TEST REPORT

ETSI EN 300 440 V2.2.1 (2018-07)

Report Reference No. ..... :	**TZ240105305-WLAN3**
Compiled by (position+printed name+signature) . :	File administrators Anna Hu
Supervised by (position+printed name+signature) . :	Technique principal Hugo Chen
Approved by (position+printed name+signature) . :	Manager Andy Zhang
Date of issue ..... :	2024/1/30

Testing Laboratory Name ..... :	Shenzhen Tongzhou Testing Co.,Ltd
Address ..... :	1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China
Applicant's name ..... :	**Shenzhen Wanbo Technology Co., Ltd.**
Address ..... :	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Test specification..... **:**	
Standard..... :	**ETSI EN 300 440 V2.2.1 (2018-07)**
TRF Originator ..... :	Shenzhen Tongzhou Testing Co.,Ltd
Master TRF ..... :	Dated 2024-01

Test item description..... :	**Wanbo Projector**
Trade Mark..... :	Wanbo
Model/Type reference ..... :	WPC24
List Model..... :	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Hardware Version ..... :	KSOC_352_S2_WB
Software Version..... :	wanbo-WPC24-KGHE
Ratings ..... :	AC 100-240V 50/60Hz 2A(Max)
Result ..... :	**PASS**

TEST REPORT

Test Report No. :	TZ240105305-WLAN3	2024/1/30 Date of issue

Equipment under Test	:	Wanbo Projector
Model /Type	:	WPC24
Listed Models	:	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Applicant	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Manufacturer	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China

Test Result:	**PASS**

The test report merely corresponds to the test sample.

** Modifited History **

Revision	Description	Issued Data	Remark
Revision 00	Initial Test Report Release	2024/1/30	Andy Zhang

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

ETSI EN 300 440 V2.2.1 (2018-07)
Short Range Devices (SRD); Radio equipment to be used in the 1 GHz to 40 GHz frequency range; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2016/53/EU

2 SUMMARY

2.1 General Remarks

Date of receipt of test sample	:	2024/1/11
Testing commenced on	:	2024/1/11
Testing concluded on	:	2024/1/29

2.2 Product Description

The **Shenzhen Wanbo Technology Co., Ltd.**'s Model: WPC24 or the "EUT" as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

Name of EUT	Wanbo Projector
Model(s) Number	WPC24
List Model	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Difference description	All the same except for the model name
Hardware version	KSOC_352_S2_WB
Software version	wanbo-WPC24-KGHE

2.3 Wireless Function Tested in this report

Wireless Type	Working Frequency	Modulation Type
WLAN(5G)	5745MHz to 5825MHz	IEEE 802.11n :OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11a:OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11ac: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK)

2.4 Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	120V / 60 Hz	○	115V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

AC 100-240V 50/60Hz 2A(Max)

2.5 Short description of the Equipment under Test (EUT)

Wanbo Projector(M/N: WPC24)

For more details, refer to the user's manual of the EUT.

2.6 EUT operation mode

The EUT has been tested under typical operating condition. The Applicant provides software to control the EUT for staying in continous transmitting and receiving mode for testing.

2.7 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - supplied by the lab

/	/	/	/
/	/	/	/
/	/	/	/

2.8 Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version	Date of receipt	Type of Test
TZ240105305-1#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	Radio
TZ240105305-2#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	SAR (EMF)
TZ240105305-3#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	EMC

2.9 Modifications

No modifications were implemented to meet testing criteria.

3 TEST ENVIRONMENT

3.1 Address of the test laboratory

Shenzhen Tongzhou Testing Co.,Ltd
1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 (2014) and CISPR Publication 22.

3.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature/NT: 25℃
High Temperature/HT: 35℃
Low Temperature/LT: 0℃
Normal Voltage: AC 230V
High Voltage/HV: AC 264V
Low Voltage/LV: AC 90V
Relative Humidity: 55 %
Air Pressure: 989 hPa

3.3 Test Description

ETSI EN 300 440 requirements		
Test Items	standard	Verdict
Transmitter requirements		
Equivalent isotropically radiated power (e.i.r.p.)	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.2.2	PASS
Permitted range of operating frequencies	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.2.3	PASS
Unwanted emissions in the spurious domain	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.2.4	PASS
Duty cycle	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.2.5	PASS
Additional requirements for FHSS equipment	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.2.6	PASS
Receiver requirements		
Adjacent channel selectivity	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.3.3	N/A
Blocking or desensitization	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.3.4	N/A
Spurious emissions	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.3.5	PASS
Spectrum access techniques		
Listen Before Talk (LBT)	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.4.2	Compliance (note1)
Detect And Avoid techniques (DAA)	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.4.3	Compliance (note1)
Adaptive Frequency Agility (AFA)	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.4.4	Compliance (note1)
2,45 GHz RFID systems		
Effective radiated power	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.5	N/A
GBSAR systems		
Effective radiated power	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.6.1	N/A
Permitted range of operating frequencies	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.6.2	N/A
DAA threshold	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.6.3	N/A
Antenna pattern	ETSI EN 300 440 V2.2.1 (2018-07)) Sub-clause 4.6.4	N/A

Remark: The measurement uncertainty is not included in the test result.

3.4 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics;Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics;Part 2 " and is documented in the Shenzhen Tongzhou Testing Co.,Ltd quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Shenzhen Tongzhou Testing Co.,Ltd is reported:

Test Items	Measurement Uncertainty	Notes
Frequency error	25 Hz	(1)
Frequency range	25 Hz	(1)
Transmitter power conducted	0.57 dB	(1)
Transmitter power Radiated	2.20 dB	(1)
Adjacent and alternate channel power Conducted	1.20 dB	(1)
Conducted spurious emission	1.60 dB	(1)
Radiated spurious emission	2.20 dB	(1)
Intermodulation attenuation	1.00 dB	(1)
Maximum useable receiver sensitivity	2.80 dB	(1)
Co-channel rejection	2.80 dB	(1)
Adjacent channel selectivity	2.80 dB	(1)
Spurious response rejection	2.80 dB	(1)
Intermodulation response rejection	2.80 dB	(1)
Blcking or desensitization	2.80 dB	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=1.96.

3.5 Equipments Used during the Test

Conducted Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
2	Signal Generator	Keysight	N5182A	MY4620709	2024/1/4	2025/1/3
3	Signal Generator	R&S	SML03	102924/0013	2024/1/4	2025/1/3
4	Power Sensor	Agilent	U2021XA	MY5365004	2024/1/4	2025/1/3
5	Power Meter	Agilent	U2531A	TW53323507	2024/1/4	2025/1/3
6	Climate Chamber	KRUOMR	KRM-1000	KRM16072901	2024/1/4	2025/1/3
7	Wideband Radio Communication Tester	R&S	CMW500	101855	2024/1/4	2025/1/3
8	Test Software	Tonscend	JS1120-3	V3.2.22	--	--

Radiated Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	Wideband Antenna	schwarzbeck	VULB 9163	958	2022/11/13	2025/11/12
2	Horn Antenna	schwarzbeck	BBHA 9120D	01989	2022/11/13	2025/11/12
3	EMI Test Receiver	R&S	ESCI	100849/003	2024/1/4	2025/1/3
4	Controller	MF	MF7802	N/A	N/A	N/A
5	Amplifier	schwarzbeck	BBV 9743	209	2024/1/4	2025/1/3
6	Amplifier	Tonscend	TSAMP-0518SE	--	2024/1/4	2025/1/3
7	RF Cable	HUBER+SUHNER	RG214	N/A	2024/1/4	2025/1/3
8	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
9	Horn Antenna	ETS	3117	00218874	2022/11/13	2025/11/12
10	Wideband Antenna	Sunol	JB3	A020115	2022/7/3	2025/7/2
11	Test Software	Tonscend	JS36-RSE	V5.0.0.0	--	--

4 TEST CONDITIONS AND RESULTS

4.1 Transmitter Requirements

4.1.1 Effective Radiated Power (radiated measurement)

APPLICABILITY

The equivalent isotropically radiated power requirement shall apply to all transmitters.

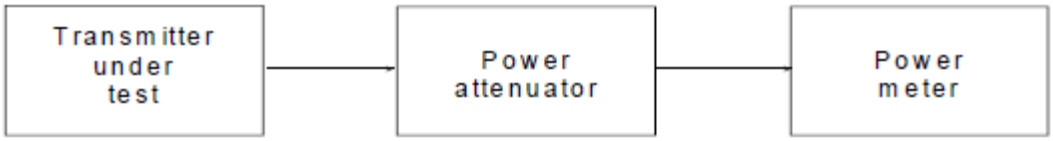
LIMIT

The transmitter maximum e.i.r.p. under normal and extreme test conditions is provided in table 2.

Table 2: Maximum radiated peak power (e.i.r.p.)

Frequency Bands	Power	Application	Notes
2 400 MHz to 2 483,5 MHz	10 mW e.i.r.p.	Non-specific short range devices	
2 400 MHz to 2 483,5 MHz	25 mW e.i.r.p.	Radio determination devices	
(a) 2 446 MHz to 2 454 MHz	500 mW e.i.r.p.	Radio Frequency Identification (RFID) devices	See also table 4 and annex D
(b) 2 446 MHz to 2 454 MHz	4 W e.i.r.p.	Radio Frequency Identification (RFID) devices	See also table 4 and annex D
5 725 MHz to 5 875 MHz	25 mW e.i.r.p.	Non-specific short range devices	
9 200 MHz to 9 500 MHz	25 mW e.i.r.p.	Radio determination devices	
9 500 MHz to 9 975 MHz	25 mW e.i.r.p.	Radio determination devices	
10,5 GHz to 10,6 GHz	500 mW e.i.r.p.	Radio determination devices	
13,4 GHz to 14,0 GHz	25 mW e.i.r.p.	Radio determination devices	
17,1 GHz to 17,3 GHz	400 mW e.i.r.p.	Radio determination devices	See annex F
24,00 GHz to 24,25 GHz	100 mW e.i.r.p.	Non-specific short range devices and Radio determination devices	

TEST CONFIGURATION



TEST PROCEDURE

☐ 4.2.2.3.1 Non spread spectrum transmitters with a -6 dB bandwidth of up to 20 MHz and spread spectrum transmitters with channel bandwidth of up to 1 MHz

☒ 4.2.2.3.2 Transmitters other than those defined in clause 4.2.2.3.1

TEST RESULTS

Pass

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Test Condition	Test Mode	Antenna	Freq(MHz)	TPC	EIRP [dBm]	EIRP Limit [dBm]	Verdict
NTNV	11A	Ant1	5745	NA	11.91	14	PASS
	11N20SISO	Ant1	5745	NA	10.51	14	PASS
	11N40SISO	Ant1	5755	NA	11.00	14	PASS
	11AC20SISO	Ant1	5745	NA	10.58	14	PASS
	11AC40SISO	Ant1	5755	NA	10.93	14	PASS
	11AC80SISO	Ant1	5775	NA	8.80	14	PASS
LTNV	11A	Ant1	5745	NA	11.55	14	PASS
	11N20SISO	Ant1	5745	NA	10.94	14	PASS
	11N40SISO	Ant1	5755	NA	10.91	14	PASS
	11AC20SISO	Ant1	5745	NA	10.73	14	PASS
	11AC40SISO	Ant1	5755	NA	10.87	14	PASS
	11AC80SISO	Ant1	5775	NA	8.87	14	PASS
HTNV	11A	Ant1	5745	NA	11.93	14	PASS
	11N20SISO	Ant1	5745	NA	10.60	14	PASS
	11N40SISO	Ant1	5755	NA	10.78	14	PASS
	11AC20SISO	Ant1	5745	NA	10.92	14	PASS
	11AC40SISO	Ant1	5755	NA	10.84	14	PASS
	11AC80SISO	Ant1	5775	NA	8.88	14	PASS

4.1.2 Permitted range of operating frequencies

APPLICABILITY

The Permitted range of operating frequencies shall apply to all transmitters.

LIMIT

According to ETSI EN 300 440 V2.2.1 (2018-07) 4.2.3.5

The width of the power spectrum envelope is fH -fL for a given operating frequency. In equipment that allows adjustment or selection of different operating frequencies, the power envelope takes up different positions in the allowed band. The frequency range is determined by the lowest value of fL and the highest value of fH resulting from the adjustment of the equipment to the lowest and highest operating frequencies.

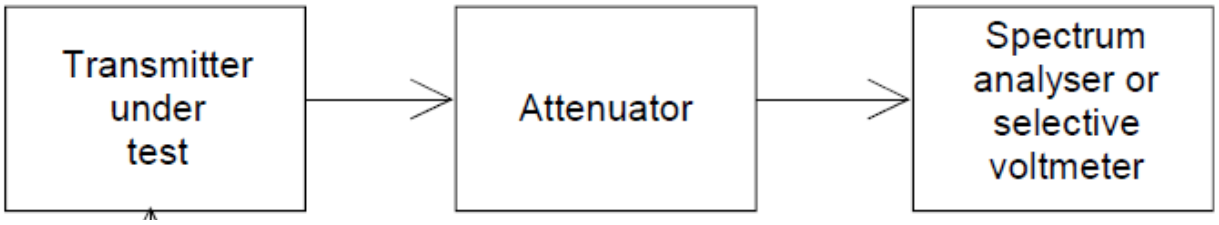
The occupied bandwidth (i.e. the bandwidth in which 99 % of the wanted emission is contained) of the transmitter shall fall within the assigned frequency band.

For all equipment the frequency range shall lie within the frequency band given by clause 4.2.2.4, table 2. For non-harmonized frequency bands the available frequency range may differ between national administrations.

Table 2: Maximum radiated peak power (e.i.r.p.)

Frequency Bands	Power	Application	Notes
2 400 MHz to 2 483,5 MHz	10 mW e.i.r.p.	Non-specific short range devices	
2 400 MHz to 2 483,5 MHz	25 mW e.i.r.p.	Radio determination devices	
(a) 2 446 MHz to 2 454 MHz	500 mW e.i.r.p.	Radio Frequency Identification (RFID) devices	See also table 4 and annex D
(b) 2 446 MHz to 2 454 MHz	4 W e.i.r.p.	Radio Frequency Identification (RFID) devices	See also table 4 and annex D
5 725 MHz to 5 875 MHz	25 mW e.i.r.p.	Non-specific short range devices	
9 200 MHz to 9 500 MHz	25 mW e.i.r.p.	Radio determination devices	
9 500 MHz to 9 975 MHz	25 mW e.i.r.p.	Radio determination devices	
10,5 GHz to 10,6 GHz	500 mW e.i.r.p.	Radio determination devices	
13,4 GHz to 14,0 GHz	25 mW e.i.r.p.	Radio determination devices	
17,1 GHz to 17,3 GHz	400 mW e.i.r.p.	Radio determination devices	See annex F
24,00 GHz to 24,25 GHz	100 mW e.i.r.p.	Non-specific short range devices and Radio determination devices	

TEST CONFIGURATION



TEST PROCEDURE

☐ 4.2.2.3.1 Non spread spectrum transmitters with a -6 dB bandwidth of up to 20 MHz and spread spectrum transmitters with channel bandwidth of up to 1 MHz

☒ 4.2.2.3.2 Transmitters other than those defined in clause 4.2.2.3.1

RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

802.11a				
Test Condition	Lower (MHz)	Highest (MHz)	Limit (MHz)	Result
NTC	5736.04	5834.04	(5725,5875)	Pass
HTLV	5736.08	5834.07	(5725,5876)	Pass
HTHV	5736.05	5834.06	(5725,5877)	Pass
LTLV	5736.02	5834.01	(5725,5878)	Pass
LTHV	5736.03	5834.04	(5725,5879)	Pass

802.11n HT40				
Test Condition	EIRP (dBm)	EIRP (mW)	Limit (MHz)	Result
NTC	5736.76	5813.56	(5725,5875)	Pass
HTLV	5736.78	5813.57	(5725,5876)	Pass
HTHV	5736.71	5813.59	(5725,5877)	Pass
LTLV	5736.73	5813.53	(5725,5878)	Pass
LTHV	5736.78	5813.53	(5725,5879)	Pass

802.11n HT20				
Test Condition	EIRP (dBm)	EIRP (mW)	Limit (MHz)	Result
NTC	5735.88	5815.96	(5725,5875)	Pass
HTLV	5735.90	5815.95	(5725,5876)	Pass
HTHV	5735.88	5815.98	(5725,5877)	Pass
LTLV	5735.85	5816.01	(5725,5878)	Pass
LTHV	5735.87	5815.92	(5725,5879)	Pass

802.11ac VHT40				
Test Condition	EIRP (dBm)	EIRP (mW)	Limit (MHz)	Result
NTC	5736.76	5813.56	(5725,5875)	Pass
HTLV	5736.74	5813.55	(5725,5876)	Pass
HTHV	5736.79	5813.52	(5725,5877)	Pass
LTLV	5736.75	5813.59	(5725,5878)	Pass
LTHV	5736.74	5813.56	(5725,5879)	Pass

802.11ac VHT20				
Test Condition	EIRP (dBm)	EIRP (mW)	Limit (MHz)	Result
NTC	5735.82	5815.93	(5725,5875)	Pass
HTLV	5735.81	5815.92	(5725,5876)	Pass
HTHV	5735.81	5815.90	(5725,5877)	Pass
LTLV	5735.79	5815.91	(5725,5878)	Pass
LTHV	5735.85	5815.94	(5725,5879)	Pass

802.11ac VHT80				
Test Condition	EIRP (dBm)	EIRP (mW)	Limit (MHz)	Result
NTC	5736.57	5813.63	(5725,5875)	Pass
HTLV	5736.79	5813.60	(5725,5876)	Pass
HTHV	5736.73	5813.67	(5725,5877)	Pass
LTLV	5736.79	5813.59	(5725,5878)	Pass
LTHV	5736.74	5813.64	(5725,5879)	Pass

4.1.3 Unwanted emissions in the spurious domain

APPLICABILITY

The unwanted emissions in the spurious domain requirement shall apply to all transmitters.

LIMIT

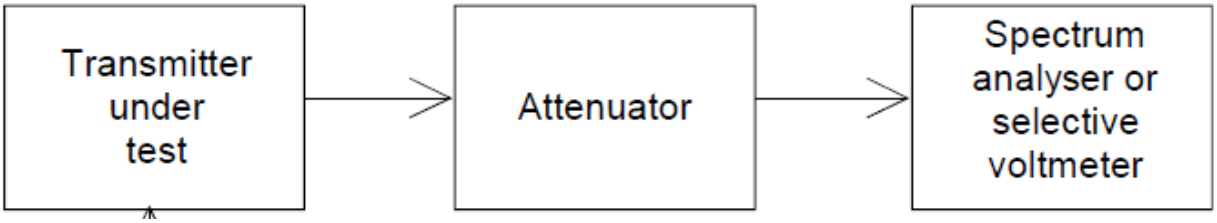
The maximum power limits of any unwanted emissions in the spurious domain are given in table 3.

Table 3: Spurious emissions

Frequency ranges / State	47 MHz to 74 MHz 87,5 MHz to 108 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies ≤ 1 000 MHz	Frequencies > 1 000 MHz
Operating	4 nW	250 nW	1 µW
Standby	2 nW	2 nW	20 nW

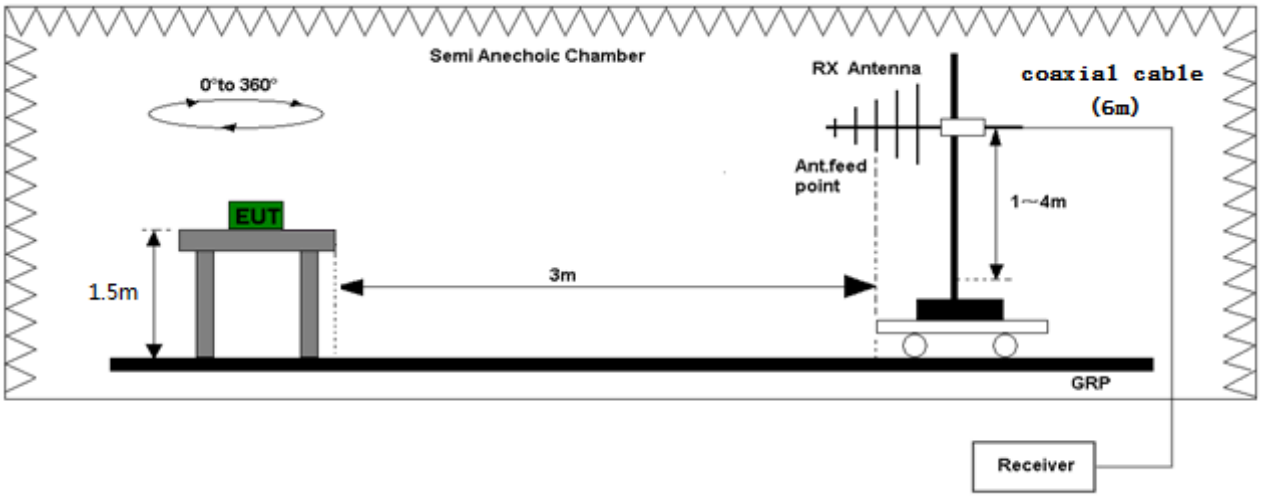
TEST CONFIGURATION

Conducted Method:

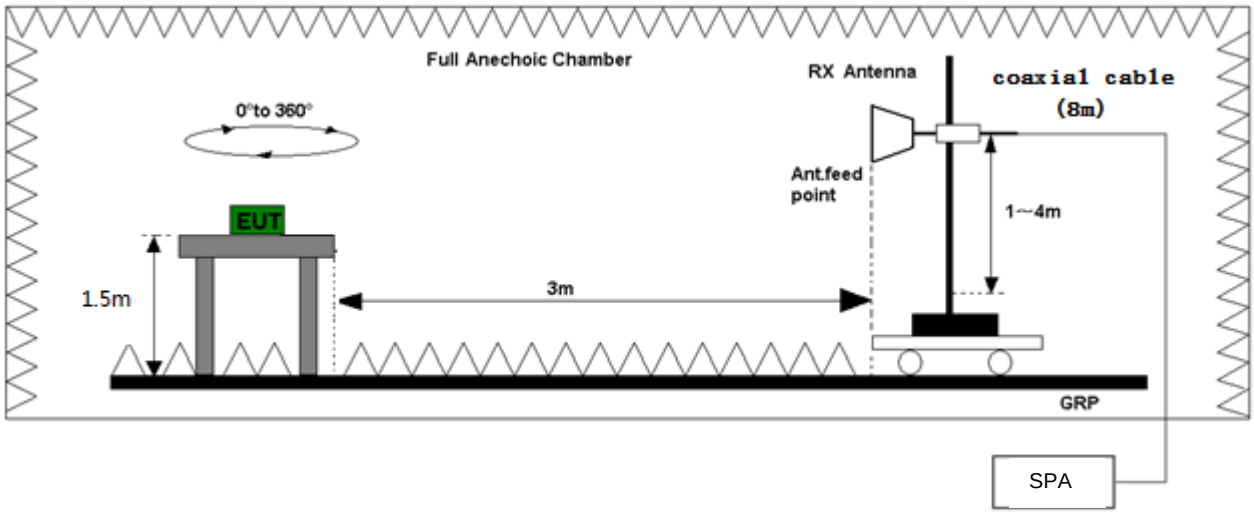


Radiated Method:

Below 1GHz



Above 1GHz



Conformance

☐ 4.2.4.3.1 Conducted spurious emission

☐ 4.2.4.3.2 Method of measurement - cabinet spurious radiation

☒ 4.2.4.3.3 Method of measurement - radiated spurious emission

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Tony Luo

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
769.89	V	-62.00	-54	8.00	PASS
772.08	H	-59.86	-54	5.86	PASS
Above 1GHz:					
Test Mode：Low Channel					
11490	H	-41.94	-30	11.94	PASS
11490	V	-43.77	-30	13.77	PASS
17235	H	-43.74	-30	13.74	PASS
17235	V	-45.49	-30	15.49	PASS
22980	H	-46.02	-30	16.02	PASS
22980	V	-48.24	-30	18.24	PASS
Test Mode：High Channel					
11650	H	-44.16	-30	14.16	PASS
11650	V	-45.51	-30	15.51	PASS
17475	H	-44.48	-30	14.48	PASS
17475	V	-47.09	-30	17.09	PASS
23300	H	-45.39	-30	15.39	PASS

23297.3	V	-48.62	-30	18.62	PASS

Note:
1. Cable loss and antenna gain was combined in the calculated result.
2. No record for margin above 20dB.

4.1.4 Duty Cycle

APPLICABILITY

Duty Cycle (DC) shall apply to all transmitting equipment except those which utilize Listen Before Talk (LBT) clause 4.4.2, or Detect And Avoid (DAA), clause 4.4.3. RFID transmitters operating in the 2 446 MHz to 2 454 MHz frequency band that transmit at a maximum radiated peak power level of less than 500 mW e.i.r.p. are also excluded.

LIMIT

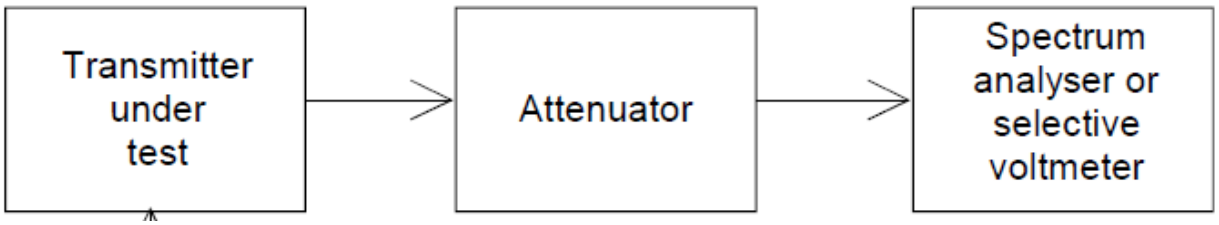
Table 4 defines the maximum duty cycle within a 1 hour period.

Table 4: Duty cycle limits

Frequency Band	Duty cycle	Application	Notes
2 400 MHz to 2 483,5 MHz	No Restriction	Generic use	
2 400 MHz to 2 483,5 MHz	No Restriction	Detection, movement and alert applications	
(a) 2 446 MHz to 2 454 MHz	No Restriction	RFID	Limits shown in annex D shall apply
(b) 2 446 MHz to 2 454 MHz	≤ 15 %	RFID	Limits shown in annex D shall apply
5 725 MHz to 5 875 MHz	No Restriction	Generic use	
9 200 MHz to 9 500 MHz	No Restriction	Radiodetermination: radar, detection, movement and alert applications	
9 500 MHz to 9 975 MHz	No Restriction	Radiodetermination: radar, detection, movement and alert applications	
10,5 GHz to 10,6 GHz	No Restriction	Radiodetermination: radar, detection, movement and alert applications	
13,4 GHz to 14,0 GHz	No Restriction	Radiodetermination: radar, detection, movement and alert applications	
17,1 GHz to 17,3 GHz	DAA or equivalent techniques	Radiodetermination: GBSAR detecting and movement and alert applications	Limits shown in annex F shall apply
24,00 GHz to 24,25 GHz	No Restriction	Generic use and for Radiodetermination: radar, detection, movement and alert applications	

For devices with a 100 % duty cycle transmitting an unmodulated carrier most of the time, a time-out shut-off facility shall be implemented in order to improve the efficient use of spectrum. The method of implementation shall be declared by the manufacturer.

TEST CONFIGURATION



TEST PROCEDURE

☐ 4.2.5.3 Method of measurement

TEST RESULTS

N/A, EUT work in 5725 MHz to 5825 MHz.

4.1.5 Additional requirements for FHSS equipment

APPLICABILITY

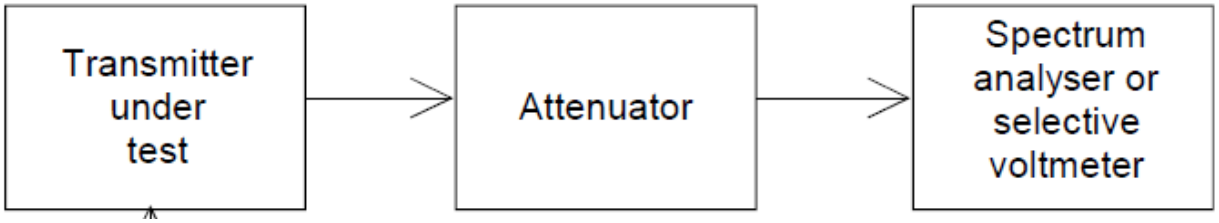
The requirements in this clause apply only to equipment using FHSS modulation.

LIMIT

FHSS modulation shall make use of at least 20 channels hopping over > 90 % of the assigned frequency band.

The dwell time per channel shall not exceed 1 s. While the equipment is operating (transmitting and/or receiving) each channel of the hopping sequence shall be occupied at least once during a period not exceeding four times the product of the dwell time per hop and the number of channels.

TEST CONFIGURATION



Conformance

Hopping Channels:

1) Set SPA as follow:
   Start frequency: MHz, stop frequency: MHz, RBW = 1 MHz, VBW = 3 MHz, Trace = Max Hold, Detector = Peak, Sweep Time = Auto.
2) Set EUT work in a condition which every channel can work, Count the channels(TX_{on}) and record as C_c.

Dwell Time:

Step 1:

1) Set SPA as follow:
   Center frequency = working frequency, sweep time = 1 S.
2) Set EUT work in the specific frequency, and record the TX_{on}(one pluse) time as C_d.

Step 2(only for FHSS):

1) Set SPA as follow: center frequency = evaluate frequency, sweep time = 4*Cc*Cd
2) Count the times of TX_{on}.

TEST RESULTS

N/A, EUT is not a FHSS Device

4.2 Receiver Requirements

4.2.1 Adjacent channel selectivity

APPLICABILITY

This requirement applies to Equipment Category 1 receivers, when invoked, as defined in clause 4.3.1.

LIMIT

The adjacent channel selectivity of the equipment under specified conditions shall not be less than the levels of the unwanted signal as stated in table 6.

Table 6: Limit for adjacent channel selectivity

Receiver category	Limit
1	-30 dBm + k
2	No limit
3	No limit

The correction factor, k, is as follows:

$$k = -20\log f - 10\log BW$$

Where:
- f is the frequency in GHz;
- BW is the channel bandwidth in MHz.

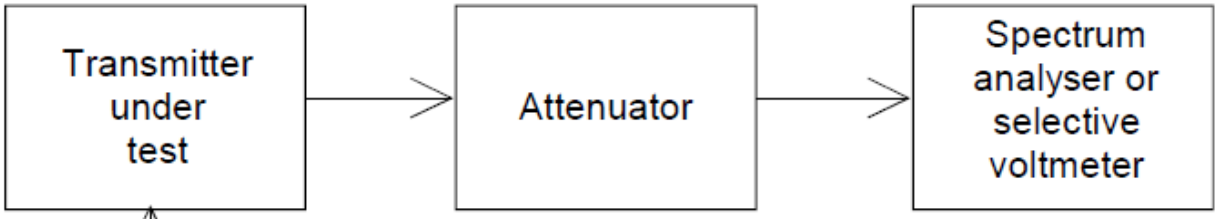
The factor k is limited within the following:
- 0 < k < 40 dB.

The measured adjacent channel selectivity shall be stated in the test report.

Limits at different bandwidths and frequencies:

BW(MHz)	Channel	Frequency (GHz)	k(dB)	Limits (dBm)
20	149	5.745	-28.20	⩾-58.20
	153	5.765	-28.23	⩾-58.23
	157	5.785	-28.26	⩾-58.26
	161	5.805	-28.29	⩾-58.29
	165	5.825	-28.32	⩾-58.32
40	151	5.755	-31.22	⩾-61.22
	159	5.795	-31.28	⩾-61.28
80	155	5.775	-34.26	⩾-64.26
Note: Channel 149 is the worst case for this test.				

TEST CONFIGURATION



Conformance

This measurement shall be conducted under normal conditions.

Two signal generators A and B shall be connected to the receiver via a combining network to the receiver, either:

a) via a test fixture or a test antenna to the receiver integrated, dedicated or test antenna; or

b) directly to the receiver permanent or temporary antenna connector.

The method of coupling to the receiver shall be stated in the test report.

Signal generator A shall be at the nominal frequency of the receiver, with normal modulation of the wanted signal.

Signal generator B shall be unmodulated and shall be adjusted to the adjacent channel centre frequency immediately above that of the wanted signal.

Initially signal generator B shall be switched off and using signal generator A the level that still gives sufficient response shall be established. The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and adjusted until the wanted criteria are met. This level shall be recorded.

The measurements shall be repeated with signal generator B unmodulated and adjusted to the adjacent channel centre immediately below the wanted signal.

The adjacent channel selectivity shall be recorded for the upper and lower adjacent channels as the level in dBm of the unwanted signal.

For tagging systems (e.g. RF identification, anti-theft, access control, location and similar systems) signal generator A may be replaced by a physical tag positioned at 70 % of the measured system range in metres. In this case, the adjacent selectivity shall be recorded as the level in dBm of lowest level of the unwanted signal (generator B) resulting in a non-read of the tag.

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Below is the worst case situation test data.

802.11a Mode

Receiver category: 1						
Test Channel		**The signal of adjacent channel(signal generator B)**				
		Adjacent channel		**Test Value (dBm)**	**Limit(dBm)**	**Verdict**
149	5745MHz	144	5720MHz(lower)	-5	⩾-58.20	PASS
		153	5765MHz(upper)	-6	⩾-58.20	PASS
Note: k=-28.20dB, BW=20MHz						

4.2.2 Blocking or desensitization

APPLICABILITY

This requirement applies to all Category 1, 2, and 3 SRD communication media receivers.

LIMIT

The blocking level, for any frequency within the specified ranges, shall not be less than the values given in table 7, except at frequencies on which spurious responses are found.

Table 6: Limits for blocking or desensitization

Receiver category	Limit
1	-30 dBm + k
2	-45 dBm + k
3	-60 dBm + k

The correction factor, k, is as follows:

$$k = -20\log f - 10\log BW$$

Where:
- f is the frequency in GHz;
- BW is the channel bandwidth in MHz.

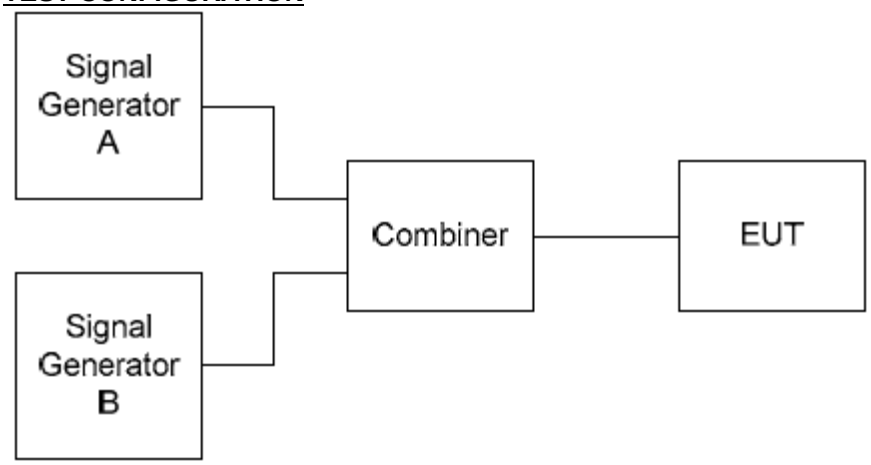
The factor k is limited within the following:
- 0 < k < 40 dB.

The measured adjacent channel selectivity shall be stated in the test report.

Limits at different bandwidths and frequencies:

BW(MHz)	Channel	Frequency (GHz)	k(dB)	Limits (dBm)
20	149	5.745	-28.20	⩾-58.20
	153	5.765	-28.23	⩾-58.23
	157	5.785	-28.26	⩾-58.26
	161	5.805	-28.29	⩾-58.29
	165	5.825	-28.32	⩾-58.32
40	151	5.755	-31.22	⩾-61.22
	159	5.795	-31.28	⩾-61.28
80	155	5.775	-34.26	⩾-64.26
Note: Channel 149 is the worst case for this test.				

TEST CONFIGURATION



Conformance

This measurement shall be conducted under normal conditions.

Two signal generators A and B shall be connected to the receiver via a combining network to the receiver, either:

a) via a test fixture or a test antenna to the receiver integrated, dedicated or test antenna; or
b) directly to the receiver permanent or temporary antenna connector.

The method of coupling to the receiver shall be stated in the test report.

Signal generator A shall be at the nominal frequency of the receiver, with normal modulation of the wanted signal.

Signal generator B shall be unmodulated and shall be adjusted to a test frequency at approximately 10 times, 20 times and 50 times of the receive channel bandwidth above upper band edge of the receive channel.

Initially signal generator B shall be switched off and using signal generator A the level which still gives sufficient response shall be established. The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and adjusted until the wanted criteria are met. This level shall be recorded.

The measurement shall be repeated with the test frequency for signal generator B at approximately 10 times, 20 times and 50 times of the receive channel bandwidth below the lower band edge of the receive channel.

The blocking or desensitization shall be recorded as the level in dBm of lowest level of the unwanted signal (generator B).

For tagging systems (e.g. RF identification, anti-theft, access control, location and similar systems) signal generator A may be replaced by a physical tag positioned at 70 % of the measured system range in metres. In this case, the blocking or desensitization shall be recorded as the ratio in dB of lowest level of the unwanted signal (generator B) resulting in a non-read of the tag. to the declared sensitivity of the receiver +3 dB.

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Below is the worst case situation test data.

Receiver category: 1							
Test Channel		Blocking Signal(signal generator B)					
		Lower or Upper	Spacing	Frequency (MHz)	Test Value (dBm)	Limit (dBm)	Verdict
149	5745MHz	Lower	10*BW	5545	5	≥-73.20	PASS
			20*BW	5345	6	≥-73.20	PASS
			50*BW	4745	8	≥-73.20	PASS
		Upper	10*BW	5845	2	≥-73.20	PASS
			20*BW	5945	10	≥-73.20	PASS
			50*BW	6745	13	≥-73.20	PASS
Note: k=-28.20dB, BW=20MHz							

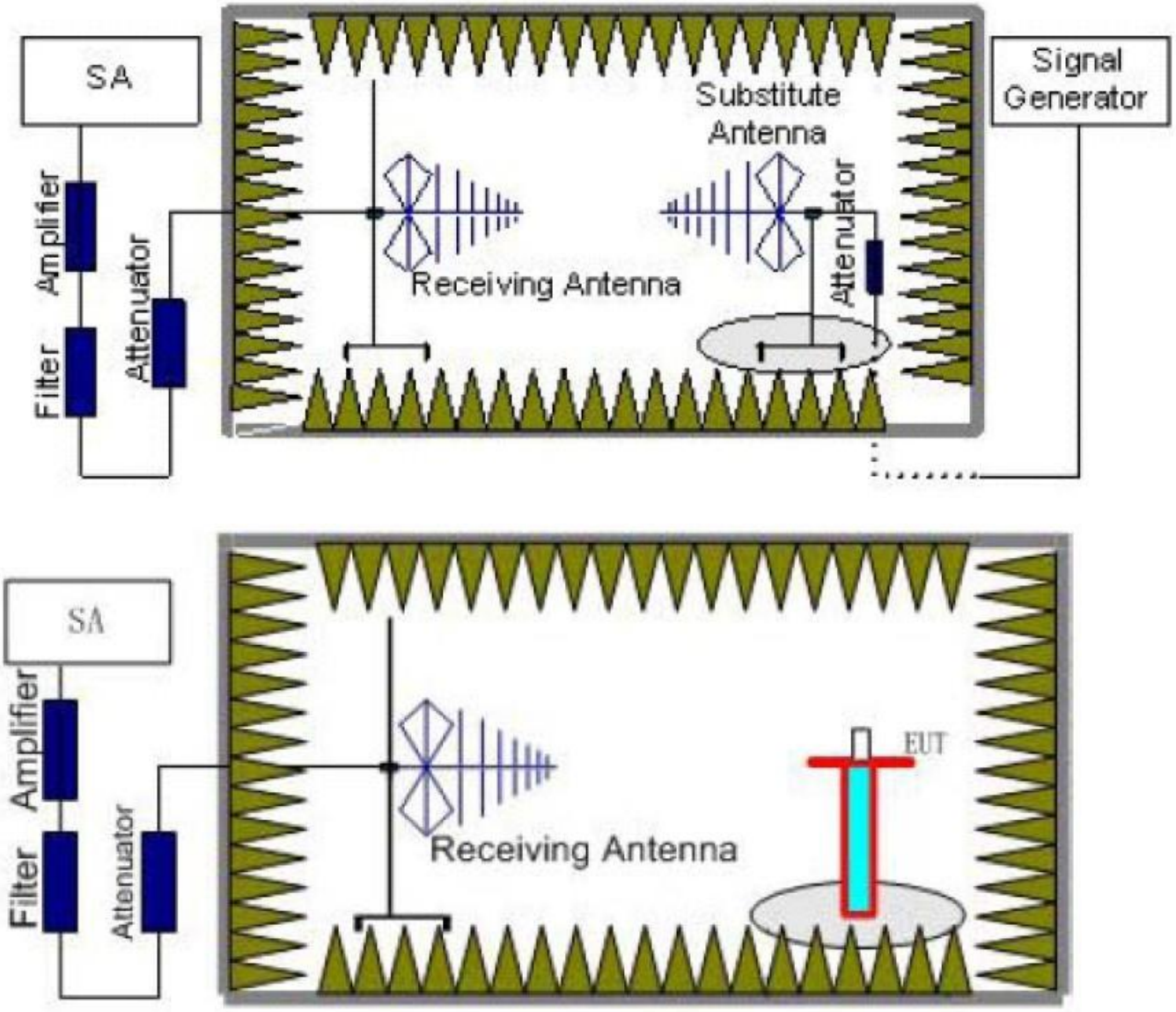
4.2.3 Receiver Spurious emissions

LIMIT

Final Draft ETSI EN 300 440 V2.2.1 (2018-07) Sub-clause 4.2.4.4

The power of any spurious emission shall not exceed 2 nW in the range 25 MHz to 1 GHz and shall not exceed 20 nW on frequencies above 1 GHz.

TEST CONFIGURATION



TEST PROCEDURE

Step 1:
The measurement is carried out in the fully anechoic chamber. EUT was placed on a 1.50 meter high non-conductive table at a 3 meter test distance from the test receive antenna. A receiving antenna was placed on the antenna mast 3 meters from the EUT. The height of receiving antenna is 1.50 m and varies in certain range to find the maximum power value. Connect the EUT to the BTS simulator via the air interface. The measurement is carried out using a spectrum analyzer or receiver. Then the antenna height and turn table rotation is adjusted till the maximum power value is founded on spectrum analyzer or receiver. A filter is necessary in the band near to the carrier frequency. A filter is needed to avoid the distortion of the testing equipment in the band above the carrier frequency.
Step 2:
A log-periodic antenna or double-ridged waveguide horn antenna shall be substituted in place of the EUT. The log-periodic antenna will be driven by a signal generator and the level will be adjusted till the same power value on the spectrum analyzer or receiver. The level of the spurious emissions can be calculated through the

level of the signal generator, cable loss, the gain of the substitution antenna and the reading of the spectrum analyzer or receiver.

Calculation procedure:

The data of cable loss, antenna gain and air loss has been calibrated in full testing frequency range before the testing.

The power of the Radiated Spurious Emissions is calculated by adding the cable loss, antenna gain and air loss. The basic equation with a sample calculation is as followed:

$P=P_R+L_C+L_A-G$

Where

P: Power of the Radiated Spurious Emissions (dBm)

P_R: reading of the receiver (dBm)

L_C: Cable Lose and power amilifer gain and filter cable loss (dB)

L_A: Air loss (dB)

G: Antenna Gain (dBi)

Assumed the reading of the receiver is -60dBm. A cable lose of 10dB, an air lose of 30dB and an antenna gain of 11dBi are added.

$P=P_R+L_C+L_A-G=-60+10+30-11=-31dBm$

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Tony Luo

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
273.50	V	-67.97	-57	10.97	PASS
576.96	H	-66.78	-57	9.78	PASS
Above 1GHz:					
Test Mode：Lowest frequency					
5790.43	H	-55.29	-47	8.29	PASS
5790.43	V	-58.14	-47	11.14	PASS
13710.96	H	-56.78	-47	9.78	PASS
13710.96	V	-59.49	-47	12.49	PASS
Test Mode： Highest frequency					
5650.40	H	-58.18	-47	11.18	PASS
5650.40	V	-58.54	-47	11.54	PASS
10750.75	H	-55.59	-47	8.59	PASS
10750.75	V	-56.91	-47	9.91	PASS
Note: 1. no record for margin above 20dB. 2. Cable loss and antenna gain was combined in the calculated result.					

4.2.4 Spectrum access techniques

Applicability

For the present document, the following access mechanisms are specified:
• Listen Before Talk (LBT) which is used to share spectrum between SRD transceiver equipment with similar power and bandwidth; or
• 17,1 GHz to 17,3 GHz GBSAR only, Detect And Avoid (DAA) which is used to protect radio communication services.
Receiver Category 2 or better shall be used for all LBT and DAA applications.
For equipment with radiated power of less than 100 µW e.i.r.p., no access technique is specified.
Equipment utilizing LBT or DAA, do not have to comply with the duty cycle conditions stated in clause 4.2.5..

Listen Before Talk (LBT)

In order to make maximum use of the available channels intelligent or polite equipment may use a Listen Before Talk (LBT) protocol with a preferred option of Adaptive Frequency Agility (AFA). AFA is defined as the capability of equipment to dynamically change channel within its available frequencies for proper operation.
For LBT equipment, the device shall listen on the next intended frequency before transmitting. If it is intended to move to a different channel then this channel can be monitored whilst still transmitting at its first channel. If it is not intended to move to a different channel then it should be treated as a single frequency device waiting for a free channel.
The channel occupancy timings refer to the maximum time a device can transmit on a channel, in any one period, and the minimum "listening" period before the device can retransmit either on the same or, for frequency agile equipment, on another channel.
For a device with LBT some of the receiver parameters become essential requirements under the RE-D [i.1]. The receiver requirements are the following:
LBT threshold, for further details, see clause 4.4.2.2.
Blocking or desensitization, for further details, see clause 4.3.4.
Adjacent channel selectivity, see clause 4.3.3, is not a mandatory requirement for equipment using LBT. However, it shall be noted that insufficient adjacent channel selectivity may reduce the apparent channel availability.
For spread spectrum systems, LBT may be used if the required timing and threshold limits can be met; if not, then a duty cycle requirement applies, see clause 4.2.5.
It shall be noted that the use of LBT may be restricted by the dwell time for Frequency Hopping Spread Spectrum systems. In case of fast frequency hopping where the dwell time is shorter than the LBT minimum listening time then a duty cycle requirement applies, see clause 4.2.5.

➢ **LBT timing parameters:**

Minimum transmitter off-time:
The minimum TX off-time allows other users with LBT facility to get access to a channel.
The minimum TX-off time is defined as the period where a specific transmitter shall remain off after a transmission or a communication dialogue between units or a polling sequence of other units.
Limit:
The limit for the minimum TX-off time is > 25 ms.
The TX-off time shall be declared in the test report by the equipment manufacturer

➢ **LBT minimum listening time:**

The minimum listening time is defined as the minimum time that the equipment listens for a received signal at or above the LBT threshold level (see clause 4.4.3) immediately prior to transmission to determine whether the intended channel is available for use.
The listening time shall consist of the "minimum fixed listening time" and an additional pseudo random part. If during the listening mode another user is detected on the intended channel, the listening time shall commence from the instant that the intended channel is free again. Alternatively, the equipment may select another channel and again start the listen time before transmission.
Limit for minimum listening time:
The total listen time, tL, consists of a fixed part, tF, and a pseudo random part, tPS, as the following:
tL=tF+tPS
a) The fixed part of the minimum listening time, tF, shall be 5 ms.
b) The pseudo random listening time tPS shall be randomly varied between 0 ms and a value of 5 ms or more in equal steps of approximately 0,5 ms as the following:
- If the channel is free from traffic at the beginning of the listen time, tL, and remains free throughout the fixed part of the listen time, tF, then the pseudo random part, tPS, is automatically set to zero by the equipment itself.

- If the channel is occupied by traffic when the equipment either starts to listen or during the listen period, then the listen time commences from the instant that the intended channel is free. In this situation the total listen time tL shall comprise tF and the pseudo random part, tPS.
The limit for total listen time for the receiver consists of the sum of a) and b) together.
Algorithmic details and values for a) and b) shall be declared by the manufacturer of the equipment.

- **Acknowledge transmissions**

An acknowledge transmission is defined as a receipt for a received message.
There is no requirement for a listen time before an acknowledge can be performed. However, it shall be noted that if the start of an acknowledge is not received before the end of normal fixed part of the listen time (5 ms) then the channel might be taken by another transmitter.

- **Maximum transmitter on-time**

A transmitter shall only be allowed to transmit continuously for a maximum specified period. This will prevent a transmitter from occupying a channel for an extended period.

The maximum on-time shall always be as short as possible for the application since SRD applications are often battery operated.
The maximum transmitter on-time is defined as the maximum time the transmitter can be on during:
a) A single transmission.
b) Multiple transmissions and acknowledgements for a communication dialogue or polling sequence of other units under the condition that the channel is free.
An equipment intended for very long messages shall be capable of switching to a "free" channel before the maximum transmitter on-time is reached for each channel of operation
Limit
The limit for a single transmission TX on-time is 2 s.
For further information on measurements of maximum transmitter on-time, see clause 4.4.2.2.
The time for the transmission dialogue or a polling sequence shall be less than 10 s.
In the case of the above timing, t, reaches the limit then the minimum TX-off time limit shall apply Automatically

- **Declaration of LBT parameters**

For automatic operated LBT devices, either software controlled or pre-programmed devices, the manufacturer shall declare all the channel LBT timings for the equipment under test.
2.8.2.6 Equipment with or without LBT using transmitter time-out-timer
For manual operated or event dependant devices, with or without software controlled functions, the manufacturer shall declare whether the transmission once triggered, follows a pre-programmed time-out-timer, or whether the transmitter
remains on until the trigger is released or the device is manually reset.
The manufacturer shall also give a description of the application for the device and include a typical usage pattern. The typical usage pattern as declared by the manufacturer shall be used to determine the channel occupancy timings

Receiver LBT threshold and transmitter max on-time

- **Applicability**

The measurements and limits apply to a transceiver that facilitates a receiver with a LBT protocol.

- **Descriptions**

The LBT threshold is defined as the received signal level above which the equipment can determine that the channel is not available for use. If the received signal is below the LBT threshold then the equipment can determine that the channel is available for use.
The definition of the maximum transmitter on-time for equipment with an LBT facility is defined in clause 4.4.2.1.4.1.

- **Method of measurements**

A signal generator and a power meter are each combined via appropriate attenuators into the equipment antenna connector. The test set-up in figure 3 shall be used.

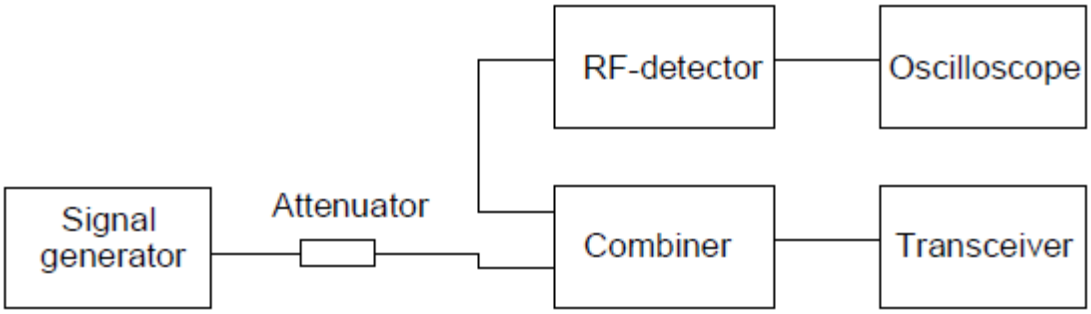


Figure 3: Measurement arrangement

For equipment with integral antenna the connection to the equipment is made either to a temporary 50 Ω antenna connector, see clause 4.2.3.1, or via a calibrated test fixture, see clause 5.8.3:
a) the LBT function of the transceiver shall be active;
b) the attenuator shall provide sufficient attenuation to protect the signal generator from burn-out by the transmitter of the transceiver;
c) the signal generator with normal test modulation is adjusted to the receiving frequency. The level is increased to approximately 20 dB above the receiver sensitivity;
d) the equipment is switched to an intended transmit mode. The equipment shall not be transmitting as the transceiver recognizes a busy channel from the signal generator;
e) the level of the signal generator is reduced in steps of 1 dB until the equipment starts to transmit. This specific signal generator level present at the receiver input of the transceiver is the LBT threshold.
The level of the received LBT threshold shall be recorded in the test report.
f) the steps c) and d) shall be repeated; and
g) the level of the signal generator is reduced in steps of 1 dB until the equipment starts to transmit and the duration of the transmit on-time is measured at the oscilloscope.
The transmit on-time is recorded in the test report.

➢ **Limits**

The LBT maximum thresholds for the receiver in listen mode are given in table 8.
Table 8: Receiver LBT threshold limit versus transmit power and channel spacing

TX power	< 100 mW	500 mW
LBT threshold	-80 dBm + c	-87 dBm + c
NOTE 1: The limit is independent of the receiver category, see clause 4.1.1. NOTE 2: The limits are based on an antenna gain of +2 dBi maximum. For other antenna gains greater than +2 dBi the limits shall be adjusted accordingly.		

The correction factor, c, is given by the following formula: c =10*logBW
Where:
- BW is the bandwidth in MHz.

➢ **Conformance**

The measured LBT threshold shall be less than the limits given table 8 and stated in the test report

Detect and Avoid techniques (DAA)

➢ **General requirements**

DAA is specified for use with Ground Based Synthetic Aperture Radar (GBSAR) systems. It provides protection to other radio communication services by utilizing the following parameters:
a) Receiver minimum listen time before the transmitter can be switched on, immediately prior to any intended transmission.
b) Receiver detect and avoid threshold.
c) An appropriate long listen-time after detection of a service to be protected is detected.
d) Maximum transmitter on-time without interruption.
e) Minimum transmitter off-time after a transmitter on-time period.
It shall be noted that DAA can only be applied if the SRD equipment is using a common antenna for both receive and transmit, or the same antenna type is used for both receive and transmit with both antennas pointing in the same direction.
The DAA function and limits are depending of the services to be protected. Requirements for the implementation of Detect And Avoid (DAA) technique for Ground Based Synthetic Aperture Radar (GBSAR) systems operating in the frequency range 17,1 GHz to 17,3 GHz are given in annex F.

Adaptive Frequency Agility (AFA)

➢ **General requirements**

SRD equipment with LBT or DAA may also employ an Adaptive Frequency Agility (AFA) function to:

• avoid co-channel operation with other systems after detection of interference from these other systems;

• where possible, provide on aggregate a uniform loading of the spectrum across all devices.

The equipment shall only use the channels dedicated for the application.

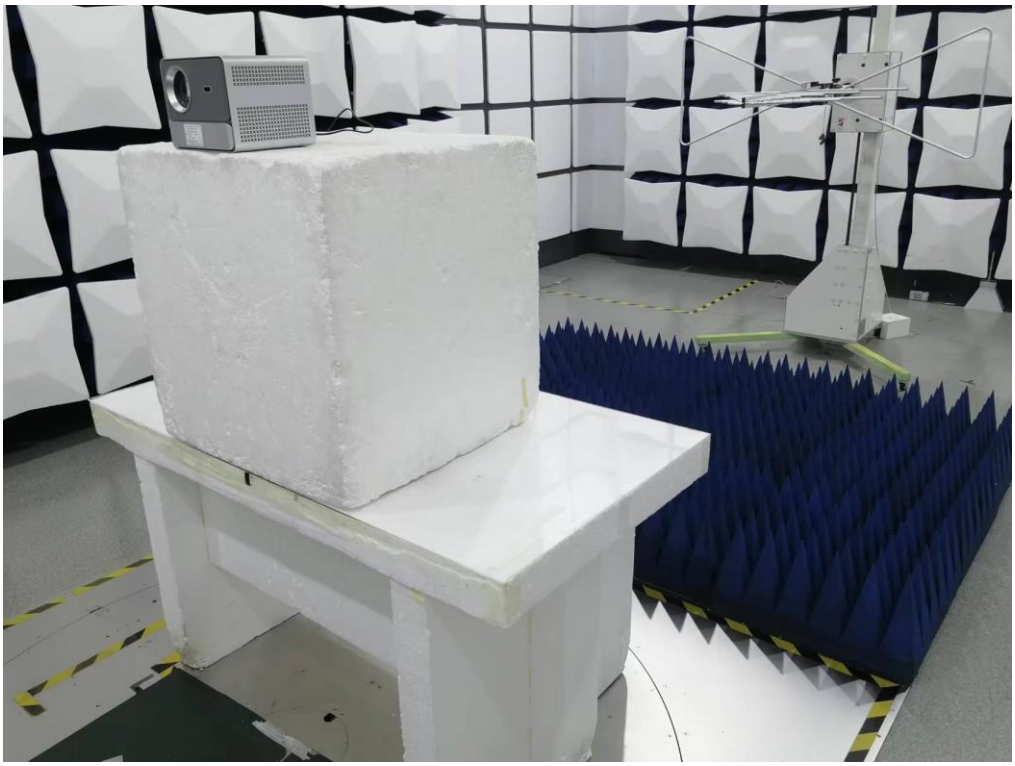
Additionally, the equipment shall either follow the restrictions for LBT given in clause 4.4.2 or the restrictions for DAA as appropriate.

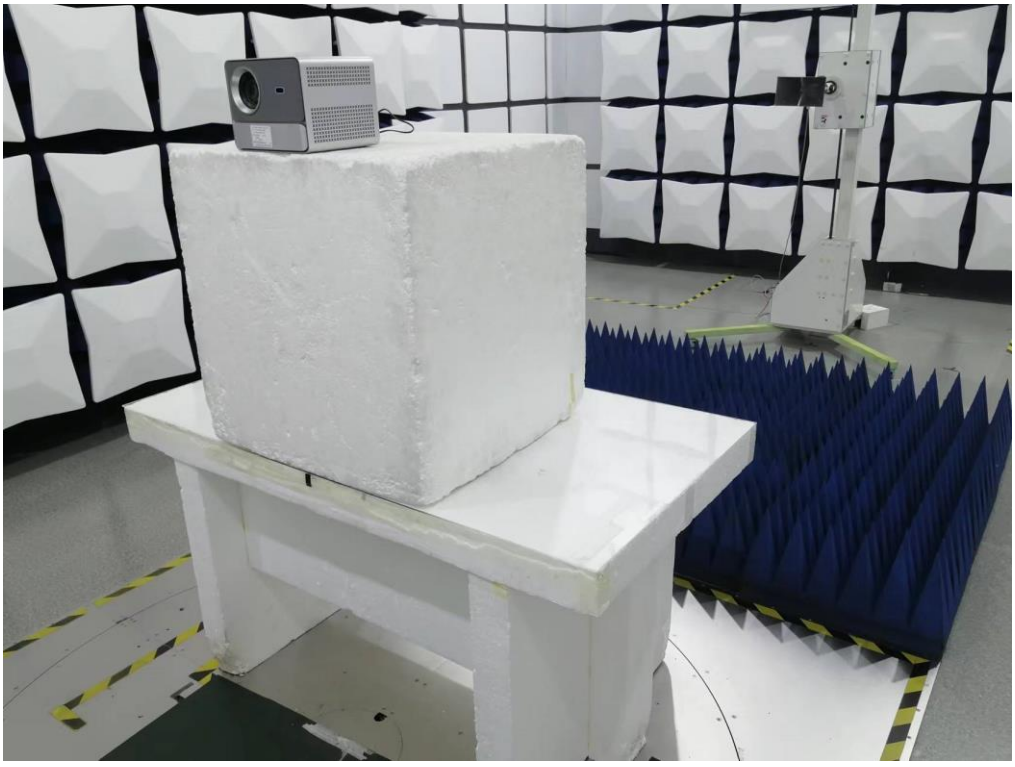
Test Result

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Test Mode	Test Frequency (MHz)	Receiver LBT threshold		Maximum transmitter on-time		Verdict
		Test Value (dBm)	Limit (dBm)	Test Value (s)	Limit (s)	
802.11a	5745	-87	≤-67.0	0.00705	≤2	PASS

5 Test Setup Photos of the EUT





6 External and Internal Photos of the EUT

Reference to the test report No. TZ240105305-RE

.....End of Report.....

TEST REPORT
ETSI EN 300 328 V2.2.2 (2019-07)

Report Reference No.....:	**TZ240105305-BLE**
Compiled by (position+printed name+signature)..:	File administrators Anna Hu
Supervised by (position+printed name+signature)..:	Technique principal Hugo Chen
Approved by (position+printed name+signature)..:	Manager Andy Zhang
Date of issue.....:	2024/1/30

Testing Laboratory Name.....:	Shenzhen Tongzhou Testing Co.,Ltd
Address .....:	1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China
Applicant's name.....:	**Shenzhen Wanbo Technology Co., Ltd.**
Address .....:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Test specification .....**:**	
Standard .....:	**ETSI EN 300 328 V2.2.2 (2019-07)**
TRF Originator.....:	Shenzhen Tongzhou Testing Co.,Ltd
Master TRF.....:	Dated 2024-01

Test item description .....:	**Wanbo Projector**
Trade Mark .....:	Wanbo
Model/Type reference.....:	WPC24
List Model .....:	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Hardware Version.....:	KSOC_352_S2_WB
Software Version .....:	wanbo-WPC24-KGHE
Ratings .....:	AC 100-240V 50/60Hz 2A(Max)
Result.....:	**Pass**

TEST REPORT

Test Report No. :	TZ240105305-BLE	2024/1/30 Date of issue

Equipment under Test	:	Wanbo Projector
Model /Type	:	WPC24
Listed Models	:	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Applicant	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Manufacturer	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China

Test Result:	**PASS**

The test report merely corresponds to the test sample.

** Modifited History **

Revision	Description	Issued Data	Remark
00	Initial Test Report Release	2024/1/30	Andy Zhang

Contents

1. TEST STANDARDS

The tests were performed according to following standards:

ETSI EN 300 328 V2.2.2 (2019-07) –Wideband transmission systems;
Data transmission equipment operating in the 2,4 GHz band; Harmonised Standard for access to radio spectrum

2. SUMMARY

2.1. General Remarks

Date of receipt of test sample	:	2024/1/11
Testing commenced on	:	2024/1/11
Testing concluded on	:	2024/1/29

2.2. Product Description

The **Shenzhen Wanbo Technology Co., Ltd.**'s Model: WPC24 or the "EUT" as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

Name of EUT	Wanbo Projector
Model(s) Number	WPC24
List Model	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Difference description	All the same except for the model name
Hardware version	KSOC_352_S2_WB
Software version	wanbo-WPC24-KGHE

2.3. Wireless Function Tested in this report

Wireless Type	Working Frequency	Modulation Type	Version
Bluetooth LE	2402MHz-2480MHz	GFSK	V5.0

2.4. Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	230V / 50 Hz	○	120V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

AC 100-240V 50/60Hz 2A(Max)

Description of the test mode

BLE used 40 channels and channel separation was 2MHz.

Channel	Frequency(MHz)	Channel	Frequency(MHz)
00	2402	20	2442
01	2404	21	2444
02	2406	22	2446
03	2408	23	2448
04	2410	24	2450
05	2412	25	2452
06	2414	26	2454
07	2416	27	2456
08	2418	28	2458
09	2420	29	2460
10	2422	30	2462
11	2424	31	2464

Channel	Frequency(MHz)	Channel	Frequency(MHz)
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

Test Frequency List

Type	Test Frequency					
	Lowest		Middle		Highest	
	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
BLE	00	2402	19	2440	39	2480

2.5. Description of the Equipment under Test (EUT)

Reference documents:	Bluetooth® Core Specification
Special test descriptions:	None
Configuration descriptions:	TX tests: Channel 00(2402MHz),Channel 19(2440MHz),Channel 39(2480MHz)
	RX/Standby tests: BLE test mode enabled, scan enabled, TX Idle
Test mode:	☐ Bluetooth Test mode loop back enabled (EUT is controlled over CMW500)
	☒ Special software is used. EUT is transmitting pseudo random data by itself
Bluetooth standard capabilities:	40channels FHSS
	channel separation 2 MHz
	used freq. range 2402-2480 MHz
	Modulation types: GFSK
	Bandwidth appr. 1MHz for single hop frequency

2.6. EUT Classification:

Type of equipment:	☒	stand alone equipment	
	☐	plug in radio equipment	
	☐	combined equipment	
Modulation types:	☒	Wide Band Modulation (None Hopping – e.g. DSSS, OFDM)	
	☐	Frequency Hopping Spread Spectrum (FHSS)	
Adaptive equipment:	☒	Yes, LBT-based	☐ Frame Based Equipment
			☒Load Based Equipment
	☐	Yes, non-LBT-based	
	☐	Yes (but can be disabled)	
	☐	No	
	☐	COT value	
	☒	CCA value	18μs
Antennas and transmit operating modes:	☐	Operating mode 1 (single antenna)	
		Equipment with 1 antenna, Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used, Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)	
	☒	Operating mode 2 (multiple antennas, no beamforming)	
		Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.	
	☐	Operating mode 3 (multiple antennas, with beamforming)	
		Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming. In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.	

2.7. EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - supplied by the lab

/	/	/	/
/	/	/	/
/	/	/	/

Modifications
No modifications were implemented to meet testing criteria.

2.8. Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version	Date of receipt	Type of Test
TZ240105305-1#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	Radio
TZ240105305-2#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	SAR (EMF)
TZ240105305-3#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	EMC

2.9. Modifications

No modifications were implemented to meet testing criteria.

3. TEST ENVIRONMENT

3.1. Address of the test laboratory

Shenzhen Tongzhou Testing Co.,Ltd
1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 (2014) and CISPR Publication 22.

3.2. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature/NT: 25℃
High Temperature/HT: 35℃
Low Temperature/LT: 0℃
Normal Voltage: AC 230V
High Voltage/HV: AC 264V
Low Voltage/LV: AC 90V
Relative Humidity: 55 %
Air Pressure: 989 hPa

3.3. Test Description

3.3.1. Main Terms

Verdict	Verdict of each test cases.
Test Case	Test cases identification number description in ETSI specification.

3.3.2. Terms used in Condition column

NTC Normal voltage, Normal Temperature
HTHV High voltage, High Temperature
LTHV High voltage, Low Temperature
HTLV Low voltage, High Temperature
LTLV Low voltage, Low Temperature

3.3.3. Terms used in Verdict column

Pass	This test cases has been tested, and EUT is conformant to the applied standards in the given frequency band.
Fail	This test cases has been tested, but EUT is not conformant to the applied standards in the given frequency band.
N/A	This test case is either not required/not applicable in the specified band or is not applicable according to the specific PICS/PIXIT for the EUT.
Inc	Test case result is ambiguous in the given frequency band.
Decl	Declaration is received from the client to demonstrate the conformity to the relevant specification in the given frequency band.
BR	This test cases is not tested in the given frequency band, but this testcases was tested with pass result for the initial model in the given frequency band.

3.3.4. Sumarry of measurement results

☒ **No deviations from the technical specifications were ascertained**
☐ **There were deviations from the technical specifications ascertained**

Test Specification Clause	Test Case	Test Condition	Mode	Pass	Fail	N/A	NP	Remark
5.4.2	RF output power	NTC	GFSK	☒	☐	☐	☐	
		LT		☒	☐	☐	☐	
		HT		☒	☐	☐	☐	
5.4.3	Power Spectral Density	NTC	GFSK	☒	☐	☐	☐	
5.4.2	Duty Cycle, Tx-sequence, Tx-gap	NTC	--	☐	☐	☒	☐	Note 1
5.4.2	Medium Utilisation (MU) factor	NTC	--	☐	☐	☒	☐	Note 1
5.4.6	Adaptivity (adaptive equipment using modulations other than FHSS)	NTC	--	☐	☐	☒	☐	Note 2
5.4.7	Occupied Channel Bandwidth	NTC	GFSK	☒	☐	☐	☐	
5.3.8	Transmitter unwanted emissions in the out-of-band domain	NTC	GFSK	☒	☐	☐	☐	
		LT		☐	☐	☒	☐	
		HT		☐	☐	☒	☐	
5.3.9	Transmitter unwanted emissions in the spurious domain (conducted & radiated)	NTC	GFSK	☒	☐	☐	☐	
5.3.10	Receiver spurious emissions (conducted & radiated)	NTC	GFSK	☒	☐	☐	☐	
5.3.11	Receiver Blocking	NTC	GFSK	☒	☐	☐	☐	

Remark: The measurement uncertainty is not included in the test result.

Note 1: These requirements apply to non-adaptive equipment or to adaptive equipment when operating in a non-adaptive mode. These requirements do not apply for equipment with a maximum declared RF Output power level of less than 10 dBm e.i.r.p.

Note 2: This requirement does not apply to non-adaptive equipment or adaptive equipment operating in a non-adaptive mode. These requirements do not apply for equipment with a maximum declared RF Output power level of less than 10 dBm e.i.r.p.

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

Mode	Data Rate
GFSK	1 Mbps

3.4. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics;Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics;Part 2 " and is documented in the Shenzhen Tongzhou Testing Co.,Ltd quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.
Hereafter the best measurement capability for Shenzhen Tongzhou Testing Co.,Ltd is reported:

No.	Item	Uncertainty
1	Occupied Channel Bandwidth	±3.6dB
2	RF power, conducted	±0.16dB
3	Power Spectral Density, conducted	±1.3dB
4	Unwanted Emissions, conducted	±1.3dB
5	All emissions, radiated	±4.7dB
6	Temperature	±0.5°C
7	Humidity	±2%
8	DC and low frequency voltages	±1.5%
9	Time	±1.0%
10	Duty Cycle	±3.0%

3.5. Equipments Used during the Test

Conducted Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
2	Signal Generator	Keysight	N5182A	MY4620709	2024/1/4	2025/1/3
3	Signal Generator	R&S	SML03	102924/0013	2024/1/4	2025/1/3
4	Power Sensor	Agilent	U2021XA	MY5365004	2024/1/4	2025/1/3
5	Power Meter	Agilent	U2531A	TW53323507	2024/1/4	2025/1/3
6	Climate Chamber	KRUOMR	KRM-1000	KRM16072901	2024/1/4	2025/1/3
7	Wideband Radio Communication Tester	R&S	CMW500	101855	2024/1/4	2025/1/3
8	Test Software	Tonscend	JS1120-3	V3.2.22	--	--

Radiated Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	Wideband Antenna	schwarzbeck	VULB 9163	958	2022/11/13	2025/11/12
2	Horn Antenna	schwarzbeck	BBHA 9120D	01989	2022/11/13	2025/11/12
3	EMI Test Receiver	R&S	ESCI	100849/003	2024/1/4	2025/1/3
4	Controller	MF	MF7802	N/A	N/A	N/A
5	Amplifier	schwarzbeck	BBV 9743	209	2024/1/4	2025/1/3
6	Amplifier	Tonscend	TSAMP-0518SE	--	2024/1/4	2025/1/3
7	RF Cable	HUBER+SUHNER	RG214	N/A	2024/1/4	2025/1/3
8	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
9	Horn Antenna	ETS	3117	00218874	2022/11/13	2025/11/12
10	Wideband Antenna	Sunol	JB3	A020115	2022/7/3	2025/7/2
11	Test Software	Tonscend	JS36-RSE	V5.0.0.0	--	--

4. TEST CONDITIONS AND RESULTS

4.1. ETSI EN 300 328 REQUIREMENTS

4.1.1. RF Output Power

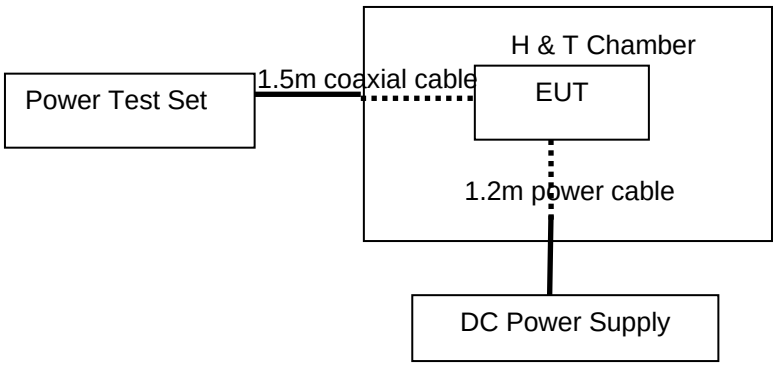
LIMIT

According to ETSI EN 300 328 V2.2.2 §4.3.2.2.3
The RF output power for non-FHSS equipment shall be equal to or less than 20 dBm.

NOTE: For Non-adaptive FHSS equipment, the manufacturer may have declared a reduced RF Output Power (see clause 5.4.1 m)) and associated Duty Cycle (see clause 5.4.1 e)) that will ensure that the equipment meets the requirement for the Medium Utilization (MU) factor further described in clause 4.3.2.5. This is verified by the conformance test referred to in clause 4.3.2.5.4.

For non-adaptive non-FHSS equipment, where the manufacturer has declared an RF output power of less than 20 dBm e.i.r.p., the RF output power shall be equal to or less than that declared value.
This limit shall apply for any combination of power level and intended antenna assembly.

TEST CONFIGURATION



TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.2.2.1.1, conducted method.

EUT DESCRIPTION:

Mode:	BT Test mode
Test Channel	Channel 00(2402MHz),Channel 19(2440MHz),Channel 39(2480MHz)
Modulation:	GFSK

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring burst Power(RMS) of a least 10 packets	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Test Condition	Test Mode	Antenna	Freq(MHz)	Burst Power [dBm]	Gain [dBi]	EIRP [dBm]	EIRP Limit [dBm]	Verdict
NTNV	BLE_1M	Ant1	2402	3.06	0.00	3.06	20	PASS
			2440	3.02	0.00	3.02	20	PASS
			2480	2.84	0.00	2.84	20	PASS
LTNV	BLE_1M	Ant1	2402	3.09	0.00	3.09	20	PASS
			2440	3.03	0.00	3.03	20	PASS
			2480	2.85	0.00	2.85	20	PASS
HTNV	BLE_1M	Ant1	2402	3.05	0.00	3.05	20	PASS
			2440	3.01	0.00	3.01	20	PASS
			2480	2.85	0.00	2.85	20	PASS

Note:.Cable loss and antenna gain was combined in the calculated result.

4.1.2. Duty Cycle,TX-sequence,TX-gap

LIMIT

ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.4.3
The Duty Cycle shall be equal to or less than the maximum value declared by the manufacturer.
The Tx-sequence time shall be equal to or less than 10 ms. The minimum Tx-gap time following a Tx-sequence shall be equal to the duration of that proceeding Tx-sequence with a minimum of 3,5 ms.

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 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p.

TEST PROCEDURE

Please refer to ETSI EN 300 328 (V2.2.2) Sub-clause 5.4.2.2.1.3
For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest, the middle, and the highest channel on which the equipment can operate. These frequencies shall be recorded.
The test procedure, which shall only be performed for non-adaptive systems and only to be performed at normal environmental conditions, shall be as follows:
Step 1:
• Use the same stored measurement samples from the procedure described in clause 5.4.2.2.1.2.
• 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 case of insufficient dynamic range, the value of 30 dB may need to be reduced appropriately.
Step 2:
• Between the saved start and stop times of each individual burst, calculate the TxOn time. Save these TxOn values.
Step 3:
• Duty Cycle (DC) is the sum of all TxOn times between the end of the first gap (which is the start of the first burst within the observation period) and the start of the last burst (within this observation period) divided by the observation period. The observation period is defined in clause 4.3.1.3.2 or clause 4.3.2.4.2.
Step 4:
• For equipment using blacklisting, the TxOn time measured for a single (and active) hopping frequency shall be multiplied by the number of blacklisted frequencies. This value shall be added to the sum calculated in step 3 above. If the number of blacklisted frequencies cannot be determined, the minimum number of hopping frequencies (N) as defined in clause 4.3.1.4.3 shall be assumed.
• The calculated value for Duty Cycle (DC) shall be recorded in the test report. This value shall be equal to or less than the maximum value declared by the manufacturer.
Step 5:
• Use the same stored measurement samples from the procedure described in clause 5.4.2.2.1.2.
• Identify any TxOff time that is equal to or greater than the minimum Tx-gap time as defined in clause 4.3.1.3.3 or clause 4.3.2.4.3. These are the potential valid gap times to be further considered in this procedure.
• Starting from the second identified gap, calculate the time from the start of this gap to the end of the preceding gap. This time is the Tx-sequence time for this transmission. Repeat this procedure until the last identified gap within the observation period is reached.
• A combination of consecutive Tx-sequence times and Tx-gap times followed by a Tx-gap time, which is at least as long as the duration of this combination, may be considered as a single Tx-sequence time and in which case it shall comply with the limits defined in clause 4.3.1.3.3 or clause 4.3.2.4.3.
• It shall be noted in the test report whether the UUT complies with the limits for the maximum Tx-sequence time and minimum Tx-gap time as defined in clause 4.3.1.3.3 or clause 4.3.2.4.3.

EUT DESCRIPTION:

Mode:	BT Test mode
Test Channel	Channel 00(2402MHz),Channel 19(2440MHz),Channel 39(2480MHz)
Modulation:	GFSK

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring average burst Power of a least 10 packets	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

Not Applicable

4.1.3. Medium Utilisation (MU) factor

LIMIT

ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 4.3.2.5.3
For non-adaptive equipment using wide band modulations other than FHSS, the maximum Medium Utilization factor shall be 10 %.
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 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p.

TEST PROCEDURE

Please refer to ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 5.4.2.2.1.4
Step 1:
• Use the same stored measurement samples from the procedure described in clause 5.4.2.2.1.2.
Step 2:
• For each burst calculate the product of (Pburst / 100 mW) and the TxOn time. Pburst is expressed in mW. TxOn time is expressed in ms.
Step 3:
• Medium Utilization is the sum of all these products divided by the observation period (expressed in ms) which is defined in clause 4.3.1.3.2 or clause 4.3.2.4.2. This value, which shall comply with the limit given in clause 4.3.1.6.3 or clause 4.3.2.5.3, shall be recorded in the test report.
If operation without blacklisted frequencies is not possible, the power of the bursts on blacklisted hopping frequencies (for the calculation of the Medium Utilization) is assumed to be equal to the average value of the RMS power of the bursts on all active hopping frequencies.

EUT DESCRIPTION:

Mode:	BT Test mode
Test Channel	Channel 00(2402MHz),Channel 19(2440MHz),Channel 39(2480MHz)
Modulation:	GFSK

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring average burst Power of a least 10 packets	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

Not Applicable according to ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 4.3.2.5.1

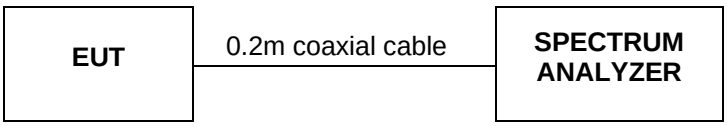
This requirement does not apply to adaptive equipment unless operating in a non-adaptive mode.
In addition, this requirement does not apply for equipment with a maximum declared RF Output power level of less than 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p.

4.1.4. Power Spectral Density

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) §4.3.2.3.3,
For equipment using wide band modulations other than FHSS, the maximum Power Spectral Density is limited to 10dBm/MHz.
These measurements shall only be performed at normal test conditions.

TEST CONFIGURATION



TEST PROCEDURE
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.3.2.1, conducted method.
The test procedure shall be as follows:
Step 1:
Connect the UUT to the spectrum analyzer 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
NOTE: For spectrum analyzers 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 be completed. Save the (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 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 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.

EUT DESCRIPTION:

Mode:	BT Test mode
Test Channel	Channel 00(2402MHz),Channel 19(2440MHz),Channel 39(2480MHz)
Modulation:	GFSK

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	10S	
Video bandwidth:	30KHz	
Resolution bandwidth:	10KHz	
Span:	83.5MHz	
Frequency range	2400-2483.5MHz	
Sweep Points	15000	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

TestMode	Antenna	Channel	PSD[dBm/MHz]	Limit[dBm/MHz]	Verdict
BLE_1M	Ant1	2402	2.98	10	PASS
		2440	2.94	10	PASS
		2480	2.76	10	PASS

4.1.5. Adaptivity (Adaptive equipment using modulations other than FHSS)

LIMIT

Requirement	Operational Mode			
	Non-LBT based Detect and Avoid	LBT based Detect and Avoid		
		Frame Based Equipment	Load Based Equipment (CCA using 'energy detect')	Load Based Equipment (CCA not using any of the mechanisms referenced as note 2)
Minimum Clear Channel Assessment (CCA) Time	NA	18 us (see note 1)	18 us (see note 2)	18 us (see note 1)
Maximum Channel Occupancy (COT) Time	40 ms	1ms to 10 ms	13ms (see note 2)	13ms
Minimum Idle Period	At least 5% of COT and 100 μ s	5% of COT	NA	NA
Extended CCA check	NA	NA	(see note 2)	>CCA
Short Control Signaling Transmissions	Maximum duty cycle of 10% within an observation period of 50 ms (see note 3)			

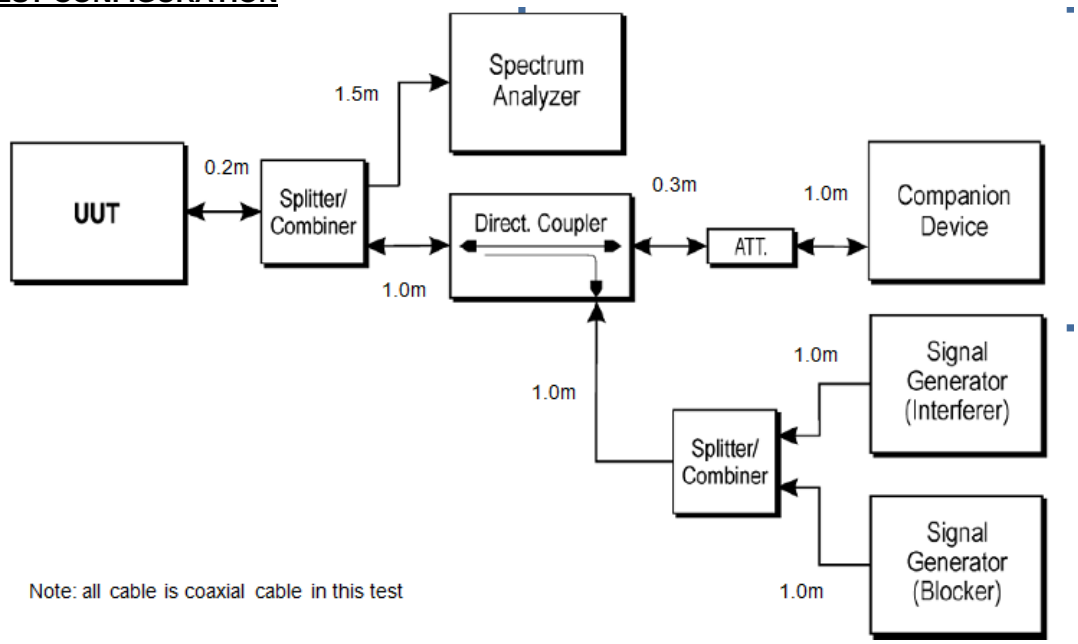
Note 1: The CCA time used by the equipment shall be declared by the supplier.
Note 2: Load Based Equipment may implement an LBT based spectrum sharing mechanism based on the Clear Channel Assessment (CCA) mode using energy detect, as described in IEEE Std. 802.11™-2007 clauses 9,15,18 or 19, in IEEE Std. 802.11n ™ -2009 clauses 9,11 and 20 or in IEEE Std. 802.15.4 ™ -2011, clauses 4 and 5.
Note 3: Adaptive equipment may or may not have Short Control Signaling Transmissions.

Wanted signal mean power from companion device:
TL = -70 dBm/MHz + 10 × log10 (100 mW / P_{out}) (Pout in mW e.i.r.p.)

Unwanted Signal parameters

Wanted signal mean power from companion device	Maximum transmit power (PH) EIRP mW	Threshold Level (TL)
sufficient to maintain the link (see note 2)	2 395 or 2 488,5 (see note 1)	-35 (see note 3)
NOTE 1: The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1. NOTE 2: A typical value which can be used in most cases is -50 dBm/MHz. NOTE 3: The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.		

TEST CONFIGURATION



MEASUREMENT DESCRIPTION

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.6.2.1.4, Conducted measurements
Step 1:
The UUT may connect to a companion device during the test. The interference signal generator, the blocking signal generator, the spectrum analyzer, the UUT and the companion device are connected using a set-up equivalent to the example given by figure 5 although the interference and blocking signal generator do not generate any signals at this point in time. The spectrum analyzer is used to monitor the transmissions of the UUT in response to the interfering and the blocking signals.
• Adjust the received signal level (wanted signal from the companion device) at the UUT to the value defined in table 6 (clause 4).
NOTE 1: Testing of Unidirectional equipment does not require a link to be established with a companion device.
• The analyzer shall be set as follows:
- RBW: =20MHz for 802 .11b/g/n(20);
= 40MHz for 802.11n(40)
[≥ Occupied Channel Bandwidth (if the analyzer does not support this setting, the highest available setting shall be used)]
- VBW: =30MHz
[3 × RBW (if the analyzer 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

Step 2:

• Configure the UUT for normal transmissions with a sufficiently high payload resulting in a minimum transmitter activity ratio (TxOn / (TxOn + TxOff)) of 0,3. Where this is not possible, the UUT shall be configured to the maximum payload possible.

• For Frame Based Equipment, using the procedure defined in clause 5.4.6.2.1.5, it shall be verified that the UUT complies with the maximum Channel Occupancy Time and minimum Idle Period defined in clause 4.3.2.6.3.2.2 step 3).

• For Load Based equipment, using the procedure defined in clause 5.4.6.2.1.5 , it shall be verified that the UUT complies with the maximum Channel Occupancy Time and minimum Idle Period defined in clause 4.3.2.6.3.2.3 , step 2 and step 3. When measuring the Idle Period of the UUT, it shall not include the transmission time of the companion device.

NOTE 2: For the purpose of testing Load Based Equipment referred to in the first paragraph of clause 4.3.2.6.3.2.3(IEEE 802.11™ [i.3] or IEEE 802.15.4™ [i.4] equipment), the limits to be applied for the minimum Idle Period and the maximum Channel Occupancy Time are the same as defined for other types of Load Based Equipment (see clause 4.3.2.6.3.2.3 step 2) and step 3). The Idle Period is considered to be equal to the CCA or Extended CCA time defined in clause 4.3.2.6.3.2.3 step 1) and step 2).

Step 3: Adding the interference signal

An interference signal as defined in clause B.6 is injected on the current operating channel of the UUT. The power spectral density level (at the input of the UUT) of this interference signal shall be equal to the detection threshold defined in clause 4.3.2.6.3.2.2 step 5) (frame based equipment) or clause 4.3.2.6.3.2.3 step 5) (load based equipment).

Step 4: Verification of reaction to the interference signal

The spectrum analyser shall be used to monitor the transmissions of the UUT on the selected operating channel with the interfering signal injected. This may require the spectrum analyser sweep to be triggered by the start of the interfering signal.

• Using the procedure defined in clause 5.4.6.2.1.5, it shall be verified that:

i) The UUT shall stop transmissions on the current operating channel.

The UUT is assumed to stop transmissions within a period equal to the maximum Channel Occupancy Time defined in clause 4.3.2.6.3.2.2 (frame based equipment) or clause 4.3.2.6.3.2.3 (load based equipment).

ii) Apart from Short Control Signalling Transmissions, there shall be no subsequent transmissions while the interfering signal is present.

To verify that the UUT is not resuming normal transmissions as long as the interference signal is present, the monitoring time may need to be 60 s or more.

iii) The UUT may continue to have Short Control Signalling Transmissions on the operating channel while the interfering signal is present. These transmissions shall comply with the limits defined in clause 4.3.2.6.4.2.

The verification of the Short Control Signalling transmissions may require the analyser settings to be changed (e.g. sweep time).

iv) Alternatively, the equipment may switch to a non-adaptive mode.

Step 5: Adding the blocking signal

• With the interfering signal present, a 100 % duty cycle CW signal is inserted as the blocking signal. The frequency and the level are provided in table 10 (clause 4.3.2.6.3.2.2) for Frame Based Equipment or in table 11 (clause 4.3.2.6.3.2.3) for Load Based Equipment.

• The spectrum analyser shall be used to monitor the transmissions of the UUT on the selected operating channel. This may require the spectrum analyser sweep to be triggered by the start of the blocking signal.

• Using the procedure defined in clause 5.4.6.2.1.5, it shall be verified that:

i) The UUT shall not resume normal transmissions on the current operating channel as long as both the interference and blocking signals remain present.

To verify that the UUT is not resuming normal transmissions as long as the interference and blocking signals are present, the monitoring time may need to be 60 s or more.

ii) The UUT may continue to have Short Control Signalling Transmissions on the operating channel while the interfering and blocking signals are present. These transmissions shall comply with the limits defined in clause 4.3.2.6.4.2.

The verification of the Short Control Signalling transmissions may require the analyser settings to be changed (e.g. sweep time).

Step 6: Removing the interference and blocking signal

• On removal of the interference and blocking signal the UUT is allowed to start transmissions again on this channel however this is not a requirement and therefore does not require testing.

Step 7:

• The steps 2 to 6 shall be repeated for each of the frequencies to be tested.

TEST RESULTS

This requirement do not apply for equipment with a maximum declared RF Output power level of less than 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p. So This requirement do not apply for EUT

4.1.6. Occupied Channel Bandwidth

LIMIT

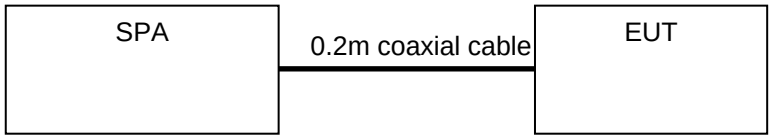
According to ETSI EN 300 328 V2.2.2 (2019-07) 4.3.2.7.3,
The Occupied Channel Bandwidth shall fall completely within the band given in table 1.

Table 1: Service frequency bands

	Service frequency bands
Transmit	2 400 MHz to 2 483,5 MHz
Receive	2 400 MHz to 2 483,5 MHz

In addition, for non-adaptive systems 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.
These measurements shall only be performed at normal test conditions.

TEST CONFIGURATION



TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.7.2.1, conducted method.
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 for frequency hopping equipment: Lowest frequency separation that is used within the hopping sequence
• Frequency Span for other types of equipment: 2 × Nominal Channel Bandwidth (e.g. 40 MHz for a 20 MHz channel)
• Detector Mode: RMS
• Trace Mode: Max Hold
• Sweep time: 1 s
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.
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.

EUT DESCRIPTION:

Mode:	BT Test mode
Test Channel	Channel 00(2402MHz),Channel 19(2440MHz),Channel 39(2480MHz)
Modulation:	GFSK

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	1S	
Video bandwidth:	130KHz	
Resolution bandwidth:	43KHz	
Span:	4MHz	
Center:	Transmit channel	
Trace:	Max hold	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

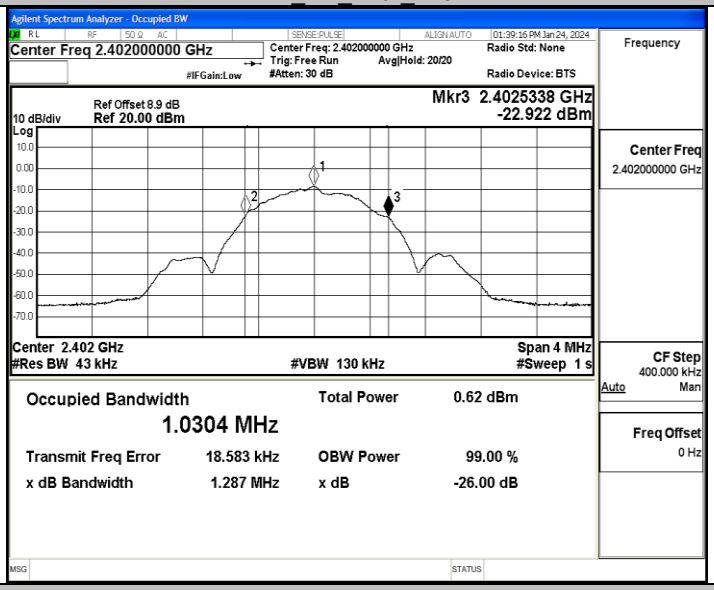
TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

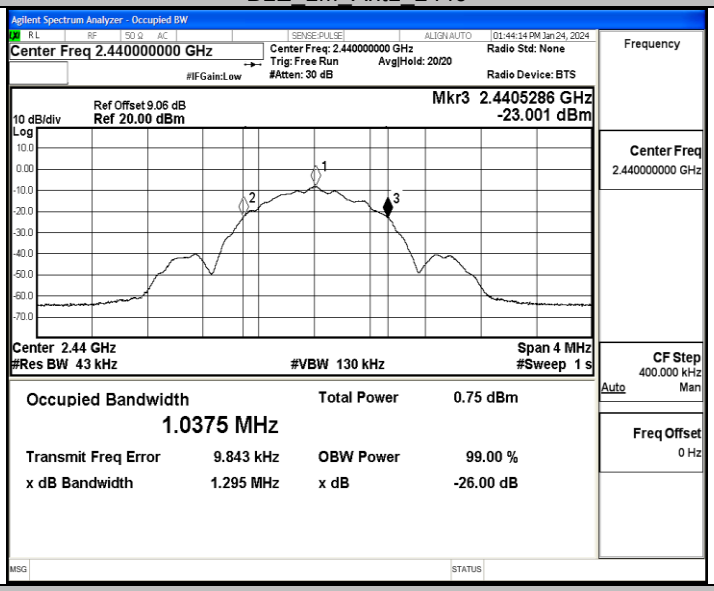
TestMode	Antenna	Channel	OCB[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.0304	2401.5034	2402.5338	2400 to 2483.5	PASS
		2440	1.0375	2439.4911	2440.5286	2400 to 2483.5	PASS
		2480	1.0430	2479.4886	2480.5316	2400 to 2483.5	PASS

Test Graphs

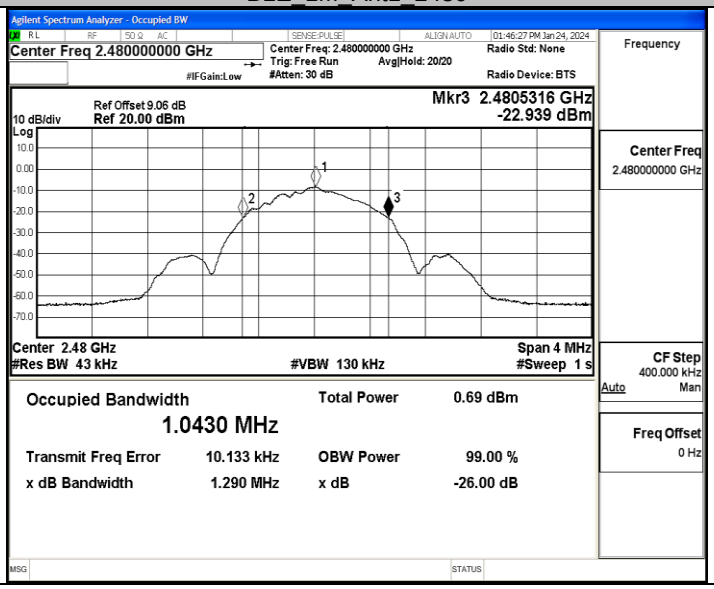
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE_1M_Ant1_2480



4.1.7. Transmitter unwanted emissions in the out-of-band domain

LIMIT

ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.8.3
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.
NOTE: Within the 2 400 MHz to 2 483,5 MHz band, the Out-of-band emissions are fulfilled by compliance with the Occupied Channel Bandwidth requirement in clause 4.3.2.7.

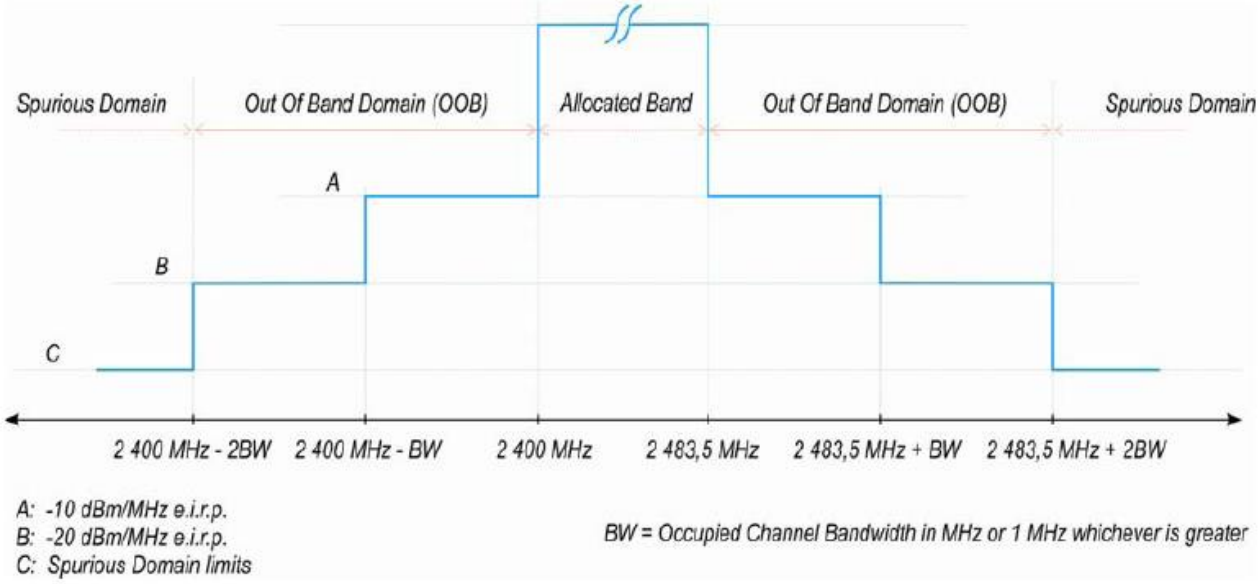
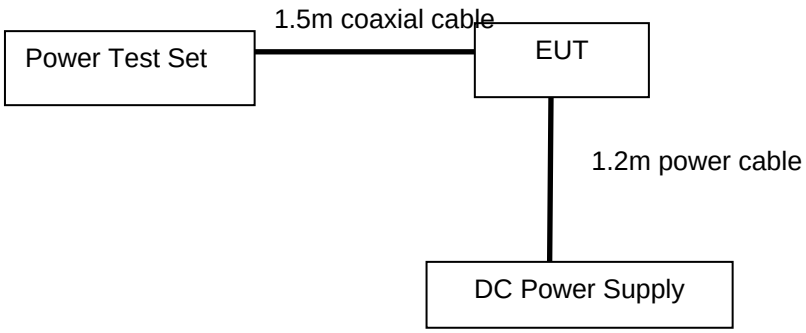


Figure 3: Transmit mask

Transmitter unwanted emissions in the out-of-band domain are emissions when the equipment is in Transmit mode, on frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious.
These measurements shall only be performed at normal test conditions.
For systems using FHSS modulation, the measurements shall be performed during normal operation (hopping).
For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These operating channels shall be recorded.
The equipment shall be configured to operate under its worst case situation with respect to output power.
If the equipment can operate with different Occupied Channel Bandwidths (e.g. 20 MHz and 40 MHz), than each channel bandwidth shall be tested separately.

TEST CONFIGURATION



TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.8.2.1, conducted method.

Connect the UUT to the spectrum analyser and use the following settings:
- Centre Frequency: evaluated frequency
- 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

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.

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 - BW + 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 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: Ach refers to the number of active transmit chains.

It shall be recorded whether the equipment complies with the mask provided in figure 1 or figure 3.

EUT DESCRIPTION:

Mode:	BT Test mode
Test Channel	Channel 00(2402MHz), Channel 39(2480MHz)
Modulation:	GFSK

MEASUREMENT DESCRIPTION

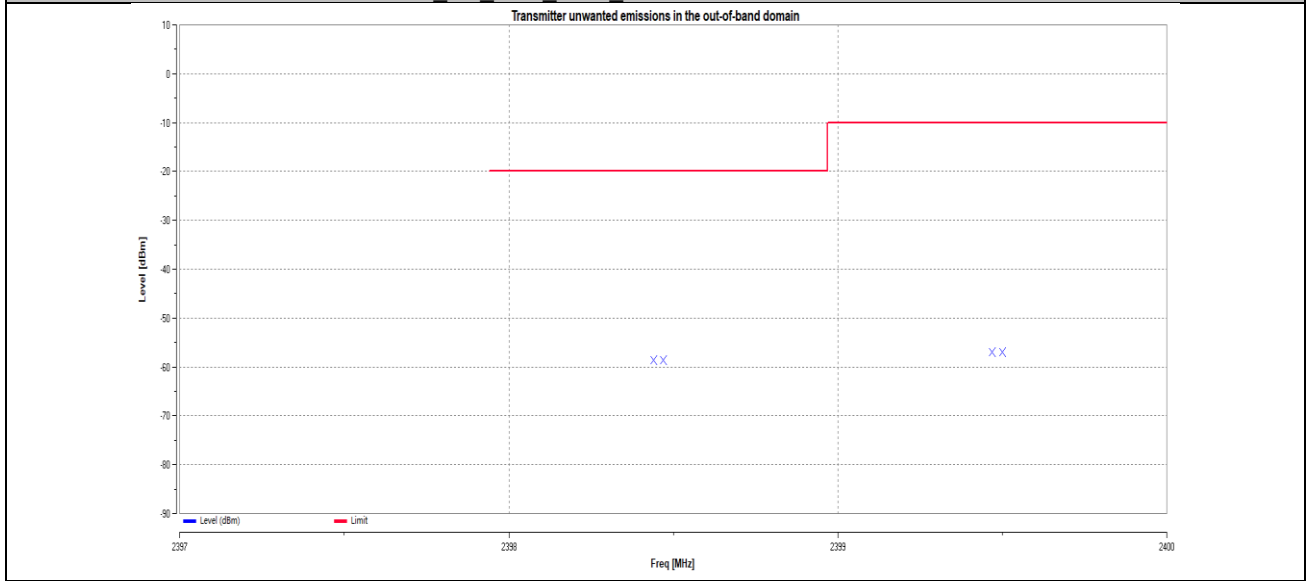
Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	depending on packet length	
Video bandwidth:	3MHz	
Resolution bandwidth:	1MHz	
Span:	0Hz	
Trace:	Trigger to burst	
Sweep points:	Sweep Time [s] / (1 µs) or 5 000 whichever is greater	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

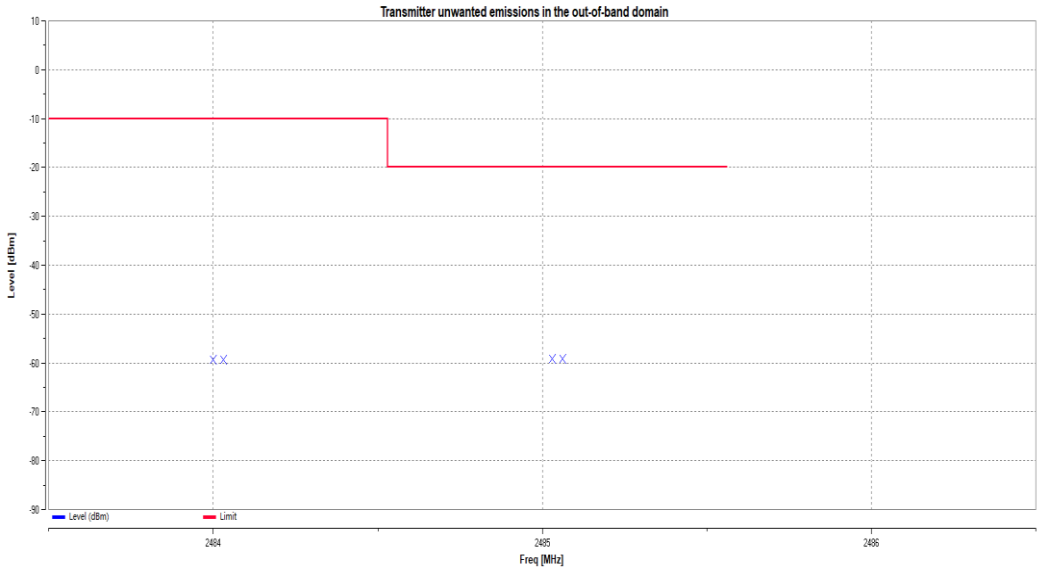
Note: Cable loss and antenna gain was combined in the calculated result.

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

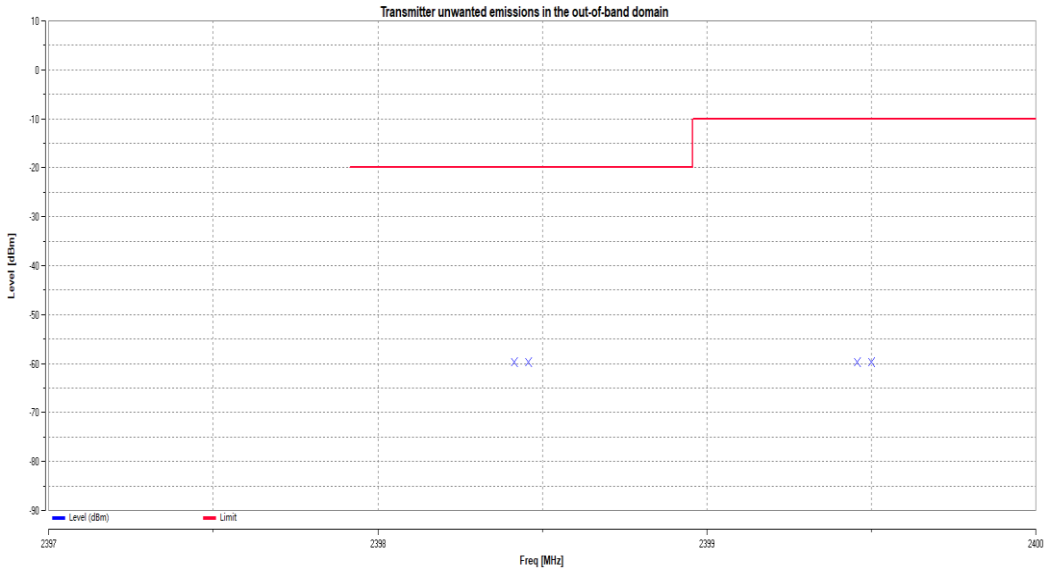
BLE_1M_Ant1_2402_2400MHz-2BW to 2400MHz



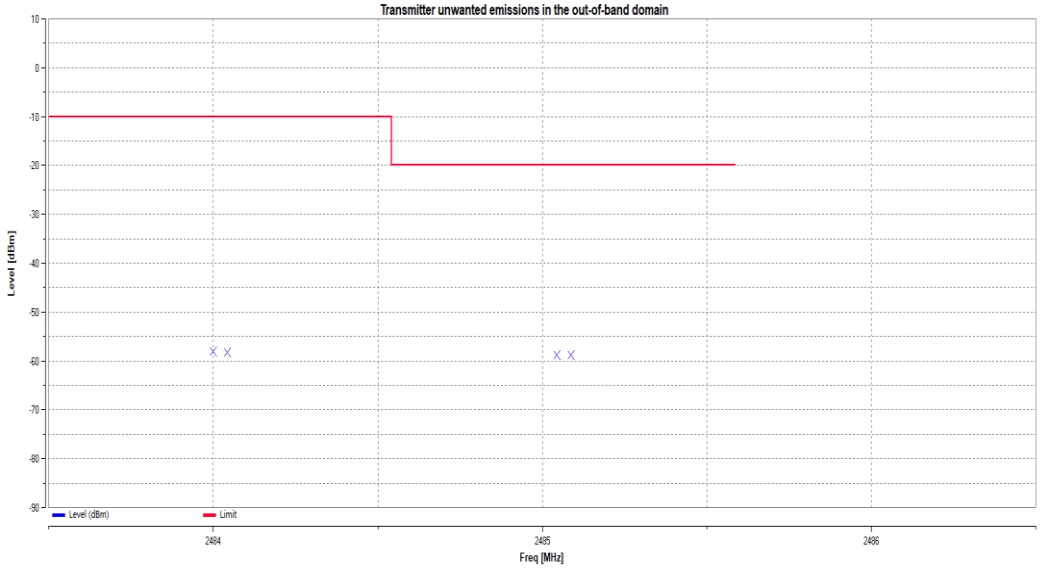
BLE_1M_Ant1_2402_2483.5MHz to 2483.5MHz+2BW



BLE_1M_Ant1_2480_2400MHz-2BW to 2400MHz



BLE_1M_Ant1_2480_2483.5MHz to 2483.5MHz+2BW



4.1.8. Transmitter unwanted emissions in the spurious domain

Limit

According to ETSI EN 300 328 V2.2.2(2019-07) §4.3.2.9.3

The transmitter unwanted emissions in the spurious domain shall not exceed the values given in table 12.

Table 12: Transmitter limits for spurious emissions

Frequency Range	Maximum power e.r.p.(.≤1 GHz) e.i.r.p.(＞1 GHz)	Limit when Standby
30 MHz to 47 MHz	-36 dBm	100 KHz
47 MHz to 74 MHz	-54 dBm	100 KHz
74MHz 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

These measurements shall only be performed at normal test conditions.
The level of spurious emissions shall be measured as, either:
a) their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation); or
b) their effective radiated power when radiated by cabinet and antenna in case of Integral antenna equipment with no antenna connectors.

For equipment using FHSS modulation, the measurements may be performed when normal hopping is disabled. In this case measurements need to be performed when operating at the lowest and the highest hopping frequency. When this is not possible, the measurement shall be performed during normal operation (hopping).

For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These frequencies shall be recorded.

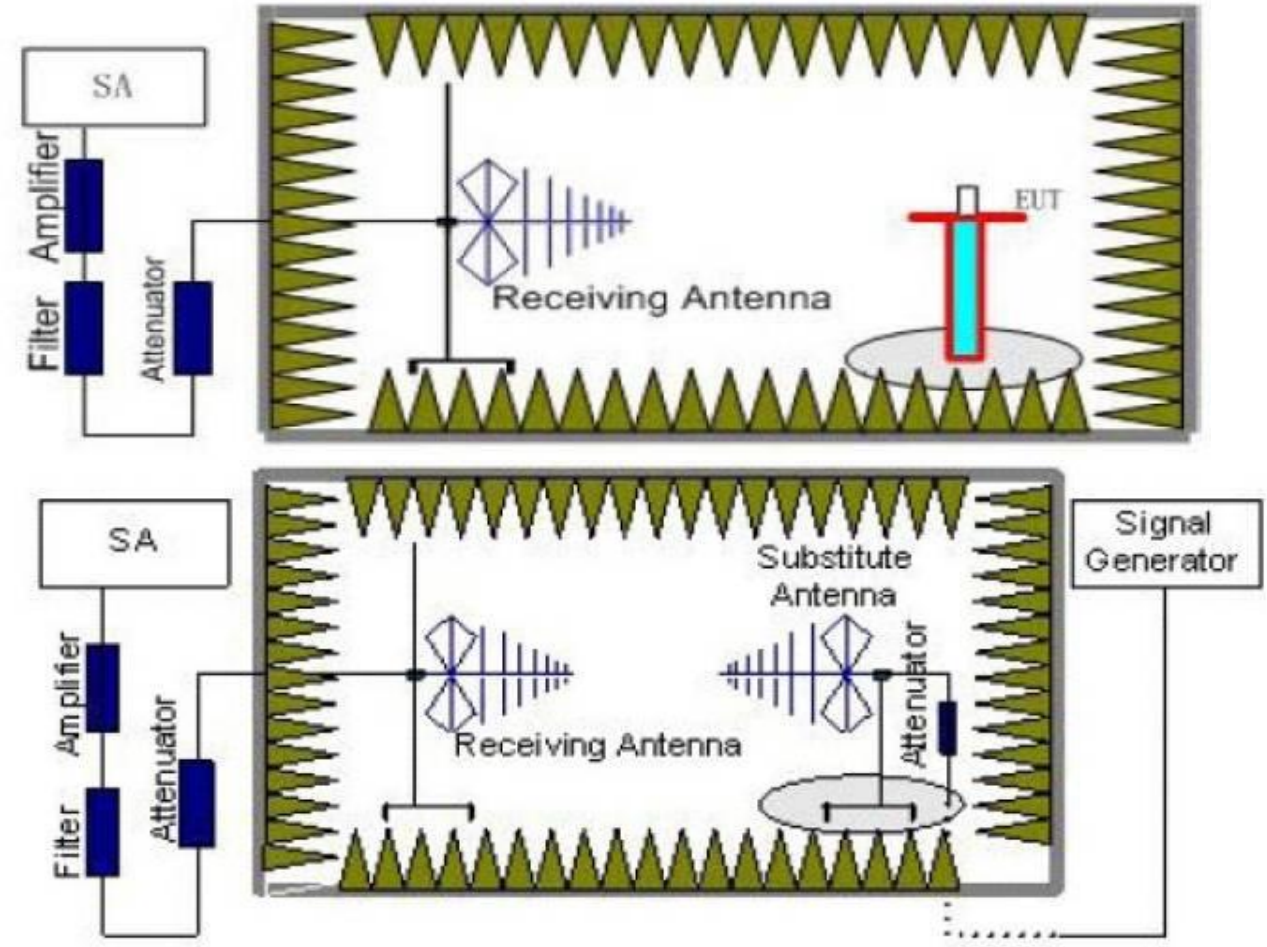
The equipment shall be configured to operate under its worst case situation with respect to output power.

If the equipment can operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz), then the equipment shall be configured to operate under its worst case situation with respect to spurious emissions.

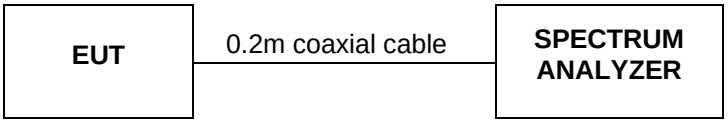
TEST CONFIGURATION

☒**Radiated Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.2, Radiated measurement.

Effective Radiated Power measurement (30 MHz to 12.75 GHz)



☒**Conducted Method:**



TEST PROCEDURE

☒**Radiated Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.2, Radiated measurement.

☒**Conducted Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.1, conducted method.
The test procedure shall be as follows:
Step 1:
The sensitivity of the measurement set-up should be such that the noise floor is at least 12 dB below the limits given in table 4 or table 12.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 19 400; for spectrum analysers not supporting this high number of sweep points, the frequency band may 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 FHSS 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.The above sweep time setting may result in long measuring times in case of FHSS equipment. To avoid such long measuring times, an FFT analyser may be used.Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range belowthe applicable limit or above, shall be individually measured using the procedure in clause 5.4.9.2.1.3 and compared to the limits given in table 4 or table 12.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 23 500; for spectrum analysers not supporting this high number of sweep points, the frequency band may 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 FHSS 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.The above sweep time setting may result in long measuring times in case of FHSS equipment. To avoid such long measuring times, an FFT analyser may 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 5.4.9.2.1.3 and compared to the limits given in table 4 or table 12.FHSS 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 5.4.9.2.1.3.
Step 4:
• In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), step 2 and step 3 need to be repeated for each of the active transmit chains (Ach).The limits used to identify emissions during this pre-scan need to be reduced by 10 × log10 (Ach).
5.4.9.2.1.3 Measurement of the emissions identified during the pre-scan
The procedure in step 1 to step 4 below shall be used to accurately measure the individual unwanted emissions identified during the pre-scan measurements above. This method assumes the spectrum analyser has a Time Domain Power function.
Step 1:
The level of the emissions shall be measured using the following spectrum analyser settings:
• Measurement Mode: Time Domain Power
• Centre Frequency: Frequency of the emission identified during the pre-scan

• Resolution Bandwidth: 100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
• Video Bandwidth: 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 Mode: Video (burst signals) or Manual (continuous signals)
• Detector Mode: 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 table 4 or table 12.

EUT DESCRIPTION:

Mode:	BT Test mode
Test Channel	Channel 00(2402MHz),Channel 19(2440MHz),Channel 39(2480MHz)
Modulation:	GFSK

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Video bandwidth:	30MHz-1GHz:300KHz; GHz -12.75GHz:3MHz;	
Resolution bandwidth:	30MHz-1GHz:100KHz; GHz -12.75GHz:1MHz;	
Sweep Points	30000	
Performed:	☒	Conducted
	☒	Radiated

Test Results

Note： only list the worst case in this item

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Tony Luo

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
653.74	V	-61.45	-54	7.45	PASS
654.91	H	-61.28	-54	7.28	PASS
Above 1GHz:					
Test Mode：Low Channel					
4804	H	-42.74	-30	12.74	PASS
4804	V	-43.38	-30	13.38	PASS
7206	H	-42.11	-30	12.11	PASS
7206	V	-42.69	-30	12.69	PASS
9608	H	-41.97	-30	11.97	PASS
9608	V	-43.23	-30	13.23	PASS
Test Mode：High Channel					
4960	H	-44.45	-30	14.45	PASS
4960	V	-43.86	-30	13.86	PASS
7440	H	-45.75	-30	15.75	PASS
7440	V	-45.56	-30	15.56	PASS
9920	H	-45.32	-30	15.32	PASS
9920	V	-43.83	-30	13.83	PASS

Note:
1. Cable loss and antenna gain was combined in the calculated result.
2. No record for margin above 20dB.

4.1.9. Receiver spurious emissions

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) §4.3.2.10.3
The spurious emissions of the receiver shall not exceed the values given in table 13.

Table 13: spurious emission limits for receivers

Frequency	Maximum power, e.r.p.	Measurement bandwidth
30 MHz to 1 GHz	-57 dBm	100 KHz
30 MHz to 12.75 GHz	-47 dBm	1 MHz

☒**Radiated Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.2, Radiated measurement.

☒**Conducted Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.10.2.1, conducted method.
The test procedure shall be as follows:
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
table 5 or table 13.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 19 400
• Sweep time: Auto
Wait for 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 5.4.10.2.1.3 and
compared to the limits given in table 5 or table 13.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 23 500; for spectrum analysers not supporting this high number of sweep points,
the frequency band may be segmented
• Sweep time: Auto
Wait for 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 5.4.10.2.1.3 and compared to
the limits given in table 5 or table 13.
FHSS 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 5.4.10.2.1.3.
Step 4:
• In case of conducted measurements on smart antenna systems (equipment with multiple receive chains), step 2 and step 3 need to be repeated for each of the active receive chains AchThe limits used to identify emissions during this pre-scan need to be reduced by 10 × log10 Ach.

The procedure in step 1 to step 4 below shall be used to accurately measure the individual unwanted emissions
identified during the pre-scan measurements above. This method assumes the spectrum analyser has a Time Domain
Power function.
Step 1:
The level of the emissions shall be measured using the following spectrum analyser settings:
• Measurement Mode: Time Domain Power
• Centre Frequency: Frequency of the emission identified during the pre-scan
• Resolution Bandwidth: 100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
• Video Bandwidth: 300 kHz (< 1 GHz) / 3 MHz (> 1 GHz)
• Frequency Span: Zero Span
• Sweep mode: Single Sweep
• Sweep time: 30 ms
• Sweep points: ⩾ 30 000
• Trigger: Video (for burst signals) or Manual (for 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 the start and stop times of the sweep.

Step 3: In case of conducted measurements on smart antenna systems (equipment with multiple receive chains), step 2 needs to be repeated for each of the active receive chains Ach.
Sum the measured power (within the observed window) for each of the active receive chains.

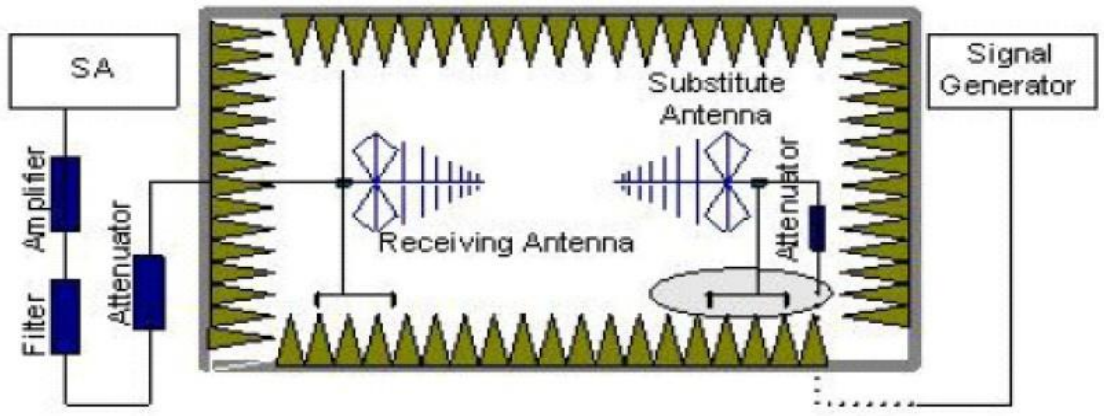
Step 4:

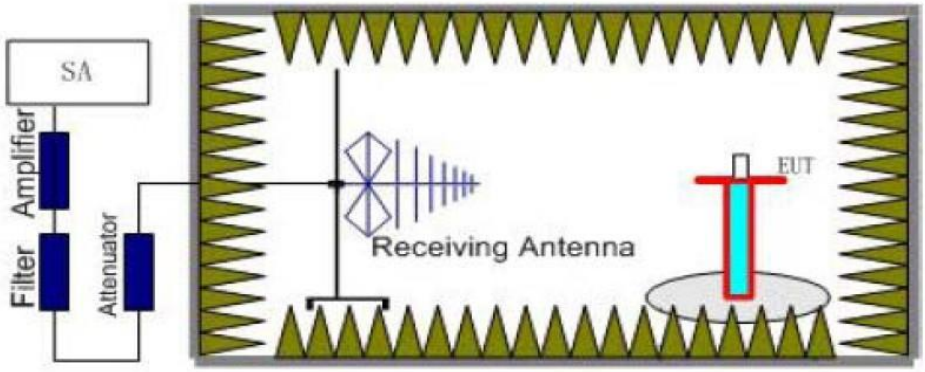
The value defined in step 3 shall be compared to the limits defined in table 5 and table 13.

Test Configuration

☒**Radiated Method:**

Effective Radiated Power measurement (30 MHz to 12.75 GHz)

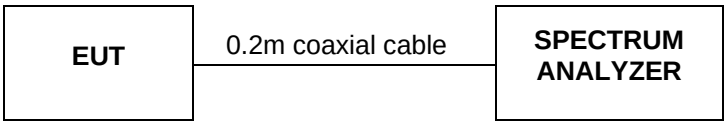




The level of spurious emissions shall be measured as, either:
a) their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation); or

b) their effective radiated power when radiated by cabinet and antenna in case of Integral antenna equipment withno temporary antenna connectors.
Testing shall be performed when the equipment is in a receive-only mode.
For equipment using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These frequencies shall be recorded.
For equipment using FHSS modulation, the measurements may be performed when normal hopping is disabled. In this case measurements need to be performed when operating at the lowest and the highest hopping frequency. These frequencies shall be recorded. When disabling the normal hopping is not possible, the measurement shall be performed during normal operation (hopping).

☒**Conducted Method:**



Test Results

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Tony Luo

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
470.79	V	-64.48	-57	7.48	PASS
696.02	H	-66.36	-57	9.36	PASS
Above 1GHz:					
Test Mode：Lowest frequency					
1702.12	H	-56.69	-47	9.69	PASS
1702.12	V	-57.38	-47	10.38	PASS
2858.52	H	-56.48	-47	9.48	PASS
2858.52	V	-56.53	-47	9.53	PASS
Test Mode： Highest frequency					
1774.95	H	-59.39	-47	12.39	PASS
1774.95	V	-56.28	-47	9.28	PASS
2337.42	H	-58.97	-47	11.97	PASS
2337.42	V	-59.44	-47	12.44	PASS

Note:
1. Cable loss and antenna gain was combined in the calculated result.
2. No record for margin above 20dB.

4.1.10. Receiver Blocking

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) §4.3.2.11.4

While maintaining the minimum performance criteria as defined in clause 4.3.2.11.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in table 14, table 15 or table 16.

The minimum performance criterion shall be a PER less than or equal to 10 %. The manufacturer may declare alternative performance criteria as long as that is appropriate for the intended use of the equipment.

Table 14: 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 × $\log_{10}$(OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × $\log_{10}$(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 P_{min} + 26 dB where P_{min} 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 P_{min} + 20 dB where P_{min} 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.

Table 15: 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 × $\log_{10}$(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 P_{min} + 26 dB where P_{min} 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.

Table 16: 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 × $\log_{10}$(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 test may be performed using a wanted signal up to P_{min} + 30 dB where P_{min} 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.			

According to ETSI EN 300 328 V2.2.2 (2019-07) § 4.2.3 Receiver categories
4.2.3.2.1 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.
4.2.3.2.2 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.
4.2.3.2.3 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.

These measurements shall only be performed at normal test conditions.
For non-frequency hopping equipment, having more than one operating channel, the equipment shall be tested operating at both the lowest and highest operating channels. Equipment which can change their operating channel automatically (adaptive channel allocation), and where this function cannot be disabled, shall be tested as a frequency hopping equipment.
If the equipment can be configured to operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz) and different data rates, then the combination of the smallest channel bandwidth and the lowest data rate for this channel bandwidth which still allows the equipment to operate as intended shall be used. This mode of operation shall be aligned with the performance criteria defined in clause 4.3.1.12.3 or clause 4.3.2.11.3 as declared by the manufacturer (see clause 5.4.1 t)) and shall be described in the test report.
It shall be verified that this performance criteria as declared by the manufacturer is achieved.

TEST CONFIGURATION

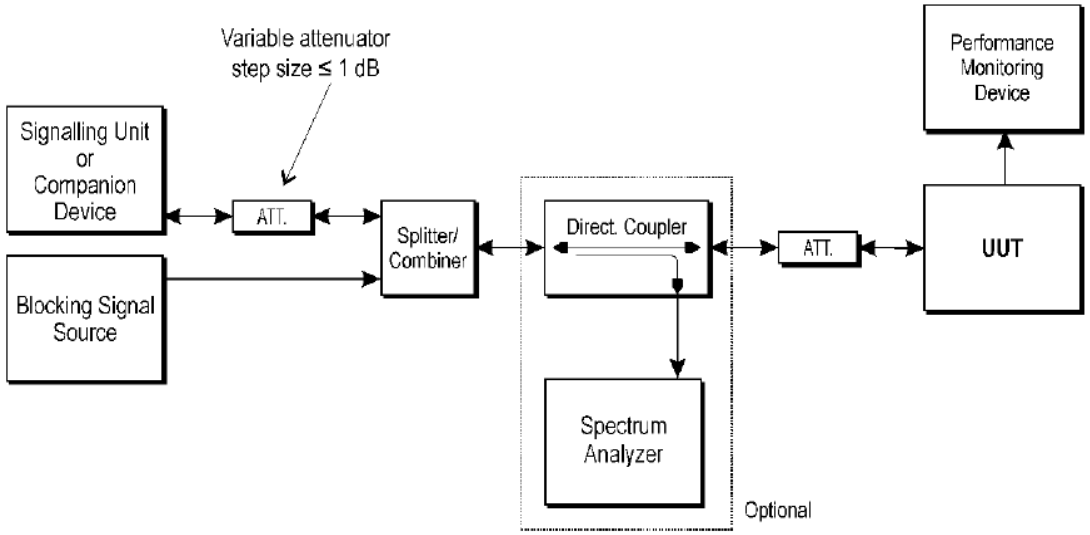


Figure 6: Test Set-up for receiver blocking

MEASUREMENT DESCRIPTION

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.11.2.1, Conducted measurements

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 Pmin.

• 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.

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

TestMode	Antenna	Freq(MHz)	Pmin [dBm]	Wanted signal [dBm]	Freq. [MHz]	CW [dBm]	PER [%]	Limit [%]	Verdict
BLE_1M	Ant1	2402	---	-68.87	2300	-34	4.50	≤10	PASS
			---	-68.87	2380	-34	5.10	≤10	PASS
		2480	---	-68.82	2504	-34	2.20	≤10	PASS
			---	-68.82	2584	-34	3.10	≤10	PASS

4.1.11. Geo-location capability

Definition& Requirements

ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.13.2 Definition
Geo-location capability is a feature of the equipment to determine its geographical location with the purpose to configure itself according to the regulatory requirements applicable at the geographical location where it operates.

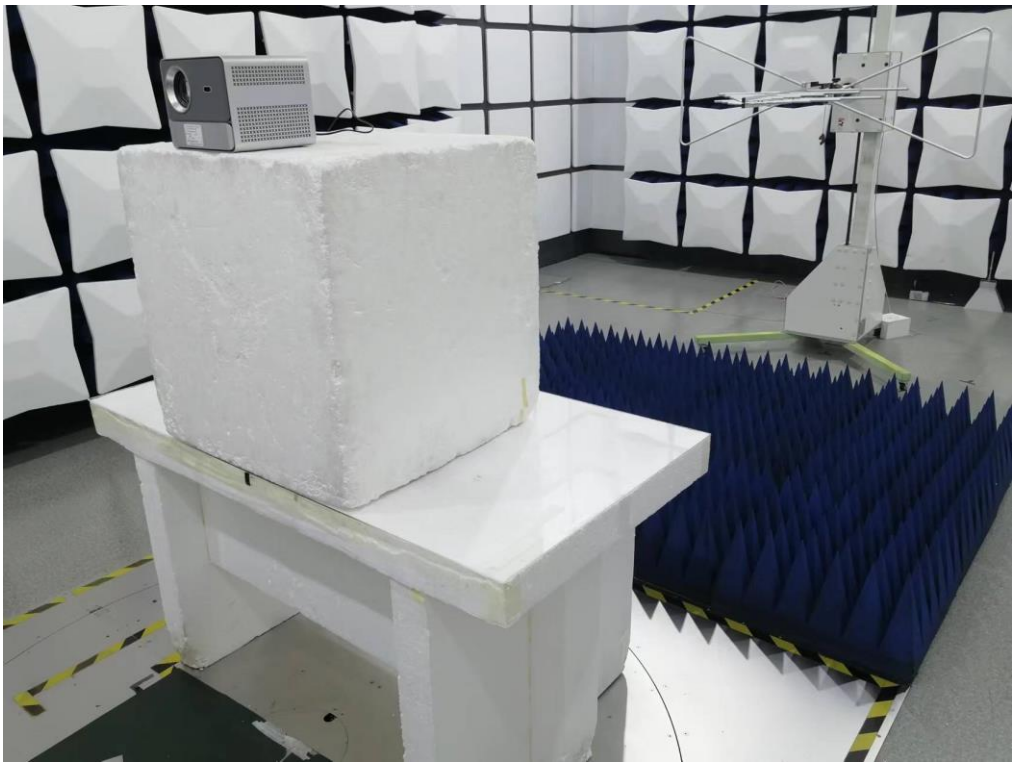
The geo-location capability may be present in the equipment or in an external device (temporary) associated with the equipment operating at the same geographical location during the initial power up of the equipment. The geographical location may also be available in equipment already installed and operating at the same geographical location.

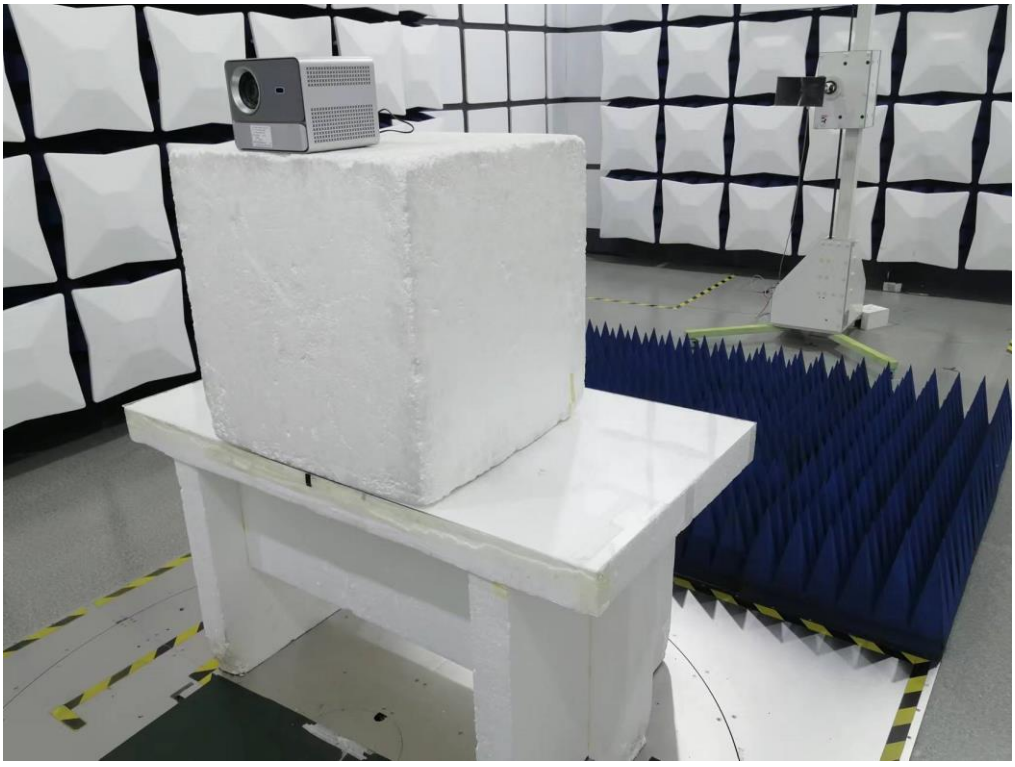
ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.13.2 Requirements
The geographical location determined by the FHSS equipment as defined in clause 4.3.1.13.2 shall not be accessible to the user in a way that would allow the user to alter it.

RESULTS

This equipment does not support Geo-location.

5. Test Setup Photos of the EUT





6. External and Internal Photos of the EUT

Reference to the test report No. TZ240105305-RE

.....End of Report.....

TEST REPORT

ETSI EN 300 328 V2.2.2 (2019-07)

Report Reference No.....:	**TZ240105305-EDR**
Compiled by (position+printed name+signature)..:	File administrators Anna Hu
Supervised by (position+printed name+signature)..:	Technique principal Hugo Chen
Approved by (position+printed name+signature)..:	Manager Andy Zhang
Date of issue.....:	2024/1/30

Testing Laboratory Name.....:	Shenzhen Tongzhou Testing Co.,Ltd
Address.....:	1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China
Applicant's name.....:	**Shenzhen Wanbo Technology Co., Ltd.**
Address.....:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Test specification ..... **:**	
Standard .....:	**ETSI EN 300 328 V2.2.2 (2019-07)**
TRF Originator.....:	Shenzhen Tongzhou Testing Co.,Ltd
Master TRF.....:	Dated 2024-01

Test item description .....:	**Wanbo Projector**
Trade Mark .....:	Wanbo
Model/Type reference.....:	WPC24
List Model .....:	WPD11， Dali 1， WPL11， EVA， WPC21， V1， DaVinci 1， DaVinci 1 Pro，WPA31，WPA34，X2 Max
Hardware Version.....:	KSOC_352_S2_WB
Software Version .....:	wanbo-WPC24-KGHE
Ratings.....:	AC 100-240V 50/60Hz 2A(Max)
Result.....:	**PASS**

TEST REPORT

Test Report No. :	TZ240105305-EDR	2024/1/30 Date of issue

Equipment under Test	:	Wanbo Projector
Model /Type	:	WPC24
Listed Models	:	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Applicant	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Manufacturer	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China

Test Result:	**PASS**

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.

** Modifited History **

Revision	Description	Issued Data	Remark
Revision 00	Initial Test Report Release	2024/1/30	Andy Zhang

Contents

1. TEST STANDARDS

The tests were performed according to following standards:

ETSI EN 300 328 V2.2.2 (2019-07) –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

2. SUMMARY

2.1. General Remarks

Date of receipt of test sample	:	2024/1/11
Testing commenced on	:	2024/1/11
Testing concluded on	:	2024/1/29

2.2. Product Description

The **Shenzhen Wanbo Technology Co., Ltd.**'s Model: WPC24 or the "EUT" as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

Name of EUT	Wanbo Projector
Model(s) Number	WPC24
List Model	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Difference description	All the same except for the model name
Hardware version	KSOC_352_S2_WB
Software version	wanbo-WPC24-KGHE

2.3. Wireless Function Tested in this report

Wireless Type	Working Frequency	Modulation Type	Version
Bluetooth BR/EDR	2402MHz-2480MHz	GFSK,π/4DQPSK,8DPSK	V5.0

2.4. Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	230V/ 50 Hz	○	120V/60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

AC 100-240V 50/60Hz 2A(Max)

Description of the test mode

79 channels are provided to the EUT.

Channel	Frequency(MHz)	Channel	Frequency(MHz)
00	2402	40	2442
01	2403	41	2443
02	2404	42	2444
03	2405	43	2445
04	2406	44	2446
05	2407	45	2447
06	2408	46	2448
07	2409	47	2449
08	2410	48	2450
09	2411	49	2451
10	2412	50	2452
11	2413	51	2453
12	2414	52	2454
13	2415	53	2455
14	2416	54	2456
15	2417	55	2457
16	2418	56	2458
17	2419	57	2459
18	2420	58	2460
19	2421	59	2461
20	2422	60	2462
21	2423	61	2463
22	2424	62	2464
23	2425	63	2465
24	2426	64	2466
25	2427	65	2467
26	2428	66	2468
27	2429	67	2469
28	2430	68	2470
29	2431	69	2471
30	2432	70	2472
31	2433	71	2473
32	2434	72	2474
33	2435	73	2475
34	2436	74	2476
35	2437	75	2477
36	2438	76	2478
37	2439	77	2479
38	2440	78	2480
39	2441		

2.5. Description of the Equipment under Test (EUT)

Reference documents:	Bluetooth® Core Specification
Special test descriptions:	None
Configuration descriptions:	TX tests: were performed with x-DH5 packets and static PRBS pattern payload.
	RX/Standby tests: BT test mode enabled, scan enabled, TX Idle
Test mode:	☒Bluetooth Test mode loop back enabled (EUT is controlled over CMW500)
	☐Special software is used. EUT is transmitting pseudo random data by itself
Bluetooth standard capabilities:	79 channels FHSS
	channel separation 1 MHz
	used freq. range 2402-2480 MHz
	Modulation types: GFSK, π/4 DQPSK, 8DPSK
	Bandwidth appr. 1MHz, 1,5 MHz, 1.5 MHz for single hop frequency
	number of hopping channels > 15 all the time
	more than 70% of band used with more than 20 channels

2.6. EUT Classification:

Type of equipment:	☒	stand alone equipment
	☐	plug in radio equipment
	☐	combined equipment
Modulation types:	☐	Wide Band Modulation (None Hopping – e.g. DSSS, OFDM)
	☒	Frequency Hopping Spread Spectrum (FHSS)
Adaptive equipment:	☒	Yes, LBT-based
	☐	Yes, non-LBT-based
	☐	Yes (but can be disabled)
	☐	No
Antennas and transmit operating modes:	☒	Operating mode 1 (single antenna) Equipment with 1 antenna, Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used, Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)
	☐	Operating mode 2 (multiple antennas, no beamforming) Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.
	☐	Operating mode 3 (multiple antennas, with beamforming) Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming. In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.

2.7. EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - supplied by the lab

/	/	/	/
/	/	/	/
/	/	/	/

2.8. Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version	Date of receipt	Type of Test
TZ240105305-1#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	Radio
TZ240105305-2#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	SAR (EMF)
TZ240105305-3#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	EMC

2.9. Modifications

No modifications were implemented to meet testing criteria.

3. TEST ENVIRONMENT

3.1. Address of the test laboratory

Shenzhen Tongzhou Testing Co.,Ltd
1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 (2014) and CISPR Publication 22.

3.2. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature/NT: 25℃
High Temperature/HT: 35℃
Low Temperature/LT: 0℃
Normal Voltage: AC 230V
High Voltage/HV: AC 264V
Low Voltage/LV: AC 90V
Relative Humidity: 55 %
Air Pressure: 989 hPa

3.3. Test Description

3.3.1. Main Terms

Verdict	Verdict of each test cases.
Test Case	Test cases identification number and description in ETSI specification.

3.3.2. Terms used in Condition column

NTC Normal voltage, Normal Temperature
HTHV High voltage, High Temperature
LTHV High voltage, Low Temperature
HTLV Low voltage, High Temperature
LTLV Low voltage, Low Temperature

3.3.3. Terms used in Verdict column

Pass	This test cases has been tested, and EUT is conformant to the applied standards in the given frequency band.
Fail	This test cases has been tested, but EUT is not conformant to the applied standards in the given frequency band.
N/A	This test case is either not required/not applicable in the specified band or is not applicable according to the specific PICS/PIXIT for the EUT.
Inc	Test case result is ambiguous in the given frequency band.
Decl	Declaration is received from the client to demonstrate the conformity to the relevant specification in the given frequency band.
BR	This test cases is not tested in the given frequency band, but this testcases was tested with pass result for the initial model in the given frequency band.

3.3.4. Sumarry of measurement results

☒ **No deviations from the technical specifications were ascertained**
☐ **There were deviations from the technical specifications ascertained**

Test Specification Clause	Test Case	Test Condition	Mode	Pass	Fail	N/A	NP	Remark
5.4.2	RF output power	NTC	GFSK π/4 DQPSK 8 DPSK	☒	☐	☐	☐	
		LT		☒	☐	☐	☐	
		HT		☒	☐	☐	☐	
5.4.2	Duty Cycle,Tx-sequence, Tx-gap	NTC	---	☐	☐	☒	☐	
5.4.4	Dwell time, min Freq.Occupation and Hopping sequence	NTC	GFSK π/4 DQPSK 8 DPSK	☒	☐	☐	☐	
5.4.5	Hopping Separation	NTC	GFSK π/4 DQPSK 8 DPSK	☒	☐	☐	☐	
5.4.2	Medium Utilisation	NTC	---	☐	☐	☒	☐	
5.4.6	Adaptivity, Short Control Signalling Transmissions	NTC	GFSK π/4 DQPSK 8 DPSK	☐	☐	☒	☐	
5.4.7	Occupied Channel Bandwidth	NTC	GFSK π/4 DQPSK 8 DPSK	☒	☐	☐	☐	
5.4.8	Transmitter unwanted emissions in the out-of-band domain	NTC	GFSK π/4 DQPSK 8 DPSK	☒	☐	☐	☐	
		LT		☐	☐	☒	☐	
		HT		☐	☐	☒	☐	
5.4.9	Transmitter unwanted emissions in the spurious domain (conducted & radiated)	NTC	GFSK π/4 DQPSK 8 DPSK	☒	☐	☐	☐	
5.4.10	Receiver spurious emissions (conducted & radiated)	NTC	GFSK π/4 DQPSK 8 DPSK	☒	☐	☐	☐	
5.4.11	Receiver Blocking	NTC	----	☒	☐	☐	☐	

Remark: The measurement uncertainty is not included in the test result.

Note 1: These requirements apply to non-adaptive equipment or to adaptive equipment when operating in a non-adaptive mode. These requirements do not apply for equipment with a maximum declared RF Output power level of less than 10 dBm e.i.r.p.

Note 2: This requirement does not apply to non-adaptive equipment or adaptive equipment operating in a non-adaptive mode. These requirements do not apply for equipment with a maximum declared RF Output power level of less than 10 dBm e.i.r.p.

3.4. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities.The measurement uncertainty was calculated for all measurements listed in this test report acc. to ETSI TR 100 028-1 [1], ETSI TS 103 051 [2] and ETSI TS 103 052 [3] and shall correspond to anexpansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 %in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).and is documented in the Shenzhen Tongzhou Testing Co.,Ltd quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device

Hereafter the best measurement capability for Shenzhen Tongzhou Testing Co.,Ltdis reported:

No.	Item	Uncertainty
1	Occupied Channel Bandwidth	±3.6dB
2	RF power,conducted	±0.16dB
3	Power Spectral Density, conducted	±1.3dB
4	Unwanted Emissions, conducted	±1.3dB
5	All emissions, radiated	±4.7dB
6	Temperature	±0.5°C
7	Humidity	±2%
8	DC and low frequency voltages	±1.5%
9	Time	±1.0%
10	Duty Cycle	±3.0%

3.5. Equipments Used during the Test

Conducted Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
2	Signal Generator	Keysight	N5182A	MY4620709	2024/1/4	2025/1/3
3	Signal Generator	R&S	SML03	102924/0013	2024/1/4	2025/1/3
4	Power Sensor	Agilent	U2021XA	MY5365004	2024/1/4	2025/1/3
5	Power Meter	Agilent	U2531A	TW53323507	2024/1/4	2025/1/3
6	Climate Chamber	KRUOMR	KRM-1000	KRM16072901	2024/1/4	2025/1/3
7	Wideband Radio Communication Tester	R&S	CMW500	101855	2024/1/4	2025/1/3
8	Test Software	Tonscend	JS1120-3	V3.2.22	--	--

Radiated Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	Wideband Antenna	schwarzbeck	VULB 9163	958	2022/11/13	2025/11/12
2	Horn Antenna	schwarzbeck	BBHA 9120D	01989	2022/11/13	2025/11/12
3	EMI Test Receiver	R&S	ESCI	100849/003	2024/1/4	2025/1/3
4	Controller	MF	MF7802	N/A	N/A	N/A
5	Amplifier	schwarzbeck	BBV 9743	209	2024/1/4	2025/1/3
6	Amplifier	Tonscend	TSAMP-0518SE	--	2024/1/4	2025/1/3
7	RF Cable	HUBER+SUHNER	RG214	N/A	2024/1/4	2025/1/3
8	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
9	Horn Antenna	ETS	3117	00218874	2022/11/13	2025/11/12
10	Wideband Antenna	Sunol	JB3	A020115	2022/7/3	2025/7/2
11	Test Software	Tonscend	JS36-RSE	V5.0.0.0	--	--

4. TEST CONDITIONS AND RESULTS

4.1. ETSI EN 300 328 REQUIREMENTS

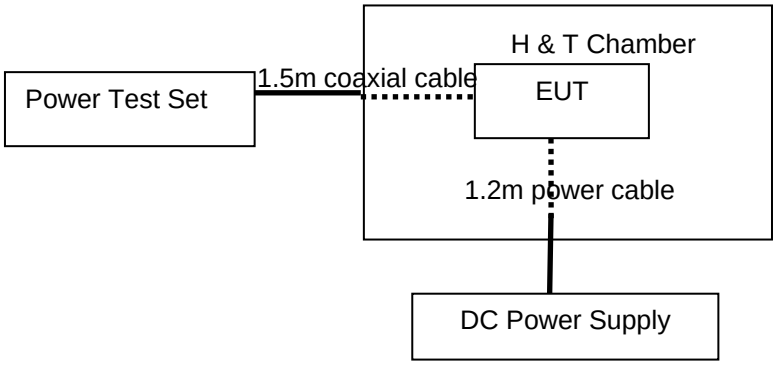
4.1.1. RF Output Power

LIMIT

ETSI EN 300 328 (V2.2.2) §4.3.1.2.2,
The RF output power for FHSS equipment shall be equal to or less than 20 dBm.
NOTE: For Non-adaptive FHSS equipment, the manufacturer may have declared a reduced RF Output Power (see
clause 5.4.1 m)) and associated Duty Cycle (see clause 5.4.1 e)) that will ensure that the equipment meets the requirement for the Medium Utilization (MU) factor further described in clause 4.3.1.6. This is verified by the conformance test referred to in clause 4.3.1.6.4.

For non-adaptive FHSS equipment, where the manufacturer has declared an RF output power lower than 20 dBm
e.i.r.p., the RF output power shall be equal to or less than that declared value.
This limit shall apply for any combination of power level and intended antenna assembly.

TEST CONFIGURATION



TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.2.2.1, conducted method.

EUT DESCRIPTION:

Mode:	BT Test mode
Hopping:	On
Packet Type:	Longest supported
Modulation:	GFSK, Π/4 DQPSK, 8DPSK

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring burst Power(EMS) of a least 10 packets	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Test Condition	TestMode	Antenna	Channel	EIRP[dBm]	Limit[dBm]	Verdict
NTNV	DH5	Ant1	Hop	5.34	20	PASS
	2DH5	Ant1	Hop	5.14	20	PASS
	3DH5	Ant1	Hop	5.07	20	PASS
LTNV	DH5	Ant1	Hop	5.33	20	PASS
	2DH5	Ant1	Hop	4.38	20	PASS
	3DH5	Ant1	Hop	5.11	20	PASS
HTNV	DH5	Ant1	Hop	5.36	20	PASS
	2DH5	Ant1	Hop	5.08	20	PASS
	3DH5	Ant1	Hop	5.12	20	PASS

Note :Cable loss and antenna gain was combined in the calculated result.

4.1.2. Duty Cycle,TX-sequence,TX-gap

LIMIT

ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 4.3.1.3
Non-adaptive FHSS equipment shall comply with the following:

- The Duty Cycle shall be equal to or less than the maximum value declared by the manufacturer.
- The maximum Tx-sequence time shall be 5 ms.
- The minimum Tx-gap time shall be 5 ms.

NOTE: For Non-adaptive FHSS equipment, the manufacturer may have declared a reduced RF Output Power (see clause 5.4.1 m)) and associated Duty Cycle (see clause 5.4.1 e)) that will ensure that the equipment meets the requirements for the Medium Utilization (MU) factors further described in clause 4.3.1.6. This is verified by the conformance test referred to in clause 4.3.1.6.4.

TEST PROCEDURE

Please refer to ETSI EN 300 328 (V2.2.2) Sub-clause 5.4.2.2.1.3
For equipment using FHSS modulation, the measurements shall be performed during normal operation (hopping) and the equipment is assumed to have no blacklisted frequencies (operating on all hopping positions). These requirements apply to non-adaptive frequency hopping equipment or to adaptive frequency hopping equipment operating in a non-adaptive mode.and only to be performed at normal environmental conditions, shall be as follows:
Step 1:
• Use the same stored measurement samples from the procedure described in clause 5.4.2.2.1.2.
• 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 case of insufficient dynamic range, the value of 30 dB may need to be reduced appropriately.
Step 2:
• Between the saved start and stop times of each individual burst, calculate the TxOn time. Save these TxOn values.
Step 3:
• Duty Cycle (DC) is the sum of all TxOn times between the end of the first gap (which is the start of the first burst within the observation period) and the start of the last burst (within this observation period) divided by the observation period. The observation period is defined in clause 4.3.1.3.2 or clause 4.3.2.4.2.
Step 4:
• For equipment using blacklisting, the TxOn time measured for a single (and active) hopping frequency shall be multiplied by the number of blacklisted frequencies. This value shall be added to the sum calculated in step 3 above. If the number of blacklisted frequencies cannot be determined, the minimum number of hopping frequencies (N) as defined in clause 4.3.1.4.3 shall be assumed.
• The calculated value for Duty Cycle (DC) shall be recorded in the test report. This value shall be equal to or less than the maximum value declared by the manufacturer.
Step 5:
• Use the same stored measurement samples from the procedure described in clause 5.4.2.2.1.2.
• Identify any TxOff time that is equal to or greater than the minimum Tx-gap time as defined in clause 4.3.1.3.3 or clause 4.3.2.4.3. These are the potential valid gap times to be further considered in this procedure.
• Starting from the second identified gap, calculate the time from the start of this gap to the end of the preceding gap. This time is the Tx-sequence time for this transmission. Repeat this procedure until the last identified gap within the observation period is reached.
• A combination of consecutive Tx-sequence times and Tx-gap times followed by a Tx-gap time, which is at least as long as the duration of this combination, may be considered as a single Tx-sequence time and in which case it shall comply with the limits defined in clause 4.3.1.3.3 or clause 4.3.2.4.3.
• It shall be noted in the test report whether the UUT complies with the limits for the maximum Tx-sequence time and minimum Tx-gap time as defined in clause 4.3.1.3.3 or clause 4.3.2.4.3.

EUT DESCRIPTION:

Mode:	BT Testmode
Test Channel	Channel 00(2402MHz),Channel 39(2441MHz),Channel 78(2480MHz)
Modulation:	GFSK, Π/4 DQPSK

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring average burst Power of a least 10 packets	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

This requirement do not apply for equipment with a maximum declared RF Output power level of less than 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p. So This requirement do not apply for EUT

4.1.3. Dwell time, Min. Freq. Occupation and Hopping Sequence

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) §4.3.1.4.3

DWELL TIME	
Condition	Limit
☐ Non-adaptive frequency hopping systems	≤ 15 ms in any [15 ms * the minimum number of hopping frequencies (N)] time domain
☒ Adaptive frequency hopping systems	≤ 400 ms in any [400 ms * the minimum number of hopping frequencies (N)] time domain
MINIMUM FREQUENCY OCCUPATION TIME	
Condition	Limit
☐ Non-adaptive frequency hopping systems	Option 1:Each hopping frequency of the hopping sequence shall be occupied at least once within a period notexceeding four times the product of the dwell time and the number of hopping frequencies in use. Option 2:The occupation probability for each frequency shall be between ((1 / U) × 25 %) and 77 % where U is the number of hopping frequencies in use.
☒ Adaptive frequency hopping systems	
HOPPING SEQUENCE (S)	
Condition	Limit
☐ Non-adaptive frequency hopping systems	≥15 hopping frequencies or 15/minimumHopping Frequency Separation (MHz) whichever is greater.
☒ Adaptive frequency hopping systems	Operating over a minimum of 70% of the Operating in the band 2.4 GHz to 2.4835 GHz
	≥15 hopping frequencies or 15/minimum Hopping Frequency Separation (MHz) whichever is greater.

TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.4.2.1 Conducted measurements.
Dwell time test procedure:
Step 1:
•The output of the transmitter shall be connected to a spectrum analyzer or equivalent.
•The analyzer shall be set as follows:
- Centre Frequency: Equal to the hopping frequency being investigated
- Frequency Span: 0 Hz
- RBW: 1MHz (~ 50 % of the Occupied Channel Bandwidth)
- VBW: 3MHz (≥ RBW)
- Detector Mode: RMS
- Sweep time: 10ms
- Number of sweep points: 30 000
- Trace mode: Clear / Write
- Trigger: Free Run

Step 2:
- Record the value of dwell time, repeat with different DH.

Minimum frequency occupation time and AccumulatedDwell Time
Step 1:
•The output of the transmitter shall beconnected to a spectrum analyzer or equivalent
•The analyzer shall be set as follows:
- Centre Frequency: Equal to the hopping frequency being investigated

- Frequency Span: 0 Hz
- RBW: 1MHz (~ 50 % of the Occupied Channel Bandwidth)
- VBW: 3MHz (≥ RBW)
- Detector Mode: RMS
- Sweep time: Equal to the Dwell Time × Minimum number of hopping frequencies (N) (see clause 4.3.1.4.3.1 orclause 4.3.1.4.3.2)
- Number of sweep points: 30 000
- Trace mode: Clear / Write
- Trigger: Free Run

Step 2:

•Save the trace data to a file for further analysis by a computing device using an appropriate software application or program.

Step 3:

•Indentify the data points related to the frequency being investigated by applying a threshold.
The data points resulting from transmissions on the hopping frequency being investigated are assumed to havemuch higher levels compared to data points resulting from transmissions on adjacent hopping frequencies. If aclear determination between these transmissions is not possible, the RBW in step 1 shall be further reduced. Inaddition, a channel filter may be used.
•Count the number of data points identified as resulting from transmissions on the frequency being investigatedand multiply this number by the time difference between two consecutive data points.

Step 4:

•The result in step 3 is the Accumulated Transmit Time which shall comply with the limit provided in clause 4.3.1.4.3.1 or clause 4.3.1.4.3.2 and which shall be recorded in the test report.

Step 5:

NOTE 1: This step is only applicable for equipment implementing Option 1 in clause 4.3.1.4.3.1 or clause 4.3.1.4.3.2 for complying with the Frequency Occupation requirement and the manufacturer decides to demonstrate compliance with this requirement via measurement.
•Make the following changes on the analyser and repeat step 2 and step 3.
Sweep time: 4 × Dwell Time × Actual number of hopping frequencies in use
The hopping frequencies occupied by the equipment without having transmissions during the dwell time (blacklisted frequencies) should be taken into account in the actual number of hopping frequencies in use. Ifthis number cannot be determined (number of blacklisted frequencies unknown) it shall be assumed that theequipment uses the maximum possible number of hopping frequencies.
•The result shall be compared to the limit for the Frequency Occupation defined in clause 4.3.1.4.3.1,option1 or clause 4.3.1.4.3.2,option1. The result of this comparison shall be recorded in the test report.

Step 6:

•Make the following changes on the analyzer:
- Start Frequency: 2 400 MHz
- Stop Frequency: 2 483,5 MHz
- RBW: 500KHz [~ 50 % of the Occupied Channel Bandwidth (single hop)]
- VBW: 2MHz (≥ RBW)
- Detector Mode: Peak
- Sweep time: 1s; this setting may result in long measuring times. To avoid such long measuring times, an FFT analyser may be used
-Number of sweep points: ~ 400 / Occupied Channel Bandwidth (MHz); the number of sweep points may need to be further increased in case of overlapping channels
- Trace Mode: Max Hold
- Trigger: Free Run

•Wait for the trace to stabilize. Identify the number of hopping frequencies used by the hopping sequence.The result shall be compared to the limit (value N) defined in clause 4.3.1.4.3.1 or clause 4.3.1.4.3.2. This value shall be recorded in the test report.
For equipment with blacklisted frequencies, it might not be possible to verify the number of hopping frequencies in use. However they shall comply with the requirement for Accumulated Transmit Time and Frequency Occupation assuming the minimum number of hopping frequencies (N) defined in clause 4.3.1.4.3.1 or clause 4.3.1.4.3.2 is used.

Step 7:

• For adaptive frequency hopping equipment, it shall be verified whether the equipment uses 70 % of the band specified in table 1. This verification can be done using the lowest and highest -20 dB points from the total spectrum envelope obtained in step 6. The result shall be recorded in the test report.

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Accumulated Transmit Time

TestMode	Antenna	Freq(MHz)	Result [ms]	Limit[ms]	Verdict
DH5	Ant1	Hop_2402	317.073	400	PASS
		Hop_2480	343.408	400	PASS
2DH5	Ant1	Hop_2402	302.326	400	PASS
		Hop_2480	303.379	400	PASS
3DH5	Ant1	Hop_2402	299.166	400	PASS
		Hop_2480	297.059	400	PASS

Frequency Occupation

TestMode	Antenna	Freq(MHz)	Result [Num.]	Limit [Num.]	Verdict
DH5	Ant1	Hop_2402	3	1	PASS
		Hop_2480	3	1	PASS
2DH5	Ant1	Hop_2402	3	1	PASS
		Hop_2480	5	1	PASS
3DH5	Ant1	Hop_2402	2	1	PASS
		Hop_2480	2	1	PASS

Hopping Sequence

TestMode	Antenna	Freq(MHz)	Hop. [Num.]	Limit[Num.]	Band Use [%]	Limit [%]	Verdict
DH5	Ant1	Hop_2402	79	15	95.20	70	PASS
2DH5	Ant1	Hop_2402	79	15	95.20	70	PASS
3DH5	Ant1	Hop_2402	79	15	95.30	70	PASS

4.1.4. Hopping Frequency Separation

LIMIT

ETSI EN 300 328 V2.2.2 (2019-07) 4.3.1.5.3.2:
Adaptive frequency hopping systemsThe minimum Hopping Frequency Separation shall be 100 kHz.

TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.5.2.1.3,option 2, conducted method.

Step 1:

•The output of the transmitter shall be connected to a spectrum analyzer or equivalent.
•The analyzer shall be set as follows:
- Centre Frequency: Centre of the two adjacent hopping frequencies
- Frequency Span: Sufficient to see the complete power envelope of both hopping frequencies
- RBW: 30 KHz (1 % of the Span)
- VBW: ≥(3 × RBW)
- Detector Mode: Max Peak
- Trace Mode: Max Hold
- Sweep Time: Auto

Step 2:

•Wait for the trace to stabilize.
•Use the marker-delta function to determine the Hopping Frequency Separation between the peaks of the twoadjacent hopping frequencies. This value shall be compared with the limits defined in clause 4.3.1.4.2 andshall be recorded in the test report.

EUT DESCRIPTION:

Mode:	BT Testmode
Hopping:	On
Packet Type:	Longest supported
Modulation:	GFSK, Π/4 DQPSK, 8DPSK

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	Max Peak	
Sweep time:	auto	
Video bandwidth:	60 KHz	
Resolution bandwidth:	20 KHz	
Span:	3 MHz	
Trace:	Max hold	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

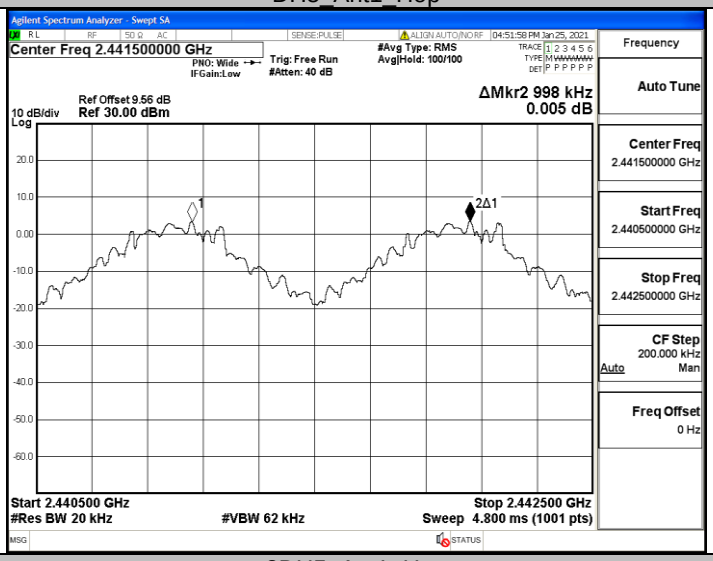
TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

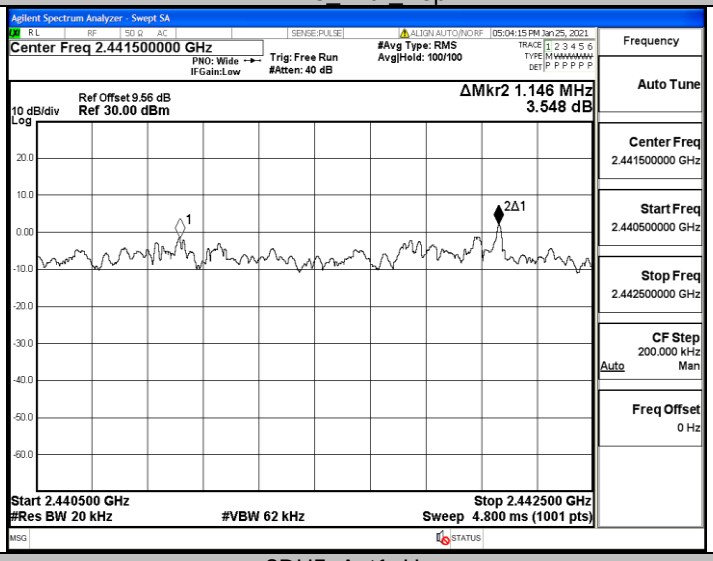
TestMode	Antenna	Channel	Result [MHz]	Limit[MHz]	Verdict
DH5	Ant1	Hop	0.998	0.100	PASS
2DH5	Ant1	Hop	1.146	0.100	PASS
3DH5	Ant1	Hop	1.008	0.100	PASS

Test Graphs

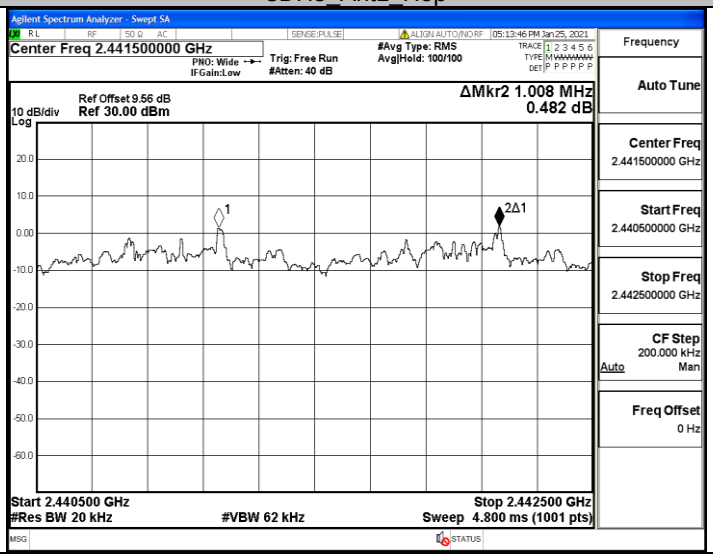
DH5_Ant1_Hop



2DH5_Ant1_Hop



3DH5_Ant1_Hop



4.1.5. Medium Utilisation (MU) factor

LIMIT

ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 4.3.2.5.3
For non-adaptive equipment using wide band modulations other than FHSS, the maximum Medium Utilization factor shall be 10 %.
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 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p.

TEST PROCEDURE

Please refer to ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 5.4.2.2.1.4
Step 1:
• Use the same stored measurement samples from the procedure described in clause 5.4.2.2.1.2.
Step 2:
• For each burst calculate the product of (Pburst / 100 mW) and the TxOn time. Pburst is expressed in mW. TxOn time is expressed in ms.
Step 3:
• Medium Utilization is the sum of all these products divided by the observation period (expressed in ms) which is defined in clause 4.3.1.3.2 or clause 4.3.2.4.2. This value, which shall comply with the limit given in clause 4.3.1.6.3 or clause 4.3.2.5.3, shall be recorded in the test report.
If operation without blacklisted frequencies is not possible, the power of the bursts on blacklisted hopping frequencies (for the calculation of the Medium Utilization) is assumed to be equal to the average value of the RMS power of the bursts on all active hopping frequencies.

EUT DESCRIPTION:

Mode:	BT Test mode
Test Channel	Channel 00(2402MHz),Channel 39(2441MHz),Channel 78(2480MHz)
Modulation:	GFSK, Π/4 DQPSK, 8DPSK

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring average burst Power of a least 10 packets	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

Not Applicable according to ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 4.3.1.6.1

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 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p.

4.1.6. Adaptivity (Adaptive Frequency Hopping)

LIMIT

Requirement	Type	
	Adaptive Frequency Hopping using LBT based DAA	Adaptive Frequency Hopping using other forms of DAA (non-LBT based)
Minimum Clear Channel Assessment (CCA) Time	At least of Max(18 us, 0.2% of COT) (Note 1)	N/A
Maximum Channel Occupancy (COT) Time	2.0ms$_{note4}$ to 60ms/Dwell time (Note 3)	40 ms
Minimum Idle Period	5% of COT and should longer then 100us	At least 5% of COT and 100 μ s
Extended CCA check	(CCA, 5% of COT)	N/A
Short Control Signaling Transmissions	Short Control Signalling Transmissions shall have a maximum TxOn / (TxOn + TxOff) ratio of 10 % within any observation period of 50 ms or within an observation period equal to the dwell time, whichever is less. (Note 2)	
Note 1: The CCA time used by the equipment shall be declared by the supplier. Note 2: Adaptive equipment may or may not have Short Control Signaling Transmissions. Note 3: For LBT based adaptive frequency hopping equipment with a dwell time < 60 ms, the maximum Channel Occupancy Time is limited by the dwell time. Note 4: acrroding to 4.3.1.7.2.2 3)of ETSI EN 300 328 V2.2.2, the 5% of COT should longer then 100us, so the minimum COT should longer then 2.0ms.		

Wanted signal mean power from companion device:
TL = -70 dBm/MHz + 10 × log10 (100 mW / P_{out}) (Pout in mW e.i.r.p.)

Unwanted Signal parameters

Wanted signal mean power from companion device	Maximum transmit power (PH) EIRP mW	Threshold Level (TL)
sufficient to maintain the link (see note 2)	2 395 or 2 488,5 (see note 1)	-35 (see note 3)
NOTE 1: The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1. NOTE 2: A typical value which can be used in most cases is -50 dBm/MHz. NOTE 3: The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.		

TEST CONFIGURATION

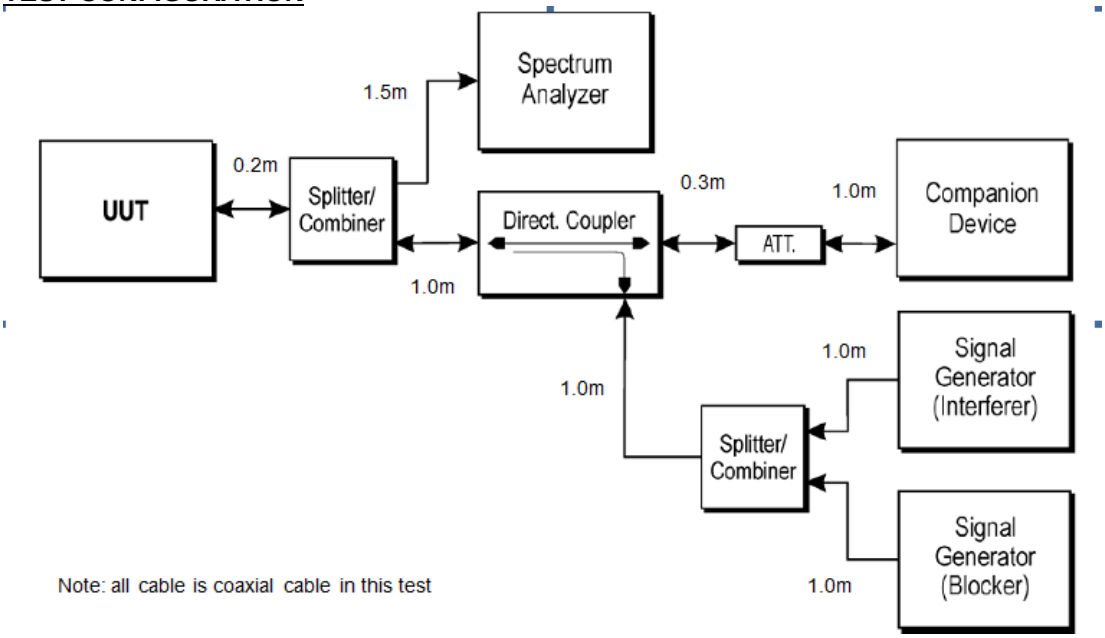


Figure 5: Test set-up for verifying the adaptivity of an equipment

MEASUREMENT DESCRIPTION

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.6.2.1.2, Conducted measurements
Step 1 to step 7 below define the procedure to verify the efficiency of the DAA based adaptive mechanisms for frequency hopping equipment. These mechanisms are described in clause 4.3.1.7.
For systems using multiple receive chains only one chain (antenna port) need to be tested. All other receiver inputs shall be terminated.

Step 1:

• The UUT shall connect to a companion device during the test. The interference signal generator, the unwanted signal generator, the spectrum analyser, the UUT and the companion device are connected using a set-up equivalent to the example given by figure 5, although the interference and unwanted signal generators do not generate any signals at this point in time. The spectrum analyser is used to monitor the transmissions of both the UUT and the companion device and it should be possible to distinguish between either transmission. In addition, the spectrum analyser is used to monitor the transmissions of the UUT in response to the interfering and the unwanted signals.

• For the hopping frequency to be tested, adjust the received signal level (wanted signal from the companion device) at the UUT to the value defined in table 2 and table 3 (clause 4).

Testing of Unidirectional equipment does not require a link to be established with a companion device.

• The analyser shall be set as follows:

- RBW: use next available RBW setting below the measured Occupied Channel Bandwidth
- Filter type: Channel Filter
- VBW: ⩾ RBW
- Detector Mode: RMS
- Centre Frequency: Equal to the hopping frequency to be tested

- Span: 0 Hz
- Sweep time: > Channel Occupancy Time of the UUT. If the Channel Occupancy Time is non-contiguous (non-LBT based equipment), the sweep time shall be sufficient to cover the period over which the Channel Occupancy Time is spread out
- Trace Mode: Clear/Write
- Trigger Mode: Video

Step 2:

• Configure the UUT for normal transmissions with a sufficiently high payload resulting in a minimum transmitter activity ratio (TxOn / (TxOn + TxOff)) of 0,3. Where this is not possible, the UUT shall be configured to the maximum payload possible.

• Using the procedure defined in clause 5.4.6.2.1.5, it shall be verified that, for equipment with a dwell time greater than the maximum allowable Channel Occupancy Time, the UUT complies with the maximum Channel Occupancy Time and minimum Idle Period defined in clause 4.3.1.7.2.2 or clause 4.3.1.7.3.2. When measuring the Idle Period of the UUT, it shall not include the transmission time of the companion device.

Step 3: Adding the interference signal

• An interference signal as defined in clause B.7 is injected centred on the hopping frequency being tested. The power spectral density level (at the input of the UUT) of this interference signal shall be equal to the detection threshold defined in clause 4.3.1.7.2.2 or clause 4.3.1.7.3.2.

Step 4: Verification of reaction to the interference signal

• The spectrum analyser shall be used to monitor the transmissions of the UUT on the selected hopping frequency with the interfering signal injected. This may require the spectrum analyser sweep to be triggered by the start of the interfering signal.

• Using the procedure defined in clause 5.4.6.2.1.5, it shall be verified that:

i) The UUT shall stop transmissions on the hopping frequency being tested.

The UUT is assumed to stop transmissions on this hopping frequency within a period equal to the maximum Channel Occupancy Time defined in clause 4.3.1.7.2.2 or clause 4.3.1.7.3.2. As stated in clause 4.3.1.7.3.2, step 3, the Channel Occupancy Time for non-LBT based frequency hopping equipment may be non-contiguous.

ii) For LBT based frequency hopping equipment, apart from Short Control Signalling Transmissions (see iii) below), there shall be no subsequent transmissions on this hopping frequency, as long as the interference signal remains present.

For non-LBT based frequency hopping equipment, apart from Short Control Signalling Transmissions (see iii) below), there shall be no subsequent transmissions on this hopping frequency for a (silent) period defined in clause 4.3.1.7.3.2, step 2. After that, the UUT may have normal transmissions again for the duration of a single Channel Occupancy Time period (which may be non-contiguous). Because the interference signal is still present, another silent period as defined in clause 4.3.1.7.3.2, step 2 needs to be included. This sequence is repeated as long as the interfering signal is present.

In case of overlapping channels, transmissions in adjacent channels may generate transmission bursts on the channel being investigated; however, they have a lower amplitude as on-channel transmissions. Care should be taken to only evaluate the on-channel transmissions. The Time Domain Power Option of the analyser may be used to measure the RMS power of the individual bursts to distinguish on-channel transmissions from transmissions on adjacent channels. In some cases, the RBW may need to be reduced.

To verify that the UUT is not resuming normal transmissions as long as the interference signal is present, the monitoring time may need to be 60 s or more. If transmissions are detected during this period, the settings of the analyser may need to be adjusted to allow an accurate assessment to verify the transmissions comply with the limits for Short Control Signalling Transmissions.

iii) The UUT may continue to have Short Control Signalling Transmissions on the hopping frequency being tested while the interference signal is present. These transmissions shall comply with the limits defined in clause 4.3.1.7.4.2.

The verification of the Short Control Signalling transmissions may require the analyser settings to be changed (e.g. sweep time).

iv) Alternatively, the equipment may switch to a non-adaptive mode.

Step 5: Adding the unwanted signal

• With the interfering signal present, a 100 % duty cycle CW signal is inserted as the unwanted signal. The frequency and the level are provided in table 2 of clause 4.3.1.7.2.2, step 6 or table 3 of clause 4.3.1.7.3.2, step 6.

• The spectrum analyser shall be used to monitor the transmissions of the UUT on the selected hopping frequency. This may require the spectrum analyser sweep to be triggered by the start of the unwanted signal.

• Using the procedure defined in clause 5.4.6.2.1.5, it shall be verified that:

i) The UUT shall not resume normal transmissions on the hopping frequency being tested as long as both the interference and unwanted signals remain present.

To verify that the UUT is not resuming normal transmissions as long as the interference and unwanted signals are present, the monitoring time may need to be 60 s or more. If transmissions are detected during this period, the settings of the analyser may need to be adjusted to allow an accurate assessment to verify

the transmissions comply with the limits for Short Control Signalling Transmissions.
ii) The UUT may continue to have Short Control Signalling Transmissions on the hopping frequency being tested while the interference and unwanted signals are present. These transmissions shall comply with the limits defined in clause 4.3.1.7.4.2.
The verification of the Short Control Signalling transmissions may require the analyser settings to be changed (e.g. sweep time).
Step 6: Removing the interference and unwanted signal
• On removal of the interference and unwanted signal, the UUT is allowed to re-include any channel previously marked as unavailable; however, for non-LBT based equipment, it shall be verified that this shall only be done after the period defined in clause 4.3.1.7.3.2, step 2.
Step 7:
• Step 2 to step 6 shall be repeated for each of the hopping frequencies to be tested.

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	> Channel Occupancy Time	
Video bandwidth:	≥ RBW	
Resolution bandwidth:	≥ Occupied Channel Bandwidth	
Span:	0 Hz	
Center:	Equal to the hopping freq. to be tested	
Trace:	clear/write video triggered	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)
	☐	Short Control Signalling Transmissions available

TEST RESULTS

This requirement do not apply for equipment with a maximum declared RF Output power level of less than 10 dBme.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBme.i.r.p. So This requirement do not apply for EUT

4.1.7. Occupied Channel Bandwidth

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) 4.3.1.8.3
The Occupied Channel Bandwidth for each hopping frequency shall fall completely within the band given in clause 1.For non-adaptive Frequency Hopping equipment with e.i.r.p greater than 10 dBm, the Occupied Channel Bandwidth forevery occupied hopping frequency shall be equal to or less than the Nominal Channel Bandwidth declared by thesupplier. See clause 5.3.1 j). This declared value shall not be greater than 5 MHz.

TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 5.3.8.2.1
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.3.8.2.1 Conducted measurement
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 for frequency hopping equipment: Lowest frequency separation that is used within the hopping sequence
•Frequency Span for other types of equipment: 2 × Nominal Channel Bandwidth (e.g. 40 MHz for a 20 MHz channel)
•Detector Mode: RMS
•Trace Mode: Max Hold
•Sweep time: 1 s
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 noisesignals left and right from the power envelope being taken into account by this measurement.

EUT DESCRIPTION:

Mode:	BT Testmode
Hopping:	Off
Packet Type:	Longest supported
Modulation:	GFSK, Π/4 DQPSK, 8DPSK

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	1S	
Video bandwidth:	60KHz	
Resolution bandwidth:	20KHz	
Span:	2MHz	
Center:	Transmit channel	
Trace:	Max hold	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

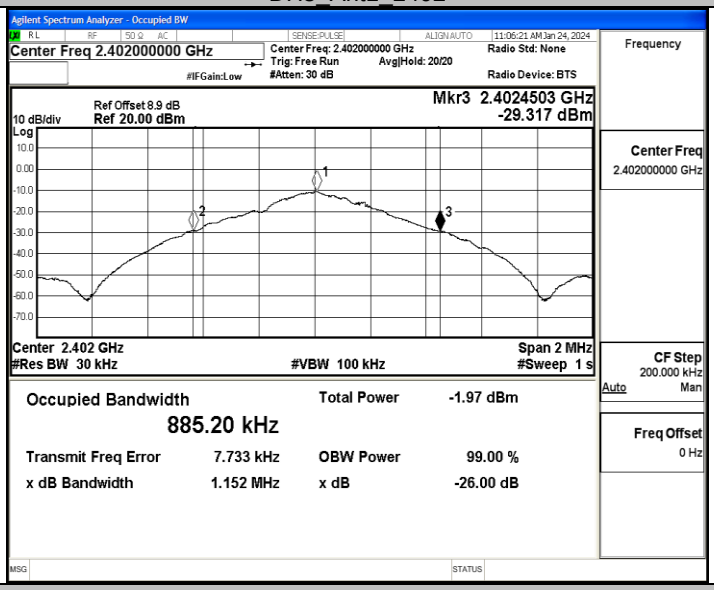
Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Test Data

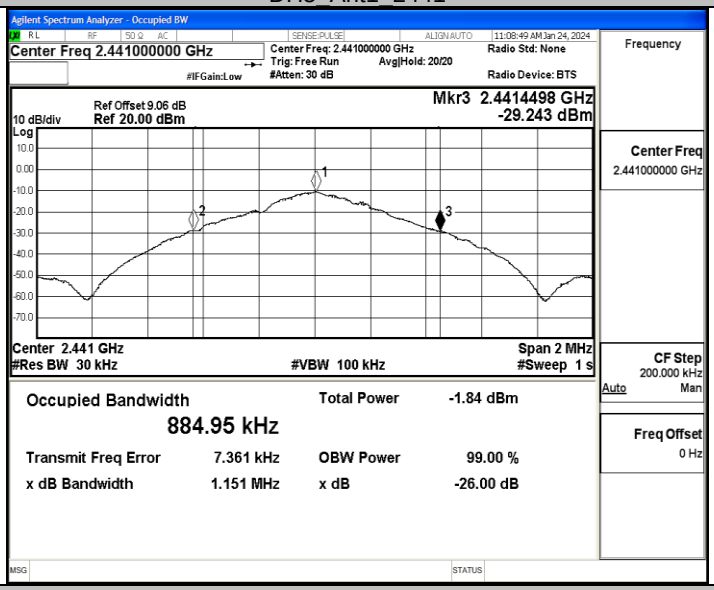
TestMode	Antenna	Channel	OCB[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.88520	2401.5651	2402.4503	2400 to 2483.5	PASS
		2441	0.88495	2440.5649	2441.4498	2400 to 2483.5	PASS
		2480	0.88540	2479.5639	2480.4493	2400 to 2483.5	PASS
2DH5	Ant1	2402	1.1941	2401.4076	2402.6017	2400 to 2483.5	PASS
		2441	1.1939	2440.4075	2441.6014	2400 to 2483.5	PASS
		2480	1.1944	2479.4068	2480.6012	2400 to 2483.5	PASS
3DH5	Ant1	2402	1.1863	2401.4129	2402.5992	2400 to 2483.5	PASS
		2441	1.1864	2440.4129	2441.5993	2400 to 2483.5	PASS
		2480	1.1865	2479.4123	2480.5988	2400 to 2483.5	PASS

Test plot as follows

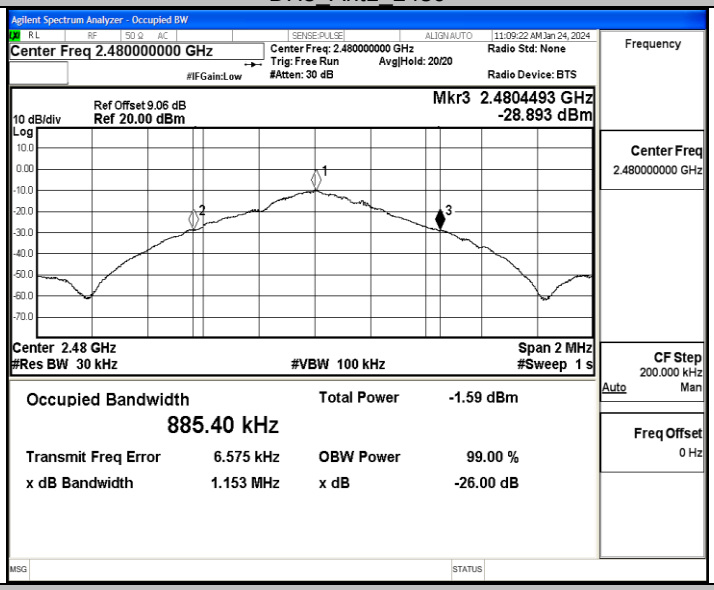
DH5_Ant1_2402



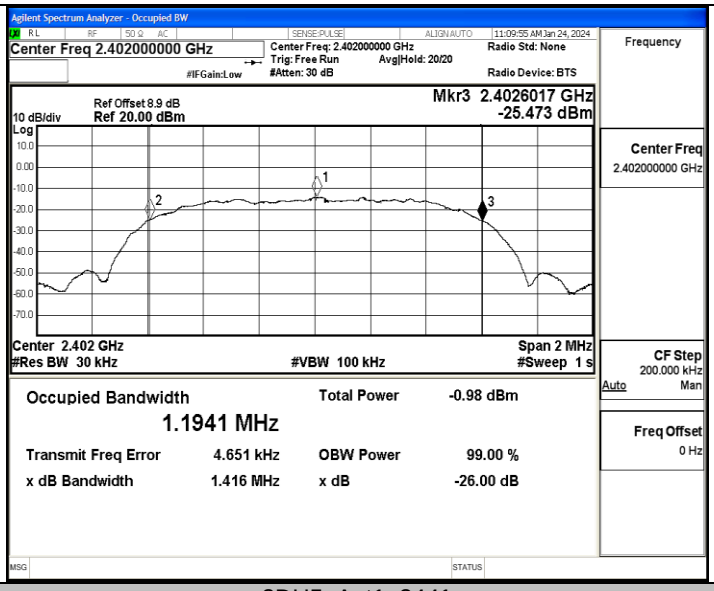
DH5_Ant1_2441



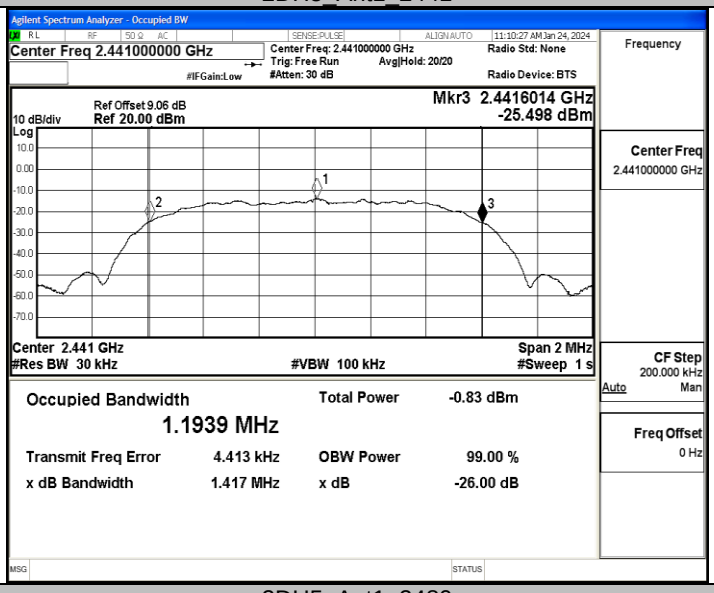
DH5_Ant1_2480



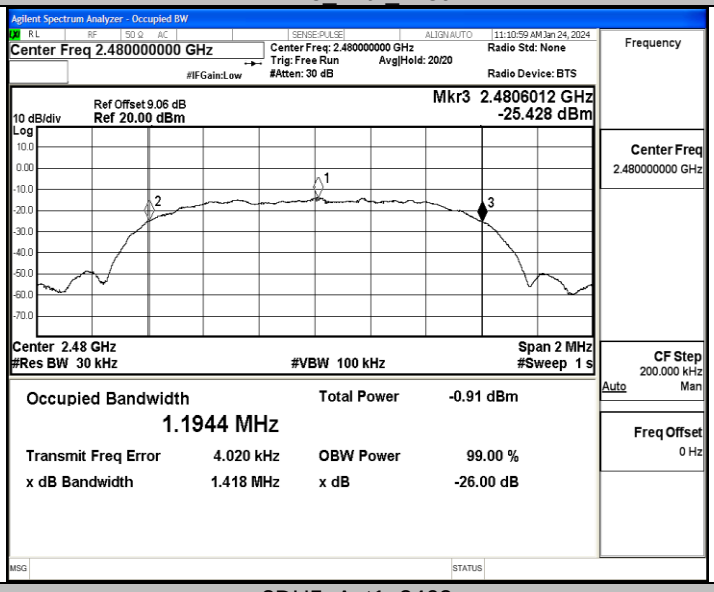
2DH5_Ant1_2402



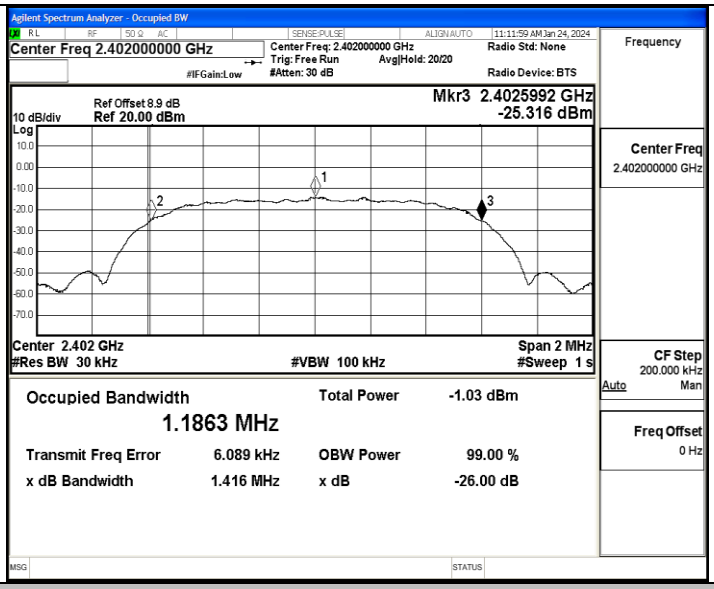
2DH5_Ant1_2441



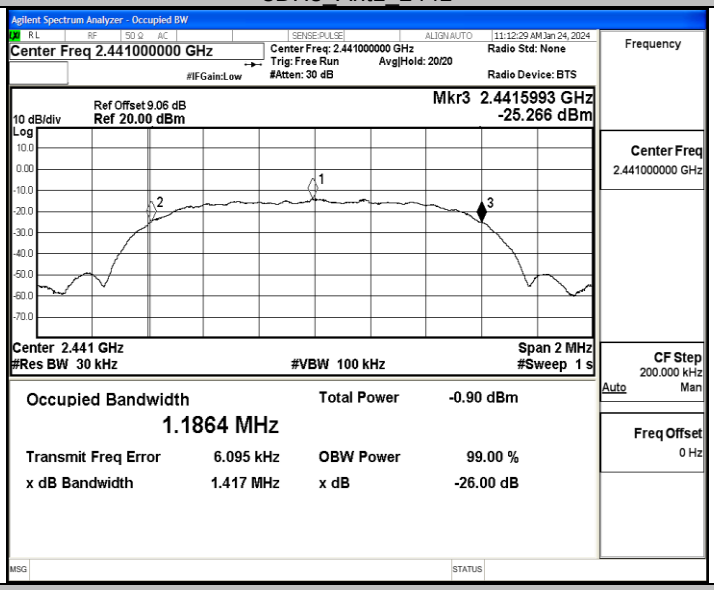
2DH5_Ant1_2480



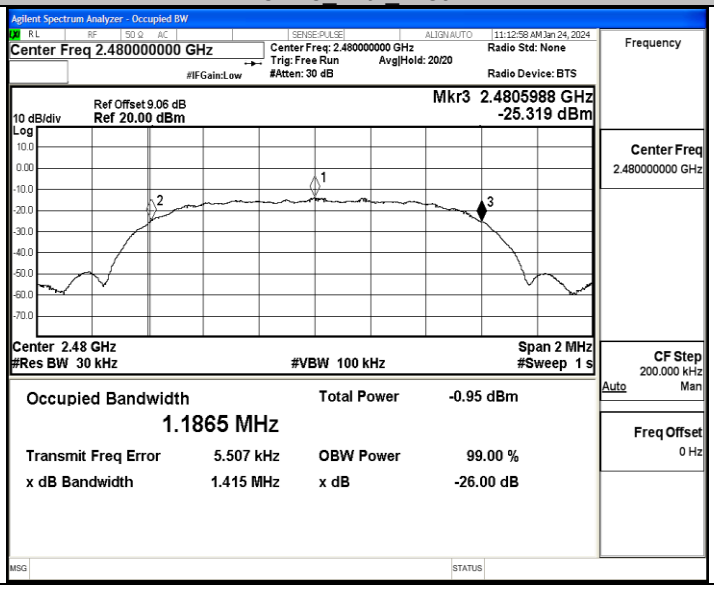
3DH5_Ant1_2402



3DH5_Ant1_2441



3DH5_Ant1_2480



4.1.8. Transmitter unwanted emissions in the out-of-band domain

LIMIT

ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 4.3.1.9.3
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.
NOTE: Within the 2 400 MHz to 2 483,5 MHz band, the Out-of-band emissions are fulfilled by compliance with the Occupied Channel Bandwidth requirement in clause 4.3.1.8

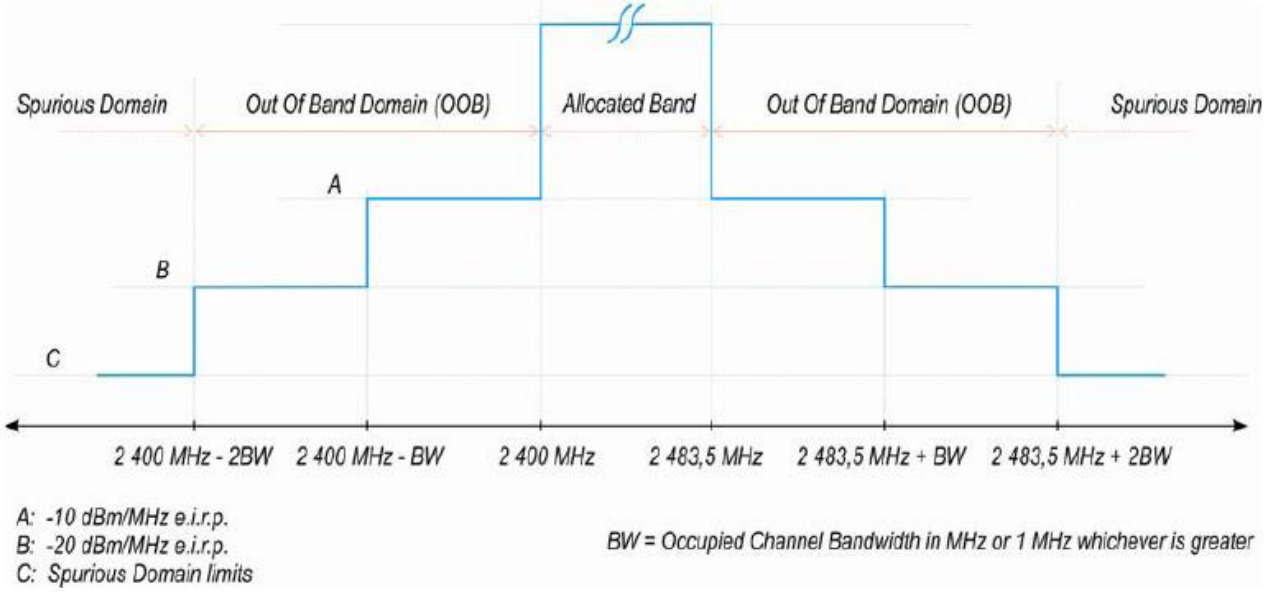
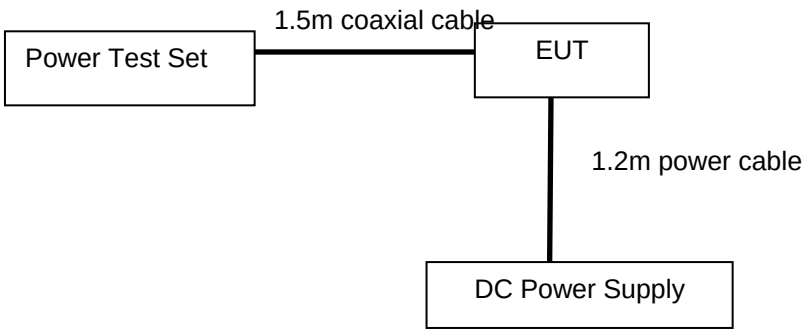


Figure 1: Transmit mask

Transmitter unwanted emissions in the out-of-band domain are emissions when the equipment is in Transmit mode, on frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious.
These measurements shall only be performed at normal test conditions.
For systems using FHSS modulation, the measurements shall be performed during normal operation (hopping).
For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These operating channels shall be recorded.
The equipment shall be configured to operate under its worst case situation with respect to output power.
If the equipment can operate with different Occupied Channel Bandwidths (e.g. 20 MHz and 40 MHz), than each channel bandwidth shall be tested separately.

TEST CONFIGURATION



TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.8.2.1, conducted method.

Connect the UUT to the spectrum analyser and use the following settings:
- Centre Frequency: evaluated frequency
- 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

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.

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 - BW + 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 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: Ach refers to the number of active transmit chains.
It shall be recorded whether the equipment complies with the mask provided in figure 1 or figure 3.

EUT DESCRIPTION:

Mode:	BT Testmode
Hopping:	On
Packet Type:	Longest supported
Modulation:	GFSK, Π/4 DQPSK, 8DPSK

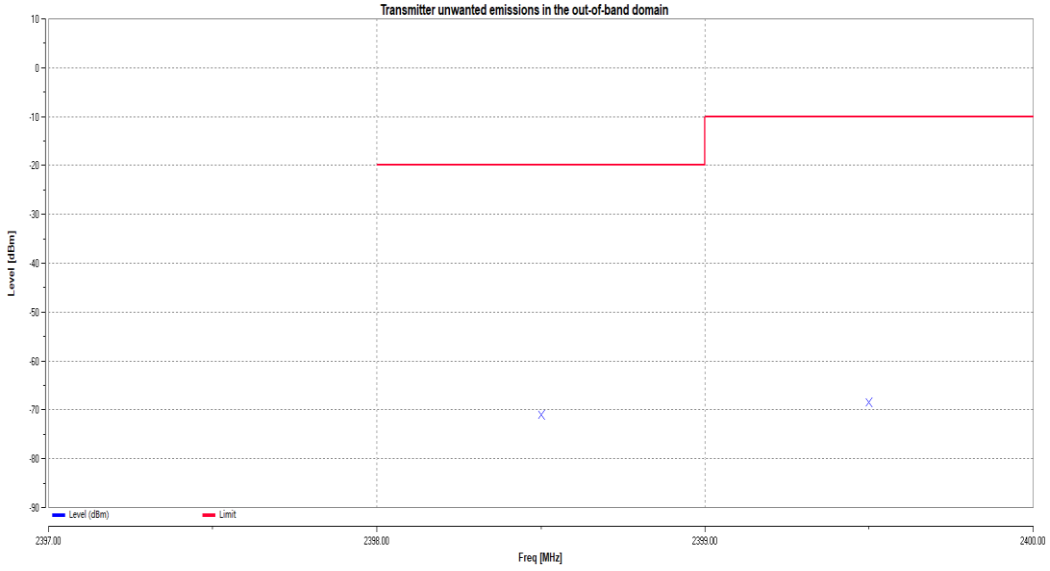
MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	depending on packet length	
Video bandwidth:	3MHz	
Resolution bandwidth:	1MHz	
Span:	0Hz	
Center:	fc (see result table)	
Trigger Mode:	Video trigger	
Sweep points:	Sweep Time [s] / (1 µs) or 5 000 whichever is greater	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

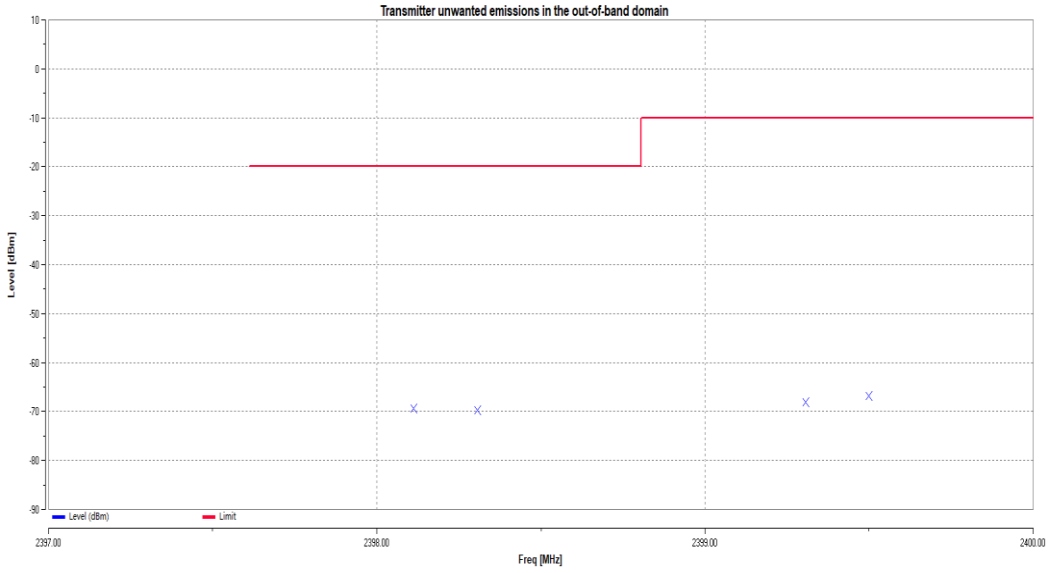
TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Tony Luo

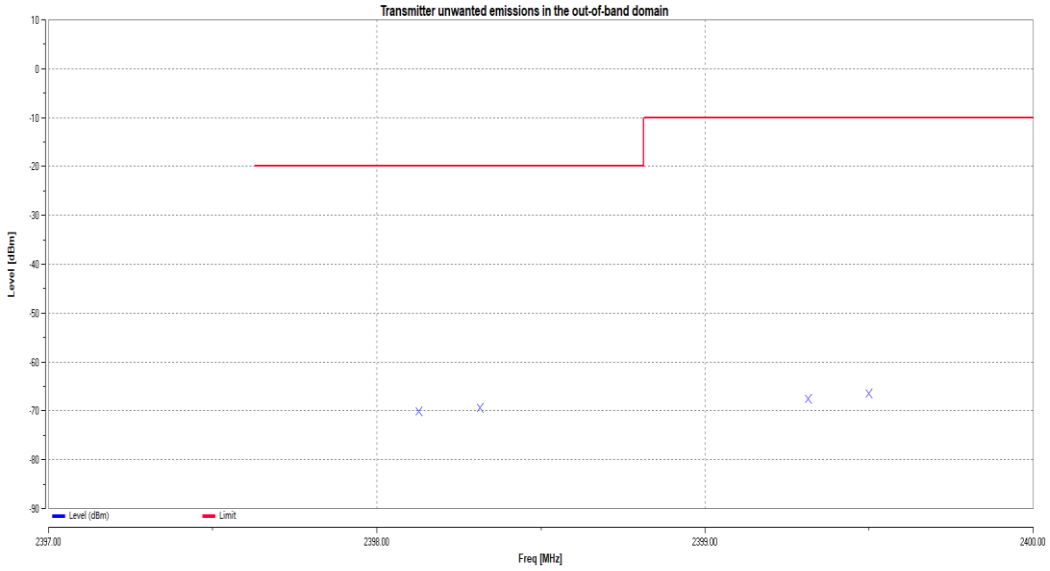
DH5_Ant1_Hop_2400MHz-2BW to 2400MHz



2DH5_Ant1_Hop_2400MHz-2BW to 2400MHz



3DH5_Ant1_Hop_2400MHz-2BW to 2400MHz



4.1.9. Transmitter unwanted emissions in the spurious domain

Limit

According to ETSI EN 300 328 V2.2.2(2019-07) §4.3.2.10.3

The transmitter unwanted emissions in the spurious domain shall not exceed the values given in table 4.

Table 1: Transmitter limits for spurious emissions

Frequency Range	Maximum power e.r.p.(.≤1 GHz) e.i.r.p.(＞1 GHz)	Limit when Standby
30 MHz to 47 MHz	-36 dBm	100 KHz
47 MHz to 74 MHz	-54 dBm	100 KHz
74MHz 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

These measurements shall only be performed at normal test conditions.
The level of spurious emissions shall be measured as, either:
a) their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation); or
b) their effective radiated power when radiated by cabinet and antenna in case of Integral antenna equipment with no antenna connectors.

For equipment using FHSS modulation, the measurements may be performed when normal hopping is disabled. In this case measurements need to be performed when operating at the lowest and the highest hopping frequency. When this is not possible, the measurement shall be performed during normal operation (hopping).

For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These frequencies shall be recorded.

The equipment shall be configured to operate under its worst case situation with respect to output power.

If the equipment can operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz), then the equipment shall be configured to operate under its worst case situation with respect to spurious emissions.

Test Procedure

☒**Radiated Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.2, Radiated measurement.

☒**Conducted Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.1, conducted method.
The test procedure shall be as follows:
Step 1:
The sensitivity of the measurement set-up should be such that the noise floor is at least 12 dB below the limits given in table 4 or table 12.
Step 2:
The emissions over the range 30 MHz to 1 000 MHz shall be identified.

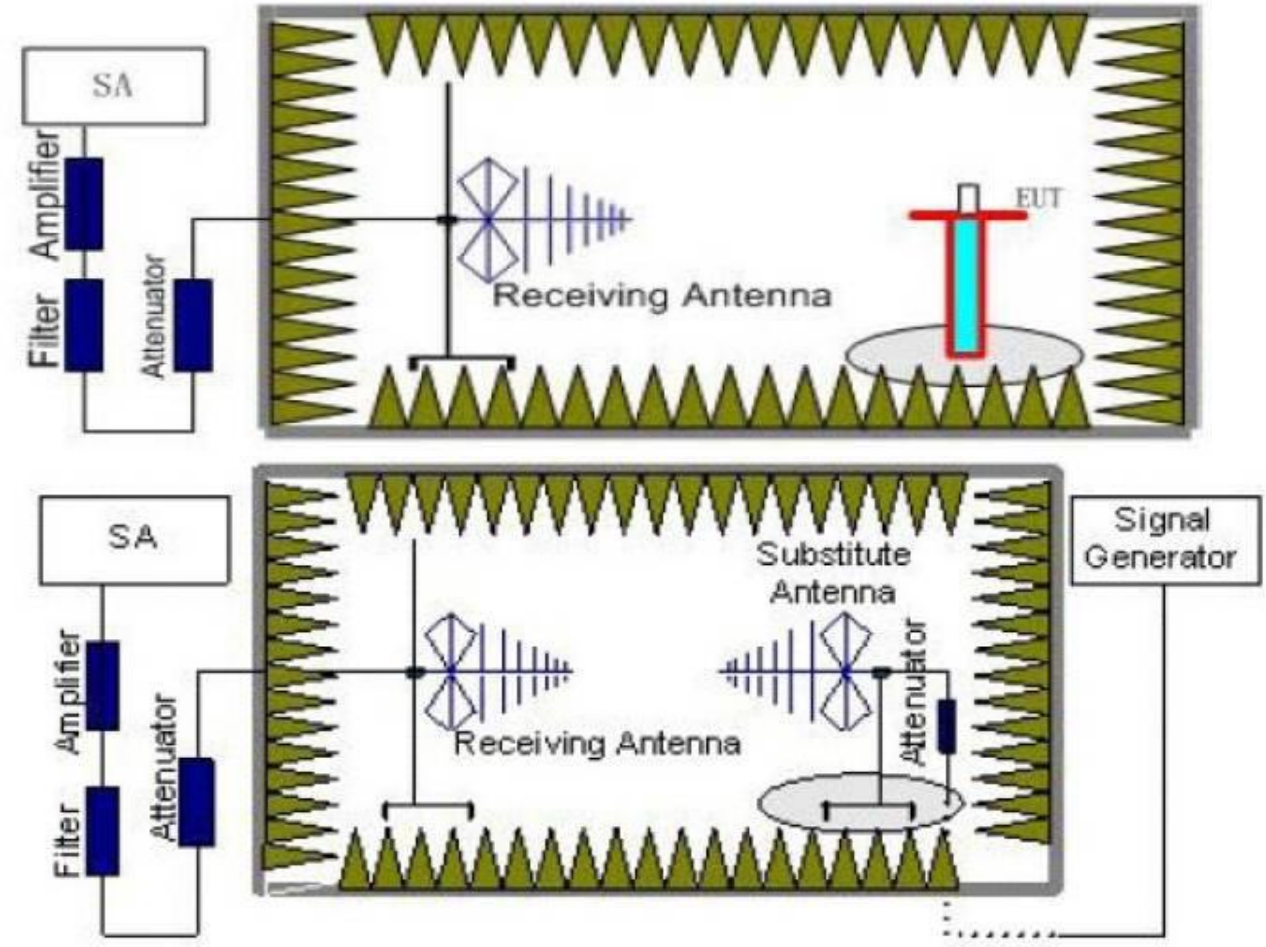
Spectrum analyser settings:
• Resolution bandwidth: 100 kHz
• Video bandwidth: 300 kHz
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 19 400; for spectrum analysers not supporting this high number of sweep points, the frequency band may be segmented.
• Sweep 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 FHSS 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.The above sweep time setting may result in long measuring times in case of FHSS equipment. To avoid such long measuring times, an FFT analyser may be used.Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range belowthe applicable limit or above, shall be individually measured using the procedure in clause 5.4.9.2.1.3 and compared to the limits given in table 4 or table 12.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 23 500; for spectrum analysers not supporting this high number of sweep points, the frequency band may 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 FHSS 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.The above sweep time setting may result in long measuring times in case of FHSS equipment. To avoid such long measuring times, an FFT analyser may 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 5.4.9.2.1.3 and compared to the limits given in table 4 or table 12.FHSS 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 5.4.9.2.1.3.
Step 4:
• In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), step 2 and step 3 need to be repeated for each of the active transmit chains (Ach).The limits used to identify emissions during this pre-scan need to be reduced by 10 × log10 (Ach).
5.4.9.2.1.3 Measurement of the emissions identified during the pre-scan
The procedure in step 1 to step 4 below shall be used to accurately measure the individual unwanted emissions identified during the pre-scan measurements above. This method assumes the spectrum analyser has a Time Domain Power function.
Step 1:
The level of the emissions shall be measured using the following spectrum analyser settings:
• Measurement Mode: Time Domain Power
• Centre Frequency: Frequency of the emission identified during the pre-scan
• Resolution Bandwidth: 100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
• Video Bandwidth: 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 Mode: Video (burst signals) or Manual (continuous signals)
• Detector Mode: 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 table 4 or table 12.

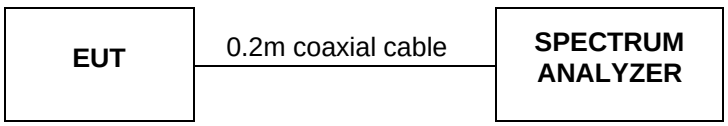
Test Configuration

☒**Radiated Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.2, Radiated measurement.

Effective Radiated Power measurement (30 MHz to 12.75 GHz)



☒**Conducted Method:**



Test Results

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
583.61	V	-61.79	-54	7.79	PASS
585.76	H	-60.51	-54	6.51	PASS
Above 1GHz:					
Test Mode： Low Channel					
4804	H	-40.87	-30	10.87	PASS
4804	V	-40.14	-30	10.14	PASS
7206	H	-42.53	-30	12.53	PASS
7206	V	-41.74	-30	11.74	PASS
9608	H	-46.69	-30	16.69	PASS
9608	V	-48.40	-30	18.40	PASS
Test Mode： High Channel					
4960	H	-40.37	-30	10.37	PASS
4960	V	-38.85	-30	8.85	PASS
7440	H	-42.46	-30	12.46	PASS
7440	V	-41.66	-30	11.66	PASS
9920	H	-42.15	-30	12.15	PASS
9920	V	-42.53	-30	12.53	PASS

Note:
1. Cable loss and antenna gain was combined in the calculated result.
2. No record for margin above 20dB.

4.1.10. Receiver spurious emissions

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) §4.3.2.11.3
The spurious emissions of the receiver shall not exceed the values given in table 5.

Table 2: spurious emission limits for receivers

Frequency	Maximum power, e.r.p.	Measurement bandwidth
30 MHz to 1 GHz	-57 dBm	100 KHz
30 MHz to 12.75 GHz	-47 dBm	1 MHz

☒**Radiated Method:**

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.2, Radiated measurement.

☒**Conducted Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.10.2.1, conducted method.
The test procedure shall be as follows:
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
table 5 or table 13.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 19 400
• Sweep time: Auto
Wait for 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 5.4.10.2.1.3 and
compared to the limits given in table 5 or table 13.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 23 500; for spectrum analysers not supporting this high number of sweep points,
the frequency band may be segmented
• Sweep time: Auto
Wait for 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 5.4.10.2.1.3 and compared to
the limits given in table 5 or table 13.
FHSS 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 5.4.10.2.1.3.
Step 4:

• In case of conducted measurements on smart antenna systems (equipment with multiple receive chains), step 2 and step 3 need to be repeated for each of the active receive chains AchThe limits used to identify emissions during this pre-scan need to be reduced by 10 × log10 Ach.

The procedure in step 1 to step 4 below shall be used to accurately measure the individual unwanted emissions
identified during the pre-scan measurements above. This method assumes the spectrum analyser has a Time Domain
Power function.
Step 1:
The level of the emissions shall be measured using the following spectrum analyser settings:
• Measurement Mode: Time Domain Power
• Centre Frequency: Frequency of the emission identified during the pre-scan
• Resolution Bandwidth: 100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
• Video Bandwidth: 300 kHz (< 1 GHz) / 3 MHz (> 1 GHz)
• Frequency Span: Zero Span
• Sweep mode: Single Sweep
• Sweep time: 30 ms
• Sweep points: ⩾ 30 000
• Trigger: Video (for burst signals) or Manual (for 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 the start and stop times of the sweep.

Step 3: In case of conducted measurements on smart antenna systems (equipment with multiple receive chains), step 2 needs to be repeated for each of the active receive chains Ach.
Sum the measured power (within the observed window) for each of the active receive chains.

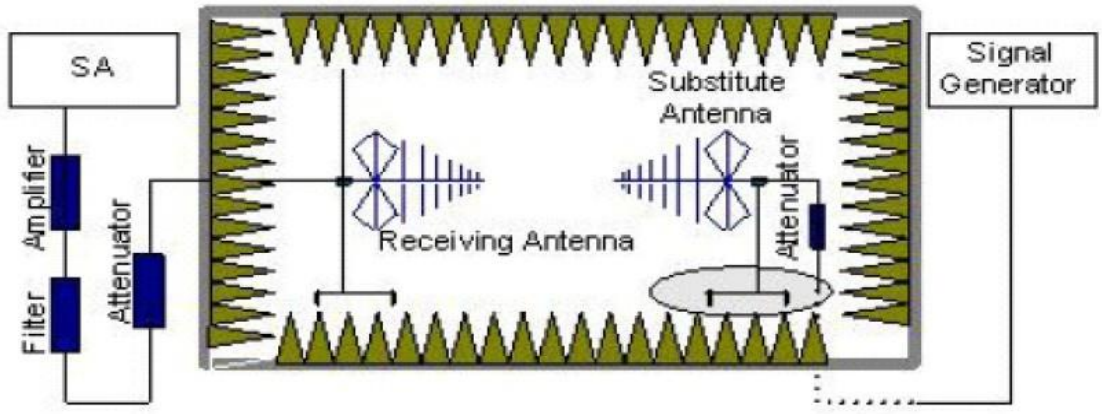
Step 4:

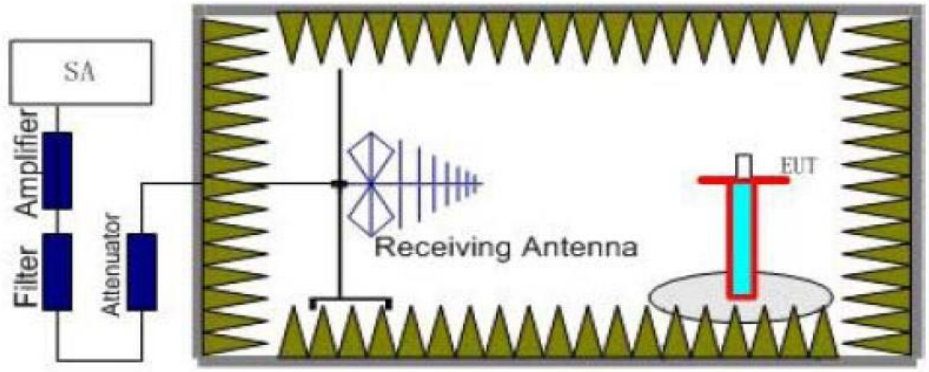
The value defined in step 3 shall be compared to the limits defined in table 5 and table 13.

Test Configuration

☒**Radiated Method:**

Effective Radiated Power measurement (30 MHz to 12.75 GHz)





The level of spurious emissions shall be measured as, either:

a) their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation); or

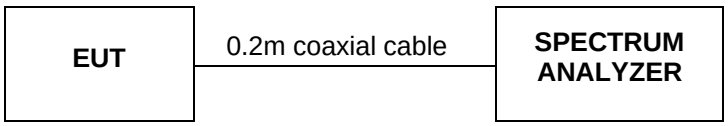
b) their effective radiated power when radiated by cabinet and antenna in case of Integral antenna equipment withno temporary antenna connectors.

Testing shall be performed when the equipment is in a receive-only mode.

For equipment using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These frequencies shall be recorded.

For equipment using FHSS modulation, the measurements may be performed when normal hopping is disabled. In this case measurements need to be performed when operating at the lowest and the highest hopping frequency. These frequencies shall be recorded. When disabling the normal hopping is not possible, the measurement shall be performed during normal operation (hopping).

☒**Conducted Method:**



Test Results

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Tony Luo

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
70.85	V	-67.38	-57	10.38	PASS
565.33	H	-66.79	-57	9.79	PASS
Above 1GHz:					
Test Mode：Lowest frequency					
1827.15	H	-56.76	-47	9.76	PASS
1827.15	V	-58.31	-47	11.31	PASS
2629.24	H	-58.16	-47	11.16	PASS
2629.24	V	-56.17	-47	9.17	PASS
Test Mode： Highest frequency					
1233.20	H	-59.73	-47	12.73	PASS
1233.20	V	-56.45	-47	9.45	PASS
2331.16	H	-55.78	-47	8.78	PASS
2331.16	V	-58.73	-47	11.73	PASS

Note:
1. Cable loss and antenna gain was combined in the calculated result.
2. No record for margin above 20dB.

4.1.11. Receiver Blocking

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) §4.3.2.11.4

While maintaining the minimum performance criteria as defined in clause 4.3.2.11.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in table 14, table 15 or table 16.

The minimum performance criterion shall be a PER less than or equal to 10 %. The manufacturer may declare alternative performance criteria as long as that is appropriate for the intended use of the equipment.

Table 14: 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 × $\log_{10}$(OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × $\log_{10}$(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 P_{min} + 26 dB where P_{min} 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 P_{min} + 20 dB where P_{min} 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.

Table 15: 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 × $\log_{10}$(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 P_{min} + 26 dB where P_{min} 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.

Table 16: 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 × $\log_{10}$(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 test may be performed using a wanted signal up to P_{min} + 30 dB where P_{min} 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.			

According to ETSI EN 300 328 V2.2.2 (2019-07) § 4.2.3 Receiver categories
4.2.3.2.1 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.
4.2.3.2.2 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.
4.2.3.2.3 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.

These measurements shall only be performed at normal test conditions.
For non-frequency hopping equipment, having more than one operating channel, the equipment shall be tested operating at both the lowest and highest operating channels. Equipment which can change their operating channel automatically (adaptive channel allocation), and where this function cannot be disabled, shall be tested as a frequency hopping equipment.
If the equipment can be configured to operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz) and different data rates, then the combination of the smallest channel bandwidth and the lowest data rate for this channel bandwidth which still allows the equipment to operate as intended shall be used. This mode of operation shall be aligned with the performance criteria defined in clause 4.3.1.12.3 or clause 4.3.2.11.3 as declared by the manufacturer (see clause 5.4.1 t)) and shall be described in the test report.
It shall be verified that this performance criteria as declared by the manufacturer is achieved.

TEST CONFIGURATION

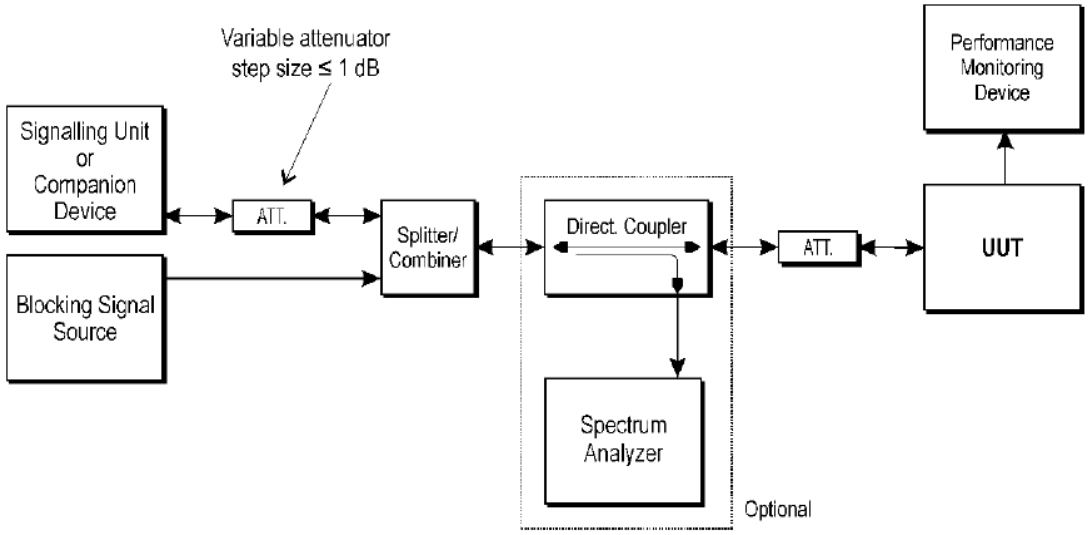


Figure 6: Test Set-up for receiver blocking

MEASUREMENT DESCRIPTION

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.11.2.1, Conducted measurements

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 Pmin.

• 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.

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

TestMode	Antenna	Freq(MHz)	Pmin [dBm]	Wanted signal [dBm]	Freq. [MHz]	CW [dBm]	PER [%]	Limit [%]	Verdict
DH5	Ant1	Hop	---	-69.53	2300	-34	5.40	≤10	PASS
			---	-69.53	2380	-34	4.20	≤10	PASS
			---	-69.53	2504	-34	3.90	≤10	PASS
			---	-69.53	2584	-34	2.50	≤10	PASS
2DH5	Ant1	Hop	---	-68.23	2300	-34	4.60	≤10	PASS
			---	-68.23	2380	-34	2.70	≤10	PASS
			---	-68.23	2504	-34	1.50	≤10	PASS
			---	-68.23	2584	-34	4.40	≤10	PASS
3DH5	Ant1	Hop	---	-68.26	2300	-34	4.50	≤10	PASS
			---	-68.26	2380	-34	3.20	≤10	PASS
			---	-68.26	2504	-34	2.10	≤10	PASS
			---	-68.26	2584	-34	4.30	≤10	PASS

4.1.12. Geo-location capability

Definition& Requirements

ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.13.2 Definition
Geo-location capability is a feature of the equipment to determine its geographical location with the purpose to configure itself according to the regulatory requirements applicable at the geographical location where it operates.

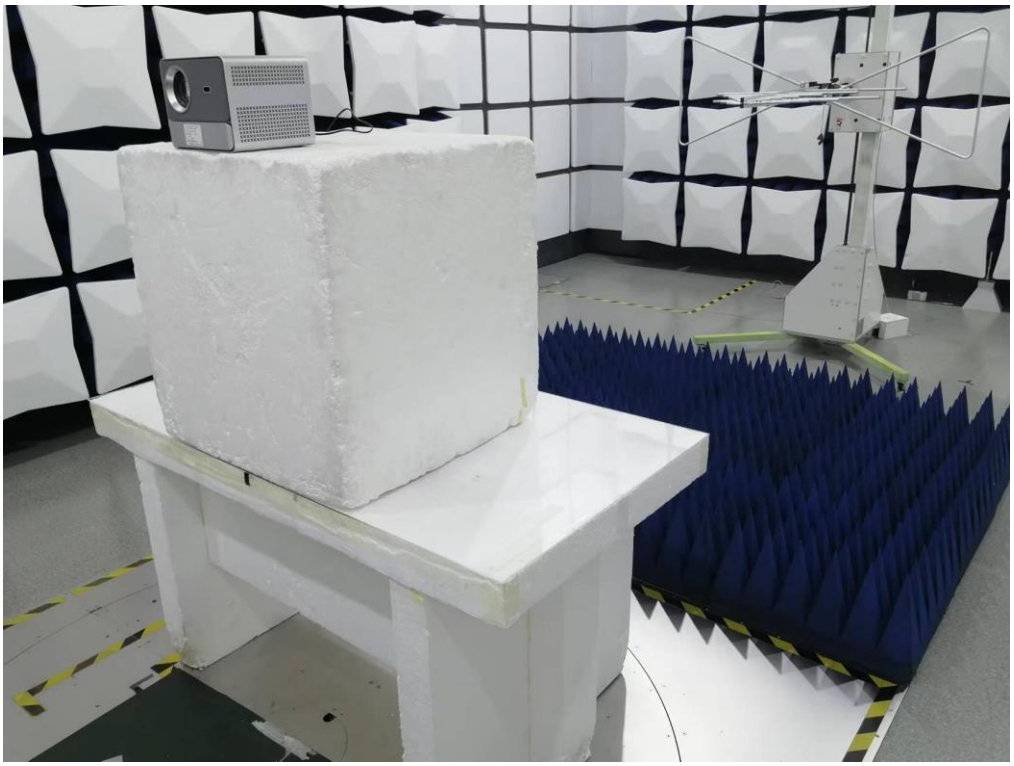
The geo-location capability may be present in the equipment or in an external device (temporary) associated with the equipment operating at the same geographical location during the initial power up of the equipment. The geographical location may also be available in equipment already installed and operating at the same geographical location.

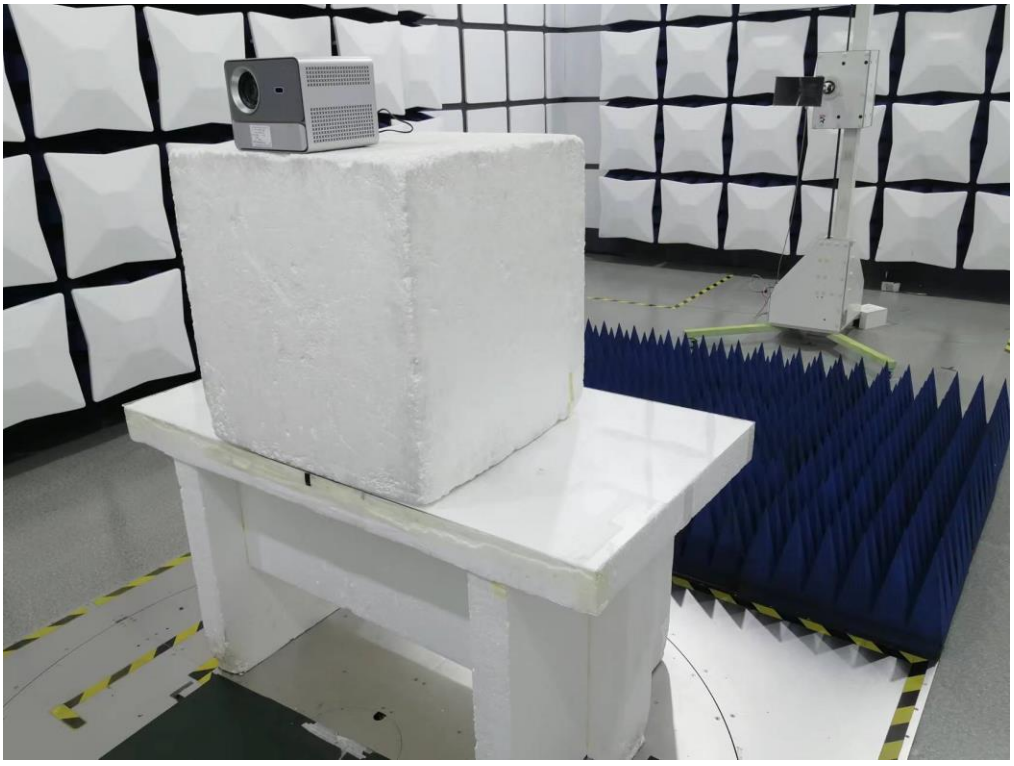
ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.13.2 Requirements
The geographical location determined by the FHSS equipment as defined in clause 4.3.1.13.2 shall not be accessible to the user in a way that would allow the user to alter it.

RESULTS

This equipment does not support Geo-location.

5. Test Setup Photos of the EUT





6. External and Internal Photos of the EUT

Reference to the test report No. TZ240105305-RE

.....End of Report.....

TEST REPORT
ETSI EN 300 328 V2.2.2 (2019-07)

Report Reference No.....:	**TZ240105305-WLAN1**
Compiled by (position+printed name+signature)..:	File administrators Anna Hu
Supervised by (position+printed name+signature)..:	Technique principal Hugo Chen
Approved by (position+printed name+signature)..:	Manager Andy Zhang
Date of issue.....:	2024/1/30

Testing Laboratory Name.....:	Shenzhen Tongzhou Testing Co.,Ltd
Address .....:	1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China
Applicant's name.....:	**Shenzhen Wanbo Technology Co., Ltd.**
Address .....:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Test specification .....**:**	
Standard .....:	**ETSI EN 300 328 V2.2.2 (2019-07)**
TRF Originator.....:	Shenzhen Tongzhou Testing Co.,Ltd
Master TRF.....:	Dated 2024-01

Test item description .....:	**Wanbo Projector**
Trade Mark .....:	Wanbo
Model/Type reference.....:	WPC24
List Model .....:	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Hardware Version.....:	KSOC_352_S2_WB
Software Version .....:	wanbo-WPC24-KGHE
Ratings .....:	AC 100-240V 50/60Hz 2A(Max)
Result.....:	**Pass**

TEST REPORT

Test Report No. :	TZ240105305-WLAN1	2024/1/30 Date of issue

Equipment under Test	:	Wanbo Projector
Model /Type	:	WPC24
Listed Models	:	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Applicant	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Manufacturer	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China

Test Result:	**PASS**

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.

** Modifited History **

Revision	Description	Issued Data	Remark
Revision 00	Initial Test Report Release	2024/1/30	Andy Zhang

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

ETSI EN 300 328 V2.2.2 (2019-07) –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

2 SUMMARY

2.1 General Remarks

Original test date:

Date of receipt of test sample	:	2024/1/11
Testing commenced on	:	2024/1/11
Testing concluded on	:	2024/1/29

2.2 Product Description

The Shenzhen Wanbo Technology Co., Ltd.'s Model: WPC24 or the "EUT" as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

Name of EUT	Wanbo Projector
Model(s) Number	WPC24
List Model	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Difference description	All the same except for the model name
Hardware version	KSOC_352_S2_WB
Software version	wanbo-WPC24-KGHE

2.3 Wireless Function Tested in this report

Wireless Type	Working Frequency	Modulation Type
WLAN(2.4G)	IEEE 802.11b:2412-2472MHz IEEE 802.11g:2412-2472MHz IEEE 802.11n HT20:2412-2472MHz IEEE 802.11n HT40:2422-2462MHz	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n HT20: OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11n HT40: OFDM (64QAM, 16QAM, QPSK,BPSK)

2.4 Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	230V / 50 Hz	○	120V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

AC 100-240V 50/60Hz 2A(Max)

Description of the test mode

IEEE 802.11b/g/n: Thirteen channels are provided to the EUT.

Channel	Frequency(MHz)	Channel	Frequency(MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	12	2467
6	2437	13	2472
7	2442		

Test Frequency List

Modulation Type	Test Frequency					
	Low		Middle		High	
	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
802.11b	1	2412	7	2442	13	2472
802.11g	1	2412	7	2442	13	2472
802.11n HT20	1	2412	7	2442	13	2472
802.11n HT40	3	2422	7	2442	11	2462

2.5 Description of the Equipment under Test (EUT)

Reference documents:	802.11™ WLAN	
Special test descriptions:	None	
Configuration descriptions:	TX tests: performed at the lowest, the middle, and the highest channel	
	RX/Standby tests: WLAN test mode enabled, scan enabled, TX Idle	
Test mode:	☒ Special software is used. EUT is transmitting pseudo random data by itself	
802.11™ WLAN standard capabilities:	channel numbers:	☒ 802.11b:13; ☒ 802.11g:13; ☒ 802.11n HT20:13; ☒ 802.11n HT40:11
	channel separation:	5MHz
	used freq. range:	☒2412-2472MHz; ☒2422-2462MHz
	modulation types:	DSSS,OFDM
	Used Bandwidth:	☒20MHz; ☒40MHz

2.6 EUT Classification

Type of equipment:	☒	stand alone equipment	
	☐	plug in radio equipment	
	☐	combined equipment	
Modulation types:	☒	Wide Band Modulation (None Hopping – e.g. DSSS, OFDM)	
	☐	Frequency Hopping Spread Spectrum (FHSS)	
Adaptive equipment:	☒	Yes, LBT-based	☐ Frame Based Equipment
			☒Load Based Equipment
	☐	Yes, non-LBT-based	
	☐	Yes (but can be disabled)	
	☐	No	
	☒	q value	N/A
	☐	COT value	
	☒	CCA value	18μs
Antennas and transmit operating modes:	☐	Operating mode 1 (single antenna)	
		Equipment with 1 antenna, Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used, Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)	
	☒	Operating mode 2 (multiple antennas, no beamforming)	
		Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.	

	☐	Operating mode 3 (multiple antennas, with beamforming)
		Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming. In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.

2.7 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - supplied by the lab

/	/	/	/
/	/	/	/
/	/	/	/

2.8 Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version	Date of receipt	Type of Test
TZ240105305-1#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	Radio
TZ240105305-2#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	SAR (EMF)
TZ240105305-3#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	EMC

2.9 Modifications

No modifications were implemented to meet testing criteria.

3 TEST ENVIRONMENT

3.1 Address of the test laboratory

Shenzhen Tongzhou Testing Co.,Ltd
1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 (2014) and CISPR Publication 22.

3.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature/NT: 25℃
High Temperature/HT: 35℃
Low Temperature/LT: 0℃
Normal Voltage: AC 230V
High Voltage/HV: AC 264V
Low Voltage/LV: AC 90V
Relative Humidity: 55 %
Air Pressure: 989 hPa

3.3 Test Description

3.3.1 Main Terms

Verdict	Verdict of each test cases.
Test Case	Test cases identification number description in ETSI specification.

3.3.2 Terms used in Condition column

NTC Normal voltage, Normal Temperature
HTHV High voltage, High Temperature
LTHV High voltage, Low Temperature
HTLV Low voltage, High Temperature
LTLV Low voltage, Low Temperature

3.3.3 Terms used in Verdict column

Pass	This test cases has been tested, and EUT is conformant to the applied standards in the given frequency band.
Fail	This test cases has been tested, but EUT is not conformant to the applied standards in the given frequency band.
N/A	This test case is either not required/not applicable in the specified band or is not applicable according to the specific PICS/PIXIT for the EUT.
Inc	Test case result is ambiguous in the given frequency band.
Decl	Declaration is received from the client to demonstrate the conformity to the relevant specification in the given frequency band.
BR	This test cases is not tested in the given frequency band, but this testcases was tested with pass result for the initial model in the given frequency band.

3.3.4 Sumarry of measurement results

☒ **No deviations from the technical specifications were ascertained**
☐ **There were deviations from the technical specifications ascertained**

Test Specification Clause	Test Case	Test Condition	Mode	Pass	Fail	N/A	NP	Remark
5.4.2	RF output power	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☒	☐	☐	☐	
		LTNV		☒	☐	☐	☐	
		HTNV		☒	☐	☐	☐	
5.4.3	Power Spectral Density	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☒	☐	☐	☐	
5.4.2	Duty Cycle, Tx-sequence, Tx-gap	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☐	☐	☒	☐	Note1
5.4.2	Medium Utilisation (MU) factor	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☐	☐	☒	☐	Note1
5.4.6	Adaptivity (adaptive equipment using modulations other than FHSS)	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☐	☐	☒	☐	Note1
5.4.7	Occupied Channel Bandwidth	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☒	☐	☐	☐	
5.3.8	Transmitter unwanted emissions in the out-of-band domain	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☒	☐	☐	☐	
		LTNV		☐	☐	☒	☐	
		HTNV		☐	☐	☒	☐	
5.3.9	Transmitter unwanted emissions in the spurious domain (conducted & radiated)	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☒	☐	☐	☐	
5.3.10	Receiver spurious emissions (conducted & radiated)	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☒	☐	☐	☐	
5.3.11	Receiver Blocking	NTC	802.11b/802.11g/802.11n HT20/802.11n HT40	☒	☐	☐	☐	

Remark: The measurement uncertainty is not included in the test result.

Note 1: These requirements apply to non-adaptive equipment or to adaptive equipment when operating in a non-adaptive mode. These requirements do not apply for equipment with a maximum declared RF Output power level of less than 10 dBm e.i.r.p.

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

Mode	Data Rate
11b/CCK	1 Mbps
11g/OFDM	6 Mbps
11n HT20/OFDM	6.5 Mbps
11n HT40/OFDM	13.5 Mbps

3.4 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics;Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics;Part 2 " and is documented in the Shenzhen Tongzhou Testing Co.,Ltd quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.
Hereafter the best measurement capability for Shenzhen Tongzhou Testing Co.,Ltd is reported:

No.	Item	Uncertainty
1	Occupied Channel Bandwidth	±3.6dB
2	RF power, conducted	±0.16dB
3	Power Spectral Density, conducted	±1.3dB
4	Unwanted Emissions, conducted	±1.3dB
5	All emissions, radiated	±4.7dB
6	Temperature	±0.5°C
7	Humidity	±2%
8	DC and low frequency voltages	±1.5%
9	Time	±1.0%
10	Duty Cycle	±3.0%

3.5 Equipments Used during the Test

Conducted Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
2	Signal Generator	Keysight	N5182A	MY4620709	2024/1/4	2025/1/3
3	Signal Generator	R&S	SML03	102924/0013	2024/1/4	2025/1/3
4	Power Sensor	Agilent	U2021XA	MY5365004	2024/1/4	2025/1/3
5	Power Meter	Agilent	U2531A	TW53323507	2024/1/4	2025/1/3
6	Climate Chamber	KRUOMR	KRM-1000	KRM16072901	2024/1/4	2025/1/3
7	Wideband Radio Communication Tester	R&S	CMW500	101855	2024/1/4	2025/1/3
8	Test Software	Tonscend	JS1120-3	V3.2.22	--	--

Radiated Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	Wideband Antenna	schwarzbeck	VULB 9163	958	2022/11/13	2025/11/12
2	Horn Antenna	schwarzbeck	BBHA 9120D	01989	2022/11/13	2025/11/12
3	EMI Test Receiver	R&S	ESCI	100849/003	2024/1/4	2025/1/3
4	Controller	MF	MF7802	N/A	N/A	N/A
5	Amplifier	schwarzbeck	BBV 9743	209	2024/1/4	2025/1/3
6	Amplifier	Tonscend	TSAMP-0518SE	--	2024/1/4	2025/1/3
7	RF Cable	HUBER+SUHNER	RG214	N/A	2024/1/4	2025/1/3
8	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
9	Horn Antenna	ETS	3117	00218874	2022/11/13	2025/11/12
10	Wideband Antenna	Sunol	JB3	A020115	2022/7/3	2025/7/2
11	Test Software	Tonscend	JS36-RSE	V5.0.0.0	--	--

4 TEST CONDITIONS AND RESULTS

4.1 ETSI EN 300 328 REQUIREMENTS

4.1.1 RF Output Power

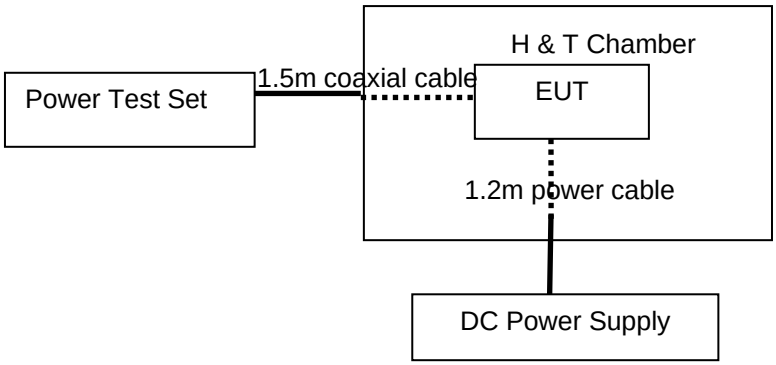
LIMIT

According to ETSI EN 300 328 V2.2.2 §4.3.2.2.3,
The RF output power for non-FHSS equipment shall be equal to or less than 20 dBm.

NOTE: For Non-adaptive FHSS equipment, the manufacturer may have declared a reduced RF Output Power (see clause 5.4.1 m)) and associated Duty Cycle (see clause 5.4.1 e)) that will ensure that the equipment meets the requirement for the Medium Utilization (MU) factor further described in clause 4.3.2.5. This is verified by the conformance test referred to in clause 4.3.2.5.4.

For non-adaptive non-FHSS equipment, where the manufacturer has declared an RF output power of less than 20 dBm e.i.r.p., the RF output power shall be equal to or less than that declared value.
This limit shall apply for any combination of power level and intended antenna assembly.

TEST CONFIGURATION



TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.2.2.1.1, conducted method.

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring burst Power(RMS) of a least 10 packets	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Test Condition	TestMode	Antenna	Channel	EIRP[dBm]	Limit[dBm]	Verdict
NTNV	11B	Ant1	2412	14.64	20	PASS
			2442	13.19	20	PASS
			2472	13.32	20	PASS
	11G	Ant1	2412	13.27	20	PASS
			2442	12.67	20	PASS
			2472	12.83	20	PASS
	11N20SISO	Ant1	2412	12.59	20	PASS
			2442	9.61	20	PASS
			2472	12.58	20	PASS
	11N40SISO	Ant1	2422	13.31	20	PASS
			2442	12.93	20	PASS
			2462	12.67	20	PASS
LTNV	11B	Ant1	2412	14.79	20	PASS
			2442	13.24	20	PASS
			2472	13.36	20	PASS
	11G	Ant1	2412	13.35	20	PASS
			2442	12.57	20	PASS
			2472	12.81	20	PASS
	11N20SISO	Ant1	2412	12.78	20	PASS
			2442	9.41	20	PASS
			2472	12.62	20	PASS
	11N40SISO	Ant1	2422	13.29	20	PASS
			2442	12.95	20	PASS
			2462	12.68	20	PASS
HTNV	11B	Ant1	2412	14.40	20	PASS
			2442	13.20	20	PASS
			2472	13.30	20	PASS
	11G	Ant1	2412	13.23	20	PASS
			2442	12.65	20	PASS
			2472	12.84	20	PASS
	11N20SISO	Ant1	2412	12.50	20	PASS
			2442	9.70	20	PASS
			2472	12.59	20	PASS
	11N40SISO	Ant1	2422	13.31	20	PASS
			2442	12.89	20	PASS
			2462	12.64	20	PASS

4.1.2 Duty Cycle,TX-sequence,TX-gap

LIMIT

ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.4.3
The Duty Cycle shall be equal to or less than the maximum value declared by the manufacturer.
The Tx-sequence time shall be equal to or less than 10 ms. The minimum Tx-gap time following a Tx-sequence shall be equal to the duration of that proceeding Tx-sequence with a minimum of 3,5 ms.

TEST PROCEDURE

Please refer to ETSI EN 300 328 (V2.2.2) Sub-clause 5.4.2.2.1.3
For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest, the middle, and the highest channel on which the equipment can operate. These frequencies shall be recorded.
The test procedure, which shall only be performed for non-adaptive systems and only to be performed at normal environmental conditions, shall be as follows:
Step 1:
• Use the same stored measurement samples from the procedure described in clause 5.4.2.2.1.2.
• 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 case of insufficient dynamic range, the value of 30 dB may need to be reduced appropriately.
Step 2:
• Between the saved start and stop times of each individual burst, calculate the TxOn time. Save these TxOn values.
Step 3:
• Duty Cycle (DC) is the sum of all TxOn times between the end of the first gap (which is the start of the first burst within the observation period) and the start of the last burst (within this observation period) divided by the observation period. The observation period is defined in clause 4.3.1.3.2 or clause 4.3.2.4.2.
Step 4:
• For equipment using blacklisting, the TxOn time measured for a single (and active) hopping frequency shall be multiplied by the number of blacklisted frequencies. This value shall be added to the sum calculated in step 3 above. If the number of blacklisted frequencies cannot be determined, the minimum number of hopping frequencies (N) as defined in clause 4.3.1.4.3 shall be assumed.
• The calculated value for Duty Cycle (DC) shall be recorded in the test report. This value shall be equal to or less than the maximum value declared by the manufacturer.
Step 5:
• Use the same stored measurement samples from the procedure described in clause 5.4.2.2.1.2.
• Identify any TxOff time that is equal to or greater than the minimum Tx-gap time as defined in clause 4.3.1.3.3 or clause 4.3.2.4.3. These are the potential valid gap times to be further considered in this procedure.
• Starting from the second identified gap, calculate the time from the start of this gap to the end of the preceding gap. This time is the Tx-sequence time for this transmission. Repeat this procedure until the last identified gap within the observation period is reached.
• A combination of consecutive Tx-sequence times and Tx-gap times followed by a Tx-gap time, which is at least as long as the duration of this combination, may be considered as a single Tx-sequence time and in which case it shall comply with the limits defined in clause 4.3.1.3.3 or clause 4.3.2.4.3.
• It shall be noted in the test report whether the UUT complies with the limits for the maximum Tx-sequence time and minimum Tx-gap time as defined in clause 4.3.1.3.3 or clause 4.3.2.4.3.

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring average burst Power of a least 10 packets	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

Not Applicable

4.1.3 Medium Utilisation (MU) factor

LIMIT

ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 4.3.2.5.3
For non-adaptive equipment using wide band modulations other than FHSS, the maximum Medium Utilization factor shall be 10 %.
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 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p.

TEST PROCEDURE

Please refer to ETSI EN 300 328 V2.2.2 (2019-07) Sub-clause 5.4.2.2.1.4
Step 1:
• Use the same stored measurement samples from the procedure described in clause 5.4.2.2.1.2.
Step 2:
• For each burst calculate the product of (Pburst / 100 mW) and the TxOn time. Pburst is expressed in mW. TxOn time is expressed in ms.
Step 3:
• Medium Utilization is the sum of all these products divided by the observation period (expressed in ms) which is defined in clause 4.3.1.3.2 or clause 4.3.2.4.2. This value, which shall comply with the limit given in clause 4.3.1.6.3 or clause 4.3.2.5.3, shall be recorded in the test report.
If operation without blacklisted frequencies is not possible, the power of the bursts on blacklisted hopping frequencies (for the calculation of the Medium Utilization) is assumed to be equal to the average value of the RMS power of the bursts on all active hopping frequencies.

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring average burst Power of a least 10 packets	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

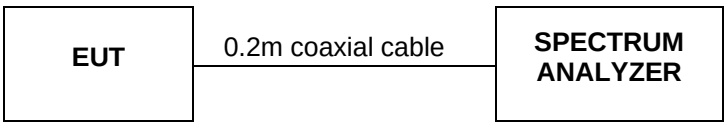
Not Applicable

4.1.4 Power Spectral Density

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) §4.3.2.3.3,
For equipment using wide band modulations other than FHSS, the maximum Power Spectral Density is limited to 10dBm/MHz.
These measurements shall only be performed at normal test conditions.

TEST CONFIGURATION



TEST PROCEDURE
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.3.2.1, conducted method.
The test procedure shall be as follows:
Step 1:
Connect the UUT to the spectrum analyzer 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
NOTE: For spectrum analyzers 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 be completed. Save the (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 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 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 DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	10S	
Video bandwidth:	30KHz	
Resolution bandwidth:	10KHz	
Span:	83.5MHz	
Frequency range	2400-2483.5MHz	
Sweep Points	15000	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

TestMode	Antenna	Channel	PSD[dBm/MHz]	Limit[dBm/MHz]	Verdict
11B	Ant1	2412	5.47	10	PASS
		2442	4.03	10	PASS
		2472	4.31	10	PASS
11G	Ant1	2412	2.15	10	PASS
		2442	1.35	10	PASS
		2472	1.30	10	PASS
11N20SISO	Ant1	2412	1.18	10	PASS
		2442	-1.68	10	PASS
		2472	0.74	10	PASS
11N40SISO	Ant1	2422	-0.96	10	PASS
		2442	-1.78	10	PASS
		2462	-1.62	10	PASS

4.1.5 Adaptivity (Adaptive equipment using modulations other than FHSS)

LIMIT

Requirement	Operational Mode			
	Non-LBT based Detect and Avoid	LBT based Detect and Avoid		
		Frame Based Equipment	Load Based Equipment (CCA using 'energy detect')	Load Based Equipment (CCA not using any of the mechanisms referenced as note 2)
Minimum Clear Channel Assessment (CCA) Time	NA	18 us (see note 1)	18 us (see note 2)	18 us (see note 2)
Maximum Channel Occupancy (COT) Time	40 ms	1ms to 10 ms	13ms (see note 2)	13ms
Minimum Idle Period	At least 5% of COT and 100 μs	5% of COT	(see note 2)	(see note 2)
Extended CCA check	NA	NA	(see note 2)	between 18 μs and at least 160 μs
Short Control Signaling Transmissions	Maximum duty cycle of 10% within an observation period of 50 ms (see note 3)			

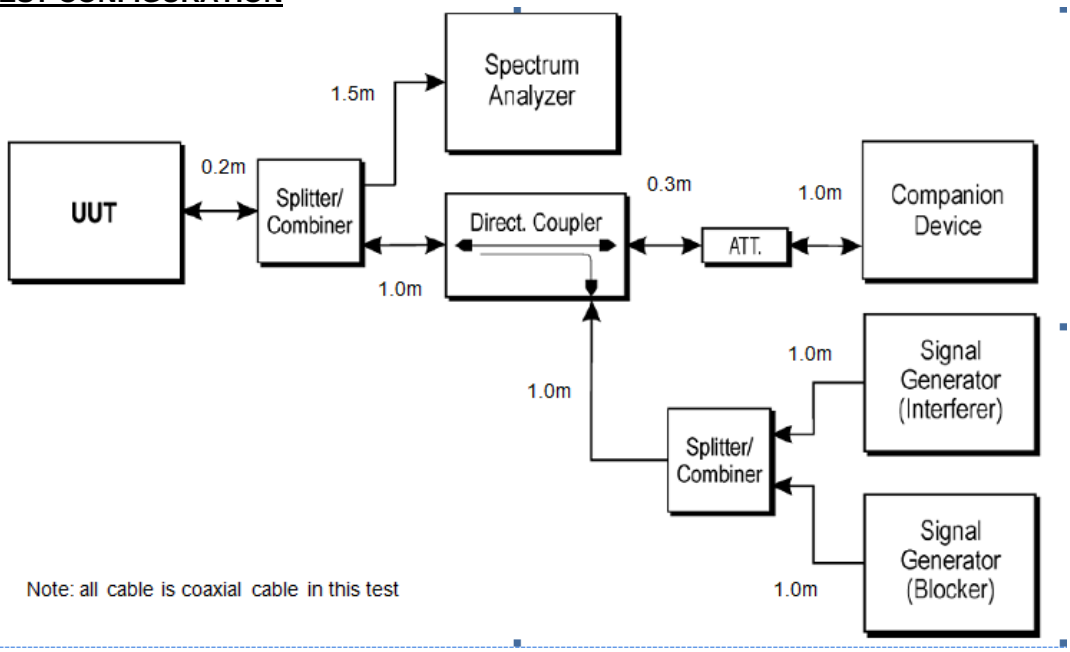
Note 1: The CCA time used by the equipment shall be declared by the supplier.
Note 2: Load Based Equipment may implement an LBT based spectrum sharing mechanism based on the Clear Channel Assessment (CCA) mode using energy detect, as described in IEEE Std. 802.11™-2007 clauses 9,15,18 or 19, in IEEE Std. 802.11n ™ -2009 clauses 9,11 and 20 or in IEEE Std. 802.15.4 ™ -2011, clauses 4 and 5.
Note 3: Adaptive equipment may or may not have Short Control Signaling Transmissions.

Wanted signal mean power from companion device:
TL = -70 dBm/MHz + 10 × log10 (100 mW / P_{out}) (Pout in mW e.i.r.p.)

Unwanted Signal parameters

Wanted signal mean power from companion device	Maximum transmit power (PH) EIRP mW	Threshold Level (TL)
sufficient to maintain the link (see note 2)	2 395 or 2 488,5 (see note 1)	-35 (see note 3)
NOTE 1: The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1. NOTE 2: A typical value which can be used in most cases is -50 dBm/MHz. NOTE 3: The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.		

TEST CONFIGURATION



MEASUREMENT DESCRIPTION

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.6.2.1.4, Conducted measurements
Step 1:
The UUT may connect to a companion device during the test. The interference signal generator, the blocking signal generator, the spectrum analyzer, the UUT and the companion device are connected using a set-up equivalent to the example given by figure 5 although the interference and blocking signal generator do not generate any signals at this point in time. The spectrum analyzer is used to monitor the transmissions of the UUT in response to the interfering and the blocking signals.
• Adjust the received signal level (wanted signal from the companion device) at the UUT to the value defined in table 6 (clause 4).
NOTE 1: Testing of Unidirectional equipment does not require a link to be established with a companion device.
• The analyzer shall be set as follows:
- RBW: =20MHz for 802 .11b/g/n(20);
= 40MHz for 802.11n(40)
[≥ Occupied Channel Bandwidth (if the analyzer does not support this setting, the highest available setting shall be used)]
- VBW: =30MHz
[3 × RBW (if the analyzer 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

Step 2:

• Configure the UUT for normal transmissions with a sufficiently high payload resulting in a minimum transmitter activity ratio (TxOn / (TxOn + TxOff)) of 0,3. Where this is not possible, the UUT shall be configured to the maximum payload possible.

• For Frame Based Equipment, using the procedure defined in clause 5.4.6.2.1.5, it shall be verified that the UUT complies with the maximum Channel Occupancy Time and minimum Idle Period defined in clause 4.3.2.6.3.2.2 step 3).

• For Load Based equipment, using the procedure defined in clause 5.4.6.2.1.5 , it shall be verified that the UUT complies with the maximum Channel Occupancy Time and minimum Idle Period defined in clause 4.3.2.6.3.2.3 , step 2 and step 3. When measuring the Idle Period of the UUT, it shall not include the transmission time of the companion device.

NOTE 2: For the purpose of testing Load Based Equipment referred to in the first paragraph of clause 4.3.2.6.3.2.3(IEEE 802.11™ [i.3] or IEEE 802.15.4™ [i.4] equipment), the limits to be applied for the minimum Idle Period and the maximum Channel Occupancy Time are the same as defined for other types of Load Based Equipment (see clause 4.3.2.6.3.2.3 step 2) and step 3). The Idle Period is considered to be equal to the CCA or Extended CCA time defined in clause 4.3.2.6.3.2.3 step 1) and step 2).

Step 3: Adding the interference signal

An interference signal as defined in clause B.6 is injected on the current operating channel of the UUT. The power spectral density level (at the input of the UUT) of this interference signal shall be equal to the detection threshold defined in clause 4.3.2.6.3.2.2 step 5) (frame based equipment) or clause 4.3.2.6.3.2.3 step 5) (load based equipment).

Step 4: Verification of reaction to the interference signal

The spectrum analyser shall be used to monitor the transmissions of the UUT on the selected operating channel with the interfering signal injected. This may require the spectrum analyser sweep to be triggered by the start of the interfering signal.

• Using the procedure defined in clause 5.4.6.2.1.5, it shall be verified that:

i) The UUT shall stop transmissions on the current operating channel.

The UUT is assumed to stop transmissions within a period equal to the maximum Channel Occupancy Time defined in clause 4.3.2.6.3.2.2 (frame based equipment) or clause 4.3.2.6.3.2.3 (load based equipment).

ii) Apart from Short Control Signalling Transmissions, there shall be no subsequent transmissions while the interfering signal is present.

To verify that the UUT is not resuming normal transmissions as long as the interference signal is present, the monitoring time may need to be 60 s or more.

iii) The UUT may continue to have Short Control Signalling Transmissions on the operating channel while the interfering signal is present. These transmissions shall comply with the limits defined in clause 4.3.2.6.4.2.

The verification of the Short Control Signalling transmissions may require the analyser settings to be changed (e.g. sweep time).

iv) Alternatively, the equipment may switch to a non-adaptive mode.

Step 5: Adding the blocking signal

• With the interfering signal present, a 100 % duty cycle CW signal is inserted as the blocking signal. The frequency and the level are provided in table 10 (clause 4.3.2.6.3.2.2) for Frame Based Equipment or in table 11 (clause 4.3.2.6.3.2.3) for Load Based Equipment.

• The spectrum analyser shall be used to monitor the transmissions of the UUT on the selected operating channel. This may require the spectrum analyser sweep to be triggered by the start of the blocking signal.

• Using the procedure defined in clause 5.4.6.2.1.5, it shall be verified that:

i) The UUT shall not resume normal transmissions on the current operating channel as long as both the interference and blocking signals remain present.

To verify that the UUT is not resuming normal transmissions as long as the interference and blocking signals are present, the monitoring time may need to be 60 s or more.

ii) The UUT may continue to have Short Control Signalling Transmissions on the operating channel while the interfering and blocking signals are present. These transmissions shall comply with the limits defined in clause 4.3.2.6.4.2.

The verification of the Short Control Signalling transmissions may require the analyser settings to be changed (e.g. sweep time).

Step 6: Removing the interference and blocking signal

• On removal of the interference and blocking signal the UUT is allowed to start transmissions again on this channel however this is not a requirement and therefore does not require testing.

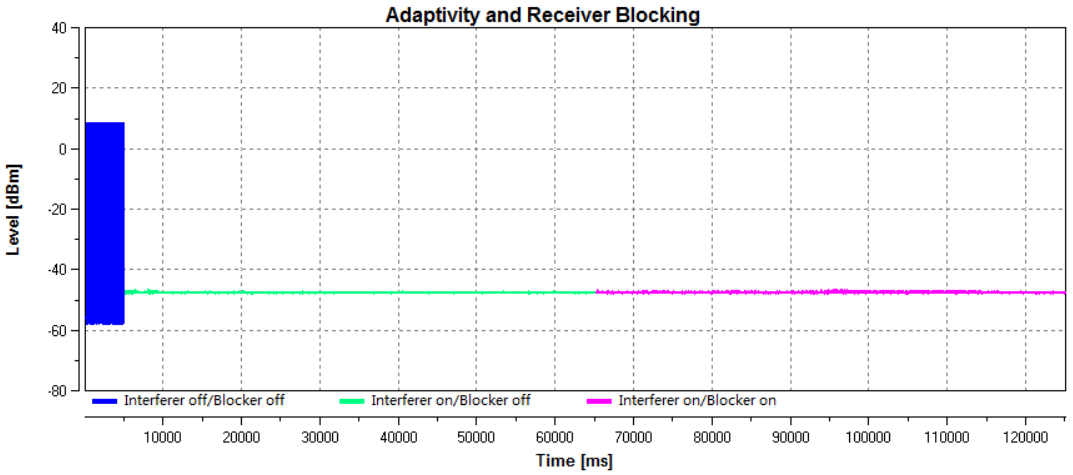
Step 7:

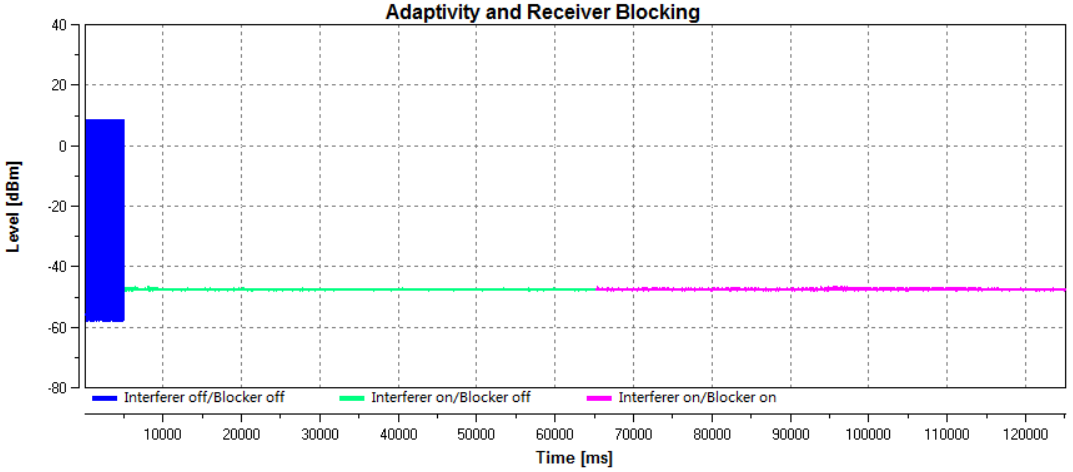
• The steps 2 to 6 shall be repeated for each of the frequencies to be tested.

TEST RESULTS

Mode	Channel	COT values(ms)	Idle values [ms]	Short Control (%)			Verdict
				Interferer values	CW values	Limit [%]	
802.11b	LCH	2.242	0.042	0	0	10	PASS
802.11b	HCH	2.279	0.065	0	0	10	PASS

Test Plot

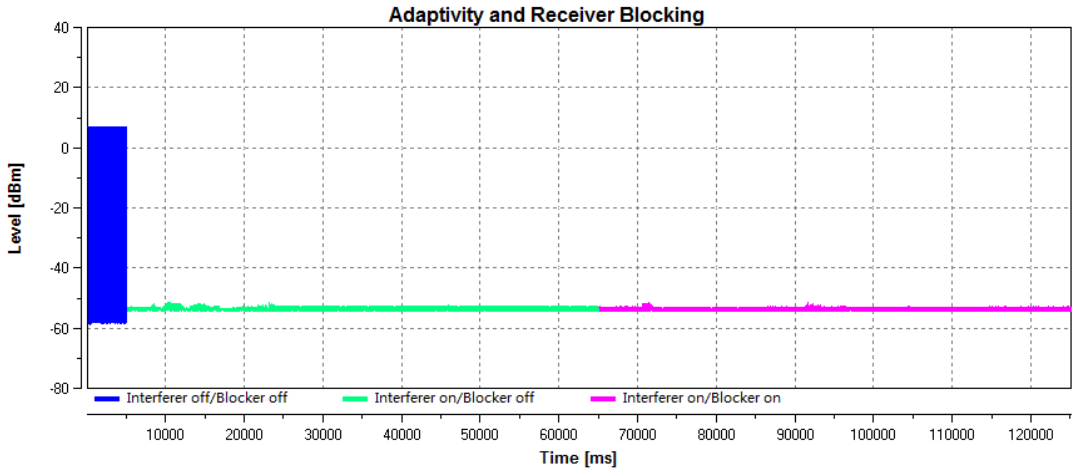


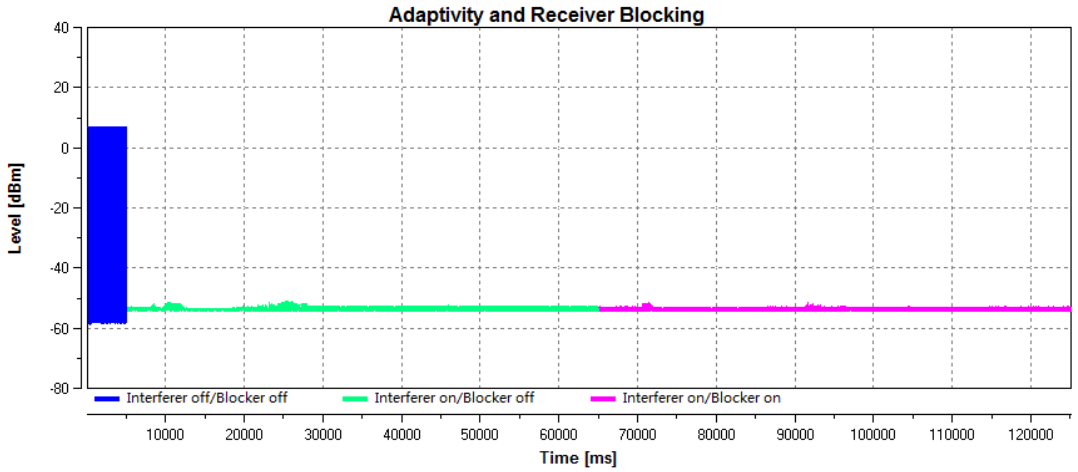


Note: Only the worst plots were recorded in this report.

Mode	Channel	COT values(ms)	Idle values [ms]	Short Control (%)			Verdict
				Interferer values	CW values	Limit [%]	
802.11g	LCH	2.125	0.047	0	0	10	PASS
802.11g	HCH	2.272	0.072	0	0	10	PASS

Test Plot

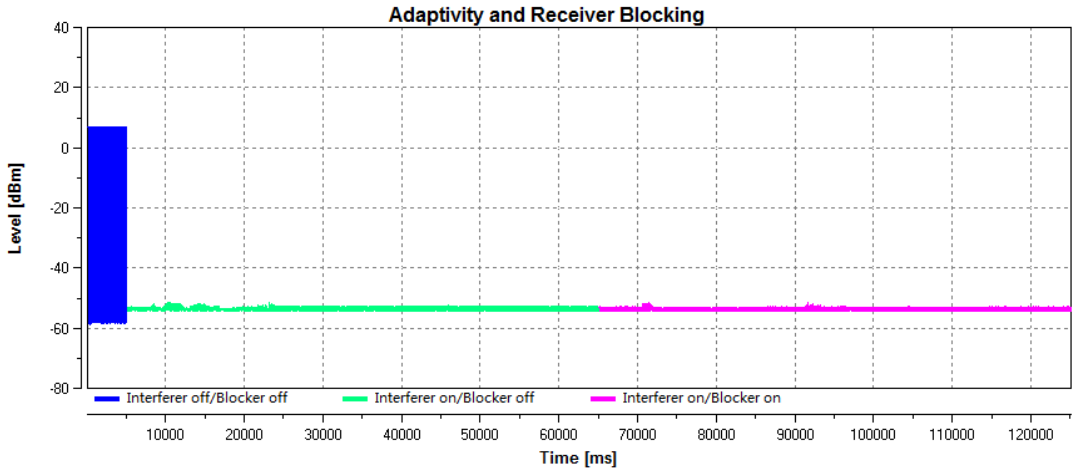


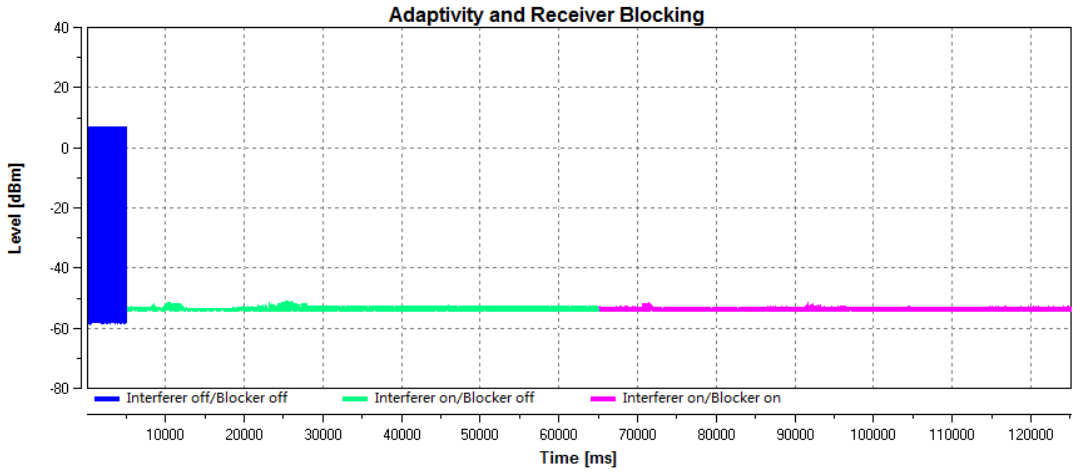


Note: Only the worst plots were recorded in this report.

Mode	Channel	COT values(ms)	Idle values [ms]	Short Control (%)			Verdict
				Interferer values	CW values	Limit [%]	
802.11n HT20	LCH	3.432	0.057	0	0	10	PASS
802.11n HT20	HCH	3.443	0.066	0	0	10	PASS

Test Plot

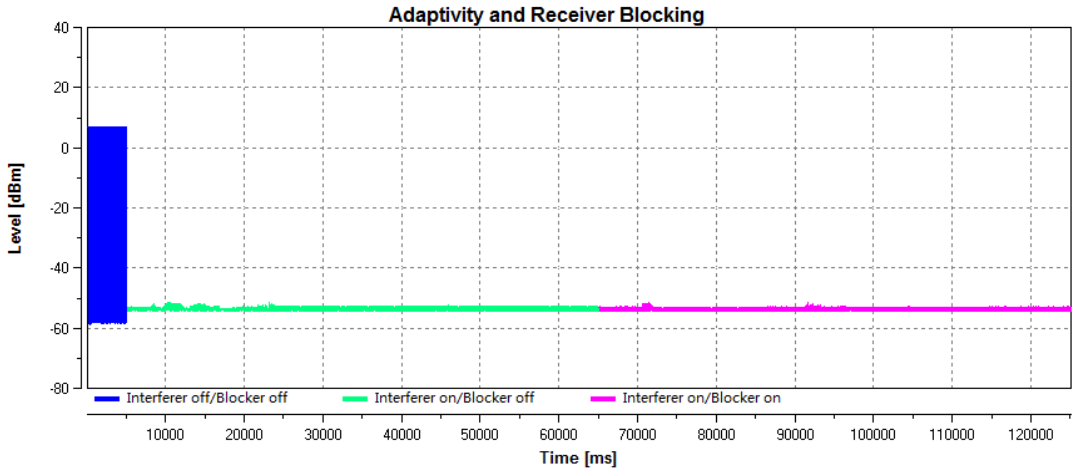


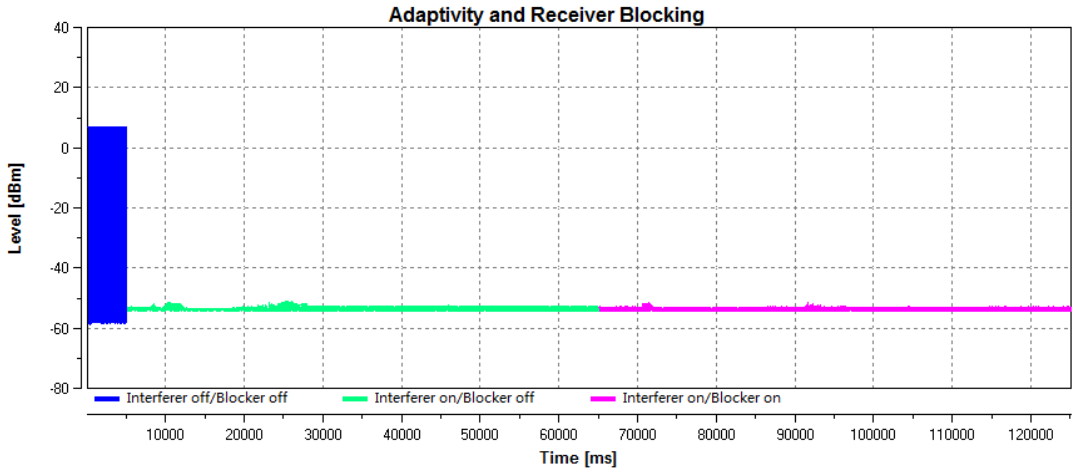


Note: Only the worst plots were recorded in this report.

Mode	Channel	COT values(ms)	Idle values [ms]	Short Control (%)			Verdict
				Interferer values	CW values	Limit [%]	
802.11n HT40	LCH	3.638	0.054	0	0	10	PASS
802.11n HT40	HCH	3.722	0.067	0	0	10	PASS

Test Plot





Note: Only the worst plots were recorded in this report.

4.1.6 Occupied Channel Bandwidth

LIMIT

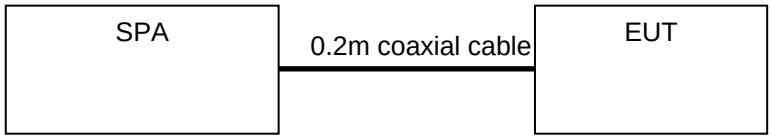
According to ETSI EN 300 328 V2.2.2 (2019-07) 4.3.2.7.3,
The Occupied Channel Bandwidth shall fall completely within the band given in table 1.

Table 1: Service frequency bands

	Service frequency bands
Transmit	2 400 MHz to 2 483,5 MHz
Receive	2 400 MHz to 2 483,5 MHz

In addition, for non-adaptive systems 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.
These measurements shall only be performed at normal test conditions.

TEST CONFIGURATION



TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.7.2.1, conducted method.
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 for frequency hopping equipment: Lowest frequency separation that is used within the hopping sequence
• Frequency Span for other types of equipment: 2 × Nominal Channel Bandwidth (e.g. 40 MHz for a 20 MHz channel)
• Detector Mode: RMS
• Trace Mode: Max Hold
• Sweep time: 1 s
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.
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.

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	auto	
Video bandwidth:	☒20 MHz(Bandwith):1.5MHz	☒40 MHz(Bandwith):3MHz
Resolution bandwidth:	☒20 MHz(Bandwith):410KHz	☒40 MHz(Bandwith):820KHz
Span:	☒20 MHz(Bandwith):40MHz	☒40 MHz(Bandwith):80MHz
Center:	Transmit channel	
Trace:	Max hold	
Performed:	☒ Conducted	
	☐ Radiated (only if no conducted sample is provided)	

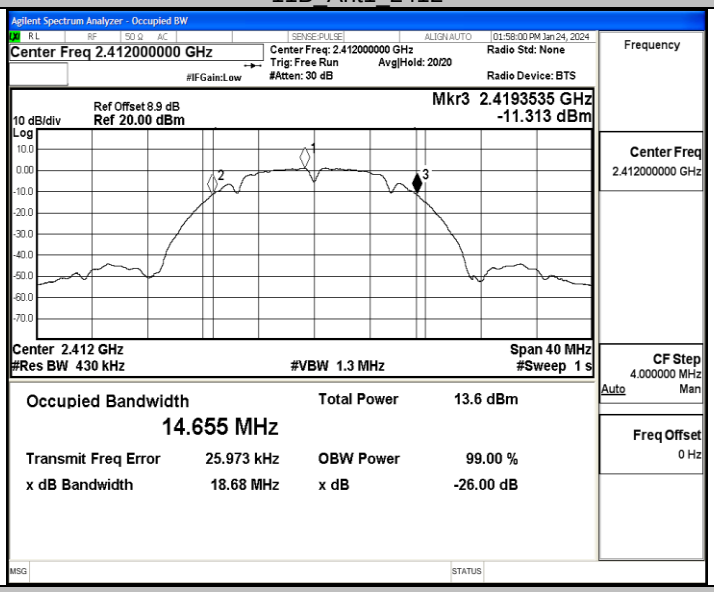
TEST RESULTS

TestMode	Antenna	Channel	OCB[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	14.655	2404.6985	2419.3535	2400 to 2483.5	PASS
		2442	14.716	2434.6234	2449.3394	2400 to 2483.5	PASS
		2472	14.642	2464.6152	2479.2572	2400 to 2483.5	PASS
11G	Ant1	2412	16.474	2403.7696	2420.2436	2400 to 2483.5	PASS
		2442	16.490	2433.7504	2450.2404	2400 to 2483.5	PASS
		2472	16.483	2463.7408	2480.2238	2400 to 2483.5	PASS
11N20SISO	Ant1	2412	17.656	2403.1826	2420.8386	2400 to 2483.5	PASS
		2442	17.664	2433.1737	2450.8377	2400 to 2483.5	PASS
		2472	17.693	2463.1384	2480.8314	2400 to 2483.5	PASS
11N40SISO	Ant1	2422	36.056	2403.9500	2440.0060	2400 to 2483.5	PASS
		2442	36.201	2423.8778	2460.0788	2400 to 2483.5	PASS
		2462	36.060	2443.9610	2480.0210	2400 to 2483.5	PASS

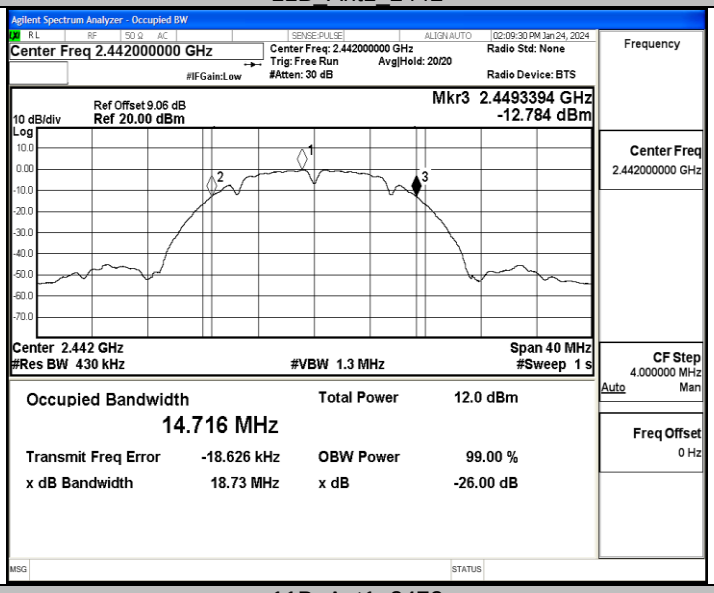
Test plot as follows:

Test Graphs

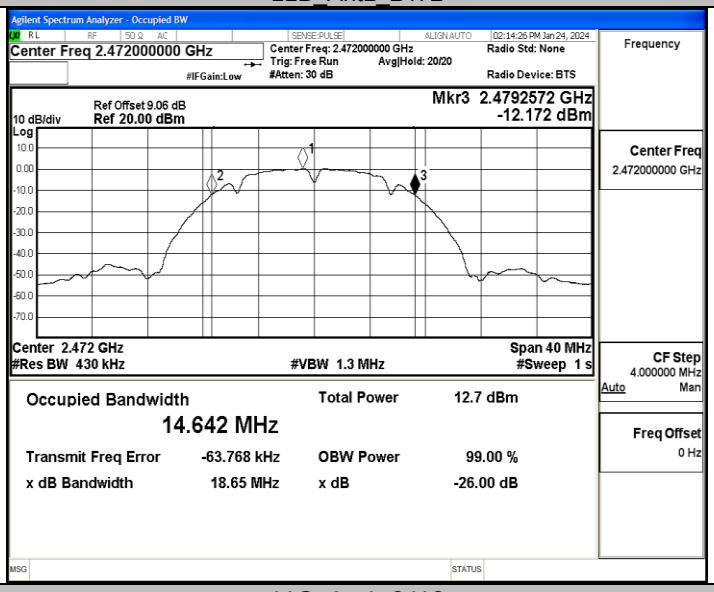
11B_Ant1_2412



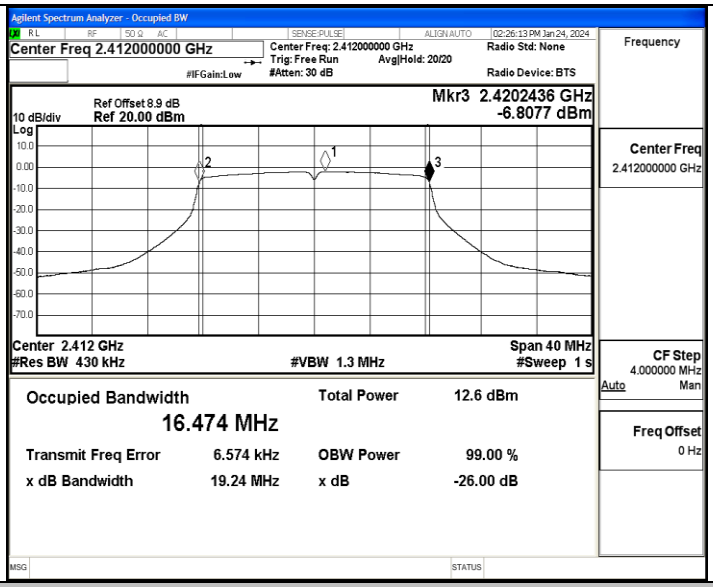
11B_Ant1_2442



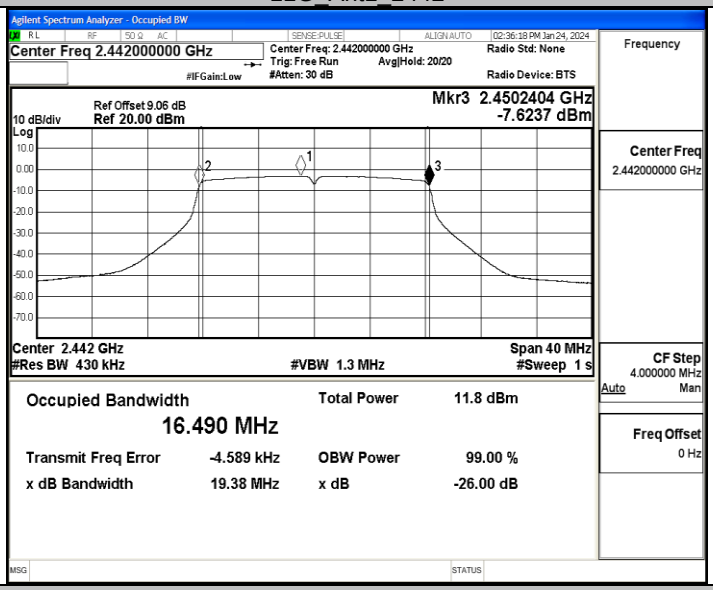
11B_Ant1_2472



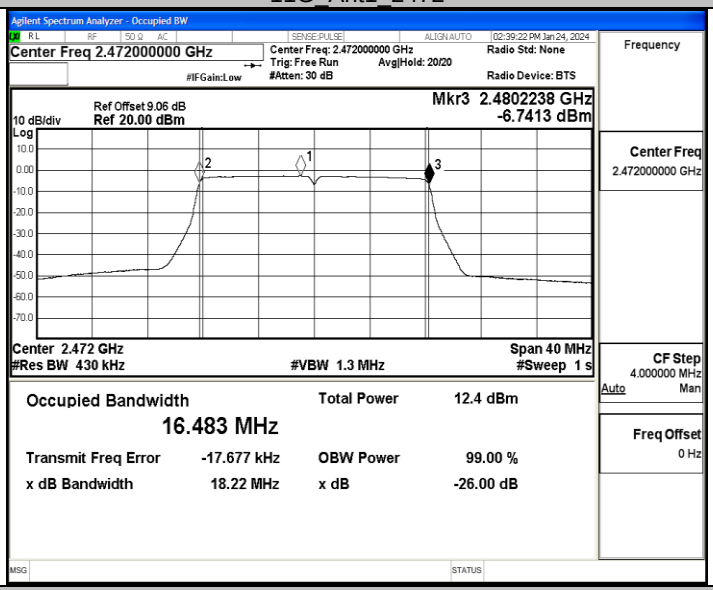
11G_Ant1_2412



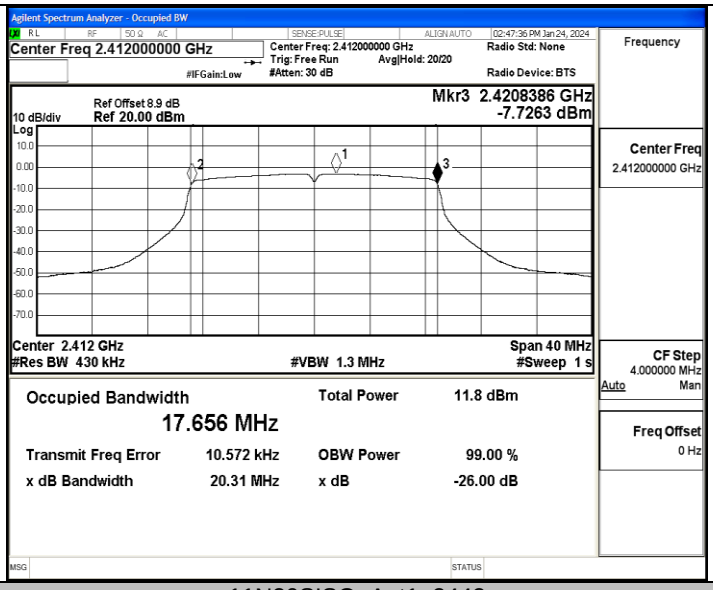
11G_Ant1_2442



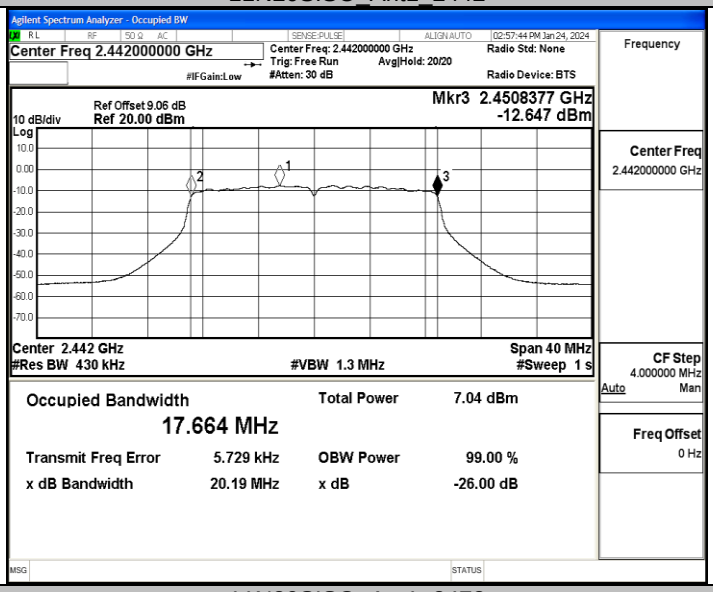
11G_Ant1_2472



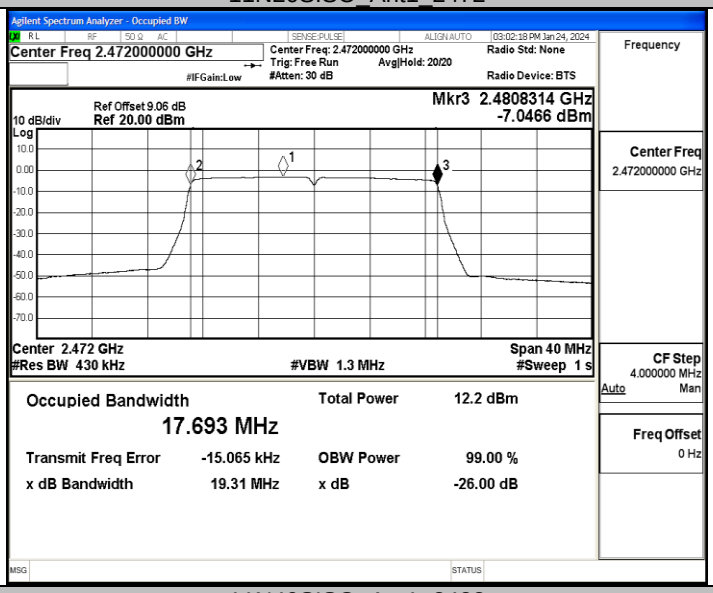
11N20SISO_Ant1_2412



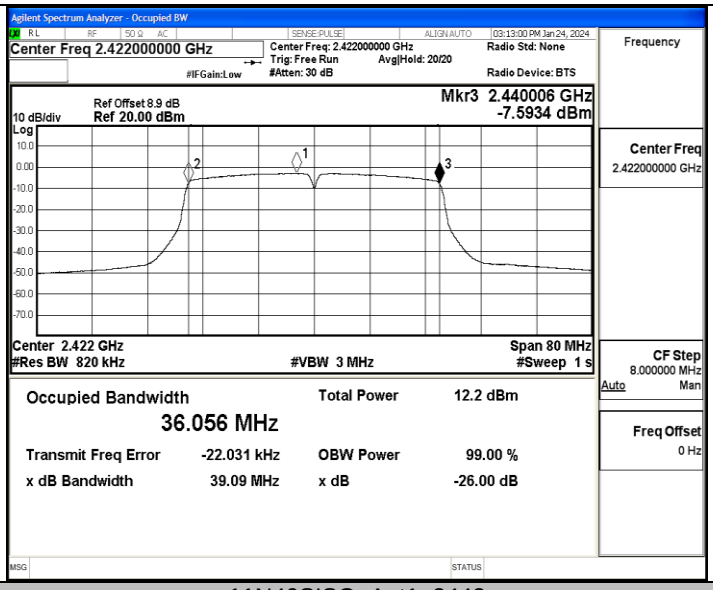
11N20SISO_Ant1_2442



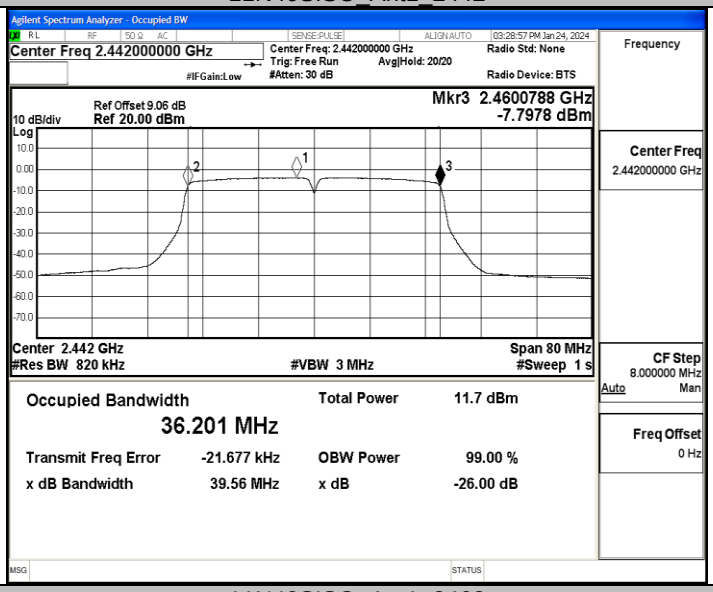
11N20SISO_Ant1_2472



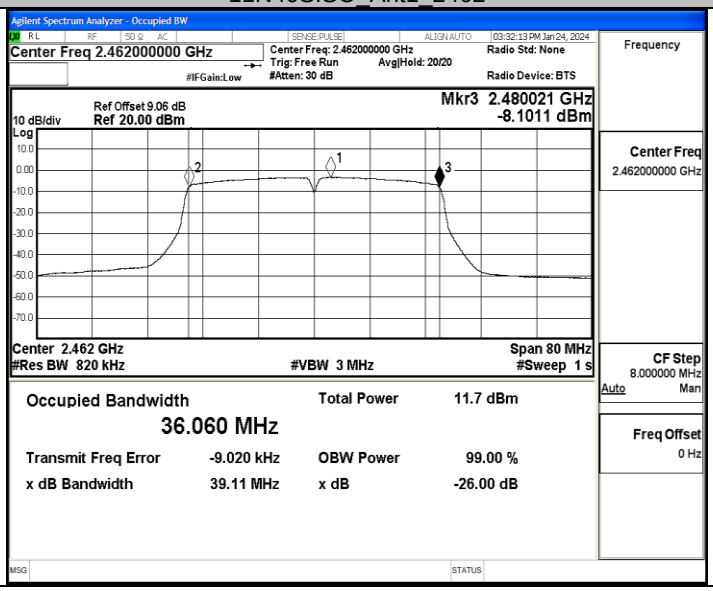
11N40SISO_Ant1_2422



11N40SISO_Ant1_2442



11N40SISO_Ant1_2462



4.1.7 Transmitter unwanted emissions in the out-of-band domain

LIMIT

ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.8.3
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.
NOTE: Within the 2 400 MHz to 2 483,5 MHz band, the Out-of-band emissions are fulfilled by compliance with the Occupied Channel Bandwidth requirement in clause 4.3.2.7.

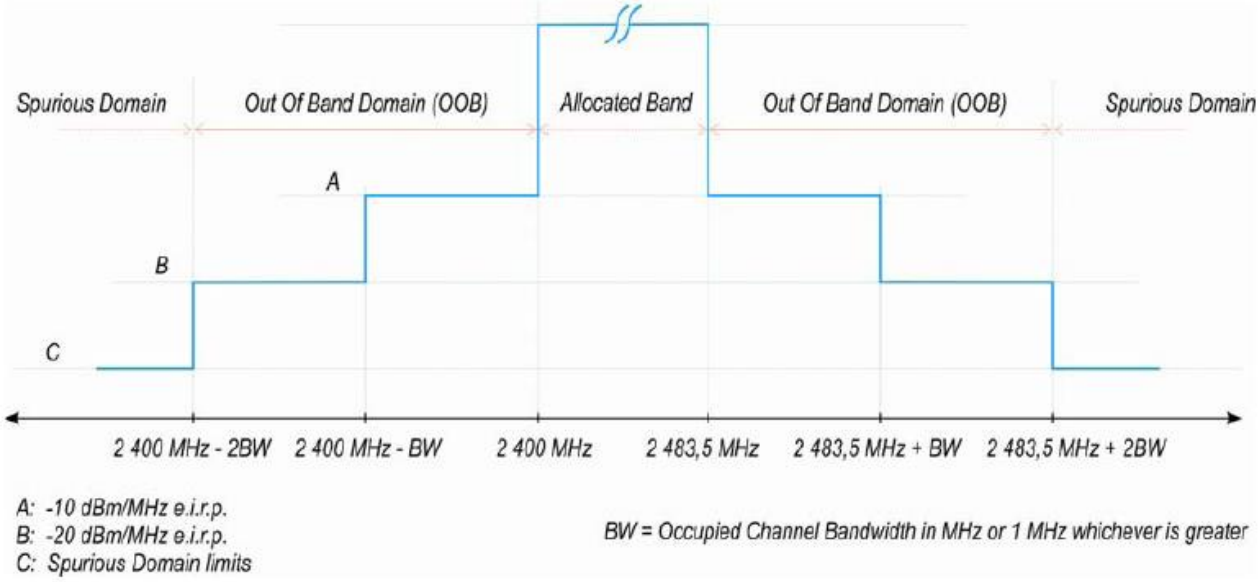
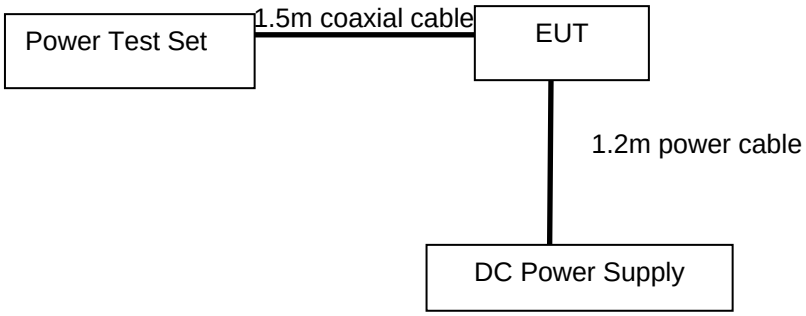


Figure 3: Transmit mask

Transmitter unwanted emissions in the out-of-band domain are emissions when the equipment is in Transmit mode, on frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious.
These measurements shall only be performed at normal test conditions.
For systems using FHSS modulation, the measurements shall be performed during normal operation (hopping).
For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These operating channels shall be recorded.
The equipment shall be configured to operate under its worst case situation with respect to output power.
If the equipment can operate with different Occupied Channel Bandwidths (e.g. 20 MHz and 40 MHz), than each channel bandwidth shall be tested separately.

TEST CONFIGURATION



TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.8.2.1, conducted method.

Connect the UUT to the spectrum analyser and use the following settings:
- Centre Frequency: evaluated frequency
- 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

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.

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 - BW + 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 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: Ach refers to the number of active transmit chains.

It shall be recorded whether the equipment complies with the mask provided in figure 1 or figure 3.

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	depending on packet length	
Video bandwidth:	3MHz	
Resolution bandwidth:	1MHz	
Span:	0Hz	
Trace:	Trigger to burst	
Sweep points:	Sweep Time [s] / (1 µs) or 5 000 whichever is greater	
Performed:	☒	Conducted
	☐	Radiated (only if no conducted sample is provided)

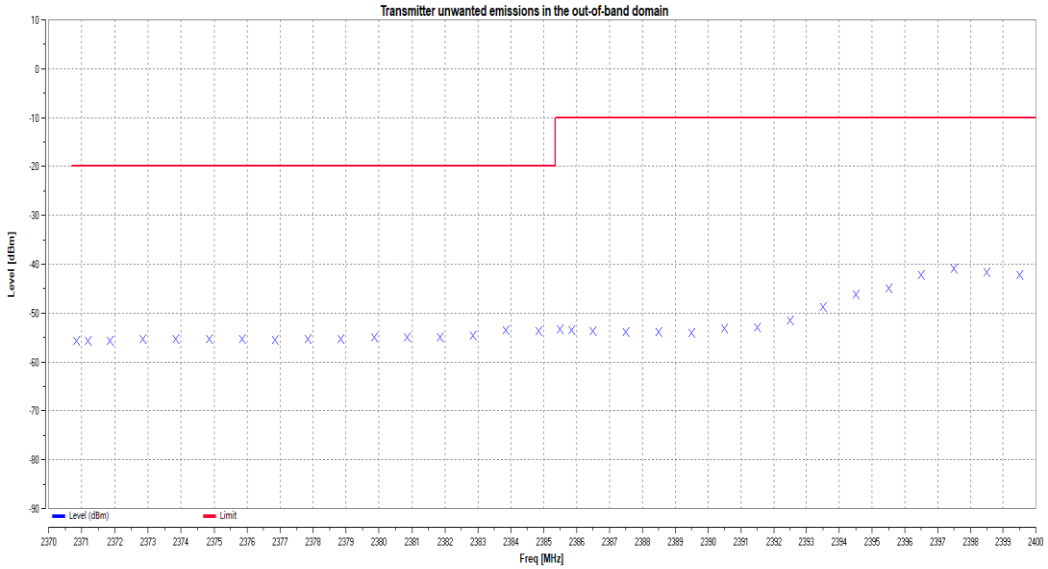
TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

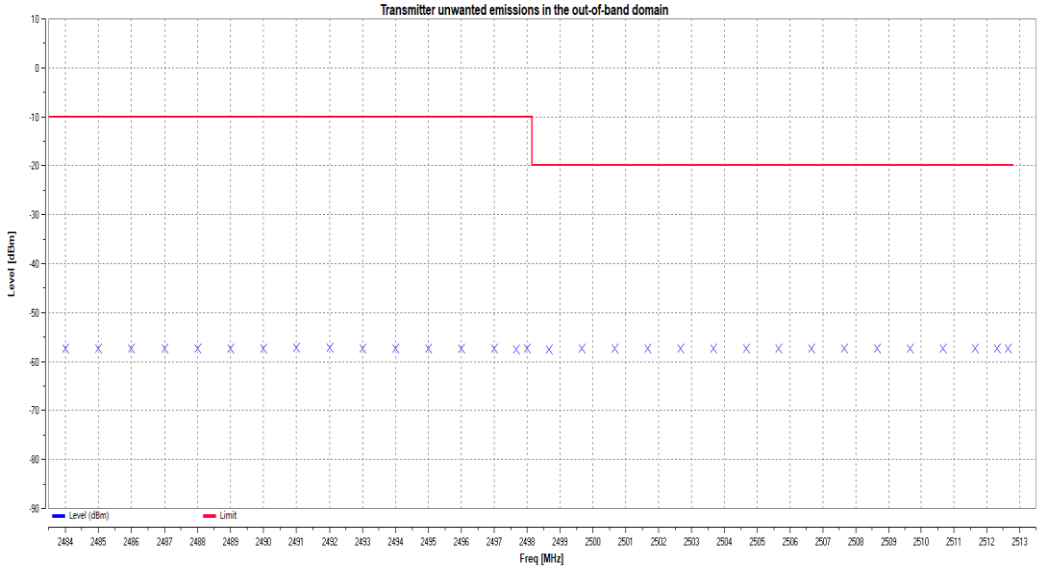
Note: Cable loss and antenna gain was combined in the calculated result.

Test Graphs

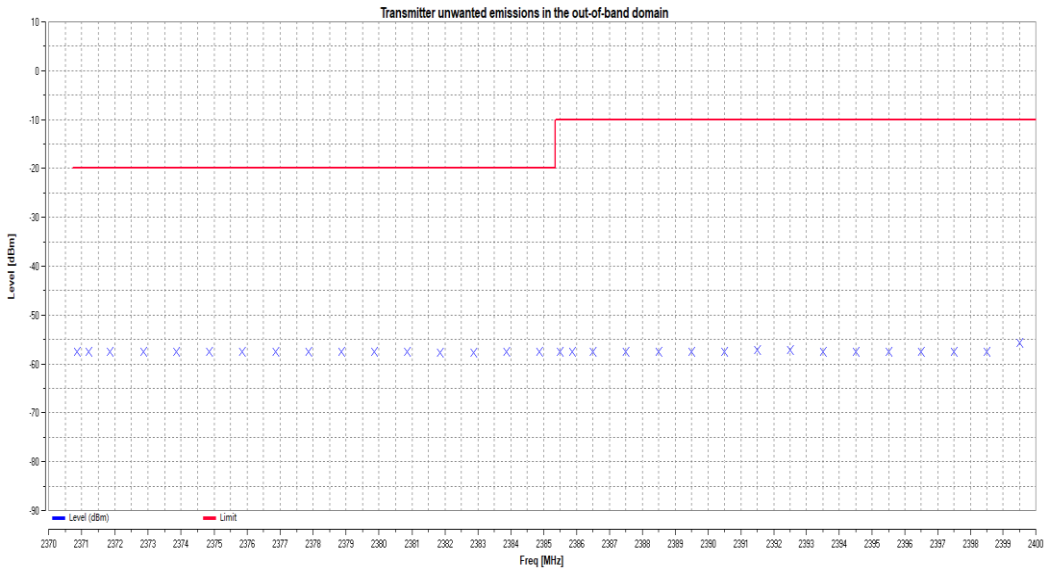
11B_Ant1_2412_2400MHz-2BW to 2400MHz



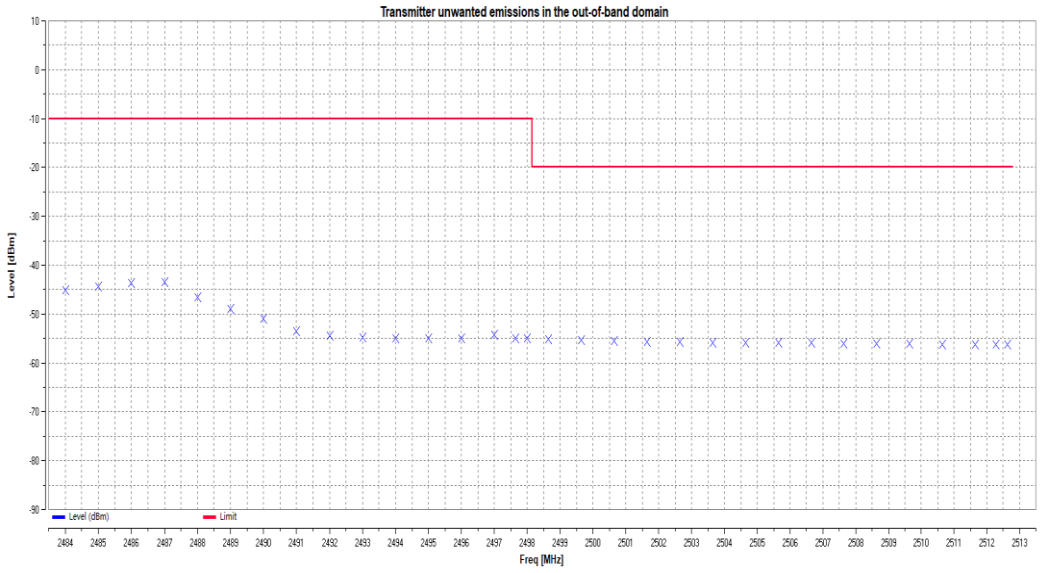
11B_Ant1_2412_2483.5MHz to 2483.5MHz+2BW



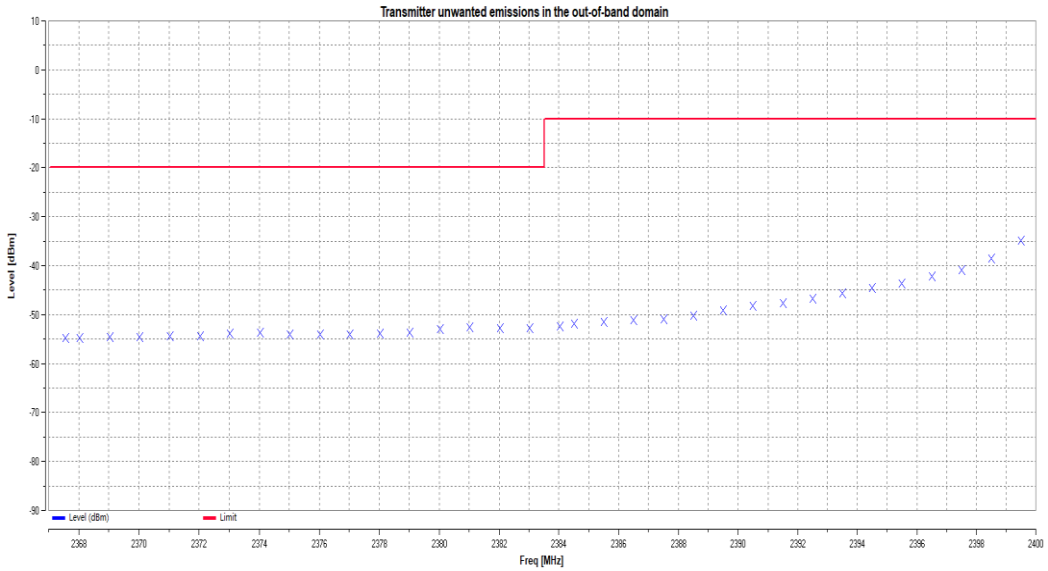
11B_Ant1_2472_2400MHz-2BW to 2400MHz



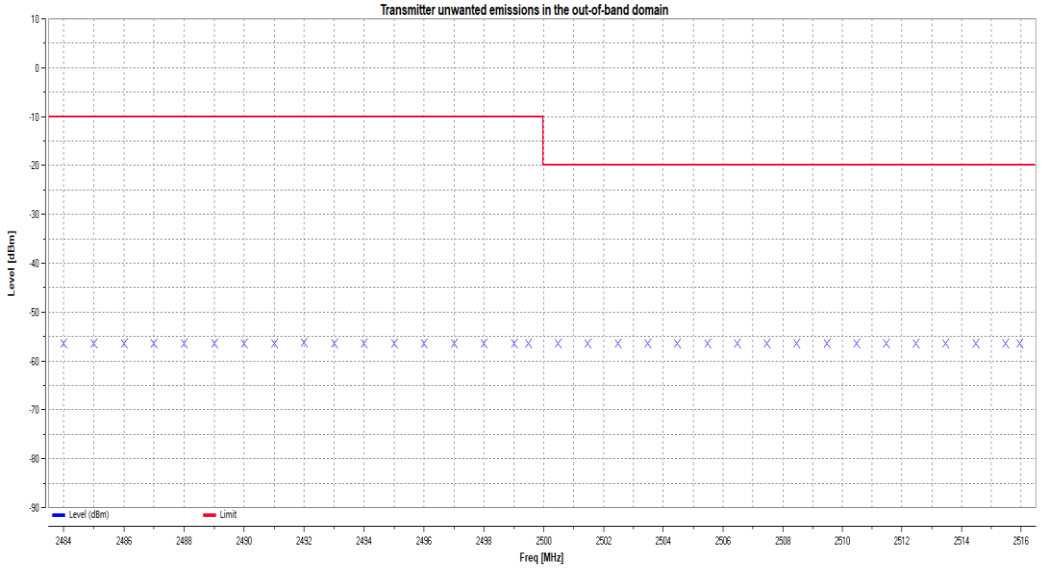
11B_Ant1_2472_2483.5MHz to 2483.5MHz+2BW



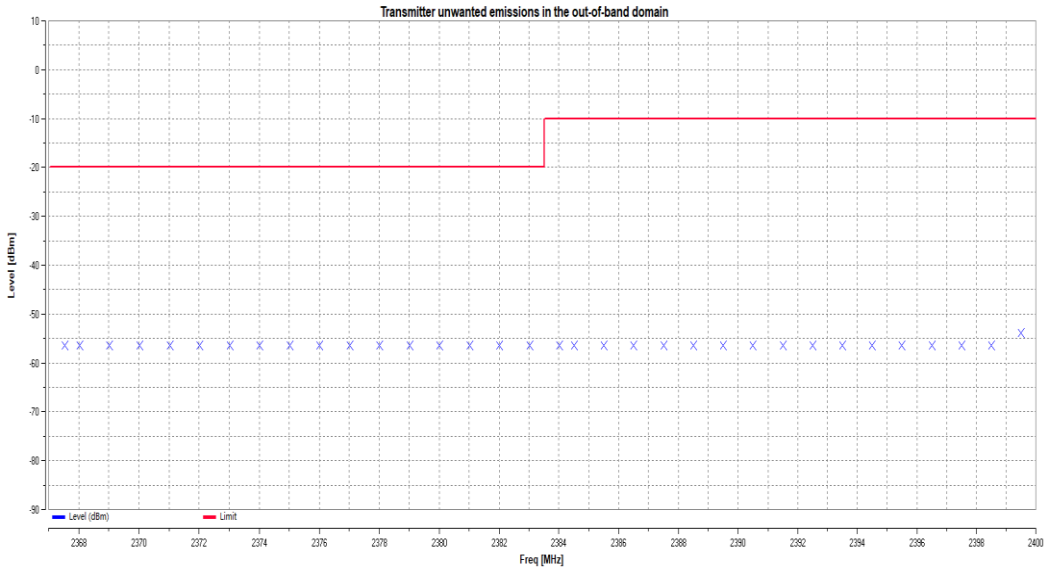
11G_Ant1_2412_2400MHz-2BW to 2400MHz



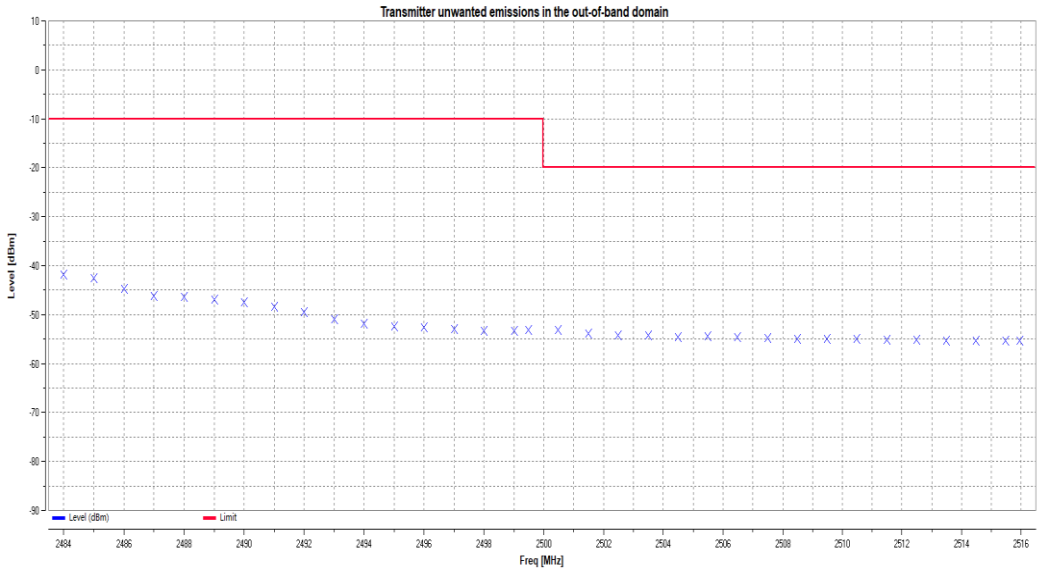
11G_Ant1_2412_2483.5MHz to 2483.5MHz+2BW



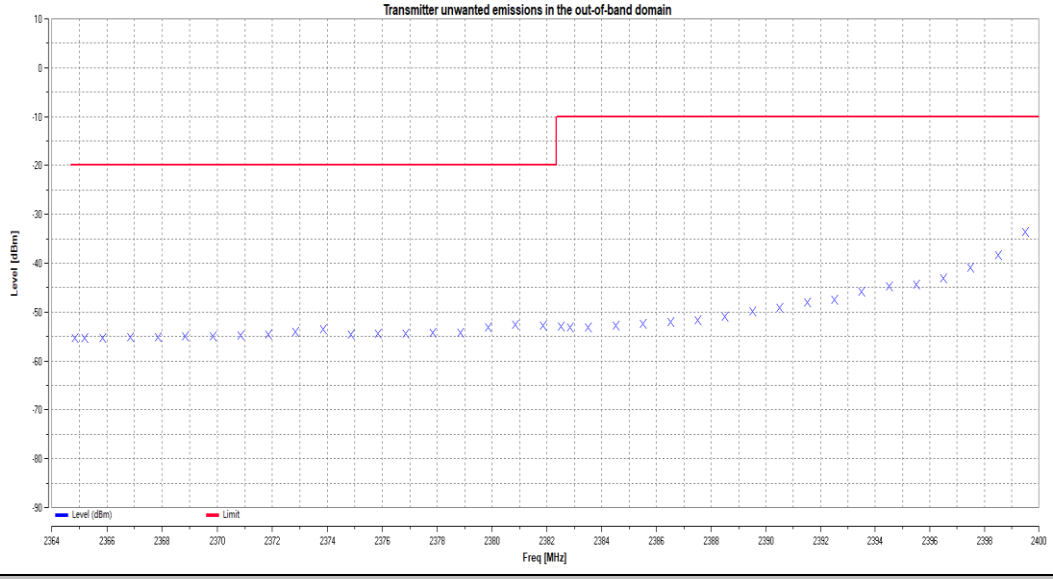
11G_Ant1_2472_2400MHz-2BW to 2400MHz



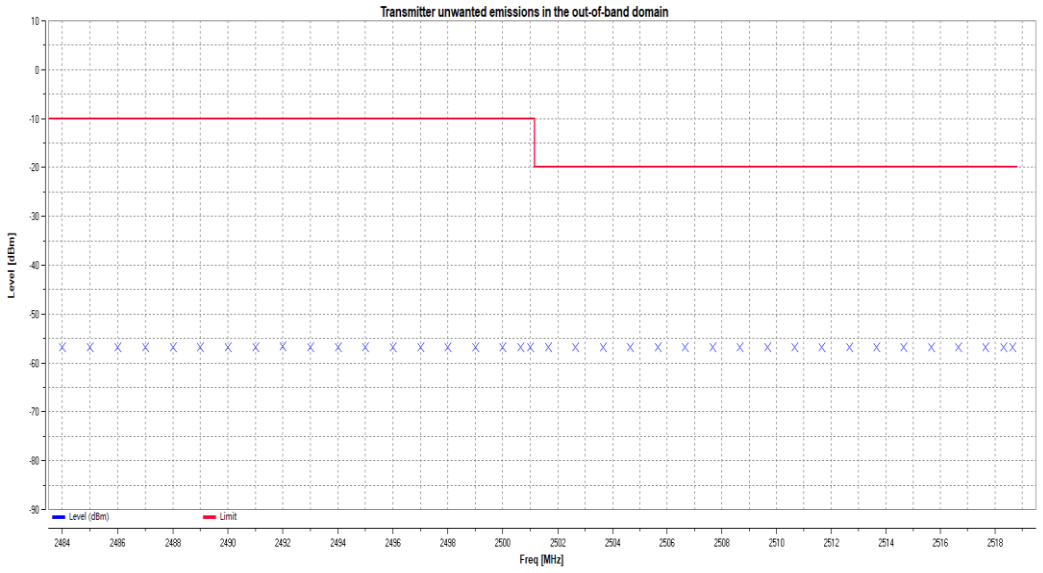
11G_Ant1_2472_2483.5MHz to 2483.5MHz+2BW



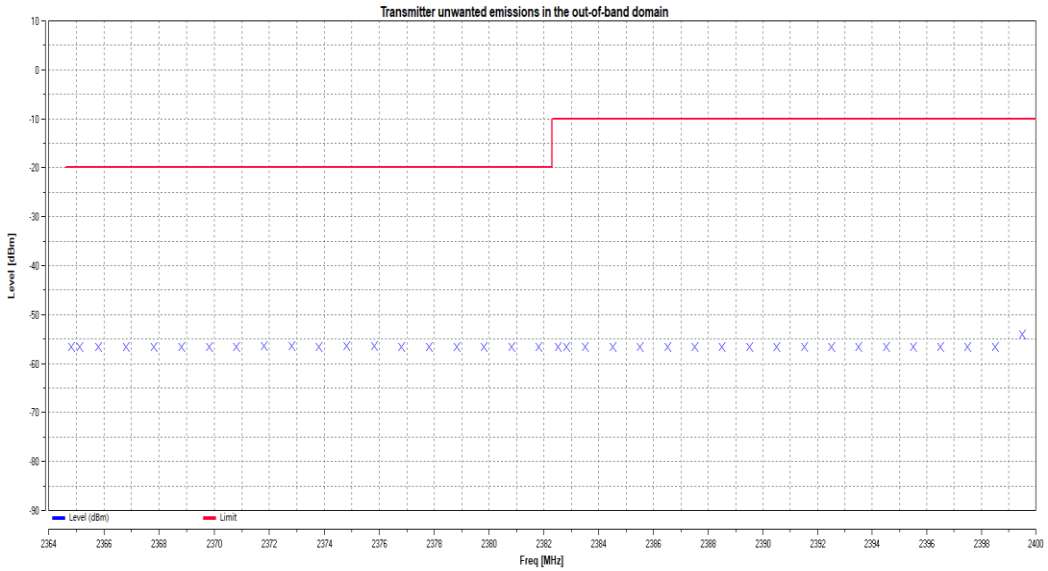
11N20SISO_Ant1_2412_2400MHz-2BW to 2400MHz



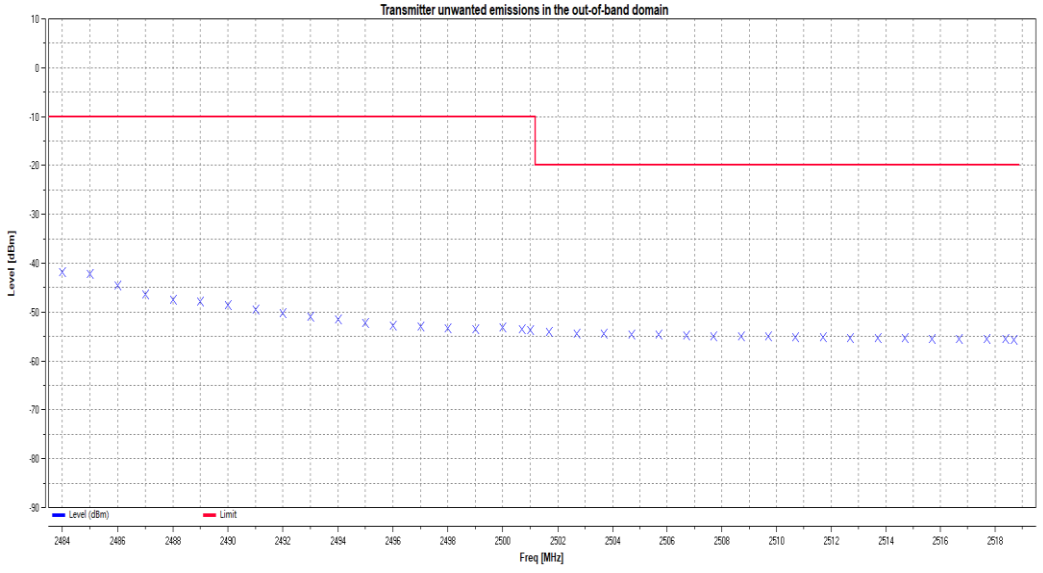
11N20SISO_Ant1_2412_2483.5MHz to 2483.5MHz+2BW



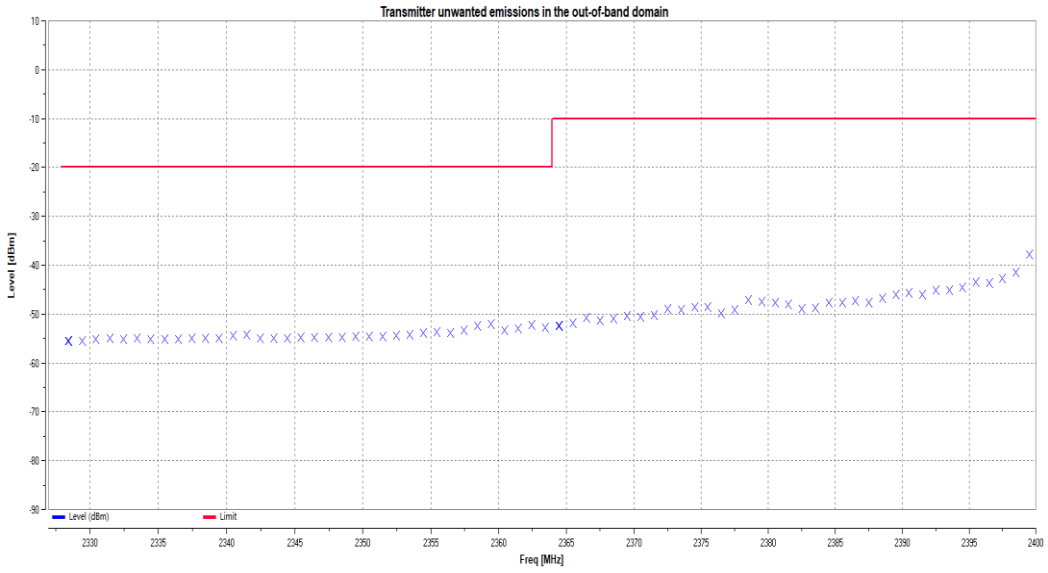
11N20SISO_Ant1_2472_2400MHz-2BW to 2400MHz



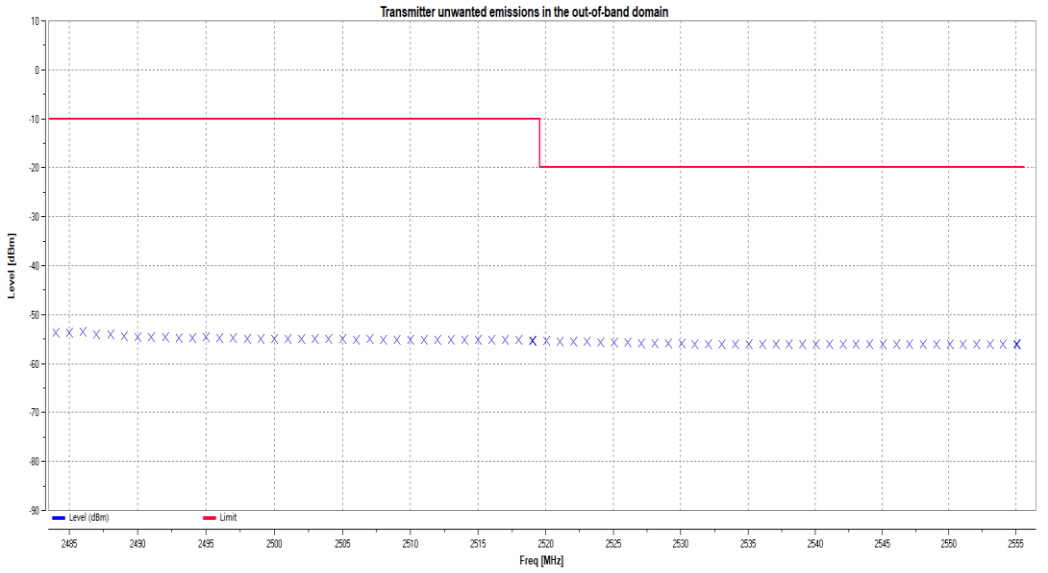
11N20SISO_Ant1_2472_2483.5MHz to 2483.5MHz+2BW



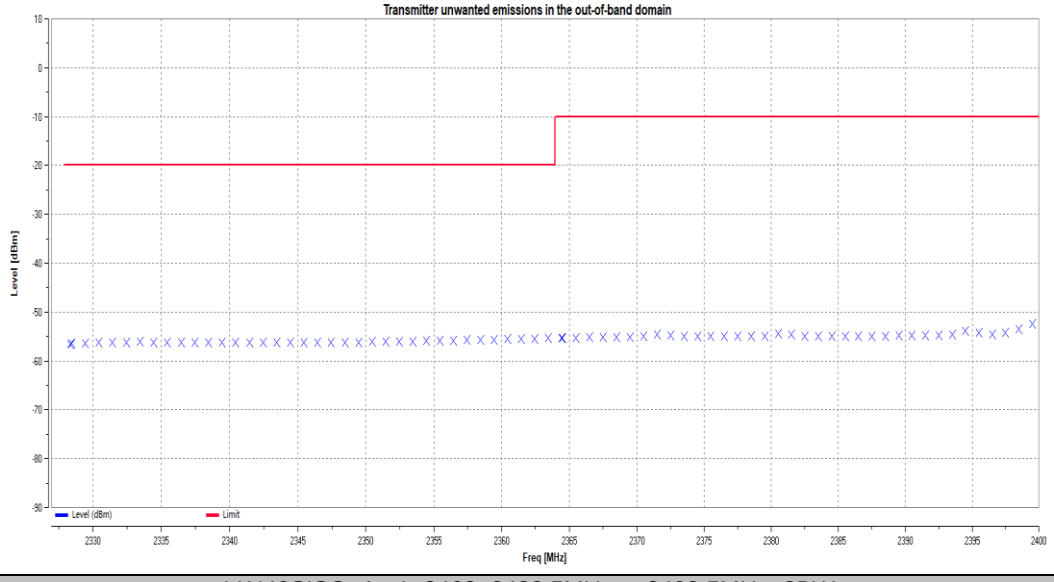
11N40SISO_Ant1_2422_2400MHz-2BW to 2400MHz



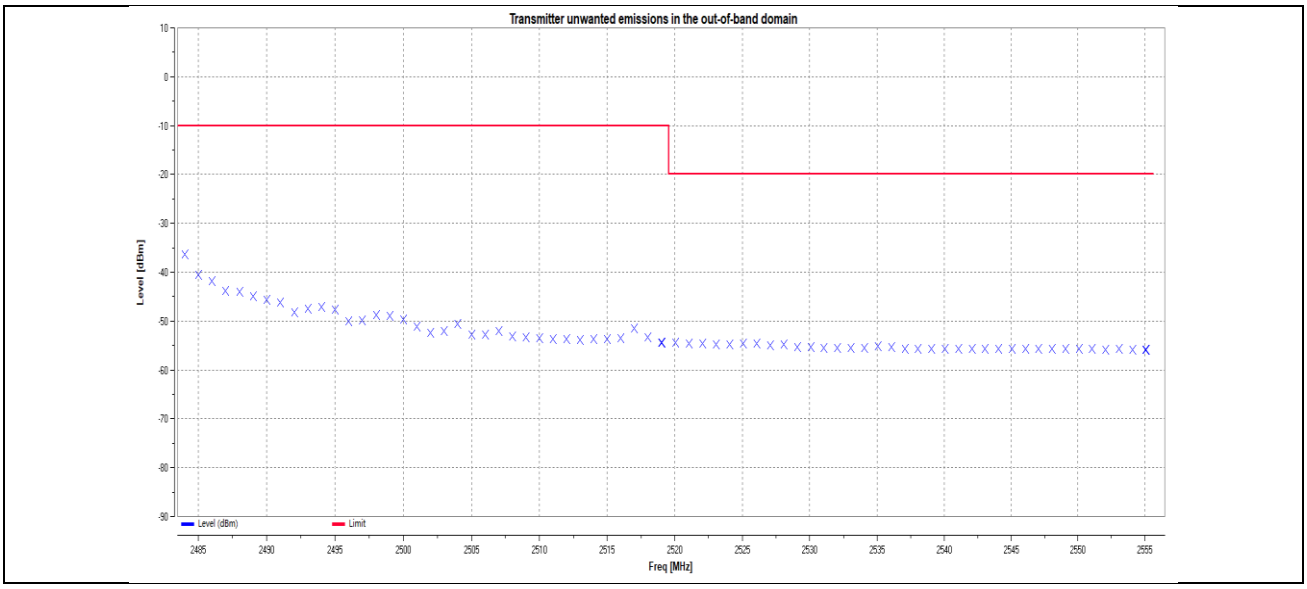
11N40SISO_Ant1_2422_2483.5MHz to 2483.5MHz+2BW



11N40SISO_Ant1_2462_2400MHz-2BW to 2400MHz



11N40SISO_Ant1_2462_2483.5MHz to 2483.5MHz+2BW


Transmitter unwanted emissions in the out-of-band domain
Level [dBm]
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Level (dBm)
Limit
2485
2490
2495
2500
2505
2510
2515
2520
2525
2530
2535
2540
2545
2550
2555
Freq [MHz]

4.1.8 Transmitter unwanted emissions in the spurious domain

Limit

According to ETSI EN 300 328 V2.2.2(2019-07) §4.3.2.9.3

The transmitter unwanted emissions in the spurious domain shall not exceed the values given in table 12.

Table 12: Transmitter limits for spurious emissions

Frequency Range	Maximum power e.r.p.(.≤1 GHz) e.i.r.p.(＞1 GHz)	Limit when Standby
30 MHz to 47 MHz	-36 dBm	100 KHz
47 MHz to 74 MHz	-54 dBm	100 KHz
74MHz 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

These measurements shall only be performed at normal test conditions.
The level of spurious emissions shall be measured as, either:
a) their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation); or
b) their effective radiated power when radiated by cabinet and antenna in case of Integral antenna equipment with no antenna connectors.

For equipment using FHSS modulation, the measurements may be performed when normal hopping is disabled. In this case measurements need to be performed when operating at the lowest and the highest hopping frequency. When this is not possible, the measurement shall be performed during normal operation (hopping).

For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These frequencies shall be recorded.

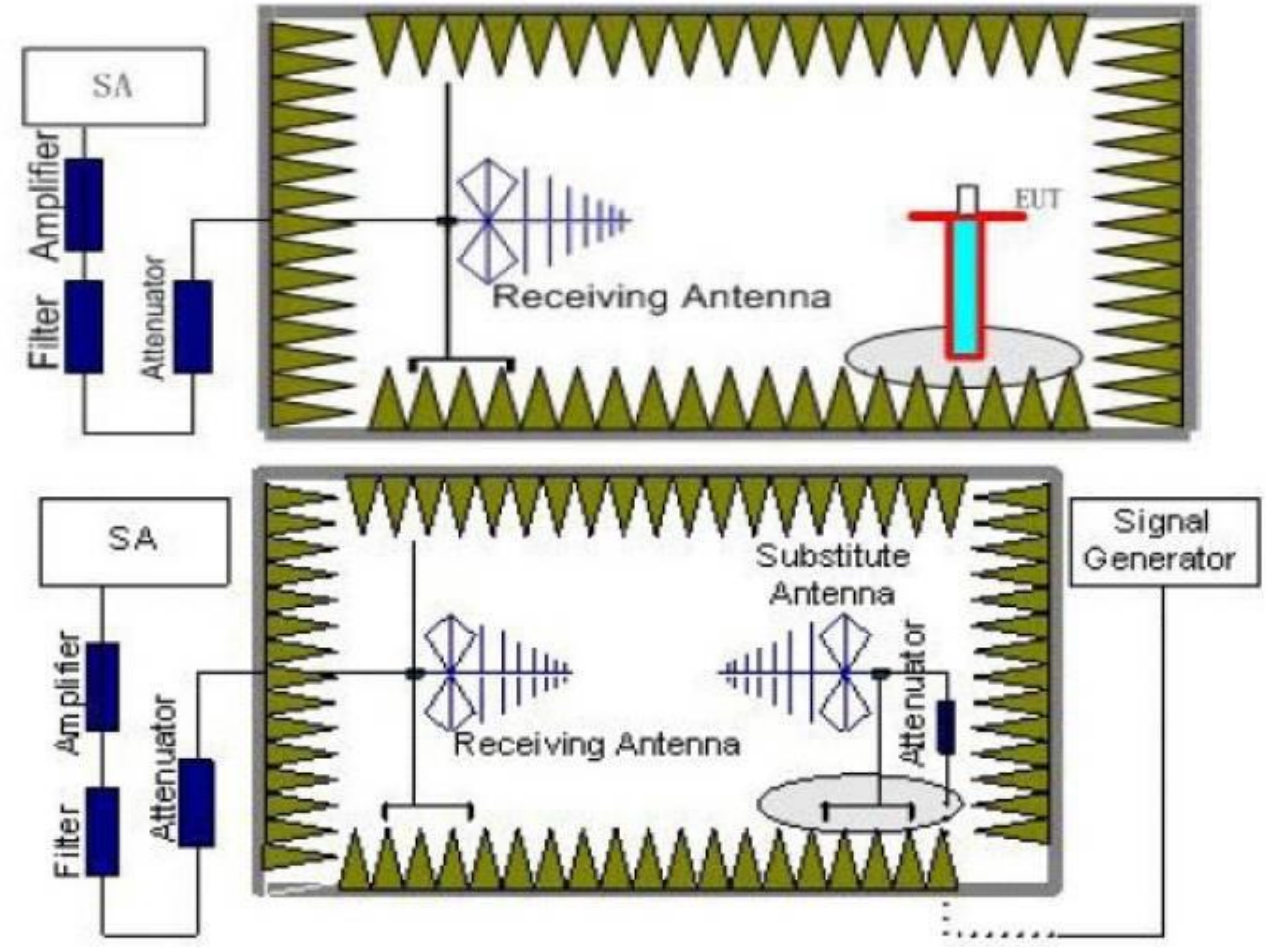
The equipment shall be configured to operate under its worst case situation with respect to output power.

If the equipment can operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz), then the equipment shall be configured to operate under its worst case situation with respect to spurious emissions.

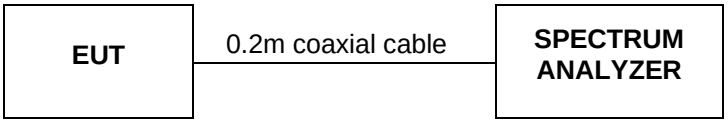
TEST CONFIGURATION

☒**Radiated Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.2, Radiated measurement.

Effective Radiated Power measurement (30 MHz to 12.75 GHz)



☒**Conducted Method:**



TEST PROCEDURE

☒**Radiated Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.2, Radiated measurement.

☒**Conducted Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.1, conducted method.
The test procedure shall be as follows:
Step 1:
The sensitivity of the measurement set-up should be such that the noise floor is at least 12 dB below the limits given in table 4 or table 12.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 19 400; for spectrum analysers not supporting this high number of sweep points, the frequency band may 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 FHSS 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.The above sweep time setting may result in long measuring times in case of FHSS equipment. To avoid such long measuring times, an FFT analyser may be used.Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range belowthe applicable limit or above, shall be individually measured using the procedure in clause 5.4.9.2.1.3 and compared to the limits given in table 4 or table 12.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 23 500; for spectrum analysers not supporting this high number of sweep points, the frequency band may 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 FHSS 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.The above sweep time setting may result in long measuring times in case of FHSS equipment. To avoid such long measuring times, an FFT analyser may 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 5.4.9.2.1.3 and compared to the limits given in table 4 or table 12.FHSS 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 5.4.9.2.1.3.
Step 4:
• In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), step 2 and step 3 need to be repeated for each of the active transmit chains (Ach).The limits used to identify emissions during this pre-scan need to be reduced by 10 × log10 (Ach).
5.4.9.2.1.3 Measurement of the emissions identified during the pre-scan
The procedure in step 1 to step 4 below shall be used to accurately measure the individual unwanted emissions identified during the pre-scan measurements above. This method assumes the spectrum analyser has a Time Domain Power function.
Step 1:
The level of the emissions shall be measured using the following spectrum analyser settings:
• Measurement Mode: Time Domain Power
• Centre Frequency: Frequency of the emission identified during the pre-scan

• Resolution Bandwidth: 100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
• Video Bandwidth: 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 Mode: Video (burst signals) or Manual (continuous signals)
• Detector Mode: 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 table 4 or table 12.

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Video bandwidth:	30MHz-1GHz:300KHz; GHz -12.75GHz:3MHz;	
Resolution bandwidth:	30MHz-1GHz:100KHz; GHz -12.75GHz:1MHz;	
Sweep Points	30000	
Performed:	☒	Conducted
	☒	Radiated

Test Results

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Tony Luo

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
490.85	V	-61.52	-54	7.52	PASS
496.15	H	-59.99	-54	5.99	PASS
Above 1GHz:					
Test Mode: Low Channel					
4824	H	-43.24	-30	13.24	PASS
4824	V	-44.58	-30	14.58	PASS
7236	H	-46.23	-30	16.23	PASS
7236	V	-43.47	-30	13.47	PASS
9648	H	-50.85	-30	20.85	PASS
9648	V	-44.42	-30	14.42	PASS
Test Mode: High Channel					
4944	H	-40.14	-30	10.14	PASS
4944	V	-41.17	-30	11.17	PASS
7416	H	-40.80	-30	10.80	PASS
7416	V	-41.14	-30	11.14	PASS
9888	H	-45.26	-30	15.26	PASS
9888	V	-46.58	-30	16.58	PASS

Note:
1. Cable loss and antenna gain was combined in the calculated result.
2. No record for margin above 20dB.

4.1.9 Receiver spurious emissions

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) §4.3.2.10.3
The spurious emissions of the receiver shall not exceed the values given in table 13.

Table 13: spurious emission limits for receivers

Frequency	Maximum power, e.r.p.	Measurement bandwidth
30 MHz to 1 GHz	-57 dBm	100 KHz
30 MHz to 12.75 GHz	-47 dBm	1 MHz

☒**Radiated Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.9.2.2, Radiated measurement.

☒**Conducted Method:**
According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.10.2.1, conducted method.
The test procedure shall be as follows:
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
table 5 or table 13.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 19 400
• Sweep time: Auto
Wait for 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 5.4.10.2.1.3 and
compared to the limits given in table 5 or table 13.
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
• Filter type: 3 dB (Gaussian)
• Detector mode: Peak
• Trace Mode: Max Hold
• Sweep Points: ⩾ 23 500; for spectrum analysers not supporting this high number of sweep points,
the frequency band may be segmented
• Sweep time: Auto
Wait for 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 5.4.10.2.1.3 and compared to
the limits given in table 5 or table 13.
FHSS 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 5.4.10.2.1.3.
Step 4:
• In case of conducted measurements on smart antenna systems (equipment with multiple receive chains), step 2 and step 3 need to be repeated for each of the active receive chains AchThe limits used to identify emissions during this pre-scan need to be reduced by 10 × log10 Ach.

The procedure in step 1 to step 4 below shall be used to accurately measure the individual unwanted emissions
identified during the pre-scan measurements above. This method assumes the spectrum analyser has a Time Domain
Power function.
Step 1:
The level of the emissions shall be measured using the following spectrum analyser settings:
• Measurement Mode: Time Domain Power
• Centre Frequency: Frequency of the emission identified during the pre-scan
• Resolution Bandwidth: 100 kHz (< 1 GHz) / 1 MHz (> 1 GHz)
• Video Bandwidth: 300 kHz (< 1 GHz) / 3 MHz (> 1 GHz)
• Frequency Span: Zero Span
• Sweep mode: Single Sweep
• Sweep time: 30 ms
• Sweep points: ⩾ 30 000
• Trigger: Video (for burst signals) or Manual (for 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 the start and stop times of the sweep.

Step 3: In case of conducted measurements on smart antenna systems (equipment with multiple receive chains), step 2 needs to be repeated for each of the active receive chains Ach.
Sum the measured power (within the observed window) for each of the active receive chains.

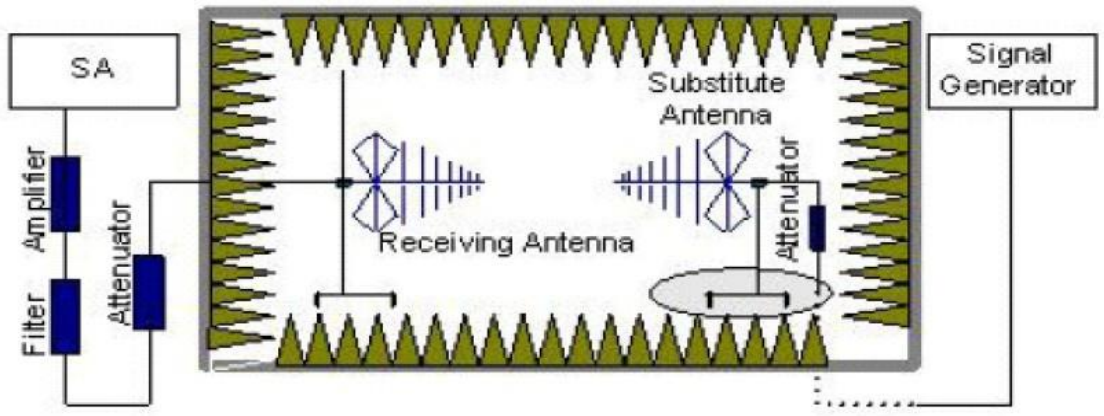
Step 4:

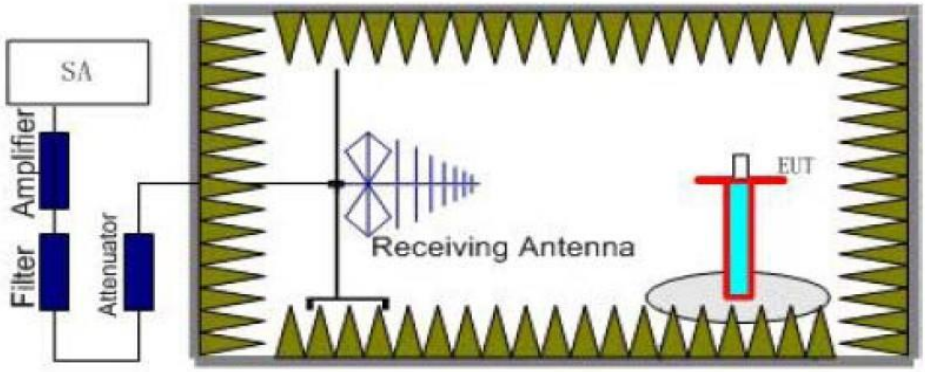
The value defined in step 3 shall be compared to the limits defined in table 5 and table 13.

Test Configuration

☒**Radiated Method:**

Effective Radiated Power measurement (30 MHz to 12.75 GHz)

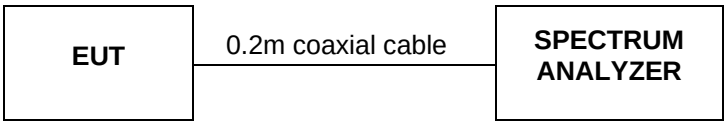




The level of spurious emissions shall be measured as, either:
a) their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation); or

b) their effective radiated power when radiated by cabinet and antenna in case of Integral antenna equipment withno temporary antenna connectors.
Testing shall be performed when the equipment is in a receive-only mode.
For equipment using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These frequencies shall be recorded.
For equipment using FHSS modulation, the measurements may be performed when normal hopping is disabled. In this case measurements need to be performed when operating at the lowest and the highest hopping frequency. These frequencies shall be recorded. When disabling the normal hopping is not possible, the measurement shall be performed during normal operation (hopping).

☒**Conducted Method:**



Test Results

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Tony Luo

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
100.57	V	-63.17	-57	6.17	PASS
777.71	H	-66.83	-57	9.83	PASS
Above 1GHz:					
Test Mode：Lowest frequency					
1296.95	H	-55.17	-47	8.17	PASS
1296.95	V	-59.99	-47	12.99	PASS
2292.84	H	-57.77	-47	10.77	PASS
2292.84	V	-59.24	-47	12.24	PASS
Test Mode： Highest frequency					
1340.33	H	-58.10	-47	11.10	PASS
1340.33	V	-59.79	-47	12.79	PASS
2715.41	H	-58.93	-47	11.93	PASS
2715.41	V	-58.25	-47	11.25	PASS

Note:
1. Cable loss and antenna gain was combined in the calculated result.
2. No record for margin above 20dB.

4.1.10 Receiver Blocking

LIMIT

According to ETSI EN 300 328 V2.2.2 (2019-07) §4.3.2.11.4

While maintaining the minimum performance criteria as defined in clause 4.3.2.11.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in table 14, table 15 or table 16.

The minimum performance criterion shall be a PER less than or equal to 10 %. The manufacturer may declare alternative performance criteria as long as that is appropriate for the intended use of the equipment.

Table 14: 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 × $\log_{10}$(OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × $\log_{10}$(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 P_{min} + 26 dB where P_{min} 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 P_{min} + 20 dB where P_{min} 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.

Table 15: 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 × $\log_{10}$(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 P_{min} + 26 dB where P_{min} 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.

Table 16: 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 × $\log_{10}$(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 test may be performed using a wanted signal up to P_{min} + 30 dB where P_{min} 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.			

According to ETSI EN 300 328 V2.2.2 (2019-07) § 4.2.3 Receiver categories
4.2.3.2.1 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.
4.2.3.2.2 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.
4.2.3.2.3 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.

These measurements shall only be performed at normal test conditions.
For non-frequency hopping equipment, having more than one operating channel, the equipment shall be tested operating at both the lowest and highest operating channels. Equipment which can change their operating channel automatically (adaptive channel allocation), and where this function cannot be disabled, shall be tested as a frequency hopping equipment.
If the equipment can be configured to operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz) and different data rates, then the combination of the smallest channel bandwidth and the lowest data rate for this channel bandwidth which still allows the equipment to operate as intended shall be used. This mode of operation shall be aligned with the performance criteria defined in clause 4.3.1.12.3 or clause 4.3.2.11.3 as declared by the manufacturer (see clause 5.4.1 t)) and shall be described in the test report.
It shall be verified that this performance criteria as declared by the manufacturer is achieved.

TEST CONFIGURATION

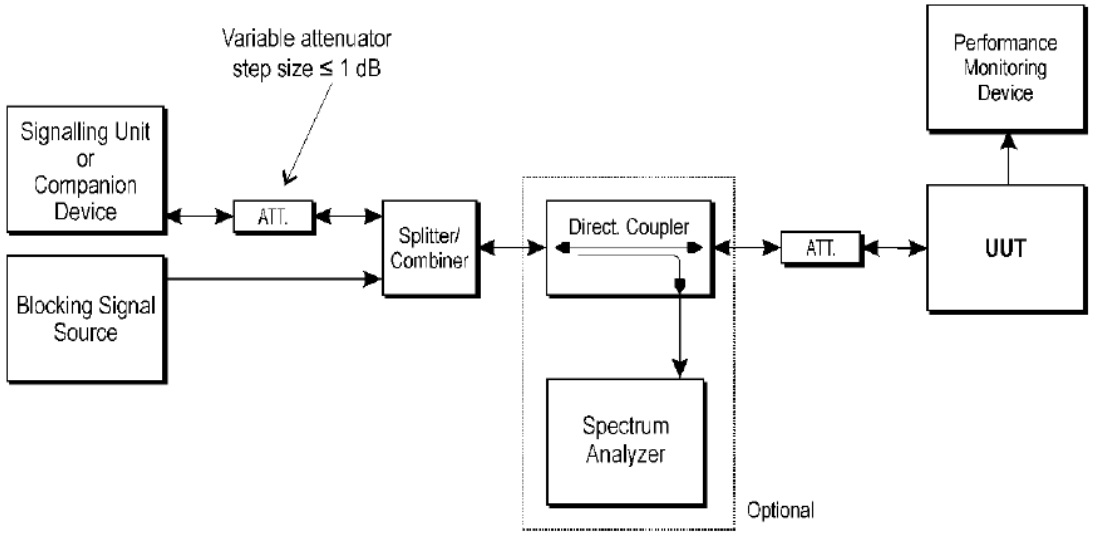


Figure 6: Test Set-up for receiver blocking

MEASUREMENT DESCRIPTION

According to ETSI EN 300 328 V2.2.2 (2019-07) §5.4.11.2.1, Conducted measurements

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 Pmin.

• 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.

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

TestMode	Channel	Wanted signal [dBm]	Freq. [MHz]	CW [dBm]	PER [%]	Limit [%]	Verdict
802.11b	2412	-74	2300	-34	0.5	<= 10	PASS
		-74	2330	-34	0.7	<= 10	PASS
		-74	2360	-34	0.8	<= 10	PASS
		-74	2524	-34	1.4	<= 10	PASS
		-74	2584	-34	1	<= 10	PASS
		-74	2674	-34	1.4	<= 10	PASS
		-68	2380	-34	0.8	<= 10	PASS
		-68	2504	-34	1.1	<= 10	PASS
	2472	-74	2300	-34	1.1	<= 10	PASS
		-74	2330	-34	1.3	<= 10	PASS
		-74	2360	-34	0.8	<= 10	PASS
		-74	2524	-34	0.6	<= 10	PASS
		-74	2584	-34	1.2	<= 10	PASS
		-74	2674	-34	0.5	<= 10	PASS
		-68	2380	-34	0.6	<= 10	PASS
		-68	2504	-34	0.6	<= 10	PASS
802.11g	2412	-74	2300	-34	1.1	<= 10	PASS
		-74	2330	-34	1.3	<= 10	PASS
		-74	2360	-34	0.7	<= 10	PASS
		-74	2524	-34	0.8	<= 10	PASS
		-74	2584	-34	0.6	<= 10	PASS
		-74	2674	-34	0.5	<= 10	PASS
		-68	2380	-34	0.8	<= 10	PASS
		-68	2504	-34	1.4	<= 10	PASS
	2472	-74	2300	-34	0.6	<= 10	PASS
		-74	2330	-34	1.4	<= 10	PASS
		-74	2360	-34	1.1	<= 10	PASS
		-74	2524	-34	1.1	<= 10	PASS
		-74	2584	-34	1.1	<= 10	PASS
		-74	2674	-34	0.8	<= 10	PASS
		-68	2380	-34	1	<= 10	PASS
		-68	2504	-34	0.5	<= 10	PASS
802.11n20	2412	-74	2300	-34	1.3	<= 10	PASS
		-74	2330	-34	0.6	<= 10	PASS
		-74	2360	-34	0.6	<= 10	PASS
		-74	2524	-34	0.8	<= 10	PASS
		-74	2584	-34	1.3	<= 10	PASS
		-74	2674	-34	1.1	<= 10	PASS
		-68	2380	-34	1.2	<= 10	PASS
		-68	2504	-34	0.9	<= 10	PASS
	2472	-74	2300	-34	1.5	<= 10	PASS
		-74	2330	-34	0.7	<= 10	PASS

		-74	2360	-34	0.8	<= 10	PASS
		-74	2524	-34	1.4	<= 10	PASS
		-74	2584	-34	1.5	<= 10	PASS
		-74	2674	-34	0.8	<= 10	PASS
		-68	2380	-34	1	<= 10	PASS
		-68	2504	-34	0.6	<= 10	PASS
802.11n40	2412	-74	2300	-34	0.8	<= 10	PASS
		-74	2330	-34	0.6	<= 10	PASS
		-74	2360	-34	0.6	<= 10	PASS
		-74	2524	-34	1.1	<= 10	PASS
		-74	2584	-34	1.4	<= 10	PASS
		-74	2674	-34	0.8	<= 10	PASS
		-68	2380	-34	1.4	<= 10	PASS
		-68	2504	-34	0.7	<= 10	PASS
	2472	-74	2300	-34	0.8	<= 10	PASS
		-74	2330	-34	0.6	<= 10	PASS
		-74	2360	-34	0.9	<= 10	PASS
		-74	2524	-34	0.8	<= 10	PASS
		-74	2584	-34	1.3	<= 10	PASS
		-74	2674	-34	1	<= 10	PASS
		-68	2380	-34	0.5	<= 10	PASS
		-68	2504	-34	1.4	<= 10	PASS

4.1.11 Geo-location capability

Definition& Requirements

ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.13.2 Definition
Geo-location capability is a feature of the equipment to determine its geographical location with the purpose to configure itself according to the regulatory requirements applicable at the geographical location where it operates.

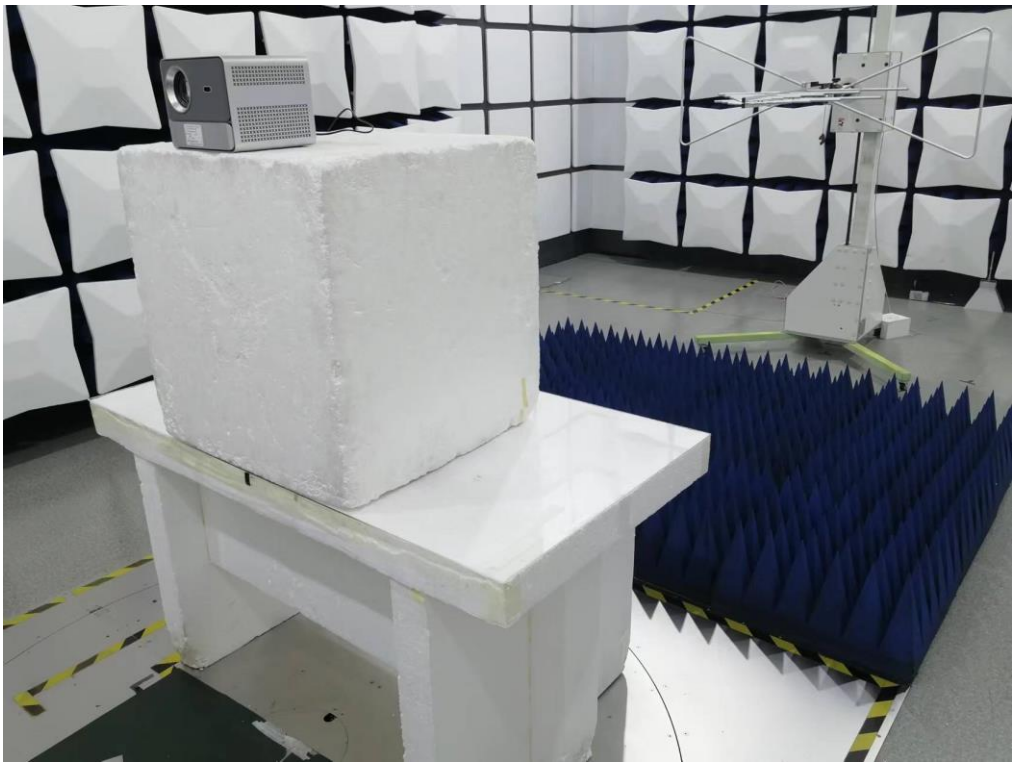
The geo-location capability may be present in the equipment or in an external device (temporary) associated with the equipment operating at the same geographical location during the initial power up of the equipment. The geographical location may also be available in equipment already installed and operating at the same geographical location.

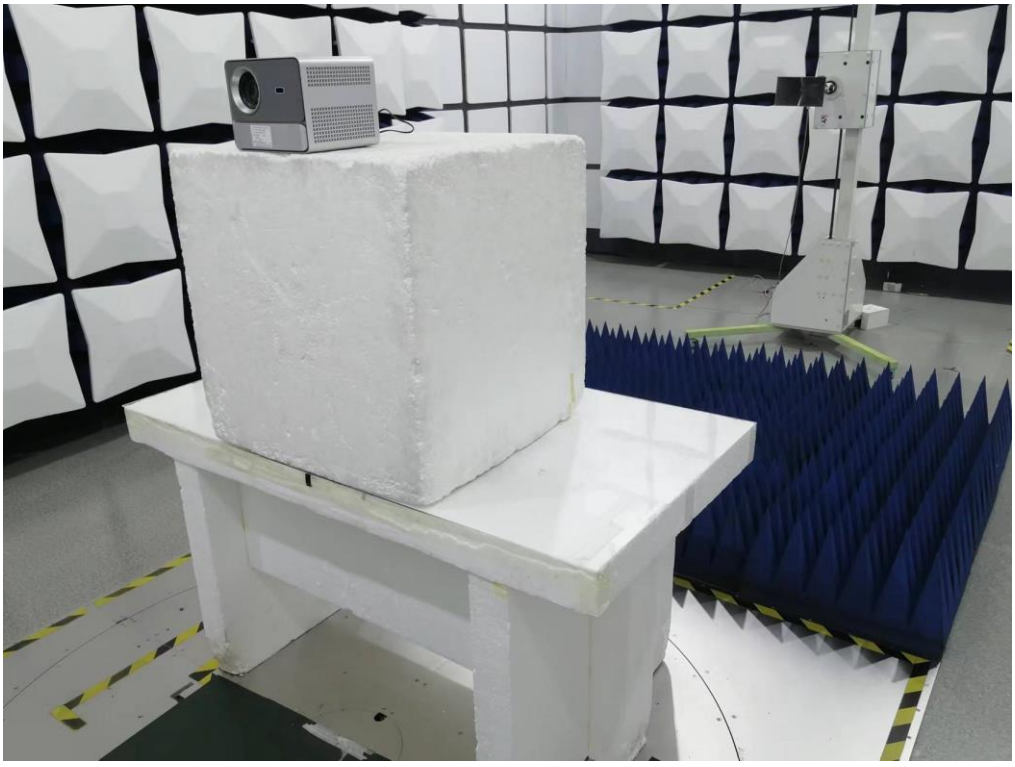
ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.13.2 Requirements
The geographical location determined by the FHSS equipment as defined in clause 4.3.1.13.2 shall not be accessible to the user in a way that would allow the user to alter it.

RESULTS

This equipment does not support Geo-location.

5 Test Setup Photos of the EUT





6 External and Internal Photos of the EUT

Reference to the test report No. TZ240105305-RE

.....End of Report.....

TEST REPORT

ETSI EN 301 893 V2.1.1 (2017-05)

Report Reference No.....:	**TZ240105305-WLAN2**
Compiled by (position+printed name+signature)..:	File administrators Anna Hu
Supervised by (position+printed name+signature)..:	Technique principal Hugo Chen
Approved by (position+printed name+signature)..:	Manager Andy Zhang
Date of issue.....:	2024/1/30

Testing Laboratory Name.....:	Shenzhen Tongzhou Testing Co.,Ltd
Address .....:	1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China

Applicant's name.....:	**Shenzhen Wanbo Technology Co., Ltd.**
Address .....:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China

Test specification .....**:**	
Standard .....:	**ETSI EN 301 893 V2.1.1 (2017-05)**
TRF Originator.....:	Shenzhen Tongzhou Testing Co.,Ltd
Master TRF.....:	Dated 2024-01

Test item description .....:	**Wanbo Projector**
Trade Mark .....:	Wanbo
Model/Type reference.....:	WPC24
List Model .....:	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Hardware Version.....:	KSOC_352_S2_WB
Software Version .....:	wanbo-WPC24-KGHE
Ratings .....:	AC 100-240V 50/60Hz 2A(Max)
Result.....:	**PASS**

TEST REPORT

Test Report No. :	TZ240105305-WLAN2	2024/1/30 Date of issue

Equipment under Test	:	Wanbo Projector
Model /Type	:	WPC24
Listed Models	:	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Applicant	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Manufacturer	:	Shenzhen Wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2 Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China

Test Result:	**PASS**

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.

** Modifited History **

Revision	Description	Issued Data	Remark
Revision 00	Initial Test Report Release	2024/1/30	Andy Zhang

Contents

1. TEST STANDARDS

The tests were performed according to following standards:

ETSI EN 301 893 V2.1.1 (2017-05)
5 GHz RLAN;
Harmonised Standard covering the essential requirements
of article 3.2 of Directive 2014/53/EU

2. SUMMARY

2.1. General Remarks

Date of receipt of test sample	:	2024/1/11
Testing commenced on	:	2024/1/11
Testing concluded on	:	2024/1/29

2.2. Product Description

The Shenzhen Wanbo Technology Co., Ltd.'s Model: WPC24 or the "EUT" as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

Name of EUT	Wanbo Projector
Model(s) Number	WPC24
List Model	WPD11，Dali 1，WPL11，EVA，WPC21，V1，DaVinci 1，DaVinci 1 Pro，WPA31，WPA34，X2 Max
Difference description	All the same except for the model name
Hardware version	KSOC_352_S2_WB
Software version	wanbo-WPC24-KGHE

2.3. Wireless Function Tested in this report

Wireless Type	Working Frequency	Modulation Type
WLAN(5G)	5180MHz to 5240MHz	IEEE 802.11n :OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11a:OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11ac:OFDM (256QAM, 64QAM, 16QAM, QPSK,BPSK)

2.4. Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	120V / 60 Hz	○	115V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

AC 230V by adapter

Support band(s)

Frequency Band(MHz)	5150-5250	5250-5350	5470-5725	5725-5850
802.11a	√	—	—	√
802.11b	—	—	—	—
802.11g	—	—	—	—
802.11n HT20	√	—	—	√
802.11n HT40	√	—	—	√

Description of the test mode

For 5.18GHz – 5.32GHz Band

4 channels are provided for 802.11a/802.11n HT20/802.11ac VHT20

Channel	Frequency(MHz)	Channel	Frequency(MHz)
36	5180	44	5220
40	5200	48	5240

2 channels are provided for 802.11n HT40/802.11ac VHT40

Channel	Frequency(MHz)	Channel	Frequency(MHz)
38	5190	46	5230

1 channel are provided for 802.11ac VHT80

Channel	Frequency(MHz)
42	5210

Test Frequency List

Modulation Type	Test Frequency					
	Lowest		Middle		Highest	
	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
802.11a	36	5180	40	5200	48	5240
802.11n HT20	36	5180	40	5200	48	5240
802.11n HT40	38	5200	40	5200	46	5230
802.11ac VHT20	36	5180	40	5200	48	5240
802.11ac VHT40	38	5200	40	5200	46	5230
802.11ac VHT80	-	-	42	5210	-	-

2.5. EUT Classification:

Type of equipment:	☒	stand alone equipment	
	☐	plug in radio equipment	
	☐	combined equipment	
Modulation types:	☒	Wide Band Modulation (None Hopping – e.g. DSSS, OFDM)	
	☐	Frequency Hopping Spread Spectrum (FHSS)	
Adaptive equipment:	☒	Yes, LBT-based	☐ Frame Based Equipment
			☒Load Based Equipment
	☐	Yes, non-LBT-based	
	☐	Yes (but can be disabled)	
	☐	No	
	☒	q value	16
	☐	COT value	
	☒	CCA value	34μs
Antennas and transmit operating modes:	☒	Operating mode 1 (single antenna)	
		Equipment with 1 antenna, Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used, Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)	
	☐	Operating mode 2 (multiple antennas, no beamforming)	
		Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.	
	☐	Operating mode 3 (multiple antennas, with beamforming)	
		Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming. In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.	

2.6. EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - supplied by the lab

/	/	/	/
/	/	/	/
/	/	/	/

2.7. Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version	Date of receipt	Type of Test
TZ240105305-1#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	Radio
TZ240105305-2#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	SAR (EMF)
TZ240105305-3#	N/A	KSOC_352_S2_WB	wanbo-WPC24-KGHE	2024/1/30	EMC

2.8. Modifications

No modifications were implemented to meet testing criteria.

3. TEST ENVIRONMENT

3.1. Address of the test laboratory

Shenzhen Tongzhou Testing Co.,Ltd

1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 (2014) and CISPR Publication 22.

3.2. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature: 25 °C
High Temperature/HT: 35℃
Low Temperature/LT: 0℃
Normal Voltage: AC 230V
High Voltage/HV: AC 264V
Low Voltage/LV: AC 90V
Relative Humidity: 55 %
Air Pressure: 989 hPa

3.3. Test Description

3.3.1 Main Terms

Verdict	Verdict of each test cases.
Test Case	Test cases identification number and description in 3GPP test specification and ETSI specification.

3.3.2 Terms used in Condition column

NTC	Normal voltage, Normal Temperature
HV	High voltage, Normal Temperature
LV	Low voltage, Normal Temperature
HT	High Temperature, Normal voltage
LT	Low Temperature, Normal voltage
HTHV	High voltage, High Temperature
LTHV	High voltage, Low Temperature
HTLV	Low voltage, High Temperature
LTLV	Low voltage, Low Temperature
Vib	Vibration

3.3.3 Terms used in Verdict column

Pass	This test cases has been tested, and EUT is conformant to the applied standards in the given frequency band.
Fail	This test cases has been tested, but EUT is not conformant to the applied standards in the given frequency band.
N/A	This test case is either not required/not applicable in the specified band or is not applicable according to the specific PICS/PIXIT for the EUT.
Inc	Test case result is ambiguous in the given frequency band.
Decl	Declaration is received from the client to demonstrate the conformity to the relevant specification in the given frequency band.
BR	This test cases is not tested in the given frequency band, but this testcases was tested with pass result for the initial model in the given frequency band.

3.3.4 Sumarry of measurement results

☒ **No deviations from the technical specifications were ascertained**
☐ **There were deviations from the technical specifications ascertained**

Test Specification Clause	Test Case	Test Condition	Mode	Pass	Fail	N/A	NP	Remark
5.4.2	Centre frequencies	NTC	☒802.11a ☒802.11n ☒802.11ac	☒	☐	☐	☐	1
		HVLT		☐	☐	☐	☐	1
		HVHT		☐	☐	☐	☐	1
		LVLT		☐	☐	☐	☐	1
		LVHT		☐	☐	☐	☐	1
5.4.3	Nominal Channel Bandwidth and Occupied Channel Bandwidth	NTC	☒802.11a ☒802.11n ☒802.11ac	☒	☐	☐	☐	1
5.4.4	RF output power, Transmit Power Control (TPC) and power density	NTC	☒802.11a ☒802.11n ☒802.11ac	☒	☐	☐	☐	1
		HVLT		☐	☐	☐	☐	1
		HVHT		☐	☐	☐	☐	1
		LVLT		☐	☐	☐	☐	1
		LVHT		☐	☐	☐	☐	1
5.4.5	Transmitter unwanted emissions outside the 5 GHz RLAN bands	NTC	☒802.11a ☒802.11n ☒802.11ac	☒	☐	☒	☐	1
5.4.6	Transmitter unwanted emissions within the 5 GHz RLAN bands	NTC	☒802.11a ☒802.11n ☒802.11ac	☒	☐	☐	☐	1
5.4.7	Receiver spurious emissions	NTC	☒802.11a ☒802.11n ☒802.11ac	☒	☐	☐	☐	1
5.4.8	Dynamic Frequency Selection (DFS)	NTC	☒802.11a ☒802.11n ☒802.11ac	☐	☐	☒	☐	1
5.4.9	Adaptivity (channel access mechanism)	NTC	☒802.11a ☒802.11n ☒802.11ac	☒	☐	☐	☐	1
5.4.10	Receiver Blocking	NTC	☒802.11a ☒802.11n ☒802.11ac	☒	☐	☐	☐	1

Test Specification Clause	Test Case	Test Condition	Mode	Pass	Fail	N/A	NP	Remark
--	User Access Restrictions	--	--	☒	☐	☐	☐	1,2
--	Geo-location capability	--	--	☐	☐	☒	☐	1,3

Remark:
1. The measurement uncertainty is not included in the test result.
2. Users can not modify the Pivotal system software and hardware of the EUT, meet the User Access Restrictions requirements
3. The EUT does not support Geo-location capability. This test case does not apply this kind of EUT

3.4. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics;Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics;Part 2 " and is documented in the Shenzhen Tongzhou Testing Co.,Ltd quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Shenzhen Tongzhou Testing Co.,Ltd is reported:

Test Items	Measurement Uncertainty	Notes
Frequency error	5.2 ppm	(1)
Transmitter power conducted	0.57 dB	(1)
Transmitter power Radiated	4.30 dB	(1)
Conducted spurious emission	1.60 dB	(1)
Radiated spurious emission	4.30 dB	(1)
Humidity	2.0 %	(1)
Temperature	0.3 ℃	(1)
Time	2.0 %	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=1.96.

3.5. Equipments Used during the Test

Conducted Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
2	Signal Generator	Keysight	N5182A	MY4620709	2024/1/4	2025/1/3
3	Signal Generator	R&S	SML03	102924/0013	2024/1/4	2025/1/3
4	Power Sensor	Agilent	U2021XA	MY5365004	2024/1/4	2025/1/3
5	Power Meter	Agilent	U2531A	TW53323507	2024/1/4	2025/1/3
6	Climate Chamber	KRUOMR	KRM-1000	KRM16072901	2024/1/4	2025/1/3
7	Wideband Radio Communication Tester	R&S	CMW500	101855	2024/1/4	2025/1/3
8	Test Software	Tonscend	JS1120-3	V3.2.22	--	--

Radiated Method						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	Wideband Antenna	schwarzbeck	VULB 9163	958	2022/11/13	2025/11/12
2	Horn Antenna	schwarzbeck	BBHA 9120D	01989	2022/11/13	2025/11/12
3	EMI Test Receiver	R&S	ESCI	100849/003	2024/1/4	2025/1/3
4	Controller	MF	MF7802	N/A	N/A	N/A
5	Amplifier	schwarzbeck	BBV 9743	209	2024/1/4	2025/1/3
6	Amplifier	Tonscend	TSAMP-0518SE	--	2024/1/4	2025/1/3
7	RF Cable	HUBER+SUHNER	RG214	N/A	2024/1/4	2025/1/3
8	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2024/1/4	2025/1/3
9	Horn Antenna	ETS	3117	00218874	2022/11/13	2025/11/12
10	Wideband Antenna	Sunol	JB3	A020115	2022/7/3	2025/7/2
11	Test Software	Tonscend	JS36-RSE	V5.0.0.0	--	--

4. TEST CONDITIONS AND RESULTS

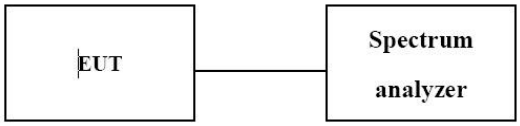
4.1. ETSI EN 301 893 REQUIREMENTS

4.1.1. Nominal Centre frequencies

LIMIT

ETSI EN 301 893 (V2.1.1) Sub-clause 4.2.1.3
The actual centre frequency for any given channel declared by the manufacturer shall be maintained within the range f_c ± 20 ppm.

TEST CONFIGURATION



TEST PROCEDURE

Please refer to ETSI EN 301 893 (V2.1.1) §5.4.2.2.1

☒ **Equipment operating without modulation**
This test method requires that the UUT can be operated in an unmodulated test mode.
The UUT shall be connected to a suitable frequency measuring device (e.g. a frequency counter or a spectrum analyser) and operated in an unmodulated mode.
The result shall be recorded.

☐ **Equipment operating with modulation**
This method is an alternative to the above method in case the UUT cannot be operated in an un-modulated mode.
The UUT shall be connected to spectrum analyser.
Max Hold shall be selected and the centre frequency adjusted to that of the UUT.
The peak value of the power envelope shall be measured and noted. The span shall be reduced and the marker moved in a positive frequency increment until the upper, (relative to the centre frequency), -10 dBc point is reached. This value shall be noted as f1.
The marker shall then be moved in a negative frequency increment until the lower, (relative to the centre frequency), -10 dBc point is reached. This value shall be noted as f2.
The centre frequency is calculated as (f1 + f2) / 2.

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Test Condition	TestMode	Channel	Result[ppm]	Limit[ppm]	Verdict
NTNV	11A	5180	1.439	±20	PASS
	11N40SISO	5190	6.284	±20	PASS
	11AC80SISO	5210	1.485	±20	PASS
LTNV	11A	5180	1.628	±20	PASS
	11N40SISO	5190	1.57	±20	PASS
	11AC80SISO	5210	9.213	±20	PASS
HTNV	11A	5180	9.153	±20	PASS
	11N40SISO	5190	3.047	±20	PASS
	11AC80SISO	5210	4.491	±20	PASS

4.1.2. Occupied Channel Bandwidth

LIMIT

ETSI EN 301 893 (V2.1.1) Sub-clause 4.2.2.2
The Nominal Channel Bandwidth for a single Operating Channel shall be 20 MHz.
Alternatively, equipment may implement a lower Nominal Channel Bandwidth with a minimum of 5 MHz, providing they still comply with the Nominal Centre Frequencies defined in clause 4.2.1 (20 MHz raster).
The Occupied Channel Bandwidth shall be between 80 % and 100 % of the Nominal Channel Bandwidth. In case of smart antenna systems (devices with multiple transmit chains) each of the transmit chains shall meet this requirement.
The Occupied Channel Bandwidth might change with time/payload.
During a Channel Occupancy Time (COT), equipment may operate temporarily with an Occupied Channel Bandwidth of less than 80 % of its Nominal Channel Bandwidth with a minimum of 2 MHz.

TEST PROCEDURE

According to ETSI EN 301 893 V2.1.1 (2017-05) clause 5.4.3.2.1, conducted method.
The test procedure shall be as follows:
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 Bandwidth: 100 kHz
- Video Bandwidth: 300 kHz
- Frequency Span: 2 × Nominal Bandwidth (e.g. 40 MHz for a 20 MHz channel)
- Sweep time: > 1 s; for larger Nominal Bandwidths, the sweep time may be increased until a value where the sweep time has no impact on the RMS value of the signal
- Detector Mode: RMS
- Trace Mode: Max Hold

Step 2:
• Wait for the trace to stabilize.
Step 3:
• 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.
• Use the 99 % bandwidth function of the spectrum analyser to measure the Occupied Channel Bandwidth of the UUT. This value shall be recorded.
The measurement described in step 1 to step 3 above shall be repeated in case of simultaneous transmissions in non-adjacent channels

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

TestMode	Antenna	Freq(MHz)	OCB[MHz]	Limit[MHz]	Verdict
11A	Ant1	5180	16.360	16 to 20	PASS
11N20SISO	Ant1	5180	17.578	16 to 20	PASS
11N40SISO	Ant1	5190	36.015	32 to 40	PASS
11AC20SISO	Ant1	5180	17.572	16 to 20	PASS
11AC40SISO	Ant1	5190	35.996	32 to 40	PASS
11AC80SISO	Ant1	5210	74.571	64 to 80	PASS

4.1.3. RF Output Power, Transmit Power Control (TPC) and Power Density

LIMIT

According to ETSI EN 301 893 V2.1.1 (2017-05) clause 4.2.3.2
-Limits for RF output power and power density at the highest power level

TPC is not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.
For devices with TPC, the RF output power and the Power Density when configured to operate at the highest stated power level (P_H) of the TPC range shall not exceed the levels given in table 2.
Devices are allowed to operate without TPC. See table 2 for the applicable limits that shall apply in this case.

Table 1: Mean e.i.r.p. limits for RF output power and power density at the highest power level

Table 2: Mean e.i.r.p. limits for RF output power and Power Density at the highest power level (P_H)

Frequency range (MHz)	Mean e.i.r.p. limit for P_H (dBm)		Mean e.i.r.p. density limit (dBm/MHz)	
	with TPC	without TPC	with TPC	without TPC
5 150 to 5 350	23	20/23 (see note 1)	10	7/10 (see note 2)
5 470 to 5 725	30 (see note 3)	27 (see note 3)	17 (see note 3)	14 (see note 3)
NOTE 1: The applicable limit is 20 dBm, except for transmissions whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz, in which case the applicable limit is 23 dBm.				
NOTE 2: The applicable limit is 7 dBm/MHz, except for transmissions whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz, in which case the applicable limit is 10 dBm/MHz.				
NOTE 3: Slave devices without a *Radar Interference Detection* function shall comply with the limits for the frequency range 5 250 MHz to 5 350 MHz.				

According to ETSI EN 301 893 V2.1.1 (2017-05) clause 4.2.3.2.3
-Limit for RF output power at the lowest power level of the TPC range
For devices using TPC, the *RF Output Power* during a transmission burst when configured to operate at the lowest stated power level (P_L) of the TPC range shall not exceed the levels given in table 3. For devices without TPC, the limits in table 3 do not apply.

Table 3: Mean e.i.r.p. limits for RF Output Power at the lowest power level of the TPC range

Frequency range	Mean e.i.r.p. (dBm) limit for P_L
5 250 MHz to 5 350 MHz	17
5 470 MHz to 5 725 MHz	24 (see note)
NOTE: Slave devices without a *Radar Interference Detection* function shall comply with the limits for the band 5 250 MHz to 5 350 MHz.	

TEST PROCEDURE

Please refer to ETSI EN 301 893 (V2.1.1) Sub-clause 5.3.4

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Power

Test Condition	Test Mode	Antenna	Freq(MHz)	TPC	EIRP [dBm]	EIRP Limit [dBm]	Verdict
NTNV	11A	Ant1	5180	NA	14.70	23	PASS
	11N20SISO	Ant1	5180	NA	14.50	23	PASS
	11N40SISO	Ant1	5190	NA	14.53	23	PASS
	11AC20SISO	Ant1	5180	NA	14.05	23	PASS
	11AC40SISO	Ant1	5190	NA	14.63	23	PASS
	11AC80SISO	Ant1	5210	NA	14.88	23	PASS
LTNV	11A	Ant1	5180	NA	14.81	23	PASS
	11N20SISO	Ant1	5180	NA	14.45	23	PASS
	11N40SISO	Ant1	5190	NA	13.83	23	PASS
	11AC20SISO	Ant1	5180	NA	14.56	23	PASS
	11AC40SISO	Ant1	5190	NA	13.93	23	PASS
	11AC80SISO	Ant1	5210	NA	14.49	23	PASS
HTNV	11A	Ant1	5180	NA	14.54	23	PASS
	11N20SISO	Ant1	5180	NA	14.41	23	PASS
	11N40SISO	Ant1	5190	NA	14.14	23	PASS
	11AC20SISO	Ant1	5180	NA	14.11	23	PASS
	11AC40SISO	Ant1	5190	NA	14.67	23	PASS
	11AC80SISO	Ant1	5210	NA	15.03	23	PASS

Power Density:

TestMode	Antenna	Freq(MHz)	EIRP PSD [dBm/MHz]	Limit [dBm]	Verdict
11A	Ant1	5180	1.51	10	PASS
11N20SISO	Ant1	5180	1.27	10	PASS
11AC20SISO	Ant1	5180	0.91	10	PASS

4.1.4. Transmitter Unwanted Emissions Outside the 5 GHz RLAN Bands

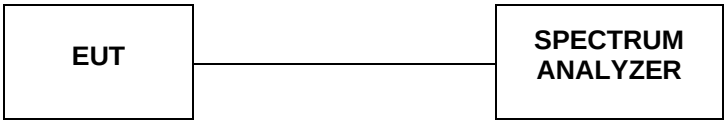
LIMIT

ETSI EN 301 893 (V2.1.1) Sub-clause 4.5.1.2
The level of unwanted emission shall not exceed the limits given in table 3.

Transmitter unwanted emission limits outside the 5 GHz RLAN bands

Frequency range	Maximum power	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 5,15 GHz	-30 dBm	1 MHz
5,35 GHz to 5,47 GHz	-30 dBm	1 MHz
5,725 GHz to 26 GHz	-30 dBm	1 MHz

TEST CONFIGURATION



TEST PROCEDURE

☒**According to ETSI EN 301 893 V2.1.1 (2017-05) clause5.4.5.2.1 Conducted measurement**
☒**According to ETSI EN 301 893 V2.1.1 (2017-05) clause5.4.5.2.2 Radiated measurement**

TEST RESULTS
Remark: We test all modulation type, and recorded the worst case.

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Tony Luo

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

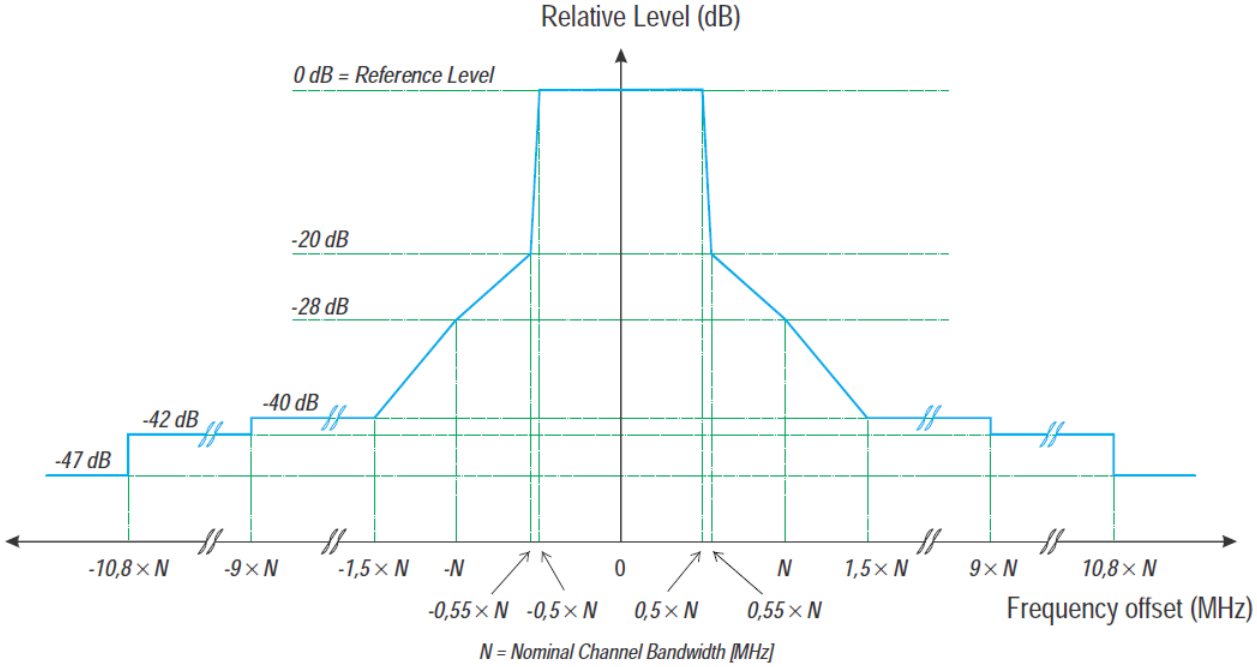
Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
676.83	V	-60.83	-54	6.83	PASS
673.82	H	-62.05	-54	8.05	PASS
Above 1GHz:					
Test Mode: Low Channel					
10360	H	-45.52	-30	15.52	PASS
10360	V	-46.81	-30	16.81	PASS
15540	H	-48.02	-30	18.02	PASS
15540	V	-46.20	-30	16.20	PASS
20720	H	-48.81	-30	18.81	PASS
20720	V	-49.55	-30	19.55	PASS
Test Mode: High Channel					
10480	H	-42.00	-30	12.00	PASS
10480	V	-43.64	-30	13.64	PASS
15720	H	-42.91	-30	12.91	PASS
15720	V	-42.73	-30	12.73	PASS
20960	H	-46.35	-30	16.35	PASS
20960	V	-47.74	-30	17.74	PASS

Note:
1. Cable loss and antenna gain was combined in the calculated result.
2. No record for margin above 20dB.

4.1.5. Transmitter Unwanted Emissions Within the 5 GHz RLAN Bands

LIMIT

According to ETSI EN 301 893 V2.1.1 (2017-05) clause 4.2.4.2.2



NOTE: dBc is the spectral density relative to the maximum spectral power density of the transmitted signal.

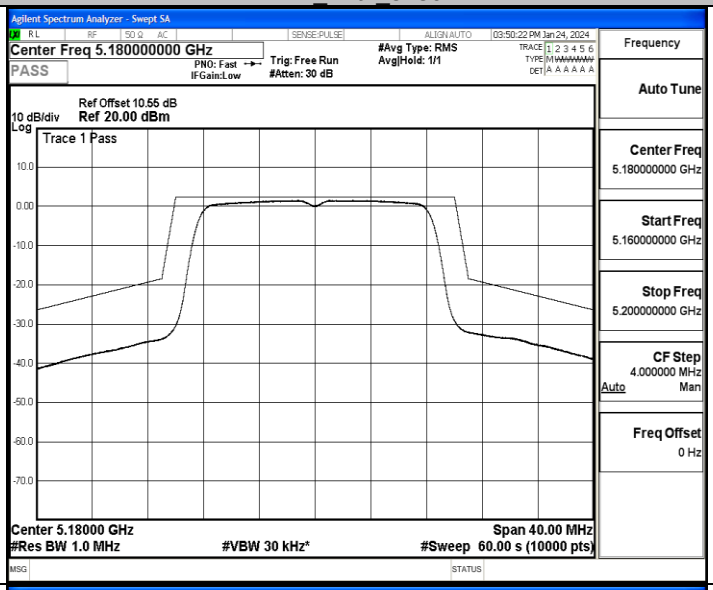
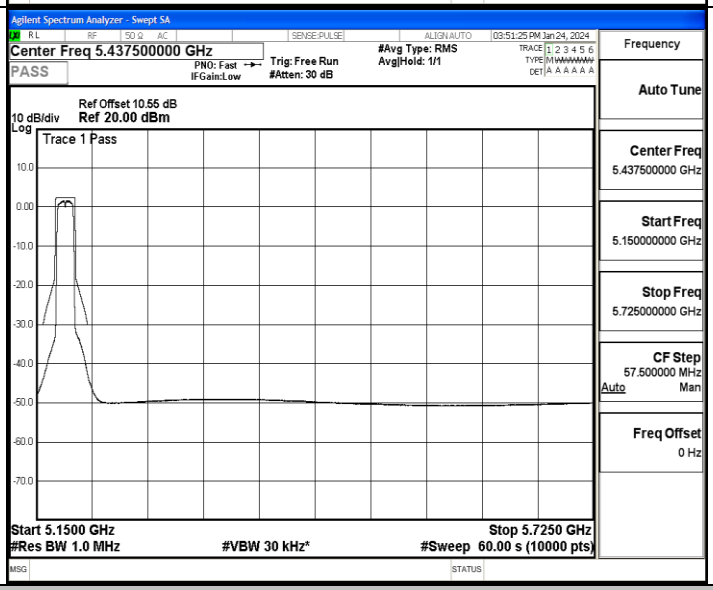
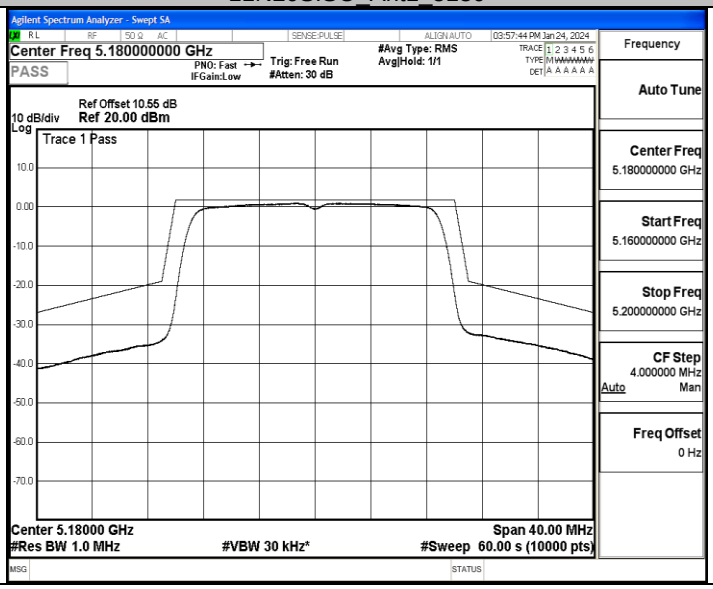
TEST PROCEDURE

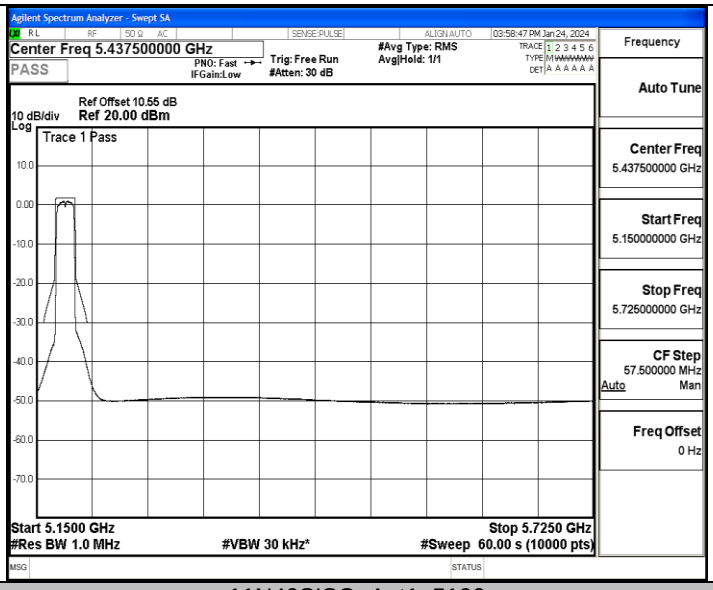
According to ETSI EN 301 893 V2.1.1 (2017-05) § 5.3.6.2.1 Conducted measurement
Step 1: Determination of the reference average power level.
Spectrum analyser settings:
- Resolution bandwidth: 1 MHz
- Video bandwidth: 30 kHz
- Detector mode: RMS
- Trace mode: Max Hold
- Sweep Time: 60000ms
- Centre Frequency: Centre frequency of the channel being tested
- Span: 2 × Nominal Channel Bandwidth

Use the marker to find the highest average power level of the power envelope of the UUT. This level shall be used as the reference level for the relative measurements.
Step 2: Determination of the relative average power levels.
Adjust the frequency range of the spectrum analyser to allow the measurement to be performed within the sub-bands 5 150 MHz to 5 350 MHz and 5 470 MHz to 5 725 MHz. No other parameter of the spectrum analyser should be changed.
Compare the relative power envelope of the UUT with the limits defined in clause 4.2.4.2.2.

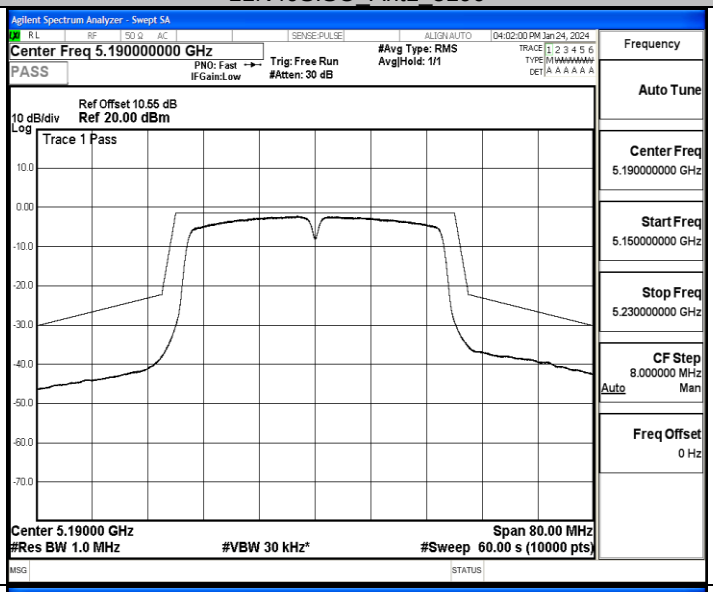
TEST RESULTS

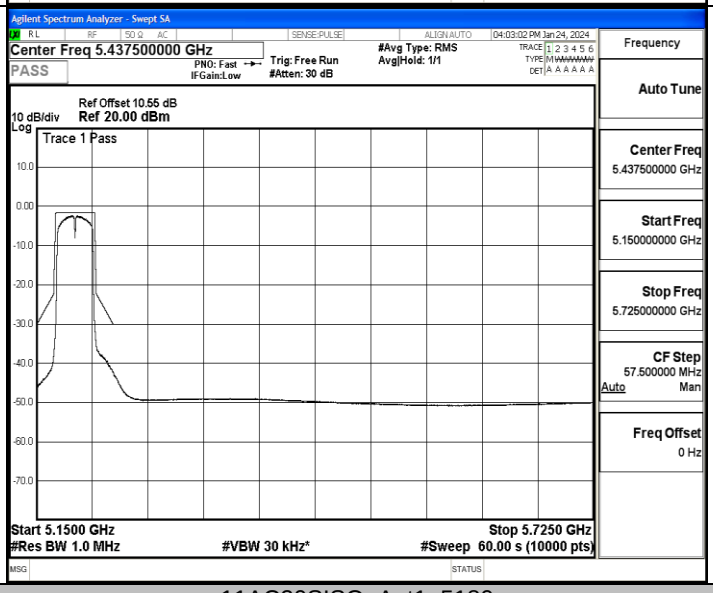
Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

11A_Ant1_5180


11N20SISO_Ant1_5180


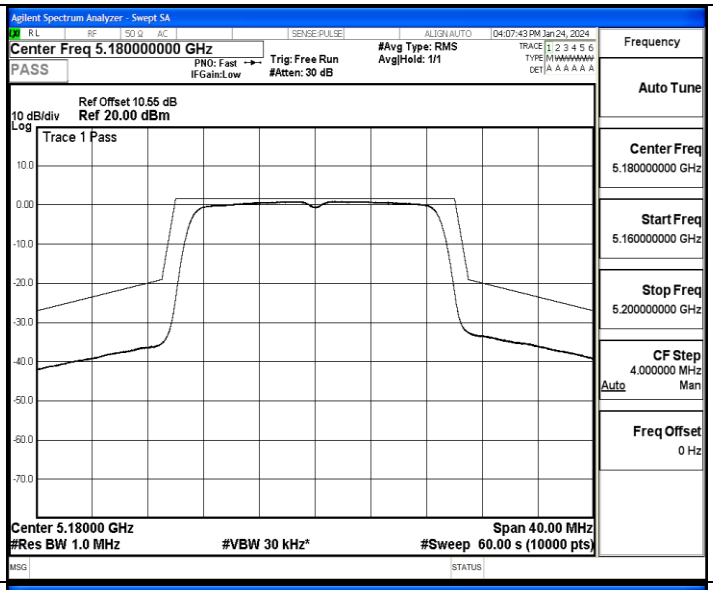


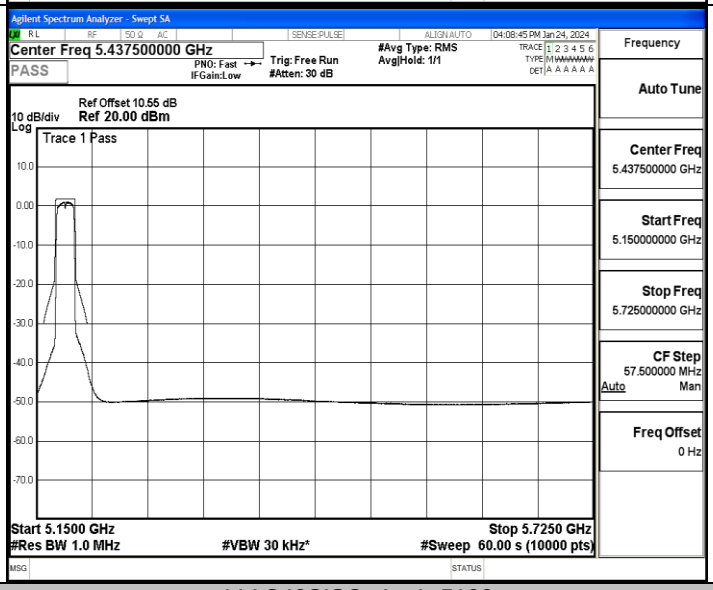
11N40SISO_Ant1_5190



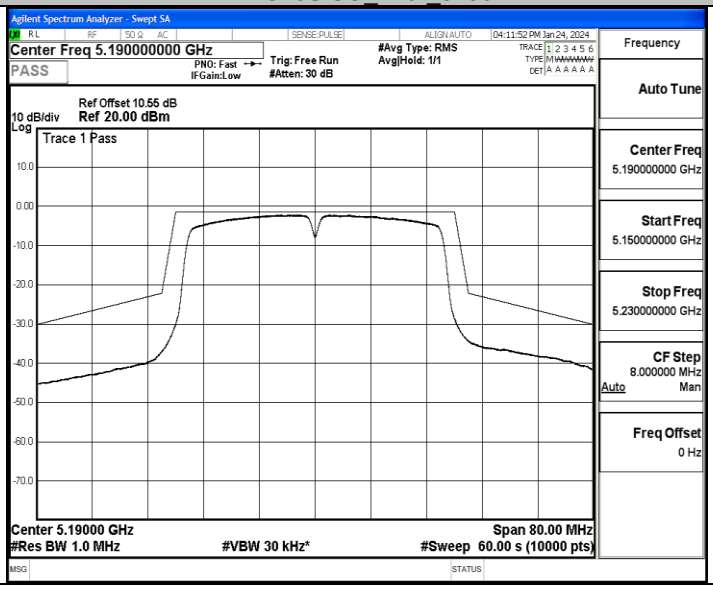


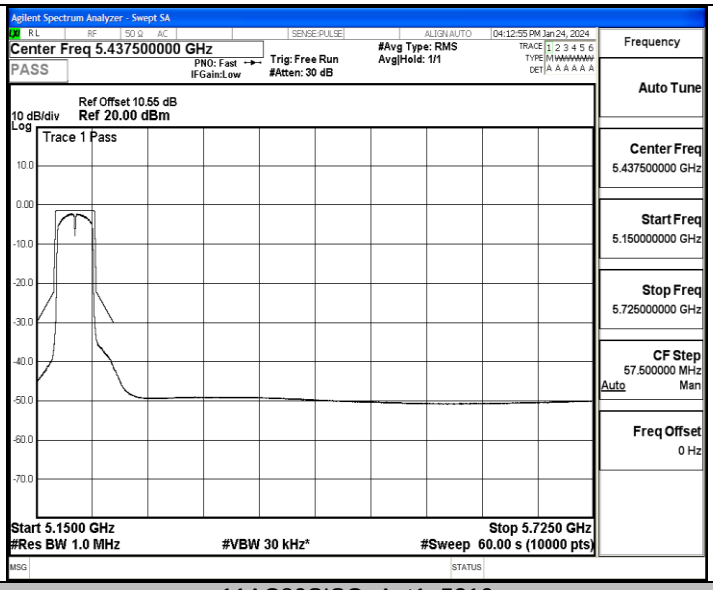
11AC20SISO_Ant1_5180



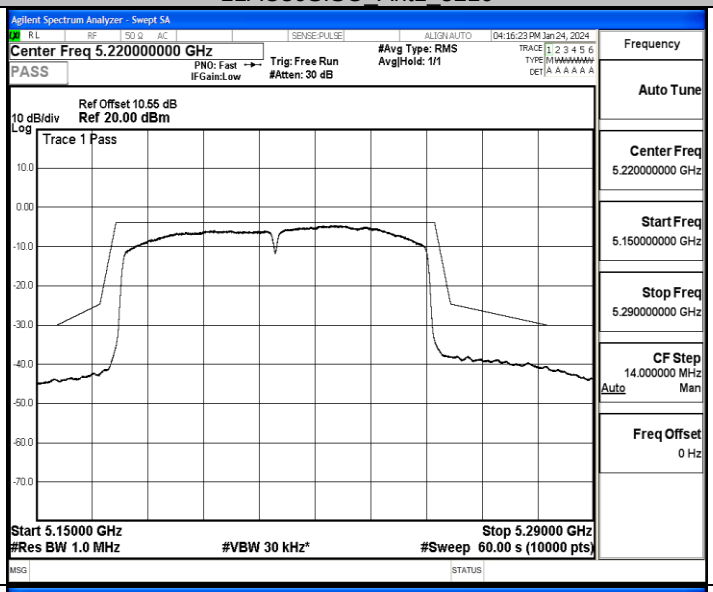


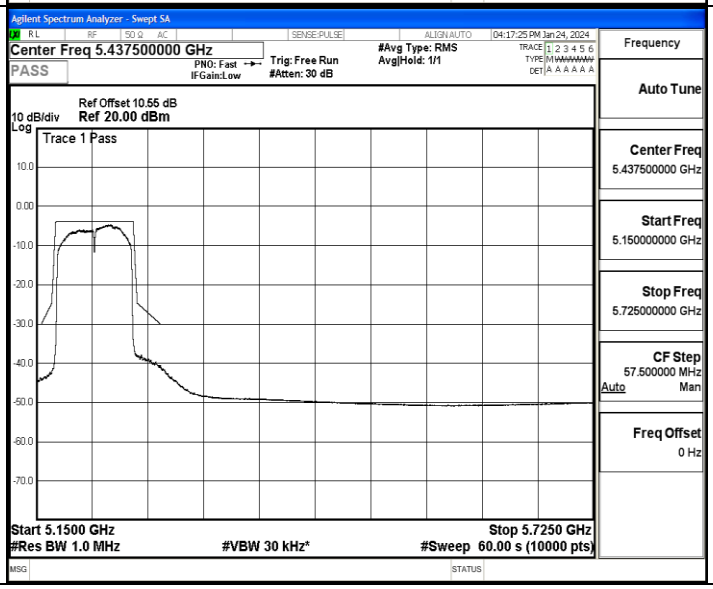
11AC40SISO_Ant1_5190





11AC80SISO_Ant1_5210





4.1.6. Receiver Spurious Emissions

LIMIT

ETSI EN 301 893 (V2.1.1) Sub-clause 4.6.2
The spurious emissions of the receiver shall not exceed the limits given in table 4.

Table 4: Spurious radiated emission limits

Frequency range	Maximum power	Measurement bandwidth
30 MHz to 1 GHz	-57 dBm	100 kHz
1 GHz to 26 GHz	-47 dBm	1 MHz

TEST PROCEDURE

Please refer to ETSI EN 301 893 (V2.1.1) Sub-clause 5.4.6

TEST RESULTS

Temperature:	22.8°C
Humidity:	56%
Test Engineer:	Tony Luo

Note: This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit (dBm)	Margin (dB)	Conclusion
Below 1GHz:					
463.76	V	-66.17	-57	9.17	PASS
898.58	H	-65.71	-57	8.71	PASS
Above 1GHz:					
Test Mode：Lowest frequency					
5264.74	H	-55.72	-47	8.72	PASS
5264.74	V	-58.36	-47	11.36	PASS
12387.18	H	-55.48	-47	8.48	PASS
12387.18	V	-57.97	-47	10.97	PASS
Test Mode： Highest frequency					
5747.91	H	-58.74	-47	11.74	PASS
5747.91	V	-57.85	-47	10.85	PASS
11931.12	H	-57.82	-47	10.82	PASS
11931.12	V	-59.84	-47	12.84	PASS
Note: 1. Cable loss and antenna gain was combined in the calculated result. 2. No record for margin above 20dB.					

4.1.7. Adaptivity (Channel Access Mechanism)

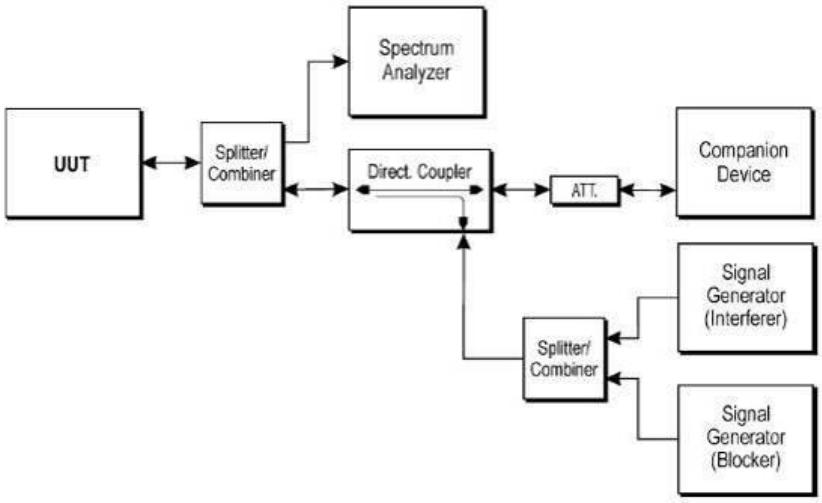
LIMIT

ETSI EN 301 893 (V2.1.1) Sub-clause 4.9.2

Adaptivity Limit

Frame Based Equipment: 1 Minimum Clear Channel Assessment (CCA) time = 20 us; 2 CCA observation time declared by the supplier; 3 COT = 1~10 ms; 4 Idle Period = 5% of COT; 5 TL = -73 dBm/MHz + 23 - PH (assuming a 0 dBi receive antenna and PH specified in dBm e.i.r.p.);
Load Based Equipment: 1 Minimum Clear Channel Assessment (CCA) time = 20 us; 2 CCA declared by the manufacturer; 3 COT ≤ 6ms; 4 R = number of clear idle slots are randomly [1~q]. Every time an Extended CCA is required and the 'R' value stored in a counter; 5 TL = -73 dBm/MHz + 23 - PH (assuming a 0 dBi receive antenna and PH specified in dBm e.i.r.p.);
Short Control Signalling Transmissions: Short Control Signalling Transmissions shall have a maximum duty cycle of 10% within an observation period of 50ms.

TEST BLOCK DIAGRAM



TEST PROCEDURE

Please refer to ETSI EN 301 893 (V2.1.1) Sub-clause 5.3.9

Step 1:

• The UUT may connect to a companion device during the test. The signal generator, spectrum analyser, UUT and the companion device are connected using a Set-up equivalent to the example given by figure 13 although the signal generator does not generate any signals at this point in time. The spectrum analyser is used to monitor the transmissions of the UUT in response to the interference signal.

• The received signal level (wanted signal from the companion device) at the UUT shall be sufficient to maintain a reliable link for the duration of the test.

• The analyser shall be set as follows:

- 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: > Channel Occupancy Time
- Trace Mode: Clear/Write
- Trigger Mode: Video or External

Step 2:
• Configure the UUT for normal transmissions with a sufficiently high payload (transmitter activity ratio > 30 %) to allow demonstration of compliance of the adaptive mechanism on the channel being tested.
• For Frame Based Equipment, using the procedure defined in clause 5.3.9.2.2, it shall be verified that the UUT complies with the maximum Channel Occupancy Time and the minimum Idle Period defined in clause 4.9.2.1.
• For Load Based equipment, using the procedure defined in clause 5.3.9.2.2, it shall be verified that the UUT complies with the maximum Channel Occupancy Time defined in clause 4.9.2.2. It shall also be verified (if necessary by repeating the test) that the measured Idle Period varies between CCA and q × CCA as defined in clause 4.9.2.2.
NOTE 1: For IEEE 802.11 [9] equipment (see first paragraph of clause 4.9.2.2) the Idle Period and the maximum Channel Occupancy Time are as defined for other types of Load Based Equipment (see clause 4.9.2.2 points 2 and 3). The CCA observation time is declared by the manufacturer (see clause 5.3.1.q)).

Step 3: Adding the interference signal.
• A 100 % duty cycle interference signal is injected on the current operating channel of the UUT. This interference signal shall be a band limited noise signal which has a flat power density (maximum ripple ±1,5 dB), and shall have a bandwidth of at least 10 MHz. The total power level of this interference signal shall be equal to the power density value defined in clause 4.9.2.1 point 5 or clause 4.9.2.2 point 5, multiplied by the Occupied Channel Bandwidth of the UUT.

Step 4: Verification of reaction to the interference signal.
• The spectrum analyser shall be used to monitor the transmissions of the UUT on the selected operating channel after the interference signal was injected. This may require the spectrum analyser sweep to be triggered by the start of the interfering signal.
• Using the procedure defined in clause 5.3.9.2.2, it shall be verified that:
i) The UUT stops transmissions on the current operating channel.
NOTE 2: The UUT is assumed to stop transmissions within a period equal to the maximum Channel Occupancy Time defined in clause 4.9.2.1 for Frame Based Equipment or clause 4.9.2.2 for Load Based Equipment. The UUT is allowed to have Short Control Signalling Transmissions on the current operating channel (see ii) and iii).
NOTE 3: For equipment having simultaneous transmissions on multiple (adjacent or non-adjacent) operating channels, the equipment is allowed to continue transmissions on other Operating Channels.
ii) Apart from Short Control Signalling Transmissions there shall be no subsequent transmissions while the interfering signal is present.
iii) The Short Control Signalling Transmissions shall comply with the limits defined in clause 4.9.2.3.
NOTE 4: The verification of the Short Control Signalling transmissions may require the analyser settings to be changed (e.g. sweep time).
NOTE 5: On removal of the interference signal the UUT may start transmissions again on this channel however this is not a requirement and therefore does not require testing.

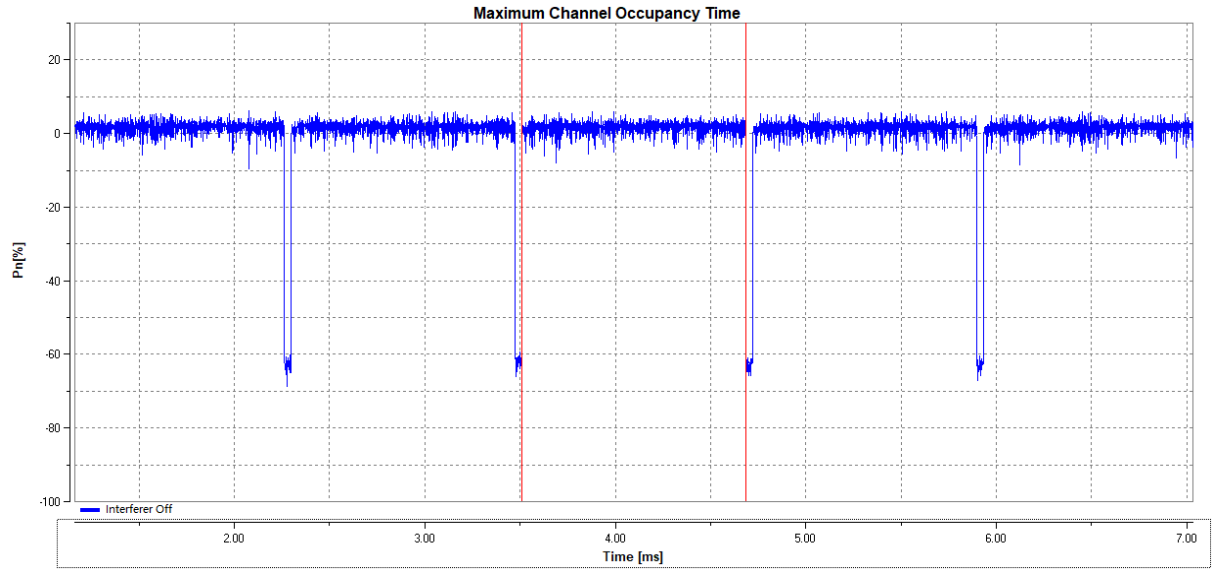
Step 5:
• The steps 2 to 4 shall be repeated for each of the channels to be tested.

TEST RESULTS

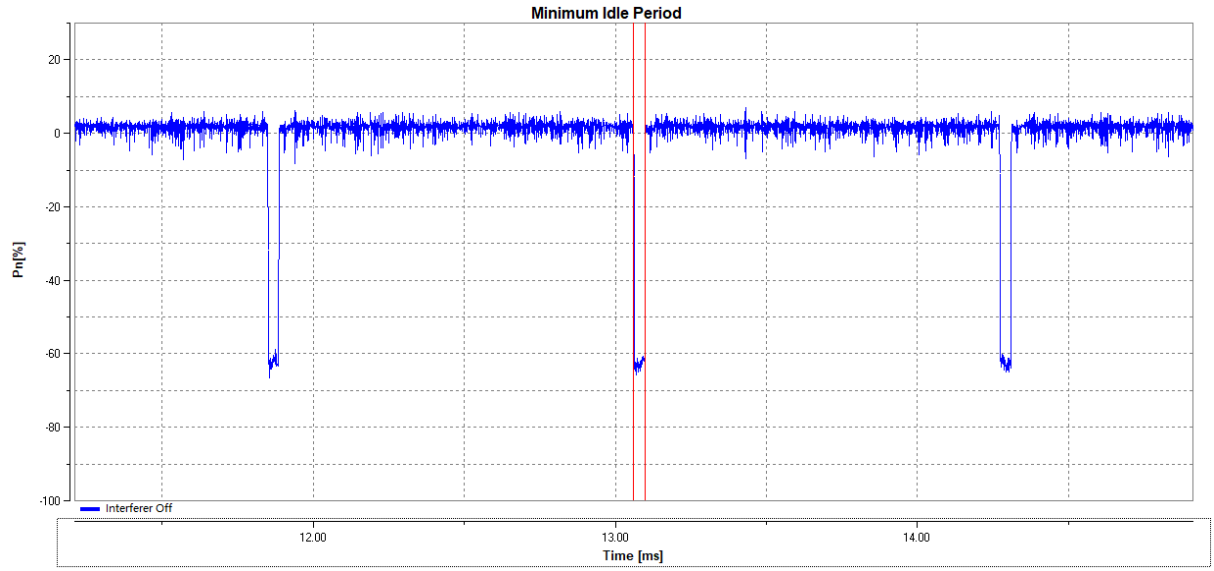
Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

Test Condition	Test Mode	Test Channel	Ant	Priority Class	COT Num[n]	Max. COT [ms]	Limit [ms]	Min. Idel Time [ms]	Limit [ms]	Idle Period probability	Verdict
TNVN	11A	5180	Ant1	2	879	1.182	<=6	0.035	>0.027	See test plot	PASS

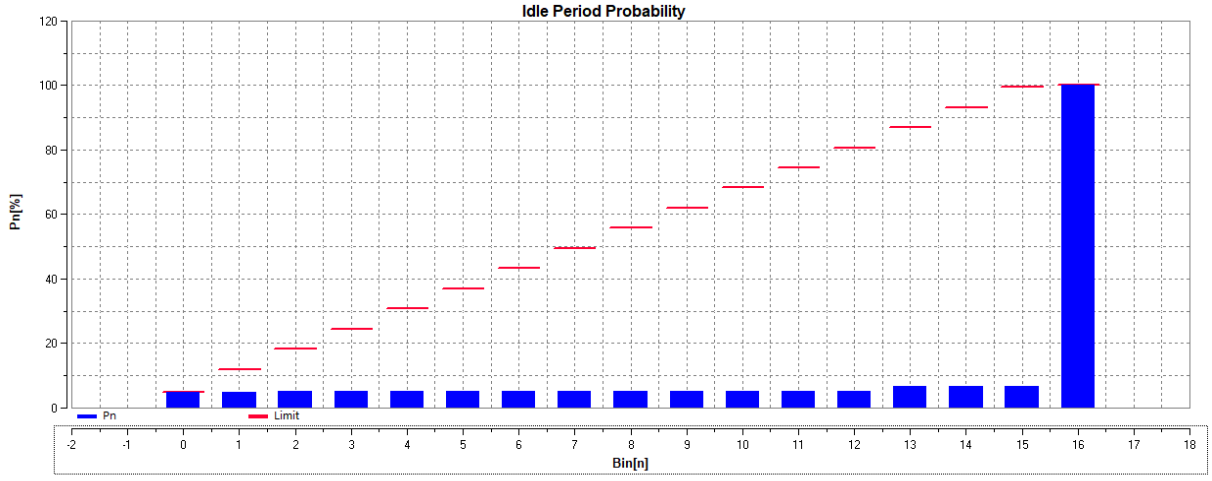
Adaptivity_Max.COT_TNVN_11A_5180_Ant1



Adaptivity_Min.IdleTime_TNVN_11A_5180_Ant1



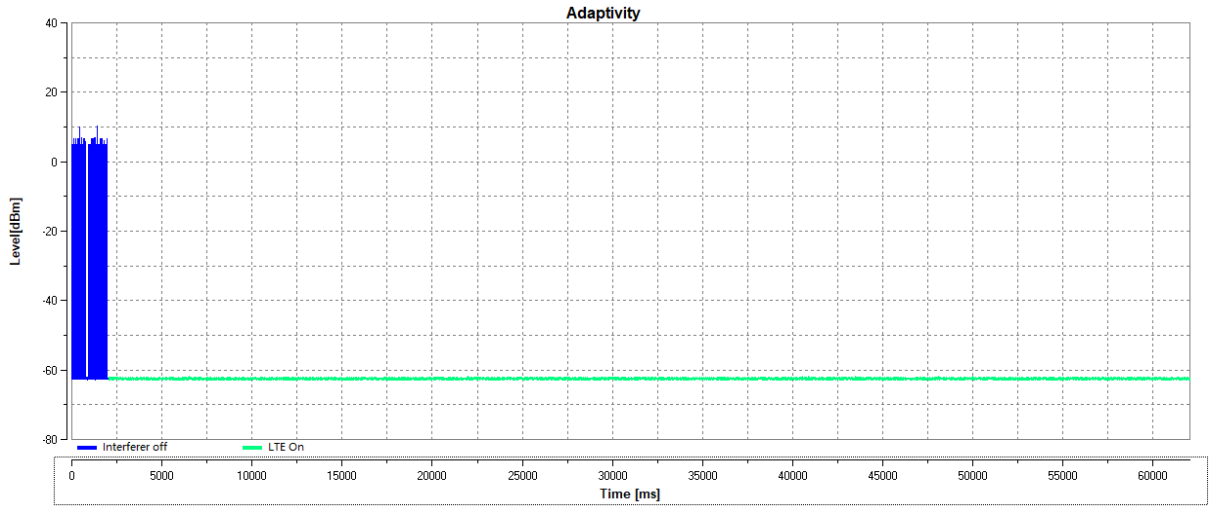
Adaptivity_Idle Period probability_TNVN_11A_5180_Ant1



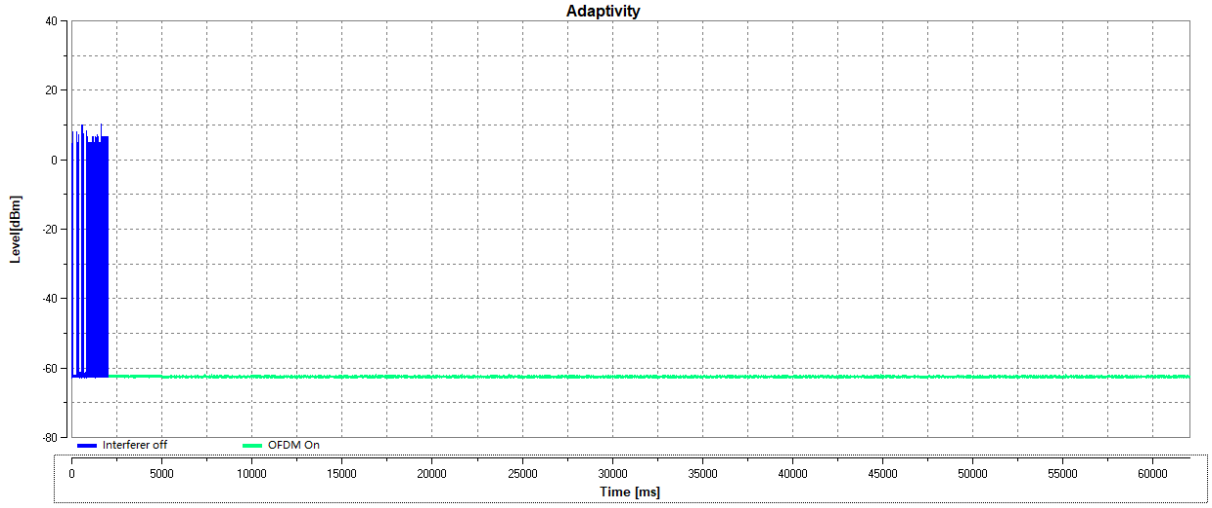
n	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
B[n]	45	0	2	0	2	0	0	0	0	0	0	0	0	12	0	0	868
P[n]	4.84	4.84	5.06	5.06	5.27	5.27	5.27	5.27	5.27	5.27	5.27	5.27	5.27	6.57	6.57	6.57	100
Limit	5	12	18.25	24.5	30.75	37	43.25	49.5	55.75	62	68.25	74.5	80.75	87	93.25	99.5	100

TEST PLOT

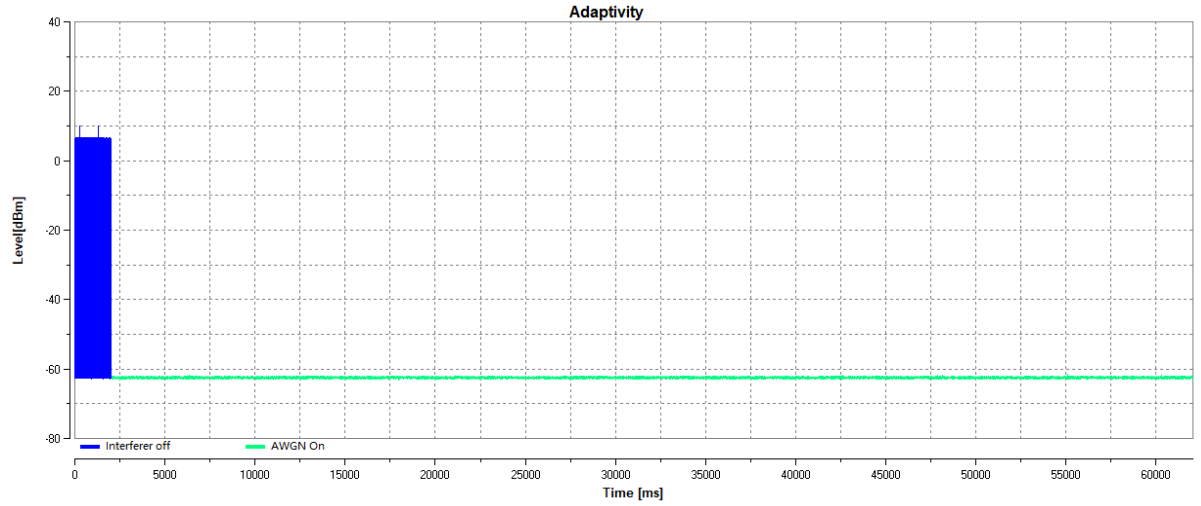
Adaptivity_LTE_TNVN_11A_5180_Ant1



Adaptivity_OFDM_TNVN_11A_5180_Ant1



Adaptivity_AWGN_TNVN_11A_5180_Ant1



4.1.8. Receiver Blocking

LIMIT

According to ETSI EN 301 893 V2.1.1 (2017-05) §4.2.8.4

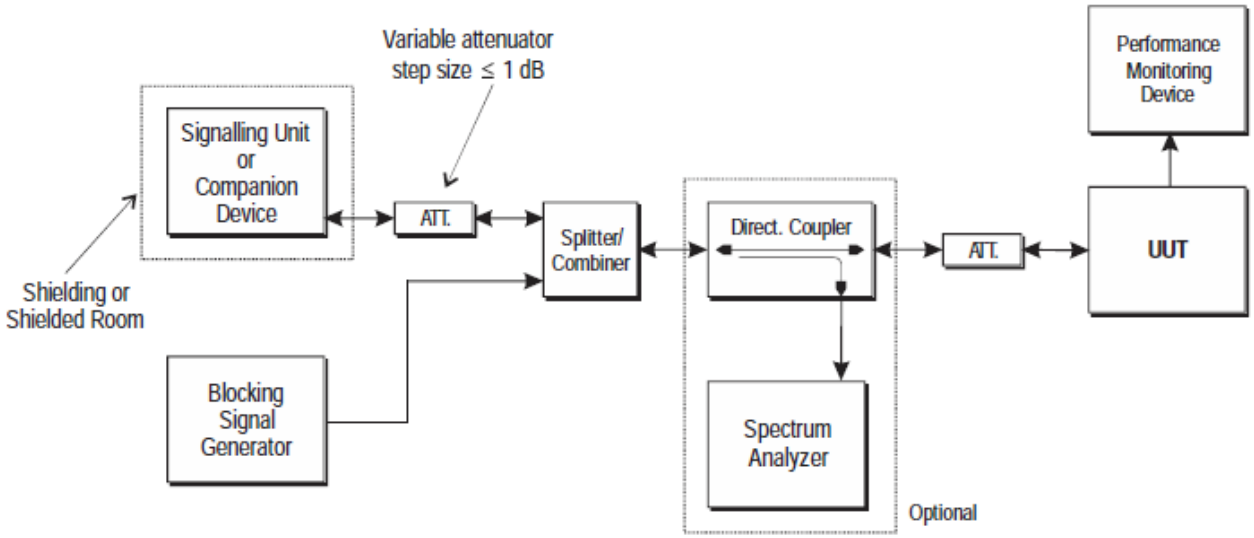
While maintaining the minimum performance criteria as defined in clause 4.2.8.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined in table 9.

Table 9: Receiver Blocking parameters

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 2)		Type of blocking signal
		Master or Slave with radar detection (see table D.2, note 2)	Slave without radar detection (see table D.2, note 2)	
Pmin + 6 dB	5 100	-53	-59	Continuous Wave
Pmin + 6 dB	4 900 5 000 5 975	-47	-53	Continuous Wave
NOTE 1: P_{min} is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined clause 4.2.8.3 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 same levels should be used at the antenna connector irrespective of antenna gain.				

The minimum performance criterion shall be a PER of less than or equal to 10 %. The manufacturer may declare alternative performance criteria as long as that is appropriate for the intended use of the equipment (see clause 5.4.1,item t)).

TEST CONFIGURATION



MEASUREMENT DESCRIPTION

According to ETSI EN 301 893 V2.1.1 (2017-05) §5.4.10.2.1, Conducted measurements

TEST RESULTS

Temperature:	22.8° C
Humidity:	56%
Test Engineer:	Anna Hu

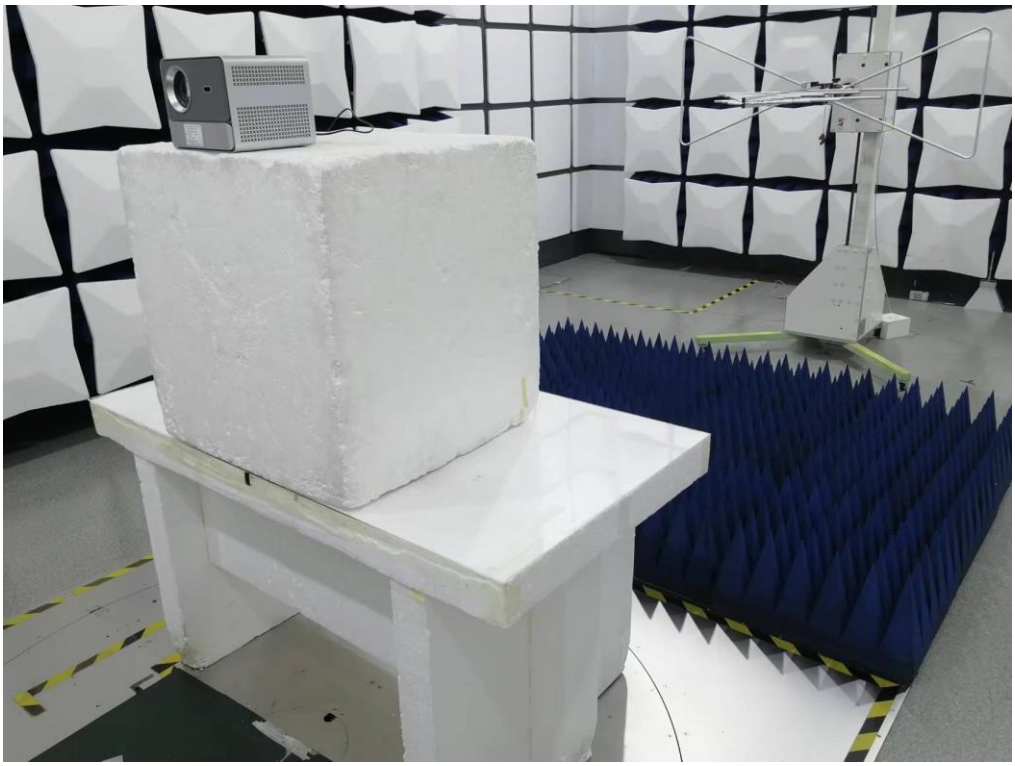
Record 802.11a. 1mbps for this test item
802.11a 5180MHz

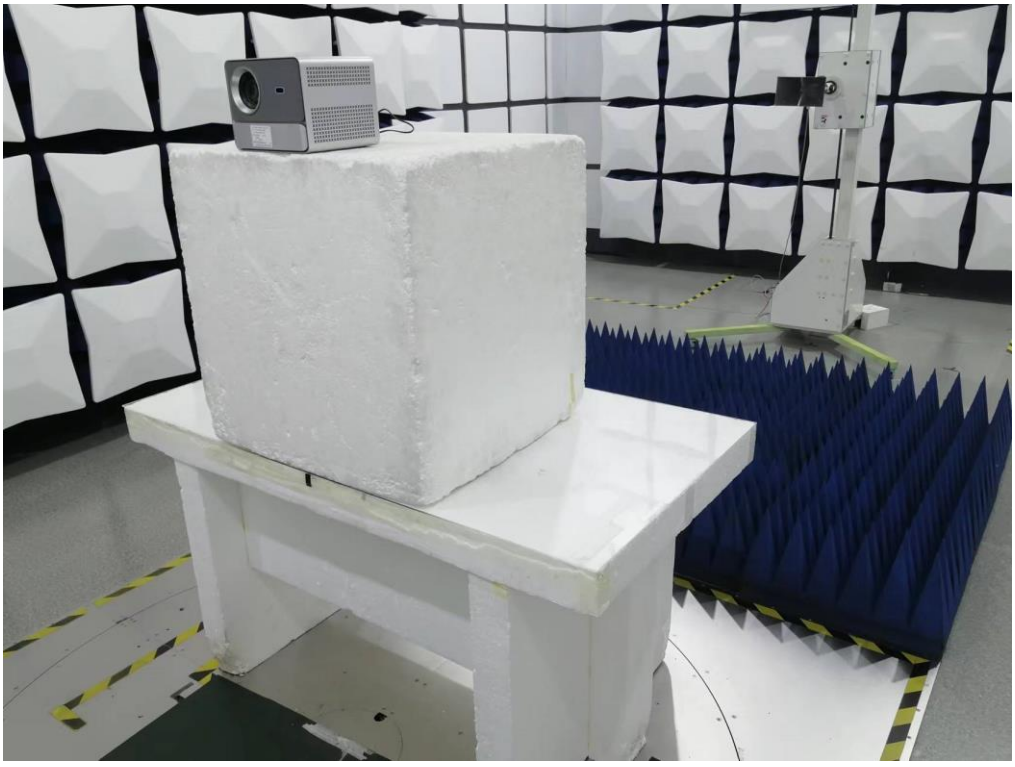
Wanted signal mean power form Companion device(dBm)	Blocking signal frequency(MHz)	Blocking signal power(dBm)	PER (%)	Limit (%)	Result
-81	5100	-59	1.93	10	Pass
-81	4900	-53	1.13	10	Pass
-81	5000	-53	0.19	10	Pass
-81	5975	-53	0.48	10	Pass
P_{min} = -87 dBm					

802.11a 5240MHz

Wanted signal mean power form Companion device(dBm)	Blocking signal frequency(MHz)	Blocking signal power(dBm)	PER (%)	Limit (%)	Result
-81	5100	-59	1.76	10	Pass
-81	4900	-53	1.40	10	Pass
-81	5000	-53	0.03	10	Pass
-81	5975	-53	1.40	10	Pass
P_{min} = -87 dBm					

5. Test Setup Photos of the EUT





6. External and Internal Photos of the EUT

Reference to the test report No. TZ240105305-RE

.....End of Report.....