TOTAL IONIZING DOSE Test Report

BC847B,215 - 100mA NPN Transistor from NXP/Nexperia

Prepared by **Florian Krimmel**

Reference
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APPROVAL

Title TID Test Report BJT COTS	
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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 **BC847B,215** a **100mA NPN Transistor from NXP/Nexperia**.

2 DOCUMENTS

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

3 PART REFERENCES

REFERENCES	
Type:	BC847B,215
Manufacturer:	NXP/Nexperia
Function:	100 mA general-purpose transistors
Technology:	Bipolar NPN Silicon
PARTS PROCUREMENT	
Packaging:	SOT23 (TO-236AB)
Date Code:	batch no. 13: Dec-2018 batch no. 14: Feb-2018 batch no. 16: Jun-2018
Distributor:	batch no. 13: Farnell batch no. 14: RS Components batch no. 16: 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

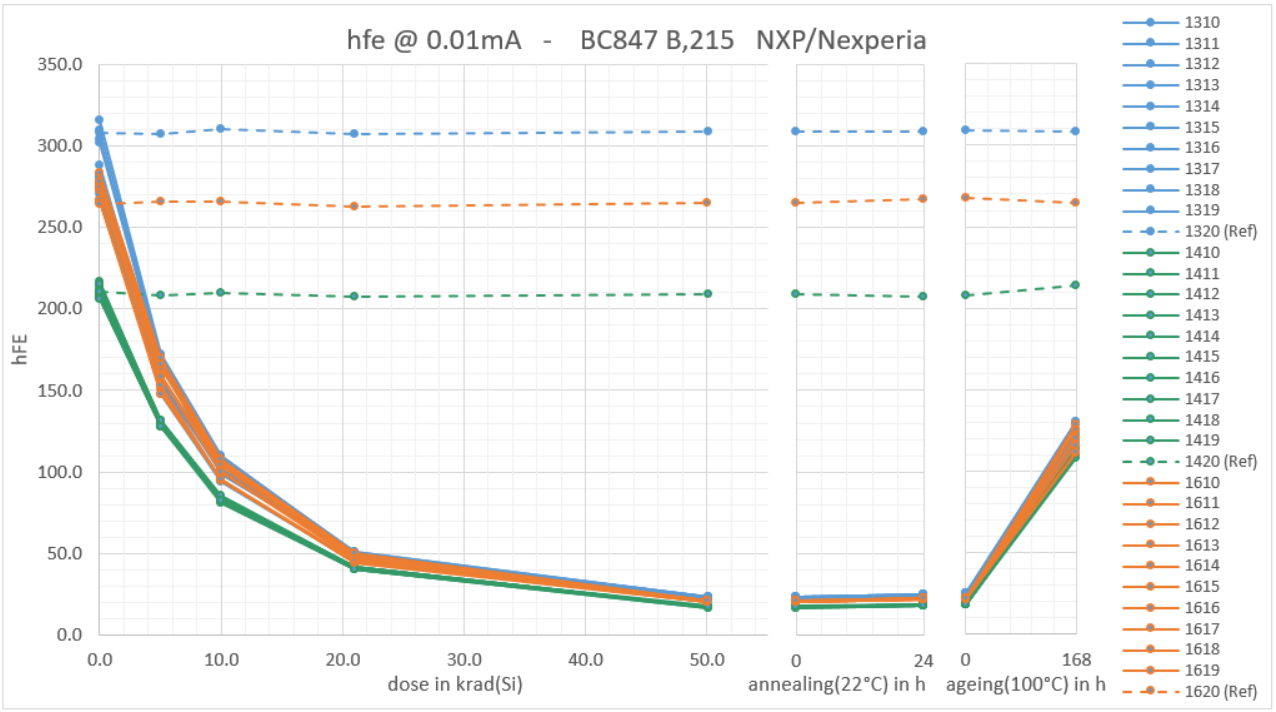
PARAMETERS	SYMBOLS	TEST CONDITIONS
Forward Current Transfer Ratio	hfe1	Ic= 0.01mA, Vce = 1V
	hfe2	Ic= 0.1mA, Vce = 1V
	hfe3	Ic= 1mA, Vce = 1V
	hfe4	Ic= 10mA, Vce = 1V
	hfe5	Ic= 100mA, Vce = 1V
Collector-Emitter Breakdown Voltage	VCEo (BR)	Ic = 10mA
Collector-Base Breakdown Voltage	VCBo (BR)	Ic = 10uA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

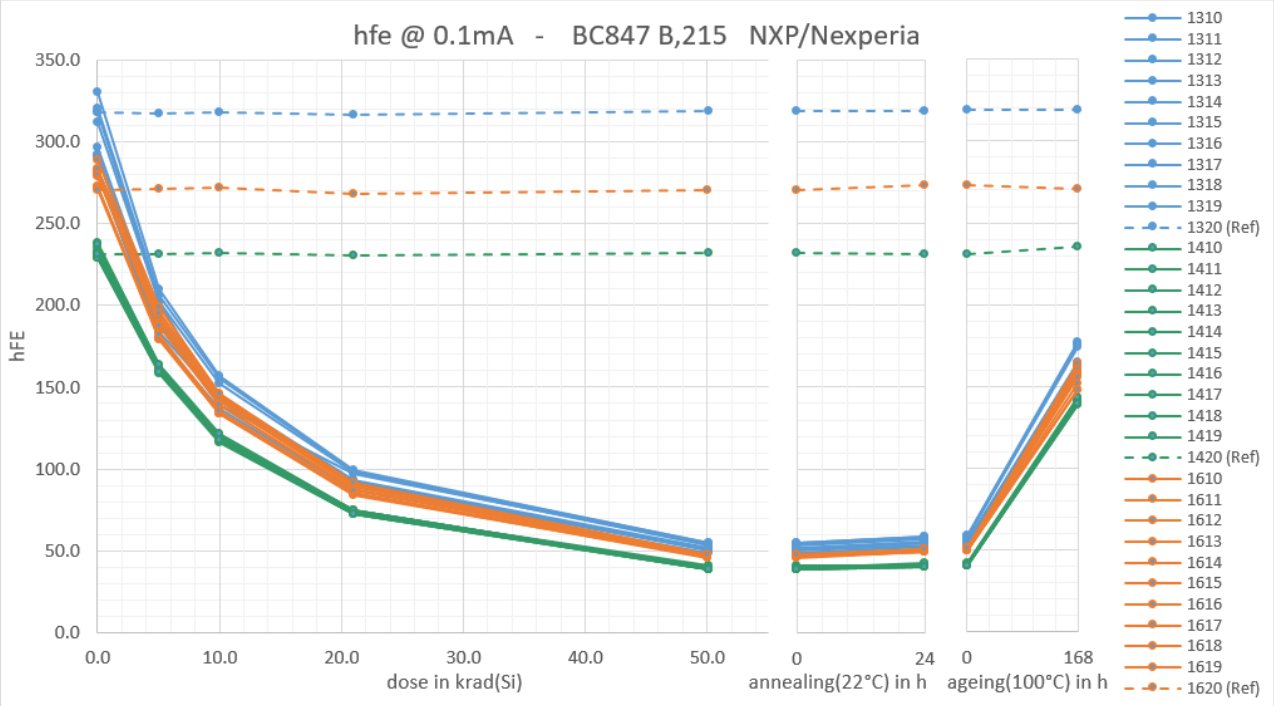


hfe @ 0.01mA	BC847 B,215 NXP/Nexperia Farnell Dec-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1310	280.3	155.7	99.5	48.5	22.5	24.0	121.0
1311	281.0	156.1	101.5	48.2	22.5	24.0	122.5
1312	270.0	153.0	101.5	49.2	22.0	23.3	118.3
1313	303.7	166.8	98.7	50.0	23.5	25.1	128.7
1314	315.3	172.3	110.2	50.6	23.7	25.3	125.4
1315	282.2	154.8	101.4	47.5	22.3	23.8	121.2
1316	287.7	158.8	102.0	48.0	22.5	24.0	122.6
1317	273.6	147.7	94.3	44.7	21.3	22.8	117.0
1318	309.4	171.0	109.1	51.1	23.6	25.2	130.2
1319	301.8	167.2	108.4	50.9	23.3	24.8	130.2
1320 (Ref)	307.9	307.4	309.9	307.4	308.3	308.8	308.1
Average	290.52	160.34	102.65	48.87	22.71	24.24	123.71
s	15.824	8.368	5.070	1.948	0.795	0.849	4.730
Average+3s	337.99	185.45	117.86	54.71	25.09	26.79	137.90
Average-3s	243.05	135.24	87.43	43.02	20.32	21.69	109.52

hfe @ 0.01mA	BC847 B,215 NXP/Nexperia RS Feb-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1410	209.9	130.0	83.7	41.7	17.5	18.6	111.2
1411	216.4	130.5	84.0	41.7	17.6	18.6	108.4
1412	213.6	131.2	84.2	41.5	17.3	18.5	114.4
1413	209.4	128.4	82.4	40.6	16.9	18.2	112.8
1414	211.1	130.3	81.9	41.2	17.2	18.4	113.5
1415	207.6	128.1	83.2	41.1	18.3	18.7	112.9
1416	206.8	127.3	80.7	40.6	16.8	18.1	111.0
1417	208.2	130.0	84.0	40.9	17.1	18.3	111.5
1418	215.2	131.9	85.9	41.9	17.4	19.2	114.5
1419	206.1	127.4	82.7	40.5	17.0	18.2	110.3
1420 (Ref)	210.3	208.5	209.5	207.6	209.1	207.8	214.0
Average	210.41	129.51	83.28	41.18	17.32	18.49	112.04
s	3.580	1.597	1.440	0.521	0.426	0.323	1.929
Average+3s	221.15	134.30	87.60	42.75	18.59	19.46	117.83
Average-3s	199.67	124.72	78.96	39.62	16.04	17.52	106.25

hfe @ 0.01mA	BC847 B,215 NXP/Nexperia Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
1610	275.0	158.4	104.2	48.3	20.7	22.4	120.7
1611	265.6	150.3	94.9	44.5	20.2	21.6	111.0
1612	277.5	166.3	106.0	49.0	20.8	22.4	125.0
1613	272.5	159.0	101.1	47.1	20.6	22.1	120.0
1614	266.5	148.0	95.5	44.1	20.2	21.6	111.7
1615	266.3	153.2	95.8	45.6	20.3	22.0	116.0
1616	274.9	163.8	104.0	48.2	20.9	22.4	125.1
1617	275.0	158.4	100.4	46.5	20.6	22.2	120.1
1618	278.1	165.9	105.1	48.9	20.8	22.3	125.7
1619	283.4	169.8	107.8	50.2	20.8	22.4	129.0
1620 (Ref)	264.5	265.7	265.7	263.0	265.0	267.6	264.6
Average	273.48	159.31	101.47	47.25	20.59	22.13	120.43
s	5.829	7.221	4.694	2.024	0.281	0.302	6.041
Average+3s	290.97	180.97	115.56	53.32	21.44	23.04	138.56
Average-3s	256.00	137.64	87.39	41.17	19.75	21.23	102.31

8.2 hfe @ 0.1 mA

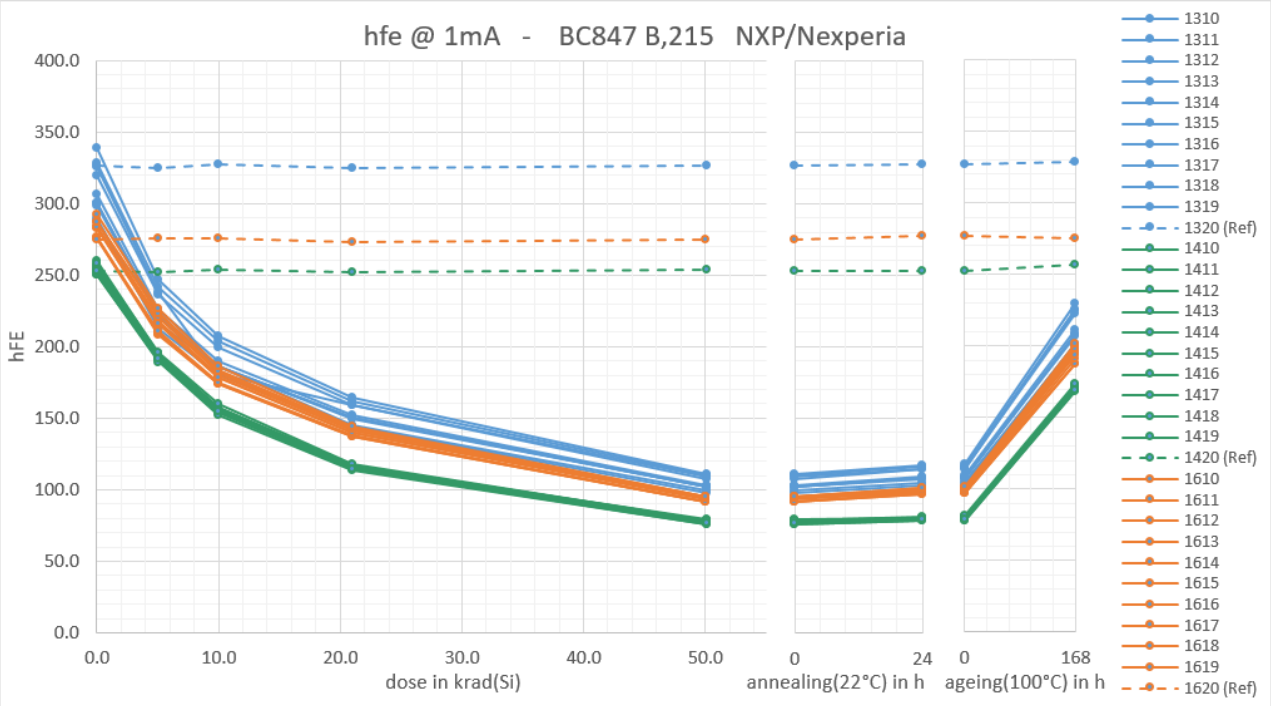


hfe @ 0.1mA	BC847 B,215 NXP/Nexperia Farnell Dec-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1310	291.9	190.6	143.4	92.6	51.3	55.1	161.4
1311	290.2	188.5	142.5	92.2	51.3	55.0	163.5
1312	279.5	183.8	142.5	91.2	50.2	53.4	157.3
1313	317.7	202.4	139.3	96.9	54.0	58.0	173.8
1314	330.2	209.4	157.1	99.1	54.7	58.9	177.0
1315	291.8	188.0	142.6	91.4	51.1	54.7	162.2
1316	296.1	191.5	145.3	92.8	51.7	55.4	164.6
1317	282.0	179.4	137.0	87.1	48.8	52.5	157.1
1318	320.0	206.1	155.4	98.6	54.6	58.6	175.9
1319	311.5	201.9	152.5	97.5	53.7	57.5	175.9
1320 (Ref)	318.1	316.9	318.1	316.3	318.4	318.8	319.3
Average	301.09	194.16	145.76	93.95	52.13	55.92	166.87
s	17.413	10.096	6.851	3.888	2.010	2.207	7.942
Average+3s	353.32	224.45	166.31	105.61	58.16	62.54	190.70
Average-3s	248.85	163.87	125.21	82.28	46.10	49.30	143.04

hfe @ 0.1mA	BC847 B,215 NXP/Nexperia RS Feb-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1410	232.9	162.8	119.1	74.9	39.8	41.6	139.3
1411	238.4	162.7	119.9	75.0	39.8	41.6	140.8
1412	235.1	162.9	120.0	74.4	39.5	41.2	142.5
1413	229.8	160.0	116.8	72.9	38.6	40.3	140.1
1414	232.3	161.2	118.5	73.9	39.2	41.0	141.1
1415	230.7	161.0	118.6	73.9	40.8	41.5	140.6
1416	229.0	158.4	116.4	72.8	38.4	40.3	138.7
1417	230.8	161.8	119.6	73.7	39.0	40.9	140.4
1418	237.1	163.5	121.7	75.2	39.7	42.3	143.5
1419	229.1	159.0	117.9	72.9	39.0	40.6	139.5
1420 (Ref)	231.3	230.9	232.0	230.2	231.8	231.2	235.5
Average	232.52	161.34	118.84	73.95	39.37	41.12	140.66
s	3.334	1.747	1.600	0.917	0.700	0.634	1.448
Average+3s	242.52	166.58	123.64	76.70	41.47	43.03	145.00
Average-3s	222.51	156.09	114.04	71.20	37.27	39.22	136.31

hfe @ 0.1mA	BC847 B,215 NXP/Nexperia Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
1610	280.1	190.7	141.8	89.3	47.3	50.9	156.9
1611	271.1	179.4	134.1	84.6	45.9	49.6	148.1
1612	282.8	196.2	144.6	90.3	47.5	51.3	161.4
1613	278.7	187.7	139.5	87.8	46.9	50.6	156.3
1614	272.2	179.6	134.0	84.3	46.2	49.6	148.2
1615	271.7	182.1	135.3	85.5	46.2	49.9	151.6
1616	279.9	192.7	142.4	89.2	47.5	51.2	159.7
1617	280.0	187.6	139.0	87.2	47.1	50.6	155.7
1618	283.2	195.0	143.7	90.2	47.4	51.1	161.0
1619	288.6	199.1	146.4	91.8	47.7	51.5	164.0
1620 (Ref)	270.3	271.4	271.7	267.9	270.2	273.1	270.7
Average	278.84	189.00	140.07	88.02	46.96	50.62	156.29
s	5.672	6.990	4.453	2.583	0.663	0.691	5.527
Average+3s	295.86	209.97	153.43	95.76	48.95	52.69	172.87
Average-3s	261.82	168.03	126.71	80.27	44.97	48.55	139.71

8.3 hfe @ 1 mA

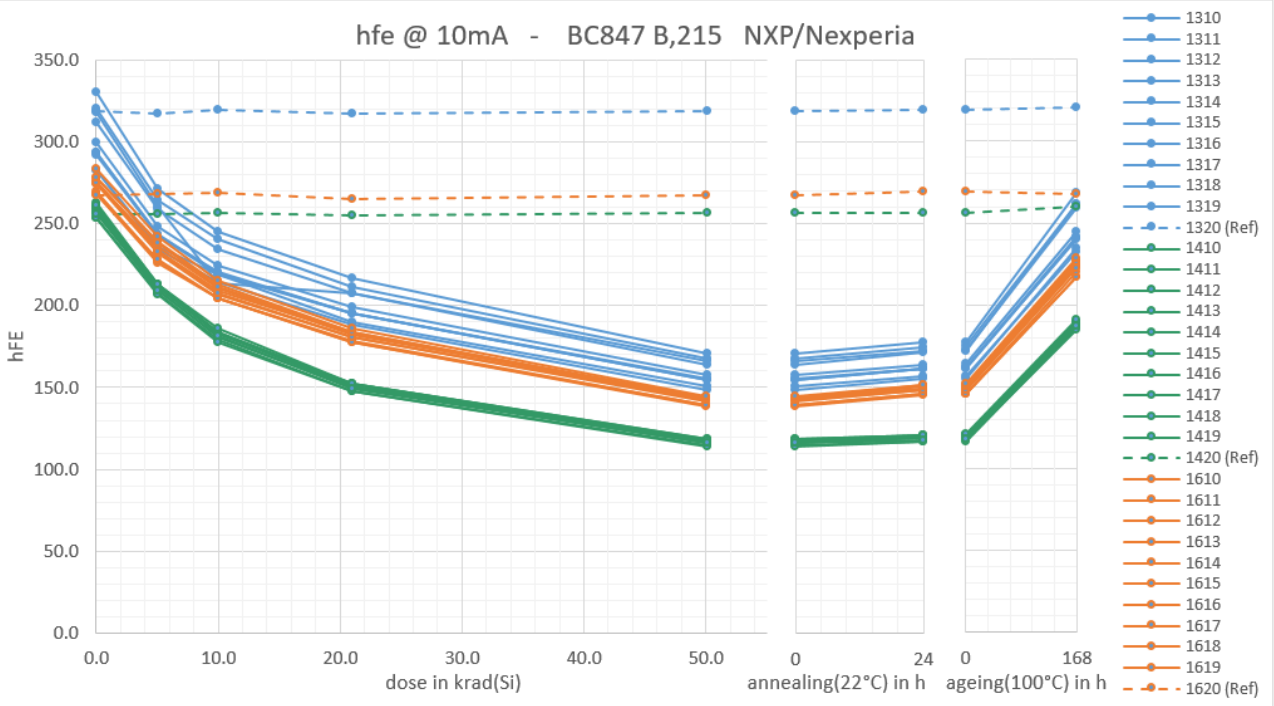


hfe @ 1mA	BC847 B,215 NXP/Nexperia Farnell Dec-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1310	300.0	222.7	186.7	150.4	102.2	108.2	206.7
1311	298.5	221.3	185.9	150.0	102.1	108.1	208.5
1312	288.3	215.7	185.9	144.9	99.5	105.0	201.0
1313	325.8	237.7	181.3	159.2	109.1	114.7	222.8
1314	338.9	247.0	207.0	164.5	111.2	117.3	229.4
1315	299.8	220.9	186.4	149.7	102.5	107.9	207.5
1316	306.1	226.0	190.1	152.3	103.4	109.2	211.1
1317	289.4	212.2	180.3	143.8	97.5	103.3	201.8
1318	327.9	241.5	203.7	161.8	109.7	116.1	225.2
1319	319.6	236.5	199.2	159.2	107.6	114.2	225.2
1320 (Ref)	326.7	324.8	327.5	324.9	326.8	327.0	328.4
Average	309.42	228.16	190.65	153.58	104.48	110.40	213.92
s	17.456	11.727	9.356	7.141	4.626	4.841	10.647
Average+3s	361.79	263.34	218.72	175.00	118.36	124.92	245.86
Average-3s	257.05	192.98	162.58	132.16	90.61	95.88	181.98

hfe @ 1mA	BC847 B,215 NXP/Nexperia RS Feb-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1410	256.0	194.8	156.6	117.2	78.4	80.6	169.5
1411	259.9	194.9	157.3	117.5	78.5	80.6	170.9
1412	256.1	194.0	156.9	116.6	77.8	80.0	172.4
1413	250.6	190.5	153.5	114.2	76.2	78.4	169.3
1414	253.6	192.6	155.2	115.7	77.2	79.5	170.9
1415	254.2	193.1	155.9	116.0	79.2	80.2	171.0
1416	250.3	189.3	152.5	113.8	75.9	78.1	168.1
1417	254.0	193.8	157.3	115.8	77.1	79.4	170.8
1418	258.4	195.7	160.1	117.6	78.3	81.6	173.8
1419	252.0	191.2	155.0	114.7	76.8	79.0	169.4
1420 (Ref)	252.9	252.2	253.5	251.8	253.3	252.7	257.2
Average	254.49	192.97	156.03	115.91	77.54	79.74	170.63
s	3.156	2.071	2.143	1.330	1.053	1.070	1.649
Average+3s	263.96	199.18	162.46	119.90	80.70	82.95	175.57
Average-3s	245.03	186.76	149.60	111.92	74.38	76.53	165.68

hfe @ 1mA	BC847 B,215 NXP/Nexperia Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
1610	283.8	218.0	180.2	141.8	94.2	99.7	195.2
1611	275.4	208.3	174.2	136.9	91.5	97.3	187.7
1612	286.6	223.8	183.9	142.9	94.8	101.0	199.5
1613	282.4	215.9	178.4	140.2	93.3	99.1	194.7
1614	276.6	209.0	173.9	136.9	91.8	97.3	187.7
1615	275.8	210.9	174.9	137.7	92.0	97.7	191.0
1616	283.4	220.4	181.7	141.6	94.8	100.0	197.4
1617	283.9	216.1	178.5	140.0	94.2	99.1	194.1
1618	287.1	222.8	183.1	142.8	94.6	100.7	198.5
1619	292.2	226.9	186.3	144.6	95.3	101.3	201.8
1620 (Ref)	274.6	275.7	276.0	272.7	274.7	277.1	275.3
Average	282.71	217.21	179.51	140.53	93.65	99.31	194.75
s	5.429	6.418	4.293	2.702	1.403	1.510	4.811
Average+3s	298.99	236.46	192.39	148.63	97.86	103.84	209.18
Average-3s	266.42	197.95	166.63	132.42	89.44	94.78	180.32

8.4 hfe @ 10 mA

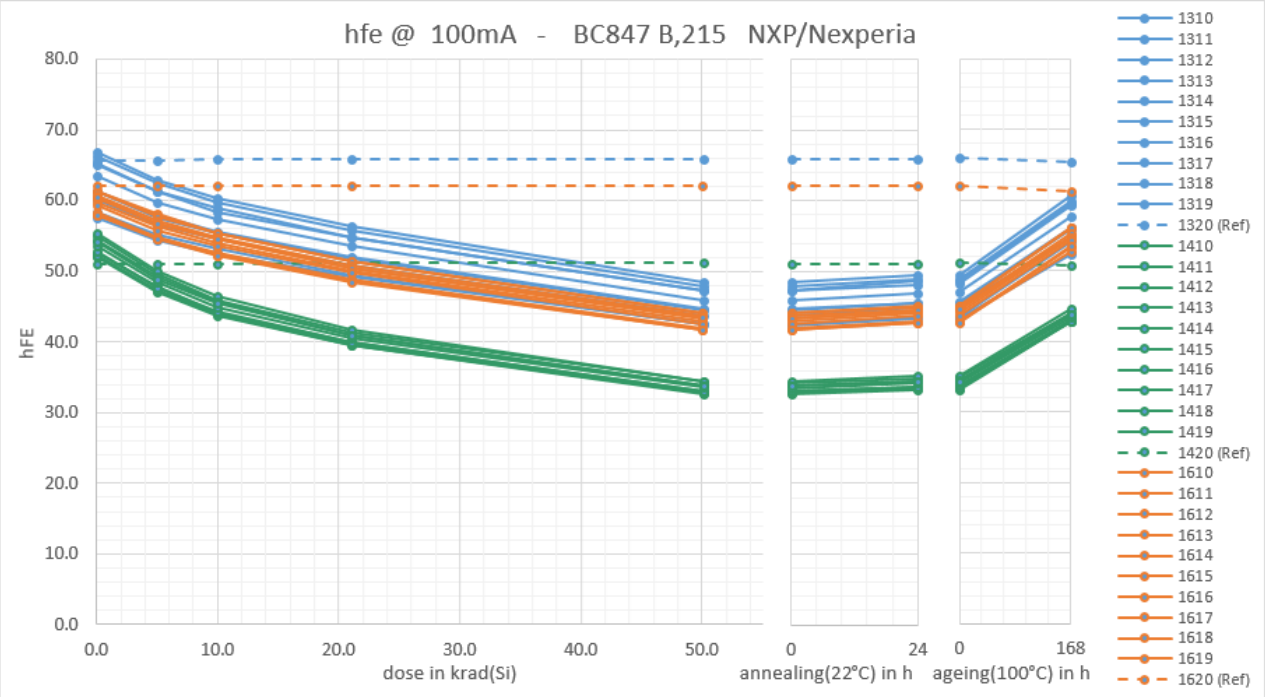


hfe @ 10mA	BC847 B,215 NXP/Nexperia Farnell Dec-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1310	293.1	243.5	219.7	195.4	154.6	161.7	239.7
1311	292.1	242.6	219.2	195.0	154.6	161.6	242.0
1312	282.2	235.9	219.2	190.0	150.6	156.7	232.6
1313	317.7	260.6	213.5	207.7	165.9	172.4	259.3
1314	330.4	271.4	245.1	216.3	171.0	177.4	268.4
1315	292.9	242.4	220.1	195.2	155.4	161.4	240.8
1316	299.3	247.9	224.3	198.8	157.3	163.9	244.9
1317	282.9	234.0	214.0	188.0	148.3	155.2	234.6
1318	320.0	264.4	240.2	211.6	167.2	174.7	261.8
1319	311.8	258.8	234.6	207.5	163.8	171.5	261.8
1320 (Ref)	318.7	316.9	319.3	316.9	318.8	319.1	320.7
Average	302.23	250.14	224.99	200.55	158.86	165.66	248.60
s	16.661	12.776	11.051	9.574	7.615	7.759	12.927
Average+3s	352.21	288.47	258.14	229.27	181.71	188.94	287.38
Average-3s	252.25	211.81	191.83	171.82	136.02	142.38	209.82

hfe @ 10mA	BC847 B,215 NXP/Nexperia RS Feb-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1410	260.5	212.9	182.9	152.0	118.2	120.5	187.5
1411	262.7	212.5	183.4	152.2	118.3	120.6	188.7
1412	259.2	211.4	182.9	151.0	117.2	119.8	189.7
1413	253.3	207.4	178.8	147.6	114.8	116.9	186.1
1414	256.6	209.8	180.7	149.9	116.4	119.0	187.9
1415	259.2	211.6	182.6	150.7	118.1	120.3	188.7
1416	253.5	206.5	177.8	147.3	114.1	117.1	185.0
1417	258.4	212.0	183.6	150.5	116.5	119.2	188.4
1418	261.3	213.1	185.8	152.2	118.1	120.9	191.1
1419	256.4	209.2	181.4	149.0	116.2	118.1	186.9
1420 (Ref)	256.1	255.5	256.9	255.1	256.7	256.1	260.4
Average	258.12	210.65	181.98	150.23	116.77	119.24	188.00
s	3.133	2.311	2.358	1.793	1.472	1.448	1.747
Average+3s	267.52	217.59	189.06	155.61	121.19	123.59	193.24
Average-3s	248.72	203.72	174.90	144.85	112.36	114.90	182.76

hfe @ 10mA	BC847 B,215 NXP/Nexperia Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
1610	275.4	233.7	208.8	182.5	142.6	149.2	223.2
1611	267.9	226.1	204.0	177.2	138.6	145.6	217.1
1612	277.9	239.0	212.4	183.8	143.7	151.1	227.2
1613	273.8	231.8	207.0	180.7	141.5	148.2	223.0
1614	269.1	227.2	204.2	177.9	139.5	145.8	217.3
1615	268.1	228.0	204.4	177.8	139.3	146.0	219.9
1616	274.7	235.8	210.4	182.1	143.5	149.5	224.6
1617	275.2	232.6	207.7	180.8	142.5	148.1	222.5
1618	278.2	237.9	211.6	183.6	143.3	150.6	225.9
1619	283.3	241.6	214.7	186.0	144.7	151.8	228.8
1620 (Ref)	267.2	268.2	268.4	265.2	267.1	269.4	267.8
Average	274.37	233.37	208.52	181.24	141.91	148.60	222.95
s	4.899	5.274	3.744	2.912	2.111	2.251	3.943
Average+3s	289.07	249.19	219.75	189.97	148.25	155.35	234.78
Average-3s	259.67	217.55	197.28	172.50	135.58	141.85	211.12

8.5 hfe @ 100 mA

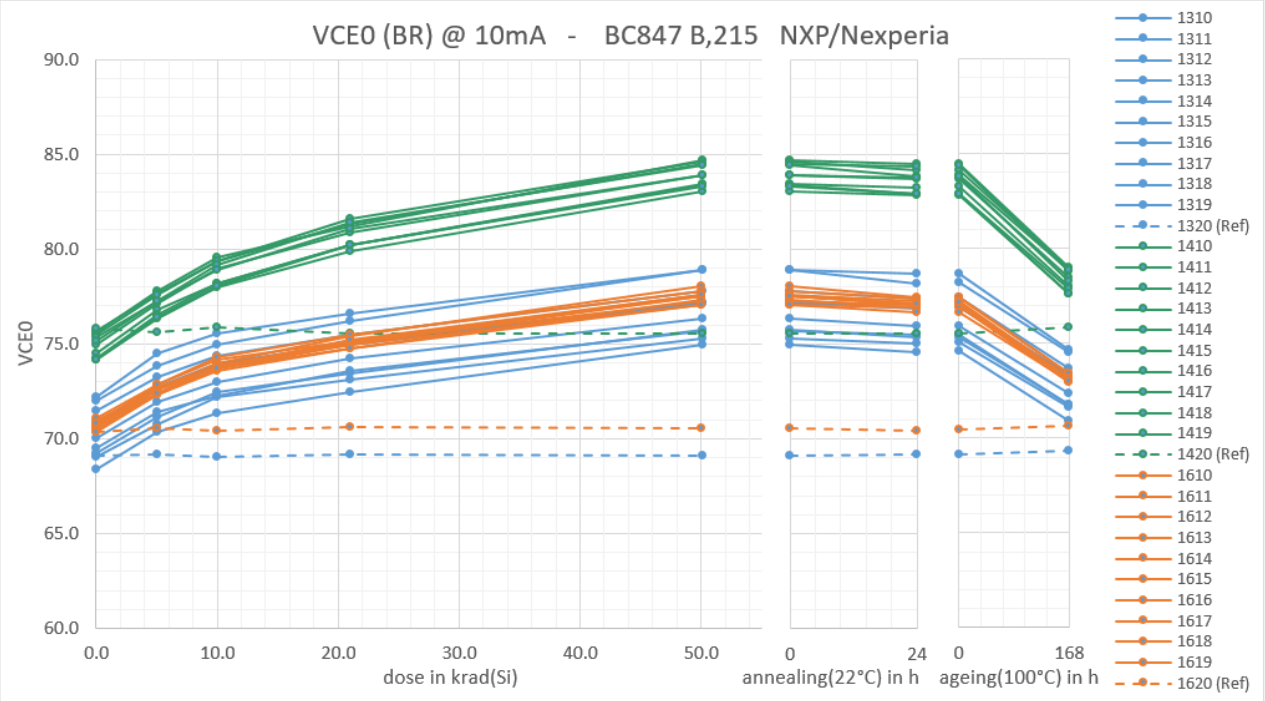


hfe @ 100mA	BC847 B,215 NXP/Nexperia Farnell Dec-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1310	61.4	57.9	55.6	52.0	44.8	45.6	56.2
1311	61.2	57.6	55.4	51.8	44.6	45.5	55.9
1312	57.6	54.4	52.4	49.2	42.4	43.3	52.3
1313	65.3	61.4	58.3	54.8	47.4	48.6	59.4
1314	66.2	62.5	59.8	55.7	47.8	48.8	59.8
1315	60.1	56.7	54.5	50.9	43.8	45.0	54.8
1316	63.5	59.8	57.3	53.5	46.0	46.9	57.8
1317	58.4	55.3	53.1	49.5	42.5	43.5	54.1
1318	66.8	62.9	60.3	56.3	48.5	49.4	60.7
1319	65.1	61.4	58.9	54.8	47.2	48.1	59.3
1320 (Ref)	65.7	65.7	66.0	66.0	66.0	66.0	65.3
Average	62.58	58.99	56.57	52.87	45.50	46.46	57.03
s	3.279	3.050	2.764	2.561	2.191	2.230	2.790
Average+3s	72.41	68.14	64.86	60.55	52.07	53.15	65.40
Average-3s	52.74	49.84	48.28	45.19	38.92	39.77	48.66

hfe @ 100mA	BC847 B,215 NXP/Nexperia RS Feb-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1410	55.0	49.6	46.0	41.4	34.3	34.9	44.1
1411	52.6	47.8	44.2	40.0	33.1	33.7	43.1
1412	52.2	47.4	43.9	39.7	32.8	33.4	43.0
1413	52.0	47.1	43.7	39.5	32.6	33.2	42.9
1414	52.3	47.4	44.1	39.7	32.8	33.4	42.8
1415	55.4	50.1	46.5	41.8	34.5	35.2	44.6
1416	52.7	47.7	44.3	40.0	33.1	33.7	42.9
1417	54.4	49.2	45.7	41.0	33.8	34.5	43.9
1418	53.5	48.4	45.0	40.5	33.5	34.2	43.5
1419	54.1	48.9	45.5	40.9	33.8	34.4	43.9
1420 (Ref)	51.0	51.0	51.0	51.1	51.1	51.1	50.8
Average	53.43	48.36	44.87	40.44	33.45	34.05	43.46
s	1.236	1.060	0.974	0.796	0.659	0.682	0.623
Average+3s	57.14	51.54	47.79	42.83	35.43	36.10	45.33
Average-3s	49.72	45.18	41.95	38.05	31.47	32.01	41.59

hfe @ 100mA	BC847 B,215 NXP/Nexperia Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
1610	60.3	56.8	54.5	50.5	43.3	44.4	55.0
1611	61.4	58.1	55.4	51.4	44.1	45.1	56.2
1612	57.9	54.7	52.3	48.7	41.8	42.8	53.4
1613	59.8	56.3	54.0	50.1	43.0	44.1	54.8
1614	61.4	57.8	55.4	51.4	44.1	45.0	56.0
1615	60.7	57.1	54.8	50.9	43.7	44.6	55.3
1616	58.3	54.8	52.6	48.8	42.0	42.9	52.9
1617	60.5	56.8	54.5	50.5	43.4	44.6	54.8
1618	59.3	55.7	53.5	49.8	42.5	43.7	54.4
1619	57.9	54.5	52.2	48.5	41.7	42.7	53.5
1620 (Ref)	62.2	62.2	62.2	62.2	62.2	62.2	61.2
Average	59.75	56.27	53.93	50.06	42.96	43.97	54.63
s	1.345	1.282	1.234	1.086	0.925	0.898	1.102
Average+3s	63.79	60.12	57.64	53.32	45.74	46.67	57.94
Average-3s	55.72	52.43	50.23	46.80	40.19	41.28	51.33

8.6 VCEo (BR) @ 10mA

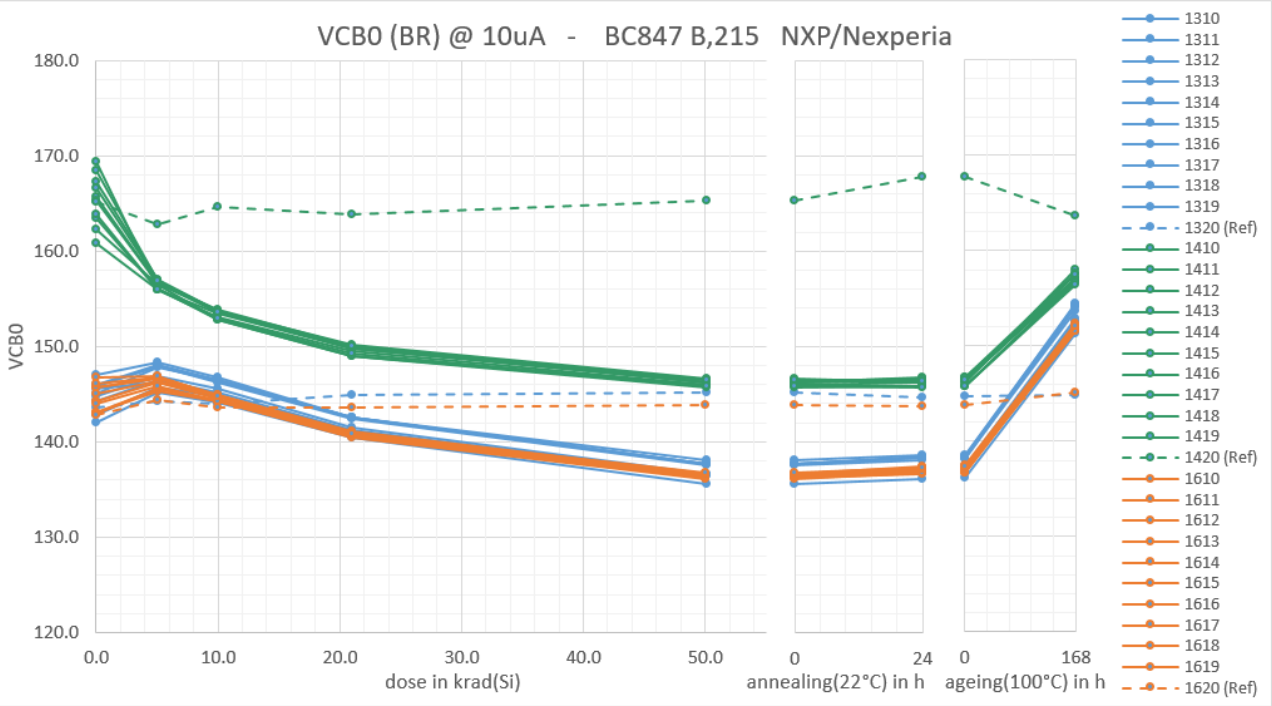


VCE0 (BR) @ 10mA	BC847 B,215 NXP/Nexperia Farnell Dec-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1310	70.7	72.6	73.9	75.0	77.1	77.1	73.3
1311	70.7	72.7	74.0	75.0	77.2	76.9	73.4
1312	72.0	73.8	75.0	76.2	78.9	78.2	74.6
1313	69.5	71.4	72.3	73.6	75.6	75.5	71.8
1314	68.4	70.3	71.3	72.5	74.9	74.6	70.9
1315	71.5	73.3	74.4	75.5	77.8	77.4	73.7
1316	70.0	71.9	73.0	74.2	76.3	75.9	72.4
1317	72.2	74.5	75.6	76.6	78.9	78.7	74.6
1318	69.0	70.8	72.2	73.1	75.3	75.0	71.6
1319	69.3	71.1	72.5	73.4	75.7	75.3	71.7
1320 (Ref)	69.1	69.2	69.1	69.2	69.1	69.1	69.3
Average	70.33	72.24	73.41	74.51	76.78	76.46	72.80
s	1.304	1.371	1.362	1.366	1.428	1.395	1.294
Average+3s	74.24	76.36	77.50	78.61	81.07	80.65	76.68
Average-3s	66.42	68.13	69.33	70.42	72.50	72.28	68.92

VCE0 (BR) @ 10mA	BC847 B,215 NXP/Nexperia RS Feb-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1410	74.5	76.8	78.2	80.2	83.4	83.2	78.0
1411	75.0	77.1	79.0	80.8	83.9	83.7	78.5
1412	75.6	77.8	79.6	81.2	84.7	84.5	79.0
1413	75.6	77.6	79.4	81.6	84.6	84.1	79.0
1414	75.5	77.6	79.3	81.4	84.5	84.4	78.8
1415	74.1	76.3	78.0	79.9	83.1	82.8	77.6
1416	75.3	77.3	79.1	81.4	84.4	83.9	78.8
1417	74.2	76.5	78.2	80.2	83.4	82.9	77.9
1418	75.2	77.3	78.9	81.1	83.9	83.8	78.3
1419	74.2	76.4	78.0	80.2	83.3	82.9	77.6
1420 (Ref)	75.8	75.6	75.9	75.5	75.6	75.5	75.9
Average	74.92	77.06	78.76	80.80	83.91	83.61	78.35
s	0.614	0.522	0.613	0.611	0.612	0.616	0.547
Average+3s	76.77	78.63	80.60	82.63	85.75	85.46	79.99
Average-3s	73.08	75.50	76.92	78.97	82.08	81.76	76.71

VCE0 (BR) @ 10mA	BC847 B,215 NXP/Nexperia Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
1610	70.7	72.6	73.7	75.0	77.5	77.0	73.1
1611	70.6	72.4	73.9	75.1	77.2	77.1	73.2
1612	71.0	72.7	74.0	75.4	78.0	77.5	73.4
1613	70.7	72.3	73.7	74.9	77.1	77.0	72.9
1614	71.1	72.9	74.2	75.2	77.5	77.1	73.2
1615	70.6	72.7	73.7	74.8	77.3	76.9	73.1
1616	70.8	72.8	74.3	75.5	77.8	77.4	73.4
1617	70.4	72.3	73.6	74.8	77.1	76.6	73.0
1618	70.5	72.3	73.8	75.1	77.6	77.3	73.1
1619	70.8	72.4	73.7	75.2	77.6	77.1	73.0
1620 (Ref)	70.4	70.5	70.5	70.6	70.6	70.4	70.6
Average	70.72	72.55	73.86	75.10	77.47	77.10	73.14
s	0.211	0.221	0.231	0.238	0.306	0.239	0.163
Average+3s	71.35	73.21	74.55	75.81	78.39	77.82	73.63
Average-3s	70.08	71.88	73.16	74.39	76.55	76.39	72.66

8.7 VCB0 (BR) @ 10uA

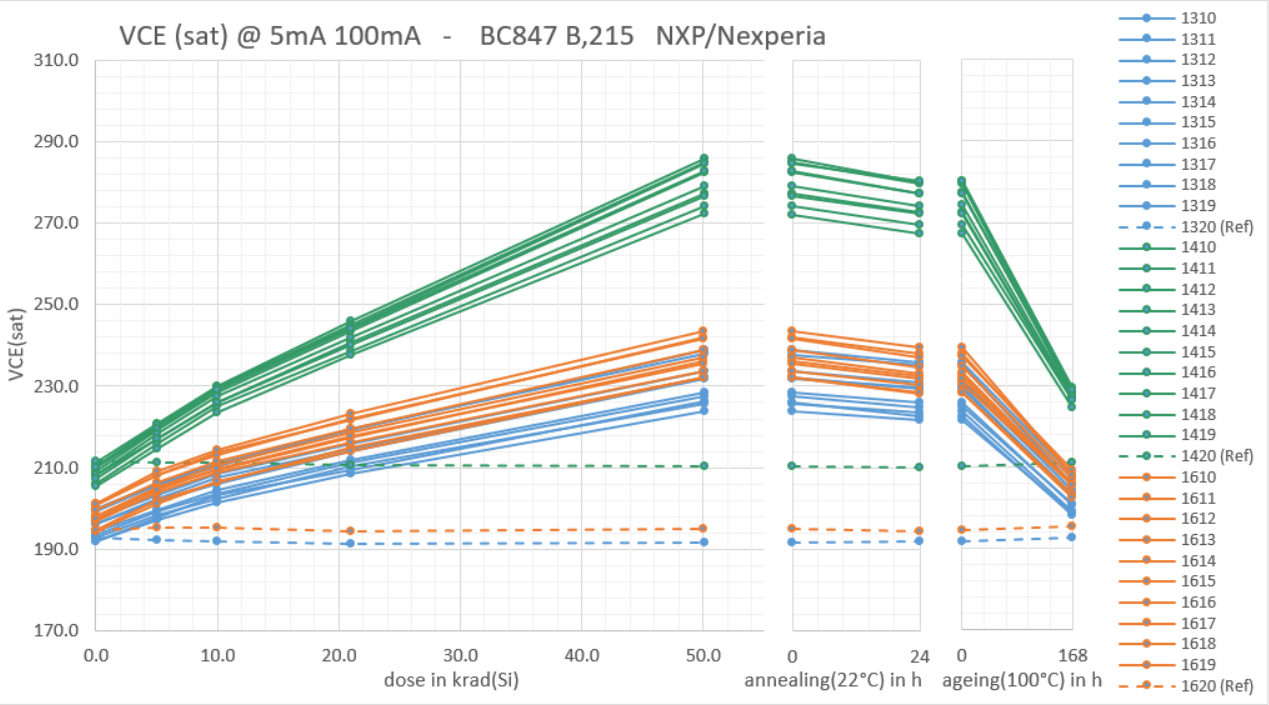


VCB0 (BR) @ 10uA BC847 B,215 NXP/Nexperia Farnell Dec-2018							
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1310	145.9	148.0	146.3	142.4	137.6	138.1	154.2
1311	145.8	147.9	146.3	142.6	137.7	138.3	153.6
1312	147.0	148.3	146.7	142.5	137.7	138.5	154.4
1313	144.2	146.5	145.2	141.2	136.6	137.2	152.5
1314	142.0	145.1	144.2	140.4	135.6	136.1	151.3
1315	146.0	148.1	146.4	142.6	137.7	138.3	154.0
1316	144.8	146.9	145.6	141.5	136.7	137.3	152.9
1317	145.1	147.9	146.4	142.6	138.0	138.5	154.3
1318	142.8	145.7	144.7	140.9	136.4	137.0	152.5
1319	145.5	146.2	144.9	141.0	136.4	137.0	152.5
1320 (Ref)	143.6	144.2	144.0	144.9	145.2	144.7	144.8
Average	144.90	147.05	145.67	141.77	137.05	137.63	153.22
s	1.529	1.127	0.892	0.838	0.805	0.820	1.055
Average+3s	149.49	150.43	148.35	144.28	139.46	140.09	156.38
Average-3s	140.31	143.67	143.00	139.25	134.63	135.17	150.05

VCB0 (BR) @ 10uA	BC847 B,215 NXP/Nexperia RS Feb-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1410	163.5	156.0	153.1	149.5	145.9	146.2	157.9
1411	160.8	156.0	153.4	149.8	146.2	146.5	156.9
1412	165.7	156.6	153.6	149.8	146.2	146.4	157.0
1413	165.3	156.5	153.9	150.1	146.3	146.8	157.6
1414	168.4	156.9	153.8	150.1	146.6	146.3	157.1
1415	162.2	156.5	152.8	149.0	145.7	145.8	156.8
1416	167.2	157.0	153.7	149.8	146.4	146.6	157.1
1417	169.3	156.0	152.7	149.0	146.0	145.8	156.6
1418	166.6	156.8	153.6	150.0	146.5	146.4	157.4
1419	163.8	156.0	152.9	149.3	145.9	145.7	156.4
1420 (Ref)	165.1	162.8	164.7	163.9	165.3	167.8	163.6
Average	165.29	156.43	153.34	149.65	146.17	146.26	157.09
s	2.714	0.420	0.432	0.414	0.310	0.356	0.463
Average+3s	173.43	157.69	154.64	150.89	147.10	147.33	158.48
Average-3s	157.14	155.17	152.04	148.41	145.24	145.20	155.70

VCB0 (BR) @ 10uA	BC847 B,215 NXP/Nexperia Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
1610	145.1	146.4	144.7	140.8	136.5	137.2	151.8
1611	143.0	145.5	144.3	140.4	136.1	136.8	151.8
1612	145.7	146.6	144.8	140.8	136.5	137.1	152.1
1613	144.3	146.2	144.6	140.7	136.5	137.1	151.6
1614	143.1	145.4	144.2	140.7	136.5	136.9	151.8
1615	142.9	145.5	144.3	140.7	136.2	136.6	151.7
1616	145.7	146.8	144.9	141.0	136.7	137.4	152.4
1617	144.0	145.8	144.3	140.5	136.4	136.8	151.5
1618	146.1	146.7	144.9	140.9	136.6	137.1	152.0
1619	146.8	146.9	144.8	140.9	136.7	137.3	152.1
1620 (Ref)	142.8	144.4	143.7	143.6	143.9	143.8	145.1
Average	144.67	146.18	144.59	140.77	136.46	137.04	151.88
s	1.401	0.577	0.273	0.173	0.196	0.249	0.272
Average+3s	148.87	147.91	145.41	141.28	137.05	137.79	152.70
Average-3s	140.47	144.45	143.77	140.25	135.87	136.29	151.07

8.8 VCE (sat) @ 5mA 100mA



VCE (sat) @ 5mA 100mA	BC847 B,215 NXP/Nexperia Farnell Dec-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1310	196.2	201.9	206.0	214.0	231.7	229.8	203.1
1311	196.4	202.3	207.5	214.8	232.1	229.3	203.6
1312	200.0	206.2	211.0	219.2	238.9	235.7	208.1
1313	191.8	197.8	203.2	209.6	226.1	222.6	198.4
1314	193.6	199.2	203.7	211.3	227.5	224.9	200.9
1315	197.6	203.4	208.4	215.9	233.8	231.0	204.5
1316	194.4	199.7	204.4	211.8	228.4	225.9	200.8
1317	199.2	205.9	210.4	219.5	237.8	235.1	205.9
1318	191.9	197.1	201.5	208.5	223.8	221.6	198.9
1319	192.9	198.3	202.3	210.3	225.7	223.6	199.2
1320 (Ref)	192.8	192.2	192.1	191.5	191.6	191.9	192.6
Average	195.40	201.16	205.84	213.48	230.60	227.94	202.34
s	2.937	3.284	3.359	3.851	5.152	5.032	3.247
Average+3s	204.21	211.02	215.91	225.04	246.06	243.04	212.08
Average-3s	186.58	191.31	195.76	201.93	215.14	212.84	192.60

VCE (sat) @ 5mA 100mA	BC847 B,215 NXP/Nexperia RS Feb-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.1	(22°C, 24h)	(100°C, 168h)
1410	206.2	216.0	225.0	238.5	274.1	269.4	226.5
1411	209.1	219.1	228.4	243.5	282.5	277.3	228.3
1412	211.3	220.9	230.0	245.8	285.6	280.1	229.1
1413	210.0	220.3	229.7	244.9	284.8	279.6	227.8
1414	210.5	220.5	229.6	244.4	284.6	280.3	229.5
1415	205.5	214.7	223.6	237.7	272.1	267.3	224.6
1416	210.0	219.7	229.0	244.1	282.9	277.2	228.9
1417	208.1	217.2	226.0	240.8	277.3	272.6	226.8
1418	208.3	218.2	227.6	241.9	279.0	274.2	227.4
1419	207.4	217.1	225.9	240.1	276.6	272.2	226.4
1420 (Ref)	211.7	211.3	211.2	210.6	210.4	210.2	211.1
Average	208.63	218.37	227.48	242.17	279.96	275.02	227.52
s	1.894	2.064	2.247	2.813	4.808	4.579	1.506
Average+3s	214.31	224.57	234.22	250.60	294.38	288.76	232.03
Average-3s	202.95	212.18	220.74	233.73	265.53	261.29	223.00

VCE (sat) @ 5mA 100mA	BC847 B,215 NXP/Nexperia Mouser Jun-2018						
	krad(Si)					annealing	ageing
DUT	0.0	5.0	10.0	21.0	50.0	(22°C, 24h)	(100°C, 168h)
1610	198.0	205.2	209.5	217.5	236.0	232.6	205.5
1611	194.8	201.9	206.3	215.0	232.2	228.2	203.3
1612	200.9	208.3	213.8	221.7	242.0	237.8	207.9
1613	198.0	205.1	210.6	218.7	237.0	233.1	205.8
1614	194.3	201.3	206.8	214.2	232.0	228.3	202.5
1615	196.8	203.8	208.7	216.2	233.8	230.4	205.7
1616	201.1	208.3	213.2	222.0	241.6	237.1	209.2
1617	197.3	204.5	209.7	217.6	235.5	231.7	205.6
1618	199.6	206.4	211.5	219.7	238.8	234.6	207.0
1619	201.3	209.1	214.2	223.2	243.5	239.4	208.1
1620 (Ref)	194.6	195.5	195.4	194.5	195.0	194.6	195.6
Average	198.21	205.39	210.42	218.56	237.24	233.31	206.06
s	2.522	2.666	2.761	3.051	4.102	3.891	2.099
Average+3s	205.77	213.38	218.71	227.71	249.54	244.98	212.36
Average-3s	190.64	197.39	202.14	209.41	224.93	221.64	199.77

9 CONCLUSION

The test results of the BC847B,215 from Nexperia 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 series

45 V, 100 mA NPN general-purpose transistors

Rev. 9 — 23 September 2014 Product data sheet

1. Product profile

1.1 General description

NPN general-purpose transistors in Surface-Mounted Device (SMD) plastic packages.

Table 1. Product overview

Type number[1]	Package			PNP complement
	NXP	JEITA	JEDEC	
BC847	SOT23	-	TO-236AB	BC857
BC847A				BC857A
BC847B				BC857B
BC847C				BC857C
BC847W	SOT323	SC-70	-	BC857W
BC847AW				BC857AW
BC847BW				BC857BW
BC847CW				BC857CW
BC847T	SOT416	SC-75	-	BC857T
BC847AT				BC857AT
BC847BT				BC857BT
BC847CT				BC857CT
BC847AM	SOT883	SC-101	-	BC857AM
BC847BM				BC857BM
BC847CM				BC857CM

[1] Valid for all available selection groups.

1.2 Features and benefits

- General-purpose transistors
- SMD plastic packages
- Three different gain selections
- AEC-Q101 qualified

1.3 Applications

- General-purpose switching and amplification

1.4 Quick reference data

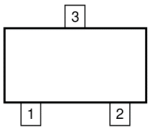
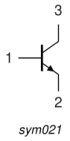
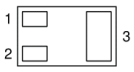
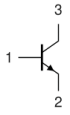
Table 2. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{CEO}	collector-emitter voltage	open base		-	-	45	V
I_C	collector current			-	-	100	mA
h_{FE}	DC current gain	V_{CE} = 5 V; I_C = 2 mA	[1]	110	-	800	
	h_{FE} group A			110	180	220	
	h_{FE} group B			200	290	450	
	h_{FE} group C			420	520	800	

[1] T_{amb} = 25 °C unless otherwise specified

2. Pinning information

Table 3. Pinning

Pin	Description		Simplified outline	Graphic symbol
SOT23, SOT323, SOT416				
1	base		 006aaa144	 sym021
2	emitter			
3	collector			
SOT883				
1	base		 Transparent top view	 sym021
2	emitter			
3	collector			

3. Ordering information

Table 4. Ordering information

Type number[1]	Package		
	Name	Description	Version
BC847	-	plastic surface-mounted package; 3 leads	SOT23
BC847A			
BC847B			
BC847C			
BC847W	SC-70	plastic surface-mounted package; 3 leads	SOT323
BC847AW			
BC847BW			
BC847CW			
BC847T	SC-75	plastic surface-mounted package; 3 leads	SOT416
BC847AT			
BC847BT			
BC847CT			
BC847AM	SC-101	leadless ultra small plastic package; 3 solder lands; body 1.0 × 0.6 × 0.5 mm	SOT883
BC847BM			
BC847CM			

[1] Valid for all available selection groups.

4. Marking

Table 5. Marking codes

Type number	Marking code[1]	Type number	Marking code[1]
BC847	1H*	BC847T	1N
BC847A	1E*	BC847AT	1E
BC847B	1F*	BC847BT	1F
BC847C	1G*	BC847CT	1G
BC847W	1H*	BC847AM	D4
BC847AW	1E*	BC847BM	D5
BC847BW	1F*	BC847CM	D6
BC847CW	1G*		

[1] * = placeholder for manufacturing site code

5. Limiting values

Table 6. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CBO}	collector-base voltage	open emitter		-	50	V
V_{CEO}	collector-emitter voltage	open base		-	45	V
V_{EBO}	emitter-base voltage	open collector		-	6	V
I_C	collector current			-	100	mA
I_{CM}	peak collector current	single pulse; $t_p \leq 1$ ms		-	200	mA
I_{BM}	peak base current	single pulse; $t_p \leq 1$ ms		-	100	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	[1]			
	SOT23			-	250	mW
	SOT323			-	200	mW
	SOT416			-	150	mW
	SOT883		[2]	-	250	mW
T_j	junction temperature			-	150	°C
T_{amb}	ambient temperature			−65	+150	°C
T_{stg}	storage temperature			−65	+150	°C

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB with 60 μm copper strip line, standard footprint.

6. Thermal characteristics

Table 7. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]				
	SOT23			-	-	500	K/W
	SOT323			-	-	625	K/W
	SOT416			-	-	833	K/W
	SOT883		[2]	-	-	500	K/W

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB with 60 μm copper strip line, standard footprint.

7. Characteristics

Table 8. Characteristics

T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{CBO}	collector-base cut-off current	V_{CB} = 30 V; I_E = 0 A		-	-	15	nA
		V_{CB} = 30 V; I_E = 0 A; T_j = 150 °C		-	-	5	µA
I_{EBO}	emitter-base cut-off current	V_{EB} = 5 V; I_C = 0 A		-	-	100	nA
h_{FE}	DC current gain	V_{CE} = 5 V; I_C = 10 µA					
	h_{FE} group A			-	170	-	
	h_{FE} group B			-	280	-	
	h_{FE} group C			-	420	-	
	DC current gain	V_{CE} = 5 V; I_C = 2 mA		110	-	800	
	h_{FE} group A			110	180	220	
	h_{FE} group B			200	290	450	
	h_{FE} group C			420	520	800	
V_{CEsat}	collector-emitter saturation voltage	I_C = 10 mA; I_B = 0.5 mA		-	90	200	mV
		I_C = 100 mA; I_B = 5 mA	[1]	-	200	400	mV
V_{BEsat}	base-emitter saturation voltage	I_C = 10 mA; I_B = 0.5 mA	[2]	-	700	-	mV
		I_C = 100 mA; I_B = 5 mA	[2]	-	900	-	mV
V_{BE}	base-emitter voltage	I_C = 2 mA; V_{CE} = 5 V	[2]	580	660	700	mV
		I_C = 10 mA; V_{CE} = 5 V		-	-	770	mV
f_T	transition frequency	V_{CE} = 5 V; I_C = 10 mA; f = 100 MHz		100	-	-	MHz
C_c	collector capacitance	V_{CB} = 10 V; I_E = i_e = 0 A; f = 1 MHz		-	-	1.5	pF
C_e	emitter capacitance	V_{EB} = 0.5 V; I_C = i_c = 0 A; f = 1 MHz		-	11	-	pF
NF	noise figure	I_C = 200 µA; V_{CE} = 5 V; R_S = 2 kΩ; f = 1 kHz; B = 200 Hz		-	2	10	dB

[1] Pulse test: $t_p \leq 300$ µs; $\delta = 0.02$.

[2] V_{BE} decreases by approximately 2 mV/K with increasing temperature.