EN 300 328 RF Test Report

(Bluetooth Low Energy)

Report No.: RECDBM-WTW-P22060902

Test Model: MGM240S22A

Series Model: BGM240S22A (refer to item 3.1 for more details)

Received Date: Jul. 06, 2022

Test Date: Jul. 13, 2022 ~ Aug. 01, 2022

Issued Date: Oct. 04, 2022

Applicant: Silicon Laboratories Finland Oy

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Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Lin Kou Laboratories

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Release Control Record

Issue No.	Description	Date Issued
RECDBM-WTW-P22060902	Original Release	Oct. 04, 2022

1 Certificate of Conformity

Product: Bluetooth Low Energy and 802.15.4 wireless radio module

Brand: SILICON LABS

Test Model: MGM240S22A

Series Model: BGM240S22A (refer to item 3.1 for more details)

Sample Status: Engineering sample fully representing the production models

Applicant: Silicon Laboratories Finland Oy

Test Date: Jul. 13, 2022 ~ Aug. 01, 2022

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 RF characteristics under the conditions specified in this report.

Prepared by : Lena Wang , **Date:** Oct. 04, 2022

Lena Wang / Specialist

Approved by : Jeremy Lin , **Date:** Oct. 04, 2022

Jeremy Lin / Project Engineer

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
4.3.2.2	RF Output Power	Pass
4.3.2.3	Power Spectral Density (Modulations other than FHSS equipment)	Pass
4.3.2.4	Duty cycle, Tx-sequence, Tx-gap (Non-adaptive equipment)	Not Applicable
4.3.2.5	Medium Utilization (Non-Adaptive Equipment)	Not Applicable
4.3.2.6	Adaptivity (Adaptive Equipment)	Pass
4.3.2.7	Occupied Channel Bandwidth	Pass
4.3.2.8	Transmitter Unwanted Emissions in the OOB Domain	Pass
4.3.2.9	Transmitter Unwanted Emissions in the Spurious Domain	Pass
4.3.2.10	Receiver Spurious Emissions	Pass
4.3.2.11	Receiver Blocking	Pass
4.3.2.12	Geo-location capability	Not Applicable

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

2.1 Test Instruments

For all tests except adaptive & receiver blocking:

Description & Manufacturer	Model No.	Serial No.	Calibrated Date	Calibrated Until
Spectrum Analyzer Agilent	N9030B	MY57140488	Feb. 24, 2022	Feb. 23, 2023
Spectrum Analyzer Rohde & Schwarz	FSV40	100980	Apr. 20, 2022	Apr. 19, 2023
USB Wideband Power Sensor KEYSIGHT	U2021XA	MY55050005/MY55190004/MY55190007/MY55210005	Jul. 13, 2022	Jul. 12, 2023
BILOG Antenna SCHWARZBECK	VULB 9168	9168-161	Oct. 28, 2021	Oct. 27, 2022
HORN Antenna ETS	3117	00034130	Nov. 14, 2021	Nov. 13, 2022
HORN Antenna SCHWARZBECK	BBHA 9170	BBHA9170243	Nov. 14, 2021	Nov. 13, 2022
Loop Antenna TESEQ	HLA 6121	45745	Jul. 21, 2021	Jul. 20, 2022
			Jul. 27, 2022	Jul. 26, 2023
Preamplifier Agilent	8449B	3008A01976	Jul. 09, 2022	Jul. 08, 2023
Preamplifier Agilent	8447D	2944A10634	Jul. 09, 2022	Jul. 08, 2023
RF signal cable HUBER+SUHNER	SUCOFLEX 104	Cable-RF2-03 (246272/4)	Jul. 09, 2022	Jul. 08, 2023
RF signal cable WOKEN	8D-FB	Cable-RF2-01	Jul. 09, 2022	Jul. 08, 2023
RF signal cable INFINET	CA3501-3501-G.90 (3m) & CA3501-3501-F.90 (2m)	INF090 (3m)*2 & TCF427S (2m)*1	Jul. 09, 2022	Jul. 08, 2023
Software ADT	ADT_Radiated_V7.6.15.9.5	NA	NA	NA
Antenna Tower Max-Full	MFA-440H	1308111	NA	NA
Turn Table ADT	NA	SN30303	NA	NA
Controller Max-Full	MF7802	MF780208363	NA	NA
Temperature & Humidity chamber TERCHY	MHU-225AU	920842	Jun. 21, 2022	Jun. 20, 2023

Note:
1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in HwaYa RF Chamber 2.
3. The horn antenna and preamplifier (model: 8449B) are used only for the measurement of emission frequency above 1GHz if tested.
4. Tested date: Jul. 25 ~ Aug. 01, 2022

For Adaptive:

Description & Manufacturer	Model No.	Serial No.	Calibrated Date	Calibrated Until
MXG Vector signal generator KEYSIGHT	N5182B	MY53052282	Dec. 21, 2021	Dec. 20, 2022
Vector signal generator Agilent	E4438C	MY47271120	Nov. 09, 2021	Nov. 08, 2022
PXA Signal Analyzer KEYSIGHT	N9030B	MY57140938	Mar. 15, 2022	Mar. 14, 2023

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. Tested date: Aug. 01, 2022

For receiver blocking

Description & Manufacturer	Model No.	Serial No.	Calibrated Date	Calibrated Until
Spectrum Analyzer Rohde & Schwarz	FSV40	100980	Apr. 20, 2022	Apr. 19, 2023
Vector signal generator Agilent	E4438C	MY47271120	Nov. 09, 2021	Nov. 08, 2022
Radio Communication Analyzer Anritsu	CBT	100946	Aug. 06, 2020	Aug. 05, 2022

Note: 1. The calibration interval of the above test instruments is 12/24 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. Tested date: Jul. 13, 2022

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	±1.132x10^{-4} %
RF output power, conducted	±1.371 dB
Power Spectral Density, conducted	±1.371 dB
Unwanted Emissions, conducted	±1.371 dB
All emissions, radiated	±3.294 dB
Temperature	±0.23 °C
Supply voltages	±0.3 %
Time	±2.53 %

2.3 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Bluetooth Low Energy and 802.15.4 wireless radio module
Brand	SILICON LABS
Test Model	MGM240S22A
Series Model	BGM240S22A
Model Difference	Refer to note
Status of EUT	Engineering sample fully representing the production module
Power Supply Rating	1.8Vdc to 3.8Vdc (from host equipment)
Typical Nominal Supply Voltage	3.0Vdc
Normal Testing Voltage	3.3Vdc
Temperature Operating Range	-40~105℃
Modulation Type	GFSK
Modulation Technology	DTS
Transfer Rate	1MBaud with 1Mbps transfer rate 1MBaud with coded 125Kbps transfer rate 1MBaud with coded 500Kbps transfer rate 2MBaud with 2Mbps transfer rate
Operating Frequency	2402 ~ 2480MHz
Number of Channel	1MBaud: 40 2MBaud: 37
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 (Measured Max. Average)	Mode A : 11.03dBm Mode B : 11.04dBm
Antenna Type	Refer to note
Antenna Connector	Refer to note
Accessory Device	NA
Data Cable Supplied	NA

Note:

1. All models are listed as below. Model MGM240S22A is the representative for final test.

	Model			
Product Spec.	Main Model: MGM240S22A		Series Model: BGM240S22A	
	Power rating: Low-Power Wireless protocols: BLE and 802.15.4		Power rating: Low-Power Wireless protocols: BLE	
Test mode	To be tested as DTS for both 802.15.4 and BLE In the case of BLE, three PHYs to test: 2Mbps , 1Mbps and 125Kbps		Testing of the Main Model will cover this Series Model / In fact, the hardware and software are exactly the same, except for one single software-related difference: the 802.15.4 protocol is disabled in the factory for marketing differentiation	
RF nominal max TX output power	10dBm			
Antenna type	Integral antenna	RF pin	Integral antenna	RF pin
Hardware	Hardware-wise, the main model and the first series model are identical. Supply voltage range: 1V8 to 3V8 (nominal 3V0) / Fully internally regulated, including the RF PA. Temperature range: -40C to +105C. The BLE wireless protocol is indentical in all the models. The 802.15.4 wireless protocol is made available only for the main model. The module's RF OUT pin exposes the 50Ω-matched RF port of the embedded radio chipset. Conducted measurements are taken at the module's RF OUT pin. The RF OUT pin can be further connected either to the adjacent RF ANT IN pin (using a 0Ω resistor), so that the integral antenna can be used, or directly to an external antenna. All radiated tests are taken both with a sample using the integral antenna, and with a sample where the RF signal from the RF OUT pin is routed instead to an external reference dipole antenna.			

2. The antenna information is listed as below.

No.	Type	Connector	Gain (dBi)	Remark
1	Integral antenna	NA	1.48	For model: MGM240S22A, BGM240S22A
2	External reference dipole antenna**	RP-SMA	2.80	For model: MGM240S22A, BGM240S22A

* 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.

** The dipole antenna is not sold with the EUT, but is used during testing as a reference antenna for radiated measurements of the parts making use of the RF pin.

3. For 1MBaud, after the pretesting three transfer rates (1Mbps, 125Kbps and 500Kbps), 1MBaud with 1Mbps and 125Kbps transfer rate were the worst case test and chosen for final test.

4. The power setting is list as below.

1MBaud

Test Mode	MGM240S22A / Integral ant.	Test Mode	MGM240S22A / Dipole ant.
CH 0	77	CH 0	66
CH 1	77	CH 1	66
CH 19	78	CH 19	66
CH 38	81	CH 38	68
CH 39	81	CH 39	68

2MBaud

Test Mode	MGM240S22A / Integral ant.	Test Mode	MGM240S22A / Dipole ant.
CH 1	86	CH 1	70
CH 19	86	CH 19	71
CH 38	92	CH 38	73

125Kbps

Test Mode	MGM240S22A / Integral ant.	Test Mode	MGM240S22A / Dipole ant.
CH 0	77	CH 0	66
CH 1	77	CH 1	66
CH 19	78	CH 19	66
CH 38	81	CH 38	68
CH 39	81	CH 39	68

3.2 Description of Test Modes

1MBaud:

40 channels are provided to this EUT:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

Note: Physical Channels 0, 12 and 39 are special low-duty-cycle channels used only for BLE advertising mode.

2MBaud:

37 channels are provided to this EUT:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
1	2404	11	2424	22	2446	32	2466
2	2406	13	2428	23	2448	33	2468
3	2408	14	2430	24	2450	34	2470
4	2410	15	2432	25	2452	35	2472
5	2412	16	2434	26	2454	36	2474
6	2414	17	2436	27	2456	37	2476
7	2416	18	2438	28	2458	38	2478
8	2418	19	2440	29	2460		
9	2420	20	2442	30	2462		
10	2422	21	2444	31	2464		

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable to										Description
	ROP	PSD	DC/TS/TG	MU	AD	OCB	EOB	SE< 1G	SE≥ 1G	RB	Condition
A	√	√	-	-	√	√	√	√	√	-	Integral ant.
B	√	√	-	-	-	√	√	√	√	√	Dipole ant.

Where ROP: RF Output Power

PSD: Power Spectral Density

DC/TS/TG: Duty Cycle/ Tx-Sequence / Tx-gap

MU: Medium Utilization

AD: Adaptivity (Channel Access Mechanism)

OCB: Occupied Channel Bandwidth

EOB: Transmitter unwanted emissions in the out-of-band domain

SE<1G: Unwanted Emissions in the Spurious Domain below 1 GHz

SE≥1G: Unwanted Emissions in the Spurious Domain above 1 GHz

RB: Receiver Blocking

Note:
1. The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Y-plane for Mode A and Z-plane for Mode B.**
2. "-": Means no effect.

RF Output Power Test:

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

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

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate
A	0 to 39	0, 1, 19, 38, 39	GFSK	1 Mbps
	1 to 38	1, 19, 38	GFSK	2 Mbps
	0 to 39	0, 1, 19, 38, 39	GFSK	125Kbps
B	0 to 39	0, 1, 19, 38, 39	GFSK	1 Mbps
	1 to 38	1, 19, 38	GFSK	2 Mbps
	0 to 39	0, 1, 19, 38, 39	GFSK	125Kbps

Power Spectral Density Test:

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

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

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate
A	0 to 39	0, 1, 19, 38, 39	GFSK	1 Mbps
	1 to 38	1, 19, 38	GFSK	2 Mbps
	0 to 39	0, 1, 19, 38, 39	GFSK	125Kbps
B	0 to 39	0, 1, 19, 38, 39	GFSK	1 Mbps
	1 to 38	1, 19, 38	GFSK	2 Mbps
	0 to 39	0, 1, 19, 38, 39	GFSK	125Kbps

Adaptivity:

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

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

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate
A	0 to 39	0, 39	GFSK	1 Mbps
	1 to 38	1, 38	GFSK	2 Mbps

Occupied Channel Bandwidth Test:

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

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

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate
A	0 to 39	0, 39	GFSK	1 Mbps
	1 to 38	1, 38	GFSK	2 Mbps
	0 to 39	0, 39	GFSK	125Kbps
B	0 to 39	0, 39	GFSK	1 Mbps
	1 to 38	1, 38	GFSK	2 Mbps
	0 to 39	0, 39	GFSK	125Kbps

Transmitter Unwanted Emissions in the Out-of-band Domain Test:

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

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

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate
A	0 to 39	0, 39	GFSK	1 Mbps
	1 to 38	1, 38	GFSK	2 Mbps
	0 to 39	0, 39	GFSK	125Kbps
B	0 to 39	0, 39	GFSK	1 Mbps
	1 to 38	1, 38	GFSK	2 Mbps
	0 to 39	0, 39	GFSK	125Kbps

Unwanted Emissions in the Spurious Domain Test (Below 1 GHz):

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

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

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate
A	0 to 39	39	GFSK	1 Mbps
	1 to 38	38	GFSK	2 Mbps
B	0 to 39	39	GFSK	1 Mbps
	1 to 38	38	GFSK	2 Mbps

Unwanted Emissions in the Spurious Domain Test (Above 1 GHz):

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

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

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate
A	0 to 39	0, 39	GFSK	1 Mbps
	1 to 38	1, 38	GFSK	2 Mbps
B	0 to 39	0, 39	GFSK	1 Mbps
	1 to 38	1, 38	GFSK	2 Mbps

Receiver Blocking test:

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

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

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate
B	0 to 39	0, 39	GFSK	125Kbps

Test Condition:

Applicable To	Environmental Conditions	Input Power	Tested by
ROP	25 deg. C, 60% RH	3.3Vdc	Chun Wu
PSD	25 deg. C, 60% RH	3.3Vdc	Chun Wu
AD	25 deg. C, 65% RH	3.3Vdc	Matthew Yang
OCB	25 deg. C, 60% RH	3.3Vdc	Chun Wu
EOB	25 deg. C, 60% RH	3.3Vdc	Chun Wu
SE<1G	25 deg. C, 64% RH, 21 deg. C, 66% RH	230Vac, 50Hz (System)	Jay Chang
SE≥1G	25 deg. C, 64% RH, 21 deg. C, 66% RH	230Vac, 50Hz (System)	Jay Chang
RB	25 deg. C, 65% RH	3.3Vdc	Oakley 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.

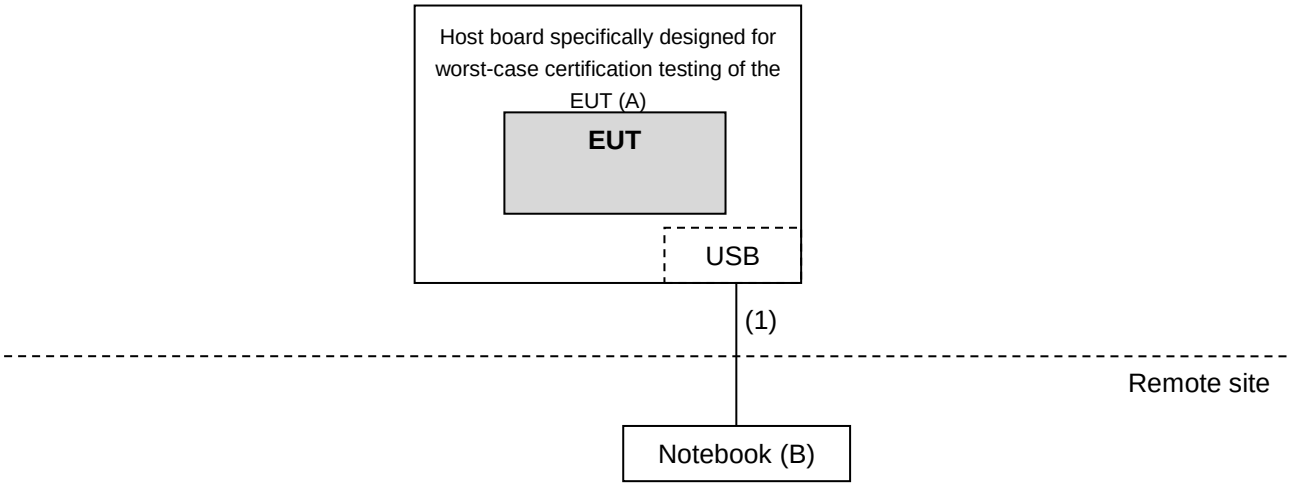
ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Host board specifically designed for worst-case certification testing of the EUT	Silicon Labs.	N/A	N/A	N/A	Provided by client
B.	Notebook	DELL	E5520	8Y4DMQ1	N/A	-

Note:

1. All power cords of the above support units are non-shielded (1.8m).
2. Item B acted as a communication partner to transfer data.

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB cable	1	1.5	Y	0	Provided 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 standards:

EN 300 328 V2.2.2 (2019-07)

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

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 measurements for RF output power was performed at both normal environmental conditions and at the extremes of the operating temperature. Controlling software (provided by manufacturer) has been activated to set the EUT on specific channel and power level.

4.1.5 Test Results

Mode A
1MBaud

Channel	Frequency (MHz)	EIRP (dBm)			Limit (dBm)	Test Result
		Test Conditions				
		25 ℃	-40 ℃	105 ℃		
0	2402	10.01	10.17	9.56	20	Pass
1	2404	9.99	10.16	9.60	20	Pass
19	2440	10.00	10.15	9.56	20	Pass
38	2478	9.99	10.14	9.58	20	Pass
39	2480	9.97	10.05	9.68	20	Pass

2MBaud

Channel	Frequency (MHz)	EIRP (dBm)			Limit (dBm)	Test Result
		Test Conditions				
		25 ℃	-40 ℃	105 ℃		
1	2404	10.46	10.63	10.18	20	Pass
19	2440	10.34	10.56	10.10	20	Pass
38	2478	10.87	11.03	10.49	20	Pass

125Kbps

Channel	Frequency (MHz)	EIRP (dBm)			Limit (dBm)	Test Result
		Test Conditions				
		25 ℃	-40 ℃	105 ℃		
0	2402	9.99	10.13	9.53	20	Pass
1	2404	9.98	10.13	9.56	20	Pass
19	2440	9.98	10.14	9.53	20	Pass
38	2478	9.97	10.08	9.56	20	Pass
39	2480	9.96	10.01	9.62	20	Pass

Mode B
1MBaud

Channel	Frequency (MHz)	EIRP (dBm)			Limit (dBm)	Test Result
		Test Conditions				
		25 ℃	-40 ℃	105 ℃		
0	2402	9.99	10.15	9.54	20	Pass
1	2404	9.99	10.16	9.60	20	Pass
19	2440	9.96	10.11	9.52	20	Pass
38	2478	9.97	10.12	9.56	20	Pass
39	2480	9.95	10.03	9.66	20	Pass

2MBaud

Channel	Frequency (MHz)	EIRP (dBm)			Limit (dBm)	Test Result
		Test Conditions				
		25 ℃	-40 ℃	105 ℃		
1	2404	10.83	11.00	10.55	20	Pass
19	2440	10.82	11.04	10.58	20	Pass
38	2478	10.84	11.00	10.46	20	Pass

125Kbps

Channel	Frequency (MHz)	EIRP (dBm)			Limit (dBm)	Test Result
		Test Conditions				
		25 ℃	-40 ℃	105 ℃		
0	2402	9.98	10.12	9.52	20	Pass
1	2404	9.98	10.13	9.56	20	Pass
19	2440	9.95	10.11	9.50	20	Pass
38	2478	9.96	10.07	9.55	20	Pass
39	2480	9.92	9.97	9.58	20	Pass

4.2 Adaptivity (Adaptive Frequency Hopping)

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

4.2.1 Limit of Adaptive

Applicability of adaptive requirements and limit for frequency hopping equipment

Requirement	Operational Mode	
	Using LBT based DAA (CCA using 'energy detect')	using 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 note 6)	40ms (see note2)
Minimum Idle Period	100us (see note 7)	100us (see note 2)
Extended CCA check	See note 4	NA
Minimum time for unavailable	NA	(see note 3)
Short Control Signalling Transmissions	Maximum duty cycle of 10 % within an observation period of 50 ms (see note 5)	

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 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 3: 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 4: Observed for a random duration between the value defined for the CCA observation time and 5 % of the Channel Occupancy Time.
Note 5: Adaptive equipment may or may not have Short Control Signaling Transmissions.
Note 6: For LBT based frequency hopping equipment with a dwell time < 60 ms, the maximum Channel Occupancy Time is limited by the dwell time.
Note 7: Minimum 5 % of the Channel Occupancy Time with a minimum of 100 µs.

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 / Pout) (Pout in mW e.i.r.p.)

Unwanted signal parameters for Adaptive frequency hopping using LBT based DAA		
Wanted signal mean power from companion device (dBm)	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 -50 dBm/MHz. Note 3: The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.		

Unwanted signal parameters for Adaptive frequency hopping using other forms of DAA (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.		

4.2.2 Test Procedure

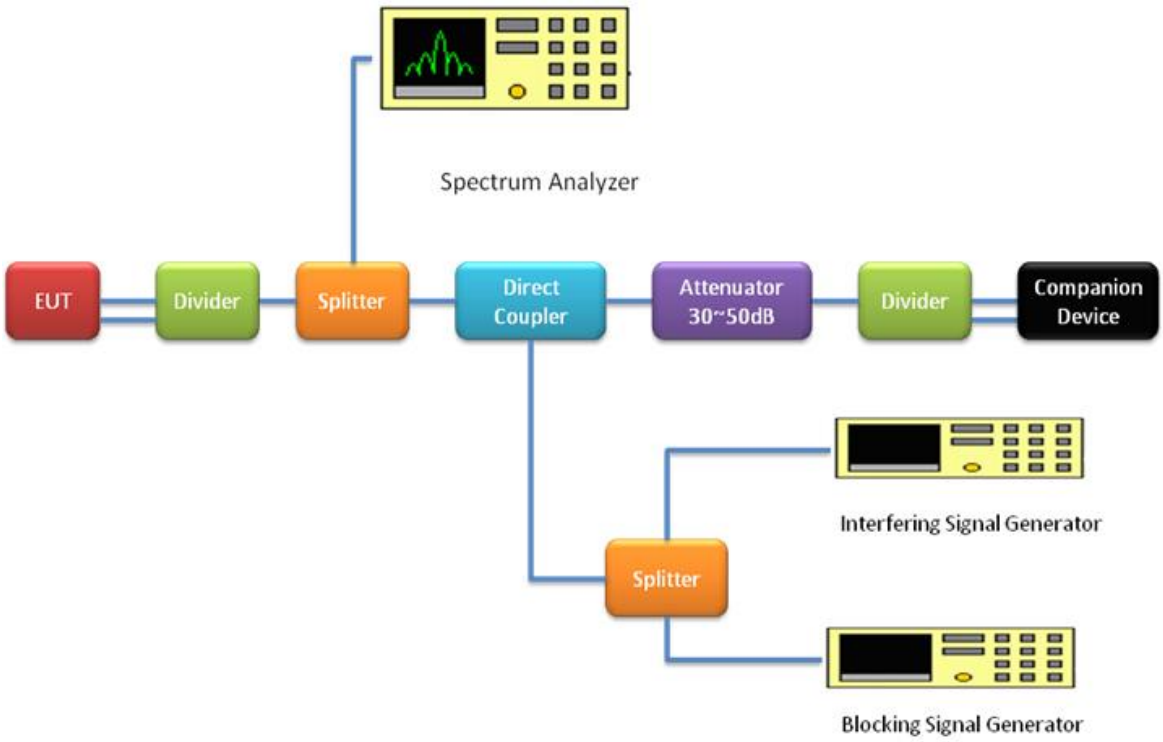
Refer to chapter 5.4.6 of EN 300 328 V2.2.2.

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

4.2.3 Deviation from Test Standard

No deviation.

4.2.4 Test Setup Configuration



UUT Software and Firmware Version

Product	Model No.	Software/Firmware Version
Bluetooth Low Energy wireless radio module	MGM240S22A	2.1.7

Companion Device Information

Product	Model No.	Software/Firmware Version
Bluetooth Low Energy wireless radio module	MGM240S22A	2.1.7

4.2.5 List of Measurements

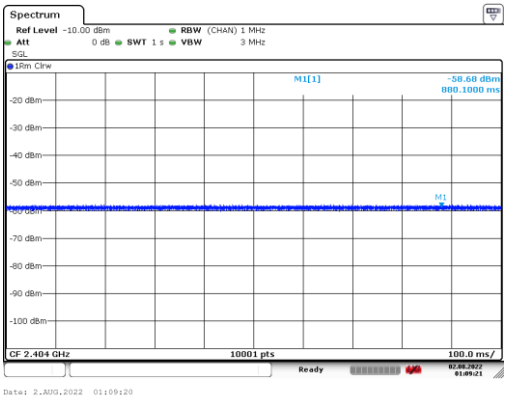
UUT Operational Mode	Applicable	Limit	
		The Maximum Channel Occupancy Time	The Minimum idle Period
Frame Based Equipment		meet in 1 ms ~ 10 ms	> 5 % x channel occupancy time
Load Based Equipment (CCA using 'energy detect')		Follow IEEE 802.11 Less than _____ms	Follow IEEE 802.11 More than _____ms
	v	13 ms	18 us
Load Based Equipment (CCA not using any of the mechanisms referenced)		13 ms	18 us

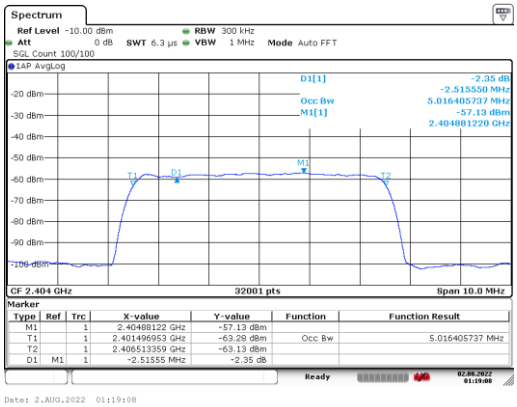
Clause	Test Parameter	Remarks	Pass/Fail
4.3.2.6.3.2.2	Adaptive (Frame Based Equipment)	Not Applicable	NA
4.3.2.6.3.2.3	Adaptive (Load Based Equipment)	Applicable	Pass
4.3.2.6.4	Short Control Signalling Transmissions	Applicable	Pass
4.3.2.6.2	Unwanted Signal Parameters	Not Applicable	NA

4.2.6 Interference Threshold Level

1MBaud

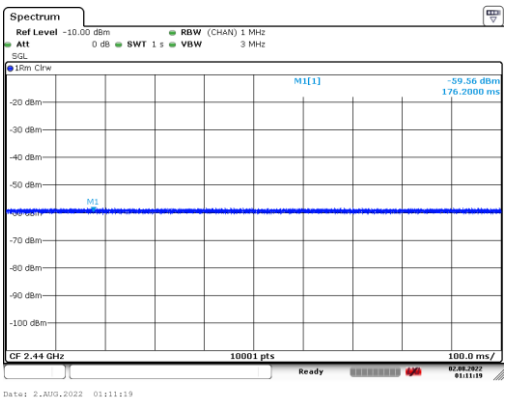
Detection Threshold Level
The maximum EIRP power is 10.17dBm and antenna gain is 1.48dBi. Detection Threshold Level = -70dBm/MHz + 10*log10 (100mW / Pout (10.4mW)) + G (1.48dBi)) = -58.69dBm/MHz. The interference signal level to the UUT is -58.69dBm/MHz

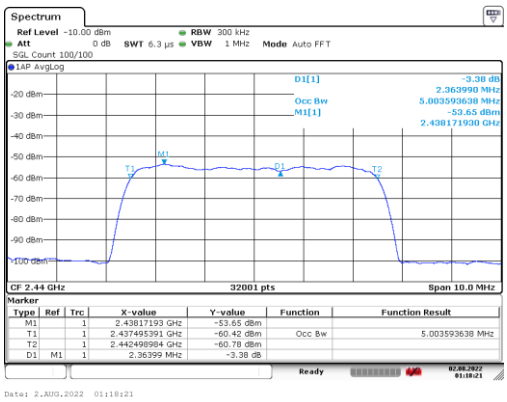




2MBaud

Detection Threshold Level
The maximum EIRP power is 11.05dBm and antenna gain is 1.48dBi. Detection Threshold Level = -70dBm/MHz + 10*log10 (100mW / Pout (12.74mW)) + G (1.48dBi))= -59.57dBm/MHz. The interference signal level to the UUT is -59.57dBm/MHz





4.2.7 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

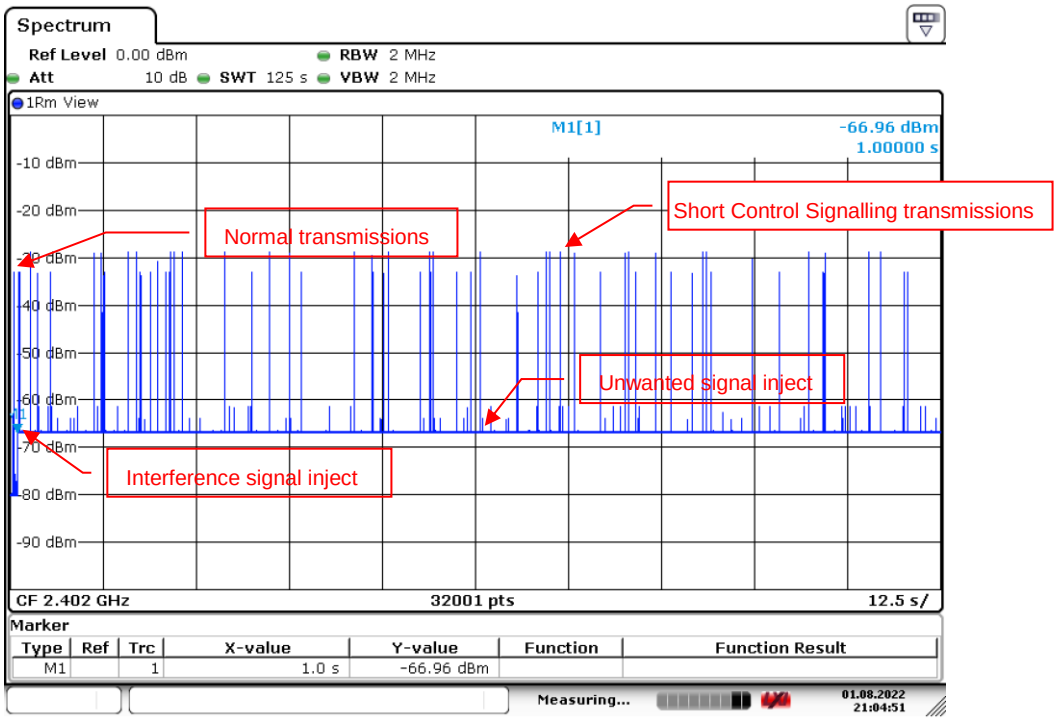
4.2.7.1 Adaptive Result

Operating Frequency Bands and Mode of EUT

Operational Mode	Operating Frequency (Low power Channel, MHz)	Operating Frequency (High power Channel, MHz)	Test Result
BT LE 1M	2402	2480	Pass
BT LE 2M	2404	2478	Pass

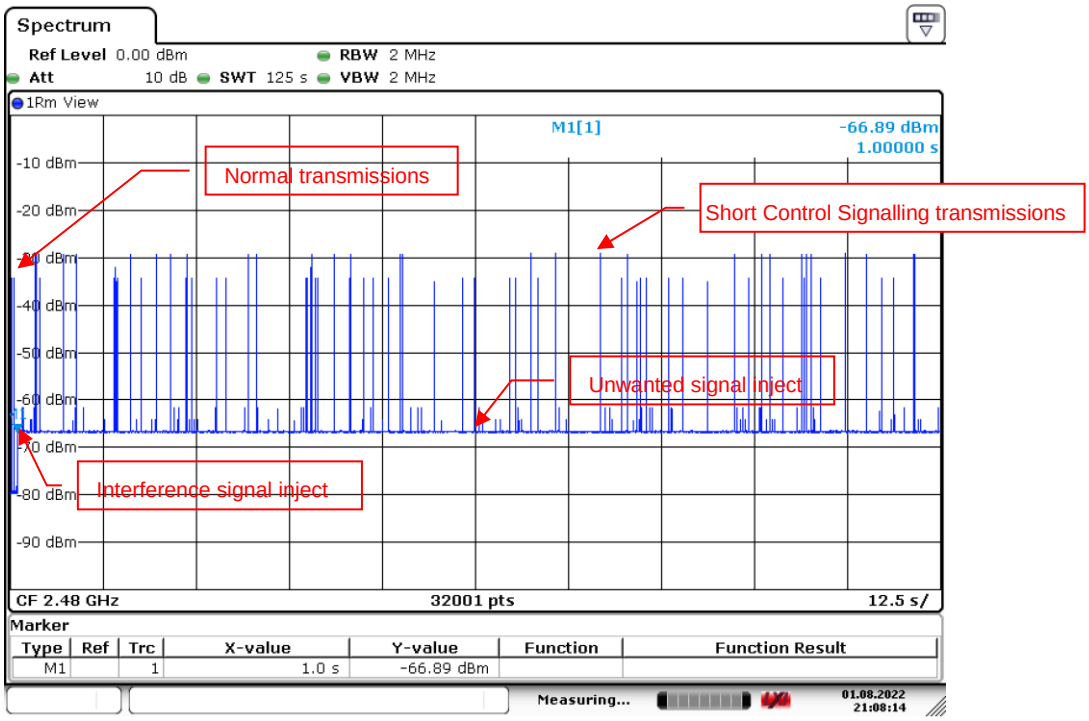
1MBaud

2402MHz



Date: 1.AUG.2022 21:04:51

2480MHz



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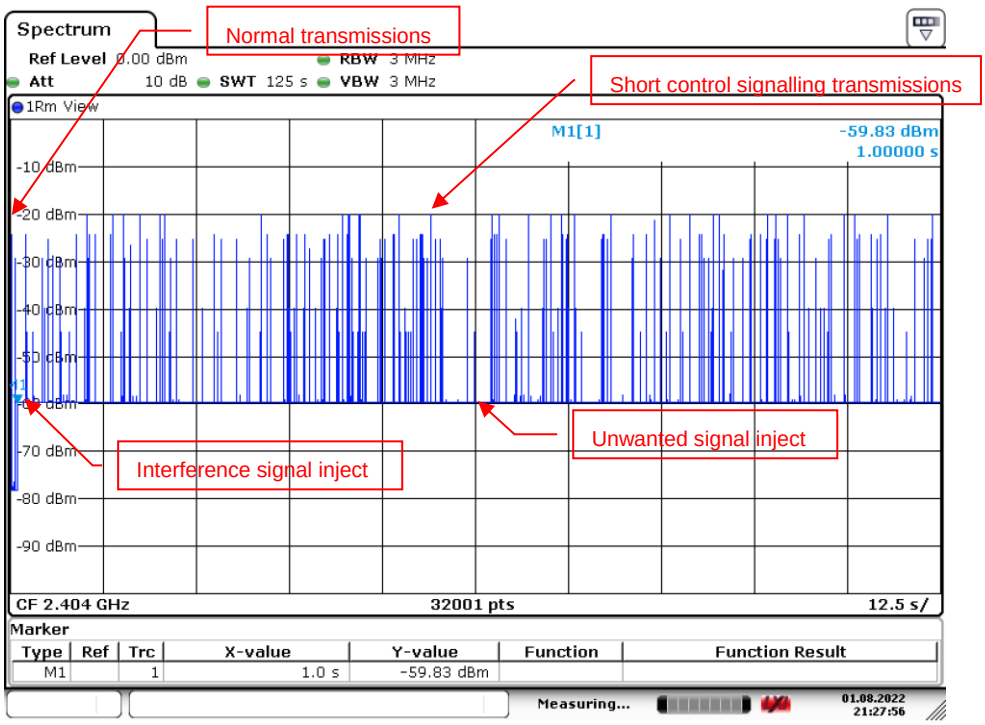
2MBaud

2404MHz



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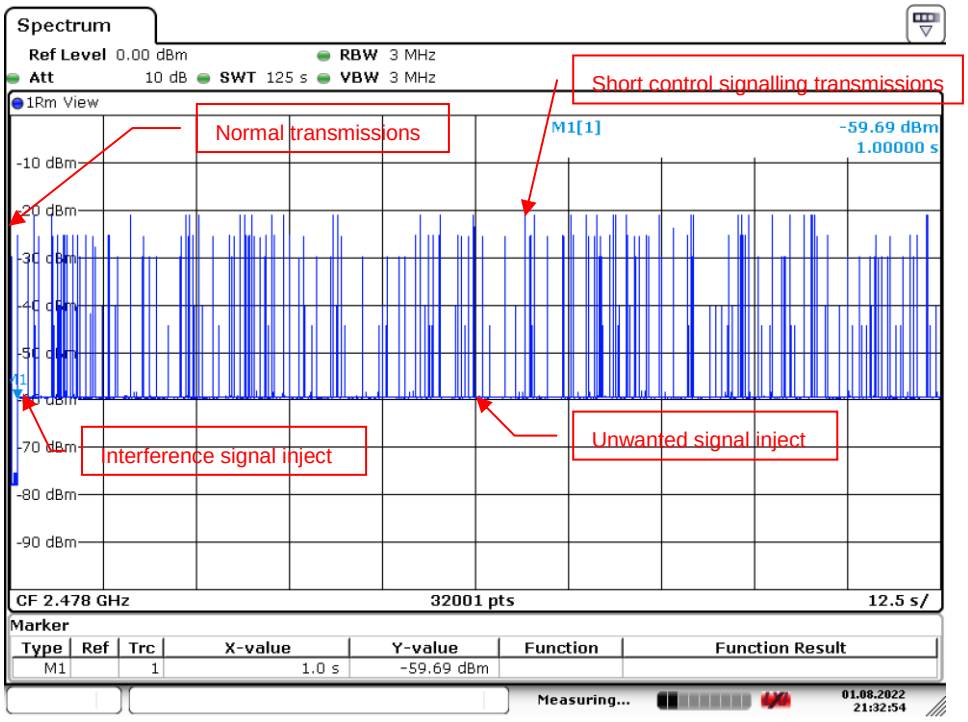
2478MHz



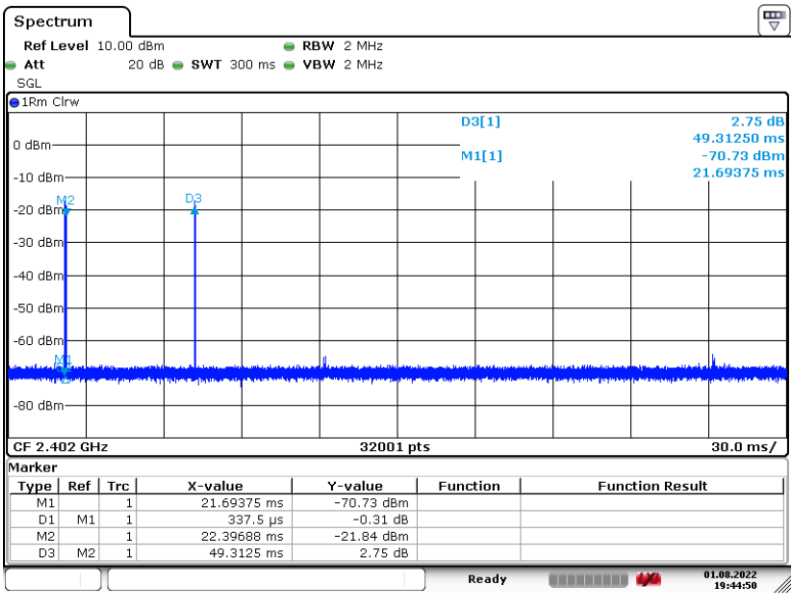
Date: 1.AUG.2022 21:32:54

4.2.7.2 The Channel Occupancy Time Result

Operating Frequency Bands and Mode of EUT

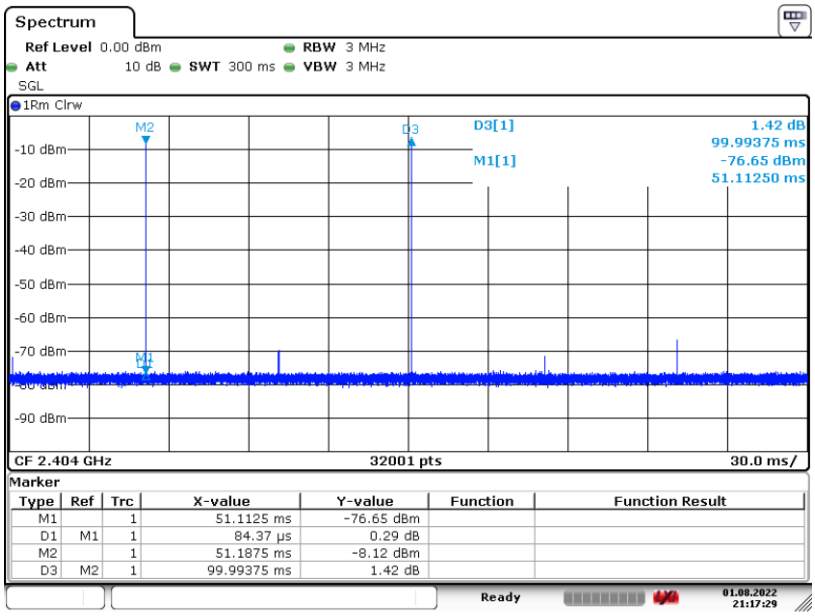
Operational Mode	Operating Frequency Low power Channel (MHz)	The Channel Occupancy Time (ms)	Minimum Idle Period (us)	Test Result
BT LE 1M	2402	0.3375	49321.5	Pass
BT LE 2M	2404	0.08437	99993.75	Pass

1MBaud



Date: 1.AUG.2022 19:44:51

2MBaud



Date: 1.AUG.2022 21:17:29

4.2.7.3 Unwanted Signal Interference

1MBaud

Channel	Channel Frequency (MHz)	Wanted Signal Mean Power from Companion Device (dBm/MHz)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm)	Pass/Fail
0	2402	-50	2488.5	-32.2	Pass
39	2480	-50	2395.0	-32.2	Pass

2MBaud

Channel	Channel Frequency (MHz)	Wanted Signal Mean Power from Companion Device (dBm/MHz)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm)	Pass/Fail
1	2404	-50	2488.5	-32.2	Pass
38	2478	-50	2395.0	-32.2	Pass

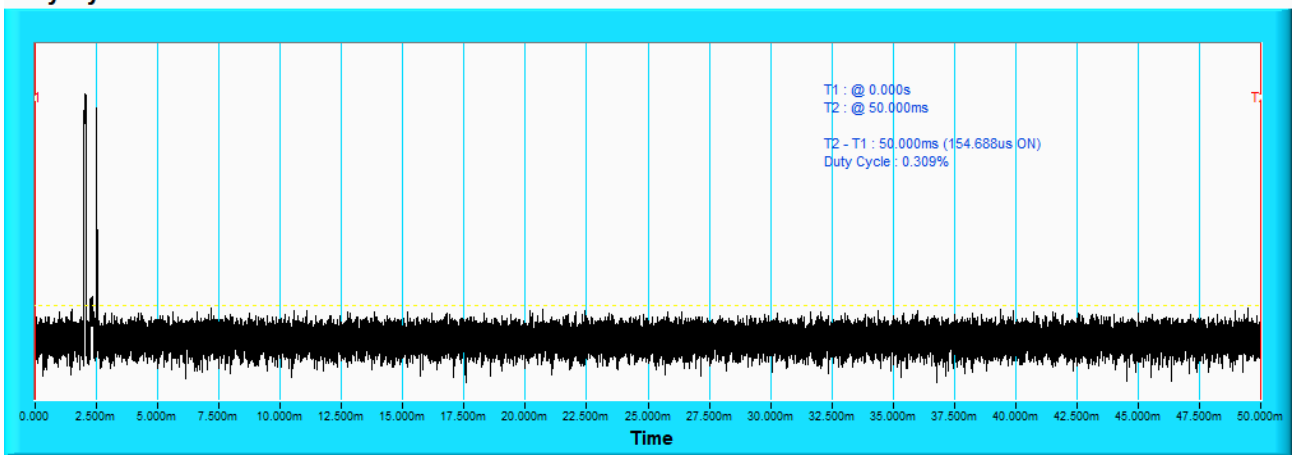
4.2.7.4 Short Control Signalling Transmissions Result

1MBaud

2402MHz

Short Control Signalling Transmission Result		
SCST total on time (ms)	SCST Limit (ms)	Test Result
0.154688	5	Pass

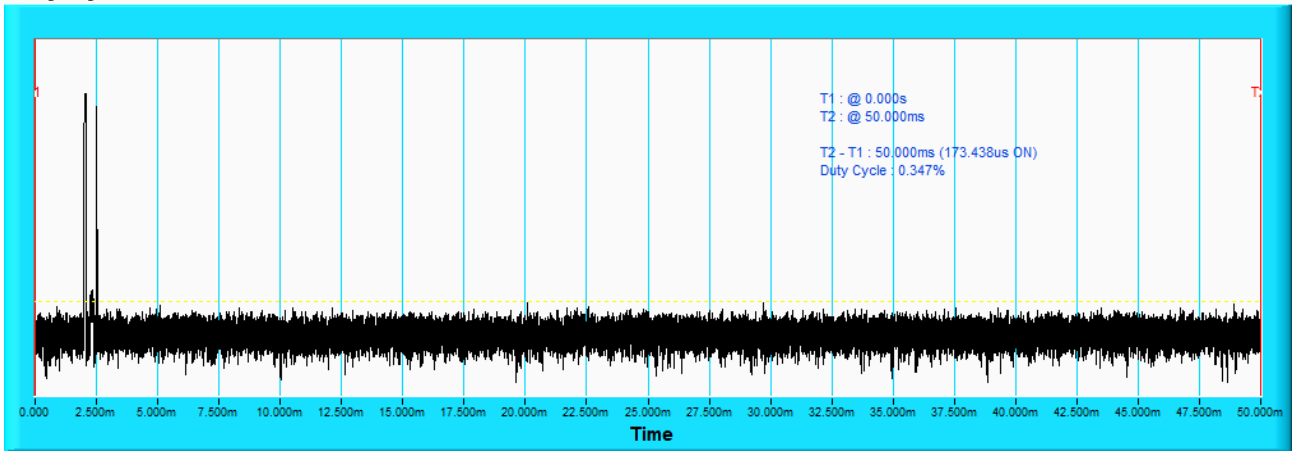
Duty Cycle



2480MHz

Short Control Signalling Transmission Result		
SCST total on time (ms)	SCST Limit (ms)	Test Result
0.173438	5	Pass

Duty Cycle

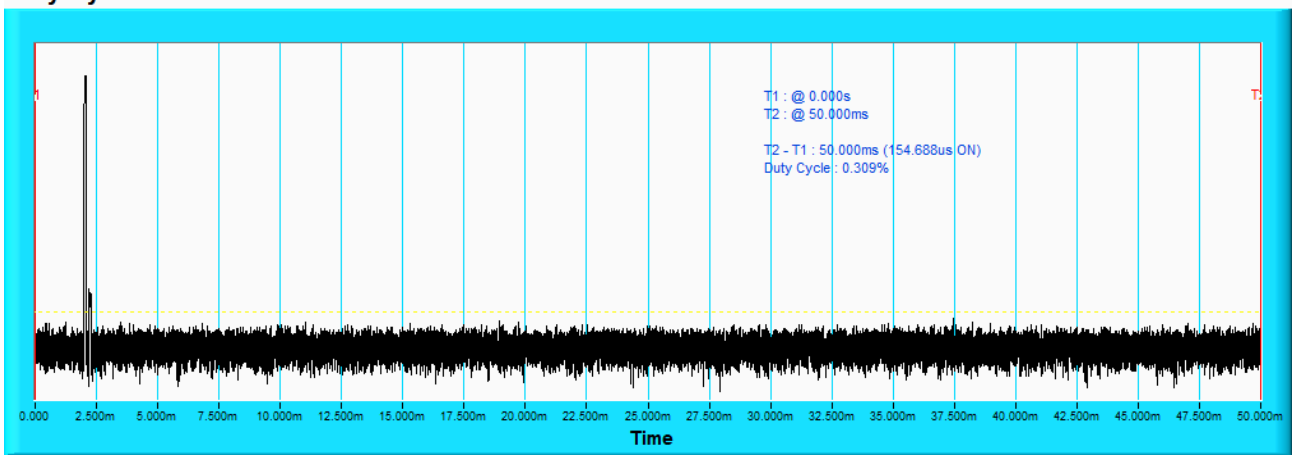


2MBaud

2404MHz

Short Control Signalling Transmission Result		
SCST total on time (ms)	SCST Limit (ms)	Test Result
0.154688	5	Pass

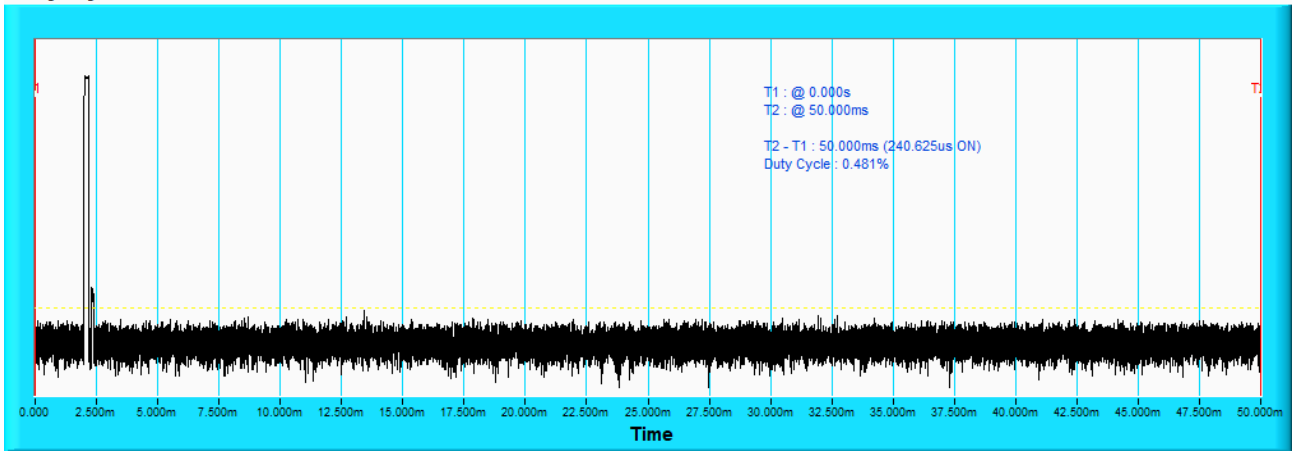
Duty Cycle



2478MHz

Short Control Signalling Transmission Result		
SCST total on time (ms)	SCST Limit (ms)	Test Result
0.240625	5	Pass

Duty Cycle



4.3 Power Spectral Density

4.3.1 Limit of Power Spectral Density

Condition	Frequency Band	Limit (e.i.r.p.)
Under normal conditions	2400 ~ 2483.5 MHz	10dBm / 1MHz

4.3.2 Test Procedures

Refer to chapter 5.4.3 of EN 300 328 V2.2.2.

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement
☒ Option 1: For equipment with continuous and non-continuous transmissions ☐ Option 2: For equipment with continuous transmission capability or for equipment operating (or with the capability to operate) with a constant duty cycle (e.g. Frame Based equipment)	

4.3.3 Deviation of Test Standard

No deviation.

4.3.4 Test Setup

The test setup has been constructed as the normal test condition. (In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator.) The power spectral density as defined in EN 300 328 clause 4.3.2.3 shall be measured and recorded. Controlling software (provided by manufacturer) has been activated to set the EUT on specific status.

4.3.5 Test Results

Mode A
1MBaud

Channel	Frequency (MHz)	EIRP PSD (dBm/MHz)	PSD Limit (dBm)	Test Result
0	2402	9.95	10	Pass
1	2404	9.94	10	Pass
19	2440	9.95	10	Pass
38	2478	9.93	10	Pass
39	2480	9.91	10	Pass

2MBaud

Channel	Frequency (MHz)	EIRP PSD (dBm/MHz)	PSD Limit (dBm)	Test Result
1	2404	9.56	10	Pass
19	2440	9.49	10	Pass
38	2478	9.93	10	Pass

125Kbps

Channel	Frequency (MHz)	EIRP PSD (dBm/MHz)	PSD Limit (dBm)	Test Result
0	2402	9.93	10	Pass
1	2404	9.92	10	Pass
19	2440	9.92	10	Pass
38	2478	9.92	10	Pass
39	2480	9.90	10	Pass

Mode B
1MBaud

Channel	Frequency (MHz)	EIRP PSD (dBm/MHz)	PSD Limit (dBm)	Test Result
0	2402	9.92	10	Pass
1	2404	9.92	10	Pass
19	2440	9.89	10	Pass
38	2478	9.91	10	Pass
39	2480	9.87	10	Pass

2MBaud

Channel	Frequency (MHz)	EIRP PSD (dBm/MHz)	PSD Limit (dBm)	Test Result
1	2404	9.88	10	Pass
19	2440	9.86	10	Pass
38	2478	9.89	10	Pass

125Kbps

Channel	Frequency (MHz)	EIRP PSD (dBm/MHz)	PSD Limit (dBm)	Test Result
0	2402	9.93	10	Pass
1	2404	9.94	10	Pass
19	2440	9.91	10	Pass
38	2478	9.92	10	Pass
39	2480	9.89	10	Pass

4.4 Occupied Channel Bandwidth

4.4.1 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

4.4.2 Test Procedure

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

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

4.4.3 Deviation from Test Standard

No deviation.

4.4.4 Test Setup

These measurements only were performed at normal test conditions. The measurement shall be performed only on the lowest and the highest frequency within the stated frequency range. In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator. Controlling software (provided by manufacturer) has been activated to set the EUT on specific status.

4.4.5 Test Results

Mode A

1MBaud

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Measured Frequencies		Limit	Pass/Fail
			F_L (MHz)	F_H (MHz)		
0	2402	1.03	2401.48	2402.51	F_L > 2400 MHz and F_H < 2483.5 MHz	Pass
39	2480	1.03	2479.48	2480.51		Pass

Note: FL is the lowest frequency of the 99% occupied bandwidth of power envelope.
FH is the highest frequency of the 99% occupied bandwidth of power envelope.

2MBaud

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Measured Frequencies		Limit	Pass/Fail
			F_L (MHz)	F_H (MHz)		
1	2404	2.05	2402.97	2405.02	F_L > 2400 MHz and F_H < 2483.5 MHz	Pass
38	2478	2.06	2476.97	2479.03		Pass

Note: FL is the lowest frequency of the 99% occupied bandwidth of power envelope.
FH is the highest frequency of the 99% occupied bandwidth of power envelope.

125Kbps

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Measured Frequencies		Limit	Pass/Fail
			F_L (MHz)	F_H (MHz)		
0	2402	1.03	2401.48	2402.51	F_L > 2400 MHz and F_H < 2483.5 MHz	Pass
39	2480	1.03	2479.48	2480.51		Pass

Note: FL is the lowest frequency of the 99% occupied bandwidth of power envelope.
FH is the highest frequency of the 99% occupied bandwidth of power envelope.

Mode B
1MBaud

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Additional requirement	Measured Frequencies		Limit	Test Result
				FL (MHz)	FH (MHz)		
0	2402	1.03	Less than 20 MHz	2401.49	2402.52	FL > 2400 MHz and FH < 2483.5 MHz	Pass
39	2480	1.03		2479.49	2480.52		Pass

Note: FL is the lowest frequency of the 99% occupied bandwidth of power envelope.
FH is the highest frequency of the 99% occupied bandwidth of power envelope.

2MBaud

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Additional requirement	Measured Frequencies		Limit	Test Result
				FL (MHz)	FH (MHz)		
1	2404	2.06	Less than 20 MHz	2402.97	2405.03	FL > 2400 MHz and FH < 2483.5 MHz	Pass
38	2478	2.06		2476.97	2479.03		Pass

Note: FL is the lowest frequency of the 99% occupied bandwidth of power envelope.
FH is the highest frequency of the 99% occupied bandwidth of power envelope.

125Kbps

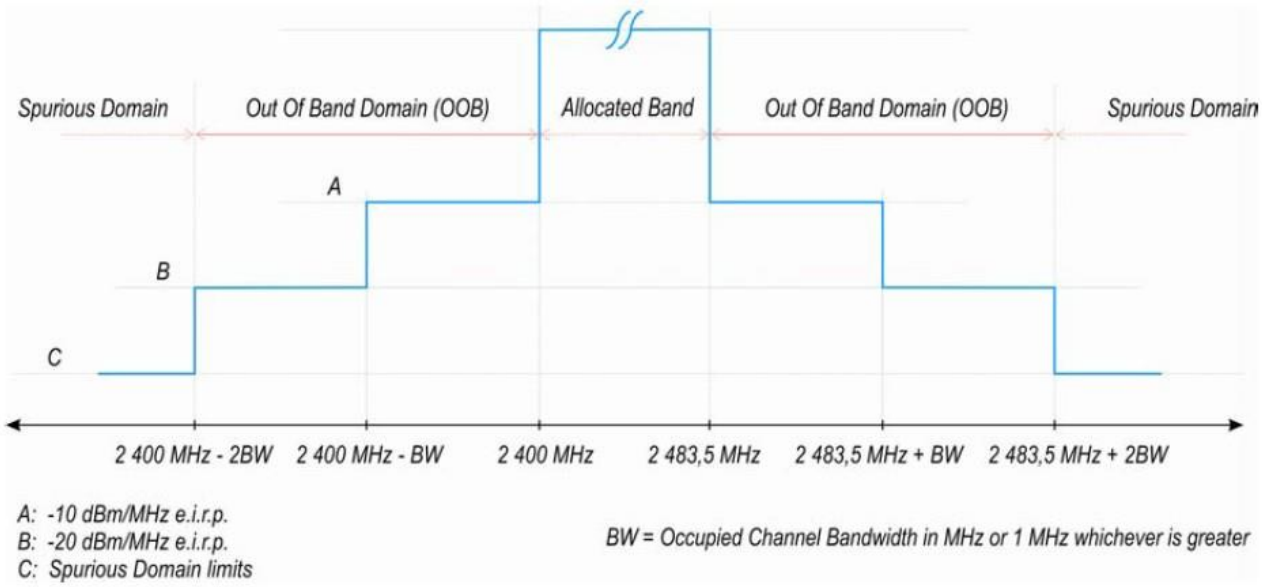
Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	Additional requirement	Measured Frequencies		Limit	Test Result
				FL (MHz)	FH (MHz)		
0	2402	1.03	Less than 20 MHz	2401.48	2402.51	FL > 2400 MHz and FH < 2483.5 MHz	Pass
39	2480	1.03		2479.48	2480.51		Pass

Note: FL is the lowest frequency of the 99% occupied bandwidth of power envelope.
FH is the highest frequency of the 99% occupied bandwidth of power envelope.

4.5 Transmitter Unwanted Emissions in the Out-of-band Domain

4.5.1 Limits of Transmitter Unwanted Emissions in the Out-of-band Domain

Condition	Limit
Under all test conditions	The transmitter unwanted emissions in the out-of-band domain but outside the allocated band, shall not exceed the values provided by the mask in below figure.



4.5.2 Test Procedure

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

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

4.5.3 Deviation from Test Standard

No deviation

4.5.4 Test Setup

The measurements were performed at normal environmental conditions. The measurement was performed at the lowest and the highest channel on which the equipment can operate. 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.

4.5.5 Test Results

Mode A
1MBaud

Channel	Frequency (MHz)	Out-Of-Band Domain			Limit (dBm/MHz)	Test Result
		Frequency Range (MHz)	Worst Frequency (MHz)	Emission Level (dBm/MHz)		
0	2402	2397.94 ~ 2398.97	2398.47	-38.72	-20	Pass
		2398.97 ~ 2400	2399.50	-21.78	-10	Pass
39	2480	2483.5 ~ 2484.53	2484.00	-39.76	-10	Pass
		2484.53 ~ 2485.56	2485.03	-49.58	-20	Pass

2MBaud

Channel	Frequency (MHz)	Out-Of-Band Domain			Limit (dBm/MHz)	Test Result
		Frequency Range (MHz)	Worst Frequency (MHz)	Emission Level (dBm/MHz)		
1	2404	2395.9 ~ 2397.95	2397.45	-52.52	-20	Pass
		2397.95 ~ 2400	2399.50	-45.06	-10	Pass
38	2478	2483.5 ~ 2485.56	2484.00	-49.96	-10	Pass
		2485.56 ~ 2487.62	2487.06	-52.83	-20	Pass

125Kbps

Channel	Frequency (MHz)	Out-Of-Band Domain			Limit (dBm/MHz)	Test Result
		Frequency Range (MHz)	Worst Frequency (MHz)	Emission Level (dBm/MHz)		
0	2402	2397.94 ~ 2398.97	2398.47	-38.67	-20	Pass
		2398.97 ~ 2400	2399.50	-21.95	-10	Pass
39	2480	2483.5 ~ 2484.53	2484.00	-39.74	-10	Pass
		2484.53 ~ 2485.56	2485.03	-49.59	-20	Pass

Mode B
1MBaud

Channel	Frequency (MHz)	Out-Of-Band Domain			Limit (dBm/MHz)	Test Result
		Frequency Range (MHz)	Worst Frequency (MHz)	Emission Level (dBm/MHz)		
0	2402	2397.94 ~ 2398.97	2398.47	-38.48	-20	Pass
		2398.97 ~ 2400	2399.50	-21.89	-10	Pass
39	2480	2483.5 ~ 2484.53	2484.00	-40.14	-10	Pass
		2484.53 ~ 2485.56	2485.03	-49.71	-20	Pass

2MBaud

Channel	Frequency (MHz)	Out-Of-Band Domain			Limit (dBm/MHz)	Test Result
		Frequency Range (MHz)	Worst Frequency (MHz)	Emission Level (dBm/MHz)		
1	2404	2395.88 ~ 2397.94	2397.44	-51.90	-20	Pass
		2397.94 ~ 2400	2399.50	-44.71	-10	Pass
38	2478	2483.5 ~ 2485.56	2484.00	-49.26	-10	Pass
		2485.56 ~ 2487.62	2487.06	-51.73	-20	Pass

125Kbps

Channel	Frequency (MHz)	Out-Of-Band Domain			Limit (dBm/MHz)	Test Result
		Frequency Range (MHz)	Worst Frequency (MHz)	Emission Level (dBm/MHz)		
0	2402	2397.94 ~ 2398.97	2398.47	-38.48	-20	Pass
		2398.97 ~ 2400	2399.50	-22.18	-10	Pass
39	2480	2483.5 ~ 2484.53	2484.00	-40.14	-10	Pass
		2484.53 ~ 2485.56	2485.03	-49.63	-20	Pass

4.6 Transmitter Spurious Emissions in the spurious domain

4.6.1 Limits of Transmitter Spurious Emissions

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.

4.6.2 Test Procedure

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

Measurement Method	
☐ 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).	
Conducted measurement (For equipment with multiple transmit chains): ☐ Option 1: The results for each of the transmit chains for the corresponding 1MHz segments shall be added and compared with the limits. ☐ Option 2: The results for each of the transmit chains shall be individually compared with the limits after these limits have been reduced by 10 x log (N) (number of active transmit chains)	

4.6.3 Deviation from Test Standard

No deviation.

4.6.4 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 equipment was configured to operate under its worst case situation with respect to output power.
3. The test setup has been constructed as the normal use condition. Controlling software (provided by manufacturer) has been activated to set the EUT on specific status.

4.6.5 Test Results

Below 1 GHz Worst-case Data
Mode A
1MBaud

Spurious Emission Frequency Range	30MHz ~ 1GHz	Operating Channel	39

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
48.05	V	-69.69	-54.00	-15.69
68.60	H	-72.19	-54.00	-18.19
99.60	V	-69.54	-54.00	-15.54
140.06	H	-77.69	-36.00	-41.69
233.21	V	-71.49	-36.00	-35.49
233.26	H	-74.49	-36.00	-38.49
445.82	V	-68.47	-36.00	-32.47
479.97	H	-65.13	-54.00	-11.13
612.78	H	-68.64	-54.00	-14.64
613.43	V	-70.74	-54.00	-16.74
860.94	H	-67.10	-36.00	-31.10
871.69	V	-66.30	-36.00	-30.30

2MBaud

Spurious Emission Frequency Range	30MHz ~ 1GHz	Operating Channel	38

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
63.40	H	-63.57	-54.00	-9.57
99.95	V	-70.84	-54.00	-16.84
100.75	H	-63.93	-54.00	-9.93
202.51	H	-70.22	-54.00	-16.22
226.21	V	-72.13	-54.00	-18.13
342.02	H	-66.44	-36.00	-30.44
346.82	V	-66.62	-36.00	-30.62
445.37	V	-65.56	-36.00	-29.56
599.88	H	-68.97	-54.00	-14.97
609.68	V	-69.97	-54.00	-15.97
862.64	H	-65.86	-36.00	-29.86
878.39	V	-66.72	-36.00	-30.72

Mode B
1MBaud

Spurious Emission Frequency Range	30MHz ~ 1GHz	Operating Channel	39

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
47.85	V	-70.17	-54.00	-16.17
92.45	H	-63.39	-54.00	-9.39
110.25	V	-70.41	-54.00	-16.41
180.01	H	-65.63	-54.00	-11.63
180.01	V	-64.02	-54.00	-10.02
232.36	H	-64.92	-36.00	-28.92
348.62	H	-65.25	-36.00	-29.25
445.67	V	-68.47	-36.00	-32.47
540.03	H	-65.97	-54.00	-11.97
607.43	V	-71.53	-54.00	-17.53
866.69	V	-67.43	-36.00	-31.43
888.24	H	-66.18	-36.00	-30.18

2MBaud

Spurious Emission Frequency Range	30MHz ~ 1GHz	Operating Channel	38

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
46.35	V	-66.23	-36.00	-30.23
59.85	H	-77.97	-54.00	-23.97
180.01	H	-69.57	-54.00	-15.57
180.01	V	-61.83	-54.00	-7.83
232.36	H	-66.59	-36.00	-30.59
342.62	V	-66.08	-36.00	-30.08
452.62	V	-64.77	-36.00	-28.77
452.72	H	-70.96	-36.00	-34.96
590.48	H	-70.02	-54.00	-16.02
592.83	V	-69.60	-54.00	-15.60
805.14	H	-68.13	-36.00	-32.13
822.24	V	-66.70	-36.00	-30.70

Above 1 GHz Worst-case Data
Mode A
1MBaud

Spurious Emission Frequency Range	1GHz ~ 12.75GHz	Operating Channel	0, 39

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
0	4804.40	H	-56.77	-30.00	-26.77
	4806.36	V	-56.91	-30.00	-26.91
	7206.31	H	-54.57	-30.00	-24.57
	7208.35	V	-54.50	-30.00	-24.50
39	4960.01	H	-57.10	-30.00	-27.10
	4960.21	V	-57.28	-30.00	-27.28

2MBaud

Spurious Emission Frequency Range	1GHz ~ 12.75GHz	Operating Channel	1, 38

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
1	4808.14	V	-56.49	-30.00	-26.49
	4808.19	H	-56.73	-30.00	-26.73
38	4956.17	V	-56.50	-30.00	-26.50
	4956.62	H	-57.32	-30.00	-27.32

Mode B
1MBaud

Spurious Emission Frequency Range	1GHz ~ 12.75GHz	Operating Channel	0, 39

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
0	4804.42	H	-57.21	-30.00	-27.21
	4804.69	V	-54.23	-30.00	-24.23
	7206.04	V	-54.31	-30.00	-24.31
	7206.13	H	-53.80	-30.00	-23.80
39	4960.43	H	-57.19	-30.00	-27.19
	4960.63	V	-55.35	-30.00	-25.35

2MBaud

Spurious Emission Frequency Range	1GHz ~ 12.75GHz	Operating Channel	1, 38

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
1	4808.68	H	-57.20	-30.00	-27.20
	4808.86	V	-54.52	-30.00	-24.52
38	4956.10	V	-55.99	-30.00	-25.99
	4956.29	H	-56.81	-30.00	-26.81

4.7 Receiver Spurious Emissions

4.7.1 Limit of Receiver Spurious Emissions

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.

4.7.2 Test Procedure

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

Measurement Method	
☐ 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).	
Conducted measurement (For equipment with multiple transmit chains): ☐ Option 1: The results for each of the transmit chains for the corresponding 1MHz segments shall be added and compared with the limits. ☐ Option 2: The results for each of the transmit chains shall be individually compared with the limits after these limits have been reduced by 10 x log (N) (number of active transmit chains)	

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. Testing was performed when the equipment was in a receive-only mode.
3. The test setup has been constructed as the normal use condition. Controlling software (provided by manufacturer) has been activated to set the EUT on specific status.

4.7.5 Test Results

Below 1 GHz Worst-case Data
Mode A
1MBaud

Spurious Emission Frequency Range	30MHz ~ 1GHz	Operating Channel	39

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
99.70	V	-69.95	-57.00	-12.95
99.90	H	-71.84	-57.00	-14.84
201.61	H	-71.54	-57.00	-14.54
232.36	V	-73.86	-57.00	-16.86
338.82	H	-69.50	-57.00	-12.50
338.92	V	-66.02	-57.00	-9.02
451.12	V	-69.36	-57.00	-12.36
480.02	H	-68.93	-57.00	-11.93
604.58	V	-70.91	-57.00	-13.91
611.63	H	-69.98	-57.00	-12.98
820.69	V	-67.95	-57.00	-10.95
871.14	H	-66.89	-57.00	-9.89

2MBaud

Spurious Emission Frequency Range	30MHz ~ 1GHz	Operating Channel	38

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
53.15	V	-61.51	-57.00	-4.51
99.60	H	-72.56	-57.00	-15.56
225.26	V	-73.04	-57.00	-16.04
226.26	H	-68.63	-57.00	-11.63
342.62	H	-67.06	-57.00	-10.06
344.87	V	-66.48	-57.00	-9.48
445.82	V	-66.01	-57.00	-9.01
479.97	H	-63.90	-57.00	-6.90
594.13	H	-69.63	-57.00	-12.63
616.63	V	-69.39	-57.00	-12.39
851.14	H	-66.94	-57.00	-9.94
883.94	V	-67.20	-57.00	-10.20

Mode B
1MBaud

Spurious Emission Frequency Range	30MHz ~ 1GHz	Operating Channel	39

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
47.75	V	-70.29	-57.00	-13.29
109.60	H	-75.90	-57.00	-18.90
180.01	V	-63.47	-57.00	-6.47
196.31	H	-68.58	-57.00	-11.58
300.01	V	-63.91	-57.00	-6.91
331.17	H	-67.65	-57.00	-10.65
351.27	V	-69.57	-57.00	-12.57
479.97	H	-70.87	-57.00	-13.87
540.03	V	-67.09	-57.00	-10.09
606.43	H	-70.30	-57.00	-13.30
849.99	H	-66.49	-57.00	-9.49
854.14	V	-67.21	-57.00	-10.21

2MBaud

Spurious Emission Frequency Range	30MHz ~ 1GHz	Operating Channel	38

Spurious Emission Level				
Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
74.40	H	-69.72	-57.00	-12.72
75.25	V	-70.22	-57.00	-13.22
180.01	V	-62.28	-57.00	-5.28
232.31	H	-65.08	-57.00	-8.08
348.02	V	-68.24	-57.00	-11.24
352.47	H	-66.87	-57.00	-9.87
445.77	H	-69.25	-57.00	-12.25
445.92	V	-63.94	-57.00	-6.94
591.08	H	-69.67	-57.00	-12.67
598.93	V	-69.08	-57.00	-12.08
839.89	V	-67.25	-57.00	-10.25
863.04	H	-66.06	-57.00	-9.06

Above 1 GHz Worst-case Data
Mode A
1MBaud

Spurious Emission Frequency Range	1GHz ~ 12.75GHz	Operating Channel	0, 39

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
0	4804.05	H	-57.19	-47.00	-10.19
	4804.30	V	-56.94	-47.00	-9.94
39	4960.25	V	-57.51	-47.00	-10.51
	4960.60	H	-57.22	-47.00	-10.22

2MBaud

Spurious Emission Frequency Range	1GHz ~ 12.75GHz	Operating Channel	1, 38

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
1	4808.43	H	-56.49	-47.00	-9.49
	4808.68	V	-57.29	-47.00	-10.29
38	4956.17	H	-57.33	-47.00	-10.33
	4956.57	V	-56.84	-47.00	-9.84

Mode B
1MBaud

Spurious Emission Frequency Range	1GHz ~ 12.75GHz	Operating Channel	0, 39

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
0	4804.08	V	-56.87	-47.00	-9.87
	4804.96	H	-57.98	-47.00	-10.98
39	4960.60	V	-57.67	-47.00	-10.67
	4960.86	H	-57.15	-47.00	-10.15

2MBaud

Spurious Emission Frequency Range	1GHz ~ 12.75GHz	Operating Channel	1, 38

Spurious Emission Level					
Channel	Frequency (MHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)
1	4808.49	V	-57.54	-47.00	-10.54
	4808.76	H	-57.26	-47.00	-10.26
38	4956.28	V	-57.25	-47.00	-10.25
	4956.31	H	-57.09	-47.00	-10.09

4.8 Receiver Blocking

4.8.1 Limit of Receiver Blocking

This requirement applies to all receiver categories.

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.			

4.8.2 Test Procedure

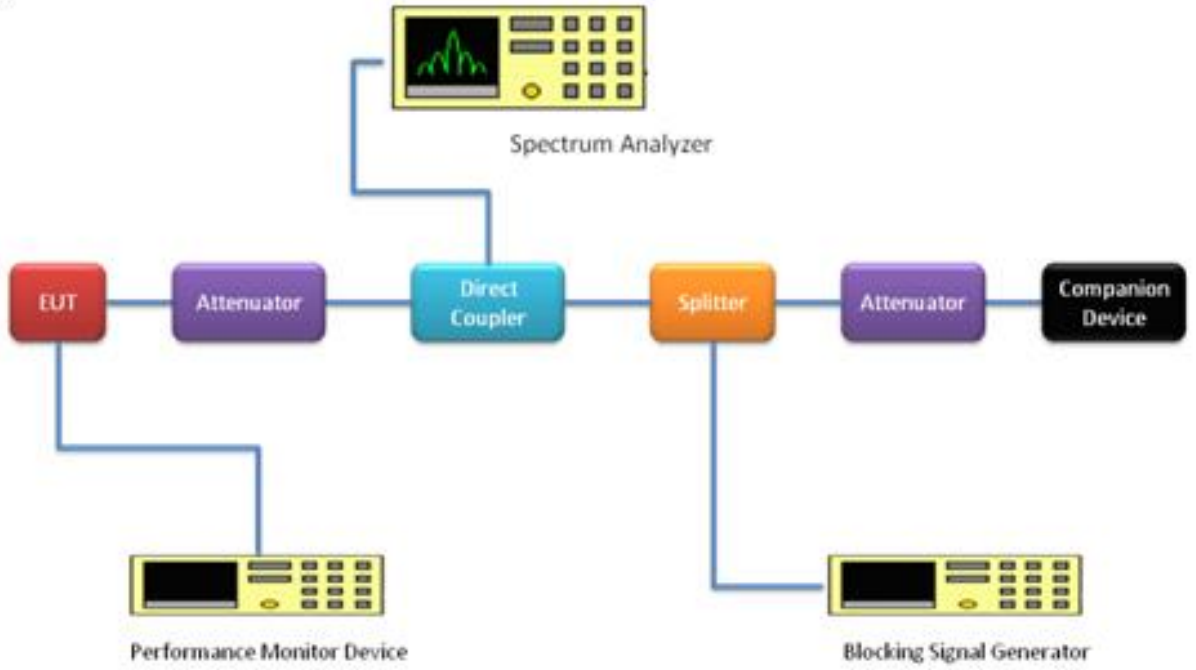
Refer to chapter 5.4.11 of EN 300 328 V2.2.2.

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

4.8.3 Deviation from Test Standard

No deviation.

4.8.4 Test Setup Configuration



4.8.5 Test Results

Receiver Category 1 Equipment	
Minimum Performance Criterion:	PER or FER ≦10%

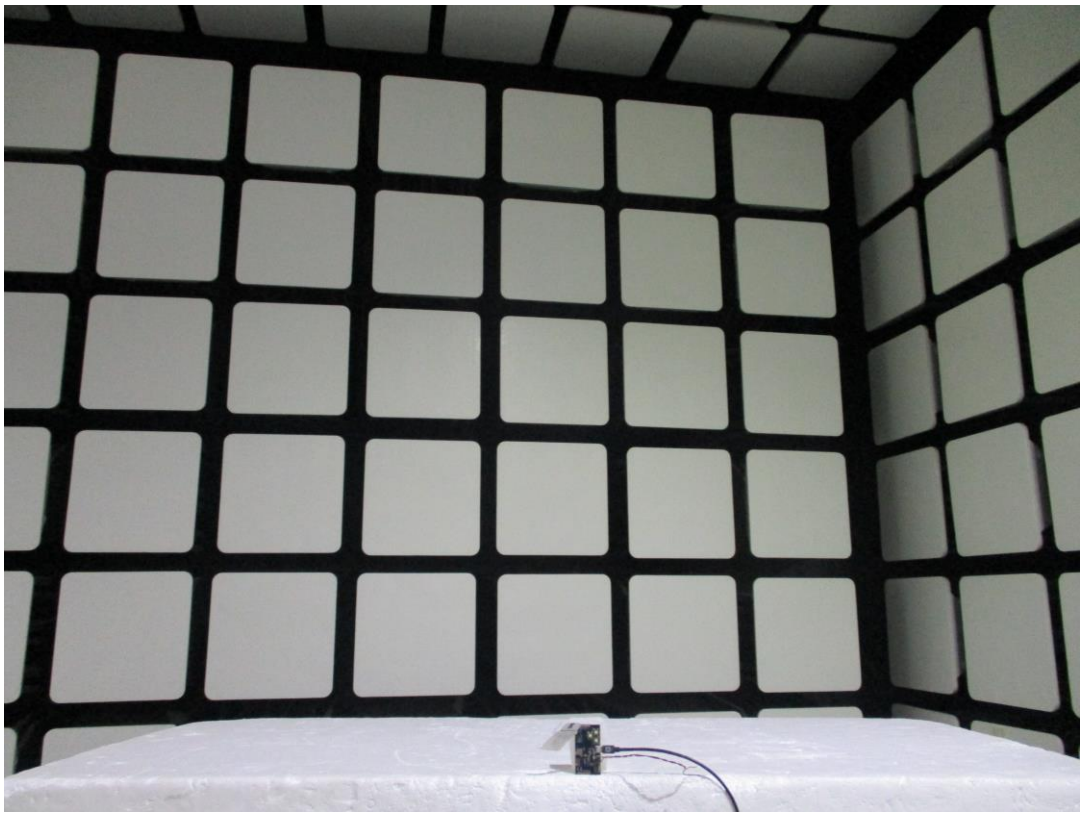
Receiver Blocking Measure Of The Capability							
Operation Mode	**Operating Frequency (MHz)**	**Wanted Signal Mean Power From Companion Device (dBm) (Note 1 & 2)**	**Blocking Signal Frequency (MHz)**	**Blocking Signal Frequency Shift (MHz) (Note 3)**	**Blocking Signal Power (dBm) (Note 2)**	**PER (%)**	**Test Result**
BT LE-1M with 125KHz	2402	-70.07	2380	-	-31.2	0.7	Pass
		-76.07	2300	-	-31.2	1.5	Pass
			2330	-	-31.2	1.9	Pass
			2360	-	-31.2	2.6	Pass
	2480	-70.07	2504	-	-31.2	1.2	Pass
		-76.07	2524	-	-31.2	0.8	Pass
			2584	-	-31.2	1.1	Pass
			2674	-	-31.2	1.3	Pass

Notes:

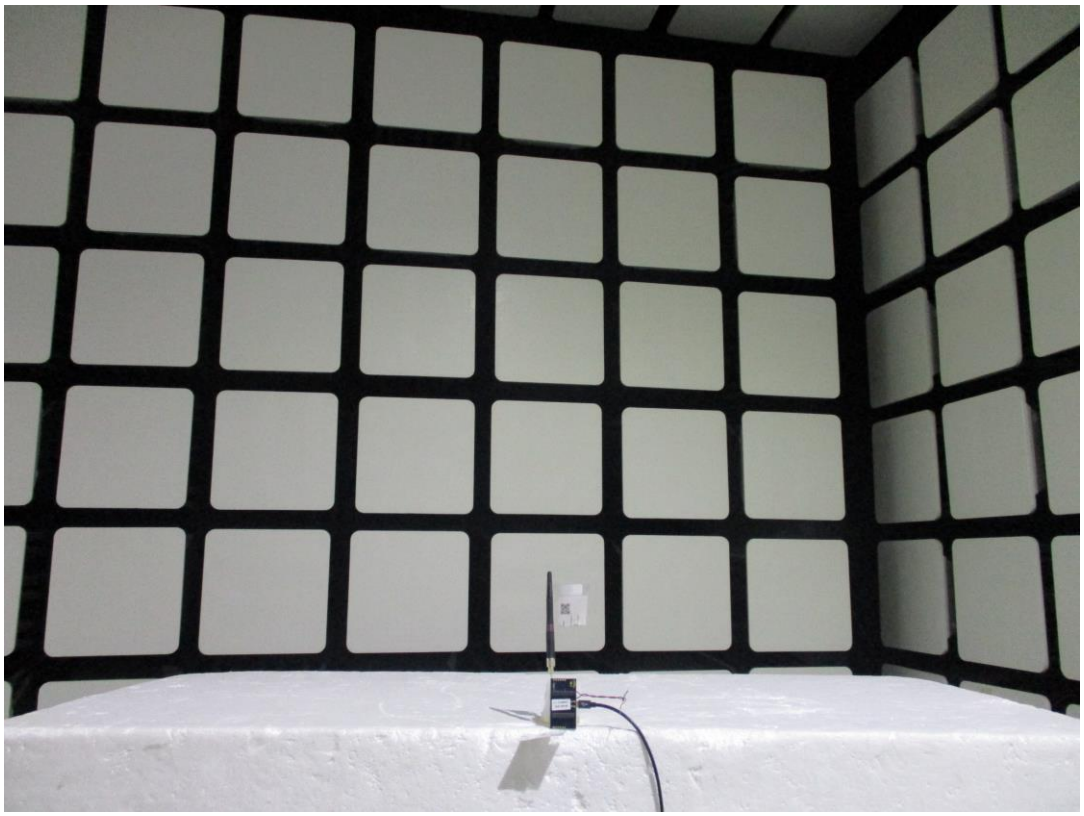
1. Wanted signal level was calculated based on the formula, which corresponds to OCBW. OCBW is 1.03 MHz.
2. In conducted measurements, the blocking signal power level has to be corrected for the (in-band) antenna assembly gain (G) at the antenna connector. The antenna gain is 2.8 dBi.
3. If the performance 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
Mode A



Mode B



Appendix – 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 FCC recognized accredited test firms and accredited and approved according to ISO/IEC 17025.

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

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

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