



FCC CO-LOCATION RADIO TEST REPORT

FCC ID : UZ7TC15BK
Equipment : Touch computer
Brand Name : Zebra
Model Name : TC15BK
Applicant : Zebra Technologies Corporation
1 Zebra Plaza, Holtsville, NY 11742
Manufacturer : Zebra Technologies Corporation
1 Zebra Plaza, Holtsville, NY 11742
Standard : FCC Part 15 Subpart E §15.407

The product was received on Feb. 24, 2022 and testing was performed from Mar. 15, 2022 to Mar. 23, 2022. We, Sporton International Inc. Wensan Laboratory, 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 from Sporton International Inc. Wensan Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Sporton International Inc. Wensan Laboratory

No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C)



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History of this test report

Report No.	Version	Description	Issue Date
FR1N2513G	01	Initial issue of report	Mar. 31, 2022



Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.407(b)	Unwanted Emissions	Pass	1.52 dB under the limit at 2484.460 MHz
3.2	15.203 15.407(a)	Antenna Requirement	Pass	-

Declaration of Conformity:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers. It's means measurement values may risk exceeding the limit of regulation standards, if measurement uncertainty is include in test results.
2. The measurement uncertainty please refer to this report "Uncertainty of Evaluation".

Comments and Explanations:

The product specifications of the EUT presented in the report are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Keven Cheng
Report Producer: Lucy Wu



1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Touch computer
Brand Name	Zebra
Model Name	TC15BK
FCC ID	UZ7TC15BK
Sample 1	Scanner (SE4710)
Sample 2	Scanner (SE4100)
EUT supports Radios application	GSM/EDGE/WCDMA/HSPA/LTE/5G NR/NFC/GNSS WLAN 11a/b/g/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
HW Version	EV2.4
SW Version	Groot-userdebug11 11-06-29.00-RG-U000-PRD-GRT FX3
MFD	26JAN22
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer.

Specification of Accessories				
AC Adapter	Brand Name	Zebra	Part Number	PWR-WUA5V12W0US
Battery 1	Brand Name	Zebra	Model Number	BT-000454
			Part Number	BT-000454-20
Battery 2	Brand Name	Zebra	Model Number	BT-000454
			Part Number	BT-000454-70
Earphone	Brand Name	Zebra	Part Number	HDST-35MM-PTVP-01
USB Cable (Type C to Type A)	Brand Name	Zebra	Part Number	CBL-TC5X-USBC2A-01
Type C-Audio Cable (Type C to 3.5mm)	Brand Name	Zebra	Part Number	ADP-USBC-35MM1-01



1.2 Product Specification of Equipment Under Test

Product Specification is subject to this standard	
Tx/Rx Frequency Range	2402 MHz ~ 2480 MHz for Bluetooth 2412 MHz ~ 2462 MHz for WLAN (2.4GHz) 5260 MHz ~ 5320 MHz
Antenna Type / Gain	WLAN (2.4GHz): PIFA Antenna with gain -1.02 dBi WLAN (5GHz): 5260 MHz ~ 5320 MHz>: PIFA Antenna with gain -1.07 dBi Bluetooth: PIFA Antenna with gain -1.02 dBi
Type of Modulation	Bluetooth LE : GFSK 802.11n : OFDM (BPSK/QPSK/16QAM/64QAM)

Note:

1. For other wireless features of this EUT, test report will be issued separately.
2. The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

1.3 Modification of EUT

No modifications made to the EUT during the testing.

1.4 Testing Location

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	Sporton Site No. 03CH16-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW3786



1.5 Applicable Standards

According to the specifications declared by the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart E
- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01.
- ♦ ANSI C63.10-2013

Remark:

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



2 Test Configuration of Equipment Under Test

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures.

2.1 Carrier Frequency and Channel

2400-2483.5 MHz	
Bluetooth - LE	
Channel	Freq. (MHz)
39	2480

2400-2483.5 MHz		5250-5350 MHz	
802.11n HT40		802.11n HT40	
Channel	Freq. (MHz)	Channel	Freq. (MHz)
09	2452	62	5310

Remark: During the Radiated Spurious Emission test, the EUT turn on the WWAN functions simultaneously.

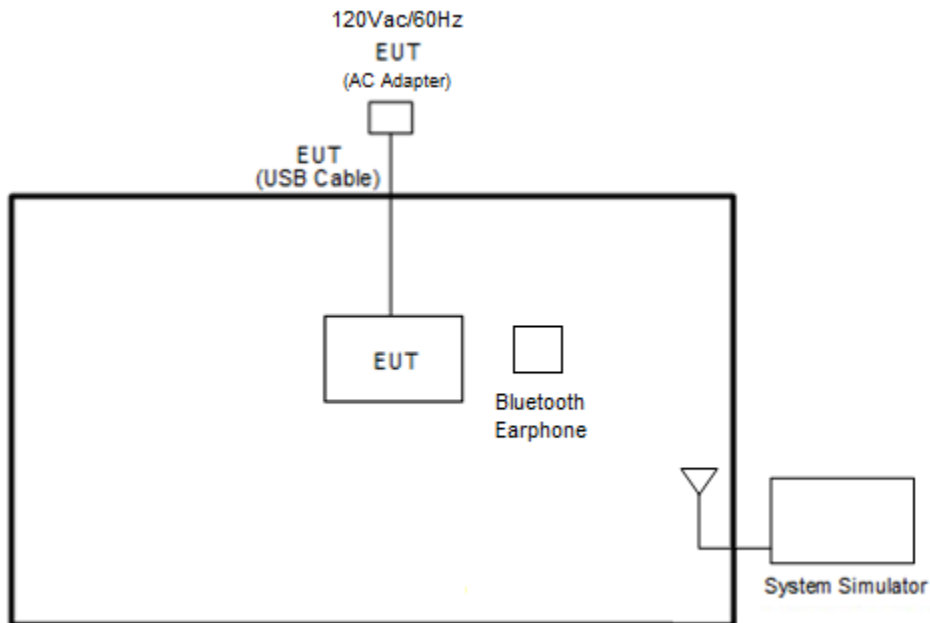
<Co-Location>

Modulation	Plane	Data Rate
Bluetooth Link + 2.4GHz 802.11n HT40 + LTE Band 7	Z	Hopping Mode +MCS0 + QPSK
Bluetooth Link + 5GHz 802.11n HT40 + LTE Band 7	X	Hopping Mode +MCS0 + QPSK
Bluetooth -LE + WLAN 5GHz Link + LTE Band 7	Z	GFSK + Normal Mode + QPSK

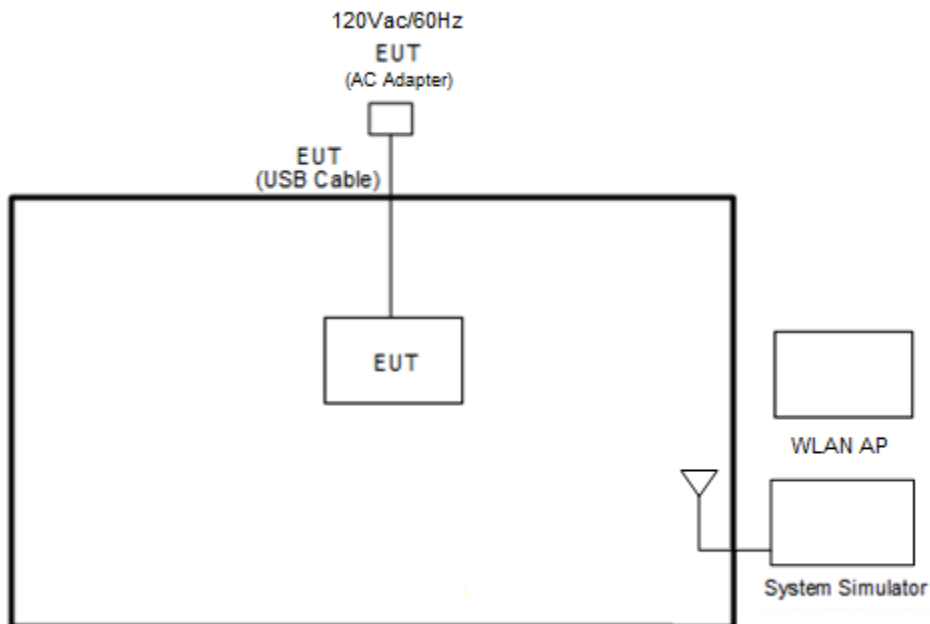
Remark: All the tests were performed with Battery 1 and Sample 1.

2.2 Connection Diagram of Test System

<For Bluetooth Link + WLAN Tx + LTE Link Mode>



<For Bluetooth - LE Tx + WLAN Link + LTE Link Mode>





2.3 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model Name	FCC ID	Data Cable	Power Cord
1.	WLAN AP	ASUS	RT-AC54U	N/A	N/A	Unshielded, 1.8 m
2.	Bluetooth Earphone	SONY	SBH20	N/A	N/A	N/A
3.	System Simulator	R&S	CMW 500	N/A	N/A	Unshielded, 1.8 m

2.4 EUT Operation Test Setup

For Bluetooth Link, the EUT links with Bluetooth Earphone via Bluetooth function under the normal operation.

For Bluetooth – LE and WLAN function, the RF test items, utility “QRCT Version 4.0 - 00185” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

For WLAN (5GHz) Link, turn on WLAN function and make the EUT link with WLAN AP under the normal operation.



3 Test Result

3.1 Unwanted Emissions Measurement

This section is to measure unwanted emissions through radiated measurement for band edge spurious emissions and out of band emissions measurement.

3.1.1 Limit of Unwanted Emissions

(1) Unwanted spurious emissions fallen in restricted bands shall comply with the general field strength limits as below table:

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

Note: The following formula is used to convert the EIRP to field strength.

$$E = \frac{1000000\sqrt{30P}}{3} \text{ } \mu\text{V/m, where P is the eirp (Watts)}$$

EIRP (dBm)	Field Strength at 3m (dBμV/m)
- 27	68.3

(2) KDB789033 D02 v02r01 G)2)c)

(i) Sections 15.407(b)(1-3) specifies the unwanted emissions limit for the U-NII-1 and U-NII-2 bands. As specified, emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz.

(ii) Section 15.407(b)(4) specifies the unwanted emissions limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b)(4)(i). The emission limits are based on the use of a peak detector.

3.1.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.



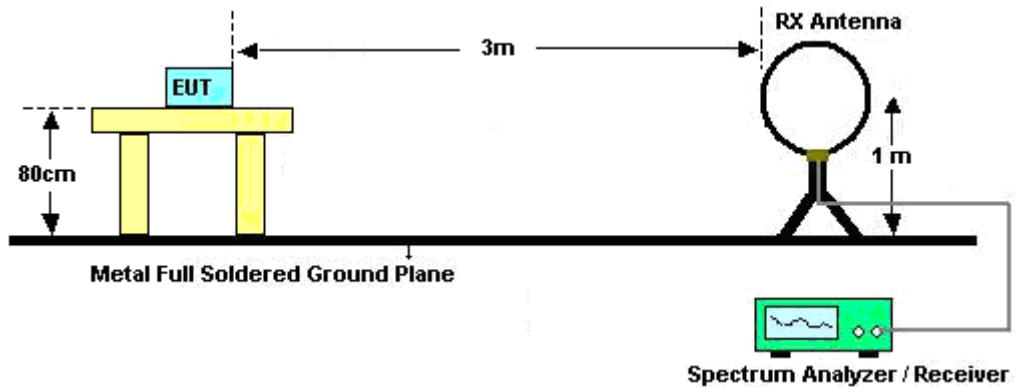
3.1.3 Test Procedures

1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01. Section G) Unwanted emissions measurement.
 - (1) Procedure for Unwanted Emissions Measurements Below 1000 MHz
 - RBW = 120 kHz
 - VBW = 300 kHz
 - Detector = Peak
 - Trace mode = max hold
 - (2) Procedure for Peak Unwanted Emissions Measurements Above 1000 MHz
 - RBW = 1 MHz
 - VBW \geq 3 MHz
 - Detector = Peak
 - Sweep time = auto
 - Trace mode = max hold
 - (3) Procedures for Average Unwanted Emissions Measurements Above 1000 MHz
 - RBW = 1 MHz
 - VBW = 10 Hz, when duty cycle is no less than 98 percent.
 - VBW \geq 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
2. The EUT is placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz respectively above ground.
3. The EUT is set 3 meters away from the receiving antenna which is mounted on the top of a variable height antenna tower.
4. The antenna is a broadband antenna and its height is adjusted between one meter and four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
5. For each suspected emission, the EUT is arranged to its worst case and then adjust the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
6. Radiated testing below 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading. When there is no suspected emission found and the emission level is with at least 6 dB margin against QP limit line, the position is marked as "-".

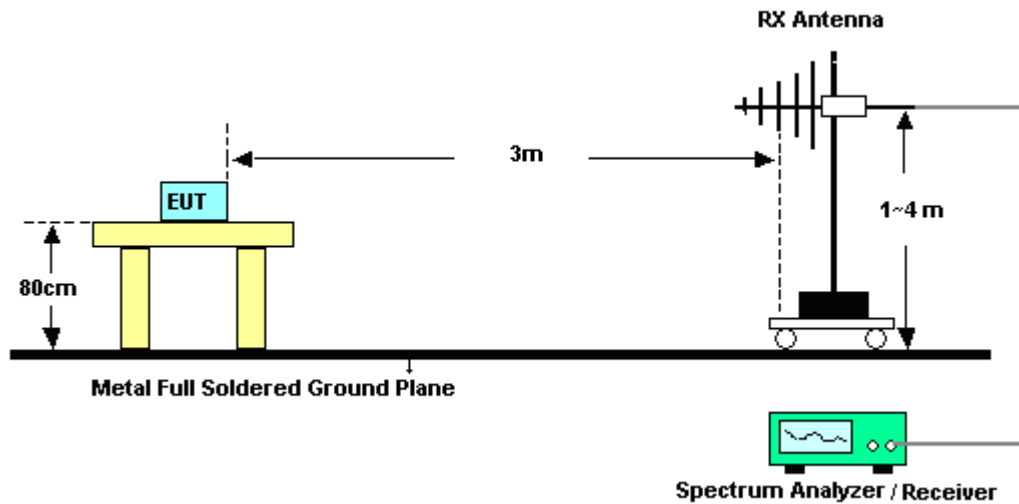
- 7. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as “-“.

3.1.4 Test Setup

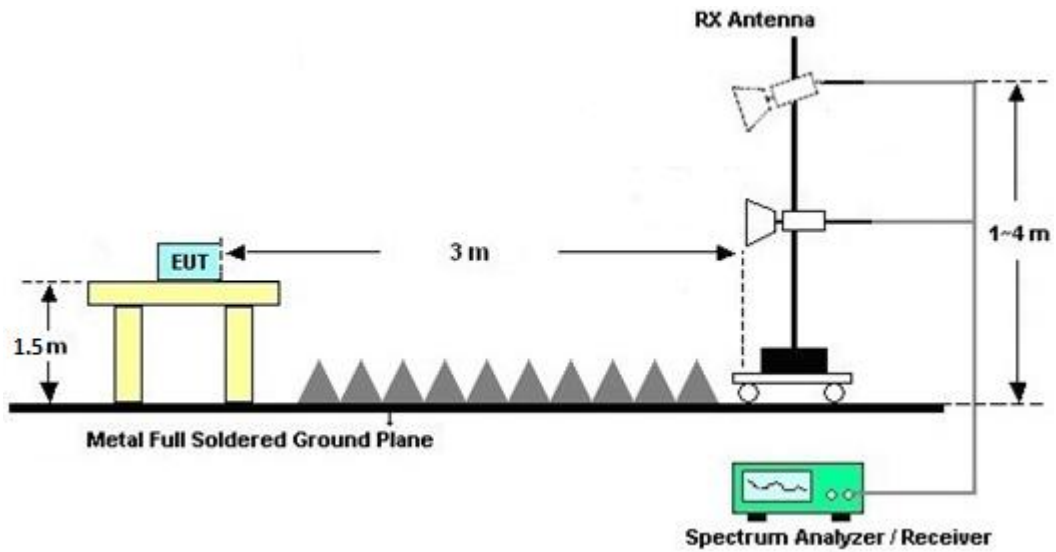
For radiated emissions below 30MHz



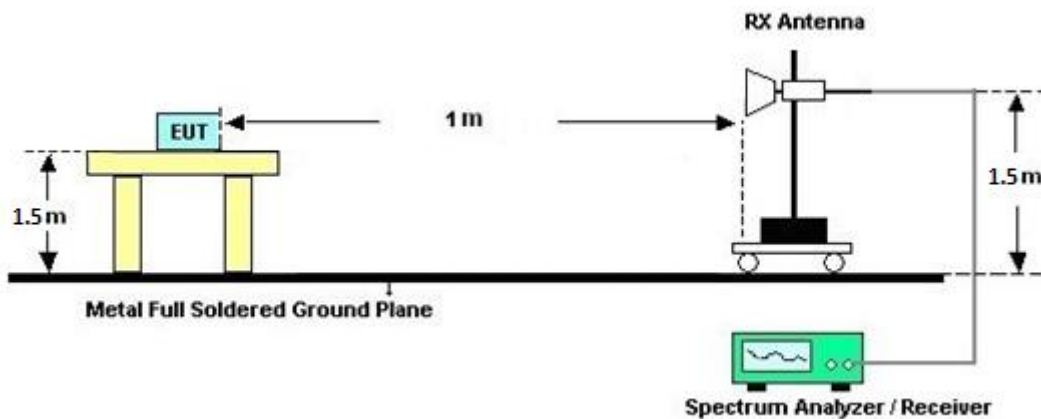
For radiated emissions from 30MHz to 1GHz



For radiated test from 1GHz to 18GHz



For radiated test above 18GHz



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

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

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.



3.1.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A and B.

3.1.7 Duty Cycle

Please refer to Appendix C.

3.1.8 Test Result of Radiated Spurious Emissions (30MHz ~ 10th Harmonic)

Please refer to Appendix A and B.



3.2 Antenna Requirements

3.2.1 Standard Applicable

If transmitting antenna directional gain is greater than 6 dBi, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.2.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.2.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.



4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Sep. 07, 2021	Mar. 15, 2022~ Mar. 23, 2022	Sep. 06, 2022	Radiation (03CH16-HY)
Bilog Antenna	TESEQ	CBL 6111D & 00802N1D01N -06	47020 & 06	30MHz to 1GHz	Oct. 09, 2021	Mar. 15, 2022~ Mar. 23, 2022	Oct. 08, 2022	Radiation (03CH16-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-02114	1G~18GHz	Aug. 04, 2021	Mar. 15, 2022~ Mar. 23, 2022	Aug. 03, 2022	Radiation (03CH16-HY)
SHF-EHF Horn Antenna	SCHWARZBE CK	BBHA 9170	00993	18GHz ~40GHz	Nov. 30, 2021	Mar. 15, 2022~ Mar. 23, 2022	Nov. 29, 2022	Radiation (03CH16-HY)
Amplifier	SONOMA	310N	371607	9kHz~1G	Jul. 05, 2021	Mar. 15, 2022~ Mar. 23, 2022	Jul. 04, 2022	Radiation (03CH16-HY)
Amplifier	EMCI	EMC051845S E	980729	1-18GHz	Jul. 09, 2021	Mar. 15, 2022~ Mar. 23, 2022	Jul. 08, 2022	Radiation (03CH16-HY)
Preamplifier	EMEC	EM18G40G	060801	18GHz~40GHz	Jun. 22, 2021	Mar. 15, 2022~ Mar. 23, 2022	Jun. 21, 2022	Radiation (03CH16-HY)
Preamplifier	Keysight	83017A	MY53270264	1GHz~26.5GHz	Dec. 09, 2021	Mar. 15, 2022~ Mar. 23, 2022	Dec. 08, 2022	Radiation (03CH16-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY57290111	3Hz~26.5GHz	Dec.15, 2021	Mar. 15, 2022~ Mar. 23, 2022	Dec. 14, 2022	Radiation (03CH16-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY11680/4P E	NA	Aug. 28, 2021	Mar. 15, 2022~ Mar. 23, 2022	Aug. 27, 2022	Radiation (03CH16-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY11688/4P E	NA	Aug. 28, 2021	Mar. 15, 2022~ Mar. 23, 2022	Aug. 27, 2022	Radiation (03CH16-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	EC-A5-300-5 757	NA	Aug. 28, 2021	Mar. 15, 2022~ Mar. 23, 2022	Aug. 27, 2022	Radiation (03CH16-HY)
Software	Audix	E3 6.2009-8-24	RK-001136	N/A	N/A	Mar. 15, 2022~ Mar. 23, 2022	N/A	Radiation (03CH16-HY)
Controller	ChainTek	3000-1	N/A	Control Turn table & Ant Mast	N/A	Mar. 15, 2022~ Mar. 23, 2022	N/A	Radiation (03CH16-HY)
Antenna Mast	ChainTek	MBS-520-1	N/A	1m~4m	N/A	Mar. 15, 2022~ Mar. 23, 2022	N/A	Radiation (03CH16-HY)
Turn Table	ChainTek	T-200-S-1	N/A	0~360 Degree	N/A	Mar. 15, 2022~ Mar. 23, 2022	N/A	Radiation (03CH16-HY)



5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.8 dB
-------------------------------------------------------------------------	--------

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.2 dB
-------------------------------------------------------------------------	--------

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.8 dB
-------------------------------------------------------------------------	--------



Appendix A. Radiated Spurious Emission

Test Engineer :	Andy Yang, Karl Hou and Wilson Wu	Temperature :	20~25°C
		Relative Humidity :	50~60%

WLAN (2.4GHz) 802.11n HT40_Tx_CH09 + Bluetooth Link + LTE Band 7 CH21110 Link

2.4GHz 2400~2483.5MHz

WIFI 802.11n HT40 (Band Edge @ 3m)

WIFI Ant. Simultaneously	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamplifier Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
Bluetooth Link + 802.11n HT40 CH09 + LTE Band 7		2384.62	56	-18	74	40.52	27.34	18.21	30.07	327	61	P	H
		2387.98	45.83	-8.17	54	30.33	27.35	18.22	30.07	327	61	A	H
	*	2452	102.81	-	-	86.92	27.61	18.33	30.05	327	61	P	H
	*	2452	95.45	-	-	79.56	27.61	18.33	30.05	327	61	A	H
		2485.37	58.64	-15.36	74	42.48	27.81	18.39	30.04	327	61	P	H
		2484.67	48.87	-5.13	54	32.71	27.81	18.39	30.04	327	61	A	H
		2362.78	55.95	-18.05	74	40.61	27.25	18.17	30.08	100	114	P	V
		2387.98	46.13	-7.87	54	30.63	27.35	18.22	30.07	100	114	A	V
	*	2452	104.85	-	-	88.96	27.61	18.33	30.05	100	114	P	V
	*	2452	97.1	-	-	81.21	27.61	18.33	30.05	100	114	A	V
		2484.25	60.86	-13.14	74	44.7	27.81	18.39	30.04	100	114	P	V
		2484.46	52.48	-1.52	54	36.32	27.81	18.39	30.04	100	114	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



**WLAN (2.4GHz) 802.11n HT40_Tx_CH09 + Bluetooth Link + LTE Band 7 CH21110 Link
(Harmonic @ 3m)**

WIFI Ant. Simultaneously	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)	
Bluetooth Link + 802.11n HT40 CH09 + LTE Band 7		4904	40.62	-33.38	74	50.97	32.72	12.3	55.37	-	-	P	H	
		7356	46.39	-27.61	74	49.32	36.65	16.08	55.66	-	-	P	H	
													H	
													H	
													H	
			4904	40.74	-33.26	74	51.09	32.72	12.3	55.37			P	V
			7356	45.56	-28.44	74	48.49	36.65	16.08	55.66			P	V
														V
														V
														V
	Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.												



WLAN (2.4GHz) 802.11n HT40_Tx_CH09 + Bluetooth Link + LTE Band 7 CH21110 Link

Emission below 1GHz (LF)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.	
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.		
Simultaneously		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)	
Bluetooth Link + 802.11n HT40 CH09 + LTE Band 7		105.66	35.88	-7.62	43.5	49.79	16.53	1.85	32.29	-	-	P	H	
		123.12	30.76	-12.74	43.5	43.54	17.51	1.98	32.27	-	-	P	H	
		184.23	29.94	-13.56	43.5	44.83	14.88	2.46	32.23	-	-	P	H	
		729.37	39.11	-6.89	46	39.15	27.63	4.69	32.36	-	-	P	H	
		739.07	39.07	-6.93	46	38.7	27.99	4.73	32.35	-	-	P	H	
		899.12	39.27	-6.73	46	36.55	28.99	5.28	31.55	-	-	P	H	
														H
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Remark	1. No other spurious found.													
	2. All results are PASS against limit line.													
	3. The emission position marked as "-" means no suspected emission found and emission level has at least 6dB margin against limit or emission is noise floor only.													



WLAN (5GHz) 802.11n HT40_Tx_CH62 + Bluetooth Link + LTE Band 7 CH21110 Link

Band 2 5250~5350MHz

WIFI 802.11an HT40 (Band Edge @ 3m)

WIFI Ant.	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
Simultaneously		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
Bluetooth Link + 802.11n HT40 CH62 + LTE Band 7		5035.7	53.6	-20.4	74	38.27	32.89	11.86	29.42	100	115	P	H
		5101.32	44.42	-9.58	54	28.71	33.19	11.96	29.44	100	115	A	H
	*	5310	102.2	-	-	86.27	32.96	12.48	29.51	100	115	P	H
	*	5310	94.9	-	-	78.97	32.96	12.48	29.51	100	115	A	H
		5371.92	55.77	-18.23	74	39.77	32.84	12.69	29.53	100	115	P	H
		5354.88	46.72	-7.28	54	30.79	32.81	12.64	29.52	100	115	A	H
		5149.26	53.13	-20.87	74	37.66	32.9	12.03	29.46	100	249	P	V
		5097.92	44.46	-9.54	54	28.77	33.18	11.95	29.44	100	249	A	V
	*	5310	105.71	-	-	89.78	32.96	12.48	29.51	100	249	P	V
	*	5310	97.77	-	-	81.84	32.96	12.48	29.51	100	249	A	V
		5352.48	57.16	-16.84	74	41.25	32.8	12.63	29.52	100	249	P	V
		5357.52	50.79	-3.21	54	34.84	32.82	12.65	29.52	100	249	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



WLAN (5GHz) 802.11n HT40_Tx_CH62 + Bluetooth Link + LTE Band 7 CH21110 Link

(Harmonic @ 3m)

WIFI Ant.	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)	
Bluetooth Link + 802.11n HT40 CH62 + LTE Band 7		10620	47.85	-26.15	74	45.36	39	18.95	55.46	-	-	P	H	
		15930	46.19	-27.81	74	40.72	37.81	22.93	55.27	-	-	P	H	
													H	
													H	
													H	
			10620	50.99	-23.01	74	48.5	39	18.95	55.46	100	235	P	V
			10620	42.14	-11.86	54	39.65	39	18.95	55.46	100	235	A	V
			15930	46.44	-27.56	74	40.97	37.81	22.93	55.27	-	-	P	V
														V
														V
	Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.												



BLE (2M)_Tx_CH39 + WLAN (5GHz) Link + LTE Band 7 CH21110 Link

BLE (Band Edge @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
Simultaneously		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE_CH39 + WLAN (5GHz) Link + LTE Band 7 Link	*	2480	96.5	-	-	80.39	27.78	18.38	30.05	139	73	P	H
	*	2480	95.03	-	-	78.92	27.78	18.38	30.05	139	73	A	H
		2488.96	56.84	-17.16	74	40.65	27.83	18.4	30.04	139	73	P	H
		2491.16	49.06	-4.94	54	32.85	27.85	18.4	30.04	139	73	A	H
													H
													H
	*	2480	97.54	-	-	81.43	27.78	18.38	30.05	102	123	P	V
	*	2480	96.25	-	-	80.14	27.78	18.38	30.05	102	123	A	V
		2487.92	56.79	-17.21	74	40.6	27.83	18.4	30.04	102	123	P	V
		2485	49.04	-4.96	54	32.88	27.81	18.39	30.04	102	123	A	V
													V
												V	
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



BLE (2M)_Tx_CH39 + WLAN (5GHz) Link + LTE Band 7 CH21110 Link

(Harmonic @ 3m)

WIFI Ant.	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)	
BLE_CH39 + WLAN (5GHz) Link + LTE Band 7 Link		4960	56.61	-17.39	74	39.67	33.02	13.33	29.41	100	156	P	H	
		4960	49.09	-4.91	54	32.15	33.02	13.33	29.41	100	156	P	H	
		7440	45.67	-28.33	74	48.67	36.22	16.45	55.67	-	-		H	
														H
														H
			4960	56.83	-17.17	74	39.89	33.02	13.33	29.41	100	89	P	V
			4960	49.31	-4.69	54	32.37	33.02	13.33	29.41	100	89	A	V
			7440	46.14	-27.86	74	49.14	36.22	16.45	55.67	-	-	P	V
														V
														V
	Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.												



Note symbol

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
-	The signal is Unintentional Radiators .
P/A	Peak or Average
H/V	Horizontal or Vertical



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

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

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) = Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
3. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path 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) + Path 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. Radiated Spurious Emission

Test Engineer :	Andy Yang, Karl Hou and Wilson Wu	Temperature :	20~25°C
		Relative Humidity :	50~60%

Note symbol

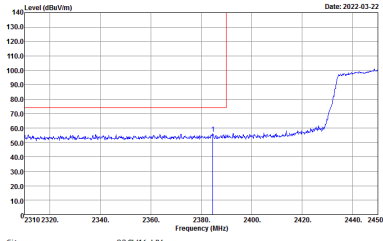
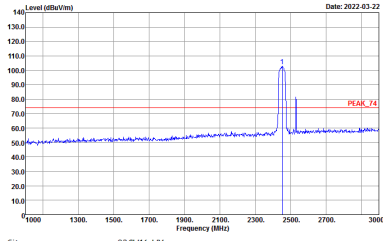
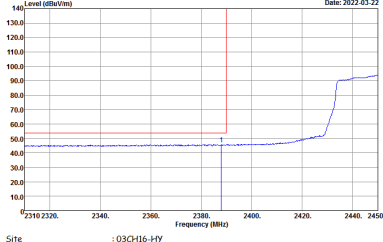
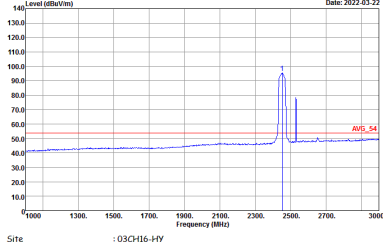
-L	Low channel location
-R	High channel location



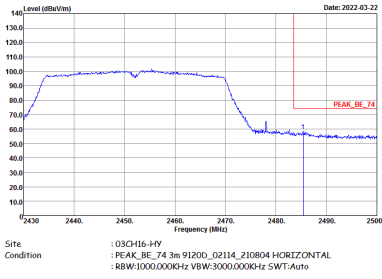
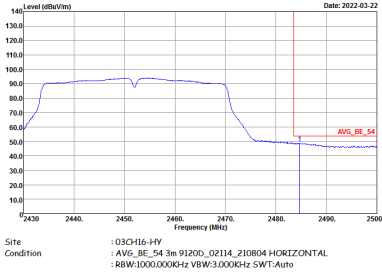
WLAN (2.4GHz) 802.11n HT40_Tx_CH09 + Bluetooth Link + LTE Band 7 CH21110 Link

2.4GHz 2400~2483.5MHz

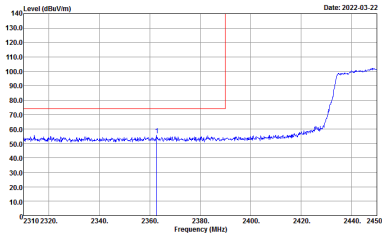
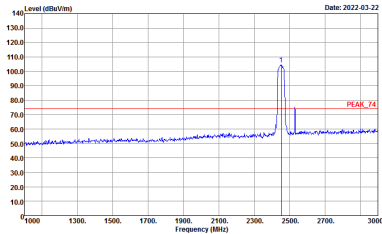
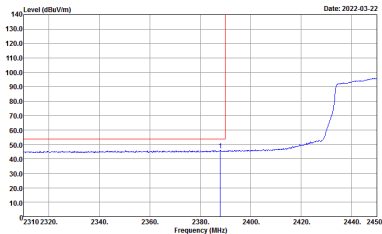
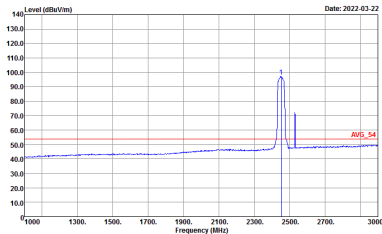
WIFI 802.11n HT40 (Band Edge @ 3m)

WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11n HT40 CH09 2452MHz - L	
Simultaneously	Horizontal	Fundamental
Peak	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>
Avg.	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : AVG_BE_54 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto</p>	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : AVG_54 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto</p>

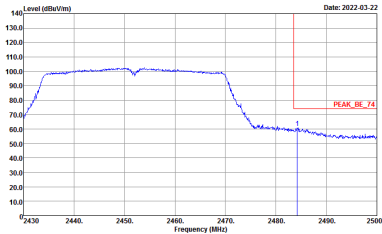
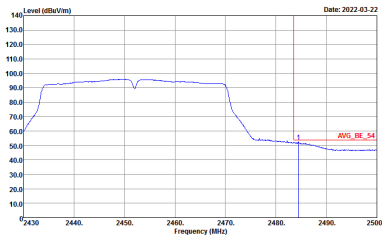


WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11n HT40 CH09 2452MHz - R	
Simultaneously	Horizontal	Fundamental
Peak		Left blank
Avg.		Left blank



WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11n HT40 CH09 2452MHz - L	
Simultaneously	Vertical	Fundamental
Peak	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>
Avg.	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : AV6_BE_54 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto</p>	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : AV6_54 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto</p>



WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11n HT40 CH09 2452MHz - R	
Simultaneously	Vertical	Fundamental
<p style="text-align: center;">Peak</p>	 <p style="font-size: small;">Date: 2022-03-22</p> <p style="font-size: x-small;">Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	<p style="text-align: center;">Left blank</p>
<p style="text-align: center;">Avg.</p>	 <p style="font-size: small;">Date: 2022-03-22</p> <p style="font-size: x-small;">Site : 03CH16-HY Condition : AVG_BE_54 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	<p style="text-align: center;">Left blank</p>



WLAN (2.4GHz) 802.11n HT40_Tx_CH09 + Bluetooth Link + LTE Band 7 CH21110 Link
(Harmonic @ 3m)

WIFI	Harmonic @ 3m	
ANT	WLAN 2.4G 802.11n HT40_Ch09 Tx + BT Link+ LTE Band 7 CH21110 Link	
Simultaneously	Horizontal	Vertical
<p>Peak</p> <p>Avg.</p>		



WLAN (2.4GHz) 802.11n HT40_Tx_CH09 + Bluetooth Link + LTE Band 7 CH21110 Link

Emission below 1GHz (LF)

WIFI	2.4GHz 2400~2483.5MHz	
ANT	802.11n HT40 LF	
Simultaneously	Horizontal	Vertical
QP / Peak	<p>Site : 03CH16-14V Condition : QP-3m BIL06_47020_211009 HORIZONTAL</p>	<p>Site : 03CH16-14V Condition : QP-3m BIL06_47020_211009 VERTICAL</p>



WLAN (5GHz) 802.11n HT40_Tx_CH62 + Bluetooth Link + LTE Band 7 CH21110 Link

Band 2 5250~5350MHz

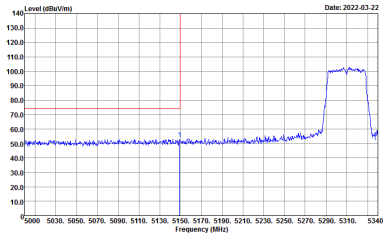
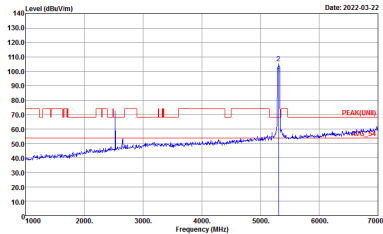
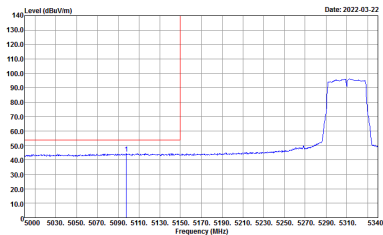
WIFI 802.11an HT40 (Band Edge @ 3m)

WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	802.11n HT40 CH62 5310 MHz - L	
Simultaneously	Horizontal	Fundamental
Peak	<p>Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>	<p>Site : 03CH16-HY Condition : PEAK(UNIT) 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>
Avg.	<p>Site : 03CH16-HY Condition : AVG_BE_54 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>	Left blank



WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	802.11n HT40 CH62 5310 MHz - R	
Simultaneously	Horizontal	Fundamental
Peak	<p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000GHz VBW:3000.000GHz SWT:Auto</p>	Left blank
Avg.	<p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : AVG_BE_54 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000GHz VBW:3000.000GHz SWT:Auto</p>	Left blank



WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	802.11n HT40 CH62 5310 MHz - L	
Simultaneously	Vertical	Fundamental
Peak	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : PEAK(UNI) 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>
Avg.	 <p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : AVG_BE_54 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	Left blank



WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	802.11n HT40 CH62 5310 MHz - R	
Simultaneously	Vertical	Fundamental
Peak	<p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	Left blank
Avg.	<p>Date: 2022-03-22</p> <p>Site : 03CH16-HY Condition : AVG_BE_54 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	Left blank



**WLAN (5GHz) 802.11n HT40_Tx_CH62 + Bluetooth Link + LTE Band 7 CH21110 Link
(Harmonic @ 3m)**

WIFI	Band 2 5250~5350MHz Harmonic @ 3m	
ANT	WLAN 5G 802.11an HT40_Ch62 Tx + BT Link +LTE Band 7 CH21110 Link	
Simultaneously	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH16-HY Condition : PEAK(UNII) 3m 9120D_02114_210804 HORIZONTAL</p>	<p>Site : 03CH16-HY Condition : PEAK(UNII) 3m 9120D_02114_210804 VERTICAL</p>



BLE (2M)_Tx_CH39 + WLAN (5GHz) Link + LTE Band 7 CH2110 Link

BLE (Band Edge @ 3m)

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz	
Simultaneously	Horizontal	Fundamental
Peak	<p>Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	<p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>
Avg.	<p>Site : 03CH16-HY Condition : AVG_BE_54 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto</p>	<p>Site : 03CH16-HY Condition : AVG_54 3m 91200_02114_210804 HORIZONTAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto</p>



BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz	
Simultaneously	Vertical	Fundamental
<p style="text-align: center;">Peak</p>	<p style="text-align: right;">Date: 2022-03-22</p> <p style="text-align: center;">PEAK_BE_74</p> <p>Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	<p style="text-align: right;">Date: 2022-03-22</p> <p style="text-align: center;">PEAK_74</p> <p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>
<p style="text-align: center;">Avg.</p>	<p style="text-align: right;">Date: 2022-03-22</p> <p style="text-align: center;">AVG_BE_54</p> <p>Site : 03CH16-HY Condition : AVG_BE_54 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto</p>	<p style="text-align: right;">Date: 2022-03-22</p> <p style="text-align: center;">AVG_54</p> <p>Site : 03CH16-HY Condition : AVG_54 3m 91200_02114_210804 VERTICAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto</p>



**BLE (2M)_Tx_CH39 + WLAN (5GHz) Link + LTE Band 7 CH21110 Link
(Harmonic @ 3m)**

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BLE(2M) CH39 Tx+ WLAN 5G Link + LTE Band 7 CH21110 Link	
Simultaneously	Horizontal	Vertical
Peak	<p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_02114_210804 HORIZONTAL</p>	<p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_02114_210804 VERTICAL</p>



Appendix C. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
Bluetooth - LE for 2Mbps	33.01	206	4.85	10kHz
2.4GHz 802.11n HT40	94.79	1.08	3kHz	
5GHz 802.11n HT40	96.27	930	1.08	3kHz

