EN 300 328 RF Test Report (BT-EDR)

Report No.:	REBBUI-WTW-P21040655-3
Test Model:	RTL8852BE
Received Date:	Apr. 21, 2021
Test Date:	May 11 to 28, 2021
Issued Date:	Aug. 05, 2021
Applicant:	Realtek Semiconductor Corp.
Address:	No. 2, Innovation Road II, Hsinchu Science Park, Hsinchu 300, Taiwan
Issued By:	Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory
Lab Address:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan
Test Location:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan

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Release Control Record

Issue No.	Description	Date Issued
REBBUI-WTW-P21040655-3	Original release.	Aug. 05, 2021

1 Certificate of Conformity

Product: 11ax RTL8852BE Combo module

Brand: REALTEK

Test Model: RTL8852BE

Sample Status: Engineering sample

Applicant: Realtek Semiconductor Corp.

Test Date: May 11 to 28, 2021

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

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : Vivian Huang , **Date:** Aug. 05, 2021

Vivian Huang / Specialist

Approved by : , **Date:** Aug. 05, 2021

Clark Lin / Technical Manager

2 Summary of Test Results

The EUT has been tested according to the following specifications:

EN 300 328 V2.2.2		
Clause	**Test Parameter**	**Results**
4.3.1.2	RF Output Power	Pass
4.3.1.3	Duty cycle, Tx-sequence, Tx-gap (Only for non-Adaptive equipment)	Not Applicable
4.3.1.4	Accumulated Transmit Time, Frequency Occupation and Hopping Sequence (Only for FHSS equipment)	Pass
4.3.1.5	Hopping Frequency Separation (Only for FHSS equipment)	Pass
4.3.1.6	Medium Utilisation (Only for non-Adaptive Equipment)	Not Applicable
4.3.1.7	Adaptivity (Adaptive Equipment)	Pass
4.3.1.8	Occupied Channel Bandwidth	Pass
4.3.1.9	Transmitter Unwanted Emission in the OOB Domain	Pass
4.3.1.10	Transmitter Unwanted Emissions in the Spurious Domain	Pass
4.3.1.11	Receiver Spurious Emissions	Pass
4.3.1.12	Receiver Blocking	Pass
4.3.1.13	Geo-location capability (Only for equipment with geo-location capability)	Not Applicable

Note:

1. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.1 Test Instruments

For spurious emissions test (Below 1GHz)

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Spectrum Analyzer Keysight	N9030A	MY54490570	June 16, 2020	June 15, 2021
Pre_Amplifier Agilent	8447D	2944A10663	Apr. 26, 2021	Apr. 25, 2022
TRILOG Antenna SCHWARZBECK	VULB9168	9168-162	Nov. 09, 2020	Nov. 08, 2021
Software	ADT_Radiated_V7.6.15.9.5	NA	NA	NA
Antenna Tower & Turn Table Max-Full	MF-7802	MF780208411	NA	NA
Power meter Anritsu	ML2495A	1529002	July 22, 2020	July 21, 2021
Power sensor Anritsu	MA2411B	1339443	July 22, 2020	July 21, 2021
Power meter Anritsu	ML2496A	1529003	Aug. 05, 2020	Aug. 04, 2021
Power sensor Anritsu	MA2411B	1339442	Aug. 05, 2020	Aug. 04, 2021
ESG Vector signal generator Agilent	E4438C	MY45094468/005 506 602 UK6 UNJ	Nov. 18, 2020	Nov. 17, 2021

NOTE:
1. The test was performed in RF Fully Chamber No. 1.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Tested Date: May 25 to 28, 2021

For spurious emissions test (Above 1GHz)

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Spectrum Analyzer Keysight	N9030A	MY55410176	June 30, 2020	June 29, 2021
Pre_Amplifier HP	8449B	3008A01923	Oct. 08, 2020	Oct. 07, 2021
Pre_Amplifier EMCI	EMC184045	980143	Jan. 05, 2021	Jan. 04, 2022
Horn_Antenna SCHWARZBECK	BBHA 9120 D	9120D-1592	Nov. 22, 2020	Nov. 21, 2021
Horn_Antenna SCHWARZBECK	BBHA 9170	BBHA9170519	Nov. 22, 2020	Nov. 21, 2021
Software	ADT_Radiated_V7.6.15.9.5	NA	NA	NA
Antenna Tower & Turn Table Max-Full	MF-7802	MF780208542	NA	NA
Power meter Anritsu	ML2495A	1529002	July 22, 2020	July 21, 2021
Power sensor Anritsu	MA2411B	1339443	July 22, 2020	July 21, 2021
Power meter Anritsu	ML2496A	1529003	Aug. 05, 2020	Aug. 04, 2021
Power sensor Anritsu	MA2411B	1339442	Aug. 05, 2020	Aug. 04, 2021
ESG Vector signal generator Agilent	E4438C	MY45094468/005 506 602 UK6 UNJ	Nov. 18, 2020	Nov. 17, 2021

NOTE:
1. The test was performed in RF Fully Chamber No. 2.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Tested Date: May 11 to 17, 2021

For receiver blocking & adaptivity test:

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Spectrum Analyzer R&S	FSW8	101497	Nov. 10, 2020	Nov. 09, 2021
Spectrum Analyzer Keysight	N9030A	MY55410176	June 30, 2020	June 29, 2021
Bluetooth Simulator Anritsu	MT8852B	1218002	May 19, 2020	May 18, 2021
ESG Vector signal generator Agilent	E4438C	MY45094468/005 506 602 UK6 UNJ	Nov. 18, 2020	Nov. 17, 2021
Upgrade the software license on current E4438C ESG Agilent	E4438CK-403	ESG E4_010001	NA	NA
MXG X-Series RF Vector Signal Generator Agilent	N5182B	MY53052700	July 14, 2020	July 13, 2021
Direct Coupler EMCI	CS20-18-436/16	1139	Jan. 11, 2021	Jan. 10, 2022
Power Splitter/combiner Mini-Circuits	ZN4PD-642W-S+	408501327_03	Sep. 30, 2020	Sep. 29, 2021
Power Splitter/combiner Mini-Circuits	ZN4PD-642W-S+	408501327_04	Sep. 30, 2020	Sep. 29, 2021

NOTE:
1. The test was performed in Adaptivity room.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Tested Date: May 14, 2021

For other test items:

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Spectrum Analyzer R&S	FSV40	101516	Mar. 08, 2021	Mar. 07, 2022
Spectrum Analyzer Keysight	N9030A	MY54490570	June 16, 2020	June 15, 2021
AC Power Source Extech Electronics	6905S	1991551	NA	NA
Temperature & Humidity Chamber TERCHY	MHU-225AU	911033	Nov. 24, 2020	Nov. 23, 2021
DC Power Supply GOOD WILL INSTRUMENT CO., LTD.	GPC - 3030D	7700087	NA	NA
ESG Vector signal generator Agilent	E4438C	MY45094468/005 506 602 UK6 UNJ	Nov. 18, 2020	Nov. 17, 2021
Power meter Anritsu	ML2495A	0824006	Apr. 28, 2021	Apr. 27, 2022
Software	ADT_RF Test Software V6.6.5.4	NA	NA	NA
MXG X-Series RF Vector Signal Generator Agilent	N5182B	MY53052700	July 14, 2020	July 13, 2021
MIMO Powermeasurement Test set (4X4) Agilent	U2021XA	U2021XA_01	Sep. 16, 2020	Sep. 15, 2021
MIMO Powermeasurement Test set (4X4) Agilent	U2021XA	U2021XA_02	Nov. 13, 2020	Nov. 12, 2021
Switch Box Agilent	PS-X10-100	PS-X10-100_01	Sep. 17, 2020	Sep. 16, 2021

NOTE:
1. The test was performed in Oven room 1.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Tested Date: May 24, 2021

2.2 Measurement Uncertainty

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

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Parameter	Uncertainty
Occupied Channel Bandwidth	$\pm 0.14 \times 10^{-4}$ %
RF output power, conducted	±1.2 dB
Power Spectral Density, conducted	±1.2 dB
Unwanted Emissions, conducted	±2.5 dB
All emissions, radiated	±4.9 dB
Temperature	±0.4 °C
Supply voltages	±0.05 %
Time	±5 %

2.3 Maximum Measurement Uncertainty

For the test methods, according to ETSI EN 300 328 standard, the measurement uncertainty figures shall be calculated 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)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028-1, in particular in annex D of the ETSI TR 100 028-2.

Maximum measurement uncertainty

Parameter	Uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±1,5 dB
Power Spectral Density, conducted	±3 dB
Unwanted Emissions, conducted	±3 dB
All emissions, radiated	±6 dB
Temperature	±1 °C
Supply voltages	±3 %
Time	±5 %

2.4 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT (BT-EDR)

Product	11ax RTL8852BE Combo module
Brand	REALTEK
Test Model	RTL8852BE
Status of EUT	Engineering sample
Nominal Voltage	3.3Vdc from host equipment
Normal Testing Voltage	Vnom= 3.3Vdc
Temperature Operating Range	-20℃ ~ 70℃
Modulation Type	GFSK, π/4-DQPSK, 8DPSK
Modulation Technology	FHSS
Transfer Rate	Up to 3Mbps
Operating Frequency	2.402 ~ 2.480GHz
Number of Channel	79
Adaptive/Non-Adaptive	☐ 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
EIRP Power	15.99 dBm
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	NA
Data Cable Supplied	NA

Note:

1. The EUT has below HW SKU configuration, as below table:

SKU No.	Interface	Description
1	PCIe + USB	Single antenna port
2	PCIe + USB	Dual antenna port
3	PCIe + UART	Dual antenna port

Note:
1. For spurious emissions (below 1GHz): From the above HW SKUs, the worse case was found in **SKU No.: 3**. Therefore only the test data of the SKU was recorded in this report.
2. For spurious emissions (above 1GHz): From the above HW SKUs, the worse case was found in **SKU No.: 2**. Therefore only the test data of the SKU was recorded in this report.

2. Simultaneously transmission condition.

Condition	Technology	
1	WLAN 5GHz	Bluetooth
Note: The emission of the simultaneous operation has been evaluated and no non-compliance was found.		

3. The antennas provided to the EUT, please refer to the following table:

Ant. Set	RF Chain No.	Brand	Model	Ant. Net Gain (dBi)	Frequency Range (GHz)	Ant. Type	Connector Type	Cable Length (mm)
1	Chain 0	ARISTOTLE	RFA-27-JP326-MHF4300	3.5	2.4~2.4835	PIFA	i-pex(MHF)	300
				5	5.15~5.85			
				5	5.875~7.125			
	Chain 1	ARISTOTLE	RFA-27-JP326-MHF4300	3.5	2.4~2.4835	PIFA	i-pex(MHF)	300
				5	5.15~5.85			
				5	5.875~7.125			
2	Chain 0	ARISTOTLE	RFA-27-C38H1-MHF4300	3	2.4~2.4835	Dipole	i-pex(MHF)	300
				5	5.15~5.85			
				5	5.875~7.125			
	Chain 1	ARISTOTLE	RFA-27-C38H1-MHF4300	3	2.4~2.4835	Dipole	i-pex(MHF)	300
				5	5.15~5.85			
				5	5.875~7.125			

Note:
1. Max. gain was selected for the final test, except for Spurious Emissions & Adaptivity test.

4. The above EUT information is declared by manufacturer and for more detailed features description, please refers to the manufacturer's specifications or user's manual.
5. The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.

3.2 Description of Test Modes

79 channels are provided for BT-EDR mode:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461		

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable to											Description
	ROP	DC/TS/TG	ATT/FO/HS	HFS	MU	AD	OCB	EOB	SE< 1G	SE≥ 1G	RB	
1	√	-	√	√	-	√	√	√	√	√	√	High power
2	√	-	√	√	-	-	√	√	-	-	-	Low power

Where **ROP:** RF Output Power
ATT/FO/HS: Accumulated Transmit Time / Frequency Occupation/ Hopping Sequence
MU: Medium Utilisation
OCB: Occupied Channel Bandwidth
SE<1G: Spurious Emissions below 1GHz
RB: Receiver Blocking
DC/TS/TG: Duty Cycle/ Tx-Sequence / Tx-gap
HFS: Hopping Frequency Separation
AD: Adaptivity (Channel Access Mechanism)
EOB: Transmitter unwanted emission in the out-of-band domain
SE≥1G: Spurious Emissions above 1GHz

Note: The EUT's PIFA antenna had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **X-plane**.

RF Output Power:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, packet type, data rates and antenna ports (if EUT with antenna diversity architecture).

Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
0 to 78	Hopping mode	FHSS	GFSK	DH5
0 to 78	Hopping mode	FHSS	8DPSK	3DH5

Accumulated Transmit Time / Frequency Occupation / Hopping Sequence:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, packet type, data rates and antenna ports (if EUT with antenna diversity architecture).

Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
0 to 78	Hopping mode	FHSS	GFSK	DH1, DH3, DH5
0 to 78	Hopping mode	FHSS	8DPSK	3DH1, 3DH3, 3DH5

Hopping Frequency Separation:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, packet type, data rates and antenna ports (if EUT with antenna diversity architecture).

Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
0 to 78	0, 78	FHSS	GFSK	DH5
0 to 78	0, 78	FHSS	8DPSK	3DH5

Adaptivity Test:

☒ Following channel(s) was (were) selected for the final test as listed below.

Available Channel	Tested Channel	Modulation Technology
0 to 78	0, 78	FHSS

Occupied Channel Bandwidth:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, packet type, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
0 to 78	0, 78	FHSS	GFSK	DH5
0 to 78	0, 78	FHSS	8DPSK	3DH5

Transmitter unwanted emission in the out-of-band domain:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, packet type, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
0 to 78	0, 78	FHSS	GFSK	DH5
0 to 78	0, 78	FHSS	8DPSK	3DH5

Spurious Emissions Test (Below 1 GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, packet type, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
0 to 78	78	FHSS	GFSK	DH5
Receiver	78	-	-	-

Spurious Emissions Test (Above 1 GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, packet type, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
0 to 78	0, 78	FHSS	GFSK	DH5
Receiver	0, 78	-	-	-

Receiver Blocking Test:

☒ Following channel(s) was (were) selected for the final test as listed below.

Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
0 to 78	0, 78	FHSS	GFSK	DH1

Test Condition:

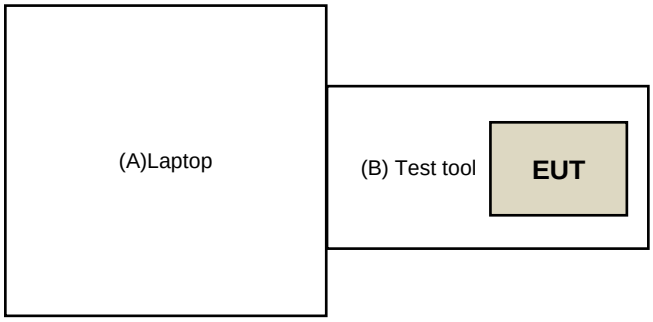
Applicable to	Environmental Conditions	Input Power	Tested by
ROP	25deg. C, 60%RH	3.3Vdc	Angus Peng,
ATT/FO/HS	25deg. C, 60%RH	3.3Vdc	Angus Peng,
AD	25deg. C, 60%RH	3.3Vdc	Tobey Chen
HFS	25deg. C, 60%RH	3.3Vdc	Angus Peng,
OCB	25deg. C, 60%RH	3.3Vdc	Angus Peng,
EOB	25deg. C, 60%RH	3.3Vdc	Angus Peng,
SE<1G	22deg. C, 72%RH,	230Vac, 50Hz (System)	Ethan Hsu
SE≥1G	25deg. C, 67%RH,	230Vac, 50Hz (System)	Ethan Hsu
RB	25deg. C, 60%RH	3.3Vdc	Tobey Chen

3.3 Description of Support Units

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

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	DELL	E6420	B92T3R1	FCC DoC	Provided by Lab
B.	Test tool	Realtek	N/A	NA	NA	Supplied by client

3.3.1 Configuration of System under Test



3.4 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standard:

EN 300 328 V2.2.2 (2019-07)

All test items have been performed and recorded as per the above standard.

4 Test Procedure and Results

4.1 RF Output Power

4.1.1 Limits of RF Output Power

Condition	Frequency Band	Limit (e.i.r.p.)
Under all test conditions	2400 ~ 2483.5 MHz	AV: 20dBm

4.1.2 Test Procedures

Refer to chapter 5.4.2 of EN 300 328 V2.2.2.

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

For extreme test condition refer to chapter Annex B.4 and procedure follow Annex B.4.3.

4.1.3 Deviation from Test Standard

No deviation.

4.1.4 Test Setup

The measurement was performed at both normal environmental conditions and at the extremes of the operating temperature. This measurement was performed during normal operation (hopping) and operating on all hopping positions. The equipment was configured to operate under its worst case situation with respect to output power. In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator. Controlling software (Bluetooth RF test tool (5.2.3.1)) has been activated to set the EUT on specific channel and power level.

4.1.5 Test Results (Mode 1)

Test Condition			EIRP Power (dBm)
GFSK			
Tnom(℃)	25	Vnom(v)	15.85
Tmin(℃)	-20	Vnom(v)	15.99
Tmax(℃)	70	Vnom(v)	15.61
8DPSK			
Tnom(℃)	25	Vnom(v)	13.19
Tmin(℃)	-20	Vnom(v)	13.41
Tmax(℃)	70	Vnom(v)	13.01

4.1.6 Test Results (Mode 2)

Test Condition			EIRP Power (dBm)
GFSK			
Tnom(℃)	25	Vnom(v)	9.47
Tmin(℃)	-20	Vnom(v)	9.68
Tmax(℃)	70	Vnom(v)	9.26
8DPSK			
Tnom(℃)	25	Vnom(v)	9.40
Tmin(℃)	-20	Vnom(v)	9.62
Tmax(℃)	70	Vnom(v)	9.22

4.2 Accumulated Transmit Time, Frequency Occupation and Hopping Sequence

4.2.1 Limits of Dwell time, Minimum Frequency Occupation and Hopping Sequence

Accumulated Transmit Time	
Condition	**Limit**
☐Non-adaptive frequency hopping systems	≤ 15 ms
☒Adaptive frequency hopping systems	≤ 400 ms

Frequency Occupation	
Condition	**Limit**
☐Non-adaptive frequency hopping systems	☒Option 1: Each hopping frequency of the hopping sequence shall be occupied at least once within a period not exceeding four times the product of the dwell time and the number of hopping frequencies in use. ☐Option 2: The occupation probability for each frequency shall be between ((1 / U) × 25 %) and 77 % where U is the number of hopping frequencies in use.
☒Adaptive frequency hopping systems	

hopping Sequence(s)	
Condition	**Limit**
☐Non-adaptive frequency hopping systems	≥5 hopping frequencies or 15MHz/minimum Hopping Frequency Separation in MHz , whichever is the greater.
☒Adaptive frequency hopping systems	Operating frequency band ≥58.45MHz (Operating over a minimum of 70 % of the operating in the band 2,4 GHz to 2,4835 GHz)
	≥15 hopping frequencies or 15MHz/minimum Hopping Frequency Separation in MHz, whichever is the greater.

4.2.2 Test Procedure

Refer to chapter 5.4.4 of EN 300 328 V2.2.2.

Measurement	
☒Conducted measurement	☐ Radiated measurement

4.2.3 Deviation from Test Standard

No deviation

4.2.4 Test Setup

The measurement was performed at normal environmental conditions only. The equipment was configured to operate at its maximum Dwell Time and maximum Duty Cycle. The measurement was performed on a minimum of 2 hopping frequencies chosen arbitrary from the actual hopping sequence. In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator. Controlling software (Bluetooth RF test tool (5.2.3.1)) has been activated to set the EUT on specific status.

4.2.5 Test Results (Mode 1)

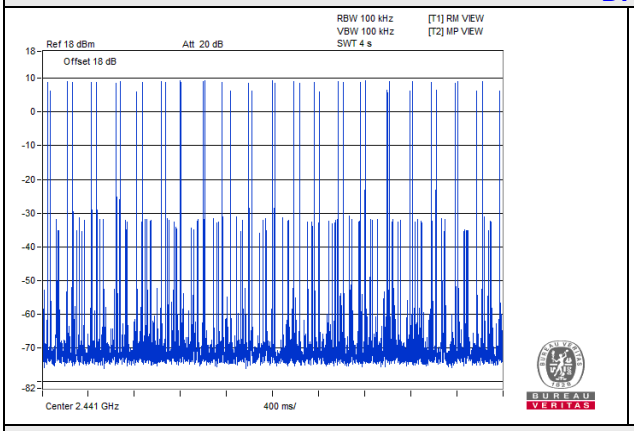
GFSK:

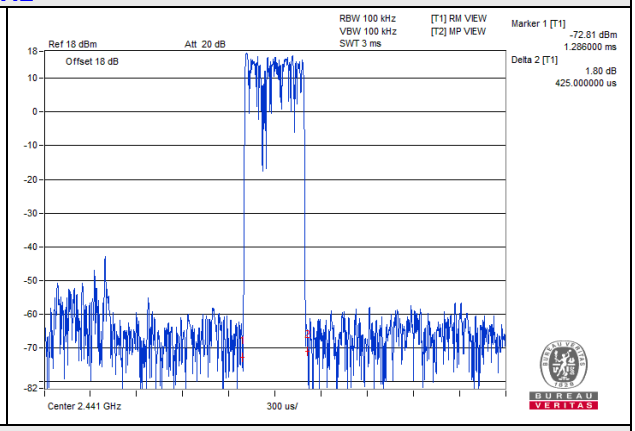
Accumulated Transmit Time							
Mode	**Minimum Number of Hopping Channel**	**NTP* (Sec)**	**Number of Hop in NTP***	**Dwell Time per Hop (msec)**	**Dwell Time in NTP* (msec)**	**Limit (msec)**	**Pass / Fail**
DH1	79	31.6	323.9	0.425	137.6575	400	Pass
DH3	79	31.6	173.8	1.671	290.4198	400	Pass
DH5	79	31.6	110.6	2.946	325.8276	400	Pass

*NTP: Number of transmission in a period (channel number *0.4sec)

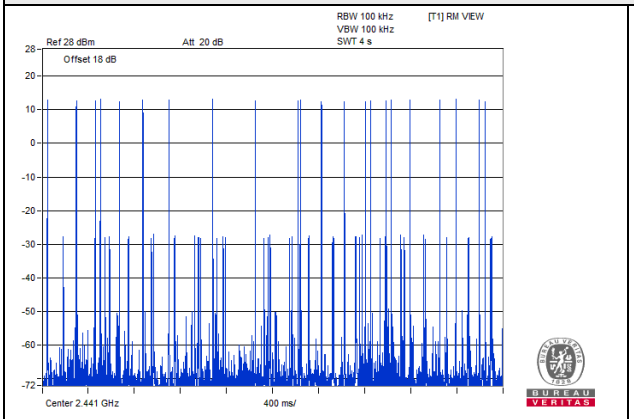
NOTE: Test plots of the transmitting time slot are shown as below.

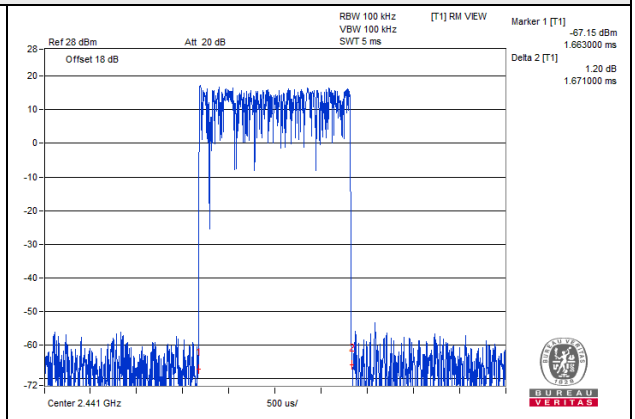
DH1


RBW 100 kHz
VBW 100 kHz
SWT 4 s
[T1] RM VIEW
[T2] MP VIEW
Ref 18 dBm
Att 20 dB
Offset 18 dB
Center 2.441 GHz
400 ms/

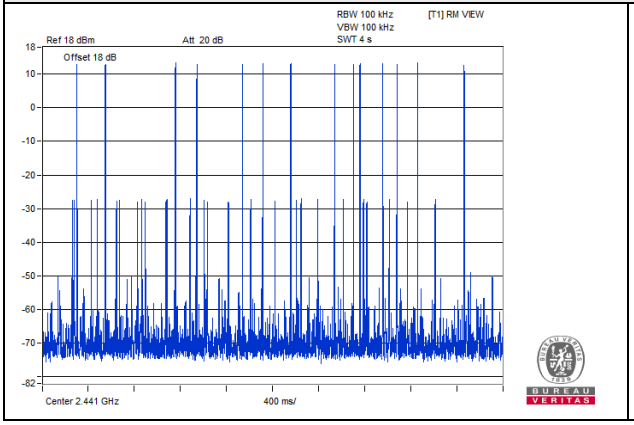

RBW 100 kHz
VBW 100 kHz
SWT 3 ms
[T1] RM VIEW
[T2] MP VIEW
Marker 1 [T1]
-72.81 dBm
1.286000 ms
Delta 2 [T1]
1.80 dB
425.000000 us
Ref 18 dBm
Att 20 dB
Offset 18 dB
Center 2.441 GHz
300 us/

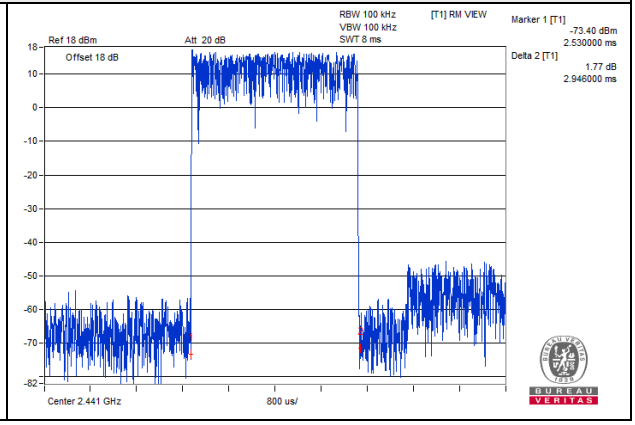
DH3


RBW 100 kHz
VBW 100 kHz
SWT 4 s
[T1] RM VIEW
Ref 28 dBm
Att 20 dB
Offset 18 dB
Center 2.441 GHz
400 ms/


RBW 100 kHz
VBW 100 kHz
SWT 5 ms
[T1] RM VIEW
Marker 1 [T1]
-67.15 dBm
1.663000 ms
Delta 2 [T1]
1.20 dB
1.671000 ms
Ref 28 dBm
Att 20 dB
Offset 18 dB
Center 2.441 GHz
500 us/

DH5


RBW 100 kHz
VBW 100 kHz
SWT 4 s
[T1] RM VIEW
Ref 18 dBm
Att 20 dB
Offset 18 dB
Center 2.441 GHz
400 ms/


RBW 100 kHz
VBW 100 kHz
SWT 8 ms
[T1] RM VIEW
Marker 1 [T1]
-73.40 dBm
2.530000 ms
Delta 2 [T1]
1.77 dB
2.946000 ms
Ref 18 dBm
Att 20 dB
Offset 18 dB
Center 2.441 GHz
800 us/

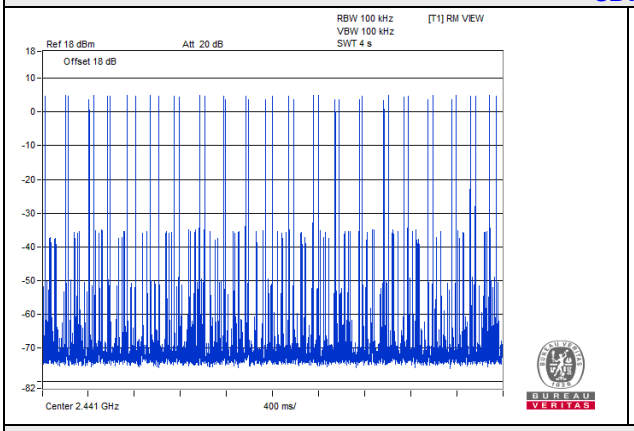
8DPSK:

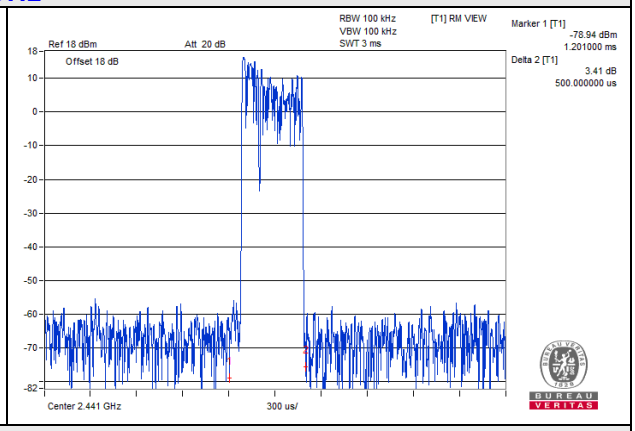
Accumulated Transmit Time							
Mode	**Minimum Number of Hopping Channel**	**NTP* (Sec)**	**Number of Hop in NTP***	**Dwell Time per Hop (msec)**	**Dwell Time in NTP* (msec)**	**Limit (msec)**	**Pass / Fail**
3DH1	79	31.6	323.9	0.5	161.95	400	Pass
3DH3	79	31.6	165.9	1.681	278.8779	400	Pass
3DH5	79	31.6	94.8	2.934	278.1432	400	Pass

*NTP: Number of transmission in a period (channel number *0.4sec)

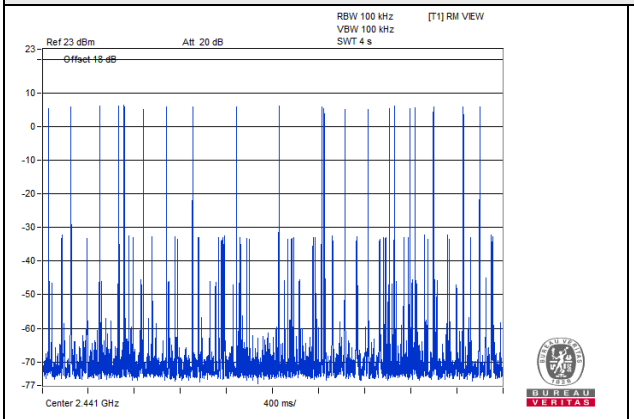
NOTE: Test plots of the transmitting time slot are shown as below.

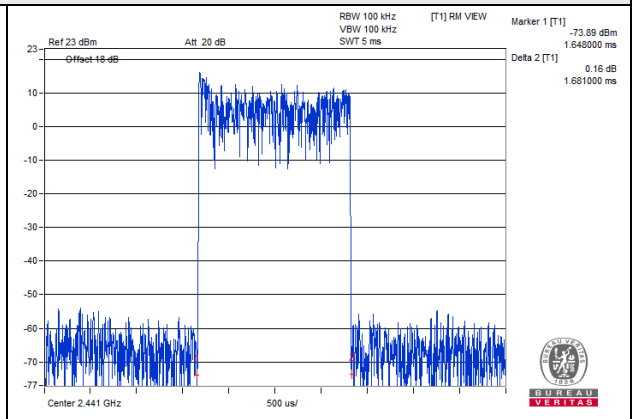
3DH1



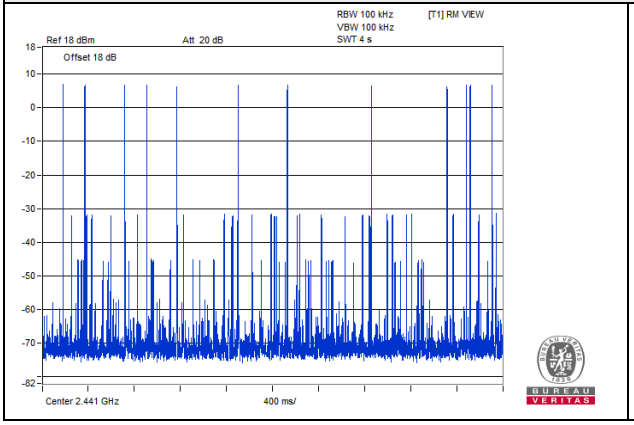


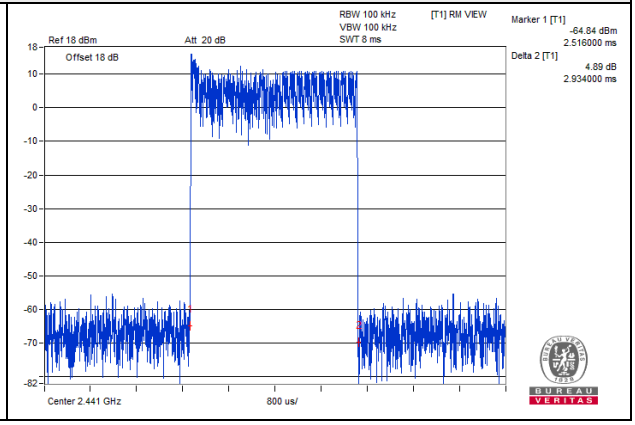
3DH3





3DH5



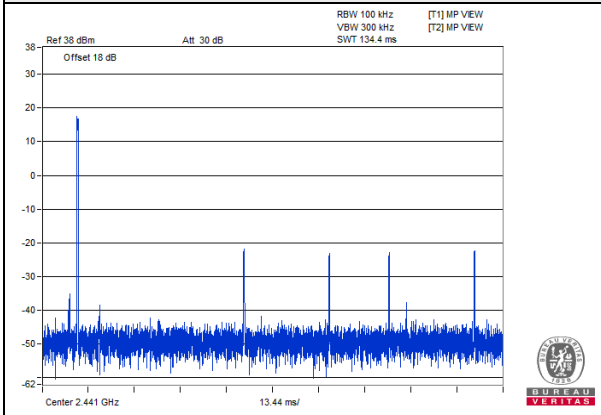


GFSK:

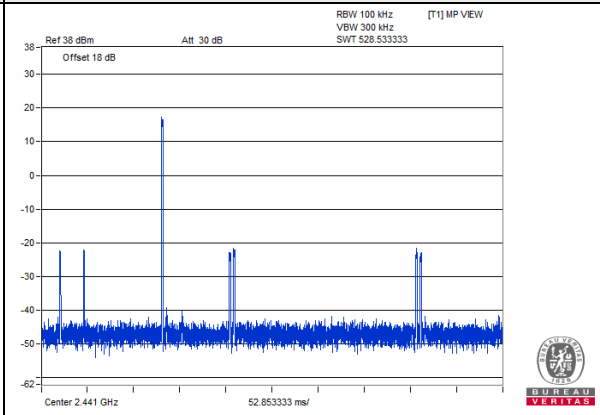
Frequency Occupation							
Mode	Actual Number of Hopping Channel	Dwell Time per Hop (msec)	T_{FO}* (msec)	Number of Hop in T_{FO}*	Dwell Time in T_{FO}*	Limit-Minimum number of Hopping in T_{FO}*	Pass / Fail
DH1	79	0.425	134.3	1	0.425	1	Pass
DH3	79	1.671	528.036	1	1.671	1	Pass
DH5	79	2.946	930.936	3	8.838	1	Pass

*T_{FO}:4 × Dwell Time × Actual number of hopping frequencies in use

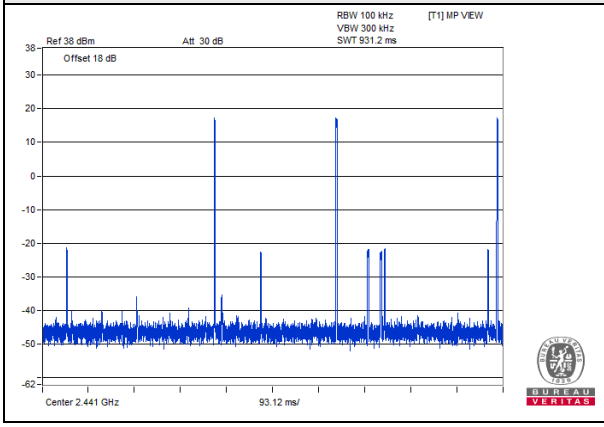
DH1



DH3



DH5

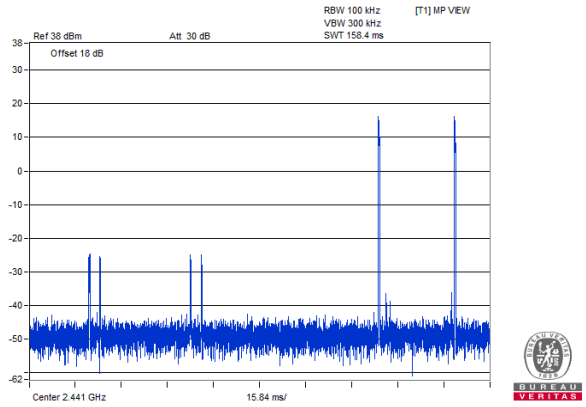


8DPSK:

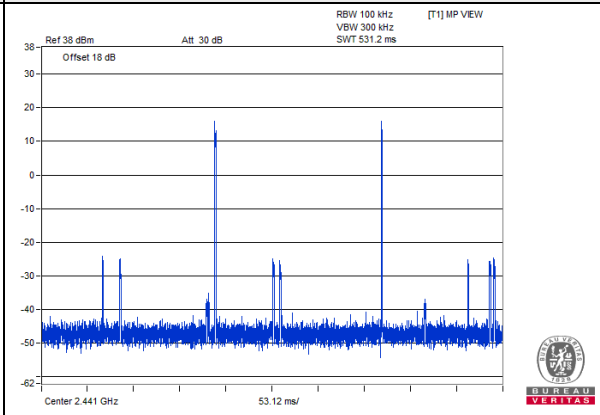
Frequency Occupation							
Mode	**Actual Number of Hopping Channel**	**Dwell Time per Hop (msec)**	**T_{FO}* (msec)**	**Number of Hop in T_{FO}***	**Dwell Time in T_{FO}***	**Limit-Minimum number of Hopping in T_{FO}***	**Pass / Fail**
3DH1	79	0.5	158	2	1	1	Pass
3DH3	79	1.681	531.196	2	3.362	1	Pass
3DH5	79	2.934	927.144	1	2.934	1	Pass

*T_{FO}:4 × Dwell Time × Actual number of hopping frequencies in use

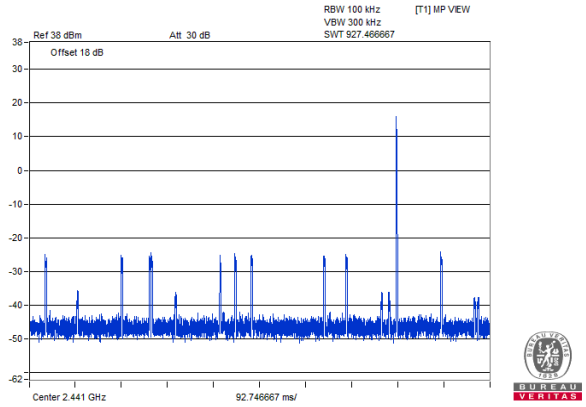
3DH1



3DH3

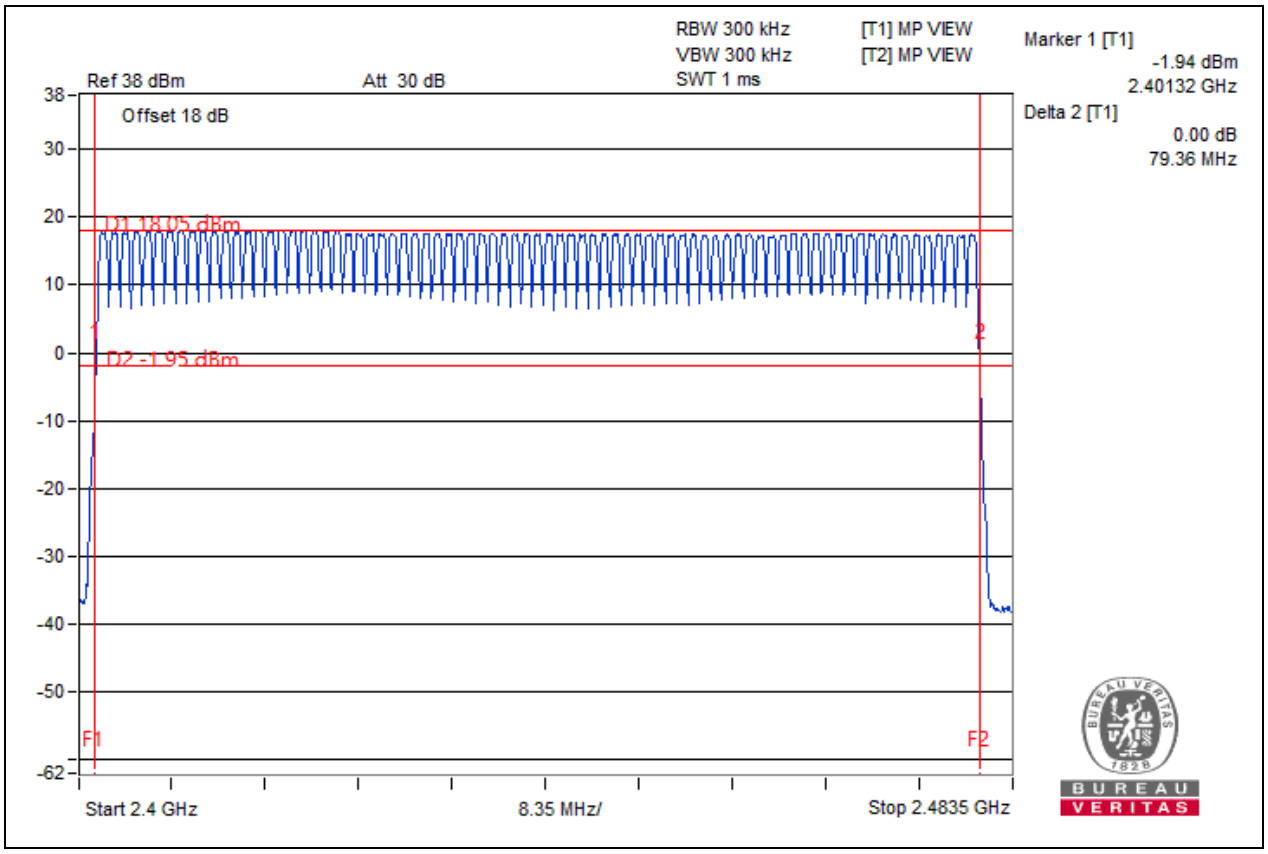


3DH5



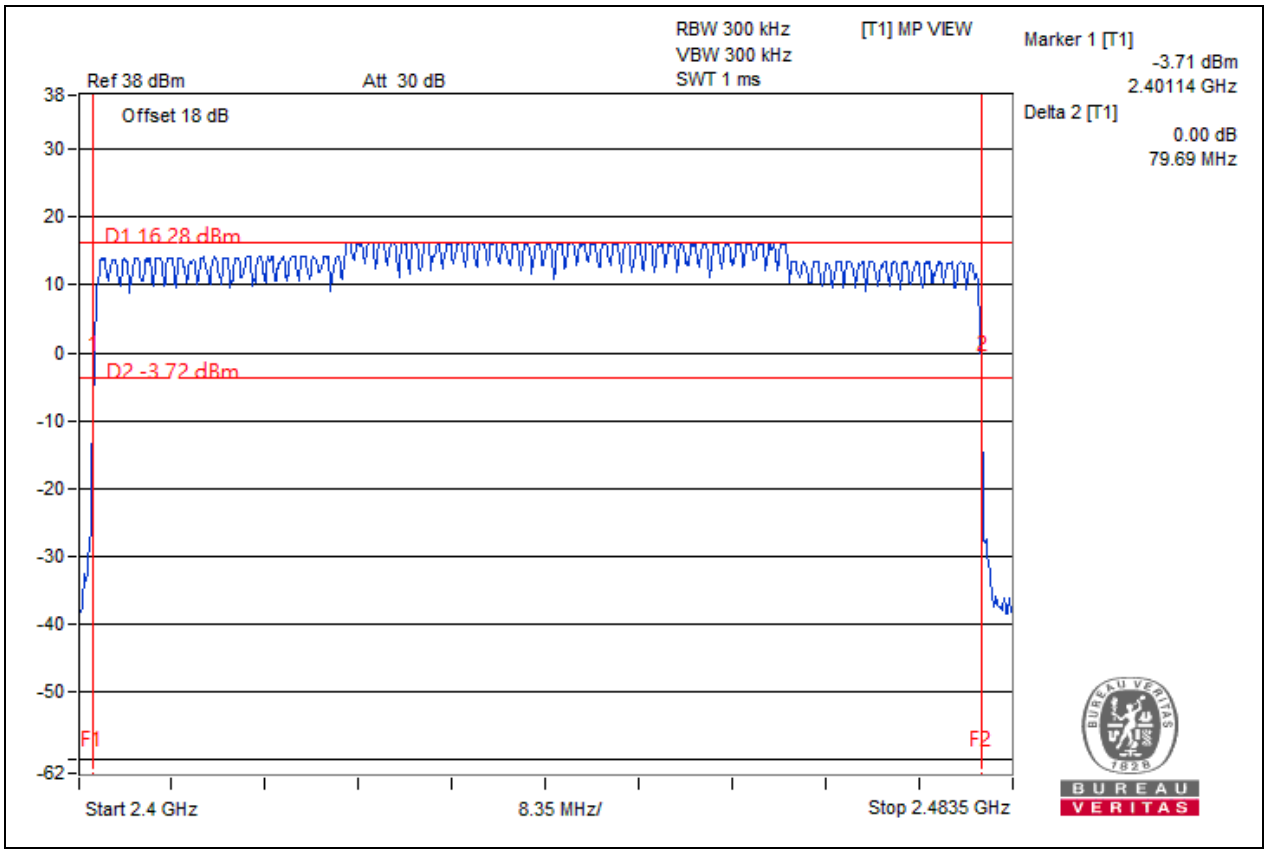
GFSK:

hopping sequence(s)		
Amount of Hopping frequency	**Limit**	**Pass/Fail**
79	≥15 hopping frequencies	PASS
Operating hopping Bandwidth (MHz)	**Limit**	**Pass/Fail**
79.36	≥58.45MHz	PASS



8DPSK:

hopping sequence(s)		
Amount of Hopping frequency	**Limit**	**Pass/Fail**
79	≥15/minimum Hopping Frequency	PASS
Operating hopping Bandwidth (MHz)	**Limit**	**Pass/Fail**
79.69	≥58.45MHz	PASS



4.2.6 Test Results (Mode 2)

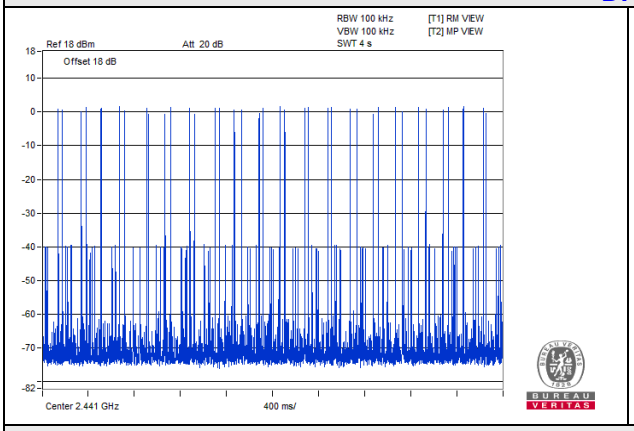
GFSK:

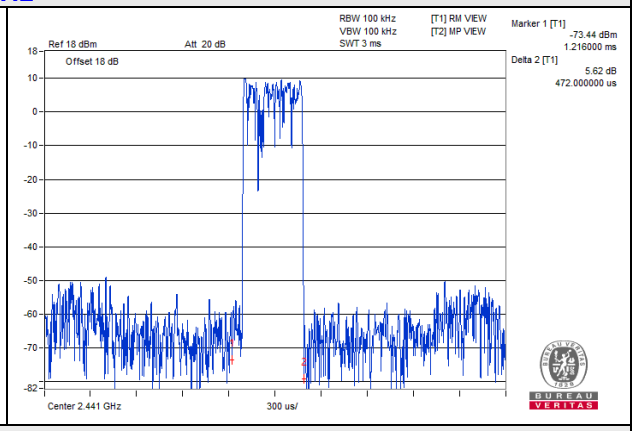
Accumulated Transmit Time							
Mode	**Minimum Number of Hopping Channel**	**NTP* (Sec)**	**Number of Hop in NTP***	**Dwell Time per Hop (msec)**	**Dwell Time in NTP* (msec)**	**Limit (msec)**	**Pass / Fail**
DH1	79	31.6	316	0.472	149.152	400	Pass
DH3	79	31.6	158	1.67	263.86	400	Pass
DH5	79	31.6	102.7	2.928	300.7056	400	Pass

*NTP: Number of transmission in a period (channel number *0.4sec)

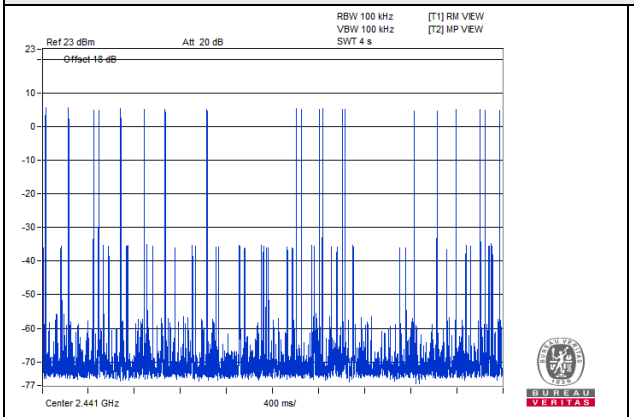
NOTE: Test plots of the transmitting time slot are shown as below.

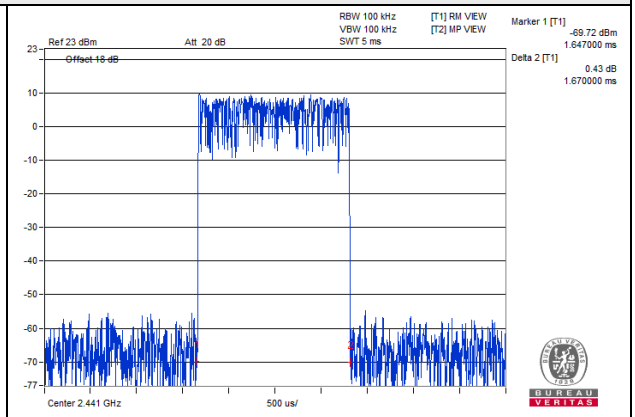
DH1


RBW 100 kHz
VBW 100 kHz
SWT 4 s
[T1] RM VIEW
[T2] MP VIEW
Ref 18 dBm
Att 20 dB
Offset 18 dB
Center 2.441 GHz
400 ms/

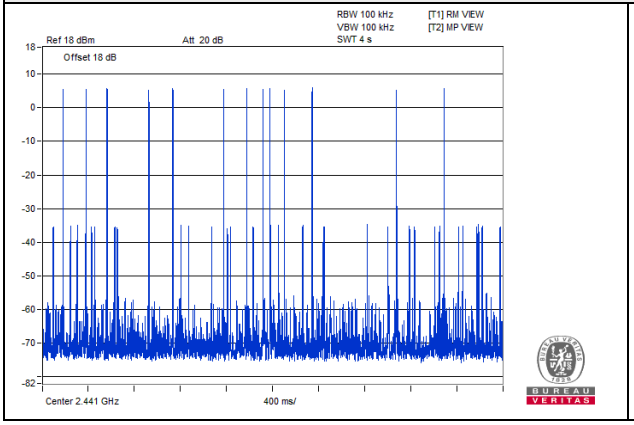

RBW 100 kHz
VBW 100 kHz
SWT 3 ms
[T1] RM VIEW
[T2] MP VIEW
Ref 18 dBm
Att 20 dB
Offset 18 dB
Marker 1 [T1]
-73.44 dBm
1.216000 ms
Delta 2 [T1]
5.62 dB
472.000000 us
Center 2.441 GHz
300 us/

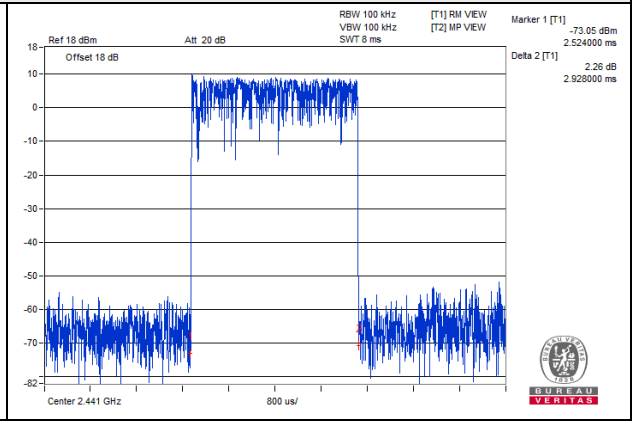
DH3


RBW 100 kHz
VBW 100 kHz
SWT 4 s
[T1] RM VIEW
[T2] MP VIEW
Ref 23 dBm
Att 20 dB
Offset 18 dB
Center 2.441 GHz
400 ms/


RBW 100 kHz
VBW 100 kHz
SWT 5 ms
[T1] RM VIEW
[T2] MP VIEW
Ref 23 dBm
Att 20 dB
Offset 18 dB
Marker 1 [T1]
-69.72 dBm
1.647000 ms
Delta 2 [T1]
0.43 dB
1.670000 ms
Center 2.441 GHz
500 us/

DH5


RBW 100 kHz
VBW 100 kHz
SWT 4 s
[T1] RM VIEW
[T2] MP VIEW
Ref 18 dBm
Att 20 dB
Offset 18 dB
Center 2.441 GHz
400 ms/


RBW 100 kHz
VBW 100 kHz
SWT 8 ms
[T1] RM VIEW
[T2] MP VIEW
Ref 18 dBm
Att 20 dB
Offset 18 dB
Marker 1 [T1]
-73.05 dBm
2.524000 ms
Delta 2 [T1]
2.26 dB
2.928000 ms
Center 2.441 GHz
800 us/

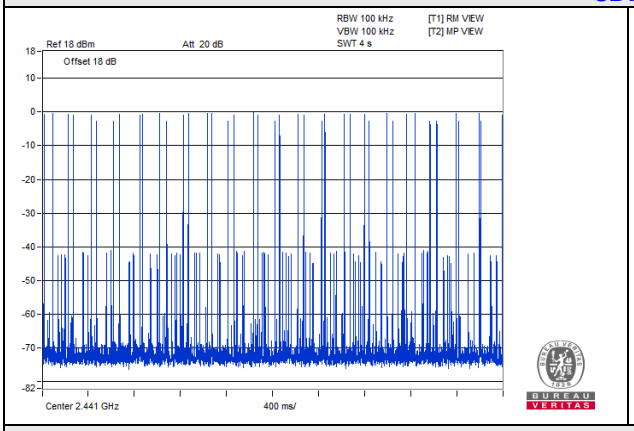
8DPSK:

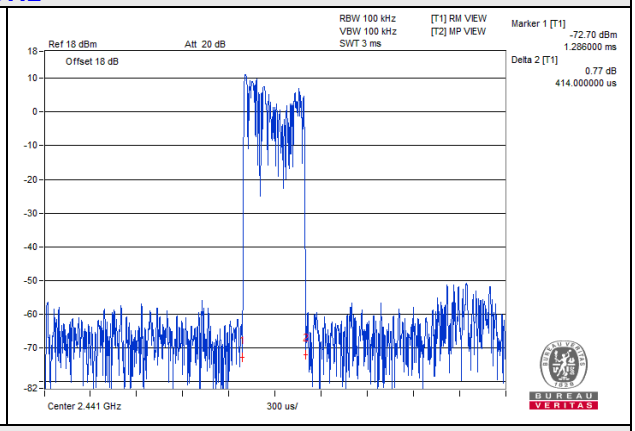
Accumulated Transmit Time							
Mode	**Minimum Number of Hopping Channel**	**NTP* (Sec)**	**Number of Hop in NTP***	**Dwell Time per Hop (msec)**	**Dwell Time in NTP* (msec)**	**Limit (msec)**	**Pass / Fail**
3DH1	79	31.6	323.9	0.414	134.0946	400	Pass
3DH3	79	31.6	173.8	1.677	291.4626	400	Pass
3DH5	79	31.6	102.7	2.936	301.5272	400	Pass

*NTP: Number of transmission in a period (channel number *0.4sec)

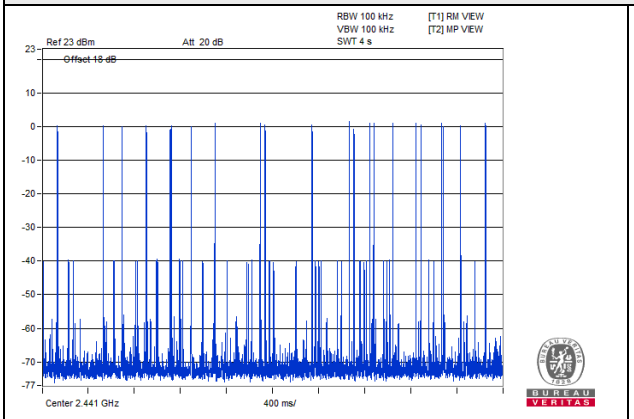
NOTE: Test plots of the transmitting time slot are shown as below.

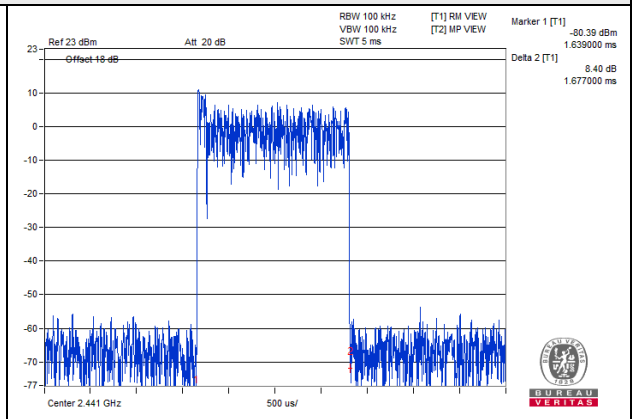
3DH1



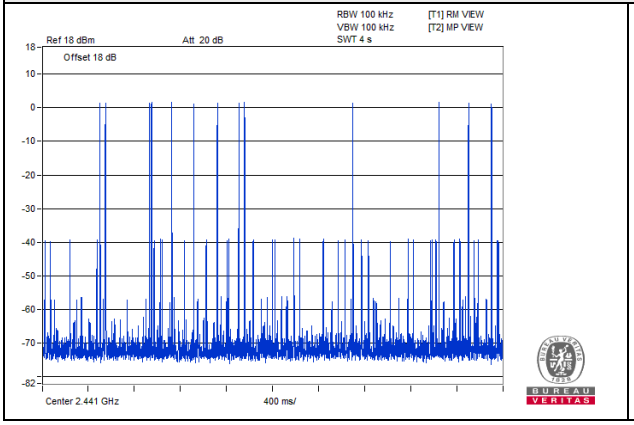


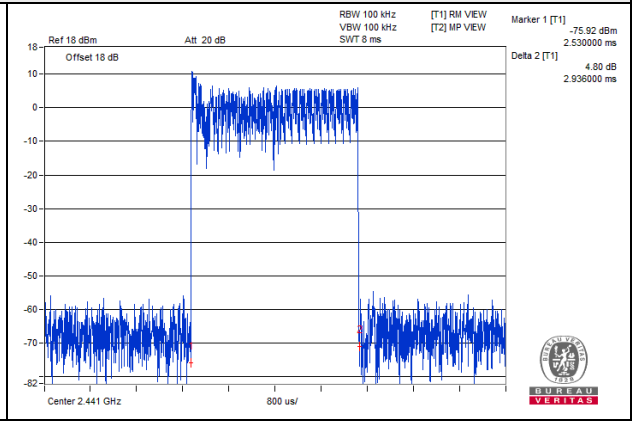
3DH3





3DH5



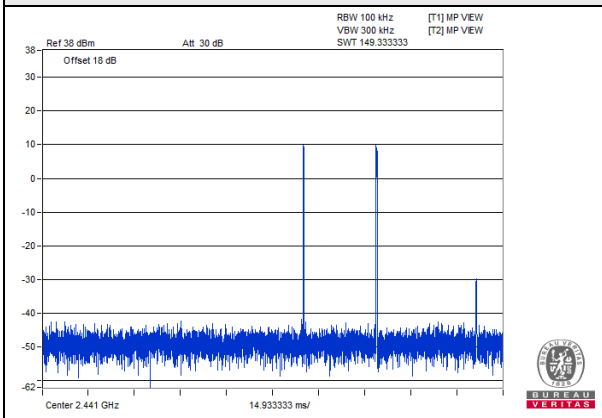


GFSK:

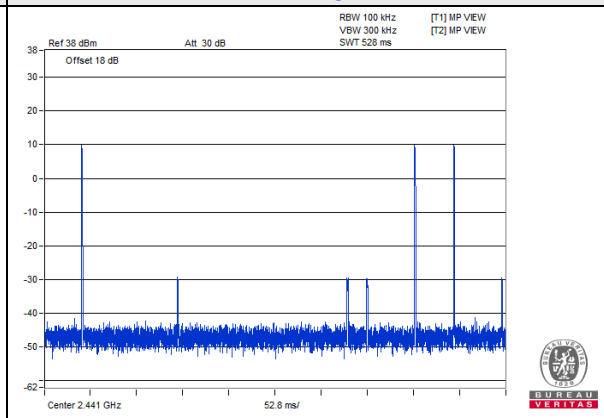
Frequency Occupation							
Mode	Actual Number of Hopping Channel	Dwell Time per Hop (msec)	T_{FO}* (msec)	Number of Hop in T_{FO}*	Dwell Time in T_{FO}*	Limit-Minimum number of Hopping in T_{FO}*	Pass / Fail
DH1	79	0.472	149.152	2	0.944	1	Pass
DH3	79	1.67	527.72	3	5.01	1	Pass
DH5	79	2.928	925.248	2	5.856	1	Pass

*T_{FO}:4 × Dwell Time × Actual number of hopping frequencies in use

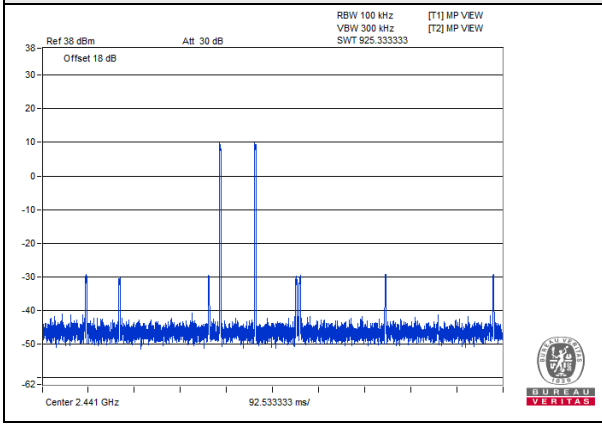
DH1



DH3



DH5

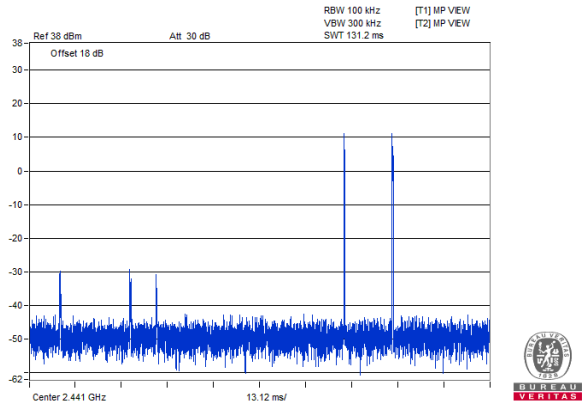


8DPSK:

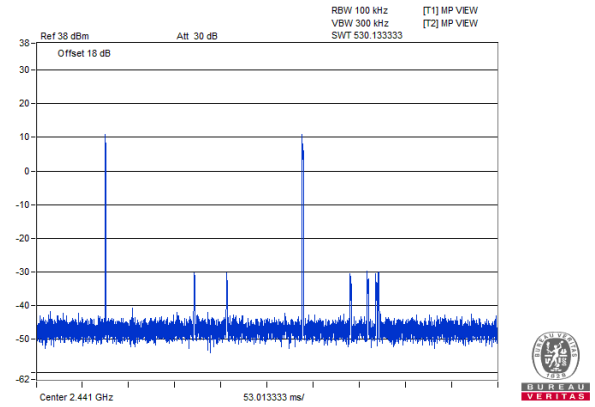
Frequency Occupation							
Mode	**Actual Number of Hopping Channel**	**Dwell Time per Hop (msec)**	**T_{FO}* (msec)**	**Number of Hop in T_{FO}***	**Dwell Time in T_{FO}***	**Limit-Minimum number of Hopping in T_{FO}***	**Pass / Fail**
3DH1	79	0.414	130.824	2	0.828	1	Pass
3DH3	79	1.677	529.932	2	3.354	1	Pass
3DH5	79	2.936	927.776	2	5.872	1	Pass

*T_{FO}:4 × Dwell Time × Actual number of hopping frequencies in use

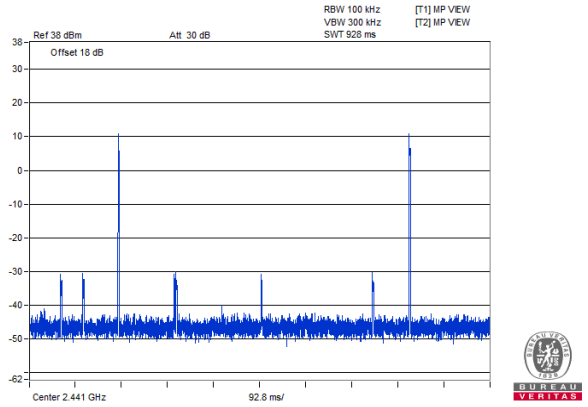
3DH1



3DH3

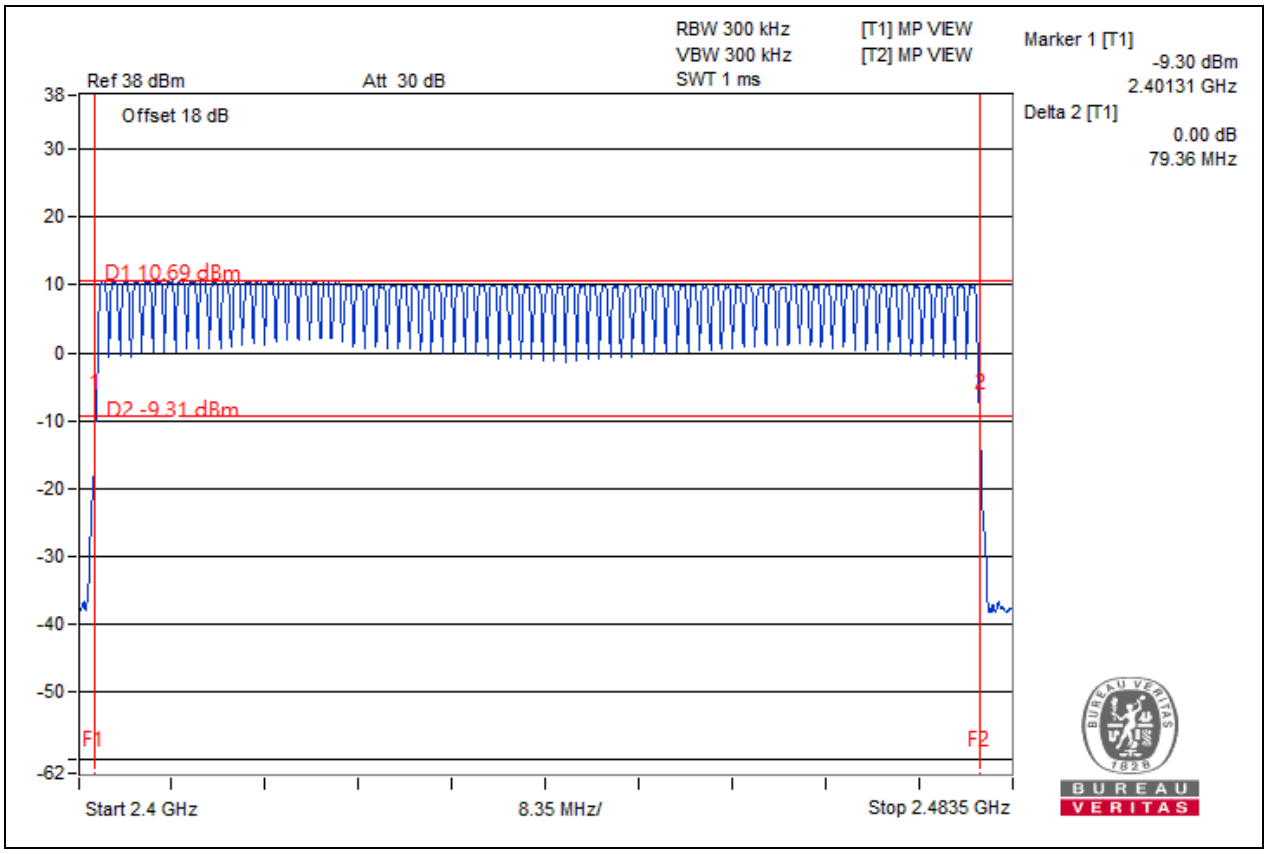


3DH5



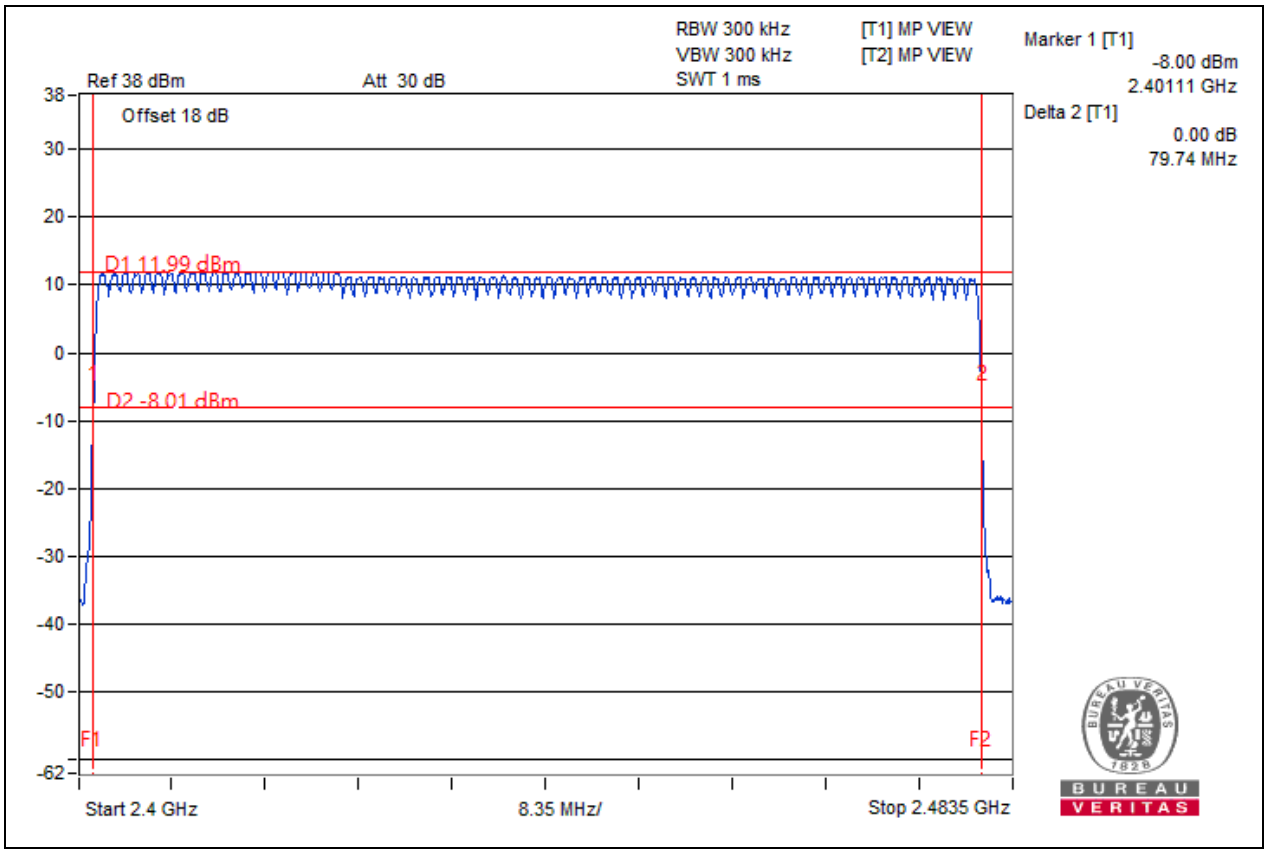
GFSK:

hopping sequence(s)		
Amount of Hopping frequency	**Limit**	**Pass/Fail**
79	≥15 hopping frequencies	PASS
Operating hopping Bandwidth (MHz)	**Limit**	**Pass/Fail**
79.36	≥58.45MHz	PASS



8DPSK:

hopping sequence(s)		
Amount of Hopping frequency	**Limit**	**Pass/Fail**
79	≥15/minimum Hopping Frequency	PASS
Operating hopping Bandwidth (MHz)	**Limit**	**Pass/Fail**
79.74	≥58.45MHz	PASS



4.3 Hopping Frequency Separation

4.3.1 Limits of Hopping Frequency Separation

Condition	Limit
☐Non-adaptive frequency hopping systems	The minimum Hopping Frequency Separation shall be equal to Occupied Channel Bandwidth of a single hop, with a minimum separation of 100 kHz.
☒Adaptive frequency hopping systems	The minimum Hopping Frequency Separation shall be 100 kHz.

4.3.2 Test Procedure

Refer to chapter 5.4.5 of EN 300 328 V2.2.2.

Measurement	
☒Conducted measurement	☐ Radiated measurement

4.3.3 Deviation from Test Standard

No deviation

4.3.4 Test Setup

The measurement was performed at normal environmental conditions only. The measurement was performed on 2 adjacent hopping frequencies. The equipment was configured to operate under its worst case situation with respect to output power. In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator. Controlling software (Bluetooth RF test tool (5.2.3.1)) has been activated to set the EUT on specific status.

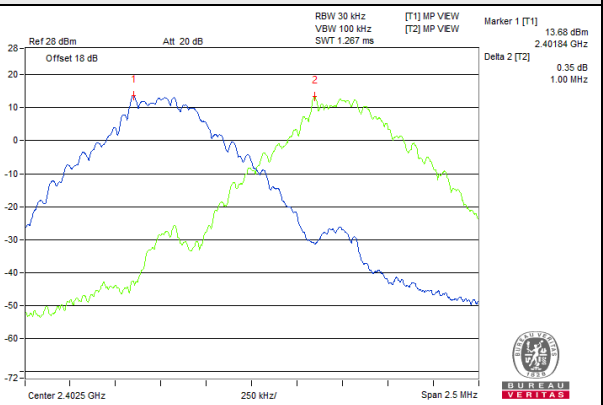
4.3.5 Test Results (Mode 1)

GFSK:

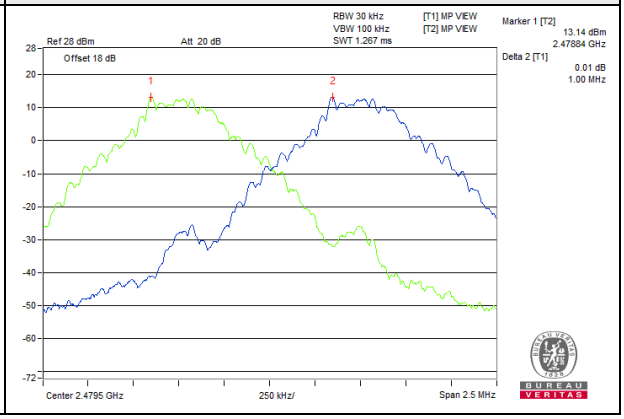
Channel Number	Frequency (MHz)	Channel Separation (MHz)	Minimum Limit (MHz)	Pass /Fail
0	2402	1	0.1	Pass
78	2480	1	0.1	Pass

Note: The limitation is from OCB of a single hop and this value must greater and equal to 100kHz.

CH0



CH78

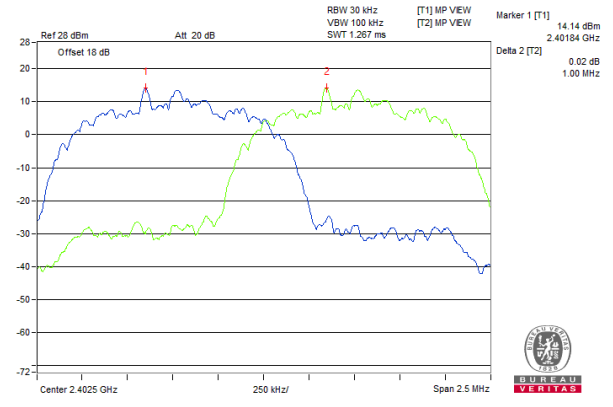


8DPSK:

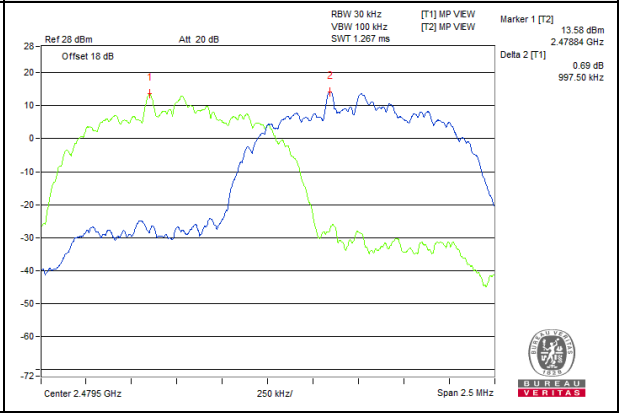
Channel Number	Frequency (MHz)	Channel Separation (MHz)	Minimum Limit (MHz)	Pass /Fail
0	2402	1	0.1	Pass
78	2480	0.99	0.1	Pass

Note: The limitation is from OCB of a single hop and this value must greater and equal to 100kHz.

CH0



CH78



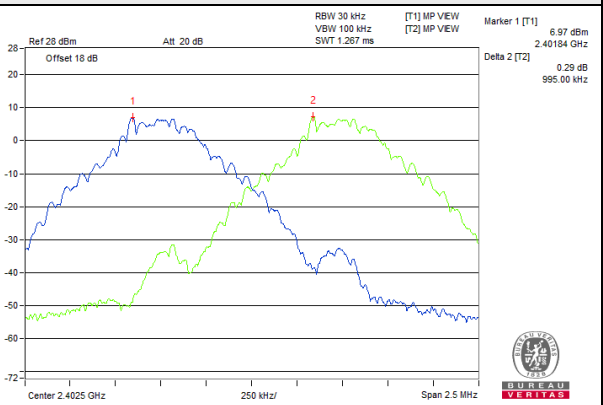
4.3.6 Test Results (Mode 2)

GFSK:

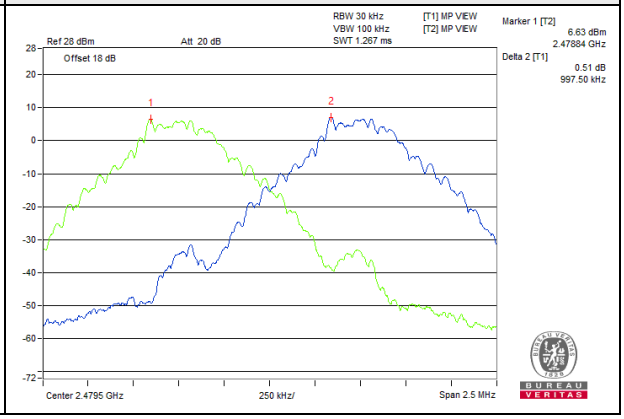
Channel Number	Frequency (MHz)	Channel Separation (MHz)	Minimum Limit (MHz)	Pass /Fail
0	2402	0.99	0.1	Pass
78	2480	0.99	0.1	Pass

Note: The limitation is from OCB of a single hop and this value must greater and equal to 100kHz.

CH0



CH78

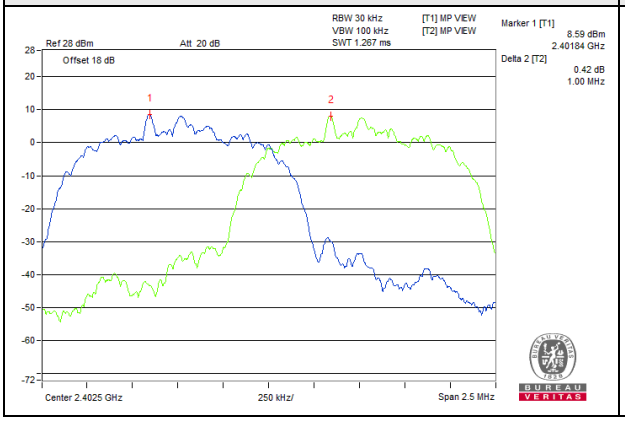


8DPSK:

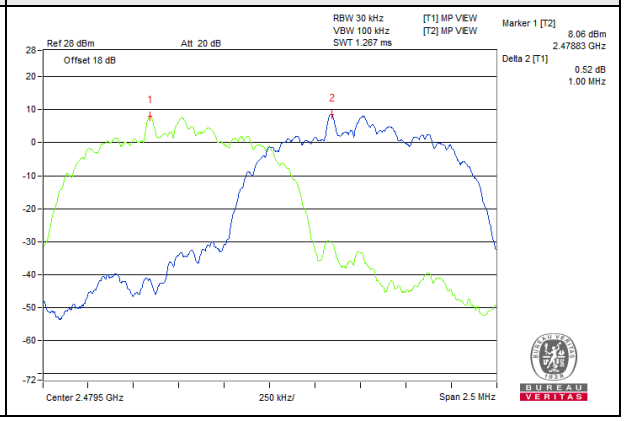
Channel Number	Frequency (MHz)	Channel Separation (MHz)	Minimum Limit (MHz)	Pass /Fail
0	2402	1	0.1	Pass
78	2480	1	0.1	Pass

Note: The limitation is from OCB of a single hop and this value must greater and equal to 100kHz.

CH0



CH78



4.4 Adaptivity (Adaptive Frequency Hopping)

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

4.4.1 Limit of Adaptive

Applicability of adaptive requirements and limit for frequency hopping equipment

Requirement	Operational Mode	
	LBT based DAA	Other forms of DAA (non-LBT based)
Minimum Clear Channel Assessment (CCA) Time	18 us (see note 1)	NA
Maximum Channel Occupancy (COT) Time	60 ms (see note2)	40 ms (see note5)
Minimum Idle Period	100 us (see note3)	100 us (see note5)
Extended CCA check	see note4	NA
Minimum time for unavailable	NA	see note6
Short Control Signalling Transmissions	Maximum duty cycle of 10 % within an observation period of 50 ms (see note 7)	

NOTE 1: The CCA observation time shall be not less than 0,2 % of the Channel Occupancy Time with a minimum of 18 µs
NOTE 2: For LBT based frequency hopping equipment with a dwell time < 60 ms, the maximum Channel Occupancy Time is limited by the dwell time.
NOTE 3: Minimum 5 % of the Channel Occupancy Time with a minimum of 100 µs.
NOTE 4: Extended CCA check is observed for a random duration between the value defined for the CCA observation time and 5 % of the Channel Occupancy Time.
NOTE 5: For equipment using a dwell time > 40 ms that want to have other transmissions during the same hop (dwell time) an Idle Period (no transmissions) of minimum 5 % of the Channel Occupancy Period with a minimum of 100 µs shall be implemented.
NOTE 6: The frequency shall remain unavailable for a minimum time equal to 1 second or 5 times the actual number of hopping frequencies multiplied with the Channel Occupancy Time whichever is the longest.
NOTE 7: Adaptive equipment may or may not have Short Control Signaling Transmissions.

Interference threshold level

Maximum transmit power (P_H) EIRP dBm	Threshold level (TL) (see notes 1 and 2)
20	-70 dBm / MHz

NOTE 1: For a 20 dBm e.i.r.p. transmitter the detection threshold level (TL) shall be equal or less than -70 dBm/MHz at the input to the receiver (assuming a 0 dBi receive antenna)
NOTE 2: For power levels below 20 dBm e.i.r.p., the detection threshold level may be relaxed to TL = -70 dBm/MHz + 10 × $\log_{10}$ (100 mW / P_{out}) (P_{out} in mW e.i.r.p.)

Unwanted signal parameters for LBT based DAA		
Wanted signal mean power from companion device	**Unwanted signal frequency (MHz)**	**Unwanted CW signal power (dBm)**
sufficient to maintain the link (see note 2)	2 395 or 2 488.5 (see note 1)	-35 (see note 3)
NOTE 1: The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483.5 MHz. NOTE 2: A typical value which can be used in most cases is -50dBm/MHz. NOTE 3: The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.		

Unwanted signal parameters for non-LBT Based		
Wanted signal mean power from companion device (dBm)	**Unwanted signal frequency (MHz)**	**Unwanted CW signal power (dBm)**
-30	2 395 or 2 488.5 (see note 1)	-35 (see note 2)
NOTE 1: The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. NOTE 2: The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.		

4.4.2 Test Procedure

Refer to chapter 5.4.6 of EN 300 328 V2.2.2.

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

4.4.3 Deviatrion from Test Standard

No deviation.

4.4.4 Test Setup Configuration

Companion Device information

PRODUCT	BRAND	MODEL NO.
Bluetooth Test Set	Anritsu	MT8852b

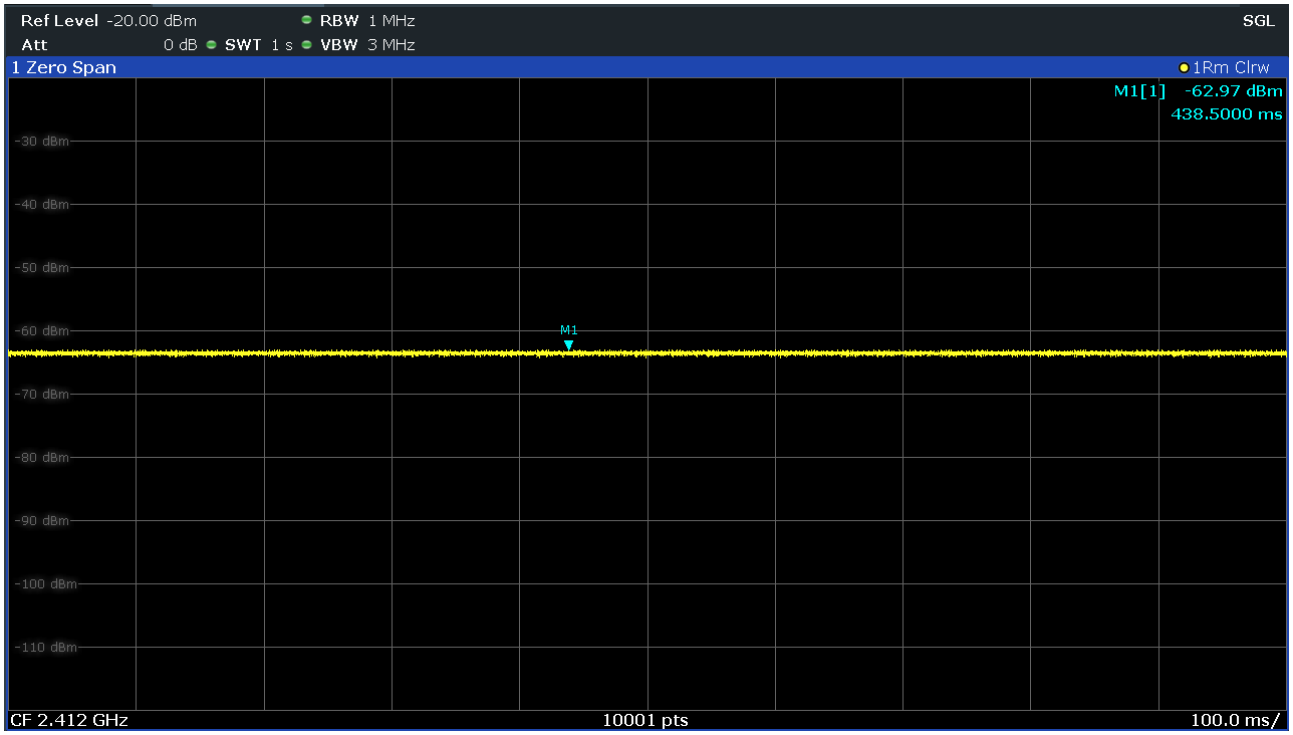
4.4.5 List of Measurements

UUT Operational Mode	Applicable	Limit	
		The Maximum Channel Occupancy Time	The Minimum idle Period
FHSS using others form of DAA (non-LBT based)	v	40 ms	5% of COT
FHSS using LBT based		60ms	5% of COT

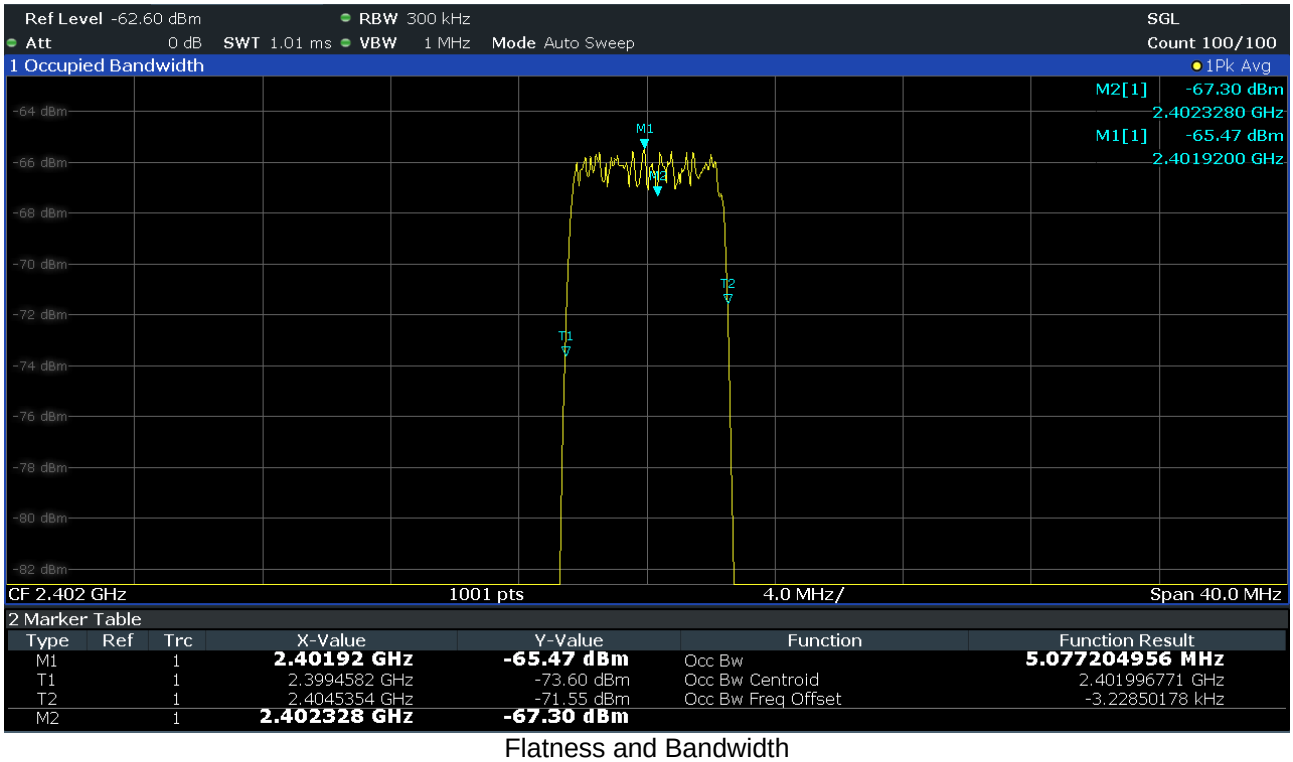
Clause	Test Parameter	Remarks	Pass/Fail
4.3.1.7.2	Adaptive FHSS using LBT Based DAA	Not Applicable	NA
4.3.1.7.3	Adaptive FHSS using others form of DAA (non-LBT based)	Applicable	PASS
4.3.1.7.4	Short Control Signalling Transmissions	Applicable	PASS
4.3.1.7.3.2.6	Unwanted signal test	Applicable	PASS

4.4.6 Interference Threshold Level

Detection Threshold Level
The maximum EIRP (nom) power is 15.85 dBm (38.46 mW) and antenna gain is 3 dBi. Detection Threshold level= -70 dBm/MHz + 10×log(100 mW / Pout (38.46 mW)) + G (3 dBi) = -62.85 dBm/MHz The interference signal level to the UUT is lower than -62.85 dBm/MHz.



Detection Threshold Level



Flatness and Bandwidth

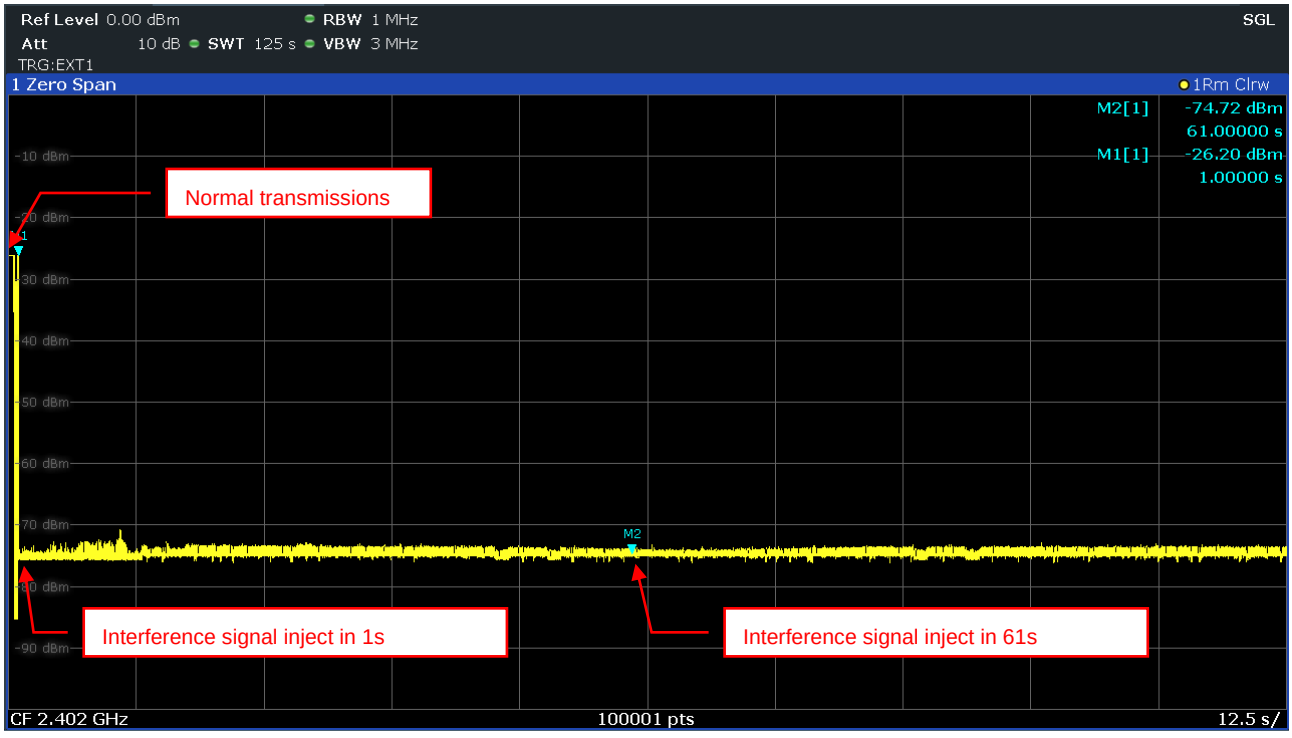
4.4.7 Test Result

☐	Not applicable to non-adaptive equipment or adaptive equipment operating in a non-adaptive mode
☐	Not applicable to equipment with RF output power is less than 10 dBm e.i.r.p.
☒	Refer to below test result

4.4.7.1 Adaptive Result

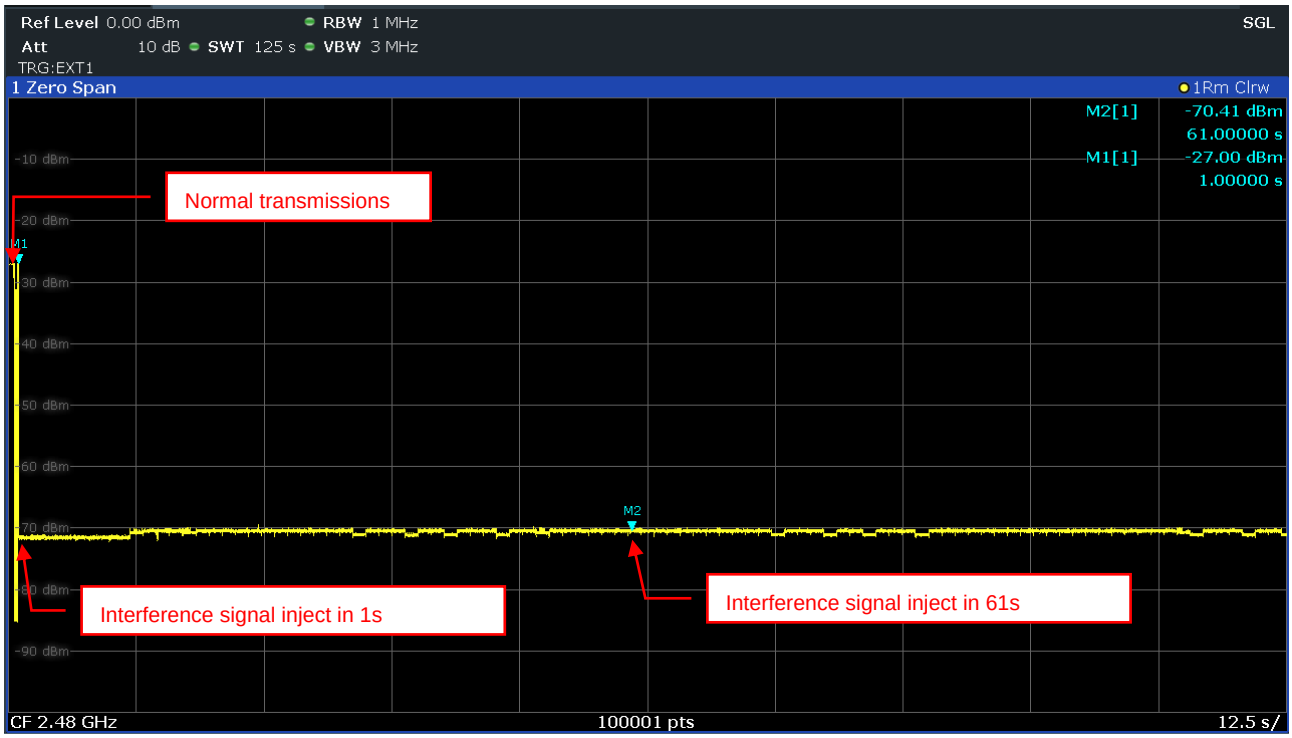
Operating Frequency Bands and Mode of EUT

Operational Mode	Operating Frequency (MHz)	Test Result
GFSK	2402	PASS



Operating Frequency Bands and Mode of EUT

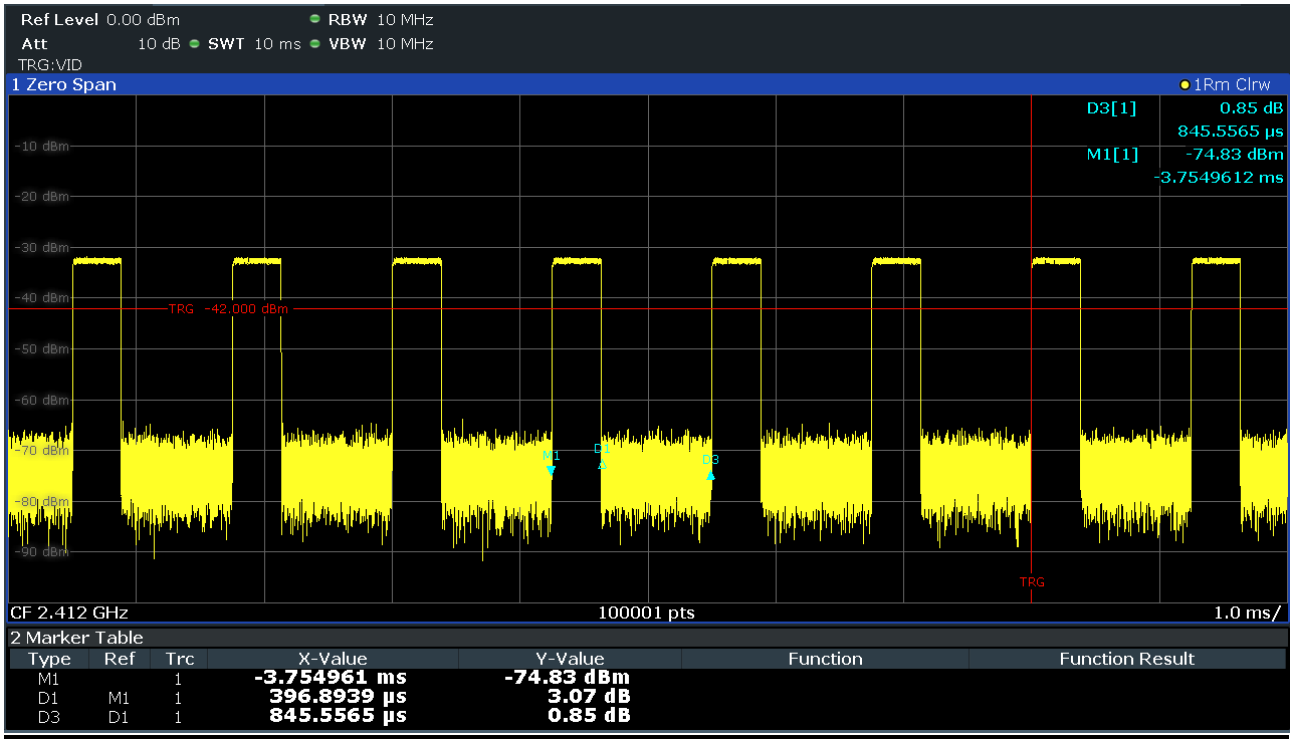
Operational Mode	Operating Frequency (MHz)	Test Result
GFSK	2480	PASS



4.4.7.2 The Channel Occupancy Time Result

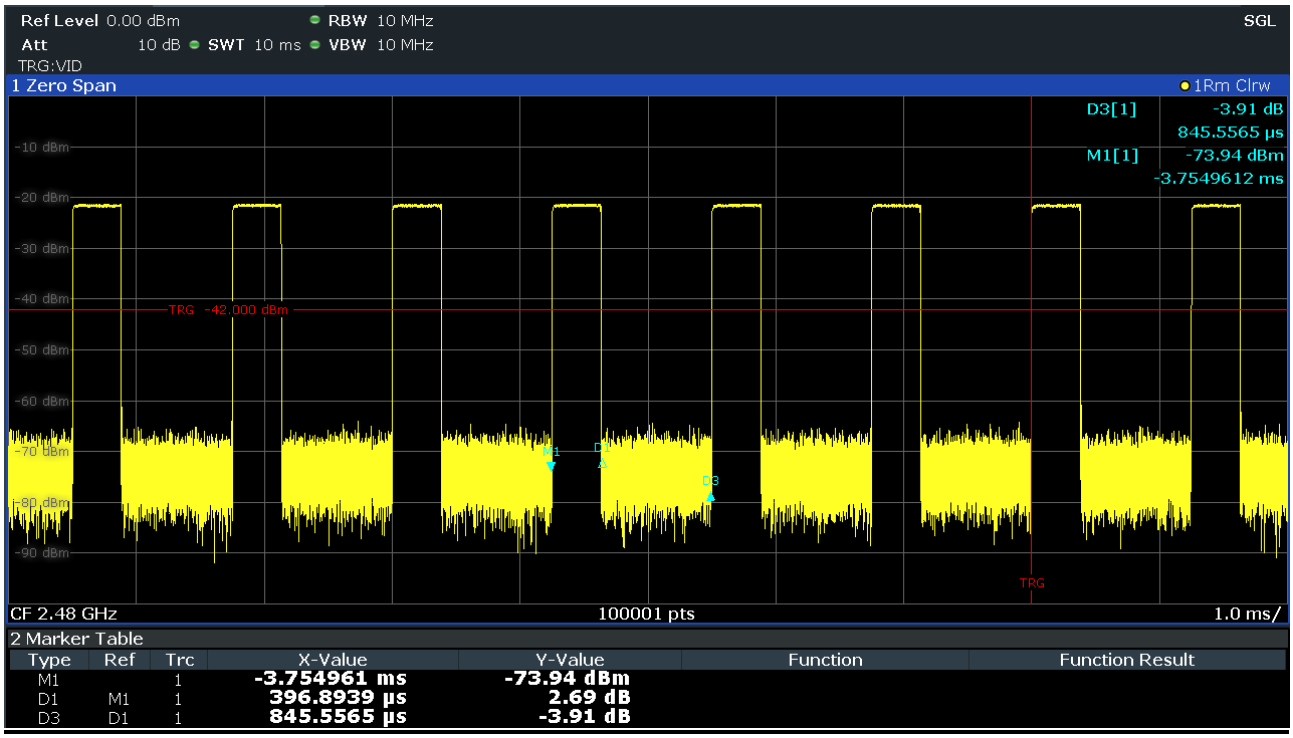
Operating Frequency Bands and Mode of EUT

Operational Mode	Operating Frequency (MHz)	The Channel Occupancy Time (ms)	Minimum Idle Period (ms)	Test Result
GFSK	2402	0.40	0.85	PASS



Operating Frequency Bands and Mode of EUT

Operational Mode	Operating Frequency (MHz)	The Channel Occupancy Time (ms)	Minimum Idle Period (ms)	Test Result
GFSK	2480	0.40	0.85	PASS



4.4.7.3 Unwanted Signal Interference Test Results

Channel	Channel Frequency (MHz)	Wanted Signal Mean Power from Companion Device (dBm/MHz)	Wanted Signal Frequency (MHz)	Unwanted Signal Power (dBm)	Pass/Fail
0	2402	-50	2488.5	-31.5	Pass
78	2480	-50	2395	-31.5	Pass

4.5 Occupied Channel Bandwidth

4.5.1 Limit of Occupied Channel Bandwidth

Condition		Limit
All types of equipment		Shall fall completely within the band 2400 to 2483.5 MHz.
Additional requirement	For non-adaptive using wide band modulations other than FHSS system and e.i.r.p. >10dBm.	Less than 20MHz
	For non-adaptive Frequency Hopping system and e.i.r.p. >10dBm.	Less than 5MHz

4.5.2 Test Procedure

Refer to chapter 5.4.7 of EN 300 328 V2.2.2.

Measurement	
☒Conducted measurement	☐ Radiated measurement

4.5.3 Deviation from Test Standard

No deviation.

4.5.4 Test Setup

The measurement was performed at normal environmental conditions only. This measurement was performed at the lowest and the highest channel. Using software to force the EUT to hop or transmit on a single Hopping Frequency. The equipment was configured to operate under its worst case situation with respect to output power. (In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator.) Controlling software (Bluetooth RF test tool (5.2.3.1)) has been activated to set the EUT on specific status.

4.5.5 Test Results (Mode 1)

GFSK:

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Measured Frequencies		Limit	Pass/Fail
			F_L (MHz)	F_H (MHz)		
0	2402	0.88	2401.57	2402.45	F_L > 2.4 GHz and F_H < 2.4835 GHz	Pass
78	2480	0.88	2479.57	2480.45		Pass

Note: F_L is the lowest frequency of the 99% occupied bandwidth of power envelope.
F_H is the highest frequency of the 99% occupied bandwidth of power envelope.

8DPSK:

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Measured Frequencies		Limit	Pass/Fail
			F_L (MHz)	F_H (MHz)		
0	2402	1.2	2401.41	2402.61	F_L > 2.4 GHz and F_H < 2.4835 GHz	Pass
78	2480	1.21	2479.4	2480.61		Pass

Note: F_L is the lowest frequency of the 99% occupied bandwidth of power envelope.
F_H is the highest frequency of the 99% occupied bandwidth of power envelope.

4.5.1 Test Results (Mode 2)

GFSK:

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Measured Frequencies		Limit	Pass/Fail
			F_L (MHz)	F_H (MHz)		
0	2402	0.89	2401.56	2402.45	F_L > 2.4 GHz and F_H < 2.4835 GHz	Pass
78	2480	0.89	2479.56	2480.45		Pass

Note: F_L is the lowest frequency of the 99% occupied bandwidth of power envelope.
F_H is the highest frequency of the 99% occupied bandwidth of power envelope.

8DPSK:

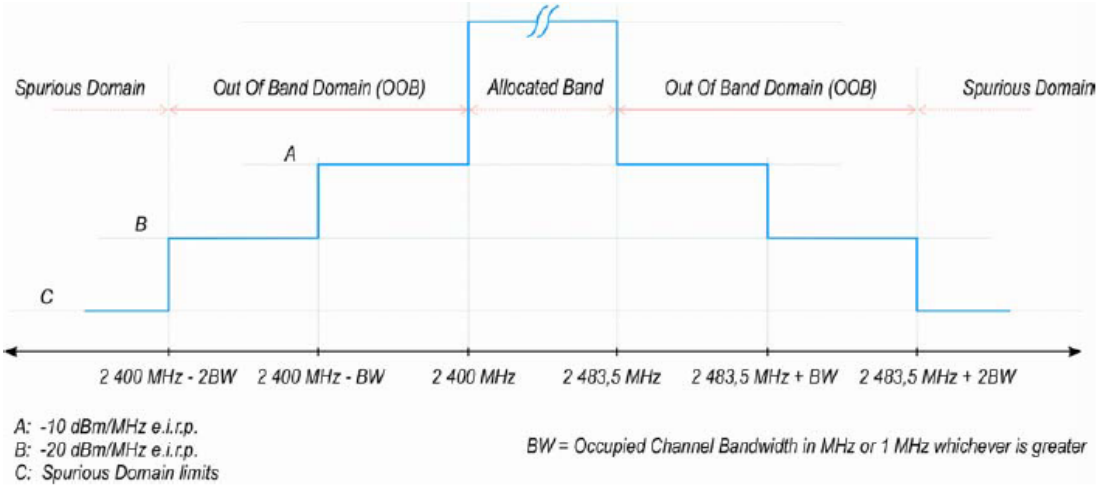
Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Measured Frequencies		Limit	Pass/Fail
			F_L (MHz)	F_H (MHz)		
0	2402	1.19	2401.41	2402.6	F_L > 2.4 GHz and F_H < 2.4835 GHz	Pass
78	2480	1.19	2479.41	2480.6		Pass

Note: F_L is the lowest frequency of the 99% occupied bandwidth of power envelope.
F_H is the highest frequency of the 99% occupied bandwidth of power envelope.

4.6 Transmitter Unwanted Emissions in the Out-of-Band Domain

4.6.1 Limits of Transmitter Unwanted Emission in the Out-of-Band Domain

Condition	Limit
Under normal conditions	The transmitter unwanted emissions in the out-of-band domain shall not exceed the values provided by the mask in below figure.



4.6.2 Test Procedure

Refer to chapter 5.4.8 of EN 300 328 V2.2.2.

Measurement	
☒ Conducted measurement	☐ Radiated measurement

4.6.3 Deviation from Test Standard

No deviation

4.6.4 Test Setup

The measurement was performed at normal environmental conditions only. The equipment was performed normal operation (hopping) during test. The equipment was configured to operate under its worst case situation with respect to output power. In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator. The frequency has to be recorded for the right and left end above threshold of highest and lowest channel respectively.

4.6.5 Test Results (Mode 1)

GFSK:

Channel Frequency		2402MHz				2480MHz			
Test Condition		OOB Emission (MHz)				OOB Emission (MHz)			
		2399 ~ 2400		2398 ~ 2399		2483.5 ~ 2484.5		2484.5 ~ 2485.5	
		Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)
Tnom 25℃	V_{nom}(v)	2399.50	-36.66	2398.50	-43.38	2484.00	-45.47	2485.00	-46.85
Power Limit (dBm/MHz)		-10.00		-20.00		-10.00		-20.00	
Pass/Fail		Pass		Pass		Pass		Pass	

8DPSK:

Channel Frequency		2402MHz				2480MHz			
Test Condition		OOB Emission (MHz)				OOB Emission (MHz)			
		2398.8 ~ 2400		2397.6 ~ 2398.8		2483.5 ~ 2484.71		2484.71 ~ 2485.92	
		Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)
Tnom 25℃	V_{nom}(v)	2399.50	-24.81	2398.30	-41.27	2484.00	-42.38	2485.21	-47.01
Power Limit (dBm/MHz)		-10.00		-20.00		-10.00		-20.00	
Pass/Fail		Pass		Pass		Pass		Pass	

4.6.6 Test Results (Mode 2)

GFSK:

Channel Frequency		2402MHz				2480MHz			
Test Condition		OOB Emission (MHz)				OOB Emission (MHz)			
		2399 ~ 2400		2398 ~ 2399		2483.5 ~ 2484.5		2484.5 ~ 2485.5	
		Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)
Tnom 25℃	V_{nom}(v)	2399.50	-40.64	2398.50	-44.07	2484.00	-48.10	2485.00	-49.07
Power Limit (dBm/MHz)		-10.00		-20.00		-10.00		-20.00	
Pass/Fail		Pass		Pass		Pass		Pass	

8DPSK:

Channel Frequency		2402MHz				2480MHz			
Test Condition		OOB Emission (MHz)				OOB Emission (MHz)			
		2398.81 ~ 2400		2397.62 ~ 2398.81		2483.5 ~ 2484.69		2484.69 ~ 2485.88	
		Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)	Freq. (MHz)	Power (dBm/ MHz)
Tnom 25℃	V_{nom}(v)	2399.50	-34.42	2398.31	-43.73	2484.00	-48.00	2485.19	-49.13
Power Limit (dBm/MHz)		-10.00		-20.00		-10.00		-20.00	
Pass/Fail		Pass		Pass		Pass		Pass	

4.7 Transmitter Unwanted Emissions in the Spurious Domain

4.7.1 Limits of Transmitter Unwanted Emissions in the Spurious Domain

Frequency Range	Maximum Power Limit	Bandwidth
30 MHz to 47 MHz	-36dBm	100kHz
47 MHz to 74 MHz	-54dBm	100kHz
74 MHz to 87,5 MHz	-36dBm	100kHz
87,5 MHz to 118 MHz	-54dBm	100kHz
118 MHz to 174 MHz	-36dBm	100kHz
174 MHz to 230 MHz	-54dBm	100kHz
230 MHz to 470 MHz	-36dBm	100kHz
470 MHz to 694 MHz	-54dBm	100kHz
694 MHz to 1 GHz	-36dBm	100kHz
1GHz ~ 12.75GHz	-30dBm	1MHz

Note: These limits are e.r.p. for emissions up to 1 GHz and as e.i.r.p. for emissions above 1 GHz.

4.7.2 Test Procedure

Refer to chapter 5.4.9 of EN 300 328 V2.2.2.

Measurement	
☐ Conducted measurement	☒ Radiated measurement

For Conducted measurement:

The level of unwanted emissions shall be measured as their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment with the antenna connector(s) terminated by a specified load (cabinet radiation).

4.7.3 Deviation from Test Standard

No deviation.

4.7.4 Test Setup

1. For the actual test configuration, please refer to the related Item in this test report (Photographs of the Test Configuration).
2. The measurements were performed when normal hopping was disabled. In this case measurements were performed when operating at the lowest and the highest hopping frequency.
3. The equipment was configured to operate under its worst case situation with respect to output power.
4. The measurement was performed at normal environmental conditions only. Controlling software (Bluetooth RF test tool (5.2.3.1)) has been activated to set the EUT on specific status.

4.7.5 Test Results

Dipole Antenna

Below 1GHz Worst-case Data

BT_GFSK

SPURIOUS EMISSION FREQUENCY RANGE	30MHz ~ 1GHz	OPERATING CHANNEL	78

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
117.90	V	-66.21	-54.00	-12.21
195.35	V	-73.32	-54.00	-19.32
212.31	H	-68.66	-54.00	-14.66
479.98	H	-63.90	-54.00	-9.90
479.98	V	-69.92	-54.00	-15.92
500.97	H	-64.06	-54.00	-10.06
509.58	V	-69.69	-54.00	-15.69
527.98	H	-63.65	-54.00	-9.65
546.09	V	-66.91	-54.00	-12.91
559.72	H	-65.97	-54.00	-11.97
573.00	V	-67.29	-54.00	-13.29
599.96	H	-69.02	-54.00	-15.02
599.96	V	-63.85	-54.00	-9.85
616.87	H	-69.96	-54.00	-15.96
624.98	V	-72.31	-54.00	-18.31
635.53	H	-72.49	-54.00	-18.49
663.83	H	-64.14	-54.00	-10.14
666.42	V	-65.12	-54.00	-11.12
688.36	V	-71.18	-54.00	-17.18
689.40	H	-73.75	-54.00	-19.75

Above 1GHz Worst-case Data

BT_GFSK

SPURIOUS EMISSION FREQUENCY RANGE	1GHz ~ 12.75GHz	OPERATING CHANNEL	0, 78

Spurious Emission Level					
Channel	**Frequency (MHz)**	**Antenna Polarization**	**Level (dBm)**	**Limit (dBm)**	**Margin (dB)**
0	7206.00	H	-59.22	-30.00	-29.22
	7206.00	V	-62.03	-30.00	-32.03
	9608.00	H	-55.58	-30.00	-25.58
	9608.00	V	-57.02	-30.00	-27.02
78	7440.00	H	-57.05	-30.00	-27.05
	7440.00	V	-58.02	-30.00	-28.02
	9920.00	H	-54.31	-30.00	-24.31
	9920.00	V	-55.27	-30.00	-25.27

PIFA Antenna

Below 1GHz Worst-case Data

BT_GFSK

SPURIOUS EMISSION FREQUENCY RANGE	30MHz ~ 1GHz	OPERATING CHANNEL	78

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
117.90	V	-67.33	-54.00	-13.33
125.01	H	-57.33	-36.00	-21.33
143.96	H	-54.47	-36.00	-18.47
202.86	H	-68.53	-54.00	-14.53
222.16	V	-72.13	-54.00	-18.13
479.98	V	-69.75	-54.00	-15.75
480.03	H	-63.18	-54.00	-9.18
498.73	H	-65.63	-54.00	-11.63
512.02	V	-69.96	-54.00	-15.96
532.21	H	-64.94	-54.00	-10.94
532.76	V	-68.69	-54.00	-14.69
548.03	H	-67.45	-54.00	-13.45
561.26	V	-67.91	-54.00	-13.91
599.96	H	-68.16	-54.00	-14.16
600.01	V	-63.82	-54.00	-9.82
612.95	H	-70.96	-54.00	-16.96
624.98	V	-72.03	-54.00	-18.03
642.34	V	-74.70	-54.00	-20.70
663.83	H	-63.53	-54.00	-9.53
663.88	V	-65.61	-54.00	-11.61

Above 1GHz Worst-case Data

BT_GFSK

SPURIOUS EMISSION FREQUENCY RANGE	1GHz ~ 12.75GHz	OPERATING CHANNEL	0, 78

Spurious Emission Level					
Channel	**Frequency (MHz)**	**Antenna Polarization**	**Level (dBm)**	**Limit (dBm)**	**Margin (dB)**
0	7206.00	H	-48.51	-30.00	-18.51
	7206.00	V	-53.55	-30.00	-23.55
	9608.00	H	-55.05	-30.00	-25.05
	9608.00	V	-55.52	-30.00	-25.52
78	7440.00	H	-44.54	-30.00	-14.54
	7440.00	V	-57.20	-30.00	-27.20
	9920.00	H	-52.25	-30.00	-22.25
	9920.00	V	-54.54	-30.00	-24.54

4.8 Receiver Spurious Emissions

4.9 Limit of Receiver Spurious Radiation

Frequency Range	Maximum Power Limit	Bandwidth
30 MHz ~ 1 GHz	-57dBm	100 kHz
1 GHz ~ 12.75 GHz	-47dBm	1 MHz

Note: These limits are e.r.p. for emissions up to 1 GHz and as e.i.r.p. for emissions above 1 GHz.

4.9.1 Test Procedure

Refer to chapter 5.4.10 of EN 300 328 V2.2.2.

Measurement	
☐ Conducted measurement	☒ Radiated measurement
For Conducted measurement: The level of unwanted emissions shall be measured as their power in a specified load (conducted spurious emissions) and their effective radiated power when radiated by the cabinet or structure of the equipment with the antenna connector(s) terminated by a specified load (cabinet radiation).	

4.9.2 Deviation from Test Standard

No deviation.

4.9.3 Test Setup

1. For the actual test configuration, please refer to the related Item in this test report (Photographs of the Test Configuration).
2. Testing was performed when the equipment was in a receive-only mode.
3. The measurements were performed when normal hopping was disabled. In this case measurements were performed when operating at the lowest and the highest hopping frequency.
4. The measurement was performed at normal environmental conditions only. Controlling software (Bluetooth RF test tool (5.2.3.1)) has been activated to set the EUT on specific status.

4.9.4 Test Results

Dipole Antenna

RX Below 1GHz Data

SPURIOUS EMISSION FREQUENCY RANGE	30MHz ~ 1GHz	OPERATING CHANNEL	78

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
34.97	V	-63.37	-57.00	-6.37
53.08	H	-60.73	-57.00	-3.73
83.63	V	-64.82	-57.00	-7.82
89.60	H	-62.26	-57.00	-5.26
99.94	V	-61.86	-57.00	-4.86
128.05	H	-60.39	-57.00	-3.39
143.97	V	-64.95	-57.00	-7.95
162.57	H	-64.04	-57.00	-7.04
165.16	V	-65.92	-57.00	-8.92
298.78	H	-60.89	-57.00	-3.89
299.82	V	-60.03	-57.00	-3.03
480.00	V	-69.45	-57.00	-12.45
499.80	H	-61.56	-57.00	-4.56
537.01	H	-61.24	-57.00	-4.24
666.45	H	-62.12	-57.00	-5.12
666.45	V	-62.83	-57.00	-5.83
699.73	H	-60.20	-57.00	-3.20
699.78	V	-64.89	-57.00	-7.89
766.94	H	-62.34	-57.00	-5.34
821.06	V	-67.95	-57.00	-10.95

RX Above 1GHz Data

SPURIOUS EMISSION FREQUENCY RANGE	1GHz ~ 12.75GHz	OPERATING CHANNEL	0, 78

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
0	6405.00	H	-60.40	-47.00	-13.40
	6405.40	V	-56.66	-47.00	-9.66
78	6613.00	H	-60.64	-47.00	-13.64
	6613.00	V	-55.81	-47.00	-8.81

PIFA Antenna

RX Below 1GHz Data

SPURIOUS EMISSION FREQUENCY RANGE	30MHz ~ 1GHz	OPERATING CHANNEL	78

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
36.17	V	-62.84	-57.00	-5.84
53.03	H	-61.67	-57.00	-4.67
88.85	H	-60.45	-57.00	-3.45
102.03	V	-62.24	-57.00	-5.24
128.30	H	-60.22	-57.00	-3.22
128.95	V	-64.76	-57.00	-7.76
160.43	H	-64.81	-57.00	-7.81
165.96	V	-67.55	-57.00	-10.55
226.80	H	-63.41	-57.00	-6.41
232.42	V	-67.57	-57.00	-10.57
299.03	V	-63.46	-57.00	-6.46
299.87	H	-61.33	-57.00	-4.33
499.80	H	-64.56	-57.00	-7.56
663.82	V	-63.58	-57.00	-6.58
666.45	H	-62.39	-57.00	-5.39
697.00	H	-61.28	-57.00	-4.28
699.73	V	-62.49	-57.00	-5.49
762.56	H	-63.96	-57.00	-6.96
829.52	V	-66.36	-57.00	-9.36
873.05	H	-64.13	-57.00	-7.13
903.79	V	-67.38	-57.00	-10.38

RX Above 1GHz Data

SPURIOUS EMISSION FREQUENCY RANGE	1GHz ~ 12.75GHz	OPERATING CHANNEL	0, 78

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
0	6404.00	H	-67.72	-47.00	-20.72
	6404.00	V	-59.17	-47.00	-12.17
78	6612.00	H	-65.61	-47.00	-18.61
	6612.00	V	-69.31	-47.00	-22.31

4.10 Receiver Blocking

4.10.1 Limit of Receiver Blocking

This requirement applies to all receiver categories.

Receiver Category		
☒Category 1	☐Category 2	☐Category 3
Minimum performance criterion	☒PER ≦10%	
	☐Alternative performance criteria (See note)	
Note: The manufacturer declared the performance criteria is x% for the intended use of the equipment.		

Receiver Category 1 Equipment			
Wanted signal mean power from companion device (dBm) (see notes 1 to 4)	**Blocking Signal Frequency (MHz)**	**Blocking Signal Power (dBm) (see note 4)**	**Type of blocking signal**
(-133 dBm + 10 × $\log_{10}$(OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × $\log_{10}$(OCBW)) or -74 dBm whichever is less (see note 3)	2 300 2 330 2 360 2 524 2 584 2 674		

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

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

Receiver Category 3 Equipment			
Wanted signal mean power from companion device (dBm) (see notes 1 to 3)	**Blocking Signal Frequency (MHz)**	**Blocking Signal Power (dBm) (See note 3)**	**Type of blocking signal**
(-139 dBm + 10 × $\log^{10}$(OCBW) +20) or (-74 dBm + 20) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
NOTE 1: OCBW is in Hz. NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured / positioned as recorded in clause 5.4.3.2.2.			

4.10.2 Test Procedure

Refer to chapter 5.4.11 of EN 300 328 V2.2.2.

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

4.10.3 Deviation from Test Standard

No deviation.

4.10.4 Test Setup Configuration

4.10.5 Test Results

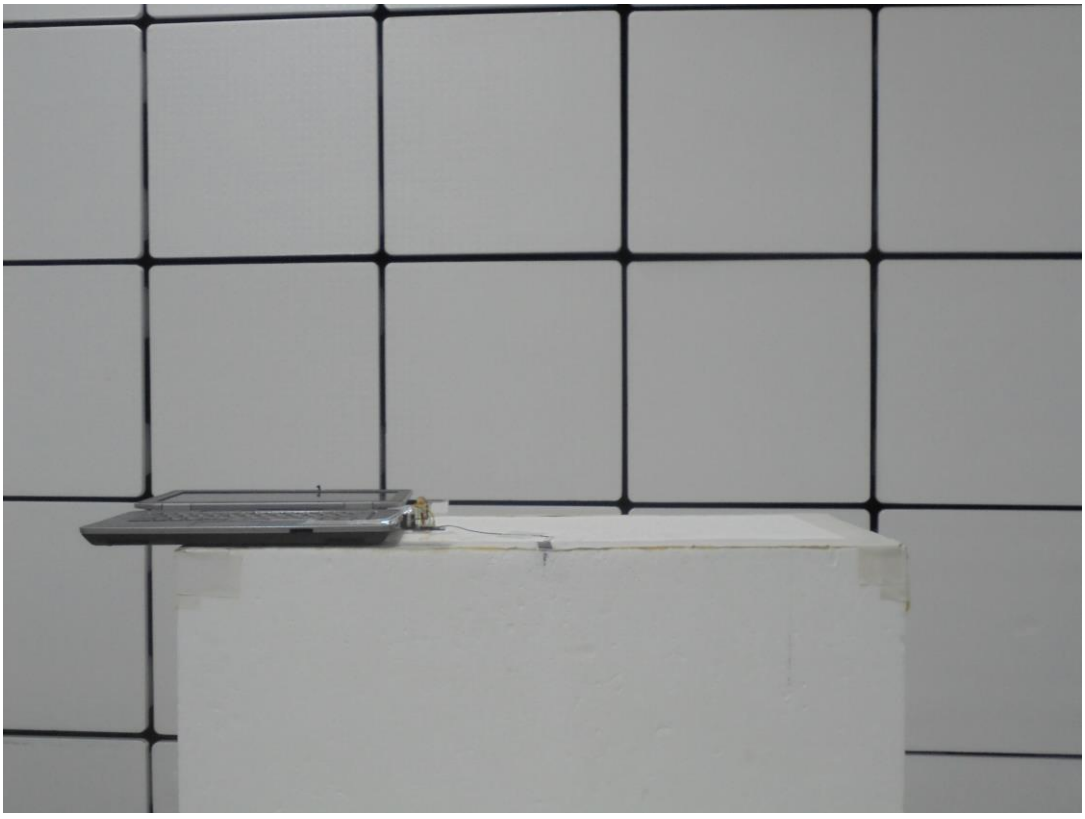
Receiver Category 1 Equipment

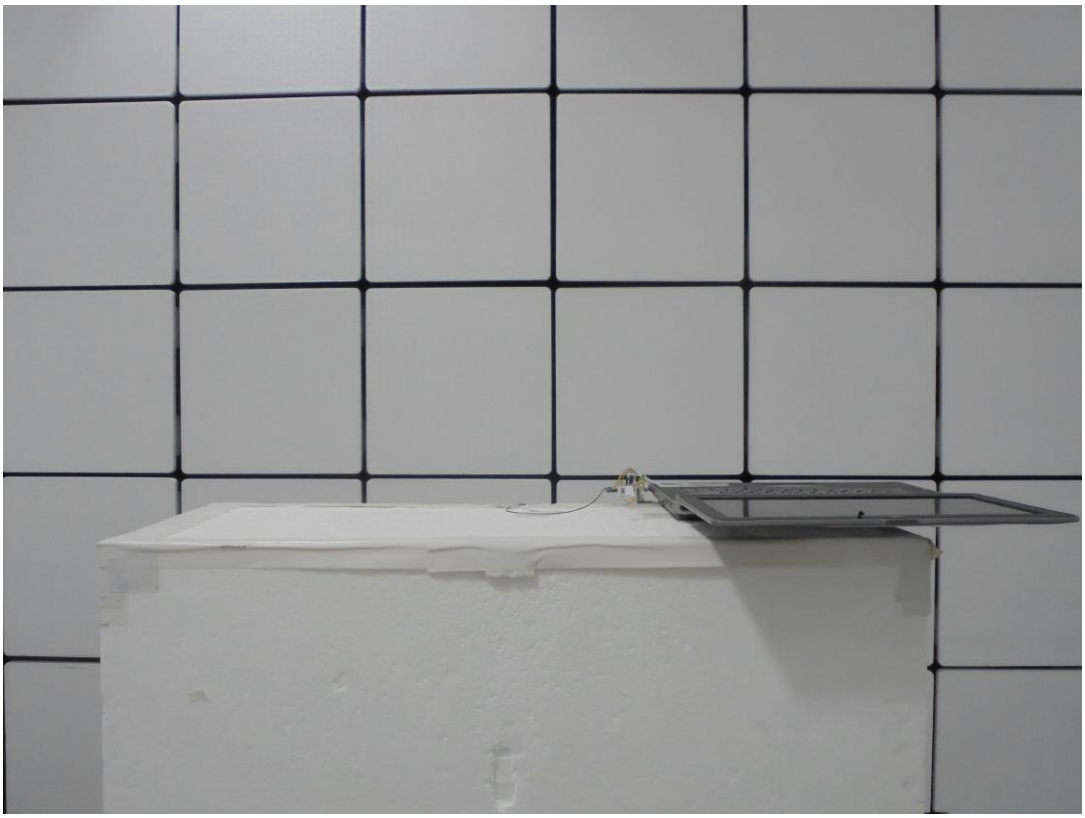
Receiver Blocking Measure Of The Capability					Blocking Signal Power		
CH 0:	OCBW (MHz):	0.88	Antenna Gain (dBi):	3.5	■ at the antenna connector		
CH 78:	OCBW (MHz):	0.88			□ in front of the antenna		
Operation Mode	**Channel Number**	**Wanted Signal Mean Power From Companion Device (dBm) (Note 1)**	**Blocking Signal Frequency (MHz)**	**Blocking Signal Frequency Shift (MHz) (Note 2)**	**Blocking Signal Power (dBm) (Note 1)**	**PER (%)**	**Test Result**
BT GFSK	0	-70.06	2380	-	-30.5	2.3	Pass
		-76.06	2300	-	-30.5	1.8	Pass
			2330	-	-30.5	2.6	Pass
			2360	-	-30.5	3.1	Pass
	78	-70.06	2504	-	-30.5	2.2	Pass
		-76.06	2524	-	-30.5	2.8	Pass
			2584	-	-30.5	2.4	Pass
			2674	-	-30.5	1.6	Pass

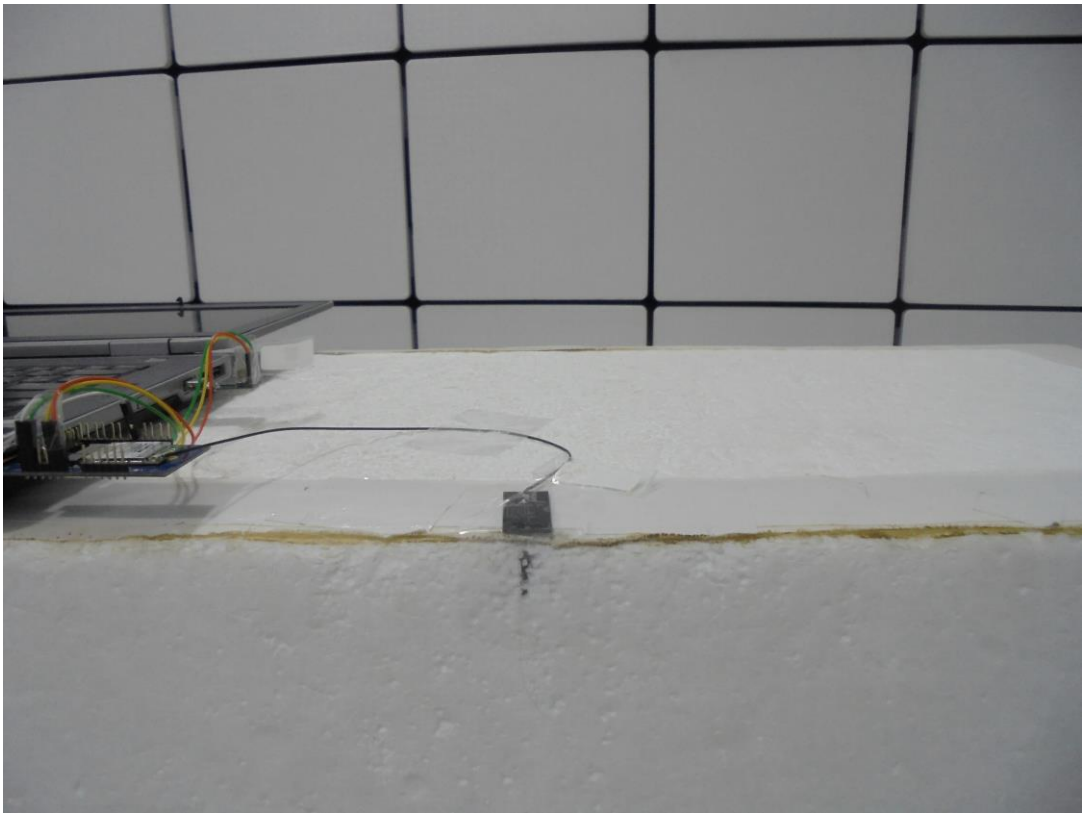
Note 1: In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G).
Note 2: If the performance criteria is not met, those frequencies of the blocking signal has been increased/decreased with a value equal to the Occupied Channel Bandwidth except the blocking frequencies 2380, 2504MHz shall be increased/decreased with a value equal to 10MHz also if the frequency offset is more than 7MHz, the level of the wanted signal shall be increased by 3dB.

5 Photographs of the Test Configuration

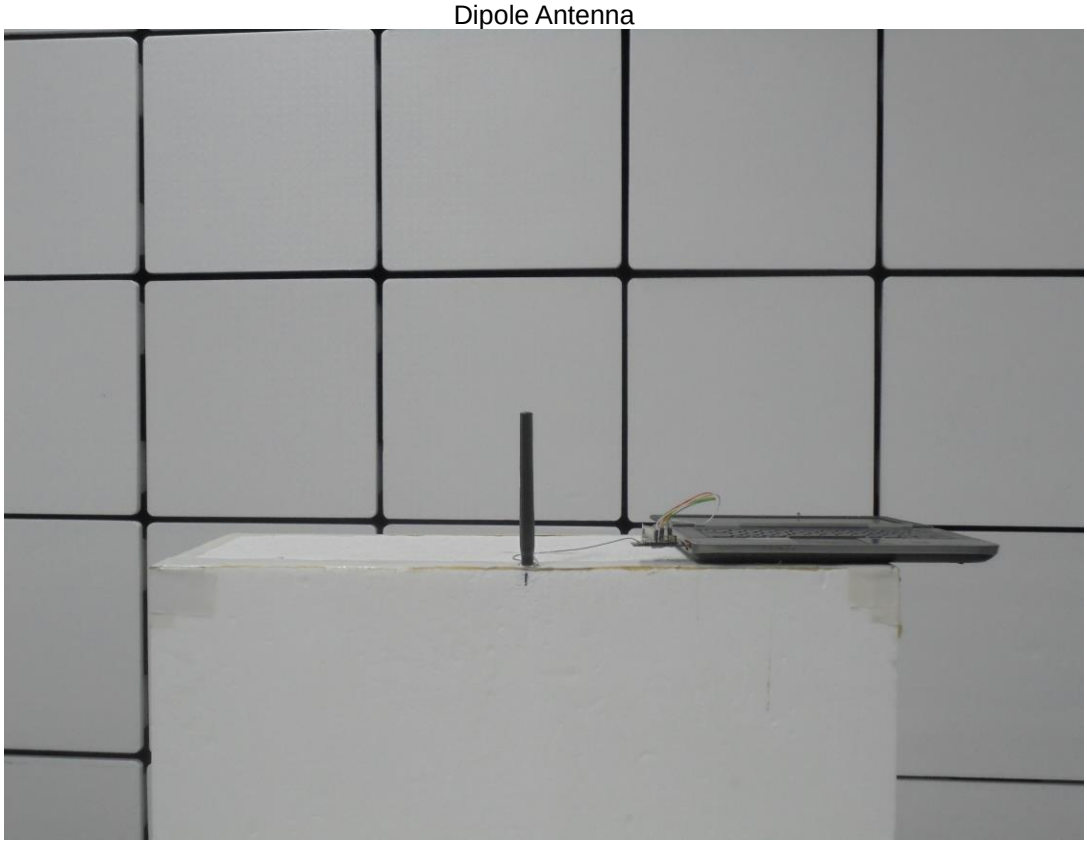
TX / RX Spurious Emission Test
PIFA Antenna







Dipole Antenna



Appendix A- Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Lin Kou EMC/RF Lab
Tel: 886-2-26052180
Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab
Tel: 886-3-6668565
Fax: 886-3-6668323

Hwa Ya EMC/RF/Safety Lab
Tel: 886-3-3183232
Fax: 886-3-3270892

Email: service.adt@tw.bureauveritas.com
Web Site: www.bureauveritas-adt.com

The address and road map of all our labs can be found in our web site also.

--- END ---

Appendix B- Test Results for reference by client's requirement

Receiver Category 1 Equipment

Receiver Blocking Measure Of The Capability					Blocking Signal Power		
CH 0:	OCBW (MHz):	0.88	Antenna Gain (dBi):	3.5	■ at the antenna connector		
CH 78:	OCBW (MHz):	0.88			□ in front of the antenna		
Operation Mode	**Channel Number**	**Wanted Signal Mean Power From Companion Device (dBm) (Note 1)**	**Blocking Signal Frequency (MHz)**	**Blocking Signal Frequency Shift (MHz) (Note 2)**	**Blocking Signal Power (dBm) (Note 1)**	**PER (%)**	**Test Result**
BT GFSK	0	-93	2380	-	-30.5	6.7	Pass
		-92	2300	-	-30.5	5.4	Pass
			2330	-	-30.5	5.3	Pass
			2360	-	-30.5	7.9	Pass
	78	-88	2504	-	-30.5	6.2	Pass
		-86	2524	-	-30.5	8.1	Pass
			2584	-	-30.5	5.8	Pass
			2674	-	-30.5	6.8	Pass

Note 1: In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G).
Note 2: If the performance criteria is not met, those frequencies of the blocking signal has been increased/decreased with a value equal to the Occupied Channel Bandwidth except the blocking frequencies 2380, 2504MHz shall be increased/decreased with a value equal to 10MHz also if the frequency offset is more than 7MHz, the level of the wanted signal shall be increased by 3dB.