CE Test Report

Equipment	:	**802.11 ac/a/b/g/n + Bluetooth 4.2 module** **(please refer to section 1.1.1 for more details.)**
Model No.	:	**ST60-2230C** **(please refer to section 1.1.1 for more details.)**
Brand Name	:	**Laird Connectivity**
Applicant	:	**Laird Connectivity, Inc.**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**EN 300 328 V2.2.2 (2019-07)**
Received Date	:	**Jun. 05, 2020**
Tested Date	:	**Apr. 24 ~ Jun. 01, 2017 (for original test)** **Jun. 05, 2020 (for new test)**

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:	**Approved by:**
James Fan / Assistant Manager	**Gary Chang / Manager**

Testing Laboratory 2732

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Release Record

Report No.	Version	Description	Issued Date
ER740701-08AD	Rev. 01	Initial issue	Jul. 30, 2020

Summary of Test Results

Ref. Std. Clause	Test Items	Measured	Result
4.3.1.2	RF Output Power	14.81 dBm	Pass
4.3.1.3	Duty cycle, Tx-Sequence, Tx-gap	Only for non-adaptive equipment	N/A
4.3.1.4	Dwell time, Minimum Frequency Occupation & Hopping Sequence	Meet the requirement of limit.	Pass
4.3.1.5	Hopping Frequency Separation	Meet the requirement of limit.	Pass
4.3.1.6	Medium Utilisation (MU) factor	Only for non-adaptive equipment	N/A
4.3.1.7	Adaptivity	Meet the requirement of limit.	Pass
4.3.1.8	Occupied Channel Bandwidth	Meet the requirement of limit.	Pass
4.3.1.9	Transmitter unwanted emissions in the out of band domain	Meet the requirement of limit.	Pass
4.3.1.10	Transmitter unwanted emissions in the spurious domain	Meet the requirement of limit.	Pass
4.3.1.11	Receiver spurious emissions	Meet the requirement of limit.	Pass
4.3.1.12	Receiver Blocking	Meet the requirement of limit.	Pass
4.3.1.13	Geo-location capability	The device has no geo-location capability.	N/A

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Information

This report is issued as a supplementary report to original ICC report no. ER740701AD. The difference is concerned with following items:

- ✧ Updating standard version from V2.1.1 to V2.2.2.
- ✧ New applicant name & brand name.

Therefore, related test items had been performed and presented in the following sections.

1.1.1 Product Details

The following models are provided to this EUT.

Brand Name	Model Name	Product Name	Description	
Laird Connectivity	ST60-SIPT	802.11 ac/a/b/g/n + Bluetooth 4.2 module	SIPT only	For marketing purpose
	SU60-SIPT			
	ST60-2230C	802.11 ac/a/b/g/n M.2 2230 + Bluetooth 4.2 module	with carrier board	
	SU60-2230C			
✦ The above models, model **ST60-2230C** was selected as a representative one for the final test and only its data was recorded in this report.				

1.1.2 Specification of the Equipment under Test (EUT)

RF General Information				
Frequency Range (MHz)	**Bluetooth Mode**	**Ch. Frequency (MHz)**	**Channel Number**	**Data Rate**
2400-2483.5	BR	2402-2480	0-78 [79]	1 Mbps
2400-2483.5	EDR	2402-2480	0-78 [79]	2 Mbps
2400-2483.5	EDR	2402-2480	0-78 [79]	3 Mbps
Note 1: Bluetooth BR uses a GFSK modulation. Note 2: Bluetooth EDR uses a combination of π/4-DQPSK and 8DPSK modulation.				

1.1.3 Antenna Details

Ant. No.	Model	Type	Connector	Operating Frequencies (MHz) / Antenna Gain (dBi)				
				2400~2483.5	5150~5250	5250~5350	5470~5725	5725~5850
1	LSR/001-0009	Dipole	IPEX U.FL	2	2	2	2	2
2	Laird NanoBlade-IP04	PCB Dipole	IPEX U.FL	2	3.9	3.9	4	4
3	Laird MAF95310 Mini NanoBlade Flex	PCB Dipole	IPEX U.FL	2.79	3.38	3.38	3.38	3.38
4	LSR/FlexPIFA 001-0016	PIFA	IPEX U.FL	2.5	3	3	3	3
5	Ethertronics WLAN_1000146	Isolated Magnetic Dipole	IPEX U.FL	2.5	3.5	3.5	3.5	3.5
6	Laird/MIMO FlexPIFA Antenna	PIFA	IPEX U.FL	2	3	3	3	3

1.1.4 EUT Operational Condition

Power Supply Type	DC 3.3V from host		
SW Version	SD-UAPSTA-8997-U14-MMC-16.68.1.p95-C3X16219_V4-MGPL-src		
Operational Climatic	☒ Tnom (20°C)	☒ Tmax (85°C)	☒ Tmin (-30°C)

1.1.5 Accessories

N/A

1.1.6 Channel List

Frequency band (MHz)				2400~2483.5			
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461	--	--

1.1.7 Test Tool and Duty Cycle

Test Tool	Command
Duty Cycle Of Test Signal (%)	76.80% - BR 76.80% - EDR
Duty Factor (dB)	1.15 - BR 1.15 - EDR

1.1.8 Power Setting

Modulation Mode	Test Frequency (MHz)		
	2402	2441	2480
BR-1Mbps	Default	Default	Default
EDR-3Mbps	Default	Default	Default

1.2 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Signal cable / Length (m)
1	Notebook	DELL	Latitude E5420	DoC	RJ45, 1m non-shielded
2	Notebook	Lenovo	T430	DoC	RJ45, 1m non-shielded
3	50Ω terminator	---	---	---	---
4	Fixture	---	---	---	---

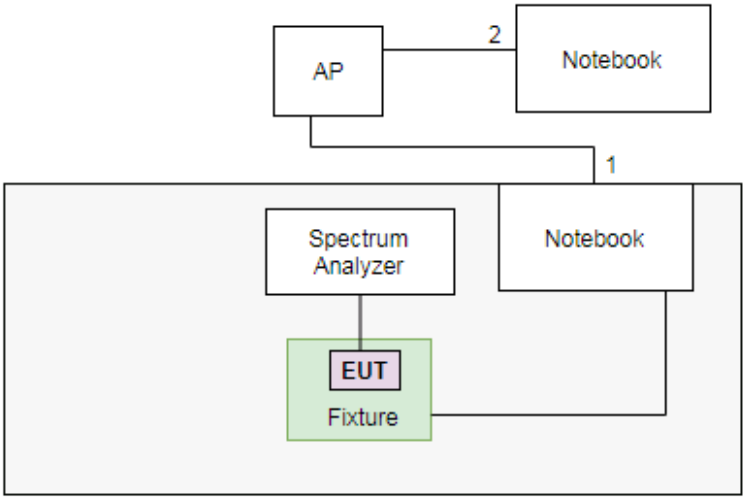
Note: No2 and 4 were provided by applicant.

1.2.1 Adaptive Equipment

Adaptive Equipment			
☐	non-Adaptive Equipment:		
	The maximum RF Output Power (e.i.r.p.): dBm		
	The maximum (corresponding) Duty Cycle: %		
☒	Adaptive Equipment without the possibility to switch to a non-adaptive mode:		
	☒	The equipment has implemented an LBT based DAA mechanism:	
		☐	The equipment is Frame Based equipment
		☒	The equipment is Load Based equipment
		☐	The equipment can switch dynamically between Frame Based and Load Based equipment
	☐	The equipment has implemented an non-LBT based DAA mechanism	
	☐	The equipment can operate in more than one adaptive mode	
	☐	Adaptive Frequency Hopping using other forms of DAA (non-LBT based)/without Short Control Signaling Transmissions	
☐	Adaptive Equipment which can also operate in a non-adaptive mode		

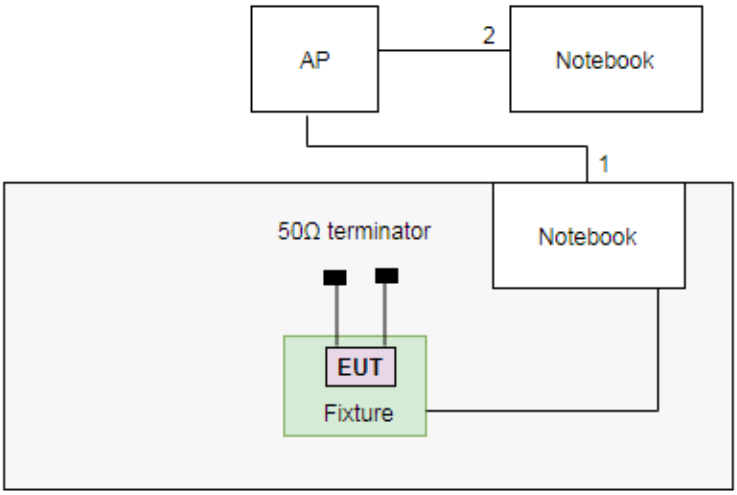
1.3 Test Setup Chart

Test Setup Diagram (Conducted)



1. RJ45, 1m non-shielded
2. RJ45, 1m non-shielded

Test Setup Diagram (Radiated)



1. RJ45, 1m non-shielded
2. RJ45, 1m non-shielded

1.4 Test Equipment List and Calibration Data

Test Item	Radiated Emissions				
Test Site	Fully-anechoic chamber 2 / (05CH02-WS)				
Tested Date	Apr. 24, 2017				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	Agilent	N9010A	MY52221474	Oct. 14, 2016	Oct. 13, 2017
Bilog Antenna 30-1000MHz	SCHWARZBECK	VULB9168	9168-563	Jan. 05, 2017	Jan. 04, 2018
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	9120D-1205	Jan. 05, 2017	Jan. 04, 2018
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170508	Dec. 29, 2016	Dec. 28, 2017
Preamplifier	Agilent	83017A	MY53270013	Jan. 10, 2017	Jan. 09, 2018
Preamplifier 30-1000MHz	EMC	EMC02325	980188	Dec. 13, 2016	Dec. 12, 2017
Preamplifier	EMC	EMC184045B	980192	Aug. 24, 2016	Aug. 23, 2017
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22622/4	Dec. 13, 2016	Dec. 12, 2017
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22623/4	Dec. 14, 2016	Dec. 13, 2017
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22621/4	Dec. 14, 2016	Dec. 13, 2017
RF cable-4M	HUBER+SUHNER	SUCOFLEX104	MY22579/4	Dec. 14, 2016	Dec. 13, 2017
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800-002	Dec. 14, 2016	Dec. 13, 2017
LF cable-3M	EMC	EMC8D-NM-NM-3000	131102	Dec. 14, 2016	Dec. 13, 2017
LF cable-10M	EMC	EMC8D-NM-NM-10000	131101	Dec. 14, 2016	Dec. 13, 2017
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	May 06, 2017				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101063	Mar. 15, 2017	Mar. 14, 2018
Spectrum Analyzer	Agilent	N9010A	MY53400091	Sep. 09, 2016	Sep. 08, 2017
TEMP&HUMIDITY CHAMBER	GIANT FORCE	GCT-225-40-SP-SD	MAF1212-002	Nov. 21, 2016	Nov. 20, 2017
Power Meter	Anritsu	ML2495A	1241002	Oct. 06, 2016	Oct. 05, 2017
Power Sensor	Anritsu	MA2411B	1207366	Oct. 06, 2016	Oct. 05, 2017
Signal Generator	R&S	SMB100A	175727	Oct. 19, 2016	Oct. 18, 2017
Radio Communication Analyzer	Anritsu	MT8820C	6201465544	Aug. 19, 2016	Aug. 18, 2017
MXG-B RF Vector Signal Generator	Agilent	N5182B	MY53050081	Apr. 15, 2017	Apr. 14, 2018
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 20, 2016	Oct. 19, 2017
AC POWER SOURCE	APC	AFC-500W	F312060012	Oct. 28, 2016	Oct. 27, 2017
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Adaptivity				
Test Site	(TH01-WS)				
Tested Date	Jun. 01, 2017				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	Keysight	EXA N9010A	MY54200247	Aug. 30, 2016	Aug. 29, 2017
Signal Generator	R&S	SMB 100A	175727	Oct. 19,2016	Oct. 18,2017
RF Cable	HUBER+SUHNER	SUCOFLEX_104	MY15686/4	Dec. 16, 2016	Dec. 15, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX_104	296081/4	Dec. 16, 2016	Dec. 15, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX_104	329023/4	Dec. 16, 2016	Dec. 15, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX_104	329021/4	Dec. 16, 2016	Dec. 15, 2017
Vector signal generator	Agilent	N5182B	MY53051912	Nov. 21, 2016	Nov. 20, 2017
Preamplifier	Burgeon	BPA-530	100219	Nov. 02, 2016	Nov. 01, 2017
Oscilloscope	National Instruments	USB-5133	F651FF	Jun. 22, 2016	Jun. 21, 2017
Measurement Software	Sporton	Sporton-3	2.2.0.0	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Receiver Blocking				
Test Site	(05CH02-WS)				
Tested Date	Jun. 05, 2020				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Wireless connectivity tester	ROHDE&SCHWARZ	CMW270	100856	Oct. 24, 2019	Oct. 23, 2020
Signal Generator	ROHDE&SCHWARZ	SMB100A	175727	Dec. 27, 2019	Dec. 26, 2020
RF Cable	HUBER+SUHNER	SUCOFLEX_104	500202/4	Oct. 16, 2019	Oct. 15, 2020
RF Cable	HUBER+SUHNER	SUCOFLEX_104	296088/4	Oct. 16, 2019	Oct. 15, 2020
RF Cable	HUBER+SUHNER	SUCOFLEX_104	329023/4	Oct. 16, 2019	Oct. 15, 2020
Combiner(1X2)	WOKEN	2WAYDIV	12101200003	Oct. 16, 2019	Oct. 15, 2020
Note: Calibration Interval of instruments listed above is one year.					

1.5 Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

EN 300 328 V2.2.2 (2019-07)

1.6 Deviation from Test Standard and Measurement Procedure

None

1.7 Measurement Uncertainty

The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty		
Parameters	**Uncertainty**	**Limit**
Occupied Channel Bandwidth	±0.0034 %	±5 %
RF output power, conducted	±0.537 dB	±1,5 dB
Power Spectral Density, conducted	±0.463 dB	±3 dB
Unwanted Emissions, conducted	±2.505 dB	±3 dB
All emissions, radiated	±3.401 dB	±6 dB
Temperature	±0.6 ^{o}C	±3 °C
Supply voltages	±0.16 %	±3 %
Time	±0.1 %	±5 %

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
RF Conducted	TH01-WS	23°C / 62%	Jack Li
Radiated Emission	05CH02-WS	24°C / 65%	Penguin Jiang
Adaptivity	TH01-WS	23°C / 67%	Jack Li
Receiver Blocking	05CH02-WS	25°C / 65%	Ryan Lee

2.2 Testing Facility

Test Laboratory	International Certification Corp.
Test Site	TH01-WS
Address of Test Site (Kwei Shan)	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.
Test Laboratory	International Certification Corp.
Test Site	05CH02-WS
Address of Test Site (Kwei Shan II)	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

2.3 The Worst Test Modes and Channel Details

Test item	Modulation Mode	Test Frequency (MHz)	Data Rate	Test Configuration
RF Output Power	GFSK 8DPSK	Hopping Hopping	1 Mbps 3 Mbps	1, 2, 3, 4
Accumulated Transmit Time Minimum Frequency Occupation Hopping Sequence	GFSK 8DPSK	Hopping Hopping	1 Mbps 3 Mbps	1
Hopping Frequency Separation	GFSK 8DPSK	two-adjacent	1 Mbps 3 Mbps	1
Occupied Channel Bandwidth	GFSK 8DPSK	2402 / 2480 2402 / 2480	1 Mbps 3 Mbps	1
Transmitter unwanted emissions in the OOB domain	GFSK 8DPSK	Hopping Hopping	1 Mbps 3 Mbps	1, 2, 3, 4
Transmitter Spurious Emissions Receiver Spurious Emissions	GFSK 8DPSK	2402 / 2480 2402 / 2480	1 Mbps 3 Mbps	1
Adaptivity	8DPSK	2402 / 2480	1 Mbps	1
Receiver Blocking	GFSK	Hopping	1 Mbps	2

NOTE:

1. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Y-plane** results were found as the worst case and were shown in this report.
2. The device can be operated under adapter mode and charging mode. Each mode was selected for related test items as below configuration.

   Configuration 1 : Dipole Antenna

   Configuration 2 : PCB Dipole Antenna

   Configuration 3 : PIFA Antenna

   Configuration 4: Isolated Magnetic Dipole Antenna
3. Conducted emission is only measured for 1 configuration since the conducted output power is same for all configuration.
4. Two 50Ω terminators are connected to antenna port of EUT for radiated emission measurement.

3 Transmitter Test Results

3.1 RF Output Power

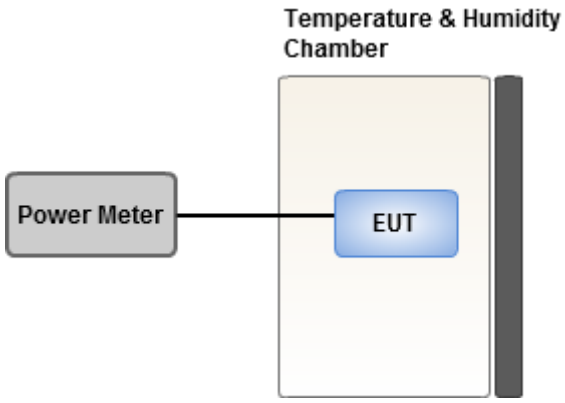
3.1.1 Limit of RF Output Power

The maximum RF output power shall be equal to or less than 20 dBm

3.1.2 Test Procedures

Reference to clause 5.4.2.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.1.3 Test Setup



3.1.4 Test Result of RF Output Power

Configuration 1 : Dipole Antenna

Condition	Modulation Mode	Freq. (MHz)	EIRP Power	Limit (dBm)
TnomVnom	BR-1Mbps	Hopping	13.27	20
TminVnom	BR-1Mbps	Hopping	**14.02**	20
TmaxVnom	BR-1Mbps	Hopping	12.86	20
TnomVnom	EDR-3Mbps	Hopping	10.25	20
TminVnom	EDR-3Mbps	Hopping	11.12	20
TmaxVnom	EDR-3Mbps	Hopping	9.80	20

Configuration 2 : PCB Dipole Antenna

Condition	Modulation Mode	Freq. (MHz)	EIRP Power	Limit (dBm)
TnomVnom	BR-1Mbps	Hopping	14.06	20
TminVnom	BR-1Mbps	Hopping	**14.81**	20
TmaxVnom	BR-1Mbps	Hopping	13.65	20
TnomVnom	EDR-3Mbps	Hopping	11.04	20
TminVnom	EDR-3Mbps	Hopping	11.91	20
TmaxVnom	EDR-3Mbps	Hopping	10.59	20

Configuration 3 : PIFA Antenna & Configuration 4: Isolated Magnetic Dipole Antenna

Condition	Modulation Mode	Freq. (MHz)	EIRP Power	Limit (dBm)
TnomVnom	BR-1Mbps	Hopping	13.77	20
TminVnom	BR-1Mbps	Hopping	**14.52**	20
TmaxVnom	BR-1Mbps	Hopping	13.36	20
TnomVnom	EDR-3Mbps	Hopping	10.75	20
TminVnom	EDR-3Mbps	Hopping	11.62	20
TmaxVnom	EDR-3Mbps	Hopping	10.30	20

3.2 Accumulated Transmit Time, Minimum Frequency Occupation and Hopping Sequence

3.2.1 Limit of Accumulated Transmit Time, Minimum Frequency Occupation and Hopping Sequence

Adaptive mode

Adaptive Frequency Hopping equipment shall be capable of operating over a minimum of 70 % of the band 2.4GHz to 2.4835GHz. The Accumulated Transmit Time on any hopping frequency shall not be greater than 400 ms within any observation period of 400 ms multiplied by the minimum number of hopping frequencies (N) that have to be used. In order for the equipment to comply with the Frequency Occupation requirement, it shall meet either of the following two options:

Option 1: Each hopping frequency of the hopping sequence shall be occupied at least once within a period not exceeding four times the product of the dwell time and the number of hopping frequencies in use.

Option 2: The occupation probability for each frequency shall be between ((1 / U) × 25 %) and 77 % where U is the number of hopping frequencies in use. The hopping sequence(s) shall contain at least N hopping frequencies at all times, where N is 15 or 15 divided by the minimum Hopping Frequency Separation in MHz, whichever is the greater.

Non-Adaptive mode

The Accumulated Transmit Time on any hopping frequency shall not be greater than 15 ms within any observation period of 15 ms multiplied by the minimum number of hopping frequencies (N) that have to be used. Non-adaptive medical devices requiring reverse compatibility with other medical devices placed on the market that are compliant with version 1.7.1 or earlier versions of ETSI EN 300 328, are allowed to have an operating mode in which the maximum Accumulated Transmit Time is 400 ms within any observation period of 400 ms multiplied by the minimum number of hopping frequencies (N) that have to be used, only when communicating to these legacy devices already placed on the market. In order for the equipment to comply with the Frequency Occupation requirement, it shall meet either of the following two options:

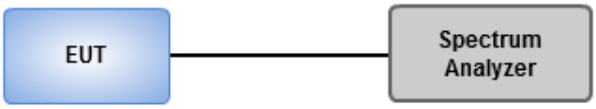
Option 1: Each hopping frequency of the hopping sequence shall be occupied at least once within a period not exceeding four times the product of the dwell time and the number of hopping frequencies in use.

Option 2: The occupation probability for each frequency shall be between ((1 / U) × 25 %) and 77 % where U is the number of hopping frequencies in use. The hopping sequence(s) shall contain at least N hopping frequencies where N is 15 or 15 divided by the minimum Hopping Frequency Separation in MHz, whichever is the greater.

3.2.2 Test Procedures

Reference to clause 5.4.4.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.2.3 Test Setup



3.2.4 Test Result of Hopping Sequence

Modulation Mode	Freq. (MHz)	Hopping Mode	Hopping Channels	Hopping Channels Limits	F_l 20dB (MHz)	F_h 20dB (MHz)	Min. Hopping Range (%)	Min. Hopping Range Limit (%)
BR-1Mbps	Hopping	Non-AFH	79	15	N/A	N/A	N/A	N/A
EDR-3Mbps	Hopping	AFH	20	20	2415	2479	82.05%	70.00%

3.2.5 Test Result of Accumulated Transmit Time

Modulation Mode	Freq. (MHz)	Hopping Mode	Worst Duty Cycle Data Packet	Minimum Number of Hop Freq. (N)	Dwell Time per Hop (ms)	Number of Hop in [N x MDT]	[N x MDT] (s)	Dwell Time in [N x MDT] (ms)	Max. Dwell Time (MDT) Limit (ms)
BR-1Mbps	Hopping	Non-AFH	DH5	79	2.88	106.6	31.6	307.01	400.00
EDR-3Mbps	Hopping	AFH	DH5	20	2.88	106.6	8	307.01	400.00

3.2.6 Test Result of Minimum Frequency Occupation

Modulation Mode	Freq. (MHz)	Hopping Mode	Worst Duty Cycle Data Packet	Actual No. of Hopping Freq. (N)	Dwell Time per Hop (ms)	No. of Hop in [4 x dwell time per hop x N]	[4 x dwell time per hop x N] (ms)	Dwell Time in [4 x dwell time per hop x N] (ms)	Min. No. of Hopping Limit in [4 x dwell time per hop x N]
BR-1Mbps	Hopping	Non-AFH	DH5	79	2.88	3.16	910.08	9.10	1
EDR-3Mbps	Hopping	AFH	3-DH5	20	2.88	3.16	230.40	9.10	1

3.3 Hopping Frequency Separation

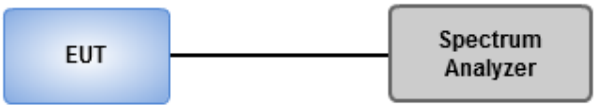
3.3.1 Limit of Hopping Frequency Separation

For adaptive Frequency Hopping equipment, the minimum Hopping Frequency Separation shall be 100 kHz. For non-adaptive Frequency Hopping equipment, the Hopping Frequency Separation shall be equal or greater than the Occupied Channel Bandwidth, with a minimum separation of 100 kHz.

3.3.2 Test Procedures

Reference to clause 5.4.5.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.3.3 Test Setup



3.3.4 Test Result of Hopping Frequency Separation

Modulation Mode	Freq. (MHz)	Hopping Mode	$F2402_{PK}$ (MHz)	$F2403_{PK}$ (MHz)	F_{HS} (MHz)	Limit F_{HS} (kHz)
BR-1Mbps	two-adjacent	Non-AFH	2401.9470	2402.9470	1.0000	100
EDR-3Mbps	two-adjacent	AFH	2401.9443	2402.9443	1.0000	100

3.4 Occupied Channel Bandwidth

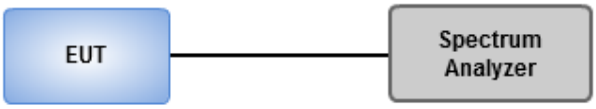
3.4.1 Limit of Occupied Channel Bandwidth

The Occupied Channel Bandwidth for each hopping frequency shall fall completely within 2.4~2.4835 GHz. For non-adaptive Frequency Hopping equipment with e.i.r.p greater than 10 dBm, the Occupied Channel Bandwidth for every occupied hopping frequency shall be equal to or less than the value declared by the supplier. This declared value shall not be greater than 5 MHz.

3.4.2 Test Procedures

Reference to clause 5.4.7.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.4.3 Test Setup

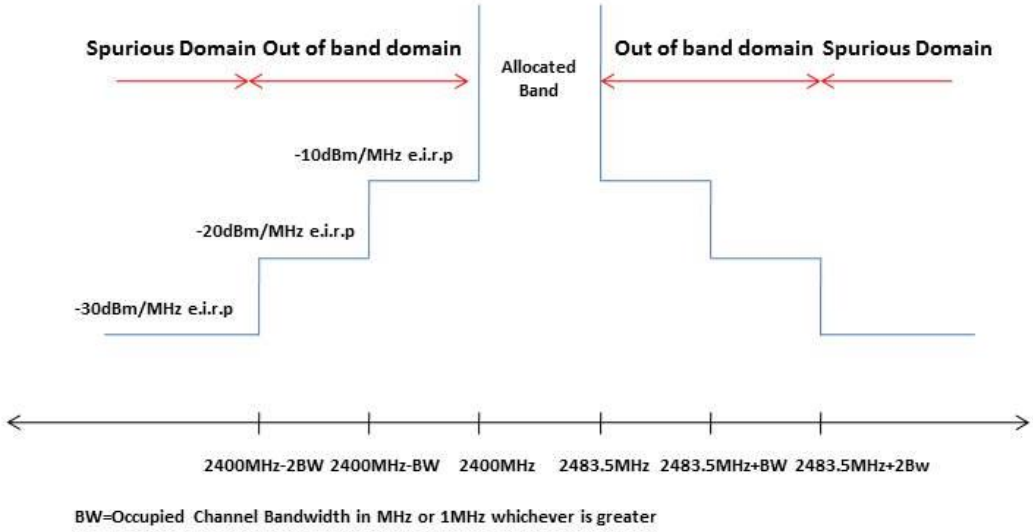


3.4.4 Test Result of Occupied Channel Bandwidth

Modulation Mode	Frequency (MHz)	99% Bandwidth (MHz)	F_L at 99% BW (MHz)	F_H at 99% BW (MHz)	20dB Bandwidth (MHz)	Limit F_L / F_H (MHz)
BR-1Mbps	2402	0.88	2401.55	2402.43	0.94	2400.0
BR-1Mbps	2480	0.88	2479.55	2480.43	0.94	2483.5
EDR-3Mbps	2402	1.19	2401.39	2402.59	1.35	2400.0
EDR-3Mbps	2480	1.19	2479.39	2480.59	1.34	2483.5

3.5 Transmitter Unwanted Emissions in the Out-Of-Band Domain

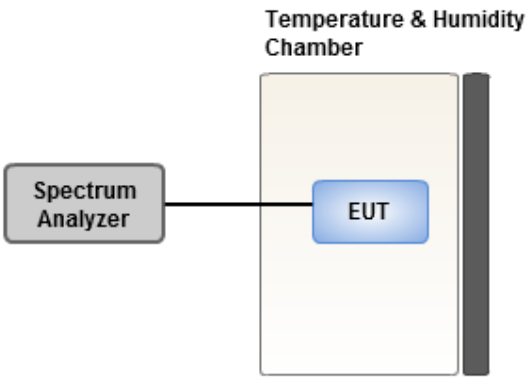
3.5.1 Limit of Transmitter Unwanted Emissions in the Out-Of-Band Domain



3.5.2 Test Procedures

Reference to clause 5.4.8.2 of ETSI EN 300 328 V2.2.2 (2019-07).

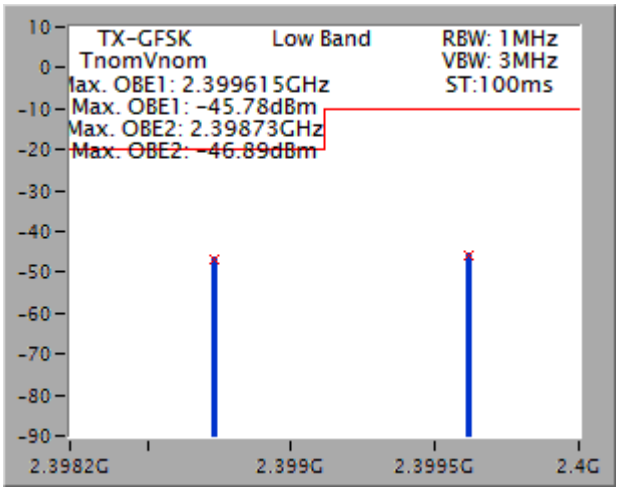
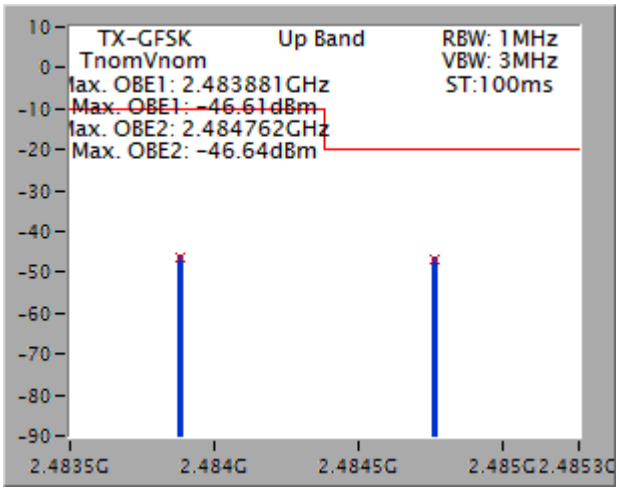
3.5.3 Test Setup



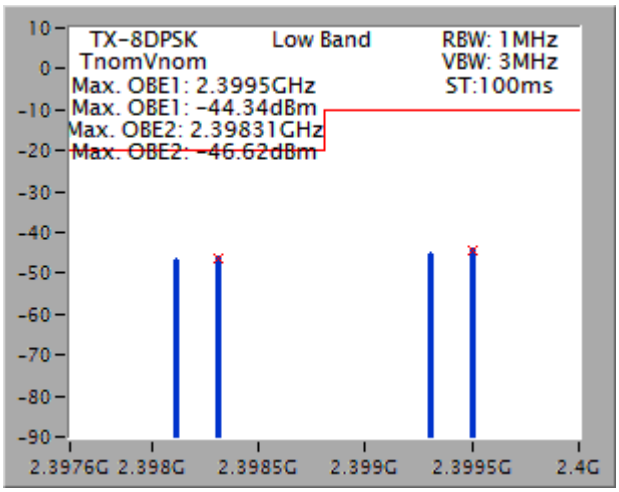
3.5.4 Test Result of Transmitter Unwanted Emissions in the Out-Of-Band Domain

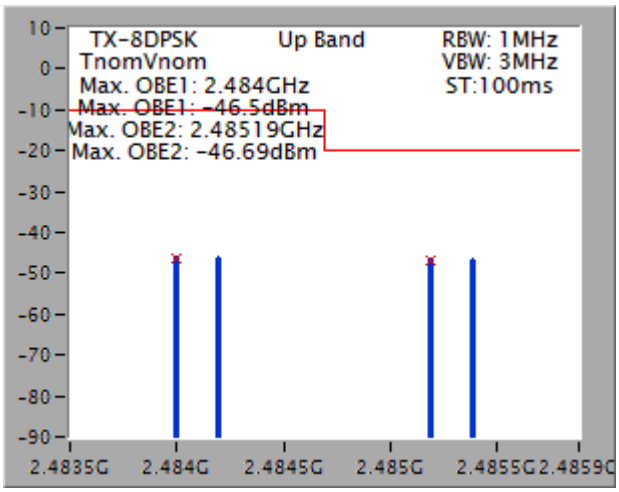
Configuration 1 : Dipole Antenna

Condition	Modulation Mode	Freq. (MHz)	OOB Freq. (MHz)	OOB Emissions (dBm)	Limit (dBm)
TnomVnom	BR-1Mbps	Hopping	2399.61	-45.78	-10
TnomVnom	BR-1Mbps	Hopping	2398.73	-46.89	-20
TnomVnom	BR-1Mbps	Hopping	2483.88	-46.61	-10
TnomVnom	BR-1Mbps	Hopping	2484.76	-46.64	-20

Low Band	Up Band
	

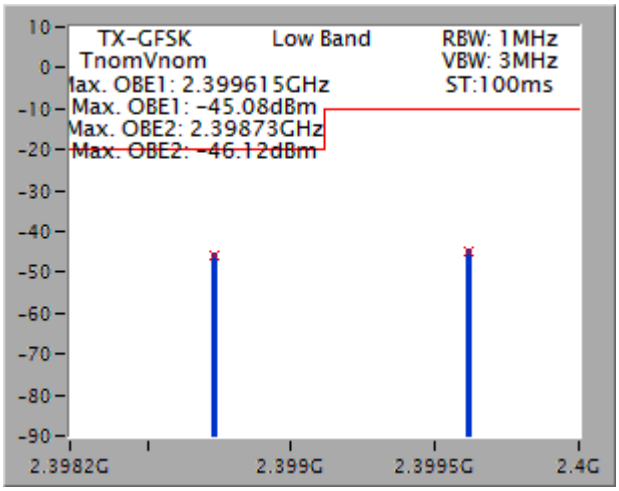
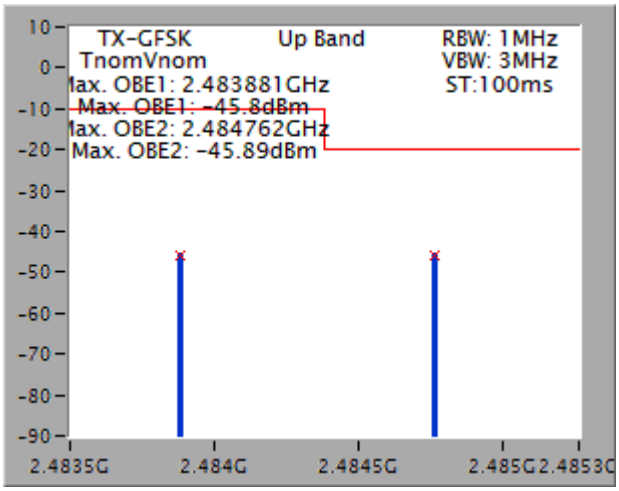
Condition	Modulation Mode	Freq. (MHz)	OOB Freq. (MHz)	OOB Emissions (dBm)	Limit (dBm)
TnomVnom	EDR-3Mbps	Hopping	2399.50	-44.34	-10
TnomVnom	EDR-3Mbps	Hopping	2398.31	-46.62	-20
TnomVnom	EDR-3Mbps	Hopping	2484.00	-46.50	-10
TnomVnom	EDR-3Mbps	Hopping	2485.19	-46.69	-20
Low Band			**Up Band**		



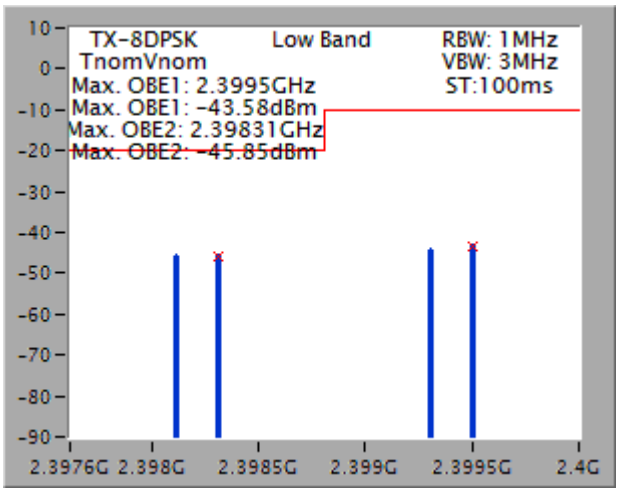
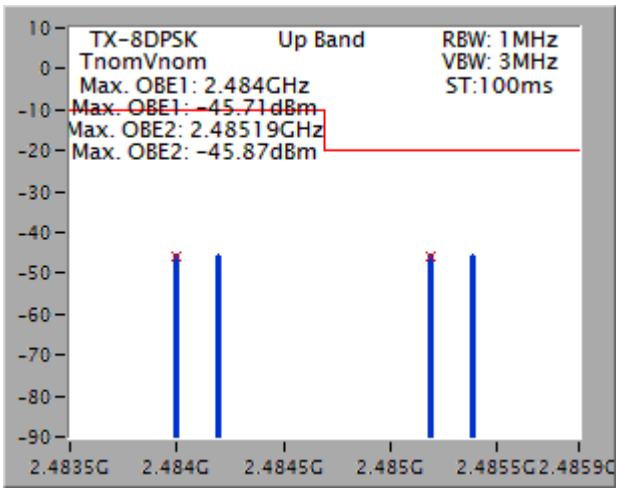


Configuration 2 : PCB Dipole Antenna

Condition	Modulation Mode	Freq. (MHz)	OOB Freq. (MHz)	OOB Emissions (dBm)	Limit (dBm)
TnomVnom	BR-1Mbps	Hopping	2399.61	-45.08	-10
TnomVnom	BR-1Mbps	Hopping	2398.73	-46.12	-20
TnomVnom	BR-1Mbps	Hopping	2483.88	-45.80	-10
TnomVnom	BR-1Mbps	Hopping	2484.76	-45.89	-20

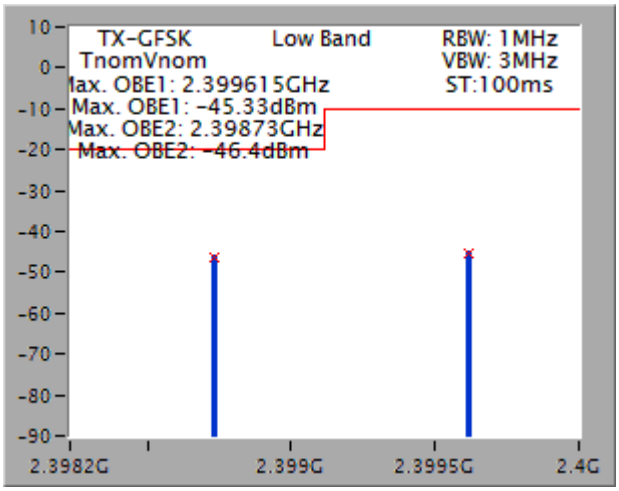
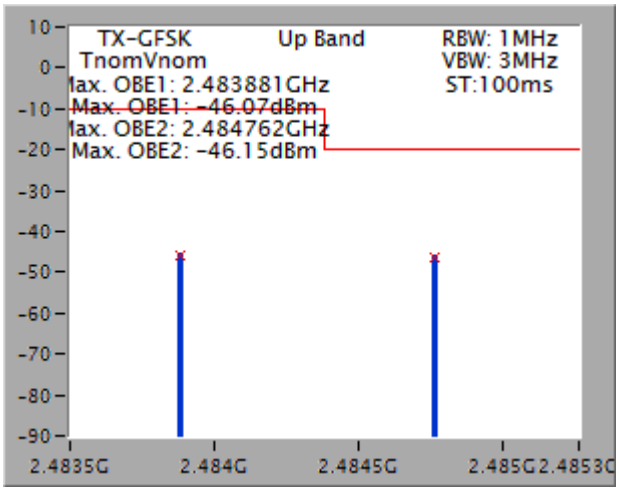
Low Band	Up Band
	

Condition	Modulation Mode	Freq. (MHz)	OOB Freq. (MHz)	OOB Emissions (dBm)	Limit (dBm)
TnomVnom	EDR-3Mbps	Hopping	2399.50	-43.58	-10
TnomVnom	EDR-3Mbps	Hopping	2398.31	-45.85	-20
TnomVnom	EDR-3Mbps	Hopping	2484.00	-45.71	-10
TnomVnom	EDR-3Mbps	Hopping	2485.19	-45.87	-20

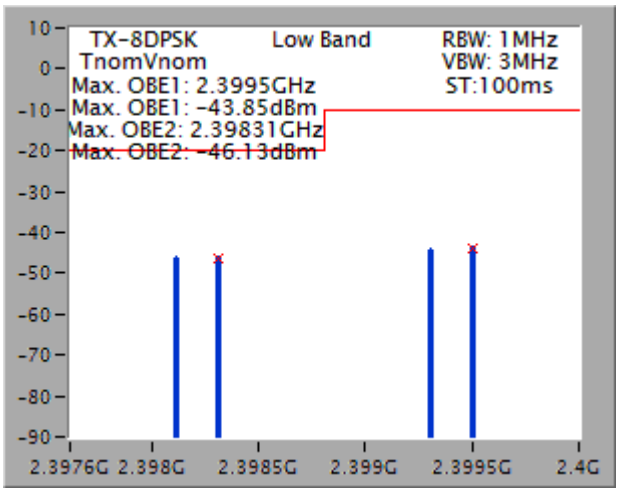
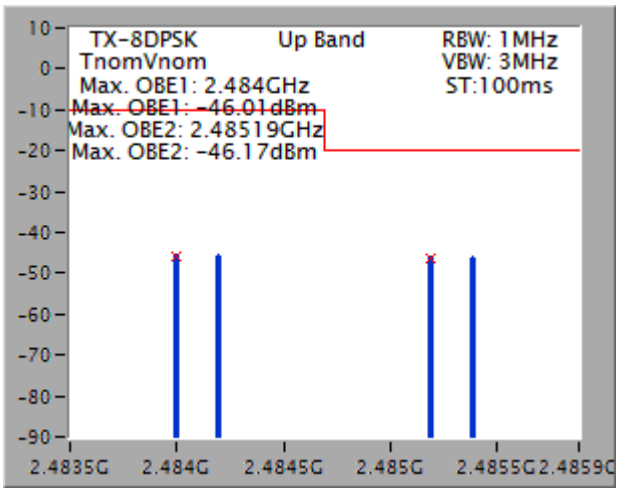
Low Band	Up Band
	

Configuration 3 : PIFA Antenna & Configuration 4: Isolated Magnetic Dipole Antenna

Condition	Modulation Mode	Freq. (MHz)	OOB Freq. (MHz)	OOB Emissions (dBm)	Limit (dBm)
TnomVnom	BR-1Mbps	Hopping	2399.61	-45.33	-10
TnomVnom	BR-1Mbps	Hopping	2398.73	-46.40	-20
TnomVnom	BR-1Mbps	Hopping	2483.88	-46.07	-10
TnomVnom	BR-1Mbps	Hopping	2484.76	-46.15	-20

Low Band	Up Band
	

Condition	Modulation Mode	Freq. (MHz)	OOB Freq. (MHz)	OOB Emissions (dBm)	Limit (dBm)
TnomVnom	EDR-3Mbps	Hopping	2399.50	-43.85	-10
TnomVnom	EDR-3Mbps	Hopping	2398.31	-46.13	-20
TnomVnom	EDR-3Mbps	Hopping	2484.00	-46.01	-10
TnomVnom	EDR-3Mbps	Hopping	2485.19	-46.17	-20

Low Band	Up Band
	

3.6 Transmitter Unwanted Emissions in the Spurious Domain

3.6.1 Limit of Transmitter Unwanted Emissions in the Spurious Domain

Conducted Emission		
Frequency Range (MHz)	**Maximum power (dBm)**	**Bandwidth (kHz)**
30 to 47	-39.01	100
47 to 74	-57.01	100
74 to 87,5	-39.01	100
87,5 to 118	-57.01	100
118 to 174	-39.01	100
174 to 230	-57.01	100
230 to 470	-39.01	100
470 to 694	-57.01	100
694 to 1000	-39.01	100
1000 to 12750	-33.01	1000

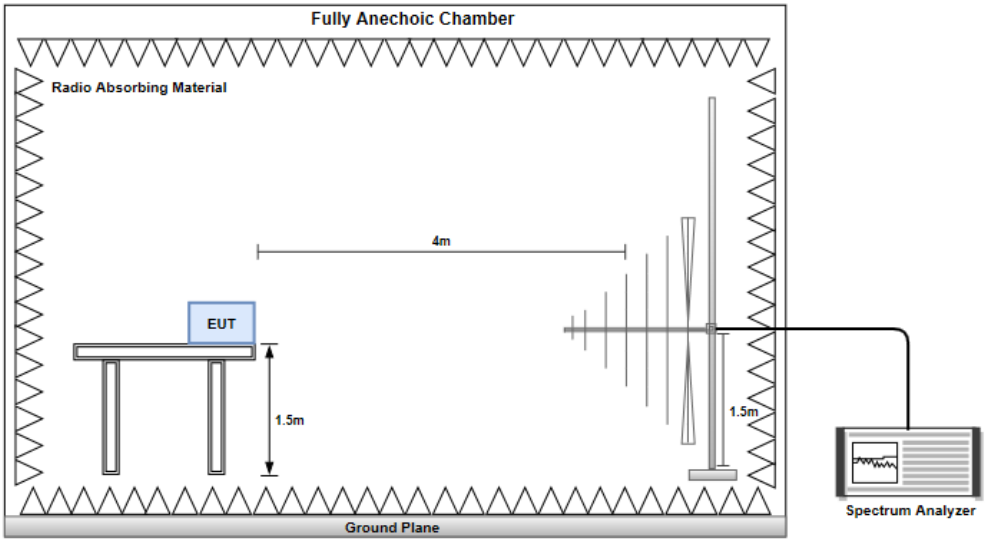
Radiated Emission		
Frequency Range (MHz)	**Maximum power (dBm)**	**Bandwidth (kHz)**
30 to 47	-36	100
47 to 74	-54	100
74 to 87,5	-36	100
87,5 to 118	-54	100
118 to 174	-36	100
174 to 230	-54	100
230 to 470	-36	100
470 to 694	-54	100
694 to 1000	-36	100
1000 to 12750	-30	1000

3.6.2 Test Procedures

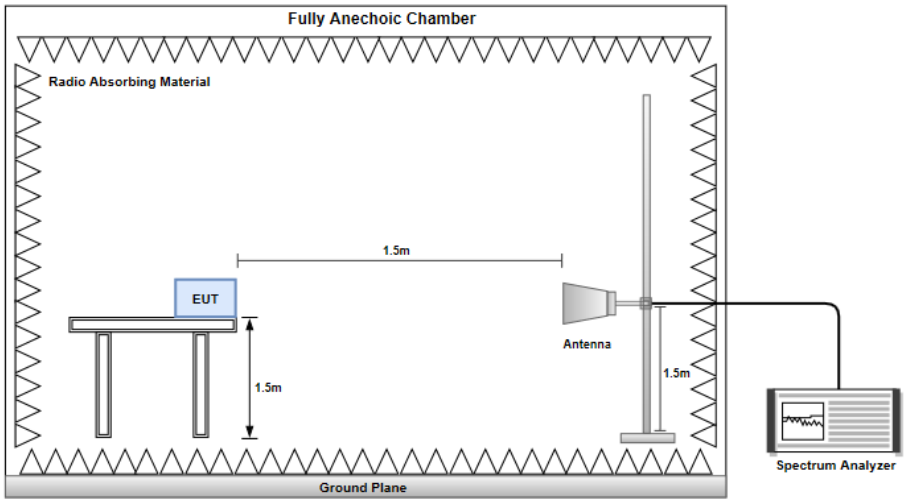
Reference to clause 5.4.9.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.6.3 Test Setup

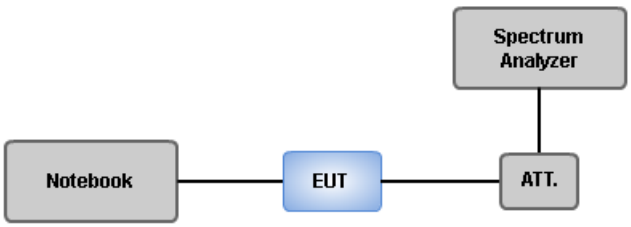
Below 1GHz



Above 1 GHz

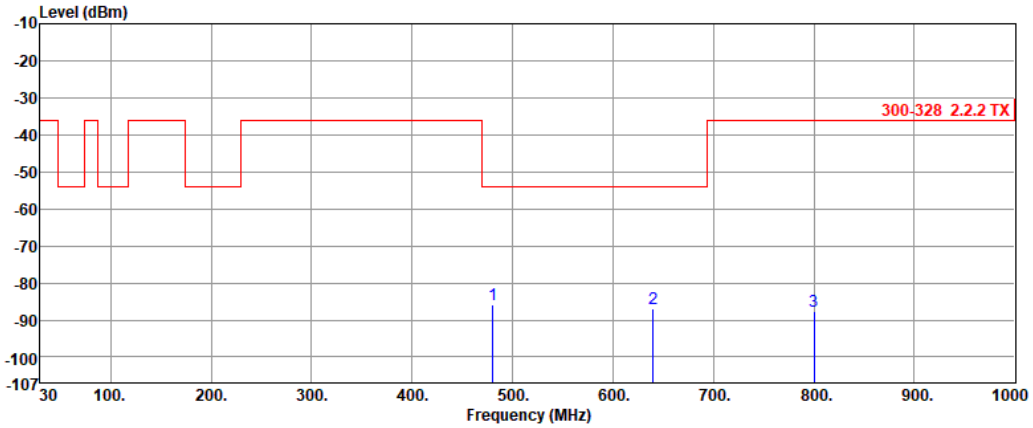


Conducted Emission



3.6.4 Transmitter Conducted Unwanted Emissions (Below 1GHz)

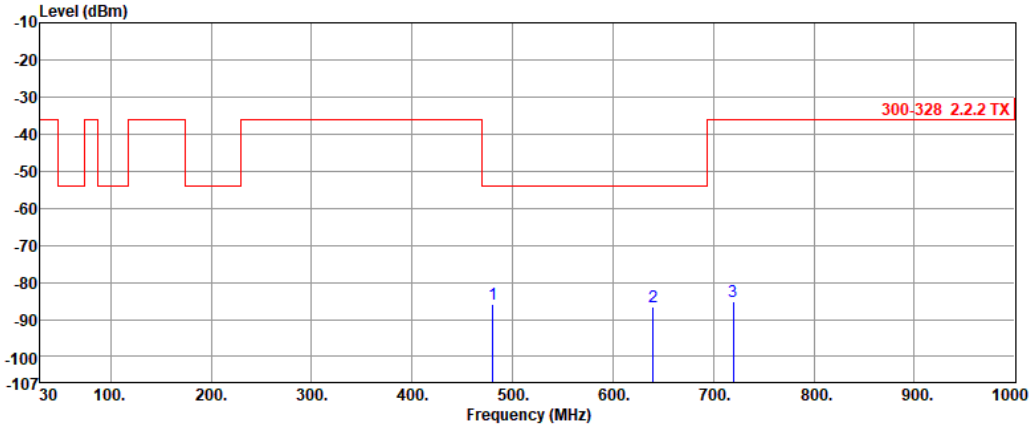
Modulation	GFSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	480.08	-85.86	-54.00	-31.86	0.00	-85.86
2	640.13	-86.83	-54.00	-32.83	0.00	-86.83
3	800.18	-87.67	-36.00	-51.67	0.00	-87.67

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

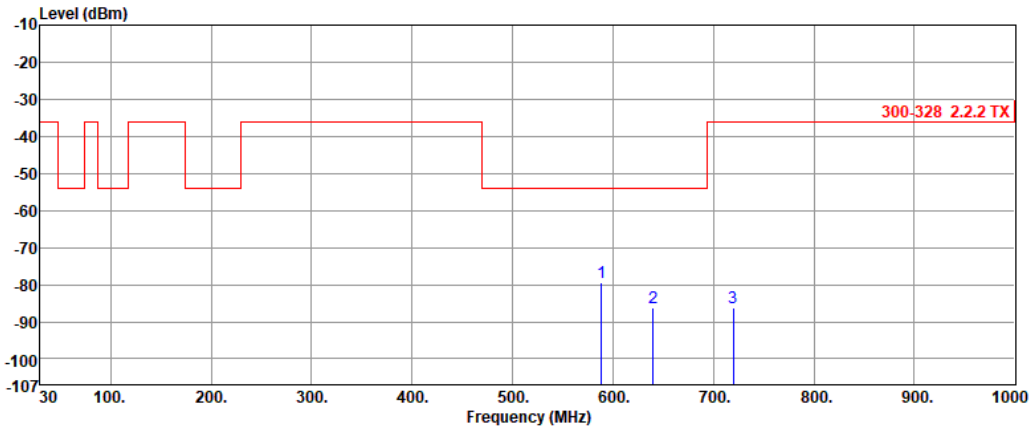
Modulation	GFSK	Test Freq. (MHz)	2480



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	480.08	-86.03	-54.00	-32.03	0.00	-86.03
2	640.13	-86.61	-54.00	-32.61	0.00	-86.61
3	719.67	-85.05	-36.00	-49.05	0.00	-85.05

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

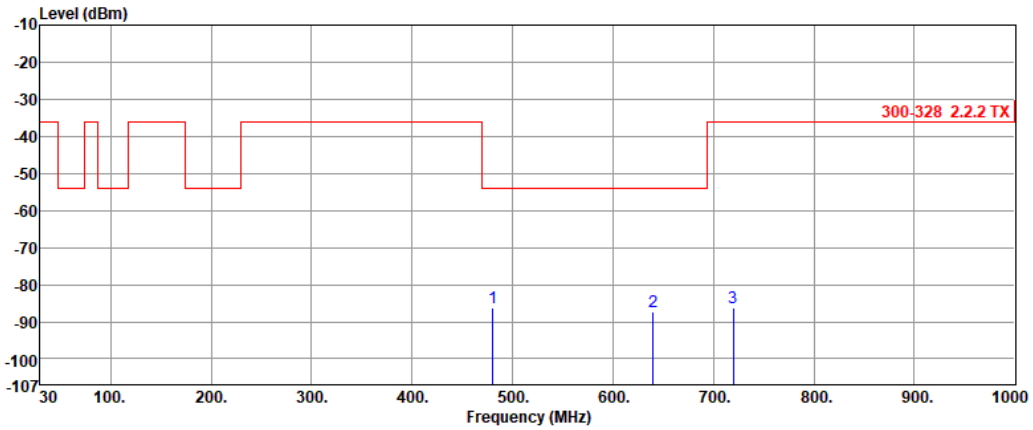
Modulation	8DPSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	588.72	-79.54	-54.00	-25.54	0.00	-79.54
2	640.13	-86.18	-54.00	-32.18	0.00	-86.18
3	719.67	-86.11	-36.00	-50.11	0.00	-86.11

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	8DPSK	Test Freq. (MHz)	2480

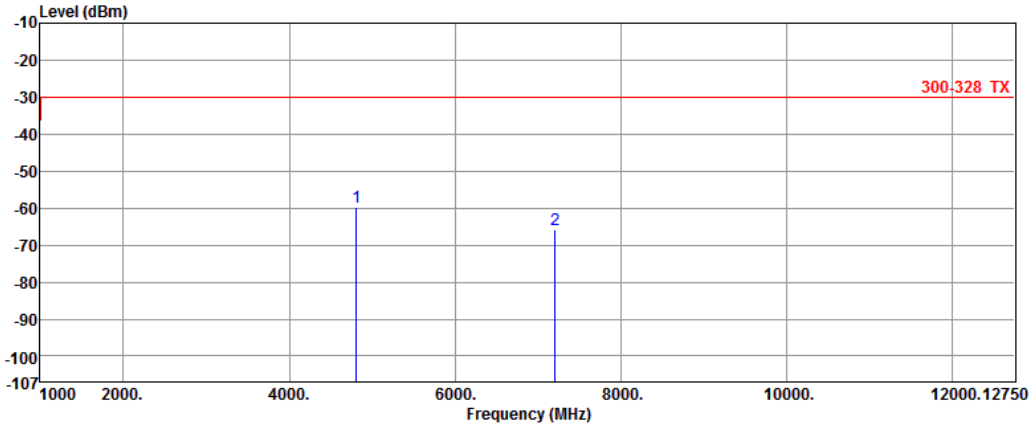


	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	480.08	-86.31	-54.00	-32.31	0.00	-86.31
2	640.13	-87.28	-54.00	-33.28	0.00	-87.28
3	719.67	-86.29	-36.00	-50.29	0.00	-86.29

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

3.6.5 Transmitter Conducted Unwanted Emissions (Above 1GHz)

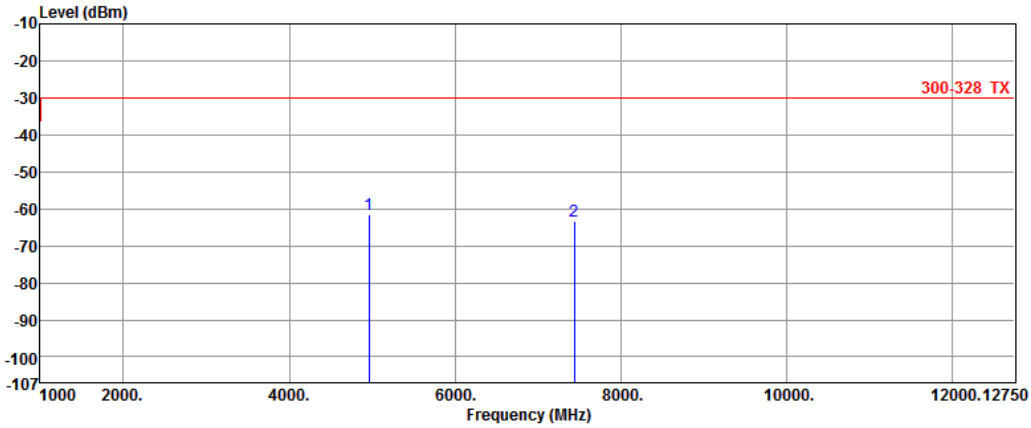
Modulation	GFSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4807.00	-59.74	-33.01	-26.73	0.00	-59.74
2	7204.00	-65.79	-33.01	-32.78	0.00	-65.79

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

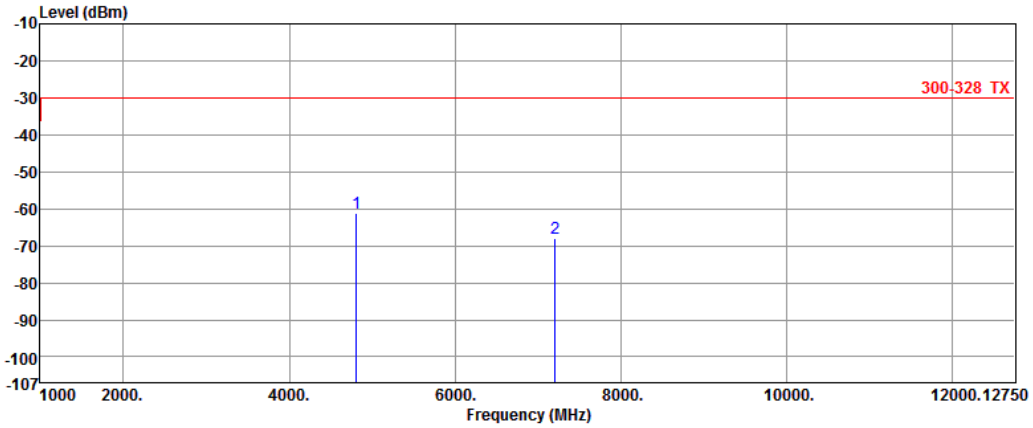
Modulation	GFSK	Test Freq. (MHz)	2480



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4959.75	-61.59	-33.01	-28.58	0.00	-61.59
2	7439.00	-63.26	-33.01	-30.25	0.00	-63.26

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

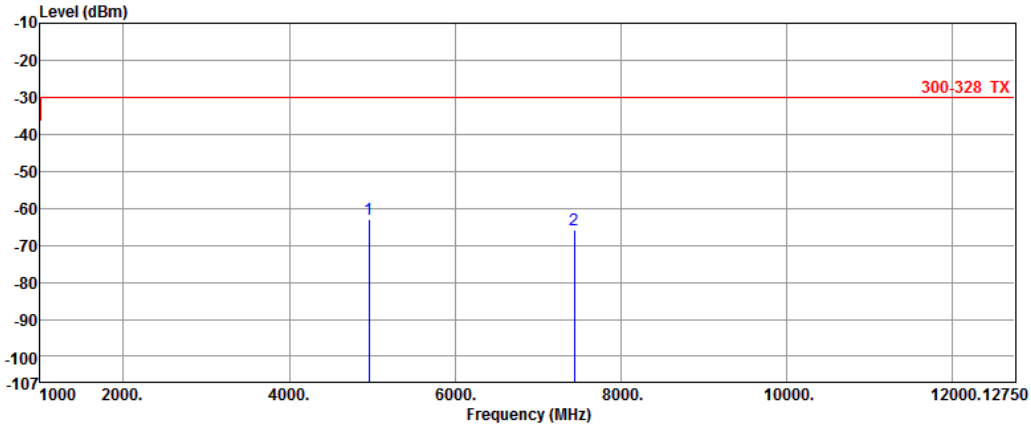
Modulation	8DPSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4807.00	-61.33	-33.01	-28.32	0.00	-61.33
2	7204.00	-68.13	-33.01	-35.12	0.00	-68.13

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	8DPSK	Test Freq. (MHz)	2480

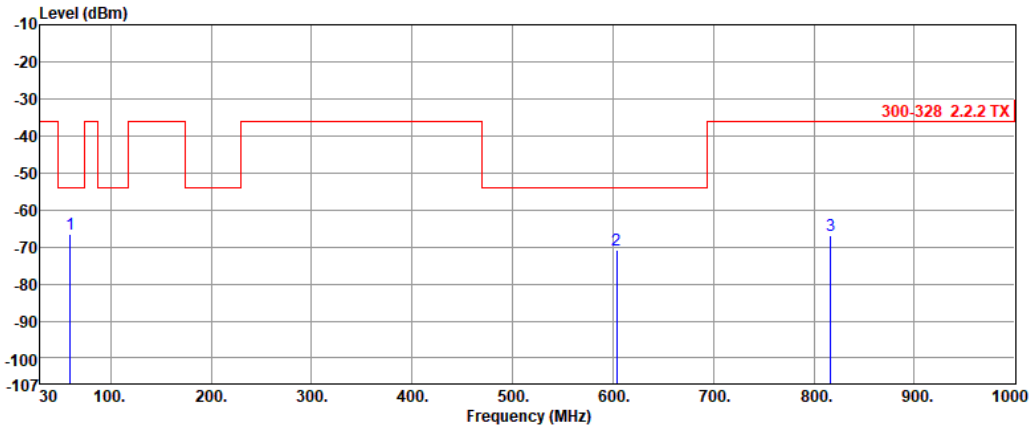


	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4959.75	-62.86	-33.01	-29.85	0.00	-62.86
2	7439.00	-65.78	-33.01	-32.77	0.00	-65.78

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

3.6.6 Transmitter Radiated Unwanted Emissions (Below 1GHz)

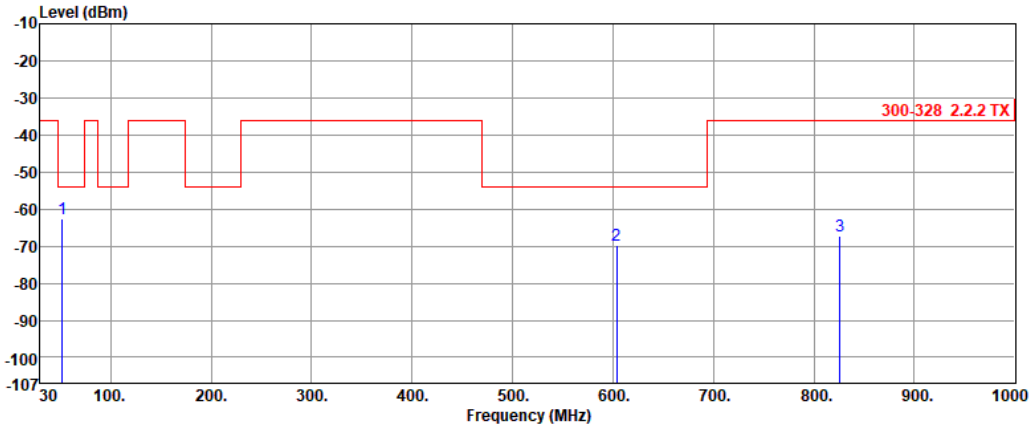
Modulation	GFSK	**Test Freq. (MHz)**	2402
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	59.46	-66.39	-54.00	-12.39	-1.60	-64.79
2	603.48	-70.81	-54.00	-16.81	6.92	-77.73
3	816.51	-66.93	-36.00	-30.93	9.87	-76.80

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

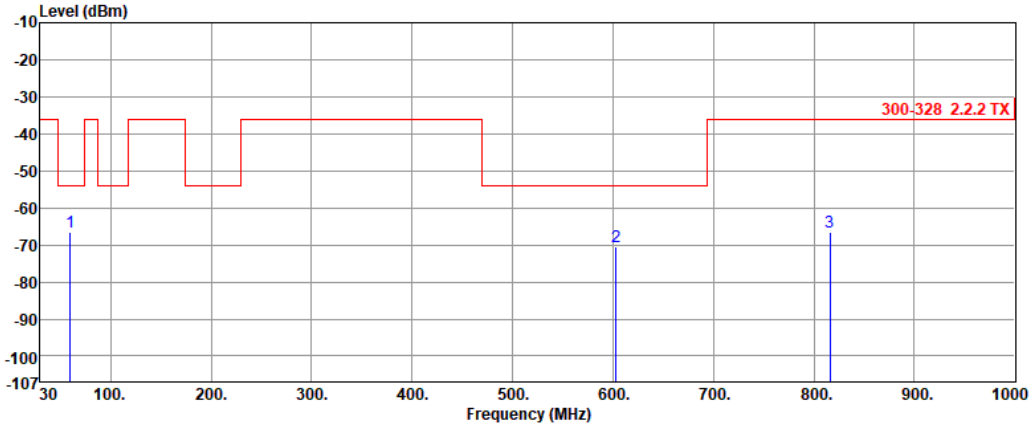
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	51.79	-62.69	-54.00	-8.69	-0.40	-62.29
2	603.61	-69.81	-54.00	-15.81	7.42	-77.23
3	825.73	-67.29	-36.00	-31.29	10.00	-77.29

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

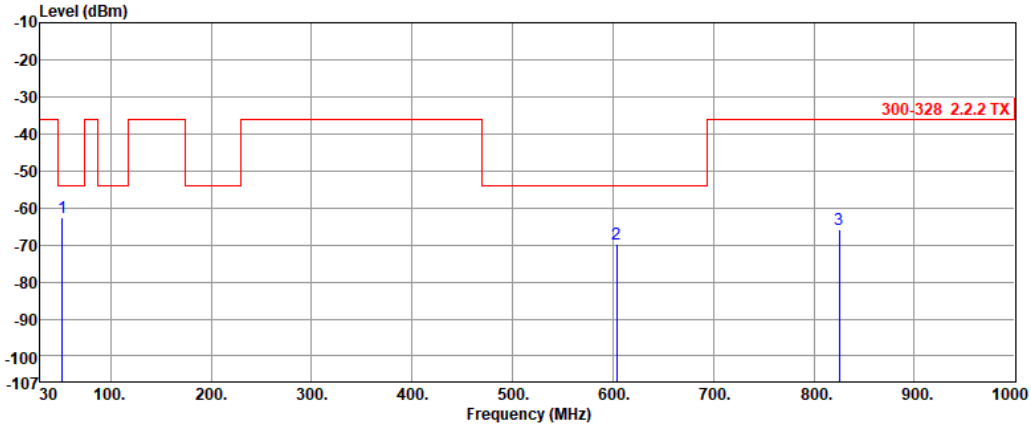
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	59.57	-66.63	-54.00	-12.63	-1.63	-65.00
2	603.35	-70.59	-54.00	-16.59	6.91	-77.50
3	816.19	-66.63	-36.00	-30.63	9.86	-76.49

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

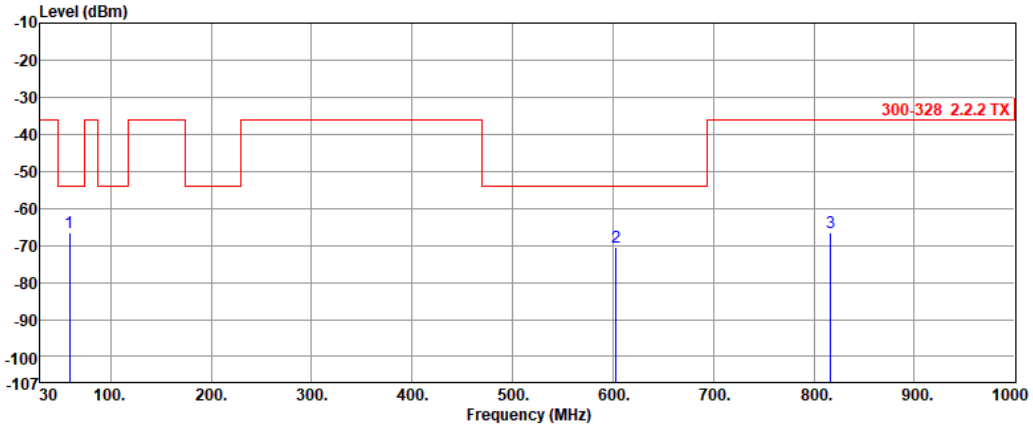
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	51.76	-62.64	-54.00	-8.64	-0.38	-62.26
2	603.63	-69.91	-54.00	-15.91	7.42	-77.33
3	825.18	-65.91	-36.00	-29.91	10.01	-75.92

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

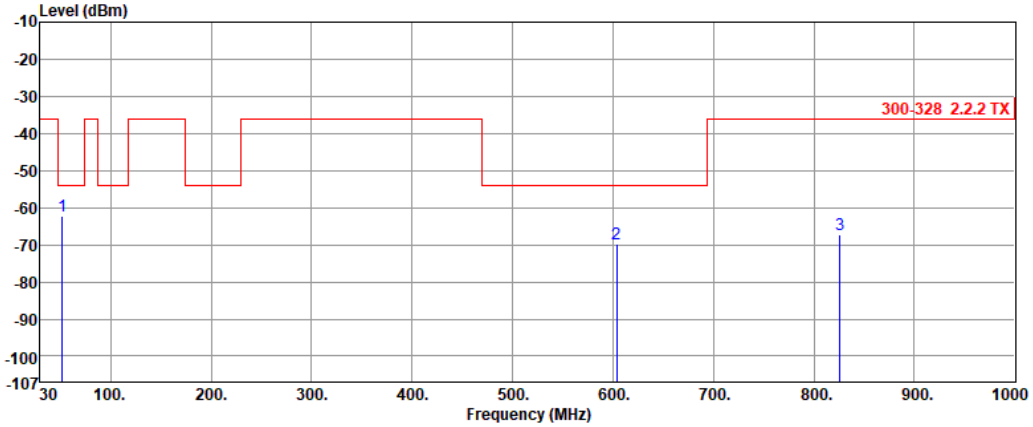
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	59.27	-66.59	-54.00	-12.59	-1.55	-65.04
2	603.19	-70.54	-54.00	-16.54	6.91	-77.45
3	816.73	-66.51	-36.00	-30.51	9.87	-76.38

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

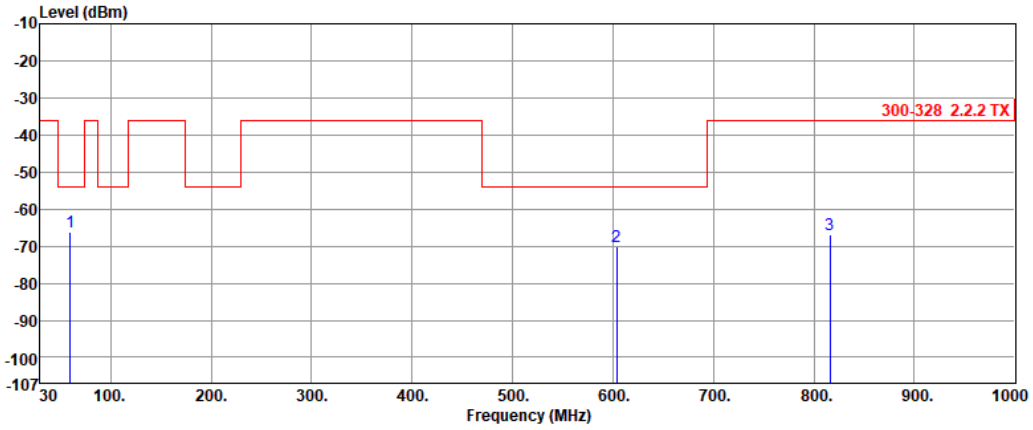
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	51.96	-62.41	-54.00	-8.41	-0.53	-61.88
2	603.53	-69.61	-54.00	-15.61	7.41	-77.02
3	825.87	-67.29	-36.00	-31.29	9.99	-77.28

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

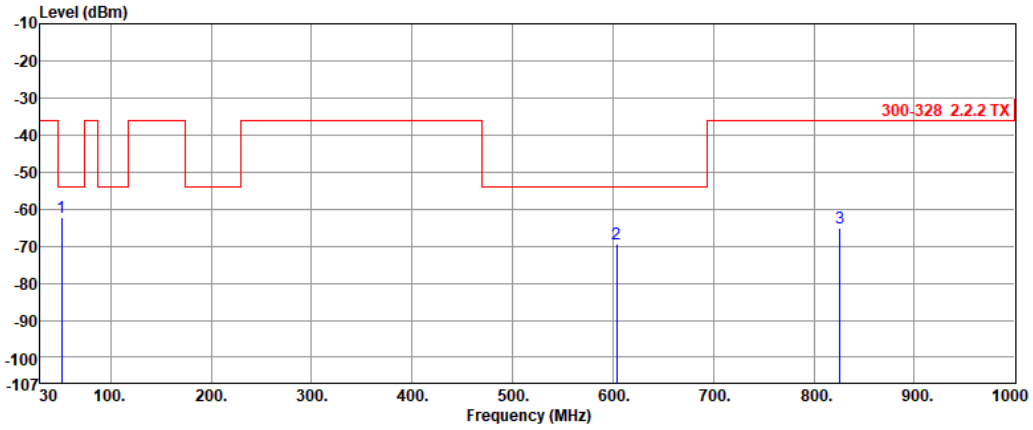
Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	59.48	-66.30	-54.00	-12.30	-1.61	-64.69
2	603.91	-70.17	-54.00	-16.17	6.93	-77.10
3	816.17	-66.81	-36.00	-30.81	9.86	-76.67

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Vertical		

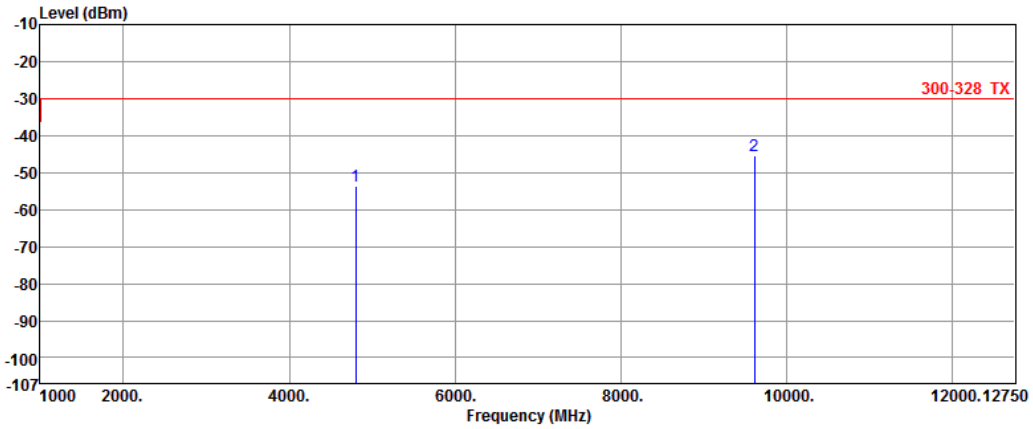


	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	51.18	-62.26	-54.00	-8.26	0.07	-62.33
2	603.59	-69.41	-54.00	-15.41	7.42	-76.83
3	825.91	-65.24	-36.00	-29.24	9.99	-75.23

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

3.6.7 Transmitter Radiated Unwanted Emissions (Above 1GHz)

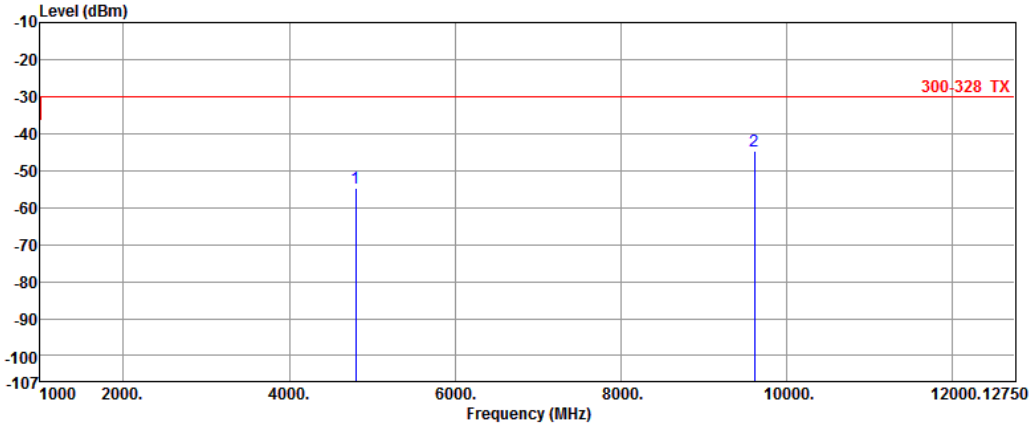
Modulation	GFSK	**Test Freq. (MHz)**	2402
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4804.24	-53.76	-30.00	-23.76	11.64	-65.40
2	9609.77	-45.34	-30.00	-15.34	20.89	-66.23

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

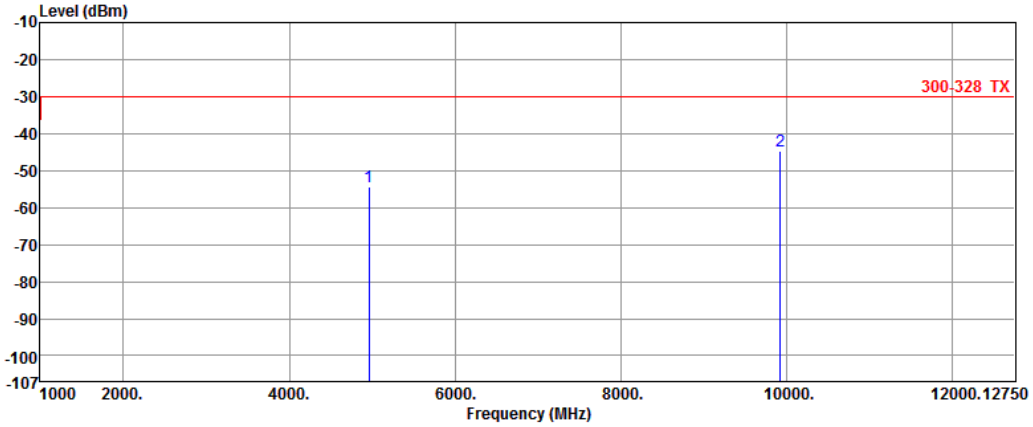
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4801.88	-54.63	-30.00	-24.63	11.91	-66.54
2	9607.33	-44.61	-30.00	-14.61	21.27	-65.88

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

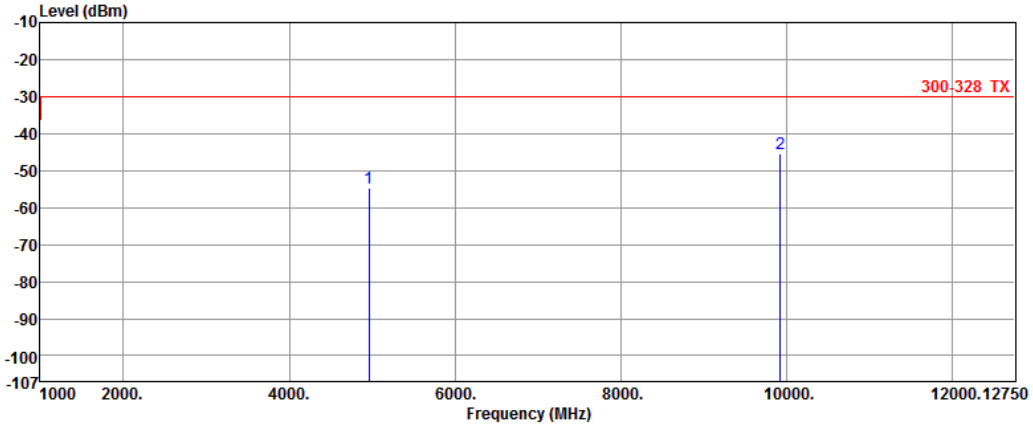
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4959.15	-54.32	-30.00	-24.32	12.22	-66.54
2	9919.45	-44.57	-30.00	-14.57	21.90	-66.47

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

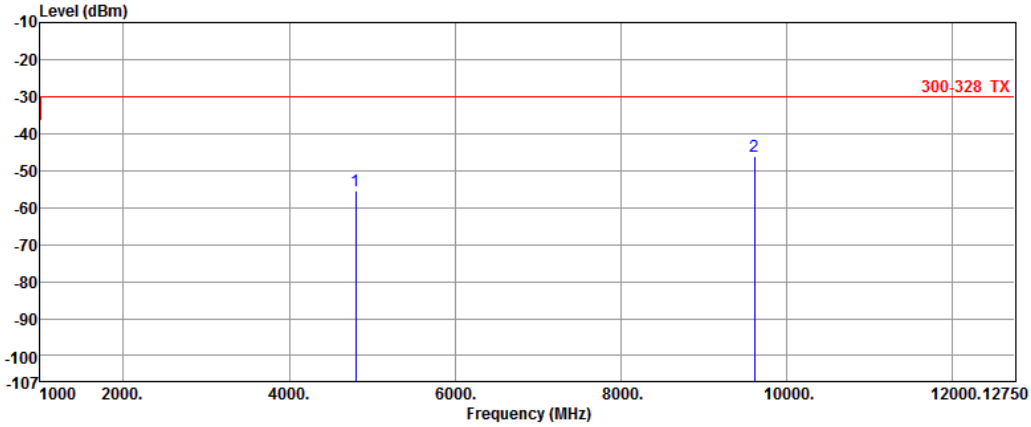
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4959.00	-54.69	-30.00	-24.69	11.65	-66.34
2	9922.20	-45.30	-30.00	-15.30	22.17	-67.47

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

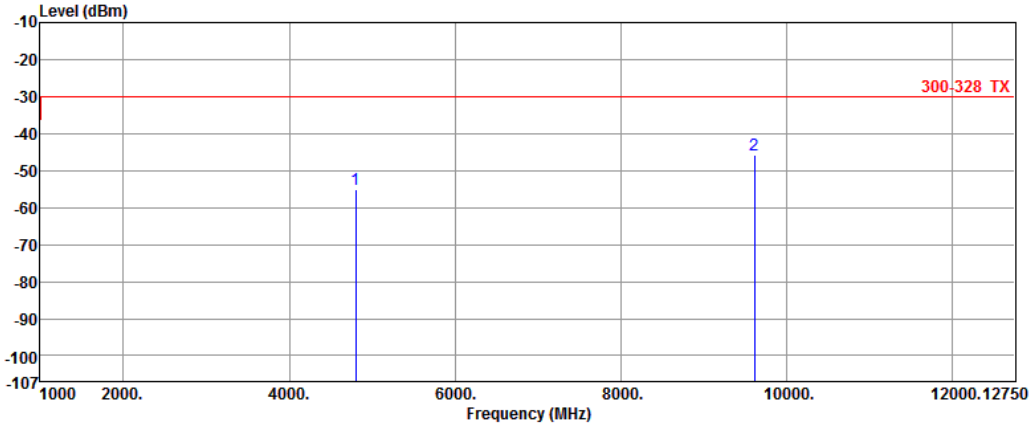
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4802.86	-55.28	-30.00	-25.28	11.64	-66.92
2	9607.15	-46.15	-30.00	-16.15	20.86	-67.01

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

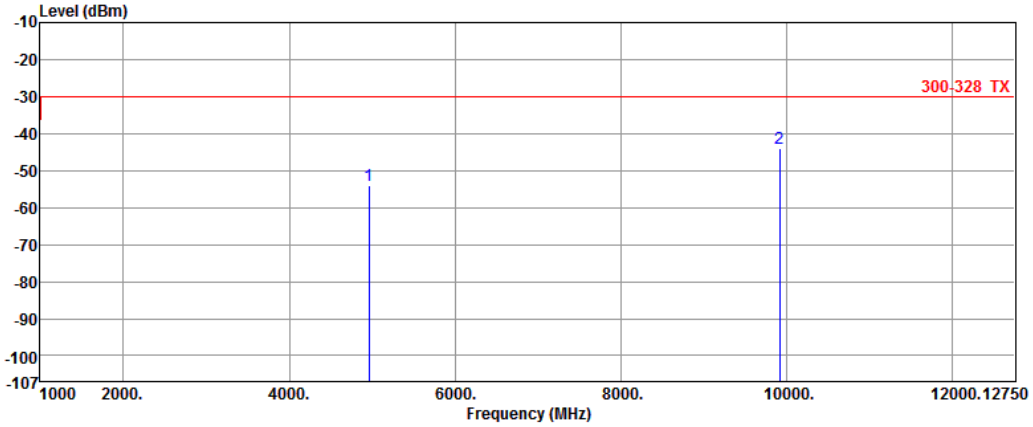
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4804.40	-55.18	-30.00	-25.18	11.89	-67.07
2	9610.08	-45.84	-30.00	-15.84	21.28	-67.12

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

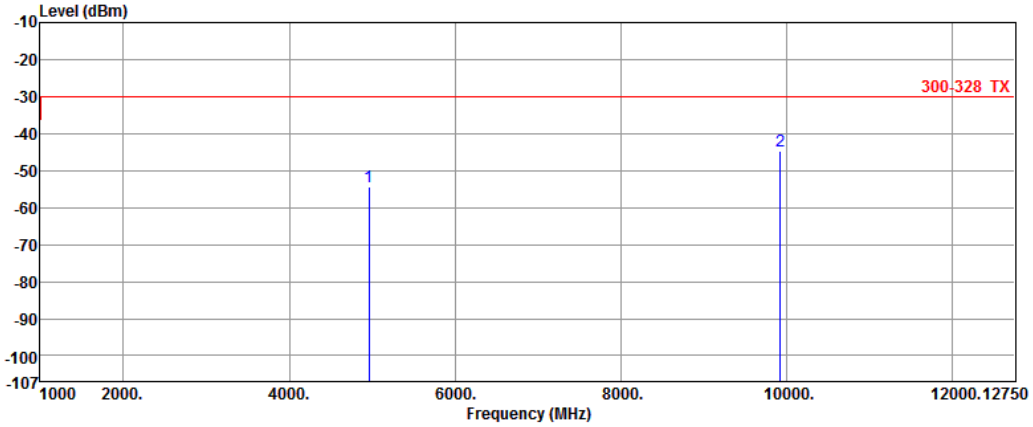
Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4961.51	-53.94	-30.00	-23.94	12.25	-66.19
2	9916.91	-44.17	-30.00	-14.17	21.93	-66.10

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4960.22	-54.33	-30.00	-24.33	11.66	-65.99
2	9919.84	-44.60	-30.00	-14.60	22.18	-66.78

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

4 Receiver Test Results

4.1 Receiver Spurious Emissions

4.1.1 Limit of Receiver Spurious Emissions

Conducted Emission		
Frequency Range	**Maximum power (dBm)**	**Measurement bandwidth (kHz)**
30 MHz to 1 GHz	-60.01	100
Above 1 GHz to 12.75 GHz	-50.01	1000

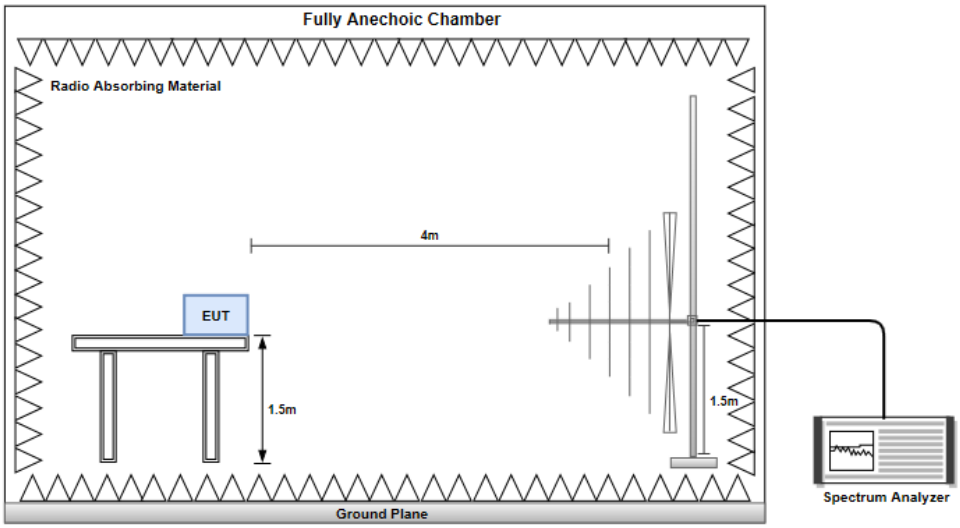
Radiated Emission		
Frequency Range	**Maximum power (dBm)**	**Measurement bandwidth(kHz)**
30 MHz to 1 GHz	-57	100
Above 1 GHz to 12,75 GHz	-47	1000

4.1.2 Test Procedures

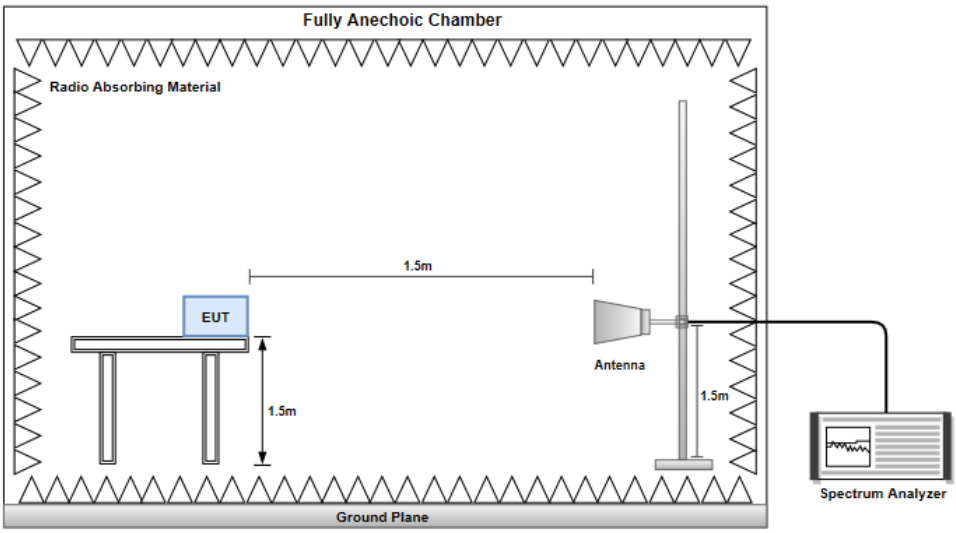
Reference to clause 5.4.10.2 of ETSI EN 300 328 V2.2.2 (2019-07).

4.1.3 Test Setup

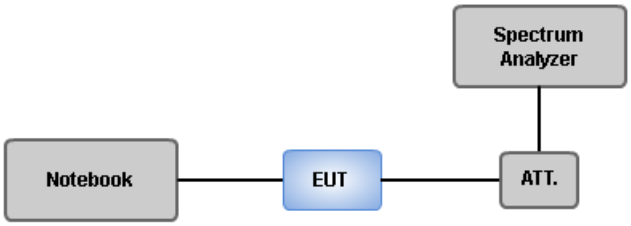
Below 1GHz



Above 1 GHz

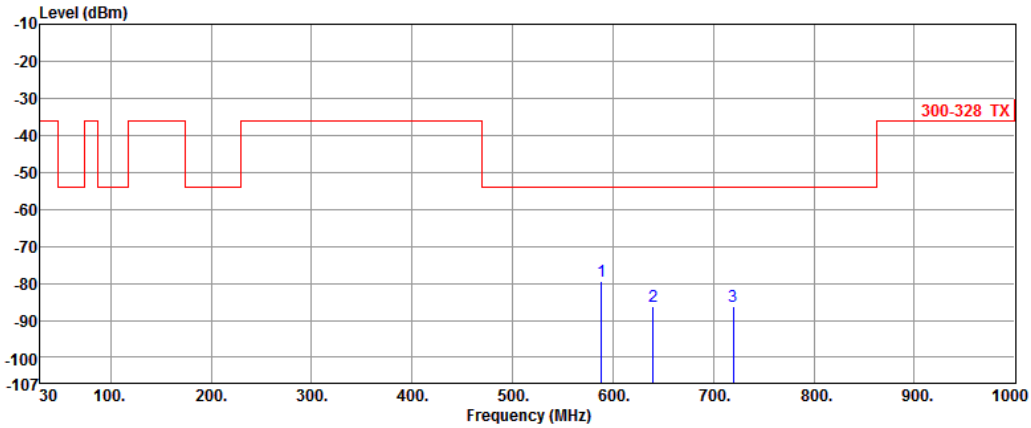


Conducted Emission



4.1.4 Receiver Conducted Unwanted Emissions (Below 1GHz)

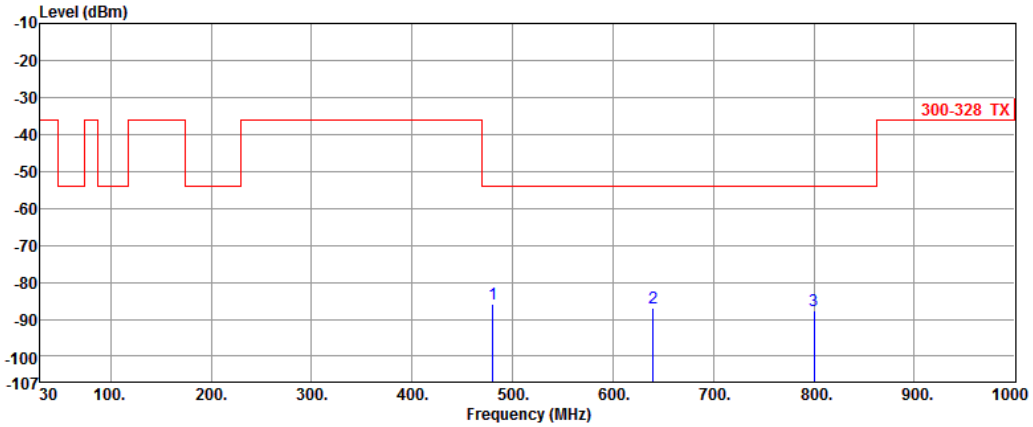
Modulation	GFSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	588.72	-79.54	-57.01	-22.53	0.00	-79.54
2	640.13	-86.18	-57.01	-29.17	0.00	-86.18
3	719.67	-86.11	-57.01	-29.10	0.00	-86.11

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

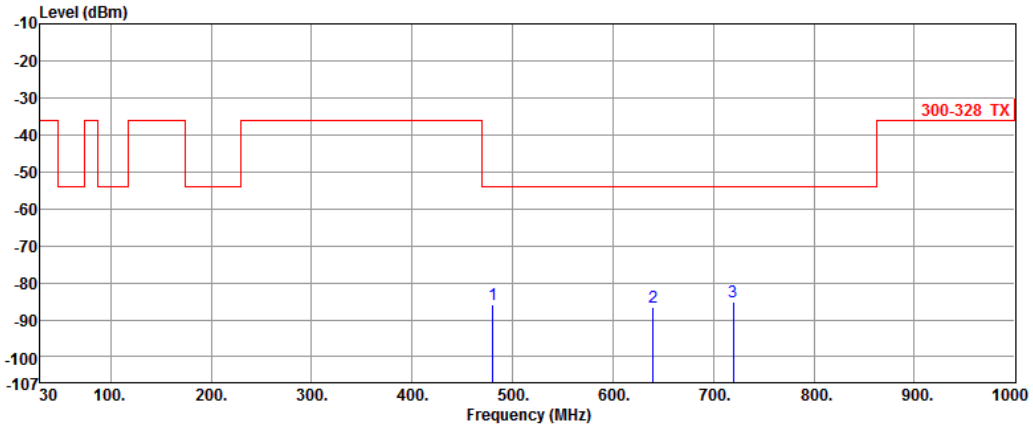
Modulation	GFSK	Test Freq. (MHz)	2480



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	480.08	-85.86	-57.01	-28.85	0.00	-85.86
2	640.13	-86.83	-57.01	-29.82	0.00	-86.83
3	800.18	-87.67	-57.01	-30.66	0.00	-87.67

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

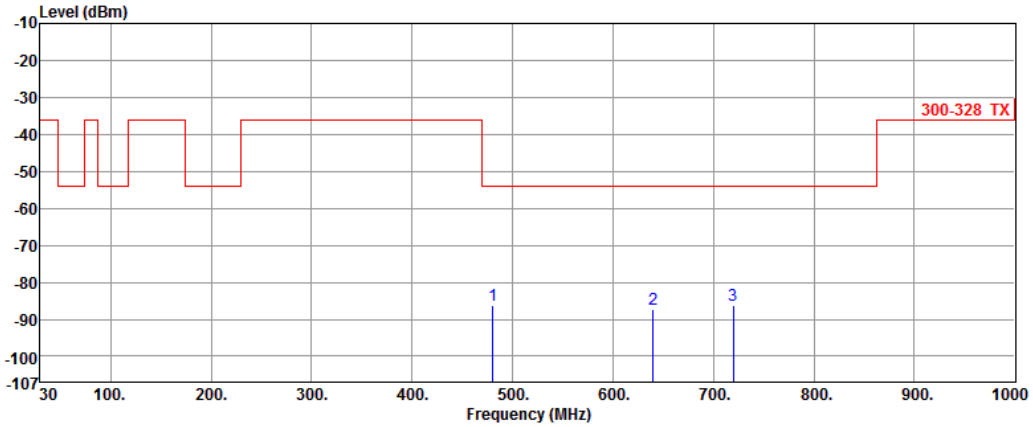
Modulation	8DPSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	480.08	-86.03	-57.01	-29.02	0.00	-86.03
2	640.13	-86.61	-57.01	-29.60	0.00	-86.61
3	719.67	-85.05	-57.01	-28.04	0.00	-85.05

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	8DPSK	Test Freq. (MHz)	2480

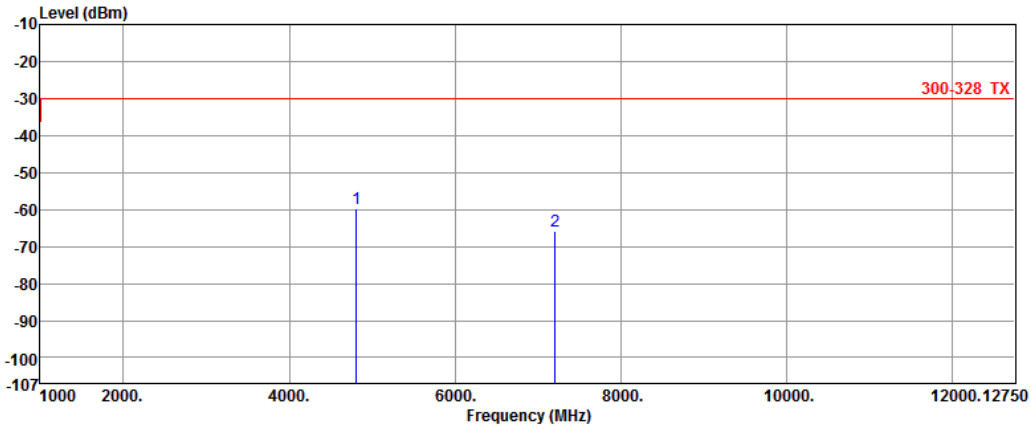


	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	480.08	-86.31	-57.01	-29.30	0.00	-86.31
2	640.13	-87.28	-57.01	-30.27	0.00	-87.28
3	719.67	-86.29	-57.01	-29.28	0.00	-86.29

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

4.1.5 Receiver Conducted Unwanted Emissions (Above 1GHz)

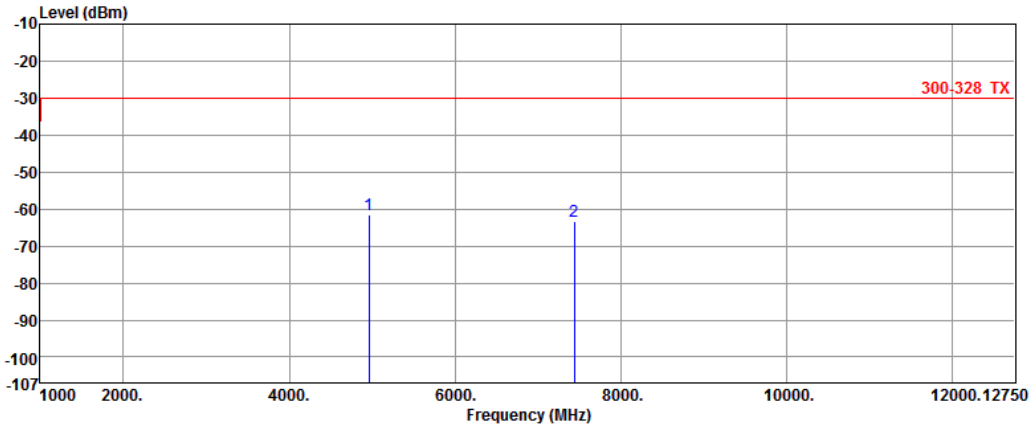
Modulation	GFSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4807.00	-59.74	-33.01	-26.73	0.00	-59.74
2	7204.00	-65.79	-33.01	-32.78	0.00	-65.79

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

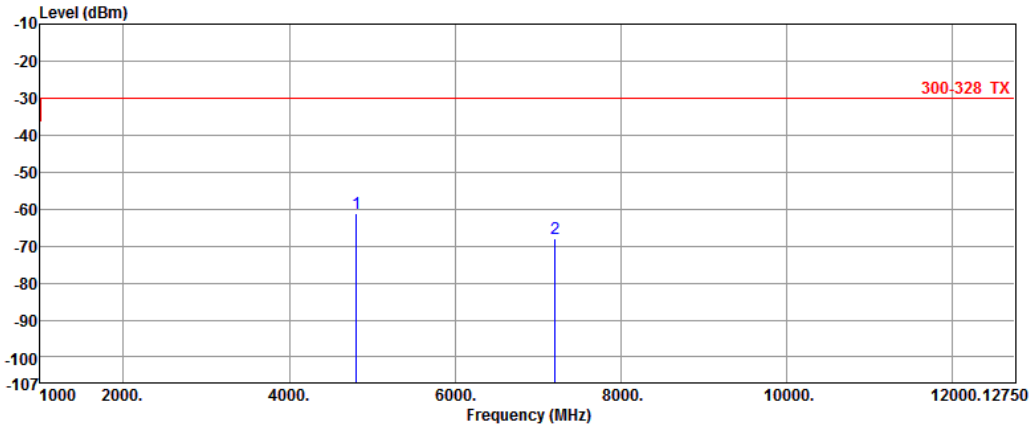
Modulation	GFSK	Test Freq. (MHz)	2480



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4959.75	-61.59	-33.01	-28.58	0.00	-61.59
2	7439.00	-63.26	-33.01	-30.25	0.00	-63.26

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

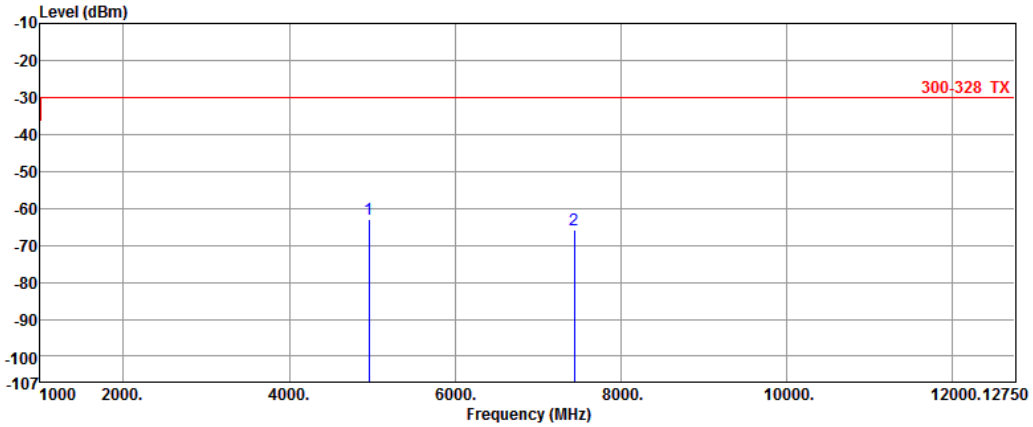
Modulation	8DPSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4807.00	-61.33	-33.01	-28.32	0.00	-61.33
2	7204.00	-68.13	-33.01	-35.12	0.00	-68.13

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	8DPSK	Test Freq. (MHz)	2480

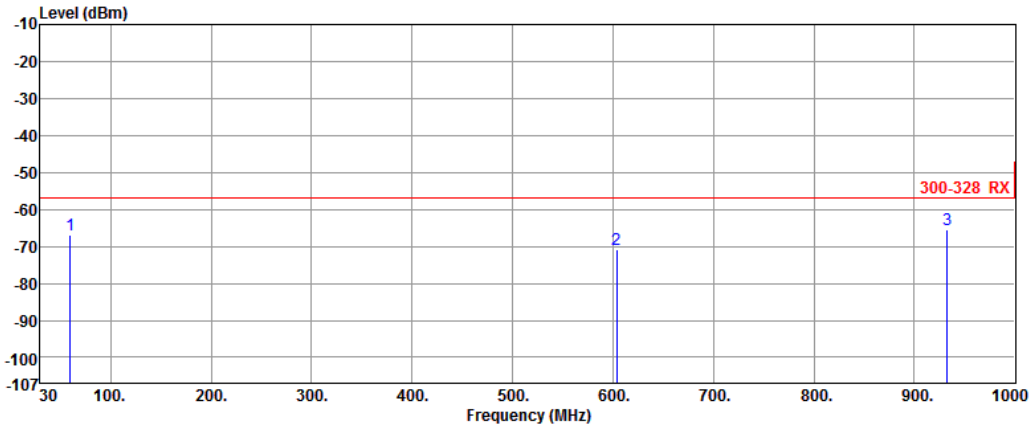


	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4959.75	-62.86	-33.01	-29.85	0.00	-62.86
2	7439.00	-65.78	-33.01	-32.77	0.00	-65.78

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

4.1.6 Receiver Radiated Unwanted Emissions (Below 1GHz)

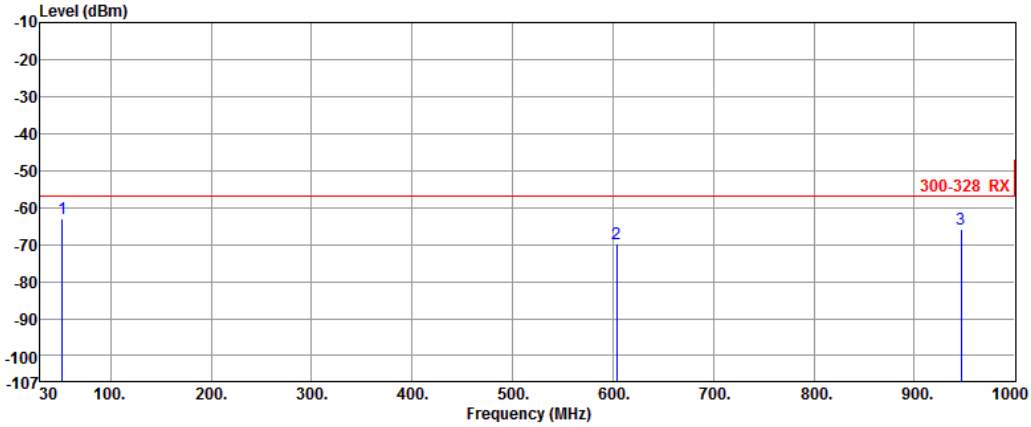
Modulation	GFSK	**Test Freq. (MHz)**	2402
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	59.51	-66.91	-57.00	-9.91	-1.62	-65.29
2	603.51	-70.74	-57.00	-13.74	6.92	-77.66
3	932.91	-65.51	-57.00	-8.51	11.78	-77.29

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

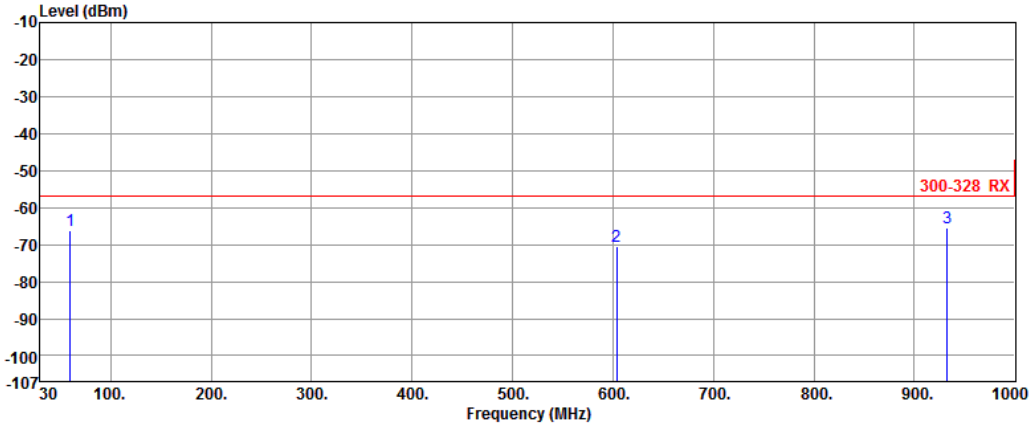
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	51.91	-62.81	-57.00	-5.81	-0.49	-62.32
2	603.51	-69.67	-57.00	-12.67	7.41	-77.08
3	946.58	-65.91	-57.00	-8.91	12.30	-78.21

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

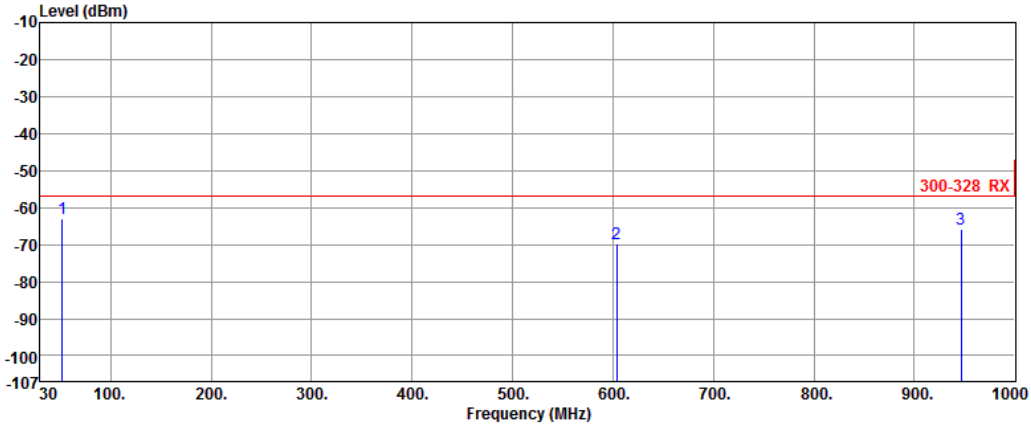
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	59.39	-66.13	-57.00	-9.13	-1.58	-64.55
2	603.41	-70.65	-57.00	-13.65	6.92	-77.57
3	932.81	-65.41	-57.00	-8.41	11.78	-77.19

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

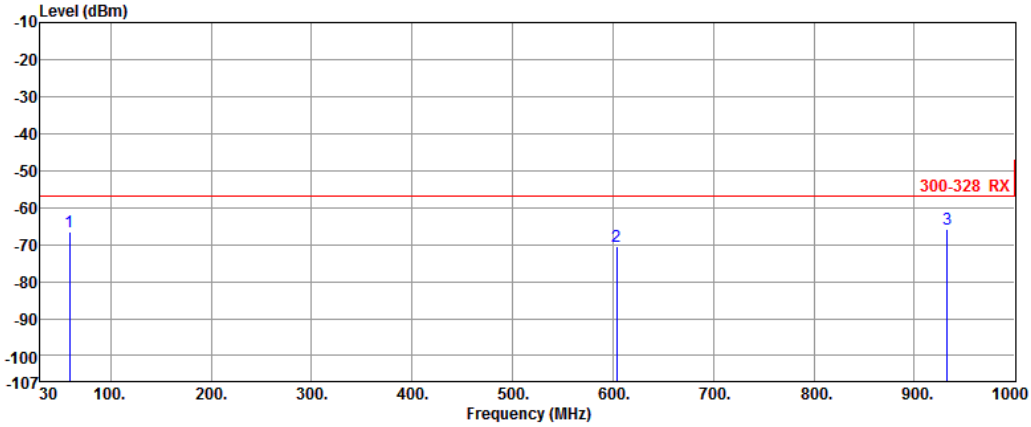
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	51.65	-62.84	-57.00	-5.84	-0.29	-62.55
2	603.53	-69.78	-57.00	-12.78	7.41	-77.19
3	946.52	-65.84	-57.00	-8.84	12.30	-78.14

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

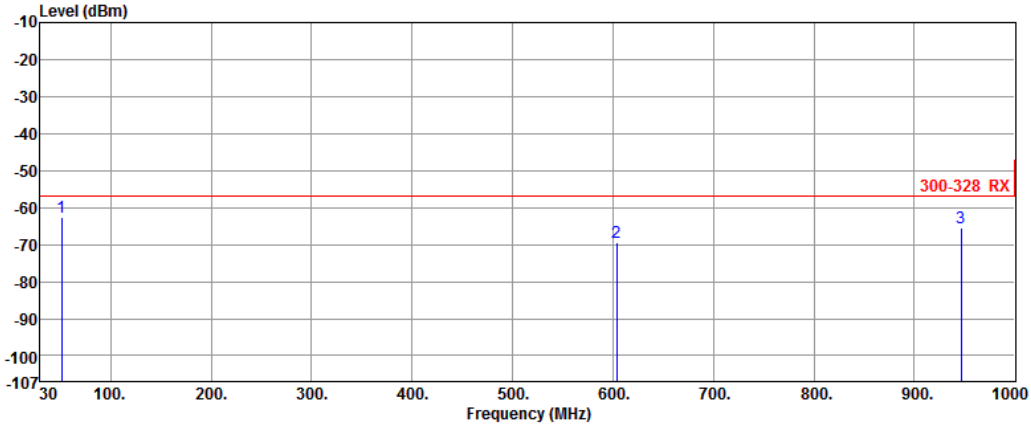
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	59.27	-66.61	-57.00	-9.61	-1.55	-65.06
2	603.41	-70.57	-57.00	-13.57	6.92	-77.49
3	932.41	-65.91	-57.00	-8.91	11.80	-77.71

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

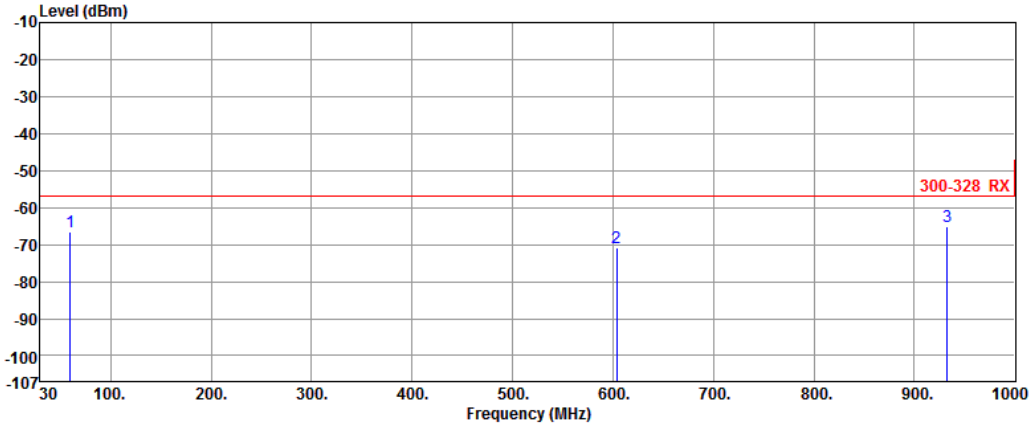
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	51.33	-62.53	-57.00	-5.53	-0.05	-62.48
2	603.78	-69.37	-57.00	-12.37	7.43	-76.80
3	946.27	-65.35	-57.00	-8.35	12.30	-77.65

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

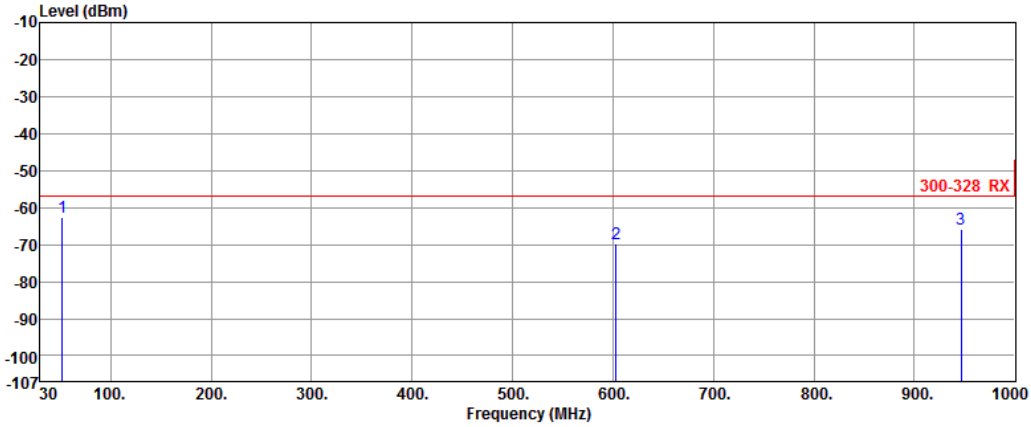
Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	59.48	-66.51	-57.00	-9.51	-1.61	-64.90
2	603.62	-70.94	-57.00	-13.94	6.92	-77.86
3	932.71	-65.23	-57.00	-8.23	11.79	-77.02

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Vertical		

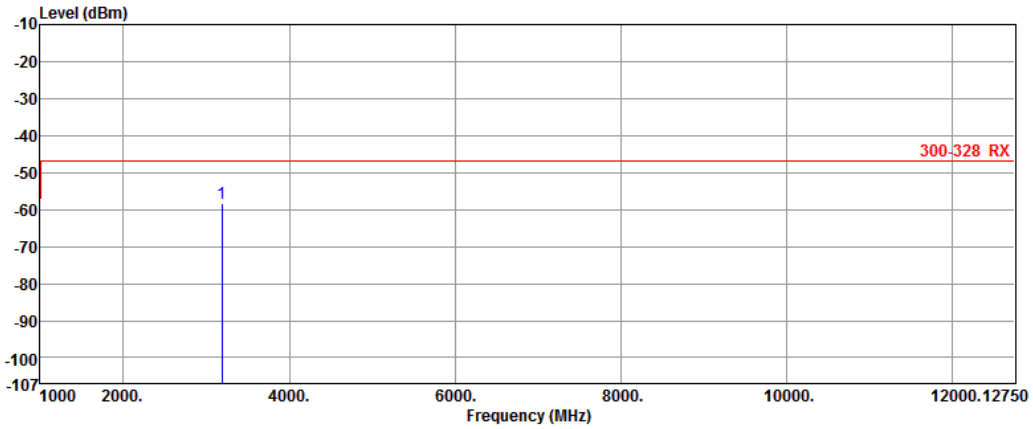


	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	51.67	-62.55	-57.00	-5.55	-0.31	-62.24
2	603.26	-69.61	-57.00	-12.61	7.39	-77.00
3	946.41	-65.91	-57.00	-8.91	12.30	-78.21

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

4.1.7 Receiver Radiated Unwanted Emissions (Above 1GHz)

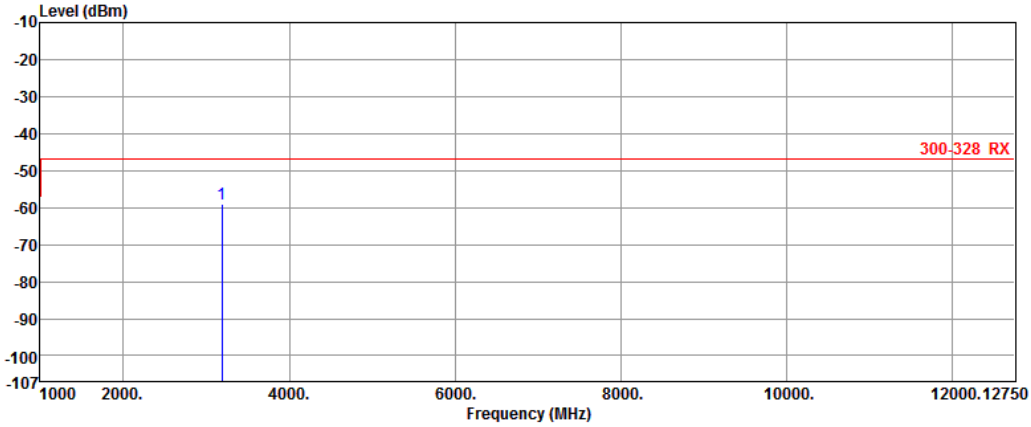
Modulation	GFSK	**Test Freq. (MHz)**	2402
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	3191.77	-58.43	-47.00	-11.43	6.82	-65.25

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

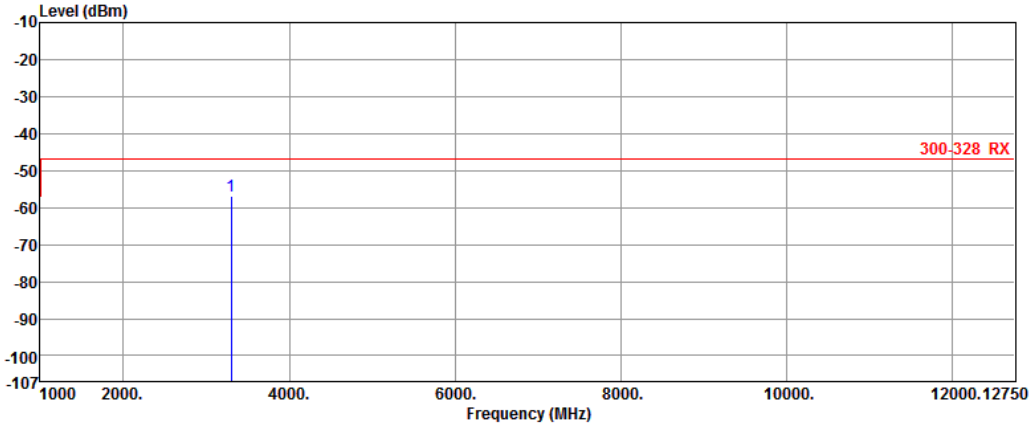
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	3192.68	-58.98	-47.00	-11.98	6.85	-65.83

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

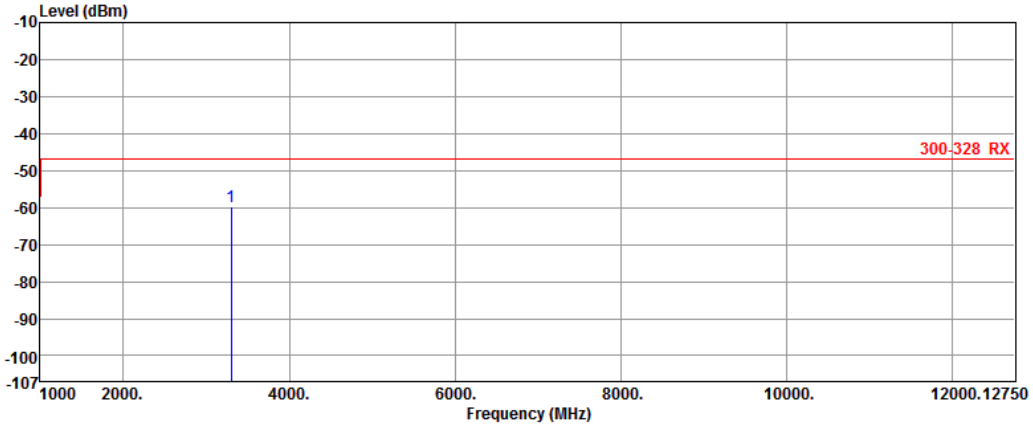
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	3298.78	-57.05	-47.00	-10.05	7.50	-64.55

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

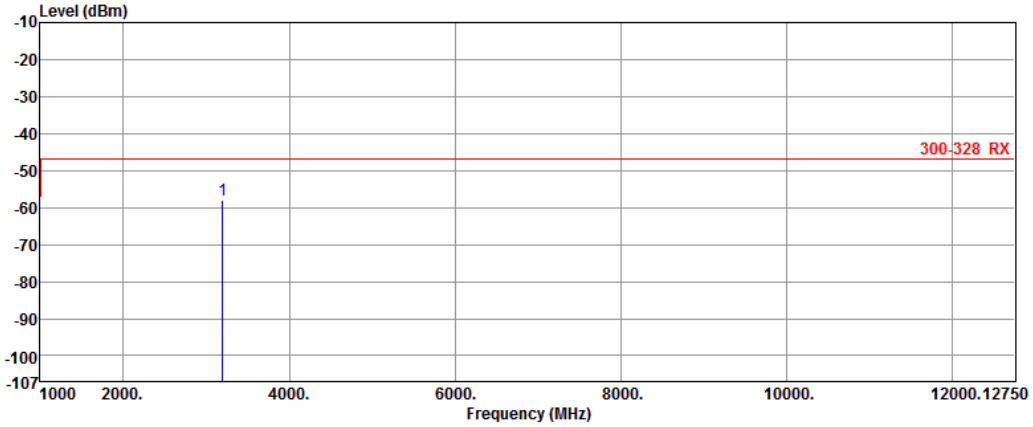
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	3298.21	-59.65	-47.00	-12.65	5.65	-65.30

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

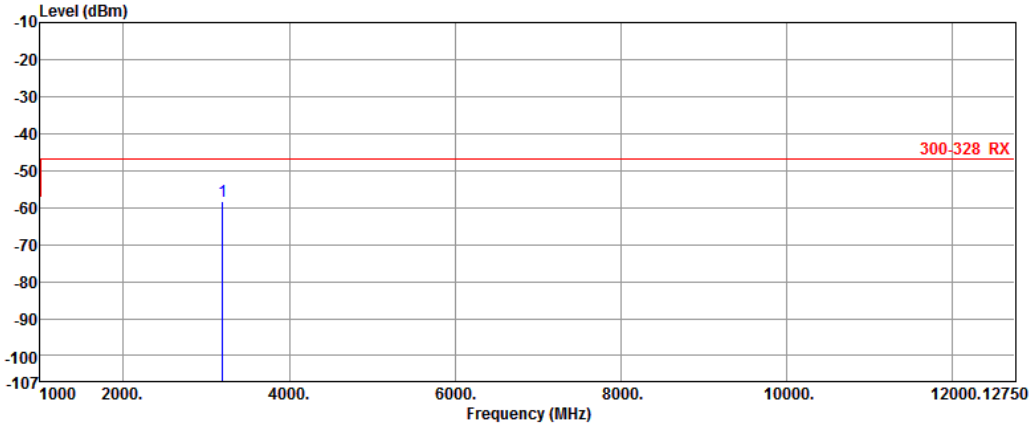
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	3193.55	-57.87	-47.00	-10.87	6.81	-64.68

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

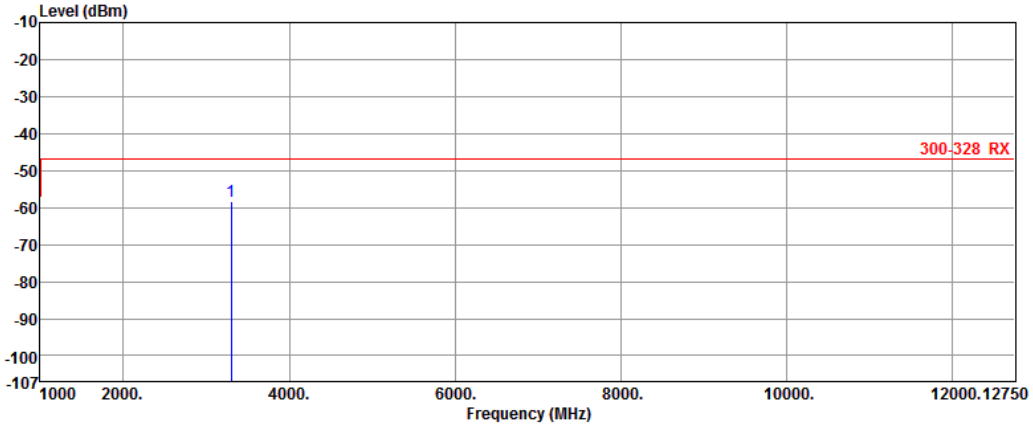
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	3196.07	-58.49	-47.00	-11.49	6.85	-65.34

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

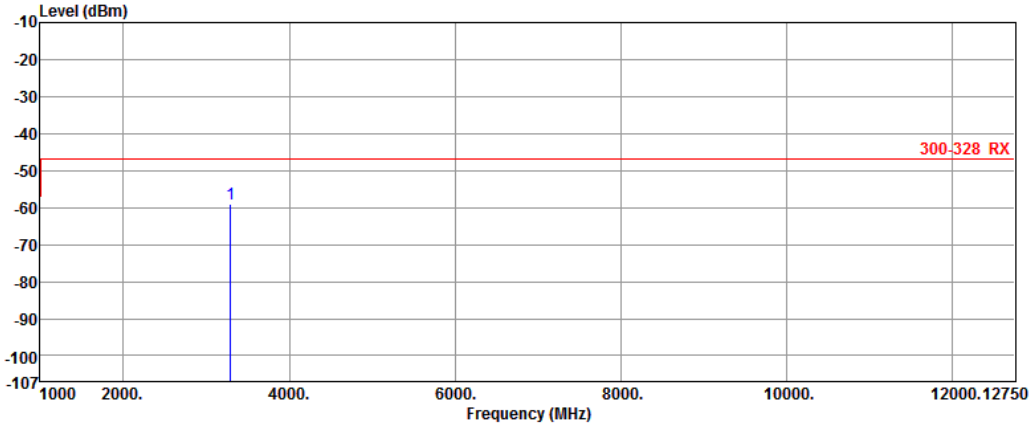
Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	3296.85	-58.41	-47.00	-11.41	7.49	-65.90

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	3296.53	-59.02	-47.00	-12.02	5.68	-64.70

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

5 Adaptivity Test Results

5.1 Adaptivity and Unwanted Signal Parameters

5.1.1 Limit of Adaptivity and Unwanted Signal Parameters

Adaptivity and Unwanted Signal Limit	
☒	Only for adaptive systems and RF Output Power > 10 dBm
☐	Non-LBT based Detect and Avoid: ◆ minimum remain unavailable = 1sec; ◆ minimum Idle Period time = 100us; ◆ maximum Channel Occupancy Time (COT) = 40ms ◆ detection threshold level = -70 dBm/MHz + 10 x $\log_{10}$(100mW / Pout) (Pout in mW e.i.r.p);
☐	LBT based Detect and Avoid (Frame Based Equipment): ◆ minimum Clear Channel Assessment (CCA) time = 18 us; ◆ COT = 1 ms to 10 ms ◆ Idle Period = 5% of COT ◆ detection threshold level = -70 dBm/MHz + 10 x $\log_{10}$(100mW / Pout) (Pout in mW e.i.r.p);
☒	LBT based Detect and Avoid (Load Based Equipment with spectrum sharing mechanism IEEE Std.): ◆ LBT based spectrum sharing mechanism may implement IEEE 802.11™-2012 [i.3] clause 9, clause 10, clause 16,clause 17, clause 19 and clause 20, or in IEEE 802.15.4™-2011 [i.4], clause 4, clause 5 and clause 8 ◆ detection threshold level = -70 dBm/MHz + 10 x $\log_{10}$(100mW / Pout) (Pout in mW e.i.r.p);
☒	Short Control Signalling Transmissions: ◆ Short Control Signalling Transmissions shall have a maximum duty cycle of 10 % within an observation period of 50 ms.

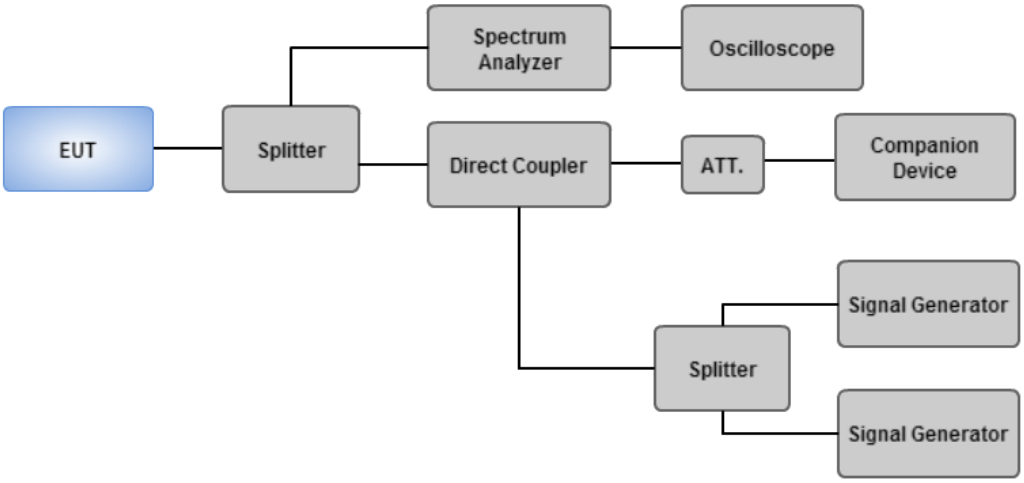
Unwanted Signal Parameters				
Equipment Type	**Wanted Signal Mean Power from Companion Device**	**Blocking Signal Frequency (MHz)**	**Blocking Signal Mean power (dBm)**	**Type of Interfering Signal**
LBT	sufficient to maintain the link (see note 2)	2395 or 2488,5 (see note 1)	-35 (see note 3)	CW
Non-LBT	-30 dBm			

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: 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.

5.1.2 Test Procedures

Reference to clause 5.4.6.2 of ETSI EN 300 328 V2.2.2 (2019-07).

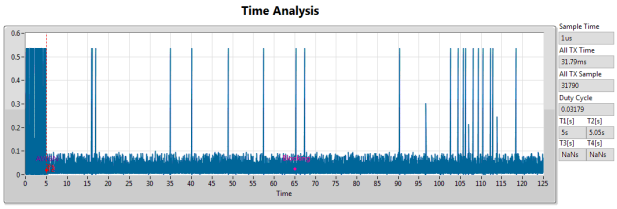
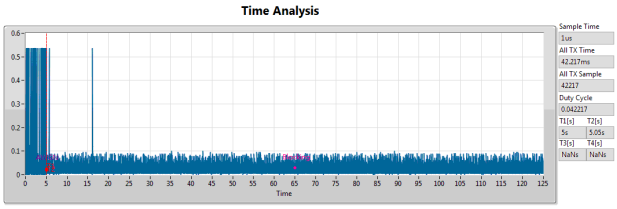
5.1.3 Test Setup



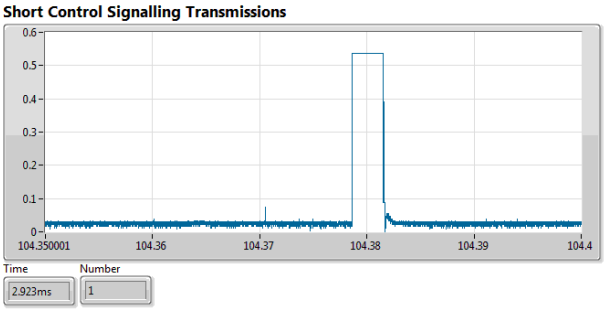
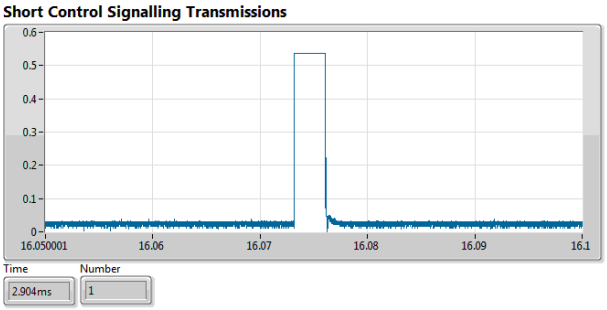
5.1.4 Test Result of Adaptivity、Unwanted Signal and Short Control Signalling Transmissions

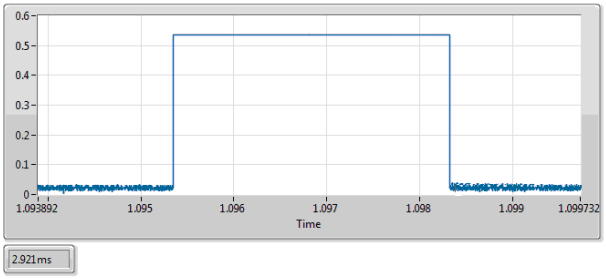
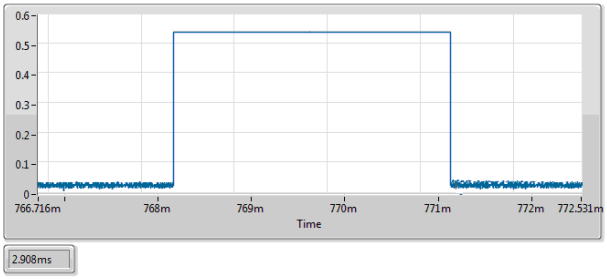
Adaptivity and Unwanted Signal Result						
EUT firmware / software version			SD-UAPSTA-8997-U14-MMC-16.68.1.p95-C3X16219_V4-MGPL-src			
Adaptivity Detection Threshold Level (dBm)			-62.02			
Unwanted Signal Level (dBm)			-32.21			
Modulation Mode	**Freq. (MHz)**	**Short Control Signalling Transmissions (ms)**	**Channel Occupancy Time (ms)**	**Idle Period Time (μs)**	**Adaptivity**	**Unwanted Signal Test Status**
GFSK/8DPSK	2402	2.923	2.921	0.831	Pass	Pass
GFSK/8DPSK	2480	2.904	2.908	1.409		
Limit		< 5 ms	< 13 ms	>18μs		
Result		**Complied**				

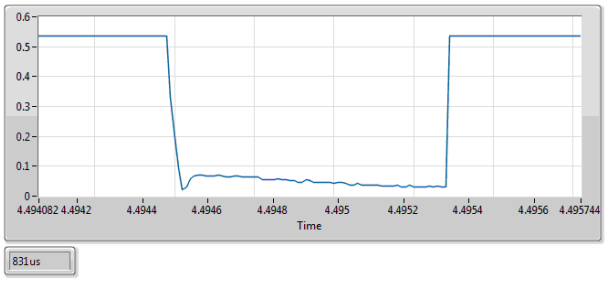
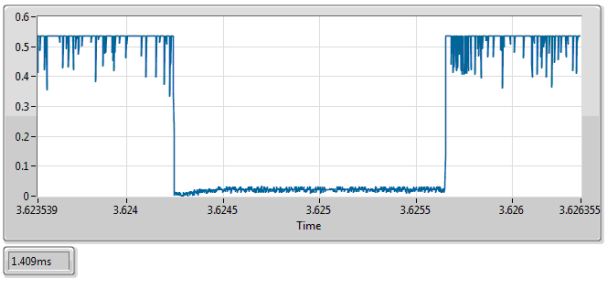
5.1.5 Test Result of Adaptivity and Unwanted Signal Plots

Adaptivity & Unwanted Signal Result Plots	
Unwanted signal: 2488.5 MHz	**Unwanted signal: 2395 MHz**
GFSK/8DPSK - 2402MHz	**GFSK/8DPSK - 2480MHz**
	

5.1.6 Test Result of Short Control Signalling Transmissions Plots

Short Control Signalling Transmissions Plots	
GFSK/8DPSK - 2402MHz	**GFSK/8DPSK - 2480MHz**
	

Channel Occupancy Time	
GFSK/8DPSK - 2402MHz	**GFSK/8DPSK - 2480MHz**
Max On Time  	**Max On Time** 

Idle Period Time	
GFSK/8DPSK - 2402MHz	**GFSK/8DPSK - 2480MHz**
Min Off Time  	**Min Off Time** 

6 Receiver Blocking Test Results

6.1 Receiver Blocking

6.1.1 Limit of Receiver Blocking

Receiver Blocking Parameters for Receiver Category 1 Equipment Limit			
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 × log10(OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × log10(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.

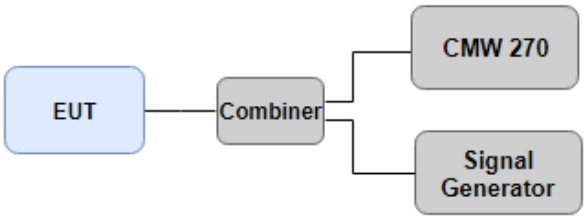
Receiver Blocking Parameters for Receiver Category 2 Equipment Limit			
Wanted Signal Mean Power from Companion Device (dBm) (see notes 1 and 3)	**Blocking Signal Frequency (MHz)**	**Blocking Signal Power (dBm) (see note 3)**	**Type of Blocking Signal**
(-139 dBm + 10 × log10(OCBW) + 10 dB) or (-74 dBm + 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.			

Receiver Blocking Parameters for Receiver Category 3 Equipment Limit			
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 × log10(OCBW) + 20 dB) or (-74 dBm + 20 dB) whichever is less	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.			

6.1.2 Test Procedures

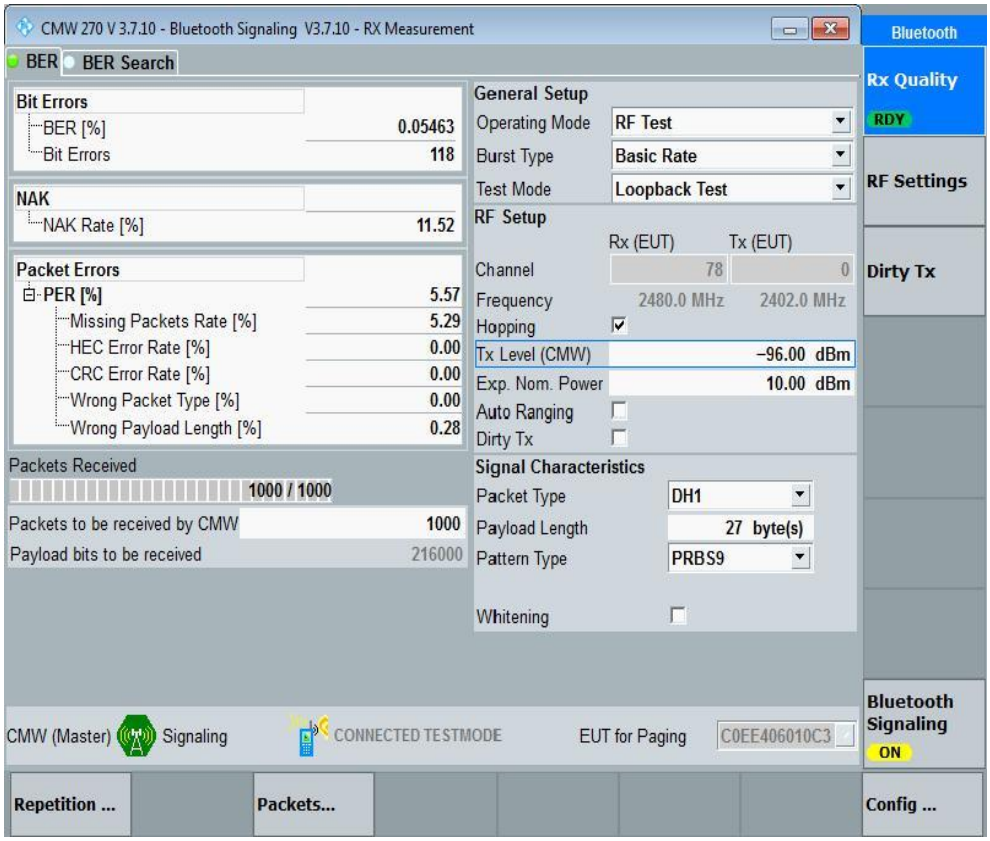
Reference to clause 5.4.11.2 of ETSI EN 300 328 V2.2.2 (2019-07).

6.1.3 Test Setup



6.1.4 Test Result of Receiver Blocking

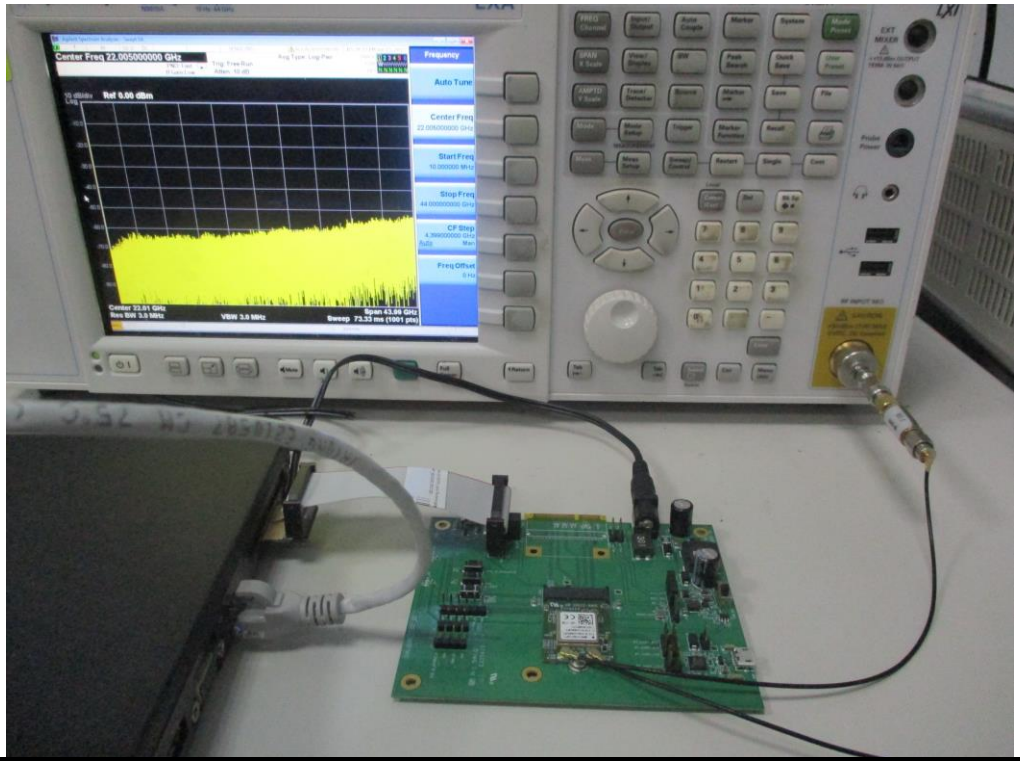
Hopping mode



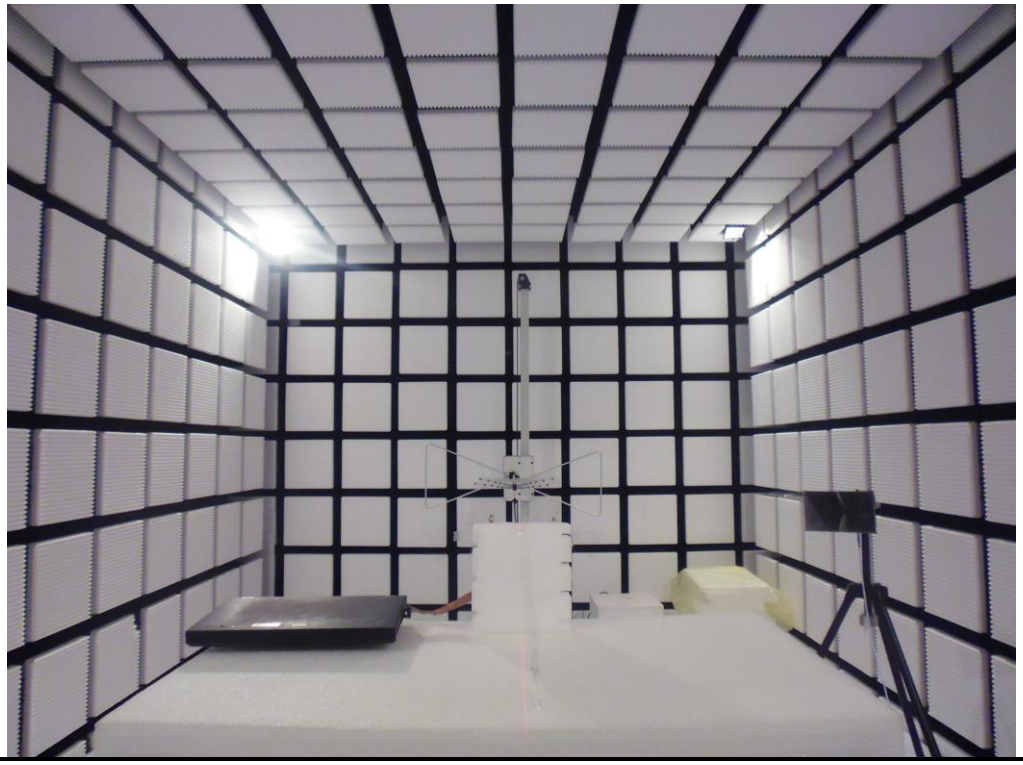
Receiver Category	1		
Performance Criteria Limit	PER ≤ 10 %		
Wanted Signal Mean Power from Companion Device (dBm)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm)	Test Result
-70.74	2380	-31.21	Pass
-70.74	2504	-31.21	Pass
-76.74	2300	-31.21	Pass
-76.74	2330	-31.21	Pass
-76.74	2360	-31.21	Pass
-76.74	2524	-31.21	Pass
-76.74	2584	-31.21	Pass
-76.74	2674	-31.21	Pass

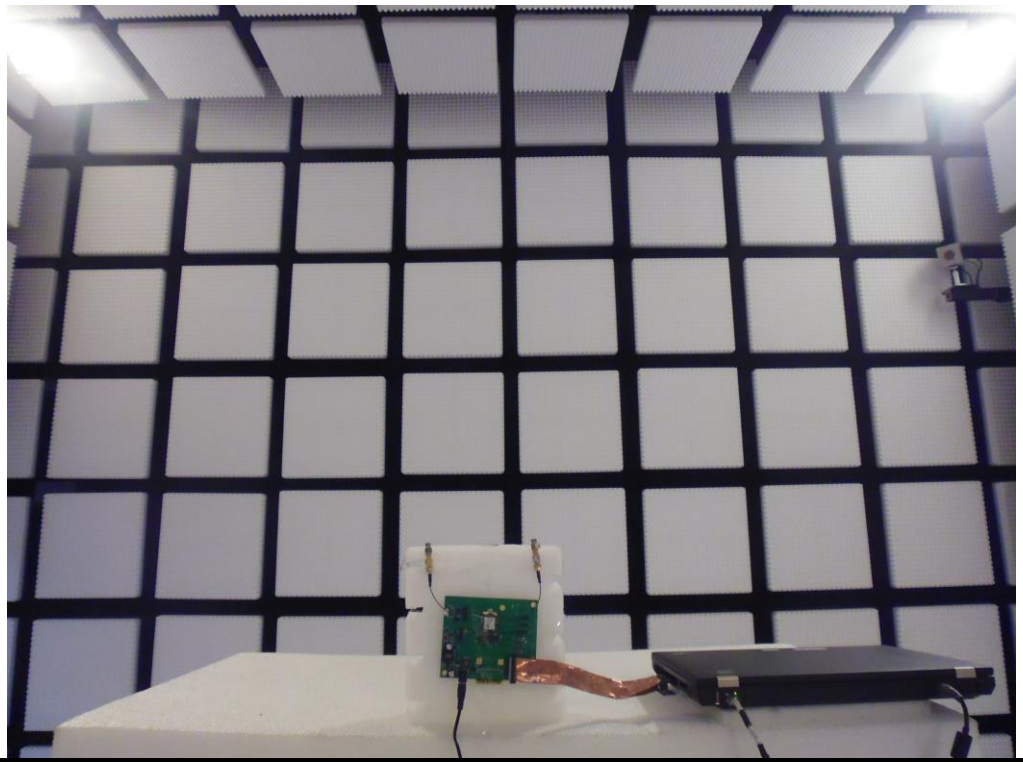
7 Photographs of the Test Configuration

Conducted Spurious Emission Test

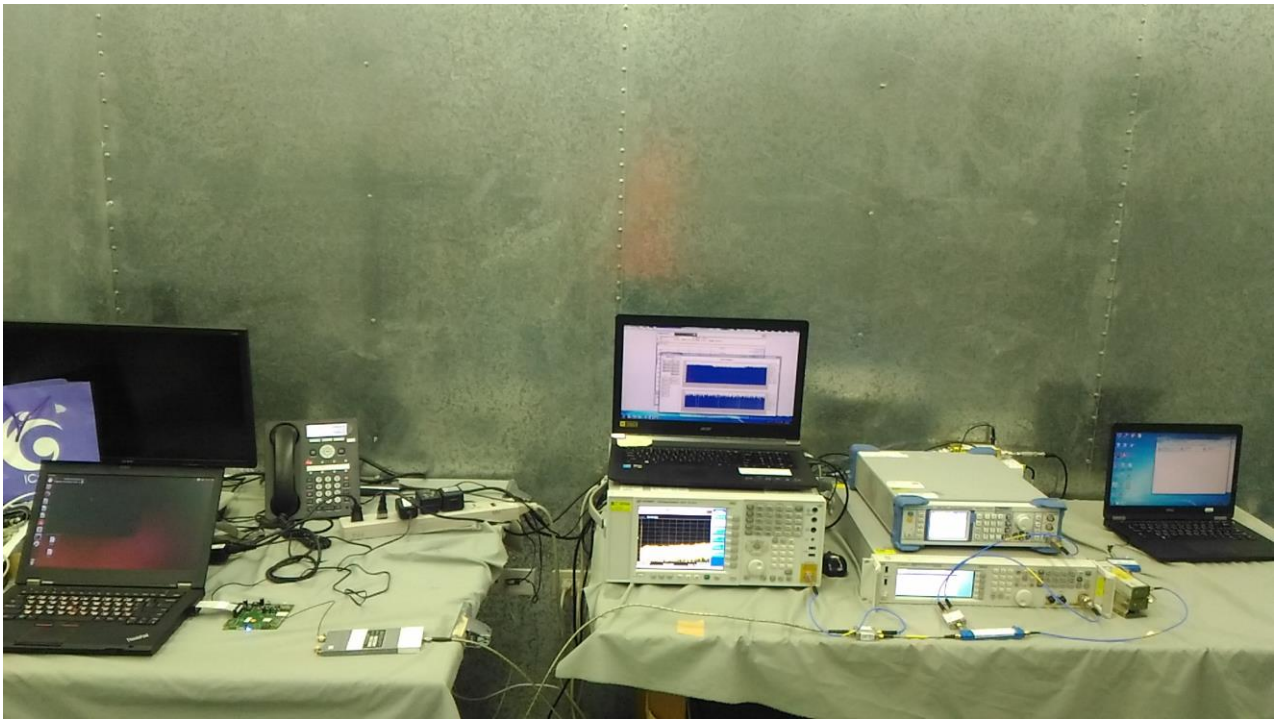


Radiated Spurious Emission Test

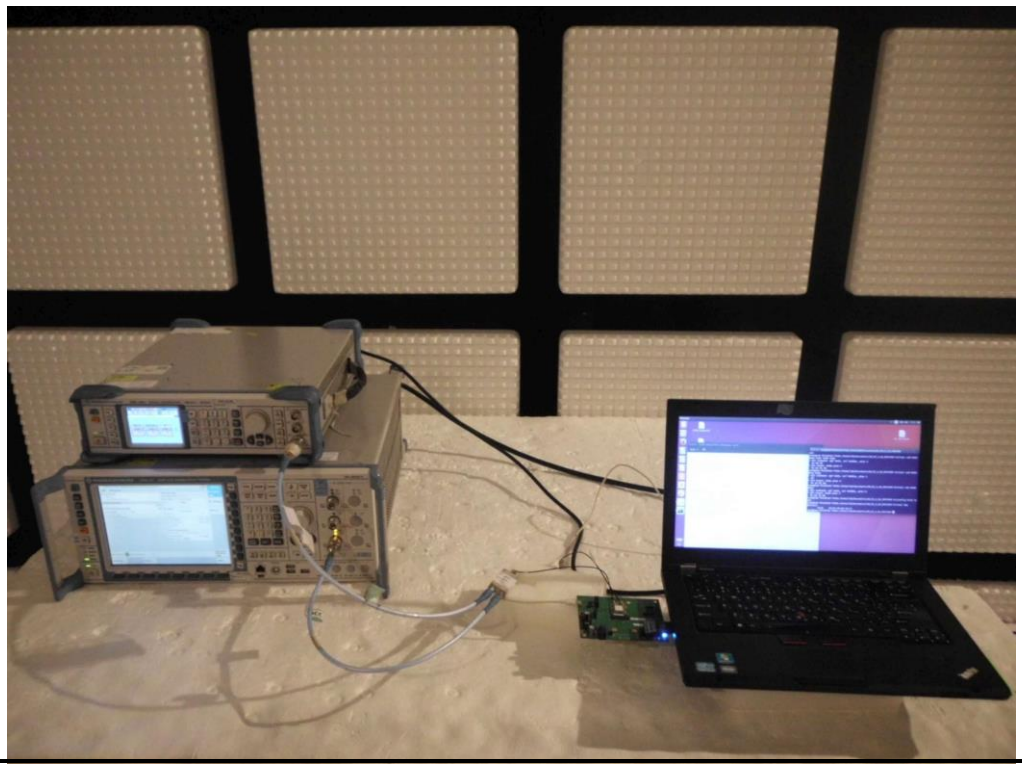




Adaptivity Test



Receiver Blocking Test



8 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website http://www.icertifi.com.tw.

Linkou	**Kwei Shan**	**Kwei Shan Site II**
Tel: 886-2-2601-1640	Tel: 886-3-271-8666	Tel: 886-3-271-8640
No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan, R.O.C.	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C..

If you have any suggestion, please feel free to contact us as below information

Tel: 886-3-271-8666
Fax: 886-3-318-0155
Email: ICC_Service@icertifi.com.tw

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