

**TEST REPORT**
ETSI EN 300 328 V2.2.2 (2019-07)**Report Reference No.**..... **HK2108172970-2ER**

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Date of issue..... 2021/08/24

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Applicant's name Shenzhen Maikete Technology Co., Ltd.

Address..... 301A, 5# Building, Furong Road, Gushu Community, Xixiang Street,
Bao'an District, Shenzhen 518126, China

Test specification

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

TRF Originator..... Shenzhen HUAKE Testing Technology Co., Ltd.

Master TRF..... Dated 2019-07

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Test item description Wireless earphones

Trade Mark N/A

Model/Type reference..... M31

List Model M32, M35, M48, M63, M64, M65, M66, M67, M68

Hardware Version..... V1.0

Software Version V02

Modulation Type GFSK, $\pi/4$ DQPSK, 8DPSK

Operation Frequency..... From 2402 MHz to 2480 MHz

Ratings..... DC 5V From Type-C or DC 3.7V From Battery

Result..... **PASS**



TEST REPORT

Test Report No. :	HK2108172970-2ER	2021/08/24
		Date of issue

Equipment under Test : Wireless earphones

Model /Type : M31

Listed Models : M32, M35, M48, M63, M64, M65, M66, M67, M68

Applicant : Shenzhen Maikejie Technology Co., Ltd.

Address : 301A, 5# Building, Furong Road, Gushu Community, Xixiang Street,
Bao'an District, Shenzhen 518126, China

Manufacturer : Shenzhen Maikejie Technology Co., Ltd.

Address : 301A, 5# Building, Furong Road, Gushu Community, Xixiang Street,
Bao'an District, Shenzhen 518126, China

Test Result:	PASS
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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.



**** Modified History ****

Revision	Description	Issued Data	Remark
Revision 1.0	Initial Test Report Release	2021/08/24	Jason Zhou



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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	:	2021/08/17
Testing commenced on	:	2021/08/17
Testing concluded on	:	2021/08/24

2.2. Product Description

Name of EUT	Wireless earphones
Model(s) Number	M31
List Models	M32, M35, M48, M63, M64, M65, M66, M67, M68
Difference description	All model's the function, software and electric circuit are the same, only with a product color and model named different. Test sample model: M31.
Hardware version	V1.0
Software version	V02
Antenna Type	Ceramic Antenna
Antenna Gain	0dBi

2.3. Equipment Under Test

Power supply system utilised

Power supply voltage	:	<input type="radio"/> 230V/ 50 Hz	<input type="radio"/> 120V/60Hz
		<input type="radio"/> 12 V DC	<input type="radio"/> 24 V DC
		<input checked="" type="radio"/> Other (specified in blank below)	

DC 5V From Type-C or DC 3.7V From Battery



Description of the test mode

Bluetooth 2.1 and EDR: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		

2.4. 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:	<input checked="" type="checkbox"/> Bluetooth Test mode loop back enabled (EUT is controlled over CBT/CMU) <input type="checkbox"/> 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, $\pi/4$ 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

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**2.5. EUT Classification:**

Type of equipment:	<input checked="" type="checkbox"/>	stand alone equipment
	<input type="checkbox"/>	plug in radio equipment
	<input type="checkbox"/>	combined equipment
Modulation types:	<input type="checkbox"/>	Wide Band Modulation (None Hopping – e.g. DSSS, OFDM)
	<input checked="" type="checkbox"/>	Frequency Hopping Spread Spectrum (FHSS)
Adaptive equipment:	<input checked="" type="checkbox"/>	Yes, LBT-based
	<input type="checkbox"/>	Yes, non-LBT-based
	<input type="checkbox"/>	Yes (but can be disabled)
	<input type="checkbox"/>	No
Antennas and transmit operating modes:	<input checked="" type="checkbox"/>	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)
	<input type="checkbox"/>	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.
	<input type="checkbox"/>	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

●	Power Cable	Length (m) :	/
		Shield :	/
		Detachable :	/

○ Adapter information

N/A

2.7. Modifications

No modifications were implemented to meet testing criteria.



3. TEST ENVIRONMENT

3.1. Address of the test laboratory

Shenzhen HUAKE Testing Technology Co., Ltd.

1-2/F., Building B2, Junfeng Zhongcheng Zhizao Innovation Park, Heping, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 (2003) and CISPR Publication 22.

3.2. Environmental conditions

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

Normal Temperature: 15°C~35°C

High Temperature: 40°C

Low Temperature: -10°C

Normal Voltage: DC 3.7V

High Voltage: DC 4.255V

Low Voltage: DC 3.145V

Relative Humidity: 55 %

Air Pressure: 989 hPa

3.3. Test Description

3.4.1 Main Terms

Verdict

Verdict of each test cases.

Test Case

Test cases identification number and description in ETSI specification.

3.4.2 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

3.4.3 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.



3.4.4 Summary 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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		LT	$\pi/4$	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		HT	DQPSK 8DPSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.2	Duty Cycle, Tx-sequence, Tx-gap	NTC	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
5.4.4	Dwell time, min Freq. Occupation and Hopping sequence	NTC	GFSK $\pi/4$ DQPSK 8DPSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.5	Hopping Separation	NTC	GFSK $\pi/4$ DQPSK 8DPSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.2	Medium Utilisation	NTC	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
5.4.6	Adaptivity, Short Control Signalling Transmissions	NTC	GFSK $\pi/4$ DQPSK 8DPSK	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
5.4.7	Occupied Channel Bandwidth	NTC	GFSK $\pi/4$ DQPSK 8DPSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.8	Transmitter unwanted emissions in the out-of-band domain	NTC	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		LT	$\pi/4$	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
		HT	DQPSK 8DPSK	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
5.4.9	Transmitter unwanted emissions in the spurious domain (conducted & radiated)	NTC	GFSK $\pi/4$ DQPSK 8DPSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.10	Receiver spurious emissions (conducted & radiated)	NTC	GFSK $\pi/4$ DQPSK 8DPSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.11	Receiver Blocking	NTC	---	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

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 ETSI TR 100 028-1 [1], ETSI TS 103 051 [2] and ETSI TS 103 052 [3] and shall correspond to an expansion 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 HUAKE Testing Technology 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 HUAKE Testing Technology Co., Ltd. is reported:

No.	Item	Uncertainty
1	Occupied Channel Bandwidth	$\pm 3.68\%$
2	RF power, conducted	$\pm 0.37\text{dB}$
3	Power Spectral Density, conducted	$\pm 0.78\text{dB}$
4	Unwanted Emissions, conducted	$\pm 2.71\text{dB}$
5	All emissions, radiated	$\pm 4.28\text{dB}$
6	Temperature	$\pm 0.5^\circ\text{C}$
7	Humidity	$\pm 2\%$
8	DC and low frequency voltages	$\pm 1.5\%$
9	Time	$\pm 1.0\%$
10	Duty Cycle	$\pm 3.0\%$



3.5. Equipment Used during the Test

RF output power & PSD & OOB & OBW & Hopping & Duty Cycle, Tx-sequence, Tx-gap & Adaptively Blocking						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	Spectrum analyzer	Agilent	N9020A	HKE-048	2020/12/10	2021/12/09
2	Signal generator	Agilent	83630A	HKE-028	2020/12/10	2021/12/09
3	Signal generator	Agilent	N5182A	HKE-029	2020/12/10	2021/12/09
4	RF automatic control unit	Tonscend	JS0806-2	HKE-060	2020/12/10	2021/12/09

Transmitter spurious emissions & Receiver spurious emissions						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	Broadband antenna	Schwarzbeck	VULB 9163	HKE-012	2020/12/10	2021/12/09
2	Horn antenna	Schwarzbeck	9120D	HKE-013	2020/12/10	2021/12/09
3	Receiver	R&S	ESR-7	HKE-010	2020/12/10	2021/12/09
4	Position controller	Taiwan MF	MF7802	HKE-011	2020/12/10	2021/12/09
5	Preamplifier	EMCI	EMC05184 5SE	HKE-015	2020/12/10	2021/12/09
6	Preamplifier	Agilent	83051A	HKE-016	2020/12/10	2021/12/09
7	High pass filter unit	Tonscend	JS0806-F	HKE-055	2020/12/10	2021/12/09
8	Spectrum analyzer	Agilent	N9020A	HKE-048	2020/12/10	2021/12/09

The calibration interval is 1 year.



4. TEST CONDITIONS AND RESULTS

4.1. ETSI EN 300 328 REQUIREMENTS

4.1.1. RF Output Power

LIMIT

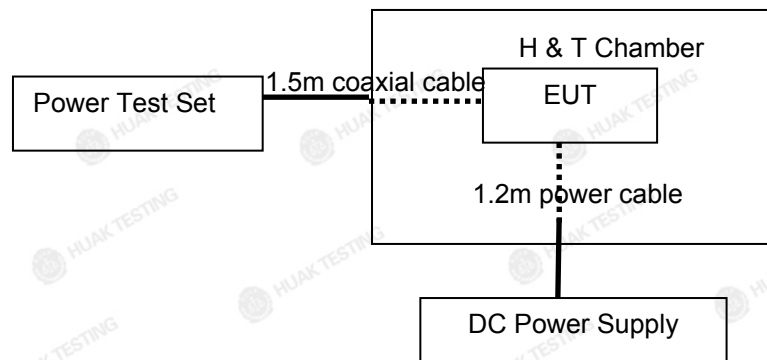
According to ETSI EN 300 328 V2.2.2 §4.3.1.2.3,

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

The maximum RF output power for non-adaptive equipment shall be declared by the supplier and shall not exceed 20 dBm. See clause 5.4.1 m). For non-adaptive equipment using wide band modulations other than FHSS, the maximum RF output power shall be equal to or less than the value declared by the supplier.

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

TEST CONFIGURATION



TEST PROCEDURE

According to ETSI EN 300 328 V2.2.2(2019-07) §5.4.2.2.1.2, conducted method..

Step 1:

- Use a fast power sensor with a minimum sensitivity of -40 dBm and capable of minimum 1 MS/s.
 - Use the following settings:
 - Sample speed 1 MS/s or faster.
 - The samples shall represent the RMS power of the signal.
 - Measurement duration: For non-adaptive equipment: equal to the observation period defined in clause 4.3.1.3.2 or clause 4.3.2.4.2. For adaptive equipment, the measurement duration shall be long enough to ensure a minimum number of bursts (at least 10) is captured.
- For adaptive equipment, to increase the measurement accuracy, a higher number of bursts may be used.

Step 2:

- For conducted measurements on devices with one transmit chain:
 - Connect the power sensor to the transmit port, sample the transmit signal and store the raw data. Use these stored samples in all following steps.
- For conducted measurements on devices with multiple transmit chains:
 - Connect one power sensor to each transmit port for a synchronous measurement on all transmit ports.
 - Trigger the power sensors so that they start sampling at the same time. Make sure the time difference between the samples of all sensors is less than 500 ns.
 - For each individual sampling point (time domain), sum the coincident power samples of all ports and store them. Use these summed samples as the new stored data set.

Step 3:

- Find the start and stop times of each burst in the stored measurement samples.
- The start and stop times are defined as the points where the power is at least 30 dB below the highest value of the stored samples in step 2.
- In case of insufficient sensitivity of the power sensor (e.g. in case of radiated measurements), the value of 30 dB may need to be reduced appropriately.

**Step 4:**

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

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

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

Step 5:

•The highest of all Pburst values (value A in dBm) will be used for maximum e.i.r.p. calculations.

Step 6:

- Add the (stated) antenna assembly gain G in dBi of the individual antenna.
- In case of smart antenna systems operating in mode with beamforming (see clause 5.3.2.2.4), add the additional beamforming gain Y in dB.
- If more than one antenna assembly is intended for this power setting, the maximum overall antenna gain (G or G + Y) shall be used.
- The RF Output Power (Pout) shall be calculated using the formula below:

$$P_{out} = A + G + Y$$

•This value, which shall comply with the limit given in clause 4.3.1.2.3 or clause 4.3.2.2.3, shall be recorded in the test report.

EUT DESCRIPTION:

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

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring burst Power(EMS) of a least 10 packets	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	Radiated (only if no conducted sample is provided)

TEST RESULTS

Test environmental		Maximum conducted Burst Power in 15 measured Bursts (RMS) [dBm]		
Test Mode	Test Condition	Antenna Measured Power (dBm)	EIRP(dBm)	Limit(dBm)
GFSK	NTC	-1.96	-1.96	20
	LT/NV	-2.63	-2.63	20
	HT/NV	-2.58	-2.58	20
$\pi/4$ DQPSK	NTC	-4.16	-4.16	20
	LT/NV	-4.72	-4.72	20
	HT/NV	-5.08	-5.08	20
8DPSK	NTC	-4.00	-4.00	20
	LT/NV	-4.15	-4.15	20
	HT/NV	-4.97	-4.97	20
Result		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 4.3.1.3.3

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

The maximum Tx-sequence Time and the minimum Tx-gap Time shall be according to the formula below:

$$\text{Maximum Tx-Sequence Time} = \text{Minimum Tx-gap Time} = M$$

where M is in the range of 3,5 ms to 10 ms.

Duty Cycle is defined as the ratio of the total transmitter 'on'-time to a 1 second observation period.

Tx-sequence is defined as a period in time during which a single or multiple transmissions may occur and which shall be followed by a Tx-gap.

Tx-gap is defined as a period in time during which no transmissions occur.

NOTE: The maximum Duty Cycle at which the equipment can operate, is declared by the supplier.

These requirements apply to non-adaptive equipment or to adaptive equipment when operating in a non-adaptive mode. The equipment is using wide band modulations other than FHSS.

These requirements 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.

Medical devices requiring reverse compatibility with other medical devices placed on the market when earlier versions of the present document were harmonised, are allowed to have an operating mode in which they do not have to comply with the requirements for Duty Cycle, Tx-sequence and Tx-gap.

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 sensitivity of the power sensor (e.g. in case of radiated measurements), 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 FHSS 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.

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**EUT DESCRIPTION:**

Mode:	BT Testmode
Test Channel	Channel 00(2402MHz),Channel 39(2441MHz),Channel 78(2480MHz)
Modulation:	GFSK, $\pi/4$ DQPSK, 8DPSK

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring average burst Power of a least 10 packets	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	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 dBme.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. Accumulated Transmit Time, Frequency 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
<input type="checkbox"/> Non-adaptive frequency hopping systems	≤ 15 ms in any $[15 \text{ ms} * \text{the minimum number of hopping frequencies (N)}]$ time domain
<input checked="" type="checkbox"/> Adaptive frequency hopping systems	≤ 400 ms in any $[400 \text{ ms} * \text{the minimum number of hopping frequencies (N)}]$ time domain
MINIMUM FREQUENCY OCCUPATION TIME	
Condition	Limit
<input type="checkbox"/> Non-adaptive frequency hopping systems	Option 1: Each hopping frequency of the hopping sequence shall be occupied at least once within a period not exceeding four times the product of the dwell time and the number of hopping frequencies in use.
<input checked="" type="checkbox"/> Adaptive frequency hopping systems	Option 2: The occupation probability for each frequency shall be between $((1 / U) \times 25 \%)$ and 77 % where U is the number of hopping frequencies in use.
HOPPING SEQUENCE (S)	
Condition	Limit
<input type="checkbox"/> Non-adaptive frequency hopping systems	≥ 15 hopping frequencies or 15/minimum Hopping Frequency Separation (MHz) whichever is greater.
<input checked="" type="checkbox"/> 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.

Accumulated Transmit Time test procedure:

Step 1:

- The output of the transmitter shall be connected to a spectrum analyser or equivalent.
- The analyser shall be set as follows:
 - Centre Frequency: Equal to the hopping frequency being investigated
 - Frequency Span: 0 Hz
 - RBW: $\sim 50 \%$ of the Occupied Channel Bandwidth
 - VBW: \geq RBW
 - Detector Mode: RMS
 - Sweep time: Equal to the applicable observation period (see clause 4.3.1.4.3.1 or clause 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:**

- Identify 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 have much higher levels compared to data points resulting from transmissions on adjacent hopping frequencies. If a clear determination between these transmissions is not possible, the RBW in step 1 shall be further reduced. In addition, a channel filter may be used.
- Count the number of data points identified as resulting from transmissions on the frequency being investigated and 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:

This step is only applicable for equipment implementing Option 1 in clause 4.3.1.4.3.1 or Option 1 in clause 4.3.1.4.3.2 for complying with the Frequency Occupation requirement.

- Make the following changes on the analyser and repeat step 2 and step 3.
Sweep time: $4 \times \text{dwell time} \times \text{Actual number of hopping frequencies in use}$.
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. If this number cannot be determined (number of blacklisted frequencies unknown) it shall be assumed that the equipment 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, Option 1 or clause 4.3.1.4.3.2, Option 1. The result of this comparison shall be recorded in the test report.

Step 6:

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

Step 7:

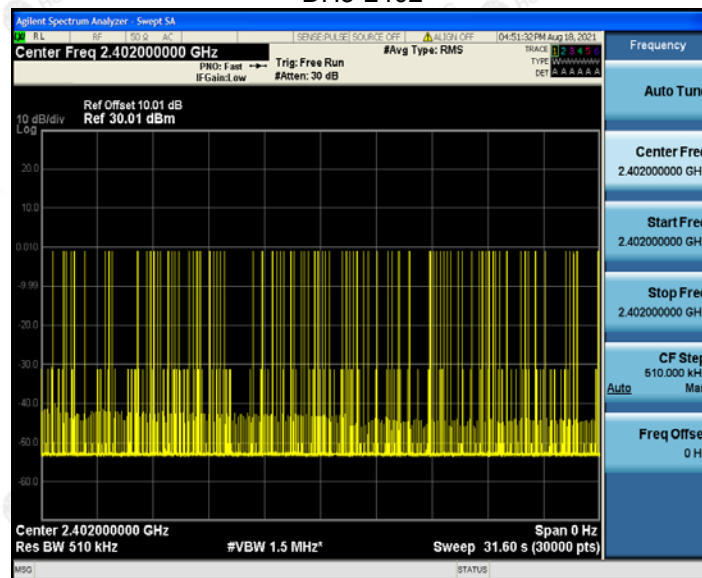
- For adaptive FHSS equipment, it shall be verified whether the equipment uses 70 % of the band specified in table 1. This verification can be done using the lowest and highest -20 dB points from the total spectrum envelope obtained in step 6. The result shall be recorded in the test report.



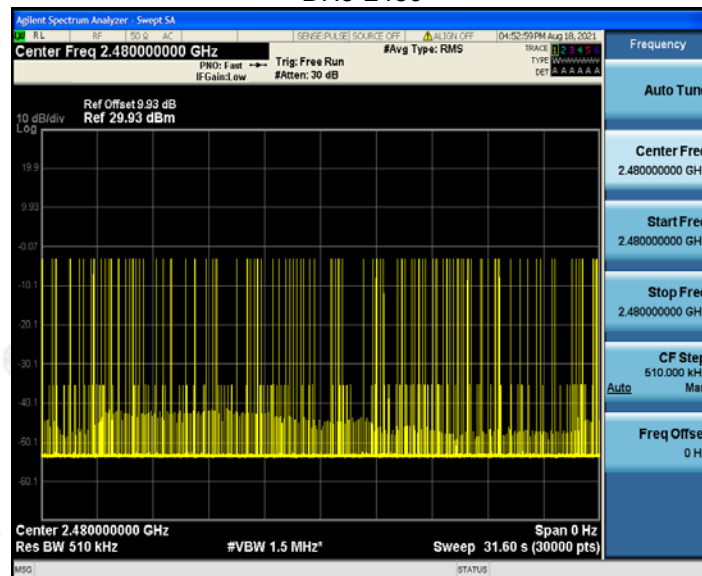
TEST RESULTS

Test Mode	Test Channel	Ant	Accumulated Dwell time [ms]	Limit [ms]	Result
DH5	2402	Ant1	322.330	<=400	PASS
DH5	2480	Ant1	312.849	<=400	PASS
2DH5	2402	Ant1	301.262	<=400	PASS
2DH5	2480	Ant1	329.703	<=400	PASS
3DH5	2402	Ant1	274.928	<=400	PASS
3DH5	2480	Ant1	294.942	<=400	PASS

DH5-2402

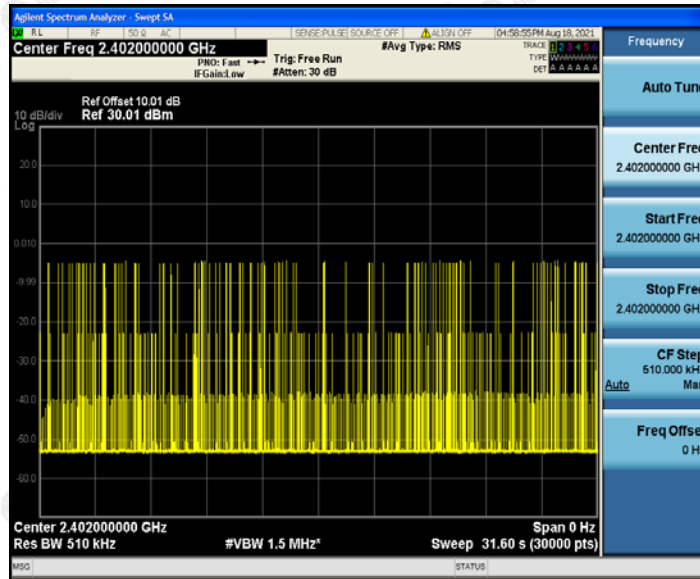


DH5-2480

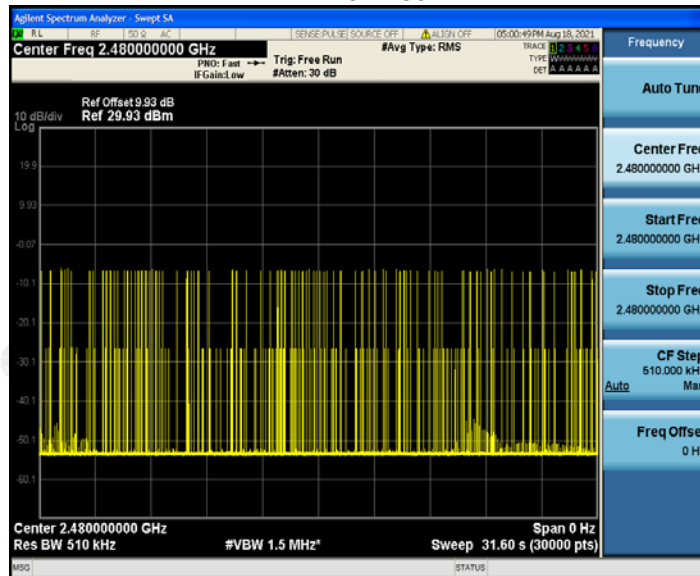




2DH5-2402

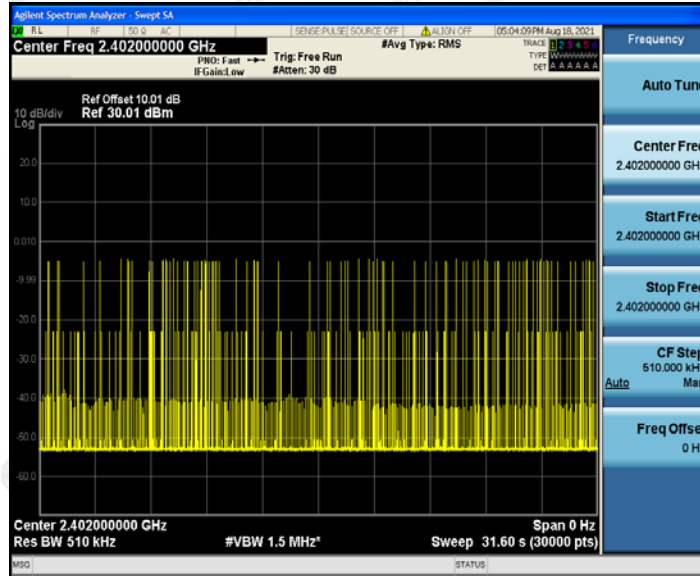


2DH5-2480

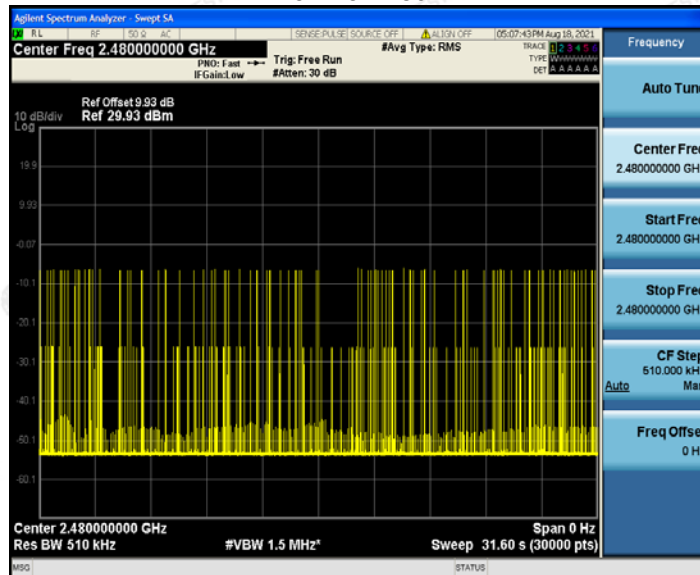




3DH5-2402



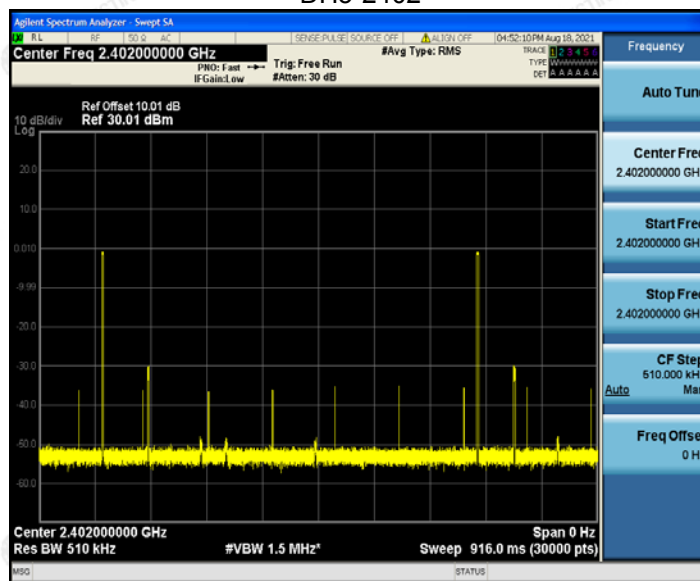
3DH5-2480



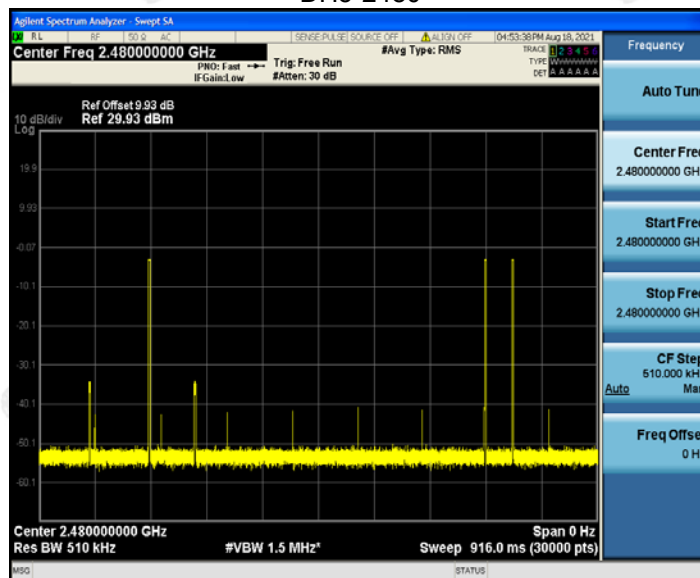


Test Mode	Test Channel	Ant	Frequency occupation times [N]	Limit [N]	Result
DH5	2402	Ant1	2	≥ 1	PASS
DH5	2480	Ant1	3	≥ 1	PASS
2DH5	2402	Ant1	5	≥ 1	PASS
2DH5	2480	Ant1	2	≥ 1	PASS
3DH5	2402	Ant1	2	≥ 1	PASS
3DH5	2480	Ant1	3	≥ 1	PASS

DH5-2402



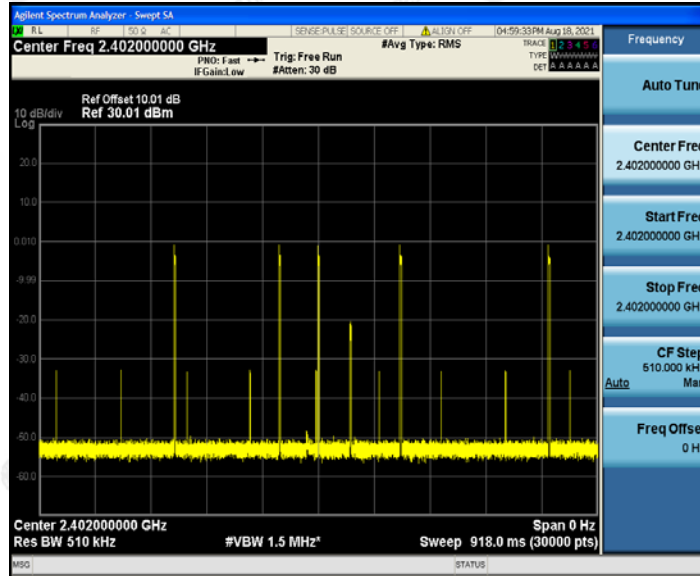
DH5-2480



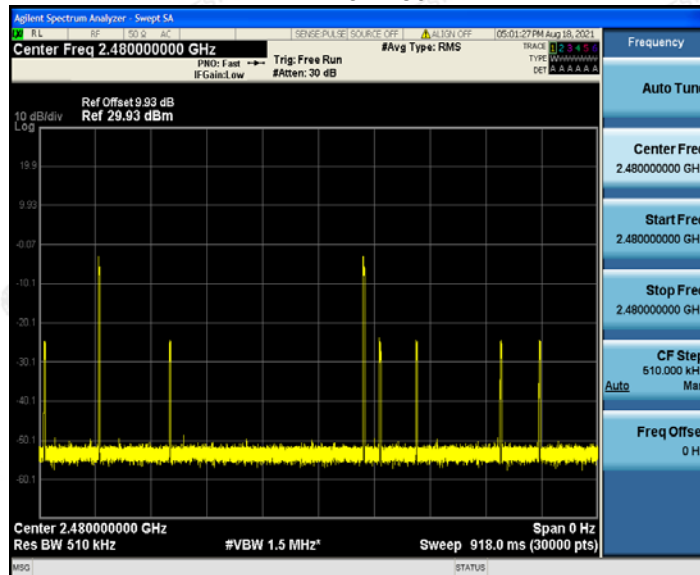
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2DH5-2402

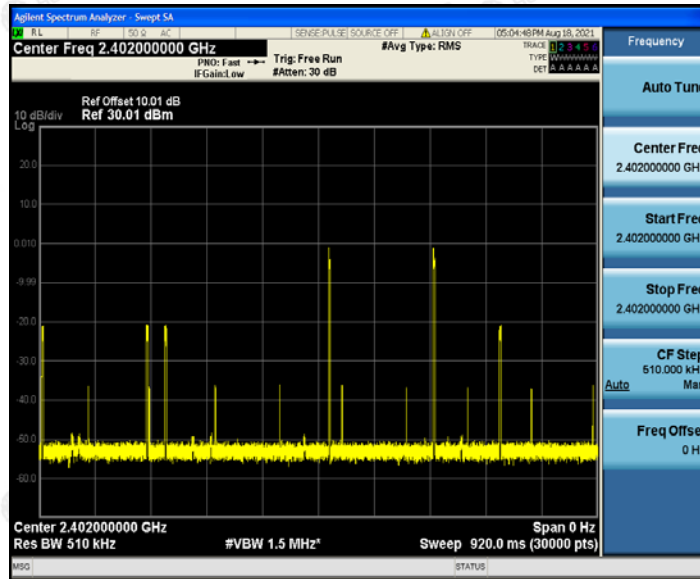


2DH5-2480

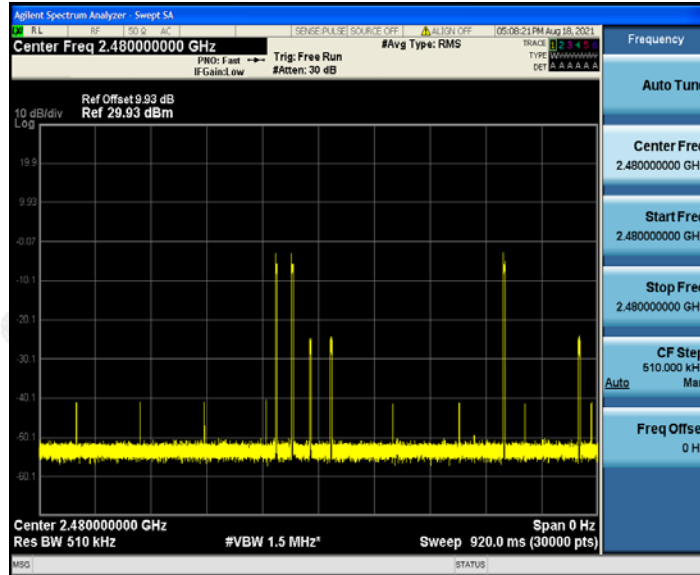




3DH5-2402



3DH5-2480



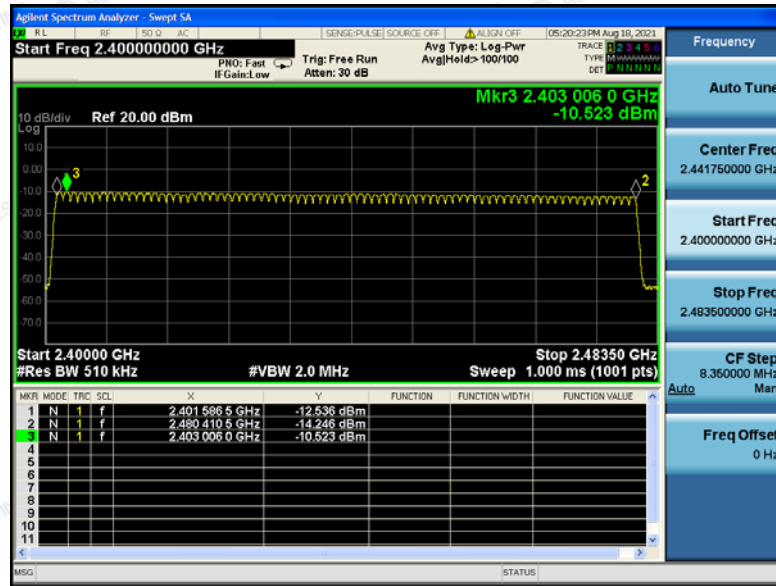
Note: 1, The Minimum frequency occupation time observe is a period of $4 \times \text{Dwell time} \times \text{Hopping frequency}$
2, The Minimum Frequency Occupation Time shall be equal to one dwell time within a period not exceeding four times the product of the dwell time per hop and the number of hopping frequencies in use.

Hopping Sequence:

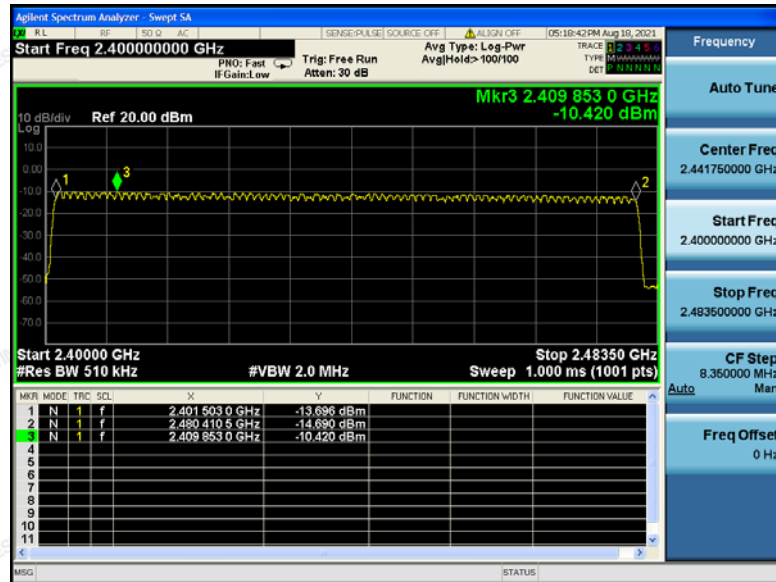
HOPPING SEQUENCE							
Hopping Mode	Hopping Channel	Hopping Channel Limit	F _L 20Db	F _H 20Db	Hopping Range	Minimum Hopping Range Limit	Result
DH5	79	15	2401.587	2480.411	94.40%	70%	Pass
2DH5	79	15	2401.503	2480.411	94.50%	70%	Pass
3DH5	79	15	2401.253	2480.661	95.10%	70%	Pass



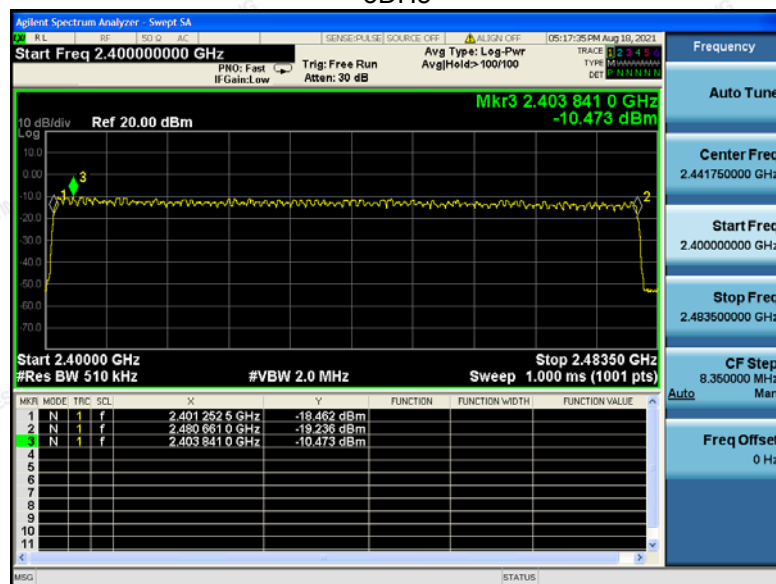
DH5



2DH5



3DH5



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4.1.4. Hopping Frequency Separation

LIMIT

ETSI EN 300 328 V2.2.2 (2019-07) 4.3.1.5.3:

Adaptive frequency hopping systems The 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 analyser or equivalent.
- The analyser 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: 1 % of the span
 - VBW: $3 \times \text{RBW}$
 - 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 centres of the two adjacent hopping frequencies (e.g. by identifying peaks or notches at the centre of the power envelope for the two adjacent signals). This value shall be compared with the limits defined in clause 4.3.1.5.3 and shall be recorded in the test report.

EUT DESCRIPTION:

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

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	Max Peak	
Sweep time:	auto	
Video bandwidth:	100KHz	
Resolution bandwidth:	30 KHz	
Span:	3 MHz	
Trace:	Max hold	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	Radiated (only if no conducted sample is provided)

**TEST RESULTS*****BDR Mode (GFSK):***

Channel Number	Frequency(MHz)	Ch. Separation (MHz)	Limit (MHz)	PASS/FAIL
			Minimum	
39	2441	1.000	0.100	PASS

EDR Mode ($\pi/4$ -DQPSK):

Channel Number	Frequency(MHz)	Ch. Separation (MHz)	Limit (MHz)	PASS/FAIL
			Minimum	
39	2441	1.000	0.100	PASS

EDR Mode (8DQPSK):

Channel Number	Frequency(MHz)	Ch. Separation (MHz)	Limit (MHz)	PASS/FAIL
			Minimum	
39	2441	1.000	0.100	PASS



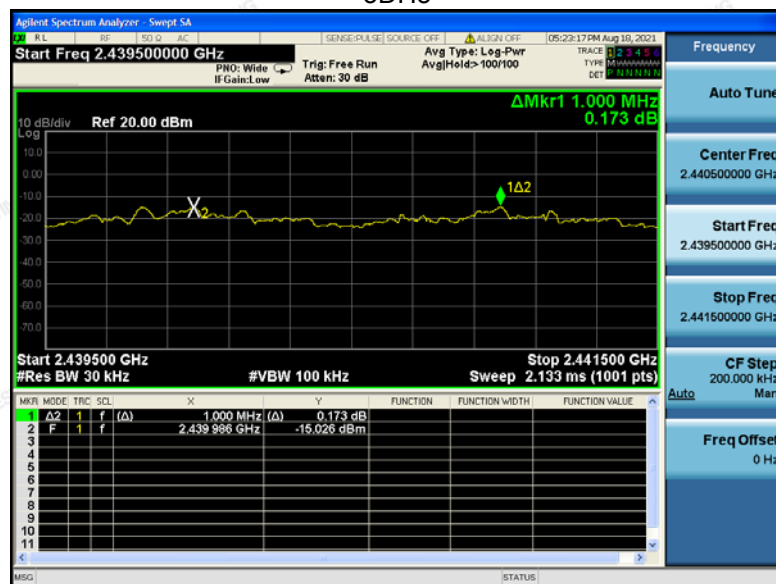
DH5



2DH5



3DH5



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4.1.5. Medium Utilisation (MU) factor

LIMIT

ETSI EN 300 328 V2.2.2(2019-07) Sub-clause 4.3.1.6.3

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, in case of FHSS equipment, 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 Testmode
Test Channel	Channel 00(2402MHz), Channel 39(2441MHz), Channel 78(2480MHz)
Modulation:	GFSK, $\pi/4$ DQPSK, 8DPSK

MEASUREMENT DESCRIPTION

Instrument:	Power Meter measuring average burst Power of a least 10 packets	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	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

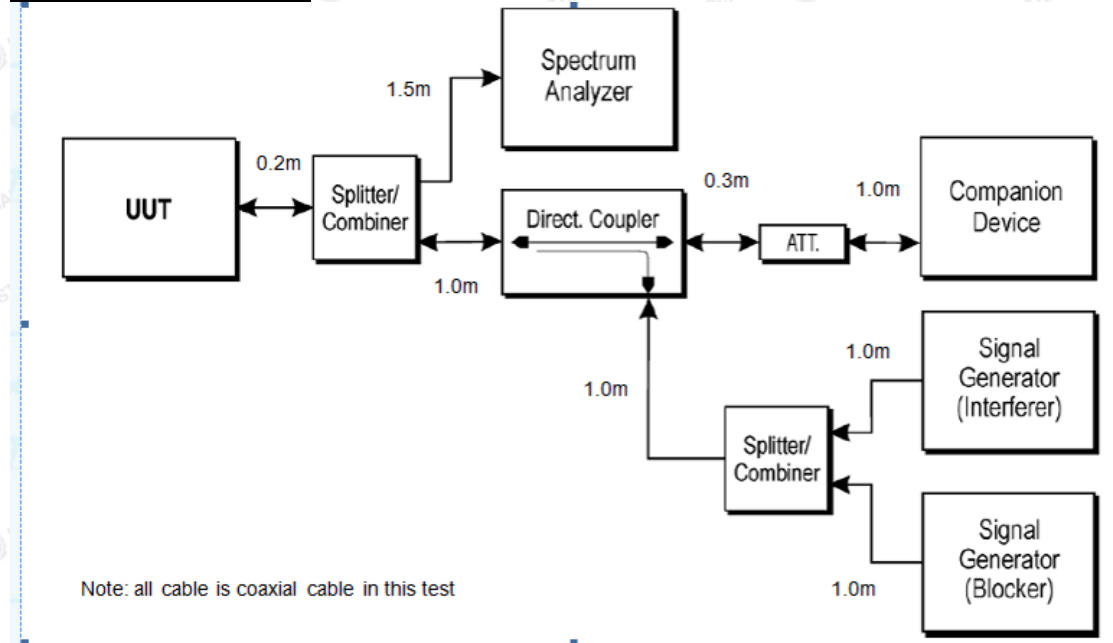
Requirement	Type	
	Adaptive Frequency Hopping using LBT based DAA	Adaptive Frequency Hopping using other forms of DAA (non-LBT based)
Minimum Clear Channel Assessment (CCA) Time	At least of Max(18 us, 0.2% of COT) (Note 1)	N/A
Maximum Channel Occupancy (COT) Time	2.0ms _{note4} to 60ms/Dwell time (Note 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 ChannelOccupancy Time is limited by the dwell time. Note 4: acroding 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 powerfrom companion device:

TL = -70 dBm/MHz + 10 × log₁₀ (100 mW / P_{out})(P_{out} 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)
<p>NOTE 1: The highest frequency shall be used for testing operatingchannels within the range 2 400 MHz to 2 442 MHz, while thelowest frequency shall be used for testing operating channelswithin the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1.</p> <p>NOTE 2: A typical value which can be used in most cases is -50 dBm/MHz.</p> <p>NOTE 3: The level specified is the level in front of the UUT antenna. In caseof conducted measurements, this level has to be corrected by theactual antenna assembly gain.</p>		

**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) §5.4.6.2.1.4, Conducted measurements

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 generator 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.

•Adjust the received signal level (wanted signal from the companion device) at the UUT to the value defined 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. Testing of Unidirectional equipment does not require a link to be established with a companion device.

•The analyser shall be set as follows:

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

**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. When measuring the Idle Period of the UUT, only transmissions from the UUT shall be considered.
- 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, only transmissions from the UUT shall be considered.

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.7 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 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 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 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 current operating channel 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.

ii) The UUT may continue to have Short Control Signalling Transmissions on the operating channel while the interfering and unwanted 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 unwanted signal

- On removal of the interference and unwanted signals 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:

- Step 2 to step 6 shall be repeated for each of the frequencies to be tested.

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**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:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	Radiated (only if no conducted sample is provided)
	<input type="checkbox"/>	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) 4.3.2.7.3,

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 for every occupied hopping frequency shall be equal to or less than the Nominal Channel Bandwidth declared by the supplier. See clause 5.3.1 j). This declared value shall not be greater than 5 MHz.

TEST PROCEDURE

Please refer to ETSI EN 300 328 (V2.2.2) Sub-clause §5.4.7.2.1

According to ETSI EN 300 328 V2.2.2 (2019-07) § 5.4.7.2.1 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: $3 \times \text{RBW}$
- Frequency Span: $2 \times \text{Nominal Channel Bandwidth}$
- 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 Testmode
Hopping:	Off
Packet Type:	Longest supported
Modulation:	GFSK, $\Pi/4$ DQPSK, 8DPSK

MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	auto	
Video bandwidth:	100KHz	
Resolution bandwidth:	30KHz	
Span:	100KHz	
Center:	Transmit channel	
Trace:	Max hold	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	Radiated (only if no conducted sample is provided)

**TEST RESULTS****Test Data**

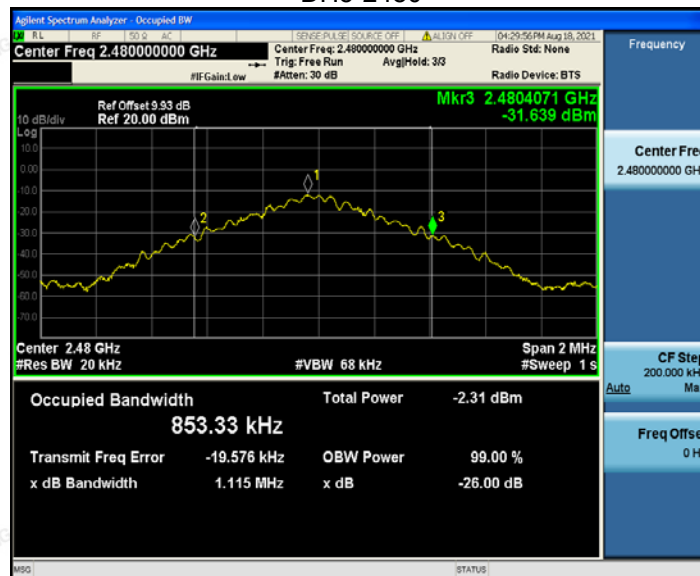
Type	CHANNEL	CHANNEL FREQUENCY (MHz)	OCCUPIED BANDWIDTH (MHz)	Measured frequencies		Limit	PASS /FAIL
				F _L (MHz)	F _H (MHz)		
1DH5	00	2402	0.863	2401.550	---	FL>2.4GHz and FH<2.4835 GHz	PASS
	78	2480	0.853	---	2480.407		PASS
2DH5	00	2402	1.182	2401.392	---	FL>2.4GHz and FH<2.4835 GHz	PASS
	78	2480	1.183	---	2480.573		PASS
3DH5	00	2402	1.185	2401.394	---	FL>2.4GHz and FH<2.4835 GHz	PASS
	78	2480	1.189	---	2480.578		PASS



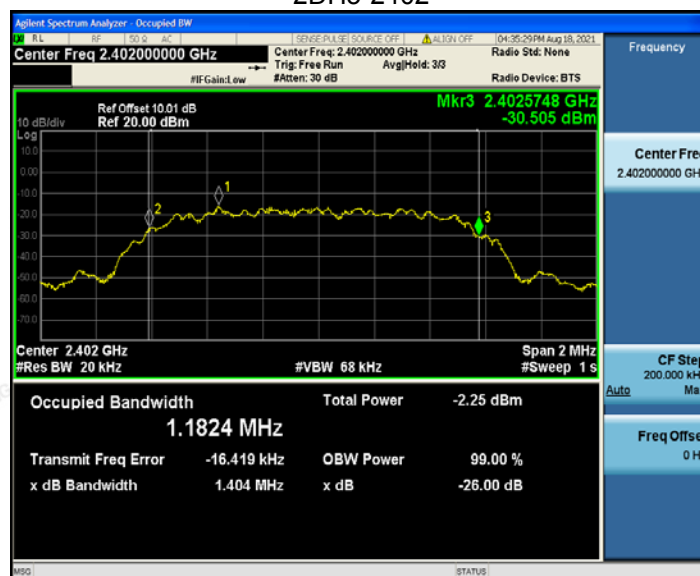
DH5-2402



DH5-2480



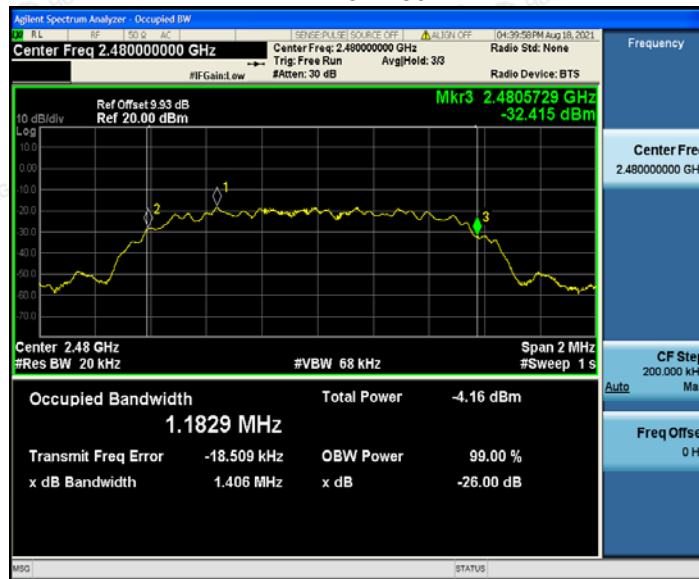
2DH5-2402



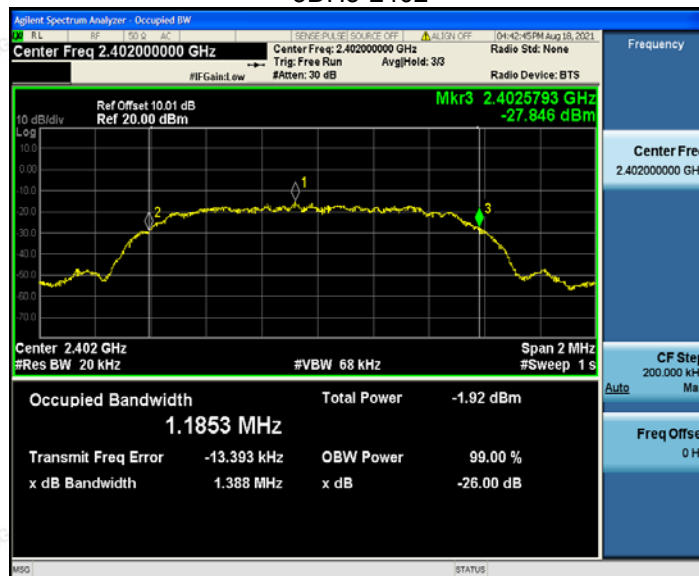
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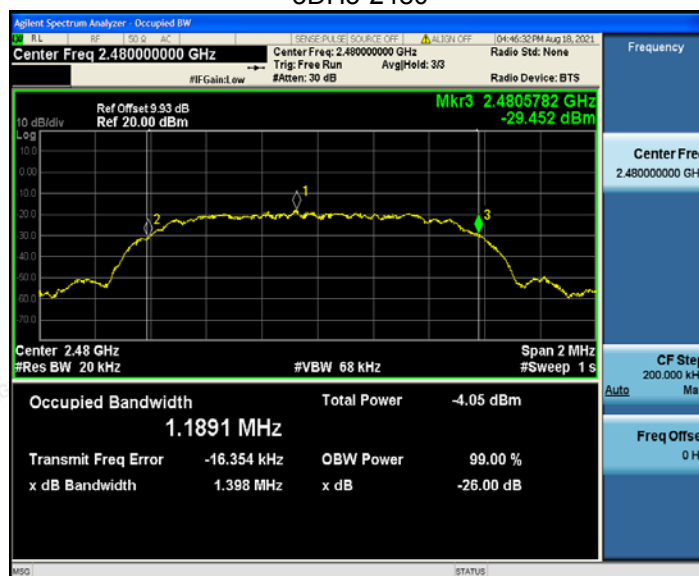
2DH5-2480



3DH5-2402



3DH5-2480



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4.1.8. 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.

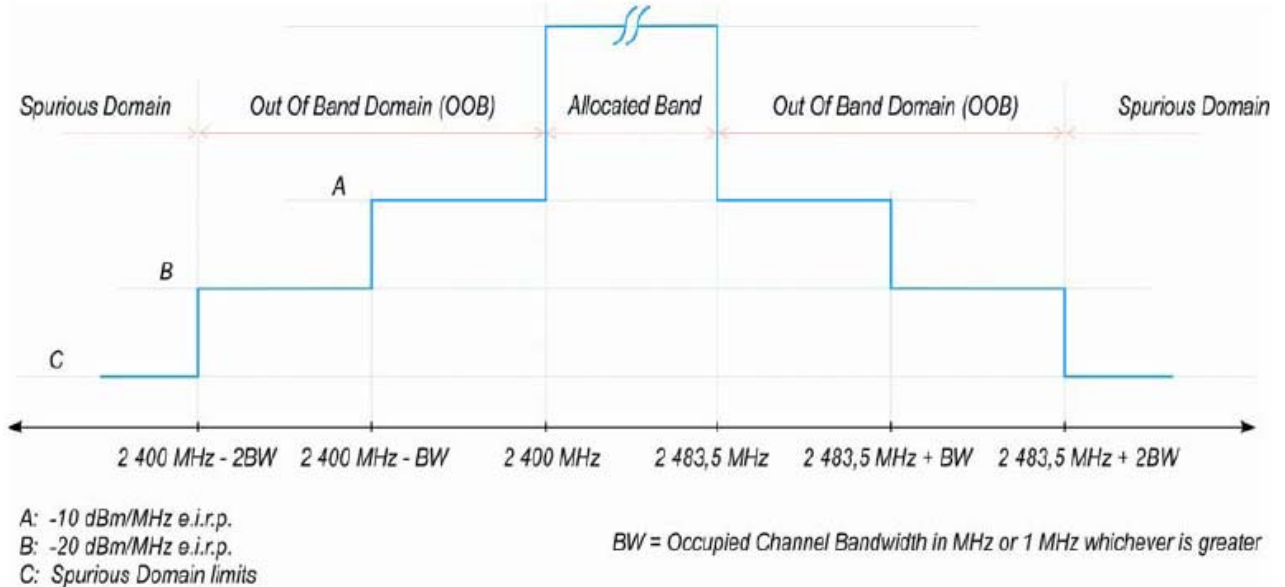


Figure 3: Transmit mask

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.

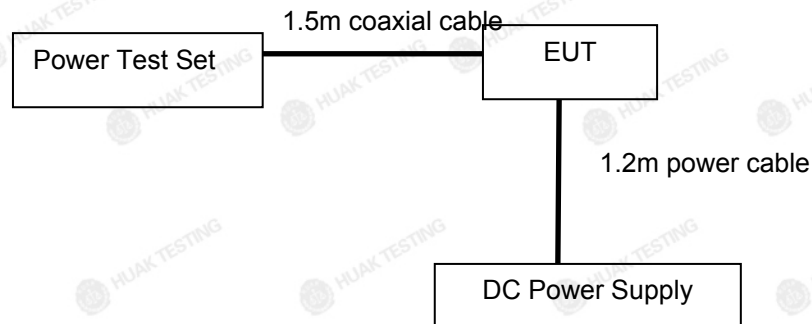
For systems using FHSS modulation, the measurements shall be performed during normal operation (hopping).

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), then 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.

Step 1:

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

- Measurement Mode: Time Domain Power
- Centre Frequency: 2 484 MHz
- Span: Zero Span
- Resolution BW: 1 MHz
- Filter mode: Channel filter
- Video BW: 3 MHz
- Detector Mode: RMS
- Trace Mode: Max Hold
- Sweep Mode: Single Sweep
- Sweep Points: Sweep time [μs] / (1 μs) with a maximum of 30 000
- Trigger Mode: Video
- 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):

- The measurement shall be performed and repeated while the trigger level is increased until no triggering takes place.
- For FHSS 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 + 2 BW):

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

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

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

Step 5 (segment 2 400 MHz - 2 BW 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 - 2 BW 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 - 2 BW + 0,5 MHz (which means this may partly overlap with the previous 1 MHz segment).

Step 6:

- In case of conducted measurements on equipment with a single transmit chain, the declared antenna assembly gain G in dBi shall be added to the results for each of the 1 MHz segments and compared with the limits provided by the mask given in figure 1 or figure 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 figure 1 or figure 3.
 - Option 2: the limits provided by the mask given in figure 1 or figure 3 shall be reduced by $10 \times \log_{10}(A_{ch})$ and the additional beamforming gain Y in dB. The results for each of the transmit chains shall be individually compared with these reduced limits

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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, $\pi/4$ DQPSK, 8DPSK
Assumed antenna gain:	0dBi

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 μ s) or 5 000 whichever is greater	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	Radiated (only if no conducted sample is provided)

TEST RESULTS

Test Condition	Test Mode	Test Channel	Ant	Freq [MHz]	Result [dBm]	Limit [dBm]	Verdict
TNVN	DH5	2402	Ant1	2398.500	-49.32	≤ -20	PASS
TNVN	DH5	2402	Ant1	2399.500	-40.42	≤ -10	PASS
TNVN	DH5	2402	Ant1	2484.000	-55.91	≤ -10	PASS
TNVN	DH5	2402	Ant1	2485.000	-58.78	≤ -20	PASS
TNVN	DH5	2480	Ant1	2398.500	-57.23	≤ -20	PASS
TNVN	DH5	2480	Ant1	2399.500	-47.79	≤ -10	PASS
TNVN	DH5	2480	Ant1	2484.000	-44.58	≤ -10	PASS
TNVN	DH5	2480	Ant1	2485.000	-52.13	≤ -20	PASS
TNVN	2DH5	2402	Ant1	2398.300	-48.54	≤ -20	PASS
TNVN	2DH5	2402	Ant1	2399.500	-47.61	≤ -20	PASS
TNVN	2DH5	2402	Ant1	2484.200	-42.63	≤ -10	PASS
TNVN	2DH5	2402	Ant1	2485.200	-40.74	≤ -10	PASS
TNVN	2DH5	2480	Ant1	2387.000	-52.19	≤ -10	PASS
TNVN	2DH5	2480	Ant1	2384.183	-53.72	≤ -10	PASS
TNVN	2DH5	2480	Ant1	2485.183	-56.96	≤ -20	PASS
TNVN	2DH5	2480	Ant1	2485.366	-58.45	≤ -20	PASS
TNVN	3DH5	2402	Ant1	2398.100	-52.04	≤ -20	PASS

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TNVN	3DH5	2402	Ant1	2399.500	-49.90	<=-20	PASS
TNVN	3DH5	2402	Ant1	2484.200	-45.92	<=-10	PASS
TNVN	3DH5	2402	Ant1	2485.200	-42.94	<=-10	PASS
TNVN	3DH5	2480	Ant1	2394.000	-54.72	<=-10	PASS
TNVN	3DH5	2480	Ant1	2394.190	-55.03	<=-10	PASS
TNVN	3DH5	2480	Ant1	2485.190	-58.54	<=-20	PASS
TNVN	3DH5	2480	Ant1	2485.381	-58.60	<=-20	PASS

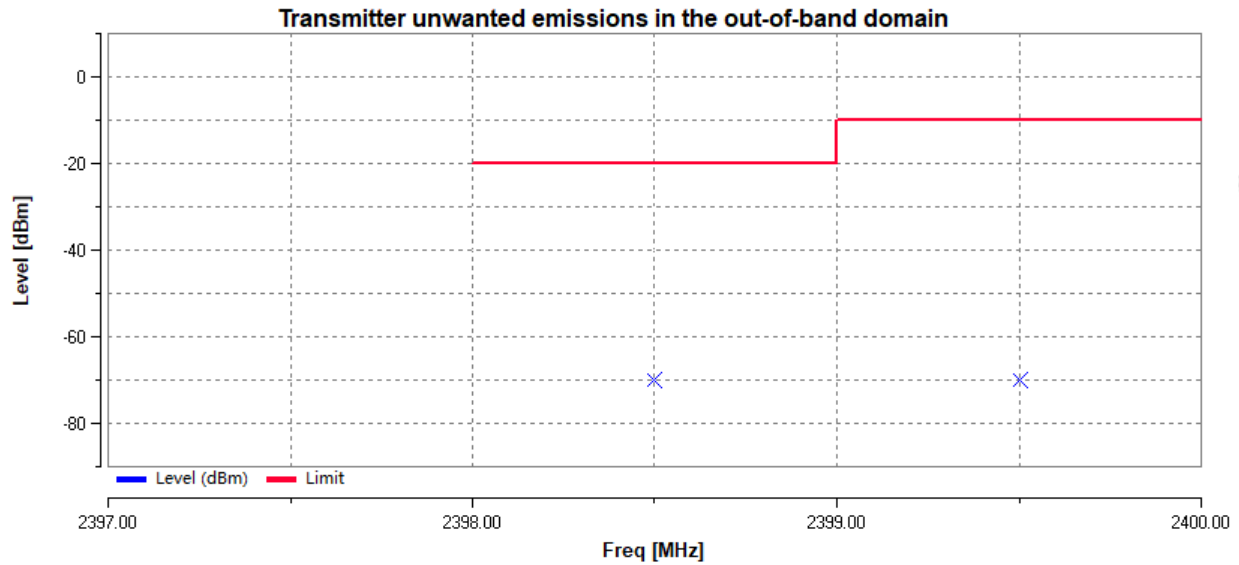
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HUAKE Testing Lab TEL : +86-755 2302 9901 FAX : +86-755 2302 9901 E-mail : service@cer-mark.com

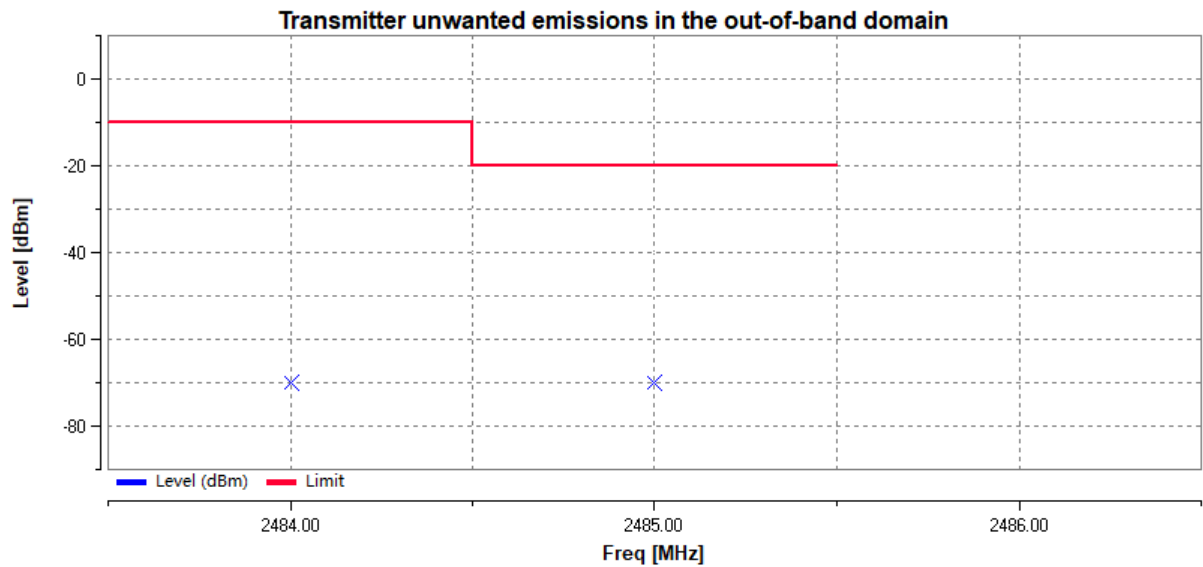
1-2/F., Building B2, Junfeng Zhongcheng Zhizao Innovation Park, Heping, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China



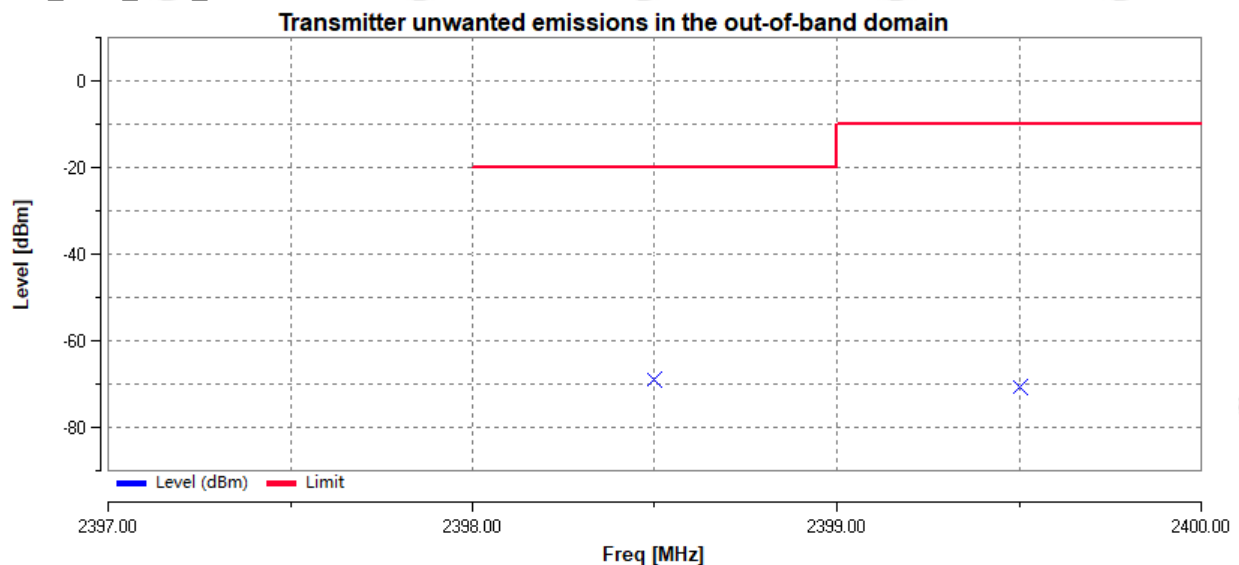
DH5_2402_Ant1_2400MHz-2BW to 2400MHz



DH5_2402_Ant1_2483.5MHz to 2483.5MHz+2BW



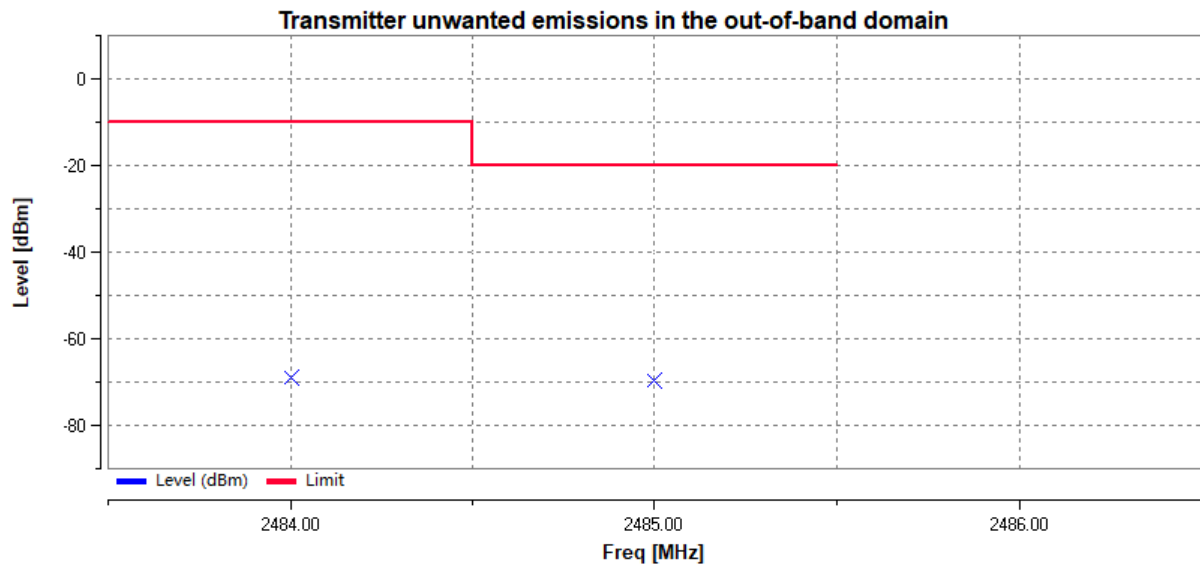
DH5_2480_Ant1_2400MHz-2BW to 2400MHz



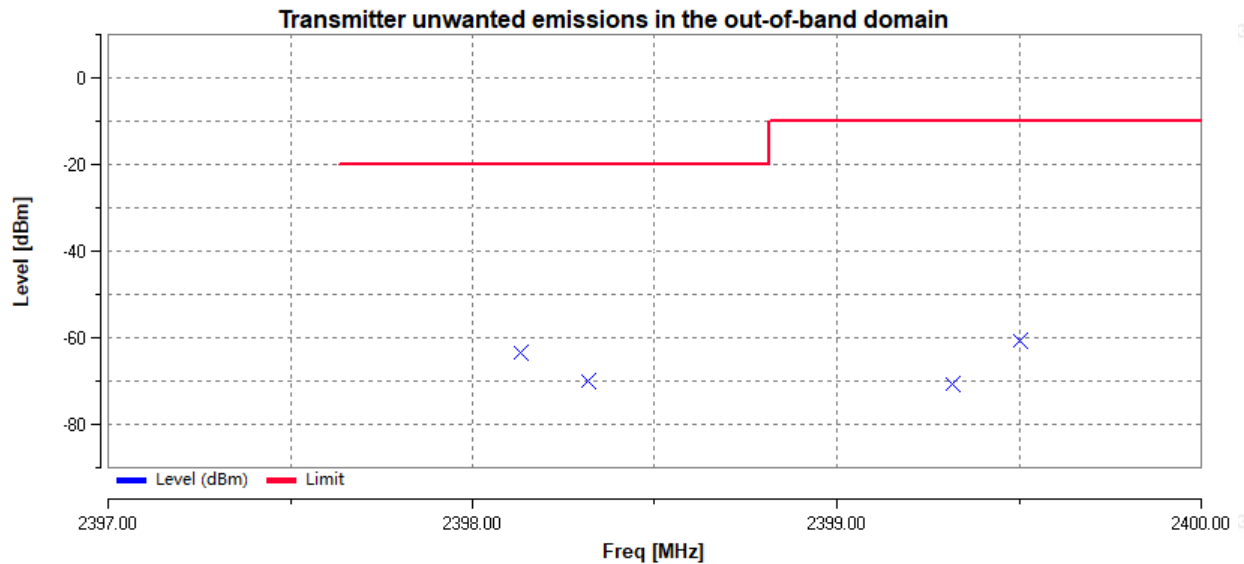
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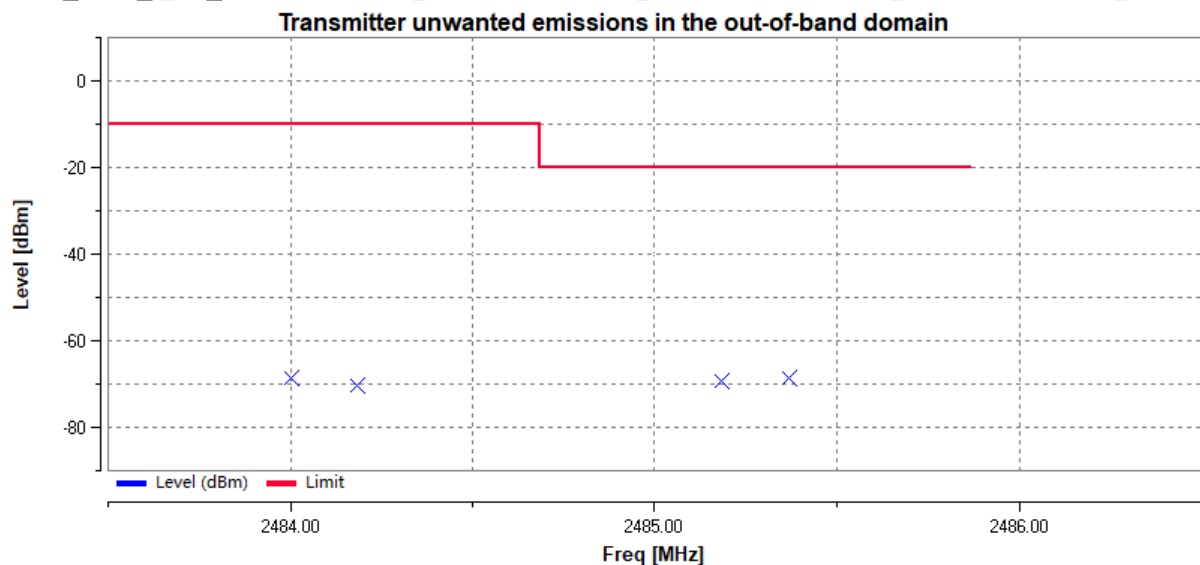
DH5_2480_Ant1_2483.5MHz to 2483.5MHz+2BW



2DH5_2402_Ant1_2400MHz-2BW to 2400MHz



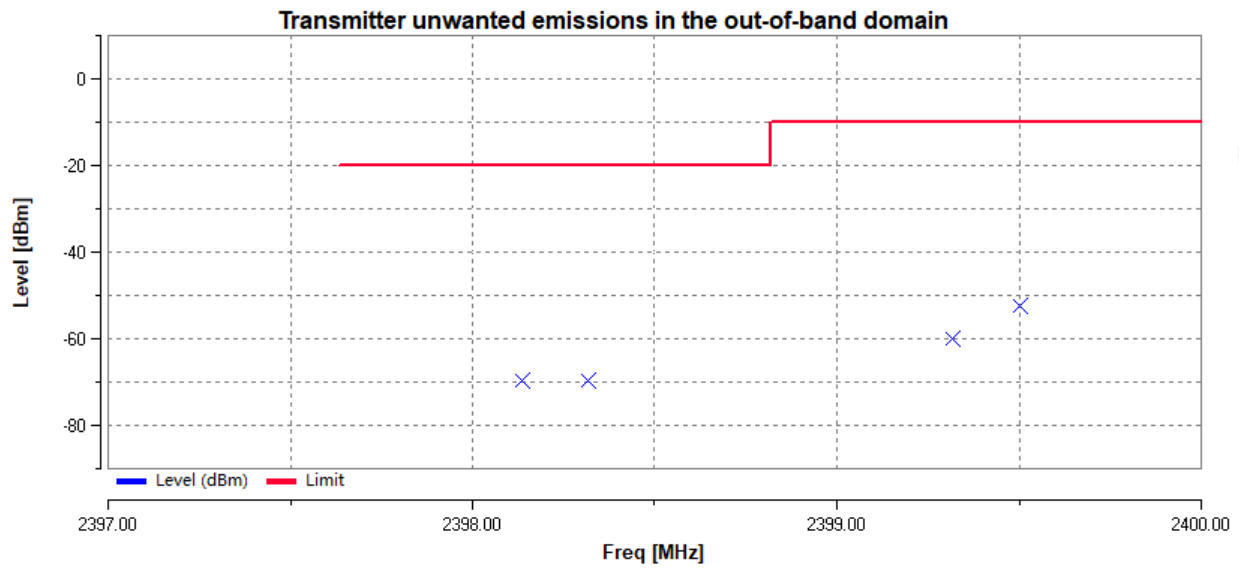
2DH5_2402_Ant1_2483.5MHz to 2483.5MHz+2BW



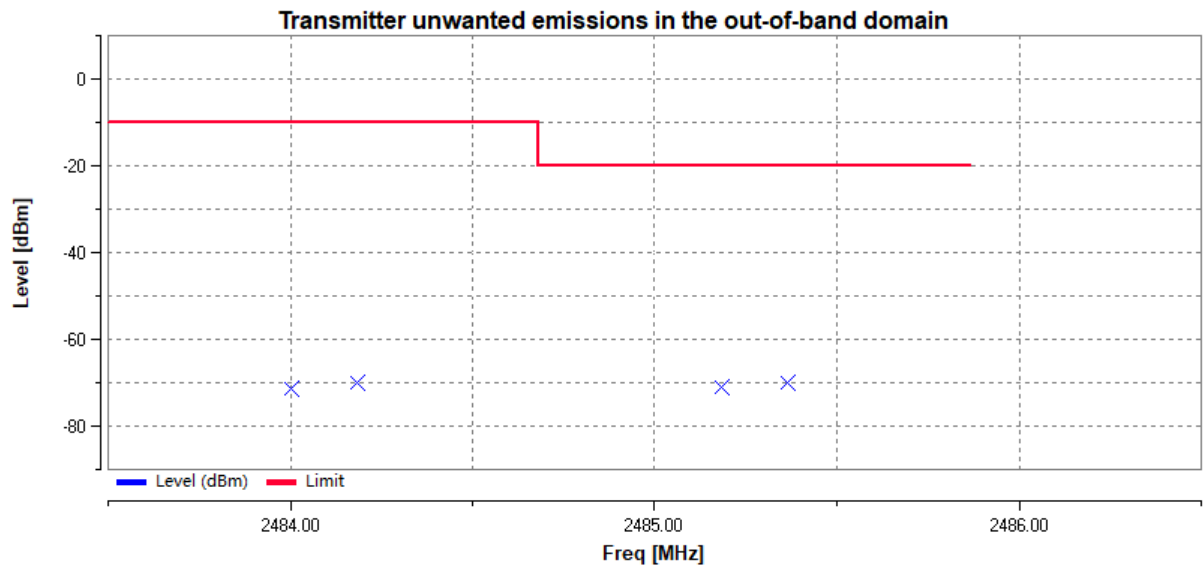
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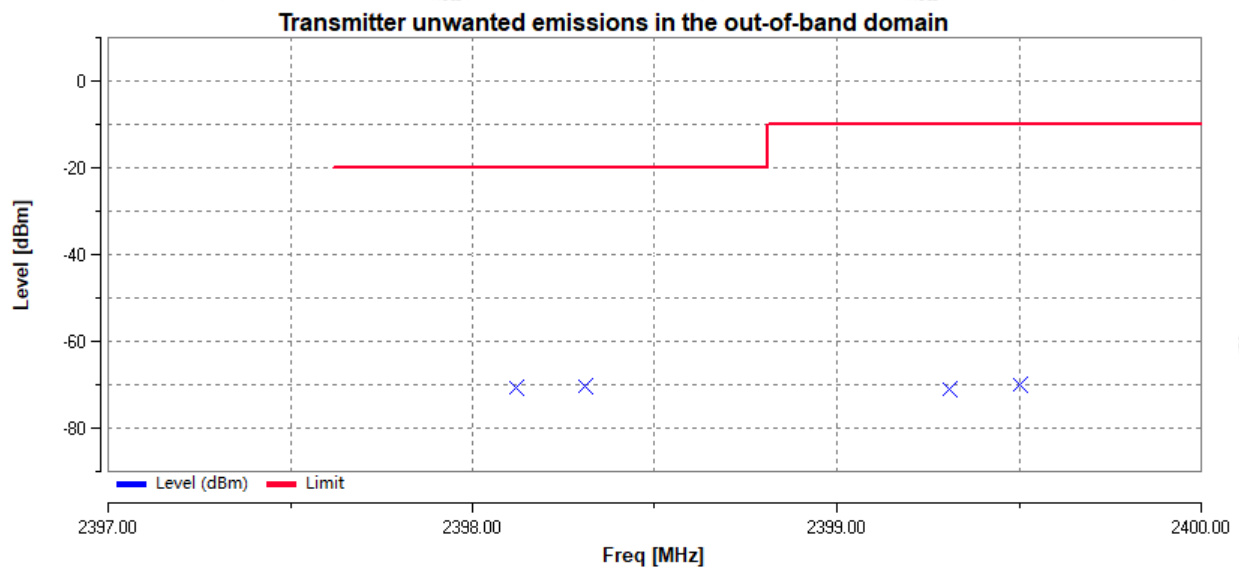
2DH5_2480_Ant1_2400MHz-2BW to 2400MHz



2DH5_2480_Ant1_2483.5MHz to 2483.5MHz+2BW



3DH5_2402_Ant1_2400MHz-2BW to 2400MHz



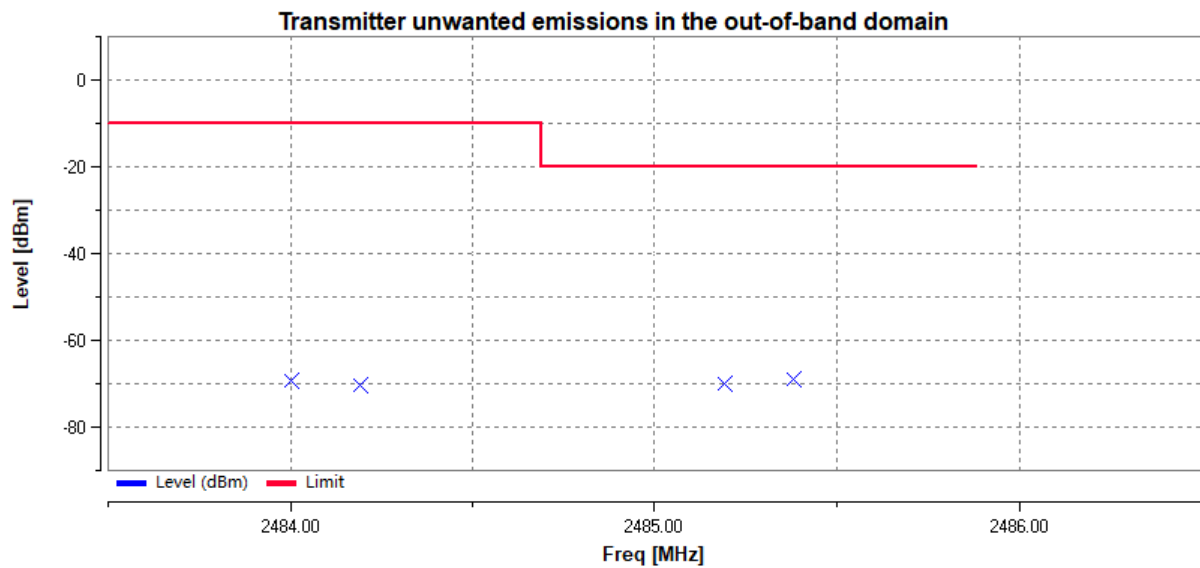
The results sh

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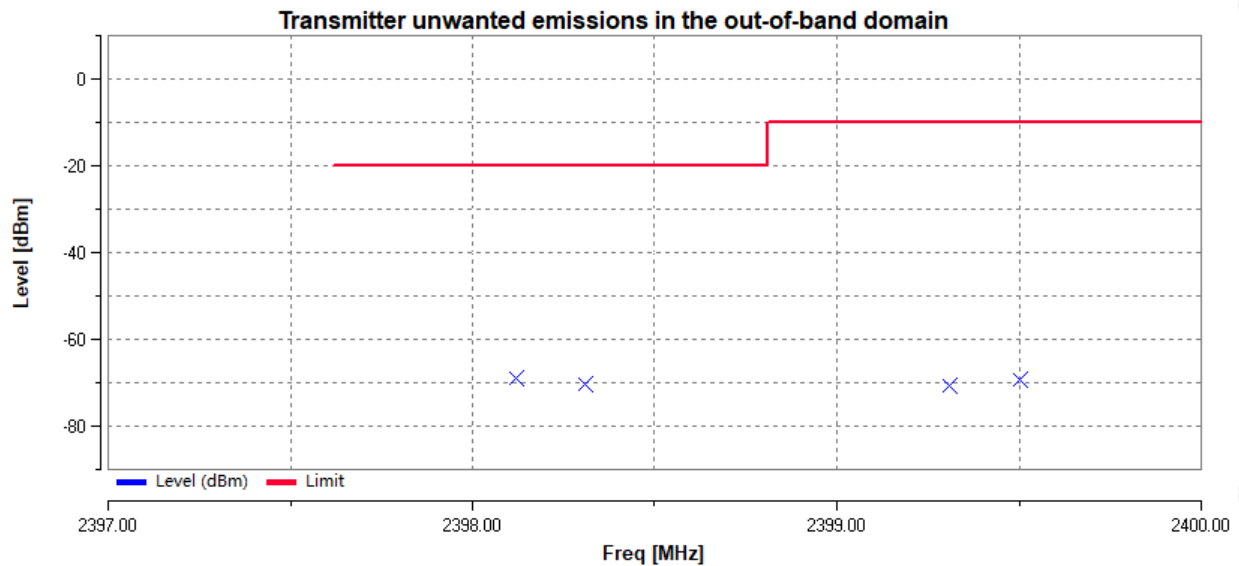
by HUAKE,



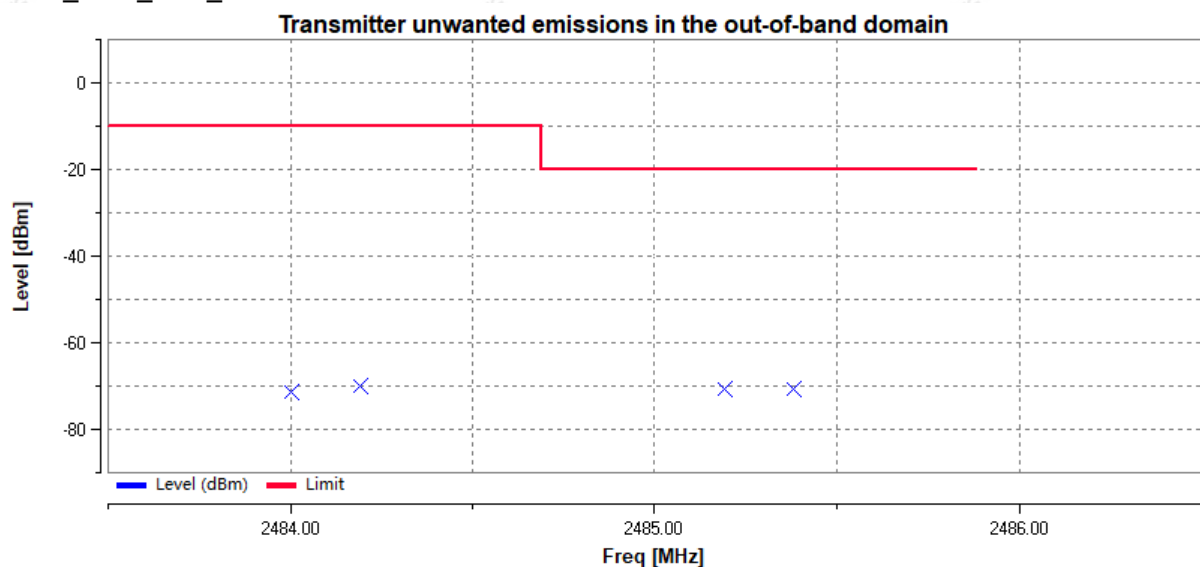
3DH5_2402_Ant1_2483.5MHz to 2483.5MHz+2BW



3DH5_2480_Ant1_2400MHz-2BW to 2400MHz



3DH5_2480_Ant1_2483.5MHz to 2483.5MHz+2B



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4.1.9. Transmitter unwanted emissions in the spurious domain

Limit

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

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

Table 4: 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 1GHz	-36 dBm	100 KHz
1 GHz to 12.75GHz	-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.

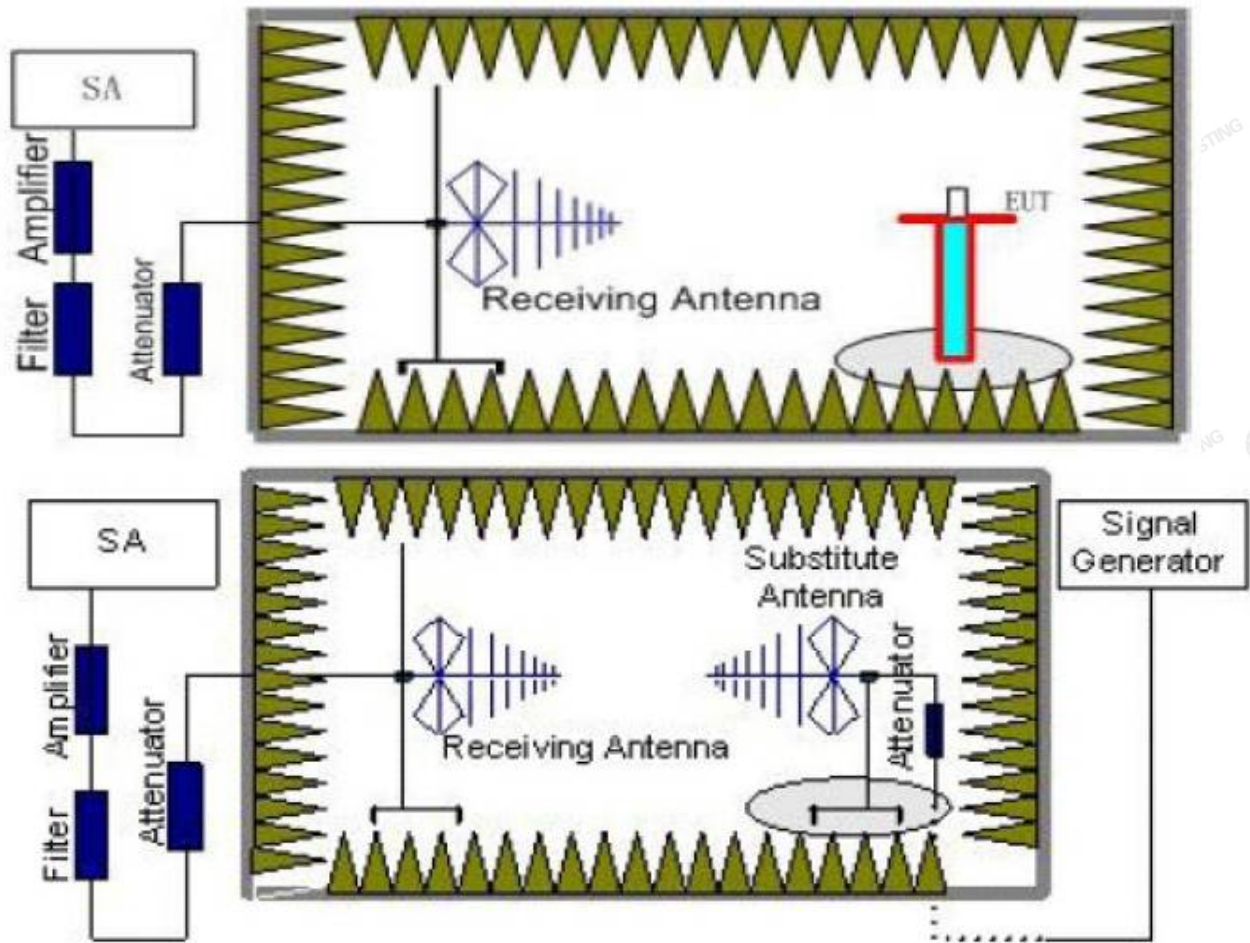
Test Procedure

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



Test Configuration

Effective Radiated Power measurement (30 MHz to 12.75 GHz)



Test Results

Remark: We test all modulation type, and recorded the worst case mode for GFSK test.



Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit	Margin	Conclusion
Below 1GHz:					
158.31	V	-54.37	-36	-18.37	PASS
255.67	V	-56.28	-36	-20.28	PASS
349.57	V	-56.66	-36	-20.66	PASS
423.99	V	-72.49	-36	-36.49	PASS
547.49	V	-77.98	-54	-23.98	PASS
876.46	V	-76.59	-36	-40.59	PASS
206.99	H	-72.26	-54	-18.26	PASS
236.32	H	-66.86	-36	-30.86	PASS
375.56	H	-75.67	-36	-38.67	PASS
468.85	H	-78.83	-36	-42.83	PASS
598.69	H	-71.39	-54	-17.39	PASS
874.67	H	-58.56	-36	-22.56	PASS
Note: 1.Cable loss and antenna gain was combined in the calculated result. 2. Other point of the measurements are below 20dB from the limit.					



Fre. (MHz)	ANT. Pol.	Result (dBm)	Limit	Margin	Conclusion
Above 1GHz:					
Test Mode: Low Channel					
1774.75	H	-54.49	-30	-24.49	PASS
1877.66	V	-55.26	-30	-25.26	PASS
2964.56	H	-58.67	-30	-28.67	PASS
3146.88	V	-53.68	-30	-23.68	PASS
3831.29	H	-53.69	-30	-23.69	PASS
3975.91	V	-56.83	-30	-26.83	PASS
4426.79	H	-55.46	-30	-25.46	PASS
4376.78	V	-50.36	-30	-20.36	PASS
5168.46	H	-51.87	-30	-21.87	PASS
4919.87	V	-52.95	-30	-22.95	PASS
5943.95	H	-54.76	-30	-24.76	PASS
6196.48	V	-56.57	-30	-26.57	PASS
Test Mode: High Channel					
1847.15	H	-54.73	-30	-24.73	PASS
2164.44	V	-54.48	-30	-24.48	PASS
2960.79	H	-54.57	-30	-24.57	PASS
3260.77	V	-55.82	-30	-25.82	PASS
3868.48	H	-53.49	-30	-23.49	PASS
3917.97	V	-55.67	-30	-25.67	PASS
4689.98	H	-54.99	-30	-24.99	PASS
4678.26	V	-52.76	-30	-22.76	PASS
5327.05	H	-51.48	-30	-21.48	PASS
5154.85	V	-54.36	-30	-24.36	PASS
5928.28	H	-52.77	-30	-22.77	PASS
6135.96	V	-50.59	-30	-20.59	PASS
Note: 1. Cable loss and antenna gain was combined in the calculated result. 2. Other point of the measurements are below 20dB from the limit.					

4.1.10. 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 5.

Table 5: spurious emission limits for receivers

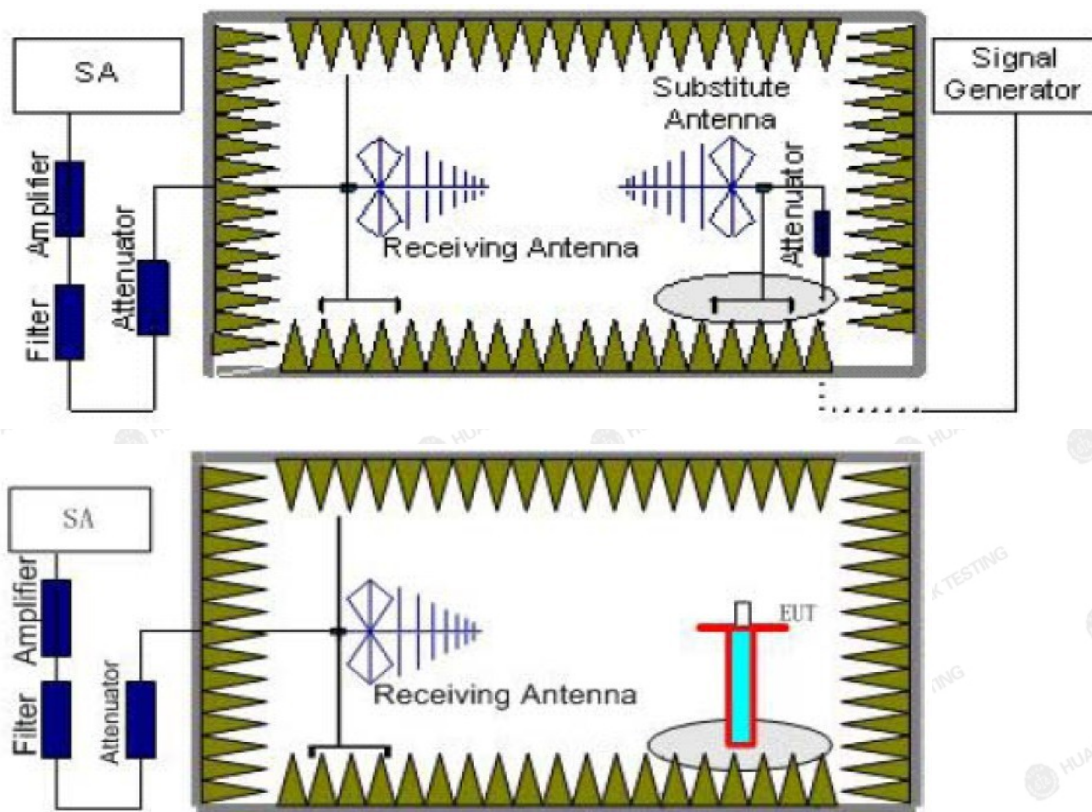
Frequency	Maximum power, e.r.p.	Measurement bandwidth
30 MHz to 1 GHz	-57 dBm	100 KHz
30 MHz to 12.75 GHz	-47 dBm	1 MHz

Test Procedure

The same as clause 4.1.8

Test Configuration

Effective Radiated Power measurement (30 MHz to 12.75 GHz)



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

- 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
- their effective radiated power when radiated by cabinet and antenna in case of Integral antenna equipment without 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).

**Test Results**

Remark: We test all modulation type, and recorded the worst case mode for GFSK test.

Fre. (MHz)	ANT. Pol.	ERP (dBm)	Limit	Margin	Conclusion
Below 1GHz:					
241.76	V	-76.56	-57	-19.56	PASS
277.23	V	-78.44	-57	-21.44	PASS
357.93	V	-75.49	-57	-18.49	PASS
427.04	V	-74.96	-57	-17.96	PASS
497.69	V	-77.75	-57	-20.75	PASS
864.12	V	-75.73	-57	-18.73	PASS
204.46	H	-74.49	-57	-17.49	PASS
347.49	H	-72.78	-57	-15.78	PASS
364.82	H	-73.59	-57	-16.59	PASS
477.27	H	-77.86	-57	-20.86	PASS
616.56	H	-75.47	-57	-18.47	PASS
865.83	H	-75.37	-57	-18.37	PASS
Note: 1.Cable loss and antenna gain was combined in the calculated result. 2.Other point of the measurements are below 20dB from the limit.					



Fre. (MHz)	ANT. Pol.	ERP (dBm)	Limit	Margin	Conclusion
Above 1GHz:					
Test Mode: Lowest frequency					
2157.86	H	-64.68	-47	-17.68	PASS
2162.09	V	-68.85	-47	-21.85	PASS
3162.78	H	-67.46	-47	-20.46	PASS
2970.67	V	-67.97	-47	-20.97	PASS
3259.68	H	-66.39	-47	-19.39	PASS
3544.97	V	-65.56	-47	-18.56	PASS
4055.39	H	-64.47	-47	-17.47	PASS
3917.27	V	-63.79	-47	-16.79	PASS
4754.94	H	-67.44	-47	-20.44	PASS
5064.84	V	-67.46	-47	-20.46	PASS
6346.87	H	-68.59	-47	-21.59	PASS
6266.77	V	-66.68	-47	-19.68	PASS
Test Mode: Highest frequency					
2269.75	H	-63.58	-47	-16.58	PASS
2136.17	V	-64.39	-47	-17.39	PASS
2243.39	H	-65.89	-47	-18.89	PASS
2430.51	V	-67.67	-47	-20.67	PASS
3390.45	H	-68.74	-47	-21.74	PASS
3453.78	V	-67.69	-47	-20.69	PASS
3842.85	H	-63.57	-47	-16.57	PASS
3912.86	V	-67.29	-47	-20.29	PASS
5273.96	H	-65.26	-47	-18.26	PASS
5311.39	V	-66.34	-47	-19.34	PASS
6342.67	H	-65.99	-47	-18.99	PASS
6455.08	V	-65.69	-47	-18.69	PASS
Note:					
1. Cable loss and antenna gain was combined in the calculated result.					
2. Other point of the measurements are below 20dB from the limit.					



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
$(-133 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}))$ or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
$(-139 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}))$ 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 $P_{\min} + 26 \text{ dB}$ 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 $P_{\min} + 20 \text{ dB}$ 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
$(-139 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}) + 10 \text{ dB})$ or $(-74 \text{ dBm} + 10 \text{ dB})$ whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
<p>NOTE 1: OCBW is in Hz.</p> <p>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 $P_{\min} + 26 \text{ dB}$ 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.</p> <p>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.</p>			

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
$(-139 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}) + 20 \text{ dB})$ or $(-74 \text{ dBm} + 20 \text{ dB})$ whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
<p>NOTE 1: OCBW is in Hz.</p> <p>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 $P_{\min} + 30 \text{ dB}$ 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.</p> <p>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.</p>			

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

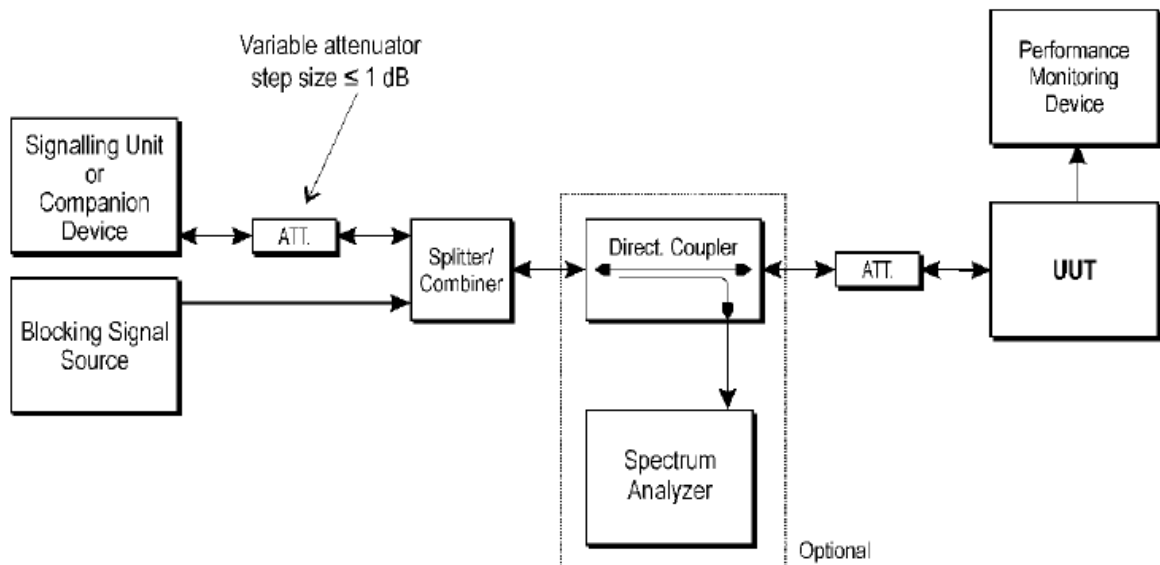


Figure 6: Test Set-up for receiver blocking

MEASUREMENT DESCRIPTION

According to ETSI EN 300 328 V2.2.1 (2019-04) §5.4.11.2.1, Conducted measurements

Step 1:

- For non-FHSS equipment, the UUT shall be set to the lowest operating channel on which the blocking test has to be performed (see clause 5.4.11.1).

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.



• Unless the option provided in note 2 of the applicable table referred to in clause 5.4.11.2.1 is used, the level of the wanted signal shall be set to the value provided in the table corresponding to the receiver category and type of equipment. The test procedure defined in clause 5.4.2, and more in particular clause 5.4.2.2.1.2, can be used to measure the (conducted) level of the wanted signal however no correction shall be made for antenna gain of the companion device (step 6 in clause 5.4.2.2.1.2 shall be ignored). This level may be measured directly at the output of the companion device and a correction is made for the coupling loss into the UUT. The actual level for the wanted signal shall be recorded in the test report.

• When the option provided in note 2 of the applicable table referred to in clause 5.4.11.2.1 is used, the attenuation of the variable attenuator shall be increased in 1 dB steps to a value at which the minimum performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is still met. The resulting level for the wanted signal at the input of the UUT is P_{min} . This signal level (P_{min}) is increased by the value provided in note 2 of the applicable 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.

• If the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 are met then proceed to step 6.

Step 5:

If the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is not met, step 3 and step 4 shall be repeated after that the frequency of the blocking signal set in step 2 has been increased with a value equal to the Occupied Channel Bandwidth except:

- For the blocking frequency 2 380 MHz, where this frequency offset shall be less than or equal to 10 MHz. If this frequency offset is more than 7 MHz, the level of the wanted signal shall be increased by 3 dB.

- For the blocking frequency 2 503,5 MHz, where this frequency offset shall be less than or equal to 10 MHz. If this frequency offset is more than 7 MHz, the level of the wanted signal shall be decreased by 3 dB.

• If the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is still not met, step 3 and step 4 shall be repeated after that the frequency of the blocking signal set in step 2 has been decreased with a value equal to the Occupied Channel Bandwidth except:

- For the blocking frequency 2 380 MHz, where this frequency offset shall be less than or equal to 10 MHz. If this frequency offset is more than 7 MHz, the level of the wanted signal shall be decreased by 3 dB.

- For the blocking frequency 2 503,5 MHz, where this frequency offset shall be less than or equal to 10 MHz. If this frequency offset is more than 7 MHz, the level of the wanted signal shall be increased by 3 dB.

• If the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is still not met, the UUT fails to comply with the Receiver Blocking requirement and step 6 and step 7 are no longer required.

• It shall be recorded in the test report whether the shift of blocking frequencies as described in the present step was used.

Step 6:

Repeat step 4 and step 5 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 7:

For non-FHSS equipment, repeat step 2 to step 6 with the UUT operating at the highest operating channel on which the blocking test has to be performed (see clause 5.4.11.1).

Step 8:

It shall be assessed and recorded in the test report whether the UUT complies with the Receiver Blocking requirement.

**TEST RESULTS**

Record GFSK for this test item

Channel 00@Result

Wanted signal mean power form companion device(dBm)	Blocking signal frequency(MHz)	Blocking signal power(dBm)	PER (%)	Limit (%)	Result
-59.64	2380	-34	1.66	10	Pass
-59.64	2504	-34	0.98	10	Pass
-59.64	2300	-34	0.87	10	Pass
-59.64	2584	-34	0.62	10	Pass

Channel 78@Result

Wanted signal mean power form companion device(dBm)	Blocking signal frequency(MHz)	Blocking signal power(dBm)	PER (%)	Limit (%)	Result
-59.69	2380	-34	1.04	10	Pass
-59.69	2504	-34	0.98	10	Pass
-59.69	2300	-34	1.54	10	Pass
-59.69	2584	-34	1.83	10	Pass

Note: EUT is Receiver Category 3 equipment.

Record $\pi/4$ DQPSK for this test item**Channel 00@Result**

Wanted signal mean power form companion device(dBm)	Blocking signal frequency(MHz)	Blocking signal power(dBm)	PER (%)	Limit (%)	Result
-58.27	2380	-34	0.93	10	Pass
-58.27	2504	-34	1.54	10	Pass
-58.27	2300	-34	1.43	10	Pass
-58.27	2584	-34	1.03	10	Pass

Channel 78@Result

Wanted signal mean power form companion device(dBm)	Blocking signal frequency(MHz)	Blocking signal power(dBm)	PER (%)	Limit (%)	Result
-58.27	2380	-34	0.94	10	Pass
-58.27	2504	-34	0.16	10	Pass
-58.27	2300	-34	1.23	10	Pass
-58.27	2584	-34	1.55	10	Pass

Note: EUT is Receiver Category 3 equipment.

**Record 8DPSK for this test item****Channel 00@Result**

Wanted signal mean power form companion device(dBm)	Blocking signal frequency(MHz)	Blocking signal power(dBm)	PER (%)	Limit (%)	Result
-58.26	2380	-34	1.56	10	Pass
-58.26	2504	-34	0.87	10	Pass
-58.26	2300	-34	1.22	10	Pass
-58.26	2584	-34	0.84	10	Pass

Channel 78@Result

Wanted signal mean power form companion device(dBm)	Blocking signal frequency(MHz)	Blocking signal power(dBm)	PER (%)	Limit (%)	Result
-58.25	2380	-34	1.37	10	Pass
-58.25	2504	-34	1.05	10	Pass
-58.25	2300	-34	0.42	10	Pass
-58.25	2584	-34	0.84	10	Pass

Note: EUT is Receiver Category 3 equipment.



4.1.12. Geo-location capability

Definition& Requirements

ETSI EN 300 328 (V2.2.2) Sub-clause 4.3.2.12.2&4.3.2.12.3

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.

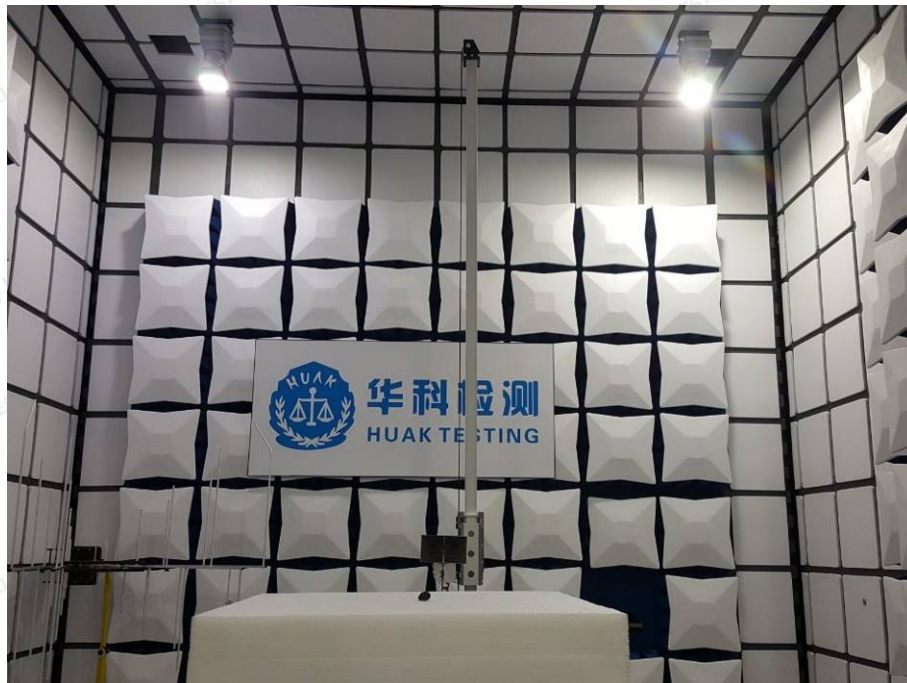
The geo-location capability may be present in the equipment or in an external device (temporary) associated with the equipment operating at the same geographical location during the initial power up of the equipment. The geographical location may also be available in equipment already installed and operating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

RESULTS

This equipment does not support Geo-location.



5. Test Setup Photos of the EUT



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6. External and Ceramic Photos of the EUT



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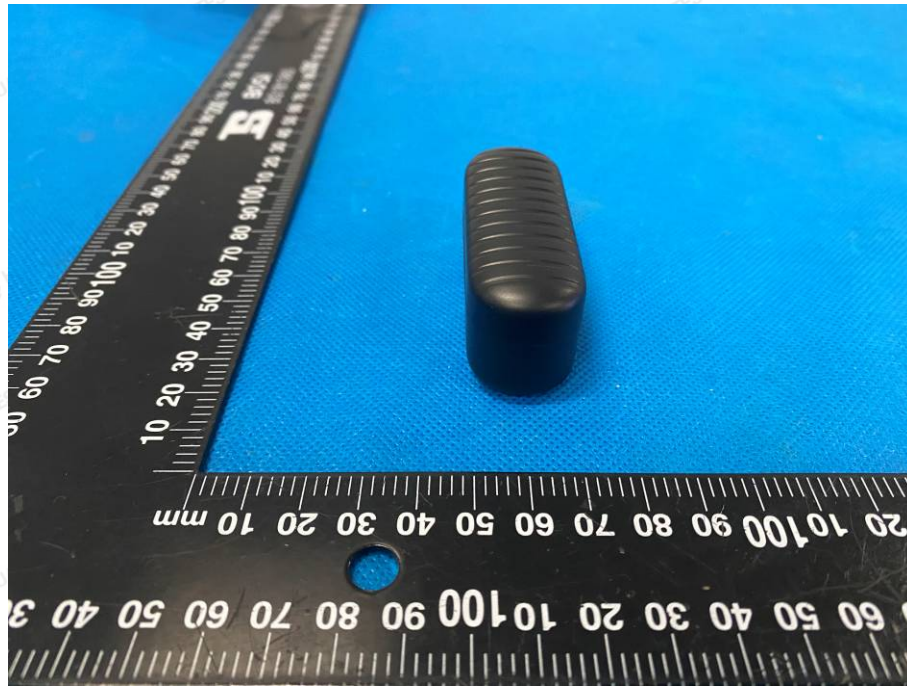
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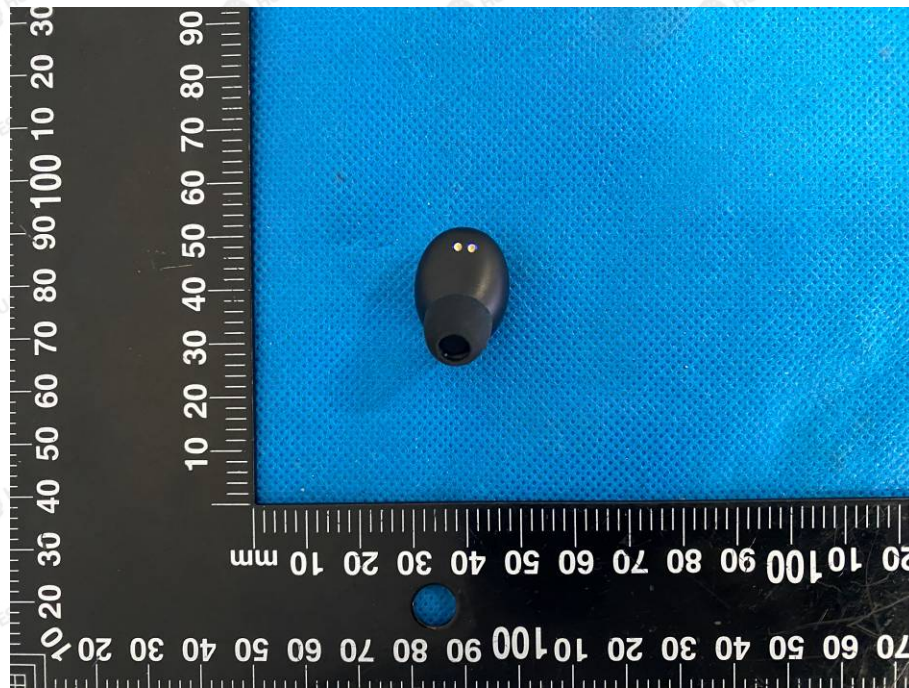
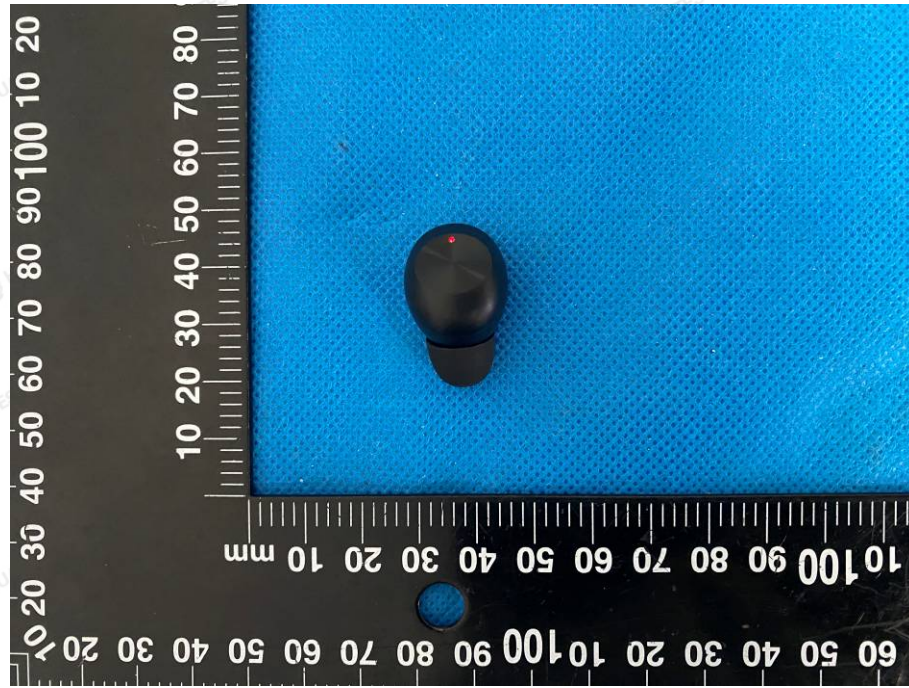
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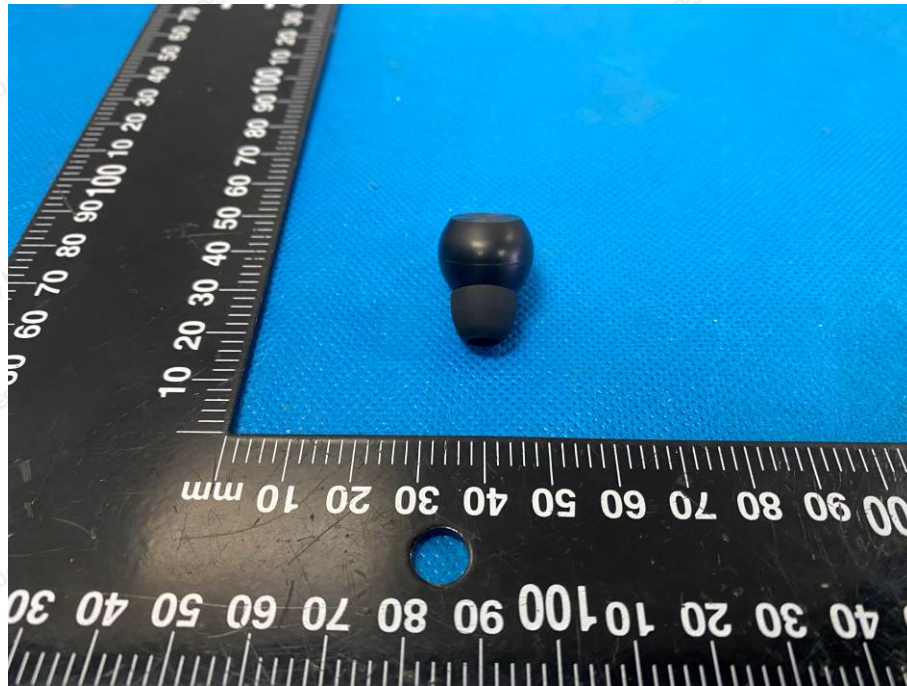
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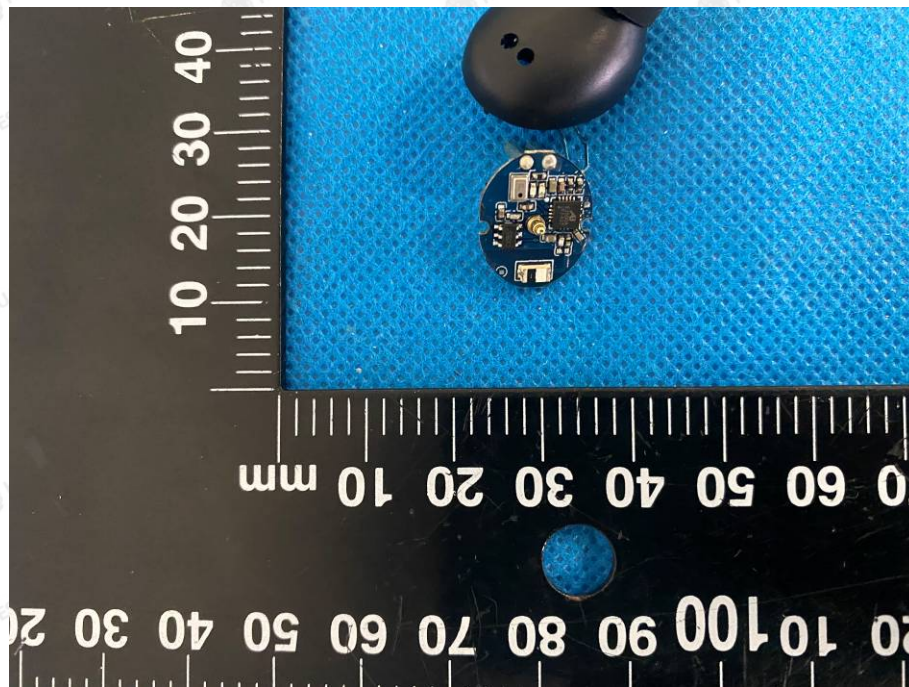
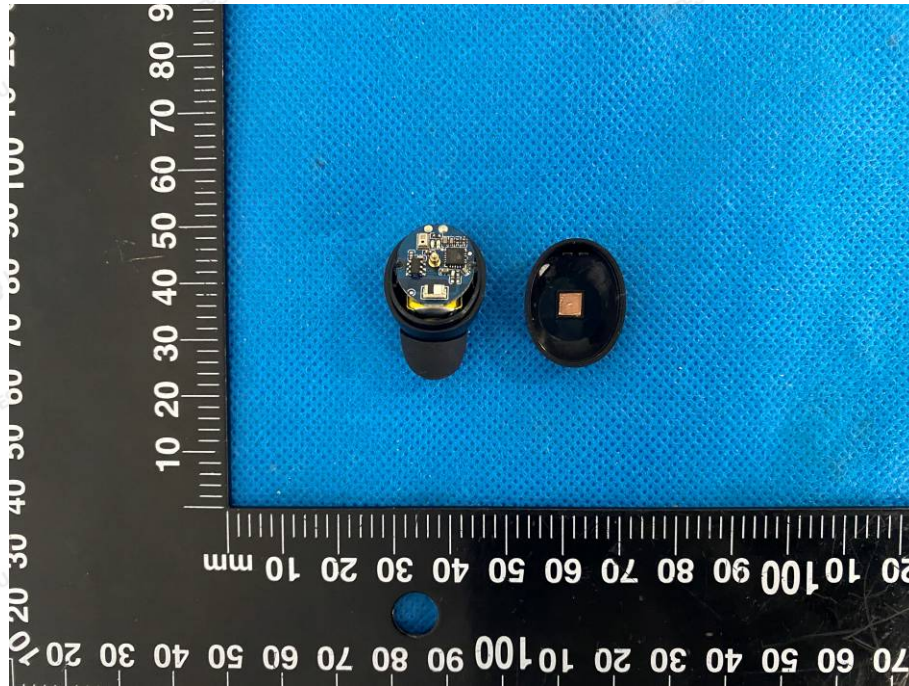
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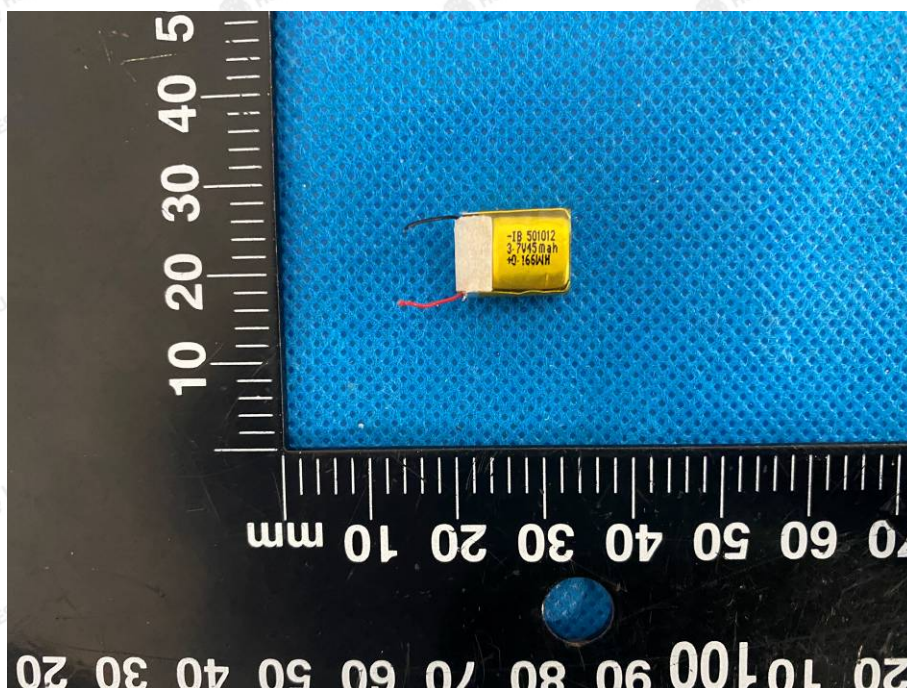
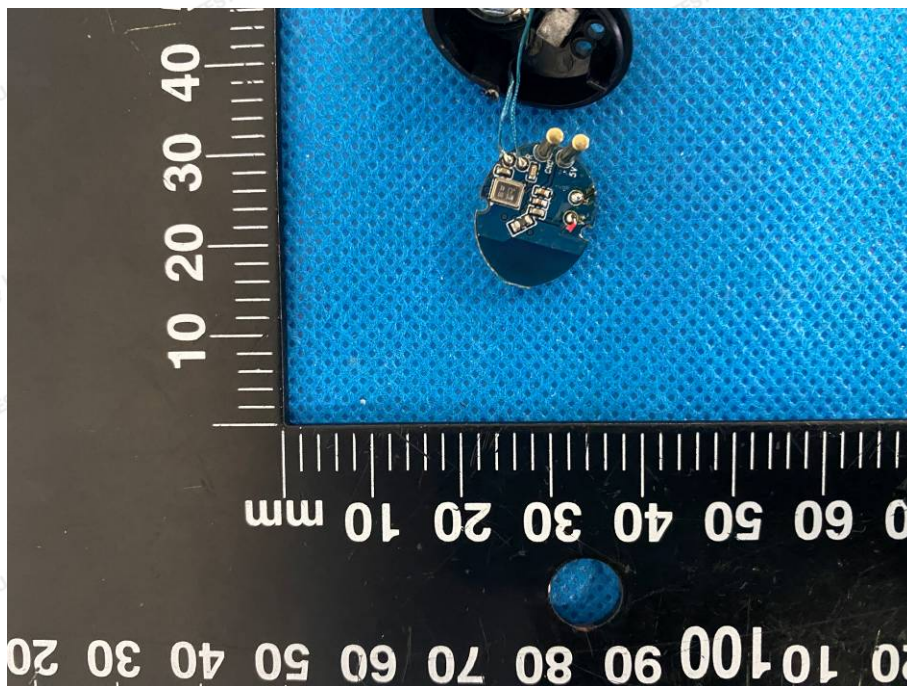
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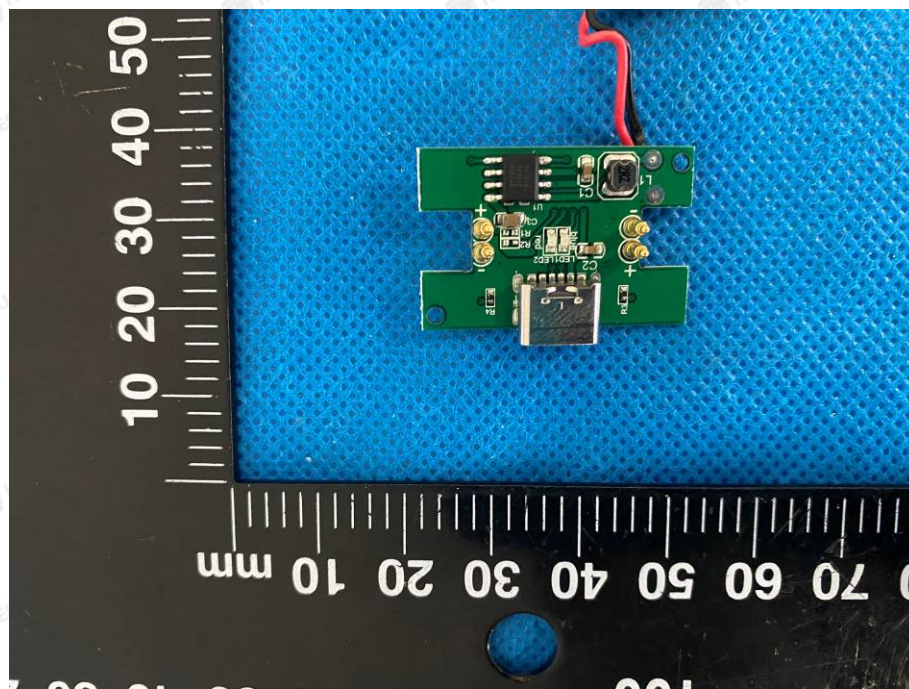
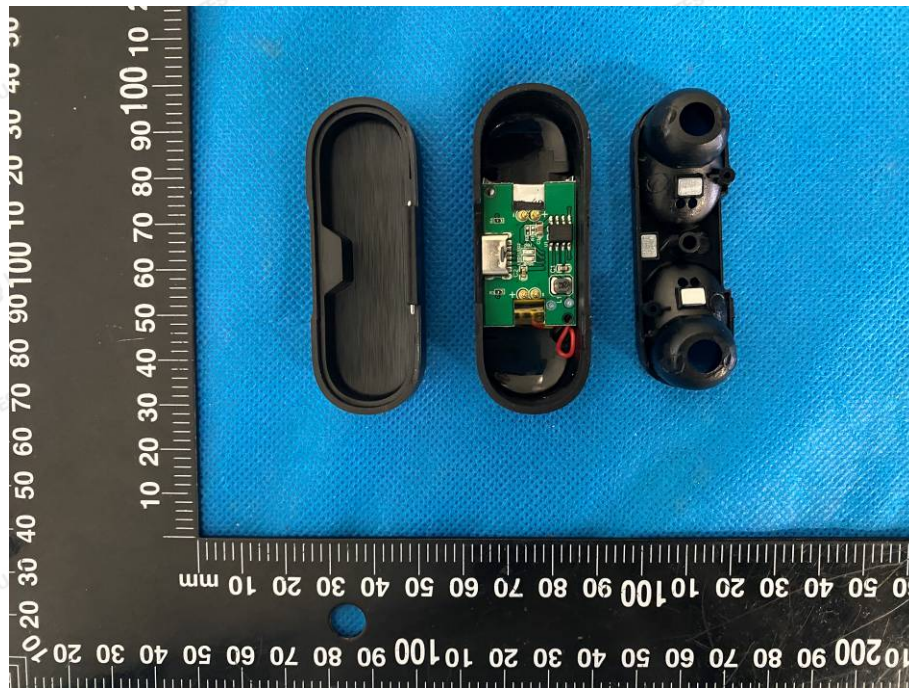
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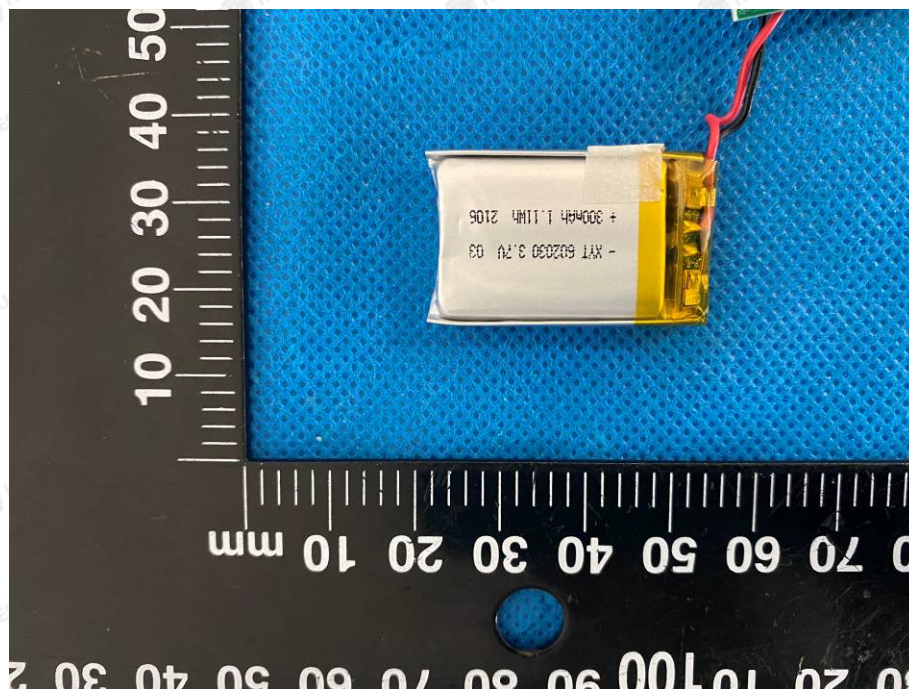
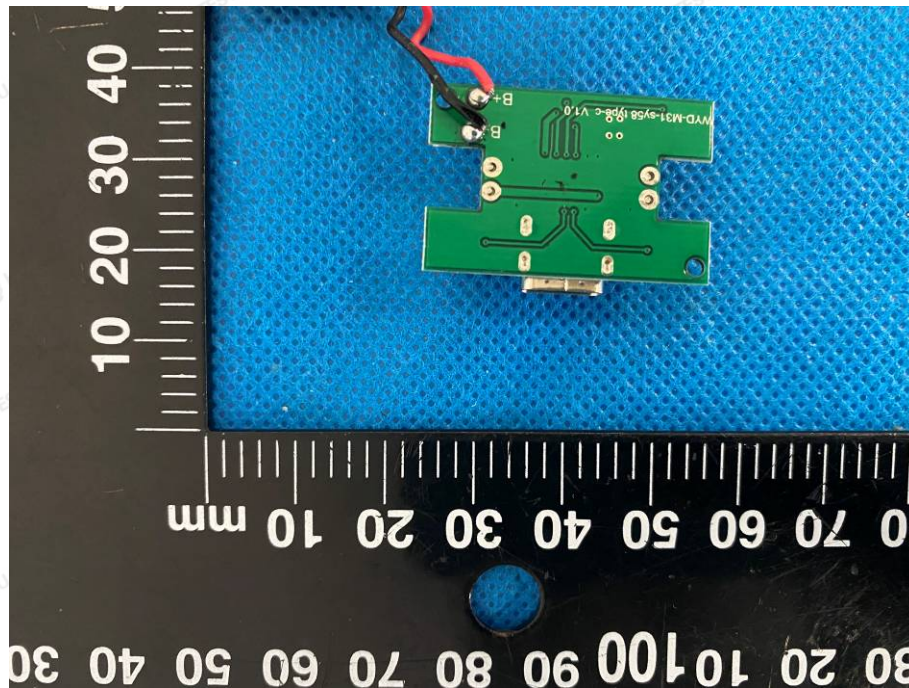


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.....End of Report.....

**ANNEX****a) The type of modulation used by the equipment:**☒ FHSS☐ other forms of modulation**b) In case of FHSS modulation:**

- In case of non-Adaptive Frequency Hopping equipment:

The number of Hopping Frequencies:

- In case of Adaptive Frequency Hopping Equipment:

The maximum number of Hopping Frequencies:

The minimum number of Hopping Frequencies:

The Dwell Time:

The Minimum Channel Occupation Time:

c) Adaptive / non-adaptive equipment:☐ non-adaptive Equipment☒ adaptive Equipment without the possibility to switch to a non-adaptive mode☐ adaptive Equipment which can also operate in a non-adaptive mode**d) In case of adaptive equipment:**

The Channel Occupancy Time implemented by the equipment: ms

☒ The equipment has implemented an LBT based DAA mechanism

- In case of equipment using modulation different from FHSS:

☐ The equipment is Frame Based equipment☒ The equipment is Load Based equipment☐ The equipment can switch dynamically between Frame Based and Load Based equipmentThe CCA time implemented by the equipment: μ s

The value q as referred to in clause 4.3.2.5.2.2

☐ The equipment has implemented an non-LBT based DAA mechanism☐ The equipment can operate in more than one adaptive mode**e) In case of non-adaptive Equipment:**

The maximum RF Output Power (e.i.r.p.): dBm

The maximum (corresponding) Duty Cycle: ...%

Equipment with dynamic behaviour, that behaviour is described here. (e.g. the different combinations of duty cycle and corresponding power levels to be declared):

f) The worst case operational mode for each of the following tests:

- RF Output Power

GFSK, π /4DQPSK, 8DPSK

- Power Spectral Density

GFSK, π /4DQPSK, 8DPSK

- Duty cycle, Tx-Sequence, Tx-gap

GFSK, π /4DQPSK, 8DPSK

- Dwell time, Minimum Frequency Occupation & Hopping Sequence (only for FHSS equipment)

GFSK, π /4DQPSK, 8DPSK

- Hopping Frequency Separation (only for FHSS equipment)

GFSK, π /4DQPSK, 8DPSK

- Medium Utilisation

GFSK, π /4DQPSK, 8DPSK

- Adaptivity & Receiver Blocking

- Occupied Channel Bandwidth

GFSK, π /4DQPSK, 8DPSK

- Transmitter unwanted emissions in the OOB domain

GFSK, π /4DQPSK, 8DPSK

- Transmitter unwanted emissions in the spurious domain

GFSK, π /4DQPSK, 8DPSK

- Receiver spurious emissions

GFSK, π /4DQPSK, 8DPSK

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**g) The different transmit operating modes (tick all that apply):****■ Operating mode 1: Single Antenna Equipment****■ Equipment with only 1 antenna**☐ Equipment with 2 diversity antennas but only 1 antenna active at any moment in time☐ Smart Antenna Systems with 2 or more antennas, but operating in a (legacy) mode where only 1 antenna is used. (e.g. IEEE 802.11™ [i.3] legacy mode in smart antenna systems)☐ Operating mode 2: Smart Antenna Systems - Multiple Antennas without beam forming☐ Single spatial stream / Standard throughput / (e.g. IEEE 802.11™ [i.3] legacy mode)☐ High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 1☐ High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 2

NOTE: Add more lines if more channel bandwidths are supported.

☐ Operating mode 3: Smart Antenna Systems - Multiple Antennas with beam forming☐ Single spatial stream / Standard throughput (e.g. IEEE 802.11™ [i.3] legacy mode)☐ High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 1☐ High Throughput (> 1 spatial stream) using Occupied Channel Bandwidth 2

NOTE: Add more lines if more channel bandwidths are supported.

h) In case of Smart Antenna Systems:

• The number of Receive chains:

• The number of Transmit chains:

☐ symmetrical power distribution☐ asymmetrical power distribution

In case of beam forming, the maximum beam forming gain:

NOTE: Beam forming gain does not include the basic gain of a single antenna.

i) Operating Frequency Range(s) of the equipment:

• Operating Frequency Range 1: 2402 MHz to 2480 MHz

• Operating Frequency Range 2: MHz to MHz

NOTE: Add more lines if more Frequency Ranges are supported.

j) Occupied Channel Bandwidth(s):☐ Occupied Channel Bandwidth 1: 1.189MHz☐ Occupied Channel Bandwidth 2: MHz

NOTE: Add more lines if more channel bandwidths are supported.

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

Other

l) The extreme operating conditions that apply to the equipment:

Operating temperature range: -10° C to 40° C

Operating voltage range: 3.145V to 4.255V ☐ AC **■** DCDetails provided are for the: **■** stand-alone equipment☐ combined (or host) equipment☐ test jig**m) The intended combination(s) of the radio equipment power settings and one or more antenna assemblies and their corresponding e.i.r.p levels:**

• Antenna Type

■ Integral Antenna

Antenna Gain: 0dBi

If applicable, additional beam forming gain (excluding basic antenna gain): dB

☐ Temporary RF connector provided



- ☐ No temporary RF connector provided
☐ Dedicated Antennas (equipment with antenna connector)
☐ Single power level with corresponding antenna(s)
☐ Multiple power settings and corresponding antenna(s)

Number of different Power Levels:

Power Level 1: dBm

Power Level 2: dBm

Power Level 3: dBm

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

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

For each of the Power Levels, provide the intended antenna assemblies, their corresponding gains (G) and the

resulting e.i.r.p. levels also taking into account the beamforming gain (Y) if applicable

Power Level 1: -1.96dBm

Number of antenna assemblies provided for this power level:

Assembly #	Gain (dBi)	e.i.r.p. (dBm)	Part number or model name
1	0	-1.96	
2			
3			
4			

NOTE 3: Add more rows in case more antenna assemblies are supported for this power level.

Power Level 2: dBm

Number of antenna assemblies provided for this power level:

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

NOTE 4: Add more rows in case more antenna assemblies are supported for this power level.

Power Level 3: dBm

Number of antenna assemblies provided for this power level:

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

NOTE 5: Add more rows in case more antenna assemblies are supported for this power level.

n) The nominal voltages of the stand-alone radio equipment or the nominal voltages of the combined (host)equipment or test jig in case of plug-in devices:

Details provided are for the: ☒ stand-alone equipment

☐ combined (or host) equipment

☐ test jig

Supply Voltage ☐ AC mains State AC voltage:

☒ DC State DC voltage : DC 3.7V

In case of DC, indicate the type of power source

☐ Ceramic Power Supply

☒ External Power Supply or AC/DC Adapter

☒ Battery: DC 3.7V

☐ Other:

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

p) The equipment type (e.g. Bluetooth®, IEEE 802.11™ [i.3], proprietary, etc.):

Other: NO FHSS

q) If applicable, the statistical analysis referred to in clause 5.4.1 q)

Not apply

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by HUAKE, this document cannot be reproduced except in full with our prior written permission. The more details and the authenticity of the report will be confirmed at <http://www.cer-mark.com>.



r) If applicable, the statistical analysis referred to in clause 5.4.1 r)
Not apply

s) Geo-location capability supported by the equipment:

☐ Yes

☐ The geographical location determined by the equipment as defined in clause 4.3.1.13.2 or clause 4.3.2.12.2 is not accessible to the user

☒ No

t) Describe the minimum performance criteria that apply to the equipment (see clause 4.3.1.12.3 or clause 4.3.2.11.3):

The minimum performance criterion shall be a PER less than or equal to 10 %.
The intended use of the equipment should be in the normal operation without lost the communication link or no unintentionally operation occurs.