



JAPAN Radio Test Report

Bluetooth

APPLICANT : Lenovo (Shanghai) Electronics Technology Co., Ltd.

PRODUNCT NAME : Lenovo smart Display

BRAND NAME : Lenovo

MODEL NAME : Lenovo CD-17302F

TYPE EMISSIONS : 78M1F1D(BR);
78M1G1D(EDR);
19M6F1D(BR_AFH);
1M03F1D(4.2 LE) ;
2M06F1D(5.0 LE)

DECLARATION : 0.150 mW/MHz (BR/EDR);

OUTPUT POWER : 0.600 mW/MHz (BR_AFH);
3.700 mW (4.2 LE);
3.700 mW (5.0 LE)

STANDARD : Article 49-20 and the relevant articles of the
Ordinance Regulating Radio Equipment

TEST PROCEDURE : MIC Notice No.88 Appendix No.43



The product sample received on Jun. 26, 2019 and completely tested on Aug. 06, 2019. We, Sporton International Inc. (KunShan), would like to declare that the tested sample has been evaluated in accordance with the procedures given in MIC Notice No.88 Appendix No.43 and shown to be compliant with the applicable technical standards. Article 2 Paragraph 1 Item 19 of the Certificate Ordinance of the Radio Law indicates the classification of the specified radio equipment.

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

Prepared by: James Huang / Manager



Approved by: Jones Tsai / Manager

Sporton International Inc. (KunShan)

No.3-2, Pingxiang Road, Kunshan Development Zone, Jiangsu, China

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REVISION HISTORY

[illegible]



1 General Description

1.1 Applicant

Lenovo (Shanghai) Electronics Technology Co., Ltd.
Section 304-305, Building No. 4, # 222, Meiyue Road, China (Shanghai) Pilot Free Trade Zone

1.2 Manufacturer

Lenovo PC HK Limited
23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, Hong Kong P.R.China

SUMMARY OF TEST RESULT


Report Section	Description	Result
3.1	Frequency Tolerance	Pass
3.2	Occupied Bandwidth and Spread-spectrum Bandwidth / Spread Factor	Pass
3.3	Unwanted Emission Intensity	Pass
3.4	RF Output Power / Tolerance	Pass
3.5	Limitation of Collateral Emission of Receiver	Pass
3.6	Transmission Antenna Gain (EIRP Antenna Power)	NA
3.7	Transmission Radiation Angle Width (3dB Beam width)	NA
3.8	Radio Interference Prevention Capability	Pass
3.9	Hopping Frequency Dwell Time	Pass
3.10	Construction Protection Confirmation	Pass



1.3 Feature of Equipment Under Test

Product Feature & Specification	
Product Name	Lenovo smart Display
Brand Name	Lenovo
Model Name	Lenovo CD-17302F
Support Category / Frequency Range	Article 2-1-19 / 2400MHz ~ 2483.5MHz
Type of Modulation	<input type="checkbox"/> Direct Spreading (DS) <input type="checkbox"/> Orthogonal frequency-division multiplexing (OFDM) <input checked="" type="checkbox"/> Frequency Hopping (FH) <input checked="" type="checkbox"/> Other :GFSK
Number of Channels	BR/EDR Mode 79 AFH Mode 20 Other : BT 4.2/5.0 40
Channel Spacing	BR/EDR/AFH Mode 1MHz Other : BT 4.2/5.0 2MHz
Declaration RF Output Power	0.150 mW/MHz (BR/EDR mode) ; 0.600 mW/MHz (BR_AFH mode) ; 3.700 mW (4.2 LE mode) ; 3.700 mW (5.0 LE mode)
Antenna Power (E.I.R.P)	-9.76 dBm/MHz (BR/EDR mode) -3.74 dBm/MHz (BR_AFH mode) 4.16 dBm (4.2 LE mode) 4.16 dBm (5.0 LE mode)
Modulation	<input checked="" type="checkbox"/> GFSK <input checked="" type="checkbox"/> π/4-DQPSK <input checked="" type="checkbox"/> 8-DPSK <input type="checkbox"/> Other : FSK
Power Source ^{NOTE}	Commercial power AC 100 ~ 240V
	External Power Source DC 20V, 1.5A
	Lithium battery DC 3.7V, mAh
	UM battery DC 1.2V

NOTE: When EUT be operated at ±10% from the normal supply voltage, the supply voltage of RF part was varied within ±1%. All test cases were done under the normal supply voltage.

Power Supply voltage 100 Vac (Nominal)	1.8	Power Supply voltage 110 Vac (+10%)	1.8	Power Supply voltage 90 Vac (-10%)	1.8
Measurement point					
					

Antenna Information			
Brand Name :	N/A	Model Name :	N/A
Antenna Type :	PIFA	Antenna Gain :	-1.52 dBi

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 Modification of EUT

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

1.5 Testing Site

Test Site	Sporton International Inc. (KunShan) Mobile Communications Laboratory
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone, Jiangsu province, China TEL: +86-0512-5790-0158 FAX: +86-0512-5790-0958
Test Site No.	Sporton Site No.: TH01-KS

Test Items	Uncertainty	Remark
Occupied Channel Bandwidth	±101.5 kHz	Confidence 95%
RF output power, conducted	±0.68 dB	Confidence 95%
Frequency Tolerance	±101.5 kHz	Confidence 95%
Power density, conducted	±0.46 dB	Confidence 95%
Temperature	±0.8 °C	Confidence 95%
Humidity	±3 %	Confidence 95%
Time	±0.33 %	Confidence 95%

1.6 Applied Standards

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

- Article 49-20 and the relevant articles of the Ordinance Regulating Radio Equipment

Remark:

- All test items were verified and recorded according to the standards and without any deviation during the test.
- The measurement was implemented in accordance with MIC Notice No. 88 Appendix No. 43.

1.7 Ancillary Equipment List

None.

2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Channel (LE Channel)	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0 (0)	2402	27	2429	54 (27)	2456
1	2403	28 (14)	2430	55	2457
2 (1)	2404	29	2431	56 (28)	2458
3	2405	30 (15)	2432	57	2459
4 (2)	2406	31	2433	58 (29)	2460
5	2407	32 (16)	2434	59	2461
6 (3)	2408	33	2435	60 (30)	2462
7	2409	34 (17)	2436	61	2463
8 (4)	2410	35	2437	62 (31)	2464
9	2411	36 (18)	2438	63	2465
10 (5)	2412	37	2439	64 (32)	2466
11	2413	38 (19)	2440	65	2467
12 (6)	2414	39	2441	66 (33)	2468
13	2415	40 (20)	2442	67	2469
14 (7)	2416	41	2443	68 (34)	2470
15	2417	42 (21)	2444	69	2471
16 (8)	2418	43	2445	70 (35)	2472
17	2419	44 (22)	2446	71	2473
18 (9)	2420	45	2447	72 (36)	2474
19	2421	46 (23)	2448	73	2475
20 (10)	2422	47	2449	74 (37)	2476
21	2423	48 (24)	2450	75	2477
22 (11)	2424	49	2451	76 (38)	2478
23	2425	50 (25)	2452	77	2479
24 (12)	2426	51	2453	78 (39)	2480
25	2427	52 (26)	2454	-	-
26 (13)	2428	53	2455	-	-

2.2 EUT Operation Test Setup

The equipment under test (EUT) was linked with Bluetooth simulator or operated by commands in order to make the EUT into the engineering modes for transmitting, receiving signals continuously, and hopping mode.

3 Test Result

3.1 Frequency Tolerance Measurement

3.1.1 Limit

Item	Limits
Frequency Tolerance	$\leq \pm 50\text{ppm}$

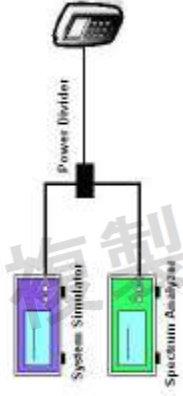
3.1.2 Measuring Instruments

See list of measuring instruments of this test report.

3.1.3 Test Procedure

- Frequency accuracy of instrument shall be less than 10% of limits tolerance (5ppm).
- Three testing methods
 - Measure frequency tolerance by the system simulator.
 - CW Tone method
 - Setting of SA is following as: RBW:1kHz / VBW:30kHz
 - Maker Max. level to get measuring frequency f.
 - 10dB down method
 - Setting of SA is following as: RBW:30kHz / VBW: 30kHz / Trace: MaxHold
 - Display line Level = Max. level – 10dB to place two markers, highest(H) and lowest(L), frequency
 - Determine measuring frequency $f = (H-L)/2$
- The frequency tolerance test case is directly measured using the frequency accuracy function of Bluetooth tester or spectrum analyzer. Then the frequency error formula is $(f-f_c)/f_c \times 10^6$ ppm and the limit is less than $\pm 50\text{ppm}$.

3.1.4 Test Setup



3.1.5 Test Result of Frequency Tolerance

Please refer to Appendix B.

Sporton International Inc. (KunShan)

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Report Version : Rev. 01

Report Template No.: BU5-JRRADIOBT Version 1.0

3.2 Occupied Bandwidth and Spread-spectrum Bandwidth / Spread Factor Measurement

3.2.1 Limit

Item	Limits
Occupied Band Width	$\leq 83.5\text{MHz}$ (FH)
	$\leq 26\text{MHz}$ (OFDM, DS and Others)
Spreading Bandwidth	$\leq 500\text{kHz}$ (FH, DS)

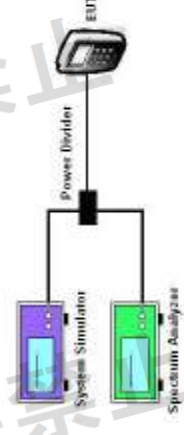
3.2.2 Measuring Instruments

See list of measuring instruments of this test report.

3.2.3 Test Procedures

- Setting of SA is following as: RBW $\leq 3\%$ of bandwidth / VBW = RBW / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold.
- EUT have transmitted each modulation signal and fixed channelize (For DSSS or OFDM Device) or continuous maximum power of hopping mode (For FHSS Device). SA set to 99% of occupied bandwidth to measure occupied bandwidth. The limit is less than 26MHz (For DSSS or OFDM Device) or 83.5MHz (For FHSS Device).
- SA set to 90% of occupied bandwidth to measure Spread Spectrum Bandwidth and must greater than 500kHz.
- Spread Spectrum Factor = Spread Spectrum Bandwidth / modulation rate of EUT.
- Spread Spectrum Factor limit is greater than 5.

3.2.4 Test Setup



3.2.5 Test Result of Occupied Bandwidth and Spread-spectrum Bandwidth / Spread Factor Measurement

Please refer to Appendix B.

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3.3 Unwanted Emission Intensity Measurement

3.3.1 Limit

Item	Limits
Tx Spurious Emission	$\leq 2.5 \mu\text{W}$ ($2387\text{MHz} > f; 2496.5\text{MHz} < f$)
	$\leq 25 \mu\text{W}$ ($2387\text{MHz} \leq f < 2400\text{MHz}$) and ($2483.5\text{MHz} < f \leq 2496.5\text{MHz}$)

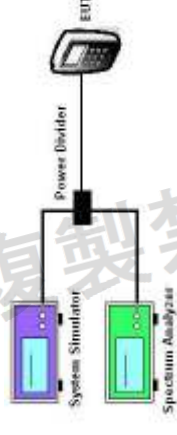
3.3.2 Measuring Instruments

See list of measuring instruments of this test report.

3.3.3 Test Procedures

- EUT have transmitted the maximum power and fixed channelize
- Setting of SA is following as: RBW:1MHz / VBW:1MHz above 1GHz, Sweep time: Auto / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold.
- Setting of SA is following as: RBW:100KHz / VBW:100KHz under 1GHz, Sweep time: Auto / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold.
- Setting of SA is following as 30MHz and stop frequency 2387MHz Then to mark peak reading value + cable loss shall be less than 2.5 μ W.
- SA adjusted to start frequency 2387MHz and stop frequency 2400MHz. Then to mark peak reading value + cable loss shall be less than 25 μ W.
- SA adjusted to start frequency 2483.5MHz and stop frequency 2496.5MHz Then to mark peak reading value + cable loss shall be less than 25 μ W.
- SA adjusted to start frequency 2496.5MHz and stop frequency 12500MHz Then to mark peak reading value + cable loss shall be less than 2.5 μ W.
- If the Result_Value is over the requirement, take total sum of 1MHz band centered at the spur frequency like ACLP measurement as Result_Value.

3.3.4 Test Setup



3.3.5 Test Result of Unwanted Emission Intensity

Please refer to Appendix B.

3.4 RF Output Power / Tolerance

3.4.1 Limit

Item	Limits
Antenna Power Density	≤ 3mW/MHz (FH form 2400~2483.5MHz)
	≤ 10mW/MHz (OFDM_DS from 2400~2483.5MHz)
	≤ 10mW (Other from 2400~2483.5MHz)
Antenna Power Error	+20%, -80% (Base on manufacturer declare antenna power density)

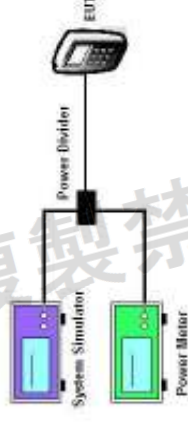
3.4.2 Measuring Instruments

See list of measuring instruments of this test report.

3.4.3 Test Procedures

1. EUT have transmitted continuous maximum power on hopping mode (For FHSS Device).
2. Frequency hopping system or combined systems of direct spread and frequency hopping:
 - i. Connect the high frequency power meter to the output of the attenuator and measure the total power (without bandwidth limitation)
 - ii. Divide the total power by the spread bandwidth to find the "average" power per MHz.
The average power per MHz is equal to the power meter value dBm + cable loss dB + $10 \log_{10} (1/\text{Duty Cycle}) \text{ dB} + 10 \log_{10} (1/\text{Spread Bandwidth}) \text{ dB}$.
 - iii. Confirm that frequency distribution of the hopping frequencies is homogeneous according to the supporting data.
If frequency distribution of the frequencies is not homogeneous, consider other measurement or correction methods based on the supporting data.
 - iv. Set the antenna power as follows:
 - Continuous waves: value in ii.
3. Antenna RF Output Power Tolerance is definition that actual measure antenna power tolerance between + 20% to - 80% power range that manufacturer declare the conducted power density.

3.4.4 Test Setup



3.4.5 Test Result of RF Output Power / Tolerance

Please refer to Appendix B.



3.5 Limitation of Collateral Emission of Receiver Measurement

3.5.1 Limit

Item	Limits
Rx Spurious Emission	$\leq 4\text{nW}$ ($f < 1\text{GHz}$)
	$\leq 20\text{nW}$ ($1\text{GHz} \leq f$)

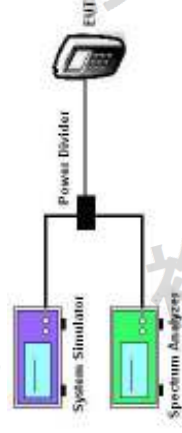
3.5.2 Measuring Instruments

See list of measuring instruments of this test report.

3.5.3 Test Procedures

1. EUT have the continuous reception mode and fixed only one channelize.
2. SA set RBW: 100KHz and VBW: 100KHz. Then adjust to start frequency 30MHz and stop frequency 1GHz. Search to mark peak reading value + cable loss shall be less than 4nW.
3. SA set RBW: 1MHz and VBW: 1MHz. Then adjust to start frequency 1000MHz and stop frequency 12.5GHz. Search to mark peak reading value + cable loss shall be less than 20nW.
4. If power level of lower emissions are more than 1/10 of limit (0.4nW for $f < 1\text{GHz}$, 2nW for $f \geq 1\text{GHz}$), all those are to be indicated in the 2nd and 3rd lines. If others are 1/10 or less more of the limit, no necessary to be indicated.

3.5.4 Test Setup



3.5.5 Test Result of Limitation of Collateral Emission of Receiver

Please refer to Appendix B.



3.6 Transmission Antenna Gain (EIRP Antenna Power) Measurement

3.6.1 Limit

Item	Limits
EIRP Power Density	$\leq 6.91\text{dBm/MHz}$ (FH form 2400~2483.5MHz)
	$\leq 12.14\text{dBm/MHz}$ (OFDM_DS from 2400~2483.5MHz)
	$\leq 12.14\text{dBm}$ (Other from 2400~2483.5MHz)

Remark: This test item will not be applied to EIRP power of EUT is lower than 12.14dBm/MHz.

3.6.2 Measuring Instruments

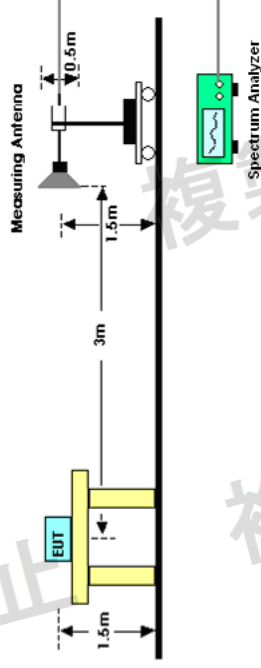
See list of measuring instruments of this test report.

3.6.3 Test Procedures

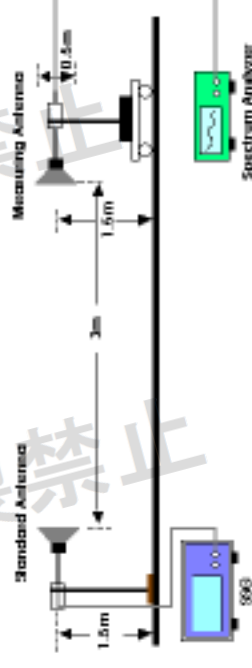
1. Set EUT ad measuring antenna at the same height and roughly facing each other.
2. Move the measuring antenna height up and down within $\pm 50\text{cm}$ of EUT height and swing it to find the maximum output of the measuring antenna. The output level at the spectrum analyzer is read as "E".
3. Remove the EUT from the turn table and put the replacing antenna facing to measuring antenna at same height. Set the standard signal generator (SSG) at same frequency and transmit on then receive the signal.
4. Swing the replacing antenna give a maximum receiving level.
5. Move the measuring antenna height up and down within $\pm 50\text{cm}$ of replacing antenna height and swing it to find the maximum receiving level.
6. Set SSG output power at Pt to give the equivalent output level of "E" or calculate Pt with SSG output which gives the nearest of "E" and difference ($\pm 1\text{dB}$). Record the Pt.
7. Calculate EIRP by the formula below $\text{EIRP} = \text{Gt} - \text{L} + \text{Pt}$.
Gt: gain of replacing antenna (dBi)
L: feeder loss between SSG and replacing antenna
Pt: Output power of the SSG
8. If the antenna for the EUT has circular polarization, sum of V-field and H-field will be result if measuring antenna is linear polarization.

3.6.4 Test Setup

<For EUT radiation measurement>



<For standard antenna measurement>



3.6.5 Test Result of Transmission Antenna Gain (EIRP Antenna Power)

Please refer to Appendix B. For the antenna gain, please refer to antenna test report.

Remark: This test item will not be applied to EIRP power of EUT is lower than 12.14dBm/MHz.

3.7 Transmission Radiation Angle Width (3dB Beamwidth) Measurement

3.7.1 Limit

Item	Limits
3dB antenna beamwidth	360/A (If $A < 1$; then $A = 1$) $A = \{ \text{EIRP Power [mW]} / 16.36 \text{ for DS, OFDM} \}$ or $A = \{ \text{EIRP Power [mW]} / 4.9 \text{ for FH} \}$

Remark: This test item will not be applied to EIRP power of EUT is lower than 12.14dBm/MHz.

3.7.2 Measuring Instruments

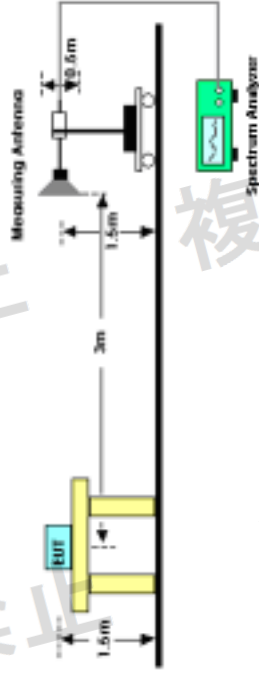
See list of measuring instruments of this test report.

3.7.3 Test Procedures

1. Set EUT and measuring antenna at the same height and roughly facing each other.
2. Set spectrum analyzer with condition in section 3.7.2 and tune reference level to observe receiving signal position.
3. Rotate directions of the EUT horizontally and vertically to find the maximum receiving power.
4. Move the measuring antenna height up and down within $\pm 50\text{cm}$ of EUT height and swing it to find the maximum output of measuring antenna. The output level at the spectrum analyzer is read as "E".
5. Calculate permitted radiation angle in horizontal and vertical using EIRP measured in another test method.
6. Calculate 3dB antenna beam width by the formula below $360/A$ (If $A < 1$; then $A = 1$).
 $A = \{ \text{EIRP Power [mW]} / 16.36 \text{ for DS, OFDM} \}$ or
 $A = \{ \text{EIRP Power [mW]} / 4.9 \text{ for FH} \}$



3.7.4 Test Setup



3.7.5 Test Result of Transmission Radiation Angle Width (3dB Beamwidth)

Please refer to Appendix B.

For the antenna gain, please refer to antenna test report.

Remark: This test item will not be applied to EIRP power of EUT is lower than 12.14dBm/MHz.



3.8 Radio Interference Prevention Capability Measurement

3.8.1 Limit

Item	Limits
Identification code	48 bits

3.8.2 Measuring Instruments

See list of measuring instruments of this test report.

3.8.3 Test Procedures

1. In the case that the EUT has the function of automatically transmitting the identification code: a. Transmit the predetermined identification codes form EUT. b. Check the transmitted identification codes with the demodulator.
2. In the case of receiving the identification code: a. Transmit the predetermined identification codes form the counterpart. b. Check if communication is normal. c. Transmit the signals other than predetermined ID codes form the counterpart. d. check if the EUT stops the transmission, or if it displays that identification codes are different from the predetermined ones.

3.8.4 Test Setup



3.8.5 Test Result of Radio Interference Prevention Capability

Please refer to Appendix B.



3.9 Hopping Frequency Dwell Time Measurement

3.9.1 Limit

Item	Limits
Hopping Freq. Dwell Time	≤ 0.4 seconds

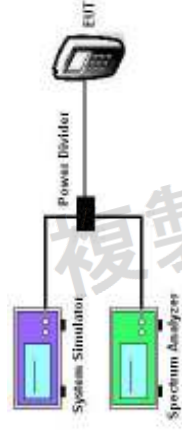
3.9.2 Measuring Instruments

See list of measuring instruments of this test report.

3.9.3 Test Procedures

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Set RBW of spectrum analyzer to 1MHz and VBW to 1MHz.
3. Use a video trigger with the trigger level set to enable triggering only on full pulses.
4. Sweep Time is more than once pulse time.
5. Set the center frequency on any frequency would be measured and set the frequency span to zero span.
6. Measure the maximum time duration of one single pulse.
7. Set the EUT in continuous transmitting for each supported maximum packet format.
8. Measure the maximum time duration of one single pulse.
9. Use the marker-delta function to calculate the dwell time.
10. Dwell Time = Total Number of channels x 0.4(s) x Average Hopping Channel x package transfer time
11. Average Hopping Channel = Total Number of hopping / sweep time

3.9.4 Test Setup



3.9.5 Test Result of Hopping Frequency Dwell Time

Please refer to Appendix B.



3.10 Construction Protection Confirmation Method

3.10.1 Limit

The high-frequency section and modulation section of the radio equipment except for the antenna system shall not be capable of being opened easily.

3.10.2 Confirmation Method

<input type="checkbox"/>	Sealed with special screws.
<input type="checkbox"/>	Plastic chassis is being welded using ultrasonic waves.
<input type="checkbox"/>	Chassis is glued using a special adhesive.
<input type="checkbox"/>	Metal covers are spot-fused.
<input type="checkbox"/>	Cover is specially interlocked.
<input checked="" type="checkbox"/>	RF and Modulation components are covered with shielding case and this shielding case is soldered.
<input type="checkbox"/>	Shield case is welded at RF and modulation parts, and ID-ROM is welded using the BGA Method.
<input type="checkbox"/>	Shield case is welded at RF and modulation parts, and ID-ROM is glued at its lead with a special adhesive.
<input type="checkbox"/>	Shield case is welded at RF and modulation parts, and ID-ROM is glued with a non-transparent laminating agent.
<input type="checkbox"/>	Other :

3.10.3 The Photos of Construction Protection





4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Periods of Test	Due Date	Calibration Body	Calibration Method
Spectrum Analyzer	R&S	FSV30	101338	10Hz~30GHz	Apr. 16, 2019	Aug. 05, 2019~ Aug. 06, 2019	Apr. 15, 2020	CEPREI Calibration and Testing Center	C
Pulse Power Sensor	Anritsu	ML2495A	1339163	300MHz~40GHz	Nov. 19, 2018	Aug. 05, 2019~ Aug. 06, 2019	Nov. 18, 2019	CEPREI Calibration and Testing Center	C
Power Meter	Anritsu	ML2495A	1435004	50MHz Bandwidth	Nov. 19, 2018	Aug. 05, 2019~ Aug. 06, 2019	Nov. 18, 2019	CEPREI Calibration and Testing Center	C
Bluetooth Tester	R&S	CBT	100783	Max input Power +27dBm	Aug. 07, 2018	Aug. 05, 2019~ Aug. 06, 2019	Aug. 06, 2019	CEPREI Calibration and Testing Center	C
AC Power Source	Chroma	61602	ABP00000081 1	AC 0V~300V, 45Hz~1000Hz	Oct. 12, 2018	Aug. 05, 2019~ Aug. 06, 2019	Oct. 11, 2019	CEPREI Calibration and Testing Center	C
Multi-meter	YFE	YF-303	YF-303-01	-	Apr. 17, 2019	Aug. 05, 2019~ Aug. 06, 2019	Apr. 16, 2020	CEPREI Calibration and Testing Center	C

Note: Above test equipment was used and kept valid calibration period during test.

Calibration Method :

- a) : Calibration conducted by the National Institute of Information and Communications Technology ~ NICT ~ or a designated calibration agency under Article 102-18 paragraph
(1) TELEC Engineering Center, Intertek Japan K.K., Keysight Technologies, Inc ~.
- b) : Correction conducted pursuant to the provisions of Article 135 or Article 144 of the Measurement Law (Law No. 51 of 1992) ~ Japan Calibration Service Syste ~
- c) : Calibration conducted in foreign countries, which shall be equivalent to the calibration conducted by the NICT or a designated calibration agency under Article 102-18 paragraph
(1) ~ TELEC Engineering Center, Intertek Japan K.K., Keysight Technologies, Inc ~.

Appendix A. Setup Photographs



Front View



Near View



Appendix B. Test Results

Please refer to the following pages for test results.

1. TEST RESULTS DATA

BLUETOOTH - BR

Environment of Test Room	Temperature Humidity	21~24 °C 49~51 %
Test Engineer	Lion Ran	

Modulation Type :	GFSK
Type Emissions :	78M1F1D

Declaration Output Power	0.150	mW/MHz
Declaration Output Power	-8.24	dBm/MHz
Antenna Power (EIRP)	-9.76	dBm/MHz
Input Power Voltage	100-240	Vac

Path Loss	5.50	dB
ON TIME	2.874	msec
Burst OFF TIME	0.886	msec
Ratio	76.45	%
Packet Type (Mode)	DH6	mode

Antenna Information:

Antenna Model	Antenna Type	Gain(dBi)
Refer to antenna report	PIFA	-1.52

1.1. Test Results (Normal Voltage)

Measurement Frequency	MHz	2402	2441	2480	Limit	Result	Note
Channel Number	Ch.	0	39	78		39	78
Reading Frequency	MHz	2402.029	2441.029	2480.029			
Frequency Tolerance	ppm	12.052	11.860	11.673	±50	PASS	PASS
Occupied Bandwidth	MHz	78.15			83.5		PASS
Spread Bandwidth	MHz	70.62			0.5		PASS
RF Output Power	mW/MHz		0.127				
RF Output Power Tolerance	%		-15.48		-80~+20		PASS
Output Power (With burst rail)	dBm		9.52				

Unwanted Emission Intensity	Under 2387MHz	µW/MHz	0.00070	0.00073	0.00089	2.5	PASS	PASS
	2387MHz - 2400MHz	µW/MHz	1201.361	1220.769	1240.178			
	2400MHz	µW/MHz	0.83946	0.00066	0.00050	25	PASS	PASS
	2400MHz - 2483.5MHz	µW/MHz	2399.990	2389.154	2391.640			
	2483.5MHz - 2496.5MHz	µW/MHz	0.00045	0.00067	0.00975	25	PASS	PASS
Limitation of Collateral Emission of Receiver	2496.5MHz - 12.5GHz	µW/MHz	2487.382	2493.378	2483.828			
		µW/MHz	0.01396	0.00728	0.01462	2.5	PASS	PASS
		MHz	3603.277	3661.291	4960.616			
	Under 1GHz	nW	0.048	0.047	0.043	4	PASS	PASS
	Collateral Emission of Receiver	MHz	994.520	986.490	958.343			
	1~12.5GHz	nW	0.418	0.408	0.413	20	PASS	PASS
		MHz	6890.322	6805.579	6856.366			

Spread Factor		70.62	5	PASS
Dwell Time	mSec	245.20	400	PASS
Radio Interference Prevention Capability		good		PASS

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2. TEST RESULTS DATA

Modulatooin Type :	8DPSK
Type Emissions :	78M1G1D

Environment of Test Room	Temperature	21~24 °C
	Humidity	49~51 %
Test Engineer		Lion Ran

Path Loss		5.50	dB
Burst	ON TIME	2.887	msec
	OFF TIME	0.870	msec
	Ratio	76.85	%
Packet Type (Mode)		3-DH5	mode

Declaration Output Power	0.150	mW/MHz
Declaration Output Power	-8.24	dBm/MHz
Antenna Power (EIRP)	-9.76	dBm/MHz
Input Power Voltage	100-240	Vac

Antenna Information:

Antenna Model	Antenna Type	Gain(dBi)
Refer to antenna report	PIFA	-1.52

2.1. Test Results (Normal Voltage)

Measurement Frequency	MHz	2402	2441	2480	Limit	Result	Note
Channel Number	Ch.	0	39	78		0	78
Reading Frequency	MHz	2402.081	2441.084	2480.080			
Frequency Tolerance	ppm	33.722	34.371	32.359	+50	PASS	PASS

Occupied Bandwidth	MHz	78.15	83.5	PASS
Spread Bandwidth	MHz	70.62	0.5	PASS
RF Output Power	mW/MHz	0.076		PASS
RF Output Power Tolerance	%	-49.30	-80~+20	PASS
Output Power (With burst ratio)	dBm	7.30		PASS

		$\mu\text{W}/\text{MHz}$	0.00061	0.00051	0.00054	2.5	PASS	PASS	PASS
Unwanted Emission Intensity	Under 2387MHz	MHz	2386.693	796.951	981.232				
	2387MHz - 2400MHz	$\mu\text{W}/\text{MHz}$	1.99986	0.00063	0.00050	25	PASS	PASS	PASS
	2483.5MHz - 2496.5MHz	MHz	2490.000	2392.149	2395.460				
		$\mu\text{W}/\text{MHz}$	0.00043	0.00050	0.01169	25	PASS	PASS	PASS
		MHz	2486.654	2492.053	2484.200				
Limitation of Collateral Emission of Receiver	2496.5MHz - 12.5GHz	$\mu\text{W}/\text{MHz}$	0.00930	0.00564	0.01306	2.5	PASS	PASS	PASS
		MHz	3603.277	4682.596	4960.916				
		nW	0.046	0.046	0.044	4	PASS	PASS	PASS
	Under 1GHz	MHz	531.488	814.409	781.529				
	1 - 12.5GHz	nW	0.395	0.385	0.480	20	PASS	PASS	PASS
		MHz	6885.114	5789.830	6885.110				

Spread Factor	10 000 Hz	70.62	5	PASS	3DH5
Dwell Time	mSec	273.69	400	PASS	
Radio Interference Prevention Capability	10 000 Hz	good		PASS	

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3. TEST RESULTS DATA

Environment of Test Room	Temperature	21~24 °C
	Humidity	49~51 %
Test Engineer	Lion Ran	

Modulatoin Type :	GFSK
Type Emissions :	19M6F1D

Declaration Output Power	0.600	mW/MHz
Declaration Output Power	-2.22	dBm/MHz
Antenna Power (E.I.R.P)	-3.74	dBm/MHz
Input Power Voltage	100-240	Vac

Path Loss		5.50	dB
Burst	ON TIME	2.874	msec
	OFF TIME	0.886	msec
	Ratio	76.45	%
Packet Type (Mode)		DH5	

Antenna Information:

Antenna Model	Antenna Type	Gain(dBi)
Refer to antenna report	PIFA	-1.52

3.1. Test Results (Normal Voltage)

Measurement Frequency	MHz	2402	2411	2421	Limit	Result	Note
Channel Number	Ch.	9	9	19		0	9 19
Reading Frequency	MHz	2402.029	2411.029	2421.029			
Frequency Tolerance	ppm	12.052	12.007	11.958	±50	PASS	PASS

Occupied Bandwidth	MHz	19.61	83.5	PASS
Spread Bandwidth	MHz	18.02	0.5	PASS
RF Output Power	mW/MHz	0.497		PASS
RF Output Power Tolerance	%	-17.17	-80~+20	PASS
Output Power (With burst ratio)	dBm	9.52		PASS

		$\mu\text{W}/\text{MHz}$	0.00072	0.00068	0.00061	2.5	PASS	PASS	PASS
Unwanted Emission Intensity	Under 2387MHz	MHz	2343.678	1205.520	1211.070				
		$\mu\text{W}/\text{MHz}$	0.00072	0.000283	0.00072	25	PASS	PASS	PASS
	2387-2400MHz	MHz	2399.990	2399.269	2399.211				
		$\mu\text{W}/\text{MHz}$	0.00061	0.00048	0.00051	25	PASS	PASS	PASS
	2483.5-2496.5MHz	MHz	2493.541	2487.609	2493.398				
Limitation of Collateral Emission of Receiver	2496.5MHz - 12.5GHz	$\mu\text{W}/\text{MHz}$	0.01419	0.00895	0.00931	2.5	PASS	PASS	PASS
		MHz	3903.277	3616.280	4842.586				
		nW	0.046	0.044	0.045	4	PASS	PASS	PASS
	Under 1GHz	MHz	906.841	904.513	977.4498				
	1-12.5GHz	nW	6393.691	0.399	0.438	20	PASS	PASS	PASS
		MHz	6963.620	6566.020	9710.712				

Spread Factor	18.02	5	PASS
Dwell Time	mSec	400	PASS
Radio Interference Prevention Capability	good		PASS

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4. TEST RESULTS DATA
BLUETOOTH - LE

Modulatooin Type :	GFSK
Type Emissions :	1M03F1D

Environment of Test Room	Temperature	21~24 °C	Modulation Type :	GFSK
	Humidity	49~51 %		
Test Engineer		Lion Ran		

Path Loss		5.50	dB
Burst	ON TIME	0.377	msec
	OFF TIME	0.249	msec
Ratio		60.18	%
Packet Type (Mode)		Low Energy mode	

Declaration Output Power	3.700	mW
Declaration Output Power	5.68	dBm
Antenna Power (EIRP)	4.16	dBm
Input Power Voltage	100~240	Vac

Antenna Information:

Antenna Model	Antenna Type	Gain(dBi)
Refer to antenna report	PIFA	-1.52

4.1. Test Results (Normal Voltage)

Measurement Frequency	MHz	2402	2440	2480	Limit	Result	Note
Channel Number	Ch.	0	19	39		0 19 39	
Reading Frequency	MHz	2402.049	2440.049	2480.049			
Frequency Tolerance	ppm	20.504	20.184	19.859	-50≤x≤+50	PASS PASS PASS	

Occupied Bandwidth	MHz	1.03	1.03	1.03	26	PASS	
Spreading Bandwidth	MHz	N/A	N/A	N/A	0.5	N/A	
RF Output Power	mW	2.858	3.357	2.917			
RF Output Power Tolerance	%	-22.71	-9.26	-21.15	-80≤x≤+20	PASS	
Output Power (With burst ratio)	dBm	4.46	5.26	4.65			

Unwanted Emission Intensity	Under 2387MHz	µV/MHz	0.00043	0.00049	0.00203	2.5	PASS	PASS
	2387MHz - 2400MHz	µV/MHz	260.885	907.132	1747.566	25	PASS	PASS
	2483.5MHz - 2496.5MHz	µV/MHz	0.00036	0.00033	0.00034	25	PASS	PASS
	2496.5MHz - 12.5GHz	µV/MHz	0.00035	0.00036	0.00370	25	PASS	PASS
	Under 1GHz	nW	0.01175	0.01500	0.00796	2.5	PASS	PASS
	Collateral Emission of Receiver	nW	7206.177	7321.206	7440.236	4	PASS	PASS
	Limitation of Collateral Emission of Receiver	nW	891.225	351.377	932.640	20	PASS	PASS

Spread Factor	N/A	5	N/A	N/A	400	PASS
Dwell Time	mSec					
Radio Interference Prevention Capability		good				

5. TEST RESULTS DATA
BLUETOOTH - LE

Environment of Test Room	Temperature	21~24 °C	Modulation Type :	GFSK
	Humidity	49~51 %		
Test Engineer		Lion Ran		

Modulatooin Type :	GFSK
Type Emissions :	2M06F1D

Declaration Output Power	3.700	mW
Declaration Output Power	5.68	dBm
Antenna Power (EIRP)	4.16	dBm
Input Power Voltage	100~240	Vac

Path Loss		5.50	dB
Burst	ON TIME	1.058	msec
	OFF TIME	0.819	msec
Ratio		56.37	%
Packet Type (Mode)		Low Energy mode	

Antenna Information:

Antenna Model	Antenna Type	Gain(dBi)
Refer to antenna report	PIFA	-1.52

5.1. Test Results (Normal Voltage)

Measurement Frequency	MHz	2402	2440	2480	Limit	Result	Note
Channel Number	Ch.	0	19	39		0 19 39	
Reading Frequency	MHz	2401.931	2439.933	2479.936			
Frequency Tolerance	ppm	-28.913	-27.275	-25.665	-50≤x≤+50	PASS PASS PASS	

Occupied Bandwidth	MHz	2.06	2.06	2.06	26	PASS	
Spreading Bandwidth	MHz	N/A	N/A	N/A	0.5	N/A	
RF Output Power	mW	3.048	2.864	1.879			
RF Output Power Tolerance	%	-17.62	-22.59	-49.21	-80≤x≤+20	PASS	
Output Power (With burst ratio)	dBm	4.84	4.57	2.74			

Unwanted Emission Intensity	Under 2387MHz	µV/MHz	0.00044	0.00054	0.00047	2.5	PASS	PASS
	2387MHz - 2400MHz	µV/MHz	935.259	981.232	560.488	25	PASS	PASS
	2483.5MHz - 2496.5MHz	µV/MHz	0.00035	0.00036	0.00031	25	PASS	PASS
	2496.5MHz - 12.5GHz	µV/MHz	0.00035	0.00036	0.00330	25	PASS	PASS
	Under 1GHz	nW	0.00617	0.00668	0.00512	2.5	PASS	PASS
	Collateral Emission of Receiver	nW	7206.177	7321.206	7439.240	4	PASS	PASS
	Limitation of Collateral Emission of Receiver	nW	846.319	191.731	983.968	20	PASS	PASS

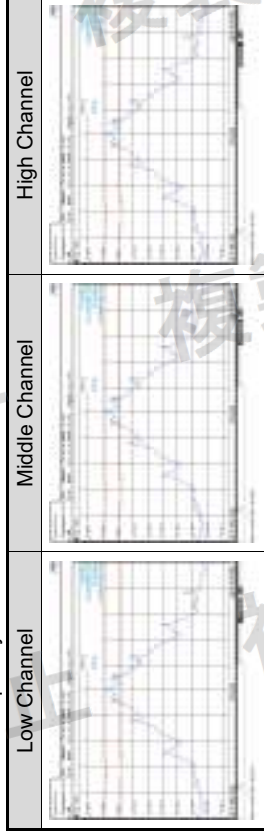
Spread Factor	N/A	5	N/A	N/A	400	PASS
Dwell Time	mSec					
Radio Interference Prevention Capability		good				



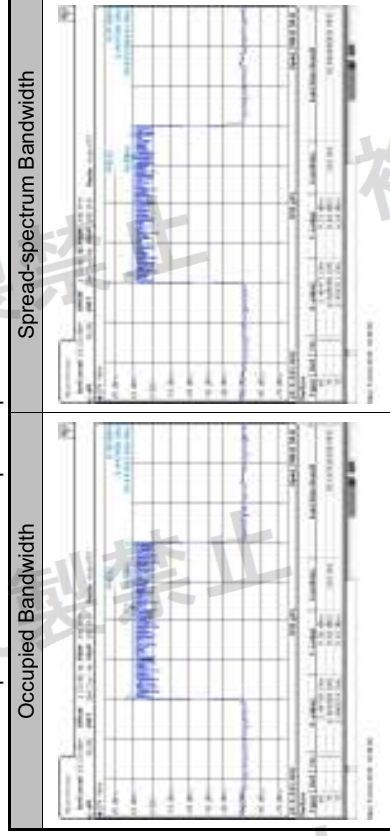
Appendix C. Test Plots

C.1. BR (Basic Rate)

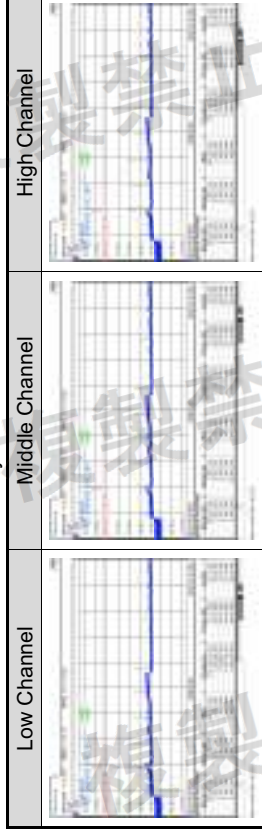
C.1.1. Frequency Tolerance



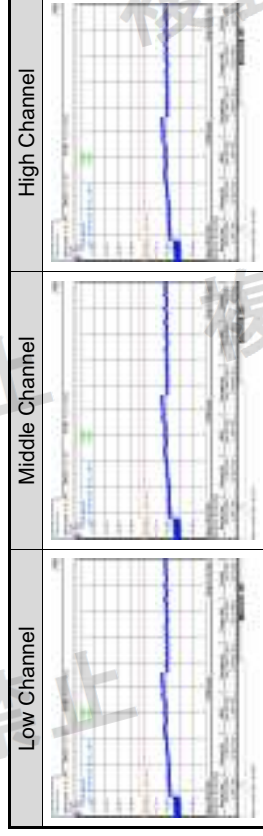
C.1.2. Occupied Bandwidth and Spread-spectrum Bandwidth



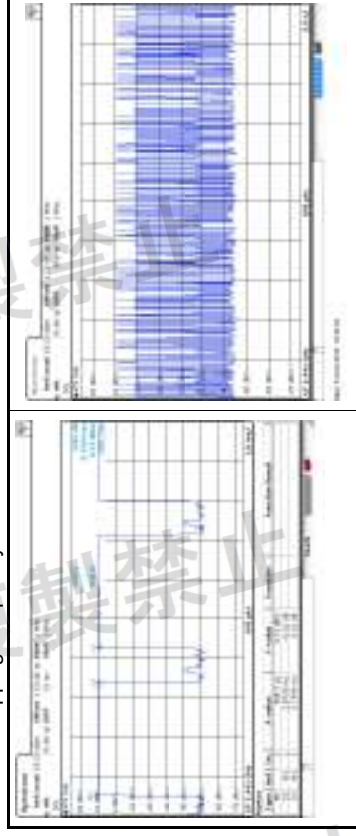
C.1.3. Unwanted Emission Intensity



C.1.4. Limitation of Collateral Emission of Receiver



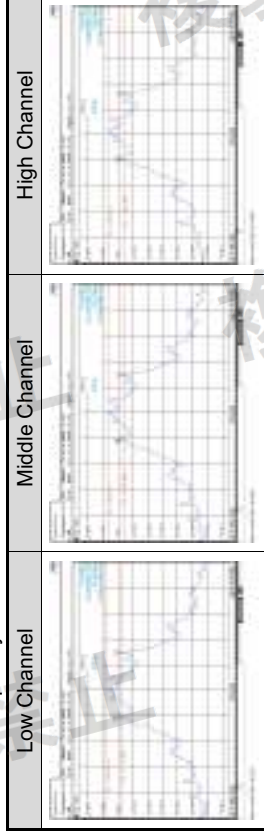
C.1.5. Hopping Frequency Dwell Time





C.2. EDR (Enhanced Data Rate)

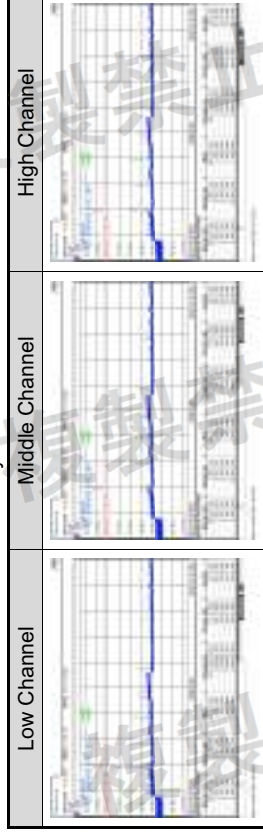
C.2.1. Frequency Tolerance



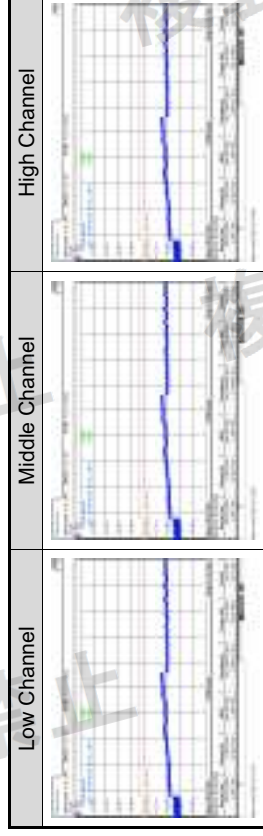
C.2.2. Occupied Bandwidth and Spread-spectrum Bandwidth



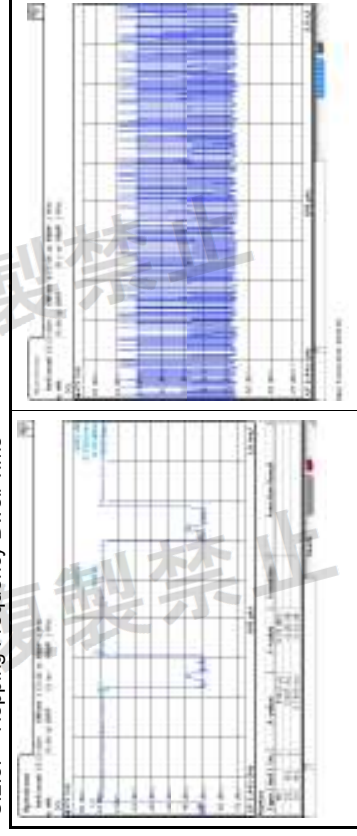
C.2.3. Unwanted Emission Intensity



C.2.4. Limitation of Collateral Emission of Receiver



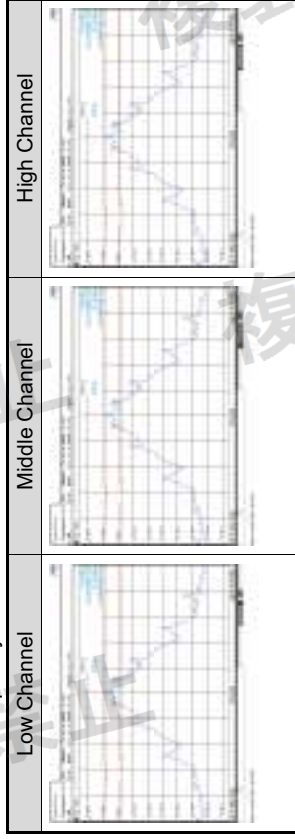
C.2.5. Hopping Frequency Dwell Time





C.3. AFH (Adaptive Frequency Hopping)

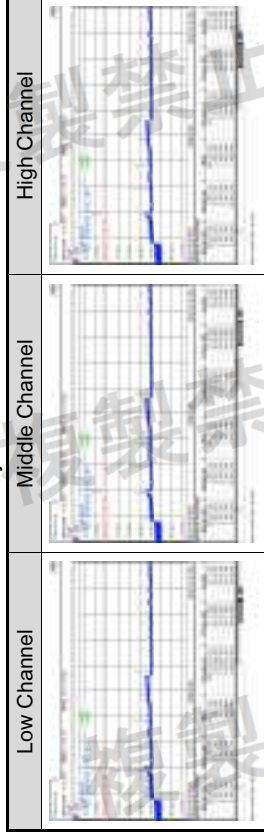
C.3.1. Frequency Tolerance



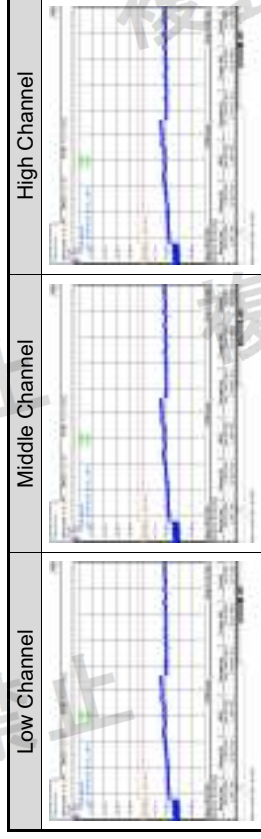
C.3.2. Occupied Bandwidth and Spread-spectrum Bandwidth



C.3.3. Unwanted Emission Intensity



C.3.4. Limitation of Collateral Emission of Receiver



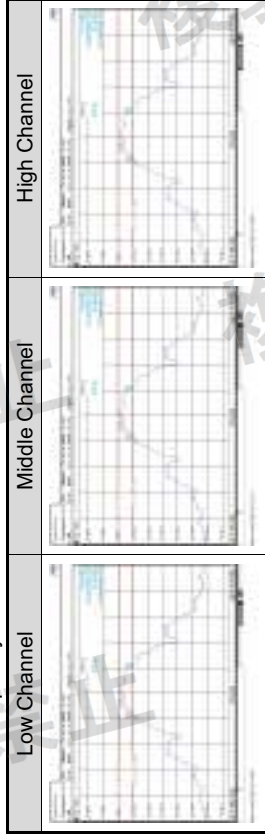
C.3.5. Hopping Frequency Dwell Time



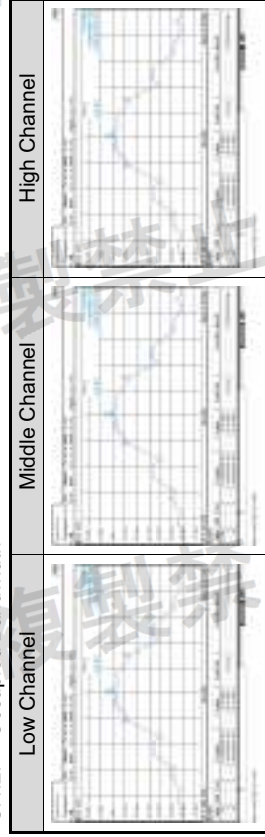


C.4. v4.2 LE (Low Energy)

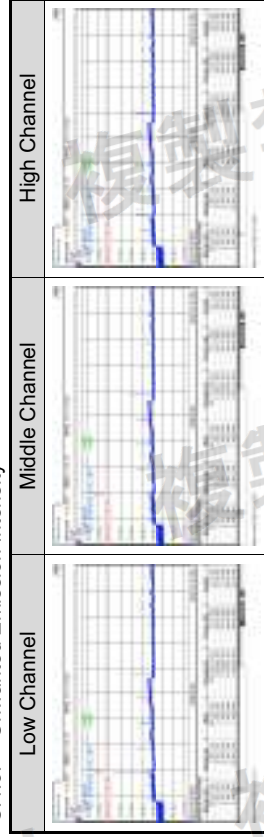
C.4.1. Frequency Tolerance



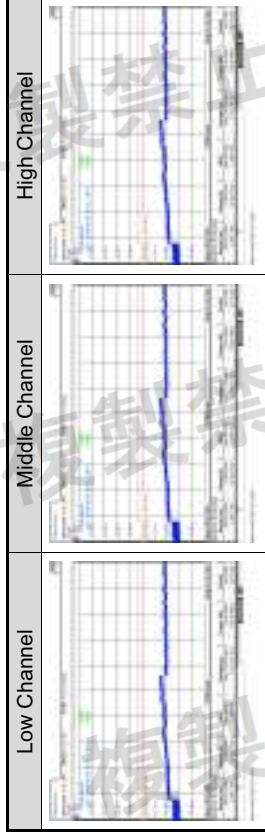
C.4.2. Occupied Bandwidth



C.4.3. Unwanted Emission Intensity



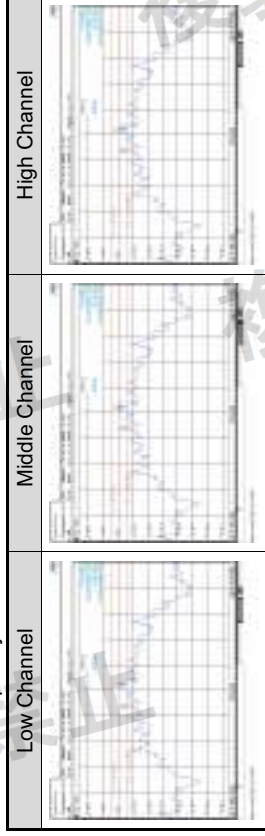
C.4.4. Limitation of Collateral Emission of Receiver



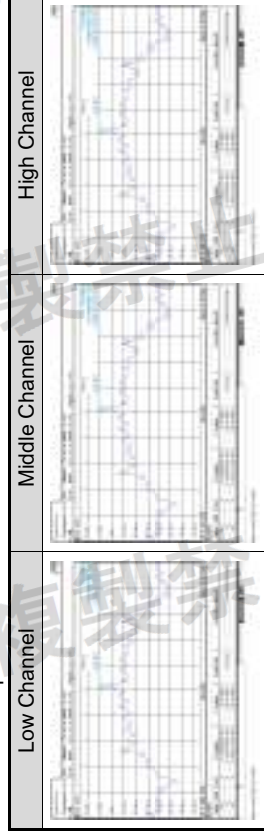


C.5. v5.0 LE

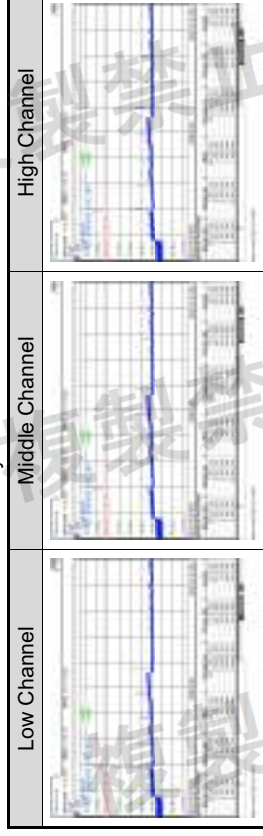
C.5.1. Frequency Tolerance



C.5.2. Occupied Bandwidth



C.5.3. Unwanted Emission Intensity



C.5.4. Limitation of Collateral Emission of Receiver

