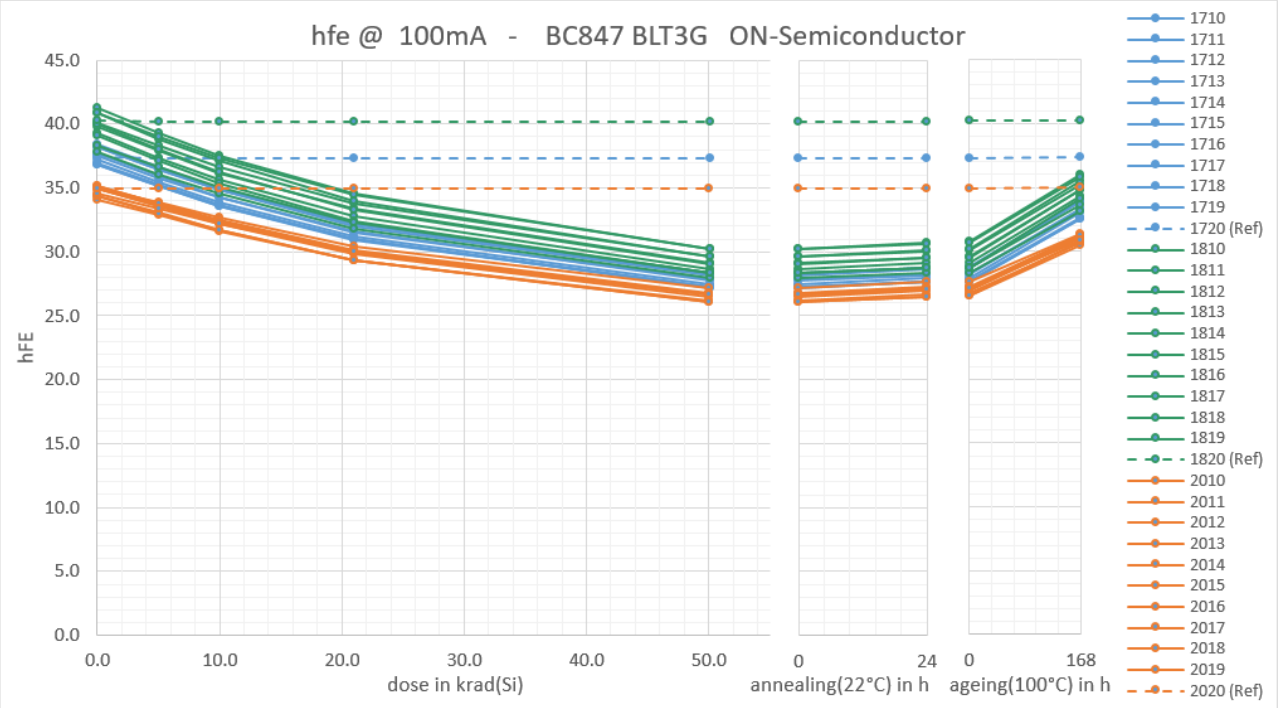


hfe @ 10mA	BC847 BLT3G ON-Semiconductor Farnell Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1710	251.6	232.7	213.7	180.5	143.8	147.2	194.3
1711	255.0	235.6	216.3	182.4	145.2	148.5	196.8
1712	259.2	239.9	220.8	185.9	148.2	150.9	200.5
1713	253.5	234.2	215.0	181.4	144.5	147.3	195.6
1714	284.2	262.5	242.3	202.5	162.0	163.8	221.5
1715	278.1	255.9	237.9	196.4	158.5	159.5	215.4
1716	254.3	235.8	217.4	181.9	144.3	147.6	196.7
1717	286.6	266.8	247.2	204.7	162.0	165.2	222.8
1718	255.6	237.5	220.0	183.3	146.9	149.2	197.5
1719	282.4	258.5	243.0	199.6	158.6	162.0	216.9
1720 (Ref)	255.2	254.7	255.2	254.6	254.9	254.9	258.0
Average	266.04	245.94	227.34	189.85	151.40	154.11	205.80
s	14.720	13.337	13.449	9.756	7.804	7.535	11.772
Average+3s	310.20	285.95	267.69	219.12	174.81	176.72	241.12
Average-3s	221.88	205.93	186.99	160.58	127.99	131.50	170.48

hfe @ 10mA	BC847 BLT3G ON-Semiconductor RS April odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1810	289.3	266.8	244.6	204.1	162.3	164.9	220.3
1811	278.7	257.0	237.9	197.9	157.2	160.0	212.5
1812	286.7	263.0	242.3	201.5	160.5	163.2	218.4
1813	266.9	247.4	231.7	191.7	152.9	155.7	203.9
1814	289.9	265.6	244.6	202.9	161.3	164.6	219.4
1815	276.3	254.1	240.3	194.6	155.5	157.3	209.4
1816	262.1	242.7	224.0	188.5	149.8	152.8	199.0
1817	291.8	268.5	244.3	202.6	161.6	163.9	219.0
1818	262.6	244.7	228.0	189.7	150.2	154.1	200.8
1819	276.0	257.2	236.8	198.6	157.5	160.4	212.5
1820 (Ref)	273.8	273.4	274.4	272.6	273.3	272.8	276.2
Average	278.02	256.72	237.46	197.20	156.88	159.69	211.52
s	11.326	9.396	7.327	5.774	4.698	4.491	8.024
Average+3s	312.00	284.91	259.44	214.52	170.98	173.16	235.59
Average-3s	244.05	228.53	215.48	179.87	142.79	146.21	187.45

hfe @ 10mA	BC847 BLT3G ON-Semiconductor Mouser Oct. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2010	270.6	255.2	238.6	200.7	162.1	165.8	211.9
2011	263.6	250.7	233.4	196.5	159.6	163.1	208.1
2012	254.9	247.0	232.8	199.9	160.1	163.9	206.4
2013	246.6	233.2	217.1	183.2	149.9	152.9	194.4
2014	250.2	235.8	219.6	185.7	151.0	154.8	196.7
2015	254.0	241.0	225.4	191.2	155.7	157.6	200.1
2016	252.8	238.3	222.2	186.8	153.4	155.9	201.8
2017	248.8	236.0	220.5	187.8	152.5	156.4	195.6
2018	247.3	236.0	219.9	186.0	152.0	155.6	198.1
2019	257.2	244.3	232.9	197.3	159.9	163.8	207.2
2020 (Ref)	262.3	261.6	262.7	256.1	261.3	262.4	257.0
Average	254.60	241.75	226.25	191.50	155.64	158.98	202.03
s	7.591	7.304	7.527	6.516	4.428	4.639	6.017
Average+3s	277.37	263.66	248.83	211.05	168.92	172.90	220.08
Average-3s	231.83	219.84	203.67	171.95	142.35	145.07	183.98

8.5 hfe @ 100 mA

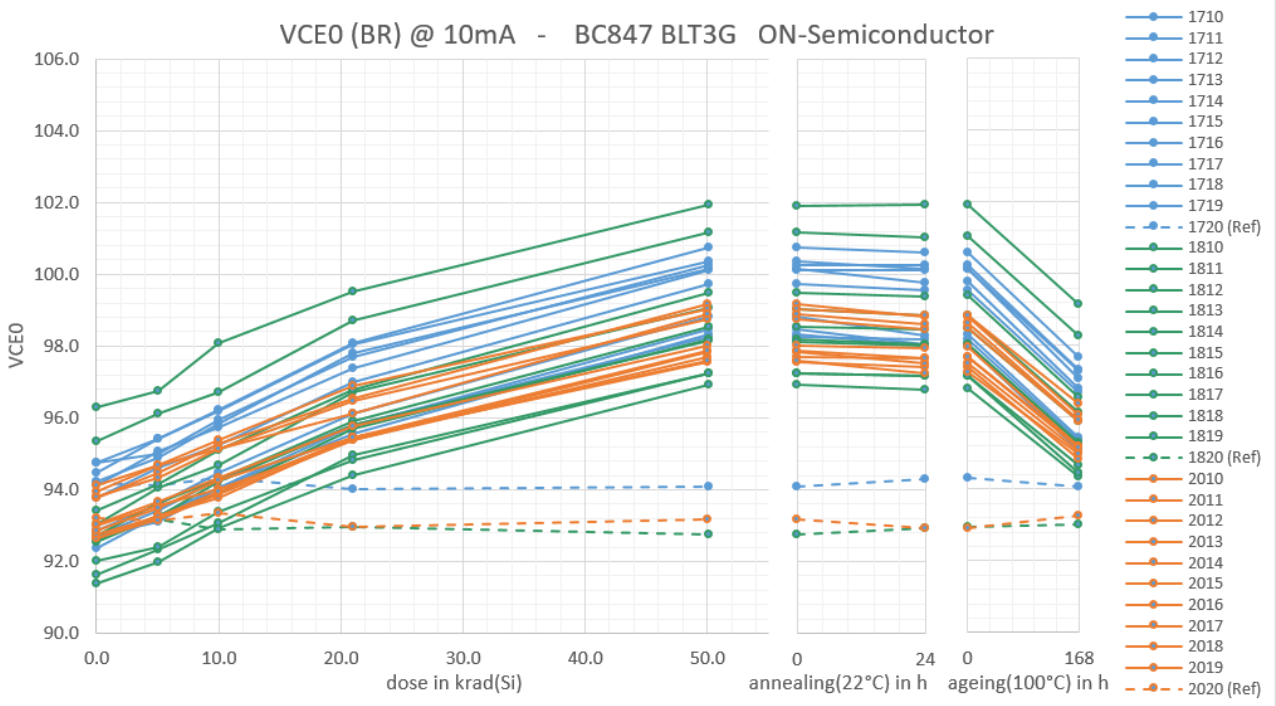


hfe @ 100mA	BC847 BLT3G ON-Semiconductor Farnell Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1710	37.5	35.7	34.2	31.5	27.8	28.3	33.3
1711	37.2	35.5	33.9	31.2	27.5	27.9	33.0
1712	36.9	35.3	33.7	31.1	27.3	27.7	32.6
1713	36.9	35.2	33.6	31.0	27.1	27.6	32.6
1714	38.4	36.6	34.9	32.2	28.2	28.7	33.9
1715	38.2	36.4	34.8	32.0	28.2	28.7	33.9
1716	37.7	35.9	34.3	31.6	27.7	28.2	33.4
1717	38.3	36.5	34.9	32.2	28.2	28.7	33.9
1718	36.9	35.2	33.6	30.9	27.2	27.6	32.6
1719	38.2	36.4	34.8	32.2	28.3	28.8	33.9
1720 (Ref)	37.4	37.3	37.3	37.3	37.3	37.3	37.4
Average	37.62	35.86	34.27	31.58	27.76	28.22	33.30
s	0.630	0.589	0.554	0.521	0.457	0.484	0.567
Average+3s	39.50	37.63	35.94	33.14	29.13	29.67	35.00
Average-3s	35.73	34.10	32.61	30.02	26.39	26.77	31.60

hfe @ 100mA	BC847 BLT3G ON-Semiconductor RS April odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1810	39.8	37.9	36.2	33.3	29.1	29.6	34.8
1811	41.2	39.3	37.5	34.6	30.2	30.7	36.0
1812	39.3	37.3	35.6	32.8	28.7	29.1	34.3
1813	40.1	38.3	36.6	33.8	29.6	30.1	35.2
1814	40.0	38.0	36.2	33.3	29.0	29.5	34.8
1815	40.8	38.8	37.1	34.0	29.7	30.1	35.5
1816	37.8	36.0	34.5	31.8	27.9	28.3	33.1
1817	39.1	37.1	35.3	32.4	28.3	28.7	34.1
1818	38.3	36.6	35.0	32.3	28.3	28.7	33.6
1819	40.8	39.0	37.3	34.4	30.2	30.6	35.8
1820 (Ref)	40.3	40.2	40.2	40.2	40.2	40.2	40.3
Average	39.73	37.83	36.15	33.27	29.11	29.55	34.72
s	1.115	1.060	1.014	0.933	0.811	0.828	0.945
Average+3s	43.08	41.01	39.19	36.07	31.54	32.04	37.56
Average-3s	36.39	34.65	33.10	30.47	26.68	27.07	31.89

hfe @ 100mA	BC847 BLT3G ON-Semiconductor Mouser Oct. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2010	34.9	33.6	32.3	29.9	26.7	27.1	31.1
2011	34.9	33.5	32.2	29.8	26.5	27.0	31.1
2012	34.9	33.9	32.7	30.5	27.2	27.6	31.3
2013	34.4	33.1	31.7	29.4	26.2	26.7	30.7
2014	35.0	33.7	32.3	29.9	26.7	27.1	31.1
2015	34.1	32.8	31.6	29.3	26.0	26.5	30.5
2016	34.4	33.0	31.7	29.3	26.0	26.5	30.7
2017	35.1	33.8	32.5	30.1	26.8	27.2	31.3
2018	35.2	33.8	32.4	30.1	26.7	27.1	31.3
2019	34.5	33.4	32.2	30.0	26.7	27.1	30.9
2020 (Ref)	34.9	34.9	34.9	34.9	34.9	34.9	35.0
Average	34.74	33.45	32.15	29.82	26.55	26.99	31.01
s	0.359	0.362	0.361	0.380	0.360	0.343	0.290
Average+3s	35.82	34.54	33.24	30.96	27.63	28.02	31.88
Average-3s	33.66	32.37	31.07	28.69	25.47	25.96	30.14

8.6 VCEo (BR) @ 10mA

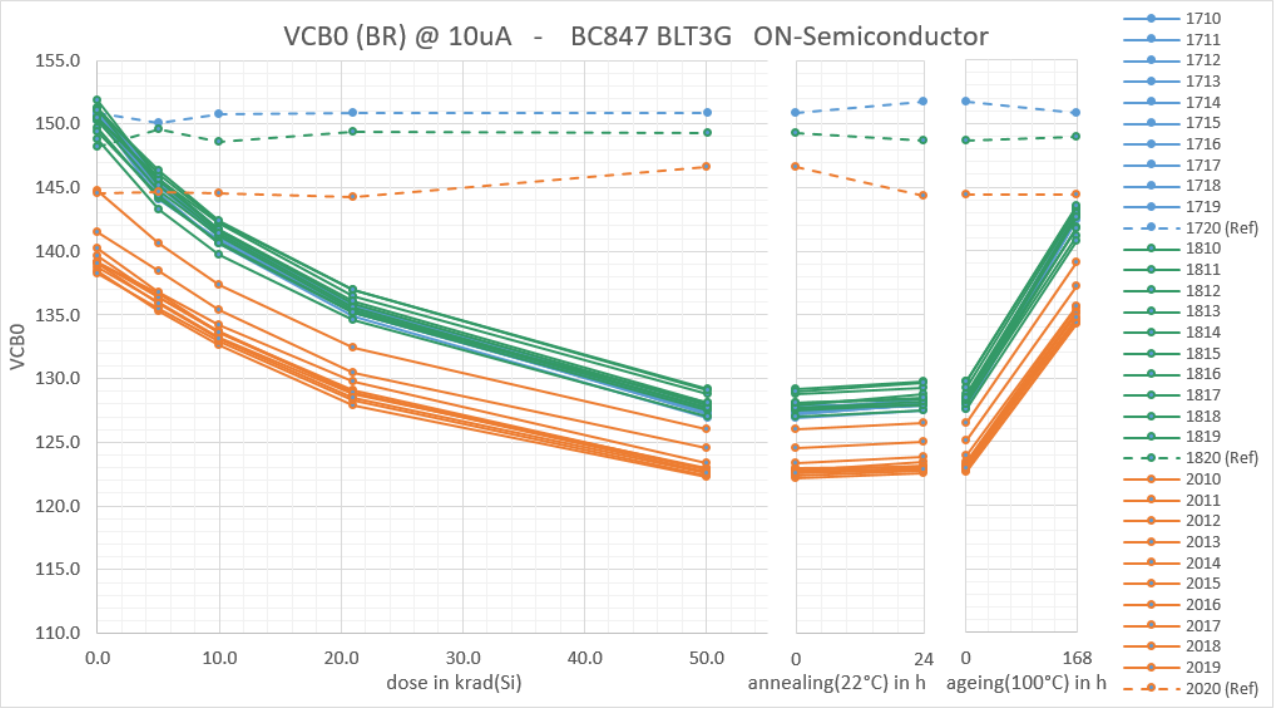


VCE0 (BR) @ 10mA	BC847 BLT3G ON-Semiconductor Farnell Nov. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1710	94.1	95.1	95.7	97.4	100.1	100.1	97.1
1711	94.2	94.9	95.8	97.8	100.2	99.8	96.8
1712	94.8	95.0	95.9	97.7	100.2	100.2	97.3
1713	94.8	95.4	96.2	98.1	100.8	100.6	97.7
1714	92.4	93.3	94.1	95.8	98.5	98.0	95.1
1715	92.8	93.6	94.5	96.1	98.8	98.3	95.4
1716	93.8	94.6	95.2	97.0	99.7	99.5	96.7
1717	92.7	93.1	94.1	95.6	98.3	98.0	95.1
1718	94.5	95.4	96.2	98.0	100.4	100.1	97.3
1719	92.7	93.4	94.3	95.8	98.3	98.2	95.4
1720 (Ref)	94.2	94.1	94.3	94.0	94.1	94.3	94.1
Average	93.68	94.38	95.20	96.93	99.52	99.29	96.39
s	0.929	0.928	0.894	1.012	0.955	1.041	1.025
Average+3s	96.47	97.17	97.89	99.96	102.39	102.42	99.47
Average-3s	90.89	91.60	92.52	93.89	96.66	96.17	93.32

VCE0 (BR) @ 10mA	BC847 BLT3G ON-Semiconductor RS April odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1810	92.5	93.3	93.9	95.7	98.2	98.0	95.3
1811	91.4	92.0	92.9	94.4	96.9	96.8	94.3
1812	93.0	94.1	94.7	96.7	99.0	98.8	96.1
1813	92.7	93.6	94.3	95.9	98.6	98.5	95.9
1814	92.6	93.3	94.2	95.8	98.1	98.0	95.3
1815	91.6	92.3	93.1	95.0	97.2	97.2	94.4
1816	96.3	96.7	98.1	99.5	101.9	101.9	99.1
1817	93.4	94.2	95.1	96.8	99.5	99.4	96.6
1818	95.3	96.1	96.7	98.7	101.2	101.0	98.3
1819	92.0	92.4	93.4	94.8	97.2	97.2	94.7
1820 (Ref)	92.7	93.2	92.9	93.0	92.8	92.9	93.0
Average	93.10	93.80	94.64	96.33	98.79	98.69	96.00
s	1.574	1.569	1.632	1.664	1.675	1.690	1.612
Average+3s	97.82	98.50	99.53	101.32	103.81	103.76	100.84
Average-3s	88.37	89.09	89.74	91.34	93.77	93.62	91.16

VCE0 (BR) @ 10mA	BC847 BLT3G ON-Semiconductor Mouser Oct. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2010	92.6	93.3	93.8	95.4	97.5	97.4	94.8
2011	92.7	93.2	93.9	95.4	97.7	97.7	95.2
2012	93.0	93.6	94.0	95.4	97.8	97.5	95.0
2013	93.8	94.5	95.3	96.5	99.2	98.8	96.1
2014	93.0	93.7	94.3	95.8	98.0	97.9	95.2
2015	94.1	94.7	95.4	96.9	99.0	98.8	96.4
2016	93.8	94.3	95.1	96.5	98.7	98.5	95.9
2017	92.8	93.3	93.9	95.5	97.6	97.3	95.0
2018	92.9	93.5	94.2	95.4	97.9	97.7	95.1
2019	93.9	94.7	95.1	96.1	98.9	98.6	95.9
2020 (Ref)	93.2	93.1	93.4	93.0	93.2	92.9	93.3
Average	93.26	93.86	94.51	95.88	98.23	98.02	95.47
s	0.586	0.611	0.648	0.567	0.644	0.610	0.547
Average+3s	95.02	95.69	96.45	97.59	100.17	99.85	97.11
Average-3s	91.51	92.03	92.57	94.18	96.30	96.19	93.82

8.7 VCB0 (BR) @ 10uA

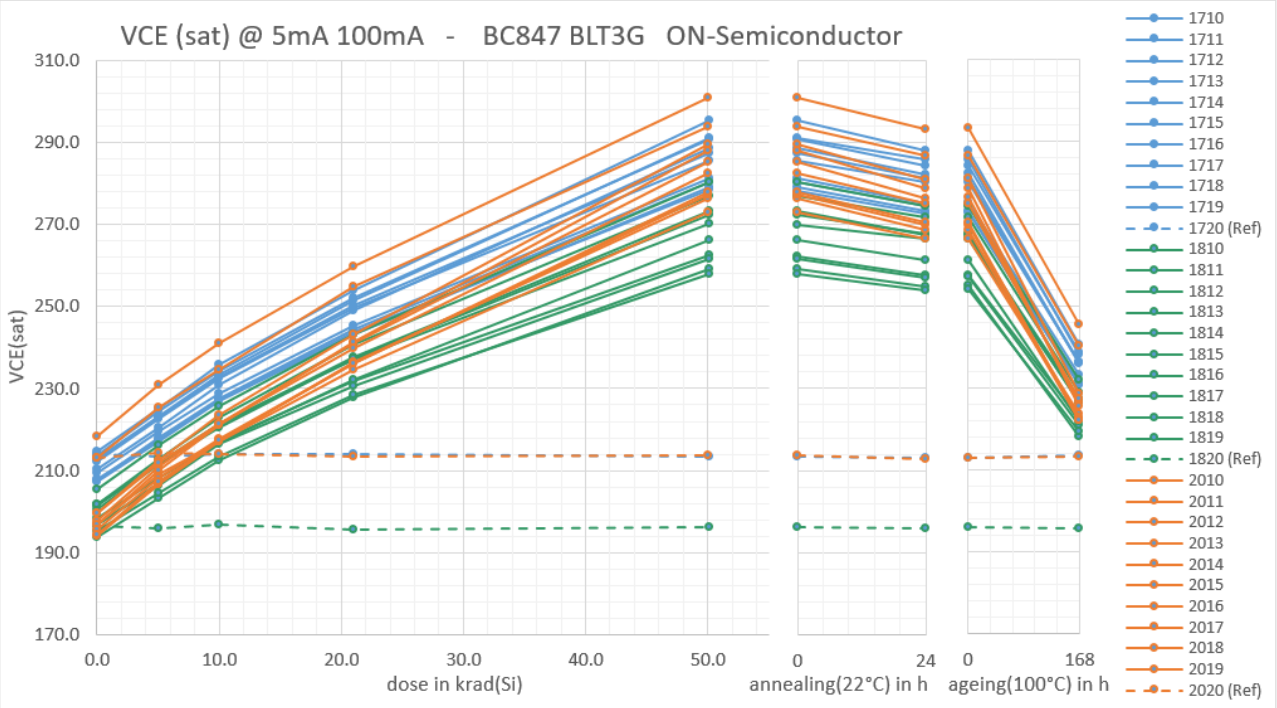


VCB0 (BR) @ 10uA BC847 BLT3G ON-Semiconductor Farnell Nov. even years							
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1710	150.6	144.1	140.9	135.2	127.4	127.9	142.5
1711	150.3	145.3	141.3	135.5	127.5	127.9	142.6
1712	150.8	145.4	141.3	135.5	127.4	128.0	142.5
1713	150.9	145.7	141.5	135.7	127.6	128.4	143.0
1714	150.8	145.2	141.2	135.5	127.3	128.0	142.8
1715	150.5	144.6	140.6	134.9	126.9	127.5	142.5
1716	150.5	145.2	141.1	135.2	127.5	128.0	142.7
1717	150.2	145.1	141.4	135.4	127.2	128.0	142.5
1718	151.2	145.7	141.7	135.7	127.9	128.0	143.2
1719	150.6	145.6	141.3	135.6	127.4	128.0	143.1
1720 (Ref)	150.9	150.1	150.7	150.8	150.9	151.8	150.9
Average	150.64	145.17	141.25	135.42	127.41	127.96	142.73
s	0.288	0.496	0.305	0.248	0.251	0.209	0.266
Average+3s	151.51	146.66	142.16	136.17	128.16	128.59	143.53
Average-3s	149.78	143.68	140.34	134.68	126.65	127.34	141.93

VCB0 (BR) @ 10uA	BC847 BLT3G ON-Semiconductor RS April odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1810	149.7	144.1	140.7	135.2	127.5	128.0	141.2
1811	148.8	143.3	139.8	134.6	127.0	127.5	140.7
1812	150.3	144.8	141.2	135.4	127.7	127.9	141.9
1813	150.5	145.7	142.2	136.5	128.8	129.2	143.2
1814	150.5	145.6	141.6	135.9	127.9	128.8	142.7
1815	151.8	145.6	141.7	136.1	128.1	128.4	142.9
1816	151.3	146.0	142.2	136.9	129.2	129.8	143.4
1817	151.1	145.2	141.4	135.6	127.7	128.2	142.6
1818	151.1	146.3	142.4	136.9	129.0	129.7	143.5
1819	149.3	144.3	140.6	135.2	128.1	128.5	141.7
1820 (Ref)	148.2	149.5	148.6	149.4	149.2	148.7	148.9
Average	150.44	145.09	141.37	135.83	128.10	128.60	142.39
s	0.945	0.947	0.840	0.784	0.710	0.760	0.961
Average+3s	153.27	147.93	143.89	138.18	130.23	130.88	145.28
Average-3s	147.60	142.25	138.85	133.48	125.97	126.32	139.51

VCB0 (BR) @ 10uA	BC847 BLT3G ON-Semiconductor Mouser Oct. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2010	141.5	138.5	135.4	130.5	124.5	125.1	137.2
2011	144.8	140.6	137.4	132.4	126.1	126.5	139.1
2012	138.7	136.0	133.3	128.8	123.0	123.1	134.5
2013	139.1	136.7	133.7	129.1	122.8	123.5	135.5
2014	138.5	135.3	132.6	127.9	122.2	122.6	134.2
2015	139.6	136.3	133.7	128.9	122.8	123.2	135.3
2016	139.2	136.3	133.6	128.9	122.6	123.0	135.1
2017	138.2	135.5	132.9	128.3	122.4	122.7	134.4
2018	139.1	135.9	133.1	128.5	122.6	122.9	134.8
2019	140.2	136.7	134.2	129.7	123.4	123.9	135.6
2020 (Ref)	144.6	144.6	144.6	144.3	146.7	144.4	144.4
Average	139.89	136.78	133.97	129.30	123.24	123.64	135.57
s	1.956	1.603	1.418	1.313	1.178	1.232	1.513
Average+3s	145.75	141.59	138.22	133.24	126.77	127.34	140.11
Average-3s	134.02	131.97	129.71	125.36	119.70	119.95	131.03

8.8 VCE (sat) @ 5mA 100mA



VCE (sat) @ 5mA 100mA			BC847 BLT3G	ON-Semiconductor	Farnell	Nov. even years	
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1710	212.2	222.5	232.4	249.5	285.5	280.2	236.4
1711	213.7	224.4	234.1	252.1	290.8	284.1	238.7
1712	210.2	220.5	230.9	248.8	288.4	282.1	236.0
1713	214.7	225.0	235.8	253.9	295.3	287.8	240.4
1714	207.3	217.0	226.8	243.3	279.0	273.2	230.9
1715	207.6	217.9	227.6	244.5	280.2	274.5	230.7
1716	212.8	223.0	232.6	250.2	287.4	281.1	236.4
1717	209.3	219.4	228.7	245.3	281.3	275.2	233.2
1718	212.8	223.2	233.4	251.3	291.0	285.7	238.1
1719	208.0	217.4	227.2	243.9	278.3	272.7	230.9
1720 (Ref)	214.0	213.4	214.0	213.9	213.6	213.1	213.6
Average	210.85	221.04	230.95	248.29	285.72	279.67	235.18
s	2.724	2.981	3.193	3.787	5.841	5.454	3.553
Average+3s	219.03	229.99	240.53	259.65	303.24	296.03	245.84
Average-3s	202.68	212.10	221.37	236.92	268.20	263.31	224.52

VCE (sat) @ 5mA 100mA	BC847 BLT3G ON-Semiconductor RS April odd years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1810	201.6	211.8	221.5	237.1	270.0	266.3	226.7
1811	198.5	208.1	217.0	231.7	262.3	257.6	222.5
1812	200.6	211.5	221.2	237.6	273.1	267.3	226.4
1813	196.9	206.2	216.6	230.4	261.5	257.1	221.1
1814	197.0	206.9	216.8	232.2	266.2	261.2	221.8
1815	193.6	203.4	212.4	227.8	259.1	254.9	218.3
1816	205.4	216.0	225.7	243.0	280.2	274.4	232.1
1817	201.8	212.9	222.9	240.7	277.0	271.7	228.9
1818	201.8	211.6	220.3	237.4	272.4	267.6	227.4
1819	195.4	204.6	213.4	228.5	257.8	254.0	219.5
1820 (Ref)	196.6	195.9	196.9	195.8	196.2	196.0	195.8
Average	199.25	209.31	218.76	234.64	267.97	263.20	224.45
s	3.582	4.067	4.248	5.244	7.740	7.233	4.489
Average+3s	210.00	221.51	231.51	250.37	291.19	284.90	237.92
Average-3s	188.51	197.11	206.02	218.91	244.74	241.50	210.98

VCE (sat) @ 5mA 100mA	BC847 BLT3G ON-Semiconductor Mouser Oct. even years						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
2010	213.1	225.5	234.5	254.8	293.8	286.7	240.2
2011	218.3	231.0	241.0	259.8	300.9	293.2	245.3
2012	196.9	209.1	217.1	234.5	273.0	266.5	223.8
2013	197.8	211.0	221.3	241.1	285.2	276.4	226.4
2014	194.2	206.8	217.2	236.4	276.2	268.6	222.1
2015	199.8	212.4	223.6	243.3	289.5	281.0	228.6
2016	196.8	210.2	221.1	241.2	288.0	278.7	225.4
2017	195.8	208.2	217.8	236.0	277.3	269.7	222.9
2018	194.3	207.4	217.4	236.0	277.9	270.3	222.2
2019	199.7	211.9	221.5	239.8	282.3	275.0	227.2
2020 (Ref)	213.0	214.2	213.9	213.6	213.7	212.9	213.1
Average	200.67	213.34	223.24	242.27	284.41	276.60	228.41
s	8.233	8.164	8.100	8.479	8.803	8.550	7.955
Average+3s	225.37	237.83	247.54	267.71	310.82	302.25	252.27
Average-3s	175.97	188.84	198.95	216.84	258.00	250.95	204.54

9 CONCLUSION

The test results of the BC847BLT3G 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

BC846ALT1G Series

General Purpose Transistors

NPN Silicon

Features

- Moisture Sensitivity Level: 1
- ESD Rating – Human Body Model: > 4000 V
  – Machine Model: > 400 V
- 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

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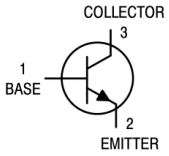
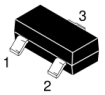
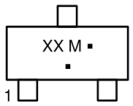




SOT–23
CASE 318
STYLE 6

MARKING DIAGRAM



XX = Device Code
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 12 of this data sheet.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage BC846 BC847, BC850 BC848, BC849	V_{CEO}	 65 45 30	Vdc
Collector–Base Voltage BC846 BC847, BC850 BC848, BC849	V_{CBO}	 80 50 30	Vdc
Emitter–Base Voltage BC846 BC847, BC850 BC848, BC849	V_{EBO}	 6.0 6.0 5.0	Vdc
Collector Current – Continuous	I_C	100	mAdc

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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 (Note 1)	$R_{\theta JA}$	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 (Note 2)	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

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

BC846ALT1G 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)	BC846A, B	$V_{(BR)CEO}$	65	–	–	V
	BC847A, B, C, BC850B, C		45	–	–	
	BC848A, B, C, BC849B, C		30	–	–	
Collector–Emitter Breakdown Voltage (I_C = 10 μA, V_{EB} = 0)	BC846A, B	$V_{(BR)CES}$	80	–	–	V
	BC847A, B, C BC850B, C		50	–	–	
	BC848A, B, C, BC849B, C		30	–	–	
Collector–Base Breakdown Voltage (I_C = 10 μA)	BC846A, B	$V_{(BR)CBO}$	80	–	–	V
	BC847A, B, C, BC850B, C		50	–	–	
	BC848A, B, C, BC849B, C		30	–	–	
Emitter–Base Breakdown Voltage (I_E = 1.0 μA)	BC846A, B	$V_{(BR)EBO}$	6.0	–	–	V
	BC847A, B, C, BC850B, C		6.0	–	–	
	BC848A, B, C, BC849B, C		5.0	–	–	
Collector Cutoff Current (V_{CB} = 30 V)		I_{CBO}	–	–	15	nA
(V_{CB} = 30 V, T_A = 150°C)			–	–	5.0	μA
ON CHARACTERISTICS						
DC Current Gain	BC846A, BC847A, BC848A	h_{FE}	–	90	–	–
(I_C = 10 μA, V_{CE} = 5.0 V)	BC846B, BC847B, BC848B		–	150	–	
	BC847C, BC848C		–	270	–	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC846A, BC847A, BC848A		110	180	220	
	BC846B, BC847B, BC848B, BC849B, BC850B		200	290	450	
	BC847C, BC848C, BC849C, BC850C		420	520	800	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{CE(sat)}$	–	–	0.25	V
(I_C = 100 mA, I_B = 5.0 mA)			–	–	0.6	
Base–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{BE(sat)}$	–	0.7	–	V
(I_C = 100 mA, I_B = 5.0 mA)			–	0.9	–	
Base–Emitter Voltage (I_C = 2.0 mA, V_{CE} = 5.0 V)		$V_{BE(on)}$	580	660	700	mV
(I_C = 10 mA, V_{CE} = 5.0 V)			–	–	770	
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_{obo}	–	–	4.5	pF
Noise Figure (I_C = 0.2 mA,		NF				dB
V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ,	BC846A,B, BC847A,B,C, BC848A,B,C		–	–	10	
f = 1.0 kHz, BW = 200 Hz)	BC849B,C, BC850B,C		–	–	4.0	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.