

JAPAN RADIO TEST REPORT

Equipment : BL600 Series Bluetooth Low Energy Module
Brand Name : Laird Technologies
Model No. : BL600-SA
Test Rule : MIC Notice No.88 Appendix No.43
Equipment Rule : MIC Ordinance Regulating Radio Equipment Article 49.20.
Filing Type : New Application
Test Location : HY RF Division
Applicant : Laird Technologies
11160 Thompson Ave. / Lenexa, Kansas / 66219 / USA
Manufacturer : Laird Technologies
11160 Thompson Ave. / Lenexa, Kansas / 66219 / USA
Test Freq. Range : 2402 ~ 2480 MHz
Received Date : Feb. 27, 2013
Final Test Date : Mar. 18, 2013

Statement

The test result in this report refers exclusively to the presented test model / sample.

Without written approval of SPORTON International Inc., the test report shall not be reproduced except in full.

The measurements and test results shown in this test report were made in accordance with the procedures and found in compliance with the limit given in **Article 2 Paragraph 1 Item 19 of the Certification** and **MIC Notice No.88 Appendix No.43**

The test equipment used to perform the test is calibrated and traceable to NML/ROC.

SPORTON International Inc.

No. 52 Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.

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History of This Test Report

Original Issue Date: Mar. 21, 2013

Report No.: JR331336

☒ No additional attachment.

☐ Additional attachment were issued as following record:

Attachment No.	Issue Date	Description

CERTIFICATE OF COMPLIANCE

according to

MIC Notice No.88 Appendix No.43

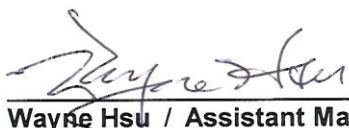
Equipment : BL600 Series Bluetooth Low Energy Module

Brand Name : Laird Technologies

Model No. : BL600-SA

Applicant : Laird Technologies
11160 Thompson Ave. / Lenexa, Kansas / 66219
/ USA

Sporton International as requested by the applicant to evaluate the Radio performance of the product sample received on Feb. 27, 2013 would like to declare that the tested sample has been evaluated and found to be in compliance with the tested rule parts. The data recorded as well as the test configuration specified is true and accurate for showing the sample's Radio nature.



Wayne Hsu / Assistant Manager

SPORTON International Inc.

No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.

1. SUMMARY OF THE TEST RESULT

Applied Standard: MIC Notice No.88 Appendix No.43			
Part	Rule Section	Description of Test	Result
3.1	3	Frequency Error	Complies
3.2	4	Occupied Bandwidth and Spread-spectrum Bandwidth / Factor	Complies
3.3	5	Unwanted Emission Intensity	Complies
3.4	6	Antenna Power Error	Complies
3.5	7	Limitation of Collateral Emission of Receiver	Complies
3.6	9	Transmission Antenna Gain (EIRP Antenna Power)	NA
3.7	10	Transmission Radiation Angle Width (3dB Bandwidth)	NA
3.8	11	Radio Interference Prevention Capability	NA
3.9	12	Hopping Frequency Dwell Time	NA
3.10	Note 1	Construction Protection Confirmation	Complies

Note 1: MIC Ordinance Regulating Radio Equipment Section 3.17 of Article 49.20

Test Items	Uncertainty	Remark
Frequency Error / 99% & 90% Bandwidth	$\pm 8.5 \times 10^{-8}$	Confidence levels of 95%
Antenna Power	$\pm 1.0\text{dB}$	Confidence levels of 95%
TX-RX Spurious Emissions	$\pm 0.5\text{dB}$	Confidence levels of 95%
Transmission Antenna Gain	$\pm 2.6\text{dB}$	Confidence levels of 95%
Temperature	$\pm 0.7^{\circ}\text{C}$	Confidence levels of 95%
Humidity	$\pm 3.2\%$	Confidence levels of 95%
DC / AC Power Source	$\pm 1.4\%$	Confidence levels of 95%

2. GENERAL INFORMATION

2.1. Product Details

Items	Description
Power Type	1.8V & 3.3V from System
Modulation	GFSK
Data Rate	1 Mbps
Frequency Range	2402 ~ 2480 MHz
Channel Number	40
Occupied Bandwidth	1.56MHz
Spread Bandwidth	0.77MHz
Spreading Factor	-
Declare Antenna Power Density	1 mW/MHz
Measure EIRP Power	0.13 dBm/MHz
Hardware Version for Test	2150-00262 V4
Software Version for Test	FW used for Radio Testing ("NORDIC_4_0_0_radio_test_example_005.hex")

2.2. Accessories

N/A

2.3. Table for Filed Antenna

Ant. No.	Type	Brand / Model	Gain (dBi)	Connector	Remark
1	Chip	ACX AT5020-E3R0HBANT/LF	0	N/A	-

Note: Regarding to more detail antenna pattern and other information, please refer to Appendix D Antenna Report.

2.4. Table for Carrier Frequencies

Frequency Band	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
2402 ~ 2480 MHz	1	2402.00	23	2446.00
	2	2404.00	24	2448.00
	3	2406.00	25	2450.00
	4	2408.00	26	2452.00
	5	2410.00	27	2454.00
	6	2412.00	28	2456.00
	7	2414.00	29	2458.00
	8	2416.00	30	2460.00
	9	2418.00	31	2462.00
	10	2420.00	32	2464.00
	11	2422.00	33	2466.00
	12	2424.00	34	2468.00
	13	2426.00	35	2470.00
	14	2428.00	36	2472.00
	15	2430.00	37	2474.00
	16	2432.00	38	2476.00
	17	2434.00	39	2478.00
	18	2436.00	40	2480.00
	19	2438.00		
	20	2440.00		
	21	2442.00		
	22	2444.00		

2.5. Table for Test Modes

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate shown in the table below is the worst-case rate with respect to the specific test item. Investigation has been done on all the possible configurations for searching the worst cases. The following table is a list of the test modes shown in this test report.

Test Items	Mode	Channel
Frequency Error	Un-modulation	1/20/40
Occupied Bandwidth (99%)	DTS	1/20/40
Spread-spectrum Bandwidth (90%)	DTS	1/20/40
Unwanted Emission Intensity	DTS	1/20/40
Antenna Power Error	DTS	1/20/40
Limitation of Emission of Receiver	DTS	1/20/40
Transmission Antenna Gain	-	-
Transmission Radiation Angle Width	-	-
Radio Interference Prevention Capability	-	-
Hopping Frequency Dwell Time	-	-

Note: EIRP power of EUT is lower than 6.91dBm/MHz, so "Transmission Antenna Gain" and "Transmission Radiation Angle Width" could be exempted tests.

2.6. Table for Testing Locations

Test Site No.	Site Category	Location
TH01-HY	OVEN Room	Hwa Ya

Open Area Test Site (OATS); Semi Anechoic Chamber (SAC); Fully Anechoic Chamber (FAC).

2.7. Table for Supporting Units

Support Unit	Brand	Model	FCC ID
Notebook	Dell Latitude	E5420	DoC

3. TEST RESULT

3.1. Frequency Error Measurement

3.1.1. Limit

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

3.1.2. Measuring Instruments and Setting

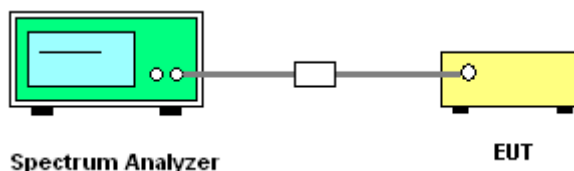
Please refer to section 4 of equipments list in this report. The following table is the setting of the spectrum.

Spectrum Parameter	Setting
Span Frequency	1 MHz
RB / VB	10 kHz / 30 kHz

3.1.3. Test Procedures

1. Frequency accuracy of SA shall be less than 10% of limits tolerance (5ppm)
2. Setting of SA is following as: RB:10kHz / VB:30kHz / SPAN: 1MHz / AT: 10dB / Ref: 0dBm
3. Center Frequency: The center frequency of testing for EUT
4. Sweep time: Auto
5. Sweep mode: Continuous sweep
6. Detect mode: Positive peak
7. Mark function: Frequency Counter (Resolution 100Hz)
8. EUT have transmitted absence of modulation signal and fixed channelize. F is using the mark cursor to mark the peak frequency value , fc is declaring of channel frequency. Then the frequency error formula is $(f_c - f)/f_c \times 10^6$ ppm and the limit is less than $\pm 50\text{ppm}$

3.1.4. Test Setup Layout



3.1.5. Test Deviation

There is no deviation with the original standard.

3.1.6. EUT Operation during Test

The EUT was inserted into notebook and placed on the test table and programmed in un-modulation function.

Test Channels(MHz)	Test Voltage
2402(CH1), 2440(CH20), 2480(CH40)	3.3Vdc & 1.8Vdc

3.1.7. Results of Frequency Error

Reference Documents	Mode	Test Item
Appendix C 19-BT LE-G1D	DTS	2. Test Result

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

3.2.1. Limit

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

3.2.2. Measuring Instruments and Setting

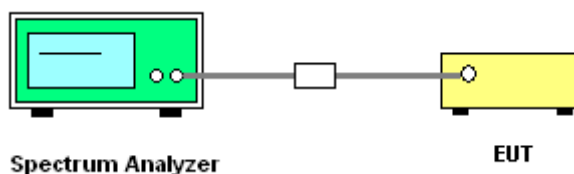
Please refer to section 4 of equipments list in this report. The following table is the setting of the spectrum.

Power Meter Parameter	Setting
Span Frequency	100 MHz
RB / VB	300 kHz

3.2.3. Test Procedures

1. Setting of SA is following as: RB:300kHz / VB:300kHz / SPAN: 100MHz / AT: 10dB Ref: 0dBm / Sweep time: Auto / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold
2. EUT have transmitted the maximum 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).
3. SA set to 90% of occupied bandwidth to measure Spread Spectrum Bandwidth and must greater than 500kHz.
4. Spread Spectrum Factor = Spread Spectrum Bandwidth / modulation rate of EUT.
5. Spread Spectrum Factor limit is greater than 5.

3.2.4. Test Setup Layout



3.2.5. Test Deviation

There is no deviation with the original standard.

3.2.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

Test Channels(MHz)	Test Voltage
2402(CH1), 2440(CH20), 2480(CH40)	3.3Vdc & 1.8Vdc

3.2.7. Results of Occupied Bandwidth and Spread-spectrum Bandwidth / Factor

Reference Documents	Mode	Test Item
Appendix C 19-BT LE-G1D	DTS	2. Test Result
		9. Spread Factor

3.3. Unwanted Emission Intensity Measurement

3.3.1. Limit

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

3.3.2. Measuring Instruments and Setting

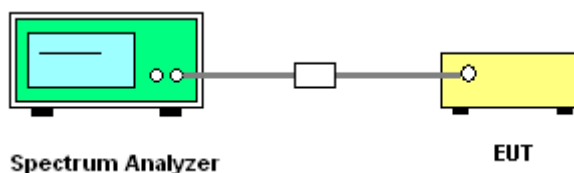
Please refer to section 4 of equipments list in this report. The following table is the setting of Spectrum Analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
RB / VB	1 MHz
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

3.3.3. Test Procedures

1. EUT have transmitted the maximum modulation signal and fixed channelize.
2. Setting of SA is following as: RB:1MHz / VB:1MHz / AT: 10dB / Ref: 0dBm / Sweep time: Auto / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold
3. 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.
4. 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.
5. 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
6. 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
7. Measure side band spurious as follows: For 2.4GHz band: 2374MHz~2400MHz and 2483.5MHz~2509.5MHz RBW = VBW = 30kHz, Result_Value = Measured_Value + 15.2 [dBm]
8. 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 Layout



3.3.5. Test Deviation

There is no deviation with the original standard.

3.3.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

Test Channels(MHz)	Test Voltage
2402(CH1), 2440(CH20), 2480(CH40)	3.3Vdc & 1.8Vdc

3.3.7. Test Result of Unwanted Emission Intensity

Reference Documents	Mode	Test Item
Appendix C 19-BT LE-G1D	DTS	2. Test Result
		6. Unwanted Emission Intensity

3.4. Antenna Power Error Measurement

3.4.1. Limit

Item	Limits
Antenna Power Density	$\leq 3\text{mW/MHz}$ (FH form 2427 – 2470.75 MHz) $\leq 10\text{mW/MHz}$ (OFDM, DS from 2400~2483.5MHz) $\leq 10\text{mW}$ (Other from 2400~2483.5MHz)
Antenna Power Error	+20%, -80% (Base on manufacturer declare antenna power density)

3.4.2. Measuring Instruments and Setting

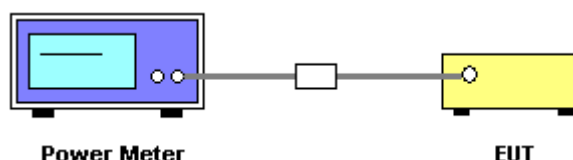
Please refer to section 4 of equipments list in this report. The following table is the setting of the power meter and spectrum analyzer.

Power Meter Parameter	Setting
Filter No.	Auto
Measurement time	0.135 s ~ 26 s
Used Average Sensor	MA2411B

3.4.3. Test Procedures

1. EUT have transmitted continuous maximum power mode.
2. The antenna power is equal to the power meter value dBm + cable loss dB + $10 \cdot \log(1/\text{duty cycle})$ dB and shall be less than limits (10mW).
3. Antenna Power Error is definition that actual measure antenna power tolerance between + 20% to - 80% power range that base on manufacturer declare the conducted power.

3.4.4. Test Setup Layout



3.4.5. Test Deviation

There is no deviation with the original standard.

3.4.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

Test Channels(MHz)	Test Voltage
2402(CH1), 2440(CH20), 2480(CH40)	3.3Vdc & 1.8Vdc

3.4.7. Test Result of Antenna Power Error

Reference Documents	Mode	Test Item
Appendix C 19-BT LE-G1D	DTS	2. Test Result
		3. Antenna Power (Conducted Power)

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 and Setting

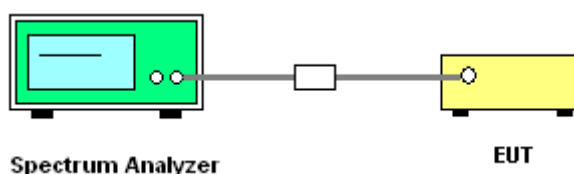
Please refer to section 4 of equipments list in this report. The following table is the setting of Spectrum Analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
RB	100 kHz (below 1GHz emissions) / 1 MHz (above 1GHz emissions)
VB	100 kHz (below 1GHz emissions) / 1 MHz (above 1GHz emissions)
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

3.5.3. Test Procedures

1. EUT have the continuous reception mode and fixed only one channelize.
2. Setting of SA is following as RB / VB: 100 kHz (below 1GHz emissions) / 1 MHz (above 1GHz emissions) / AT: 10dB / Ref: 0dBm / Sweep time: Auto / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold
3. SA set RB: 100kHz and VB: 100kHz. Then adjust to start frequency 30MHz and stop frequency 1000MHz. Search to mark peak reading value + cable loss shall be less than 4nW
4. SA set RB: 1MHz and VB: 1MHz. Then adjust to start frequency 1000MHz and stop frequency 12500MHz. Search to mark peak reading value + cable loss shall be less than 20nW
5. 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 Layout



3.5.5. Test Deviation

There is no deviation with the original standard.

3.5.6. EUT Operation during Test

The EUT was programmed to be in continuously reception mode.

Test Channels(MHz)	Test Voltage
2402(CH1), 2440(CH20), 2480(CH40)	3.3Vdc & 1.8Vdc

3.5.7. Test Result of Limitation of Collateral Emission of Receiver

Reference Documents	Mode	Test Item
Appendix C 19-BT LE-G1D	DTS	2. Test Result
		7. Limitation of Collateral Emission of Receiver

3.6. Transmission Antenna Gain (EIRP Antenna Power) Measurement

3.6.1. Limit

Item	Limits
EIRP Power	$\leq 16.91\text{dBm/MHz}$ (FH form 2427 – 2470.75 MHz) $\leq 22.14\text{dBm/MHz}$ (OFDM,DS from 2400~2483.5MHz) $\leq 22.14\text{dBm}$ (Other from 2400~2483.5MHz)
Note: This test item will not be applied to the EIRP power of EUT is lower than 6.91dBm/MHz	

3.6.2. Measuring Instruments and Setting

Please refer to section 4 of equipments list in this report. The following table is the setting of spectrum analyzer.

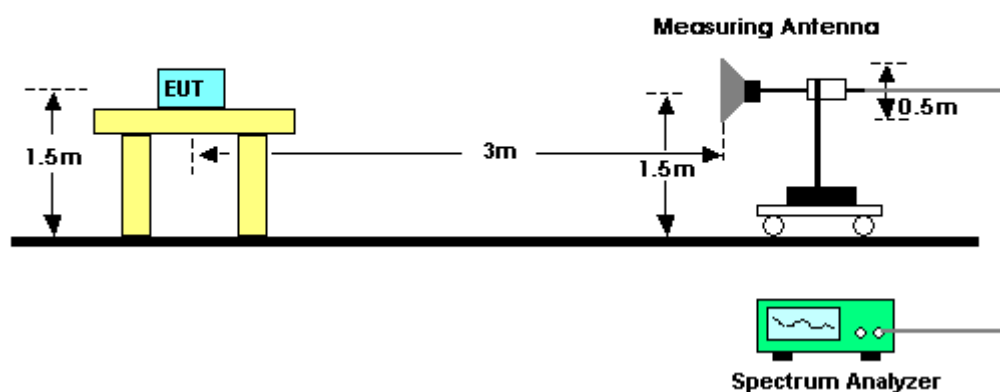
Spectrum Parameter	Setting
Attenuation	Auto
RB / VB	1 MHz
Span	0 MHz
Detector	Peak
Trace	Max Hold

3.6.3. Test Procedures

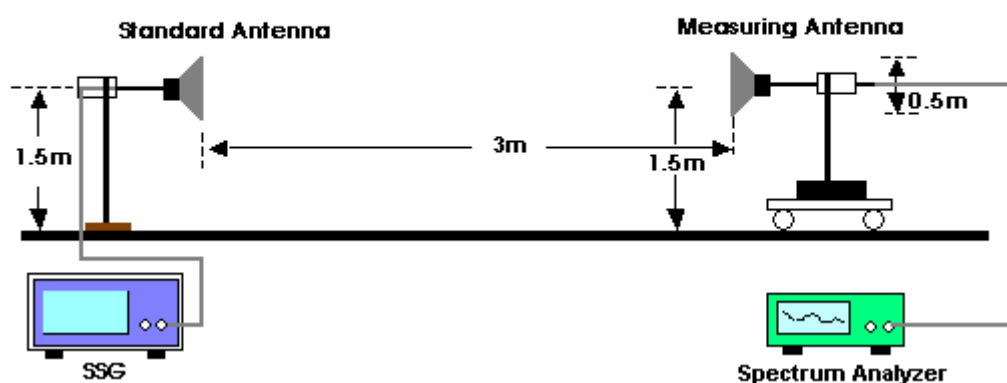
1. Set EUT and measuring antenna at the same height and roughly facing each other.
2. Move the measuring antenna height up and down within $\pm 50\text{cm}$ of EUT height and swing it to find the maximum output of the measuring antenna. The output level at the spectrum analyzer is read as "E".
3. Remove 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 $\text{EIRP} = G_t - L + P_t$.
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 Layout

For EUT radiation measurement



For standard antenna measurement



3.6.5. Test Deviation

There is no deviation with the original standard.

3.6.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

Test Channels(MHz)	Test Voltage
2402(CH1), 2440(CH20), 2480(CH40)	3.3Vdc & 1.8Vdc

3.6.7. Results of Transmission Antenna Gain (EIRP Antenna Power)

Reference Documents	Mode	Test Item
Appendix C 19-BT LE-G1D	DTS	5. Transmission Antenna Gain (EIRP Power)

Note: This test item will not be applied to EIRP power of EUT is lower than 6.91dBm/MHz

3.7. Transmission Radiation Angle Width (3dB Bandwidth) Measurement

3.7.1. Limit

Item	Limits
3dB antenna beam width	360/A (If $A < 1$; then $A = 1$) $A = \{\text{EIRP Power [mW]} / 16.36 \text{ for DS, OFDM}\}$ or $A = \{\text{EIRP Power [mW]} / 4.9 \text{ for FH}\}$
Note: This test item will not be applied to EIRP power of EUT is lower than 6.91dBm/MHz	

3.7.2. Measuring Instruments and Setting

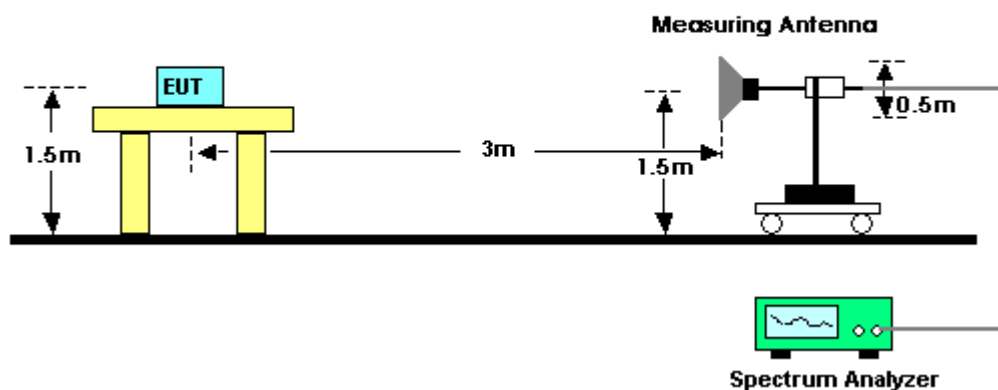
Please refer to section 4 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	0 MHz
RB	1 MHz
VB	1 kHz
Y scale	5 dB
Detector	Peak
Trace	Max Hold

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 Layout



3.7.5. Test Deviation

There is no deviation with the original standard.

3.7.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

Test Channels(MHz)	Test Voltage
2402(CH1), 2440(CH20), 2480(CH40)	3.3Vdc & 1.8Vdc

3.7.7. Test Result of Transmission Radiation Angle Width (3dB Bandwidth)

Reference Documents	Mode	Test Item
Appendix C 19-BT LE-G1D	DTS	4. Transmission Radiation Angle Width
Appendix D. Ant. Report	2.4G	Radiated antenna pattern

Note: This test item will not be applied to EIRP power of EUT is lower than 6.91dBm/MHz

3.8. Radio Interference Prevention Capability Measurement

3.8.1. Limit

Item	Limits
Identification code	≥ 48 bits

3.8.2. Measuring Instruments and Setting

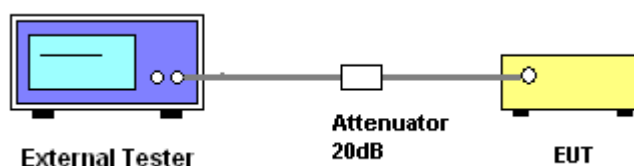
Please refer to section 4 of equipments list in this report. The following table is the setting of the CMU200.

CMU200 Parameter	Setting
ID code	Master

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 ocde: 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 idnetification codes are different from the predetermined ones.

3.8.4. Test Setup Layout



3.8.5. Test Deviation

There is no deviation with the original standard.

3.8.6. EUT Operation during Test

The EUT was programmed to be in normal transmitting mode.

Test Channels(MHz)	Test Voltage
2402(CH1), 2440(CH20), 2480(CH40)	3.3Vdc & 1.8Vdc

3.8.7. Test Result of Radio Interference Prevention Capability

Reference Documents	Mode	Test Item
Appendix C 19-BT LE-G1D	DTS	2.Test Result (ID Code)

3.9. Hopping Frequency Dwell Time Measurement

3.9.1. Limit

Item	Limits
Hopping Freq. Dwell Time	$\leq 0.4 \text{ sec (In } 0.4 \text{ sec} \times \text{ spreading rate)}$

3.9.2. Measuring Instruments and Setting

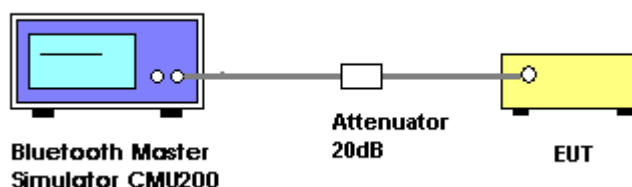
Please refer to section 4 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
RB / VB	1 MHz
Span	0 MHz
Sweep	Single
Detector	Peak
Trigger mode	Video

3.9.3. Test Procedures

1. The transmitter output (antenna port) was connected to the spectrum analyser
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 measure and set the frequency span to zero span.
6. Measure the maximum time duration of one single pulse.
7. Dwell time= (Spreading bandwidth / 43) x 0.4 x duty cycle

3.9.4. Test Setup Layout



3.9.5. Test Deviation

There is no deviation with the original standard.

3.9.6. EUT Operation during Test

Dwell time test was not performed.

3.9.7. Test Result of Hopping Frequency Dwell Time

Dwell time test was not performed.

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

Protected Method	Description
Shielding Case	RF and Modulation components are covered with shielding case and this shielding case is soldered, The case of equipment could not be opened easily.

3.10.3. Reference Documents

Reference Documents	Item
Photo	

4. LIST OF MEASURING EQUIPMENTS

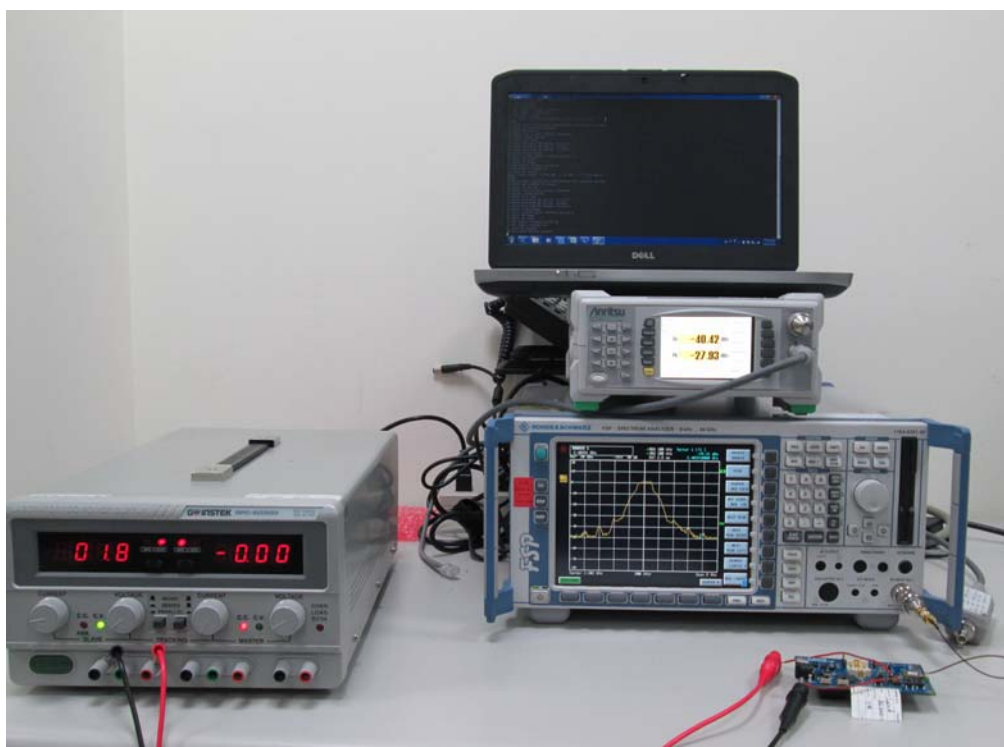
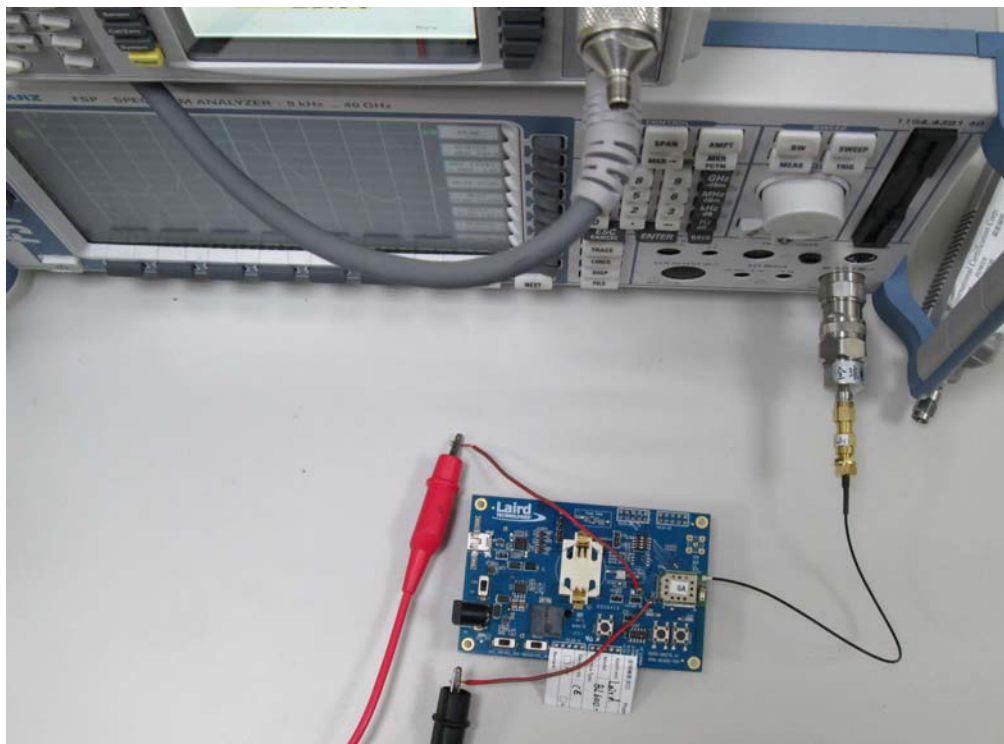
Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Remark	Cal. Body
Spectrum Analyzer	R&S	FSV 40	101486	9KHz~40GHz	Nov. 14, 2012	Conducted (TH01-HY)	ETC
DC Power Source	G.W.	GPC-6030D	C671845	DC 1V ~ 60V	Jun. 19, 2012	Conducted (TH01-HY)	ETC
AC Power Source	G.W	APS-9102	EL920581	AC 0V ~ 300V	Jul. 02, 2012	Conducted (TH01-HY)	ETC
Temp. and Humidity Chamber	Giant Force	GTH-225-20-SP-SD	MAA1112-007	-20 ~ 100℃	Nov. 21, 2012	Conducted (TH01-HY)	ETC
Signal Generator	R&S	SMR40	100116	10MHz ~ 40GHz	Jun. 26, 2012	Conducted (TH01-HY)	ETC
Power Sensor	Anritsu	MA2411B	1027452	300MHz ~ 40GHz	Sep. 08, 2012	Conducted (TH01-HY)	ETC
Power Meter	Anritsu	ML2495A	1124009	300MHz ~ 40GHz	Sep. 08, 2012	Conducted (TH01-HY)	ETC
RF Cable-2m	HUBER+SUHNER	SUCOFLEX_104	SN 345675/4	1GHz ~ 26.5GHz	NA	Conducted (TH01-HY)	-
RF Cable-3m	HUBER+SUHNER	SUCOFLEX_104	SN 345669/4	1GHz ~ 26.5GHz	NA	Conducted (TH01-HY)	-

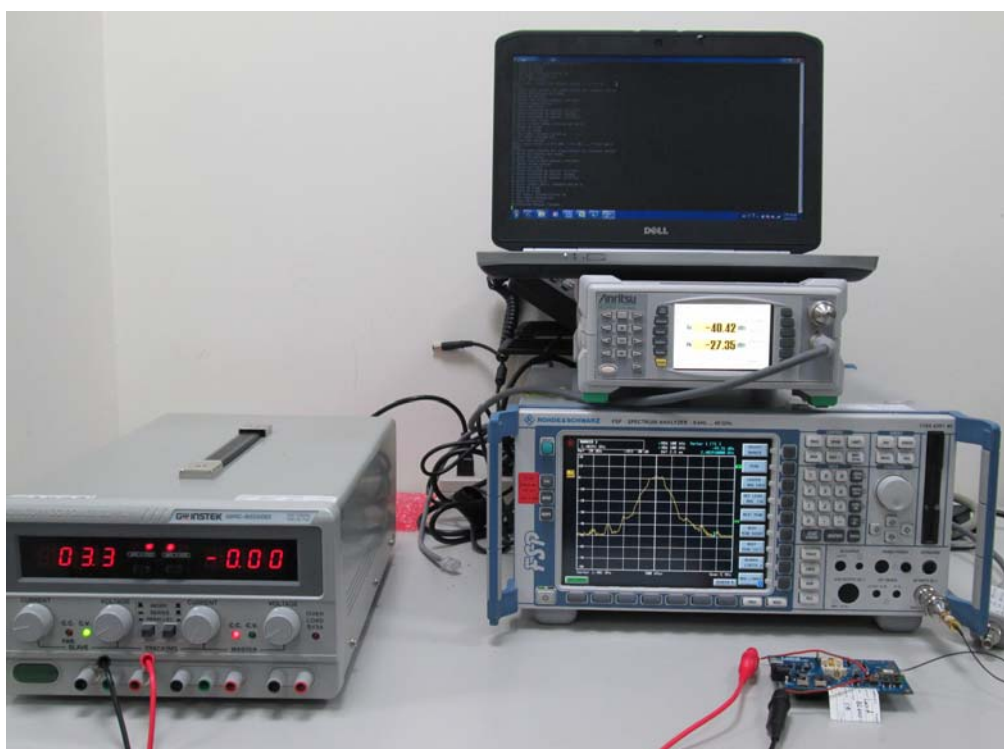
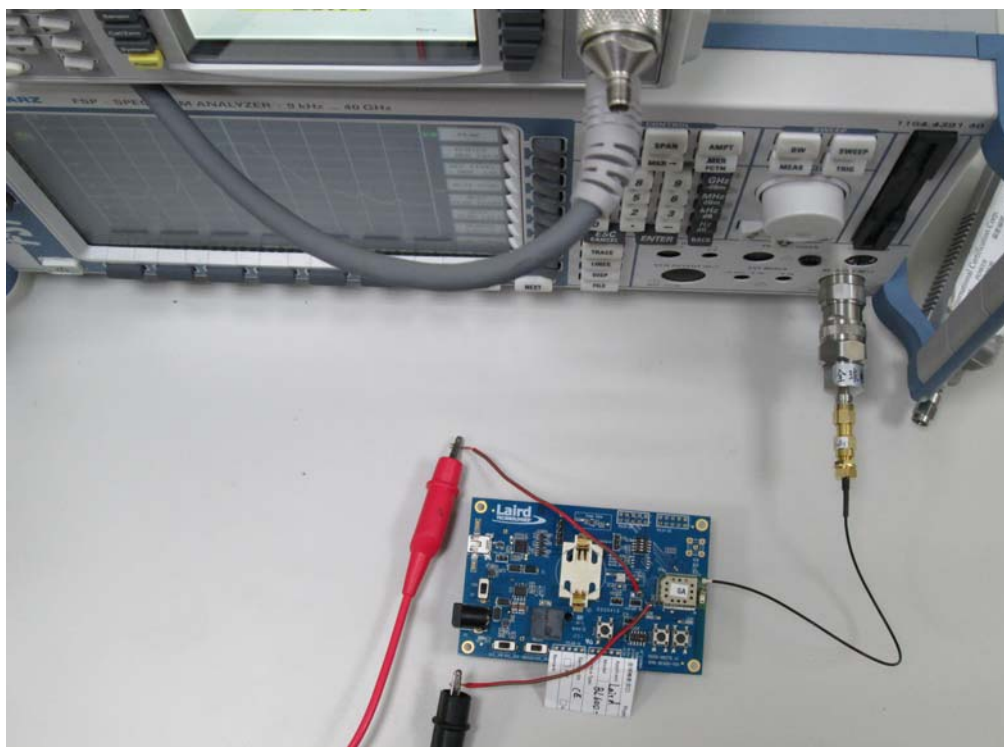
Note: Calibration Interval of instruments listed above is one year.

5. TEST LOCATION

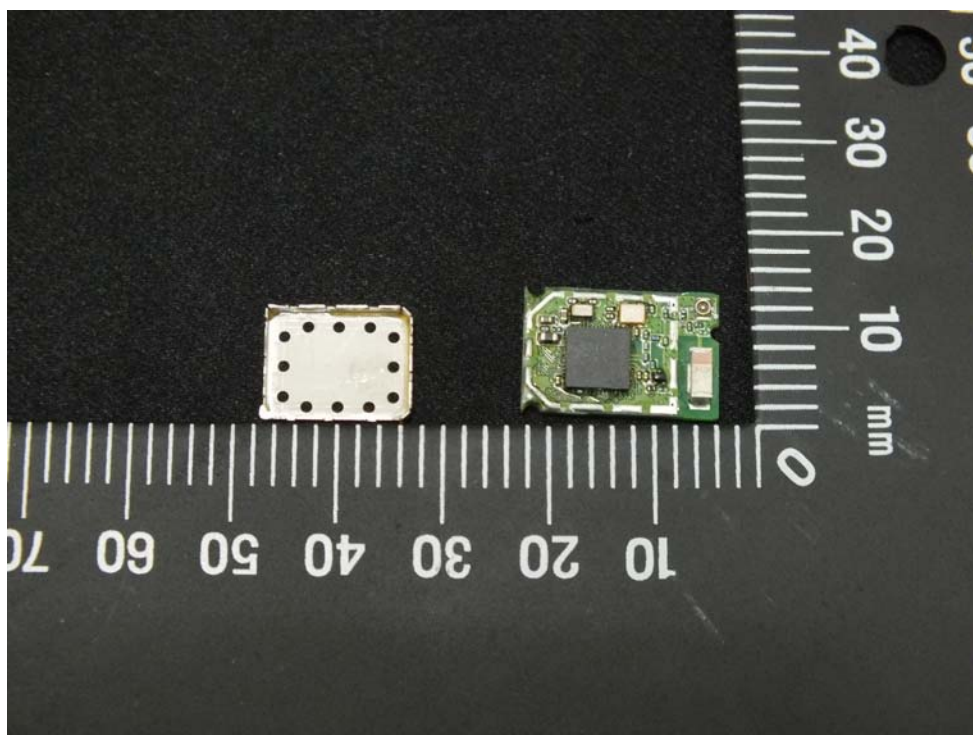
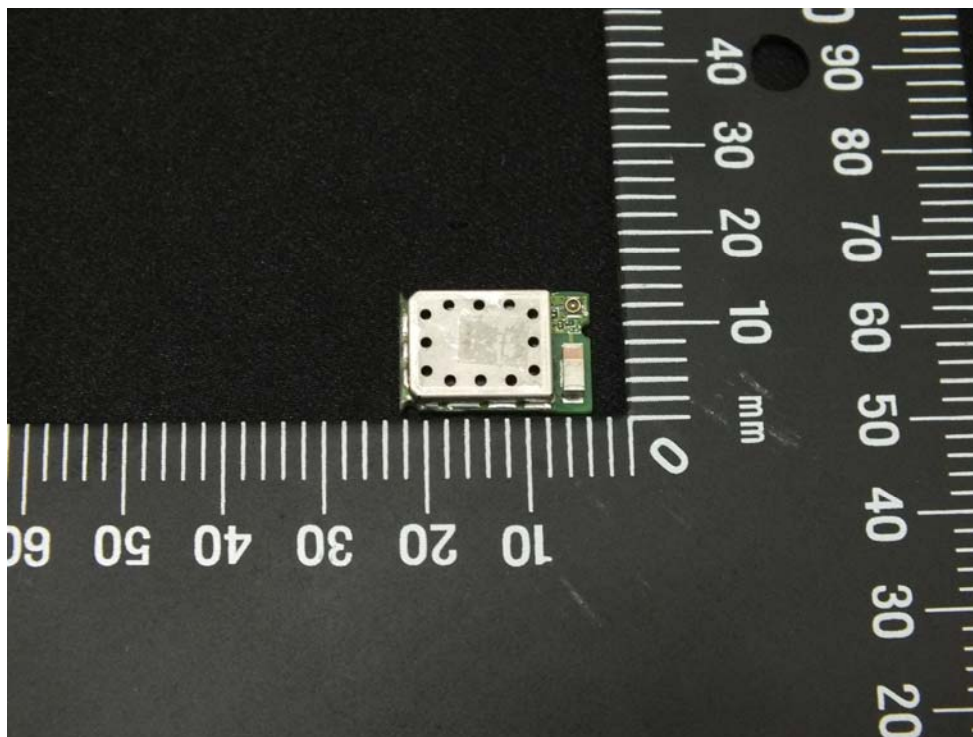
SHIJR	ADD : 6Fl., No. 106, Sec. 1, Shintai 5th Rd., Shijr City, Taipei, Taiwan 221, R.O.C. TEL : 886-2-2696-2468 FAX : 886-2-2696-2255
HWA YA	ADD : No. 52, Hwa Ya 1st Rd., Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C. TEL : 886-3-327-3456 FAX : 886-3-318-0055
LINKOU	ADD : No. 30-2, Dingfu Tsuen, Linkou Shiang, Taipei, Taiwan 244, R.O.C TEL : 886-2-2601-1640 FAX : 886-2-2601-1695
DUNGHU	ADD : No. 3, Lane 238, Kangle St., Neihu Chiu, Taipei, Taiwan 114, R.O.C. TEL : 886-2-2631-4739 FAX : 886-2-2631-9740
JUNGHE	ADD : 7Fl., No. 758, Jungjeng Rd., Junghe City, Taipei, Taiwan 235, R.O.C. TEL : 886-2-8227-2020 FAX : 886-2-8227-2626
NEIHU	ADD : 4Fl., No. 339, Hsin Hu 2 nd Rd., Taipei 114, Taiwan, R.O.C. TEL : 886-2-2794-8886 FAX : 886-2-2794-9777
JHUBEI	ADD : No.8, Lane 728, Bo-ai St., Jhubei City, HsinChu County 302, Taiwan, R.O.C. TEL : 886-3-656-9065 FAX : 886-3-656-9085

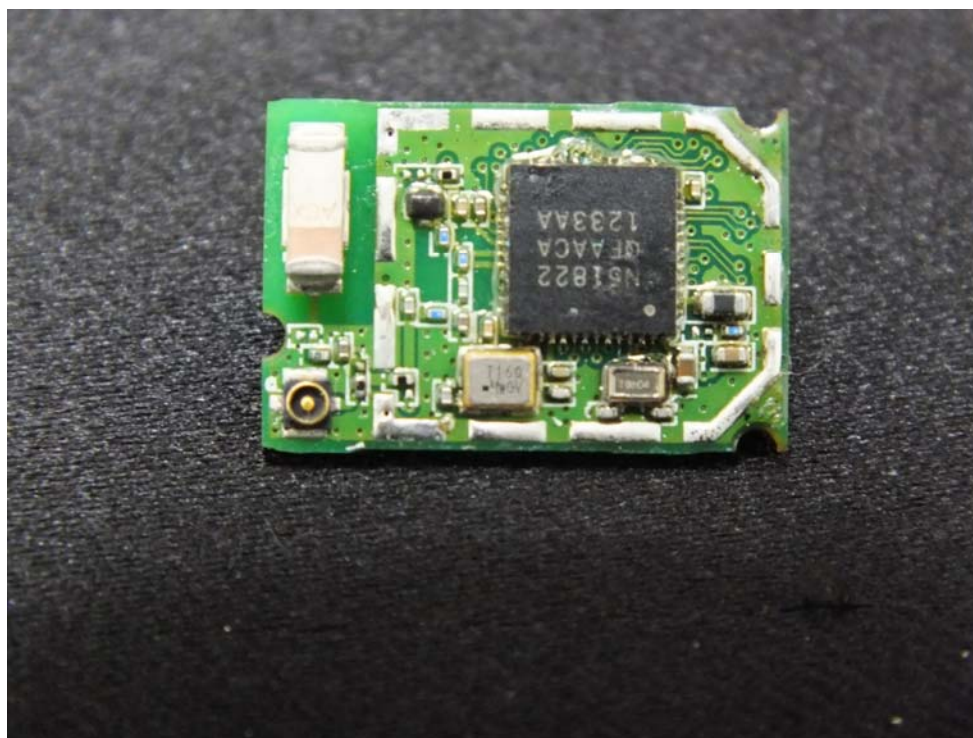
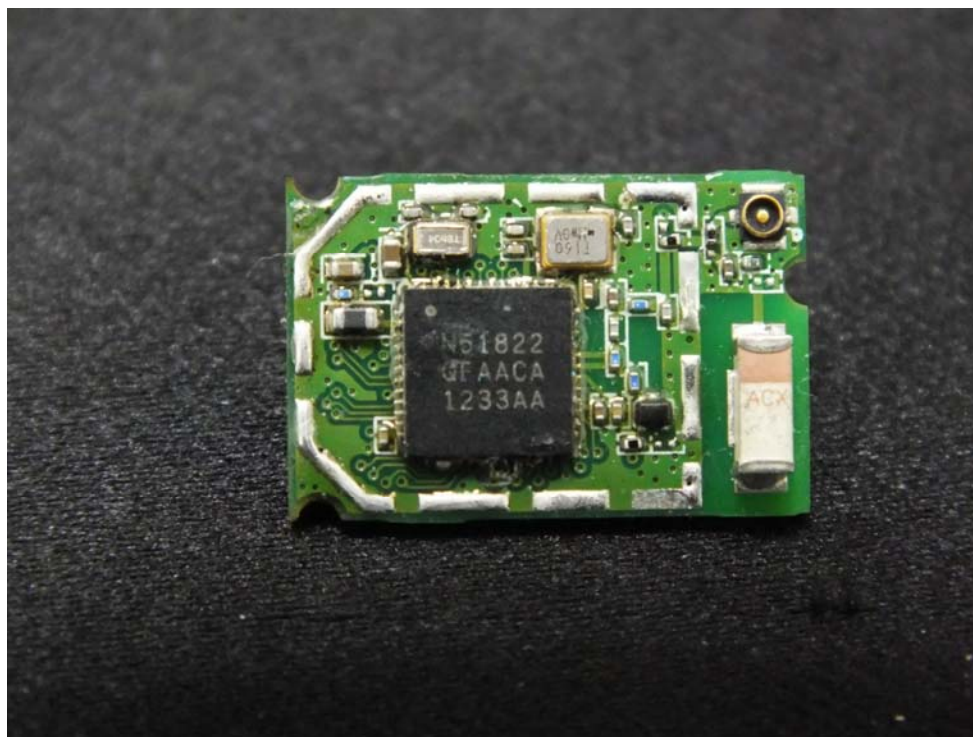
Appendix A. Test Photos

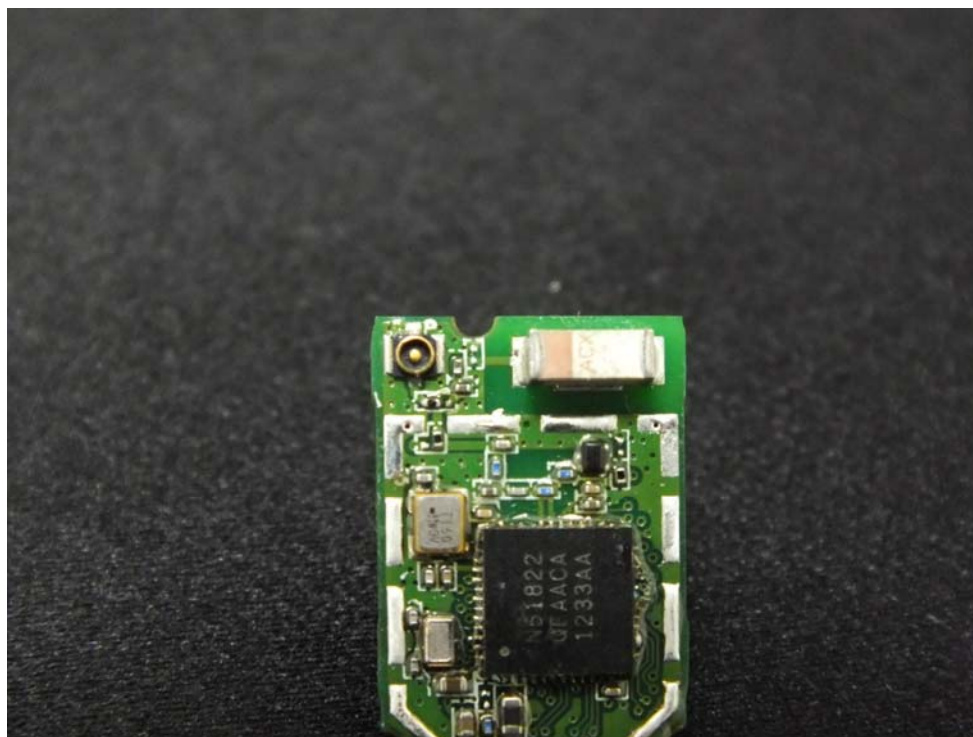




Appendix B. Photographs of EUT







Appendix C 19-BT LE-G1D

1. General Information

Specified Radio Equipment	Class	Article 2 Paragraph 1 Item 19	Model	BL600-SA	Sporton No.	331336
	Type of Emission	G1D	Serial No.	NA	Test Date	2013/4/12
	Modulation Type	GFSK	Antenna Power	1 mW/MHz	Test Location	SPORTON Lab.
	Frequency	2402~2480MHz			Temp. / Humid.	23.1℃ / 58%
					Test Conducted By	Ian Du
					Name	Ian Du
					Department	Radio Service Group

2. Test Results

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (1.8V)			High Voltage (1.98V)			Low Voltage (1.62V)			Remarks	
	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	Low/Mid/High of test frequency range	
	Measured Frequency	MHz	2402.0172	2440.0168	2480.0161	2402.0155	2440.0169	2480.0174	2402.0163	2440.0164	2480.0172		
	Frequency Error	ppm	7.16	6.89	6.49	6.45	6.93	7.02	6.79	6.72	6.94	Limit ≤ 50 ppm	
	Occupied Bandwidth	MHz	1.17	1.23	1.56	1.17	1.24	1.56	1.17	1.23	1.56	Limit ≤ 26 MHz (RB/VB : 300kHz)	
	Spread-spectrum Bandwidth	MHz	0.72	0.73	0.76	0.72	0.73	0.77	0.72	0.73	0.77	≥ 500kHz	
	Unwanted Emission Intensity (Power emission within 1MHz bandwidth)	※ 1	μW	0.20464	0.02153	0.02104	0.21528	0.02056	0.02070	0.24099	0.02080	0.02000	Limit ≤ 2.5 μW (-26 dBm)
		※ 2	μW	0.89950	0.01057	0.01096	0.94189	0.00916	0.00895	1.01391	0.01062	0.01000	Limit ≤ 25 μW (-16 dBm)
		※ 3	μW	0.01172	0.01219	0.34356	0.01074	0.01091	0.33806	0.01189	0.01245	0.39628	Limit ≤ 25 μW (-16 dBm)
		※ 4	μW	0.03192	0.03784	0.03776	0.03733	0.03266	0.03614	0.03327	0.03890	0.03733	Limit ≤ 2.5 μW (-26 dBm)
Antenna Power (Conducted)	mW/MHz	0.98770	1.00607	1.01304	0.98998	1.01071	1.02006	0.98317	0.99226	1.00375	Limit ≤ 10 mW/MHz (10 dBm/MHz)		
Antenna Power Error	mW/MHz	-0.01230	0.00607	0.01304	-0.01002	0.01071	0.02006	-0.01683	-0.00774	0.00375			
	%	-1.23	0.61	1.30	-1.00	1.07	2.01	-1.68	-0.77	0.38	Limit + 20% ~ - 80%		
Limitation of Collateral Emission of Receiver	nW	0.0200	0.0187	0.0175	0.0192	0.0187	0.0182	0.0176	0.0186	0.0199	Limit ≤ 4 nW (-54 dBm)		
Hopping Frequency Dwell Time	sec	2.3659	2.4378	2.2336	2.4044	2.3714	2.1928	2.3714	2.3659	2.2080	Limit ≤ 20 nW (-47 dBm)		
Radio Interference Prevention Function	ID Code	Good , MAC address : C1-AF-7E-F6-27-06											
	Carrier Sense	-	-	-	-	-	-	-	-	-			

※ 1: Frequency Band 1 (30 MHz ≤ f ≤ 2387 MHz)

※ 4: Frequency Band 4 (2496.5 MHz ≤ f < 12.5 GHz)

※ 2: Frequency Band 2 (2387 MHz < f ≤ 2400 MHz)

※ 5: Frequency Band 5 (30 MHz ≤ f < 1000 MHz)

※ 3: Frequency Band 3 (2483.5 MHz ≤ f < 2496.5 MHz)

※ 6: Frequency Band 6 (1000 MHz ≤ f < 12.5 GHz)

3. Antenna Power (Conducted Power)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (1.8V)			High Voltage (1.98V)			Low Voltage (1.62V)			Remarks
	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw (IF of Spectrum)	dBm	-19.39	-19.31	-19.28	-19.38	-19.29	-19.25	-19.41	-19.37	-19.32	
	Power Measurement System Loss	dB	19.71	19.71	19.71	19.71	19.71	19.71	19.71	19.71	19.71	Refer to Calibration Result
	Transmitter Duty Cycle Factor	dB	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	Duty Factor = 10 × 10Log ₁₀ (1/Duty Cycle)
	Equivalent Noise Bandwidth	MHz	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	ENB = Total_Sum^2 / Peak_Level * Point_Width
	Equivalent Noise Bandwidth Factor	dB	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	ENB Factor = 10 × 10Log ₁₀ (1/ENB)
	Antenna Power (Conducted)	dBm/MHz	-0.05	0.03	0.06	-0.04	0.05	0.09	-0.07	-0.03	0.02	Limit ≤ 10 mW/MHz (10 dBm/MHz)
	Antenna Power (Conducted)	mW/MHz	0.9877	1.0061	1.0130	0.9900	1.0107	1.0201	0.9832	0.9923	1.0038	
	Antenna Power Error	mW	-0.0123	0.0061	0.0130	-0.0100	0.0107	0.0201	-0.0168	-0.0077	0.0038	
	%	-1.23	0.61	1.30	-1.00	1.07	2.01	-1.68	-0.77	0.38	Limit + 20% ~ - 80%	
Transmitter ON _{Time}	msec	2.1700									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz	
Transmitter (ON+OFF) _{Time}	msec	2.2300										
Transmitter Duty Cycle	%	97.31%										

4. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm/MHz)

No.	Antenna Power		Antenna				Cable			Total Gain D=B+C	EIRP F=A+D	Permitted Angle	Judgement	Remarks (Antenna Model)
	A		Type	Gain B (dBi)	3dB Beam- width Horizontal (Degree)	3dB Beam- width Vertical (Degree)	Model	Length (m)	Loss C (dB)					
1	0.09		chip	0.00			-	-		0.00	0.09	360.00	Good	Model: AT5020-E3R0HBANT/LF
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														

5. Transmission Antenna Gain (EIRP Power) (This test item will not be applied to the EIRP power is lower than 12.14dBm/MHz)

Antenna	Test Frequency		Output Level from SG		Cable Loss Between SG and Replacing Antenna		Replacing Standard Antenna Gain		EIRP Power Radiated Measurement		Remarks (Antenna Model)
	(MHz)		(Pt)	(dBm)	(L)	(dB)	(Gt)	(dBi)	EIRP = Pt - L + Gt	(dBm)	
1											
1											
1											
2											
2											0
2											
3											
3											0
3											
4											
4											0
4											

6. Unwanted Emission Intensity

Test Voltage		V	Normal Voltage (1.8V)			High Voltage (1.98V)			Low Voltage (1.62V)			Remarks
Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
Unwanted Emission Intensity	※ 1	MHz	2378.50	1218.70	1239.20	2323.90	1218.80	1239.20	2378.50	1218.70	1239.20	RBW : 1 MHz ; VBW : 1 MHz
	※ 2	MHz	2399.95	2397.94	2387.20	2399.99	2394.72	2390.13	2399.99	2391.53	2393.76	
	※ 3	MHz	2498.19	2496.21	2483.51	2484.81	2493.09	2483.57	2487.18	2492.11	2483.51	
	※ 4	MHz	10625.50	12058.50	9177.50	11378.50	9988.50	11218.50	11175.50	10234.50	12347.50	
	※ 1	dB	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	
	※ 2	dB	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	
	※ 3	dB	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	
	※ 4	dB	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	
	※ 1	dBm	-37.05	-46.83	-46.93	-36.83	-47.03	-47.00	-36.34	-46.98	-47.15	
	※ 2	dBm	-30.62	-49.92	-49.76	-30.42	-50.54	-50.64	-30.10	-49.90	-50.16	
	※ 3	dBm	-49.47	-49.30	-34.80	-49.95	-49.78	-34.67	-49.41	-49.21	-34.18	
	※ 4	dBm	-45.13	-44.39	-44.40	-44.45	-45.03	-44.59	-44.95	-44.27	-44.45	
	※ 1	dBm	-36.89	-46.67	-46.77	-36.67	-46.87	-46.84	-36.18	-46.82	-46.99	Limit ≤ 2.5 μW (-26 dBm)
	※ 2	dBm	-30.46	-49.76	-49.60	-30.26	-50.38	-50.48	-29.94	-49.74	-50.00	Limit ≤ 25 μW (-16 dBm)
	※ 3	dBm	-49.31	-49.14	-34.64	-49.69	-49.62	-34.71	-49.25	-49.05	-34.02	Limit ≤ 25 μW (-16 dBm)
	※ 4	dBm	-44.96	-44.22	-44.23	-44.28	-44.86	-44.42	-44.78	-44.10	-44.28	Limit ≤ 2.5 μW (-26 dBm)
	※ 1	μW	0.2046	0.0215	0.0210	0.2153	0.0206	0.0207	0.2410	0.0208	0.0200	Limit ≤ 2.5 μW (-26 dBm)
	※ 2	μW	0.8995	0.0106	0.0110	0.9419	0.0092	0.0090	1.0139	0.0106	0.0100	Limit ≤ 25 μW (-16 dBm)
	※ 3	μW	0.0117	0.0122	0.3436	0.0107	0.0109	0.3381	0.0119	0.0124	0.3963	Limit ≤ 25 μW (-16 dBm)
	※ 4	μW	0.0319	0.0378	0.0378	0.0373	0.0327	0.0361	0.0333	0.0389	0.0373	Limit ≤ 2.5 μW (-26 dBm)

- ※ 1: Frequency Band 1 (30 MHz ≤ f ≤ 2387 MHz) ※ 4: Frequency Band 4 (2496.5 MHz ≤ f < 12.5 GHz)
 ※ 2: Frequency Band 2 (2387 MHz < f ≤ 2400 MHz) ※ 5: Frequency Band 5 (30 MHz ≤ f < 1000 MHz)
 ※ 3: Frequency Band 3 (2483.5 MHz ≤ f < 2496.5 MHz) ※ 6: Frequency Band 6 (1000 MHz ≤ f < 12.5 GHz)

7. Limitation of Collateral Emission of Receiver

Test Voltage		V	Normal Voltage (1.8V)			High Voltage (1.98V)			Low Voltage (1.62V)			Remarks	
Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480		
Spurious Emission Frequency	※ 5	MHz	752.20	752.20	752.20	752.20	752.20	752.20	752.20	752.20	752.20	1st	30MHz~1000MHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
	※ 5	MHz	-	-	-	-	-	-	-	-	-	2nd	
	※ 5	MHz	-	-	-	-	-	-	-	-	-	3rd	
	※ 6	MHz	2806.00	2822.00	2839.00	2806.00	2806.00	2839.00	2806.00	2822.00	2839.00	1st	1000MHz~12.5GHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
	※ 6	MHz	-	-	-	-	-	-	-	-	-	2nd	
	※ 6	MHz	-	-	-	-	-	-	-	-	-	3rd	
Cable Loss	※ 5	dB	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	1st	
	※ 5	dB	-	-	-	-	-	-	-	-	-	2nd	
	※ 5	dB	-	-	-	-	-	-	-	-	-	3rd	
	※ 6	dB	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	1st	
	※ 6	dB	-	-	-	-	-	-	-	-	-	2nd	
	※ 6	dB	-	-	-	-	-	-	-	-	-	3rd	
Spectrum Raw	※ 5	dBm	-77.08	-77.37	-77.65	-77.26	-77.36	-77.49	-77.64	-77.40	-77.11	1st	
	※ 5	dBm	-	-	-	-	-	-	-	-	-	2nd	
	※ 5	dBm	-	-	-	-	-	-	-	-	-	3rd	
	※ 6	dBm	-56.42	-56.29	-56.67	-56.35	-56.41	-56.75	-56.41	-56.42	-56.72	1st	
	※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	
	※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
Spurious Emission Intensity	※ 5	dBm	-76.99	-77.28	-77.56	-77.17	-77.27	-77.40	-77.55	-77.31	-77.02	1st	Limit ≤ 4 nW (-54 dBm) RBW : 100 kHz ; VBW : 100 kHz
	※ 5	dBm	-	-	-	-	-	-	-	-	-	2nd	
	※ 5	dBm	-	-	-	-	-	-	-	-	-	3rd	
	※ 6	dBm	-56.26	-56.13	-56.51	-56.19	-56.25	-56.59	-56.25	-56.26	-56.56	1st	Limit ≤ 20 nW (-47 dBm) RBW : 1 MHz ; VBW : 1 MHz
	※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	
	※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
Spurious Emission Intensity	※ 5	nW	0.0200	0.0187	0.0175	0.0192	0.0187	0.0182	0.0176	0.0186	0.0199	Total Emission Power	
	※ 5	nW	0.0200	0.0187	0.0175	0.0192	0.0187	0.0182	0.0176	0.0186	0.0199	1st	Limit ≤ 4 nW (-54 dBm) RBW : 100 kHz ; VBW : 100 kHz
	※ 5	nW	-	-	-	-	-	-	-	-	-	2nd	
	※ 5	nW	-	-	-	-	-	-	-	-	-	3rd	
	※ 6	nW	2.3659	2.4378	2.2336	2.4044	2.3714	2.1928	2.3714	2.3659	2.2080	Total Emission Power	
	※ 6	nW	2.3659	2.4378	2.2336	2.4044	2.3714	2.1928	2.3714	2.3659	2.2080	1st	Limit ≤ 20 nW (-47 dBm) RBW : 1 MHz ; VBW : 1 MHz
※ 6	nW	-	-	-	-	-	-	-	-	-	2nd		
※ 6	nW	-	-	-	-	-	-	-	-	-	3rd		

- ※ 1: Frequency Band 1 (30 MHz ≤ f ≤ 2387 MHz) ※ 4: Frequency Band 4 (2496.5 MHz ≤ f < 12.5 GHz)
 ※ 2: Frequency Band 2 (2387 MHz < f ≤ 2400 MHz) ※ 5: Frequency Band 5 (30 MHz ≤ f < 1000 MHz)
 ※ 3: Frequency Band 3 (2483.5 MHz ≤ f < 2496.5 MHz) ※ 6: Frequency Band 6 (1000 MHz ≤ f < 12.5 GHz)

Appendix C 19-BT LE-G1D

1. General Information

Specified Radio Equipment	Class	Article 2 Paragraph 1 Item 19	Model	BL600-SC	Sporton No.	331336
	Type of Emission	G1D	Serial No.	NA	Test Date	2013/4/12
	Modulation Type	GFSK	Antenna Power	1 mW/MHz	Test Location	SPORTON Lab.
	Frequency	2402~2480 MHz			Temp. / Humid.	23.1℃ / 58%
					Test Conducted By	
					Name	Ian Du
					Department	Radio Service Group

2. Test Results

Test Voltage	V	Normal Voltage (3.3V)			High Voltage (3.63V)			Low Voltage (2.97V)			Remarks
		2402	2440	2480	2402	2440	2480	2402	2440	2480	
Test Frequency	MHz	2402.0173	2440.0165	2480.0159	2402.0152	2440.0168	2480.0172	2402.0165	2440.0163	2480.0171	Low/Mid/High of test frequency range
Measured Frequency	MHz	7.20	6.76	6.41	6.33	6.89	6.94	6.87	6.68	6.90	Limit ≤ 50 ppm
Frequency Error	ppm	1.15	1.21	1.51	1.15	1.21	1.53	1.15	1.20	1.52	Limit ≤ 26 MHz (RB/VB : 300kHz)
Occupied Bandwidth	MHz	0.73	0.73	0.75	0.72	0.73	0.76	0.72	0.73	0.75	≥ 500kHz
Spread-spectrum Bandwidth	MHz	0.24717	0.02259	0.02382	0.25003	0.02148	0.02009	0.23605	0.02382	0.02228	Limit ≤ 2.5 μW (-26 dBm)
Unwanted Emission Intensity (Power emission within 1MHz bandwidth)	※ 1	μW	0.01315	0.01253	0.38019	0.01202	0.01130	0.36559	0.01148	0.01250	Limit ≤ 25 μW (-16 dBm)
	※ 2	μW	0.04198	0.04688	0.04365	0.04188	0.04355	0.04634	0.04508	0.04046	Limit ≤ 2.5 μW (-26 dBm)
	※ 3	μW	0.99914	1.01772	1.02477	1.00375	1.02241	1.02950	0.99455	1.01304	Limit ≤ 10 mW/MHz (10 dBm/MHz)
	※ 4	μW	-0.00086	0.01772	0.02477	0.00375	0.02241	0.02950	-0.00545	0.01304	Limit ≤ 25 μW (-16 dBm)
Antenna Power (Conducted)	mW/MHz	0.0217	0.0220	0.0209	0.0219	0.0201	0.0214	0.0222	0.0207	0.0221	Limit ≤ 2.5 μW (-26 dBm)
Antenna Power Error	%	-0.09	1.77	2.48	0.38	2.24	2.95	-0.54	1.30	2.95	Limit + 20% ~ - 80%
Limitation of Collateral Emission of Receiver	nW	2.3174	2.3281	2.3768	2.3067	2.3496	2.3496	2.3227	2.3496	2.3823	Limit ≤ 4 nW (-54 dBm)
Hopping Frequency Dwell Time	sec	-	-	-	-	-	-	-	-	-	Limit ≤ 20 nW (-47 dBm)
Radio Interference Prevention Function	ID Code	Good , MAC address : C1:AF:7E:F6:27:06									
	Carrier Sense	-	-	-	-	-	-	-	-	-	

※ 1: Frequency Band 1 (30 MHz ≤ f ≤ 2387 MHz)

※ 2: Frequency Band 2 (2387 MHz < f ≤ 2400 MHz)

※ 3: Frequency Band 3 (2483.5 MHz ≤ f < 2496.5 MHz)

※ 4: Frequency Band 4 (2496.5 MHz ≤ f < 12.5 GHz)

※ 5: Frequency Band 5 (30 MHz ≤ f < 1000 MHz)

※ 6: Frequency Band 6 (1000 MHz ≤ f < 12.5 GHz)

3. Antenna Power (Conducted Power)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (3.3V)			High Voltage (3.63V)			Low Voltage (2.97V)			Remarks
	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw (IF of Spectrum)	dBm	-19.34	-19.26	-19.23	-19.32	-19.24	-19.21	-19.36	-19.28	-19.21	
	Power Measurement System Loss	dB	19.71	19.71	19.71	19.71	19.71	19.71	19.71	19.71	19.71	Refer to Calibration Result
	Transmitter Duty Cycle Factor	dB	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	Duty Factor = $10 \times 10\text{Log}_{10}(1/\text{Duty Cycle})$
	Equivalent Noise Bandwidth	MHz	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	ENB = $\text{Total_Sum}^2 / \text{Peak_Level} * \text{Point_Width}$
	Equivalent Noise Bandwidth Factor	dB	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	ENB Factor = $10 \times 10\text{Log}_{10}(1/\text{ENB})$
	Antenna Power (Conducted)	dBm/MHz	0.00	0.08	0.11	0.02	0.10	0.13	-0.02	0.06	0.13	Limit $\leq 10 \text{ mW/MHz}$ (10 dBm/MHz)
	Antenna Power (Conducted)	mW/MHz	0.9991	1.0177	1.0248	1.0038	1.0224	1.0295	0.9946	1.0130	1.0295	
	Antenna Power Error	mW	-0.0009	0.0177	0.0248	0.0038	0.0224	0.0295	-0.0054	0.0130	0.0295	
	%	-0.09	1.77	2.48	0.38	2.24	2.95	-0.54	1.30	2.95	Limit + 20% ~ - 80%	
Transmitter ON _{Time}	msec	2.1700									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz	
Transmitter (ON+OFF) _{Time}	msec	2.2300										
Transmitter Duty Cycle	%	97.31%										

4. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm/MHz)

No.	Antenna Power		Antenna				Cable			Total Gain D=B+C	EIRP F=A+D	Permitted Angle	Judgement	Remarks (Antenna Model)
	A	Type	Gain B	3dB Beam-width Horizontal	3dB Beam-width Vertical	Model	Length	Loss C						
	(dBm/MHz)		(dBi)	(Degree)	(Degree)		(m)	(dB)		(dBi)	dBm/MHz	(Degree)		
1	0.13	chip	0.00			-	-			0.00	0.13	360.00	Good	Model: AT5020-E3R0HBANT/LF
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														

5. Transmission Antenna Gain (EIRP Power) (This test item will not be applied to the EIRP power is lower than 12.14dBm/MHz)

Antenna	Test Frequency		Output Level from SG		Cable Loss Between SG and Replacing Antenna		Replacing Standard Antenna Gain		EIRP Power Radiated Measurement		Remarks (Antenna Model)
	(MHz)		(Pt)	(dBm)	(L)	(dB)	(Gt)	(dBi)	EIRP = Pt - L + Gt	(dBm)	
1											
1											
1											
2											
2											
2											
3											
3											
3											
4											
4											
4											

6. Unwanted Emission Intensity

Test Voltage		V	Normal Voltage (3.3V)			High Voltage (3.63V)			Low Voltage (2.97V)			Remarks
Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
Unwanted Emission Intensity	※ 1	MHz	2378.50	1218.70	1239.20	2378.50	1218.70	1239.20	2378.50	1218.70	1239.20	RBW : 1 MHz ; VBW : 1 MHz
	※ 2	MHz	2399.99	2390.77	2393.14	2399.93	2388.46	2390.21	2399.97	2392.01	2397.87	
	※ 3	MHz	2494.50	2483.73	2483.55	2483.99	2488.89	2483.55	2491.26	2494.52	2483.57	
	※ 4	MHz	10509.50	10581.50	11232.50	12434.50	11189.50	11247.50	11189.50	11204.50	7527.50	
	※ 1	dB	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	
	※ 2	dB	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	
	※ 3	dB	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	
	※ 4	dB	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	
	※ 1	dBm	-36.23	-46.62	-46.39	-36.18	-46.84	-47.13	-36.43	-46.39	-46.68	
	※ 2	dBm	-29.21	-49.90	-50.32	-29.68	-50.32	-49.51	-29.26	-49.26	-49.57	
	※ 3	dBm	-48.97	-49.18	-34.36	-49.36	-49.63	-34.53	-49.56	-49.19	-34.53	
	※ 4	dBm	-43.94	-43.46	-43.77	-43.95	-43.78	-43.51	-43.63	-44.10	-44.08	
Unwanted Emission Intensity	※ 1	dBm	-36.07	-46.46	-46.23	-36.02	-46.68	-46.97	-36.27	-46.23	-46.52	Limit ≤ 2.5 μW (-26 dBm)
	※ 2	dBm	-29.05	-49.74	-50.16	-29.52	-50.16	-49.35	-29.10	-49.10	-49.41	Limit ≤ 25 μW (-16 dBm)
	※ 3	dBm	-48.81	-49.02	-34.20	-49.20	-49.47	-34.37	-49.40	-49.03	-34.37	Limit ≤ 25 μW (-16 dBm)
	※ 4	dBm	-43.77	-43.29	-43.60	-43.78	-43.61	-43.34	-43.46	-43.93	-43.91	Limit ≤ 2.5 μW (-26 dBm)
	※ 1	μW	0.2472	0.0226	0.0238	0.2500	0.0215	0.0201	0.2360	0.0238	0.0223	Limit ≤ 2.5 μW (-26 dBm)
	※ 2	μW	1.2445	0.0106	0.0096	1.1169	0.0096	0.0116	1.2303	0.0123	0.0115	Limit ≤ 25 μW (-16 dBm)
	※ 3	μW	0.0132	0.0125	0.3802	0.0120	0.0113	0.3656	0.0115	0.0125	0.3656	Limit ≤ 25 μW (-16 dBm)
	※ 4	μW	0.0420	0.0469	0.0437	0.0419	0.0436	0.0463	0.0451	0.0405	0.0406	Limit ≤ 2.5 μW (-26 dBm)
	※ 1	dBm	-36.07	-46.46	-46.23	-36.02	-46.68	-46.97	-36.27	-46.23	-46.52	Limit ≤ 2.5 μW (-26 dBm)
	※ 2	dBm	-29.05	-49.74	-50.16	-29.52	-50.16	-49.35	-29.10	-49.10	-49.41	Limit ≤ 25 μW (-16 dBm)
	※ 3	dBm	-48.81	-49.02	-34.20	-49.20	-49.47	-34.37	-49.40	-49.03	-34.37	Limit ≤ 25 μW (-16 dBm)
	※ 4	dBm	-43.77	-43.29	-43.60	-43.78	-43.61	-43.34	-43.46	-43.93	-43.91	Limit ≤ 2.5 μW (-26 dBm)

- ※ 1: Frequency Band 1 (30 MHz ≤ f ≤ 2387 MHz) ※ 4: Frequency Band 4 (2496.5 MHz ≤ f < 12.5 GHz)
 ※ 2: Frequency Band 2 (2387 MHz < f ≤ 2400 MHz) ※ 5: Frequency Band 5 (30 MHz ≤ f < 1000 MHz)
 ※ 3: Frequency Band 3 (2483.5 MHz ≤ f < 2496.5 MHz) ※ 6: Frequency Band 6 (1000 MHz ≤ f < 12.5 GHz)

7. Limitation of Collateral Emission of Receiver

Test Voltage		V		Normal Voltage (3.3V)			High Voltage (3.63V)			Low Voltage (2.97V)			Remarks	
Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480			
Spurious Emission Frequency	※ 5	MHz	752.20	752.20	752.20	752.20	752.20	752.20	752.20	752.20	752.20	1st	30MHz~ 1000MHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.	
	※ 5	MHz	-	-	-	-	-	-	-	-	-	2nd		
	※ 5	MHz	-	-	-	-	-	-	-	-	-	3rd		
	※ 6	MHz	2806.00	2839.00	2839.00	2789.00	2839.00	2839.00	2806.00	2789.00	2839.00	1st	1000MHz~12.5GHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.	
	※ 6	MHz	-	-	-	-	-	-	-	-	-	2nd		
	※ 6	MHz	-	-	-	-	-	-	-	-	-	3rd		
Cable Loss	※ 5	dB	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	1st		
	※ 5	dB	-	-	-	-	-	-	-	-	-	2nd		
	※ 5	dB	-	-	-	-	-	-	-	-	-	3rd		
	※ 6	dB	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	1st		
	※ 6	dB	-	-	-	-	-	-	-	-	-	2nd		
	※ 6	dB	-	-	-	-	-	-	-	-	-	3rd		
Spectrum Raw	※ 5	dBm	-76.73	-76.66	-76.89	-76.68	-77.05	-76.79	-76.63	-76.93	-76.64	1st		
	※ 5	dBm	-	-	-	-	-	-	-	-	-	2nd		
	※ 5	dBm	-	-	-	-	-	-	-	-	-	3rd		
	※ 6	dBm	-56.51	-56.49	-56.40	-56.53	-56.45	-56.45	-56.50	-56.45	-56.39	1st		
	※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd		
	※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd		
Spurious Emission Intensity	※ 5	dBm	-76.64	-76.57	-76.80	-76.59	-76.96	-76.70	-76.54	-76.84	-76.55	1st	Limit ≤ 4 nW (-54 dBm)	
	※ 5	dBm	-	-	-	-	-	-	-	-	-	2nd		RBW : 100 kHz ; VBW : 100 kHz
	※ 5	dBm	-	-	-	-	-	-	-	-	-	3rd		
	※ 6	dBm	-56.35	-56.33	-56.24	-56.37	-56.29	-56.29	-56.34	-56.29	-56.23	1st	Limit ≤ 20 nW (-47 dBm)	
	※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd		RBW : 1 MHz ; VBW : 1 MHz
	※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd		
Spurious Emission Intensity	※ 5	nW	0.0217	0.0220	0.0209	0.0219	0.0201	0.0214	0.0222	0.0207	0.0221	Total Emission Power		
	※ 5	nW	0.0217	0.0220	0.0209	0.0219	0.0201	0.0214	0.0222	0.0207	0.0221	1st	Limit ≤ 4 nW (-54 dBm)	
	※ 5	nW	-	-	-	-	-	-	-	-	-	2nd		RBW : 100 kHz ; VBW : 100 kHz
	※ 5	nW	-	-	-	-	-	-	-	-	-	3rd		
	※ 6	nW	2.3174	2.3281	2.3768	2.3067	2.3496	2.3496	2.3227	2.3496	2.3823	Total Emission Power		
	※ 6	nW	2.3174	2.3281	2.3768	2.3067	2.3496	2.3496	2.3227	2.3496	2.3823	1st	Limit ≤ 20 nW (-47 dBm)	
	※ 6	nW	-	-	-	-	-	-	-	-	-	2nd		RBW : 1 MHz ; VBW : 1 MHz
	※ 6	nW	-	-	-	-	-	-	-	-	-	3rd		
	※ 6	nW	-	-	-	-	-	-	-	-	-	-	-	

- ※ 1: Frequency Band 1 (30 MHz ≤ f ≤ 2387 MHz) ※ 4: Frequency Band 4 (2496.5 MHz ≤ f < 12.5 GHz)
 ※ 2: Frequency Band 2 (2387 MHz < f ≤ 2400 MHz) ※ 5: Frequency Band 5 (30 MHz ≤ f < 1000 MHz)
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Appendix D. Antenna Information

AT5020 Series

Multilayer Chip Antenna

Features

- ❖ Monolithic SMD with small, low-profile and light-weight type.
- ❖ Wide bandwidth

Applications

- ❖ 2.4GHz WLAN, Home RF, Bluetooth Modules, etc.



Specifications

Part Number	Frequency Range (MHz)	Peak Gain (dBi typ.)	Average Gain (dBi typ.)	VSWR	Impedance
AT5020-E3R0HBAN_	2400~2500	0dBi (XZ-V)	-1.5dBi (XZ-V)	2 max.	50 Ω

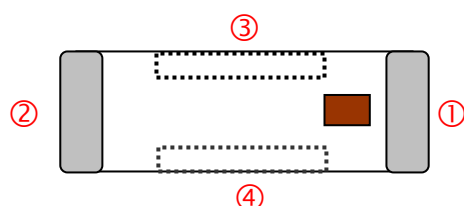
Q'ty/Reel (pcs) : 2,000 pcs
 Operating Temperature Range : -40 ~ +85 °C
 Storage Temperature Range : +5 ~ +35 °C, Humidity 45~75%RH
 Storage Period : 12 months max.
 Power Capacity : 2W max.

Part Number

AT 5020 - E 3R0 HBAN □ □
 ① ② ③ ④ ⑤ ⑥ ⑦

① Type	AT : Antenna	② Dimensions (L × W)	5.0× 2.0 mm
③ Material Code	E	④ Frequency Range	3R0=3000MHz
⑤ Specification Code	HBAN	⑥ Packaging	T: Tape & Reel B: Bulk
⑦ Soldering	=lead-containing /LF=lead-free		

Terminal Configuration

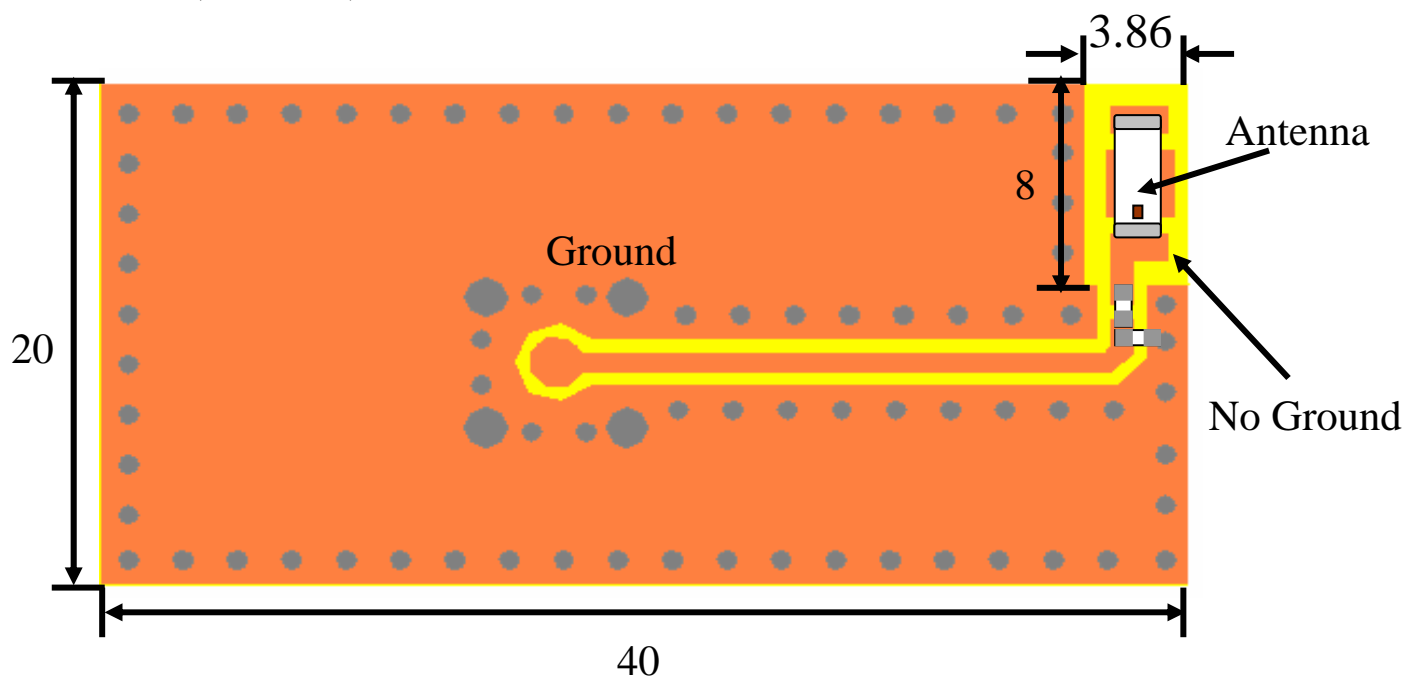


No.	Terminal Name	No.	Terminal Name
①	Feeding Point	③	NC
②	NC	④	NC

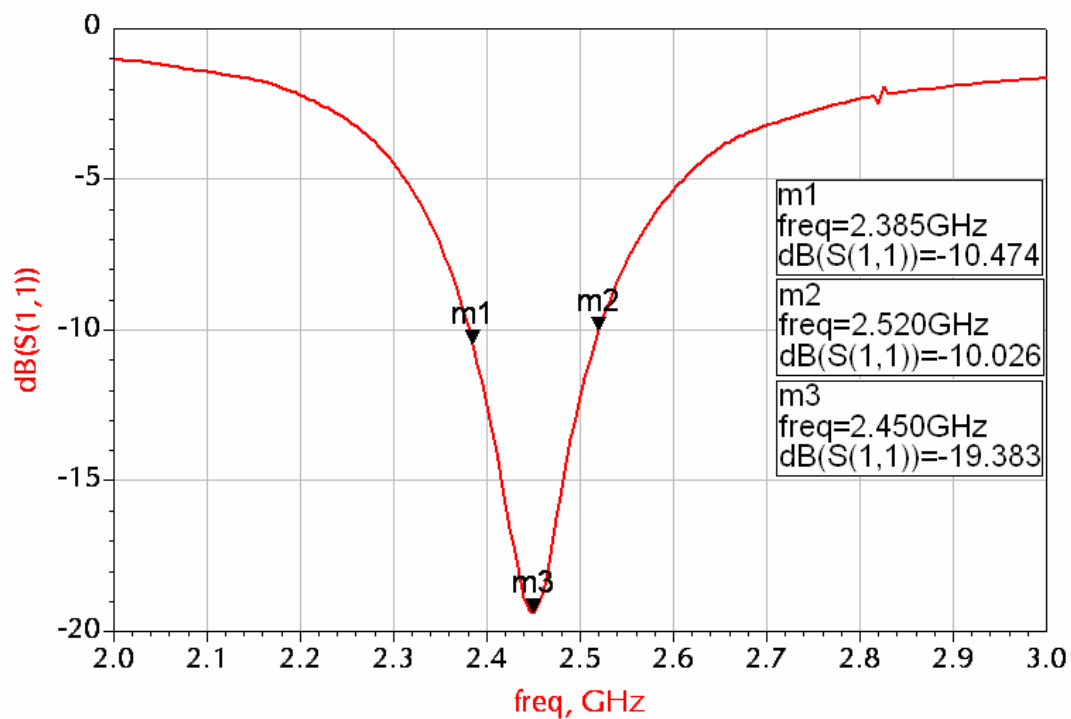
Unit : mm

Typical Electrical Characteristics (T=25°C)

❖ Test Board (Unit in mm)

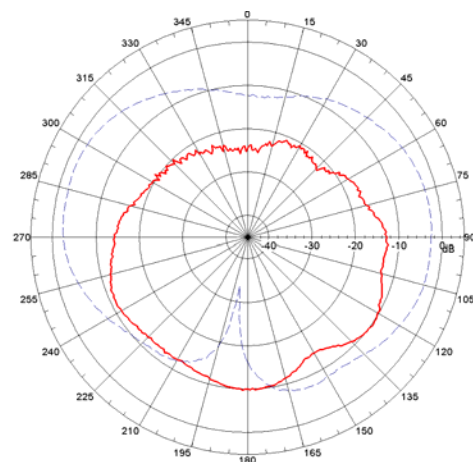
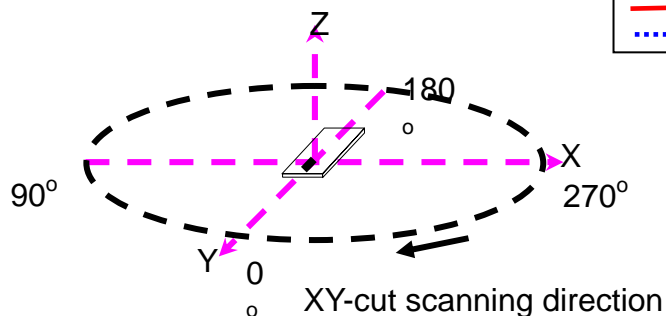


❖ Return Loss(with matching)

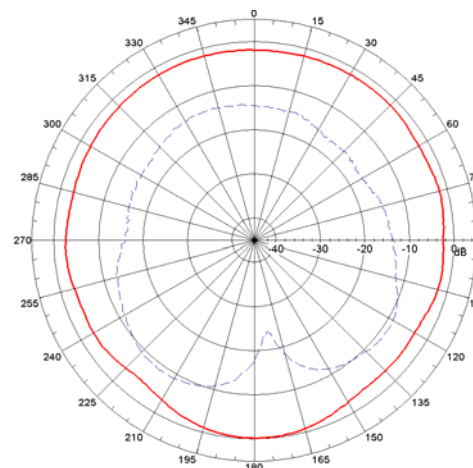
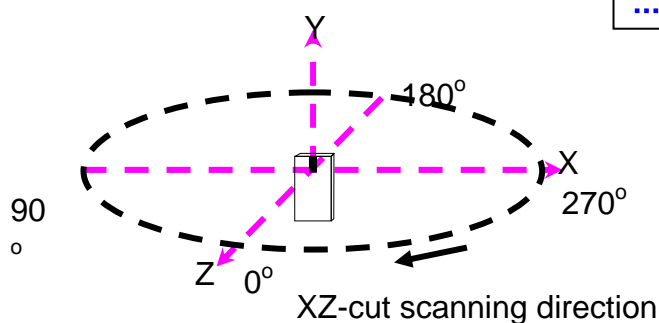


❖ Radiation Patterns

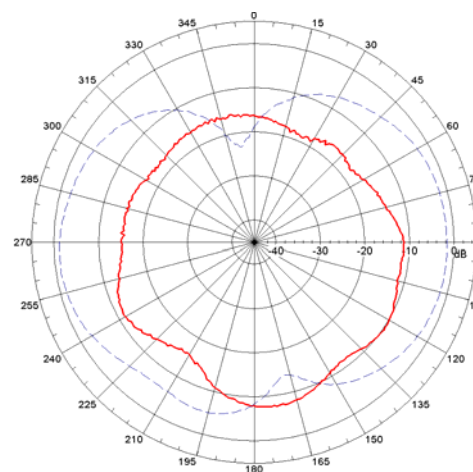
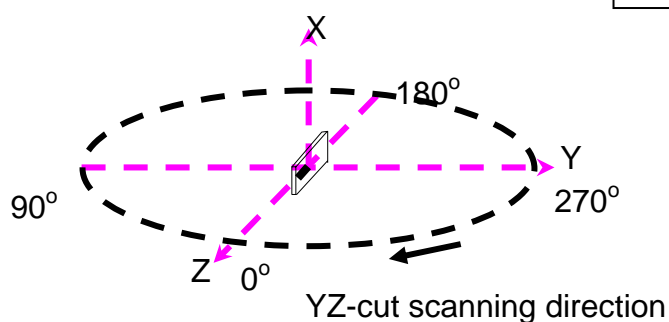
XY-V/XY-H



XZ-V/XZ-H



YZ-V/YZ-H



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