RADIO TEST REPORT

Report No.:STS2110087W01

Issued for

Mobile Action Technology Inc.

12F, NO.661, Bannan Rd., Zhonghe Dist. New Taipei City, Taiwan (R.O.C.) 235030

Product Name:	Bluetooth GPS Logger
Brand Name:	Mobile Action
Model Name:	GT-120B
Series Model:	N/A
Test Standard:	ETSI EN 300 328 V2.2.2 (2019-07)

Shenzhen STS Test Services Co., Ltd.
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TEL: +86-755 3688 6288 FAX: +86-755 3688 6277 E-mail:sts@stsapp.com

TEST REPORT CERTIFICATION

Applicant's Name :	Mobile Action Technology Inc.
Address :	12F, NO.661, Bannan Rd., Zhonghe Dist. New Taipei City, Taiwan (R.O.C.) 235030
Manufacturer's Name :	Heisei Technology Co., Ltd.
Address :	3F, No.5, Alley 8, Lane 45, Pao Hsin Rd. Hsin-Tien Dist. New Taipei City 23145, Taiwan R.O.C.

Product Description

Product Name :	Bluetooth GPS Logger
Brand Name :	Mobile Action
Model Name :	GT-120B
Series Model :	N/A
Test Standards :	ETSI EN 300 328 V2.2.2 (2019-07)

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Date of Test :	
Date of receipt of test item :	29 Oct. 2021
Date (s) of performance of tests :	29 Oct. 2021 ~ 16 Nov. 2021
Date of Issue :	16 Nov. 2021
Test Result :	**Pass**

Testing Engineer : Chris Chen

(Chris Chen)

Technical Manager : Sean She

(Sean she)

Authorized Signatory : Vita Li

(Vita Li)

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Revision History

Rev.	Issue Date	Report No.	Effect Page	Contents
00	16 Nov. 2021	STS2110087W01	ALL	Initial Issue

1. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards:

ETSI EN 300 328 V2.2.2			
Test Item	Limit	Frequency Range (MHz)	Applicable (Yes/No)
TRANSMITTER PARAMETERS			
RF output power	Clause 4.3.2.2.3	2400-2483.5	Y
Power Spectral Density	Clause 4.3.2.3.3		Y
Duty Cycle, Tx-sequence, Tx-gap	Clause 4.3.2.4.3		N
Medium Utilization	Clause 4.3.2.5.3		N
Adaptivity (adaptive equipment using modulations other than FHSS)	Clause 4.3.2.6		N
Occupied Channel Bandwidth	Clause 4.3.2.7.3		Y
Transmitter unwanted emissions in the OOB domain	Clause 4.3.2.8.3	FL=2400-2BW FH=2483.5+2BW	Y
Transmitter unwanted emissions in the spurious domain (Conducted)	Clause 4.3.2.9.3	30-12750	N
Transmitter unwanted emissions in the spurious domain (Radiated)			Y
RECEIVER PARAMETERS			
Spurious emissions (Conducted)	Clause 4.3.2.10.3	30-12750	N
Spurious emissions (Radiated)			Y
Receiver Blocking	Clause 4.3.2.11.4	2400-2483.5	Y
Geo-location capability	Clause 4.3.2.12.3	--	N

1.1 TEST FACTORY

SHENZHEN STS TEST SERVICES CO., LTD
Add. : A 1/F, Building B, Zhuoke Science Park, No.190 Chongqing Road, HepingShequ, Fuyong Sub-District, Bao'an District, Shenzhen, Guang Dong, China

FCC test Firm Registration Number: 625569

IC test Firm Registration Number: 12108A

A2LA Certificate No.: 4338.01

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement **y** ±**U**, where expended uncertainty **U** is based on a standard uncertainty multiplied by a coverage factor of **k=2**, providing a level of confidence of approximately **95** %.

No.	Item	Uncertainly
1	RF output power, conducted	±0.68dB
2	Unwanted Emissions, conducted	±2.988dB
3	All emissions, radiated below 1GHz	±2.26dB
4	All emissions, radiated 1GHz-18GHz	±2dB
5	All emissions, radiated>18G	±2.88dB

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF THE EUT

<table>
<tr><td>Product Name</td><td>Bluetooth GPS Logger</td></tr>
<tr><td>Brand Name</td><td>Mobile Action</td></tr>
<tr><td>Model Name</td><td>GT-120B</td></tr>
<tr><td>Series Model</td><td>N/A</td></tr>
<tr><td>Model Difference</td><td>N/A</td></tr>
<tr><td>Product Description</td><td>The EUT is Bluetooth GPS Logger
<table>
<tr><td>Operation Frequency:</td><td>2402~2480 MHz</td></tr>
<tr><td>Bluetooth Version:</td><td>5.1</td></tr>
<tr><td>Bluetooth Configuration:</td><td>LE (Support 1M PHY)</td></tr>
<tr><td>Modulation Type:</td><td>GFSK</td></tr>
<tr><td>Number Of Channel</td><td>40CH</td></tr>
<tr><td>Antenna Designation:</td><td>Ceramics Antenna</td></tr>
<tr><td>Antenna Gain(Peak)</td><td>2.5dBi</td></tr>
</table>
Based on the application, features, or specification exhibited in User Manual, the EUT is considered as an ITE/Computing Device. More details of EUT technical specification, please refer to the User Manual.</td></tr>
<tr><td>Channel List</td><td>Refer to Note 2.</td></tr>
<tr><td>Rating</td><td>Input: DC 5V</td></tr>
<tr><td>Battery</td><td>Rated Voltage: 3.7V
Charge Limit Voltage: 4.2V
Capacity: 380mAh</td></tr>
<tr><td>Hardware version number</td><td>V1.1</td></tr>
<tr><td>Software version number</td><td>V1.0</td></tr>
<tr><td>Connecting I/O Port(s)</td><td>Refer to Note 1.</td></tr>
</table>

Note:

1. For a more detailed features description, please refer to the manufacturer's specifications or the User Manual, the antenna information refer the manufacturer provide report, applicable only to the tested sample identified in the report.

2.

Channel List for BLE							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	2402	10	2422	20	2442	30	2462
01	2404	11	2424	21	2444	31	2464
02	2406	12	2426	22	2446	32	2466
03	2408	13	2428	23	2448	33	2468
04	2410	14	2430	24	2450	34	2470
05	2412	15	2432	25	2452	35	2472
06	2414	16	2434	26	2454	36	2474
07	2416	17	2436	27	2456	37	2476
08	2418	18	2438	28	2458	38	2478
09	2420	19	2440	29	2460	39	2480

a) The type of modulation used by the equipment:
□FHSS
■non-FHSS

b) In case of FHSS:
• In case of non-Adaptive FHSS equipment:
The number of Hopping Frequencies:
• In case of Adaptive FHSS equipment:
The maximum number of Hopping Frequencies:
The minimum number of Hopping Frequencies:
•The (average) Dwell Time:

c) Adaptive / non-adaptive equipment:
□non-adaptive Equipment
■adaptive Equipment without the possibility to switch to a non-adaptive mode
□adaptive Equipment which can also operate in a non-adaptive mode

d) In case of adaptive equipment:
The maximum Channel Occupancy Time implemented by the equipment: ..... ms
□The equipment has implemented an LBT mechanism
•In case of non-FHSS equipment:
■The equipment is Frame Based equipment
□The equipment is Load Based equipment
□The equipment can switch dynamically between Frame Based and Load Based equipment
The CCA time implemented by the equipment: ..... μs
□The equipment has implemented a DAA mechanism
□The equipment can operate in more than one adaptive mode

e) In case of non-adaptive Equipment:
The maximum RF Output Power (e.i.r.p.): …….. dBm
The maximum (corresponding) Duty Cycle:……..%
Equipment with dynamic behavior, that behavior is described here. (e.g. the different combinations of duty cycle and corresponding power levels to be declared)

f) The worst case operational mode for each of the following tests:
- RF Output Power
  GFSK
- Power Spectral Density
  GFSK
- Occupied Channel Bandwidth
  GFSK
- Transmitter unwanted emissions in the OOB domain
  GFSK

- Transmitter unwanted emissions in the spurious domain
  GFSK
- Receiver spurious emissions
  GFSK
- Receiver Blocking
  GFSK

g) The different transmit operating modes (tick all that apply):
■Operating mode 1: Single Antenna Equipment
■Equipment with only one antenna
□Equipment with two diversity antennas but only one antenna active at any moment in time
□Smart Antenna Systems with two or more antennas, but operating in a (legacy) mode where only one antenna is used. (BLE mode in smart antenna systems)
□Operating mode 2: Smart Antenna Systems - Multiple Antennas without beam forming
□Single spatial stream / Standard throughput / (BLE mode)
□High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 1
□High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 2
NOTE: Add more lines if more channel bandwidths are supported.
□Operating mode 3: Smart Antenna Systems - Multiple Antennas with beam forming
□Single spatial stream / Standard throughput (BLE mode)
□High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 1
□High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 2
NOTE: Add more lines if more channel bandwidths are supported.

h) In case of Smart Antenna Systems:
- The number of Receive chains: .....
- The number of Transmit chains: .....

□symmetrical power distribution
□asymmetrical power distribution
In case of beam forming, the maximum beam forming gain: .....
NOTE: Beam forming gain does not include the basic gain of a single antenna.

i) Operating Frequency Range(s) of the equipment:
• Operating Frequency Range 1: 2402 MHz to 2480 MHz
• Operating Frequency Range 2:
NOTE: Add more lines if more Frequency Ranges are supported.

j) Occupied Channel Bandwidth(s):
Occupied Channel Bandwidth : 1.037MHz
Occupied Channel Bandwidth : 1.043MHz
NOTE: Add more lines if more channel bandwidths are supported.

k) Type of Equipment (stand-alone, combined, plug-in radio device, etc.):
■Stand-alone
□Combined Equipment (Equipment where the radio part is fully integrated within another type of equipment)
□Plug-in radio device (Equipment intended for a variety of host systems)
Other.....

l) The extreme operating conditions that apply to the equipment:
Operating temperature range: -10°C – 50°C
Operating voltage range: DC 3.33V ~ DC 4.07V (Normal: DC 3.7V)
□Details provided are for the:
■stand-alone equipment
□combined (or host) equipment
□test jig

m) The intended combination(s) of the radio equipment power settings and one or more antenna assemblies and their corresponding e.i.r.p levels:

• Antenna Type

■PIFA Antenna

Antenna Gain:2.5dBi

If applicable, additional beamforming gain (excluding basic antenna gain): ..... dB

□Temporary RF connector provided

□No temporary RF connector provided

□Dedicated Antennas (equipment with antenna connector)

□Single power level with corresponding antenna(s)

□Multiple power settings and corresponding antenna(s)

Number of different Power Levels: .....

Power Level 1: ..... dBm

Power Level 2: ..... dBm

Power Level 3: ..... dBm

NOTE 1: Add more lines in case the equipment has more power levels.

NOTE 2: These power levels are conducted power levels (at antenna connector).

• For each of the Power Levels, provide the intended antenna assemblies, their, corresponding gains (G) and the resulting e.i.r.p. levels also taking into account the beamforming gain (Y) if applicable

Power Level 1: ..... dBm

Number of antenna assemblies provided for this power level: .....

Assembly #	Gain (dBi)	e.i.r.p.(dBm)	Part number or model name
1	2.5	1.25	GT-120B
2			
3			
4			

NOTE: Add more rows in case more antenna assemblies are supported for this power level.

Power Level 2: ..... dBm

Number of antenna assemblies provided for this power level: .....

Assembly #	Gain (dBi)	e.i.r.p.(dBm)	Part number or model name
1			
2			
3			
4			

NOTE: Add more rows in case more antenna assemblies are supported for this power level.

Power Level 3: ..... dBm

Number of antenna assemblies provided for this power level: .....

Assembly #	Gain (dBi)	e.i.r.p.(dBm)	Part number or model name
1			
2			
3			
4			

NOTE: Add more rows in case more antenna assemblies are supported for this power level.

n) The nominal voltages of the stand-alone radio equipment or the nominal voltages of the combined (host) equipment or test jig in case of plug-in devices:
Details provided are for the: ■stand-alone equipment
□combined (or host) equipment
□test jig Supply Voltage
□AC mains State AC voltage:
■DC State DC voltage: 3.7V
In case of DC, indicate the type of power source
□Internal Power Supply
□External Power Supply or AC/DC adapter
■Battery: 3.7V
□Other: .....

o) Describe the test modes available which can facilitate testing:

RF Function	Type	Mode Or Modulation type	ANT Gain(dBi)	Power Class	Software For Testing
BLE	BLE	GFSK	2.5	default	nRFgo Studio

p) The equipment type (e.g. Bluetooth®, IEEE 802.11™, IEEE 802.15.4™, proprietary, etc.):
BLE

q) If applicable, the statistical analysis referred to in clause 5.4.1 q)
(to be provided as separate attachment)

r) If applicable, the statistical analysis referred to in clause 5.4.1 r)
(to be provided as separate attachment)

s) Geo-location capability supported by the equipment:
□ Yes
□The geographical location determined by the equipment as defined in clause 4.3.1.13.2 or clause 4.3.2.12.2 is not accessible to the user
■ No

2.2 ENVIRONMENTAL CONDITIONS FOR TESTING

Test Condition	Temperature(℃)	Voltage(V)	Relative Humidity(%)
NT/NV	25	3.7	42
LT/NV	-10	3.7	/
HT/NV	50	3.7	/

Note:

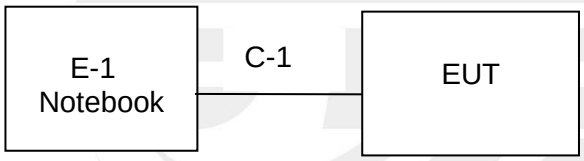
(1) The EUT can only work from LT -10°C to HT 50°C which is declared by the manufacturer, and the EUT can`t operate normally at higher or lower temperature than the declared range.

(2) NV: Normal Voltage; NT: Normal Temperature.

(3) LT: Low Extreme Test Temperature; HT: High Extreme Test Temperature.

(4) The measurements are performed at the highest, middle, lowest available channels.

2.3 TEST MODE



The EUT was programmed to be in continuously transmitting mode.

Channel List for BLE		
Test Channel	EUT Channel	Test Frequency (MHz)
lowest	CH00	2402
middle	CH19	2440
highest	CH39	2480

2.4 DESCRIPTION OF NECESSARY ACCESSORIES AND SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Necessary accessories

Item	Equipment	Mfr/Brand	Model/Type No.	Length	Note
N/A	N/A	N/A	N/A	N/A	N/A

Support units

Item	Equipment	Mfr/Brand	Model/Type No.	Length	Note
E-1	Notebook	HP	500-320cx	N/A	N/A
C-1	DC Cable	N/A	N/A	30cm	NO

Note: For detachable type I/O cable should be specified the length in cm in『Length』column.

2.5 EQUIPMENTS LIST

Radiation Test equipment

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Bilog Antenna	TESEQ	CBL6111D	34678	2020.10.12	2022.10.11
Horn Antenna	SCHWARZBECK	BBHA 9120D	02014	2021.10.11	2023.10.10
Pre-Amplifier (0.1M-3GHz)	EM	EM330	060665	2021.10.08	2022.10.07
Pre-Amplifier (1G-18GHz)	SKET	LNPA-01018G-45	SK2018080901	2021.09.30	2022.09.29
Wireless Communications Test Set	R&S	CMW 500	131428	2021.03.04	2022.03.03
Signal Analyzer	R&S	FSV 40-N	101823	2021.09.30	2022.09.29
Temperature & Humidity	SW-108	SuWei	N/A	2021.03.04	2022.03.03
Turn table	EM	SC100_1	60531	N/A	N/A
Antenna mast	EM	SC100	N/A	N/A	N/A
AC Power Source	APC	KDF-11010G	F214050035	N.C.R	N.C.R
Test SW	BALUN	BL410-E/15.2.0.399			

RF Connected Test equipment

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Power Sensor	Keysight	U2021XA	MY55520005	2021.09.30	2022.09.29
			MY55520006	2021.09.30	2022.09.29
			MY56120038	2021.09.30	2022.09.29
			MY56280002	2021.09.30	2022.09.29
Signal Generator	Agilent	N5182A	MY46240556	2021.09.30	2022.09.29
Signal Analyzer	Agilent	N9020A	MY49100060	2021.09.30	2022.09.29
Universal Radio communication tester	R&S	CMU200	111058	2021.09.29	2022.09.28
Wireless Communications Test Set	R&S	CMW 500	131428	2021.03.04	2022.03.03
Temperature & Humidity	HH660	Mieo	N/A	2021.10.09	2022.10.08
Temperature& Humidity test chamber	Safety test	AG80L	171200018	2021.03.04	2022.03.03
Programmable power supply	Agilent	E3642A	MY40002025	2021.10.08	2022.10.07
Attenuator	HP	8494B	DC-18G	2021.04.28	2022.04.27
AC Power Source	APC	KDF-11010G	F214050035	N.C.R	N.C.R
Router	WAVLINK	WL-WN575A2	WL1512260336	N.C.R	N.C.R
Test SW	MWRF-TEST	MTS 8310/2.0.0.0			

3. RF OUTPUT POWER

3.1 LIMIT

FHSS:

The maximum RF output power for adaptive Frequency Hopping equipment shall be equal to or less than 20 dBm. The maximum RF output power for non-adaptive Frequency Hopping equipment shall be declared by the manufacturer. See clause 5.4.1 m). The maximum RF output power for this equipment shall be equal to or less than the value declared by the manufacturer. This declared value shall be equal to or less than 20 dBm.

Other than FHSS:

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. See clause 5.4.1 m). 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.

Limit
20 dBm

Between the start and stop times of each individual burst calculate the RMS power over the burst using the formula below. The start and stop points shall be included. Save these P_{burst} values, as well as the start and stop times for each burst.

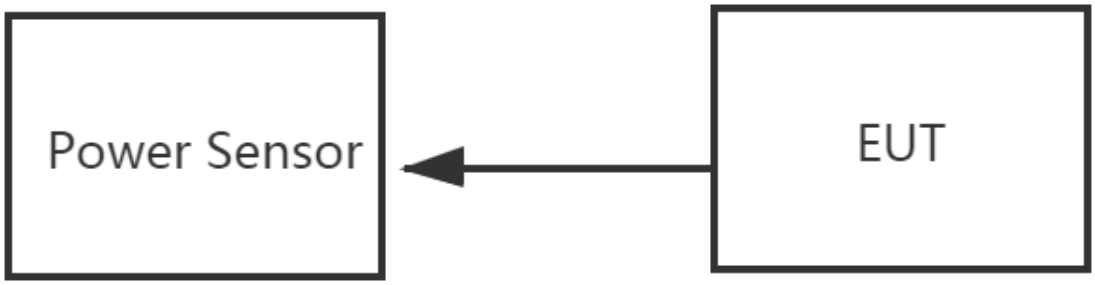
$$P_{burst} = \frac{1}{k}\sum_{n=1}^{k} P_{sample}(n)$$

with k being the total number of samples and n the actual sample number.

3.2 TEST PROCEDURES

1. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.2.1 for the test conditions.
2. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.2.2 for the measurement method.
   a) 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 b)
   b) Clause 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) is captured
   c) Print the plots from power sensor by used power sensor on PC, select the max result and record it.

3.3 TEST SETUP



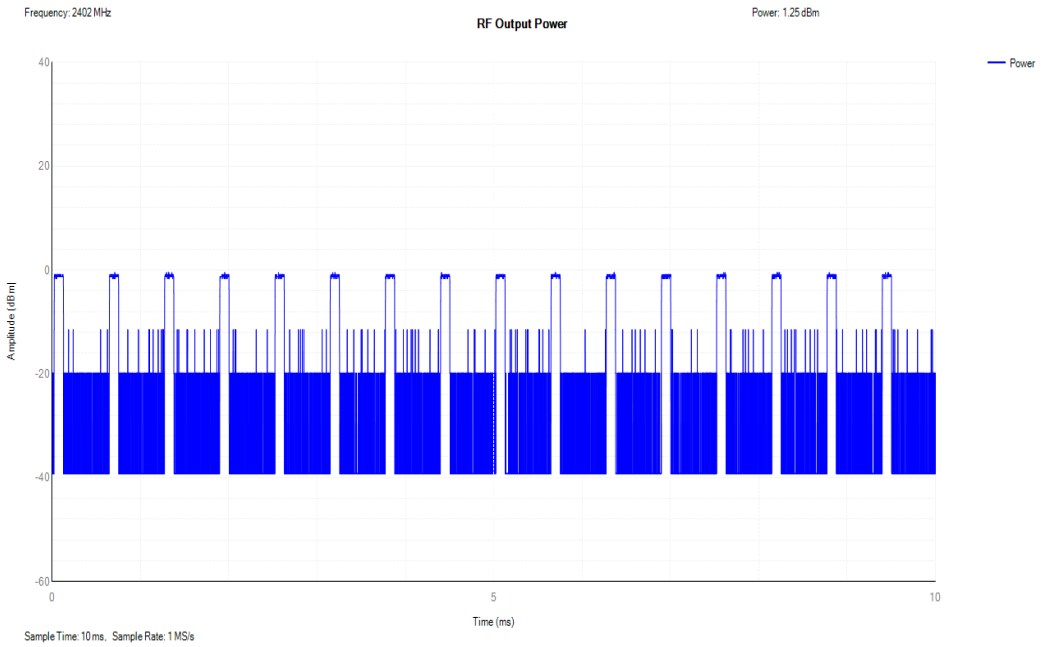
3.4 TEST RESULTS

Test conditions		Average EIRP Power (dBm)		
		Low Channel	Middle Channel	High Channel
Normal		1.25	0.17	0.07
Extreme	LTNV	1.09	0.02	-0.11
	HTNV	1.13	0.02	-0.12
Max. E.I.R.P		1.25		
Limit		20dBm (-10dBW)		
Burst plot		> 10		
Result		Complies		

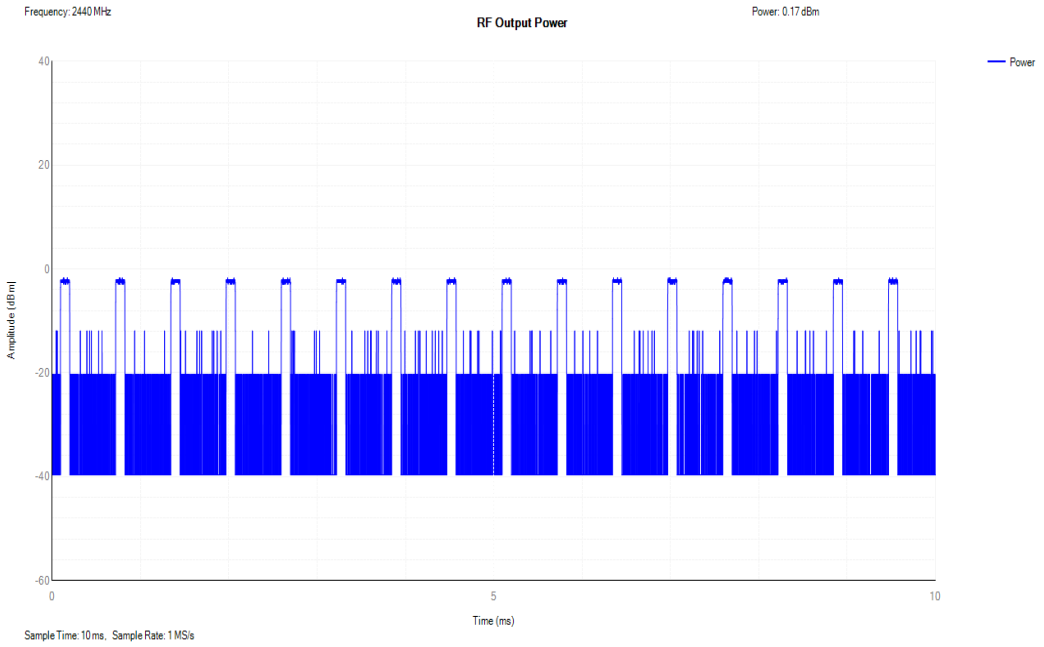
Note: Average EIRP Power = Burst power + antenna gain

Test Plot

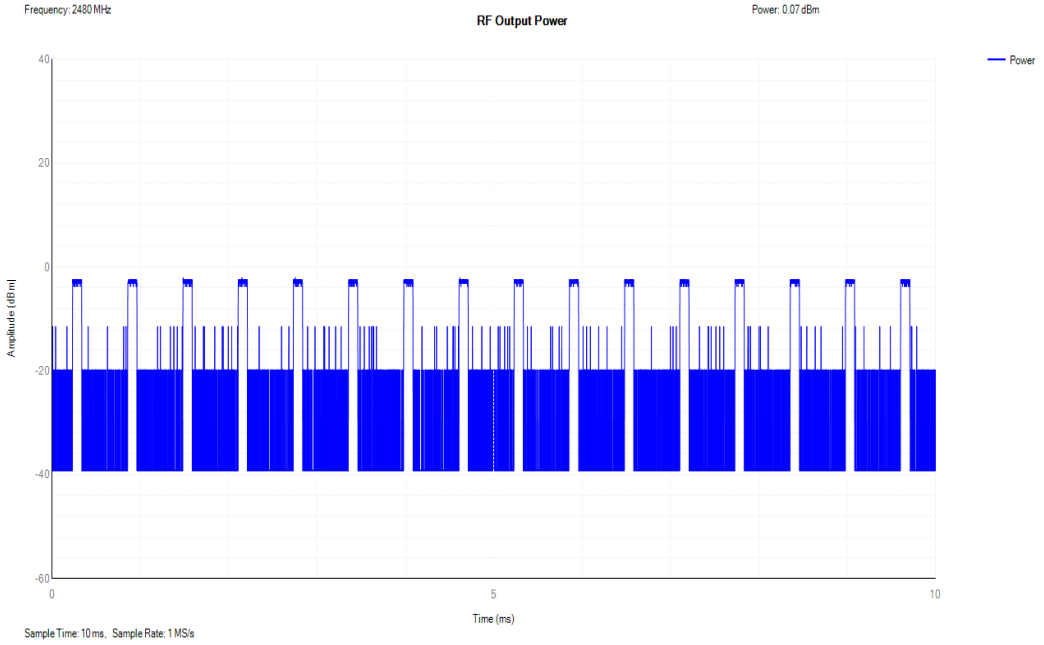
CH00



CH19


Frequency: 2440 MHz
RF Output Power
Power: 0.17 dBm
Power
40
20
0
-20
-40
-60
Amplitude [dBm]
0
5
10
Time (ms)
Sample Time: 10 ms, Sample Rate: 1 MS/s

CH39


Frequency: 2480 MHz
RF Output Power
Power: 0.07 dBm
Power
40
20
0
-20
-40
-60
Amplitude [dBm]
0
5
10
Time (ms)
Sample Time: 10 ms, Sample Rate: 1 MS/s

4. POWER SPECTRAL DENSITY

4.1 LIMIT

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

4.2 TEST PROCEDURES

The measurement shall be repeated for the equipment being configured to operate at the lowest, the middle, and the highest frequency of the stated frequency range.

1. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.3.1 for the test conditions.
2. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.3.2 for the measurement method.

a). Connect the UUT to the spectrum analyzer and use the following settings:

Frequency range	2400MHz-2483.5MHz
RBW/VBW	10KHz/30KHz
Sweep points	>8350 / Auto (Set as 10000)
Sweep time	For non-continuous transmissions: 2 × Channel Occupancy Time × number of sweep points
	For continuous transmissions: 10 s; the sweep time may be increased further until a value where the sweep time has no further impact anymore on the RMS value of the signal.
Detector	RMS
Trace	Max hold

b). For conducted measurements on smart antenna systems using either operating mode 2 or 3 (see clause 5.3.2.2), repeat the measurement for each of the transmit ports. For each frequency point, add up the amplitude (power) values for the different transmit chains and use this as the new data set.

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

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

e). 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.

f). Shift the start point of the samples added up in step 5 by 1 sample and repeat the procedure in step e (i.e. sample #2 to #101).

g). 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.

h). From all the recorded results, the highest value is the maximum Power Spectral Density for the UUT.

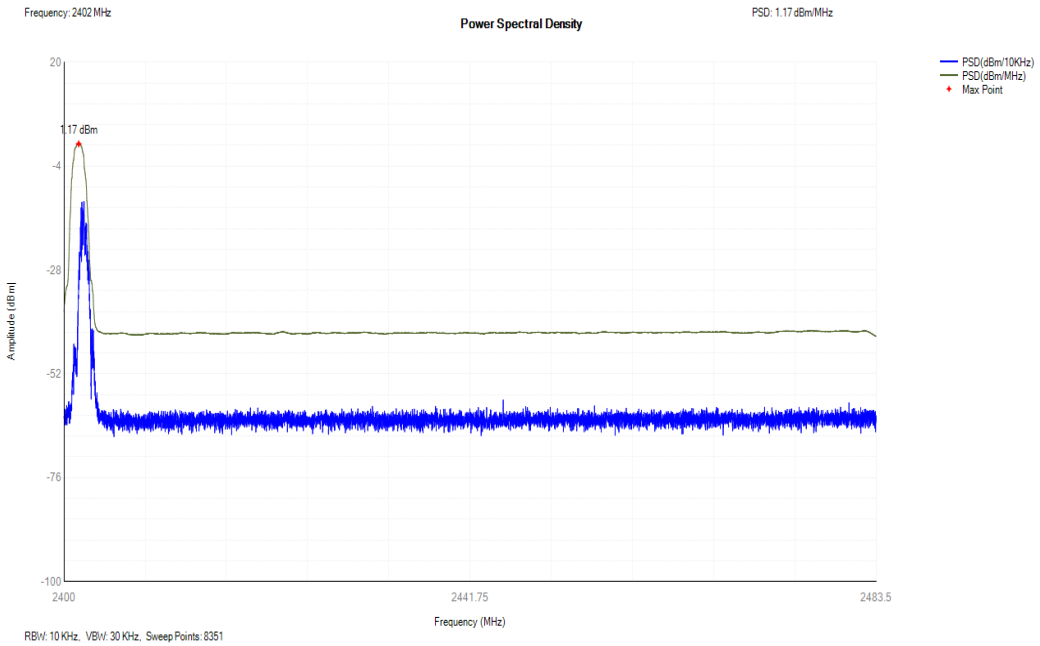
4.3 TEST SETUP

4.4 TEST RESULTS

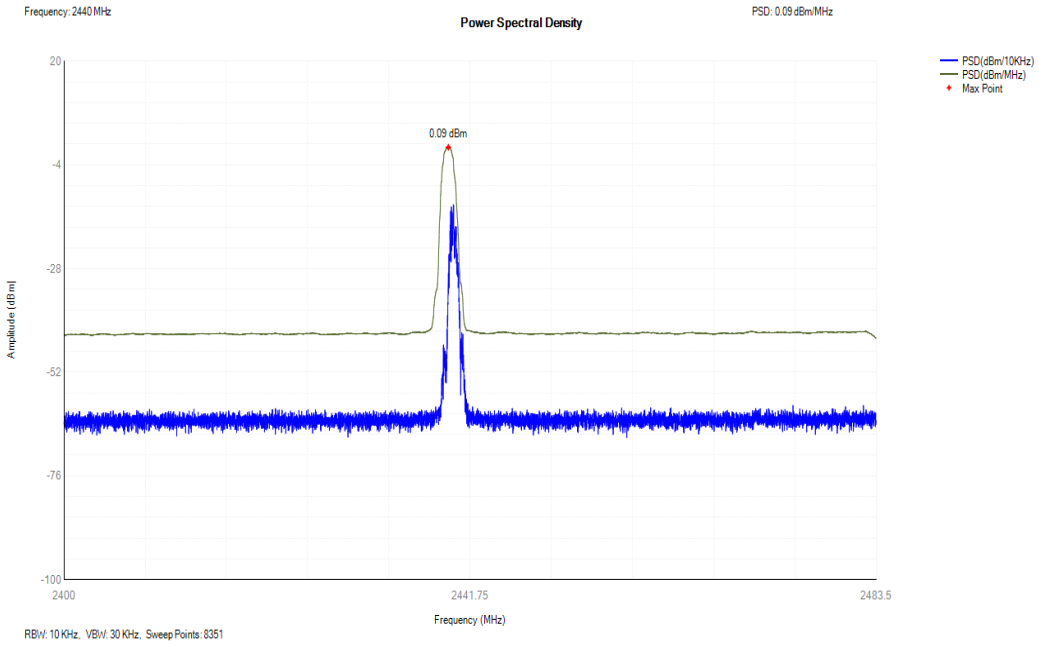
Condition	Mode	Frequency (MHz)	Max PSD (dBm/MHz)	Limit (dBm/MHz)	Verdict
NVNT	BLE	2402	1.17	10	Pass
NVNT	BLE	2440	0.09	10	Pass
NVNT	BLE	2480	0.07	10	Pass

Test Plot

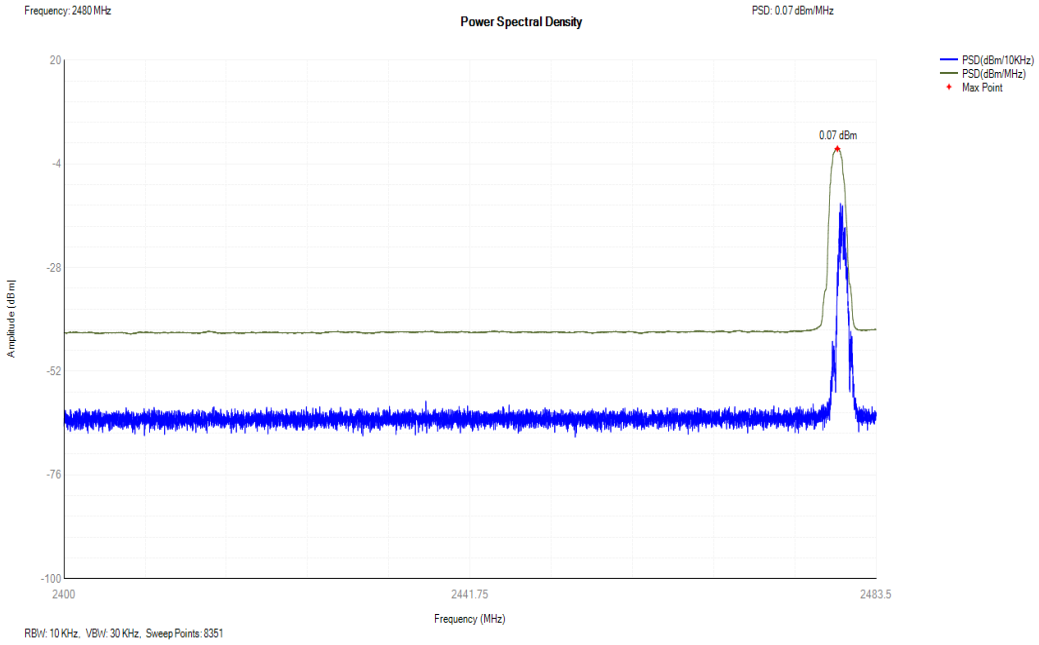
CH00



CH19


Frequency: 2440 MHz
Power Spectral Density
PSD: 0.09 dBm/MHz
PSD(dBm/10KHz)
PSD(dBm/MHz)
Max Point
0.09 dBm
Amplitude (dBm)
20
-4
-28
-52
-76
-100
2400
2441.75
2483.5
Frequency (MHz)
RBW: 10 KHz, VBW: 30 KHz, Sweep Points: 8351

CH39


Frequency: 2480 MHz
Power Spectral Density
PSD: 0.07 dBm/MHz
PSD(dBm/10KHz)
PSD(dBm/MHz)
Max Point
0.07 dBm
Amplitude (dBm)
20
-4
-28
-52
-76
-100
2400
2441.75
2483.5
Frequency (MHz)
RBW: 10 KHz, VBW: 30 KHz, Sweep Points: 8351

5. OCCUPIED CHANNEL BANDWIDTH

5.1 LIMIT

The Occupied Channel Bandwidth shall fall completely within the band 2400 MHz to 2483.5 MHz. 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.

5.2 TEST PROCEDURES

1. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.7.1 for the test conditions.
2. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.7.2 for the measurement method.

-- 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 × Nominal Channel Bandwidth

-- Detector Mode: RMS

-- Trace Mode: Max Hold

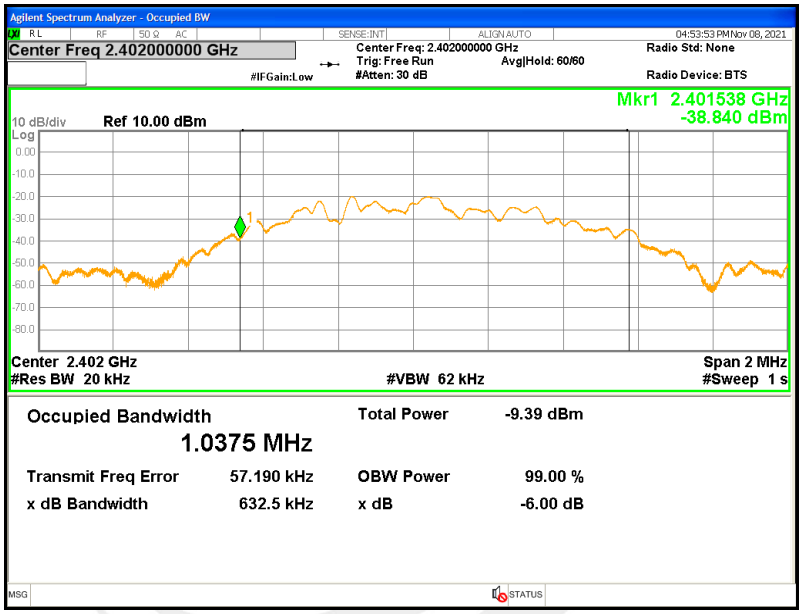
-- Sweep time: 1S

5.3 TEST SETUP

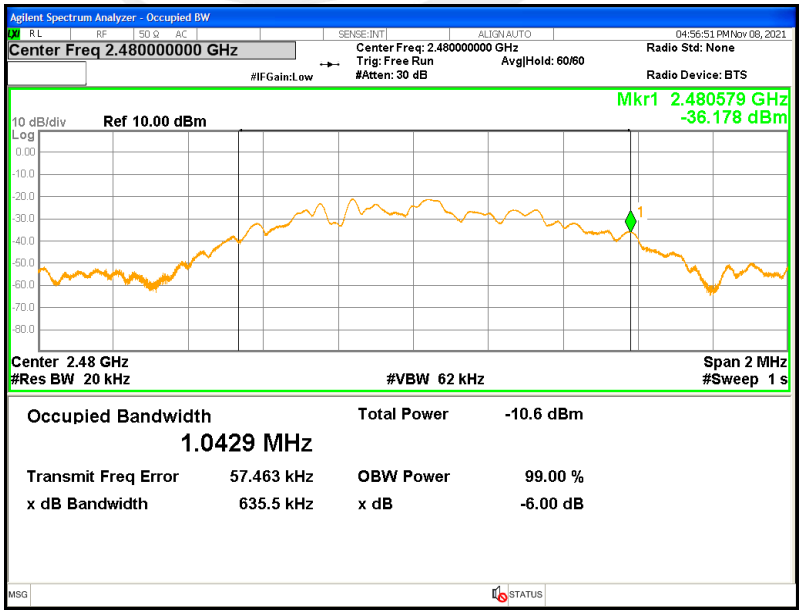
5.4 TEST RESULTS

Condition	Mode	Frequency (MHz)	Center Frequency (MHz)	OBW (MHz)	Lower Edge (MHz)	Upper Edge (MHz)	Limit OBW (MHz)	Verdict
NVNT	BLE	2402	2402.057	1.037	2401.538	2402.576	2400 - 2483.5MHz	Pass
NVNT	BLE	2480	2480.057	1.043	2479.536	2480.579	2400 - 2483.5MHz	Pass

Channel 00



Channel 39



6. TRANSMITTER UNWANTED EMISSIONS IN THE OUT-OF-BAND DOMAIN

6.1 LIMIT

Clause	Frequency	Limit
4.3.2.8.3	2400-BW~2400 2483.5~2483.5+BW	-10dBm/MHz
	2400-2BW~2400-BW 2483.5+BW~2483.5+2BW	-20dBm/MHz
	<2400-2BW >2483.5+2BW	-30dBm/MHz

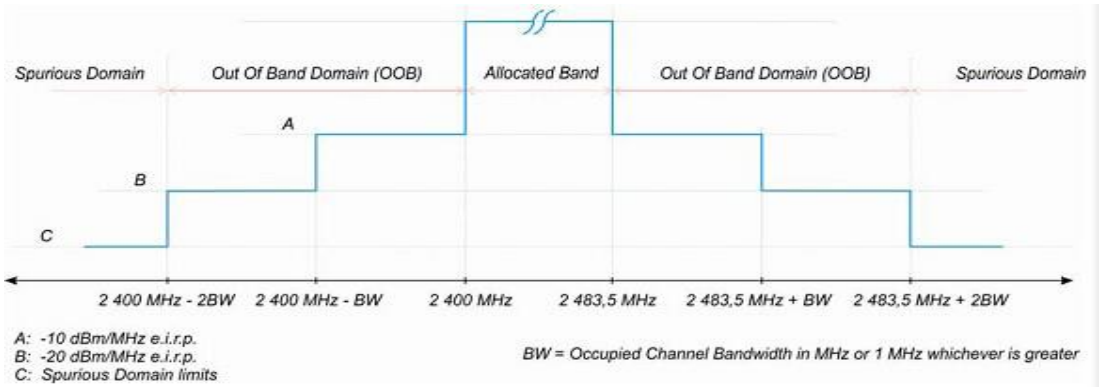


Figure 1: Transmit mask

6.2 TEST PROCEDURES

1. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.8.1 for the test conditions.
2. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.8.2 for the measurement method.

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

- Centre Frequency: 2484 MHz
- Span: 0 Hz
- 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; 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

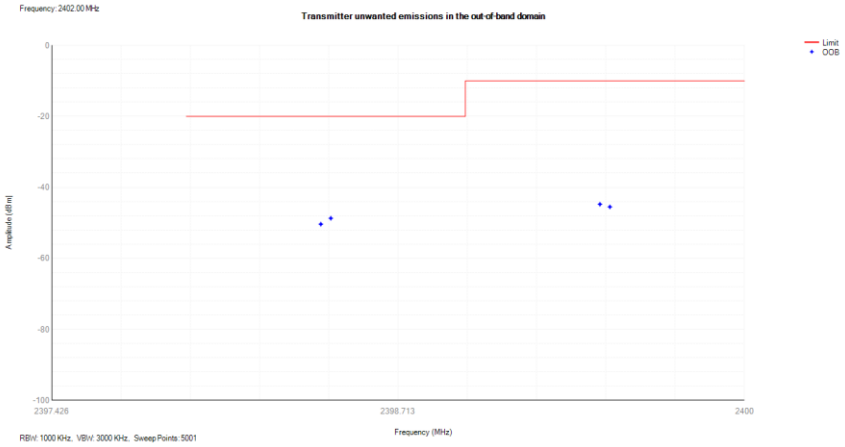
6.3 TEST SETUP

6.4 TEST RESULTS

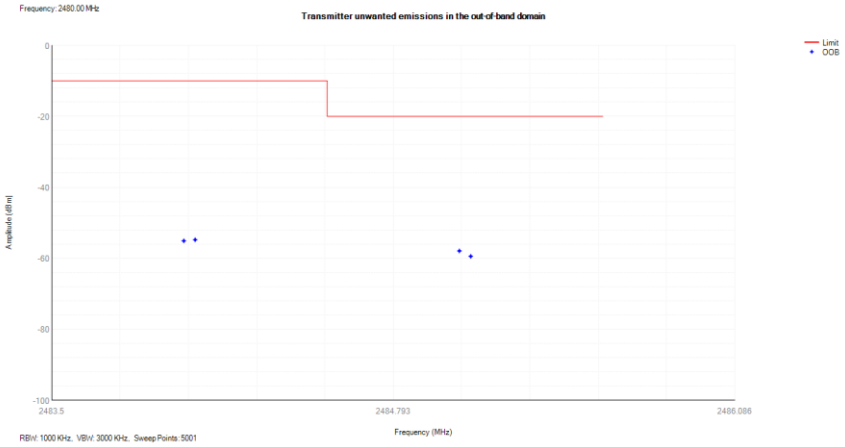
Condition	Mode	Frequency (MHz)	OOB Frequency (MHz)	Level (dBm/MHz)	Limit (dBm/MHz)	Verdict
NVNT	BLE	2402	2399.5	-45.5	-10	Pass
NVNT	BLE	2402	2399.463	-44.76	-10	Pass
NVNT	BLE	2402	2398.463	-48.71	-20	Pass
NVNT	BLE	2402	2398.426	-50.37	-20	Pass
NVNT	BLE	2480	2484	-55.08	-10	Pass
NVNT	BLE	2480	2484.043	-54.77	-10	Pass
NVNT	BLE	2480	2485.043	-57.91	-20	Pass
NVNT	BLE	2480	2485.086	-59.44	-20	Pass

TEST PLOT

BLE LOW



BLE HIGH



7. ADAPTIVE (CHANNEL ACCESS MECHANISM)

7.1 LIMIT

The frequency range of the equipment is determined by the lowest and highest.

Non-LBT based Detect and Avoid:

1. 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.
2. COT ≤ 40ms;
3. Idle Period = 5% of COT;
4. Detection threshold level = -70 dBm/MHz + (20 dBm - Pout e.i.r.p.)/1 MHz (Pout in dBm).

LBT based Detect and Avoid:

1. CCA observation time declared by the supplier:
   a. If the equipment shall perform a Clear Channel Assessment (CCA) check using energy detect. The equipment shall observe the operating channel for the duration of the CCA observation time which shall be not less than 18 µs.
2. COT = 1~10 ms;
3. Idle Period = 5% of COT;
4. Detection threshold level = -70 dBm/MHz + (20 dBm - Pout e.i.r.p.)/1 MHz (Pout in dBm).

LBT based Detect and Avoid (Load Based Equipment):

1. CCA declared by the manufacturer:
   a. If the equipment shall perform a Clear Channel Assessment (CCA) check using energy detect. The equipment shall observe the operating channel for the duration of the CCA observation time which shall be not less than 18 µs.
   b. If the equipment finds the channel occupied, it shall not transmit on this channel, The equipment shall perform an Extended CCA check in which the channel is observed for a random duration in the range between 18 µs and at least 160 µs.
2. COT ≤ (13 / 32) * q ms; q = [4~32]; 1.625ms~13ms;
3. Detection threshold level = -70 dBm/MHz + (20 dBm - Pout e.i.r.p.)/1 MHz (Pout in dBm).

Short Control Signalling Transmissions:

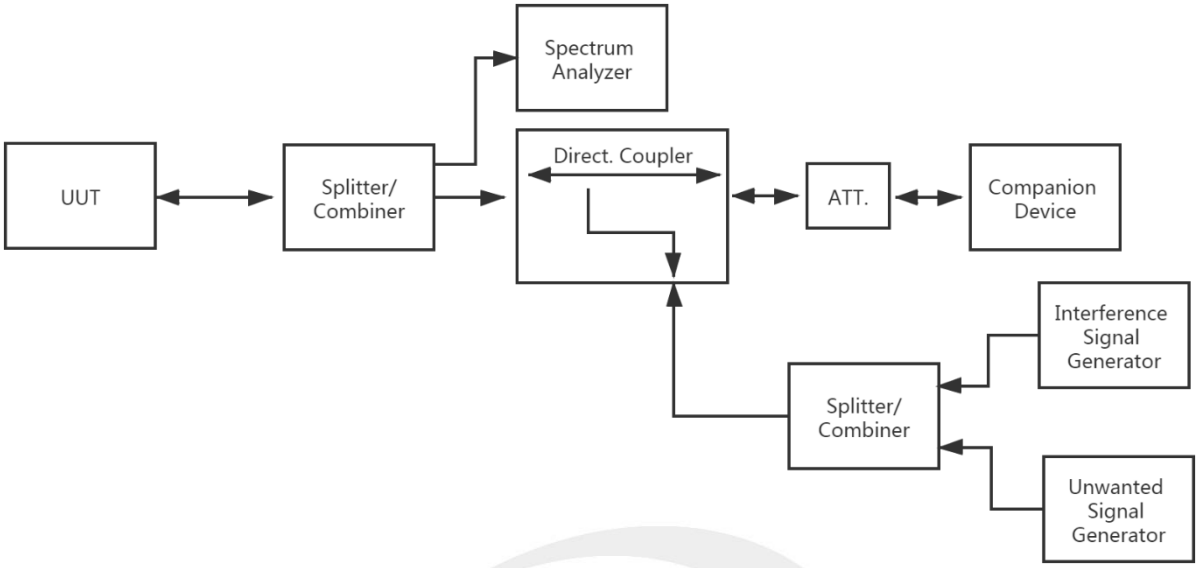
Short Control Signalling Transmissions shall have a maximum duty cycle TxOn / (TxOn + TxOff) ratio of 10 % within any observation period of 50 ms.

7.2 TEST PROCEDURES

1. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.6.1 for the test conditions.
2. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.6.2 for the measurement method.
3. The spectrum analyzer sweep was triggered by the start of the interfering signal, with the interfering signal present, a 100 % duty cycle CW signal is inserted as the blocking signal.

- RBW: ⩾ Occupied Channel Bandwidth (if the analyser does not support this setting, the highest available setting shall be used)
- VBW: 3 × RBW (if the analyser does not support this setting, the highest available setting shall be used)
- Detector Mode: RMS
- Centre Frequency: Equal to the centre frequency of the operating channel
- Span: 0 Hz
- Sweep time: > maximum Channel Occupancy Time
- Trace Mode: Clear Write
- Trigger Mode: Video

7.3 TEST SETUP



a. BLE is normal transmission
b. Interference shall be injected -> BLE shall stop transmission.
c. Blocking shall be injected -> BLE does not resume any normal transmission
d. Removing the interference and blocking signal

7.4 TEST RESULTS

The power less than 10dBm, not applicable.

8. SPURIOUS EMISSIONS – TRANSMITTER

8.1 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 694 MHz	-54 dBm	100 KHz
694 MHz to 1 GHz	-36 dBm	100 KHz
1 GHz to 12.75 GHz	-30 dBm	1 MHz

8.2 TEST PROCEDURES

1. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.9.1 for the test conditions.
2. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.9.2 for the measurement method.

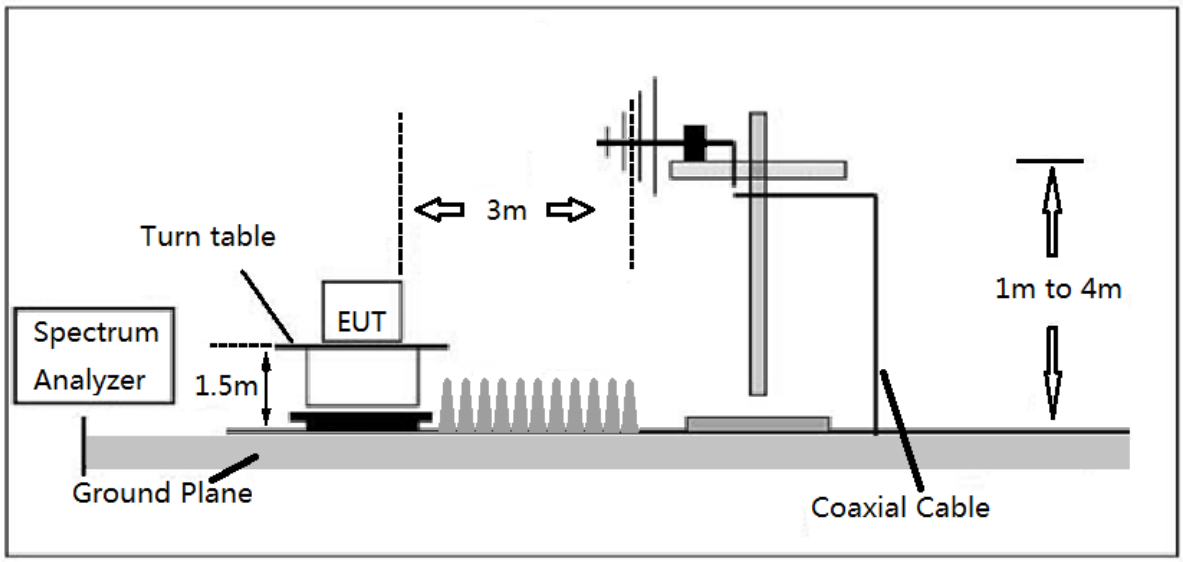
Spectrum analyser settings:

Spectrum Analyzer	Setting	
Frequency Start to Stop	30 MHz to 1000 MHz	1000 MHz to 12750MHz
Resolution Bandwidth	100 kHz	1 MHz
Video Bandwidth	300 kHz	3 MHz
Filter Type	3 dB (Gaussian)	
Detector Mode	Peak	
Trace Mode	Max Hold	
Sweep Points	≥ 19 400 (Set as 20000)	≥ 23 500 (Set as 24000)
Sweep Time	For non continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, Below 1GHz such that for each 100 kHz frequency step, Above 1GHz such that for each 1MHz frequency step, the measurement time is greater than two transmissions of the UUT, on any channel	

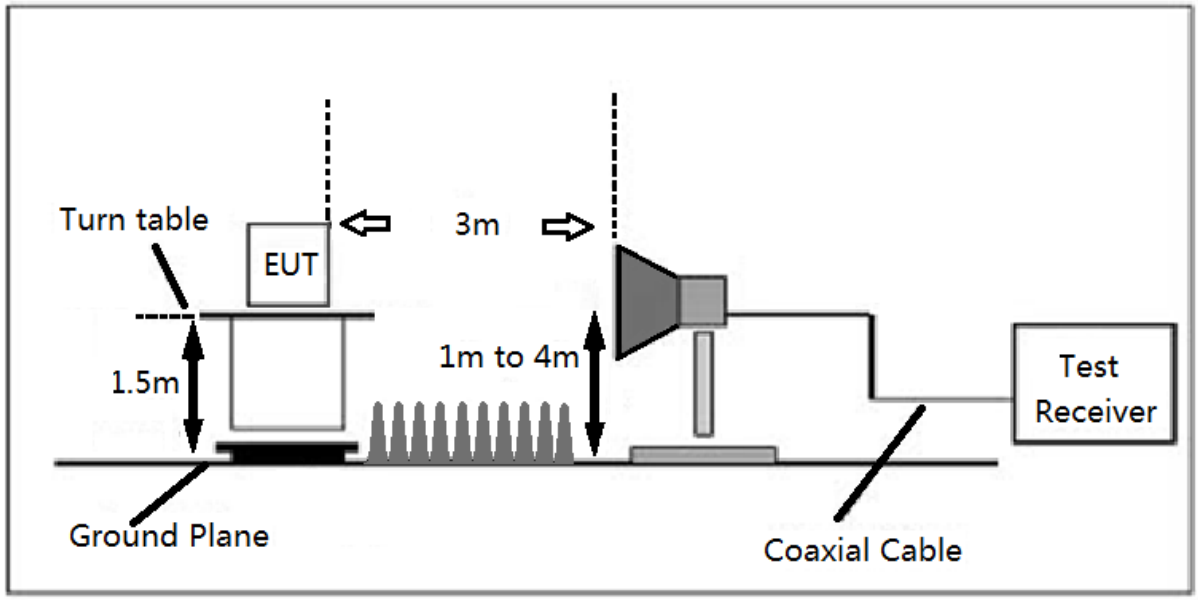
a. The EUT was placed on the top of the turntable (1.5m) in Semi Anechoic Room.
b. The test shall be made in the transmitting mode. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
c. This measurement shall be repeated with the transmitter in standby mode where applicable.
d. For 30~12750MHz spurious emissions measurement, the receiving antenna was placed 3 meters far away from the EUT.
e. The antenna shall vary between 1 m to 4 m to find each suspected emissions of both horizontal and vertical polarization. Each recorded suspected value is indicated as Read Level.
f. Replace the EUT by standard antenna and feed the RF port by signal generator.
g. Adjust the frequency of the signal generator to the suspected emission and slightly rotate the turntable to locate the position with maximum reading.
h. Adjust the power level of the signal generator to reach the same reading with Read Level.
i. The level of the spurious emission is the power level of generator plus the gain of the standard antenna in dBi and minus the loss of the cable used between the signal generator and the standard antenna.
j. 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 ETSI EN 300 328 (V2.2.2) clause 5.4.9.2.1.3 and compared to the limits.
k. The measurement shall be repeated at the lowest and the highest channel of the stated frequency range.
l. EUT Orthogonal Axis:
"X" - denotes Laid on Table; "Y" - denotes Vertical Stand; "Z" - denotes Side Stand.

8.3 TEST SETUP

(A) Radiated Emission Test Set-Up, Frequency Below 1000MHz.



(B) Radiated Emission Test Set-Up Frequency Above 1GHz.



8.4 EUT OPERATION DURING TEST

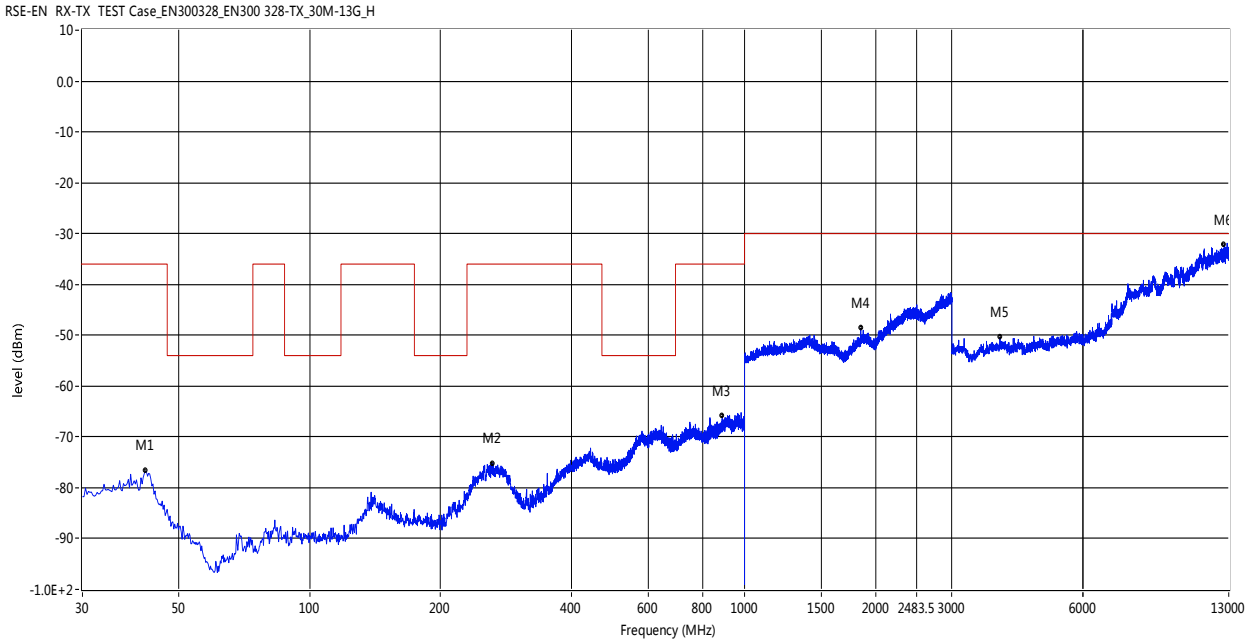
1. The EUT was programmed to be in continuously transmitting mode.
2. For the initial investigation on the highest, lowest frequency, no significant differences in spurious emissions were observed between these 2 channels. The worst test data was shown.
3. There is a filter used during the test, the fundamental signals will be not shown in the plot.

8.5 TEST RESULT

Remark: The all data rate modes had been test, but only worse test data was recorded in the test report.

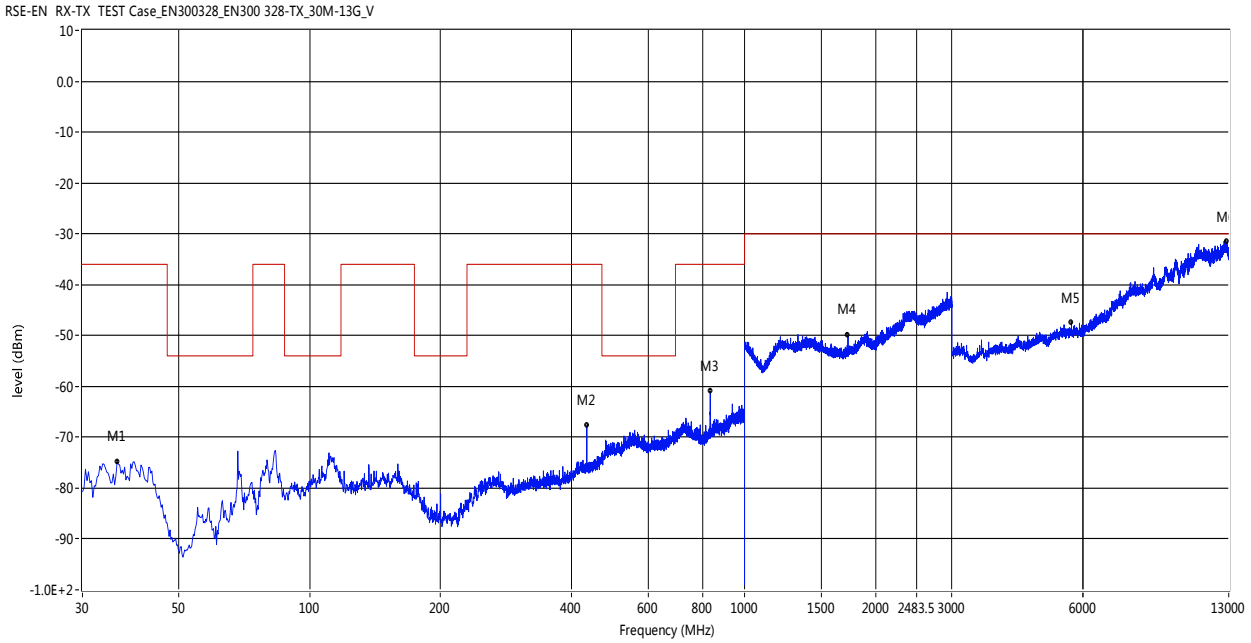
TX 2402MHz

Horizontal



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
41.883	-76.73	-5.65	-36.0	-40.73	155.70	Horizontal	Vertical	Pass
263.285	-75.24	-3.12	-36.0	-39.24	26.40	Horizontal	Vertical	Pass
890.148	-65.91	8.46	-36.0	-29.91	296.60	Horizontal	Vertical	Pass
1851.500	-48.67	14.46	-30.0	-18.67	229.60	Horizontal	Vertical	Pass
3870.000	-50.44	4.01	-30.0	-20.44	194.70	Horizontal	Vertical	Pass
12690.000	-32.18	22.96	-30.0	-2.18	360.00	Horizontal	Vertical	Pass

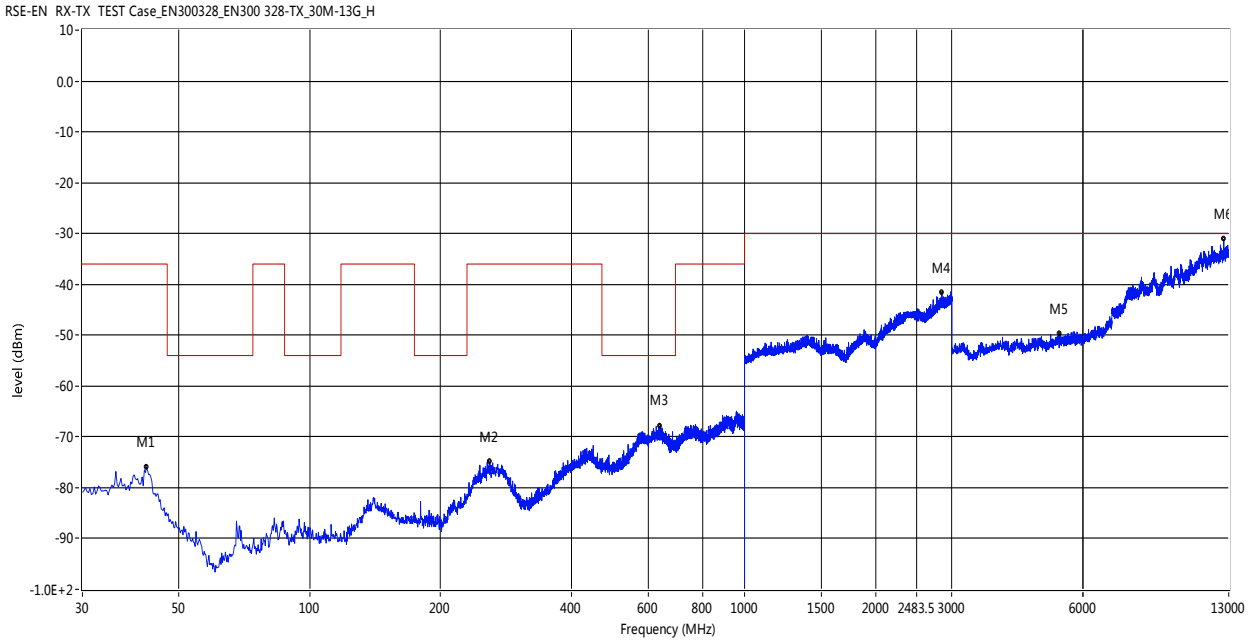
Vertical



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
36.062	-74.78	-10.00	-36.0	-38.78	250.30	Vertical	Vertical	Pass
434.005	-67.76	1.07	-36.0	-31.76	135.70	Vertical	Vertical	Pass
834.130	-60.96	7.39	-36.0	-24.96	30.10	Vertical	Vertical	Pass
1730.000	-49.86	12.02	-30.0	-19.86	271.90	Vertical	Vertical	Pass
5650.000	-47.51	7.13	-30.0	-17.51	128.60	Vertical	Vertical	Pass
12880.000	-31.58	23.69	-30.0	-1.58	99.90	Vertical	Vertical	Pass

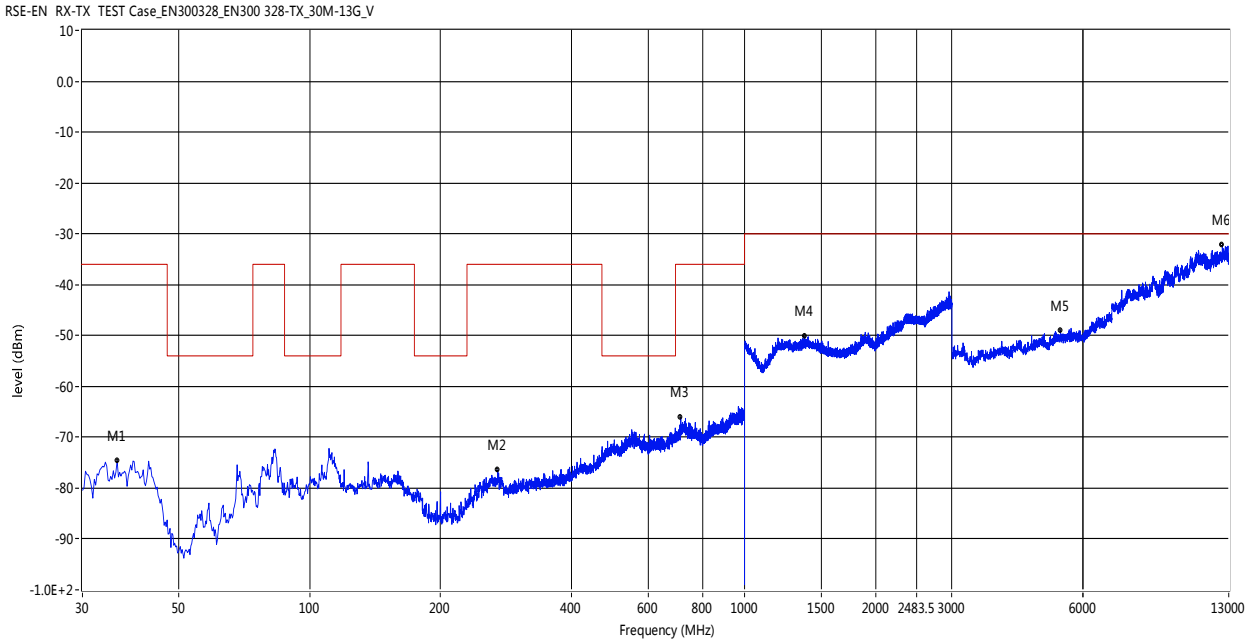
TX 2480MHz

Horizontal



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
42.125	-75.96	-5.83	-36.0	-39.96	215.80	Horizontal	Vertical	Pass
259.647	-74.92	-2.63	-36.0	-38.92	207.20	Horizontal	Vertical	Pass
639.645	-67.79	7.25	-54.0	-13.79	33.30	Horizontal	Vertical	Pass
2845.500	-41.63	20.67	-30.0	-11.63	316.30	Horizontal	Vertical	Pass
5320.000	-49.65	5.90	-30.0	-19.65	28.40	Horizontal	Vertical	Pass
12665.000	-31.16	22.83	-30.0	-1.16	298.30	Horizontal	Vertical	Pass

Vertical



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
36.062	-74.61	-10.00	-36.0	-38.61	263.50	Vertical	Vertical	Pass
270.802	-76.41	-4.49	-36.0	-40.41	274.60	Vertical	Vertical	Pass
713.607	-66.05	7.78	-36.0	-30.05	17.10	Vertical	Vertical	Pass
1375.000	-50.24	13.62	-30.0	-20.24	0.30	Vertical	Vertical	Pass
5332.500	-48.99	6.80	-30.0	-18.99	97.40	Vertical	Vertical	Pass
12565.000	-32.19	23.05	-30.0	-2.19	335.50	Vertical	Vertical	Pass

9. SPURIOUS EMISSIONS – RECEIVER

9.1 LIMIT

Clause	Test Item	Frequency(MHz)	Limit
4.3.2.10.3	Spurious emissions (radiated)	30-1000	-57dBm
		1000-12750	-47dBm

9.2 TEST PROCEDURES

1. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.10.1 for the test conditions.

2. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.10.2 for the measurement method.

Spectrum analyser settings:

Spectrum Analyzer	Setting	
Frequency Start to Stop	30 MHz to 1000 MHz	1000 MHz to 12750MHz
Resolution Bandwidth	100 kHz	1 MHz
Video Bandwidth	300 kHz	3 MHz
Filter Type	3 dB (Gaussian)	
Detector Mode	Peak	
Trace Mode	Max Hold	
Sweep Points	⩾ 19 400 (Set as 20000)	⩾ 23 500 (Set as 24000)
Sweep Time	For non continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, Below 1GHz such that for each 100 kHz frequency step, Above 1GHz such that for each 1MHz frequency step, the measurement time is greater than two transmissions of the UUT, on any channel.	

a. The EUT was placed on the top of the turntable (1.5m) in Semi Anechoic Room.
b. The test shall be made in the transmitting mode. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
c. This measurement shall be repeated with the transmitter in standby mode where applicable.
d. For 30~12750MHz spurious emissions measurement, the receiving antenna was placed 3 meters far away from the EUT.
e. The antenna shall vary between 1 m to 4 m to find each suspected emissions of both horizontal and vertical polarization. Each recorded suspected value is indicated as Read Level.
f. Replace the EUT by standard antenna and feed the RF port by signal generator.
g. Adjust the frequency of the signal generator to the suspected emission and slightly rotate the turntable to locate the position with maximum reading.
h. Adjust the power level of the signal generator to reach the same reading with Read Level.
i. The level of the spurious emission is the power level of generator plus the gain of the standard antenna in dBi and minus the loss of the cable used between the signal generator and the standard antenna.
j. 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 ETSI EN 300 328 (V2.2.2) clause 5.4.9.2.1.3 and compared to the limits.
k. The measurement shall be repeated at the lowest and the highest channel of the stated frequency range.
l. EUT Orthogonal Axis:
"X" - denotes Laid on Table; "Y" - denotes Vertical Stand; "Z" - denotes Side Stand.

9.3 TEST SETUP

This test setup layout is the same as that shown in section 8.3.

9.4 EUT OPERATION DURING TEST

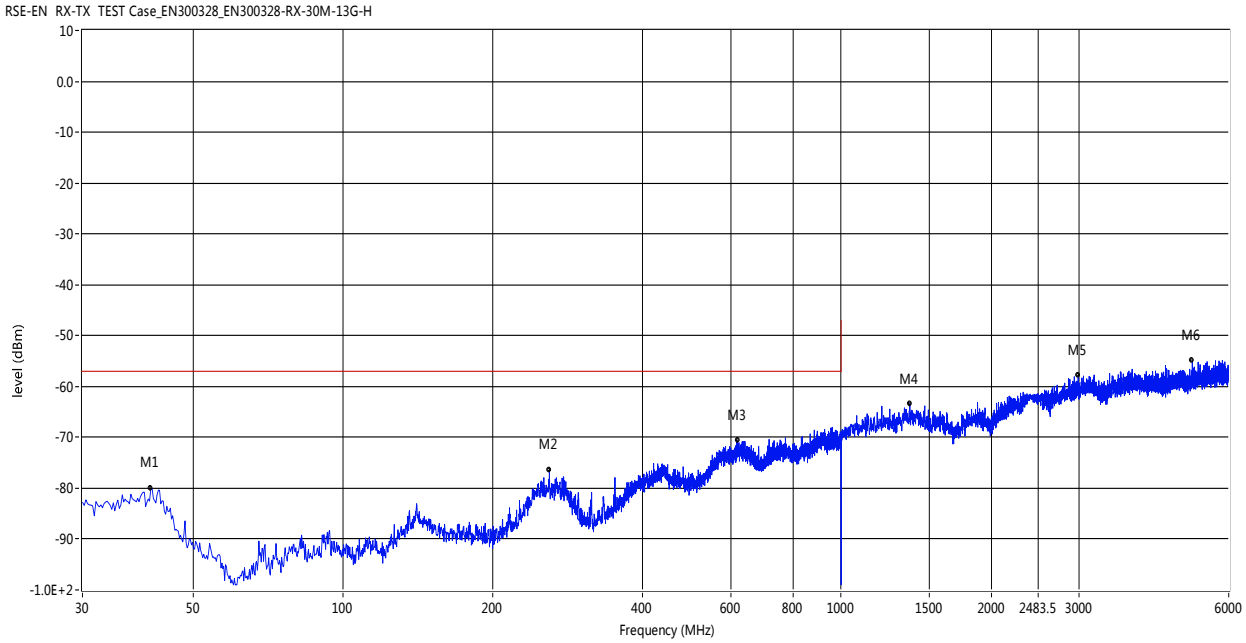
The EUT was programmed to be in continuously receiving mode.

9.5 TEST RESULT

Remark: 1. The all data rate modes had been test, but only worse test data was recorded in the test report.
2. The emissions above 6GHz and below 12.75GHz are too small to be measured and are at least 10 dB below the limit. The signal is mainly from the environmental noise.

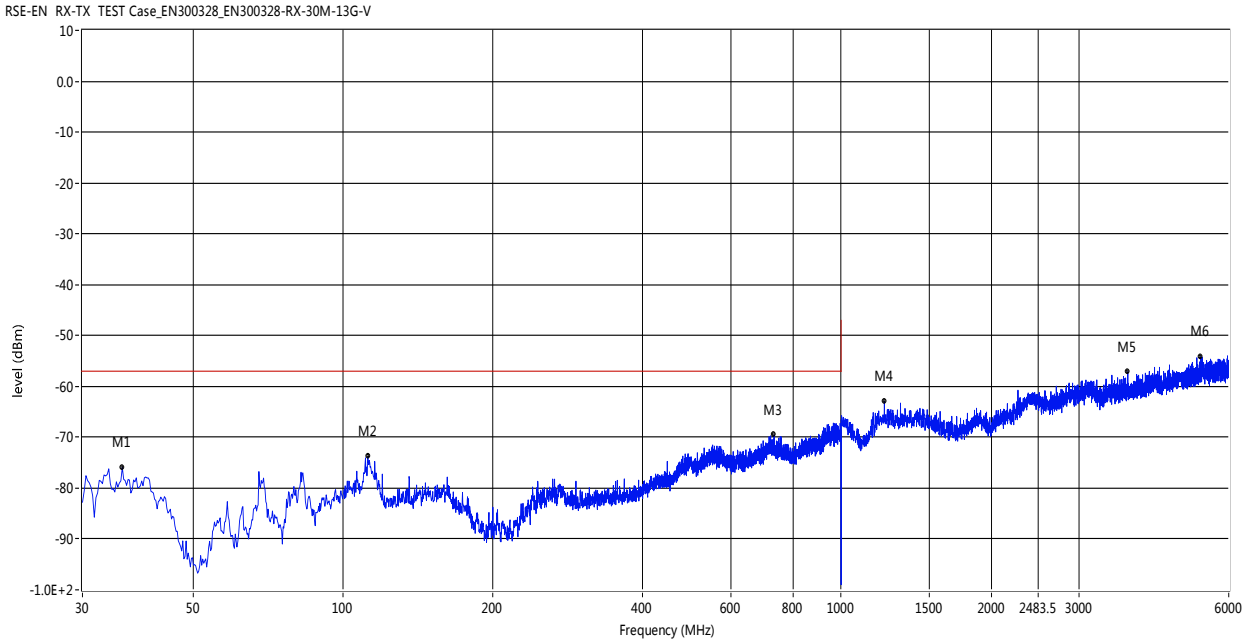
RX 2480MHz

Horizontal



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
41.155	-79.96	-5.10	-57.0	-22.96	5.00	Horizontal	Vertical	Pass
259.647	-76.38	-2.63	-57.0	-19.38	10.00	Horizontal	Vertical	Pass
619.275	-70.69	7.23	-57.0	-13.69	8.00	Horizontal	Vertical	Pass
1373.750	-63.36	-3.64	-47.0	-16.36	10.00	Horizontal	Vertical	Pass
2991.250	-57.83	2.32	-47.0	-10.83	2.00	Horizontal	Vertical	Pass
5068.750	-54.95	5.66	-47.0	-7.95	8.00	Horizontal	Vertical	Pass

Vertical



Frequency (MHz)	Result (dBm)	Factor (dB)	PK Limit (dBm)	Over Limit (dB)	Table (o)	ANT	EUT	Verdict
36.062	-75.92	-10.00	-57.0	-18.92	6.00	Vertical	Vertical	Pass
112.207	-73.84	-4.24	-57.0	-16.84	3.00	Vertical	Vertical	Pass
733.492	-69.53	7.88	-57.0	-12.53	3.00	Vertical	Vertical	Pass
1221.250	-62.93	-4.14	-47.0	-15.93	9.00	Vertical	Vertical	Pass
3762.500	-57.09	2.81	-47.0	-10.09	5.00	Vertical	Vertical	Pass
5273.750	-54.15	7.25	-47.0	-7.15	3.00	Vertical	Vertical	Pass

10. RECEIVER BLOCKING

10.1 LIMIT

While maintaining the minimum performance criteria as defined in clause 4.3.1.12.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in below.

Receiver Category 1

Receiver Blocking parameters for Receiver Category 1 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 4)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 4)	Type of blocking signal
(-133 dBm + 10 × log10(OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × log10(OCBW)) or -74 dBm whichever is less (see note 3)	2 300 2 330 2 360 2 524 2 584 2 674		

NOTE 1: OCBW is in Hz.
NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.
NOTE 3: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 20 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.
NOTE 4: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.

Receiver Category 2

Receiver Blocking parameters receiver Category 2 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
(-139 dBm + 10 × log10(OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
NOTE 1: OCBW is in Hz. NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.			

Receiver Category 3

Receiver Blocking parameters receiver Category 3 equipment

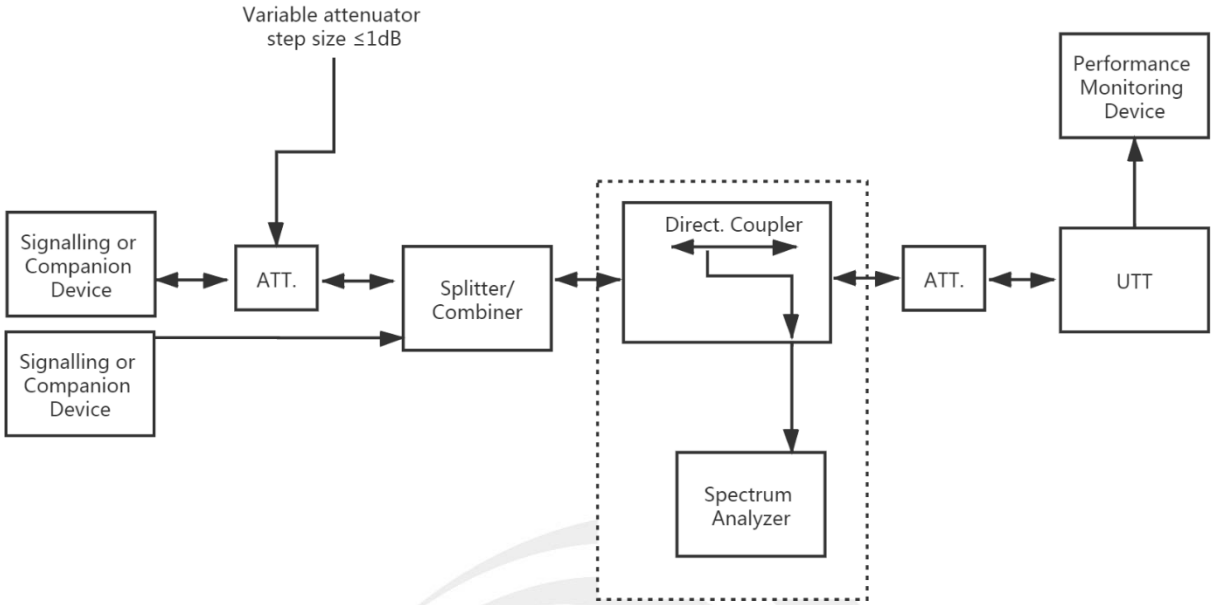
Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking Signal
(-139 dBm + 10 × log10(OCBW) + 20 dB) or (-74 dBm + 20 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
NOTE 1: OCBW is in Hz. NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative the test may be performed using a wanted signal up to Pmin + 30 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.			

10.2 TEST PROCEDURES

1. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.11.1 for the test conditions.

2. Please refer to ETSI EN 300 328 (V2.2.2) clause 5.4.11.2 for the measurement method.

10.3 TEST SETUP



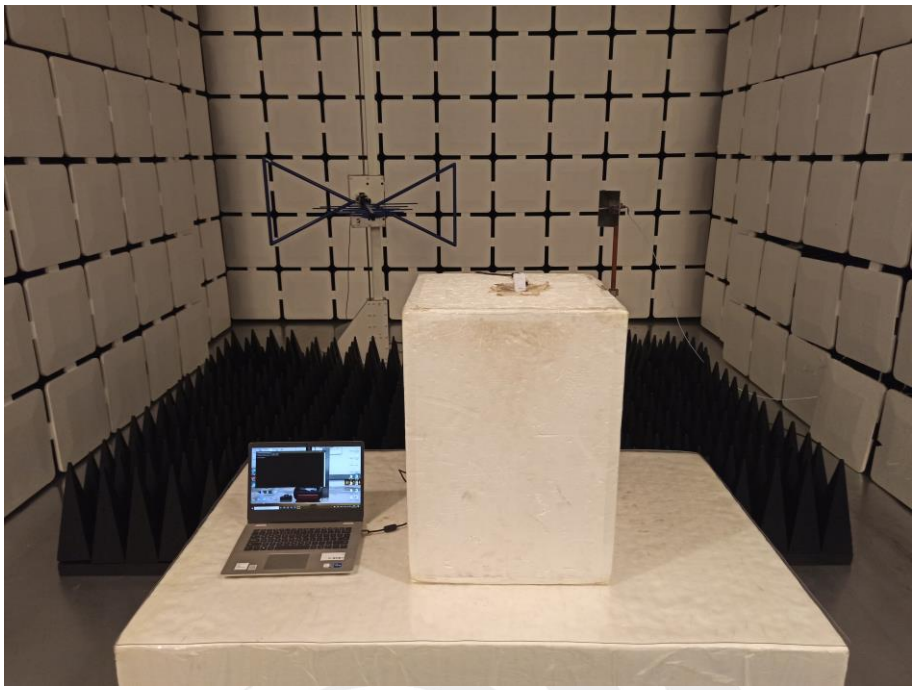
10.4 TEST RESULTS

Note: The power more than 0dBm, less than 10dBm, belong to category 2.

Wanted signal mean power from companion device (dBm)	Test Channel	Blocking signal frequency (MHz)	Blocking signal power(dBm) CW	PER	Limit	Results
-66.32	Low	2300 2380	-34	0.26%	≤10%	PASS
				0.54%		
	High	2504 2584		0.38%		
				0.39%		

NOTE 1: OCBW is 1043000Hz.
NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.
NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.

Test Setup Photos



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