



# Shenzhen Asia Test Technology Co., Ltd.

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# TEST REPORT

## ETSI EN 300 328

Equipment under Test : Extending Bluetooth Controller

Model /Type : PG-9023

Listed Models : N/A

**Applicant** : Pega Limited

Address : Unit 10A, 12/F, Tower 2, China HK City, 33 Canton Road, Tsim Sha Tsui, Hong Kong

**Manufacturer** : Shenzhen IPEGA Electronics Technology Co., Ltd

Address : 1-3/F, Building 4A, ipega Industrial Zone, Block 88, Long Wang Miao Industrial Zone, Bai Shi Xia, Fuyong Town, Baoan District, Shenzhen City, China

**Laboratory** : **Shenzhen Asia Test Technology Co.,Ltd.**

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Website : www.att-lab.cn

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.

<b>Test Result:</b>	<b>PASS</b>
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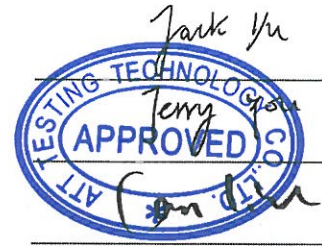
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Date of issue ..... : Mar. 12, 2015



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Address ..... : 7 / F, Xinwei Building, Gushu Village, Xixiang Town, Baoan District, Shenzhen, China

**Testing Laboratory Name** ..... : **Shenzhen Asia Test Technology Co.,Ltd.**

Address ..... : 7 / F, Xinwei Building, Gushu Village, Xixiang Town, Baoan District, Shenzhen, China

**Applicant's name** ..... : Pega Limited

Address ..... : Unit 10A, 12/F, Tower 2, China HK City, 33 Canton Road, Tsim Sha Tsui, Hong Kong

**Test specification**..... :

Standard ..... : **ETSI EN 300 328 V1.8.1: 2012-06**

TRF Originator ..... : Shenzhen Asia Test Technology Co.,Ltd..

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**Test item description**..... : Extending Bluetooth Controller

Trade Mark..... : ipega

Manufacturer..... : Shenzhen IPEGA Electronics Technology Co., Ltd

Model/Type reference..... : PG-9023

List Model..... : N/A

Modulation Type ..... : GFSK

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

Ratings..... : DC 3.7V(Li-battery)  
DC 5V(for charge by USB)

Hardware version..... : N/A

Software version ..... : N/A

Result..... : **PASS**



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# 1. TEST STANDARDS

The tests were performed according to following standards:

[ETSI EN 300 328 V1.8.1\(2012-06\)](#) –Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive

# 2. SUMMARY

## 2.1. General Remarks

Date of receipt of test sample	:	Mar. 05, 2015
Testing commenced on	:	Mar. 06, 2015
Testing concluded on	:	Mar. 12, 2015

## 2.2. Product Description

The **Pega Limited's** Model: PG-9023 or the "EUT" as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

Name of EUT	Extending Bluetooth Controller
Model Number	PG-9023
Antenna Type	Internal
BT CE Operation frequency	2402MHz-2480MHz
BT Modulation Type	GFSK
Hardware version	N/A
Software version	N/A
Bluetooth	Supported v3.0

## 2.3. Equipment Under Test

### Power supply system utilised

Power supply voltage	:	<input type="radio"/> 120V / 60 Hz	<input type="radio"/> 115V / 60Hz
		<input type="radio"/> 12 V DC	<input type="radio"/> 24 V DC
		<input checked="" type="radio"/> Other (specified in blank below)	

DC 3.70V

### Description of the test mode

Bluetooth 3.0: 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



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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
	Bandwidth appr. 1MHz, 1,5 MHz, 1.5 MHz for single hop frequency
	number of hopping channels > 15 all the time
	more than 70% of band used with more than 20 channels

## 2.5. EUT Classification:

Type of equipment:	<input checked="" type="checkbox"/>	stand alone equipment
	<input type="checkbox"/>	plug in radio equipment

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	<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 type="checkbox"/>	Yes, LBT-based
	<input checked="" 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

<input type="checkbox"/>	Power Cable	Length (m) :	/
		Shield :	/
		Detachable :	/
<input type="checkbox"/>	Multimeter	Manufacturer :	/
		Model No. :	/

### 2.7. Modifications

No modifications were implemented to meet testing criteria.



### 3. TEST ENVIRONMENT

#### 3.1. Address of the test laboratory

Shenzhen Asia Test Technology Co.,Ltd.

7 / F, Xinwei Building, Gushu Village, Xixiang Town, Baoan District, Shenzhen, 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: 25 °C
- High Temperature: 55 °C
- Low Temperature: -20 °C
- Normal Voltage : DC 3.70V
- High Voltage:DC 4.20v
- Low Voltage:DC 3.50V
- Relative Humidity: 55 %
- Air Pressure: 989 hPa

#### 3.3. Configuration of Tested System

Fig. 2-1 Configuration of Tested System

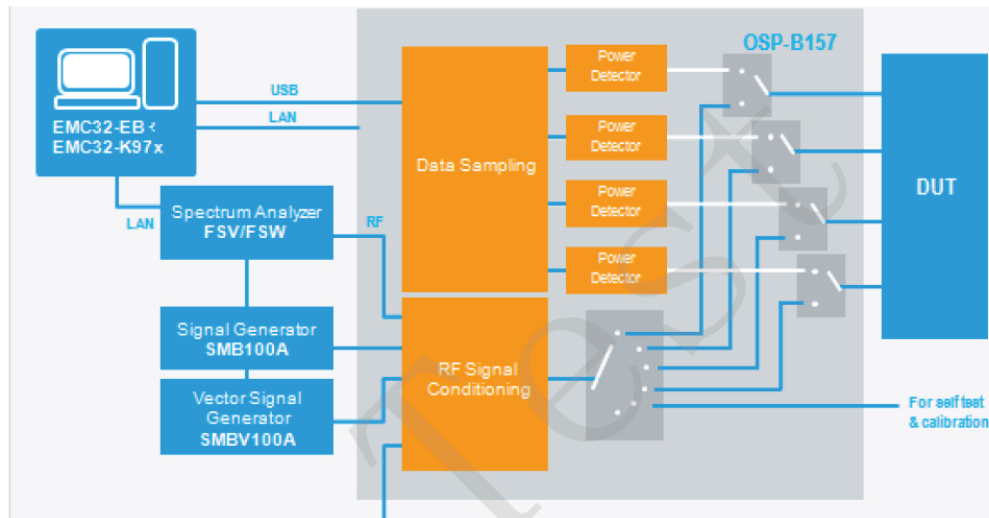


Table 2-1 Equipment Used in Tested System

#### Adapter 1:

- Mode: YM05000700U
- Input:AC 100-240V~50/60Hz 0.1A
- Output:DC 5.0V DC 700mA
- ◇ Shielded      ◆ Unshielded



### 3.4. Test setting of system:

Setting	Value
Modulation	FHSS
Adaptive	Yes
Number Of Transmission Chains	1
Antenna Gain Port 1	0 dBi
Beamforming Gain	0 dB
Nominal Channel Bandwidth	1 MHz
Maximum EIRP	20 dBm
Attenuation / Pathloss File Port 1	DUT cable 12.75Ghz_10dB
Spurious Tx Receiver reference level below power	20 dB
power measurement for radiated	No
DUT Port Occupied Channel Bandwidth	1
LBT Based	Yes
Dual Mode	No
Short Signaling	Yes
CCA	20 us
DUT Port Adaptivity	1
Channel Occupation Time	15 ms
Minimum Number of Hopping Frequencies	15
Maximum Number of Hopping Frequencies	79
Number of active Hopping Frequencies	79
Number of Blacklisted Hopping Frequencies	0
Hopping Frequency Separation	1 MHz
Dwell Time	15 ms
Maximum Dwell Time	400 ms
DUT Port Dwell Time	1
Maximum final spurious measurements	3



### 3.5. Test Description

#### 3.5.1 Main Terms

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

#### 3.5.2 Terms used in Condition column

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

#### 3.5.3 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.

#### 3.5.4 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
5.3.2	RF output power	NTC	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		LT		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		HT		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.3.2	Duty Cycle, Tx-sequence, Tx-gap	NTC	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
5.3.4	Dwell time, min Freq. Occupation and Hopping sequence	NTC	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.3.5	Hopping Separation	NTC	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.3.2	Medium Utilisation	NTC	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
5.3.7	Adaptivity, Short Control	NTC	GFSK	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	



	Signalling Transmissions							
5.3.8	Occupied Channel Bandwidth	NTC	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.3.9	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		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		HT		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.3.10	Transmitter unwanted emissions in the spurious domain (conducted & radiated)	NTC	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.3.11	Receiver spurious emissions (conducted & radiated)	NTC	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.3.7	Receiver Blocking	NTC	----	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

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

### 3.6. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics;Part 1" and TR-100028-02 "Electromagnetic compatibilityand Radio spectrum Matters (ERM);Uncertainties in the measurementof mobile radio equipment characteristics;Part 2 " and is documented in the Jiangsu Provincial Supervising & Testing Institute for Products Quality 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 Jiangsu Provincial Supervising & Testing Institute for Products Quality is reported:

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



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

### 3.7. Equipments Used during the Test

#### Details for Radiated emissions test equipment

Item	Test Equipment	Manufacturer	Model No.	Number	Last Cal.
1	EMI Test Receiver	Rohde&Schwarz	ESU40	NTIe-511-011-01-P	2014/08/14
2	RF Test Panel	Rohde&Schwarz	OSP120	NTIe-511-011-23-P	N/A
3	EMI Test Software	Rohde&Schwarz	EMC32	N/A	N/A
4	Signal Genertor	Rohde&Schwarz	SMB100A	NTIe-511-011-02-P	2014/08/14
5	Signal Genertor	Rohde&Schwarz	SMB100A	NTIe-511-011-03-P	2014/08/14
6	Universal Radio Communication Tester	Rohde&Schwarz	CMU200	NTIe-511-011-04-P	2014/08/14
7	Wideband Radio Communication Tester	Rohde&Schwarz	CMW500	NTIe-511-011-29-P	2014/08/14
8	Bluetooth Communication Tester	Rohde&Schwarz	CBT 32	NTIe-511-011-04-P	2014/08/14
9	Broadband Antenna	Schwarzbeck	VULB 9163	NTIe-511-011-09-P	2014/08/14
10	Horn Antenna	Rohde&Schwarz	HF907	NTIe-511-011-10-P	2014/08/14
11	Pre-amplifier	Rohde&Schwarz	SCU18	NTIe-511-011-11-P	2014/08/14
12	Horn	ETS	3160-09	NTIe-511-011-15-P	2014/08/14
13	Horn	ETS	3160-09	NTIe-511-011-16-P	2014/08/14
14	Horn	ETS	3160-10	NTIe-511-011-17-P	2014/08/14
15	Horn	ETS	3160-10	NTIe-511-011-18-P	2014/08/14
16	Pre-amplifier	Rohde&Schwarz	SCU26	NTIe-511-011-19-P	2014/08/14
17	Pre-amplifier	Rohde&Schwarz	SCU40	NTIe-511-011-20-P	2014/08/14
18	Vector Signal Generator	Rohde&Schwarz	SMU200A	NTIe-511-011-24-P	2014/08/14

#### Details for Conducted test equipment

Item	Test Equipment	Manufacturer	Model No.	Number	Last Cal.
1	Power Sensor	Rohde&Schwarz	OSP-B157	NTIe-511-051-01-P	2014/07/01
2	Bluetooth Communication Tester	Rohde&Schwarz	CBT 32	NTIe-511-011-04-P	2014/07/01
3	EMI Test Software	Rohde&Schwarz	EMC32	N/A	N/A
4	MXA Signal Analyzer	Agilent	N9020A	NTIe-511-051-02-P	2014/07/01
5	Signal Genertor	Rohde&Schwarz	SMB100A	NTIe-511-011-03-P	2014/07/01
6	Vector Signal Generator	Rohde&Schwarz	SMU200A	NTIe-511-011-24-P	2014/07/01

The Cal. Interval was one year.



## 4. TEST CONDITIONS AND RESULTS

### 4.1. ETSI EN 300 328 REQUIREMENTS

#### 4.1.1. RF Output Power

##### LIMIT

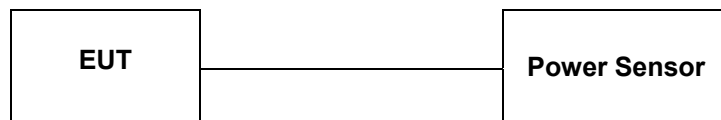
##### **ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.1.1.2**

The maximum RF output power for adaptive Frequency Hopping equipment shall be equal to or less than 20 dBm.

The maximum RF output power for non-adaptive Frequency Hopping equipment, shall be declared by the supplier. See clause 5.3.1 m). The maximum RF output power for this equipment shall be equal to or less than the value declared by the supplier. This declared value shall be equal to or less than 20 dBm.

The RF output power is defined as the mean equivalent isotropically radiated power (e.i.r.p.) of the equipment during a transmission burst.

##### TEST CONFIGURATION



##### TEST PROCEDURE

Please refer to ETSI EN 300 328 (V1.8.1) Sub-clause 5.3.2.2.1.1

##### **Step 1:**

- Use a fast power sensor suitable for 2.4 GHz and capable of 1 MS/s.
  - Use the following settings:
    - Sample speed 1 MS/s or faster.
    - The samples must represent the power of the signal.
    - Measurement duration: For non-adaptive equipment: equal to the observation period defined in clauses 4.3.1.2.1 or 4.3.2.3.1. For adaptive equipment, the measurement duration shall be long enough to ensure a minimum number of bursts (at least 10) are captured.
- NOTE 1: For adaptive equipment, to increase the measurement accuracy, a higher number of bursts may be used.

##### **Step 2:**

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

##### **Step 3:**

- Find the start and stop times of each burst in the stored measurement samples.
- NOTE 2: The start and stop times are defined as the points where the power is at least 20 dB below the RMS burst power calculated in step 4.

##### **Step 4:**

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

##### **Step 5:**

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



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## Step 6:

- Add the (stated) antenna assembly gain "G" in dBi of the individual antenna.
- If applicable, add the additional beamforming gain "Y" in dB.
- If more than one antenna assembly is intended for this power setting, the maximum overall antenna gain (G or G + Y) shall be used.
- The RF Output Power (P) shall be calculated using the formula below:  

$$P = A + G + Y$$
- This value, which shall comply with the limit given in clauses 4.3.1.1.2 or 4.3.2.1.2, shall be recorded in the test report.

## EUT DESCRIPTION:

Mode:	BT Test mode
Hopping:	On
Packet Type:	Longest supported
Modulation:	GFSK

## 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 bust 315) Test Mode:GFSK Mode				
Antenna Gain: 0.00 dBi		Test Method: Conducted		
Test Condition		Maximum conducted Burst Power (RMS) [dBm]		
Test environmental				
Temperature ( °C )	Voltage ( V )	Measured Power (dBm)	Antenna Gain(dBi)	EIRP (dBm)
T Nor ( 25°C )	3.70	2.89	0.00	2.89
T min ( -20°C )	3.70	2.88	0.00	2.88
T Max ( +55°C )	3.70	2.76	0.00	2.76
<b>Result</b>		<b>Pass</b>		
<b>Limit</b>		<b>20dBm</b>		

Note :1. Measured Power include the cable loss.



#### 4.1.2. Duty Cycle, TX-sequence, TX-gap (Not Applicable)

##### LIMIT

##### **ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.1.2**

For non-adaptive FHSS equipment, the Duty Cycle shall be equal to or less than the maximum value declared by the supplier. In addition, the maximum Tx-sequence time shall be 5 ms while the minimum Tx-gap time shall be 5 ms.

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

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

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 (V1.8.1) Sub-clause 5.3.2.2.1.2**

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 5.3.2.2.1.1.

##### **Step 2:**

- Between the saved start and stop times of each individual burst, calculate the TxOn time. Save these TxOn values.
- Between the saved stop and start times of two subsequent bursts, calculate the TxOff time. Save these TxOff values.

##### **Step 3:**

- Duty Cycle is the sum of all TxOn times divided by the observation period defined in clauses 4.3.1.2.1 or 4.3.2.3.1.
- For equipment using blacklisting, the TxOn time measured for a single (and active) hopping frequency shall be multiplied by the number of blacklisted frequencies. This value shall be added to the sum calculated in the previous bullet point. If the number of blacklisted frequencies cannot be determined, the minimum number of hopping frequencies as defined in clause 4.3.1.3.2 shall be assumed.
- The above calculated value for Duty Cycle shall be recorded in the test report. This value shall be equal to or less than the maximum value declared by the supplier.

##### **Step 4:**

- Any TxOff time that is greater than the minimum Tx-gap time is considered a Tx-gap. The lowest Tx-gap time shall be recorded in the test report. The minimum Tx-gap time is defined in clauses 4.3.1.2.2 or 4.3.2.3.2.
- The Tx-sequence time is the time between two subsequent Tx-gaps. The maximum Tx-sequence time shall be recorded in the test report. Any Tx-sequence shall be shorter than the value defined in clauses 4.3.1.2.2 or 4.3.2.3.2.

##### EUT DESCRIPTION:

Mode:	BT Test mode
Hopping:	On
Packet Type:	Longest supported
Modulation:	GFSK



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



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

##### LIMIT

##### **ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.1.3.2.2**

##### **Adaptive frequency hopping systems:**

Adaptive Frequency Hopping systems shall be capable of operating over a minimum of 70 % of the band specified in clause 1.

The maximum accumulated dwell time on any hopping frequency shall be 400 ms within any period of 400 ms multiplied by the minimum number of hopping frequencies (N) that have to be used.

The hopping sequence(s) shall contain at least N hopping frequencies at all times, where N is 15 or 15 divided by the minimum Hopping Frequency Separation in MHz, whichever is the greater.

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.

##### TEST PROCEDURE

##### **Please refer to ETSI EN 300 328 (V1.8.1) Sub-clause 5.3.4.2**

These measurements shall only be performed at normal test conditions.

##### **Step 1:**

- The output of the transmitter shall be connected to a spectrum analyzer or equivalent.
- The analyzer shall be set as follows:
  - Centre Frequency: Equal to the hopping frequency being investigated
  - Frequency Span: 0 Hz
  - RBW: 500kHz
  - VBW: 1MHz
  - Detector Mode: RMS
  - Sweep time: Equal to the Dwell Time × Minimum number of hopping frequencies (N) (see clause 4.3.1.3.2)
  - 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 Dwell Time which shall comply with the limit provided in clauses 4.3.1.3.2.1 or 4.3.1.3.2.2 and which shall be recorded in the test report.

##### **Step 5:**

- Make the following changes on the analyzer and repeat steps 2 and 3.

Sweep time: 4 × Dwell Time × Actual number of hopping frequencies in use

The hopping frequencies occupied by the system 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 can not be determined (number of blacklisted frequencies unknown) it shall be assumed that the equipment uses the minimum number of hopping frequencies as defined in clauses 4.3.1.4.2.1 or 4.3.1.4.2.2.



- The result shall be compared to the limit for the Minimum Frequency Occupation Time defined in clauses 4.3.1.3.2.1 or 4.3.1.3.2.2. This value shall be recorded in the test report.

**Step 6:**

- Make the following changes on the analyzer:

Start Frequency: 2 400 MHz  
Stop Frequency: 2 483.5 MHz  
RBW: 500kHz  
VBW: 1MHz  
Detector Mode: RMS  
Sweep time: Auto  
Trace Mode: Max Hold  
Trigger: Free Run

- When the trace has completed, identify the number of hopping frequencies used by the hopping sequence.
- The result shall be compared to the limit (value N) defined in clauses 4.3.1.3.2.1 or 4.3.1.3.2.2. This value shall be recorded in the test report.

For equipment with blacklisted frequencies, it might not be possible to verify the number of hopping frequencies in use. However they shall comply with the requirement for accumulated Dwell time and Minimum Frequency Occupation Time assuming the minimum number of hopping frequencies defined in clauses 4.3.1.3.2.1 or 4.3.1.3.2.2 are in use.

**Step 7:**

- For adaptive systems, using the lowest and highest -20 dB points from the total spectrum envelope obtained in step 6, it shall be verified whether the system uses 70 % of the band specified in clause 1. The result shall be recorded in the test report.

**EUT DESCRIPTION:**

***Dwell Time:***

Definition: The Dwell Time is the time that a particular hopping frequency would be occupied by the transmitter during a single hop. The equipment itself is not required to transmit on this hopping frequency during the Dwell Time.

***Minimum Frequency Occupation Time:***

Definition: The Minimum Frequency Occupation Time is the minimum time each hopping frequency shall be occupied within a given period.

Requirement: The Minimum Frequency Occupation Time shall be equal to one dwell time within a period

***Hopping Sequence:***

Definition: The Hopping Sequence of a Frequency Hopping system is the unrepeated pattern of the hopping frequencies used by the equipment.

Requirement a): The hopping sequence(s) shall contain at least N hopping frequencies at all times, where N is 15 or 15 divided by the minimum Hopping Frequency Separation in MHz, whichever is the greater.

According to the Bluetooth Core Specification physical channels use at least  $N_{min} = 20$  RF channels

Requirement b): Adaptive Frequency Hopping systems shall be capable of operating over a minimum of 70 % of the band.

Bandwidth ISM Band: 83.5 MHz, Used Bandwidth: 79MHz



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### TEST RESULTS

#### *Dwell Time:*

DH5	Frequency (MHz)	Accumulated Dwell Time (ms)	Limit (ms)	Measurement Time (ms)	Result
	2402.032641	80.003	400	6000.000	PASS
	2480.017025	64.602	400	6000.000	PASS

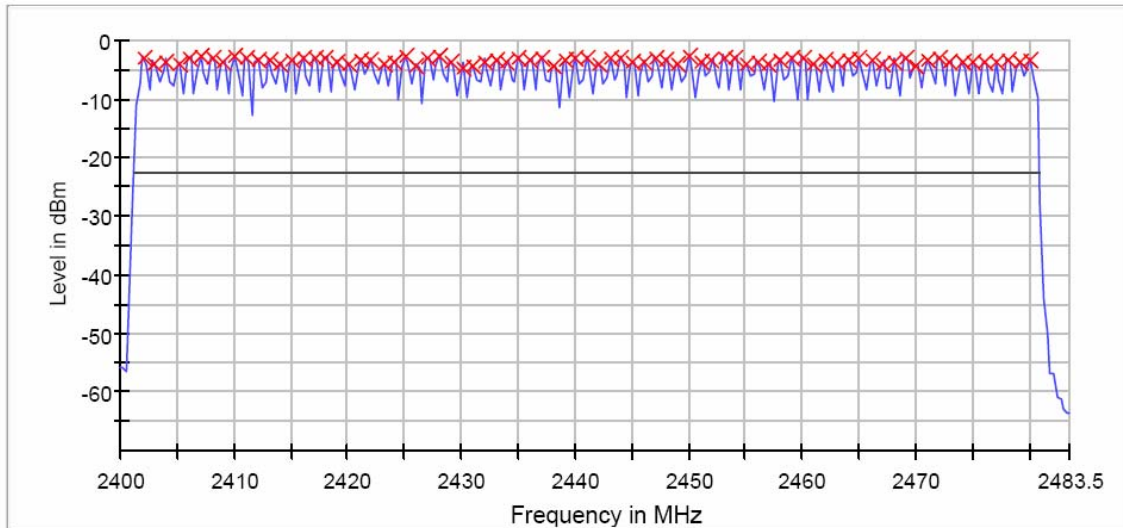
#### *Minimum Frequency Occupation Time:*

DH5	Frequency (MHz)	Minimum Frequency Occupation (ms)	Limit (ms)	Measurement Time (ms)	Result
	2402.032641	60.358	> 0	4740.000	PASS
	2480.017025	42.503	> 0	4740.000	PASS



### Hopping Sequence:

DH5	Number of Hopping Frequencies	Limit	Band Allocation (%)	Limit Band Allocation (%)	Result
	79	$\geq 16$	94	$\geq 70$	PASS





#### 4.1.4. Hopping Frequency Separation

##### LIMIT

##### ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.1.4.2.2

For Adaptive frequency hopping systems, The minimum Hopping Frequency Separation shall be 100 kHz. These measurements shall only be performed at normal test conditions and the measurement shall be performed on 2 adjacent hopping frequencies. The frequencies on which the test was performed shall be recorded

##### TEST PROCEDURE

##### Please refer to ETSI EN 300 328 (V1.8.1) Sub-clause 5.3.5.2

##### *Option 1*

##### Step 1:

- The output of the transmitter shall be connected to a spectrum analyzer or equivalent.
- The analyzer shall be set as follows:  
Centre Frequency: Centre of the two adjacent hopping frequencies  
Frequency Span: Sufficient to see the complete power envelope of both hopping frequencies  
RBW: 30KHz  
VBW: 100KHz  
Detector Mode: RMS  
Trace Mode: Max Hold  
Sweep time: Auto

##### Step 2:

- Allow the trace to stabilize.
- Use the marker function of the analyser to define the lower- and the upper -20 dB points for both hopping frequencies F1 and F2. This will result in F<sub>1L</sub> and F<sub>1H</sub> for hopping frequency F1 and in F<sub>2L</sub> and F<sub>2H</sub> for hopping frequency F2. These values shall be recorded in the report.

##### Step 3:

- Calculate the centre frequencies F<sub>1C</sub> and F<sub>2C</sub> for both hopping frequencies using the formulas below. These values shall be recorded in the report.

$$F_{1C} = \frac{F_{1L} + F_{1H}}{2} \quad F_{2C} = \frac{F_{2L} + F_{2H}}{2}$$

- Calculate the -20 dB channel bandwidth (BW<sub>CHAN</sub>) using the formula below. This value shall be recorded in the report.

$$BW_{CHAN} = F_{1H} - F_{1L}$$

- Calculate the Hopping Frequency Separation (F<sub>HS</sub>) using the formula below. This value shall be recorded in the report.

$$F_{HS} = F_{2C} - F_{1C}$$

- Compare the measured Hopping Frequency Separation with the limit defined in clause 4.3.1.4.2. In addition, for non-Adaptive Frequency Hopping equipment, the Hopping Frequency Separation shall be equal to or greater than the -20 dB channel bandwidth or:

$$F_{HS} \geq BW_{CHAN}$$

##### Step 4:

For adaptive systems, in case of overlapping channels which will prevent the definition of the -20 dB reference points F<sub>1H</sub> and F<sub>2L</sub>, a higher reference level (e.g. -10 dB or -6 dB) may be chosen to define the reference points F<sub>1L</sub>; F<sub>1H</sub>; F<sub>2L</sub> and F<sub>2H</sub>.

Alternatively, special test software may be used to:



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- force the UUT to hop or transmit on a single Hopping Frequency by which the -20 dBm reference points can be measured separately for the 2 adjacent Hopping Frequencies; and/or
- force the UUT to operate without modulation by which the centre frequencies F1C and F2C can be measured directly.

## Option 2

### Step 1:

- The output of the transmitter shall be connected to a spectrum analyzer or equivalent.
- The analyzer shall be set as follows:
  - Centre Frequency: Centre of the two adjacent hopping frequencies
  - Frequency Span: Sufficient to see the complete power envelope of both hopping frequencies
  - RBW: 30KHz
  - VBW: 100KHz
  - Detector Mode: RMS
  - Trace Mode: Max Hold
  - Sweep Time: Auto

### Step 2:

- Allow the trace to stabilize.
- Use the marker-delta function to determine the Hopping Frequency Separation between the peaks of the two adjacent hopping frequencies. This value shall be compared with the limits defined in clause 4.3.1.4.2 and shall be recorded in the test report.

## EUT DESCRIPTION:

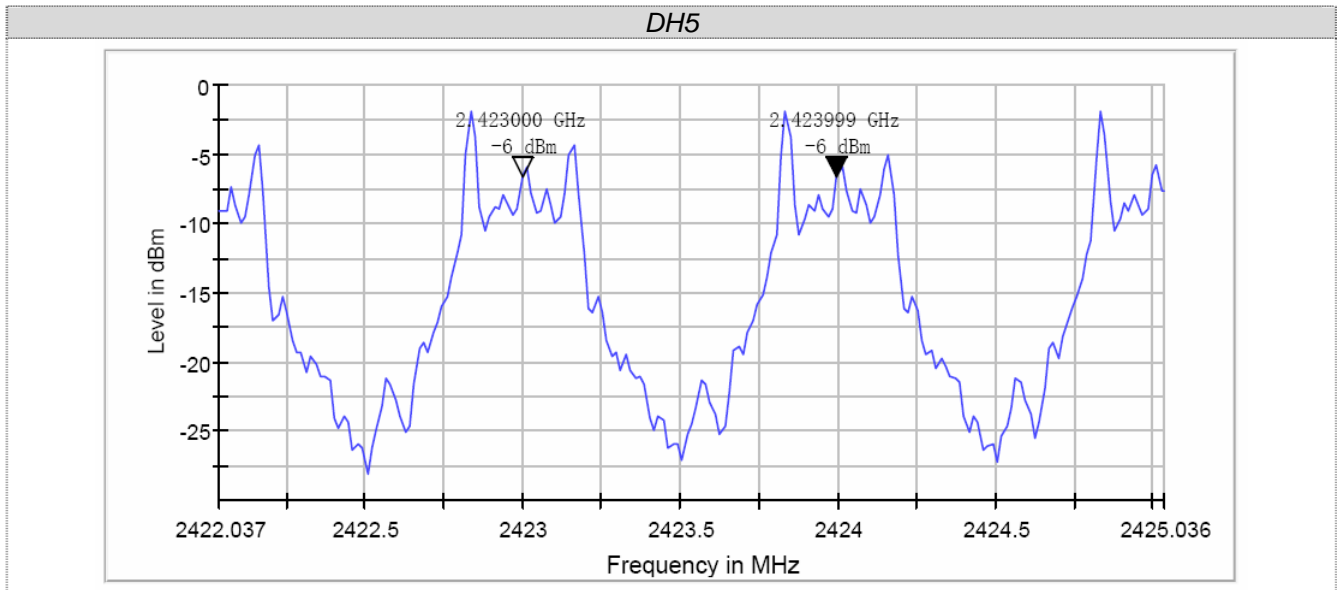
Mode:	BT Test mode
Hopping:	On
Packet Type:	Longest supported
Modulation:	GFSK

## MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	auto	
Video bandwidth:	30 KHz	
Resolution bandwidth:	100 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

DH5	Hopping Frequency Separation (MHz)	Limit (MHz)	Center Frequency of Separation (MHz)	Result
	0.999700	$\geq 0.1$	2428.464586	PASS



#### 4.1.5. Medium Utilisation (MU) factor (Not Applicable)

##### LIMIT

##### **ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.6.2**

The maximum Medium Utilisation factor for non-adaptive Frequency Hopping equipment 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 (V1.8.1) Sub-clause 5.3.2.2.1.3

##### **Step 1:**

- Use the same stored measurement samples from the procedure described in clause 5.3.2.2.1.1.

##### **Step 2:**

- For each burst calculate the product of ( $P_{burst}/100$  mW) and the TxOn time.  
NOTE: Pburst is expressed in mW. TxOn time is expressed in ms.

##### **Step 3:**

- Medium Utilisation is the sum of all these products divided by the observation period (expressed in ms) which is defined in clauses 4.3.1.2.1 or 4.3.2.3.1. This value, which shall comply with the limit given in clauses 4.3.1.5.2 or 4.3.2.4.2, shall be recorded in the test report.

##### 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



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



#### 4.1.6. Adaptivity (Adaptive Frequency Hopping) (Not Applicable)

##### LIMIT

##### **ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.1.6**

The maximum Medium Utilisation factor for non-adaptive Frequency Hopping equipment 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.

For Non-LBT based Detect and Avoid, The detection threshold shall be proportional to the transmit power of the transmitter: for a 20 dBm e.i.r.p. transmitter the detection threshold level shall be equal or lower than [-70 dBm/MHz] at the input to the receiver (assuming a 0 dBi receive antenna).

For power levels below 20 dBm e.i.r.p., the detection threshold level may be relaxed to [-70 dBm/MHz] + 20 - Pout e.i.r.p. (Pout in dBm).

Adaptive Frequency Hopping (AFH) equipment uses a Detect And Avoid (DAA) mechanism which allows an equipment to adapt to its environment by identifying frequencies that are being used by other equipment.

Adaptive Frequency Hopping systems shall implement either of the DAA mechanisms provided in clauses 4.3.1.6.1 (LBT based DAA) or 4.3.1.6.2.(non LBT based DAA)

NOTE: Adaptive systems are allowed to switch dynamically between different adaptive modes.

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



#### 4.1.7. Receiver blocking (Not Applicable)

##### LIMIT

##### **ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.1.11.2**

Adaptive Frequency Hopping equipment shall comply with the requirements defined in clauses 4.3.1.6.1 (LBT based DAA) or 4.3.1.6.2 (non-LBT based DAA) in the presence of a blocking signal with characteristics as provided in table 3.

Table 3: Receiver Blocking parameters

Equipment Type (LBT / non- LBT)	Wanted signal mean power from companion device	Blocking signal frequency [MHz]	Blocking signal power [dBm]	Type of interfering signal
LBT	sufficient to maintain the link (see note 2)	2 395 or 2 488,5 (see note 1)	-30	CW
Non-LBT	-30 dB			

NOTE 1: The highest blocking frequency shall be used for testing the lowest operating hopping frequency, while the lowest blocking frequency shall be used for testing the highest hopping frequency.  
NOTE 2: A typical value which can be used in most cases is -50 dBm/MHz.

This requirement does not apply to non-adaptive equipment or adaptive equipment 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.

Receiver blocking is a measure of the capability of the adaptivity mechanism to operate as intended. in the presence of an unwanted signal (blocking signal) on frequencies other than those of the operating channel and the adjacent channels.

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



#### 4.1.8. Occupied Channel Bandwidth

##### LIMIT

##### **ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.1.7.2**

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 value declared by the supplier. This declared value shall not be greater than 5 MHz.

The Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal. These measurements shall only be performed at normal test conditions.

In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains) measurements need only to be performed on one of the active transmit chains (antenna outputs).

For systems using FHSS modulation and which have overlapping channels, special software might be required to force the UUT to hop or transmit on a single Hopping Frequency.

The measurement shall be performed only on the lowest and the highest frequency within the stated frequency range. The frequencies on which the test were performed shall be recorded.

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 PROCEDURE

##### **Please refer to ETSI EN 300 328 (V1.8.1) Sub-clause 5.3.8.2.1**

##### **Step 1:**

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

- Centre Frequency: The centre frequency of the channel under test
- Resolution BW: ~ 1 % of the span without going below 1 %
- Video BW: 3 × RBW
- Frequency Span: 2 × Occupied Channel Bandwidth (e.g. 40 MHz for a 20 MHz channel)
- Detector Mode: RMS
- Trace Mode: Max Hold

##### **Step 2:**

Wait until the trace is completed.

Find the peak value of the trace and place the analyser marker on this peak.

##### **Step 3:**

Use the 99 % bandwidth function of the spectrum analyser to measure the Occupied Channel Bandwidth of the UUT. This value shall be recorded.

NOTE: Make sure that the power envelope is sufficiently above the noise floor of the analyser to avoid the noise signals left and right from the power envelope being taken into account by this measurement.

##### EUT DESCRIPTION:

Mode:	BT Test mode
Hopping:	Off
Packet Type:	Longest supported
Modulation:	GFSK

##### MEASUREMENT DESCRIPTION

Instrument:	Spectrum Analyzer
Detector:	RMS
Sweep time:	auto
Video bandwidth:	100KHz
Resolution bandwidth:	30KHz
Span:	3 MHz



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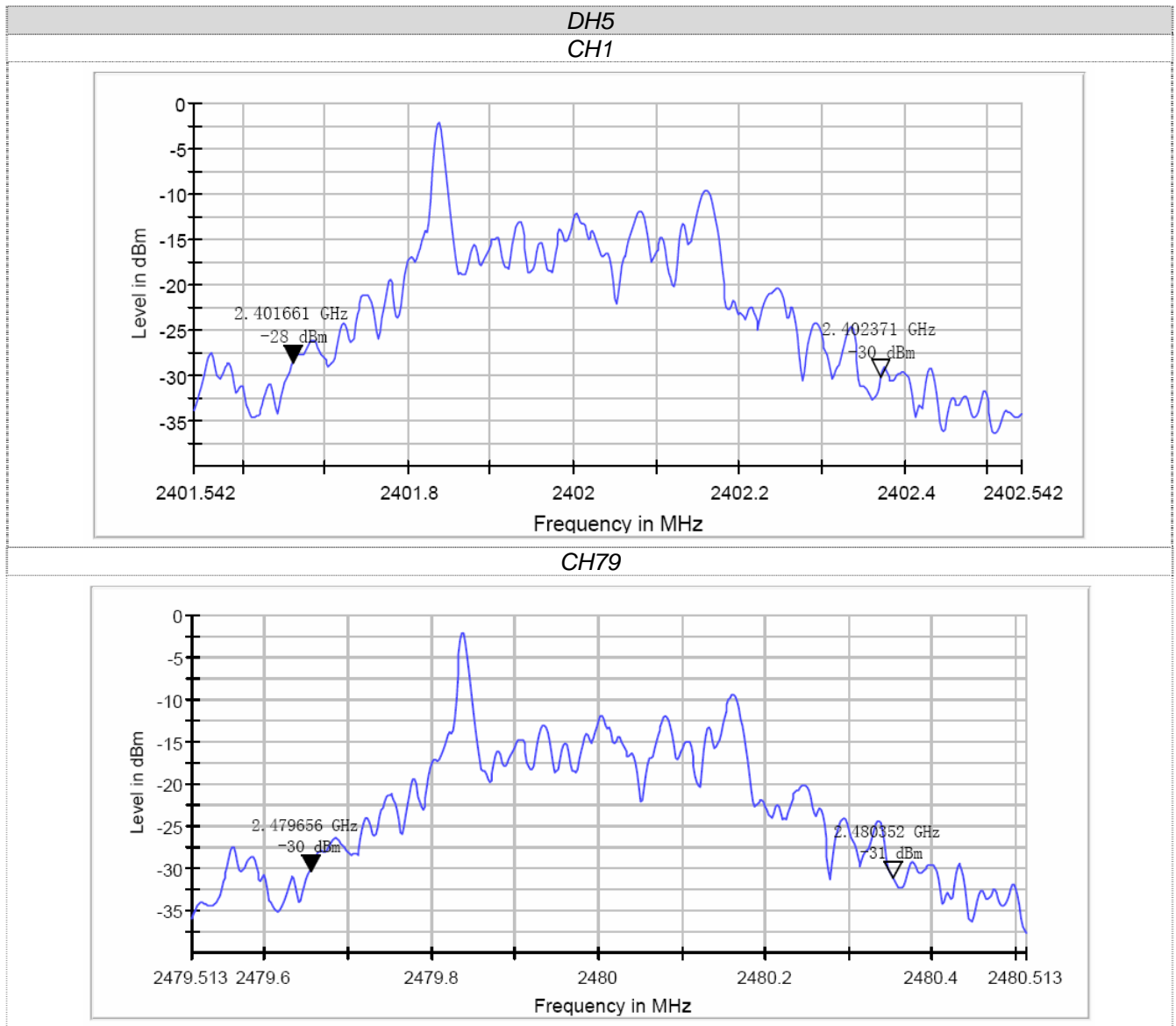
Center:	Transmit channel	
Trace:	Max hold	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	Radiated (only if no conducted sample is provided)

## TEST RESULTS

	Channel	DUT Bandwidth (MHz)	Occupied Channel Bandwidth (MHz)	Result
DH5	CH01	1.000000	0.708319	PASS
	CH79	1.000000	0.696347	PASS



**Test plot as follows:**





#### 4.1.9. Transmitter unwanted emissions in the out-of-band domain

##### LIMIT

##### **ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.1.8.2**

The transmitter unwanted emissions in the out-of-band domain but outside the allocated band, shall not exceed the values provided by the mask in figure 1.

NOTE: Within the 2 400 MHz to 2 483,5 MHz band, the Out-of-band emissions are fulfilled by compliance with the Occupied Channel Bandwidth requirement in clause 4.3.1.7.

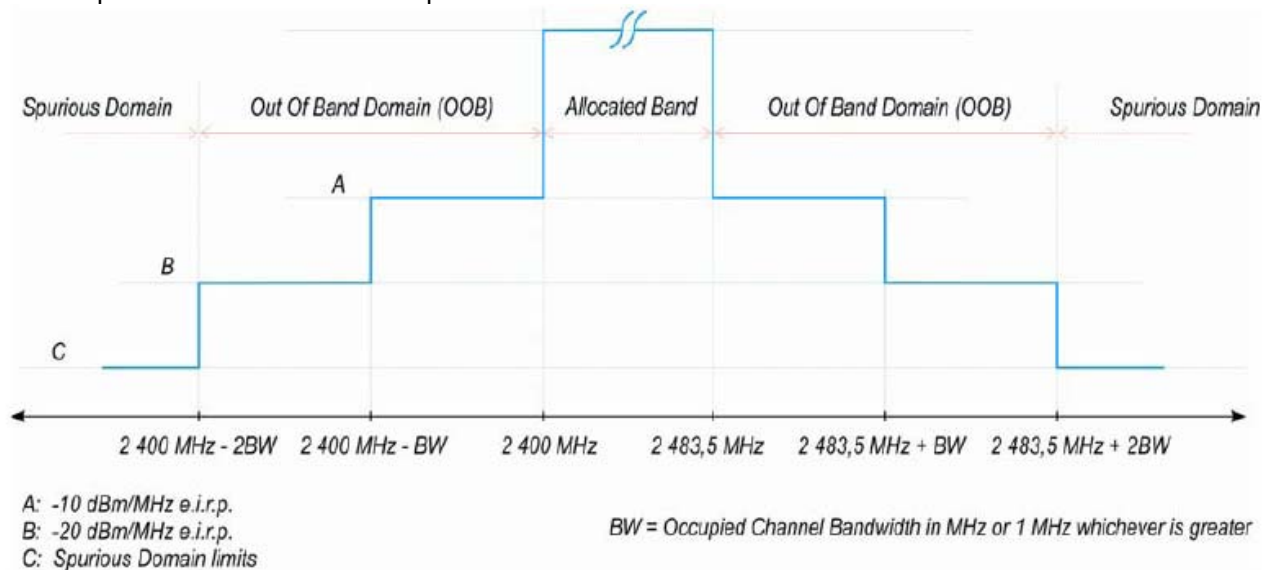


Figure 1: Transmit mask

Transmitter unwanted emissions in the out-of-band domain are emissions when the equipment is in Transmit mode, on frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious.

These measurements have to be performed at normal environmental conditions and shall be repeated at the extremes of the operating temperature range.

In the case of equipment intended for use with an integral antenna and where no external (temporary) antenna connectors are provided, a test fixture as described in clause B.3 may be used to perform relative measurements at the extremes of the operating temperature range.

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 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 Occupied Channel Bandwidths (e.g. 20 MHz and 40 MHz), then each channel bandwidth shall be tested separately.

##### TEST PROCEDURE

##### **Please refer to ETSI EN 300 328 (V1.8.1) Sub-clause 5.3.9.2.1**

The Out-of-band emissions within the different horizontal segments of the mask provided in figures 1 and 3 shall be measured using the steps below. This method assumes the spectrum analyser is equipped with the Time Domain Power option.

##### **Step 1:**

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

- Centre Frequency: The centre frequency of the channel under test  
Centre Frequency: 2 484 MHz  
Span: 0 Hz



Resolution BW: 1 MHz  
Filter mode: Channel filter  
Video BW: 3 MHz  
Detector Mode: RMS  
Trace Mode: Clear / Write  
Sweep Mode: Continuous  
Sweep Points: 5 000  
Trigger Mode: Video trigger

NOTE 1: In case video triggering is not possible, an external trigger source may be used.  
Sweep Time: Suitable to capture one transmission burst

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

- Adjust the trigger level to select the transmissions with the highest power level.
- For frequency hopping equipment operating in a normal hopping mode, the different hops will result in signal bursts with different power levels. In this case the burst with the highest power level shall be selected.
- Set a window (start and stop lines) to match with the start and end of the burst and in which the RMS power shall be measured using the Time Domain Power function.
- Select RMS power to be measured within the selected window and note the result which is the RMS power within this 1 MHz segment (2 483,5 MHz to 2 484,5 MHz). Compare this value with the applicable limit provided by the mask.
- Increase the centre frequency in steps of 1 MHz and repeat this measurement for every 1 MHz segment within the range 2 483,5 MHz to 2 483,5 MHz + BW. The centre frequency of the last 1 MHz segment shall be set to 2 483,5 MHz + BW - 0,5 MHz (which means this may partly overlap with the previous 1 MHz segment).

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

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

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

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

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

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

### Step 6:

- In case of conducted measurements on equipment with a single transmit chain, the declared antenna assembly gain "G" in dBi shall be added to the results for each of the 1 MHz segments and compared with the limits provided by the mask given in figures 1 or 3. If more than one antenna assembly is intended for this power setting, the antenna with the highest gain shall be considered.
- In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the measurements need to be repeated for each of the active transmit chains. The declared antenna assembly gain "G" in dBi for a single antenna shall be added to these results. If more than one antenna assembly is intended for this power setting, the antenna with the highest gain shall be considered.

Comparison with the applicable limits shall be done using any of the options given below:

Option 1: the results for each of the transmit chains for the corresponding 1 MHz segments shall be added. The additional beamforming gain "Y" in dB shall be added as well and the resulting values compared with the limits provided by the mask given in figures 1 or 3.

Option 2: the limits provided by the mask given in figures 1 or 3 shall be reduced by  $10 \times \log_{10}(Ach)$  and the additional beamforming gain "Y" in dB. The results for each of the transmit chains shall be individually compared with these reduced limits



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NOTE 2: Ach refers to the number of active transmit chains.

## EUT DESCRIPTION:

Mode:	BT Test mode
Hopping:	On
Packet Type:	Longest supported
Modulation:	GFSK
Assumed antenna gain:	0 dBi

## MEASUREMENT DESCRIPTION

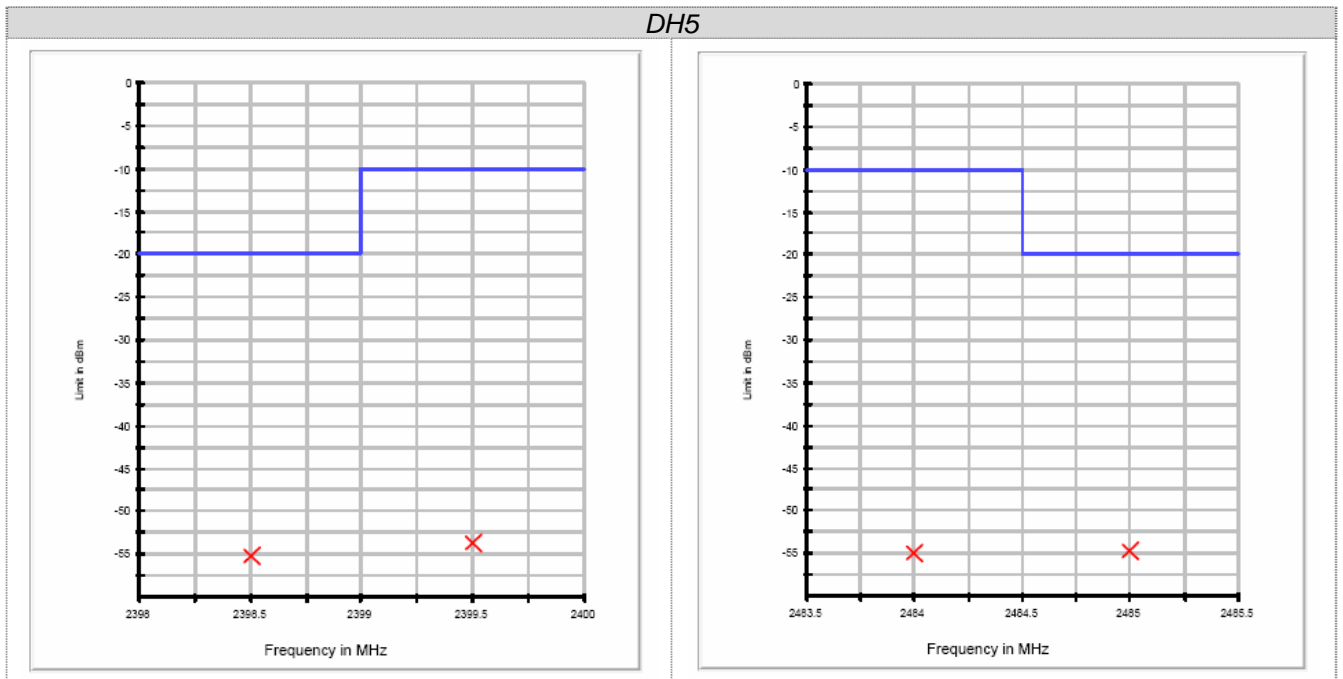
Instrument:	Spectrum Analyzer	
Detector:	RMS	
Sweep time:	depending on packet length	
Video bandwidth:	3MHz	
Resolution bandwidth:	1MHz	
Span:	0Hz	
Center:	fc (see result table)	
Trace:	Trigger to burst	
Sweep points:	5000	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	Radiated (only if no conducted sample is provided)

## TEST RESULTS

DH5	Unwanted emissions [dBm] (including Antenna Gain)			
	Frequency	NTC	LT	HT
CH01 (BW=1MHz)	2398-2399MHz Limit:< -20dBm/MHz	-55.1	-55.1	-55.3
	2399 – 2400 MHz Limit:< -10dBm/MHz	-54.4	-54.8	-54.4
	2483.5 – 2484.5MHz Limit:< -10dBm/MHz	-55.4	-55.6	-55.7
	2484.5 – 2485.5MHz Limit:< -20dBm/MHz	-55.0	-55.1	-55.2
	<b>Test Results</b>	<b>Pass</b>		



**Test plot as follows:**





#### 4.1.10. Transmitter unwanted emissions in the spurious domain

##### LIMIT

##### **ETSI EN 300 328 (V1.8.1) Sub-clause 4.3.1.9.2**

The transmitter unwanted emissions in the spurious domain shall not exceed the values given in table 1

Table 1: Transmitter limits for spurious emissions

Frequency range	Maximum power, e.r.p. ( $\leq 1$ GHz) e.i.r.p. ( $> 1$ GHz)	Bandwidth
30 MHz to 47 MHz	-36 dBm	100 kHz
47 MHz to 74 MHz	-54 dBm	100 kHz
74 MHz to 87,5 MHz	-36 dBm	100 kHz
87,5 MHz to 118 MHz	-54 dBm	100 kHz
18 MHz to 174 MHz	-36 dBm	100 kHz
174 MHz to 230 MHz	-54 dBm	100 kHz
230 MHz to 470 MHz	-36 dBm	100 kHz
470 MHz to 862 MHz	-54 dBm	100 kHz
862 MHz to 1 GHz	-36 dBm	100 kHz
1 GHz to 12.75 GHz	-30 dBm	1 MHz

Transmitter unwanted emissions in the spurious domain are emissions outside the allocated band and outside the out-of-band domain as indicated in figure 1 when the equipment is in Transmit mode.

These measurements shall only be performed at normal test conditions.

For systems 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 Occupied 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

##### **Please refer to ETSI EN 300 328 (V1.8.1) Sub-clause 5.3.10.2.1 & 5.3.10.2.2**

In case of conducted measurements, the radio equipment shall be connected to the measuring equipment via a suitable attenuator.

The spectrum in the spurious domain (see figures 1 or 3) shall be searched for emissions that exceed the limit values given in tables 1 or 4 or that come to within 6 dB below these limits. Each occurrence shall be recorded.

##### **Pre-scan**

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

##### **Step 1:**

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

##### **Step 2:**

The emissions over the range 30 MHz to 1 000 MHz shall be identified.

Spectrum analyser settings:

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



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

- Sweep time:

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

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

Allow the trace to stabilize. Any emissions identified during the sweeps above and that fall within the 6 dB range below the applicable limit or above, shall be individually measured using the procedure in clause 5.3.10.2.1.2 and compared to the limits given in tables 1 or 4.

### Step 3

The emissions over the range 1 GHz to 12,75 GHz shall be identified.

Spectrum analyser settings:

- Resolution bandwidth: 1 MHz
- Video bandwidth: 3 MHz
- Detector mode: Peak
- Trace Mode: Max Hold
- Sweep Points:  $\geq 11\,750$

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

- Sweep time:

For non continuous transmissions (duty cycle less than 100 %), the sweep time shall be sufficiently long, such that for each 1 MHz frequency step, the measurement time is greater than two transmissions of the UUT.

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

Allow the trace to stabilize. Any emissions identified during the sweeps above that fall within the 6 dB range below the applicable limit or above, shall be individually measured using the procedure in clause 5.3.10.2.1.2 and compared to the limits given in tables 1 or 4.

Frequency Hopping equipment may generate a block (or several blocks) of spurious emissions anywhere within the spurious domain. If this is the case, only the highest peak of each block of emissions shall be measured using the procedure in clause 5.3.10.2.1.2.

### Step 4:

- In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the steps 2 and 3 need to be repeated for each of the active transmit chains (Ach). The limits used to identify emissions during this pre-scan need to be reduced with  $10 \times \log_{10}(\text{Ach})$  (number of active transmit chains).

### Measurement of the emissions identified during the pre-scan

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

#### Step 1:

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

- Centre Frequency: Frequency of emission identified during the pre-scan
- Resolution Bandwidth: 100 kHz ( $< 1$  GHz) / 1 MHz ( $> 1$  GHz)
- Video Bandwidth: 300 kHz ( $< 1$  GHz) / 3 MHz ( $> 1$  GHz)
- Frequency Span: Wide enough to capture each individual emission identified during the pre-scan
- Sweep mode: Continuous
- Sweep time: Auto
- Trigger: Free run
- Detector: RMS
- Trace Mode: Max Hold



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## Step 2:

In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), the step 1 needs to be repeated for each of the active transmit chains (Ach).

The trace data for each transmit chain has to be recorded.

Sum the power in each of the traces for each individual frequency bin.

## Step 3:

Use the marker function to find the highest peak within the measurement trace and record its value and its frequency.

## Step 4:

The measured values shall be compared to the limits defined in tables 1 and 4.

## EUT DESCRIPTION:

Mode:	BT Test mode
Hopping:	Off, lowest & highest frequency
Packet Type:	Longest supported
Modulation:	GFSK
Assumed antenna gain:	0 dBi

## MEASUREMENT DESCRIPTION

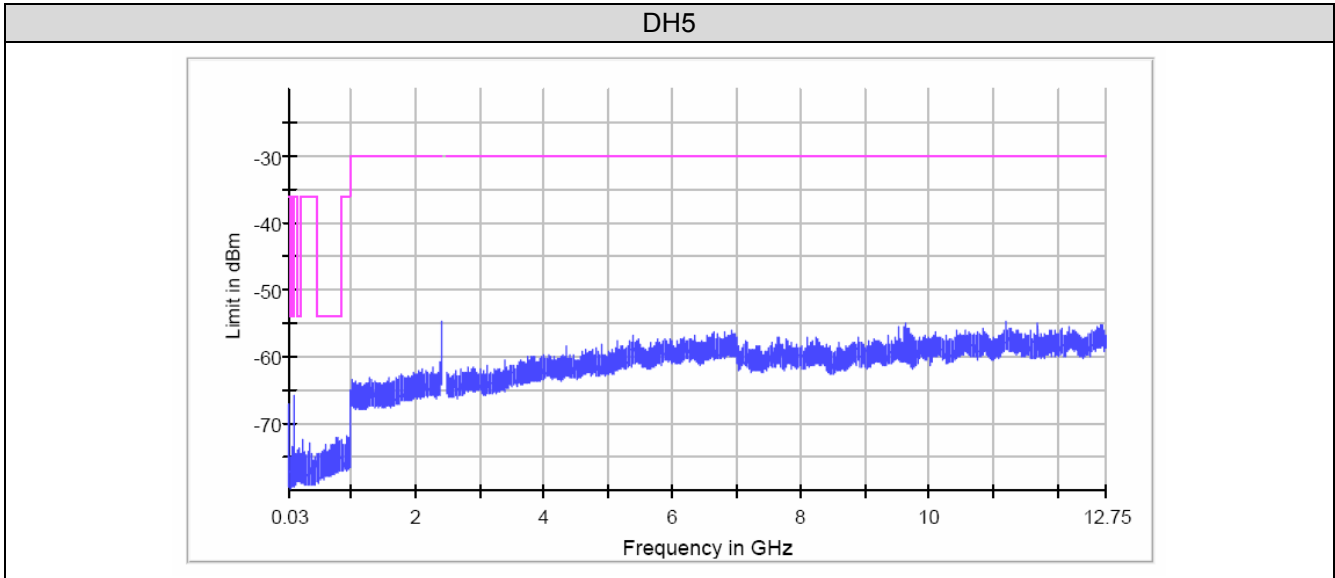
Instrument:	Spectrum Analyzer	
Detector:	Peak for prescan / RMS for emission retest	
Sweep time:	Auto	
Video bandwidth:	Below 1 GHz: 300 kHz / above 3MHz	
Resolution bandwidth:	Below 1 GHz: 100 kHz / above 1MHz	
Trace:	Max hold	
Sweep points:	40001	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	Radiated (only if no conducted sample is provided)

## TEST RESULTS

**Pass**

### ***Conducted Spurious Emissions***

Measured Modulation	<input checked="" type="checkbox"/> <b>GFSK</b>	<input type="checkbox"/> <b><math>\pi/4</math> DQPSK</b>	<input type="checkbox"/> <b>8DPSK</b>
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**4.1.11. Receiver spurious emissions**

**LIMIT**

**ETSI EN 300 328(V1.8.1) Sub-clause 4.3.1.10.2**

The spurious emissions of the receiver shall not exceed the values given in table 2.

Table 2: Spurious emission limits for receivers

Frequency range	Maximum power e.r.p. ( $\leq 1$ GHz) e.i.r.p. ( $> 1$ GHz)	Measurement bandwidth
30 MHz to 1 GHz	-57 dBm	100 kHz
1 GHz to 12,75 GHz	-47 dBm	1 MHz

These measurements shall only be performed at normal test conditions. Testing shall be performed when the equipment is in a receive-only mode. 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. For systems 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 CONFIGURATION**

The same as described in section 4.1.10

**TEST PROCEDURE**

The same as described in section 4.1.10

**EUT DESCRIPTION:**

Mode:	BT Receiver/Idle Mode
Hopping:	Off, lowest & highest frequency
Modulation:	GFSK
Assumed antenna gain:	0 dBi

**MEASUREMENT DESCRIPTION**



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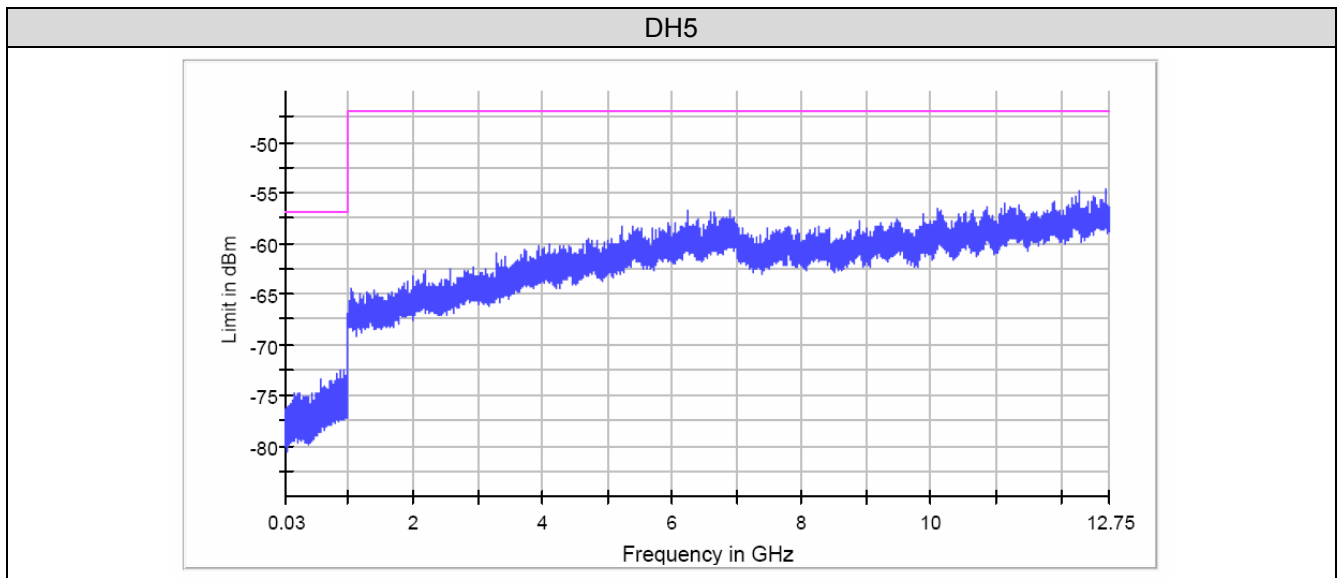
Instrument:	Spectrum Analyzer	
Detector:	Peak for prescan / RMS for emission retest	
Sweep time:	Auto	
Video bandwidth:	Below 1 GHz: 300 kHz / above 3MHz	
Resolution bandwidth:	Below 1 GHz: 100 kHz / above 1MHz	
Trace:	Max hold	
Sweep points:	40001	
Performed:	<input checked="" type="checkbox"/>	Conducted
	<input type="checkbox"/>	Radiated (only if no conducted sample is provided)

## TEST RESULTS

Pass

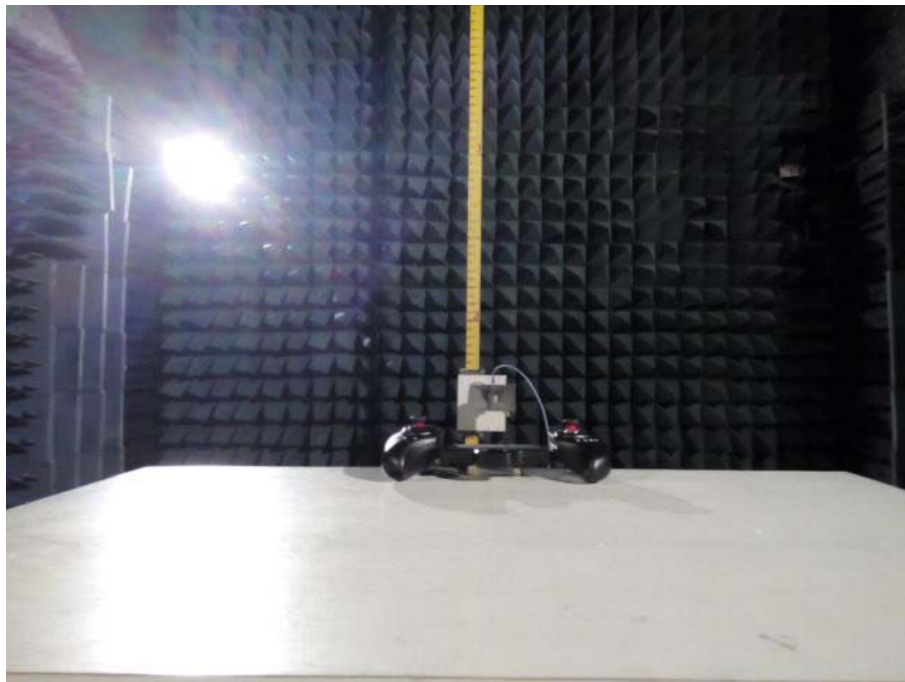
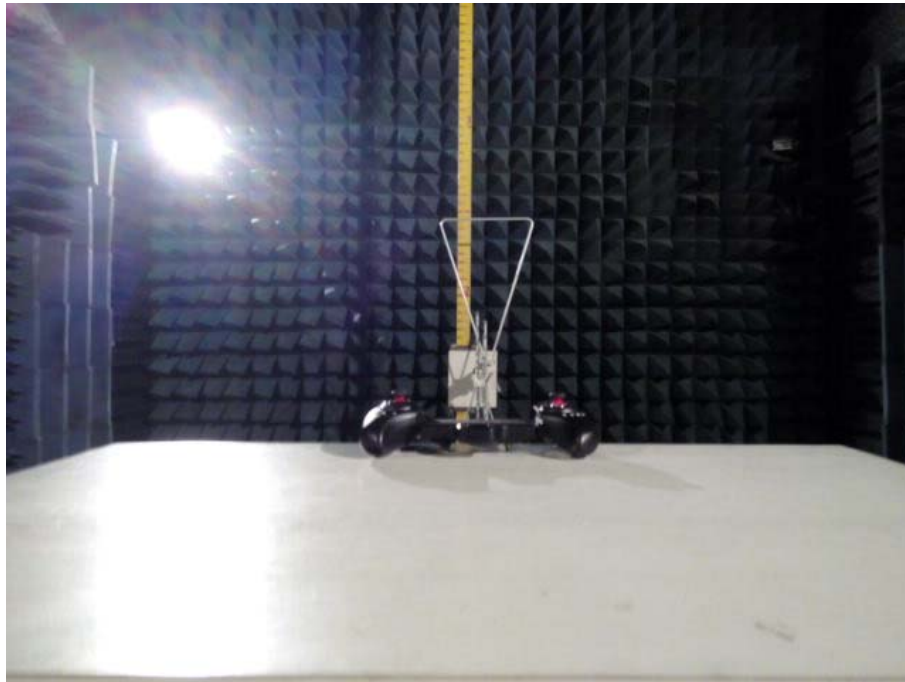
### Conducted Spurious Emissions

Measured Modulation	<input checked="" type="checkbox"/> GFSK	<input type="checkbox"/> $\pi/4$ DQPSK	<input type="checkbox"/> 8DPSK
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**5. Test Setup Photos of the EUT**



**6. External and Internal Photos of the EUT**

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