

Japan Test Report

Equipment : Intelligent BT4.0 Dual Mode USB Dongle
Model No. : BT900-US
Brand Name : Laird Technologies
Applicant : Laird Technologies
Address : 11160 Thompson Ave., Lenexa, Kansas 66219,
USA
Standard : ARIB STD-T66 Ver. 3.7
Received Date : Oct. 22, 2015
Tested Date : Oct. 23, 2015

Measurement was conducted by the following test method:
the test method of Ordinance Concerning Technical Regulations Conformity Certification
etc. of Specified Radio Equipment in Annex 1, the Ministry of Internal Affairs and
Communication notification in Annex "43" of Article 88, Paragraph 1 or the test method
more than equivalent.

We, International Certification Corp., would like to declare that the tested sample has been
evaluated and in compliance with the requirement of the above standards. The test results
contained in this report refer exclusively to the product. It may be duplicated completely for
legal use with the approval of the applicant. It shall not be reproduced except in full without
the written approval of our laboratory.

Approved & Reviewed by:



Gary Chang / Manager



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Release Record

Report No.	Version	Description	Issued Date
JR442807-03AD	Rev. 01	Initial issue	Nov. 17, 2015

Summary of Test Results

Ref. Std. Clause	Description	Result
3.2(2)(3)	Antenna Power / Tolerances for antenna power	Pass
3.2(4)	Frequency Tolerance	Pass
3.2(6)	Transmitter Spurious Emission	Pass
3.2(7)	Occupied Bandwidth	Pass
3.2(8)	Spreading Bandwidth	Pass
3.2(9)	Spreading Factor	Pass
3.2(11)	Dwell time	Pass
3.4.1	Interference prevention function	Pass
3.3(1)	Receiver Spurious Emission	Pass

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

Power Type	5Vdc from Host.
Type(s) of Modulation / Technology	FHSS / GFSK = 1Mbps, $\pi/4$ DQPSK = 2Mbps, 8DPSK = 3Mbps
Frequency Range (MHz)	2402 ~ 2480 MHz
Total Channel Number	79
HW Version	Rev. 1
SW Version	9.1.2.0

1.1.2 Antenna Details

Ant. No.	Type	Brand	Model	Gain (dBi)	Connector	Remark
1	Chip	ACX	AT3216-B2R7HAA_3216	0.5	N/A	---

Note: Please refer to Appendix B for more details about antenna pattern and other information.

1.1.3 Antenna Power

Operating Mode	Rated Power (mW/MHz)	Measured Conducted Power (mW/MHz)	Radiated Power (mW/MHz)
GFSK (non-AFH)	0.1	0.08	0.09
GFSK (AFH)	0.4	0.33	0.38
8DPSK (non-AFH)	0.1	0.04	0.05
8DPSK (AFH)	0.4	0.17	0.19

1.1.4 Channel List

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

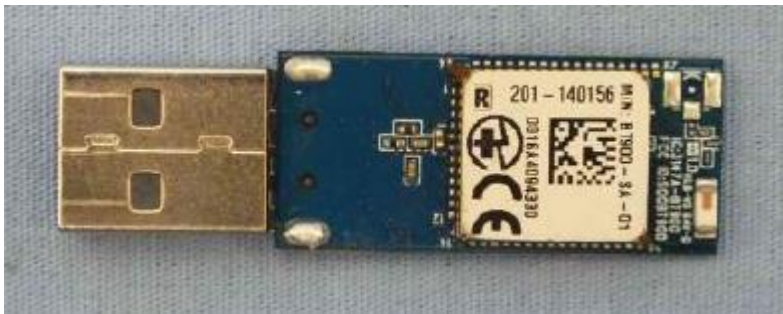
1.1.5 Test Tool and Power Setting

Test Tool
CSR Blue Test3 v. 2.5.8

Power Setting			
Channel	Frequency (MHz)	GFSK	8DPSK
0	2402	63	63
39	2441	63	63
78	2480	63	63

1.1.6 Protection Method for High Frequency and Modulation Section

Protected Method	Description
Shielding Case	RF and Modulation components are covered with shielding case and this shielding case is soldered.

Photo	
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1.2 Test Equipment and Calibration Data

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101063	Feb. 03, 2015	Feb. 02, 2016
Power Meter	Anritsu	ML2495A	1241002	Sep. 21, 2015	Sep. 20, 2016
Power Sensor	Anritsu	MA2411B	1207366	Sep. 21, 2015	Sep. 20, 2016
Signal Generator	R&S	SMB100A	175727	Oct. 05, 2015	Oct. 04, 2016
DC POWER SOURCE	GW INSTEK	GPC-3060D	EM884797	Oct. 20, 2015	Oct. 19, 2016
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Measurement Software	Agilent	EN RF test	1.140904	NA	NA
Note: Calibration Interval of instruments listed above is one year.					
Note 2: Above instruments are calibrated by Electronics Testing Center					

1.3 Testing Applied Standards

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

ARIB STD-T66 Ver. 3.7

1.4 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor ($k=2$))

Measurement Uncertainty	
Parameters	Uncertainty
Frequency error	± 33.988 Hz
Bandwidth	± 33.988 Hz
Conducted power	± 0.537 dB
TX Conducted emission	± 2.308 dB
RX Conducted emission	± 2.525 dB

2 Test Configuration

2.1 Testing Location and Conditions

Test Site	Site Category	Ambient Condition	Tested By
TH01-WS	OVEN Room	21℃ / 66%	Allen Yu

2.2 Supporting Units

Support Unit	Brand	Model	FCC ID
Notebook	DELL	Latitude E6430	DoC

2.3 The Worst Test Modes and Channel Details

Test item	Mode	Test channel
Antenna Power	GFSK, 8DPSK	0 / 39 / 78
Frequency Tolerance	Un-modulation	0 / 39 / 78
Transmitter Spurious Emission	GFSK, 8DPSK	0 / 39 / 78
Occupied Bandwidth	GFSK, 8DPSK	0 / 39 / 78
Spreading Bandwidth	GFSK, 8DPSK	0 / 39 / 78
Spreading Factor	GFSK, 8DPSK	0 / 39 / 78
Dwell time	GFSK, 8DPSK	0 / 39 / 78
Receiver Spurious Emission	GFSK, 8DPSK	0 / 39 / 78

3 Transmitter Test Results

3.1 Antenna Power

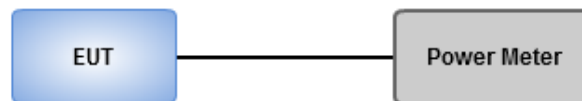
3.1.1 Limit of Antenna Power

Mode	Limit	Tolerance
1) FH, FH+DS, FH+OFDM	3 mW / MHz	+20 % , -80 %
2) OFDM(Narrow- bandwidht), DS	10 mW / MHz	
3) Other than 1) & 2)	10mW	
4) OFDM (Wide-band)	5 mW / MHz	

3.1.2 Test Procedures

1. Measure the total power by Power Meter in a state of hopping mode
2. Measure the burst ratio. Then calculate the real total power by burst ratio.
3. Calculate the mean power per 1MHz by dividing the total power by spread bandwidth
4. Output Power Density (mW/MHz) = Total Output Power (mW) / Burst Ratio / Spread Bandwidth (MHz)

3.1.3 Test Setup



3.1.4 Test Result of Maximum Transmit Power

Reference Documents	Test Items
Appendix A 19-BT-F1D	1. Test Results
	2. Antenna Power (Conducted Power)

3.2 Frequency Tolerance

3.2.1 Limit of Frequency Tolerance

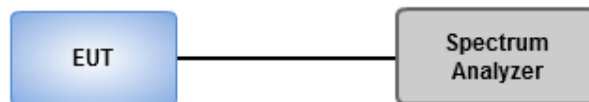
Frequency tolerance shall be +/- 50ppm.

3.2.2 Test Procedures

1. Set Span = 150kHz, RBW = 1kHz, VBW = 30kHz, Sweep time = Auto, detector = Peak.
2. Use Peak search function to find the max peak value and record this value (RF).
3. Calculate frequency tolerance by below formula
$$FT(ppm) = \{ (RF) - (MF) / (MF) \} \times 1000000$$

(FT: Frequency Tolerance, RF: Reading Frequency, MF: Measurement Frequency.)

3.2.3 Test Setup



3.2.4 Test Result of Frequency Tolerance

Reference Documents	Test Items
Appendix A 19-BT-F1D	1. Test Results

3.3 Occupied Bandwidth

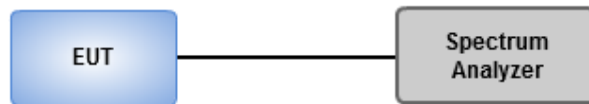
3.3.1 Limit of Occupied Bandwidth

Mode	Limit (MHz)
FH	83.5
FH+DS	83.5
FH+OFDM	83.5
OFDM(Narrow- bandwidht), DS	26
Others	26
OFDM (Wide-band)	38

3.3.2 Test Procedures

1. Set Span = 200MHz, RBW = VBW = 300kHz, detector = Peak, Sweep time = Auto.
2. Enable OBW function of spectrum analyzer to measure 99% bandwidth of total power.

3.3.3 Test Setup



3.3.4 Test Result of Occupied Bandwidth

Reference Documents	Test Items
Appendix A 19-BT-F1D	1. Test Results

3.4 Spreading Bandwidth and Factor

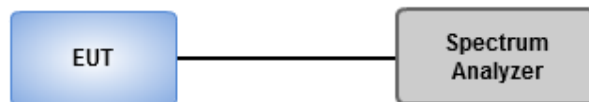
3.4.1 Limit of Spreading Bandwidth and Factor

Item	Limit
Spreading bandwidth	$\geq 500\text{kHz}$
Spreading factor for DSSS (operates at 2400~2483.5 MHz)	≥ 5
Spreading factor for DSSS (operates at 2471~2497 MHz)	≥ 10

3.4.2 Test Procedures

1. Set Span = 20MHz, RBW = VBW = 300kHz, detector = Peak, Sweep time = Auto.
2. Enable OBW (90%) function of spectrum analyzer to measure 90% bandwidth of total power.

3.4.3 Test Setup



3.4.4 Test Result of Spreading Bandwidth and Factor

Reference Documents	Test Items
Appendix A 19-BT-F1D	1. Test Results
	8. Spread Factor

3.5 Transmitter Spurious Emissions

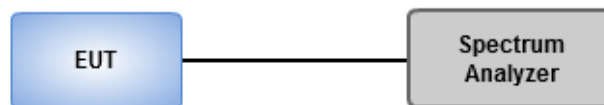
3.5.1 Limit of Transmitter Spurious Emissions

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 ($2483.5\text{MHz} < f \leq 2496.5\text{MHz}$).

3.5.2 Test Procedures

1. Set EUT to transmit at rated power and channel to perform test.
2. Set RBW = VBW = 1MHz, Detector type = Peak, Sweep time = Auto.
3. Following above setting of spectrum analyzer to measure spurious emission of 30~12750 MHz.

3.5.3 Test Setup



3.5.4 Test Result of Transmitter Spurious Emissions

Reference Documents	Test Items
Appendix A 19-BT-F1D	1. Test Results
	5. Unwanted Emission Intensity

3.6 Dwell time

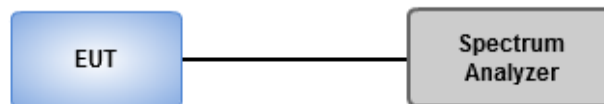
3.6.1 Limit of Dwell time

Limits	Shall be less than 0.4 second
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3.6.2 Test Procedures

1. Set EUT to transmit at rated power and channel to perform test.
2. Set RBW = VBW = 300kHz, Detector type = Peak, Span = Zero Span, Sweep time = 5 msec.
3. Use marker function to measure Burst on and off time.
4. Burst ratio = On Time / (On Time + Off time)

3.6.3 Test Setup



3.6.4 Test Result of Transmitter Spurious Emissions

Reference Documents	Test Items
Appendix A 19-BT-F1D	1. Test Results
	7. Hopping Frequency Dwell Time

3.7 Interference prevention function

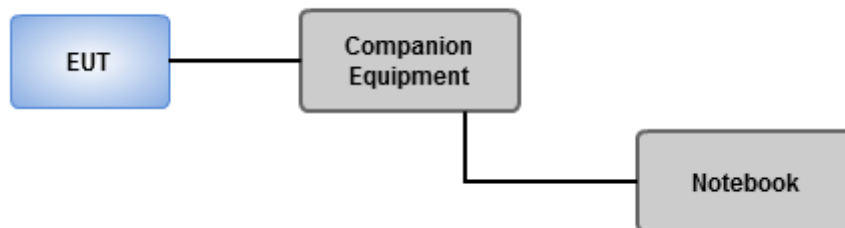
3.7.1 Limit of Interference Prevention Function

Limits
The identification code shall be 48 bits long

3.7.2 Test Procedures

1. Set EUT under operating mode and link up with companion equipment
2. Check communication status between EUT and companion equipment is normal
3. Confirm the MAC address of EUT

3.7.3 Test Setup



3.7.4 Test Result of Interference Prevention Function

Reference Documents	Test Items
Appendix A 19-BT-F1D	1. Test Results

4 Receiver Test Results

4.1 Receiver Spurious Emissions

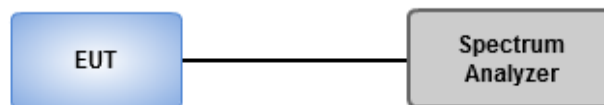
4.1.1 Limit of Receiver Spurious Emissions

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

4.1.2 Test Procedures

1. Set EUT to transmit at rated power and channel to perform test
2. Set RBW = VBW = 100kHz, detector = Peak, Sweep time = Auto for emission measurement below 1GHz.
3. Set RBW = VBW=1MHz, detector = Peak, Sweep time = Auto for emission measurement above 1GHz.

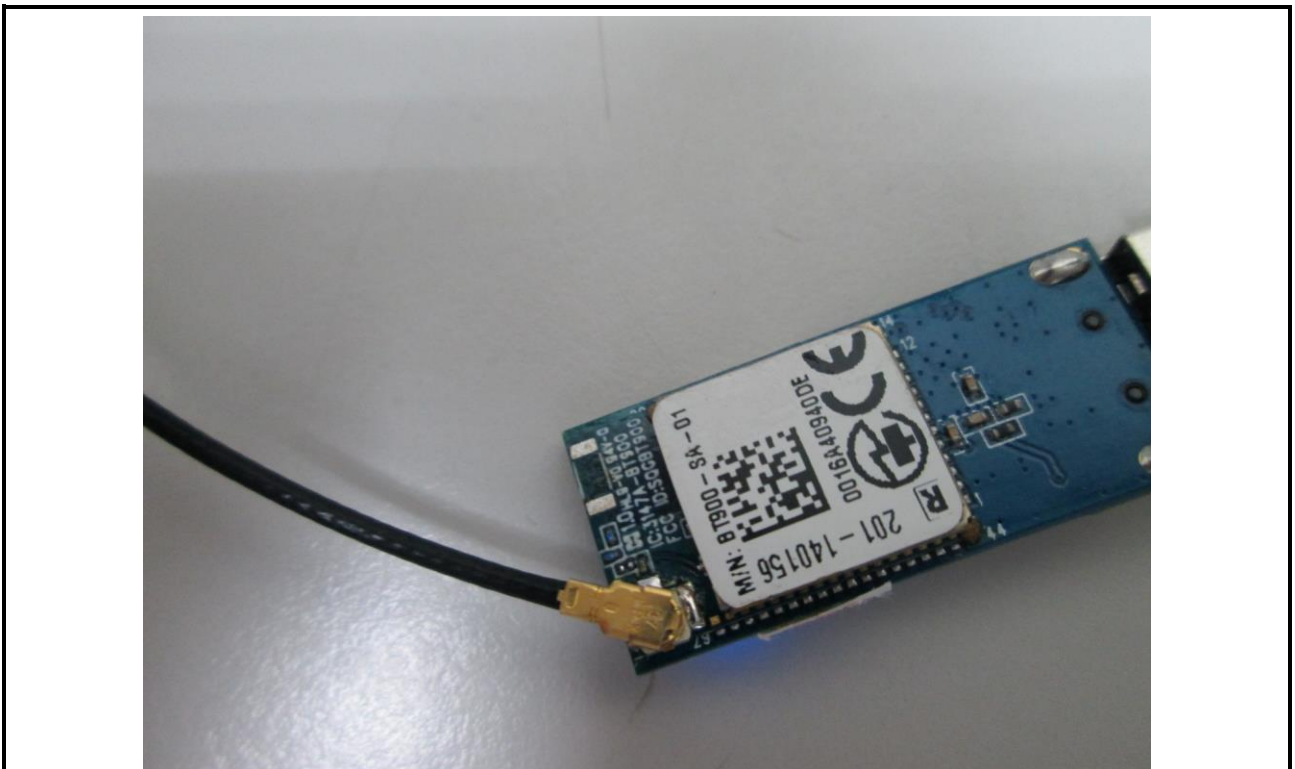
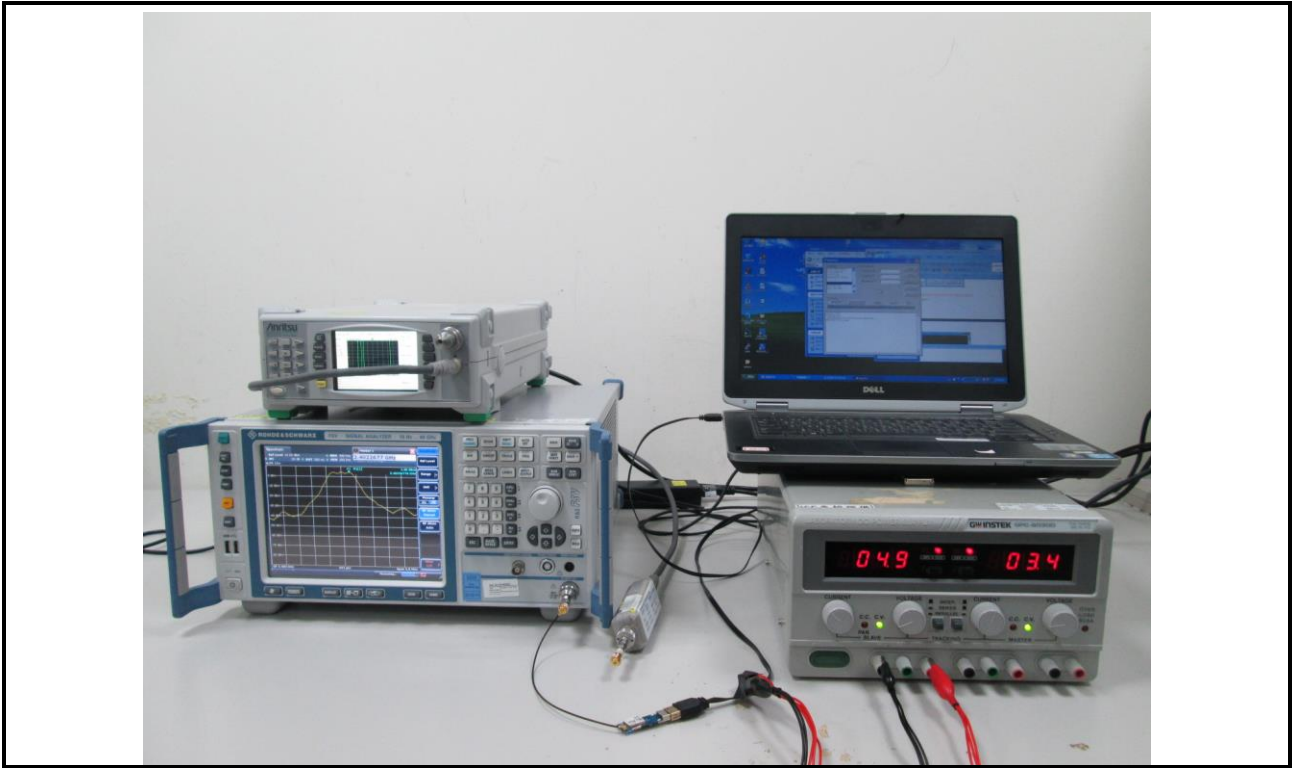
4.1.3 Test Setup

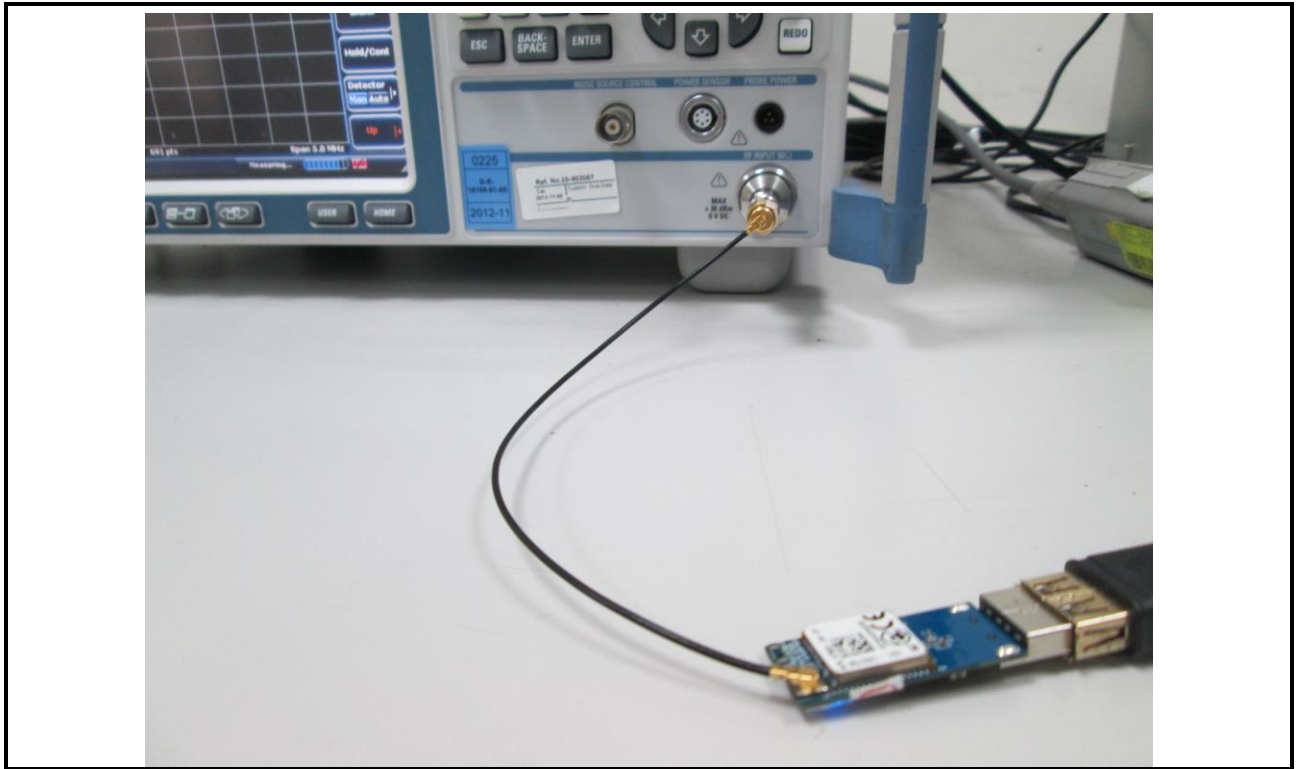


4.1.4 Test Result of Receiver Spurious Emissions

Reference Documents	Test Items
Appendix A 19-BT-F1D	1. Test Results
	6. Limitation of Collateral Emission of Receiver

5 Photographs of the Test Configuration





6 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp, it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan Hsiang. Location map can be found on our website <http://www.icertifi.com.tw>.

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If you have any suggestion, please feel free to contact us as below information

Tel: 886-3-271-8666

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Email: ICC_Service@icertifi.com.tw

==END==

Appendix A 19-BT-F1D

1. Test Results

Testing for Electrical Specification	Test Voltage		V		Normal Voltage (5V)		Remarks	
	Test Frequency		MHz		2402	2441	2480	Low/Mid/High of test frequency range
	Measured Frequency		MHz		2401.9998	2440.9979	2479.9976	
	Frequency Error		ppm		-0.08	-0.86	-0.97	Limit ≤ 50 ppm
	Occupied Bandwidth		MHz		78.66		Limit ≤ 83.5 MHz (RB/VB : 1MHz)	
	Spread-spectrum Bandwidth		MHz		71.29		Spread Factor Limit ≥ 5 (DSSS and FHSS)	
	Unwanted Emission Intensity (Power emission within 1MHz bandwidth)		※ 1	μW	0.00010		Limit ≤ 0.25 μW (-36 dBm)	
			※ 2	μW	0.00495		Limit ≤ 2.5 μW (-26 dBm)	
			※ 3	μW	1.06170		Limit ≤ 25 μW (-16 dBm)	
			※ 4	μW	0.19770		Limit ≤ 25 μW (-16 dBm)	
			※ 5	μW	0.04477		Limit ≤ 2.5 μW (-26 dBm)	
	Antenna Power (Measured Power)		mW/MHz		0.082789		Limit ≤ 3 mW/MHz (4.77 dBm/MHz)	
	Antenna Power (Rated Power)		mW/MHz		0.10			
	Antenna Power Error		mW/MHz		-0.017211			
			%		-17.21		Limit + 20% ~ - 80%	
	Limitation of Collateral Emission of Receiver		※ 6	nW	0.0015	0.0011	0.0012	Limit ≤ 4 nW (-54 dBm)
			※ 7	nW	0.1629	0.0815	0.2099	Limit ≤ 20 nW (-47 dBm)
	Hopping Frequency Dwell Time		sec		0.2860	0.2840	0.2840	Limit ≤ 0.4 sec (In 0.4 sec × spreading rate)
	Radio Interference Prevention Function		ID Code	Good, MAC Address :00-16-A4-00-00-00				
		Carrier Sense	NR		NR		NR: Not Require	

※ 1: Frequency Band 1 (30 MHz $\leq$ f $\leq$ 1000 MHz)※ 2: Frequency Band 2 (1000 MHz < f $\leq$ 2387 MHz)※ 3: Frequency Band 3 (2387 MHz < f $\leq$ 2400 MHz)※ 4: Frequency Band 4 (2483.5 MHz $\leq$ f < 2496.5 MHz)※ 5: Frequency Band 5 (2496.5 MHz $\leq$ f < 12.5 GHz)※ 6: Frequency Band 6 (30 MHz $\leq$ f < 1000 MHz)※ 7: Frequency Band 7 (1000 MHz $\leq$ f < 12.5 GHz)

2. Antenna Power (Conducted Power)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (5V)	Remarks
	Test Frequency	MHz	2402 ~ 2480	
	Power Meter Raw from EUT	dBm	5.20	
	Cable Loss	dB	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.02	Duty Factor = 10 × 10Log ₁₀ (1/Duty Cycle)
	Spreading Bandwidth Factor	dB	-18.53	BW Factor = 10 × 10Log ₁₀ (1/Spreading BW)
	Antenna Power (Conducted)	dBm/MHz	-10.82	Limit ≤ 3 mW/MHz (4.77 dBm/MHz)
	Antenna Power (Conducted)	mW/MHz	0.08279	
	Antenna Power Error	mW	-0.01721	
		%	-17.21	Limit + 20% ~ - 80%
	Transmitter ON _{Time}	msec	2.9710	RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Transmitter (ON+OFF) _{Time}	msec	3.7536	
	Transmitter Duty Cycle (DH5)	%	79.15%	Max TX on time mode

3. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 6.91dBm/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					
1	(dBm/MHz)		(dBi)	(Degree)	(Degree)		(m)	(dB)	(dBi)	(dBm/MHz)	(Degree)		
	-10.82	chip	0.50						0.50	-10.32	360.00	Good	

4. Transmission Antenna Gain (EIRP Power) (This test item will not be applied to the EIRP power is lower than 6.91dBm/MHz)

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

5. Unwanted Emission Intensity

Test Voltage		V	Normal Voltage (5V)		Remarks
Test Frequency		MHz	Hopping		
Unwanted Emission Frequency	※ 1	MHz	885.60		RBW : 100 kHz ; VBW : 100kHz
	※ 2	MHz	2365.90		RBW : 1 MHz ; VBW : 1 MHz
	※ 3	MHz	2399.99		
	※ 4	MHz	2483.55		
	※ 5	MHz	2561.50		
Cable Loss	※ 1	dB	0.88		
	※ 2	dB	1.49		
	※ 3	dB	1.49		
	※ 4	dB	1.49		
	※ 5	dB	1.49		
Spectrum Raw	※ 1	dBm	-70.71		
	※ 2	dBm	-54.54		
	※ 3	dBm	-31.23		
	※ 4	dBm	-38.53		
	※ 5	dBm	-44.98		
Unwanted Emission Intensity	※ 1	dBm	-69.83		Limit ≤ 0.25 μW (-36 dBm)
	※ 2	dBm	-53.05		Limit ≤ 2.5 μW (-26 dBm)
	※ 3	dBm	-29.74		Limit ≤ 25 μW (-16 dBm)
	※ 4	dBm	-37.04		Limit ≤ 25 μW (-16 dBm)
	※ 5	dBm	-43.49		Limit ≤ 2.5 μW (-26 dBm)
Unwanted Emission Intensity	※ 1	μW	0.0001		Limit ≤ 0.25 μW (-36 dBm)
	※ 2	μW	0.0050		Limit ≤ 2.5 μW (-26 dBm)
	※ 3	μW	1.0617		Limit ≤ 25 μW (-16 dBm)
	※ 4	μW	0.1977		Limit ≤ 25 μW (-16 dBm)

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		※ 5	μW	0.0448	Limit ≦ 2.5 μW (-26 dBm)		
※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)							
※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz)							
※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz)							
※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)							
※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)							
※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)							
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)							
6. Limitation of Collateral Emission of Receiver							
Limitation of Collateral Emission	Test Voltage	V	Normal Voltage (5V)			Remarks	
	Test Frequency	MHz	2402	2441	2480		
	Spurious Emission Frequency	※ 6	MHz	8000.00	933.30	868.70	1st 30MHz~1000MHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated
		※ 6	MHz	-	-	-	2nd 1000MHz~12.5GHz::
		※ 6	MHz	-	-	-	3rd
		※ 7	MHz	10278.00	7865.00	10594.00	1st Maximum emission and all emissions beyond 1/10 of the limitation must be indicated
		※ 7	MHz	-	-	-	2nd
		※ 7	MHz	-	-	-	3rd
	Cable Loss	※ 6	dB	1.09	1.09	1.09	1st
		※ 6	dB	-	-	-	2nd
		※ 6	dB	-	-	-	3rd
		※ 7	dB	5.68	1.76	5.68	1st
		※ 7	dB	-	-	-	2nd
		※ 7	dB	-	-	-	3rd
	Spectrum Raw	※ 6	dBm	-89.33	-90.53	-90.46	1st
		※ 6	dBm	-	-	-	2nd
		※ 6	dBm	-	-	-	3rd
		※ 7	dBm	-73.56	-72.65	-72.46	1st
		※ 7	dBm	-	-	-	2nd
		※ 7	dBm	-	-	-	3rd
	Spurious Emission Intensity	※ 6	dBm	-88.24	-89.44	-89.37	1st Limit ≦ 4 nW (-54 dBm)
		※ 6	dBm	-	-	-	2nd RBW : 100 kHz ; VBW : 100 kHz
		※ 6	dBm	-	-	-	3rd
		※ 7	dBm	-67.88	-70.89	-66.78	1st Limit ≦ 20 nW (-47 dBm)
		※ 7	dBm	-	-	-	2nd RBW : 1 MHz ; VBW : 1 MHz
		※ 7	dBm	-	-	-	3rd
	Spurious Emission Intensity	※ 6	nW	0.0015	0.0011	0.0012	Total Emission Power
		※ 6	nW	0.0015	0.0011	0.0012	1st Limit ≦ 4 nW (-54 dBm)
		※ 6	nW	-	-	-	2nd RBW : 100 kHz ; VBW : 100 kHz
		※ 6	nW	-	-	-	3rd
		※ 7	nW	0.1629	0.0815	0.2099	Total Emission Power
		※ 7	nW	0.1629	0.0815	0.2099	1st Limit ≦ 20 nW (-47 dBm)
		※ 7	nW	-	-	-	2nd RBW : 1 MHz ; VBW : 1 MHz
		※ 7	nW	-	-	-	3rd

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz) ※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz) ※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz) ※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz) ※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz) ※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz) ※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

7. Hopping Frequency Dwell Time

DH5	Test Voltage	V	Normal Voltage (5V)			Remarks
	Test Frequency	MHz	2402	2441	2480	Limit ≧ 0.4 sec (In 0.4 sec × spreading rate)
	Pulse Duration	msec	2.9710	2.9500	2.9500	RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Measurement Time	sec	28.52	28.52	28.52	The total sum of holding time at arbitrary frequencies within the time multiplied 0.4 sec by the spreading rate
	Dwell Time	sec	0.2860	0.2840	0.2840	

8. Spread Factor

Spread Factor	Test Voltage	V	Normal Voltage (5V)			Remarks
	Test Frequency	MHz	2402 ~ 2480			
	Spread-Spectrum Bandwidth	MHz	71.29			
	Modulation Rate	Mcps	1.000			
	Spread Factor		71.2900			Spread Factor Limit ≧ 5 (DSSS and FHSS)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (5V)			Remarks
	Test Frequency	MHz	2402	2441	2480	Low/Mid/High of test frequency range
	Occupied Bandwidth	MHz	19.64			Limit $\leq$ 83.5 MHz (RB/VB : 1MHz)
	Spread-spectrum Bandwidth	MHz	17.63			Spread Factor Limit $\geq$ 5 (DSSS and FHSS)
	Antenna Power (Measured Power)	mW/MHz	0.334771			Limit $\geq$ 3 mW/MHz (4.77 dBm/MHz)
	Antenna Power (Rated Power)	mW/MHz	0.40			
	Antenna Power Error	mW/MHz	-0.065229			
		%	-16.31			Limit + 20% ~ - 80%
	Hopping Frequency Dwell Time	sec	0.2794	0.2774	0.2774	Limit $\leq$ 0.4 sec (In 0.4 sec $\times$ spreading rate)
	Radio Interference Prevention Function	ID Code	Good, MAC Address : 00-16-A4-00-00-00			
	Carrier Sense	NR	NR	NR	NR: Not Require	

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (5V)	Remarks
	Test Frequency	MHz	2402 ~ 2480	
	Power Meter Raw from EUT	dBm	5.20	
	Cable Loss	dB	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.02	Duty Factor = $10 \times 10\log_{10}(1/\text{Duty Cycle})$
	Spreading Bandwidth Factor	dB	-12.46	BW Factor = $10 \times 10\log_{10}(1/\text{Spreading BW})$
	Antenna Power (Conducted)	dBm/MHz	-4.75	Limit $\leq$ 3 mW/MHz (4.77 dBm/MHz)
	Antenna Power (Conducted)	mW/MHz	0.33477	
	Antenna Power Error	%	-0.0523	
	%	-16.31	Limit + 20% ~ - 80%	
Transmitter ON _{Time}	msec	2.9710	RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz	
Transmitter (ON+OFF) _{Time}	msec	3.7536		
Transmitter Duty Cycle (DH5)	%	79.15%	Max TX on time mode	

[illegible]

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

Test Voltage		V	Normal Voltage (SV)			Remarks
DH5	Test Frequency	MHz	2402	2441	2480	Limit ≤ 0.4 sec (In $0.4 \text{ sec} \times \text{spreading rate}$)
	Pulse Duration	msec	2.9710	2.9500	2.9500	RBW : 1 MHz ; VBW : 1 MHz ; SP : Ohz
	Measurement Time	sec	7.05	7.05	7.05	The total sum of holding time at arbitrary frequencies within the time multiplied 0.4 sec by the spreading rate
	Dwell Time	sec	0.2794	0.2774	0.2774	

Spread Factor	Test Results		
	Test Voltage	V	Normal Voltage (5V)
	Test Frequency	MHz	2402 ~ 2480
	Spread-Spectrum Bandwidth	MHz	17.63
	Modulation Rate	Mcps	1.000
	Spread Factor		17.6300
		Spread Factor Limit ≥ 5 (DSSS and FHSS)	

Test Voltage	V	Normal Voltage (5V)			Remarks
Test Frequency	MHz	2402	2441	2480	Low/Mid/High of test frequency range
Measured Frequency	MHz	2401.9990	2440.9972	2479.9979	
Frequency Error	ppm	-0.42	-1.15	-0.85	Limit ≤ 50 ppm
Occupied Bandwidth	MHz		78.54		Limit ≤ 83.5 MHz (RB/NB : 1MHz)
Spread-spectrum Bandwidth	MHz		70.93		Spread Factor Limit ≥ 5 (DSSS and FHSS)
⊗ 1	μW		-43.95000		Limit ≤ 2.5 μW (-26 dBm)
⊗ 2	μW		0.00378		Limit ≤ 2.5 μW (-26 dBm)
⊗ 3	μW		2.74789		Limit ≤ 25 μW (-16 dBm)
⊗ 4	μW		0.05035		Limit ≤ 25 μW (-16 dBm)
⊗ 5	μW		0.04027		Limit ≤ 2.5 μW (-26 dBm)
Antenna Power (Measured Power)	mW/MHz		0.043070		Limit ≤ 3 mW/MHz (4.77 dBm/MHz)
Antenna Power (Rated Power)	mW/MHz		0.10		
Antenna Power Error	mW/MHz		-0.056930		
	%		-56.93		Limit + 20% ~ - 80%
Limitation of Collateral	nW	0.0009	0.0011	0.0011	Limit ≤ 4 nW (-54 dBm)
Emission of Collateral	nW	0.0828	0.1795	0.2000	Limit ≤ 20 nW (-47 dBm)
Hopping Frequency Dwell Time	sec	0.2845	0.2825	0.2825	Limit ≤ 0.4 sec (In 0.4 sec × spreading rate)
Radio Interference Prevention Function	ID Code	Good, MAC Address: 00-16-A4-00-00-00			
	Carrier Sense	NR	NR	NR	NR: Not Require

2. Antenna Power (Conducted Power)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (5V)	Remarks
	Test Frequency	MHz	2402 ~ 2480	
	Power Meter Raw from EUT	dBm	2.34	
	Cable Loss	dB	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.02	Duty Factor = $10 \times 10\text{Log}_{10}(1/\text{Duty Cycle})$
	Spreading Bandwidth Factor	dB	-18.51	BW Factor = $10 \times 10\text{Log}_{10}(1/\text{Spreading BW})$
	Antenna Power (Conducted)	dBm/MHz	-13.66	Limit ≤ 3 mW/MHz (4.77 dBm/MHz)
	Antenna Power (Conducted)	mW/MHz	0.04307	
	Antenna Power Error	mW	0.05893	
		%	-56.93	Limit + 20% ~ - 80%
Transmitter ON _{Time}	msec	2.9710	RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz	
Transmitter (ON+OFF) _{Time}	msec	3.7536		
Transmitter Duty Cycle (30H5)	%	79.15%	Max TX on time mode	

[illegible]

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

Test Voltage	V	Normal Voltage (5V)	Remarks
Test Frequency	MHz	Hopping	
Unwanted Emission Frequency	※ 1	MHz 996.50	RBW : 100 kHz ; VBW : 100kHz
	※ 2	MHz 2343.50	RBW : 1 MHz ; VBW : 1 MHz
	※ 3	MHz 2399.99	
	※ 4	MHz 2483.51	
	※ 5	MHz 2590.50	
Cable Loss	※ 1	dB 0.88	
	※ 2	dB 1.49	
	※ 3	dB 1.49	
	※ 4	dB 1.49	
	※ 5	dB 1.49	
Spectrum Raw	※ 1	dBm -70.43	
	※ 2	dBm -55.72	
	※ 3	dBm -27.10	
	※ 4	dBm -44.47	
	※ 5	dBm -45.44	
Unwanted Emission Intensity	※ 1	dBm -69.55	Limit ≤ 0.25 μW (-36 dBm)
	※ 2	dBm -54.23	Limit ≤ 2.5 μW (-26 dBm)
	※ 3	dBm -26.61	Limit ≤ 25 μW (-16 dBm)
	※ 4	dBm -42.98	Limit ≤ 25 μW (-16 dBm)
	※ 5	dBm -43.95	Limit ≤ 2.5 μW (-26 dBm)

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Unwanted Emission Intensity	※ 1	μW	0.0001	Limit ≦ 0.25 μW (-36 dBm)
	※ 2	μW	0.0038	Limit ≦ 2.5 μW (-26 dBm)
	※ 3	μW	2.7479	Limit ≦ 25 μW (-16 dBm)
	※ 4	μW	0.0504	Limit ≦ 25 μW (-16 dBm)
	※ 5	μW	0.0403	Limit ≦ 2.5 μW (-26 dBm)

- ※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
- ※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz)
- ※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz)
- ※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
- ※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
- ※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
- ※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

6. Limitation of Collateral Emission of Receiver

Limitation of Collateral Emission	Test Voltage		Normal Voltage (5V)			Remarks	
	Test Frequency		MHz	2402	2441	2480	
	Spurious Emission Frequency	※ 6	MHz	752.20	922.10	922.10	1st 30MHz~1000MHz::
		※ 6	MHz	-	-	-	2nd Maximum emission and all emissions beyond 1/10 of the
		※ 6	MHz	-	-	-	3rd limitation must be indicated.
		※ 7	MHz	7865.00	10528.00	10545.00	1st 1000MHz~12.5GHz::
		※ 7	MHz	-	-	-	2nd Maximum emission and all emissions beyond 1/10 of the
		※ 7	MHz	-	-	-	3rd limitation must be indicated.
	Cable Loss	※ 6	dB	0.88	0.88	0.88	1st
		※ 6	dB	-	-	-	2nd
		※ 6	dB	-	-	-	3rd
		※ 7	dB	1.76	5.68	5.68	1st
		※ 7	dB	-	-	-	2nd
		※ 7	dB	-	-	-	3rd
	Spectrum Raw	※ 6	dBm	-91.18	-90.30	-90.30	1st
		※ 6	dBm	-	-	-	2nd
		※ 6	dBm	-	-	-	3rd
		※ 7	dBm	-72.58	-73.14	-72.67	1st
		※ 7	dBm	-	-	-	2nd
		※ 7	dBm	-	-	-	3rd
	Spurious Emission Intensity	※ 6	dBm	-90.30	-89.42	-89.42	1st Limit ≦ 4 nW (-54 dBm)
		※ 6	dBm	-	-	-	2nd RBW : 100 kHz ; VBW : 100 kHz
		※ 6	dBm	-	-	-	3rd
		※ 7	dBm	-70.82	-67.46	-66.99	1st
		※ 7	dBm	-	-	-	2nd Limit ≦ 20 nW (-47 dBm)
		※ 7	dBm	-	-	-	3rd RBW : 1 MHz ; VBW : 1 MHz
	Spurious Emission Intensity	※ 6	nW	0.0009	0.0011	0.0011	Total Emission Power
		※ 6	nW	0.0009	0.0011	0.0011	1st Limit ≦ 4 nW (-54 dBm)
		※ 6	nW	-	-	-	2nd RBW : 100 kHz ; VBW : 100 kHz
		※ 6	nW	-	-	-	3rd
		※ 7	nW	0.0828	0.1795	0.2000	Total Emission Power
		※ 7	nW	0.0828	0.1795	0.2000	1st Limit ≦ 20 nW (-47 dBm)
		※ 7	nW	-	-	-	2nd RBW : 1 MHz ; VBW : 1 MHz
		※ 7	nW	-	-	-	3rd

- ※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
- ※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz)
- ※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz)
- ※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
- ※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
- ※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
- ※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

7. Hopping Frequency Dwell Time

DH5	Test Voltage		Normal Voltage (5V)			Remarks	
	Test Frequency		MHz	2402	2441	2480	Limit ≧ 0.4 sec (In 0.4 sec × spreading rate)
	Pulse Duration		msec	2.9710	2.9500	2.9500	RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Measurement Time		sec	28.37	28.37	28.37	The total sum of holding time at arbitrary frequencies within the time multiplied 0.4 sec by the spreading rate
	Dwell Time		sec	0.2845	0.2825	0.2825	

8. Spread Factor

Spread Factor	Test Voltage		Normal Voltage (5V)			Remarks	
	Test Frequency		MHz	2402 ~ 2480			
	Spread-Spectrum Bandwidth		MHz	70.93			
	Modulation Rate		Mcps	3.000			
	Spread Factor			23.6433			Spread Factor Limit ≧ 5 (DSSS and FHSS)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (5 V)			Remarks
	Test Frequency	MHz	2402	2441	2480	Low/Mid/High of test frequency range
	Occupied Bandwidth	MHz	19.80			Limit $\leq$ 83.5 MHz (RB/VB : 1MHz)
	Spread-spectrum Bandwidth	MHz	17.67			Spread Factor Limit $\geq$ 5 (DSSS and FHSS)
	Antenna Power (Measured Power)	mW/MHz	0.172887			Limit $\leq$ 3 mW/MHz (4.77 dBm/MHz)
	Antenna Power (Rated Power)	mW/MHz	0.40			
	Antenna Power Error	mW/MHz	-0.227113			
		%	-56.78			Limit + 20% ~ - 80%
	Hopping Frequency Dwell Time	sec	0.2800	0.2780	0.2780	Limit $\leq$ 0.4 sec (In 0.4 sec $\times$ spreading rate)
	Radio Interference Prevention Function	ID Code	Good, MAC Address :00-16-A4-00-00-00			
	Carrier Sense	NR	NR	NR	NR: Not Require	

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (5V)	Remarks
	Test Frequency	MHz	2402 ~ 2480	
	Power Meter Raw from EUT	dBm	2.34	
	Cable Loss	dB	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.02	Duty Factor = $10 \times 10\log_{10}(1/\text{Duty Cycle})$
	Spreading Bandwidth Factor	dB	-12.47	BW Factor = $10 \times 10\log_{10}(1/\text{Spreading BW})$
	Antenna Power (Conducted)	dBm/MHz	-7.62	Limit ≤ 3 mW/MHz (4.77 dBm/MHz)
	Antenna Power (Conducted)	mW/MHz	0.17289	
	Antenna Power Error	mW	-0.22711	
		%	-56.78	Limit + 20% ~ - 80%
Transmitter ON _{Time}	msec	2.9710	RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz	
Transmitter (ON+OFF) _{Time}	msec	3.7536		
Transmitter Duty Cycle (3DH5)	%	79.15%	Max TX on time mode	

[illegible]

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

DH5	Test Voltage	V	Normal Voltage (5V)			Remarks
	Test Frequency	MHz	2402	2441	2480	Limit $\leq$ 0.4 sec (In 0.4 sec $\times$ spreading rate) RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz The total sum of holding time at arbitrary frequencies within the time multiplied 0.4 sec by the spreading rate
	Pulse Duration	msec	2.9710	2.9500	2.9500	
	Measurement Time	sec	7.07	7.07	7.07	
	Dwell Time	sec	0.2800	0.2780	0.2780	

Spread Factor	Test Voltage	V	Normal Voltage (5 V)	Remarks
	Test Frequency	MHz	2402 ~ 2480	
	Spread-Spectrum Bandwidth	MHz	17.67	
	Modulation Rate	Mcps	3.000	
	Spread Factor		5.8900	Spread Factor Limit ≥ 5 (DSSS and FHSS)

Power Supply Voltage Fluctuation Test

Voltage Fluctuation Test	Normal Voltage	High Voltage	Low Voltage
Input DC Power	5	5.5	4.5
Output DC Power	3.3	3.3	3.29
Voltage Variation (%)	-	0.000000	-0.003030

Note: Voltage Variation (%) = (Output High or Low Voltage - Output Normal Voltage) / Output Normal Voltage X 100

During the input supply voltage to the EUT from the external power source is varied by +/- 10%, if output voltage had been confirmed that the fluctuation of power supply to the RF circuit of EUT (excluding power source) is equal to or less than +/- 1%. Exempt extremely high and low supply voltage condition tests, EUT only operated in normal voltage to test all regulations.

Calibration Result

1. Linearity Check

SG Output (dBm)	Spectrum Raw (dBm)	Power Meter Raw (dBm)	Remark
0	-1.3	-0.93	• SG Test Frequency : 2450 MHz • RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz • ATT(30dB) ; Ref : 20 dBm
-5	-6.34	-5.88	
-10	-11.17	-10.84	
0	-1.64	-1.66	• SG Test Frequency : 5250 MHz • RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz • ATT(30dB) ; Ref : 20 dBm
-5	-6.6	-6.62	
-10	-11.48	-11.58	

2. Frequency Accuracy Confirmation

SG Output (dBm)	Spectrum Raw (MHz)	Frequency Error (ppm)	Remark
2450	2450.0002	0.0816	• SG Output : 0dBm • RBW : 30 kHz ; VBW : 30 kHz ; SP : 300kHz • Limit $\leq$ 10% of frequency error limits
5250	5250.0012	0.2286	

3. Cable Loss

SG Output (MHz)	Power Meter Raw Without Cable (dBm)	Power Meter Raw With Cable (dBm)	Cable Loss (dB)	Remark
1000	-0.23	-1.11	0.88	• SG Output : 0dBm
2450	-0.87	-2.36	1.49	
5250	-1.67	-3.43	1.76	
12500	-3.69	-9.37	5.68	
26000	-5.55	-19.13	13.58	

4. Power Measurement System Loss (EUT Output to IF Output of Spectrum)

SG Output (MHz)	Spectrum Raw (dBm)	Power Meter Raw With Cable form IF (dBm)	System Path Loss EUT to IF (dB)	Remark
2450	-1.03	-20.58	19.71	• SG : 0 dBm • RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz • ATT(30dB) ; Ref : 20 dBm
5250	-5.39	-22.01	20.34	

Appendix B. Antenna Information

AT3216 Series

Multilayer Chip Antenna

Features

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

Applications

- ❖ Bluetooth/Wireless LAN/Home RF
- ❖ ISM band 2.4GHz applications



Specifications

Part Number	Frequency Range (MHz)	Peak Gain (XZ-V)	Average Gain (XZ-V)	VSWR	Impedance
AT3216 -B2R7HAA_	2400 ~ 2500	0.5 dBi typ.	-0.5 dBi typ.	2 max.	50 Ω

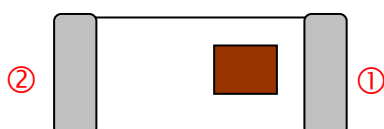
Q'ty/Reel (pcs) : 3,000pcs
 Operating Temperature Range : -40 ~ +85 °C
 Storage Temperature Range : +5 ~ +35 °C, Humidity 45~75%RH
 Storage Period : 12 months max.
 Power Capacity : 2W max.

Part Number

AT 3216 - B 2R7 HAA □ □
 ① ② ③ ④ ⑤ ⑥ ⑦

① Type	AT : Antenna	② Dimensions (L × W)	3.2× 1.6 mm
③ Material Code	B	④ Frequency Range	2R7=2700MHz
⑤ Specification Code	HAA	⑥ Packaging	T: Tape & Reel B: Bulk
⑦ Soldering	=lead-containing /LF=lead-free		

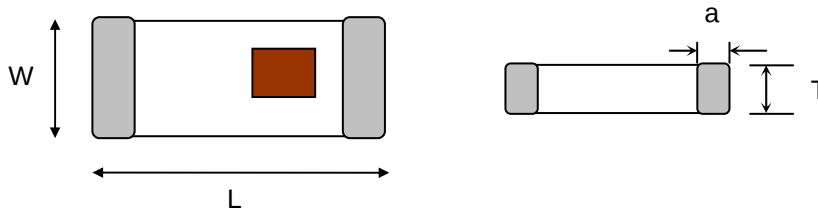
Terminal Configuration



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

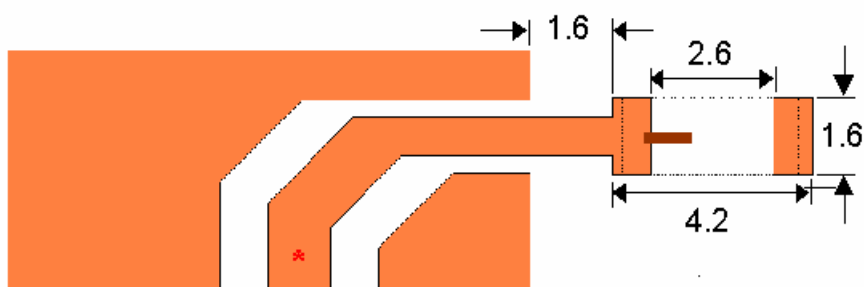
Dimensions and Recommended PC Board Pattern

Unit : mm

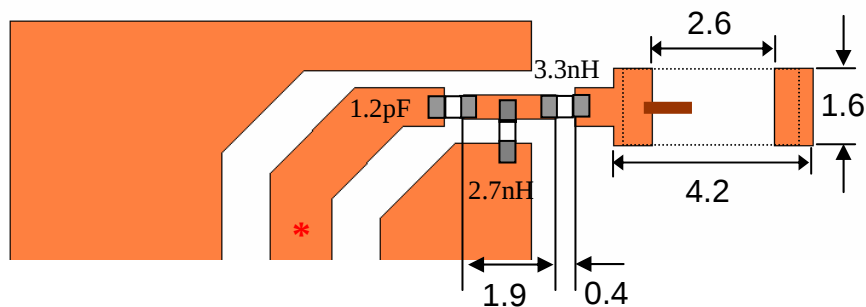


Mark	L	W	T	a
Dimensions	3.2±0.2	1.6±0.2	1.3+ 0.1/-0.2	0.5±0.3

(a) Without Matching Circuits



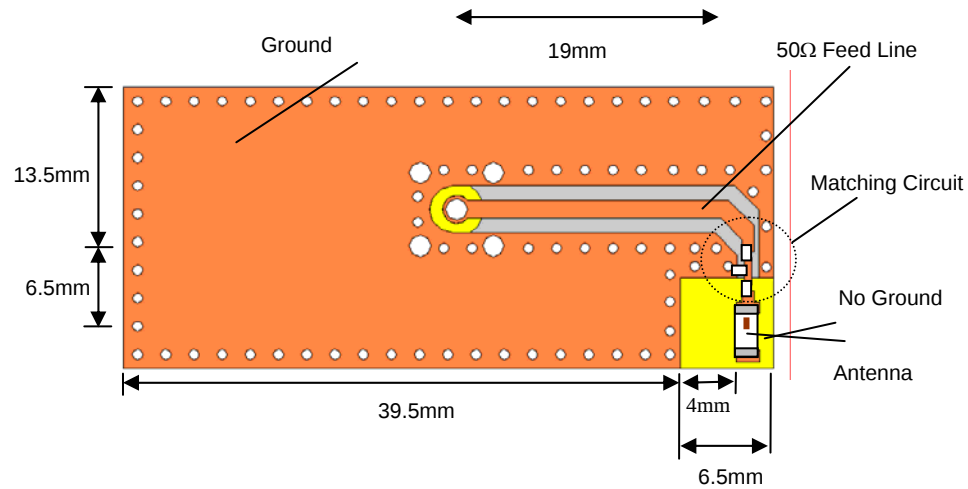
(b) With Matching Circuits



*Line width should be designed to match 50Ω characteristic impedance, depending on PCB material and thickness.

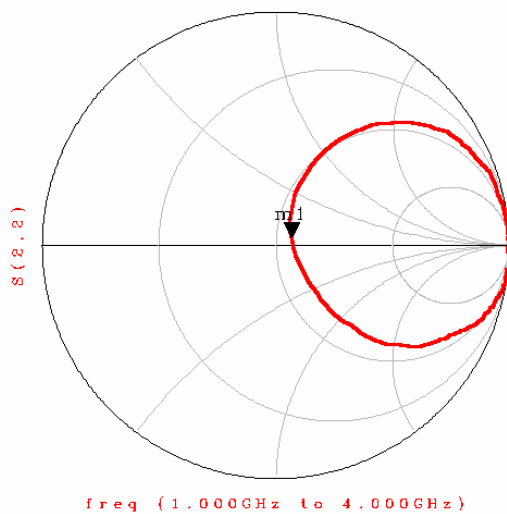
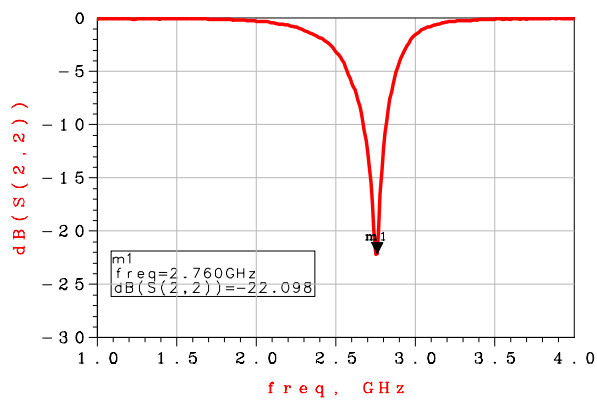
Typical Electrical Characteristics (T=25°C)

❖ Test Board

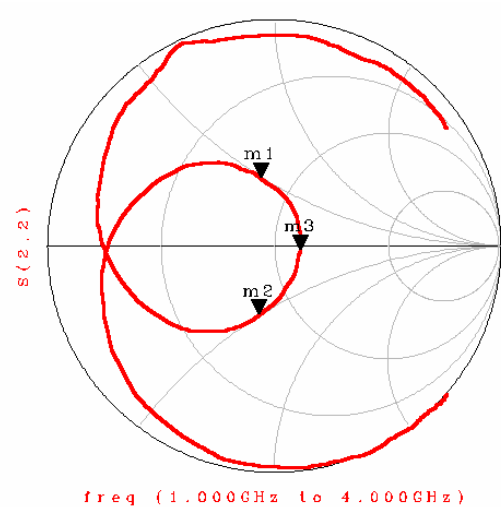
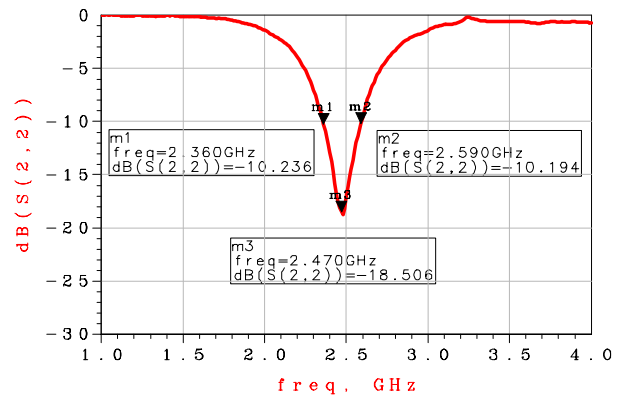


❖ Return Loss

(a) Without Matching Circuits

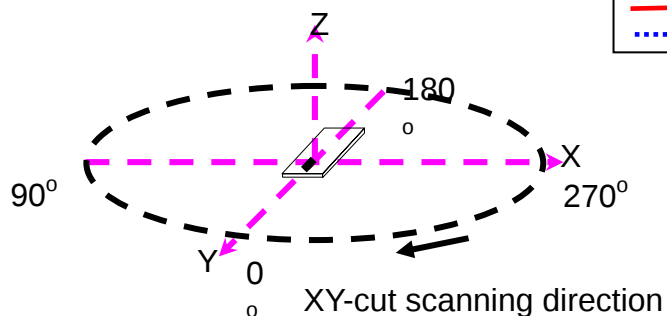


(b) With Matching Circuits

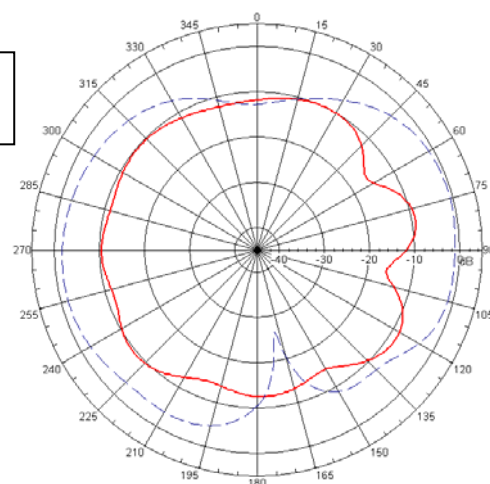


Radiation Patterns

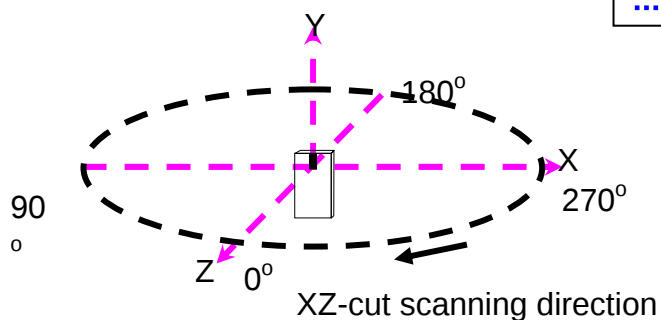
XY-V/XY-H



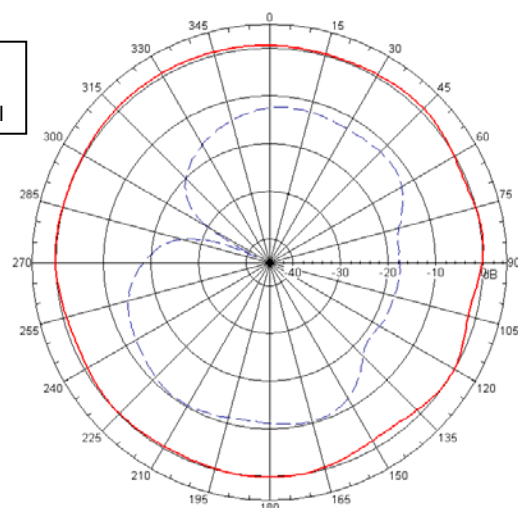
XY cut @2.45GHz
— Vertical
... Horizontal



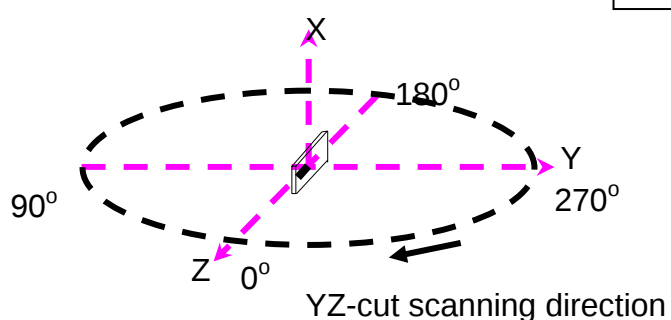
XZ-V/XZ-H



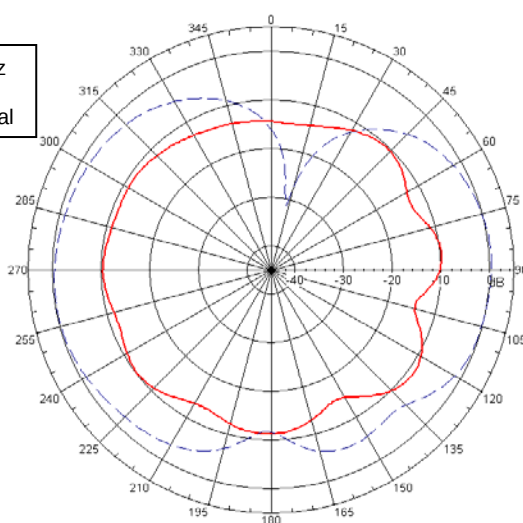
XZ cut @2.45GHz
— Vertical
... Horizontal



YZ-V/YZ-H



YZ cut @2.45GHz
— Vertical
... Horizontal



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