

## RADIO TEST REPORT

For

Shenzhen Wesion Technology Co., Ltd.

Single Board Computer

Test Model: VIM2 Max

Additional Model: VIM2 Pro, VIM2 Basic

Prepared for : Shenzhen Wesion Technology Co., Ltd.  
Address : Room 511, A Building, Mingyou Purchasing Center, Baoyuan Road, Xixiang Street, Bao'an District, Shenzhen, China. 518102

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Date of receipt of test sample : September 22, 2017  
Number of tested samples : 1  
Date of Test : September 22, 2017~December 05, 2017  
Date of Report : December 05, 2017



**RADIO TEST REPORT****ETSI EN 300 328 V2.1.1 (2016-11)**

Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

**Report Reference No.** ..... : **LCS170922077AE3**

**Date of Issue** ..... : **December 05, 2017**

**Testing Laboratory Name** ..... : **Shenzhen LCS Compliance Testing Laboratory Ltd.**

**Address** ..... : **1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China**

**Testing Location/ Procedure** ..... : **Full application of Harmonised standards ☒**  
**Partial application of Harmonised standards ☐**  
**Other standard testing method ☐**

**Applicant's Name** ..... : **Shenzhen Wesion Technology Co., Ltd.**

**Address** ..... : **Room 511, A Building, Mingyou Purchasing Center, Baoyuan Road, Xixiang Street, Bao'an District, Shenzhen, China. 518102**

**Test Specification**

**Standard** ..... : **ETSI EN 300 328 V2.1.1 (2016-11)**

**Test Report Form No.** ..... : **LCSEMC-1.0**

**TRF Originator** ..... : **Shenzhen LCS Compliance Testing Laboratory Ltd.**

**Master TRF** ..... : **Dated 2017-06**

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**Test Item Description** ..... : **Single Board Computer**

**Trade Mark** ..... : **Khadas**

**Test Model** ..... : **VIM2 Max**

**Ratings** ..... : **Input: 5V $\equiv$  2000mA**  
**Output: USB1: 5V $\equiv$  900mA**  
**USB2: 5V $\equiv$  500mA**

**Result** ..... : **Positive**

**Compiled by:**

*Raig Ye*

Raig Ye/ Administrators

**Supervised by:**

*Dick Su*

Dick Su/ Technique principal

**Approved by:**

*Gavin Liang*

Gavin Liang/ Manager

**RADIO -- TEST REPORT****Test Report No. : LCS170922077AE3**December 05, 2017  
Date of issue

Test Model..... : VIM2 Max

EUT..... : Single Board Computer

**Applicant..... : Shenzhen Wesion Technology Co., Ltd.**Address..... : Room 511, A Building, Mingyou Purchasing Center, Baoyuan  
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**Factory..... : Shenzhen Wesion Technology Co., Ltd.**Address..... : Room 511, A Building, Mingyou Purchasing Center, Baoyuan  
Road, Xixiang Street, Bao'an District, Shenzhen, China. 518102

Telephone..... : /

Fax..... : /

**Test Result:****Positive**

The test report merely corresponds to the test sample.  
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

**Revision History**

Revision	Issue Date	Revisions	Revised By
000	December 05, 2017	Initial Issue	Gavin Liang

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## 1. GENERAL INFORMATION

### 1.1. Product Description for Equipment Under Test (EUT)

EUT	: Single Board Computer
Test Model	: VIM2 Max
Additional Model No.	: VIM2 Pro, VIM2 Basic
Model Declaration	: PCB board, structure and internal of these model(s) are the same, So no additional models were tested.
	Input: 5V $\overline{=}$ 2000mA
Power Supply	: Output: USB1: 5V $\overline{=}$ 900mA USB2: 5V $\overline{=}$ 500mA
Hardware Version	: V12
Software Version	: Android 7.1
<b>Bluetooth</b>	
Frequency Range	: 2.402-2.480GHz
Channel Number	: 79 channels for Bluetooth V4.2 (DSS) 40 channels for Bluetooth V4.2 (DTS)
Channel Spacing	: 1MHz for Bluetooth V4.2 (DSS) 2MHz for Bluetooth V4.2 (DTS)
Modulation Type	: GFSK, $\pi$ /4-DQPSK, 8-DPSK for Bluetooth V4.2 (DSS) GFSK for Bluetooth V4.2 (DTS)
Bluetooth Version	: V4.2
Antenna Description	: PCB Antenna, 2.5dBi (Max.)
<b>2.4G WLAN</b>	
Frequency Range	: 2.412-2.472GHz
Channel Number	: 13 Channels for WIFI 20MHz Bandwidth(802.11b/g/n-HT20) 11 Channels for WIFI 40MHz Bandwidth(802.11n-HT40)
Channel Spacing	: 5MHz
Modulation Type	: IEEE 802.11b: DSSS(CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n: OFDM (64QAM, 16QAM, QPSK, BPSK)
Antenna Description	: PCB Antenna, 2.5dBi (Max.)
<b>WIFI(5.2G Band)</b>	
Frequency Range	: 5180-5240MHz / 5260-5320MHz / 5500-5720MHz 4 Channels for 20MHz bandwidth(5180-5240MHz) 4 Channels for 20MHz bandwidth(5260-5320MHz) 12 Channels for 20MHz bandwidth(5500-5720MHz) 2 channels for 40MHz bandwidth(5190~5230MHz)
Channel Number	: 2 channels for 40MHz bandwidth(5270~5310MHz) 6 Channels for 40MHz bandwidth(5510-5710MHz) 1 channels for 80MHz bandwidth(5210MHz) 1 channels for 80MHz bandwidth(5290MHz) 3 Channels for 80MHz bandwidth(5530-5690MHz)
Modulation Type	: 802.11a/n/ac: OFDM
Antenna Description	: PCB Antenna, 2.5dBi (Max.)
<b>SRD(5.8G Band)</b>	
Frequency Range	: 5745-5825MHz 5 Channels for 20MHz bandwidth(5725-5825MHz)
Channel Number	: 2 channels for 40MHz bandwidth(5755~5795MHz) 1 channels for 80MHz bandwidth(5775MHz)
Modulation Type	: 802.11a/n/ac: OFDM
Antenna Description	: PCB Antenna, 2.5dBi (Max.)

## 1.2. Objective

This Type approval report is prepared on behalf of **Shenzhen Wesion Technology Co., Ltd.** in accordance with ETSI EN 300 328 V2.1.1 (2016-11), Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

The objective is to determine compliance with ETSI EN 300 328 V2.1.1 (2016-11).

## 1.3. Related Submittal(s)/Grant(s)

No Related Submittals.

## 1.4. Test Methodology

All measurements contained in this report were conducted with ETSI EN 300 328 V2.1.1 (2016-11).

## 1.5. Description of Test Facility

FCC Registration Number. is 254912.

Industry Canada Registration Number. is 9642A-1.

ESMD Registration Number. is ARCB0108.

UL Registration Number. is 100571-492.

TUV SUD Registration Number. is SCN1081.

TUV RH Registration Number. is UA 50296516-001.

NVLAP Registration Code is 600167-0.

## 1.6. Support equipment List

Manufacturer	Description	Model	Serial Number	Certificate
--	--	--	--	--

## 1.7. External I/O

I/O Port Description	Quantity	Cable
LAN Port	1	N/A
USB Port	2	N/A
Type-C Sort	1	0.8m, shielded
HDMI Slot	1	1.0m, shielded
Audio Output Port	1	1.0m, shielded
TF Card Slot	1	N/A





### 1.9. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty
Occupied Channel Bandwidth	5 %
RF output power, conducted	1,5 dB
Power Spectral Density, conducted	3 dB
Unwanted Emissions, conducted	3 dB
All emissions, radiated	6 dB
Temperature	1 °C
Humidity	5 %
DC and low frequency voltages	3 %
Time	5 %
Duty Cycle	5 %

### 1.9. Test Environment

Items	Required (IEC 68-1)	Actual
Temperature (°C)	15-35	21
Humidity (%RH)	25-75	50
Barometric pressure (mbar)	860-1060	950-1000

### 1.10. Description Of Test Modes

LCS has verified the construction and function in typical operation. All the test modes were carried out with the EUT in normal operation, which was shown in this test report and defined as:

Test Mode
Mode1: Transmit by BLE
Mode2: Receive by BLE

Note:

- (1) For portable device, radiated spurious emission was verified over X, Y, Z Axis, and shown the worst case on this report.
- (2) Regard to the frequency band operation for systems using Wide Band modulation: the lowest, middle, highest frequency channel for conducted test, and the lowest, highest frequency channel for radiation spurious test.
- (3) The extreme test condition for voltage and temperature were declared by the manufacturer.

## **2. SYSTEM TEST CONFIGURATION**

### **2.1. Justification**

The system was configured for testing in engineering mode.

### **2.2. EUT Exercise Software**

N/A.

### **2.3. Special Accessories**

N/A.

### **2.4. Block Diagram/Schematics**

Please refer to the related document.

### **2.5. Equipment Modifications**

Shenzhen LCS Compliance Testing Laboratory Ltd. has not done any modification on the EUT.

### **2.6. Configuration of Test Setup**

Please refer to the test setup photo.

### 3. SUMMARY OF TEST RESULT

- ☒ No deviations from the test standards  
☐ Deviations from the test standards as below description:

Technical requirements for the equipment using wide band modulations other than FHSS:

Performed Test Item	Normative References	Test Performed	Deviation
RF Output Power & Receiver Category	ETSI EN 300 328 V2.1.1 (2016-11)	Yes	No
Power Spectral Density	ETSI EN 300 328 V2.1.1 (2016-11)	Yes	No
Duty cycle, Tx-Sequence, Tx-gap	ETSI EN 300 328 V2.1.1 (2016-11)	N/A	N/A
Medium Utilisation (MU) factor	ETSI EN 300 328 V2.1.1 (2016-11)	N/A	N/A
Adaptivity	ETSI EN 300 328 V2.1.1 (2016-11)	N/A	N/A
Occupied Channel Bandwidth	ETSI EN 300 328 V2.1.1 (2016-11)	Yes	No
Transmitter unwanted emissions in the out-of-band domain	ETSI EN 300 328 V2.1.1 (2016-11)	Yes	No
Transmitter unwanted emissions in the spurious domain	ETSI EN 300 328 V2.1.1 (2016-11)	Yes	No
Receiver Spurious Emissions	ETSI EN 300 328 V2.1.1 (2016-11)	Yes	No
Receiver Blocking	ETSI EN 300 328 V2.1.1 (2016-11)	Yes	No

Note: The EUT can operate in an adaptive mode, and can't operate in a non-adaptive mode which is stated by the supplier.

## 4. RF OUTPUT POWER

### 4.1. Limit

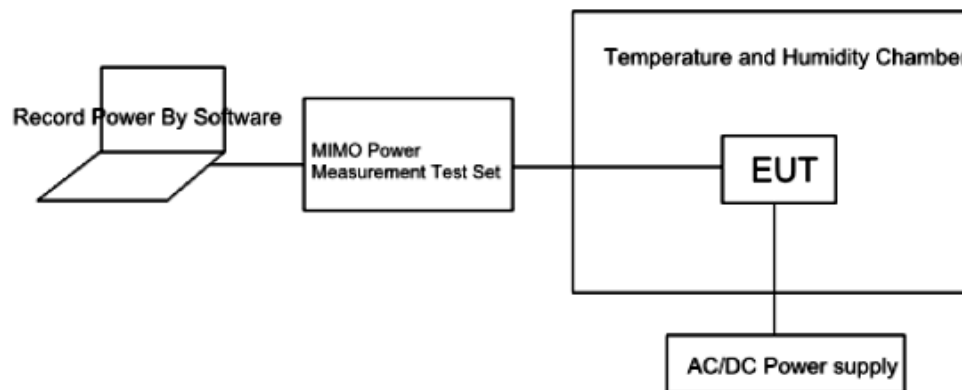
For adaptive equipment using wide band modulations other than FHSS, the maximum RF output power shall be 20 dBm.

The maximum RF output power for non-adaptive equipment shall be declared by the supplier and shall not exceed 20 dBm. For non-adaptive equipment using wide band modulations other than FHSS, the maximum RF output power shall be equal to or less than the value declared by the supplier.

This limit shall apply for any combination of power level and intended antenna assembly.

### 4.2. Test Setup

For Conducted Measurement



### 4.3. Test Procedure

Refer to ETSI EN 300 328 V2.1.1 (2016-11) Clause 5.4.2

**Step 1:**

- The fast power sensor use the following setting: Sample speed 1 MS/s.

**Step 2:**

- 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.

**Step 3:**

- Find the start and stop times of each burst in the stored measurement samples.

**Step 4:**

- Between the start and stop times of each individual burst calculate the RMS power over the burst. Save these Pburst values, as well as the start and stop times for each burst.

**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.

The RF Output Power (P) shall be calculated using the formula below:

$$P = A + G + Y$$



#### 4.4. Test Result

Pass

\*\*\*Note: 20 bursts had been captured for power measurement.

Product	:	Single Board Computer
Test Item	:	RF Output Power
Test Mode	:	Mode 1: Transmit by BLE

Test Conditions		Frequency (MHz)	RF Output Power EIRP (dBm)	Limit (dBm)
Tnom (25°C)	Vnom (DC 5.0V)	2402	3.89	20
		2440	3.74	
		2480	3.59	
Tmax (65°C)	Vnom (DC 5.0V)	2402	3.60	20
		2440	<b>4.16</b>	
		2480	3.55	
Tmin (-10°C)	Vnom (DC 5.0V)	2402	3.46	20
		2440	4.15	
		2480	3.39	

#### 4.5. Receiver Category

**Receiver Category 1:** Adaptive equipment with a maximum RF output power greater than 10 dBm e.i.r.p. shall be considered as receiver category 1 equipment.

**Receiver Category 2:** Non-adaptive equipment with a Medium Utilization (MU) factor greater than 1 % and less than or equal to 10 % or adaptive equipment with a maximum RF output power of 10 dBm e.i.r.p. shall be considered as receiver category 2 equipment.

**Receiver Category 3:** Non-adaptive equipment with a maximum Medium Utilization (MU) factor of 1 % or adaptive equipment with a maximum RF output power of 0 dBm e.i.r.p. shall be considered as receiver category 3 equipment.

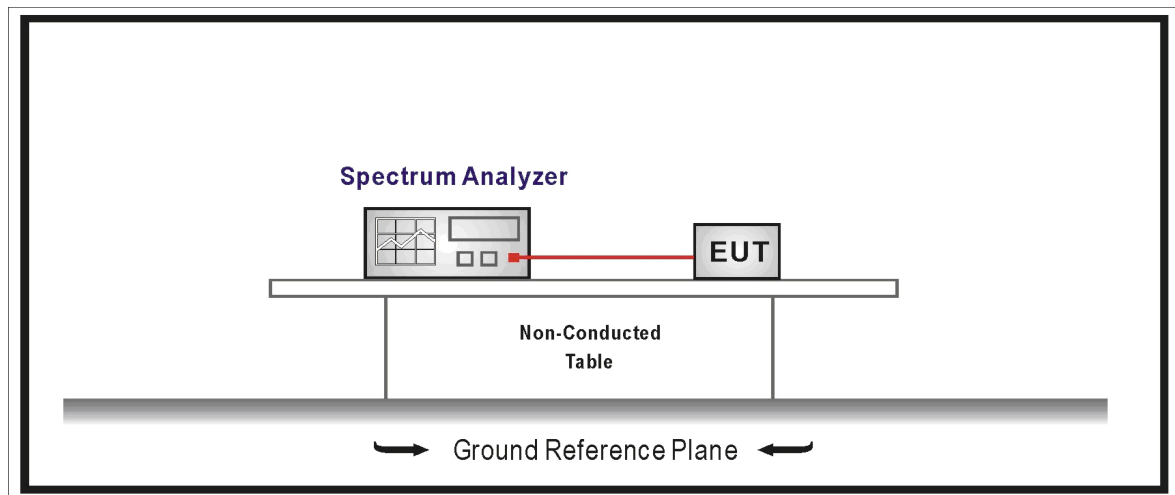
As this is an adaptivity device with a maximum power of 4.16dBm, **it belongs to receiver category 2.**

## 5. POWER SPECTRAL DENSITY

### 5.1. Limit

For equipment using wide band modulations other than FHSS, the maximum Power Spectral Density is limited to 10dBm per MHz.

### 5.2. Test Setup



### 5.3. Test Procedure

Refer to ETSI EN 300 328 V2.1.1 (2016-11) Clause 5.4.3

#### Step 1:

Connect the UUT to the spectrum analyser and use the following settings:

- Start Frequency: 2 400 MHz
- Stop Frequency: 2 483,5 MHz
- Resolution BW: 10 kHz
- Video BW: 30 kHz
- Sweep Points: > 8 350
- Detector: RMS
- Trace Mode: Max Hold
- Sweep time: Auto

For non-continuous signals, wait for the trace to be completed. Save the (trace) data set to a file.

#### Step 2:

For each frequency point, add up the amplitude (power) values for the different transmit chains and use this as the new data set.

#### Step 3:

Add up the values for amplitude (power) for all the samples in the file.

**Step 4:**

Normalize the individual values for amplitude so that the sum is equal to the RF Output Power (e.i.r.p.).

**Step 5:**

Starting from the first sample in the file (lowest frequency), add up the power of the following samples representing a 1 MHz segment and record the results for power and position (i.e. sample #1 to #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 1 sample and repeat the procedure in step 5 (i.e. sample #2 to #101).

**Step 7:**

Repeat step 6 until the end of the data set and record the radiated 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.

**5.5. Test Result**

Product	:	Single Board Computer
Test Item	:	Maximum Spectral Power Density
Test Mode	:	Mode 1: Transmit by BLE

Frequency (MHz)	Total Power Density (dBm/MHz)	Limit (dBm/MHz)
2402	-3.61	10.00
2440	-3.45	10.00
2480	-3.79	10.00

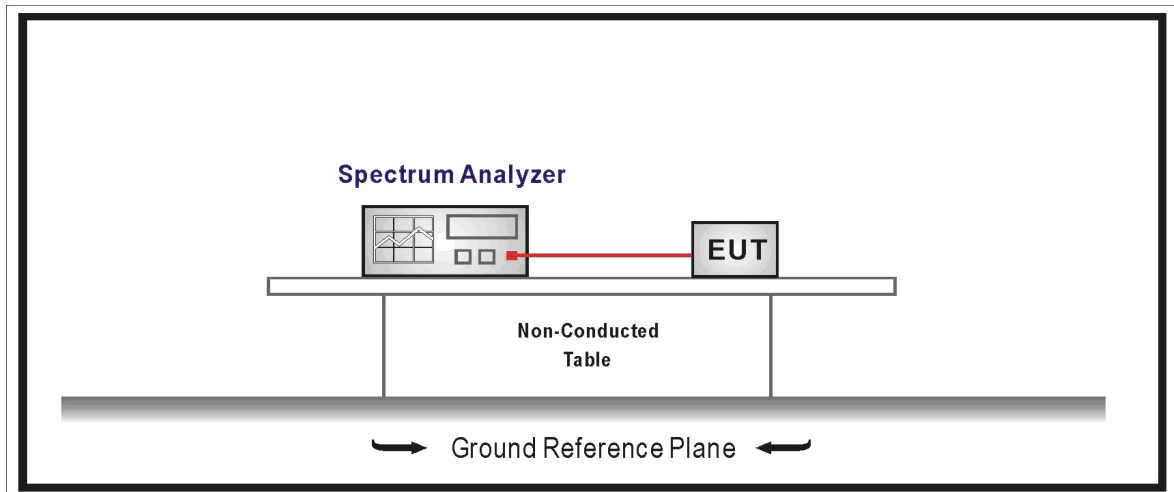
## 6. DUTY CYCLE, TX-SEQUENCE, TX-GAP

### 6.1. Limit

The Duty Cycle shall be equal to or less than the maximum value declared by the supplier.

The maximum Tx-sequence Time and the minimum Tx-gap Time shall be according to the formula below: Maximum Tx-Sequence Time = Minimum Tx-gap Time = M  
where M is in the range of 3,5 ms to 10 ms.

### 6.2. Test Setup



### 6.3. Test Procedure

Refer to ETSI EN 300 328 V2.1.1 (2016-11) Clause 5.3.2

### 6.4. Test Result

These requirements apply to non-adaptive frequency hopping equipment or to adaptive frequency hopping equipment operating in a non-adaptive mode.

These requirements do not apply for equipment with a maximum declared RF Output power of less than 10dBm E.I.R.P. or for equipment when operating in a mode where the RF Output power is less than 10dBm E.I.R.P.

No applicable.

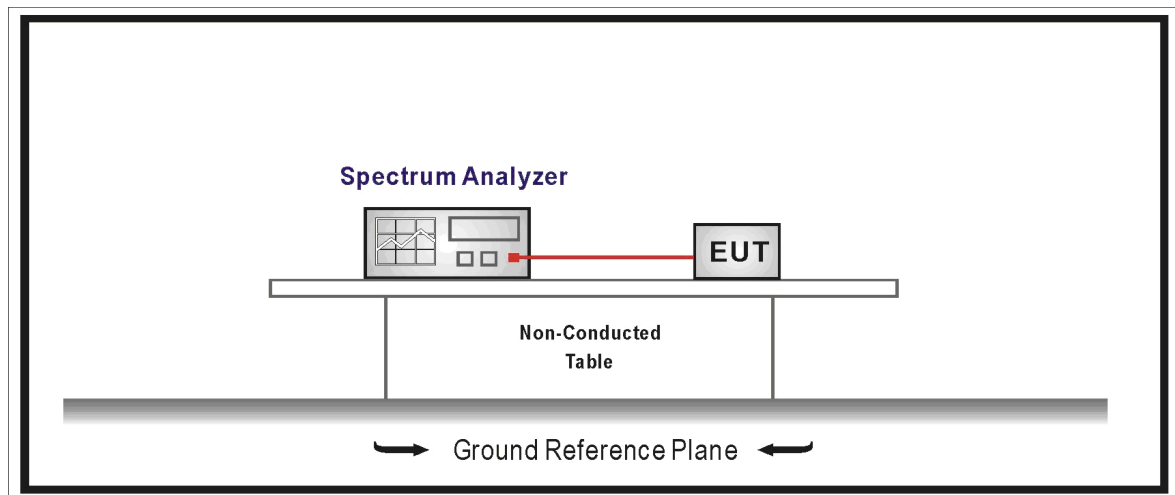
## 7. MEDIUM UTILISATION (MU) FACTOR

### 7.1. Limit

#### For non-adaptive equipment

The maximum Medium Utilisation factor for non-adaptive Frequency Hopping equipment shall be 10 %.

### 7.2. Test Setup



### 7.3. Test Procedure

Refer to ETSI EN 300 328 V2.1.1 (2016-11) Clause 5.4.2

### 7.4. Test Result

This requirement does not apply to adaptive equipment unless operating in a non-adaptive mode.

In addition, this requirement does not apply for equipment with a maximum declared RF Output power level of less than 10dBm E.I.R.P. or for equipment when operating in a mode where the RF Output power is less than 10dBm E.I.R.P.

No applicable.

## 8. ADAPTIVITY (ADAPTIVE EQUIPMENT USING MODULATIONS OTHER THAN FHSS)

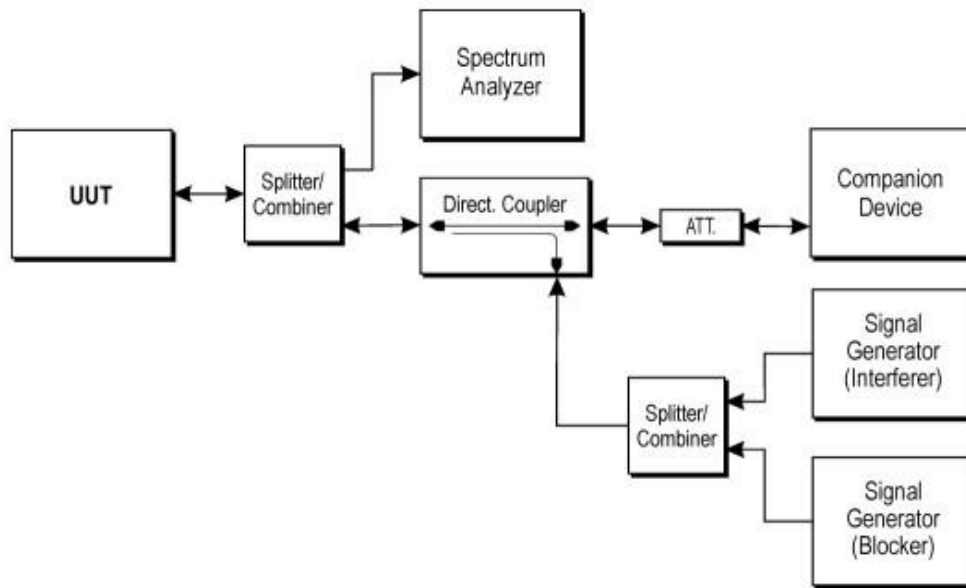
### 8.1. Limit

Adaptivity Limit
<input type="checkbox"/> Non-LBT based Detect and Avoid --- The channel shall remain unavailable for a minimum time equal to 1 s after which the channel may be considered again as an 'available' channel; --- $COT \leq 40$ ms; --- $COT \leq 60$ ms; --- Idle Period shall be minimum 5% of COT with a minimum of 100us; --- Detection threshold level = $-70\text{dBm/MHz} + 20 - P_{\text{out E.I.R.P}}$ ( $P_{\text{out}}$ in dBm);
<input type="checkbox"/> LBT based Detect and Avoid(Frame Based Equipment) --- The CCA observation time shall be not less than 20 us; --- The CCA time used by the equipment shall be declared by the supplier; --- $COT = 1-10$ ms; --- Idle Period = 5% of COT; --- Detection threshold level = $-70\text{dBm/MHz} + 20 - P_{\text{out E.I.R.P}}$ ( $P_{\text{out}}$ in dBm);
<input checked="" type="checkbox"/> LBT based Detect and Avoid(Load Based Equipment) --- The CCA observation time shall be not less than 20 us; --- The CCA time used by the equipment shall be declared by the supplier; --- $COT \leq (13 / 32) * q$ ms; $q = [4 \sim 32]$ ; 1.625ms~13ms; --- R = number of clear idle slots are randomly $[1 \sim q]$ . Every time an Extended CCA is required and the 'R' value stored in a counter. --- Detection threshold level = $-70\text{dBm/MHz} + 20 - P_{\text{out E.I.R.P}}$ ( $P_{\text{out}}$ in dBm);
<input type="checkbox"/> Short Control Signalling Transmissions: --- Short Control Signalling Transmissions shall have a maximum duty cycle of 10% within an observation period of 50ms.



## 8.2. Test Setup

Conducted measurements



## 8.3. Test Procedure

Refer to ETSI EN 300 328 V2.1.1 (2016-11) Clause 5.4.7

## 8.4. Test Result

This requirement does not apply to non-adaptive equipment or adaptive equipment operating in a non-adaptive mode providing the equipment complies with the requirements and/or restrictions applicable to non-adaptive equipment.

In addition, this requirement does not apply for equipment with a maximum declared RF Output power level of less than 10dBm E.I.R.P. or for equipment when operating in a mode where the RF Output power is less than 10dBm E.I.R.P.

No applicable.

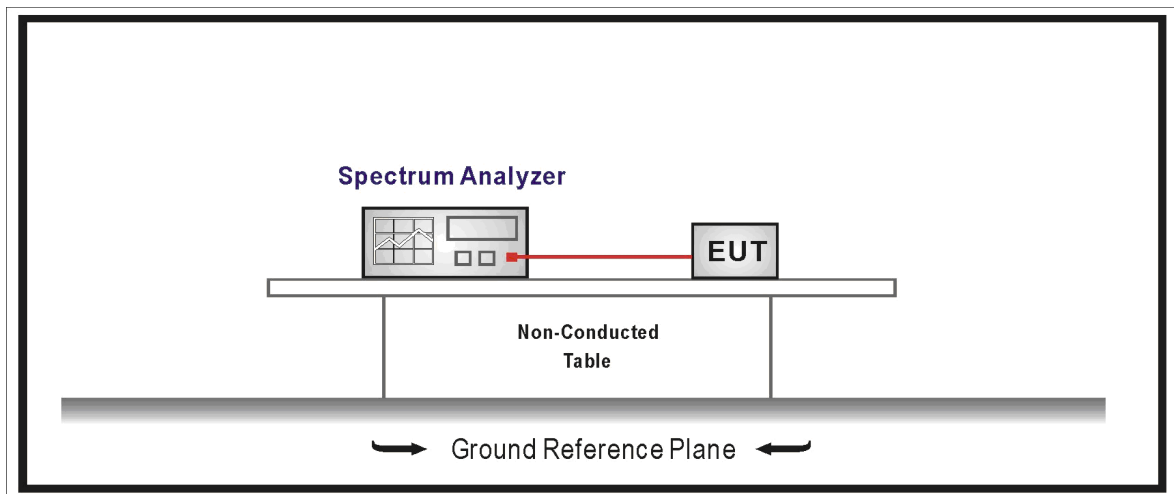
## 9. OCCUPIED CHANNEL BANDWIDTH

### 9.1. Limit

The Occupied Channel Bandwidth for each hopping frequency shall fall completely within the band given in 2.4GHz to 2.4835GHz.

For non-adaptive Frequency Hopping equipment with E.I.R.P greater than 10dBm, the Occupied Channel Bandwidth for every occupied hopping frequency shall be equal to or less than the value declared by the supplier. This declared value shall not be greater than 5 MHz.

### 9.2. Test Setup



### 9.3. Test Procedure

Refer to ETSI EN 300 328 V2.1.1 (2016-11) Clause 5.4.8

#### 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:  $\sim 1\%$  of the span without going below  $1\%$  (We set RBW= 20KHz)
- Video BW:  $3 \times$  RBW (We set RBW= 62KHz)
- Frequency Span:  $2 \times$  Occupied Channel Bandwidth (e.g. 40 MHz for a 20 MHz channel)
- Detector Mode: RMS
- Trace Mode: Max Hold

#### Step 2:

Wait until the trace is completed. 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.

#### 9.4. Test Result

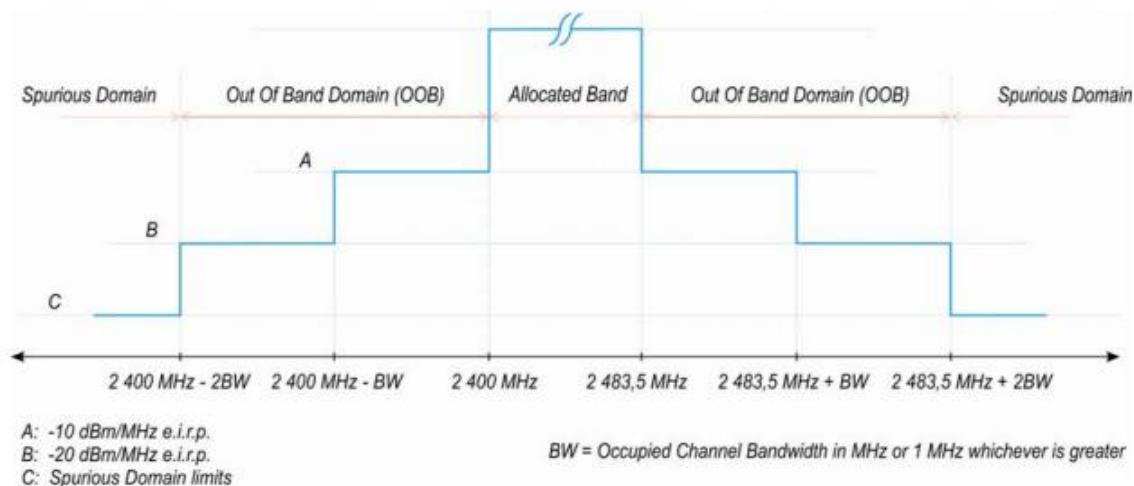
Product	:	Single Board Computer
Test Item	:	Occupied Channel Bandwidth
Test Mode	:	Mode 1: Transmit by BLE
Test Result	:	Pass

Channel No.	Frequency (MHz)	99% Bandwidth (MHz)	Limit
00	2402	1.01	Within the band 2400.0MHz~2483.5MHz
39	2480	1.02	

## 10. TRANSMITTER UNWANTED EMISSIONS IN THE OUT-OF-BAND DOMAIN

### 10.1. 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 3.

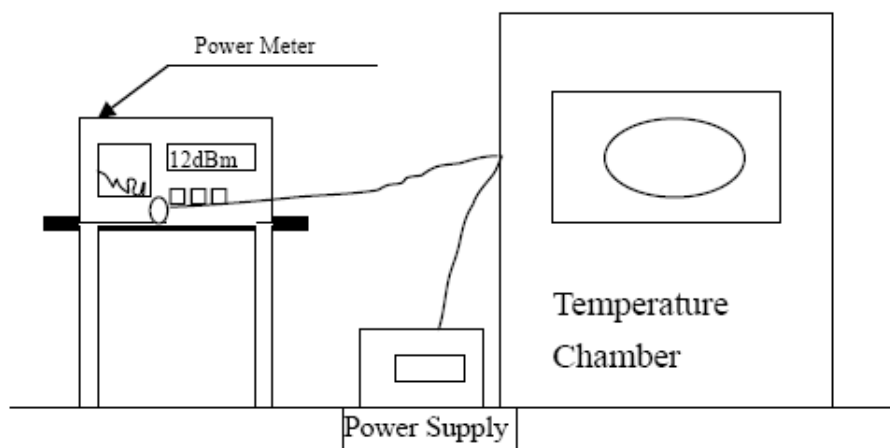


**Figure 3: Transmit mask**

Note: All equipments are calibrated with traceable calibrations. Each calibration is traceable to the national or international standards.

### 10.2. Test Setup

For Conducted Measurement



### 10.3. Test Procedure

Refer to ETSI EN 300 328 V2.1.1 (2016-11) Clause 5.4.9

#### Step 1:

- Connect the UUT to the spectrum analyser and use the following settings:
- Centre Frequency: 2 484 MHz
- Span: 0 Hz
- Resolution BW: 1 MHz
- Filter mode: Channel filter
- Video BW: 3 MHz
- Detector Mode: RMS
- Trace Mode: Clear / Write
- Sweep Mode: Continuous
- Sweep Points: 5 000
- Trigger Mode: Video trigger

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

- Sweep Time: Suitable to capture one transmission burst

#### 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.

#### 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.

**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.

**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  $10 \times \log_{10}(A_{ch})$  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:  $A_{ch}$  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.



#### 10.4. Test Result

Product	:	Single Board Computer
Test Item	:	Transmitter unwanted emissions in the out-of-band domain
Test Mode	:	Mode 1: Transmit by BLE

Frequency (MHz)	Test Conditions (°C)	Max measured Values (dBm/MHz)	Limit (dBm/MHz)
2400-2BW~ 2400-BW	25	-64.92	-20
2400-BW~2400	25	-68.18	-10
2483.5~ 2483.5+BW	25	-67.56	-10
2483.5+BW~ 2483.5+2BW	25	-68.14	-20

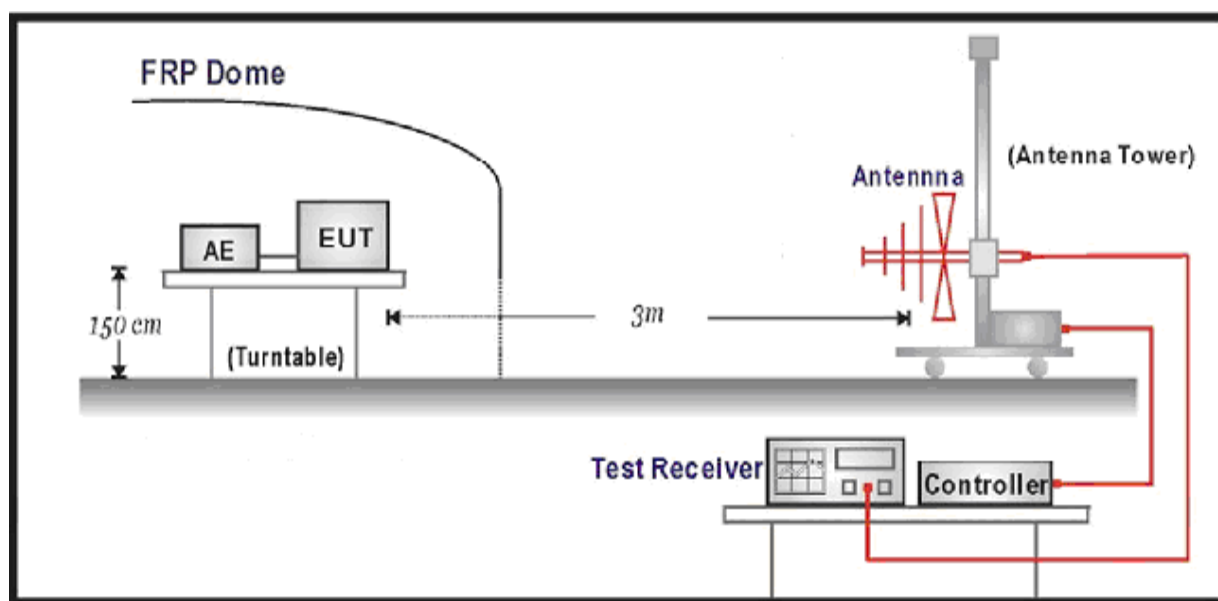
## 11. TRANSMITTER UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

### 11.1. Limit

Transmitter Limits for Spurious Emissions		
Frequency Range	Maximum power E.R.P. ( $\leq 1\text{GHz}$ ) E.I.R.P. ( $> 1\text{GHz}$ )	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

### 11.2. Test Setup

For Radiated Measurement



### 11.3. Test Procedure

Refer to ETSI EN 300 328 V2.1.1 (2016-11) Clause 5.4.10

#### 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 bandwidth: 100 kHz
- Video bandwidth: 300 kHz
- Detector mode: Peak
- Trace Mode: Max Hold
- Sweep Points:  $\geq 9\,970$

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. 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 the same hopping frequency in different hopping sequences. 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 5.3.10.2.1.2 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 bandwidth: 1 MHz
- Video bandwidth: 3 MHz
- Detector mode: Peak
- Trace Mode: Max Hold
- Sweep Points:  $\geq 11\,750$

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.

## 11.4. Test Result

Product	:	Single Board Computer
Test Item	:	Transmitter spurious emissions
Test Mode	:	Mode 1: Transmit by BLE(radiated method)

Frequency (MHz)	Polarization (H/V)	Measure Level (dBm)	Limit (dBm)	Margin (dB)	Detector
Channel 0 (2402MHz)					
247.51	H	-43.79	-36.00	-7.79	PK
129.00	V	-48.91	-36.00	-12.91	PK
918.39	H	-50.77	-36.00	-14.77	PK
880.29	V	-46.56	-36.00	-10.56	PK
4799.08	H	-39.90	-30.00	-9.90	PK
4806.23	V	-47.52	-30.00	-17.52	PK
7200.11	H	-42.99	-30.00	-12.99	PK
7204.02	V	-43.66	-30.00	-13.66	PK
Channel 39 (2480MHz)					
189.13	H	-64.99	-54.00	-10.99	PK
232.46	V	-67.93	-54.00	-13.93	PK
869.06	H	-48.02	-36.00	-12.02	PK
929.30	V	-47.41	-36.00	-11.41	PK
4958.88	H	-37.94	-30.00	-7.94	PK
4961.37	V	-43.81	-30.00	-13.81	PK
7438.29	H	-41.66	-30.00	-11.66	PK
7440.75	V	-37.21	-30.00	-7.21	PK

Product	:	Single Board Computer
Test Item	:	Transmitter spurious emissions
Test Mode	:	Mode 1: Transmit by BLE(conducted method)

Frequency(MHz)	Measure Level(dBm)	Limit(dBm)	Margin(dB)	Detector
Channel 0 (2402MHz)				
148.40	-51.23	-36.00	-15.23	PK
829.88	-69.20	-54.00	-15.20	PK
4807.61	-39.94	-30.00	-9.94	PK
7206.69	-38.98	-30.00	-8.98	PK
Channel 39 (2480MHz)				
286.16	-47.79	-36.00	-11.79	PK
873.55	-49.17	-36.00	-13.17	PK
4954.51	-42.64	-30.00	-12.64	PK
7436.30	-43.12	-30.00	-13.12	PK

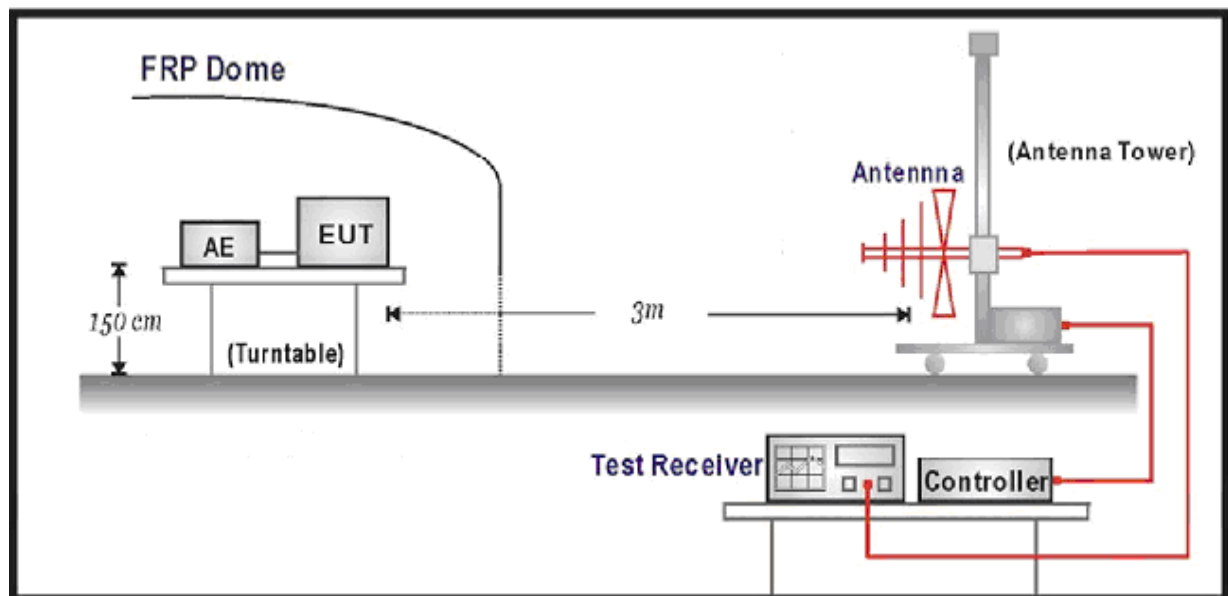
## 12. RECEIVER SPURIOUS EMISSIONS

### 12.1. Limit

Spurious emissions limits for receivers		
Frequency Range	Maximum power E.R.P. ( $\leq 1\text{GHz}$ ) E.I.R.P. ( $> 1\text{GHz}$ )	Measurement bandwidth
30 MHz to 1 GHz	-57 dBm	100 kHz
1 GHz to 12.75 GHz	-47 dBm	1 MHz

### 12.2. Test Setup

For Radiated Measurement



### 12.3. Test Procedure

Refer to ETSI EN 300 328 V2.1.1 (2016-11) Clause 5.4.11

#### 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 bandwidth: 100 kHz
- Video bandwidth: 300 kHz
- Detector mode: Peak
- Trace Mode: Max Hold
- Sweep Points:  $\geq 9\,970$
- 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 bandwidth: 1 MHz
- Video bandwidth: 3 MHz
- Detector mode: Peak
- Trace Mode: Max Hold
- Sweep Points:  $\geq 11\,750$
- 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 receive chains), the steps 2 and 3 need to be repeated for each of the active receive chains (Ach). The limits used to identify emissions during this pre-scan need to be reduced with  $10 \times \log_{10}(\text{Ach})$  (number of active receive chains).



## 12.4. Test Result

Product	:	Single Board Computer
Test Item	:	Receiver spurious emissions
Test Mode	:	Mode 2: Receive by BLE(radiated method)

Frequency (MHz)	Polarization (H/V)	Measure Level (dBm)	Limit (dBm)	Margin (dB)	Detector
Channel 0 (2402MHz)					
112.23	H	-66.39	-57.00	-9.18	PK
225.65	V	-65.46	-57.00	-8.92	PK
876.79	H	-70.58	-57.00	-12.85	PK
976.68	V	-64.99	-57.00	-6.84	PK
1868.68	H	-60.98	-47.00	-11.91	PK
1692.61	V	-59.37	-47.00	-11.54	PK
1983.72	H	-56.41	-47.00	-8.17	PK
2646.79	V	-63.11	-47.00	-14.05	PK
Channel 39 (2480MHz)					
125.58	H	-62.96	-57.00	-8.92	PK
137.76	V	-71.67	-57.00	-12.90	PK
853.49	H	-72.42	-57.00	-14.98	PK
865.82	V	-68.80	-57.00	-11.45	PK
1517.57	H	-57.13	-47.00	-8.04	PK
1807.75	V	-59.81	-47.00	-12.12	PK
1964.41	H	-57.10	-47.00	-10.32	PK
2357.63	V	-58.14	-47.00	-10.09	PK

Product	:	Single Board Computer
Test Item	:	Receiver spurious emissions
Test Mode	:	Mode 2: Receive by BLE(conducted method)

Frequency(MHz)	Measure Level(dBm)	Limit(dBm)	Margin(dB)	Detector
Channel 0 (2402MHz)				
156.82	-68.18	-57.00	-11.18	PK
985.47	-75.76	-57.00	-18.76	PK
1406.33	-63.85	-47.00	-16.85	PK
2805.18	-61.18	-47.00	-14.18	PK
Channel 39 (2480MHz)				
241.77	-69.85	-57.00	-12.85	PK
973.32	-67.78	-57.00	-10.78	PK
1487.24	-56.48	-47.00	-9.48	PK
2419.16	-58.57	-47.00	-11.57	PK

## 13. RECEIVER BLOCKING

### 13.1. Limit

Adaptive Frequency Hopping equipment shall comply with the requirements defined in clause 4.3.1.12.4

**Table 6: Receiver Blocking parameters for Receiver Category 1 equipment**

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal
$P_{\min} + 6 \text{ dB}$	2 380 2 503,5	-53	CW
$P_{\min} + 6 \text{ dB}$	2 300 2 330 2 360	-47	CW
$P_{\min} + 6 \text{ dB}$	2 523,5 2 553,5 2 583,5 2 613,5 2 643,5 2 673,5	-47	CW
NOTE 1: $P_{\min}$ is the minimum level of wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.			
NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.			

**Table 7: Receiver Blocking parameters receiver category 2 equipment**

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal
$P_{\min} + 6 \text{ dB}$	2 380 2 503,5	-57	CW
$P_{\min} + 6 \text{ dB}$	2 300 2 583,5	-47	CW
NOTE 1: $P_{\min}$ is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.			
NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.			

**Table 8: Receiver Blocking parameters receiver category 3 equipment**

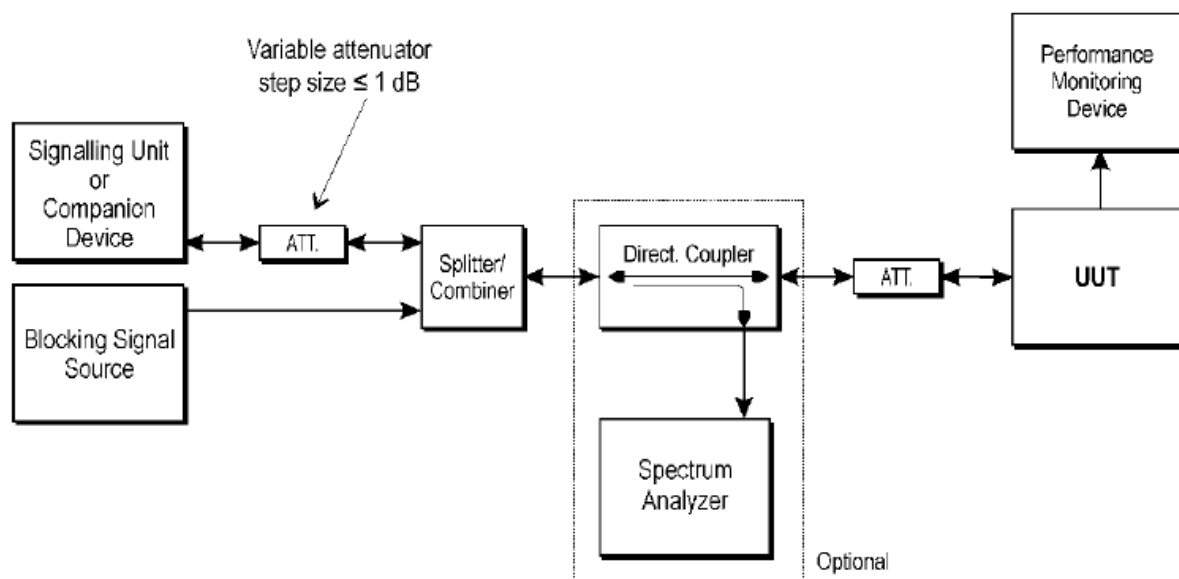
Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal
$P_{\min} + 12$ dB	2 380 2 503,5	-57	CW
$P_{\min} + 12$ dB	2 300 2 583,5	-47	CW

NOTE 1:  $P_{\min}$  is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.

NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.

### 13.2. Test Setup

Conducted measurements



### 13.3. Test Procedure

Step 1:

- For non-frequency hopping equipment, the UUT shall be set to the lowest operating channel.

Step 2:

- The blocking signal generator is set to the first frequency as defined in the appropriate table corresponding to the receiver category and type of equipment.

Step 3:

- With the blocking signal generator switched off, a communication link is established between the UUT and the associated companion device using the test setup shown in figure 6. The attenuation of the variable attenuator shall be increased in 1 dB steps to a value at which the minimum performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is still met. The resulting level for the wanted signal at the input of the UUT is  $P_{\min}$ .

- This signal level (Pmin) is increased by the value provided in the table corresponding to the receiver category and type of equipment.

Step 4:

- The blocking signal at the UUT is set to the level provided in the table corresponding to the receiver category and type of equipment. It shall be verified and recorded in the test report that the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is met.

Step 5:

- Repeat step 4 for each remaining combination of frequency and level for the blocking signal as provided in the table corresponding to the receiver category and type of equipment.

Step 6:

- For non-frequency hopping equipment, repeat step 2 to step 5 with the UUT operating at the highest operating channel.

### 13.4. Test Result

Product	:	Single Board Computer
Test Item	:	Receiver spurious emissions(conducted)
Test Mode	:	Receiving
Test Environment	:	25°C 43.5%RH

Wanted signal mean power from companion device (dBm)	Test mode	Test channel (MHz)	Blocking signal frequency (MHz)	Pmin	Blocking signal power (dBm)		Type of blocking signal	PER (%)		Test Result
					Test Value	Limit		Test Value	Limit	
Pmin + 6 dB	BLE	2402	2380	-88	-29	≥-57	CW	3.92	10	Pass
			2503.5	-88	-34	≥-57	CW	4.94	10	Pass
			2300	-88	-20	≥-47	CW	4.33	10	Pass
			2583.5	-88	-21	≥-47	CW	3.45	10	Pass
		2480	2380	-87	-27	≥-57	CW	6.10	10	Pass
			2503.5	-87	-30	≥-57	CW	4.96	10	Pass
			2300	-87	-26	≥-47	CW	2.50	10	Pass
			2583.5	-87	-20	≥-47	CW	3.45	10	Pass

### 13.5. List of Measuring Equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	X-series USB Peak and Average Power Sensor Aglient	Agilent	U2021XA	MY54080022	2017-10-26	2018-10-25
2	4 CH. Simultaneous Sampling 14 Bits 2MS/s	Agilent	U2531A	MY54080016	2017-10-26	2018-10-25
3	Test Software	Ascentest	AT890-SW	20160630	N/A	N/A
4	RF Control Unit	Ascentest	AT890-RFB	N/A	2017-06-17	2018-06-16
5	ESA-E SERIES SPECTRUM ANALYZER	Agilent	E4407B	MY41440754	2017-11-17	2018-11-16
6	MXA Signal Analyzer	Agilent	N9020A	MY49100040	2017-06-17	2018-06-16
7	SPECTRUM ANALYZER	R&S	FSP	100503	2017-06-17	2018-06-16
8	MXG Vector Signal Generator	Agilent	N5182A	MY47071151	2017-11-17	2018-11-16
9	ESG VECTOR SIGNAL GENERATOR	Agilent	E4438C	MY42081396	2017-11-17	2018-11-16
10	PSG Analog Signal Generator	Agilent	E8257D	MY4520521	2017-11-17	2018-11-16
11	Universal Radio Communication Tester	R&S	CMU 200	105788	2017-06-17	2018-06-16
12	WIDEBAND RADIO COMMUNICATION TESTER	R&S	CMW 500	103818	2017-06-17	2018-06-16
13	RF Control Unit	Tonscend	JS0806-1	N/A	2017-06-17	2018-06-16
14	DC Power Supply	Agilent	E3642A	N/A	2017-11-17	2018-11-16
15	LTE Test Software	Tonscend	JS1120-1	N/A	N/A	N/A
16	Temperature & Humidity Chamber	GUANGZHOU GOGN WEN	GDS-100	70932	2017-10-11	2018-10-10
17	DC Source	CHROMA	62012P-80-60	34782951	2017-10-11	2018-10-10
18	RF Filter	Micro-Tronics	BRC50718	S/N-017	2017-06-17	2018-06-16
19	RF Filter	Micro-Tronics	BRC50719	S/N-011	2017-06-17	2018-06-16
20	RF Filter	Micro-Tronics	BRC50720	S/N-011	2017-06-17	2018-06-16
21	RF Filter	Micro-Tronics	BRC50721	S/N-013	2017-06-17	2018-06-16
22	RF Filter	Micro-Tronics	BRM50702	S/N-195	2017-06-17	2018-06-16
23	Splitter/Combiner	Micro-Tronics	PS2-15	CB11-20	2017-06-17	2018-06-16
24	Splitter/Combiner	Micro-Tronics	CB11-20	N/A	2017-06-17	2018-06-16
25	Attenuator	Micro-Tronics	PAS-8-10	S/N23466	2017-06-17	2018-06-16
26	Exposure Level Tester	Narda	ELT-400	N-0713	2017-04-03	2018-04-02
27	B-Field Probe	Narda	ELT-400	M-1154	2017-04-11	2018-04-10
28	3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	2017-06-17	2018-06-16
29	Positioning Controller	MF	MF-7082	/	2017-06-17	2018-06-16
30	EMI Test Software	AUDIX	E3	N/A	2017-06-17	2018-06-16
31	EMI Test Receiver	R&S	ESR 7	101181	2017-06-17	2018-06-16
32	AMPLIFIER	QuieTek	QTK-A2525G	CHM10809065	2017-11-17	2018-11-16
33	Active Loop Antenna	SCHWARZBECK	FMZB 1519B	00005	2017-06-23	2018-06-22
34	By-log Antenna	SCHWARZBECK	VULB9163	9163-470	2017-05-02	2018-05-01
35	Horn Antenna	EMCO	3115	6741	2017-06-23	2018-06-22
36	Broadband Horn Antenna	SCHWARZBECK	BBHA 9170	791	2017-09-21	2018-09-20
37	Broadband Preamplifier	SCHWARZBECK	BBV 9719	9719-025	2017-09-21	2018-09-20
38	RF Cable-R03m	Jye Bao	RG142	CB021	2017-06-17	2018-06-16
39	RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	2017-06-17	2018-06-16

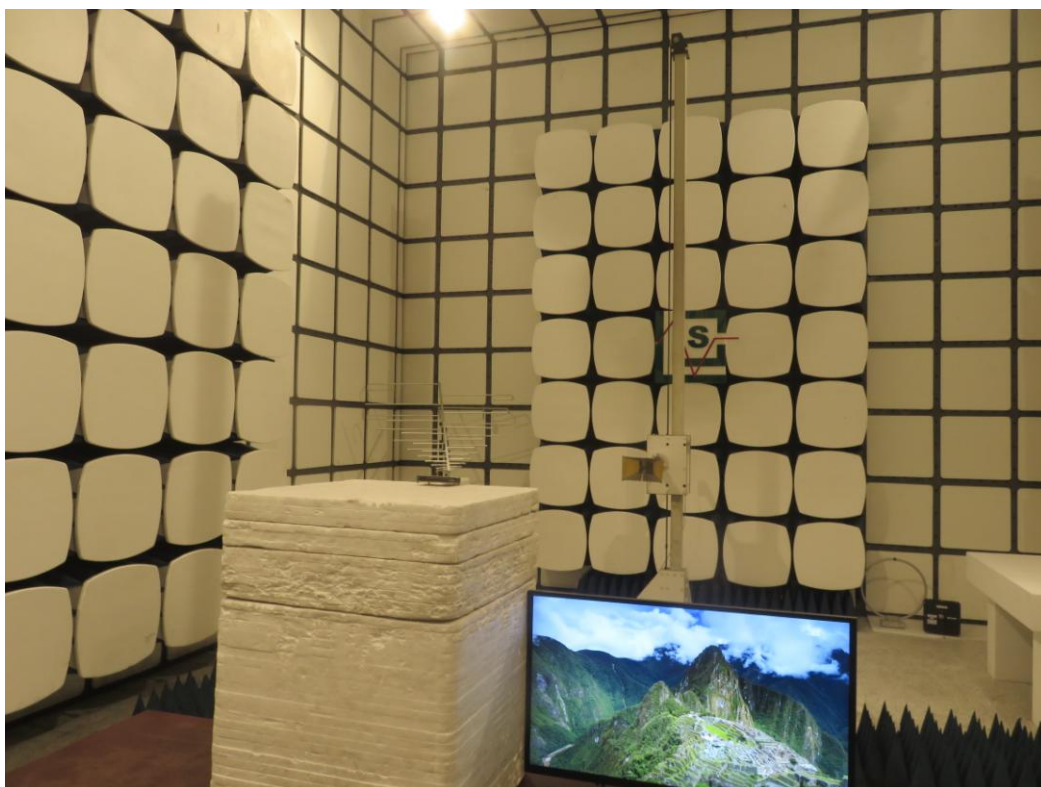
Note: All equipment is calibrated through GUANGZHOU LISAI CALIBRATION AND TEST CO.,LTD.



## 14. PHOTOGRAPHS OF TEST SETUP



Spurious Emission Below 1GHz



Spurious Emission Above 1GHz

-----THE END OF REPORT-----