Report No.: GTS201607000066E03

SPECTRUM REPORT (Bluetooth)

Applicant:	Red Bear Company Limited
Address of Applicant:	1711 Block B, Wah Luen Industrial Centre, 15-21 Wong Chuk Yeung Street, Fo Tan, Hong Kong

Equipment Under Test (EUT)

Product Name:	RedBear IoT pHAT
Model No.:	PHAT-IOT
Applicable standards:	ETSI EN 300 328 V1.9.1 (2015-02)
Date of sample receipt:	July 06, 2016
Date of Test:	July 07-12, 2016
Date of report issue:	July 13, 2016
Test Result :	PASS *

* In the configuration tested, the EUT detailed in this report complied with the standards specified above.

The CE mark as shown below can be used, under the responsibility of the manufacturer, after completion of an EC Declaration of Conformity and compliance with all relevant EC Directives. The protection requirements with respect to electromagnetic compatibility contained in Directive 1999/5/EC are considered.

Robinson Lo
Laboratory Manager

2 Version

Version No.	Date	Description
00	*July 13, 2016*	*Original*

Prepared By:	Edward.Pan	***Date:***	*July 13, 2016*
	Project Engineer		
Check By:	Andy.Wu	***Date:***	*July 13, 2016*
	Reviewer		

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4 Test Summary

Radio Spectrum Matter (RSM) Part of Tx					
Test	**Test Requirement**	**Test method**	**Limit/Severity**	**Uncertainty**	**Result**
RF Output Power	Clause 4.3.2.2	Clause 5.3.2.2	20dBm	±1.5dB	PASS
Power Spectral Density	Clause 4.3.2.3	Clause 5.3.3.2	10dBm/MHz	±3dB	PASS
Duty Cycle, Tx-sequence, Tx-gap	Clause 4.3.2.4	Clause 5.3.2.2	Clause 4.3.2.4.3	±5 %	N/A
Medium Utilisation (MU) factor	Clause 4.3.2.5	Clause 5.3.2.2	≤ 10%	±5 %	N/A
Adaptivity	Clause 4.3.2.6	Clause 5.3.7.2	Clause 4.3.2.6.2.2 & Clause 4.3.2.6.3.2 & Clause 4.3.2.6.4.2	--	N/A
Occupied Channel Bandwidth	Clause 4.3.2.7	Clause 5.3.8.2	Clause 4.3.2.7.3	±5 %	PASS
Transmitter unwanted emissions in the OOB domain	Clause 4.3.2.8	Clause 5.3.9.2	Clause 4.3.2.8.3	±3dB	PASS
Transmitter unwanted emissions in the spurious domain	Clause 4.3.2.9	Clause 5.3.10.2	Clause 4.3.2.9.3	±6dB	PASS
Radio Spectrum Matter (RSM) Part of Rx					
Receiver spurious emissions	Clause 4.3.2.10	Clause 5.3.11.2	Clause 4.3.2.10.3	±6dB	PASS
Receiver Blocking	Clause 4.3.2.11	Clause 5.3.7.2	Clause 4.3.2.11.3	--	N/A
Geo-location capability	Clause 4.3.2.12	--	--	--	N/A

Remark:

Tx: In this whole report Tx (or tx) means Transmitter.

Rx: In this whole report Rx (or rx) means Receiver.

Temperature (Uncertainty): ±1°C Humidity(Uncertainty): ±5%

Uncertainty: ± 3%(for DC and low frequency voltages)

5 General Information

5.1 Client Information

Applicant:	Red Bear Company Limited
Address of Applicant:	1711 Block B, Wah Luen Industrial Centre, 15-21 Wong Chuk Yeung Street Fo Tan, Hong Kong
Manufacturer/Factory:	Red Bear Company Limited
Address of Manufacturer/Factory:	1711 Block B, Wah Luen Industrial Centre, 15-21 Wong Chuk Yeung Street Fo Tan, Hong Kong

5.2 General Description of EUT

Product Name:	RedBear IoT pHAT
Model No.:	PHAT-IOT
Operation Frequency:	2402~2480MHz
Channel numbers:	40
Channel separation:	2MHz
Modulation technology:	GFSK
Antenna Type:	PCB Antenna
Antenna gain:	3.3dBi (declare by Applicant)
Power Supply:	DC 5.0V

Operation Frequency each of channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	2402MHz	11	2422MHz	21	2442MHz	31	2462MHz
2	2404MHz	12	2424MHz	22	2444MHz	32	2464MHz
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
9	2418MHz	19	2438MHz	29	2458MHz	39	2478MHz
10	2420MHz	20	2440MHz	30	2460MHz	40	2480MHz

The test frequencies are below:

Channel	**Frequency (MHz)**
Lowest:	2402
Middle:	2440
Highes:	2480

5.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

● **FCC —Registration No.: 600491**

Global United Technology Services Co., Ltd., Shenzhen EMC Laboratory has been registered and fuly described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in files. Registration 600491, June 22, 2016.

● **Industry Canada (IC) —Registration No.: 9079A-2**

The 3m Semi-anechoic chamber of Global United Technology Services Co., Ltd. Has been Registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 9079A-2, June 26, 2013.

5.4 Test Location

All tests were performed at:

Global United Technology Services Co., Ltd.
Address: No. 301-309, 3/F., Jinyuan Business Building, No.2, Laodong Industrrial Zone, Xixiang Road, Baoan District, Shenzhen, Guangdong, China 518102
Tel: 0755-27798480
Fax: 0755-27798960

5.5 Description of Support Units

The EUT has been tested as an independent unit.

5.6 Deviation from Standards

None.

5.7 Abnormalities from Standard Conditions

None.

5.8 Other Information Requested by the Customer

None.

6 Test Instruments List

Radiated Emission:						
Item	**Test Equipment**	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal.Date (mm-dd-yy)**	**Cal.Due date (mm-dd-yy)**
1	3m Semi- Anechoic Chamber	ZhongYu Electron	9.2(L)*6.2(W)* 6.4(H)	GTS250	Mar. 27 2016	Mar. 26 2017
2	Control Room	ZhongYu Electron	6.2(L)*2.5(W)* 2.4(H)	GTS251	N/A	N/A
3	EMI Test Receiver	Rohde & Schwarz	ESU26	GTS203	June 29 2016	June 28 2017
4	BiConiLog Antenna	SCHWARZBECK MESS-ELEKTRONIK	VULB9163	GTS214	Feb. 21 2016	Feb. 20 2017
5	Double -ridged waveguide horn	SCHWARZBECK MESS-ELEKTRONIK	9120D-829	GTS208	June 25 2016	June 24 2017
6	Horn Antenna	ETS-LINDGREN	3160	GTS217	Mar. 26 2016	Mar. 25 2017
7	EMI Test Software	AUDIX	E3	N/A	N/A	N/A
8	Coaxial Cable	GTS	N/A	GTS213	Mar. 26 2016	Mar. 25 2017
9	Coaxial Cable	GTS	N/A	GTS211	Mar. 26 2016	Mar. 25 2017
10	Coaxial cable	GTS	N/A	GTS210	Mar. 26 2016	Mar. 25 2017
11	Coaxial Cable	GTS	N/A	GTS212	Mar. 26 2016	Mar. 25 2017
12	Amplifier(100kHz-3GHz)	HP	8347A	GTS204	June 29 2016	June 28 2017
13	Amplifier(2GHz-20GHz)	HP	8349B	GTS206	June 29 2016	June 28 2017
14	Amplifier (18-26GHz)	Rohde & Schwarz	AFS33-18002 650-30-8P-44	GTS218	June 25 2016	June 24 2017
15	Band filter	Amindeon	82346	GTS219	Mar. 27 2016	Mar. 26 2017
16	Constant temperature and humidity box	Oregon Scientific	BA-888	GTS248	May 08 2016	May 07 2017
17	D.C. Power Supply	Instek	PS-3030	GTS232	May 08 2016	May 07 2017
18	Universal radio communication tester	Rohde & Schwarz	CMU200	GTS235	May 08 2016	May 07 2017
19	Splitter	Agilent	11636B	GTS237	May 08 2016	May 07 2017

7 Radio Technical Specification in ETSI EN 300 328

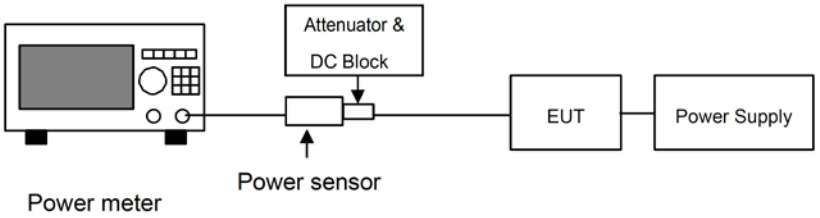
7.1 Test Environment and Mode

Test mode:			
Transmitting mode:	Keep the EUT in transmitting mode with modulation.		
Receiving mode	Keep the EUT in receiving mode.		
Operating Environment:			
Item	**Normal condition**	**Extreme condition**	
		High Temp	**Low Temp**
Temperature	+25ºC	+55ºC	-20ºC
Humidity	20%-95%		
Atmospheric Pressure:	1008 mbar		

Setting	Value
Modulation	Other (GFSK)
Adaptive	Yes
Number of Transmission Chains	1
Antenna Gain 1	3.3dBi
Beamforming Gain	2.14dB
Nominal Channel Bandwidth	1.2MHz
Maximum EIRP	-4.41dBm
DUT Frequency not configurable	No
Frequency Low	2402MHz
Frequency Mid	2440MHz
Frequency High	2480MHz
Attenuation/Pathloss File 1	Attenuator Port1
DUT Port Occupied Channel Bandwidth	1
LBT/DAA Based	Yes
DUT Port Adaptivity	1
Channel Occupation Time	13ms

7.2 Transmitter Requirement

7.2.1 RF Output Power

Test Requirement:	ETSI EN 300 328 clause 4.3.2.2
Test Method:	ETSI EN 300 328 clause 5.3.2.2.1.2
Limit:	20dBm
Test setup:	
Test procedure:	**Step 1:** Use a fast power sensor suitable for 2,4 GHz and capable of 1 MS/s. Use the following settings: - Sample speed 1 MS/s or faster. - The samples must represent the power of the signal. - Measurement duration: For non-adaptive equipment: equal to the observation period defined in clauses 4.3.1.3.2 or clause 4.3.2.4.2. For adaptive equipment, the measurement duration shall be long enough to ensure a minimum number of bursts (at least 10) are captured. NOTE 1: For adaptive equipment, to increase the measurement accuracy, a higher number of bursts may be used. **Step 2:** For conducted measurements on devices with one transmit chain: -Connect the power sensor to the transmit port, sample the transmit signal and store the raw data.Use these stored samples in all following steps. For conducted measurements on devices with multiple transmit chains: -Connect one power sensor to each transmit port for a synchronous measurement on all transmit ports. -Trigger the power sensors so that they start sampling at the same time. Make sure the time difference between the samples of all sensors is less than 500 ns. -For each individual sampling point (time domain), sum the coincident power samples of all ports and store them. Use these summed samples in all following steps. **Step 3:** Find the start and stop times of each burst in the stored measurement samples. The start and stop times are defined as the points where the power is at least 30 dB below the highest value of the stored samples in step 2. NOTE 2: In case of insufficient dynamic range, the value of 30 dB may need to be reduced appropriately.

	Step 4: Between the start and stop times of each individual burst calculate the RMS power over the burst using the formula below. Save these Pburst values, as well as the start and stop times for each burst. $P_{burst} = \frac{1}{k}\sum_{n=1}^{k} P_{sample}(n)$ with 'k' being the total number of samples and 'n' the actual sample number **Step 5:** The highest of all Pburst values (value "A" in dBm) will be used for maximum e.i.r.p. calculations. **Step 6:** Add the (stated) antenna assembly gain "G" in dBi of the individual antenna. If applicable, add the additional beamforming gain "Y" in dB. If more than one antenna assembly is intended for this power setting, the maximum overall antenna gain (G or G + Y) shall be used. The RF Output Power (P) shall be calculated using the formula below: P = A + G + Y This value, which shall comply with the limit given in clause 4.3.1.2.3 or clause 4.3.2.2.3, shall be recorded in the test report.
Measurement Record:	Uncertainty: ± 1.5dB
Test Instruments:	See section 6.0
Test mode:	Transmitting mode

Measurement Data

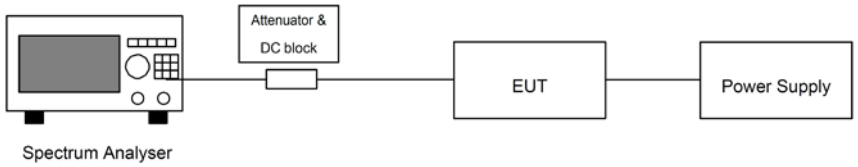
Test conditions	Channel	Burst RMS power (dBm)	Antenna Gain(dBi)	Calculated Power (dBm)	Limit (dBm)	Result
Normal	Lowest	-7.86	3.30	-4.56	20	Pass
	Middle	-7.71	3.30	-4.41		
	Highest	-7.99	3.30	-4.69		
NVHT	Lowest	-7.93	3.30	-4.63		
	Middle	-7.81	3.30	-4.51		
	Highest	-8.09	3.30	-4.79		
NVLT	Lowest	-7.88	3.30	-4.58		
	Middle	-7.73	3.30	-4.43		
	Highest	-8.01	3.30	-4.71		

Remark:

1>. Volt= Voltage, Temp= Temparature

2>. Antenna Gain=3.3dBi

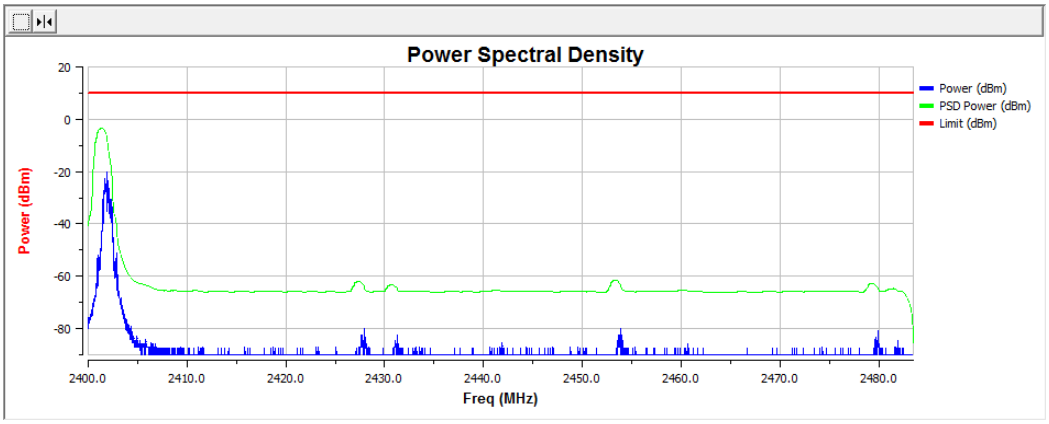
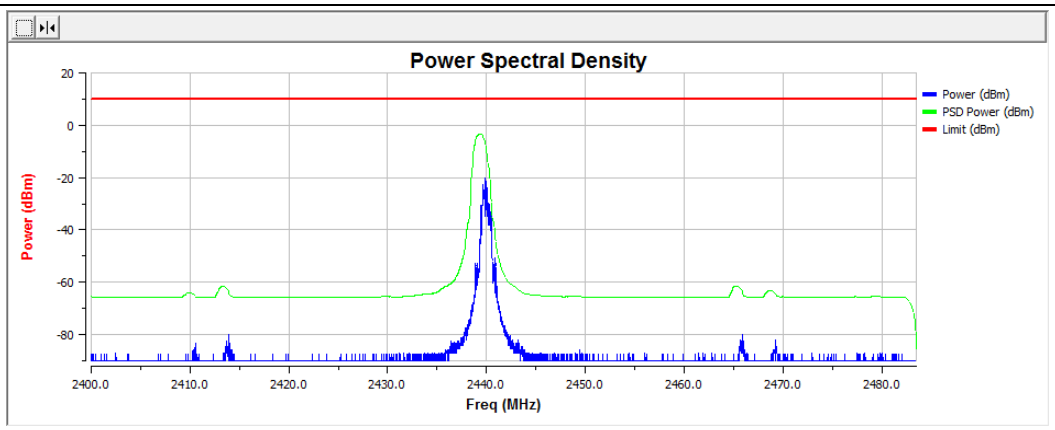
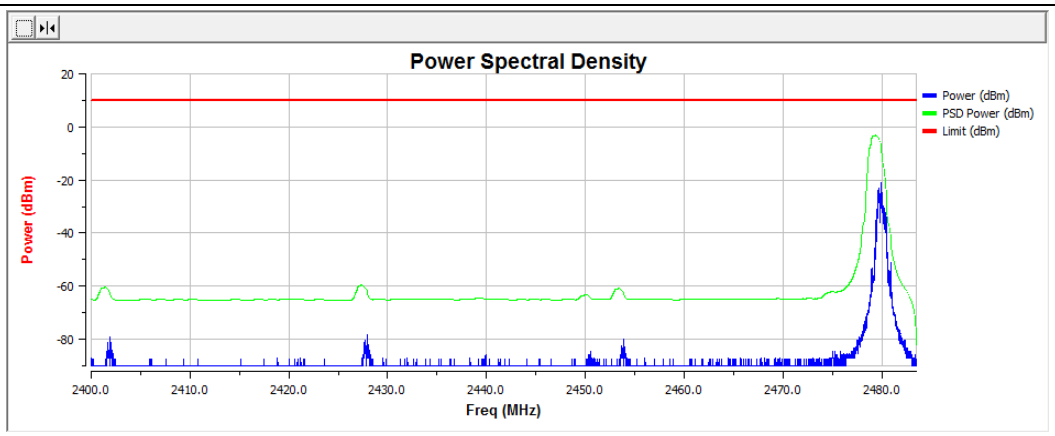
7.2.2 Power Spectral Density

Test Requirement:	ETSI EN 300 328 clause 4.3.2.3
Test Method:	ETSI EN 300 328 clause 5.3.3.2.1
Limit:	10dBm/MHz
Test setup:	
Test procedure:	**Step 1:** Connect the UUT to the spectrum analyser and use the following settings: Start Frequency: 2400 MHz Stop Frequency: 2483.5 MHz Resolution BW: 10 kHz Video BW: 30 kHz Sweep Points: > 8350 NOTE:For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented. Detector: RMS Trace Mode: Max Hold Sweep time: 10 s; the sweep time may be increased further until a value where the sweep time has no impact on the RMS value of the signal. For non-continuous signals, wait for the trace to stabilize. Save the data (trace data) set to a file. **Step 2:** For conducted measurements on smart antenna systems using either operating mode 2 or operating mode 3 (see clause 5.1.3.2), repeat the measurement for each of the transmit ports. For each sampling point (frequency domain), add up the coincident power values (in mW) for the different transmit chains and use this as the new data set. **Step 3:** Add up the values for power for all the samples in the file using the formula below. $P_{Sum} = \sum_{n=1}^{k} P_{sample}(n)$ with 'k' being the total number of samples and 'n' the actual sample number. **Step 4:** Normalize the individual values for power (in dBm) so that the sum is equal to the RF Output Power (e.i.r.p.) measured in clause 5.3.2 and save the corrected data. The following formulas can be used: $C_{Corr} = P_{Sum} - P_{e.i.r.p.}$

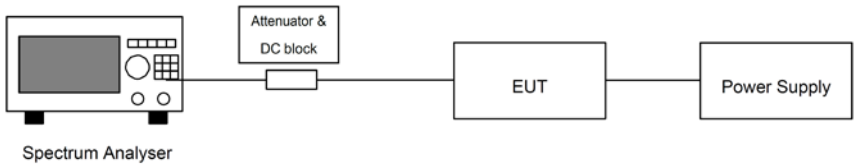
	$P_{Samplecorr}(n) = P_{Sample}(n) - C_{Corr}$ with 'n' being the actual sample number **Step 5:** Starting from the first sample PSamplecorr(n) (lowest frequency), add up the power (in mW) of the following samples representing a 1 MHz segment and record the results for power and position (i.e. sample #1 to sample #100). This is the Power Spectral Density (e.i.r.p.) for the first 1 MHz segment which shall be recorded. **Step 6:** Shift the start point of the samples added up in step 5 by one sample and repeat the procedure in step 5 (i.e. sample #2 to sample #101). **Step 7:** Repeat step 6 until the end of the data set and record the Power Spectral Density values for each of the 1 MHz segments. From all the recorded results, the highest value is the maximum Power Spectral Density for the UUT. This value, which shall comply with the limit given in clause 4.3.2.3.3, shall be recorded in the test report.
Measurement Record:	Uncertainty: ±3dB
Test Instruments:	See section 6.0
Test mode:	Transmitting mode

Measurement Data

Bluetooth mode			
Channel	Power Spectral Density (dBm/MHz)	Limit (dBm/MHz)	Result
Lowest	-3.45	10.00	Pass
Middle	-3.38		
Highest	-3.21		

Lowest Channel

Middle Channel

Highest Channel


7.2.3 Occupied Channel Bandwidth

Test Requirement:	ETSI EN 300 328 clause 4.3.2.7
Limit:	The Occupied Channel Bandwidth shall fall completely within the band given in clause 1.In addition, for non-adaptive equipment using wide band modulations other than FHSS and with e.i.r.p greater than 10 dBm, the occupied channel bandwidth shall be less than 20 MHz.
Test setup:	
Test Precedure:	**Step 1:** Connect the UUT to the spectrum analyser and use the following settings: Centre Frequency: The centre frequency of the channel under test Resolution BW: ~ 1 % of the span without going below 1 % Video BW: 3 × RBW Frequency Span: 2 × Occupied Channel Bandwidth (e.g. 40 MHz for a 20 MHz channel) Detector Mode: RMS Trace mode: Max Hold Sweep time: 1s **Step 2:** Wait for the trace to stabilize.Find the peak value of the trace and place the analyser marker on this peak. **Step 3:** Use the 99 % bandwidth function of the spectrum analyser to measure the Occupied Channel Bandwidth of the UUT.This value shall be recorded. NOTE: Make sure that the power envelope is sufficiently above the noise floor of the analyser to avoid the noise signals left and right from the power envelope being taken into account by this measurement.
Test Instruments:	See section 6.0
Test mode:	Transmitting mode

Measurement Data:

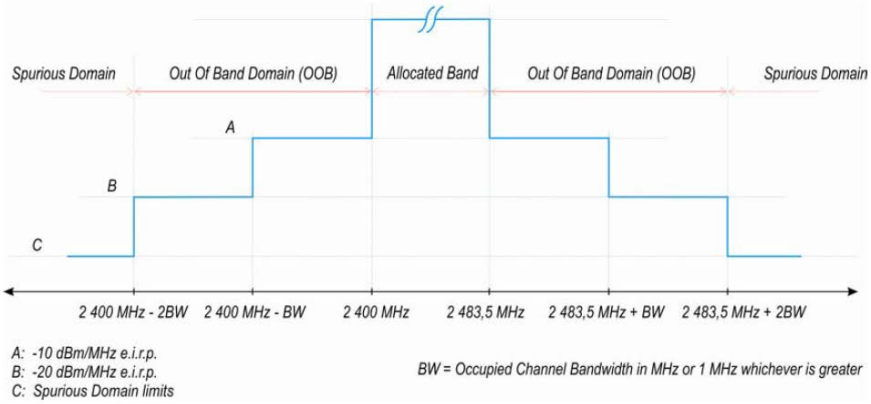
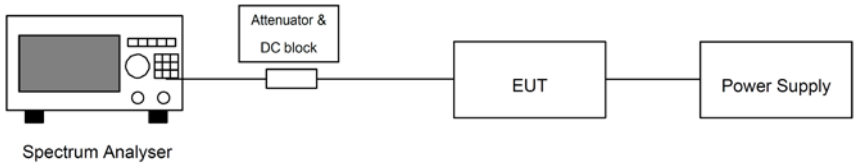
Bluetooth mode					
Test Channel	**99% Bandwidth (MHz)**	**Declared Bandwidth (MHz)**	**F_L/F_H (MHz)**	**Limit**	**Result**
Lowest	1.054	1.0	2401.42	2400MHz ~ 2483.5MHz	Pass
Highest	1.054	1.0	2480.47		Pass

Test plots are below:

Lowest Channel

Highest Channel

7.2.4 Transmitter unwanted emissions in the OOB domain

Test Requirement:	ETSI EN 300 328 clause 4.3.2.8
Test Method:	ETSI EN 300 328 clause 5.3.9.2
Limit:	The transmitter unwanted emissions in the out-of-band domain but outside the allocated band, shall not exceed the values provided by the mask in figure 1.  **Figure 1: Transmit mask**
Test setup:	
Test procedure:	The applicable mask is defined by the measurement results from the tests performed under clause 5.3.8 (Occupied Channel Bandwidth). The Out-of-band emissions within the different horizontal segments of the mask provided in figures 1 and 3 shall be measured using the steps below. This method assumes the spectrum analyser is equipped with the Time Domain Power option. **Step 1:** Connect the UUT to the spectrum analyser and use the following settings: Centre Frequency: 2 484 MHz Span: 0Hz Resolution BW: 1 MHz Filter mode: Channel filter Video BW: 3 MHz Detector Mode: RMS Trace Mode: Max Hold Sweep Mode: Continuous Sweep Points: Sweep Time [s] / (1 µs) or 5 000 whichever is greater Trigger Mode: Video trigger

NOTE 1: In case video triggering is not possible, an external trigger source may be used.

Sweep Time: > 120 % of the duration of the longest burst detected during the measurement of the RF Output Power

Step 2: (segment 2 483,5 MHz to 2 483,5 MHz + BW)

Adjust the trigger level to select the transmissions with the highest power level.

For frequency hopping equipment operating in a normal hopping mode, the different hops will result in signal bursts with different power levels. In this case the burst with the highest power level shall be selected.

Set a window (start and stop lines) to match with the start and end of the burst and in which the RMS power shall be measured using the Time Domain Power function.

Select RMS power to be measured within the selected window and note the result which is the RMS power within this 1 MHz segment (2 483,5 MHz to 2 484,5 MHz). Compare this value with the applicable limit provided by the mask.

Increase the centre frequency in steps of 1 MHz and repeat this measurement for every 1 MHz segment within the range 2 483,5 MHz to 2 483,5 MHz + BW. The centre frequency of the last 1 MHz segment shall be set to 2 483,5 MHz + BW - 0,5 MHz (which means this may partly overlap with the previous 1 MHz segment).

Step 3: (segment 2 483,5 MHz + BW to 2 483,5 MHz + 2BW)

Change the centre frequency of the analyser to 2 484 MHz + BW and perform the measurement for the first 1 MHz segment within range 2 483,5 MHz + BW to 2 483,5 MHz + 2BW. Increase the centre frequency in 1 MHz steps and repeat the measurements to cover this whole range. The centre frequency of the last 1 MHz segment shall be set to 2 483,5 MHz + 2 BW - 0,5 MHz. (which means this may partly overlap with the previous 1 MHz segment).

Step 4: (segment 2 400 MHz - BW to 2 400 MHz)

Change the centre frequency of the analyser to 2 399,5 MHz and perform the measurement for the first 1 MHz segment within range 2 400 MHz - BW to 2 400 MHz Reduce the centre frequency in 1 MHz steps and repeat the measurements to cover this whole range. The centre frequency of the last 1 MHz segment shall be set to 2 400 MHz - 2BW + 0,5 MHz. (which means this may partly overlap with the previous 1 MHz segment).

Step 5: (segment 2 400 MHz - 2BW to 2 400 MHz - BW)

Change the centre frequency of the analyser to 2 399,5 MHz - BW and perform the measurement for the first 1 MHz segment within range 2 400 MHz - 2BW to 2 400 MHz - BW. Reduce the centre frequency in 1 MHz steps and repeat the measurements to cover this whole range. The centre frequency of the last 1 MHz segment shall be set to 2 400 MHz - 2BW + 0,5 MHz. (which means this may partly overlap with the previous 1 MHz segment).

Step 6:

In case of conducted measurements on equipment with a single transmit

	chain, the declared antenna assembly gain "G" in dBi shall be added to the results for each of the 1 MHz segments and compared with the limits provided by the mask given in figures 1 or 3. If more than one antenna assembly is intended for this power setting, the antenna with the highest gain shall be considered. In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the measurements need to be repeated for each of the active transmit chains. The declared antenna assembly gain "G" in dBi for a single antenna shall be added to these results. If more than one antenna assembly is intended for this power setting, the antenna with the highest gain shall be considered. Comparison with the applicable limits shall be done using any of the options given below: Option 1: the results for each of the transmit chains for the corresponding 1 MHz segments shall be added. The additional beamforming gain "Y" in dB shall be added as well and the resulting values compared with the limits provided by the mask given in figures 1 or 3. Option 2: the limits provided by the mask given in figures 1 or 3 shall be reduced by 10 x log10(Ach) and the additional beamforming gain "Y" in dB. The results for each of the transmit chains shall be individually compared with these reduced limits. NOTE 2: Ach refers to the number of active transmit chains. It shall be recorded whether the equipment complies with the mask provided in figures 1 or 3.
Measurement Record:	Uncertainty: ± 1.5dB
Test Instruments:	See section 6.0
Test mode:	Transmitting mode

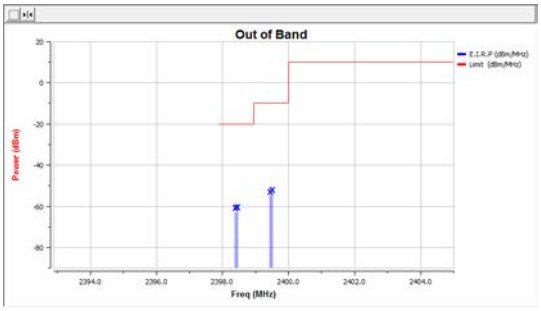
Measurement Data:

Test Condition	Test Channel	Antenna	Frequency (MHz)	Level (dBm)	Limit (dBm)
Normal	Lowest Channel	Antenna 1	2399.50	-54.10	-10
		Antenna 1	2398.50	-62.50	-20
	Highest Channel	Antenna 1	2484.00	-67.45	-10
		Antenna 1	2485.00	-69.25	-20
NVLT	Lowest Channel	Antenna 1	2399.45	-55.00	-10
		Antenna 1	2398.40	-62.75	-20
	Highest Channel	Antenna 1	2484.05	-67.20	-10
		Antenna 1	2485.10	-69.20	-20
NVHT	Lowest Channel	Antenna 1	2399.45	-55.85	-10
		Antenna 1	2398.45	-61.45	-20
	Highest Channel	Antenna 1	2484.05	-59.25	-10
		Antenna 1	2485.05	-58.95	-20

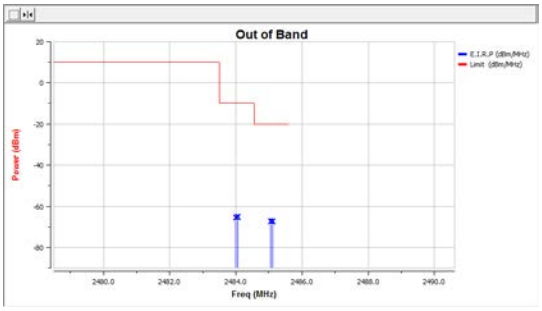
Test plots at normal condition are followed:

Condition:	Normal

CH Low (Normal Temp)



CH High (Normal Temp)

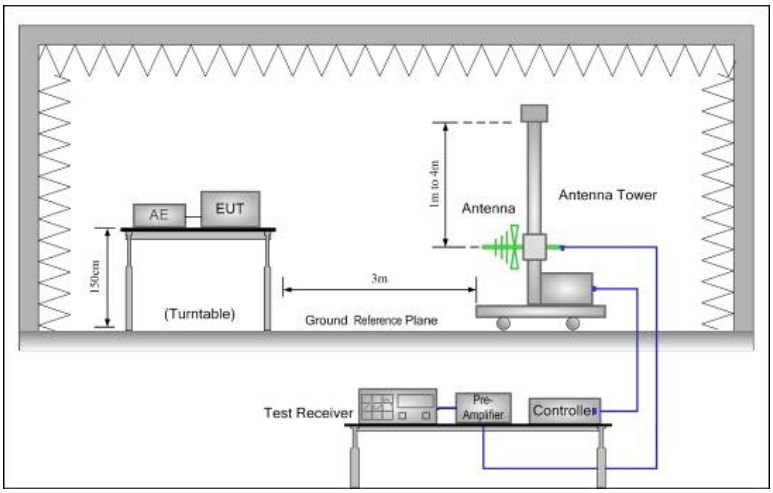


7.2.5 Transmitter unwanted emissions in the spurious domain

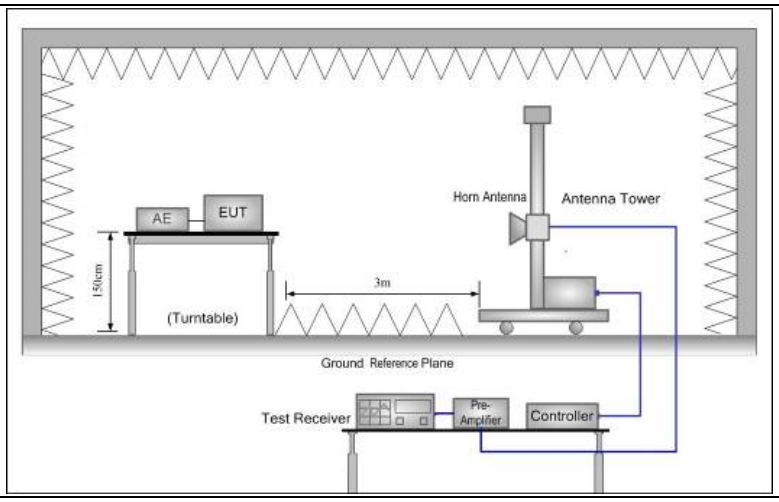
Test Requirement:	ETSI EN 300 328 clause 4.3.2.9
Test Method:	ETSI EN 300 328 clause 5.3.10.2
Limit:	

Frequency Range	Maximum power e.r.p. (≤ 1 GHz) e.i.r.p. (> 1 GHz)	Bandwidth
30 MHz to 47 MHz	-36 dBm	100 kHz
47 MHz to 74 MHz	-54 dBm	100 kHz
74 MHz to 87.5 MHz	-36 dBm	100 kHz
87.5 MHz to 118 MHz	-54 dBm	100 kHz
118 MHz to 174 MHz	-36 dBm	100 kHz
174 MHz to 230 MHz	-54 dBm	100 kHz
230 MHz to 470 MHz	-36 dBm	100 kHz
470 MHz to 862 MHz	-54 dBm	100 kHz
862 MHz to 1 GHz	-36 dBm	100 kHz
1 GHz to 12.75 GHz	-30 dBm	1 MHz

Test Frequency range:	30MHz to 12.75GHz
Test setup:	Below 1GHz



Above 1GHz



Test procedure:

1. Pre-scan

The test procedure below shall be used to identify potential unwanted emissions of the UUT.

Step 1:

The sensitivity of the spectrum analyser should be such that the noise floor is at least 12 dB below the limits given in tables 1 or 4.

Step 2:

The emissions over the range 30 MHz to 1 000 MHz shall be identified. Spectrum analyser settings:

Resolution BW:	100 kHz
Video BW	300 kHz
Detector mode:	Peak
Trace Mode:	Max Hold
Sweep Points:	≥ 19400

NOTE 1: For spectrum analysers not supporting this high number of sweep points, the frequency band may need to be segmented.

Sweep time: For non continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, such that for each 100 kHz frequency step, the measurement time is greater than two transmissions of the UUT. on any channel.

For Frequency Hopping equipment operating in a normal operating (hopping not disabled) mode, the sweep time shall be further increased to capture multiple transmissions on any of the hopping frequencies.

NOTE 2: The above sweep time setting may result in long measuring times in case of frequency hopping quipment. To avoid such long measuring times, an FFT analyser could be used.

Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range below the applicable limit or above, shall be individually measured using the procedure in clause 5.3.10.2.1.3 and compared to the limits given in tables 1 or 4.

Step 3:

The emissions over the range 1 GHz to 12,75 GHz shall be identified.
Spectrum analyser settings:

Resolution BW:	1 MHz
Video BW	3 MHz
Filter type:	3 dB (Gaussian)
Detector mode:	Peak
Trace Mode:	Max Hold
Sweep Points:	≥ 23500

NOTE 2: For spectrum analysers not supporting this high number of sweep points, the frequency band may need to be segmented.

Sweep time:	For non continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, such that for each 1 MHz frequency step, the measurement time is greater than two transmissions of the UUT. on any channel.
	For Frequency Hopping equipment operating in a normal operating (hopping not disabled) mode, the sweep time shall be further increased to capture multiple transmissions on any of the hopping frequencies.

NOTE 2: The above sweep time setting may result in long measuring times in case of frequency hopping equipment. To avoid such long measuring times, an FFT analyser could be used.

Allow the trace to stabilize. Any emissions identified during the sweeps above that fall within the 6 dB range below the applicable limit or above, shall be individually measured using the procedure in clause 5.3.10.2.1.3 and compared to the limits given in tables 1 or 4.

Frequency Hopping equipment may generate a block (or several blocks) of spurious emissions anywhere within the spurious domain. If this is the case, only the highest peak of each block of emissions shall be measured using the procedure in clause 5.3.10.2.1.3.

Step 4:

In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the steps 2 and 3 need to be repeated for each of the active transmit chains (Ach).The limits used to identifyemissions during this pre-scan need to be reduced with 10 × log10 (Ach) (number of active transmit chains).

2. Measurement of the emissions identified during the pre-scan

The steps below shall be used to accurately measure the individual unwanted emissions identified during the pre-scan measurements above.

Step 1:

The level of the emissions shall be measured using the following spectrum analyser settings:

Centre Frequency:	Time Domain Power
Centre Frequency:	Frequency of emission identified during the pre-scan
Resolution BW:	100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)

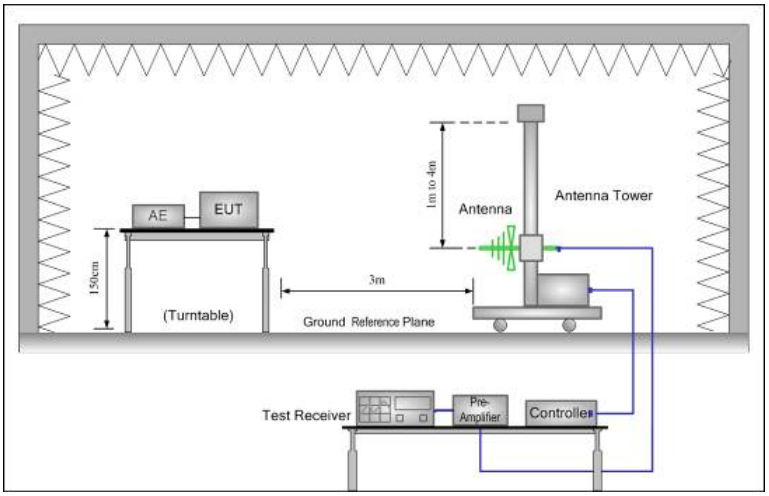
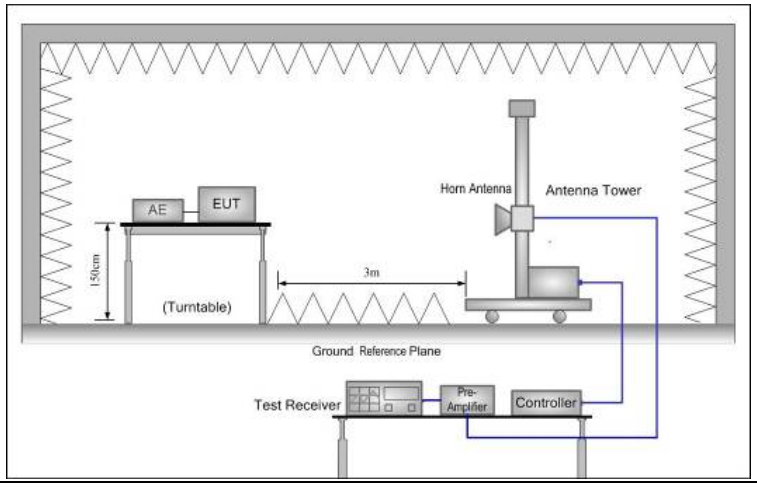
	Video BW: 300 kHz (< 1 GHz) / 3 MHz (> 1 GHz) Frequency Span: Zero Span Sweep mode: Single Sweep Sweep time: > 120 % of the duration of the longest burst detected during the measurement of the RF Output Power Sweep points: Sweep time [µs] / (1 µs) with a maximum of 30 000 Trigger: Video (burst signals) or Manual (continuous signals) Detector: RMS **Step 2:** Set a window where the start and stop indicators match the start and end of the burst with the highest level and record the value of the power measured within this window.If the spurious emission to be measured is a continuous transmission, the measurement window shall be set to match the start and stop times of the sweep. **Step 3:** In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), step 2 needs to be repeated for each of the active transmit chains (Ach). Sum the measured power (within the observed window) for each of the active transmit chains. **Step 4:** The value defined in step 3 shall be compared to the limits defined in tables 1 and 4.
Measurement Record:	Uncertainty: ± 6dB
Test Instruments:	See section 6.0
Test mode:	Transmitting mode

Measurement Data

Bluetooth mode				
The lowest channel				
Frequency (MHz)	Spurious Emission		Limit (dBm)	Test Result
	polarization	Level(dBm)		
117.75	Vertical	-69.82	-54.00	Pass
514.82	V	-65.85	-54.00	
4804.00	V	-50.54	-30.00	
7206.00	V	-45.82	-30.00	
9608.00	V	-42.17	-30.00	
12010.00	V	-41.54	-30.00	
110.42	Horizontal	-67.00	-30.00	
808.44	H	-68.02	-54.00	
4804.00	H	-50.13	-36.00	
7206.00	H	-46.32	-30.00	
9608.00	H	-41.97	-30.00	
12010.00	H	-44.14	-30.00	
The highest channel				
Frequency (MHz)	Spurious Emission		Limit (dBm)	Test Result
	polarization	Level(dBm)		
89.21	Vertical	-66.90	-54.00	Pass
649.80	V	-69.10	-54.00	
4960.00	V	-51.52	-30.00	
7440.00	V	-46.12	-30.00	
9920.00	V	-42.34	-30.00	
12400.00	V	-41.57	-30.00	
96.41	Horizontal	-68.42	-30.00	
824.77	H	-69.59	-54.00	
4960.00	H	-51.33	-36.00	
7440.00	H	-46.79	-30.00	
9920.00	H	-42.54	-30.00	
12400.00	H	-44.64	-30.00	

7.3 Receiver Requirement

7.3.1 Spurious Emissions

Test Requirement:	ETSI EN 300 328 clause 4.3.2.10
Test Method:	ETSI EN 300 328 clause 5.3.11.2
Limit:	Frequency / Maximum power e.r.p. (≤ 1 GHz) e.i.r.p. (> 1 GHz) / Measurement bandwidth 30MHz to 1000 MHz / -57 dBm / 100 kHz 1GHz to 12.75GHz / -47 dBm / 1 MHz
Test Frequency range:	30MHz to 12.75GHz
Test setup:	Below 1GHz  Above 1GHz 

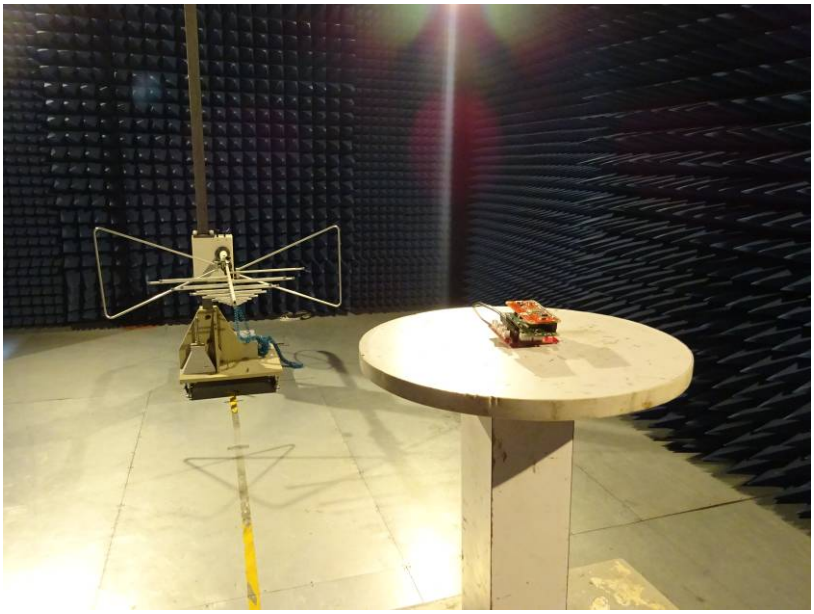
Test procedure:	**1. Pre-scan** The test procedure below shall be used to identify potential unwanted emissions of the UUT. **Step 1:** The sensitivity of the spectrum analyser should be such that the noise floor is at least 12 dB below the limits given in tables 2 or 5. **Step 2:** The emissions over the range 30 MHz to 1 000 MHz shall be identified. Spectrum analyser settings: Resolution BW: 100 kHz Video BW 300 kHz Detector mode: Peak Trace Mode: Max Hold Sweep Points: ≥ 9970 Sweep time: Auto Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range below the applicable limit or above, shall be individually measured using the procedure in clause 5.3.11.2.1.2 and compared to the limits given in tables 2 or 5. **Step 3:** The emissions over the range 1 GHz to 12,75 GHz shall be identified. Spectrum analyser settings: Resolution BW: 1 MHz Video BW 3 MHz Detector mode: Peak Trace Mode: Max Hold Sweep Points: ≥ 11750 Sweep time: Auto Allow the trace to stabilize. Any emissions identified during the sweeps above that fall within the 6 dB range below the applicable limit or above, shall be individually measured using the procedure in clause 5.3.11.2.1.2 and compared to the limits given in tables 2 or 5. Frequency Hopping equipment may generate a block (or several blocks) of spurious emissions anywhere within the spurious domain. If this is the case, only the highest peak of each block of emissions shall be measured using the procedure in clause 5.3.11.2.1.2. **Step 4:** In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the steps 2 and 3 need to be repeated for each of the active transmit chains (Ach).The limits used to identifyemissions during this pre-scan need to be reduced with 10 × log10 (Ach) (number of active transmit chains). **2. Measurement of the emissions identified during the pre-scan**

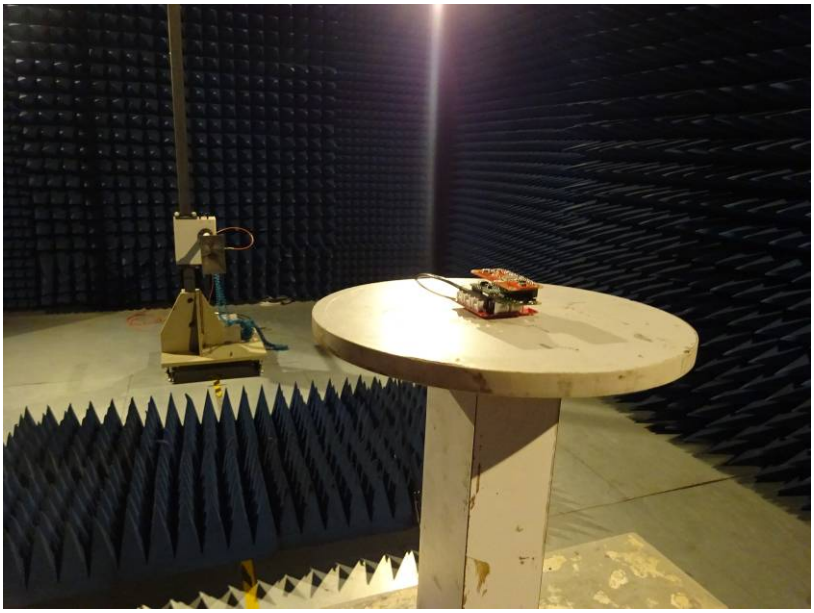
	The steps below shall be used to accurately measure the individual unwanted emissions identified during the pre-scan measurements above. **Step 1:** The level of the emissions shall be measured using the following spectrum analyser settings: Centre Frequency: Frequency of emission identified during the pre-scan Resolution BW: 100 kHz (< 1 GHz) / 1 MHz (> 1 GHz) Video BW 300 kHz (< 1 GHz) / 3 MHz (> 1 GHz) Frequency Span: Wide enough to capture each individual emission indentified during the pre-scan Sweep mode: Continuous Sweep time: Auto Trigger: Free run Detector: RMS Trace Mode: Max Hold **Step 2:** In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the step 1 needs to be repeated for each of the active transmit chains (Ach). The trace data for each transmit chain has to be recorded. Sum the power in each of the traces for each individual frequency bin. **Step 3:** Use the marker function to find the highest peak within the measurement trace and record its value and its frequency. **Step 4:** The measured values shall be compared to the limits defined in tables 2 and 5.
Measurement Record:	Uncertainty: ± 6dB
Test mode:	Kept Rx in receiving mode
Test Instruments:	See section 6.0

Measurement Data:

Bluetooth mode				
The lowest channel				
Frequency (MHz)	Spurious Emission		Limit (dBm)	Test Result
	polarization	Level(dBm)		
85.81	Vertical	-69.56	2nW/ -57dBm below 1GHz, 20nW/ -47dBm above 1GHz.	Pass
473.36	V	-68.87		
4804.00	V	-60.94		
7206.00	V	-57.00		
9608.00	V	-52.02		
12400.00	V	-50.94		
77.16	Horizontal	-69.76		
782.71	H	-68.82		
4804.00	H	-63.70		
7206.00	H	-57.97		
9608.00	H	-53.50		
12010.00	H	-55.08		
The highest channel				
Frequency (MHz)	Spurious Emission		Limit (dBm)	Test Result
	polarization	Level(dBm)		
68.87	Vertical	-69.08	2nW/ -57dBm below 1GHz, 20nW/ -47dBm above 1GHz.	Pass
743.95	V	-67.17		
4960.00	V	-62.12		
7440.00	V	-56.85		
9920.00	V	-51.97		
12400.00	V	-51.40		
77.65	Horizontal	-71.95		
544.80	H	-69.50		
4960.00	H	-63.17		
7440.00	H	-56.37		
9920.00	H	-52.41		
12400.00	H	-54.12		

8 Test setup photo





9 EUT Constructional Details

Reference to the test report No. : GTS201607000066E01

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