TEST REPORT

Product Name	:	Small speakers
Trade mark	:	N/A
Model No.	:	P329.24X
Report Number	:	BLA-EMC-201910-A15-02
Date of sample receipt	:	October 12, 2019
Date of Test	:	October 12, 2019–October 22, 2019
Date of Issue	:	October 24, 2019
Test standard	:	ETSI EN 300 328 V2.2.2 (2019-07)
Test result	:	PASS

Prepared for:

Prepared by:

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Compiled by: Lucas

Review by: Sweet.Wang

Approved by: Emen_li

Date: October 24, 2019

2 Version

Version No.	Date	Description
00	*October 24, 2019*	*Original*

3 Contents

4 Test Summary

Test Items	Test Requirement	Test method	Limit/Severity	Result
Radio Spectrum Matter (RSM) Part of Tx				
RF Output Power	Clause 4.3.1.2	Clause 5.4.2.2.1.2	Clause 4.3.1.2.3	PASS
Duty Cycle, Tx-sequence, Tx-gap	Clause 4.3.1.3	Clause 5.4.2.2.1.3	Clause 4.3.1.3.3	N/A
Accumulated Transmit Time, Frequency Occupation and Hopping Sequence	Clause 4.3.1.4	Clause 5.4.4.2	Clause 4.3.1.4.3	PASS
Hopping Frequency Separation	Clause 4.3.1.5	Clause 5.4.5.2	Clause 4.3.1.5.3	PASS
Medium Utilisation (MU) factor	Clause 4.3.1.6	Clause 5.4.2.2.1.4	Clause 4.3.1.6.3	N/A
Adaptivity (Adaptive Frequency Hopping)	Clause 4.3.1.7	Clause 5.4.6.2	Clause 4.3.1.7	N/A
Occupied Channel Bandwidth	Clause 4.3.1.8	Clause 5.4.7.2	Clause 4.3.1.8.3	PASS
Transmitter unwanted emissions in the out-of-band domain	Clause 4.3.1.9	Clause 5.4.8.2	Clause 4.3.1.9.3	PASS
Transmitter unwanted emissions in the spurious domain	Clause 4.3.1.10	Clause 5.4.9.2	Clause 4.3.1.10.3	PASS
Radio Spectrum Matter (RSM) Part of Rx				
Receiver spurious emissions	Clause 4.3.1.11	Clause 5.4.10.2	Clause 4.3.1.11.3	PASS
Receiver Blocking	Clause 4.3.1.12	Clause 5.4.11.2	Clause 4.3.1.12.4	PASS

Remark:
Tx: In this whole report Tx (or tx) means Transmitter.
Rx: In this whole report Rx (or rx) means Receiver.
Pass: Meet the requirement.
N/A: Not Applicable.

5 General Information

5.1 Client Information

Applicant:	
Address:	
Manufacturer:	
Address:	
Factory:	
Adress:	

5.2 General Description of E.U.T.

Product Name:	Small speakers
Model No.:	P329.24X
Test Model No.:	P329.24X
Hardware version:	EPOT-M1
Software version:	5.0
Operation Frequency:	2402MHz~2480MHz
Channel number:	79
Channel separation:	1MHz
Modulation type:	Frequency Hopping Spread Spectrum (FHSS)
Equipment Type:	Adaptive equipment
Modulation Technology:	GFSK, π/4 DQPSK
Antenna Type:	PCB Antenna
Antenna gain:	-0.58dBi (declare by Applicant)
Power supply:	Rechargeable Li-ion polymer Battery DC3.7V, 320mAh

Operation Frequency each of channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402MHz	20	2422MHz	40	2442MHz	60	2462MHz
1	2403MHz	21	2423MHz	41	2443MHz	61	2463MHz
2	2404MHz	22	2424MHz	42	2444MHz	62	2464MHz
3	2405MHz	23	2425MHz	43	2445MHz	63	2465MHz
…	…	…	…	…	…	…	…
17	2419MHz	37	2439MHz	57	2459MHz	77	2479MHz
18	2420MHz	38	2440MHz	58	2460MHz	78	2480MHz
19	2421MHz	39	2441MHz	59	2461MHz		
Remark:The EUT operation in above frequency list, and used test software to control the EUT for staying in continuous transmitting and receiving mode. Channel 0, 39 and 78 of Bluetooth were chosen for testing.							

5.3 Test environment and mode

Operating Environment:	
Temperature:	Normal: 15℃ ~ 35℃, Extreme: -20℃ ~ +55℃
Humidity:	20 % ~ 75 % RH
Atmospheric Pressure:	1008 mbar
Voltage:	Nominal: 3.7Vdc, Extreme: Low 3.5Vdc, High 4.2Vdc
Test mode:	
Transmitting mode:	Keep the EUT in continuously transmitting mode with modulation.
Hopping mode:	Keep the EUT in normal hopping mode.
Receiving mode:	Keep the EUT in receiving mode.

5.4 Description of Support Units

The EUT has been tested as an independent unit.

5.5 Measurement Uncertainty

Parameter	Expanded Uncertainty (Confidence of 95%)
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±1.5 dB
Power Spectral Density, conducted	±3.0 dB
Unwanted Emissions, conducted	±3.0 dB
Temperature	±3 °C
Supply voltages	±3 %
Time	±5 %
Radiated Emission (30MHz ~ 1000MHz)	±4.35 dB
Radiated Emission (1GHz ~ 18GHz)	±4.44 dB

5.6 Laboratory Location

All tests were performed at:

BlueAsia of Technical Services(Shenzhen) Co., Ltd.

IOT Test Centre of BlueAsia
No. 448 Bulong Road, Bantian Street, Longgang District, Shenzhen, China

Telephone: TEL: +86-755-28682673 FAX: +86-755-28682673
No tests were sub-contracted.

5.7 Test Instruments list

Radiated Emission:

Test Equipment	Manufacturer	Model No.	Serial No.	Cal.Date (mm-dd-yy)	Cal. Due date (mm-dd-yy)
3m SAC	SKET	9m*6 m*6m	966	06-10-2018	06-09-2023
Broadband Antenna	SCHWARZBECK	VULB9168	00836 P:00227	07-14-2019	07-13-2020
Horn Antenna	SCHWARZBECK	9120D	01892 P:00331	07-14-2019	07-13-2020
EMI Test Software	EZ	EZ	N/A	N/A	N/A
Pre-amplifier	SKET	N/A	N/A	07-19-2019	07-18-2020
Spectrum analyzer	Rohde & Schwarz	FSP40	100817	05-24-2019	05-23-2020
EMI Test Receiver	Rohde & Schwarz	ESR7	101199	03-21-2019	03-20-2020
Controller	SKET	N/A	N/A	N/A	N/A
Vector Signal Generator	Agilent	E4438C	MY45092582	05-24-2019	05-23-2020
Signal Generator	Agilent	E8257D	MY44320250	05-24-2019	05-23-2020
Coaxial Cable	BlueAsia	BLA-XC-02	N/A	N/A	N/A
Coaxial Cable	BlueAsia	BLA-XC-03	N/A	N/A	N/A
Coaxial Cable	BlueAsia	BLA-XC-01	N/A	N/A	N/A

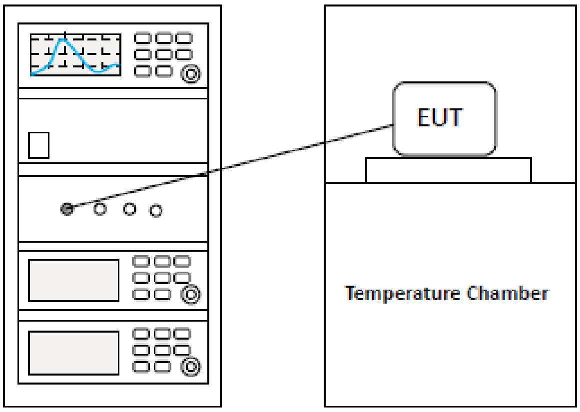
Conducted method:

Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Date (mm-dd-yy)	Cal. Due date (mm-dd-yy)
Spectrum Analyzer	Agilent	N9030A	MY50510123	05-24-2019	05-23-2020
Spectrum analyzer	Rohde & Schwarz	FSP40	100817	05-24-2019	05-23-2020
Vector Signal Generator	Agilent	E4438C	MY45092582	05-24-2019	05-23-2020
Signal Generator	Agilent	E8257D	MY44320250	05-24-2019	05-23-2020
Power Sensor	D.A.R.E	RPR3006W	17I00015SNO27	05-24-2019	05-23-2020
Power Sensor	D.A.R.E	RPR3006W	17I00015SNO28	05-24-2019	05-23-2020
DC Power Supply	LODESTAR	LP305DE	N/A	07-19-2019	07-18-2020
Temperature Humidity Chamber	Mingle	TH101B	N/A	07-19-2019	07-18-2020

6 Radio Technical Specification in ETSI EN 300 328

6.1 Transmitter Requirement

6.1.1 RF Output Power

Test Requirement:	ETSI EN300 328clause 4.3.1.2
Test Method:	ETSI EN300 328clause 5.4.2.2.1.2
Limit:	20dBm
Test setup:	
Test procedure:	1. Use a fast power sensor suitable for 2,4 GHz and capable of 1 MS/s. 2. Connect the power sensor to the transmit port, sample the transmit signal and store the raw data, every channel 25 bursts. Usethese stored samples in all following steps. 3. Find the start and stop times of each burst in the stored measurement samples. 4. Between the start and stop times of each individual burst calculate the RMS power over the burst. Save thesePburst values, as well as the start and stop times for each burst. 5. The highest of all P_{burst} values (value "A" in dBm) will be used for maximum e.i.r.p. calculations. 6. Add the (stated) antenna assembly gain "G" in dBi of the individual antenna. The RF Output Power (P) shall be calculated using the formula below:P = A + G
Test Instruments:	See section 5.7 for details
Test mode:	Hopping mode
Test Result:	Pass

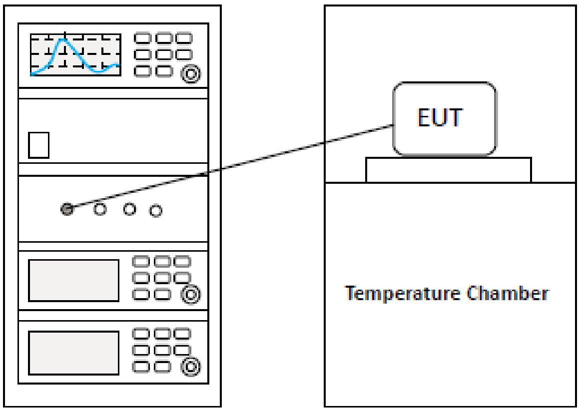
Measurement Data:

Test conditions	Modulation	Read Level (dBm)	Antenna Gain(dBi)	EIRP (dBm)	Limit (dBm)	Result
NTNV	GFSK	3.11	-0.58	2.53	20	Pass
	π/4DQPSK	3.83	-0.58	3.25		
LTNV	GFSK	3.06	-0.58	2.48		
	π/4DQPSK	3.80	-0.58	3.22		
HTNV	GFSK	3.10	-0.58	2.52		
	π/4DQPSK	3.78	-0.58	3.20		

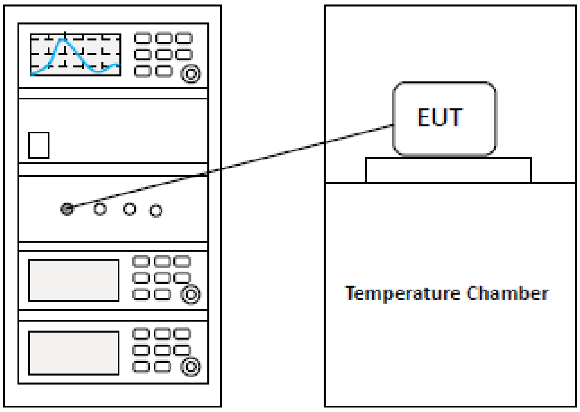
Remark:

1. NTNV: Normal Temperature Normal Voltage, LTNV: Low Temperature Normal Voltage, HTNV: High Temperature Normal Voltage.
2. Antenna Gain = -0.58dBi, which declared by applicant.

6.1.2 Duty Cycle, Tx-sequence, Tx-gap

Test Requirement:	ETSI EN300 328clause 4.3.1.3
Test Method:	ETSI EN300 328clause 5.4.2.2.1.3
Limit:	For non-adaptive FHSS equipment, the Duty Cycle shall be equal to or less than the maximum value declared by thesupplier. In addition, the maximum Tx-sequence time shall be 5 ms while the minimum Tx-gap time shall be 5 ms.
Test setup:	
Test procedure:	1. Use the same stored measurement samples from the procedure in section 6.2.1 2. Between the saved start and stop times of each individual burst, calculate the Tx_{On} time. Save these Tx_{On}values. Between the saved stop and start times of two subsequent bursts, calculate the Tx_{Off} time. Save these Tx_{Off}values. 3. Duty Cycle is the sum of all Tx_{On} times divided by the observation period. 4. For equipment using blacklisting, the Tx_{On} time measured for a single (and active) hopping frequency shall bemultiplied by the number of blacklisted frequencies. This value shall be added to the sum calculated in theprevious bullet point. If the number of blacklisted frequencies cannot be determined, the minimum number ofhopping frequencies shall be assumed. 5. The above calculated value for Duty Cycle shall be recorded in the test report. This value shall be equal to orless than the maximum value declared by the supplier. 6. Any Tx_{Off} time that is greater than the minimum Tx-gap time is considered a Tx-gap. The lowest Tx-gap timeshall be recorded in the test report. 7. The Tx-sequence time is the time between two subsequent Tx-gaps. The maximum Tx-sequence time shall berecorded in the test report.
Test Instruments:	See section 5.7 for details
Test mode:	Hopping mode
TestResult:	Not required for e.i.r.p less than 10 dBm

6.1.3 Accumulated Transmit Time, Frequency Occupation and Hopping Sequence

Test Requirement:	ETSI EN 300 328 clause 4.3.1.4
Test Method:	ETSI EN300 328clause 5.4.4.2
Limit:	Refer to clasue 4.3.1.4.3
Test setup:	
Test procedure:	1. The output of the transmitter shall be connected to a spectrum analyzer or equivalent. The spectrum analyzer setup refer to clause 5.3.4.2.1. 2. Save the trace data to a file for further analysis by a computing device using an appropriate softwareapplication or program. 3. Indentify the data points related to the frequency being investigated by applying a threshold.Count the number of data points identified as resulting from transmissions on the frequency being investigatedand multiply this number by the time difference between two consecutive data points. 4. The result in step 3 is the accumulated Dwell Time which shall comply with the limit. 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 result shall be compared to the limit for the Minimum Frequency Occupation Time 6. Make the following changes on the analyzer: Start Frequency: 2 400 MHz, Stop Frequency: 2 483,5 MHz RBW: ~ 50 % of the Occupied Channel Bandwidth (single hop) VBW: ≥ RBW, Detector Mode: RMS, Sweep time: Auto When the trace has completed, indentify the number of hopping frequencies used by the hopping sequence. 7. For adaptive systems, using the lowest and highest -20 dB points from the total spectrum envelope obtained instep 6, it shall be verified whether the system uses 70% of the band specified in clause 1. The result shall berecorded in the test report.
Test Instruments:	See section 5.7 for details
Test mode:	Hopping mode
TestResult:	Pass

Test Item: Dwell time							
EUT Config.	Frequency (MHz)	Burst Number	Burst Length (ms)	Measure Time (ms)	Accumulated Dwell Time (ms)	Limit (ms)	Result
DH5	2441	65	2.89	31600	187.85	<=400	Pass
2DH5	2441	67	2.89	31600	193.63	<=400	Pass

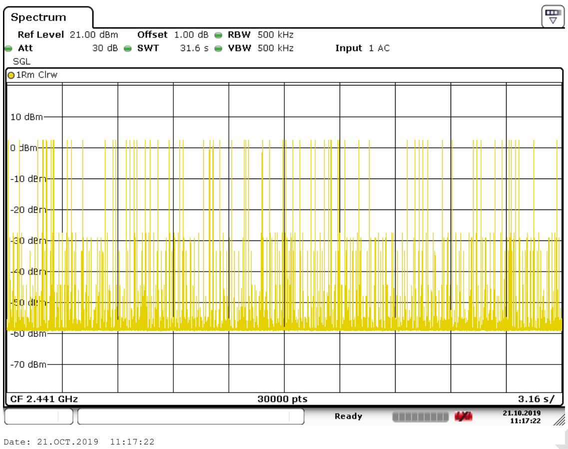
Test Item: Minimum Frequency Occupation Time					
EUT Config.	Frequency (MHz)	Minimum Frequency Occupation (ms)	Measure Time (ms)	Burst Number	Result
DH5	2441	5.78	913.2	2	Pass
2DH5	2441	8.67	913.2	3	Pass

Test Item: Hopping Sequence			
EUT Config.	Hopping Numbers Observed	Band Use[%]	Result
DH5	79	95.37	Pass
2DH5	79	95.95	Pass

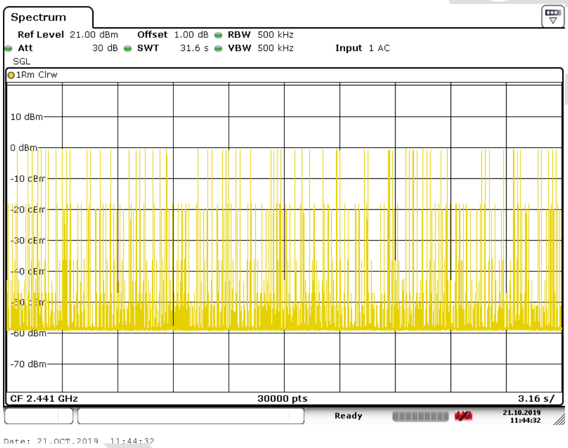
Test Plots:

Dwell Time

DH5

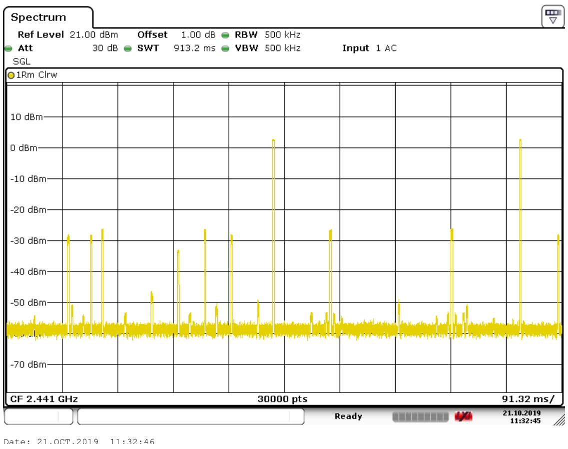


2DH5

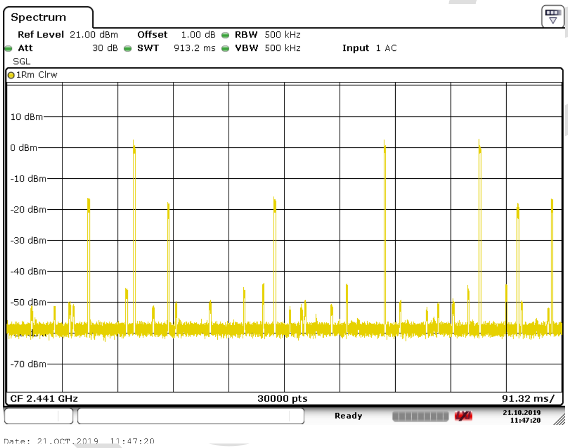


Minimum Frequency Occupation Time

DH5

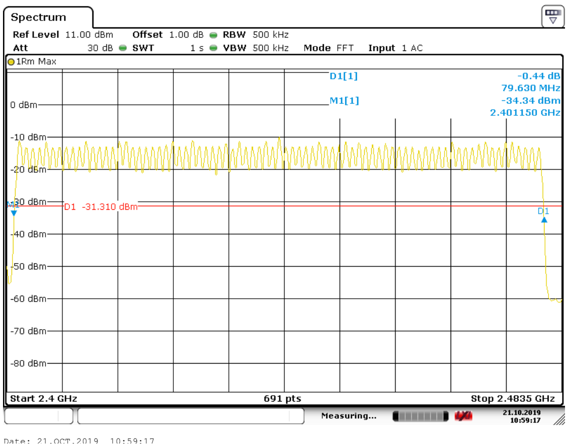


2DH5

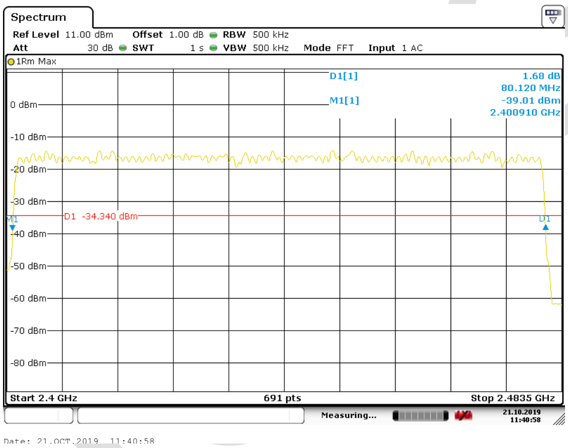


Hopping sequence

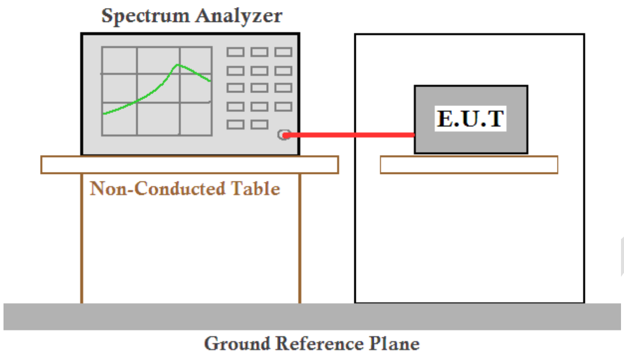
DH5



2DH5



6.1.4 Hopping Frequency Separation

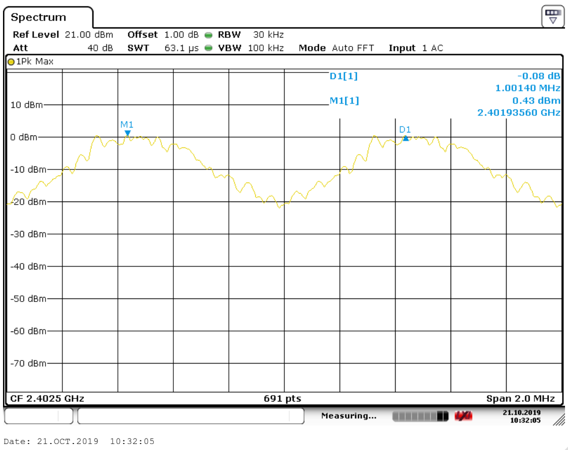
Test Requirement:	ETSI EN 300 328 clause 4.3.1.5
Test Method:	ETSI EN300 328clause 5.4.5.2
Limit:	≥100kHz
Test setup:	
Test procedure:	1. Connect EUT antenna terminal to the spectrum analyzer with a low loss cable. Equipment mode: spectrum analyzer, detector function: RMS RBW=1% of the Span, VBW=3×RBW 2. Adjust the center frequency of spectrum analyzer on any frequency be measured. 3. Measure the channel separation by spectrum analyzer Marker function. 4. Use the marker-delta function to determine the Hopping Frequency Separation between the peaks of the twoadjacent hopping frequencies. 5. Repeat above procedures until all frequencies measured were complete.
Test Instruments:	See section 5.7 for details
Test mode:	Hopping mode
TestResult:	Pass

Measurement Data:

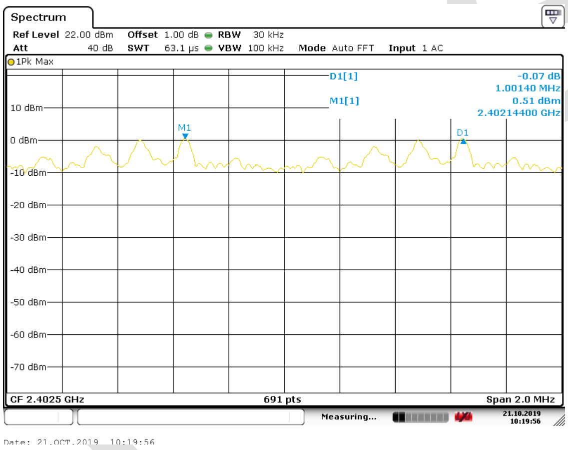
Mode	Hopping Frequency Separation (MHz)	Limit (MHz)	Result
DH5	1.00	>=0.1	Pass
2DH5	1.00	>=0.1	Pass
3DH5	1.00	>=0.1	Pass

Test plots:

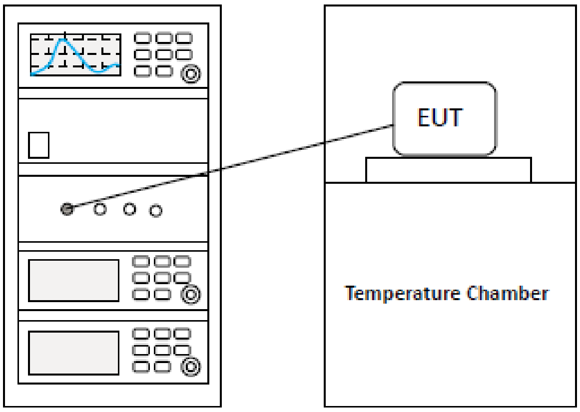
Modulation mode: GFSK



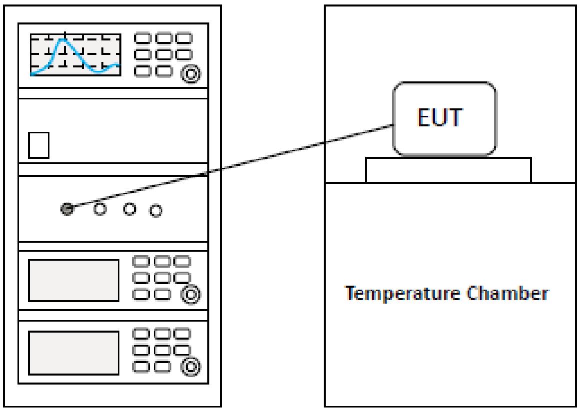
Modulation mode:π/4DQPSK



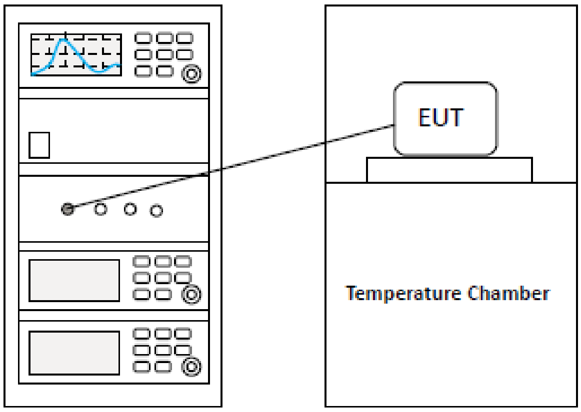
6.1.5 Medium Utilisation (MU) factor

Test Requirement:	ETSI EN 300 328 clause 4.3.1.6
Limit:	≤ 10%
Test setup:	
Test procedure:	1. Use a fast power sensor suitable for 2,4 GHz and capable of 1 MS/s. 2. Connect the power sensor to the transmit port, sample the transmit signal and store the raw data.Usethese stored samples in all following steps. 3. Find the start and stop times of each burst in the stored measurement samples. 4. Between the start and stop times of each individual burst calculate the RMS power over the burst. Save thesePburst values, as well as the start and stop times for each burst. 5. The highest of all P_{burst} values (value "A" in dBm) will be used for maximum e.i.r.p. calculations. 6. Add the (stated) antenna assembly gain "G" in dBi of the individual antenna. The RF Output Power (P) shall be calculated using the formula below:P = A + G 7. The Medium Utilisation (MU) factor is a measure to quantify the amount of resources (Power and Time) used bynon-adaptive equipment. The Medium Utilisation factor is defined by the formula: MU = (P/100 mW) × DC where: MU is Medium Utilisation factor in %. P is the RF output power expressed in mW. DC is the Duty Cycle expressed in %.
Test Instruments:	See section 5.7 for details
Test mode:	Hopping mode
Test Result:	Not required for e.i.r.p less than 10 dBm

6.1.6 Adaptivity (Adaptive Frequency Hopping)

Test Requirement:	ETSI EN300 328clause 4.3.1.7
Test mothod:	ETSI EN 300 328 clause 5.4.6.2
Test setup:	
Test procedure:	1. The UUT may connect to a companion device during the test. 2. Configure the UUT for normal transmissions with a sufficiently high payload to allow demonstration ofcompliance of the adaptive mechanism on the hopping frequency being tested. 3. Adding the interference signal 4. Verification of reaction to the interference signal 5. Adding the blocking signal 6. Removing the interference and blocking signal 7. The steps 2 to 6 shall be repeated for each of the hopping frequencies to be tested.
Test Instruments:	See section 5.7 for details
Test mode:	Hopping mode
Test Result:	Not required for e.i.r.p less than 10 dBm

6.1.7 Occupied Channel Bandwidth

Test Requirement:	ETSI EN 300 328 clause 4.3.1.8
Test Method:	ETSI EN300 328clause 5.4.7.2
Limit:	2400MHz ≤ f ≤ 2483.5 MHz
Test setup:	
Test procedure:	1. Connect EUT antenna terminal to the spectrum analyzer with a low loss cable and use the following setting: Centre Frequency: The centre frequency of the channel under test Resolution BW: ~ 1 % of the span without going below 1 %RBW=1% of the Span, VBW=3×RBW Frequency Span: 2 × Occupied Channel Bandwidth (e.g. 40 MHz for a 20 MHz channel),Detector Mode: RMS, Trace Mode: Max Hold 2. Wait until the trace is completed. Find the peak value of the trace and place the analyser marker on this peak. 3. Use the 99 % bandwidth function of the spectrum analyser to measure the Occupied Channel Bandwidth of the UUT.This value shall be recorded. NOTE: Make sure that the power envelope is sufficiently above the noise floor of the analyser to avoid the noisesignals left and right from the power envelope being taken into account by this measurement.
Test Instruments:	See section 5.7 for details
Test mode:	Transmitting mode
Test Result:	Pass

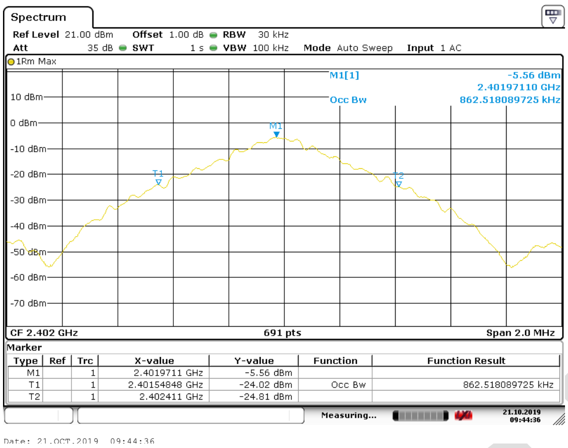
Measurement Data:

EUT Config.	Channel	Frequency (MHz)	Occupied Channel Bandwidth (MHz)	Band edge (MHz)	Limit (MHz)	Result
DH5	Lowest	2402	0.862	2401.55	2400.00	Pass
	Highest	2480	0.865	2480.41	2483.50	Pass
2DH5	Lowest	2402	1.220	2401.37	2400.00	Pass
	Highest	2480	1.220	2480.59	2483.50	Pass

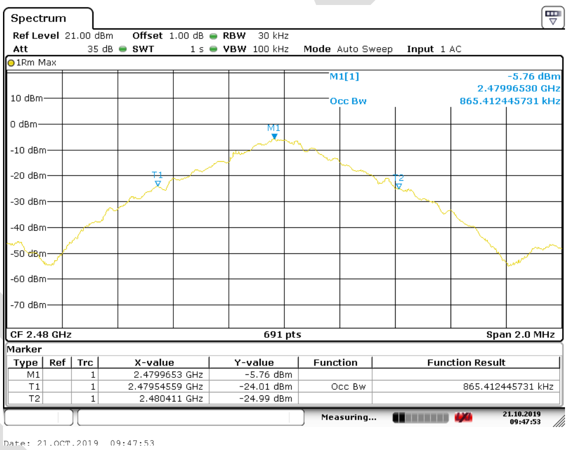
Test Plots:

DH5

The Lowest Channel

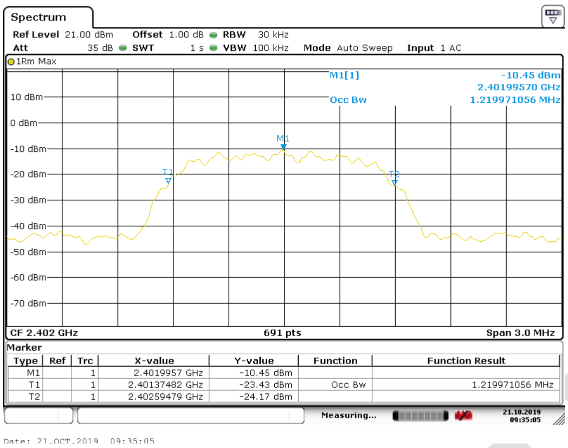


The Highest channel

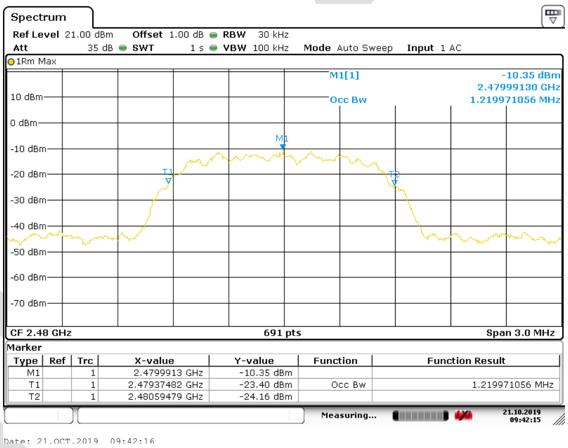


2DH5

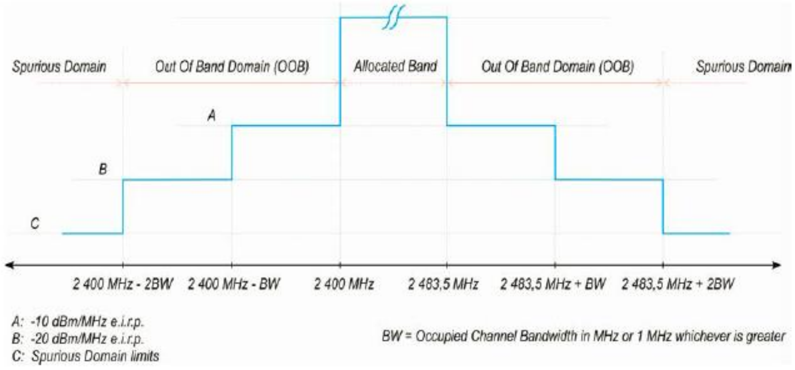
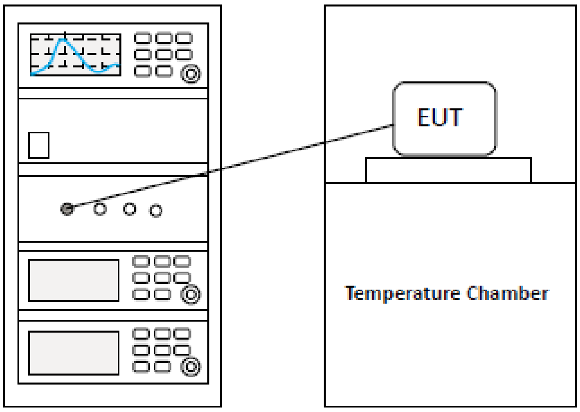
The Lowest Channel



The Highest channel



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

Test Requirement:	ETSI EN 300 328 clause 4.3.1.9
Test Method:	ETSI EN300 328clause 5.4.8.2
Limit:	
Test mode:	Transmitting mode
Test Instruments:	See section 5.6
Test setup:	
Test procedure:	1. Connect EUT antenna terminal to the spectrum analyzer with a low loss cable and use the following setting: Centre Frequency: 2484 MHz, Span: Span: 0 Hz RBW=1 MHz, VBW=3 MHz,Detector Mode: RMS, Trace Mode:Clear/Write, Sweep mode: Continous,Sweep Points: 5000, Trigger mode: Video Trigger 2. Segment 2483,5 MHz to 2483,5 MHz + BW 3. Segment 2483,5 MHz + BW to 2483,5 MHz + 2BW 4. Segment 2400 MHz - BW to 2400 MHz 5. Segment 2400 MHz - 2BW to 2400 MHz - BW 6. In case of conducted measurements on equipment with a single transmit chain, the declared antenna assemblygain "G" in dBi shall be added to the results for each of the 1 MHz segments and compared with the limits. In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains), themeasurements need to be repeated for each of the active transmit chains.
Test Instruments:	See section 5.7 for details
Test mode:	Transmitting mode
Tes Result:	Pass

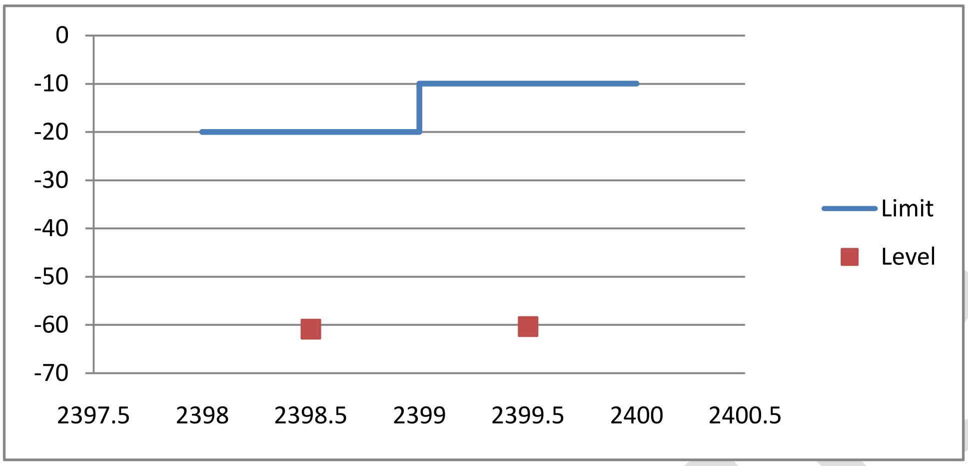
Measurement Data:

DH5				
Test conditions	Segment (MHz)	Read Level (dBm)	Limit (dBm)	Result
NTNV	2400-BW~2400	-60.36	-10	Pass
	2400-2BW~2400-BW	-60.89	-20	
	2483.5~2483.5+BW	-63.13	-10	
	2483.5+BW~2483.5+2BW	-66.37	-20	
LTNV	2400-BW~2400	-62.02	-10	
	2400-2BW~2400-BW	-61.47	-20	
	2483.5~2483.5+BW	-64.25	-10	
	2483.5+BW~2483.5+2BW	-65.05	-20	
HTNV	2400-BW~2400	-61.73	-10	
	2400-2BW~2400-BW	-62.15	-20	
	2483.5~2483.5+BW	-64.02	-10	
	2483.5+BW~2483.5+2BW	-65.59	-20	
2DH5				
Test conditions	Segment (MHz)	Read Level (dBm)	Limit (dBm)	Result
NTNV	2400-BW~2400	-60.36	-10	Pass
	2400-2BW~2400-BW	-60.89	-20	
	2483.5~2483.5+BW	-63.13	-10	
	2483.5+BW~2483.5+2BW	-66.37	-20	
LTNV	2400-BW~2400	-62.03	-10	
	2400-2BW~2400-BW	-61.17	-20	
	2483.5~2483.5+BW	-63.18	-10	
	2483.5+BW~2483.5+2BW	-62.26	-20	
HTNV	2400-BW~2400	-61.13	-10	
	2400-2BW~2400-BW	-62.02	-20	
	2483.5~2483.5+BW	-63.47	-10	
	2483.5+BW~2483.5+2BW	-61.29	-20	

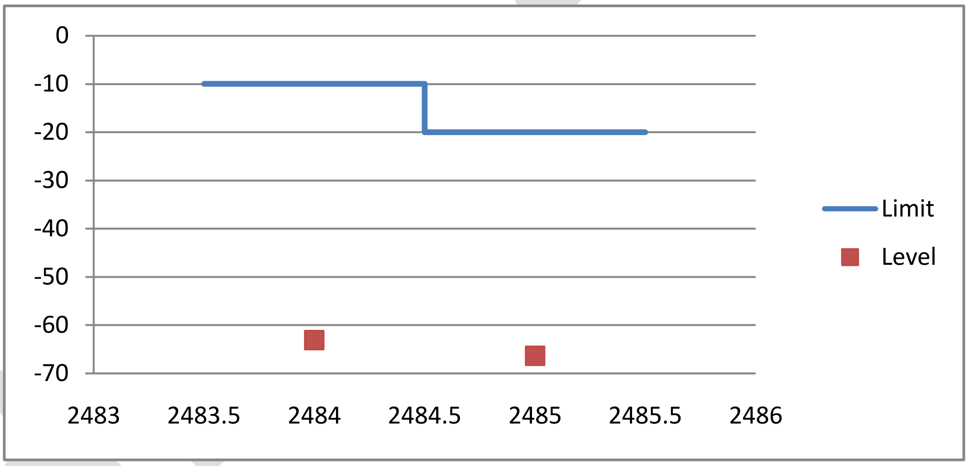
Remark:
1. *NTNV: Normal Temperature Normal Voltage, LTNV: Low Temperature Normal Voltage, LTHV: High Temperature Normal Voltage.*
2. *Antenna Gain = -0.58dBi, which declared by applicant.*
3. *The above data is only reflects of the worst test data.*

Test Plots:

DH5
NTNV

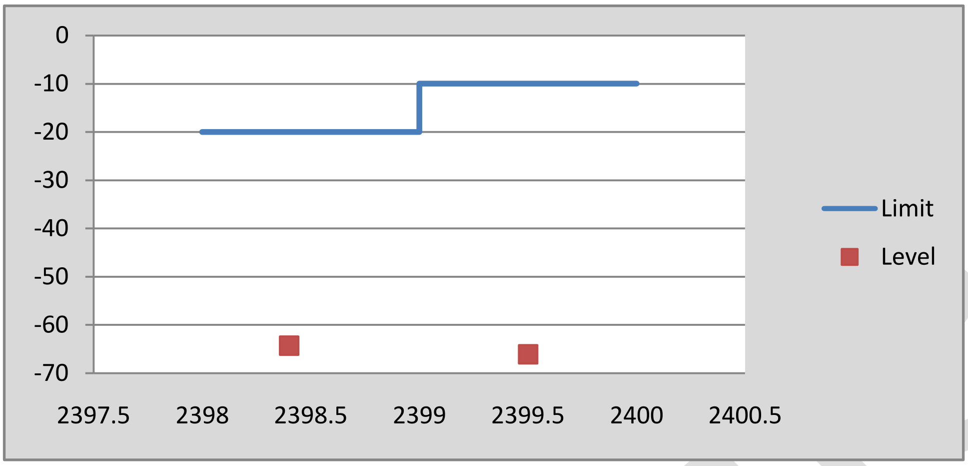


The Lowest Channel

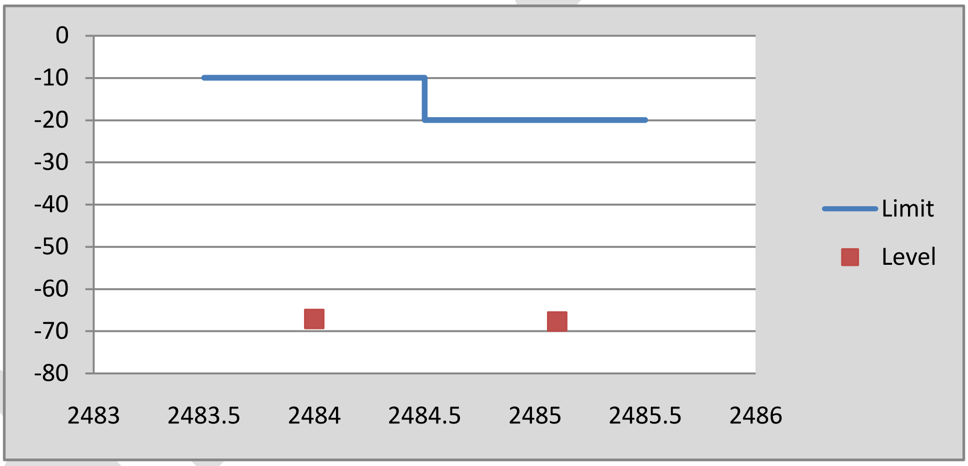


The Highest channel

2DH5
NTNV



The Lowest Channel



The Highest channel

6.1.9 Spurious emissions

Test Requirement:	ETSI EN300 328clause 4.3.1.10
Test Method:	ETSI EN300 328clause 5.4.9.2
Receiver setup:	RBW = 100kHz, VBW = 300kHz, Detector = Peak for Below 1 GHz RBW=1MHz, VBW=3MHz, Detector=Peak for Above 1 GHz
Test Frequency range:	30MHz to 12.75GHz

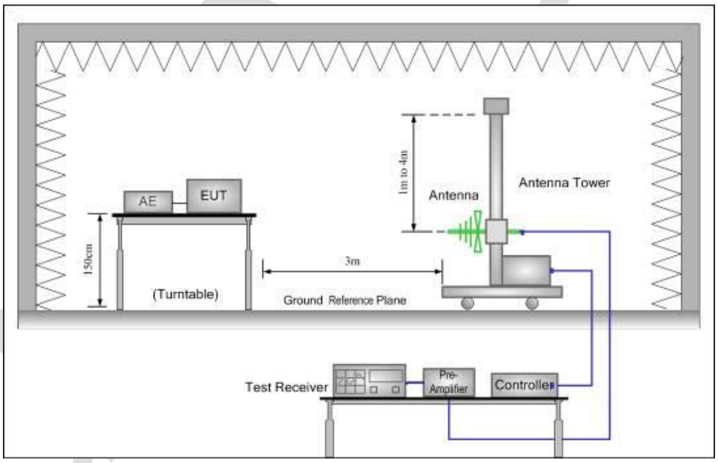
Limit:

Table 4: Transmitter limits for spurious emissions

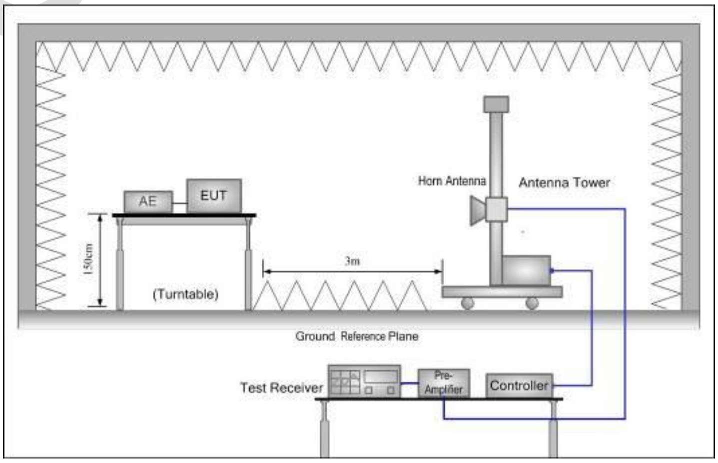
Frequency range	Maximum power	Bandwidth
30 MHz to 47 MHz	-36 dBm	100 kHz
47 MHz to 74 MHz	-54 dBm	100 kHz
74 MHz to 87,5 MHz	-36 dBm	100 kHz
87,5 MHz to 118 MHz	-54 dBm	100 kHz
118 MHz to 174 MHz	-36 dBm	100 kHz
174 MHz to 230 MHz	-54 dBm	100 kHz
230 MHz to 470 MHz	-36 dBm	100 kHz
470 MHz to 694 MHz	-54 dBm	100 kHz
694 MHz to 1 GHz	-36 dBm	100 kHz
1 GHz to 12,75 GHz	-30 dBm	1 MHz

Test setup:

Below 1GHz



Above 1GHz



Test procedure:

Below 1GHz

1. On the test site as test setup graph above,the EUT shall be placed at the 1.5m support on the turntable and in the position closest to normal use as declared by the provider.
2. The test antenna shall be oriented initially for vertical polarization and shall be chosen to correspond to the frequency ofthe transmitter.The output of the test antenna shall be connected to the measuring

	receiver. 3. The transmitter shall be switched on, if possible, without modulation and the measuring receiver shall be tuned to thefrequency of the transmitter under test. 4. The test antenna shall be raised and lowered from 1m to 4m until a maximum signal level isdetected by the measuring receiver. Then the turntable should be rotated through 360° in the horizontal plane, until the maximum signal level is detected bythe measuring receiver. 5. Repeat step 4 for test frequency with the test antenna polarized horizontally. 6. Remove the transmitter and replace it with a substitution antenna (theantenna should be half-wavelength for each frequency involved). Thecenter of the substitution antenna should be approximately at the samelocation as the center of the transmitter. At the lower frequencies, wherethe substitution antenna is very long, this will be impossible to achievewhen the antenna is polarized vertically. In such case the lower end of theantenna should be 0.3 m above the ground. 7. Feed the substitution antenna at the transmitter end with a signal generatorconnected to the antenna by means of a nonradiating cable. With theantennas at both ends vertically polarized, and with the signal generatortuned to a particular test frequency, raise and lower the test antenna toobtain a maximum reading at the spectrum analyzer. Adjust the level of thesignal generator output until the previously recorded maximum reading forthis set of conditions is obtained. This should be done carefully repeatingthe adjustment of the test antenna and generator output. 8. Repeat step 7 with both antennas horizontally polarized for each test frequency. 9. Calculate power in dBm into a reference ideal half-wave dipole antenna byreducing the readings obtained in steps 7 and 8 by the power loss in thecable between the generator and the antenna, and further corrected for thegain of the substitution antenna used relative to an ideal half-wave dipoleantenna by the following formula: ERP(dBm) = Pg(dBm) – cable loss (dB) + antenna gain (dBd) where:Pg is the generator output power into the substitution antenna. **Above 1GHz**: Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber, and the test antenna do not need to raise from 1 to 4m, just test in 1.5m height.
Test Instruments:	See section 5.7 for details
Test mode:	Transmitting mode
Test Result:	Pass

Remark:

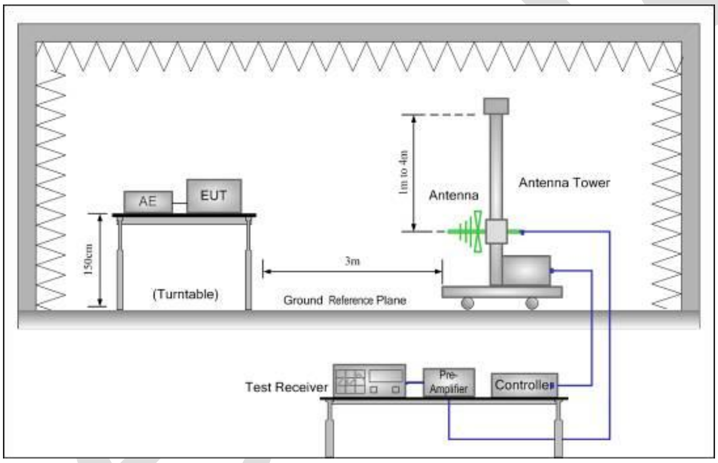
During the test, pre-scan the GFSK, Pi/4QPSK modulation, and found the GFSK modulation which it is worse case.

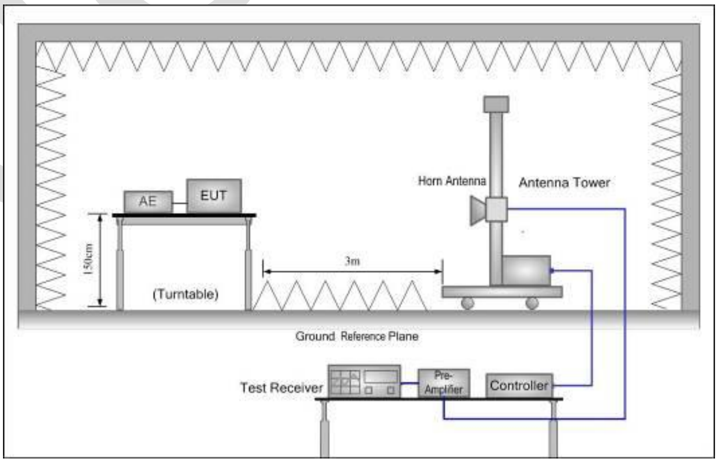
Measurement Data:

GFSK:The lowest channel				
Frequency (MHz)	Spurious Emission		Limit (dBm)	Test Result
	Polarization	Level(dBm)		
107.89	Vertical	-68.17	-54.00	Pass
554.83	V	-65.27		
154.28	V	-71.25	-36.00	
416.18	V	-68.79		
4804.00	V	-50.14	-30.00	
49.01	Horizontal	-73.28	-54.00	
578.67	H	-64.50		
153.74	H	-70.22	-36.00	
413.27	H	-68.50		
4804.00	H	-45.57	-30.00	
GFSK: The highest channel				
Frequency (MHz)	**Spurious Emission**		**Limit (dBm)**	**Test Result**
	Polarization	**Level(dBm)**		
107.89	Vertical	-69.25	-54.00	Pass
554.83	V	-66.71		
154.28	V	-72.03	-36.00	
416.18	V	-69.19		
4960.00	V	-46.46	-30.00	
49.01	Horizontal	-74.38	-54.00	
578.67	H	-65.51		
153.74	H	-69.03	-36.00	
413.27	H	-69.85		
4960.00	H	-44.05	-30.00	

6.2 Receiver requirement

6.2.1 Spurious emissions

<table>
<tr><td>Test Requirement:</td><td>ETSI EN300 328clause 4.3.1.11</td></tr>
<tr><td>Test Method:</td><td>ETSI EN300 328clause 5.4.10.2</td></tr>
<tr><td>Receiver setup:</td><td>RBW = 100kHz, VBW = 300kHz, Detector = peak for Below 1 GHz
RBW=1MHz, VBW=3MHz, Detector=Peak for Above 1 GHz</td></tr>
<tr><td>Test Frequency range:</td><td>30MHz to 12.75GHz</td></tr>
<tr><td>Limit:</td><td>Table 5: Spurious emission limits for receivers
<table>
<tr><th>Frequency range</th><th>Maximum power</th><th>Bandwidth</th></tr>
<tr><td>30 MHz to 1 GHz</td><td>-57 dBm</td><td>100 kHz</td></tr>
<tr><td>1 GHz to 12,75 GHz</td><td>-47 dBm</td><td>1 MHz</td></tr>
</table></td></tr>
<tr><td>Test setup:</td><td>Below 1GHz


Above 1GHz

</td></tr>
<tr><td>Test procedure:</td><td>Below 1GHz:
1. On the test site as test setup graph above,the EUT shall be placed at the 1.5m support on the turntable and in the position closest to normal use as declared by the provider.
2. The test antenna shall be oriented initially for vertical polarization and shall be chosen to correspond to the frequency ofthe transmitter.The output of the test antenna shall be connected to the measuring receiver.
3. The transmitter shall be switched on, if possible, without modulation and the measuring receiver shall be tuned to thefrequency of the transmitter under test.
4. The test antenna shall be raised and lowered from 1m to 4m until a</td></tr>
</table>

	maximum signal level isdetected by the measuring receiver. Then the turntable should be rotated through 360° in the horizontal plane, until the maximum signal level is detected bythe measuring receiver. 5. Repeat step 4 for test frequency with the test antenna polarized horizontally. 6. Remove the transmitter and replace it with a substitution antenna (theantenna should be half-wavelength for each frequency involved). Thecenter of the substitution antenna should be approximately at the samelocation as the center of the transmitter. At the lower frequencies, wherethe substitution antenna is very long, this will be impossible to achievewhen the antenna is polarized vertically. In such case the lower end of theantenna should be 0.3 m above the ground. 7. Feed the substitution antenna at the transmitter end with a signal generatorconnected to the antenna by means of a nonradiating cable. With theantennas at both ends vertically polarized, and with the signal generatortuned to a particular test frequency, raise and lower the test antenna toobtain a maximum reading at the spectrum analyzer. Adjust the level of thesignal generator output until the previously recorded maximum reading forthis set of conditions is obtained. This should be done carefully repeatingthe adjustment of the test antenna and generator output. 8. Repeat step 7 with both antennas horizontally polarized for each test frequency. 9. Calculate power in dBm into a reference ideal half-wave dipole antenna byreducing the readings obtained in steps 7 and 8 by the power loss in thecable between the generator and the antenna, and further corrected for thegain of the substitution antenna used relative to an ideal half-wave dipoleantenna by the following formula: ERP(dBm) = Pg(dBm) – cable loss (dB) + antenna gain (dBd) where:Pg is the generator output power into the substitution antenna. **Above 1GHz**: Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber, and the test antenna do not need to raise from 1 to 4m, just test in 1.5m height.
Test Instruments:	See section 5.7 for details
Test mode:	Receiving mode
Test Result:	Pass

Remark:

During the test, pre-scan the GFSK, Pi/4QPSK modulation, and found the GFSK modulation which it is worse case.

Measurement Data:

GFSK:The lowest channel				
Frequency (MHz)	Spurious Emission		Limit (dBm)	Test Result
	Polarization	Level(dBm)		
107.89	Vertical	-68.35	-57.00	Pass
729.36	V	-63.38		
4804.00	V	-54.05	-47.00	
133.15	Horizontal	-71.70	-57.00	
526.40	H	-66.23		
4804.00	H	-52.59	-47.00	
GFSK: The highest channel				
Frequency (MHz)	**Spurious Emission**		**Limit (dBm)**	**Test Result**
	Polarization	**Level(dBm)**		
107.89	Vertical	-69.43	-57.00	Pass
729.36	V	-64.02		
4960.00	V	-53.94	-47.00	
133.15	Horizontal	-72.07	-57.00	
526.40	H	-67.72		
4960.00	H	-55.17	-47.00	

6.2.2 Receiver Blocking

Test Requirement:	ETSI EN300 328clause 4.3.1.12
Test mothod:	ETSI EN 300 328 clause 5.4.11.2
Test Limit:	While maintaining the minimum performance criteria as defined in clause 4.3.1.12.3, the blocking levels at specifiedfrequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided intable 6, table 7 or table 8.

Table 6: Receiver Blocking parameters for Receiver Category 1 equipment

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

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

Table 7: Receiver Blocking parameters receiver Category 2 equipment

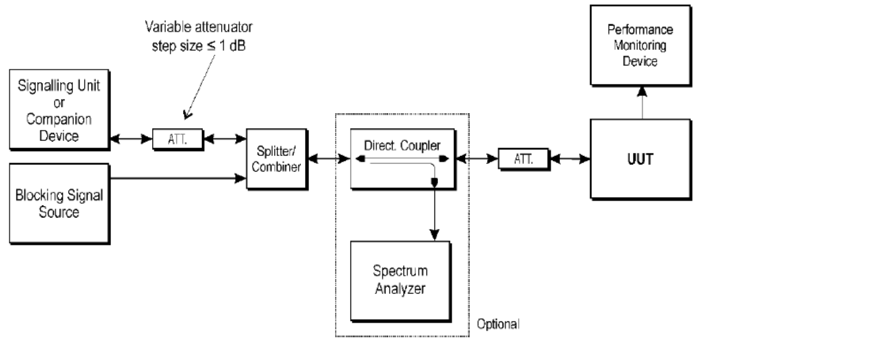
Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
(-139 dBm + 10 × $\log_{10}$(OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW

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

Table 8: Receiver Blocking parameters receiver Category 3 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
(-139 dBm + 10 × $\log_{10}$(OCBW) + 20 dB) or (-74 dBm + 20 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW

NOTE 1: OCBW is in Hz.
NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative the test may be performed using a wanted signal up to P_{min} + 30 dB where P_{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.
NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.

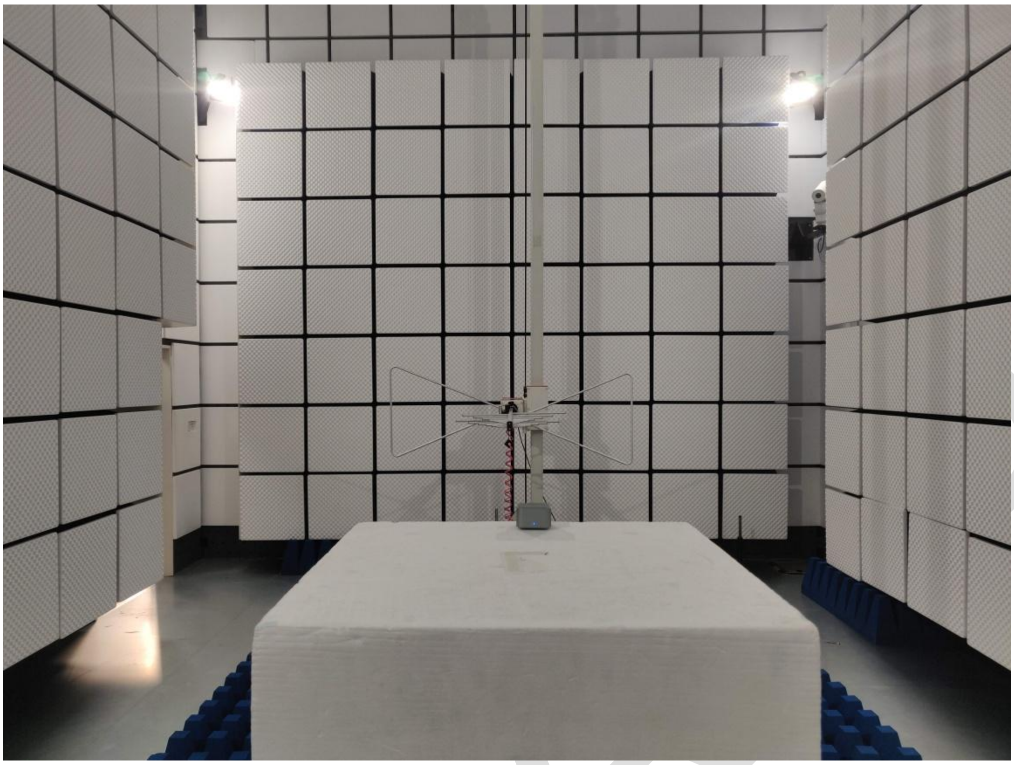
Test setup:	 **Figure 6: Test Set-up for receiver blocking**
Test procedure:	1. For non-frequency hopping equipment, the UUT shall be set to the lowest operating channel. 2. The blocking signal generator is set to the first frequency as defined in the appropriate table corresponding to the receiver category and type of equipment. 3. With the blocking signal generator switched off, a communication link is established between the UUT and the associated companion device using the test setup shown in figure 6. The attenuation of the variable attenuator shall be increased in 1 dB steps to a value at which the minimum performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is still met. The resulting level for the wanted signal at the input of the UUT is P_{min}. This signal level (P_{min}) is increased by the value provided in the table corresponding to the receiver category and type of equipment. 4. The blocking signal at the UUT is set to the level provided in the table corresponding to the receiver category and type of equipment. It shall be verified and recorded in the test report that the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is met. 5. Repeat step 4 for each remaining combination of frequency and level for the blocking signal as provided in the table corresponding to the receiver category and type of equipment. 6. For non-frequency hopping equipment, repeat step 2 to step 5 with the UUT operating at the highest operating channel.
Test Instruments:	See section 5.7 for details
Test mode:	Receiving mode
Test Result:	Pass

Measurement Data:

Receiver Category	Test Channel	Pmin (dBm)	Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm)	PER (%)	Limit (%)	Result
2	All channel Hopping	-124	Pmin + 26 dB	2380	-34	6	10	Pass
				2300	-34	5	10	Pass
				2504	-34	6	10	Pass
				2584	-34	6	10	Pass

7 Test setup photo

Radiated Emission Below 1GHz



Radiated Emission Above 1GHz

8 EUT Constructional Details

Reference to the test report No. BLA-EMC-201910-A15-01

ANNEX Application form for testing

InaccordancewithEN300328 V2.1.1,clause5.4.1,thefollowinginformationisprovidedbythe supplier.

a) Thetypeofmodulationusedby theequipment:

☒FHSS

☐Otherformsofmodulation

b) IncaseofFHSSmodulation:

- Incaseofnon-AdaptiveFrequencyHoppingequipment:
  ThenumberofHoppingFrequencies: ....
- IncaseofAdaptiveFrequencyHoppingEquipment:
  ThemaximumnumberofHoppingFrequencies: 79
  TheminimumnumberofHoppingFrequencies: 79
- TheDwellTime: 0.193s
- TheMinimumChannelOccupationTime: 5.78ms

c) Adaptive/non-adaptiveequipment:

☐ Non-adaptiveEquipment

☒AdaptiveEquipmentwithoutthepossibilityto switchto a non-adaptivemode

☐AdaptiveEquipmentwhichcanalsooperateina non-adaptivemode

d) Incaseofadaptiveequipment:

TheChannelOccupancyTimeimplementedbytheequipment: ms

☐TheequipmenthasimplementedanLBTbasedDAAmechanism

- Incaseofequipmentusingmodulationdifferent fromFHSS:

☐TheequipmentisFrameBased equipment

☒TheequipmentisLoadBasedequipment

☐TheequipmentcanswitchdynamicallybetweenFrameBasedand LoadBasedequipment

TheCCAtimeimplementedbytheequipment: µs

Thevalueq asreferredtoinclause4.3.2.5.2.2.2: ....

☐Theequipmenthasimplementedannon-LBTbasedDAAmechanism

☐Theequipmentcanoperateinmorethanoneadaptive mode

e) Incaseofnon-adaptiveEquipment:

ThemaximumRFOutputPower(e.i.r.p.): dBm

Themaximum(corresponding)DutyCycle:%

Equipmentwithdynamicbehaviour,thatbehaviourisdescribedhere.(e.g.thedifferentcombinationsofdutycycle andcorrespondingpowerlevelsto bedeclared):

f) Theworstcaseoperationalmodeforeachofthefollowingtests:

- RFOutputPower π/4DQPSK
- PowerSpectralDensityN/A
- Dutycycle,Tx-Sequence,Tx-gap ....
- Dwelltime,MinimumFrequencyOccupation&HoppingSequence(onlyforFHSSequipment) 0.193s, 5.78ms, 79 channels
- HoppingFrequencySeparation(onlyforFHSSequipment)8DPSK
- MediumUtilisationN/A
- Adaptivity& ReceiverBlocking GFSK
- OccupiedChannelBandwidth 8DPSK
- TransmitterunwantedemissionsintheOOBdomain GFSK
- Transmitterunwantedemissionsinthespuriousdomain GFSK
- ReceiverspuriousemissionsGFSK

g) Thedifferenttransmitoperating modes(tickallthatapply):

☒Operatingmode1:Single AntennaEquipment

☒Equipmentwithonly1antenna

☐Equipmentwith2 diversityantennasbutonly1 antennaactiveat anymomentintime

☐SmartAntennaSystemswith2 ormoreantennas,butoperatingina (legacy)mode whereonly1 antennais used.(e.g.IEEE802.11™[i.3]legacymodein smartantennasystems)

☐Operatingmode2:Smart AntennaSystems-MultipleAntennaswithoutbeamforming

☐Singlespatialstream/Standardthroughput/(e.g.IEEE802.11™[i.3]legacymode)

☐HighThroughput(>1spatialstream)usingOccupiedChannelBandwidth1
☐HighThroughput(>1spatialstream)usingOccupiedChannelBandwidth2
NOTE: Addmorelinesif morechannelbandwidthsaresupported.
☐Operatingmode3:Smart AntennaSystems-MultipleAntennaswithbeamforming
☐Singlespatialstream/Standardthroughput(e.g.IEEE802.11™[i.3]legacymode)
☐HighThroughput(>1spatialstream)usingOccupiedChannelBandwidth1
☐HighThroughput(>1spatialstream)usingOccupiedChannelBandwidth2
NOTE: Addmorelinesif morechannelbandwidthsaresupported.

h) IncaseofSmartAntennaSystems:

- Thenumberof Receivechains: ....
- ThenumberofTransmitchains:...........

☐Symmetricalpowerdistribution
☐asymmetricalpowerdistribution
Incaseofbeamforming,themaximumbeamforminggain: ....
NOTE: Beamforminggaindoesnotincludethebasicgainofasingleantenna.

i) OperatingFrequencyRange(s)oftheequipment:

- OperatingFrequencyRange1: 2402 MHzto2480MHz
- OperatingFrequencyRange2: ....MHzto........... MHz

NOTE: Addmorelinesif moreFrequencyRangesaresupported.

j) OccupiedChannelBandwidth(s):

- OccupiedChannelBandwidth1:1.220MHz
- OccupiedChannelBandwidth2:..................MHz

NOTE: Addmorelinesif morechannelbandwidthsaresupported.

k) TypeofEquipment(stand-alone,combined,plug-inradiodevice,etc.):

☒Stand-alone
☐ CombinedEquipment(Equipmentwheretheradiopartisfullyintegratedwithinanothertypeofequipment)
☐Plug-inradiodevice(Equipmentintendedfora varietyof hostsystems) ☐
Other...

l) Theextremeoperatingconditionsthatapplyto the equipment:

Operatingtemperaturerange: -20° C to +55°C
Operatingvoltagerange:3.5V to 4.2V ☐AC☒DC
Detailsprovidedareforthe: ☒ stand-aloneequipment
☐combined(or host)equipment
☐testjig

m) Theintendedcombination(s)oftheradioequipmentpowersettingsandoneormore antennaassemblies andtheircorrespondinge.i.r.plevels:

- AntennaType:

☒IntegralAntenna
☒AntennaGain: -0.58dBi
Ifapplicable,additionalbeamforminggain(excludingbasicantennagain): dB
☐TemporaryRFconnectorprovided
☐No temporaryRFconnectorprovided
☐DedicatedAntennas(equipmentwithantenna connector)
☐Singlepowerlevelwithcorrespondingantenna(s)
☐Multiplepowersettingsandcorrespondingantenna(s)NumberofdifferentPower Levels: ...
Power Level1: dBm
Power Level2: dBm
Power Level3: dBm
NOTE1: Addmorelinesincasetheequipmenthas morepowerlevels.
NOTE2: Thesepowerlevelsareconductedpowerlevels(atantennaconnector).

- ForeachofthePower Levels,providetheintendedantennaassemblies,theircorrespondinggains(G) andtheresultinge.i.r.p.levelsalsotakingintoaccountthebeamforminggain(Y)ifapplicable

PowerLevel1: dBm

Numberofantennaassembliesprovidedforthispowerlevel: ....

Assembly#	Gain(dBi)	e.i.r.p. (dBm)	Partnumberormodelname
1			
2			
3			
4			

PowerLevel2: dBm

Numberofantennaassembliesprovidedforthispowerlevel: ....

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

PowerLevel3: dBm

Numberofantennaassembliesprovidedforthispowerlevel: ....

Assembly#	Gain(dBi)	e.i.r.p. (dBm)	Partnumberormodelname
1			
2			
3			
4			

n) Thenominalvoltagesofthestand-aloneradioequipmentorthenominalvoltagesofthecombined(host) equipmentortestjig incaseofplug-indevices:

Detailsprovidedareforthe: ☒ stand-aloneequipment
☐combined(or host)equipment
☐testjig

SupplyVoltage ☐ACmainsStateAC voltage V
☒DC StateDC voltage 3.7V

IncaseofDC,indicatethetypeofpowersource
☐InternalPowerSupply
☒ExternalPowerSupplyorAC/DCadapter
☒Battery
☐Other:.....

o) Describethetestmodesavailablewhichcanfacilitatetesting:

Hopping mode and continuous transmitting mode control in engineer mode.

p) Theequipmenttype(e.g.Bluetooth®,IEEE802.11™[i.3],proprietary,etc.):

Bluetooth

Configuration for testing

Fromallcombinationsofconductedpowersettingsandintendedantennaassembly(ies)specifiedinclause 5.4.1m),specifythecombinationresultinginthe higheste.i.r.p.fortheradioequipment.

Unlessotherwisespecifiedin EN300328,thispowersettingisto be usedfortestingagainsttherequirementsofEN300328.Incasethereismorethanonesuchconductedpowersettingresult inginthesame(highest)e.i.r.p.level, the highestpowersettingisto be usedfortesting.SeealsoEN300328,clause5.3.2.3.

Highest overall e.i.r.p. value: 3.25 dBm	
Corresponding Antenna assembly gain: -0.58dBi	Antenna Assembly #: 1
Corresponding conducted power setting: 3.83dBm (also the power level to be used for testing)	Listed as Power Setting #: 7

Additional information provided bythe applicant

Modulation:

ITUClass(es)ofemission: FHSS

Canthetransmitteroperateunmodulated? ☐yes ☒ no

DutyCycle

Thetransmitteris intendedfor: ☐ Continuousduty
☐Intermittentduty
☒Continuousoperationpossiblefortestingpurposes

AbouttheUUT

☒Theequipmentsubmittedarerepresentativeproductionmodels
☐If not,theequipmentsubmittedarepre-productionmodels?
☐Ifpre-productionequipmentaresubmitted,thefinalproductionequipmentwillbeidenticalinallrespects withtheequipmenttested
☐Ifnot,supplyfulldetails
....
☐Theequipmentsubmittedis CEmarked
☐Inadditionto theCE mark,theClass-IIidentifier(AlertSign)isaffixed.

Additionalitemsand/orsupportingequipmentprovided

☐Sparebatteries(e.g.forportableequipment)
☒Batterychargingdevice
☒ExternalPowerSupplyorAC/DCadapter
☐TestJigorinterfacebox
☐ RFtestfixture(forequipmentwithintegratedantennas)
☐HostSystem Manufacturer: ....
Model#: ....
Modelname: ....
☐ Combinedequipment Manufacturer: ....
Model#: ....
Modelname: ....
☒UserManual
☒Technicaldocumentation(Handbookandcircuitdiagrams)

*** End of Report ***

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