FCC RF Test Report

APPLICANT	:	**Bullitt Group**
EQUIPMENT	:	**Mobile Phone**
BRAND NAME	:	**CAT**
MODEL NAME	:	**B35**
FCC ID	:	**ZL5B35EPA**
STANDARD	:	**47 CFR Part 15 Subpart C §15.247**
CLASSIFICATION	:	**(DSS) Spread Spectrum Transmitter**

This is a data re-used report which is only valid together with the original test report. We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.

Jason Jia

Reviewed by: Jason Jia / Supervisor

James Huang

Approved by: James Huang / Manager

ACCREDITED Cert #5145.02

Sporton International (Kunshan) Inc.
No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300
People's Republic of China

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR9D1021-02A	Rev. 01	Initial issue of report	Feb. 25, 2020
FR9D1021-02A	Rev. 02	Retest Radiated Spurious item. Add the test site information. Add the test setup photo. Revise the applicant information.	Mar. 02, 2020

1 General Description

1.1 Applicant

Bullitt Group
One Valpy, Valpy Street, Reading, Berkshire, England RG1 1AR

1.2 Manufacturer

Bullitt Group
One Valpy, Valpy Street, Reading, Berkshire, England RG1 1AR

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Mobile Phone
Brand Name	CAT
Model Name	B35
FCC ID	ZL5B35EPA
EUT supports Radios application	GSM/GPRS/EGPRS/WCDMA/HSPA/DC-HSDPA/ HSPA+(16QAM uplink is not supported)/LTE/GNSS WLAN 2.4GHz 802.11b/g/n HT20/HT40 Bluetooth BR/EDR/LE FM Receiver
HW Version	MP_NZ
SW Version	LTE_0208120.0_B35_53
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	2402 MHz ~ 2480 MHz
Number of Channels	79
Carrier Frequency of Each Channel	2402+n*1 MHz; n=0~78
Antenna Type / Gain	PIFA Antenna type with gain 0.50 dBi
Type of Modulation	Bluetooth BR (1Mbps) : GFSK Bluetooth EDR (2Mbps) : π/4-DQPSK Bluetooth EDR (3Mbps) : 8-DPSK

1.5 Modification of EUT

No modifications are made to the EUT during all test items.

1.6 Testing Location

Sporton International (Kunshan) Inc. is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Test Firm	Sporton International (Kunshan) Inc.		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	03CH05-KS	CN1257	314309

1.7 Test Software

Item	Site	Manufacture	Name	Version
1.	03CH05-KS	AUDIX	E3	6.2009-8-24al

1.8 Re-use of Measured Data

1.6.1 Introduction Section

This application re-uses data collected on a similar device. The subject device of this application (Model: B35, FCC ID: ZL5B35EPA) is electrically identical to the reference device (Model: B35, FCC ID: ZL5B35E) for the portions of the circuitry corresponding to the data being re-used, as treated by KDB Publication 484596 D01.

1.6.2 Difference Section

For details concerning the similarity with respect to component placement, mechanical/electrical design etc., please refer to the Product Equality Declaration.

The re-used RF data includes the following bands provided in Appendix B (Sporton RF Report No. FR840307-04A for the reference device Model: B35, FCC ID: ZL5B35E).

1.6.3 Reference detail Section:

Equipment Class	Reference FCC ID	Folder Test	Report Title/Section
DSS (BR/EDR)	ZL5B35E	Part15C(FR840307-04A)	RSE retest due to the spot check data is 15.22dB worse than original, all the other test items are applicable.
DTS (BLE)	ZL5B35E	Part15C(FR840307-04B)	All sections applicable
DTS (WLAN)	ZL5B35E	Part15C(FR840307-04C)	All sections applicable

1.6.4 Spot Check Verification Data Section

In order to confirm hardware similarity of the subject device with the reference device, spot check measurements were performed on the subject device for the following test items, the test result were consistent with FCC ID: ZL5B35E.

Assertions concerning the similarity of these devices are based on representations by the applicant. The applicant accepts full responsibility for the validity of the similarity claim, and for the determination that verification test data are sufficient to support it.

Test Item	Mode	ZL5B35E Worst Result	ZL5B35EPA Worst Result	Difference (dB)
Radiated Spurious Emission (dBuV/m)	BT (BR/EDR)	43.57	58.79	15.22
	BT (LE)	39.1	43.49	4.39
	11b, 2.4GHz	53.08	50.81	-2.27

2 Radiated Band Edges and Spurious Emission Measurement

2.1.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

2.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

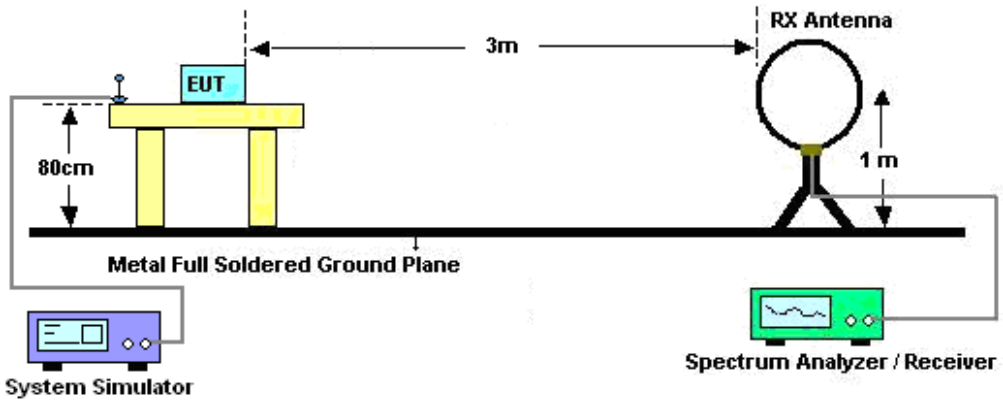
2.1.3 Test Procedures

1. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
4. Set to the maximum power setting and enable the EUT transmit continuously.
5. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz, RBW=1MHz for f>1GHz ; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
   (3) For average measurement: use duty cycle correction factor method per 15.35(c).
   Duty cycle = On time/100 milliseconds
   On time = $N_1*L_1+N_2*L_2+...+N_{n-1}*LN_{n-1}+N_n*L_n$
   Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.
   Average Emission Level = Peak Emission Level + 20*log(Duty cycle)
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
7. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
8. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

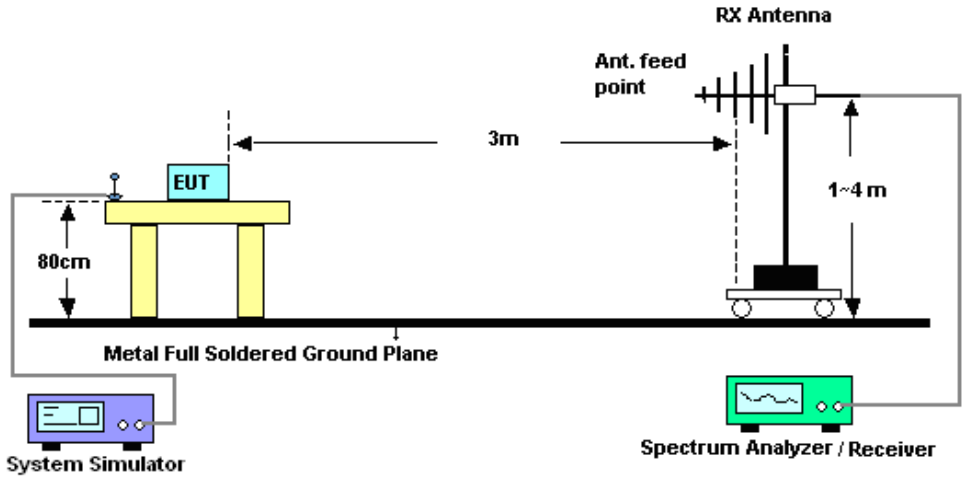
Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.76dB) derived from 20log (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

2.1.4 Test Setup

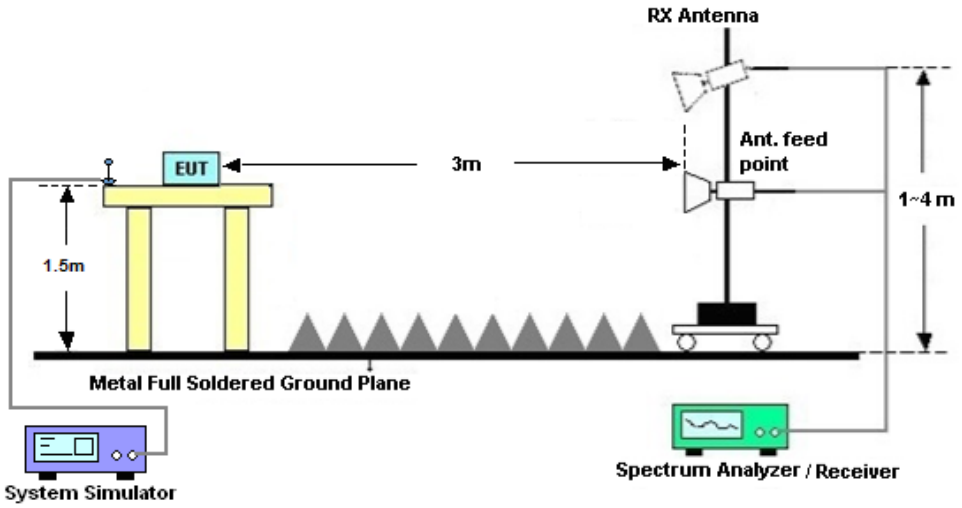
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



2.1.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

2.1.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A.

2.1.7 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix A.

2.1.8 Duty cycle correction factor for average measurement

Please refer to Appendix B.

3 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
EMI Test Receiver	Keysight	N9038A	MY57290151	3Hz~8.5GHz;Max 30dBm	Jul. 18, 2019	Feb. 13, 2020~ Feb. 14, 2020	Jul. 17, 2020	Radiation (03CH05-KS)
EXA Spectrum Analyzer	Keysight	N9010A	MY55150244	10Hz-44G,MAX 30dB	Apr. 16, 2019	Feb. 13, 2020~ Feb. 14, 2020	Apr. 15, 2020	Radiation (03CH05-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Nov. 10, 2019	Feb. 13, 2020~ Feb. 14, 2020	Nov. 09, 2020	Radiation (03CH05-KS)
Bilog Antenna	TeseQ	CBL6111D	49922	30MHz-1GHz	May 30, 2019	Feb. 13, 2020~ Feb. 14, 2020	May 29, 2020	Radiation (03CH05-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	75959	1GHz~18GHz	Jan. 26, 2020	Feb. 13, 2020~ Feb. 14, 2020	Jan. 25, 2021	Radiation (03CH05-KS)
SHF-EHF Horn	Com-power	AH-840	101070	18GHz~40GHz	Jan. 08, 2020	Feb. 13, 2020~ Feb. 14, 2020	Jan. 07, 2021	Radiation (03CH05-KS)
Amplifier	SONOMA	310N	187289	9KHz-1GHz	Aug. 06, 2019	Feb. 13, 2020~ Feb. 14, 2020	Aug. 05, 2020	Radiation (03CH05-KS)
Amplifier	MITEQ	TTA1840-35-HG	2014749	18~40GHz	Jan. 14, 2020	Feb. 13, 2020~ Feb. 14, 2020	Jan. 13, 2021	Radiation (03CH05-KS)
high gain Amplifier	MITEQ	AMF-7D-00101800-30-10P	2025788	1Ghz-18Ghz	Aug. 17, 2019	Feb. 13, 2020~ Feb. 14, 2020	Aug. 16, 2020	Radiation (03CH05-KS)
Amplifier	Keysight	83017A	MY53270316	500MHz~26.5GHz	Oct. 18, 2019	Feb. 13, 2020~ Feb. 14, 2020	Oct. 17, 2020	Radiation (03CH05-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	Feb. 13, 2020~ Feb. 14, 2020	NCR	Radiation (03CH05-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Feb. 13, 2020~ Feb. 14, 2020	NCR	Radiation (03CH05-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Feb. 13, 2020~ Feb. 14, 2020	NCR	Radiation (03CH05-KS)

NCR: No Calibration Required

4 Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**2.5**

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**2.5**

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**2.1**

Appendix A. Radiated Spurious Emission

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

BLE	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BT CH 00 2402MHz		2388	53.8	-20.2	74	48.19	31.2	7.04	32.63	106	67	P	H
		2388	29.04	-24.96	54	-	-	-	-	-	-	A	H
		2402	95.95	-	-	90.33	31.2	7.04	32.62	106	67	P	H
		2402	71.19	17.19	54	-	-	-	-	-	-	A	H
		2388.91	53.19	-20.81	74	47.58	31.2	7.04	32.63	215	88	P	V
		2388.91	28.43	-25.57	54	-	-	-	-	-	-	A	V
		2402	98.53	-	-	92.91	31.2	7.04	32.62	215	88	P	V
		2402	73.77	19.77	54	-	-	-	-	-	-	A	V
BT CH 78 2480MHz		2483.74	58.79	-15.21	74	52.46	31.77	7.16	32.6	103	130	P	H
		2483.74	34.03	-19.97	54	-	-	-	-	-	-	A	H
		2480	93.28	-	-	86.95	31.77	7.16	32.6	103	130	P	H
		2480	68.52	14.52	54	-	-	-	-	-	-	A	H
		2484.7	53.94	-20.06	74	47.61	31.77	7.16	32.6	100	99	P	V
		2484.7	29.18	-24.82	54	-	-	-	-	-	-	A	V
		2480	100.44	-	-	94.11	31.77	7.16	32.6	100	99	P	V
		2480	75.68	21.68	54	-	-	-	-	-	-	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

BLE	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BT CH 00 2402MHz		4806	45.96	-28.04	74	65.01	33.7	9.81	62.56	150	360	P	H
		4806	44.82	-29.18	74	63.87	33.7	9.81	62.56	150	360	P	V
BT CH 39 2441MHz		4884	45.58	-28.42	74	64.4	33.77	9.95	62.54	100	360	P	H
		7320	41.24	-32.76	74	56.36	35.89	12.64	63.65	100	360	P	H
		4884	44.18	-29.82	74	63	33.77	9.95	62.54	100	360	P	V
		7320	40.19	-33.81	74	55.31	35.89	12.64	63.65	100	360	P	V
BT CH 78 2480MHz		4962	44.6	-29.4	74	63.13	33.85	10.13	62.51	150	360	P	H
		7440	38.91	-35.09	74	54.73	36.11	12.84	64.77	150	360	P	H
		4962	42.05	-31.95	74	60.58	33.85	10.13	62.51	150	360	P	V
		7440	38.89	-35.11	74	54.71	36.11	12.84	64.77	150	360	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission below 1GHz

2.4GHz BLE (LF)

BLE	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
2.4GHz BT LF		34.85	16.56	-23.44	40	-1.51	50.39	0.68	33			P	H
		128.94	15.99	-27.51	43.5	10.76	37.02	1.25	33.04			P	H
		186.17	14.24	-29.26	43.5	12.44	33.22	1.51	32.93			P	H
		252.13	14.81	-31.19	46	8.8	37.05	1.76	32.8			P	H
		378.23	18.17	-27.83	46	9.21	39.33	2.15	32.52			P	H
		759.44	25.21	-20.79	46	8.52	46.15	3.04	32.5	100	0	P	H
		34.85	16.93	-23.07	40	11.6	37.65	0.68	33			P	V
		226.91	13.32	-32.68	46	4.13	40.37	1.67	32.85			P	V
		347.19	16.11	-29.89	46	5.09	41.75	2.06	32.79			P	V
		522.76	20.85	-25.15	46	8.81	42.2	2.52	32.68			P	V
		802.12	26.47	-19.53	46	8.61	46.84	3.13	32.11			P	V
		929.19	27.53	-18.47	46	6.67	49.65	3.35	32.14	100	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

Note symbol

*	**Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is **not under limit 6dB**.
P/A	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

A calculation example for radiated spurious emission is shown as below:

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1+2		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 01 2412MHz		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Level(dBμV/m) =

Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

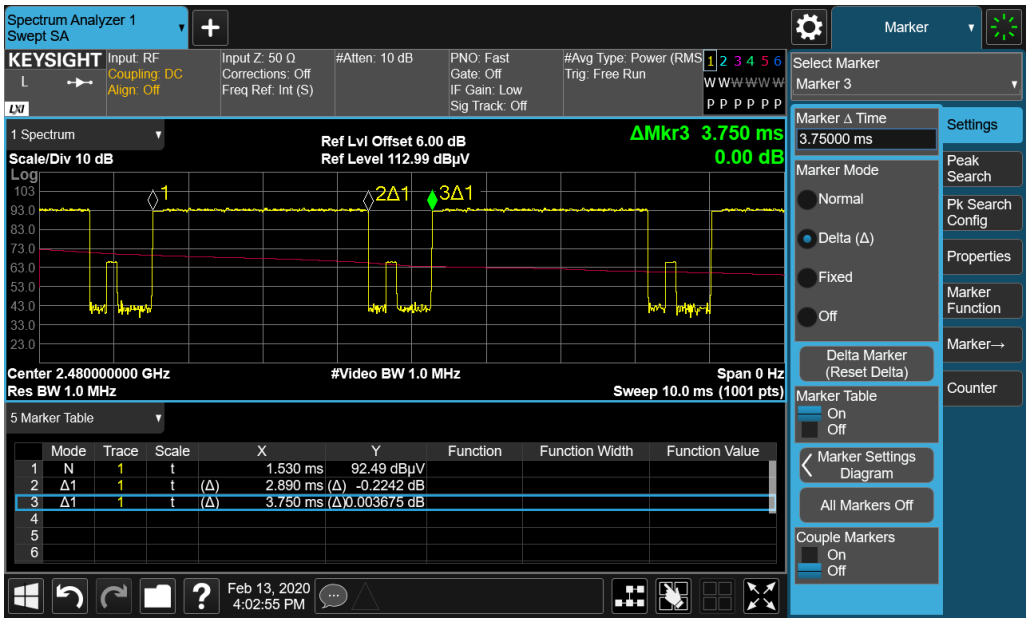
= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

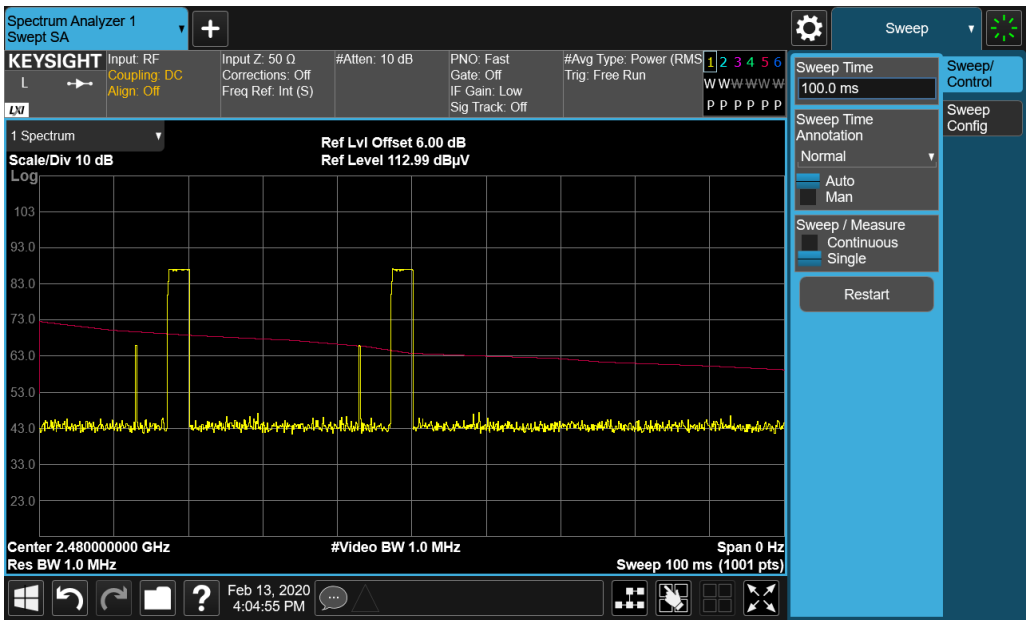
Both peak and average measured complies with the limit line, so test result is "PASS".

Appendix B. Duty Cycle Plots

3DH5 on time (One Pulse) Plot on Channel 39



3DH5 on time (Count Pulses) Plot on Channel 39



Note:

1. Worst case Duty cycle = on time/100 milliseconds = 2 * 2.89 / 100 = 5.78 %
2. Worst case Duty cycle correction factor = 20*log(Duty cycle) = -24.76 dB
3. 3DH5 has the highest duty cycle worst case and is reported.

Duty Cycle Correction Factor Consideration for AFH mode:

Bluetooth normal hopping rate is 1600Hz and reduced to 800Hz in AFH mode; due to the reduced number of hopping frequencies, with the same packet configuration the dwell time in each channel frequency within 100msec period is longer in AFH mode than normal mode.

In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time DH5 packet is observed; the period to have DH5 packet completing one hopping sequence is

2.89 ms x 20 channels = 57.8 ms

There cannot be 2 complete hopping sequences within 100ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period. [100ms / 57.8ms] = 2 hops

Thus, the maximum possible ON time:

2.89 ms x 2 = 5.78 ms

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

20 x log(5.78 ms/100ms) = -24.76 dB

Appendix D. Reference Report

Please refer to Sporton report number FR840307-04A which is issued separately.