

Prüfbericht-Nr.: <i>Test report no.:</i>	CN21B1MY(P15C-BLE) 001		Auftrags-Nr.: <i>Order no.:</i>	238515396	Seite 1 von 35 Page 1 of 35
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	N/A		Auftragsdatum: <i>Order date:</i>	2021-05-20	
Auftraggeber: <i>Client:</i>	Meshreen Inc. 5F.-501C, No. 502, Sec. 2, Ren-ai Rd., Linkou Dist., New Taipei City 244, Taiwan				
Prüfgegenstand: <i>Test item:</i>	K32W Middle Power ZigBee Module with PCB antenna/with u-FL connector				
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	MSK32WT-M10; MSK32WT-M13				
Auftrags-Inhalt: <i>Order content:</i>	FCC Part 15C Test report (BLE, ZigBee)				
Prüfgrundlage: <i>Test specification:</i>	FCC 47CFR Part 15: Subpart C Section 15.247				
Wareneingangsdatum: <i>Date of sample receipt:</i>	2021-06-01				
Prüfmuster-Nr.: <i>Test sample no.:</i>	A003063922-001, 005 A003063922-003				
Prüfzeitraum: <i>Testing period:</i>	2021-06-02 - 2021-07-19				
Ort der Prüfung: <i>Place of testing:</i>	EMC/RF Taipei Testing Site				
Prüflaboratorium: <i>Testing laboratory:</i>	Taipei Testing Laboratories				
Prüfergebnis*: <i>Test result*:</i>	Pass				
überprüft von: <i>compiled by:</i>	 Ryan Chen Senior Project Manager		genehmigt von: <i>authorized by:</i>	 Brenda Chen Senior Project Manager	
Datum: <i>Date:</i>			Ausstellungsdatum: <i>Issue date:</i>		
2021-07-20			2021-07-20		
Stellung / Position:	Stellung / Position:				
Sonstiges / Other:					
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>			Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>		
* Legende: 1 = sehr gut 2 = gut 3 = befriedigend 4 = ausreichend 5 = mangelhaft P(ass) = entspricht o.g. Prüfgrundlage(n) F(all) = entspricht nicht o.g. Prüfgrundlage(n) * Legend: 1 = very good 2 = good 3 = satisfactory 4 = sufficient 5 = poor P(ass) = passed a.m. test specification(s) F(all) = failed a.m. test specification(s) Nos					
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i>					

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TEST SUMMARY

Report Section	FCC Clause	Test Item	Result
5.1.1	15.247(b) & 15.203	Antenna Requirement	Pass
5.1.2	15.247(b)(3)	Peak Output Power	Pass
5.1.3	15.247(a)(2)	6 dB Bandwidth	Pass
5.1.3	2.1049	99% Occupied Bandwidth	Pass
5.1.4	15.247(e)	Power Spectral Density	Pass
5.1.5	15.247(d)	Conducted Spurious Emissions and Band Edges	Pass
5.1.6	15.247(d) & 15.205 & 15.209	Radiated Spurious Emissions and Band Edges	Pass
5.2.1	15.207	Mains Conducted Emission	Pass

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

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APPENDIX A - TEST RESULT OF CONDUCTED for BLE

APPENDIX B - TEST RESULT OF RADIATED EMISSIONS & MAINS CONDUCTED EMISSION FOR BLE

Appendix C- Test Result of Conducted for ZigBee

Appendix D - Test Result of Radiated Emissions & Mains Conducted Emission for ZigBee

Appendix SP - Photographs of Test Setup

APPENDIX EP - PHOTOGRAPHS OF EUT

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HISTORY OF THIS TEST REPORT

Report No.	Description	Date Issued
CN21B1MY(P15C-BLE) 001	Original Release	2021-07-20

1. General Remarks

1.1 Complementary Materials

All attachments are integral parts of this test report. This applies especially to the following appendix:

Appendix A - Test Result of Conducted for BLE

Appendix B - Test Result of Radiated Emissions & Mains Conducted Emission for BLE

Appendix C - Test Result of Conducted for ZigBee

Appendix D - Test Result of Radiated Emissions & Mains Conducted Emission for ZigBee

Appendix SP - Photographs of Test Setup

Appendix EP - Photographs of EUT

Applied Standard and Test Levels

Radio

FCC 47CFR Part 15: Subpart C Section 15.247

FCC 47CFR Part 2: Subpart J Section 2.1049

ANSI C63.10:2013

KDB 558074 D01 15.247 Meas Guidance v05r02

1.2 Decision Rule of Conformity

The decision rule of conformity of this test report is following the requirements of the requested standard in the quotation, and agreed among testing laboratory and manufacturer (applicant) to exclude the consideration of Measurement Uncertainty, unless it is required by the specific standard.

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2. Test Sites

2.1 Test Laboratory

Taipei Testing Laboratories

11F. No.758, Sec. 4, Bade Rd., Songshan Dist.
Taipei City 105
Taiwan (R.O.C.)

2.2 Test Facility

Taipei Testing Laboratories

No.458-18, Sec. 2, Fenliao Rd., Linkou Dist.,
New Taipei City 244
Taiwan (R.O.C.)
FCC Registration No.: 226631
ISED Registration No.: 25563

2.3 Traceability

All measurement equipment calibrations are traceable to NML(Taiwan)/NIST(USA) or where calibration is performed outside Taiwan, to equivalent nationally recognized standards organizations.

2.4 Calibration

Equipment requiring calibration is calibrated periodically in a suitably accredited Calibration Lab. Additionally all equipment is verified for proper performance on a regular basics using in house standards or comparisons.

2.5 Measurement Uncertainty

All measurement uncertainty values are shown with a coverage factor of k=2 to indicate a 95% level of confidence.

Emission Measurement Uncertainty

Parameter	Uncertainty
Radiated Emission (9 kHz ~ 30 MHz)	± 1.15 dB
Radiated Emission (30 MHz ~ 200 MHz)	± 1.30 dB
Radiated Emission (200 MHz ~ 1 GHz)	± 1.30 dB
Radiated Emission (1 GHz ~ 18 GHz)	± 1.54 dB
Radiated Emission (18 GHz ~ 40 GHz)	± 2.52 dB
Mains Conducted Emission	± 1.65 dB

3. General Product Information

3.1 Product Function and Intended Use

The EUT is a K32W Middle Power ZigBee Module with PCB antenna/with u-FL connector. It contains a Bluetooth/ZigBee compatible module enabling the user to communicate data through a wireless interface. For details refer to the User Guide, Data Sheet and Circuit Diagram.

3.2 System Details and Ratings

Basic Information of EUT

Item	EUT information
Kind of Equipment/Test Item	K32W Middle Power ZigBee Module with PCB antenna/with u-FL connector
Type Identification	MSK32WT-M10; MSK32WT-M13
FCC ID	2AZ3D- K32WM10

Technical Specification of EUT

Item	EUT information
Operating Frequency	BLE: 2402 MHz ~ 2480 MHz ZigBee: 2405 MHz ~ 2480 MHz
Channel Number	BLE:40 ZigBee: 16
Data Rate	BLE:1Mbps, 2Mbps ZigBee: 250 Kbps
Operation Voltage	3.3Vdc
Modulation	BLE: GFSK ZigBee: OQPSK
Maximum Output Power (mW)	BLE: 5.97 ZigBee: 8.55
Antenna Information	Refer to 5.1.1
Accessory Device	Refer to 4.4

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Note:

1. All models are listed as below.

Main Model	Series Model	Difference
MSK32WT-M10	MSK32W-M10	Disable NFC tag function
	MS9090T-M10	Disable ZigBee function
	MS9090-M10	Disable ZigBee & NFC function
	MS9030T-M10	Disable ZigBee & smaller Flash/RAM Size
	MS9030-M10	Disable ZigBee, NFC function, and smaller flash/RAM size
	MS5189T-M10	Disable BT Function
	MS5189-M10	Disable BT Function & NFC Function
	MS5188T-M10	Disable BT Function & smaller Flash/RAM Size
	MS5188-M10	Disable BT & NFC tag Function, Smaller Flash/RAM size
MSK32WT-M13	MSK32W-M13	Disable NFC tag function
	MS9090T-M13	Disable ZigBee function
	MS9090-M13	Disable ZigBee & NFC function
	MS9030T-M13	Disable ZigBee & smaller Flash/RAM Size
	MS9030-M13	Disable ZigBee, NFC function, and smaller flash/RAM size
	MS5189T-M13	Disable BT Function
	MS5189-M13	Disable BT Function & NFC Function
	MS5188T-M13	Disable BT Function & smaller Flash/RAM Size
	MS5188-M13	Disable BT & NFC tag Function, Smaller Flash/RAM size

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3.3 Noise Generating and Noise Suppressing Parts

Refer to the Circuit Diagram.

3.4 Submitted Documents

- Circuit Diagram
- Instruction Manual
- Rating Label
- Technical Description

4. Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

The test modes were adapted accordingly in reference to the instructions for use.

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output expected by the customer and is going to be fixed on the firmware of the final end product.

Table for Parameters of Test Software Setting

BLE	
Frequency (MHz)	Power Setting
2402	9
2440	9
2478	9
2480	4

ZigBee	
Frequency (MHz)	Power Setting
2405	10
2435	10
2475	10
2480	-2.25

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4.2 Carrier Frequency and Channel

BLE

Channel	Freq. (MHz)						
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

ZigBee

Channel	Freq. (MHz)	Channel	Freq. (MHz)
11	2405	19	2445
12	2410	20	2450
13	2415	21	2455
14	2420	22	2460
15	2425	23	2465
16	2430	24	2470
17	2435	25	2475
18	2440	26	2480

4.3 Test Operation and Test Software

Setup for testing: Test samples are provided with a USB interface which makes it possible to control them through a test software installed on a notebook computer.

This software was running on the laptop computer connected to the EUT. It was used to enable the operation modes listed as below.

Test Software	Tera term
---------------	-----------

The samples were used as follows:

A003063922-001 (MSK32WT-M10), A003063922-005 (MSK32WT-M13) for radiated

A003063922-003 for conducted

Full test was applied on all test modes, but only worst case was shown.

EUT Configure Mode	Applicable To				Description
	Antenna Port Conducted Measurement	Radiated Spurious Emissions above 1 GHz	Radiated Spurious Emissions below 1 GHz	Mains Conducted Emission	
BLE	√	√	√	√	-
ZigBee	√	√	√	√	-

Note:

1. The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when position on Z-plane.
2. "-" means no effect.
3. The conducted measurement was performed on model number: MSK32WT-M13 and the radiated measurement was performed on both model number: MSK32WT-M10; MSK32WT-M13.

Antenna Port Conducted Measurement

Pre-Scan full test was applied on all test modes, but only worst case was shown.
 Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Frequency (MHz)	Tested Frequency (MHz)	Date Rate (Mbps)
BLE	2402 to 2480	2402, 2440, 2478, 2480	1 Mbps
BLE	2402 to 2480	2402, 2440, 2478, 2480	2 Mbps
ZigBee	2405 to 2475	2405, 2435, 2475, 2480	250 kbps

Radiated Spurious Emissions (Above 1 GHz)

Pre-Scan full test was applied on all test modes, but only worst case was shown.
 Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Frequency (MHz)	Tested Frequency (MHz)	Date Rate (Mbps)
BLE	2402 to 2480	2402, 2440, 2478, 2480	1 Mbps
BLE	2402 to 2480	2402, 2440, 2478, 2480	2 Mbps
ZigBee	2405 to 2475	2405, 2435, 2475, 2480	250 kbps

Radiated Spurious Emissions (Below 1 GHz)

Pre-Scan full test was applied on all test modes, but only worst case was shown.
 Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Frequency (MHz)	Tested Frequency (MHz)	Date Rate (Mbps)
BLE	2402 to 2480	2440	1 Mbps
BLE	2402 to 2480	2440	2 Mbps
ZigBee	2405 to 2475	2475	250 kbps

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Mains Conducted Emission

- Pre-Scan full test was applied on all test modes, but only worst case was shown.
- Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Frequency (MHz)	Tested Frequency (MHz)	Date Rate
BLE	2402 to 2480	2440	2 Mbps
ZigBee	2405 to 2475	2475	250 kbps

Test Condition

Test Item	Ambient Temperature		Relative Humidity		Tested by
	BLE	ZigBee	BLE	ZigBee	
Conducted Measurement	24.3 °C	23.5 °C	55.1 %	61.6 %	Chun-yi / Andy Chen
Radiated Spurious Emissions above 1 GHz	23.9-25.9 °C	23.9-25.9 °C	50-60 %	50-60 %	Eagle Tsai
Radiated Spurious Emissions below 1 GHz	23.9-25.9 °C	23.9-25.9 °C	50-60 %	50-60 %	Eagle Tsai
Mains Conducted Emission	21.9 °C	23.9-25.9 °C	59 %	50-60 %	Simon Tsai

4.4 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

Accessory of EUT

None.

Support Unit

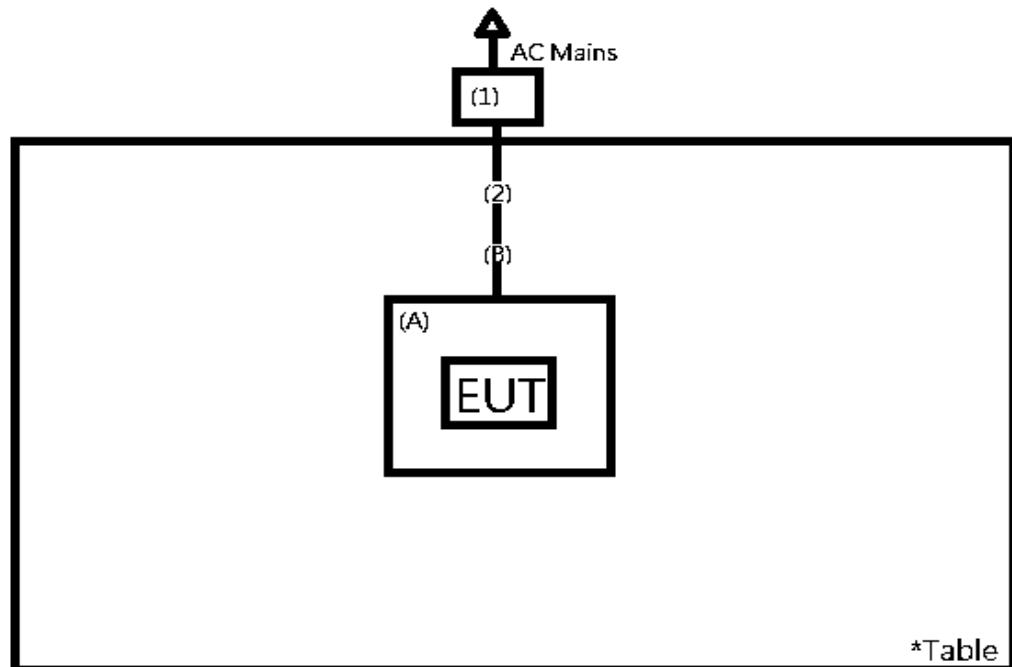
Conducted Test					
No.	Description	Brand	Model	S/N	Remark
-	Notebook	HP	TPN-C139	CND93662WT	-
MSK32WT-M10					
ZigBee & BLE- Radiated Test					
No.	Description	Brand	Model	S/N	Remark
1	NoteBook	Lenovo	TP00094F	SL10R25257	-
2	Signal Cable	TUV	TUV-030	-	300 cm shielded cable w/o core
A	Fixture	Meshreen	Meshreen-001	-	-
B	Signal Cable	Meshreen	Meshreen-002	-	50 cm shielded cable w/o core
Mains Conducted Test					
A	Fixture	Meshreen	Meshreen-001	-	-
B	Signal	Meshreen	Meshreen-002	-	50 cm shielded cable w/o core
1	Adapter	Lenovo	ADLX65NCC3A	-	-
2	Notebook	Lenovo	81BL	-	-

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MSK32WT-M13					
BLE-Radiated Test					
No.	Description	Brand	Model	S/N	Remark
A	Fixture	Meshreen	Meshreen-001	-	-
B	Signal Cable	Meshreen	Meshreen-002	-	180 cm shielded cable w/o core
1	NoteBook	Lenovo	TP00094F	SL10R25257	-
ZigBee-Radiated Test					
1	NoteBook	Lenovo	TP00094F	SL10R25257	-
2	Signal Cable	TUV	TUV-030	-	300 cm shielded cable w/o core
A	Fixture	Meshreen	Meshreen-001	-	-
B	Signal Cable	Meshreen	Meshreen-002	-	50 cm shielded cable w/o core
Mains Conducted Test					
A	Fixture	Meshreen	Meshreen-001	-	-
B	Signal	Meshreen	Meshreen-002	-	50 cm shielded cable w/o core
1	Adapter	Lenovo	ADLX65NCC3A	-	-
2	Notebook	Lenovo	81BL	-	-

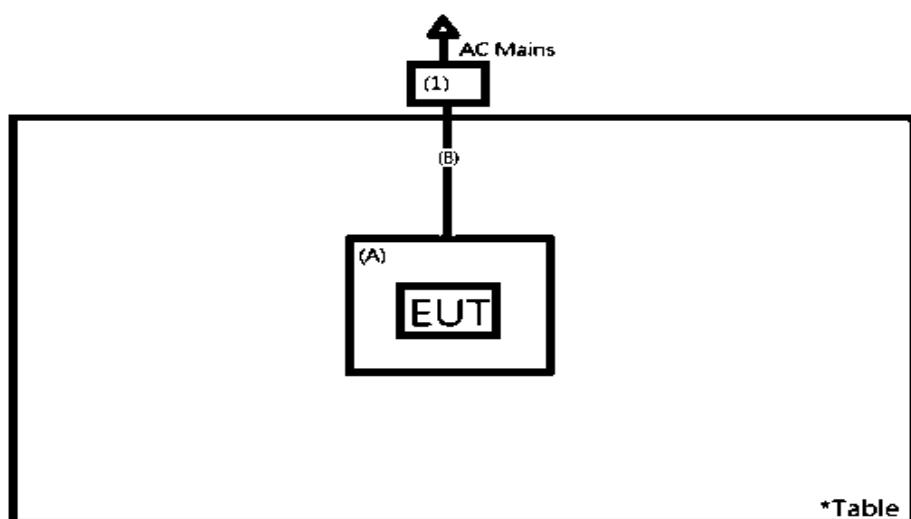
4.5 Test Setup Diagram

<Radiated Spurious Emissions mode, MSK32WT-M10, ZigBee & BLE>



*Table

<Radiated Spurious Emissions mode, MSK32WT-M13, BLE>

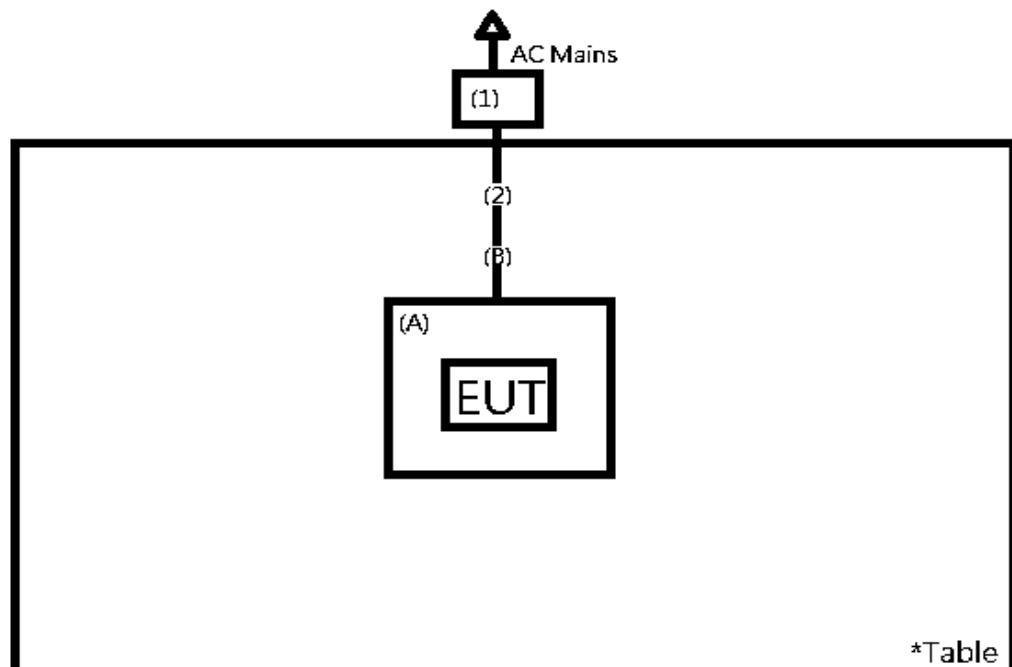


*Table

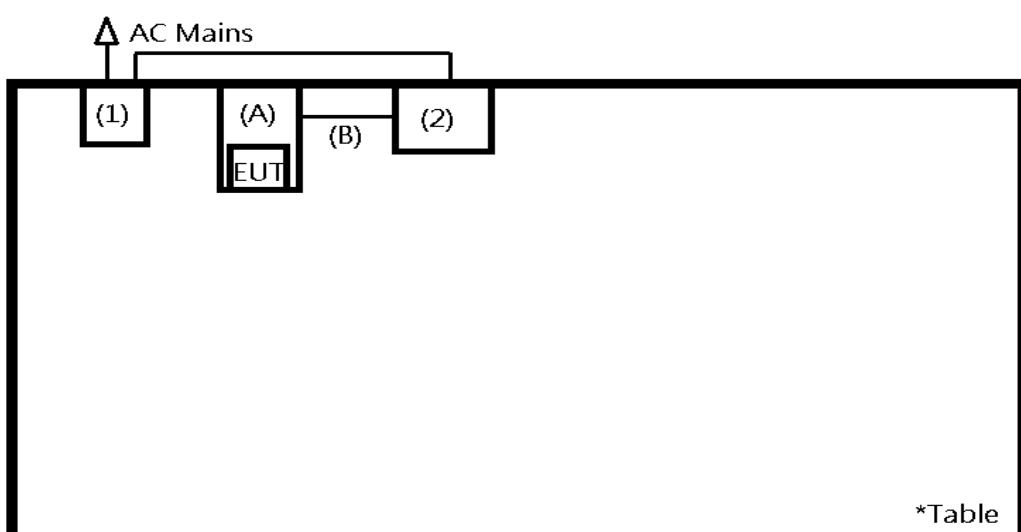
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<Radiated Spurious Emissions mode, MSK32WT-M13, ZigBee>



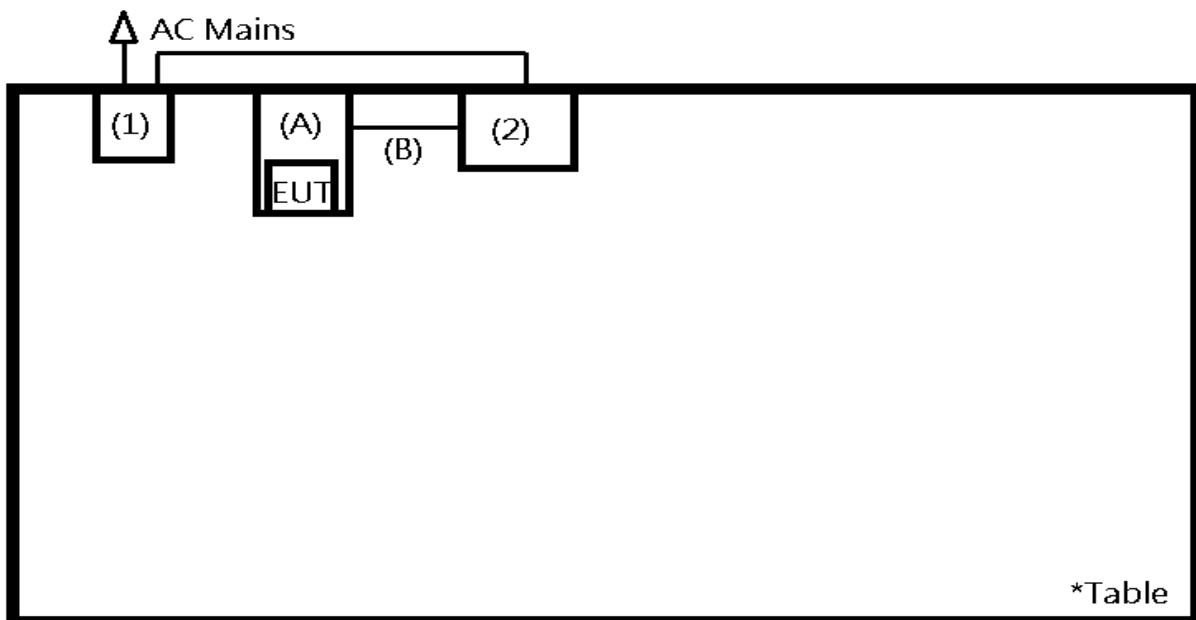
<Mains Conducted Emission mode, MSK32WT-M10>



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<Mains Conducted Emission mode, MSK32WT-M13>



*Table

5. Test Results

5.1 Transmitter Requirement & Test Suites

5.1.1 Antenna Requirement

Requirement Use of approved antennas only

According to the manufacturer declaration, the antenna information is as listed below. The antenna is with no possibility of replacement with a non-approved antenna by the end-user. Therefore, the EUT is considered to comply with this provision.

Model No.	Antenna Type	Antenna Gain (dBi)
MSK32WT-M10	PCB Antenna	1.6
MSK32WT-M13	Dipole Antenna	2.43

Refer to EUT photo for details.

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5.1.2 Peak Output Power

Limit 1 watt (30 dBm)

Kind of Test Site Shielded room

Test Setup



Test Instruments

BLE

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Power Meter	Anritsu	ML2495A	1901008	2021/3/24	2022/3/23	2021/6/21	2021/6/24
Power Sensor	Anritsu	MA2411B	1725269	2021/3/24	2022/3/23	2021/6/21	2021/6/24

ZigBee

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Power Meter	Anritsu	ML2495A	1901008	2021/3/24	2022/3/23	2021/6/2	2021/6/2
Power Sensor	Anritsu	MA2411B	1725269	2021/3/24	2022/3/23	2021/6/2	2021/6/2

Test Procedures

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

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Test Result

Peak Output Power

<1Mbps>

Channel	Channel Frequency (MHz)	Peak Output Power		Limit (dBm)
		(dBm)	(mW)	
0	2402	7.76	5.97	30
19	2440	7.54	5.68	30
38	2478	7.37	5.46	30
39	2480	1.71	1.48	30

<2Mbps>

Channel	Channel Frequency (MHz)	Peak Output Power		Limit (dBm)
		(dBm)	(mW)	
0	2402	7.76	5.97	30
19	2440	7.53	5.66	30
38	2478	7.36	5.45	30
39	2480	1.69	1.48	30

< ZigBee>

Channel	Channel Frequency (MHz)	Peak Output Power		Limit (dBm)
		(dBm)	(mW)	
11	2405	9.32	8.55	30
17	2435	9.19	8.30	30
25	2475	8.91	7.78	30
26	2480	-5.68	0.27	30

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Average Power

<1Mbps>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
0	2402	7.73	5.93
19	2440	7.50	5.62
38	2478	7.34	5.42
39	2480	1.65	1.46

<2Mbps>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
0	2402	7.73	5.93
19	2440	7.50	5.62
38	2478	7.33	5.41
39	2480	1.64	1.46

< ZigBee>

Channel	Channel Frequency	Average Power	
	(MHz)	(dBm)	(mW)
11	2405	9.29	8.49
17	2435	9.16	8.24
25	2475	8.86	7.69
26	2480	-5.84	0.26

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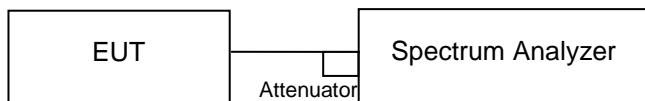
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5.1.3 6 dB Bandwidth and 99% Occupied Bandwidth

Limit The minimum 6 dB bandwidth shall be at least 500 kHz.

Kind of Test Site Shielded room

Test Setup



Test Instruments

BLE

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Spectrum Analyzer	R&S	FSV40	101512	2021/1/29	2022/1/28	2021/6/21	2021/6/24

ZigBee

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Spectrum Analyzer	R&S	FSV40	101512	2021/1/29	2022/1/28	2021/6/2	2021/7/19

Test Procedure

- Set resolution bandwidth (RBW) = 100 kHz
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.
- For 99% occupied bandwidth measurement, the transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth and set the detector to PEAK. The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5% of the total mean power of a given emission.

Test Results

Please refer to Appendix A for BLE, Appendix C for ZigBee

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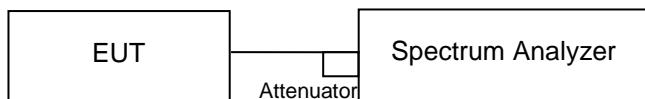
5.1.4 Power Spectral Density

Limit

The power spectral density shall not be greater than 8 dBm in any 3 kHz band.

Kind of Test Site Shielded room

Test Setup



Test Instruments

BLE

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Spectrum Analyzer	R&S	FSV40	101512	2021/1/29	2022/1/28	2021/6/21	2021/6/24

ZigBee

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Spectrum Analyzer	R&S	FSV40	101512	2021/1/29	2022/1/28	2021/6/2	2021/7/19

Test Procedure

- a. Set analyzer center frequency to DTS channel center frequency.
- b. Set the span to 1.5 times the DTS bandwidth.
- c. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- d. Set the VBW $\geq 3 \times \text{RBW}$.
- e. Detector = peak.
- f. Sweep time = auto couple.
- g. Trace mode = max hold.
- h. Allow trace to fully stabilize.
- i. Use the peak marker function to determine the maximum amplitude level within the RBW.

Test Results

Please refer to Appendix A for BLE, Appendix C for ZigBee

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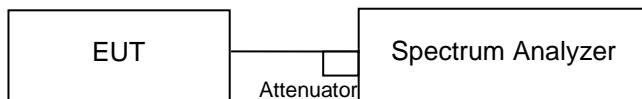
5.1.5 Conducted Spurious Emissions and Frequency Band Edges Measured in 100kHz Bandwidth

Limit

20dB (below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.)

Kind of Test Site Shielded room

Test Setup



Test Instruments

BLE

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Spectrum Analyzer	R&S	FSV40	101512	2021/1/29	2022/1/28	2021/6/21	2021/6/24

ZigBee

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date	Test Date	
						From	Until
Spectrum Analyzer	R&S	FSV40	101512	2021/1/29	2022/1/28	2021/6/2	2021/7/19

Test Procedure

Measurement procedure REF

1. Set the RBW = 100 kHz.
2. Set the VBW \geq 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Measurement procedure OOBE

1. Set RBW = 100 kHz.
2. Set VBW \geq 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.

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6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

Test Results

Please refer to Appendix A for BLE, Appendix C for ZigBee

5.1.6 Radiated Spurious Emissions and Band Edges

Limit

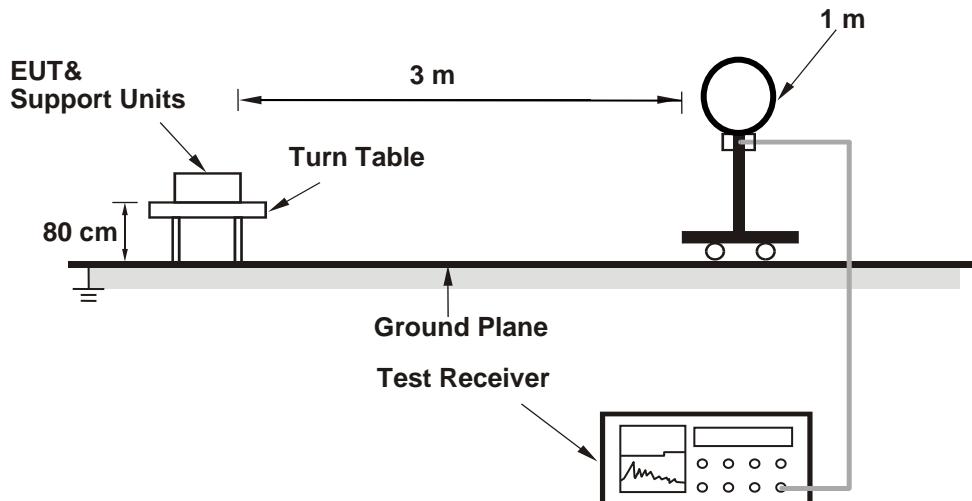
Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a).

Emissions radiated outside the restricted and authorized frequency bands must either comply with the radiated emission limits specified for the restricted bands or in §15.247(d).

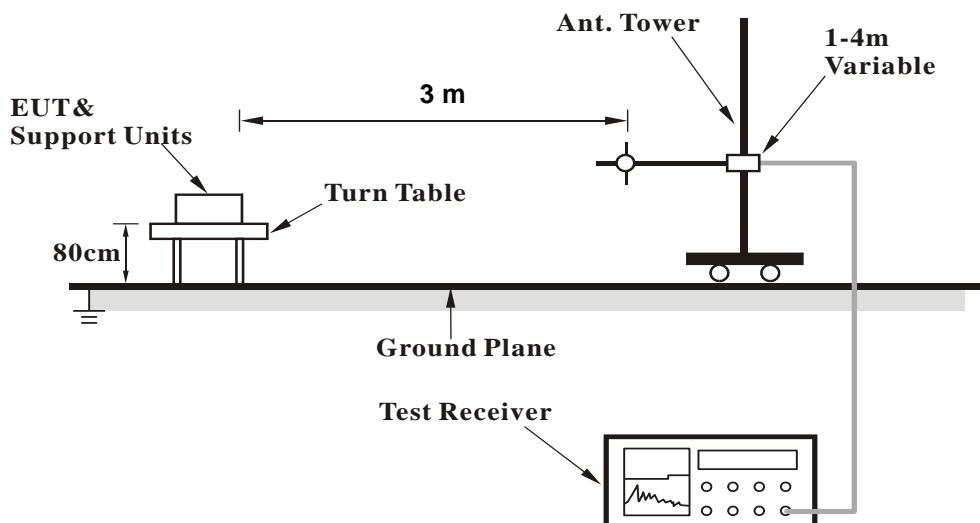
Kind of Test Site 3m Semi-Anechoic Chamber

Test Setup

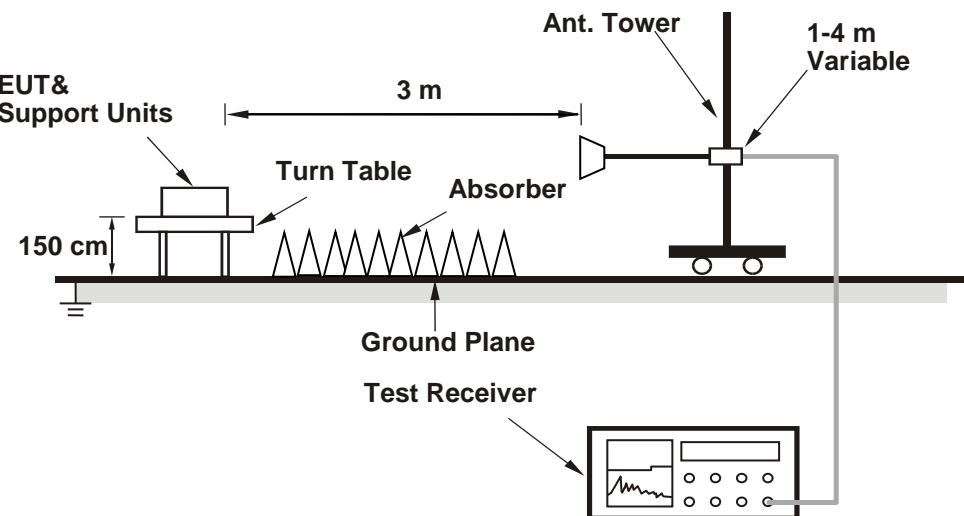
<Radiated Emissions below 30 MHz>



<Radiated Emissions 30 MHz to 1 GHz>



<Radiated Emissions above 1 GHz>



For the actual test configuration, please refer to the attached file (Test Setup Photo).

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Test Instruments

MSK32WT-M10: ZigBee, BLE ; MSK32WT-M13: ZigBee

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
Signal Analyzer	R&S	FSV40	101508	2021/3/16	2022/3/15
Receiver	R&S	ESR7	102109	2021/3/16	2022/3/15
Bilog Antenna	SCHWARZBECK	VULB-9168	00951	2021/2/18	2022/2/17
Horn Antenna	ETS-Lindgren	3117	00218930	2020/12/1	2021/11/30
LF-AMP	Agilent	8447D	2944A10772	2021/2/18	2022/2/17
HF-AMP + AC source	EMCI	EMC051845SE	980633	2021/2/9	2022/2/8
HF-AMP + AC source	EMCI	EMC184045SE	980657	2021/2/1	2022/1/31
Horn Antenna	SCHWARZBECK	BBHA 9170	00887	2021/4/8	2022/4/7
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104EA	800056/4EA	2021/3/17	2022/3/16
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104	804680/4	2021/3/17	2022/3/16
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104	MY37202/4	2021/3/17	2022/3/16
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	800898/2EA	2021/4/16	2022/4/15
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	800901/2EA	2021/4/16	2022/4/15
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	801027/2EA	2021/4/16	2022/4/15
Loop Antenna	Chance Most	EMCILPA600 +calibration	287	2021/1/15	2022/1/14

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MSK32WT-M13: BLE

Kind of Equipment	Manufacturer	Type	S/N	Calibration Date	Calibration Due Date
Signal Analyzer	R&S	FSV40	101509	2021/3/24	2022/3/23
Receiver	R&S	ESR7	102108	2021/3/17	2022/3/16
Bilog Antenna	SCHWARZBECK	VULB-9168	00950	2021/1/25	2022/1/24
Horn Antenna	ETS-Lindgren	3117	00218929	2020/11/6	2021/11/5
LF-AMP	Agilent	8447D	2727A05146	2021/2/1	2022/1/31
HF-AMP + AC source	EMCI	EMC051845SE	980635	2021/2/1	2022/1/31
HF-AMP + AC source	EMCI	EMC184045SE	980656	2021/2/9	2022/2/8
Horn Antenna	SCHWARZBECK	BBHA 9170	00890	2021/4/14	2022/4/13
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104EA	800057/4EA	2021/4/14	2022/4/13
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104	802244/4	2021/4/14	2022/4/13
Microwave Cable	HUBER+SUHNER	SUCOFLEX 104	MY37203/4	2021/4/14	2022/4/13
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	800897/2EA	2021/3/11	2022/3/10
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	800902/2EA	2021/3/11	2022/3/10
Microwave Cable	HUBER+SUHNER	SUCOFLEX 102EA	801026/2EA	2021/3/11	2022/3/10
Loop Antenna	Chance Most	EMCILPA600 +calibration	287	2021/1/18	2022/1/15

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Test Procedures

For Radiated Emissions below 30 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel (OPEN), perpendicular (CLOSE), and ground-parallel (GROUND) orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9 kHz at frequency below 30 MHz.
2. All modes of operation were investigated and the worst-case emissions are reported.

For Radiated Emissions above 30 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30 MHz ~ 1 GHz) / 1.5 meters (for above 1 GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to peak and average detected function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) or Peak detection (PK) at frequency below 1 GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1 GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is $\geq 1/T$ (Duty cycle $< 98\%$) or 10 Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1 GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.
5. The Radiated Emissions testing was performed in the X, Y and Z axis orientation. The worst-case Axis orientation is recorded in this test report.

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Test Results

Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB)

Level (dBuV/m) = Reading (dBuV) + Factor (dB/m)

Please refer to Appendix B for BLE, Appendix D for ZigBee.

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Test Procedures

- a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/50 uH of coupling impedance for the measuring instrument.
- b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels under (Limit – 20 dB) was not recorded.

Note: The resolution bandwidth and video bandwidth of test receiver is 9 kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15 MHz – 30 MHz.

Test Results

Please refer to Appendix B for BLE, Appendix D for ZigBee.