



TEST REPORT

Application No.: GZCR2108020964AT
Applicant: AfterShokz LLC
Address of Applicant: 3200 Gracie Kiltz Lane, Suite 400, Austin, TX 78758, United States
Manufacturer: Shokz Holding Limited
Address of Manufacturer: Room 2603A, 26/F., Tower 1, Lippo Centre, 89 Queensway, Admiralty, Hong Kong
Factory: Shenzhen Shokz Co., Ltd.
Address of Factory: Floors 1-4, Factory Building 26, Shancheng Industrial Park, Shixin Community, Langxin Community, Shiyan Street, Bao'an District, Shenzhen, Guangdong, China

Equipment Under Test (EUT):

EUT Name: OpenComm
Model No.: C102
Trade Mark: SHOKZ
Standard(s) : 47 CFR Part 15, Subpart C 15.247
Date of Receipt: 2021-08-25
Date of Test: 2021-08-25 to 2021-08-28
Date of Issue: 2021-08-28

Test Result:	Pass*
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* In the configuration tested, the EUT complied with the standards specified above.

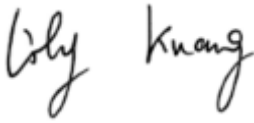

Kobe Jian
EMC Laboratory Manager



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Revision Record				
Version	Chapter	Date	Modifier	Remark
01		2021-08-28		Original

Authorized for issue by			
			
		<hr/> Lily Kuang/Project Engineer	
			
		<hr/> Ricky Liu/Reviewer	



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2 Test Summary

Radio Spectrum Technical Requirement				
Item	Standard	Method	Requirement	Result
Antenna Requirement	47 CFR Part 15, Subpart C 15.247	N/A	47 CFR Part 15, Subpart C 15.203 & 15.247(b)(4)	Pass
Other requirements Frequency Hopping Spread Spectrum System Hopping Sequence		N/A	47 CFR Part 15, Subpart C 15.247(a)(1),(g),(h)	Pass

Radio Spectrum Matter Part				
Item	Standard	Method	Requirement	Result
Conducted Emissions at AC Power Line (150kHz-30MHz)	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.2	47 CFR Part 15, Subpart C 15.207	Pass
Conducted Peak Output Power		ANSI C63.10 (2013) Section 7.8.5	47 CFR Part 15, Subpart C 15.247(b)(1)	Pass
20dB Bandwidth		ANSI C63.10 (2013) Section 7.8.7	47 CFR Part 15, Subpart C 15.247(a)(1)	Pass
Carrier Frequencies Separation		ANSI C63.10 (2013) Section 7.8.2	47 CFR Part 15, Subpart C 15.247a(1)	Pass
Hopping Channel Number		ANSI C63.10 (2013) Section 7.8.3	47 CFR Part 15, Subpart C 15.247a(1)(iii)	Pass
Dwell Time		ANSI C63.10 (2013) Section 7.8.4	47 CFR Part 15, Subpart C 15.247a(1)(iii)	Pass
Conducted Band Edges Measurement		ANSI C63.10 (2013) Section 7.8.6	47 CFR Part 15, Subpart C 15.247(d)	Pass
Conducted Spurious Emissions		ANSI C63.10 (2013) Section 7.8.8	47 CFR Part 15, Subpart C 15.247(d)	Pass
Radiated Emissions which fall in the restricted bands		ANSI C63.10 (2013) Section 6.10.5	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass
Radiated Spurious Emissions (Below 1GHz)		ANSI C63.10 (2013) Section 6.4,6.5,6.6	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass
Radiated Spurious Emissions (Above 1GHz)		ANSI C63.10 (2013) Section 6.4,6.5,6.6	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass

Note:

E.U.T./EUT means Equipment Under Test.

Pass means the test result passed the test standard requirement, please find the detailed decision rule in the report relative section.



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4 General Information

4.1 Details of E.U.T.

Power supply: Rechargeable Li-ion Battery
 Nominal voltage: 3.80V, 170mAh

Cable(s): USB unshielded cable: 106cm

Operation Frequency: 2402MHz to 2480MHz

Bluetooth Version: V5.1 Classic

Modulation Type: GFSK, pi/4DQPSK, 8DPSK

Number of Channels: 79

Channel Spacing: 1MHz

Spectrum Spread Technology: Frequency Hopping Spread Spectrum(FHSS)

Antenna Type: Integral Antenna

Antenna Gain: 0dBi

Hardware Version: 6.1

Firmware Version: 4.21

S/N: C1021280000010

Test Software: Blue test3

RF Power setting level: Default and cannot be changed by user

4.2 Description of Support Units

Description	Manufacturer	Model No.	Serial No.
Adapter	Apple	A1443	RE089



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4.3 Measurement Uncertainty

Test Item	Measurement Uncertainty
Conducted Emissions at AC Power Line (150kHz-30MHz)	±3.12dB
Conducted Peak Output Power	± 0.75dB
20dB Bandwidth	± 3%
Carrier Frequencies Separation	± 7.25 x 10 ⁻⁸
Hopping Channel Number	± 7.25 x 10 ⁻⁸
Dwell Time	± 0.37%
Conducted Band Edges Measurement	± 0.75dB
Conducted Spurious Emissions	± 0.75dB
Radiated Emissions which fall in the restricted bands	±5.08dB (1GHz-6GHz);±5.14dB(above 6GHz)
Radiated Spurious Emissions (Below 1GHz)	±5.06dB (3m); ±4.46dB (10m)
Radiated Spurious Emissions (Above 1GHz)	±5.08dB (1GHz-6GHz);±5.14dB(above 6GHz)

Remark:

The U_{lab} (lab Uncertainty) is less than U_{CISPR} (CISPR Uncertainty), so the test results
 – compliance is deemed to occur if no measured disturbance level exceeds the disturbance limit;
 – non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit.

4.4 Test Location

All tests were performed at:

SGS-CSTC Standards Technical Services Co., Ltd., Guangzhou Branch EMC Laboratory,
 198 Kezhu Road, Sciencetech Park, Guangzhou Economic & Technology Development District,
 Guangzhou, China 510663

Tel: +86 20 82155555

Fax: +86 20 82075059

No tests were sub-contracted.



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4.5 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **NVLAP (Lab Code: 200611-0)**

SGS-CSTC Standards Technical Services Co., Ltd., Guangzhou EMC Laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP/NIST). NVLAP Code: 200611-0.

The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

- **ACMA**

SGS-CSTC Standards Technical Services Co., Ltd., EMC Laboratory can also perform testing for the Australian/New Zealand Regulatory Compliance Mark (RCM).

- **SGS UK(Certificate No.: 32), SGS-TUV SAARLAND and SGS-FIMKO**

Have approved SGS-CSTC Standards Technical Services Co., Ltd., EMC Laboratory as a supplier of EMC TESTING SERVICES and SAFETY TESTING SERVICES.

- **CNAS (Lab Code: L0167)**

SGS-CSTC Standards Technical Services Co., Ltd., EMC Laboratory has been assessed and in compliance with CNAS-CL01:2018 accreditation criteria for testing laboratories (identical to ISO/IEC 17025:2017 General Requirements) for the Competence of Testing Laboratories.

- **FCC Recognized Accredited Test Firm(Registration No.: 486818)**

SGS-CSTC Standards Technical Services Co., Ltd., EMC Laboratory has been accredited and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Designation Number: CN5016, Test Firm Registration Number: 486818.

- **ISED (Registration No.: 4620B, CAB identifier: CN0052)**

SGS-CSTC Standards Technical Services Co., Ltd., has been registered by Innovation Science and Economic Development Canada for Wireless Device Testing laboratories to test to Canadian radio equipment requirements. Registration No. 4620B, CAB identifier: CN0052.

- **VCCI (Registration No.: R-12460, C-12584, G-20107 and T-11179)**

The 10m Semi-anechoic chamber, 966 Anechoic Chamber and Shielded Room of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: R-12460, C-12584, G-20107 and T-11179 respectively.

- **CBTL (Lab Code: TL129)**

SGS-CSTC Standards Technical Services Co., Ltd., E&E Laboratory has been assessed and fully comply with the requirements of ISO/IEC 17025:2017, the Basic Rules, IECEE 01 and Rules of procedure IECEE 02, and the relevant IECEE CB-Scheme Operational documents.

4.6 Deviation from Standards

None

4.7 Abnormalities from Standard Conditions

None



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5 Equipment List

Conducted Emissions at AC Power Line (150kHz-30MHz)					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	ChangZhou ZhongYu	8m x 3m x 3.8m	EMC0306	N/A	N/A
Two-Line V-Network	Rohde & Schwarz	ENV216	EMC0118	2021-01-08	2022-01-06
Two-Line V-Network-GZ	Rohde & Schwarz	ENV216	EMC2135	2020-09-25	2021-09-24
Coaxial Cable	HangTianXing	2m	EMC0107	2020-09-09	2022-09-08
Test Software E3c	Audix	Ver. 5.4.1221b	GZE100-62	N/A	N/A
EMI Test Receiver(9kHz-3.6GHz)	Rohde & Schwarz	ESR4	EMC2221	2021-06-01	2022-05-31

Conducted Peak Output Power					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Power Meter (U2021XA_Ch2)	Agilent Technologies	U2021XA_Ch2	SEM009-02	2021-05-19	2022-05-18
6dB Attenuator	HP	8491A	EMC2062	2020-04-15	2022-04-14
MI CABLE	SGS-EMC	0.8M	EMC2136	2019-11-02	2021-11-01

20dB Bandwidth					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
EXA Signal Analyzer(10Hz-44GHz)	Agilent Technologies	N9010A	EMC2138	2020-09-17	2021-09-16
6dB Attenuator	HP	8491A	EMC2062	2020-04-15	2022-04-14
MI CABLE	SGS-EMC	0.8M	EMC2136	2019-11-02	2021-11-01

Carrier Frequencies Separation					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
EXA Signal Analyzer(10Hz-44GHz)	Agilent Technologies	N9010A	EMC2138	2020-09-17	2021-09-16
6dB Attenuator	HP	8491A	EMC2062	2020-04-15	2022-04-14
MI CABLE	SGS-EMC	0.8M	EMC2136	2019-11-02	2021-11-01

Hopping Channel Number					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
EXA Signal Analyzer(10Hz-44GHz)	Agilent Technologies	N9010A	EMC2138	2020-09-17	2021-09-16
6dB Attenuator	HP	8491A	EMC2062	2020-04-15	2022-04-14
MI CABLE	SGS-EMC	0.8M	EMC2136	2019-11-02	2021-11-01



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Dwell Time					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
EXA Signal Analyzer(10Hz-44GHz)	Agilent Technologies	N9010A	EMC2138	2020-09-17	2021-09-16
6dB Attenuator	HP	8491A	EMC2062	2020-04-15	2022-04-14
MI CABLE	SGS-EMC	0.8M	EMC2136	2019-11-02	2021-11-01

Conducted Band Edges Measurement					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
EXA Signal Analyzer(10Hz-44GHz)	Agilent Technologies	N9010A	EMC2138	2020-09-17	2021-09-16
6dB Attenuator	HP	8491A	EMC2062	2020-04-15	2022-04-14
MI CABLE	SGS-EMC	0.8M	EMC2136	2019-11-02	2021-11-01

Conducted Spurious Emissions					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
EXA Signal Analyzer(10Hz-44GHz)	Agilent Technologies	N9010A	EMC2138	2020-09-17	2021-09-16
6dB Attenuator	HP	8491A	EMC2062	2020-04-15	2022-04-14
MI CABLE	SGS-EMC	0.8M	EMC2136	2019-11-02	2021-11-01

Radiated Emissions which fall in the restricted bands					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
EMI Test Receiver(20Hz-26.5GHz)	Rohde & Schwarz	ESIB26	EMC0522	2021-01-08	2022-01-07
Chamber cable(Above 1GHz)	Scoflex	KMKM-8.0m	EMC0545	2020-09-09	2022-09-08
Horn Antenna(1GHz-18GHz)	SCHWARZBECK MESS-ELEKTRONIK	BBHA 9120D	EMC2026	2019-09-25	2022-09-24
1GHz-26.5 GHz Pre-Amplifier	Agilent	8449B	EMC0521	2021-01-08	2022-01-07
2.4GHz Filter	Micro-Tronics	BRM 50702	EMC2069	2021-01-08	2022-01-07
966 Anechoic Chamber	C.R.T	9m x 6m x 6m	EMC2142	2020-12-20	2023-12-19
MXE EMI Receiver(10Hz-8.4GHz)	Keysight	N9038A	EMC2139	2020-11-13	2021-11-12
EXA Signal Analyzer(10Hz-44GHz)	Keysight	N9010A	EMC2138	2020-09-17	2021-09-16
Test Software E3	Audix	Ver.6.120110a	GZE100-61	N/A	N/A
Notch Filter (5150-5880)	Mico-Tronics	BRM50716	EMC2168	2021-07-29	2022-07-28
Horn Antenna(14-40GHz)	SCHWARZBECK	BBHA 9170	EMC2041	2020-06-28	2023-06-27



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Microwave Broadband Preamplifier (18-40GHz)	SCHWARZBECK	BBV 9721	EMC2172	2020-09-09	2021-09-08
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Radiated Spurious Emissions (Below 1GHz)					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Trilog Broadband Antenna(25MHz-1GHz)-On Site	SCHWARZBECK MESS-ELEKTRONIK	VULB 9168	EMC2174	2018-09-06	2021-09-05
Trilog Broadband Antenna(25MHz-1GHz)-Lab	SCHWARZBECK MESS-ELEKTRONIK	VULB 9168	SEM003-18	2019-02-22	2022-02-22
Amplifier(9kHz-1.3GHz)	HP	8447F	EMC2065	2021-05-19	2022-05-18
Active Loop Antenna-RED	ETS-Lindgren	6502	EMC2190	2019-12-27	2021-12-26
High Pass Filter (915MHz)	FSY MICROWAVE	HM1465-9SS	EMC2079	2021-01-08	2022-01-07
10m Semi-Anechoic Chamber	ETS	N/A	EMC0530	2019-10-20	2022-10-19
Test Software E3	Audix	Ver.6.120110a	GZE100-61	N/A	N/A

Radiated Spurious Emissions (Above 1GHz)					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
EMI Test Receiver(20Hz-26.5GHz)	Rohde & Schwarz	ESIB26	EMC0522	2021-01-08	2022-01-07
Chamber cable(Above 1GHz)	Scoflex	KMKM-8.0m	EMC0545	2020-09-09	2022-09-08
Horn Antenna(1GHz-18GHz)	SCHWARZBECK MESS-ELEKTRONIK	BBHA 9120D	EMC2026	2019-09-25	2022-09-24
1GHz-26.5 GHz Pre-Amplifier	Agilent	8449B	EMC0521	2021-01-08	2022-01-07
2.4GHz Filter	Micro-Tronics	BRM 50702	EMC2069	2021-01-08	2022-01-07
966 Anechoic Chamber	C.R.T	9m x 6m x 6m	EMC2142	2020-12-20	2023-12-19
MXE EMI Receiver(10Hz-8.4GHz)	Keysight	N9038A	EMC2139	2020-11-13	2021-11-12
EXA Signal Analyzer(10Hz-44GHz)	Keysight	N9010A	EMC2138	2020-09-17	2021-09-16
Test Software E3	Audix	Ver.6.120110a	GZE100-61	N/A	N/A
Notch Filter (5150-5880)	Mico-Tronics	BRM50716	EMC2168	2021-07-29	2022-07-28
Horn Antenna(14-40GHz)	SCHWARZBECK	BBHA 9170	EMC2041	2020-06-28	2023-06-27



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 Guangzhou Branch: 198 Meihu Road, Science Park, Guangzhou Economic & Technology Development District, Guangzhou, China 510663 t (86-20) 82155555 f (86-20) 82075058 sgs.china@sgs.com
 中国·广州·经济技术开发区科学城科珠路198号 邮编: 510663 t (86-20) 82155555 f (86-20) 82075058 sgs.china@sgs.com

Microwave Broadband Preamplifier (18-40GHz)	SCHWARZBECK	BBV 9721	EMC2172	2020-09-09	2021-09-08
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General used equipment					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
DMM	Fluke	73	EMC0006	2021-07-05	2022-07-05
DMM	Fluke	73	EMC0007	2021-07-05	2022-07-05



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6 Radio Spectrum Technical Requirement

6.1 Antenna Requirement

6.1.1 Test Requirement:

47 CFR Part 15, Subpart C 15.203 & 15.247(b)(4)

6.1.2 Conclusion

Standard Requirement:

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

EUT Antenna:

The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 0dBi.

Please refer to internal photos.



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6.2 Other requirements Frequency Hopping Spread Spectrum System Hopping Sequence

6.2.1 Test Requirement:

47 CFR Part 15, Subpart C 15.247(a)(1),(g),(h)

Limit:

Standard Requirement:

The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

Compliance for section 15.247(a)(1):

According to Technical Specification, the pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONES; i.e. the shift register is initialized with nine ones.

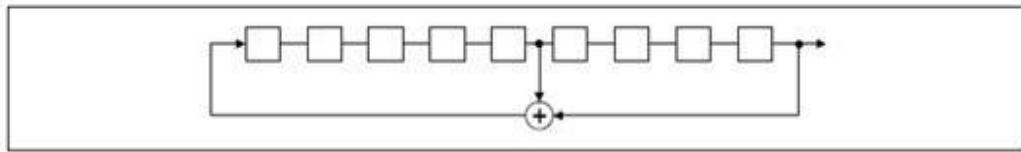
- > Number of shift register stages: 9
- > Length of pseudo-random sequence: $2^9 - 1 = 511$ bits
- > Longest sequence of zeros: 8 (non-inverted signal)

Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:

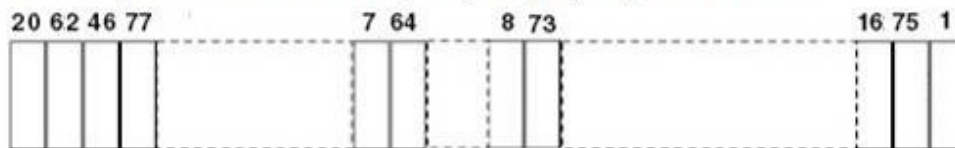


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Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.

According to Technical Specification, the receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any transmitters and shift frequencies in synchronization with the transmitted signals.

Compliance for section 15.247(g):

According to Technical Specification, the system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.

Compliance for section 15.247(h):

According to Technical specification, the system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.

The system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

6.2.2 Conclusion

Standard Requirement:

The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The



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coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

Compliance for section 15.247(a)(1):

According to Technical Specification, the pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONES; i.e. the shift register is initialized with nine ones.

- > Number of shift register stages: 9
- > Length of pseudo-random sequence: $2^9 - 1 = 511$ bits
- > Longest sequence of zeros: 8 (non-inverted signal)

Linear Feedback Shift Register for Generation of the PRBS sequence

Each frequency used equally on the average by each transmitter.

According to Technical Specification, the receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any transmitters and shift frequencies in synchronization with the transmitted signals.

Compliance for section 15.247(g):

According to Technical Specification, the system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.

Compliance for section 15.247(h):

According to Technical specification, the system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.

The system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.



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7 Radio Spectrum Matter Test Results

7.1 Conducted Emissions at AC Power Line (150kHz-30MHz)

Test Requirement 47 CFR Part 15, Subpart C 15.207
 Test Method: ANSI C63.10 (2013) Section 6.2
 Limit:

Frequency of emission(MHz)	Conducted limit(dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.
 Detector: Peak for pre-scan (9kHz resolution bandwidth) 0.15M to 30MHz

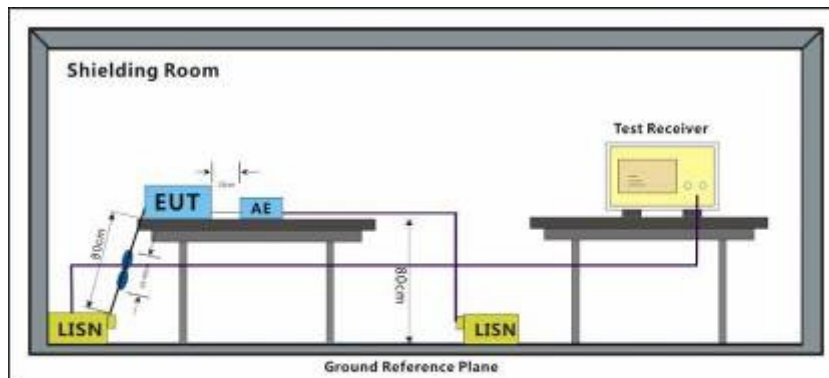
7.1.1 E.U.T. Operation

Operating Environment:
 Temperature: 25.2 °C Humidity: 52.4 % RH Atmospheric Pressure: 995 mbar

7.1.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Final test	01	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.1.3 Test Setup Diagram



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7.1.4 Measurement Procedure and Data

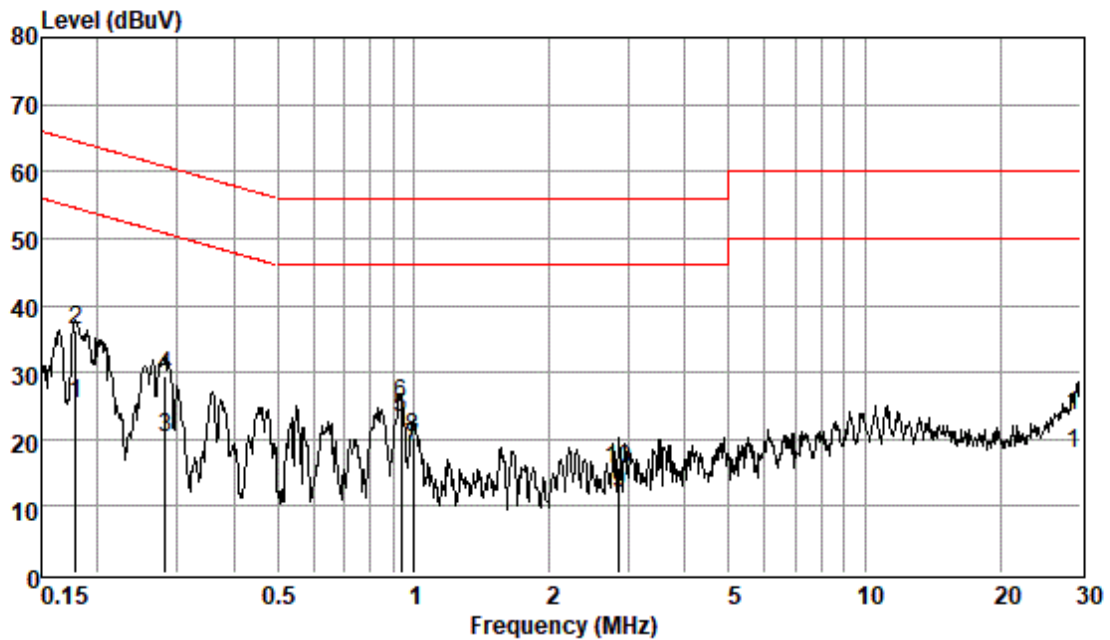
- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50ohm/50μH + 5ohm linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
- 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane.
- 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

Remark: LISN=Read Level+ Cable Loss+ LISN Factor



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Test Mode: 01; Line: Live line



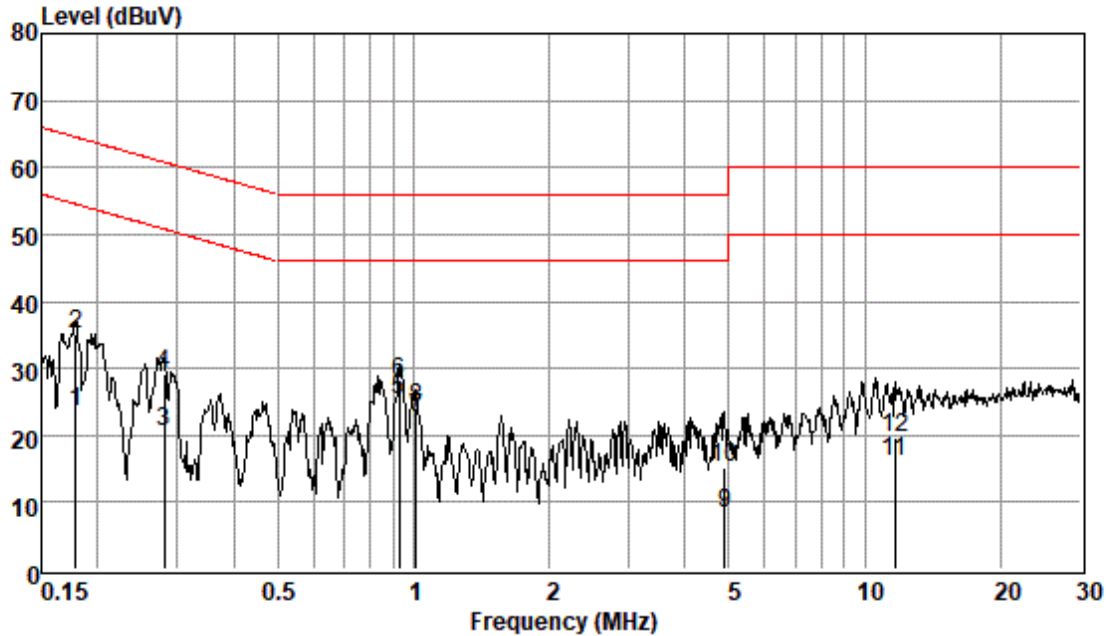
Pol : LINE
Mode :
Model :

Frequency MHz	Read Level dBuV	Cable Loss dB	LISN Factor dB	Measured Level dBuV	Limit Line dBuV	Over Limit dB	Remark
0.18	15.51	0.06	9.62	25.19	54.55	-29.36	Average
0.18	26.63	0.06	9.62	36.31	64.55	-28.24	QP
0.28	10.56	0.06	9.62	20.24	50.76	-30.52	Average
0.28	19.78	0.06	9.62	29.46	60.76	-31.30	QP
0.94	13.52	0.07	9.62	23.21	46.00	-22.79	Average
0.94	15.46	0.07	9.62	25.15	56.00	-30.85	QP
1.00	8.93	0.07	9.62	18.62	46.00	-27.38	Average
1.00	10.62	0.07	9.62	20.31	56.00	-35.69	QP
2.85	2.23	0.14	9.62	11.99	46.00	-34.01	Average
2.85	5.65	0.14	9.62	15.41	56.00	-40.59	QP
30.00	7.42	0.44	9.99	17.85	50.00	-32.15	Average
30.00	13.13	0.44	9.99	23.56	60.00	-36.44	QP



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Test Mode: 01; Line: Neutral Line



Pol : NEUTRAL
 Mode :
 Model :

Frequency MHz	Read Level dBuV	Cable Loss dB	LISN Factor dB	Measured Level dBuV	Limit Line dBuV	Over Limit dB	Remark
0.18	14.01	0.06	9.55	23.62	54.55	-30.93	Average
0.18	25.53	0.06	9.55	35.14	64.55	-29.41	QP
0.28	10.91	0.06	9.54	20.51	50.81	-30.30	Average
0.28	19.48	0.06	9.54	29.08	60.81	-31.73	QP
0.93	15.75	0.07	9.55	25.37	46.00	-20.63	Average
0.93	18.48	0.07	9.55	28.10	56.00	-27.90	QP
1.02	12.90	0.07	9.55	22.52	46.00	-23.48	Average
1.02	14.56	0.07	9.55	24.18	56.00	-31.82	QP
4.90	-1.49	0.18	9.56	8.25	46.00	-37.75	Average
4.90	5.44	0.18	9.56	15.18	56.00	-40.82	QP
11.62	6.28	0.26	9.61	16.15	50.00	-33.85	Average
11.62	9.87	0.26	9.61	19.74	60.00	-40.26	QP



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7.2 Conducted Peak Output Power

Test Requirement 47 CFR Part 15, Subpart C 15.247(b)(1)
 Test Method: ANSI C63.10 (2013) Section 7.8.5
 Limit:

Frequency range(MHz)	Output power of the intentional radiator(watt)
902-928	1 for ≥ 50 hopping channels
	0.25 for $25 \leq$ hopping channels < 50
	1 for digital modulation
2400-2483.5	1 for ≥ 75 non-overlapping hopping channels
	0.125 for all other frequency hopping systems
	1 for digital modulation
5725-5850	1 for frequency hopping systems and digital modulation

7.2.1 E.U.T. Operation

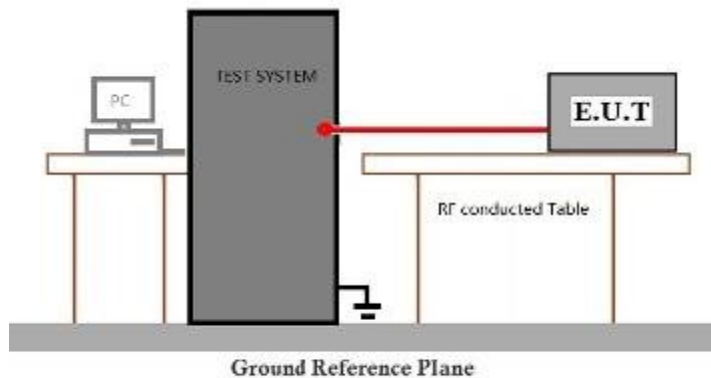
Operating Environment:

Temperature: 25.6 °C Humidity: 53.3 % RH Atmospheric Pressure: 995 mbar

7.2.2 Test Mode Description

Pre-scan / Mode	Description
Final test Code	
Final test 00	TX_non-Hop mode Keep the EUT in continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.2.3 Test Setup Diagram



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7.2.4 Measurement Procedure and Data

cable loss=0.9dB

Please Refer to Appendix for Details



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7.3 20dB Bandwidth

Test Requirement 47 CFR Part 15, Subpart C 15.247(a)(1)
 Test Method: ANSI C63.10 (2013) Section 7.8.7

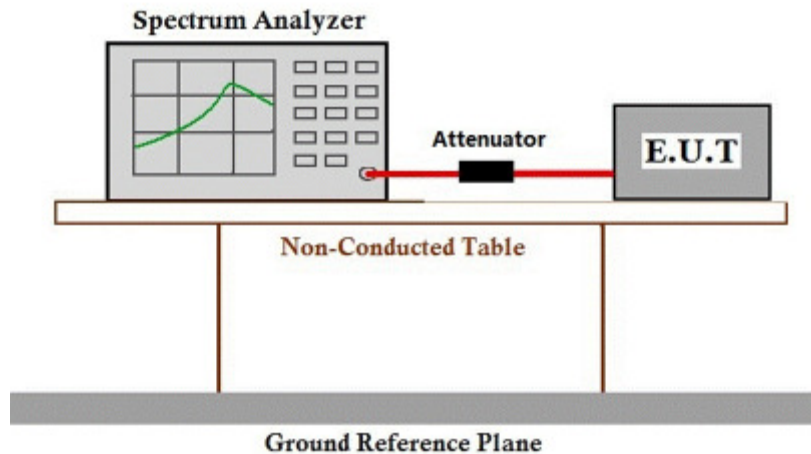
7.3.1 E.U.T. Operation

Operating Environment:
 Temperature: 25.6 °C Humidity: 53.3 % RH Atmospheric Pressure: 995 mbar

7.3.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Final test	00	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.3.3 Test Setup Diagram



7.3.4 Measurement Procedure and Data

cable loss=0.9dB

Please Refer to Appendix for Details



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7.4 Carrier Frequencies Separation

Test Requirement 47 CFR Part 15, Subpart C 15.247a(1)

Test Method: ANSI C63.10 (2013) Section 7.8.2

Limit:

2/3 of the 20dB bandwidth base on the transmission power is less than 0.125W.

7.4.1 E.U.T. Operation

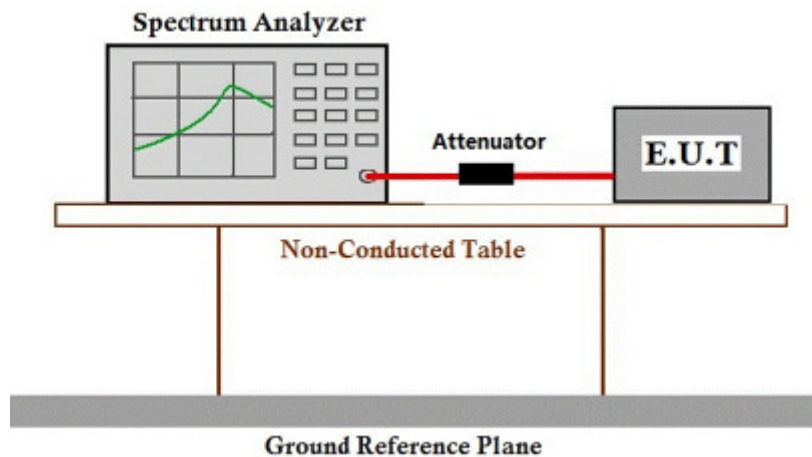
Operating Environment:

Temperature: 25.6 °C Humidity: 53.3 % RH Atmospheric Pressure: 995 mbar

7.4.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Final test	02	TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.4.3 Test Setup Diagram



7.4.4 Measurement Procedure and Data

cable loss=0.9dB

Please Refer to Appendix for Details



7.5 Hopping Channel Number

Test Requirement 47 CFR Part 15, Subpart C 15.247a(1)(iii)
 Test Method: ANSI C63.10 (2013) Section 7.8.3
 Limit:

Frequency range(MHz)	Number of hopping channels (minimum)
902-928	50 for 20dB bandwidth <250kHz
	25 for 20dB bandwidth ≥250kHz
2400-2483.5	15
5725-5850	75

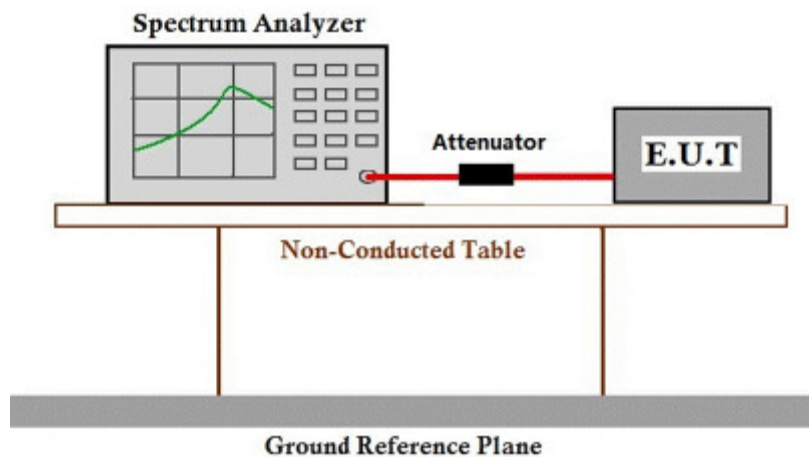
7.5.1 E.U.T. Operation

Operating Environment:
 Temperature: 25.6 °C Humidity: 53.3 % RH Atmospheric Pressure: 995 mbar

7.5.2 Test Mode Description

Pre-scan / Mode	Description
Final test Code	
Final test 02	TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.5.3 Test Setup Diagram



7.5.4 Measurement Procedure and Data

cable loss=0.9dB

Please Refer to Appendix for Details



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7.6 Dwell Time

Test Requirement 47 CFR Part 15, Subpart C 15.247a(1)(iii)
 Test Method: ANSI C63.10 (2013) Section 7.8.4
 Limit:

Frequency(MHz)	Limit
902-928	0.4s within a 20s period(20dB bandwidth<250kHz)
	0.4s within a 10s period(20dB bandwidth≥250kHz)
2400-2483.5	0.4s within a period of 0.4s multiplied by the number of hopping channels
5725-5850	0.4s within a 30s period

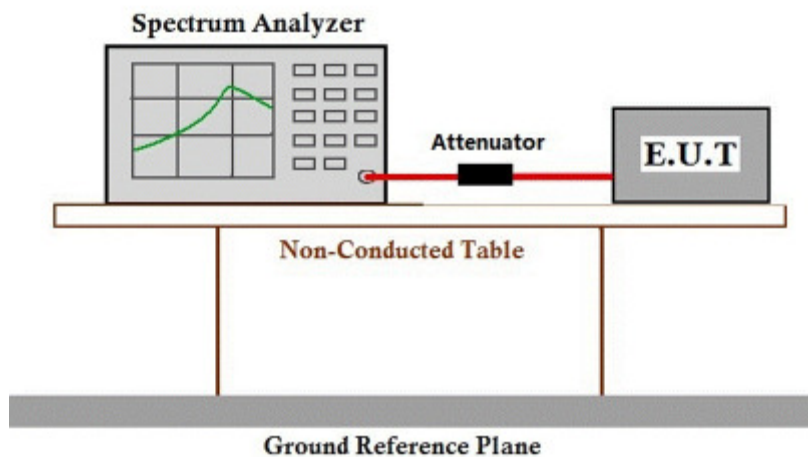
7.6.1 E.U.T. Operation

Operating Environment:
 Temperature: 25.6 °C Humidity: 53.3 % RH Atmospheric Pressure: 995 mbar

7.6.2 Test Mode Description

Pre-scan / Mode	Description
Final test Code	
Final test 02	TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.6.3 Test Setup Diagram



7.6.4 Measurement Procedure and Data

cable loss=0.9dB

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7.7 Conducted Band Edges Measurement

Test Requirement 47 CFR Part 15, Subpart C 15.247(d)

Test Method: ANSI C63.10 (2013) Section 7.8.6

Limit:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

7.7.1 E.U.T. Operation

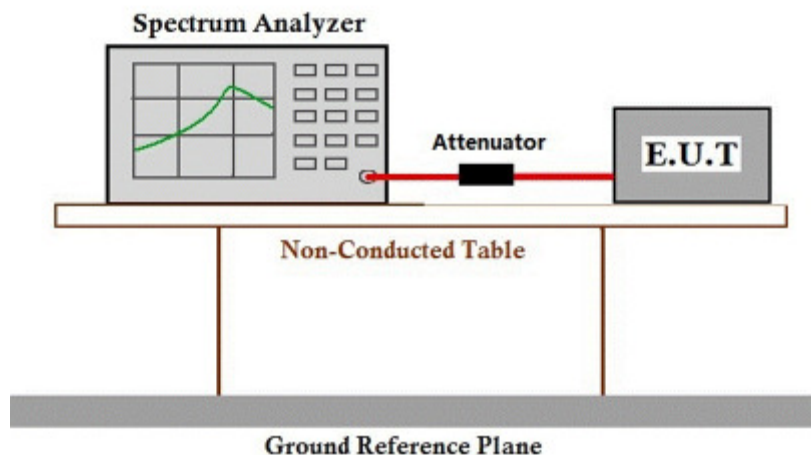
Operating Environment:

Temperature: 25.6 °C Humidity: 53.3 % RH Atmospheric Pressure: 995 mbar

7.7.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Final test	00	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.
Final test	02	TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.7.3 Test Setup Diagram



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7.7.4 Measurement Procedure and Data

cable loss=0.9dB

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7.8 Conducted Spurious Emissions

Test Requirement 47 CFR Part 15, Subpart C 15.247(d)
 Test Method: ANSI C63.10 (2013) Section 7.8.8
 Limit:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

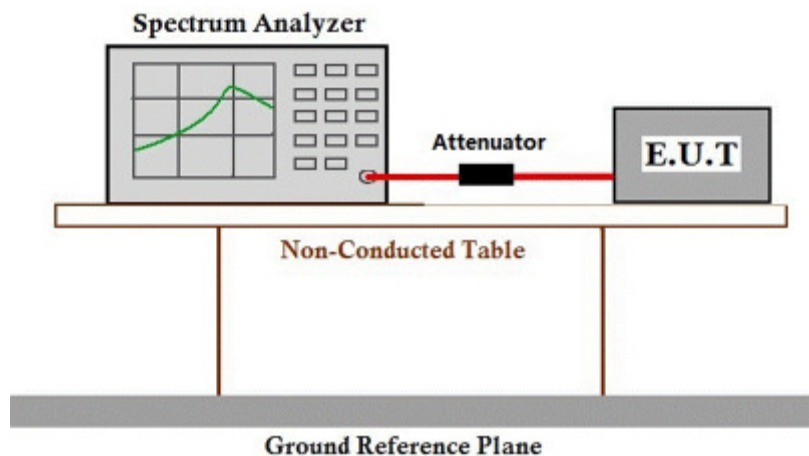
7.8.1 E.U.T. Operation

Operating Environment:
 Temperature: 25.6 °C Humidity: 53.3 % RH Atmospheric Pressure: 995 mbar

7.8.2 Test Mode Description

Pre-scan / Mode	Description
Final test Code	
Final test 00	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.8.3 Test Setup Diagram



7.8.4 Measurement Procedure and Data

cable loss=0.9dB

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7.9 Radiated Emissions which fall in the restricted bands

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209
 Test Method: ANSI C63.10 (2013) Section 6.10.5
 Limit:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

7.9.1 E.U.T. Operation

Operating Environment:
 Temperature: 25.7 °C Humidity: 54.4 % RH Atmospheric Pressure: 995 mbar

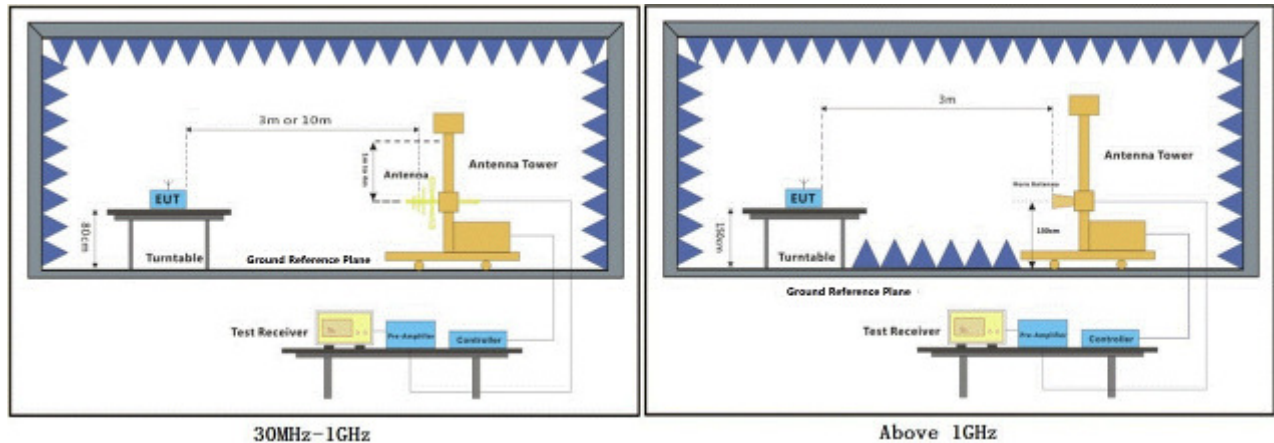
7.9.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Pre-scan	00	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.
Final test	01	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.



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7.9.3 Test Setup Diagram



7.9.4 Measurement Procedure and Data

- a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- h. Test the EUT in the lowest channel, the Highest channel.
- i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
- j. Repeat above procedures until all frequencies measured was complete.

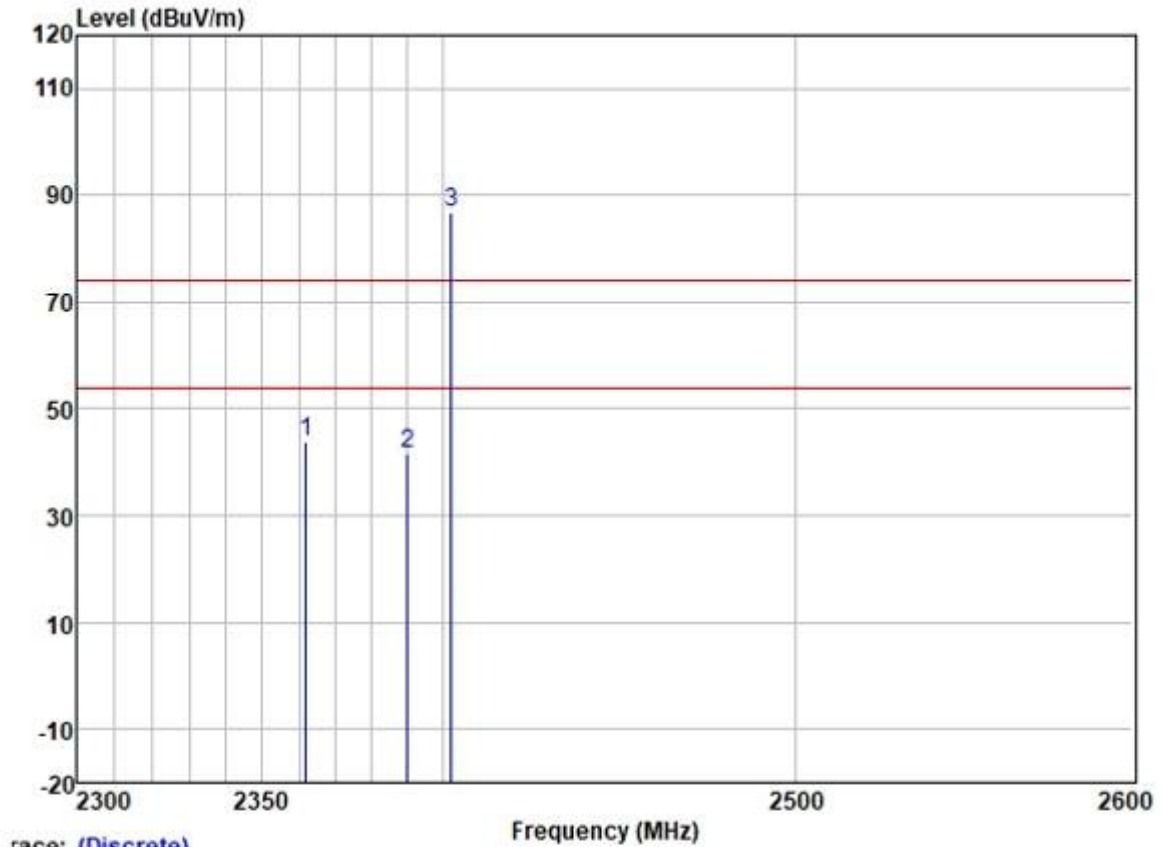
Remark 1: Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor

Remark 2: For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.



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Test Mode: 01; Polarity: Horizontal; Modulation:GFSK; ; Channel:Low



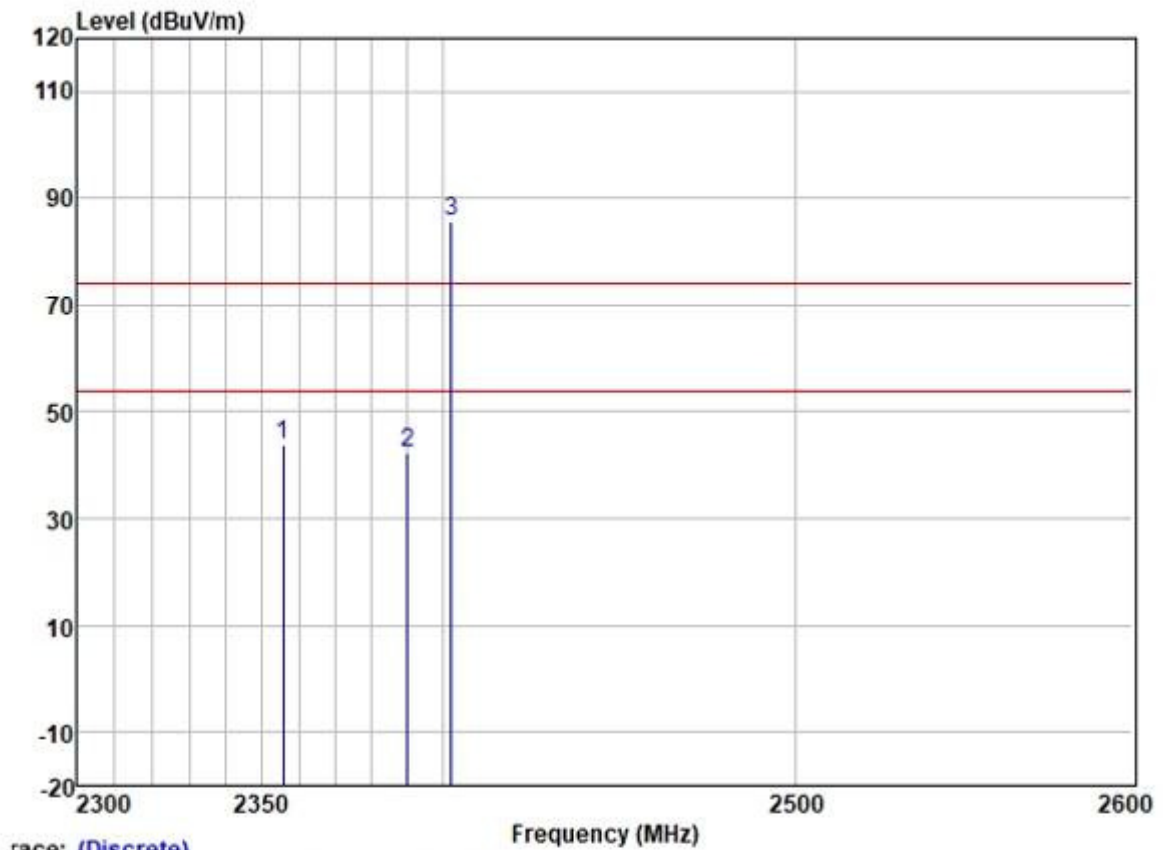
Trace: (Discrete)

	Read Freq	Antenna Level	Cable Factor	Preamp Loss	Preamp Factor	Level	Limit	Over	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	2361.771	50.75	27.27	3.42	37.61	43.83	74.00	-30.17	HORIZONTAL	Peak
2	2390.000	48.34	27.33	3.48	37.59	41.56	74.00	-32.44	HORIZONTAL	Peak
3 *	2402.000	93.45	27.35	3.50	37.59	86.71	74.00	12.71	HORIZONTAL	Peak



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Test Mode: 01; Polarity: Vertical; Modulation:GFSK; ; Channel:Low



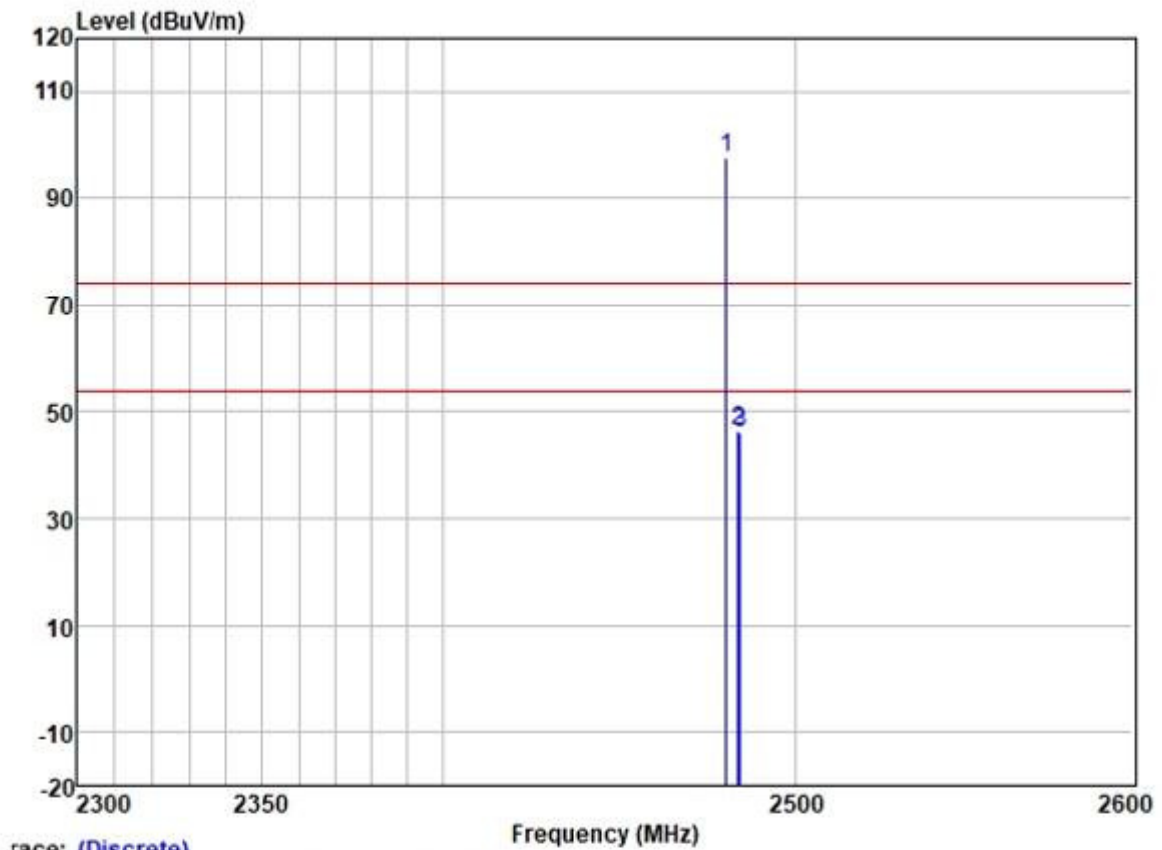
Trace: (Discrete)

	Read Freq	Antenna Level	Cable Factor	Preamp Loss	Preamp Factor	Level	Limit	Over	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	2355.674	50.92	27.25	3.40	37.61	43.96	74.00	-30.04	VERTICAL	Peak
2	2390.000	49.01	27.33	3.48	37.59	42.23	74.00	-31.77	VERTICAL	Peak
3 *	2402.000	92.49	27.35	3.50	37.59	85.75	74.00	11.75	VERTICAL	Peak



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Test Mode: 01; Polarity: Horizontal; Modulation:GFSK; ; Channel:High



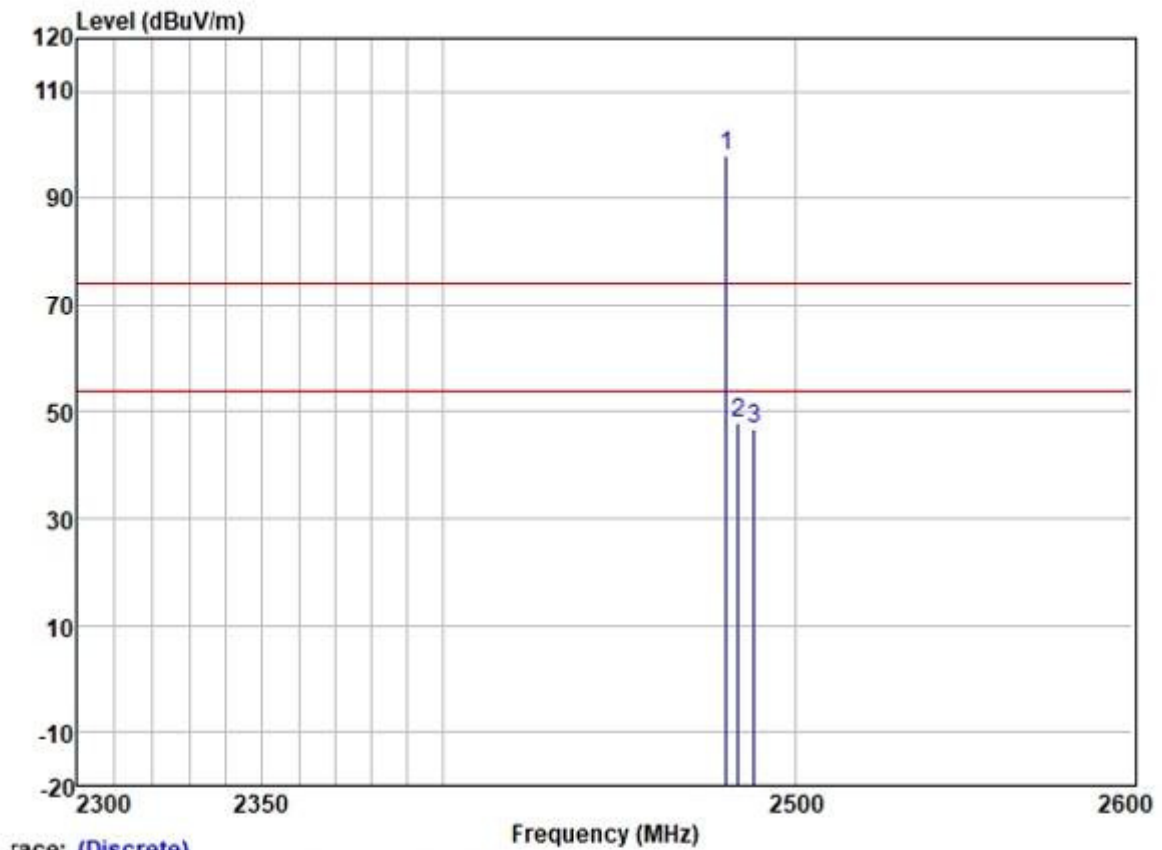
Trace: (Discrete)

	Read	Antenna	Cable	Preamp		Limit	Over		
Freq	Level	Factor	Loss	Factor	Level	Line	Limit	Pol/Phase	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1 *	2480.000	104.04	27.47	3.60	37.57	97.54	74.00	23.54	HORIZONTAL Peak
2	2483.500	52.94	27.48	3.53	37.57	46.38	74.00	-27.62	HORIZONTAL Peak
3	2484.121	52.81	27.48	3.53	37.57	46.25	74.00	-27.75	HORIZONTAL Peak



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Test Mode: 01; Polarity: Vertical; Modulation:GFSK; ; Channel:High



Trace: (Discrete)

	Read Freq	Antenna Level	Cable Factor	Preamp Loss	Preamp Factor	Limit Level	Over Limit	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dB		
1 *	2480.000	104.65	27.47	3.60	37.57	98.15	74.00	24.15	VERTICAL Peak
2	2483.500	54.61	27.48	3.53	37.57	48.05	74.00	-25.95	VERTICAL Peak
3	2488.044	53.50	27.48	3.53	37.56	46.95	74.00	-27.05	VERTICAL Peak



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7.10 Radiated Spurious Emissions (Below 1GHz)

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209
 Test Method: ANSI C63.10 (2013) Section 6.4,6.5,6.6
 Limit:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

7.10.1 E.U.T. Operation

Operating Environment:
 Temperature: 25.9 °C Humidity: 53.8 % RH Atmospheric Pressure: 995 mbar

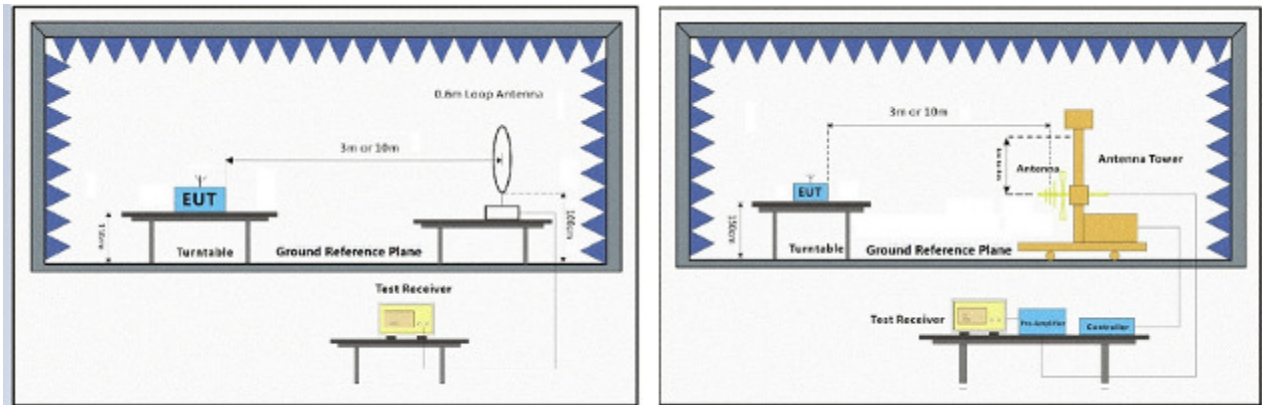
7.10.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Pre-scan	00	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.
Final test	01	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.



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7.10.3 Test Setup Diagram



7.10.4 Measurement Procedure and Data

- For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- Test the EUT in the lowest channel, the middle channel, the Highest channel.
- The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
- Repeat above procedures until all frequencies measured was complete.

Remark:

- Through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report.
- The field strength is calculated by adding the Antenna Factor, Cable Factor & Pre-amplifier. The basic equation with a sample calculation is as follows:
 Final Test Level = Receiver Reading + Antenna Factor + Cable Factor - Pre-amplifier Factor
- Scan from 9kHz to 1 GHz, the disturbance below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.



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The test was performed at a 10m test site. According to below formulate and the test data at 10m test distance,

$$L_3 / L_{10} = D_{10} / D_3$$

Note:

L₃: Level at 3m distance. Unit: uV/m;

L₁₀: Level at 10m distance. Unit: uV/m;

D₃: 3m distance. Unit: m

D₁₀: 10m distance. Unit: m

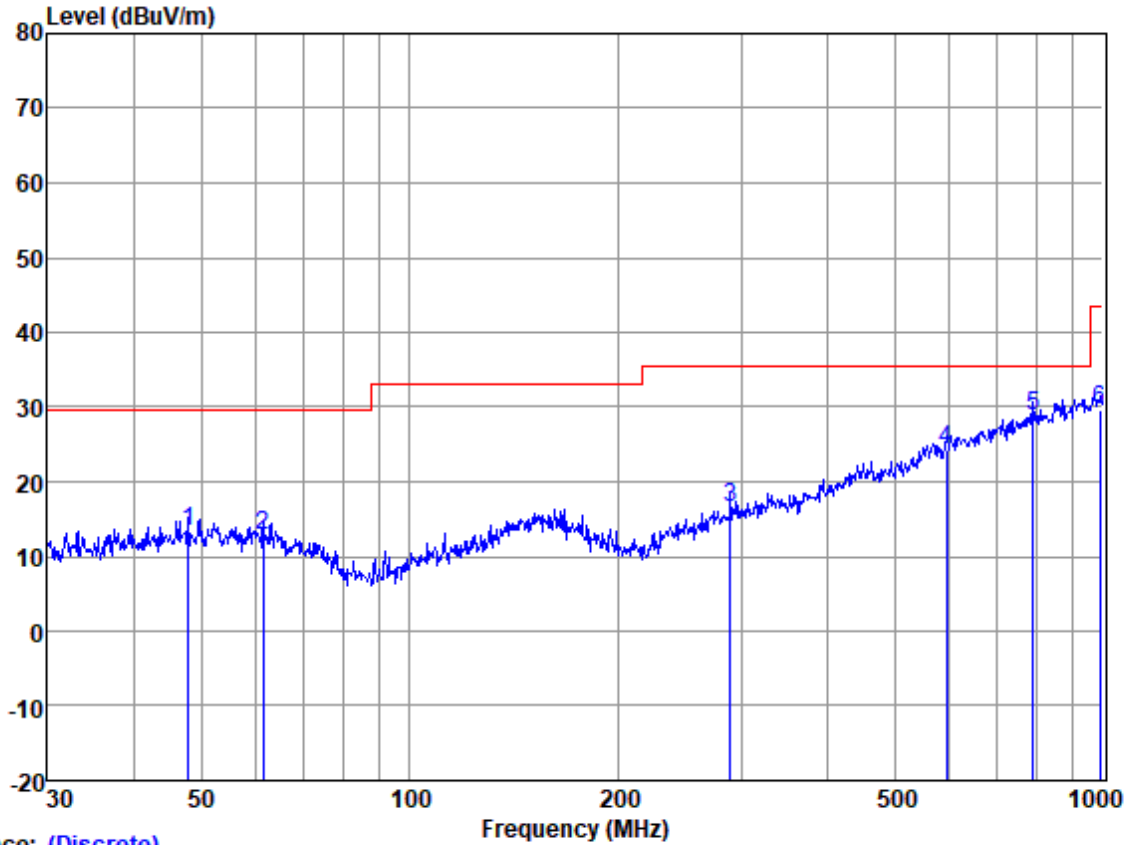
The level at 3m test distance is below:

Frequency (MHz)	Level at 10m (dBuV/m)	Level at 10m (uV/m)	Level at 3m (uV/m)	Level at 3m (dBuV/m)	Limit at 3m (dBuV/m)	Margin (dB)	Ant. Polarization
47.83	13.35	4.65	15.50	23.81	40.00	-16.19	H
61.35	12.88	4.41	14.69	23.34	40.00	-16.66	H
290.02	16.58	6.75	22.48	27.04	46.00	-18.96	H
593.05	24.32	16.44	54.81	34.78	46.00	-11.22	H
793.40	28.79	27.51	91.70	39.25	46.00	-6.75	H
989.54	29.68	30.48	101.60	40.14	54.00	-13.86	H
45.06	15.58	6.01	20.04	26.04	40.00	-13.96	V
57.39	18.93	8.84	29.47	29.39	40.00	-10.61	V
64.89	16.03	6.33	21.10	26.49	40.00	-13.51	V
276.12	15.92	6.25	20.84	26.38	46.00	-19.62	V
574.63	24.75	17.28	57.59	35.21	46.00	-10.79	V
785.09	28.62	26.98	89.92	39.08	46.00	-6.92	V



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Test Mode: 01; Polarity: Horizontal



Trace: (Discrete)

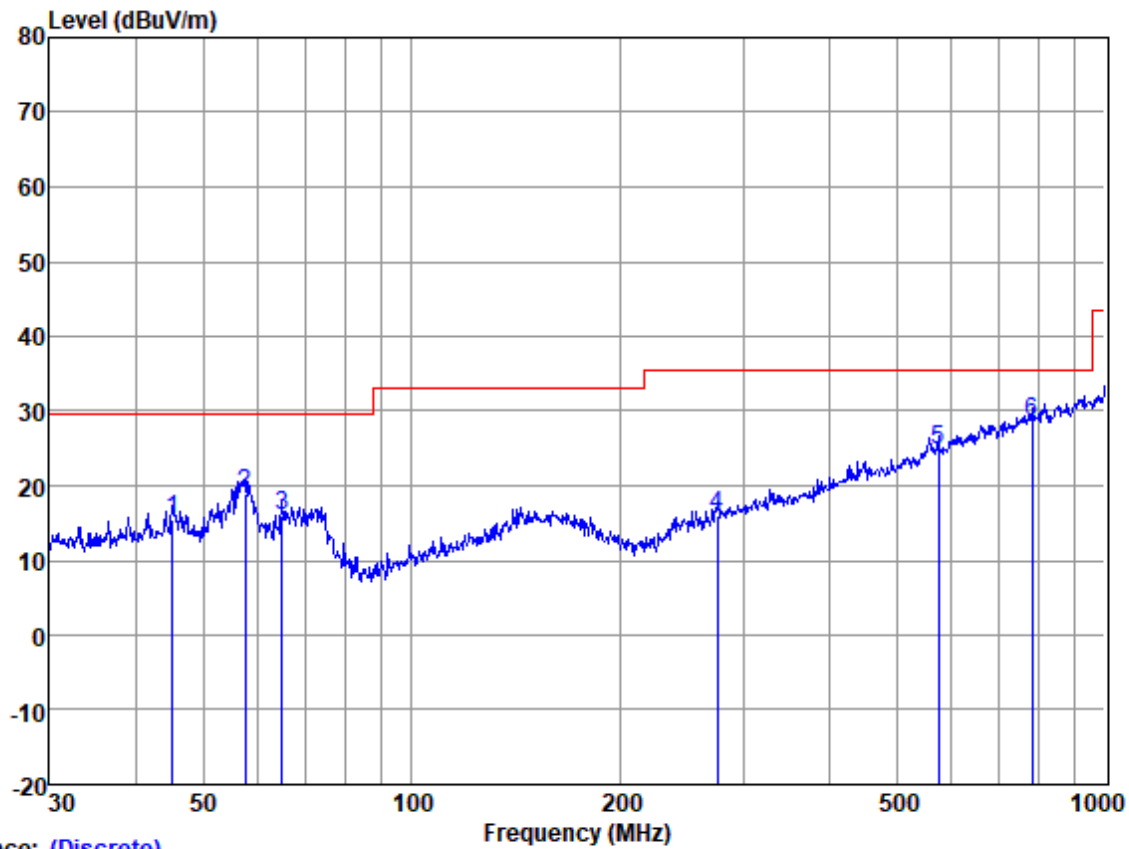
Site : SGS
Job :
Model :
Power :
Test Mode :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Measured Level	Limit Line	Over Limit	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dBuV		
1	47.83	25.40	13.99	1.13	27.17	13.35	29.50	-16.15	HORIZONTAL	QP
2	61.35	25.57	13.18	1.28	27.15	12.88	29.50	-16.62	HORIZONTAL	QP
3	290.02	26.62	13.40	3.12	26.56	16.58	35.60	-19.02	HORIZONTAL	QP
4	593.05	27.82	19.60	5.10	28.20	24.32	35.60	-11.28	HORIZONTAL	QP
5	793.40	28.16	22.53	6.14	28.04	28.79	35.60	-6.81	HORIZONTAL	QP
6	989.54	25.78	24.20	7.37	27.67	29.68	43.50	-13.82	HORIZONTAL	QP



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Test Mode: 01; Polarity: Vertical



Trace: (Discrete)

Site : SGS
Job :
Model :
Power :
Test Mode :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Measured Level	Limit Line	Over Limit	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dBuV		
1	45.06	27.78	13.85	1.12	27.17	15.58	29.50	-13.92	VERTICAL	QP
2	57.39	31.24	13.63	1.22	27.16	18.93	29.50	-10.57	VERTICAL	QP
3	64.89	29.08	12.75	1.35	27.15	16.03	29.50	-13.47	VERTICAL	QP
4	276.12	26.37	13.05	3.07	26.57	15.92	35.60	-19.68	VERTICAL	QP
5	574.63	28.89	19.05	4.98	28.17	24.75	35.60	-10.85	VERTICAL	QP
6	785.09	28.15	22.40	6.11	28.04	28.62	35.60	-6.98	VERTICAL	QP



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7.11 Radiated Spurious Emissions (Above 1GHz)

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209
 Test Method: ANSI C63.10 (2013) Section 6.4,6.5,6.6
 Limit:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

7.11.1 E.U.T. Operation

Operating Environment:
 Temperature: 25.7 °C Humidity: 54.4 % RH Atmospheric Pressure: 995 mbar

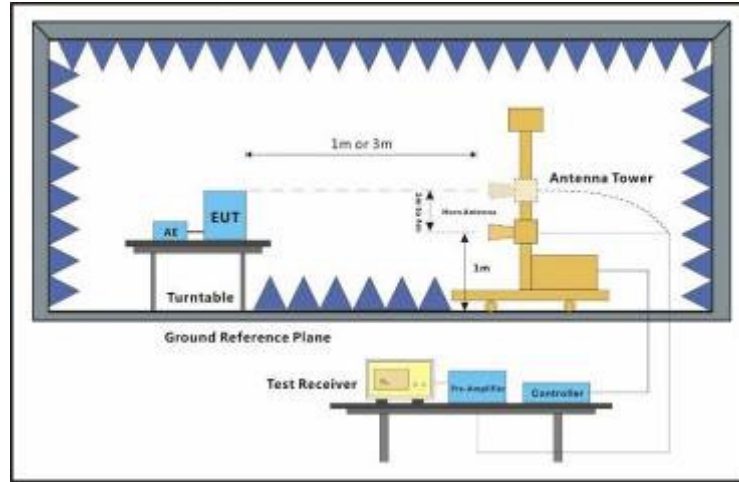
7.11.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Final test	00	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.
Pre-scan	01	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation, pi/4DQPSK modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.



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7.11.3 Test Setup Diagram



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7.11.4 Measurement Procedure and Data

- a. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- g. Test the EUT in the lowest channel, the middle channel, the Highest channel.
- h. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
- i. Repeat above procedures until all frequencies measured was complete.

Remark:

1) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

$$\text{Final Test Level} = \text{Receiver Reading} + \text{Antenna Factor} + \text{Cable Factor} - \text{Preamplifier Factor}$$

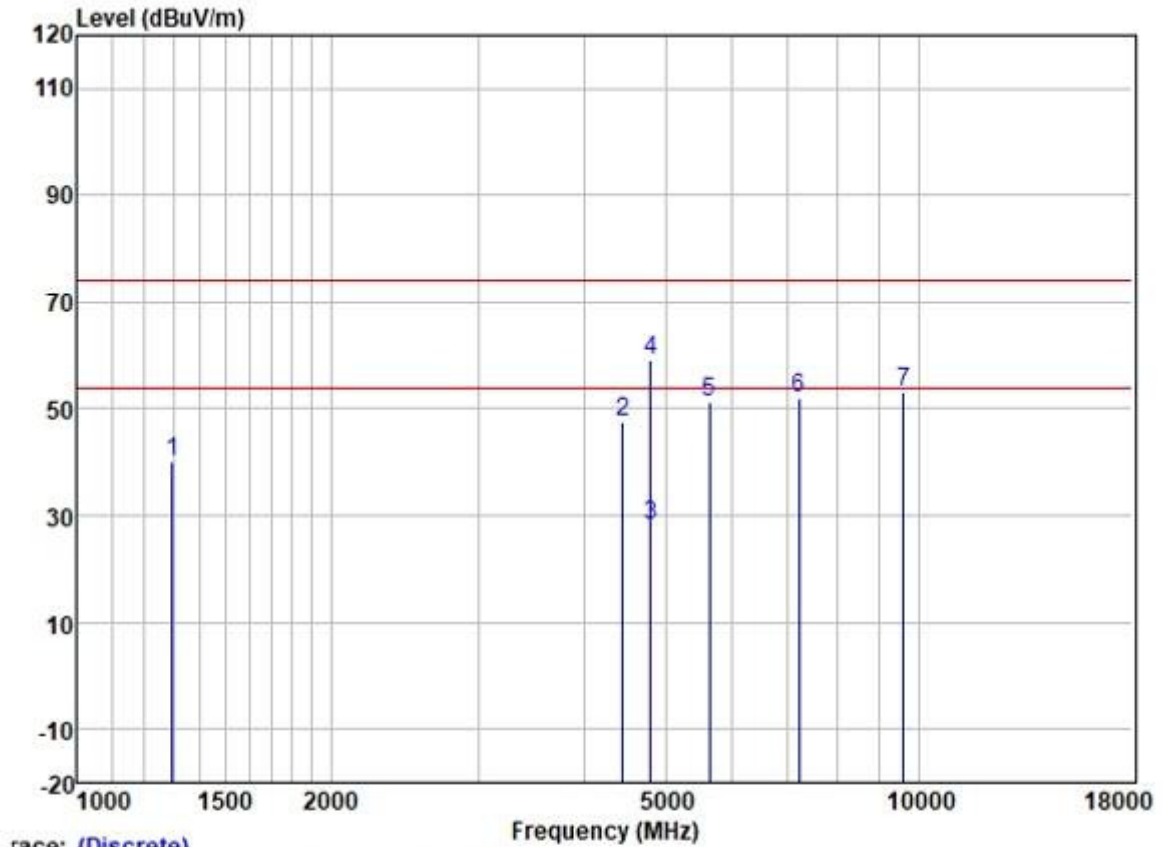
2) Scan from 1GHz to 25GHz, the disturbance above 18GHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

3) The field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.



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Test Mode: 00; Polarity: Horizontal; Modulation:GFSK; ; Channel:Low



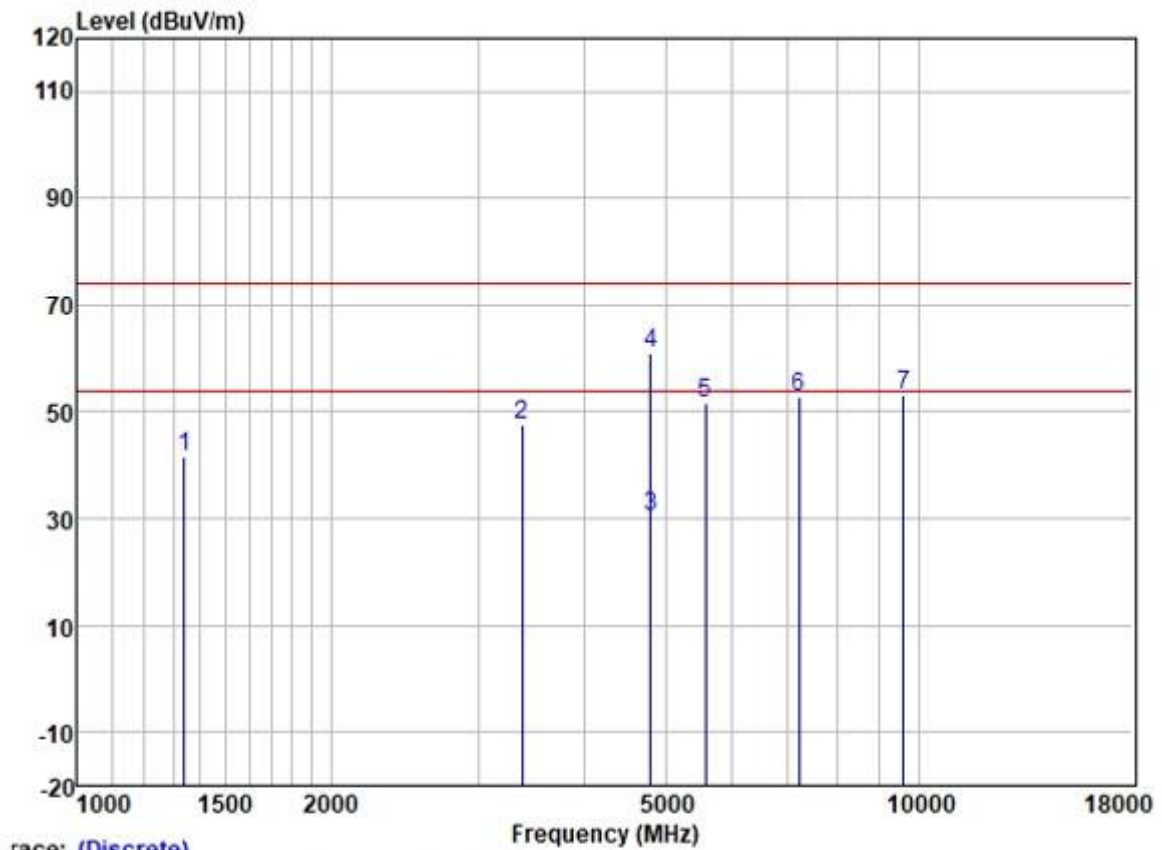
Trace: (Discrete)

	Read Freq	Antenna Level	Cable Factor	Preamp Loss	Preamp Factor	Level	Limit	Over	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	1297.917	50.55	25.19	2.58	38.31	40.01	74.00	-33.99	HORIZONTAL	Peak
2	4444.257	48.93	30.73	4.83	36.81	47.68	74.00	-26.32	HORIZONTAL	Peak
3	4804.000	28.26	31.42	5.40	36.83	28.25	54.00	-25.75	HORIZONTAL	Average
4	4804.000	59.07	31.42	5.40	36.83	59.06	74.00	-14.94	HORIZONTAL	Peak
5	5642.072	49.83	31.95	6.35	36.89	51.24	74.00	-22.76	HORIZONTAL	Peak
6	7206.000	48.09	35.54	5.98	37.38	52.23	74.00	-21.77	HORIZONTAL	Peak
7	9608.000	44.97	38.37	7.07	37.42	52.99	74.00	-21.01	HORIZONTAL	Peak



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Test Mode: 00; Polarity: Vertical; Modulation:GFSK; ; Channel:Low



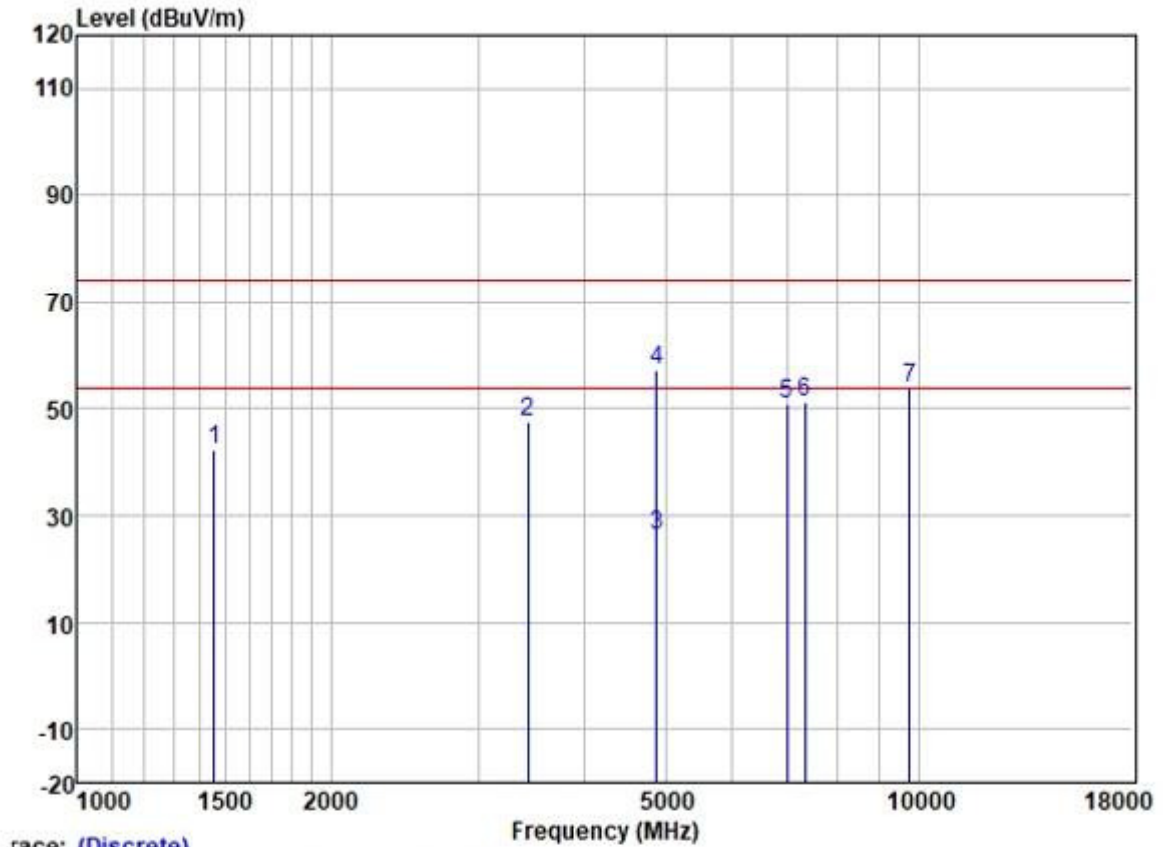
Trace: (Discrete)

	Read	Antenna	Cable	Preamp		Limit	Over			
	Freq	Level	Factor	Loss	Factor	Level	Line	Limit	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	1341.994	51.88	25.30	2.60	38.27	41.51	74.00	-32.49	VERTICAL	Peak
2	3381.912	51.74	28.83	4.10	36.99	47.68	74.00	-26.32	VERTICAL	Peak
3	4804.000	30.28	31.42	5.40	36.83	30.27	54.00	-23.73	VERTICAL	Average
4	4804.000	61.09	31.42	5.40	36.83	61.08	74.00	-12.92	VERTICAL	Peak
5	5576.638	50.36	31.87	6.32	36.89	51.66	74.00	-22.34	VERTICAL	Peak
6	7206.000	48.79	35.54	5.98	37.38	52.93	74.00	-21.07	VERTICAL	Peak
7	9608.000	45.16	38.37	7.07	37.42	53.18	74.00	-20.82	VERTICAL	Peak



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Test Mode: 00; Polarity: Horizontal; Modulation:GFSK; ; Channel:middle



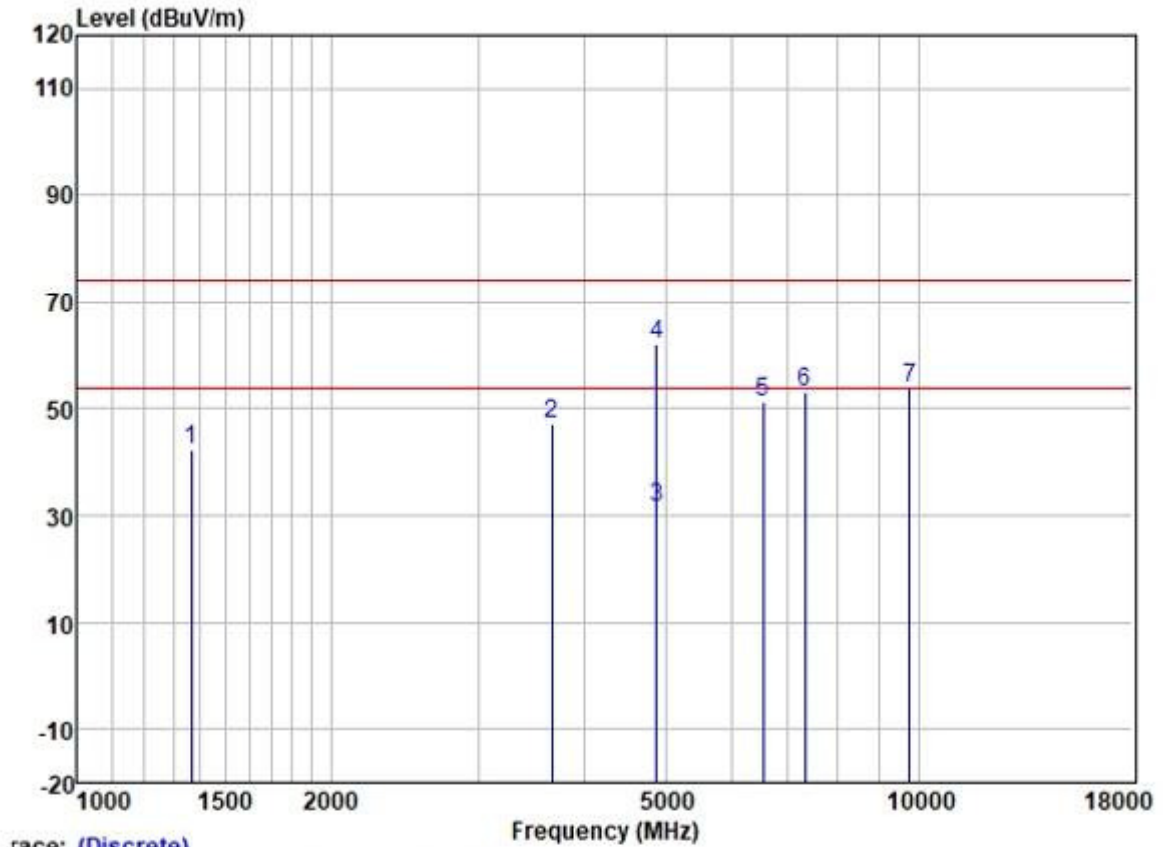
Trace: (Discrete)

	Read Freq	Antenna Level	Cable Factor	Preamp Loss	Preamp Factor	Level	Limit	Over	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	1453.049	52.27	25.45	2.71	38.17	42.26	74.00	-31.74	HORIZONTAL	Peak
2	3434.108	51.57	28.87	4.16	36.97	47.63	74.00	-26.37	HORIZONTAL	Peak
3	4882.000	26.11	31.56	5.52	36.84	26.35	54.00	-27.65	HORIZONTAL	Average
4	4882.000	56.92	31.56	5.52	36.84	57.16	74.00	-16.84	HORIZONTAL	Peak
5	6982.641	47.22	34.97	5.81	37.23	50.77	74.00	-23.23	HORIZONTAL	Peak
6	7323.000	46.68	36.00	6.13	37.43	51.38	74.00	-22.62	HORIZONTAL	Peak
7	9764.000	45.63	38.50	7.02	37.41	53.74	74.00	-20.26	HORIZONTAL	Peak



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Test Mode: 00; Polarity: Vertical; Modulation:GFSK; ; Channel:middle



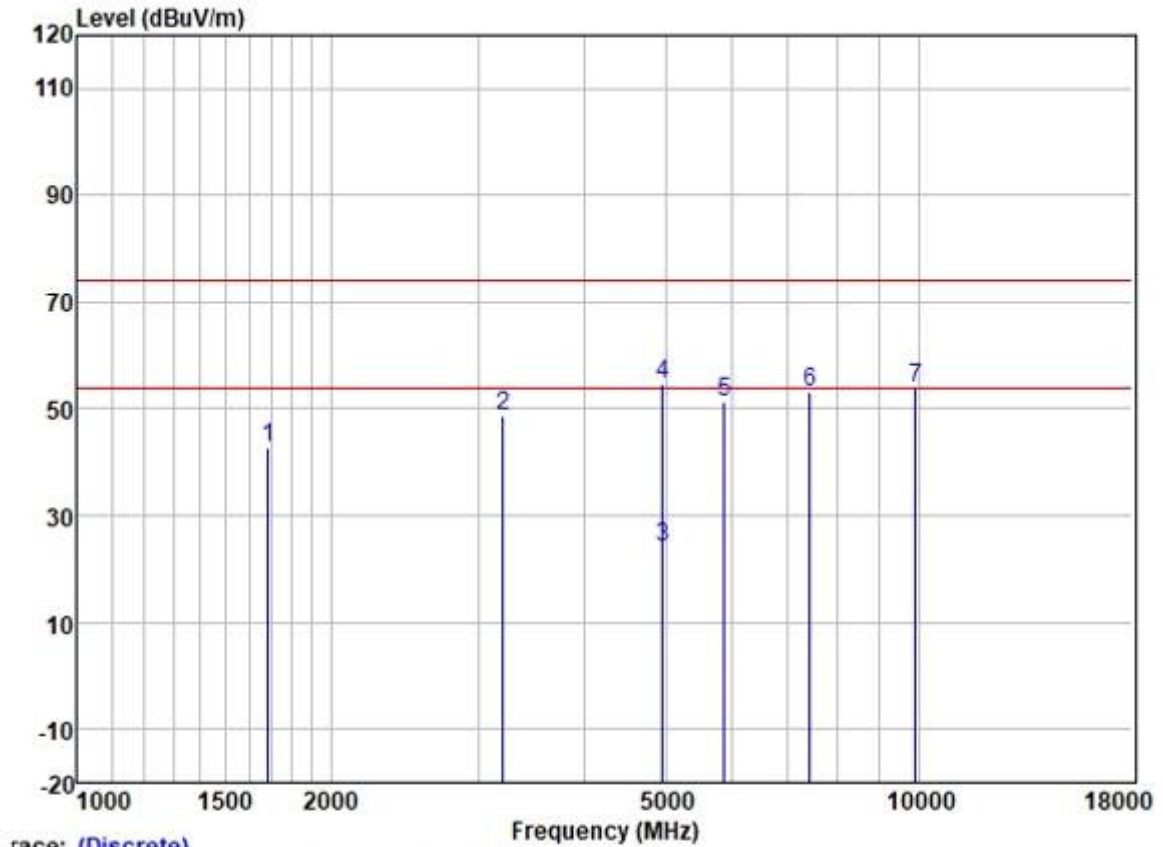
Trace: (Discrete)

	Read Freq	Antenna Level	Cable Factor	Preamp Loss	Preamp Factor	Level	Limit	Over	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	1364.524	52.69	25.34	2.60	38.25	42.38	74.00	-31.62	VERTICAL	Peak
2	3670.520	50.54	29.17	4.54	36.88	47.37	74.00	-26.63	VERTICAL	Peak
3	4882.000	31.23	31.56	5.52	36.84	31.47	54.00	-22.53	VERTICAL	Average
4	4882.000	62.04	31.56	5.52	36.84	62.28	74.00	-11.72	VERTICAL	Peak
5	6539.821	48.38	34.06	5.84	37.03	51.25	74.00	-22.75	VERTICAL	Peak
6	7323.000	48.60	36.00	6.13	37.43	53.30	74.00	-20.70	VERTICAL	Peak
7	9764.000	45.65	38.50	7.02	37.41	53.76	74.00	-20.24	VERTICAL	Peak



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Test Mode: 00; Polarity: Horizontal; Modulation:GFSK; ; Channel:High



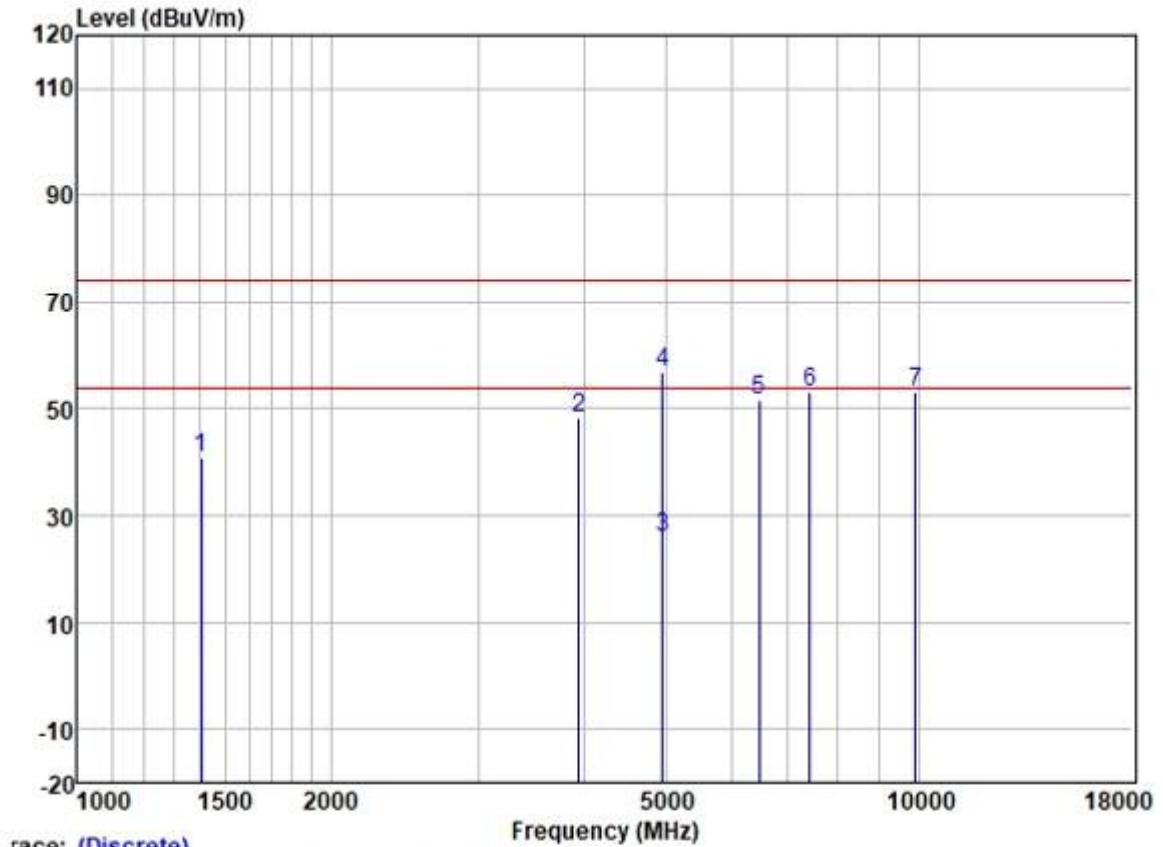
Trace: (Discrete)

	Read Freq	Antenna Level	Cable Factor	Preamp Loss	Preamp Factor	Level	Limit	Over	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	1686.741	52.10	25.69	2.80	37.91	42.68	74.00	-31.32	HORIZONTAL	Peak
2	3212.383	53.08	28.61	4.01	37.09	48.61	74.00	-25.39	HORIZONTAL	Peak
3	4960.000	23.45	31.65	5.65	36.84	23.91	54.00	-30.09	HORIZONTAL	Average
4	4960.000	54.26	31.65	5.65	36.84	54.72	74.00	-19.28	HORIZONTAL	Peak
5	5878.787	49.90	32.29	5.93	36.90	51.22	74.00	-22.78	HORIZONTAL	Peak
6	7440.000	48.11	36.27	6.22	37.47	53.13	74.00	-20.87	HORIZONTAL	Peak
7	9920.000	45.63	38.65	6.96	37.40	53.84	74.00	-20.16	HORIZONTAL	Peak



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Test Mode: 00; Polarity: Vertical; Modulation:GFSK; ; Channel:High



Trace: (Discrete)

	Read	Antenna	Cable	Preamp		Limit	Over			
	Freq	Level	Factor	Loss	Factor	Level	Line	Limit	Pol/Phase	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		
1	1403.199	50.89	25.39	2.61	38.22	40.67	74.00	-33.33	VERTICAL	Peak
2	3946.855	50.74	29.74	4.60	36.81	48.27	74.00	-25.73	VERTICAL	Peak
3	4960.000	25.51	31.65	5.65	36.84	25.97	54.00	-28.03	VERTICAL	Average
4	4960.000	56.32	31.65	5.65	36.84	56.78	74.00	-17.22	VERTICAL	Peak
5	6461.664	48.74	33.92	5.86	37.00	51.52	74.00	-22.48	VERTICAL	Peak
6	7440.000	48.11	36.27	6.22	37.47	53.13	74.00	-20.87	VERTICAL	Peak
7	9920.000	44.97	38.65	6.96	37.40	53.18	74.00	-20.82	VERTICAL	Peak



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8 Test Setup Photo

Refer to Appendix –Test Setup Photo for GZCR2108020964AT.

9 EUT Constructional Details (EUT Photos)

Refer to Appendix – External and Internal Photos for GZCR2108020964AT.



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10 Appendix

1. Bandwidth

1.1 OBW

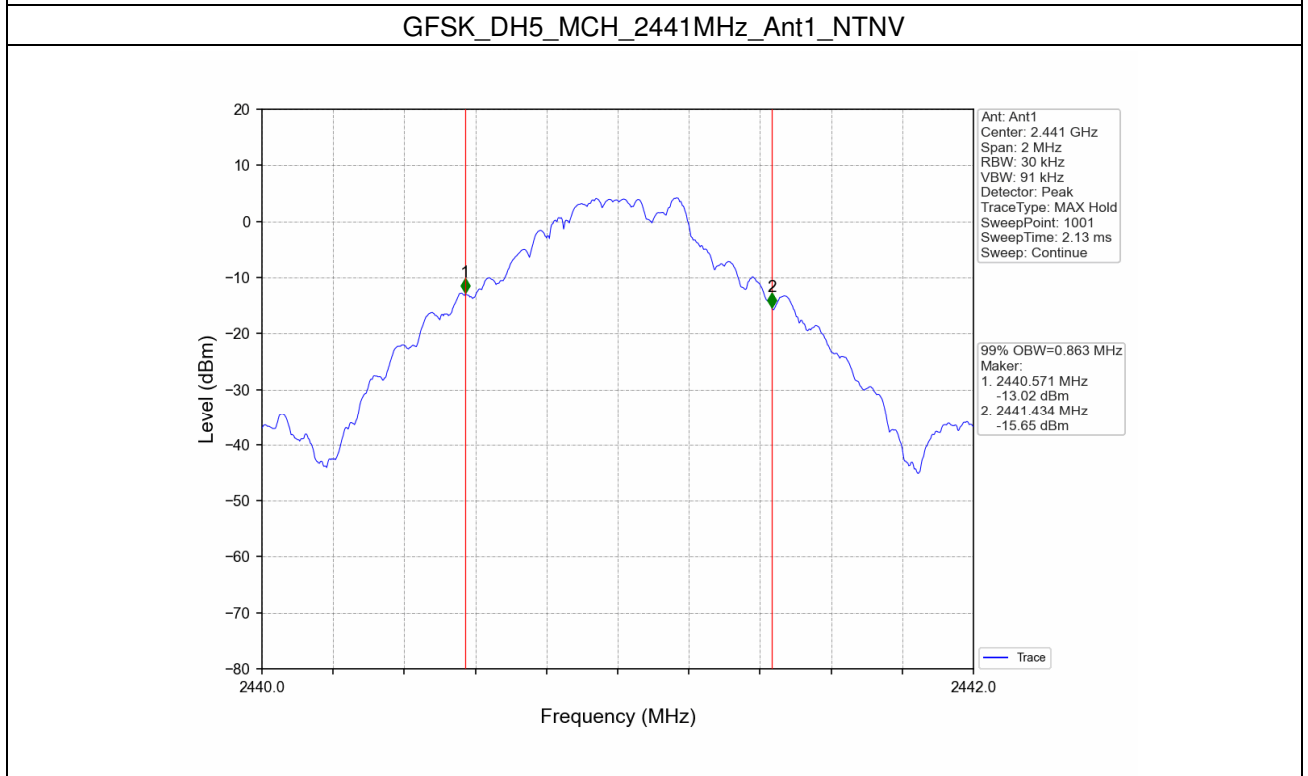
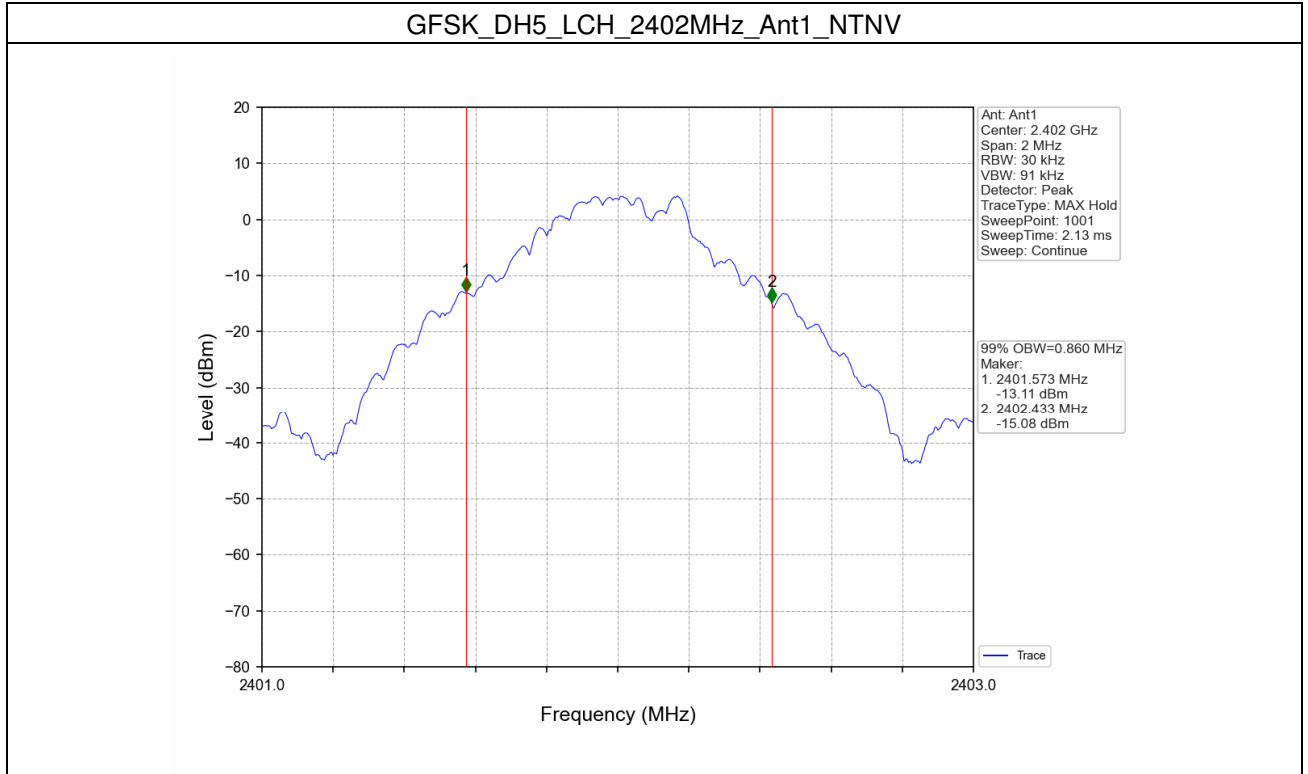
1.1.1 Test Result

Mode	TX Type	Frequency (MHz)	Packet Type	Ant	99% Occupied Bandwidth (MHz)	Verdict
					Result	
GFSK	SISO	2402	DH5	1	0.860	Pass
		2441	DH5	1	0.863	Pass
		2480	DH5	1	0.860	Pass
Pi/4QPSK	SISO	2402	2DH5	1	1.209	Pass
		2441	2DH5	1	1.214	Pass
		2480	2DH5	1	1.215	Pass
8DPSK	SISO	2402	3DH5	1	1.197	Pass
		2441	3DH5	1	1.202	Pass
		2480	3DH5	1	1.197	Pass

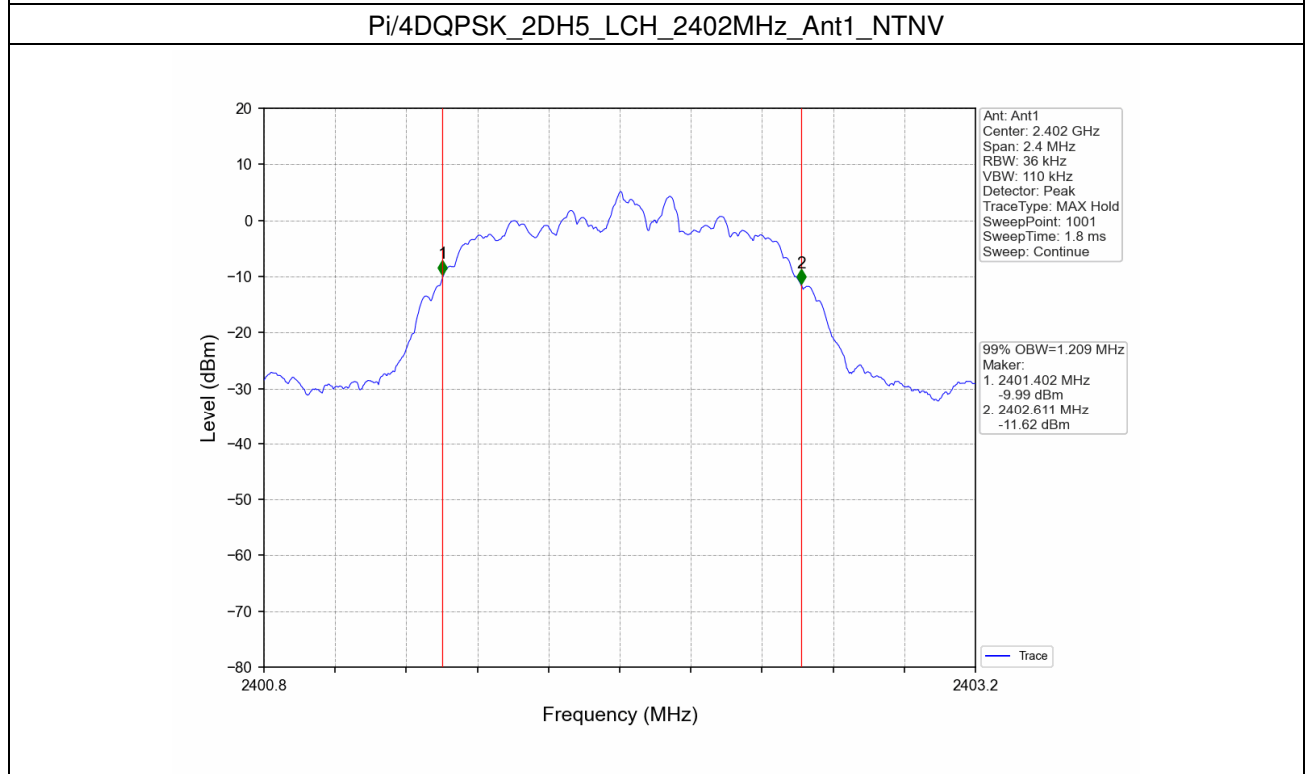
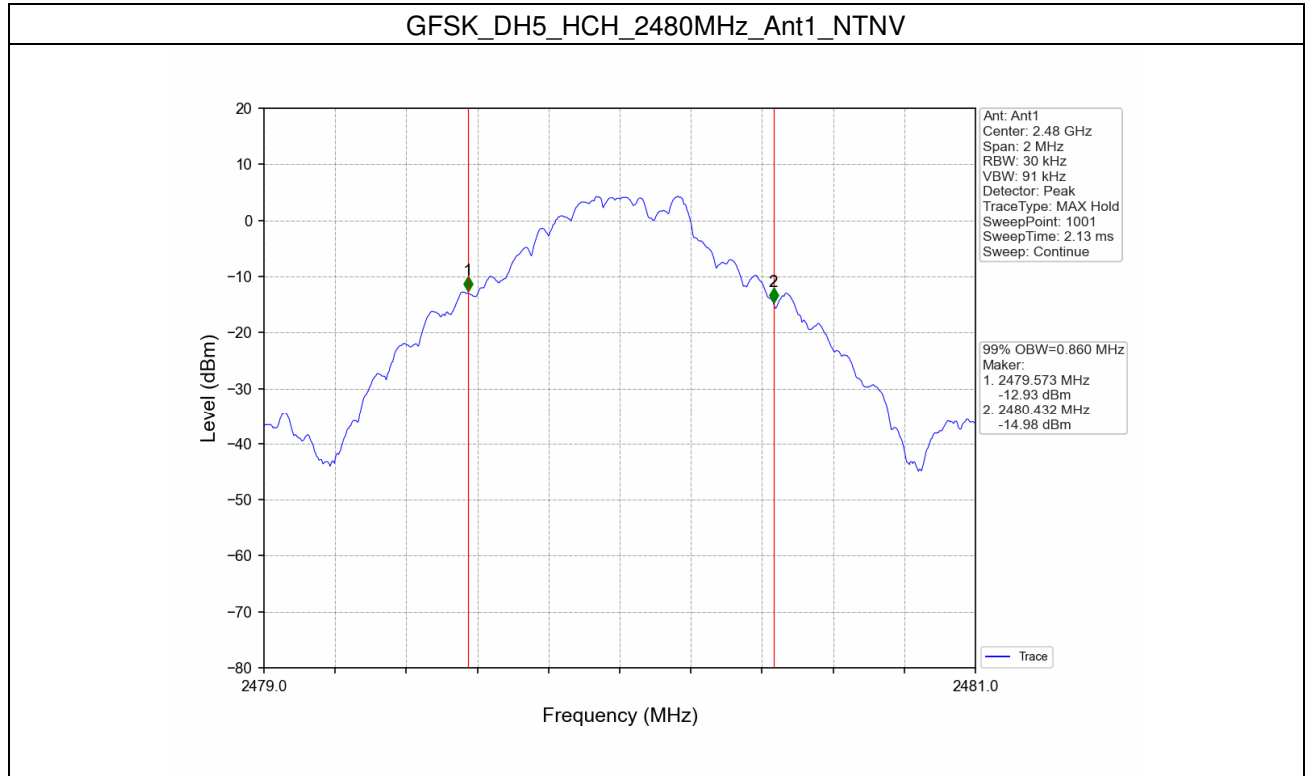


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1.1.2 Test Graph

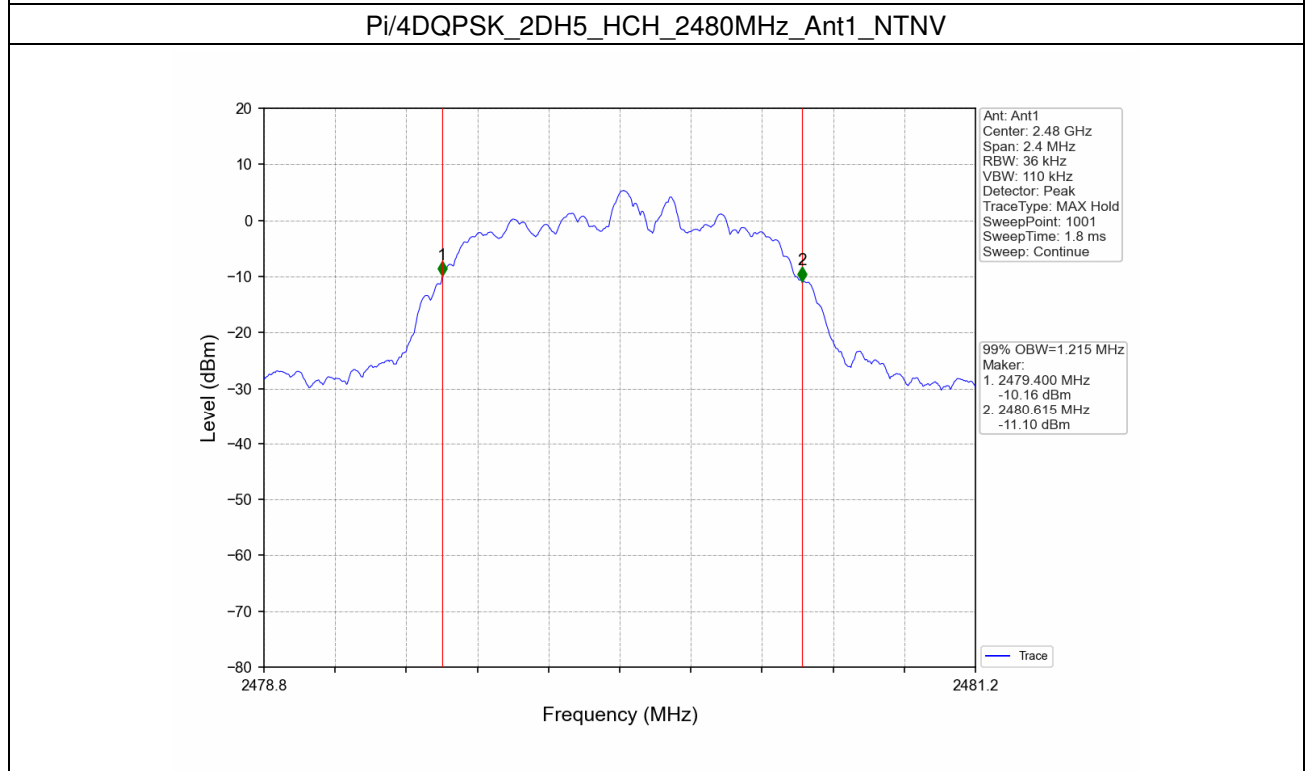
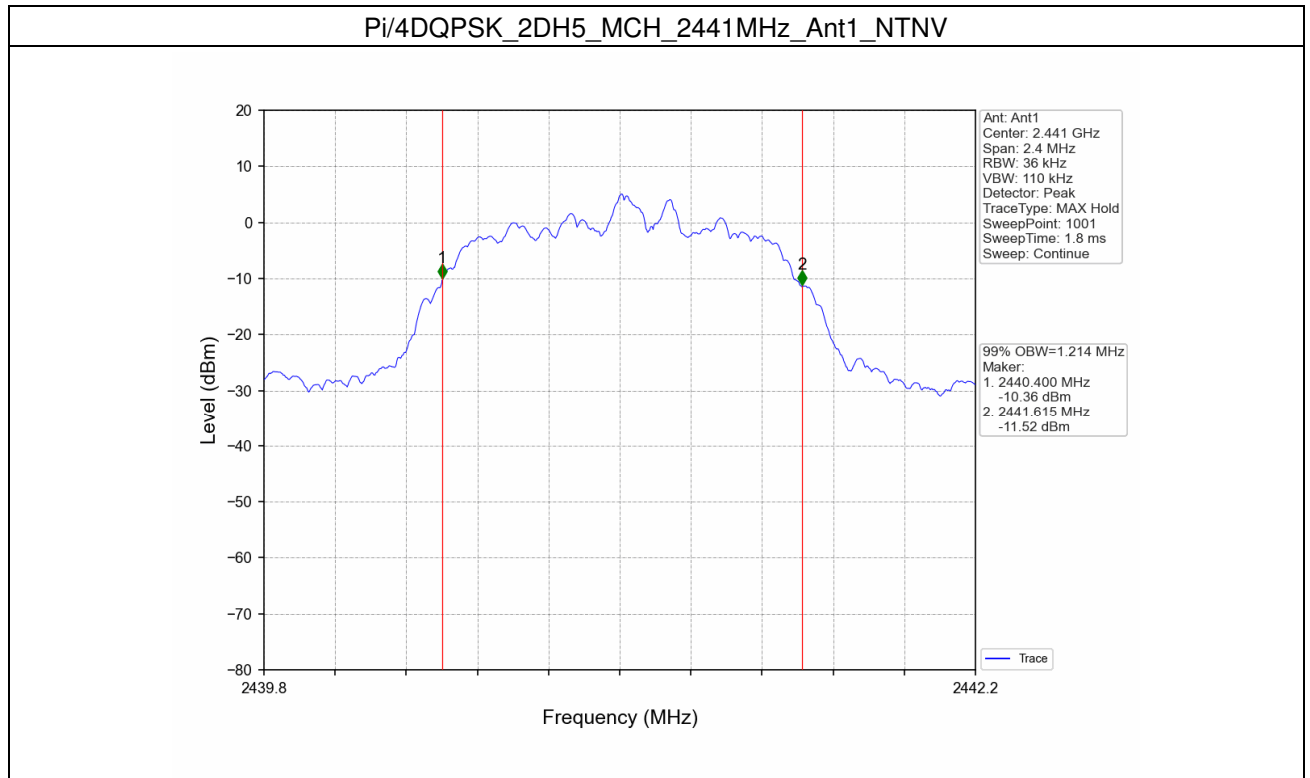


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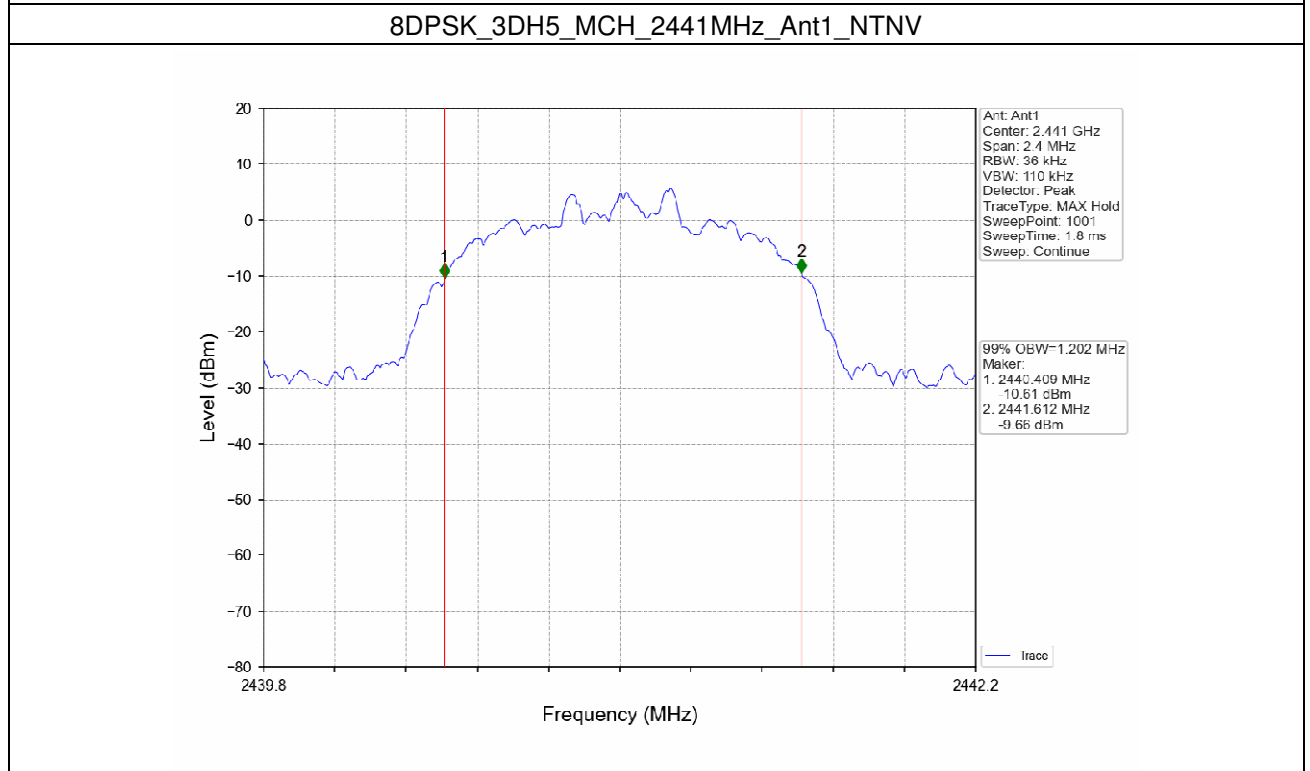
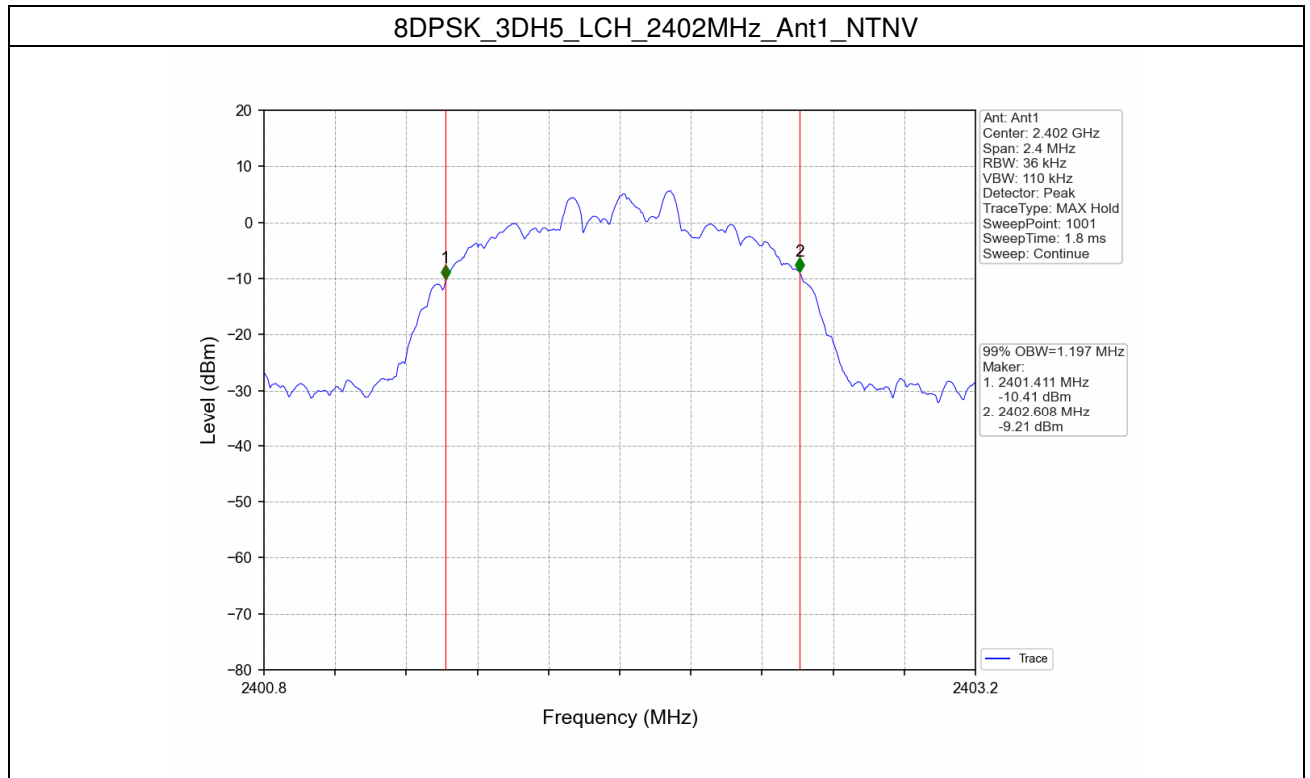
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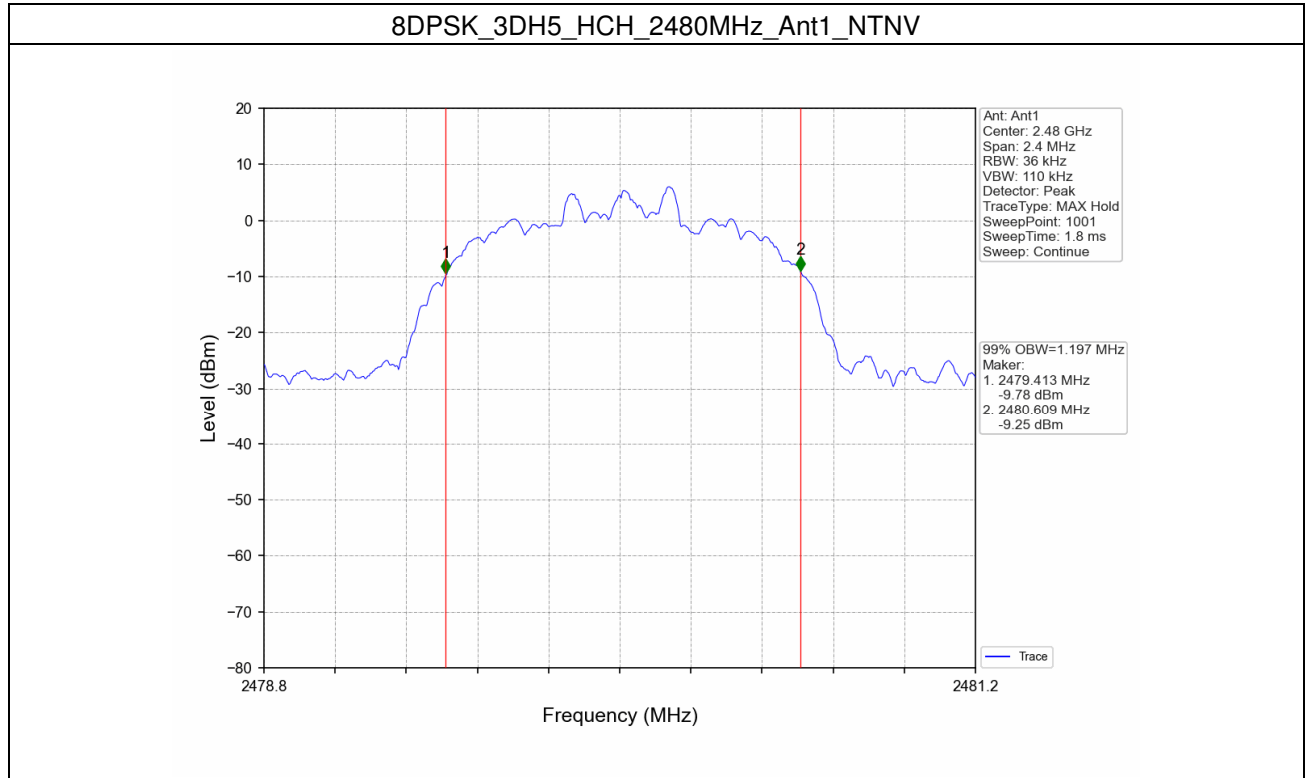
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1.2 20dB BW

1.2.1 Test Result

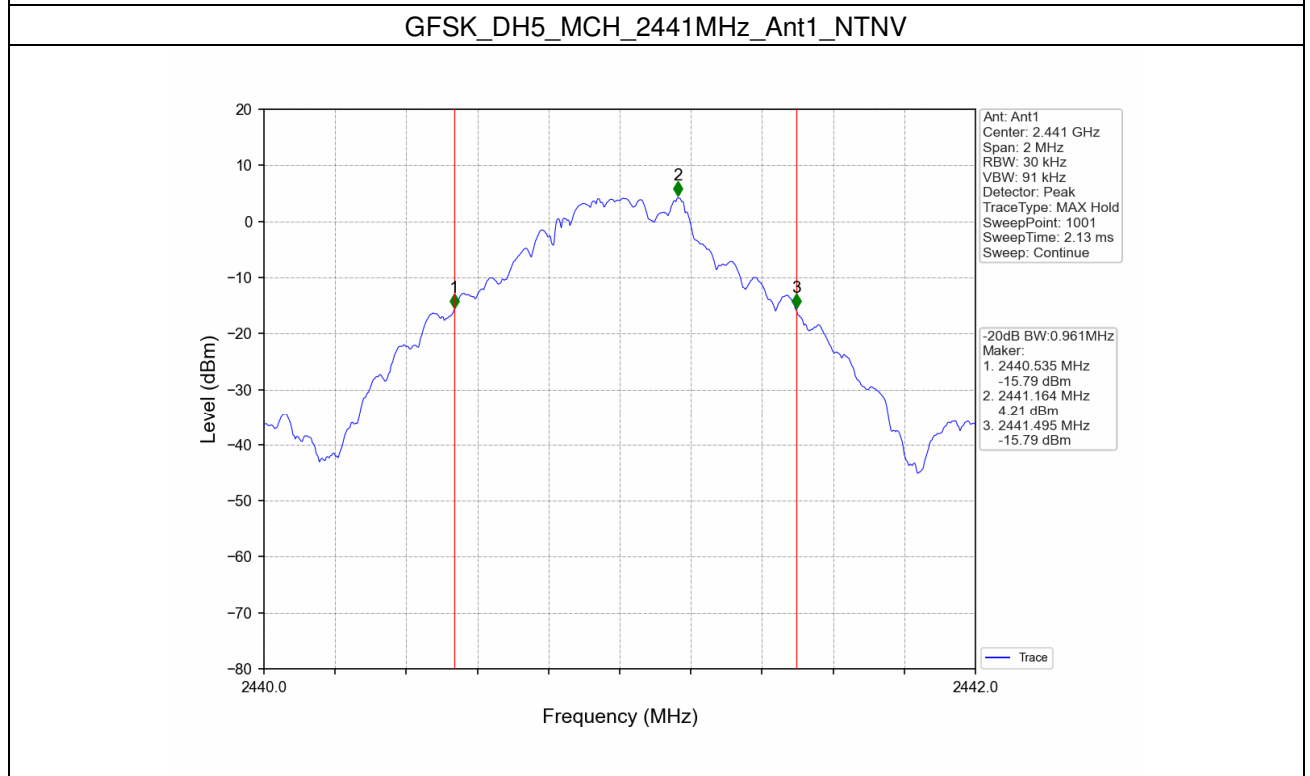
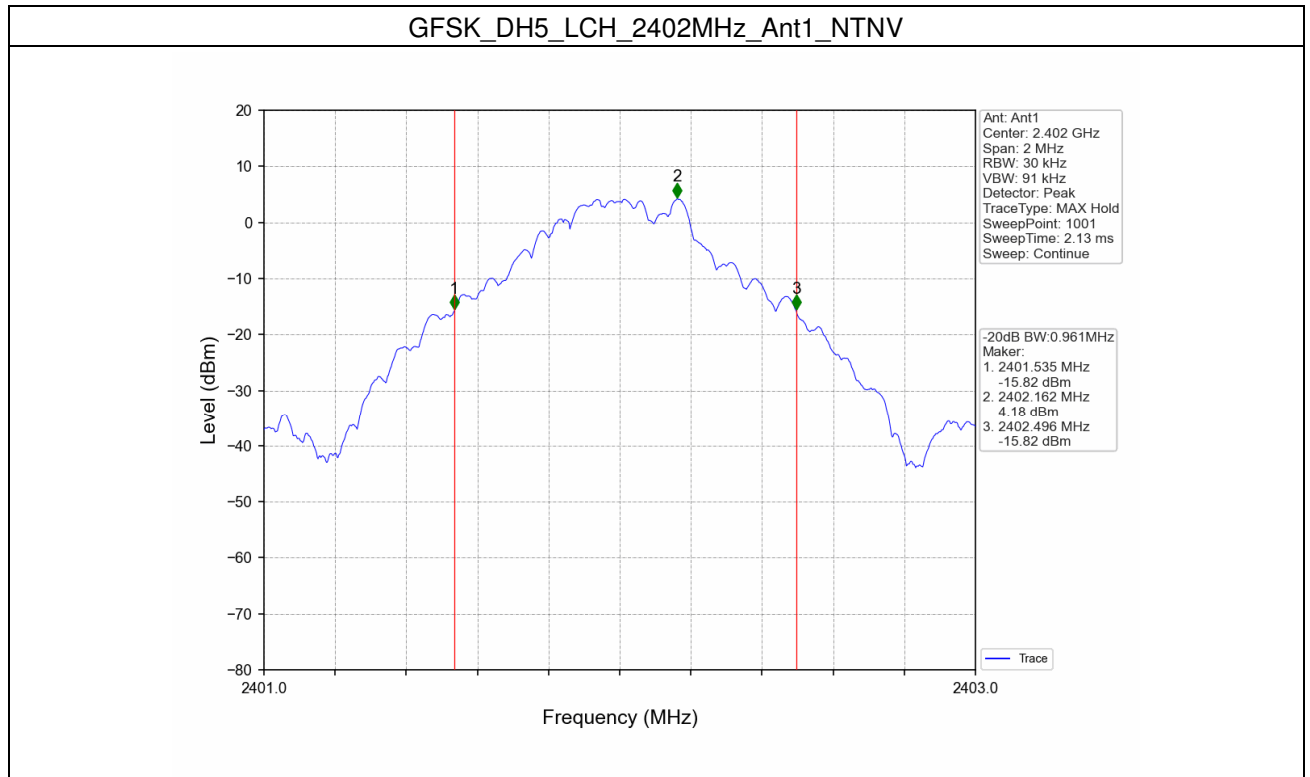
Mode	TX Type	Frequency (MHz)	Packet Type	Ant	20dB Bandwidth (MHz)	Verdict
					Result	
GFSK	SISO	2402	DH5	1	0.961	Pass
		2441	DH5	1	0.961	Pass
		2480	DH5	1	0.959	Pass
Pi/4DQPSK	SISO	2402	2DH5	1	1.350	Pass
		2441	2DH5	1	1.346	Pass
		2480	2DH5	1	1.334	Pass
8DPSK	SISO	2402	3DH5	1	1.314	Pass
		2441	3DH5	1	1.314	Pass
		2480	3DH5	1	1.312	Pass



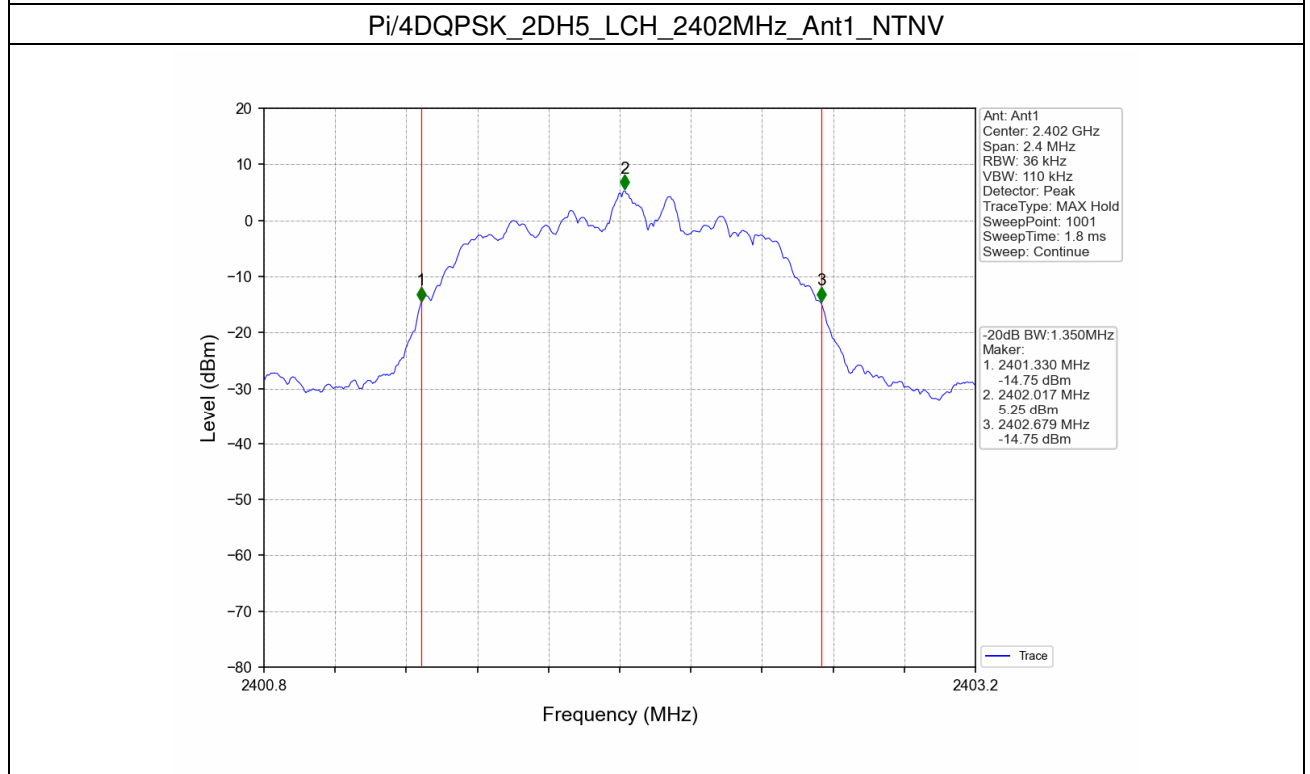
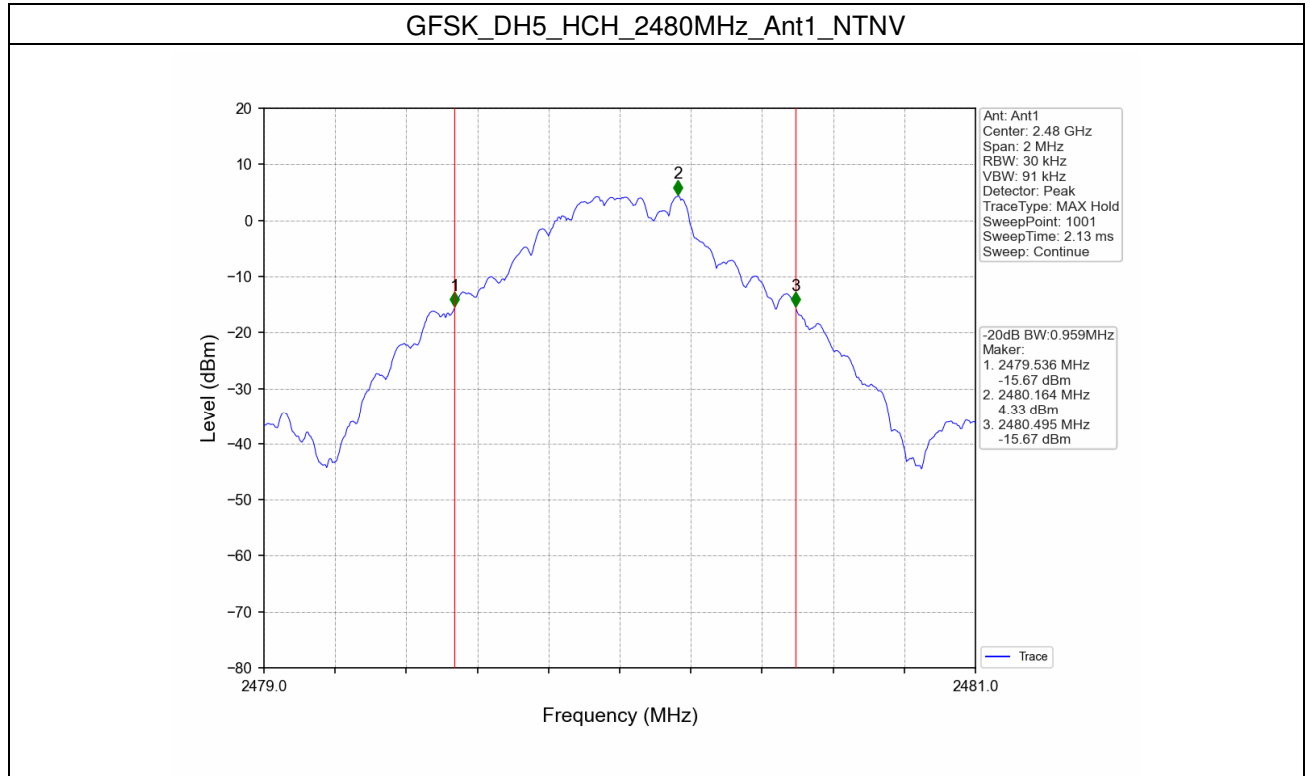
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1.2.2 Test Graph



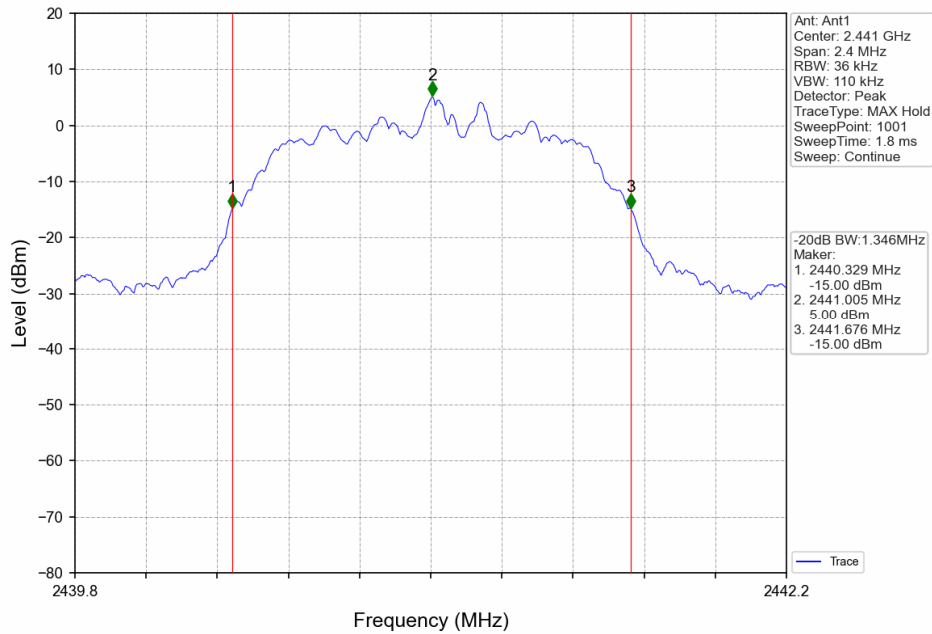
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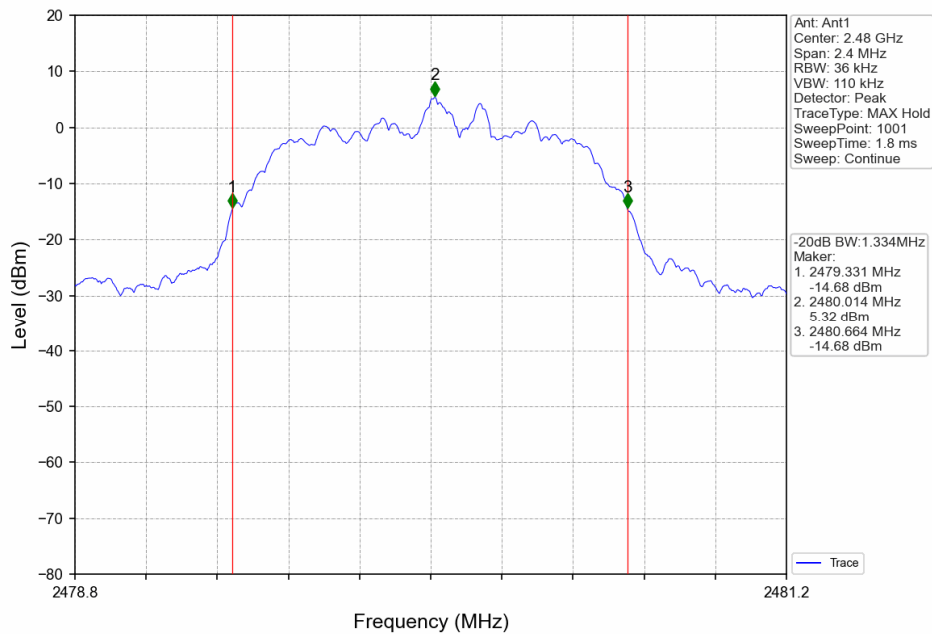
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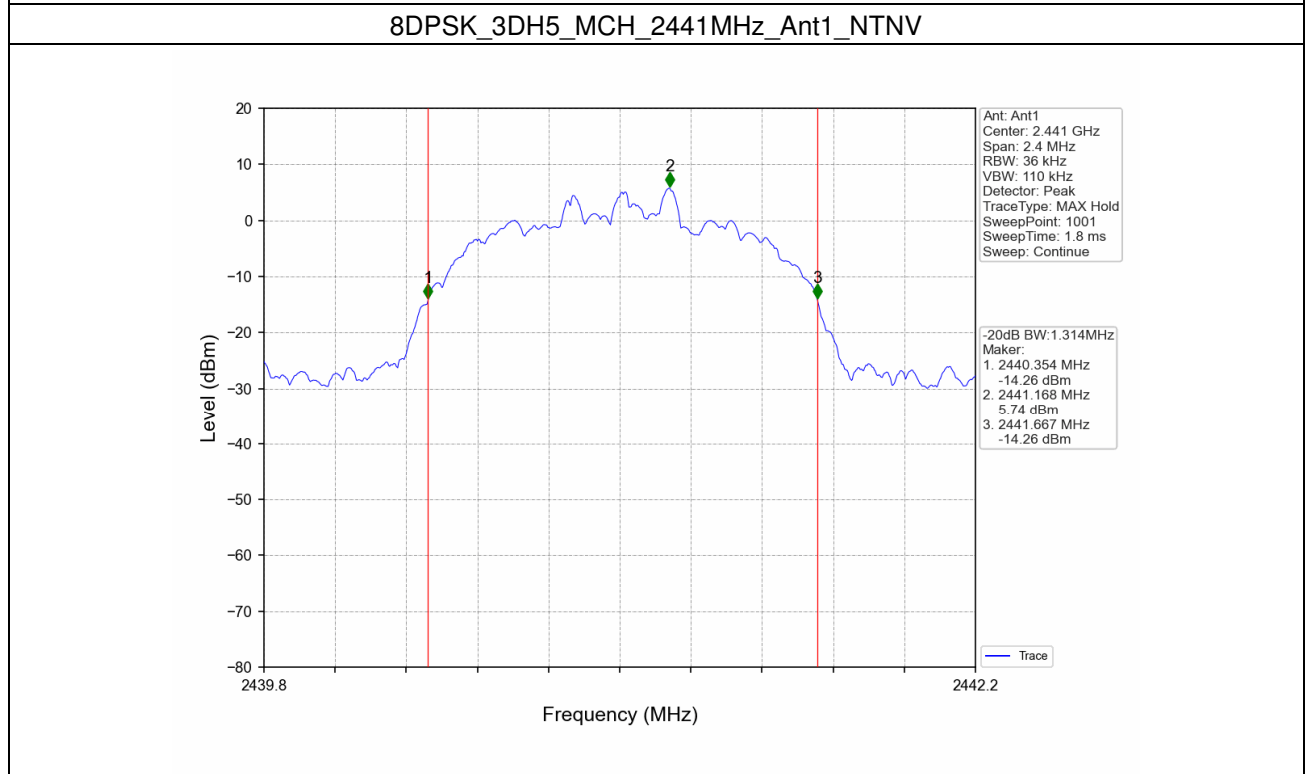
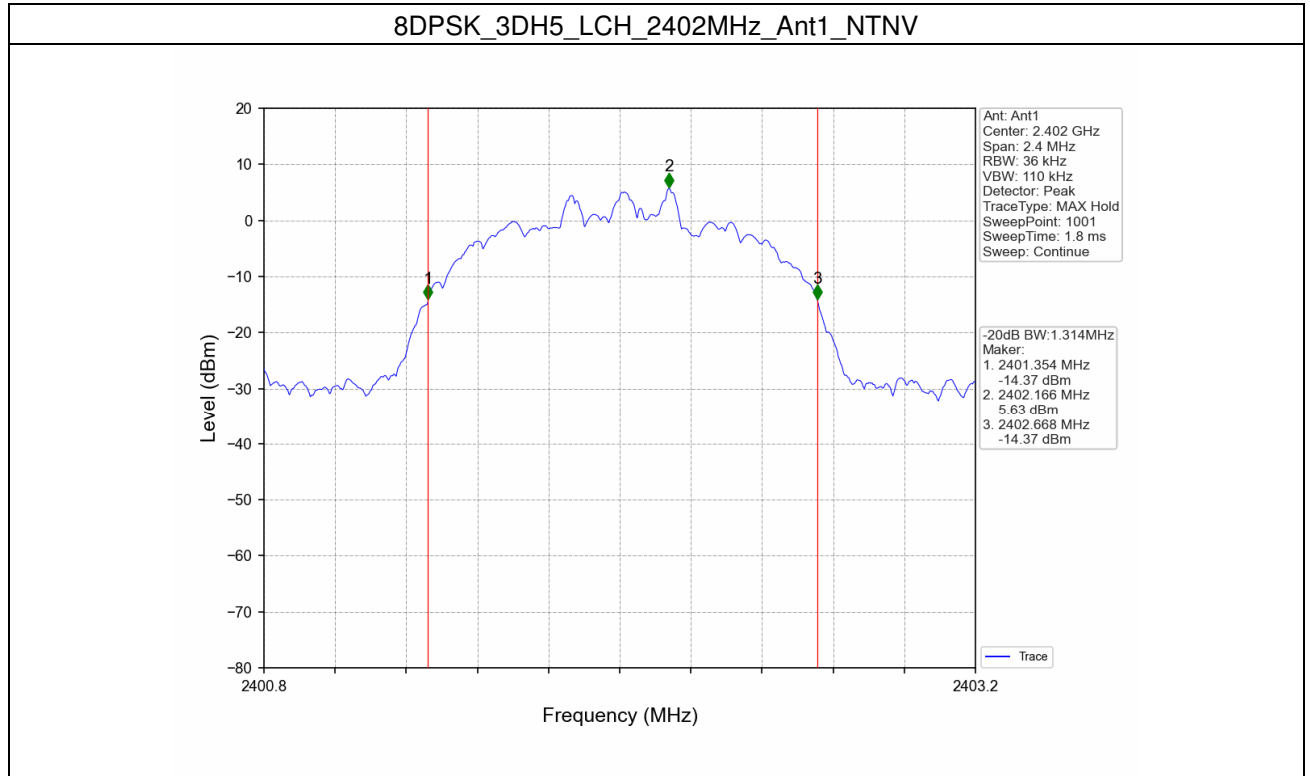
Pi/4DQPSK_2DH5_MCH_2441MHz_Ant1_NTNV



Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV

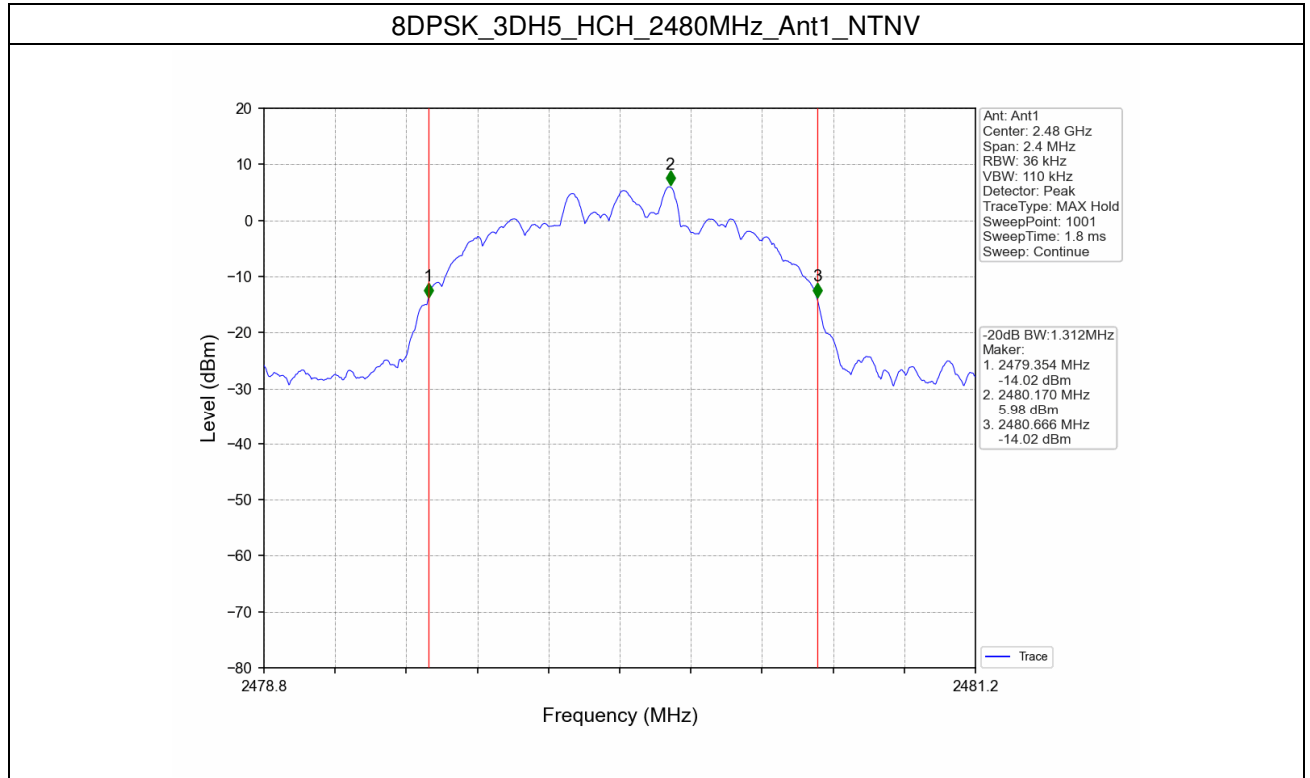


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2. Maximum Conducted Output Power

2.1 Power

2.1.1 Test Result

Mode	TX Type	Frequency (MHz)	Packet Type	Maximum Peak Conducted Output Power (dBm)		Verdict
				Ant1	Limit	
GFSK	SISO	2402	DH5	6.52	<=30	Pass
		2441	DH5	6.56	<=30	Pass
		2480	DH5	6.68	<=30	Pass
Pi/4DQPSK	SISO	2402	2DH5	8.38	<=20.97	Pass
		2441	2DH5	8.52	<=20.97	Pass
		2480	2DH5	9.20	<=20.97	Pass
8DPSK	SISO	2402	3DH5	8.56	<=20.97	Pass
		2441	3DH5	9.01	<=20.97	Pass
		2480	3DH5	9.37	<=20.97	Pass

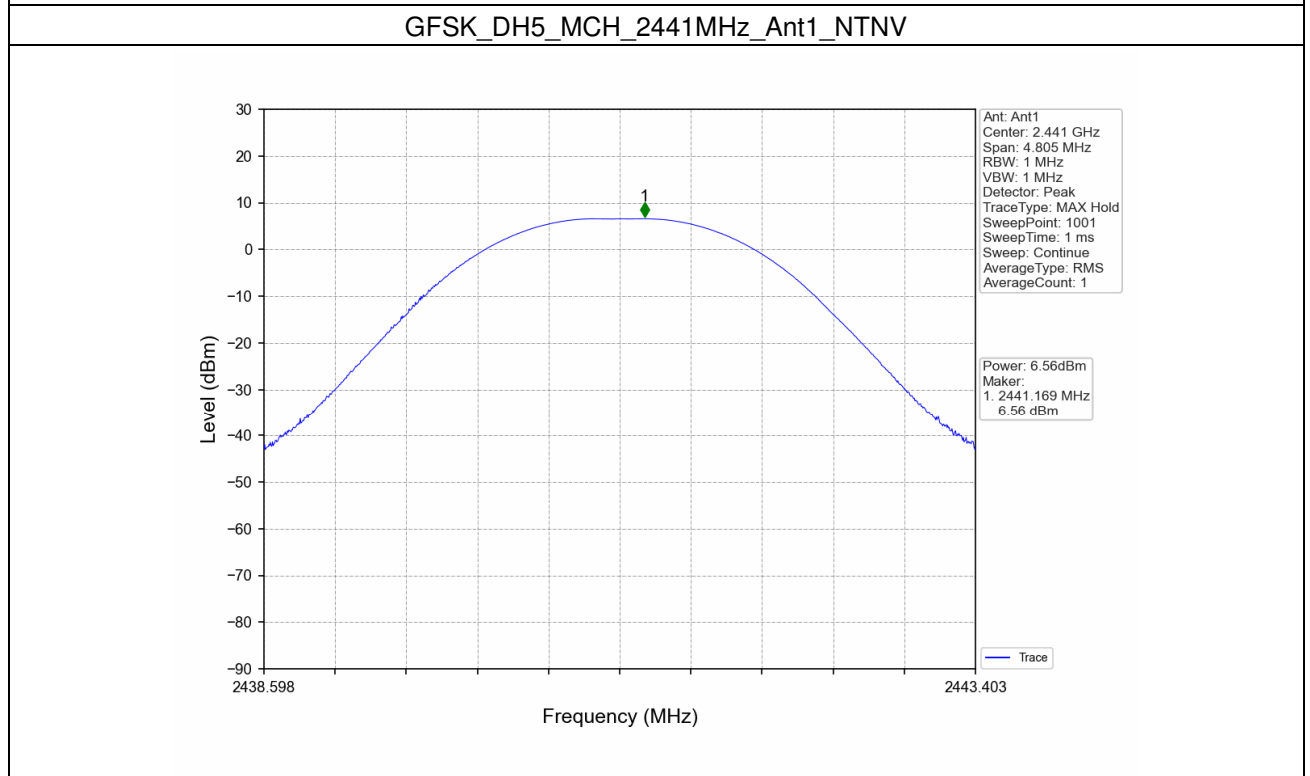
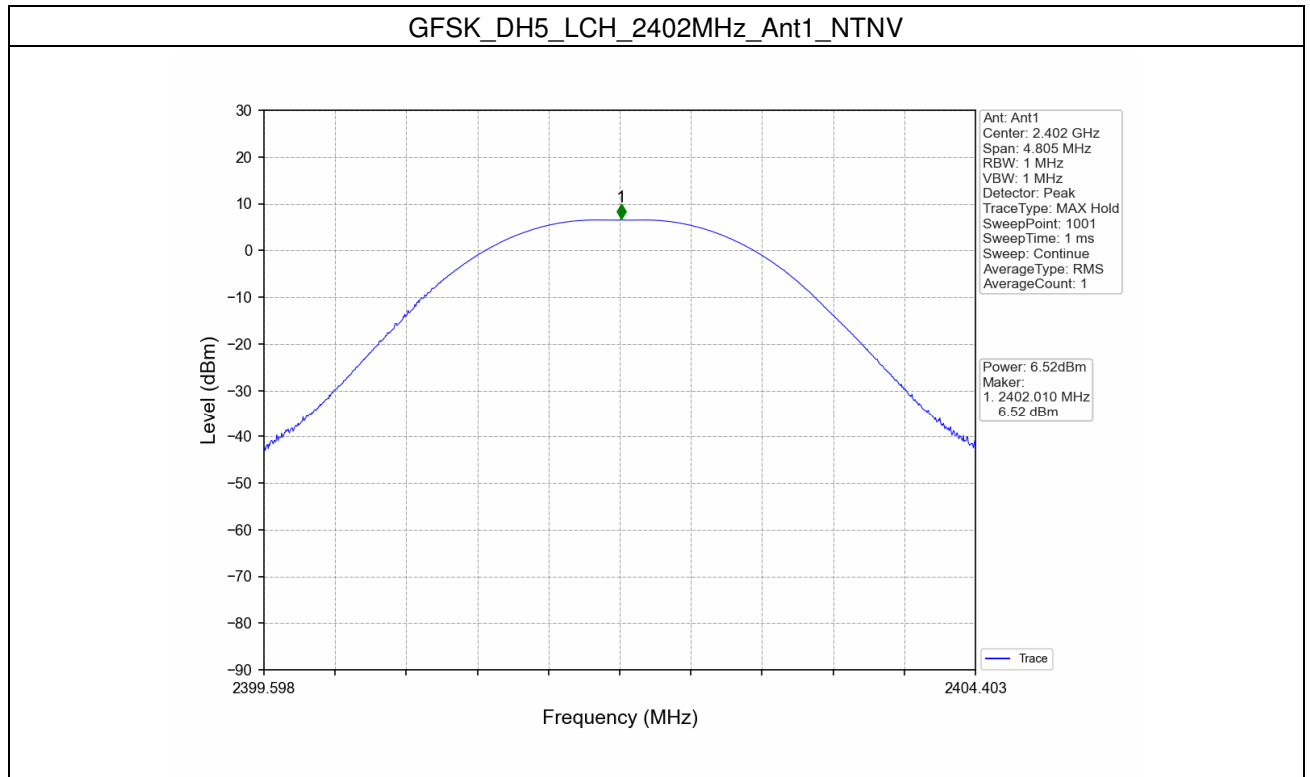
Note1: Antenna Gain: Ant1: 0.00dBi;



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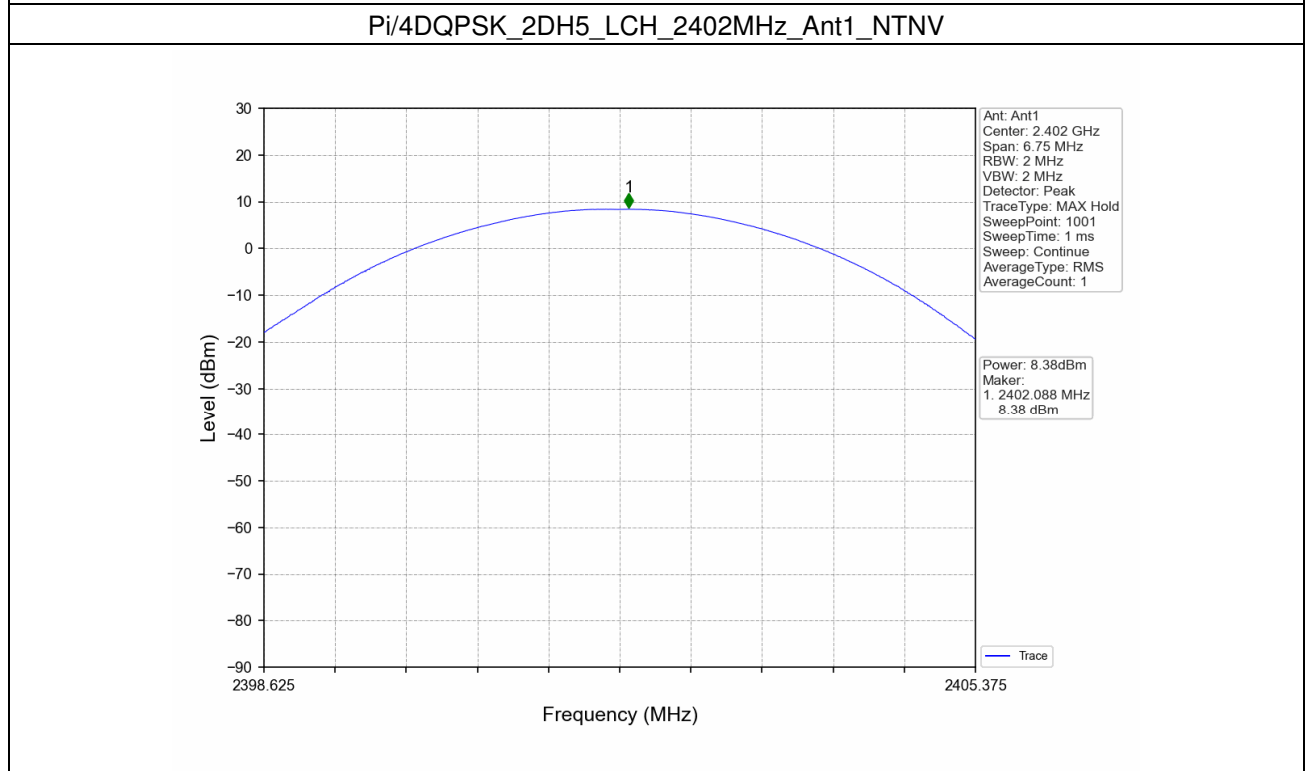
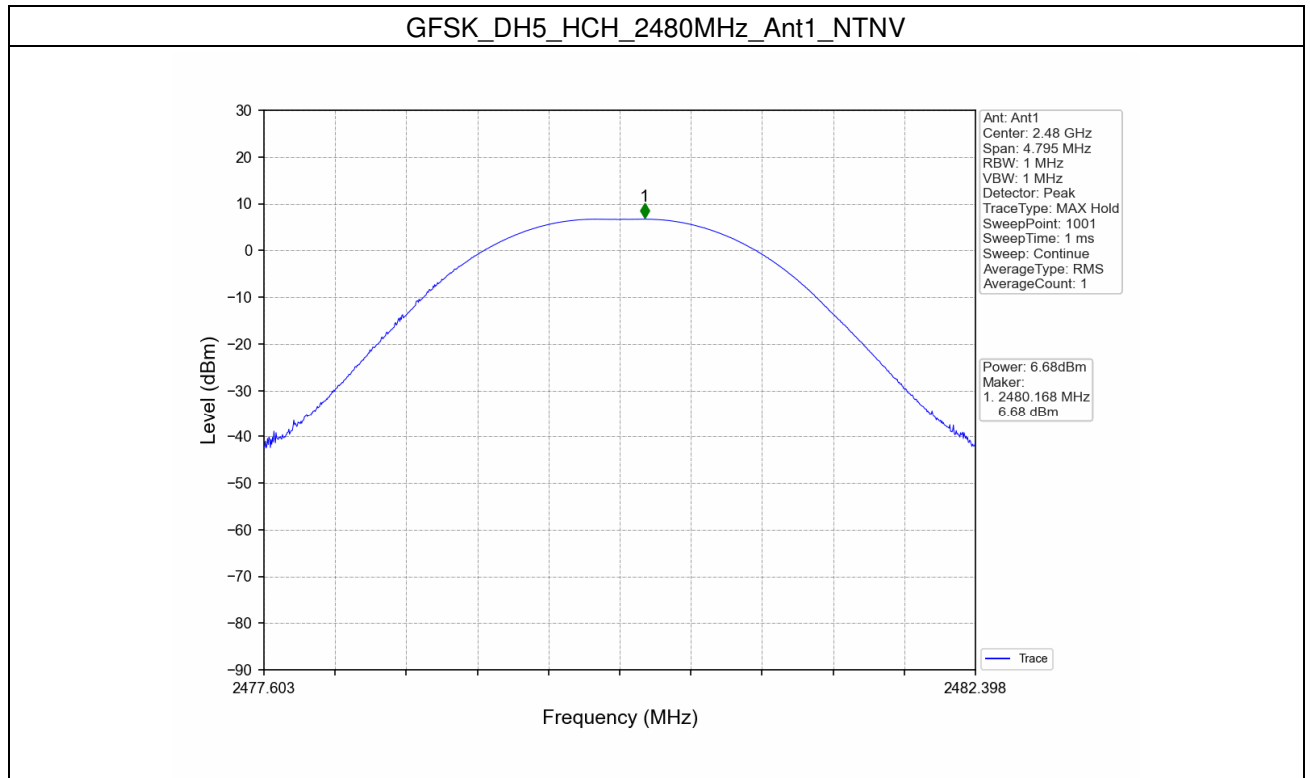
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2.1.2 Test Graph



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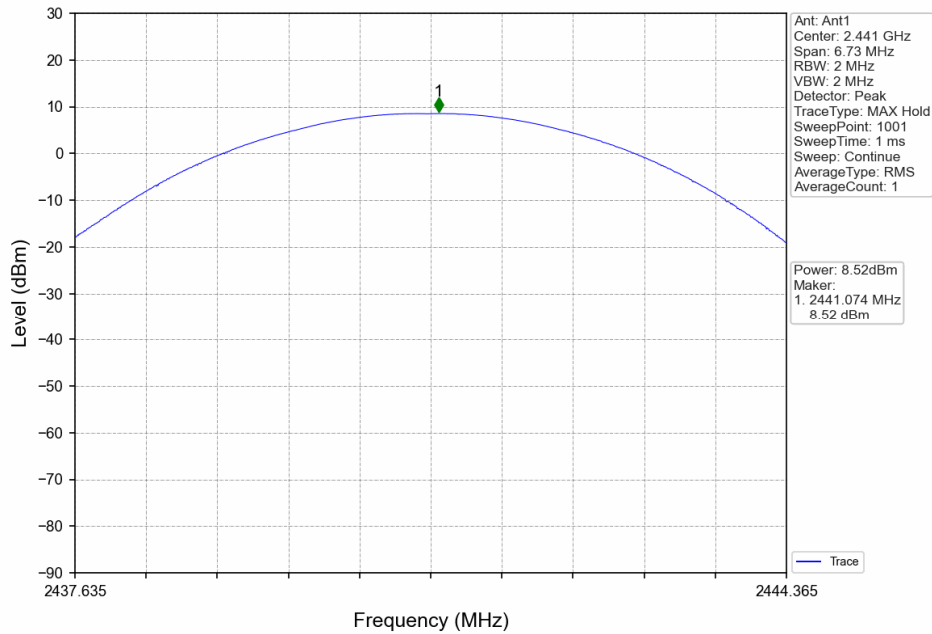
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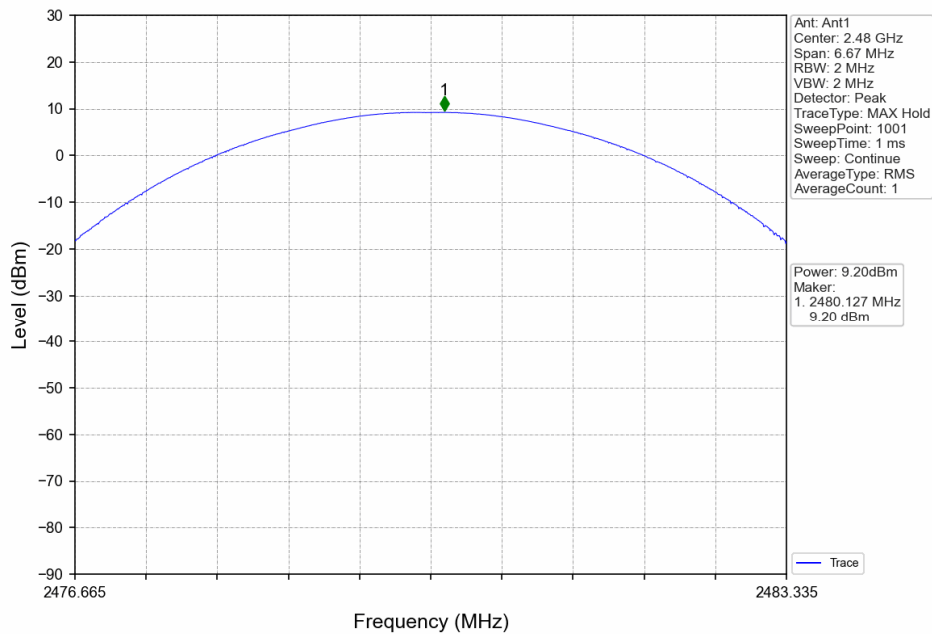
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Pi/4DQPSK_2DH5_MCH_2441MHz_Ant1_NTNV

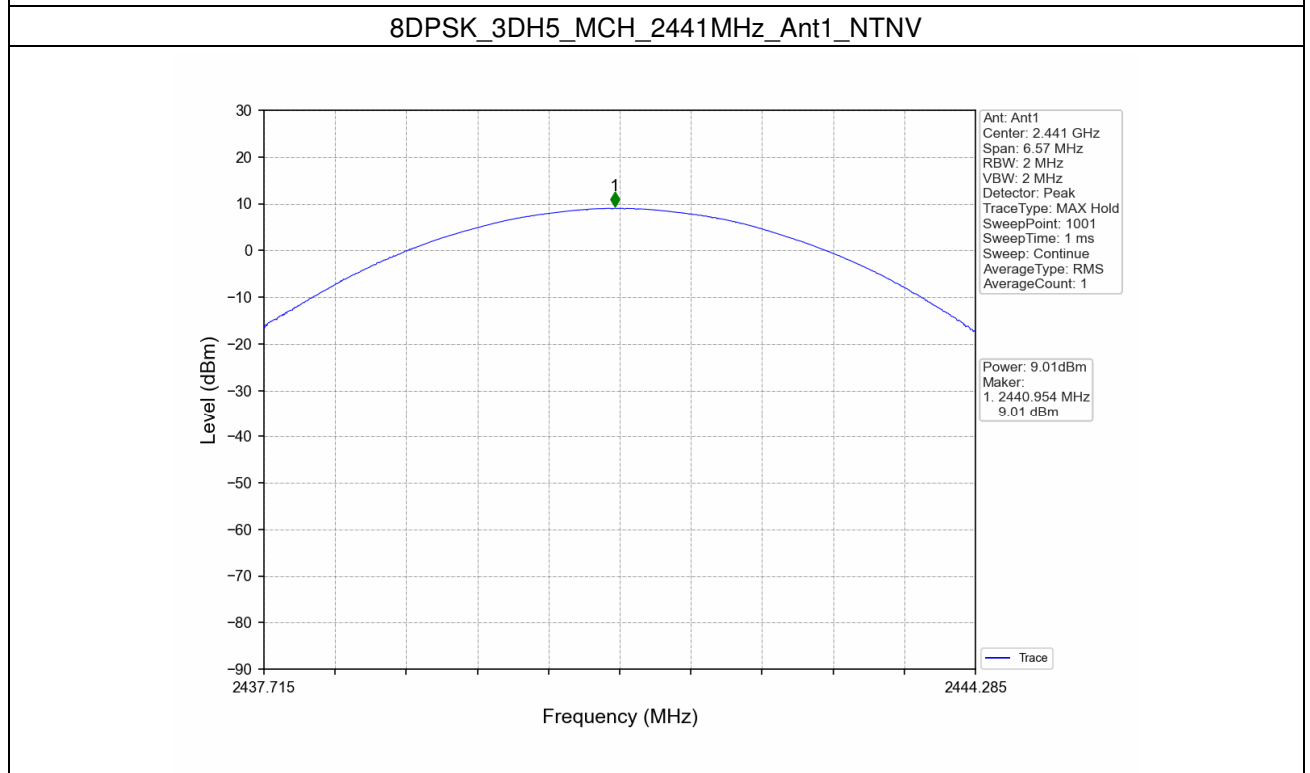
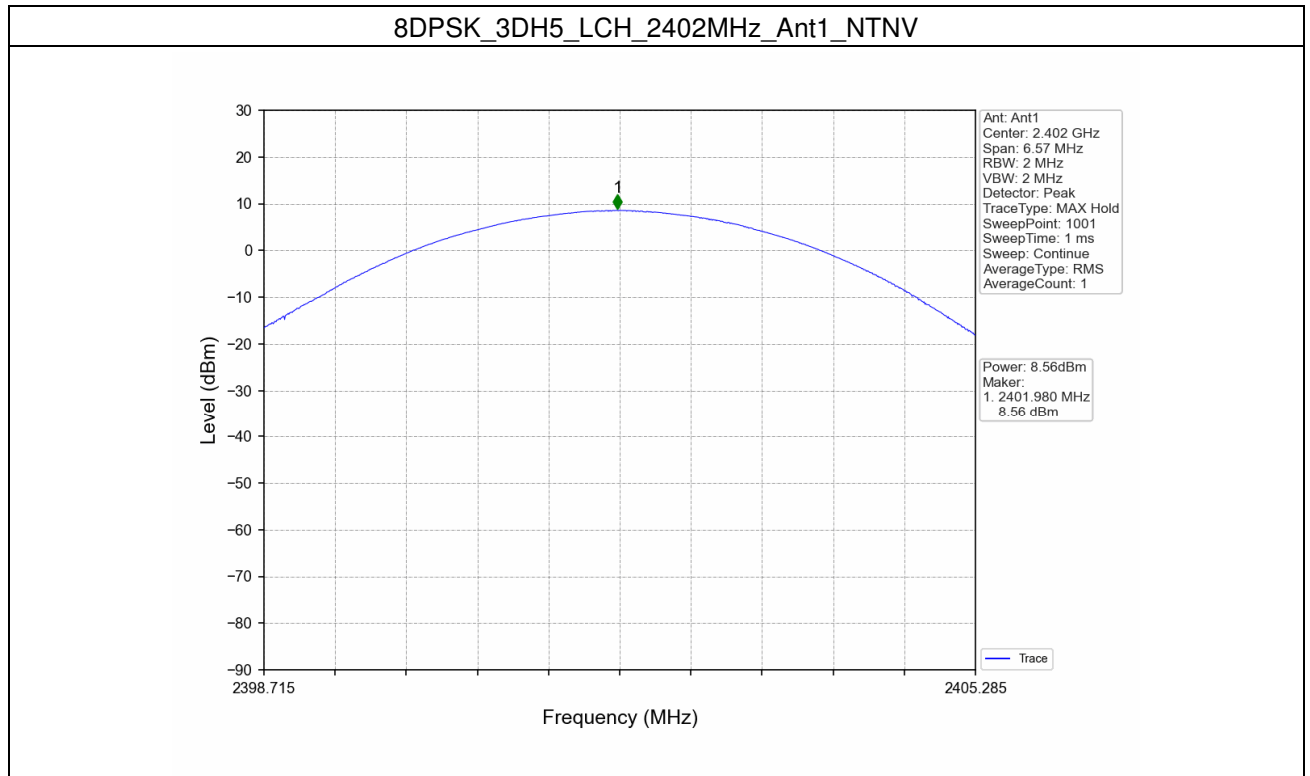


Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV



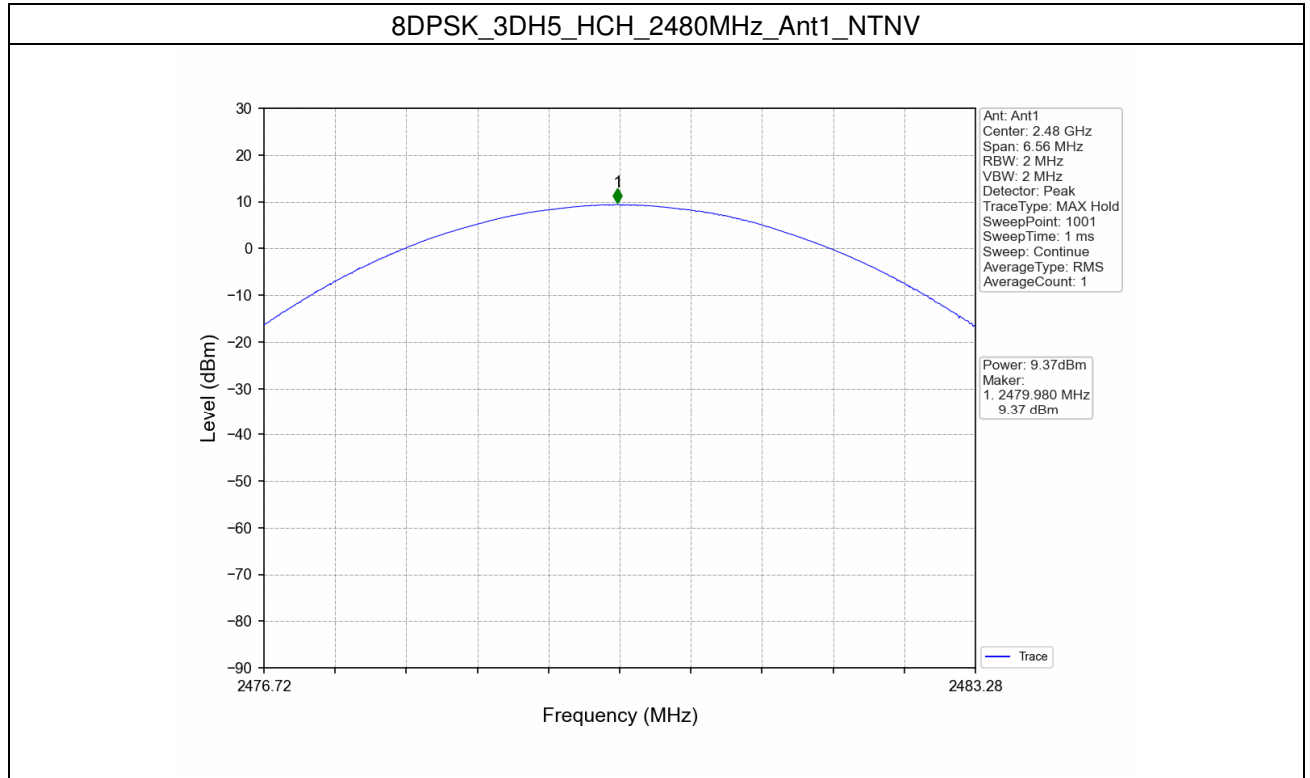
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3. Carrier Frequency Separation

3.1 Ant1

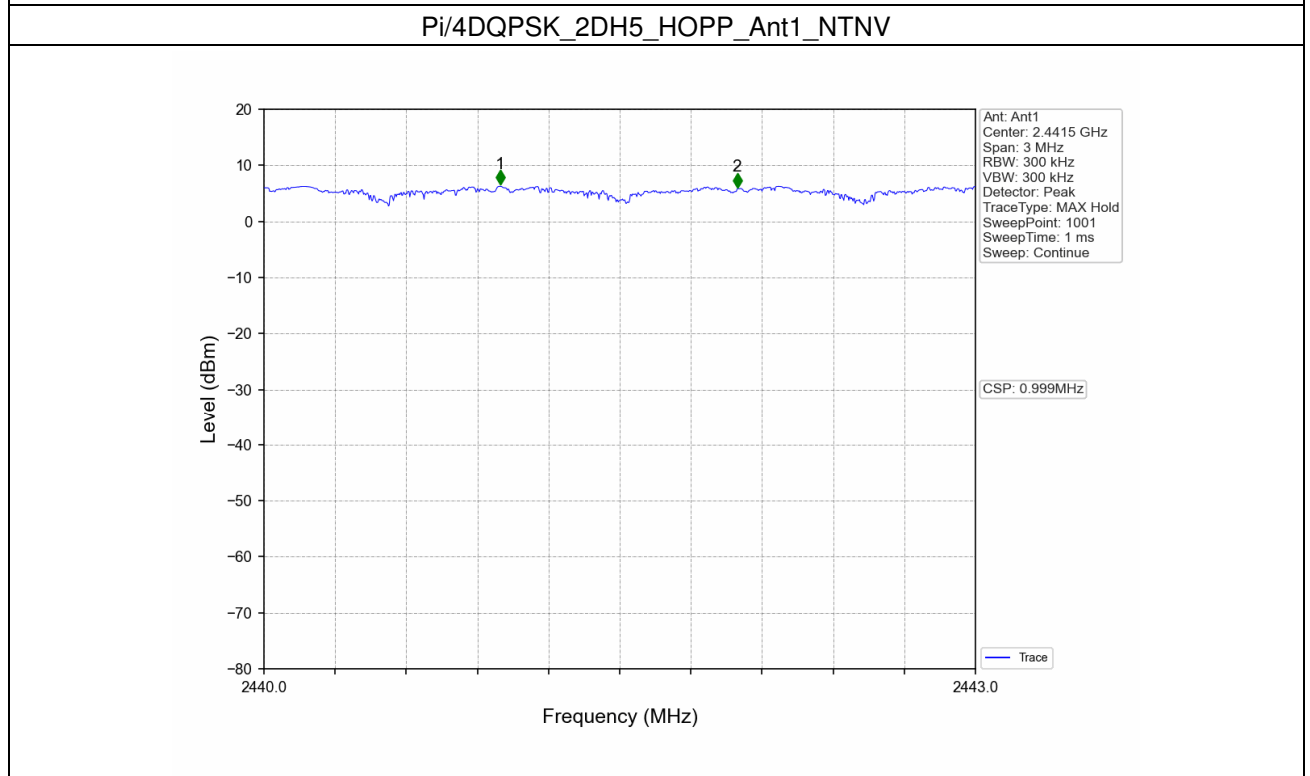
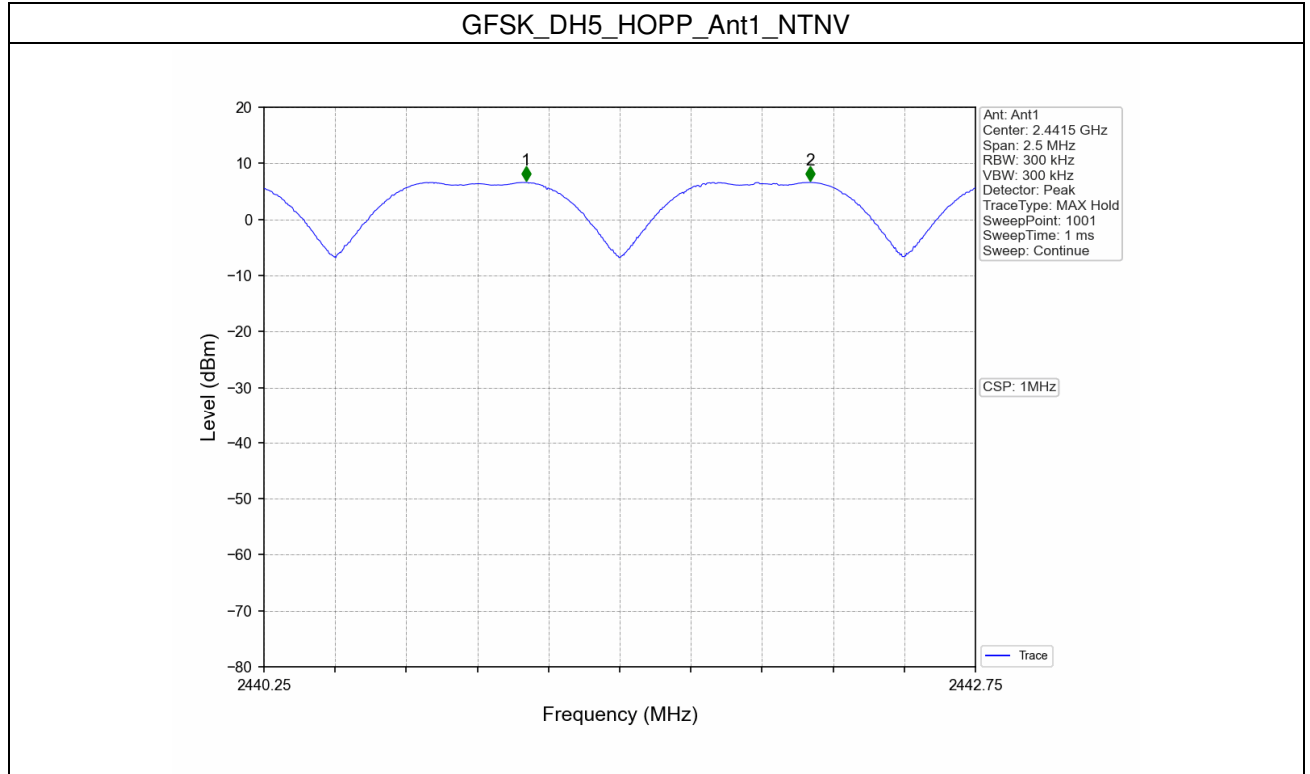
3.1.1 Test Result

Ant1							
Mode	TX Type	Frequency (MHz)	Packet Type	Channel Separation (MHz)	20dB Bandwidth (MHz)	Limit (MHz)	Verdict
GFSK	SISO	HOPP	DH5	1.000	0.961	≥ 0.961	Pass
Pi/4DQPSK	SISO	HOPP	2DH5	0.999	1.346	≥ 0.897	Pass
8DPSK	SISO	HOPP	3DH5	0.999	1.314	≥ 0.876	Pass



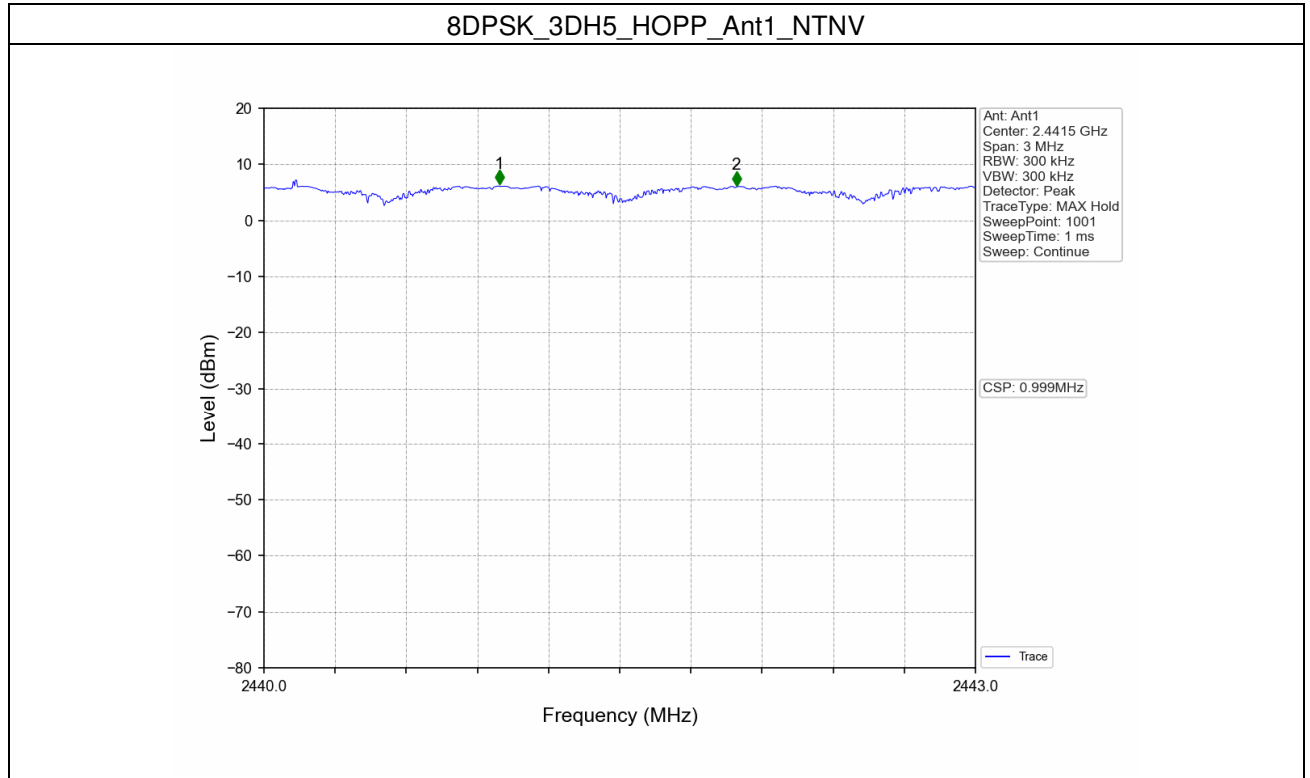
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3.1.2 Test Graph



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4. Number of Hopping Frequencies

4.1 HoppNum

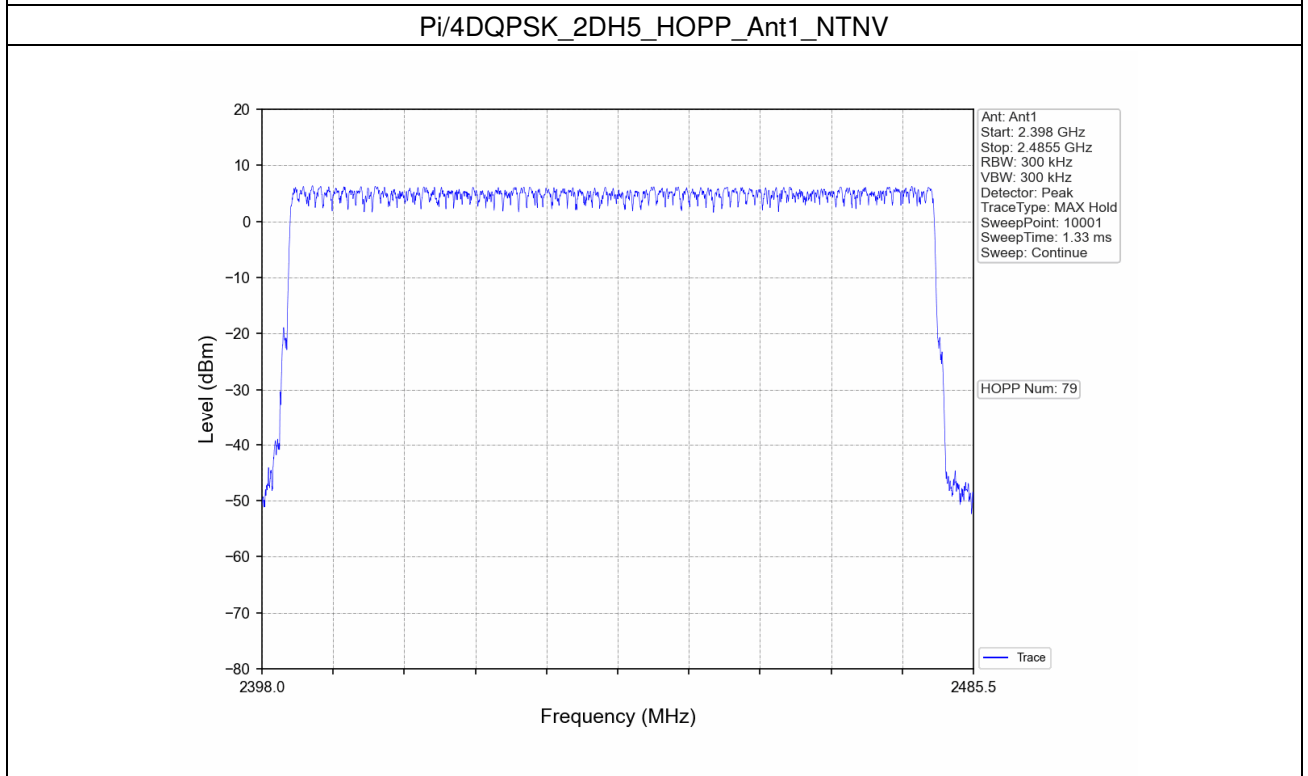
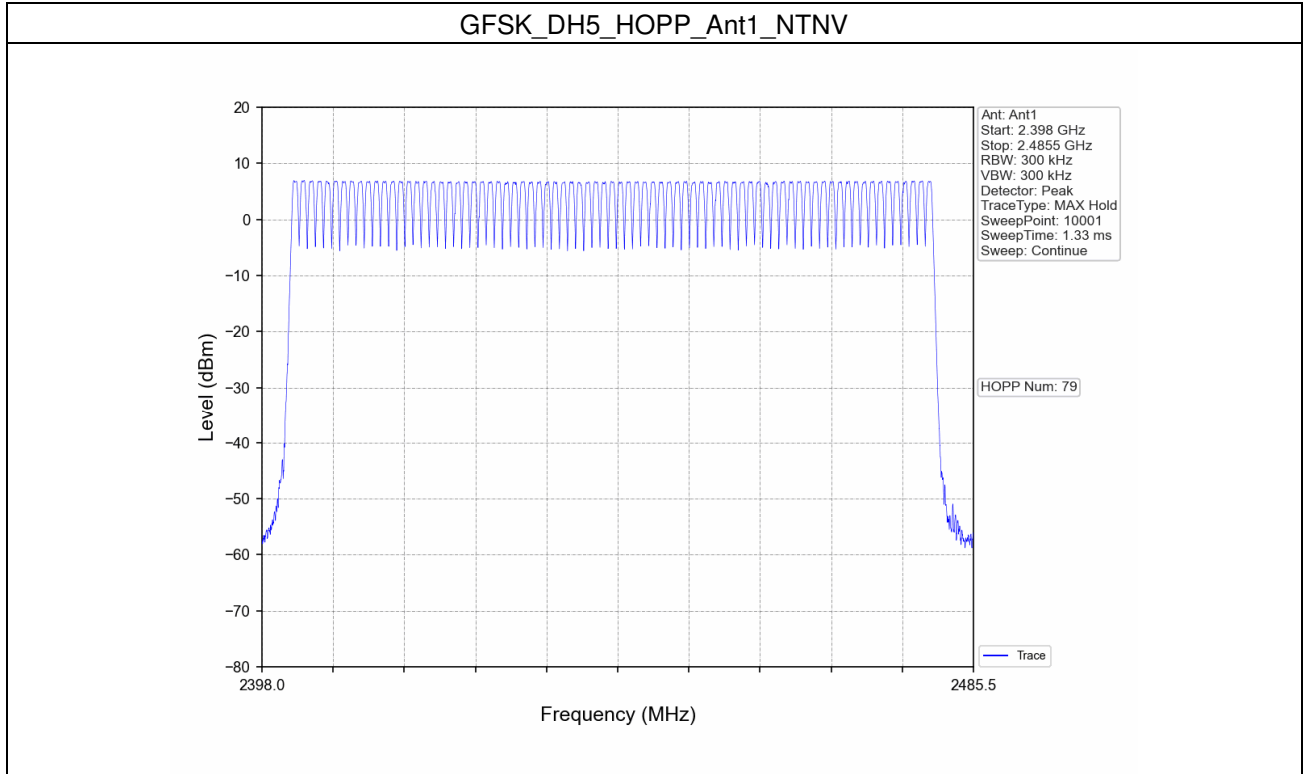
4.1.1 Test Result

Mode	TX Type	Frequency (MHz)	Packet Type	Num of Hopping Frequencies		Verdict
				Ant1	Limit	
GFSK	SISO	HOPP	DH5	79	>=15	Pass
Pi/4DQPSK	SISO	HOPP	2DH5	79	>=15	Pass
8DPSK	SISO	HOPP	3DH5	79	>=15	Pass



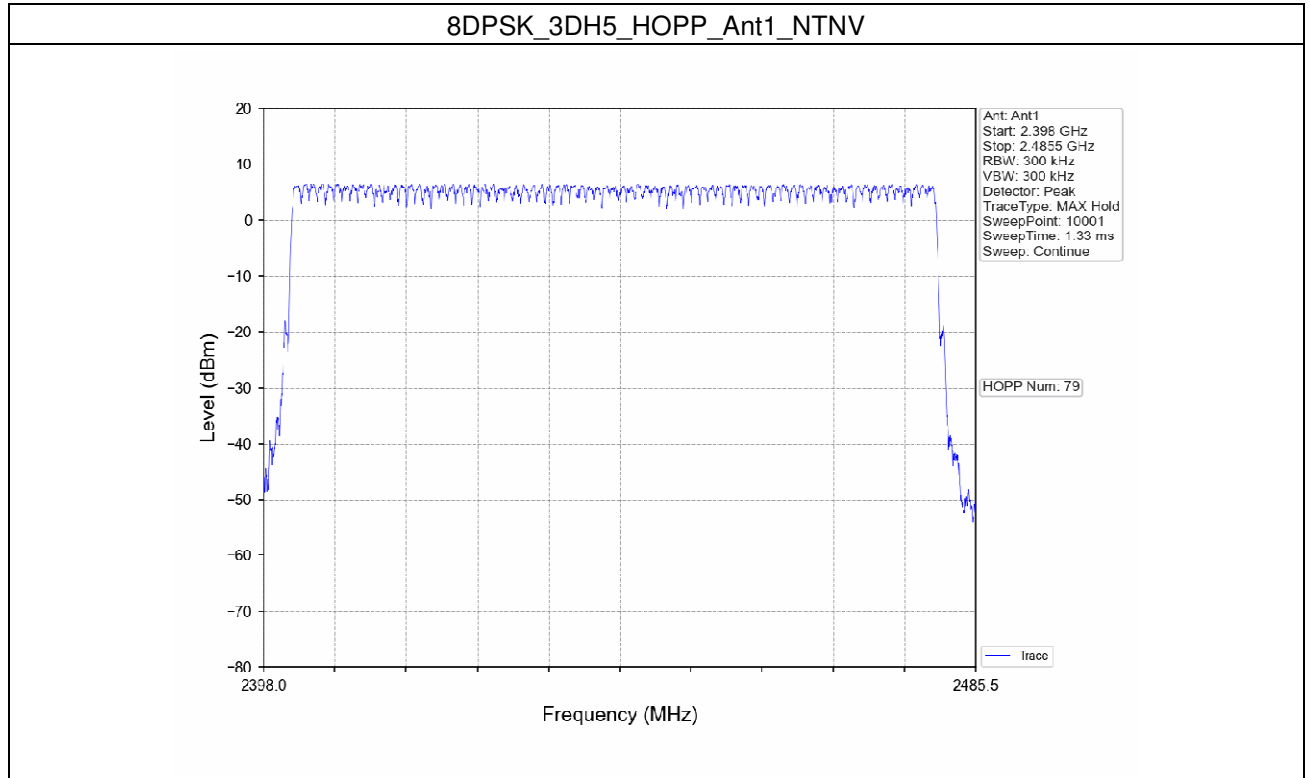
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4.1.2 Test Graph



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5. Time of Occupancy (Dwell Time)

5.1 Ant1

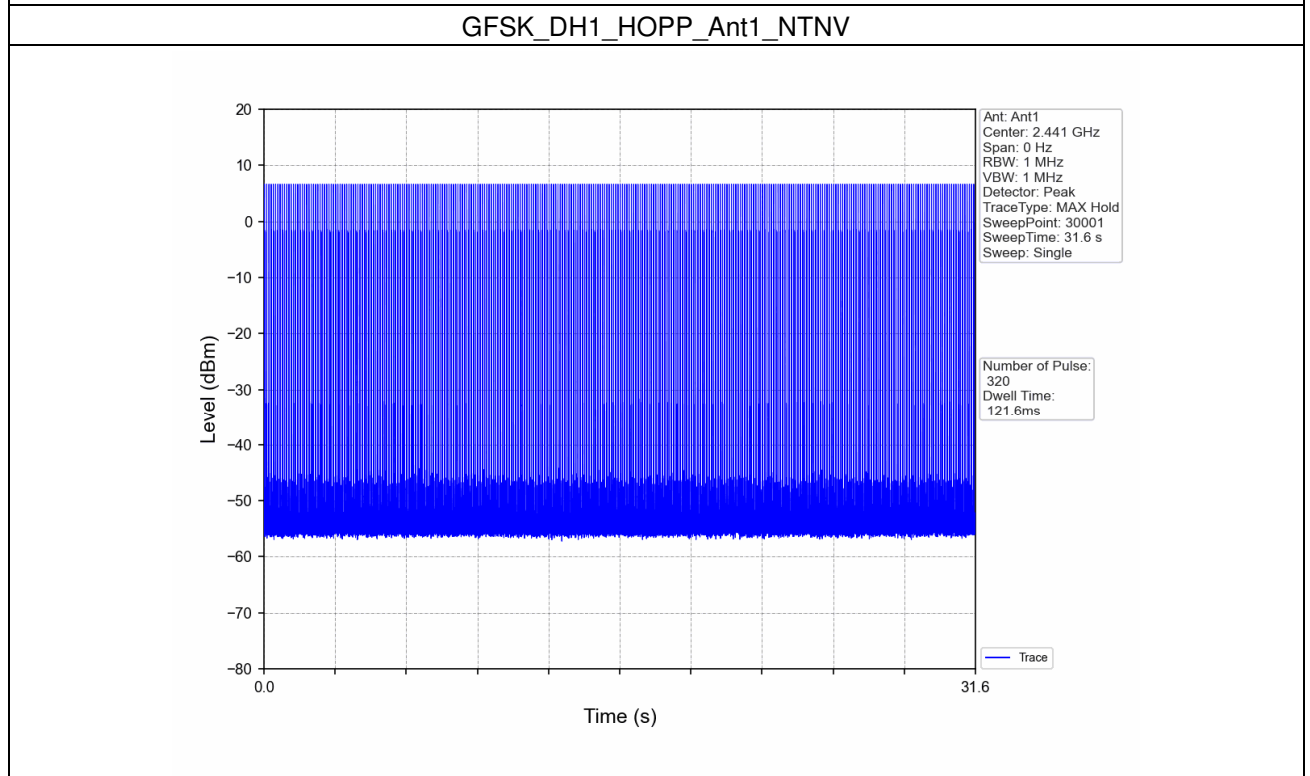
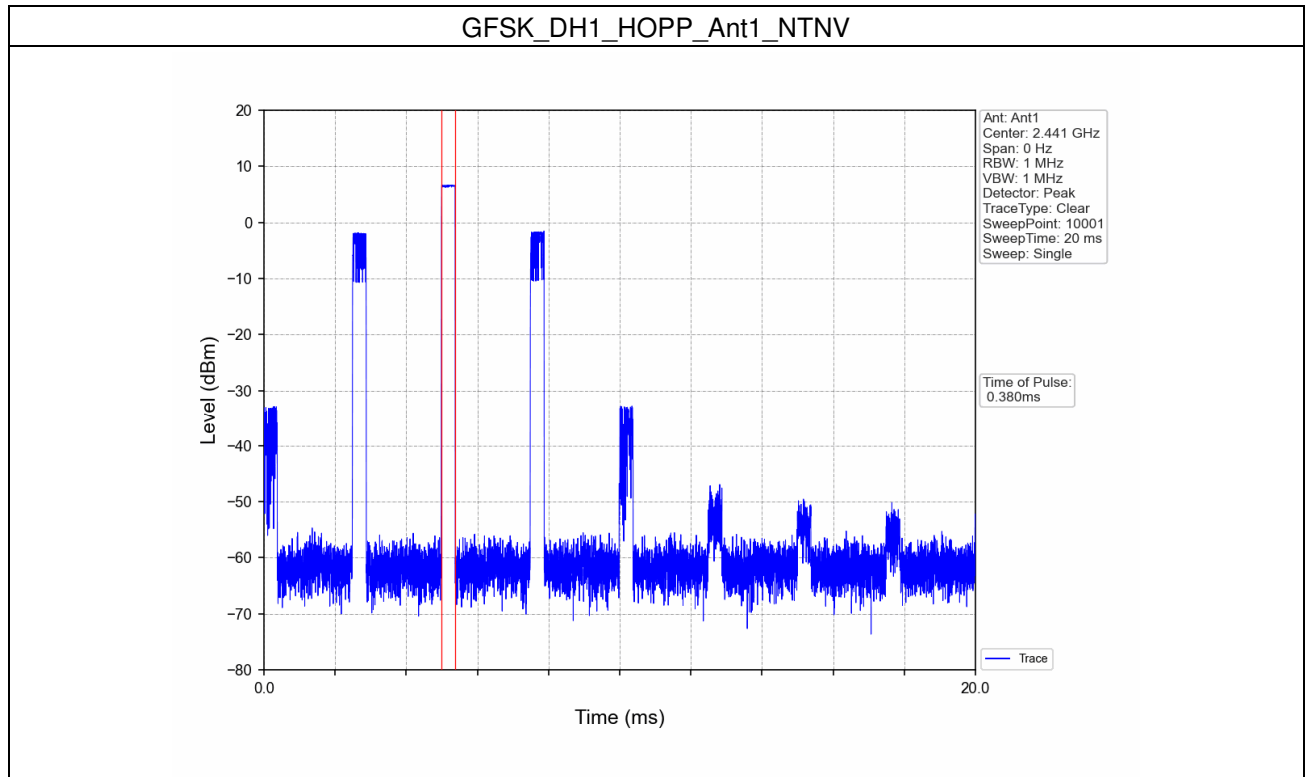
5.1.1 Test Result

Ant1									
Mode	TX Type	Frequency (MHz)	Packet Type	Duration of Single Pulse (ms)	Observation Period (s)	Num of Pulse in Observation Period	Dwell Time (ms)	Limit (ms)	Verdict
GFSK	SISO	HOPP	DH1	0.380	31.600	320	121.600	<=400	Pass
			DH3	1.634	31.600	160	261.440	<=400	Pass
			DH5	2.884	31.600	106	305.704	<=400	Pass
Pi/4DQPSK	SISO	HOPP	2DH1	0.392	31.600	320	125.440	<=400	Pass
			2DH3	1.642	31.600	160	262.720	<=400	Pass
			2DH5	2.892	31.600	107	309.444	<=400	Pass
8DPSK	SISO	HOPP	3DH1	0.392	31.600	320	125.440	<=400	Pass
			3DH3	1.640	31.600	160	262.400	<=400	Pass
			3DH5	2.892	31.600	107	309.444	<=400	Pass



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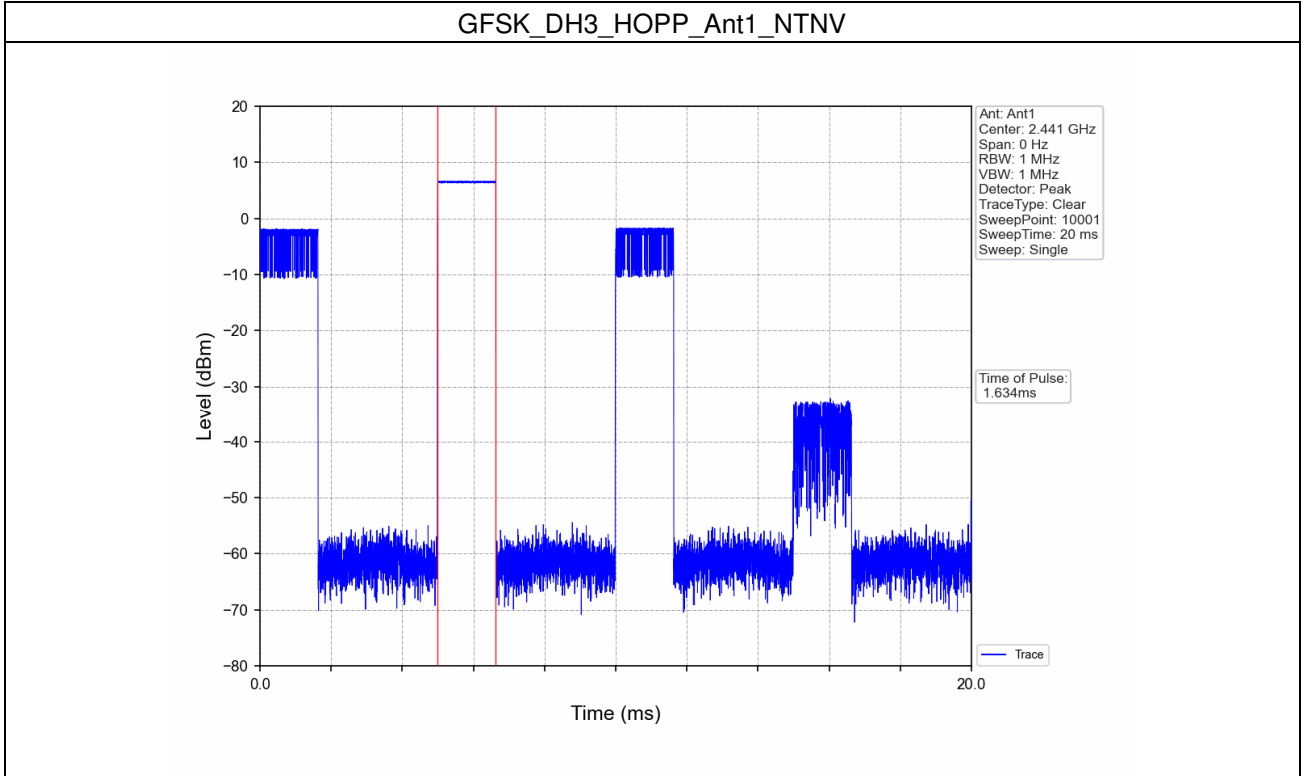
5.1.2 Test Graph



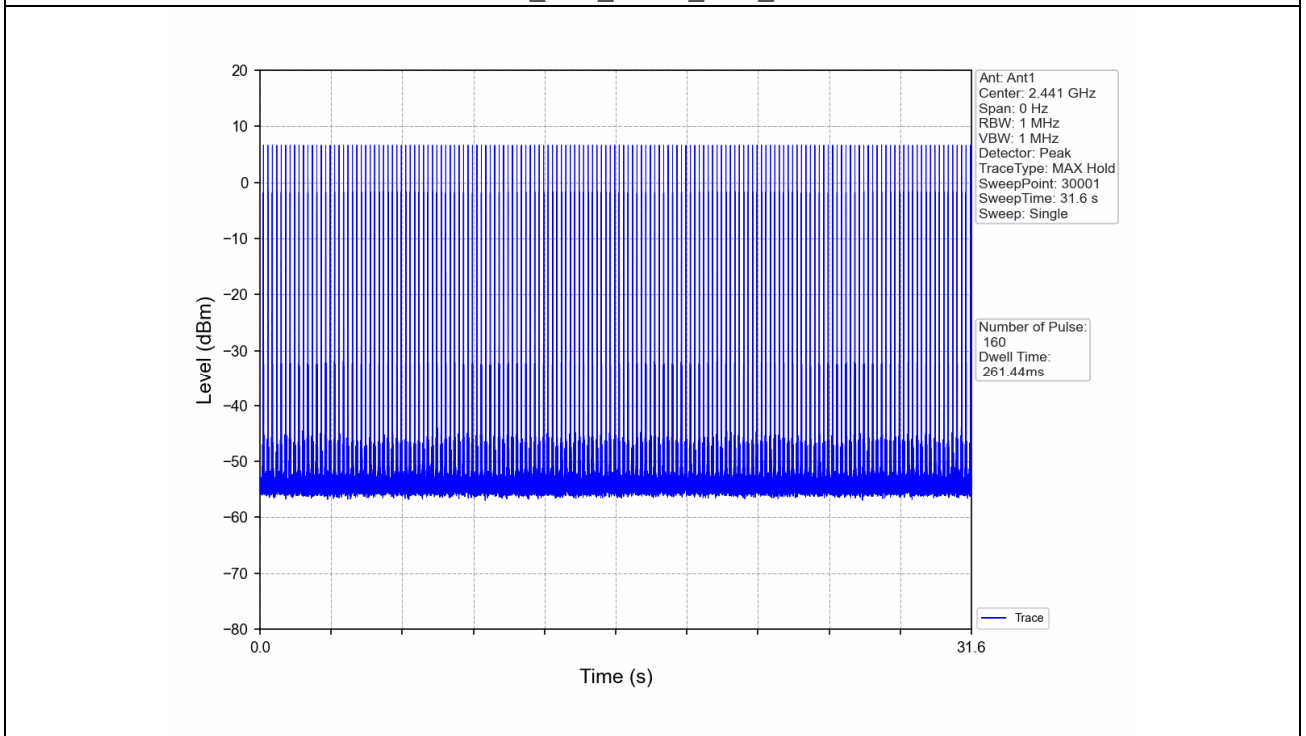
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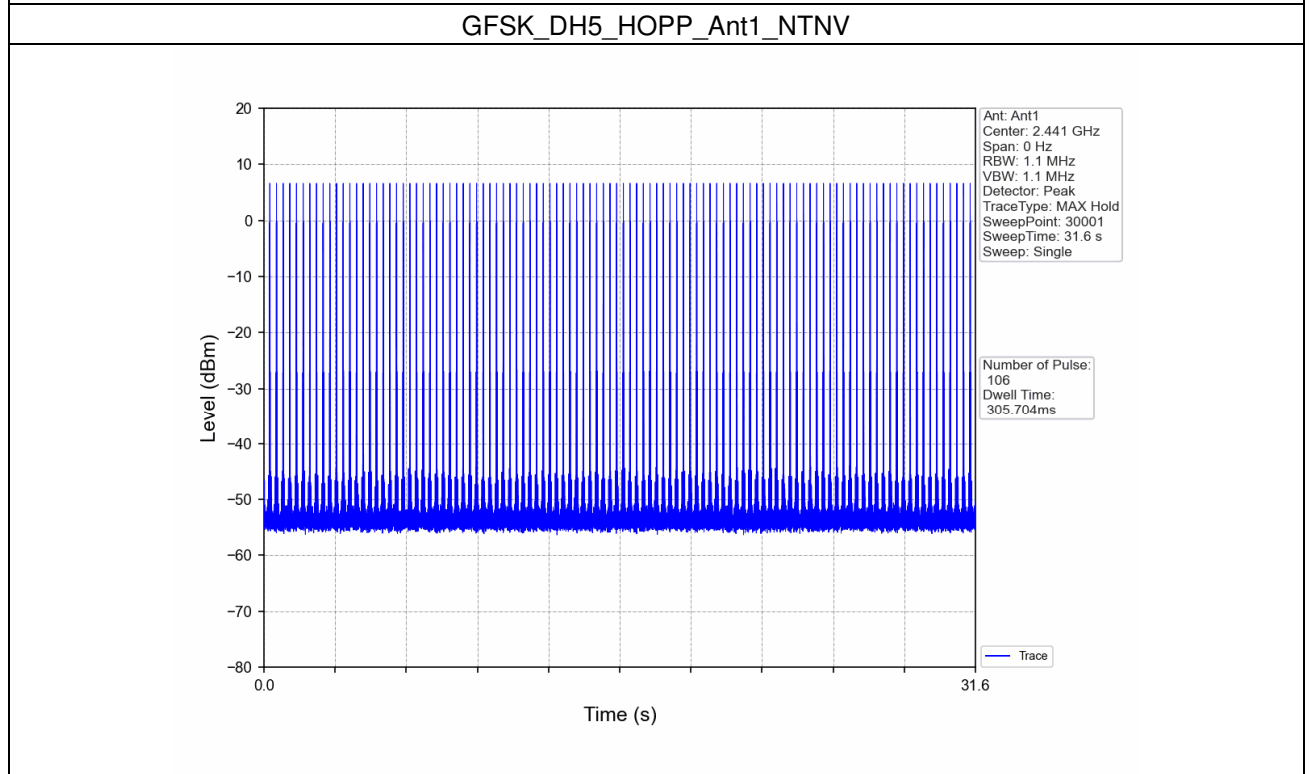
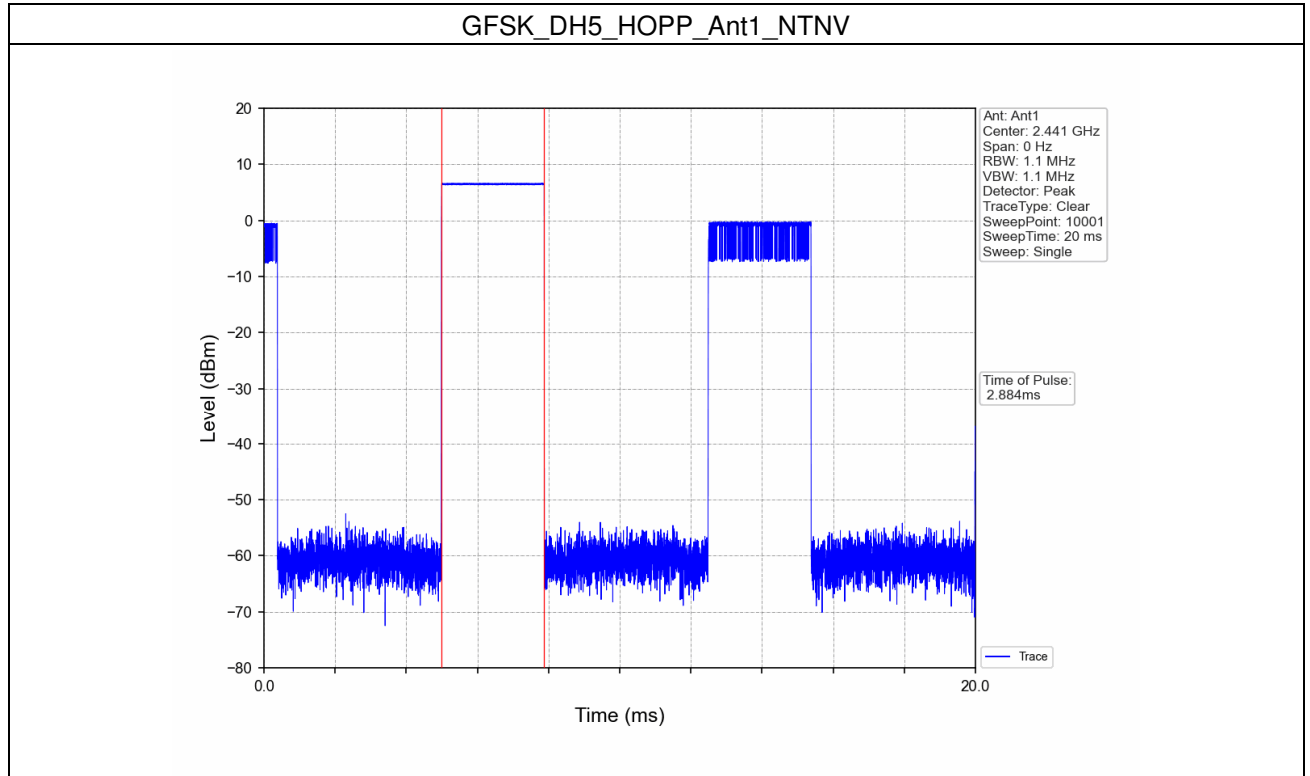
GFSK_DH3_HOPP_Ant1_NTNV



GFSK_DH3_HOPP_Ant1_NTNV

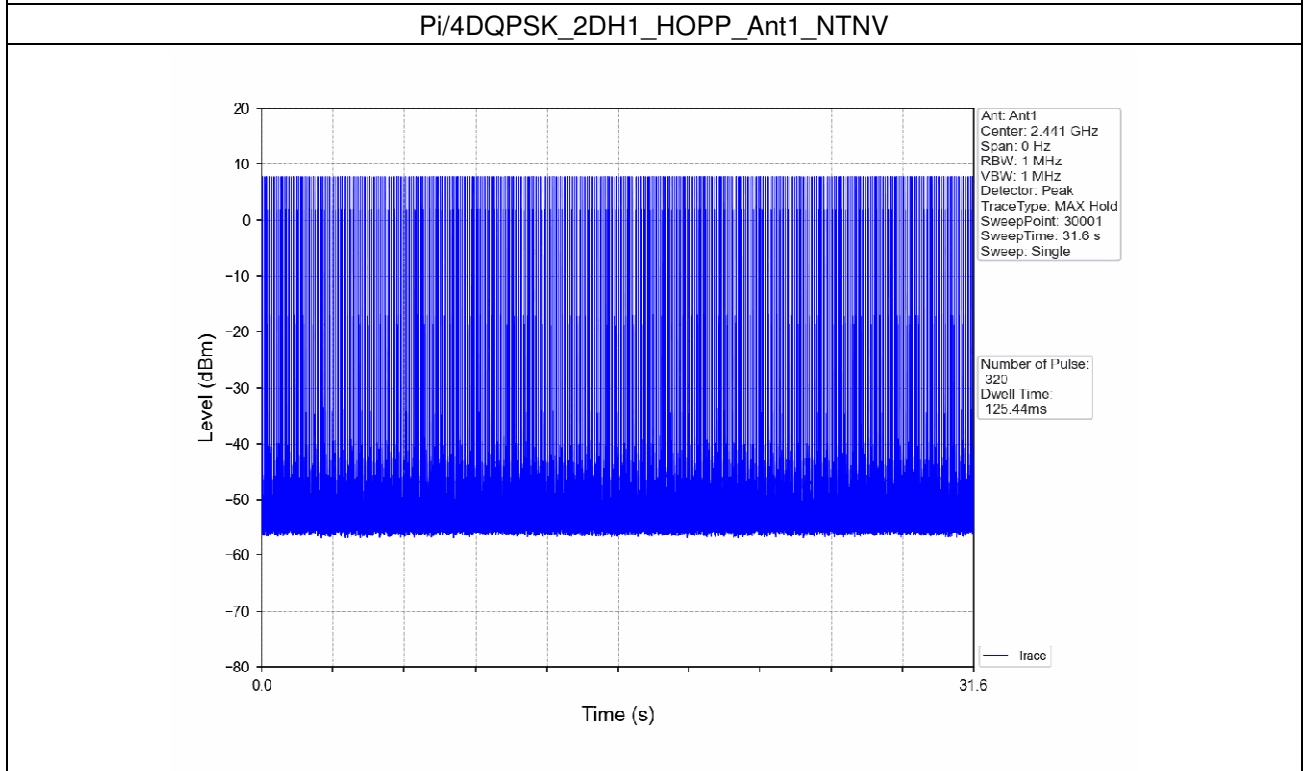
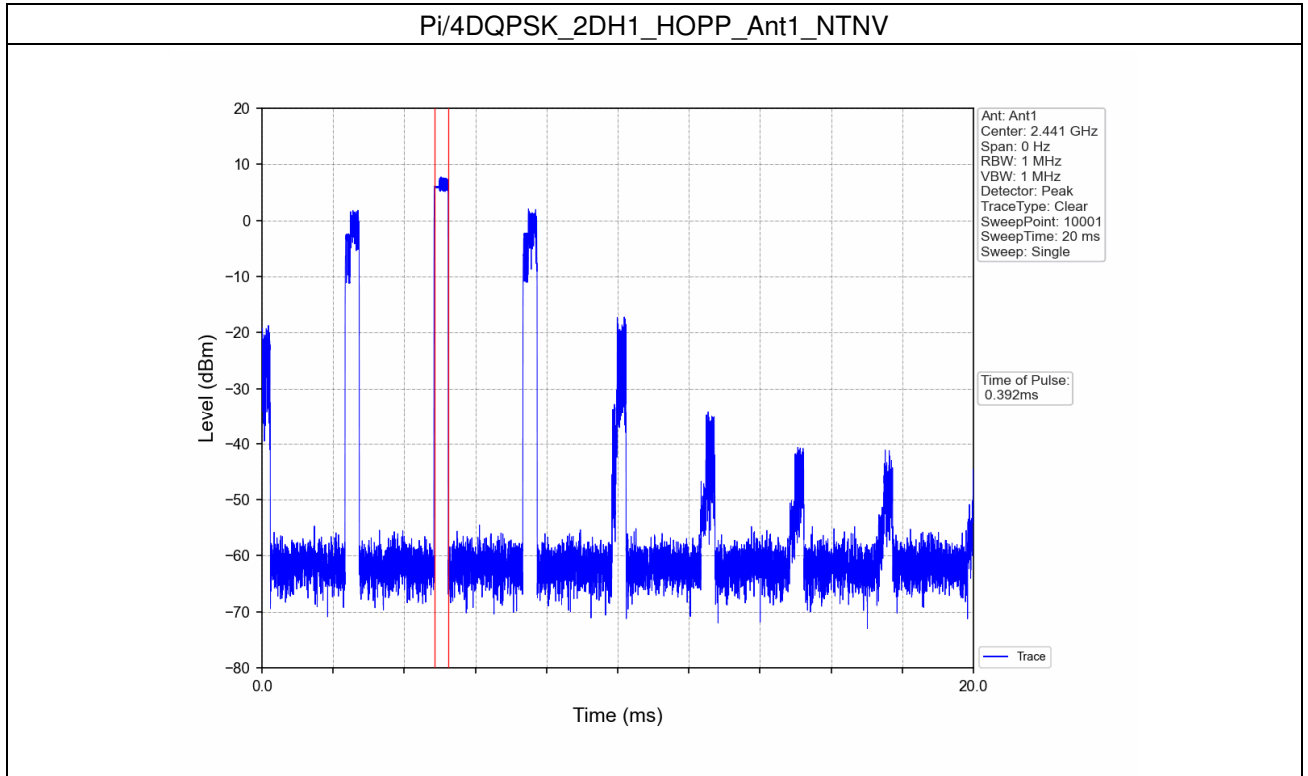


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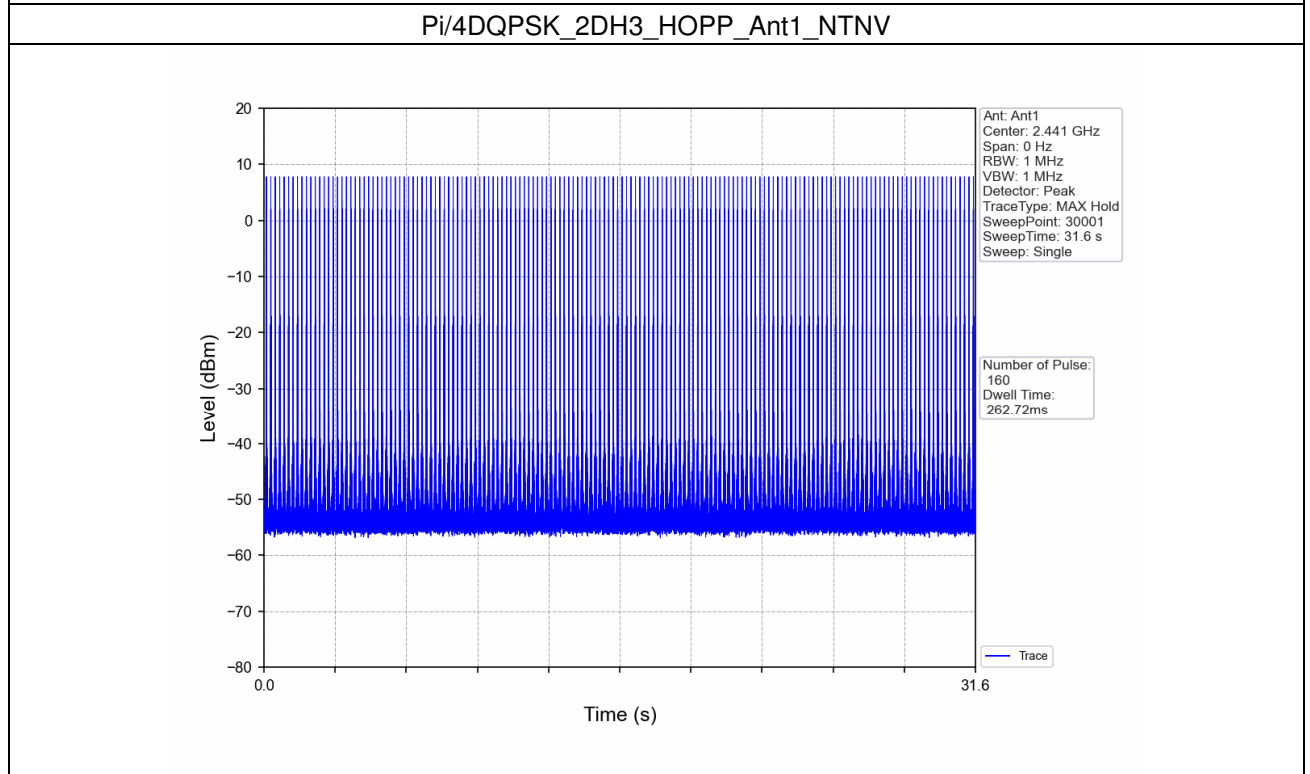
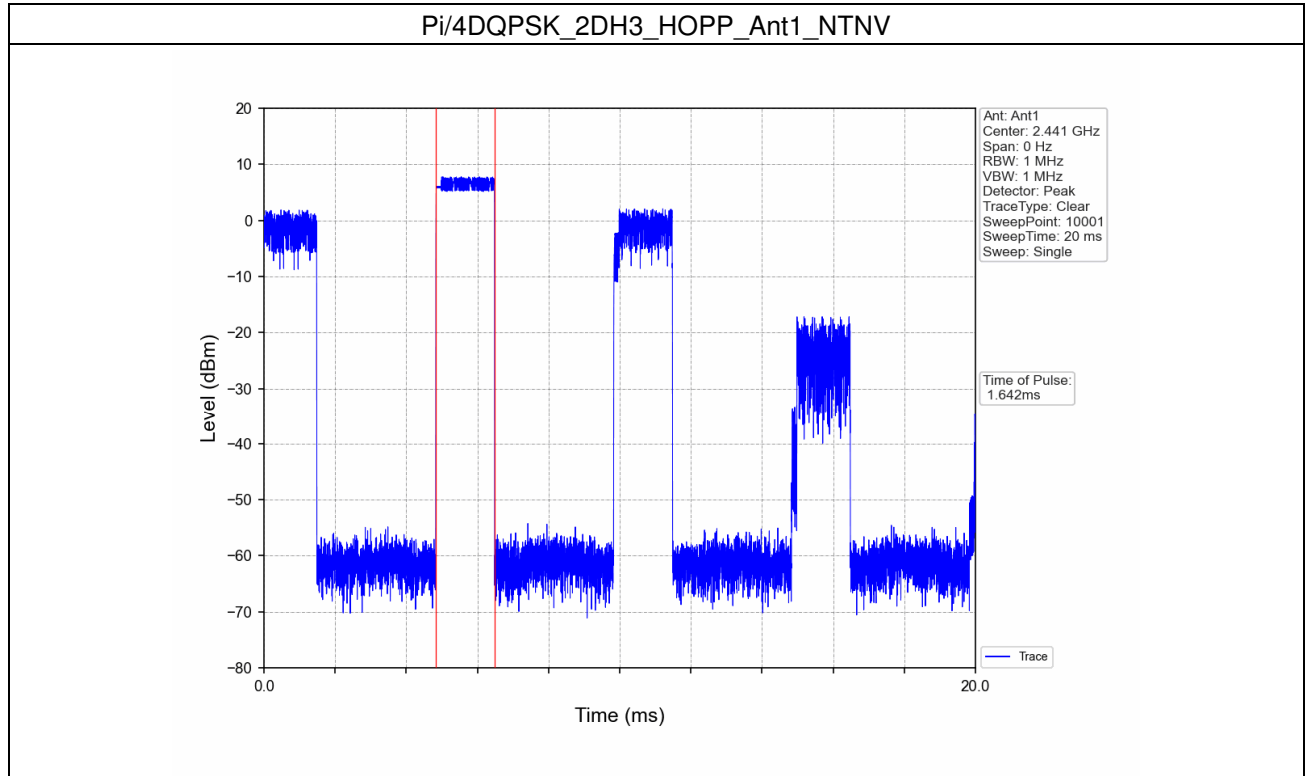


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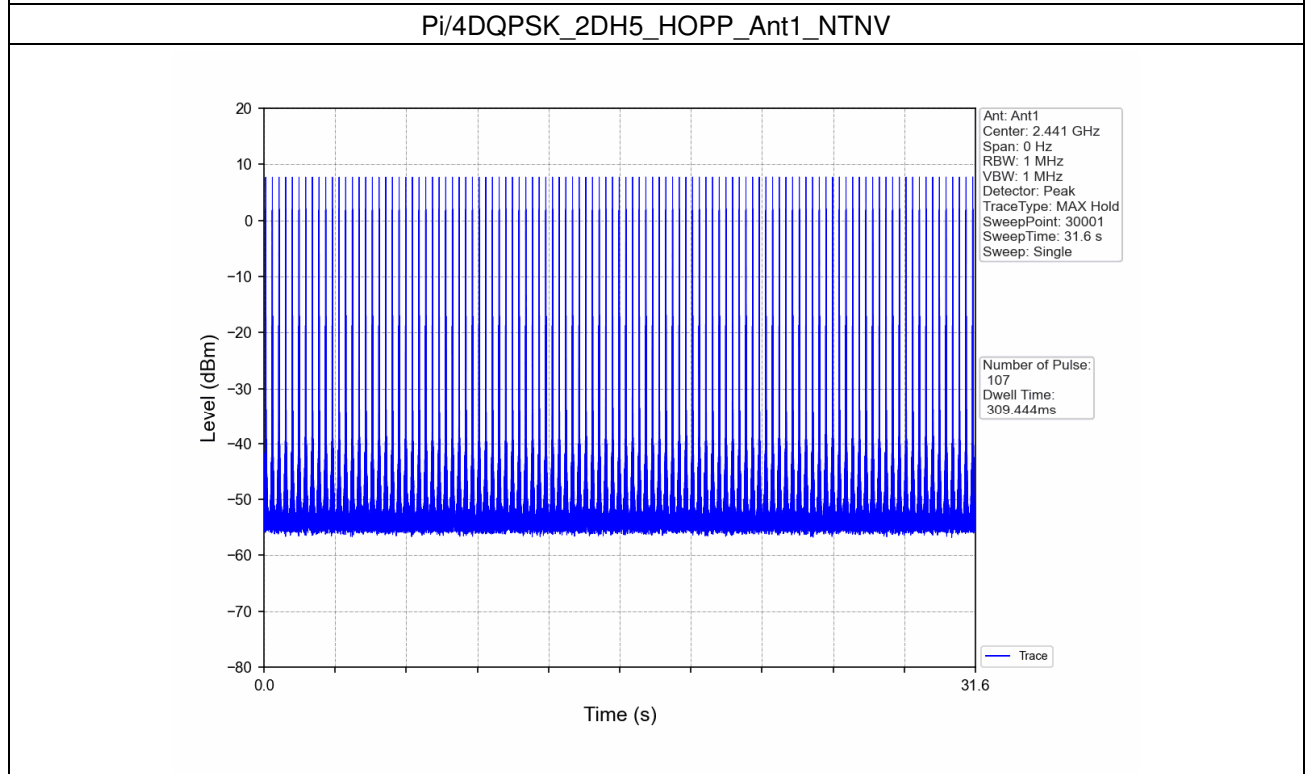
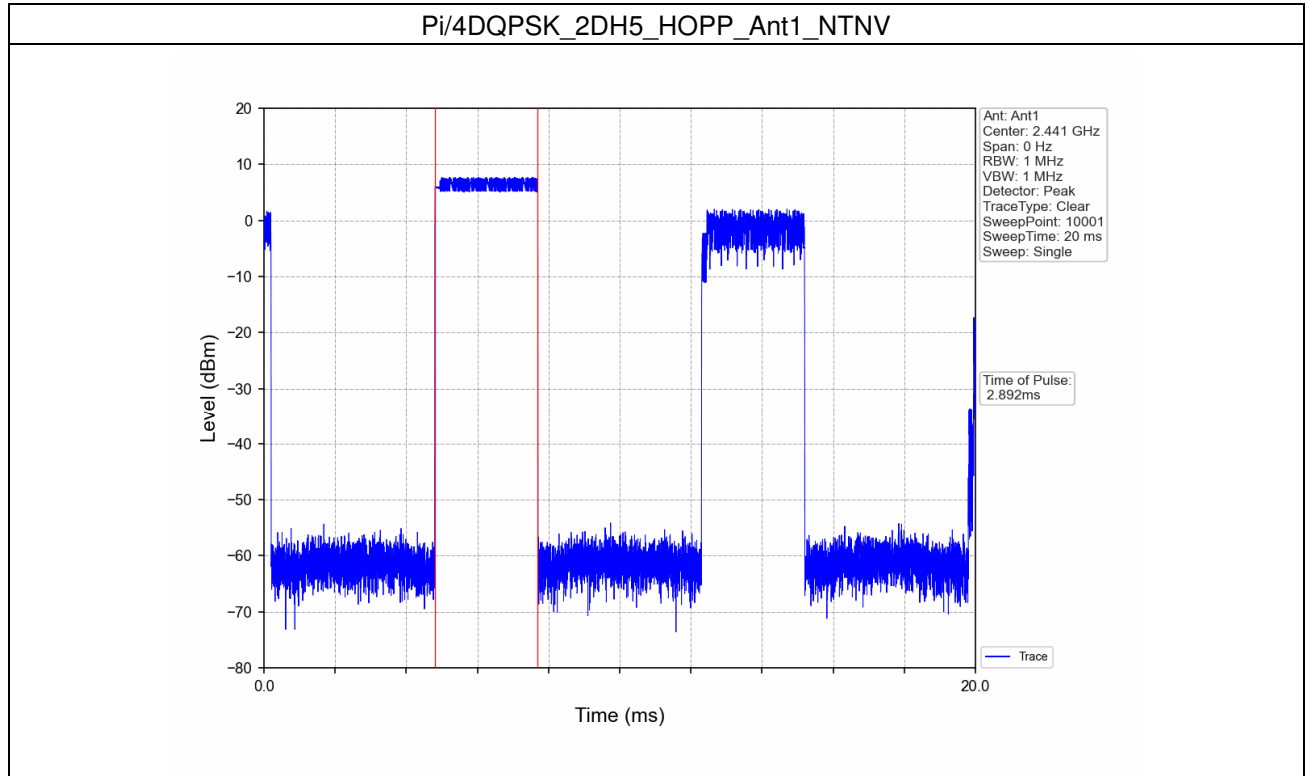
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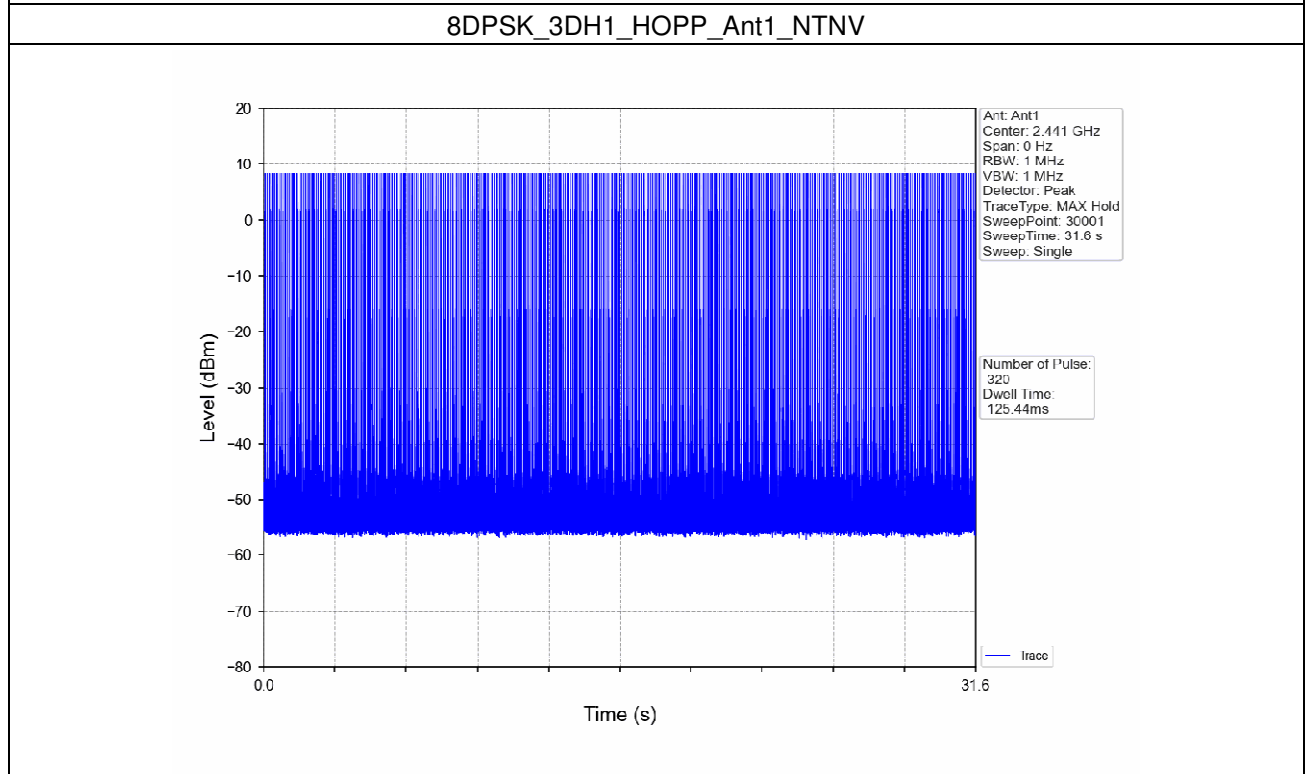
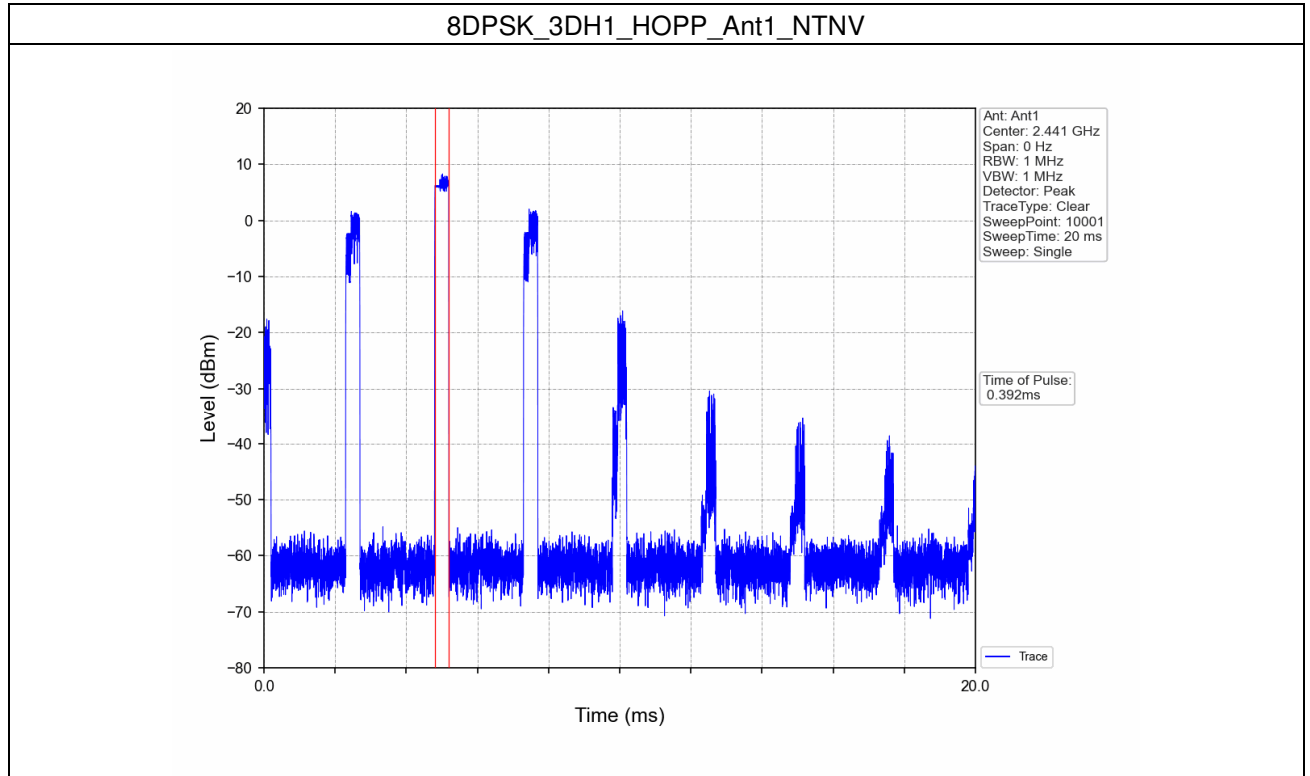
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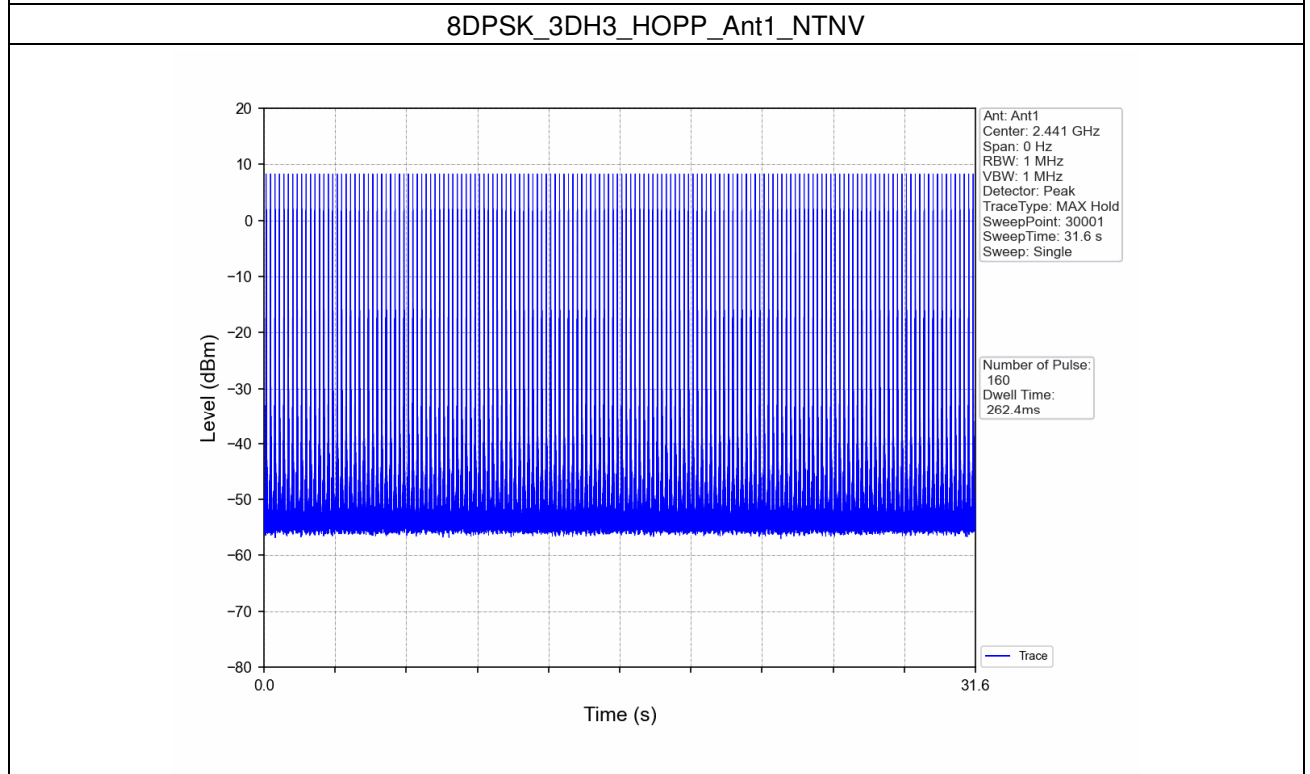
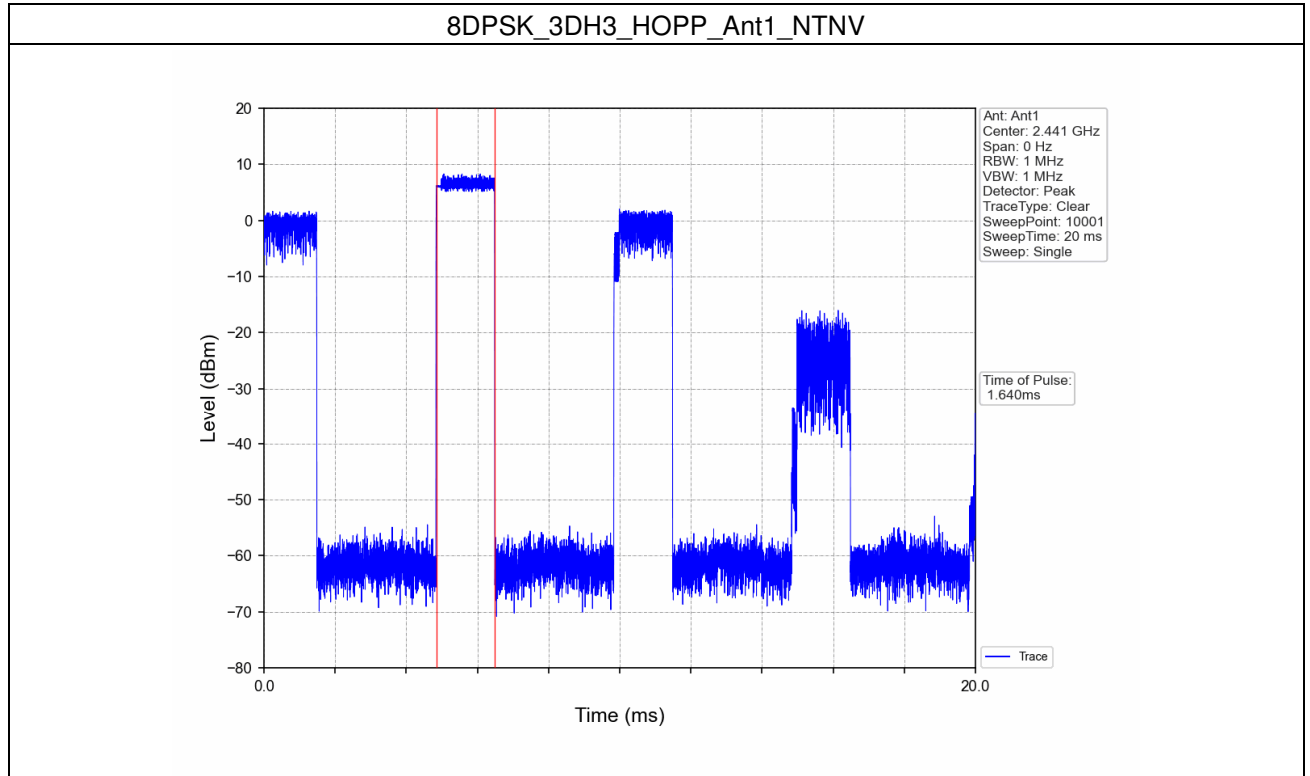


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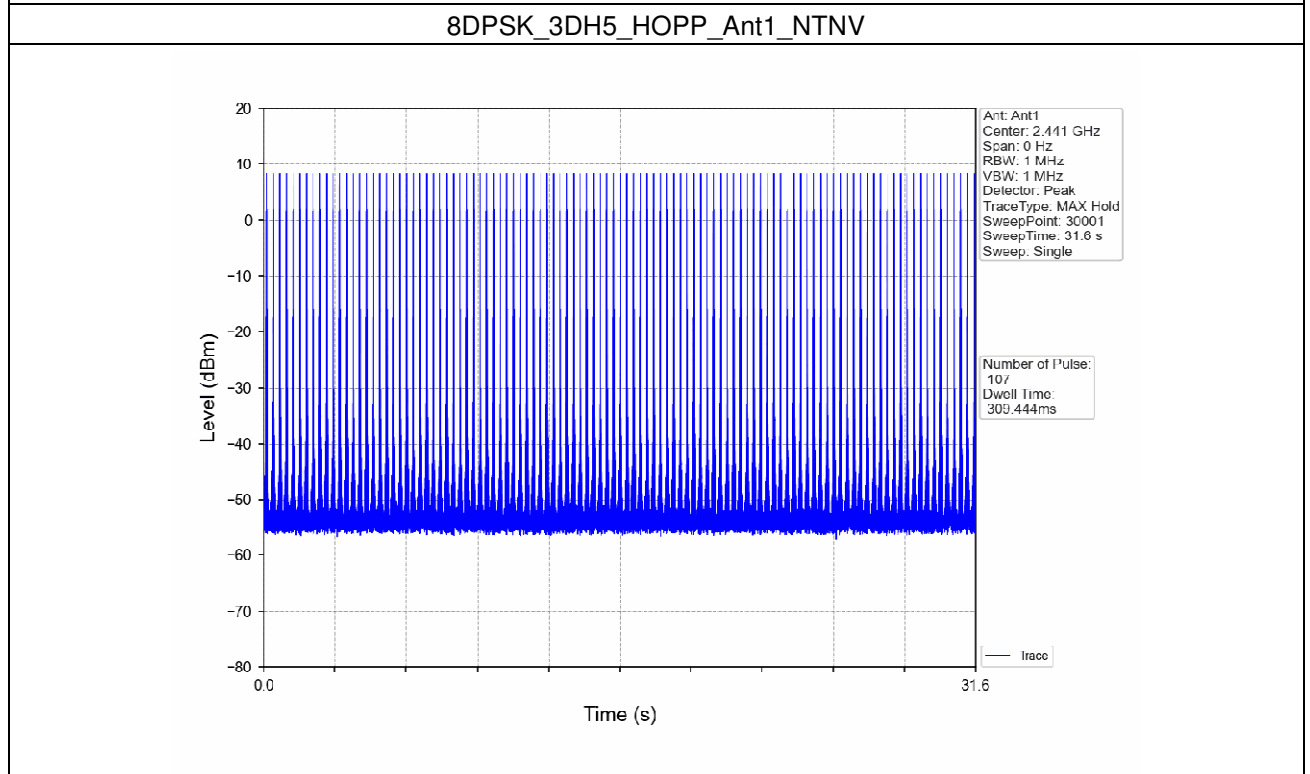
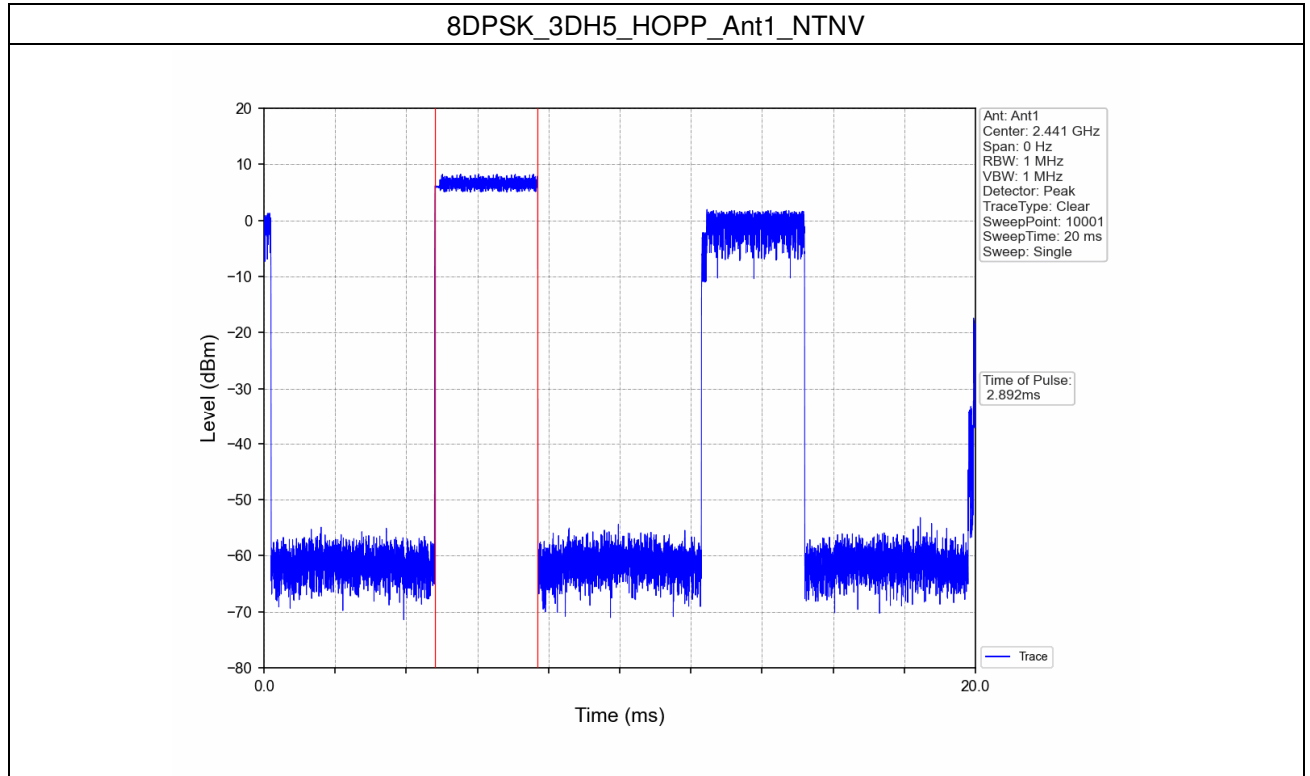


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6. Unwanted Emissions In Non-restricted Frequency Bands

6.1 Ref

6.1.1 Test Result

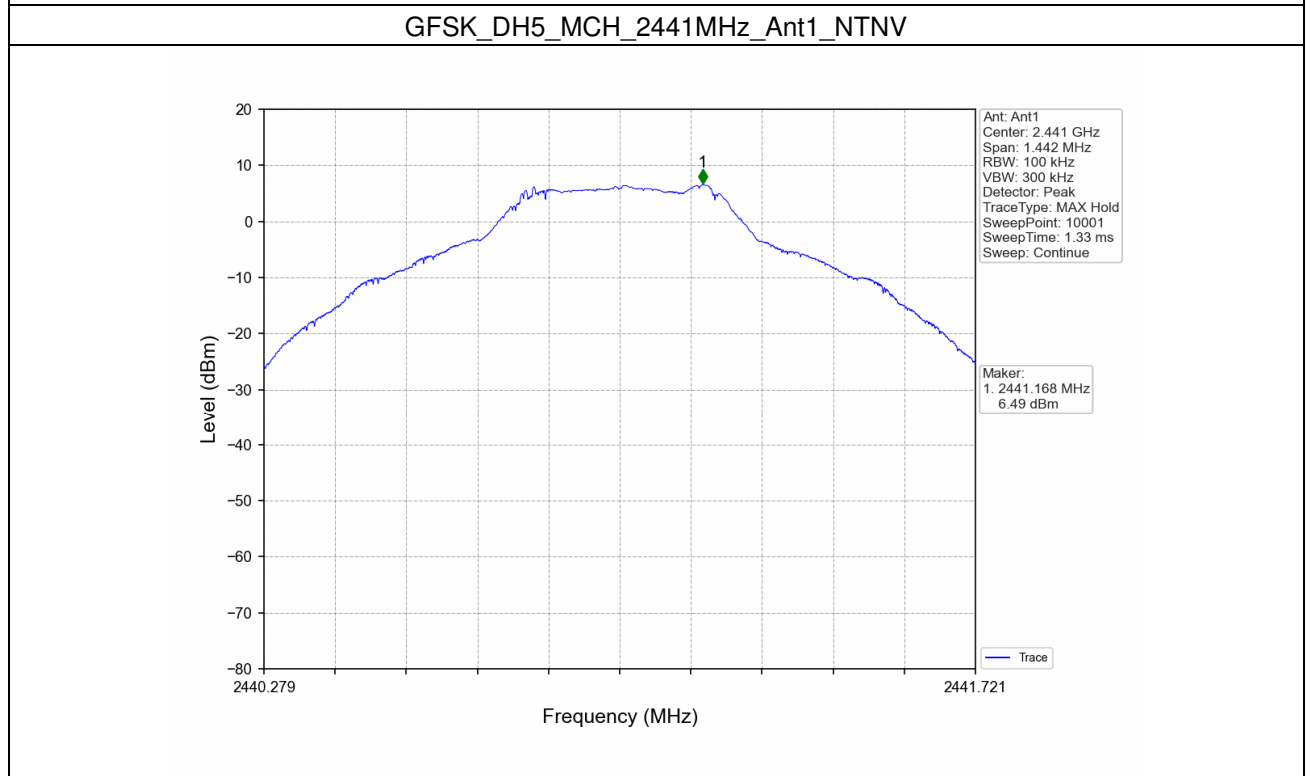
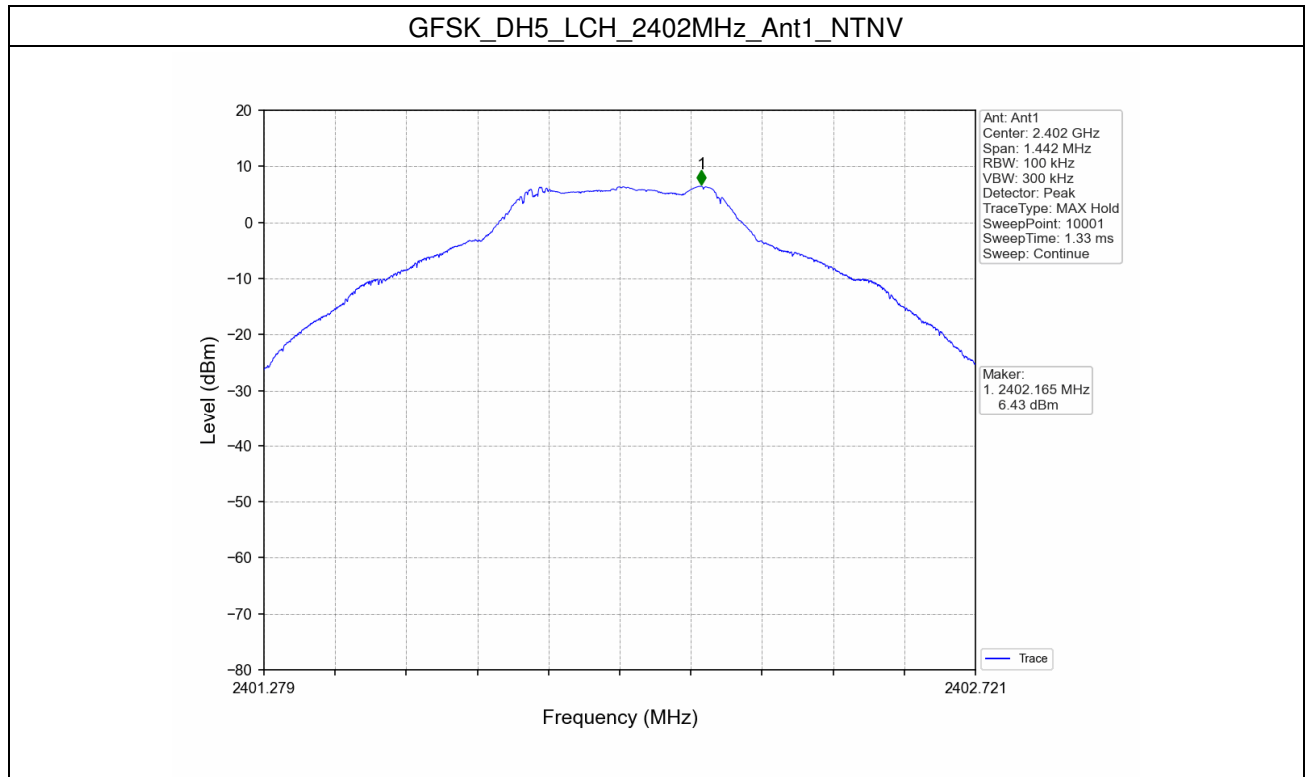
Mode	TX Type	Frequency (MHz)	Packet Type	Ant	Level of Reference (dBm)
GFSK	SISO	2402	DH5	1	6.43
		2441	DH5	1	6.49
		2480	DH5	1	6.51
Pi/4DQPSK	SISO	2402	2DH5	1	6.61
		2441	2DH5	1	6.45
		2480	2DH5	1	6.63
8DPSK	SISO	2402	3DH5	1	6.44
		2441	3DH5	1	6.51
		2480	3DH5	1	6.79

Note1: Refer to FCC Part 15.247 (d) and ANSI C63.10-2013, the channel contains the maximum PSD level was used to establish the reference level.



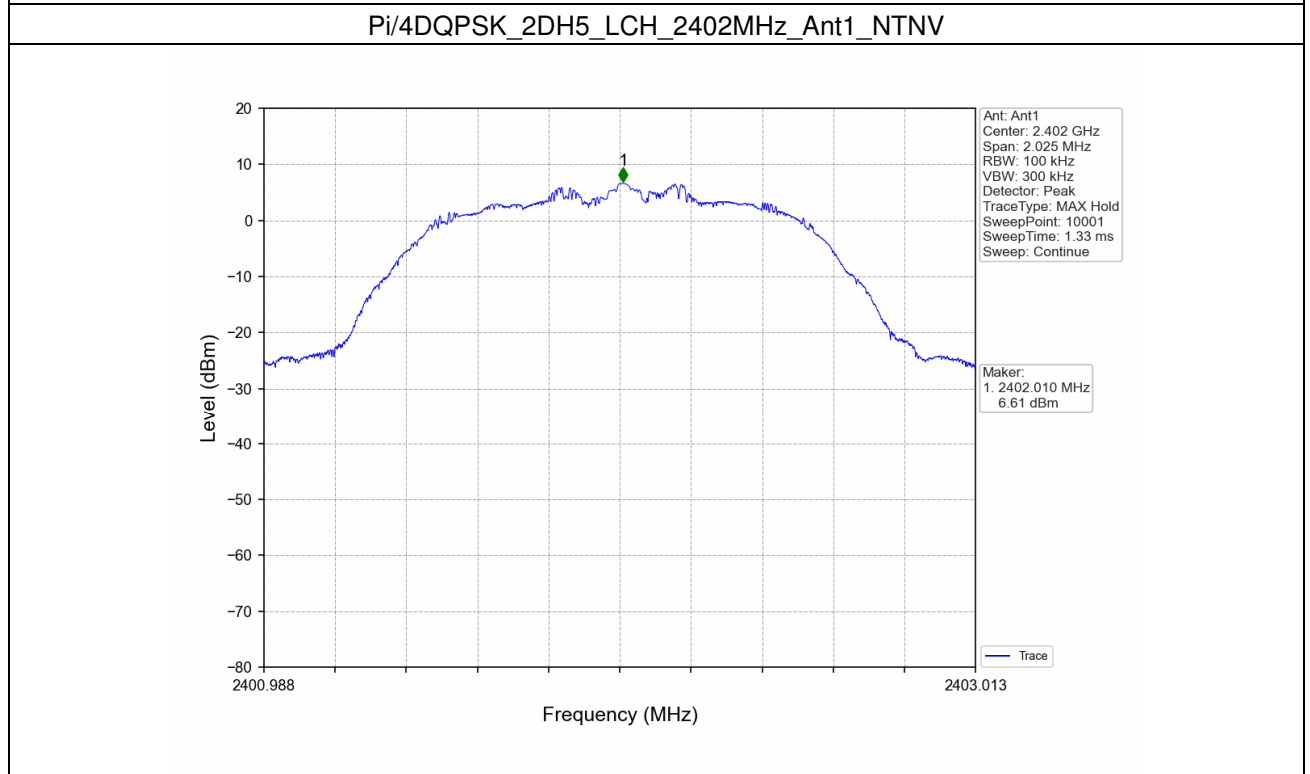
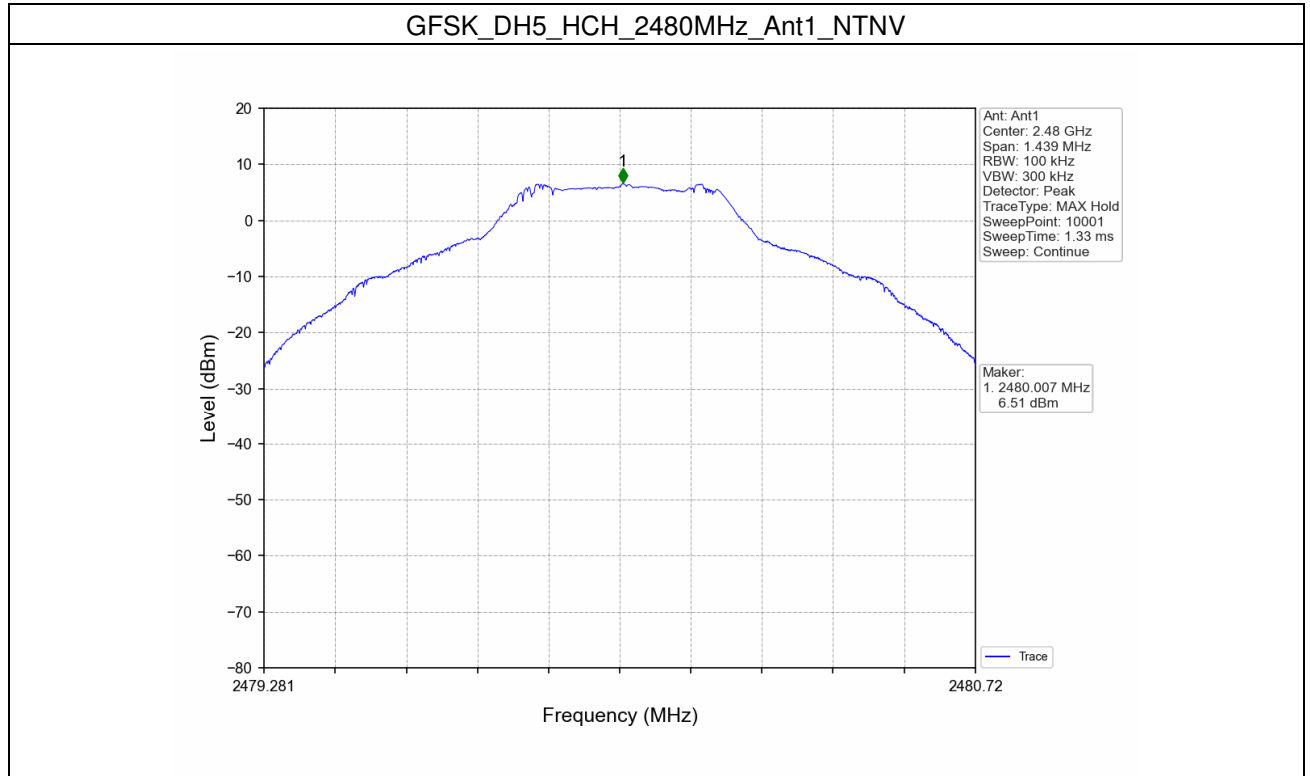
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6.1.2 Test Graph



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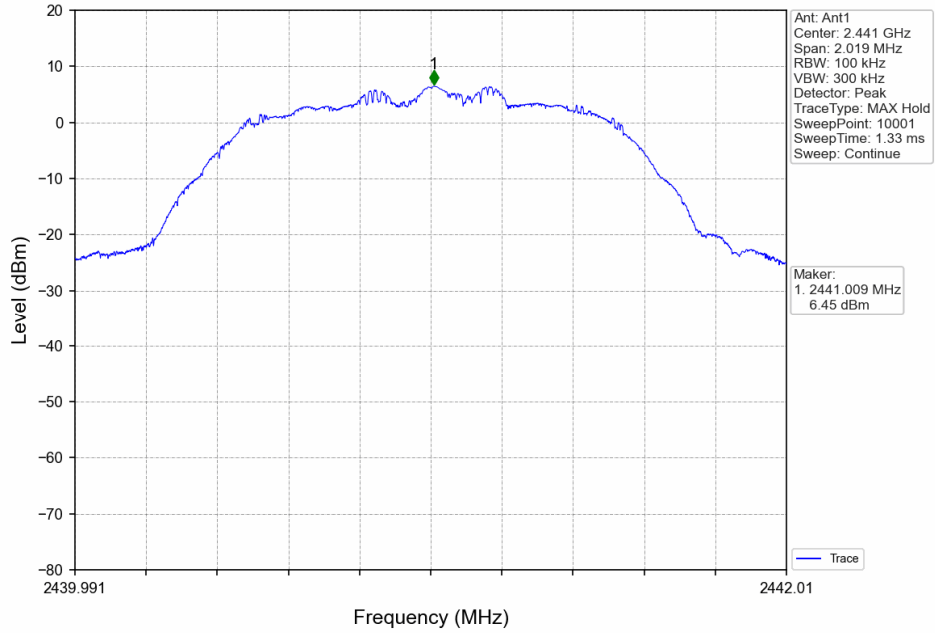
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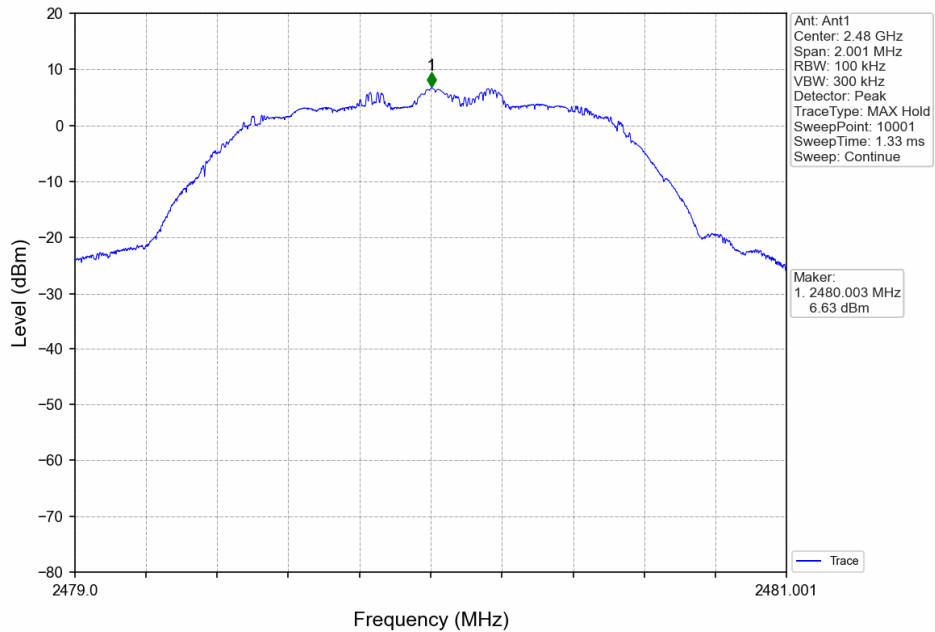
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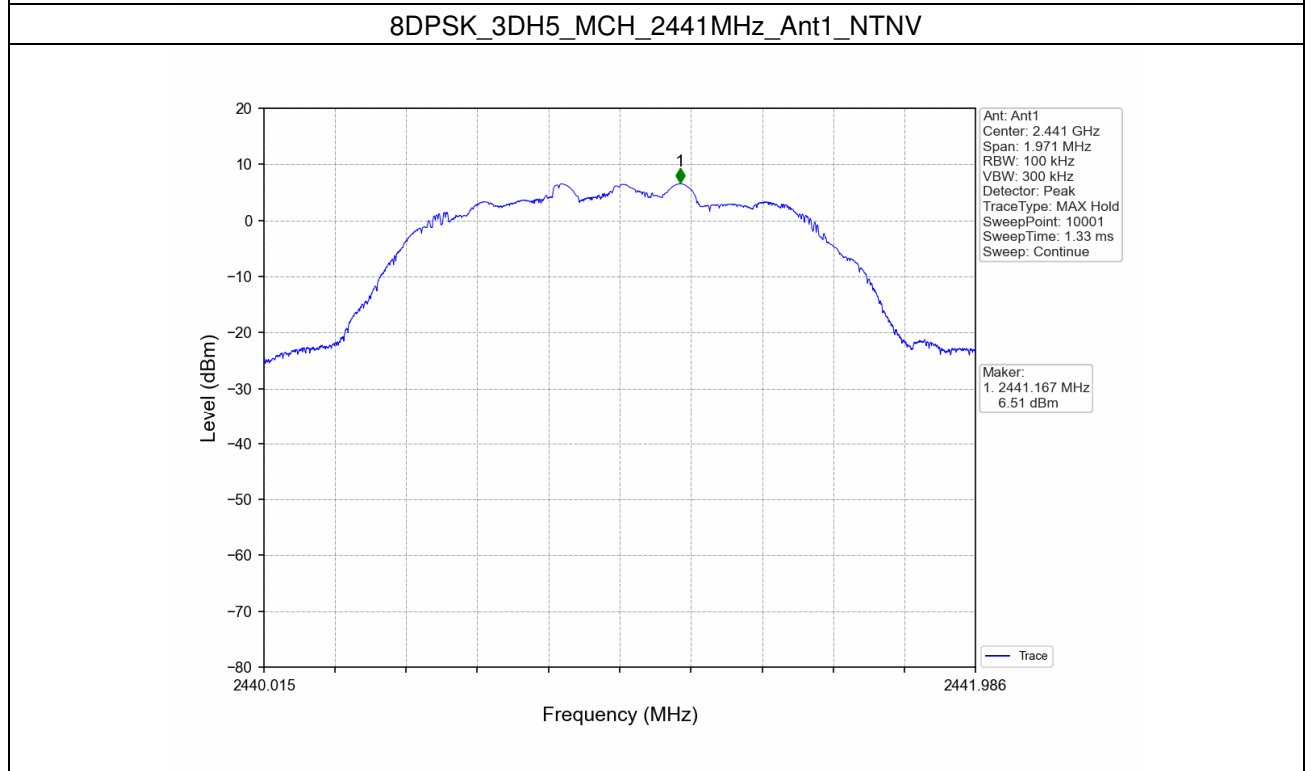
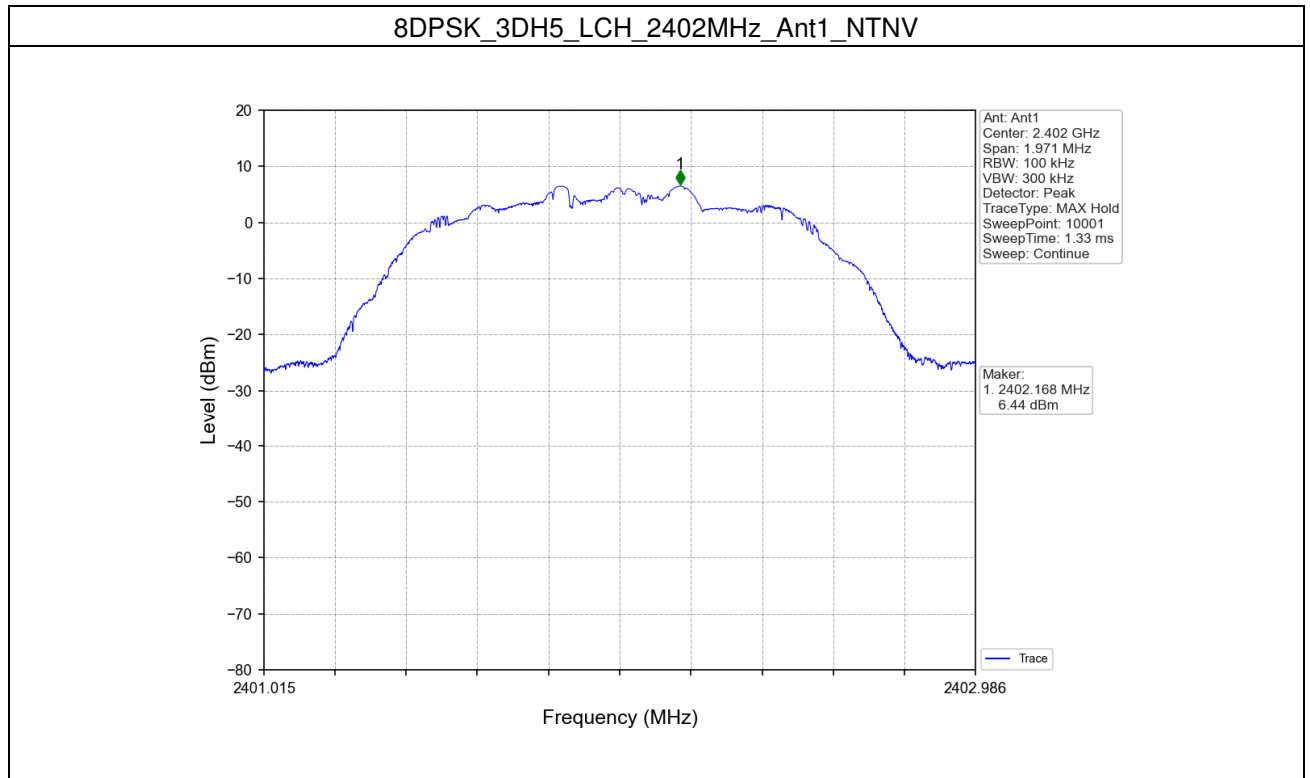
Pi/4DQPSK_2DH5_MCH_2441MHz_Ant1_NTNV



Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV

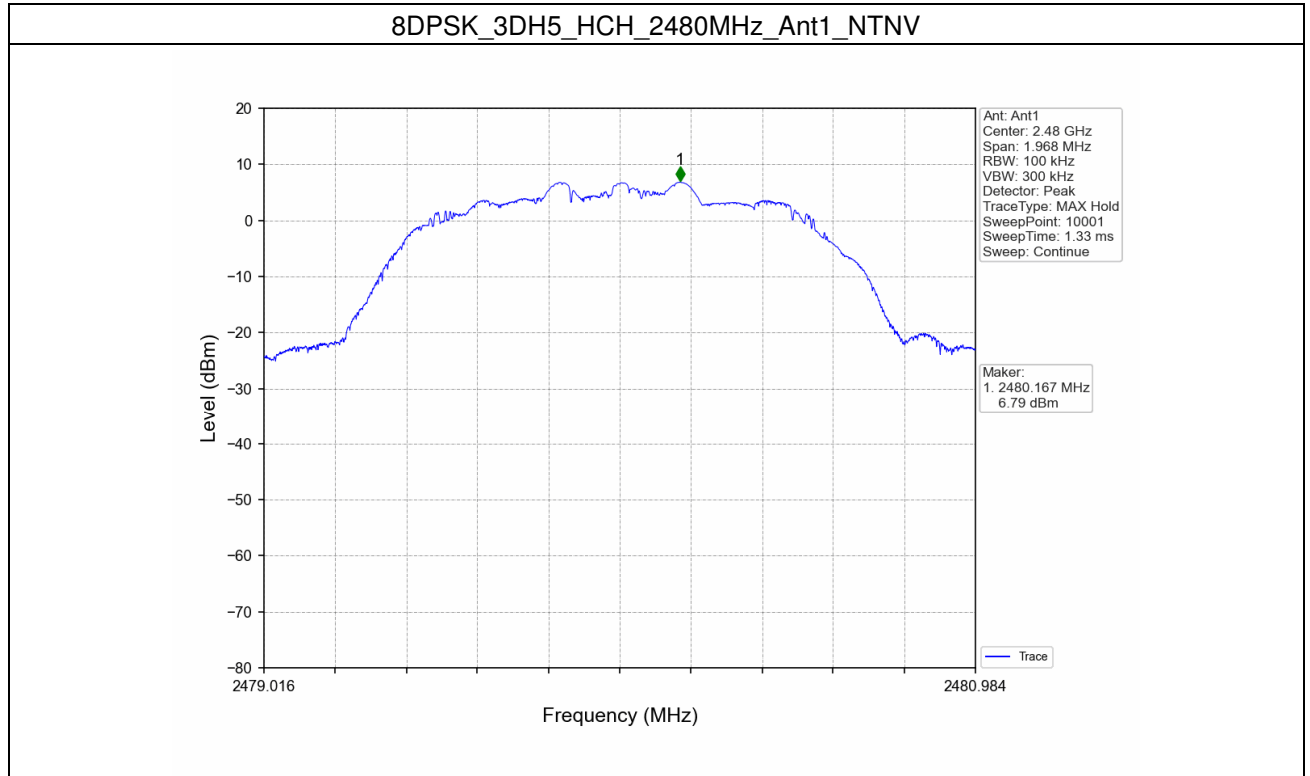


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6.2 CSE

6.2.1 Test Result

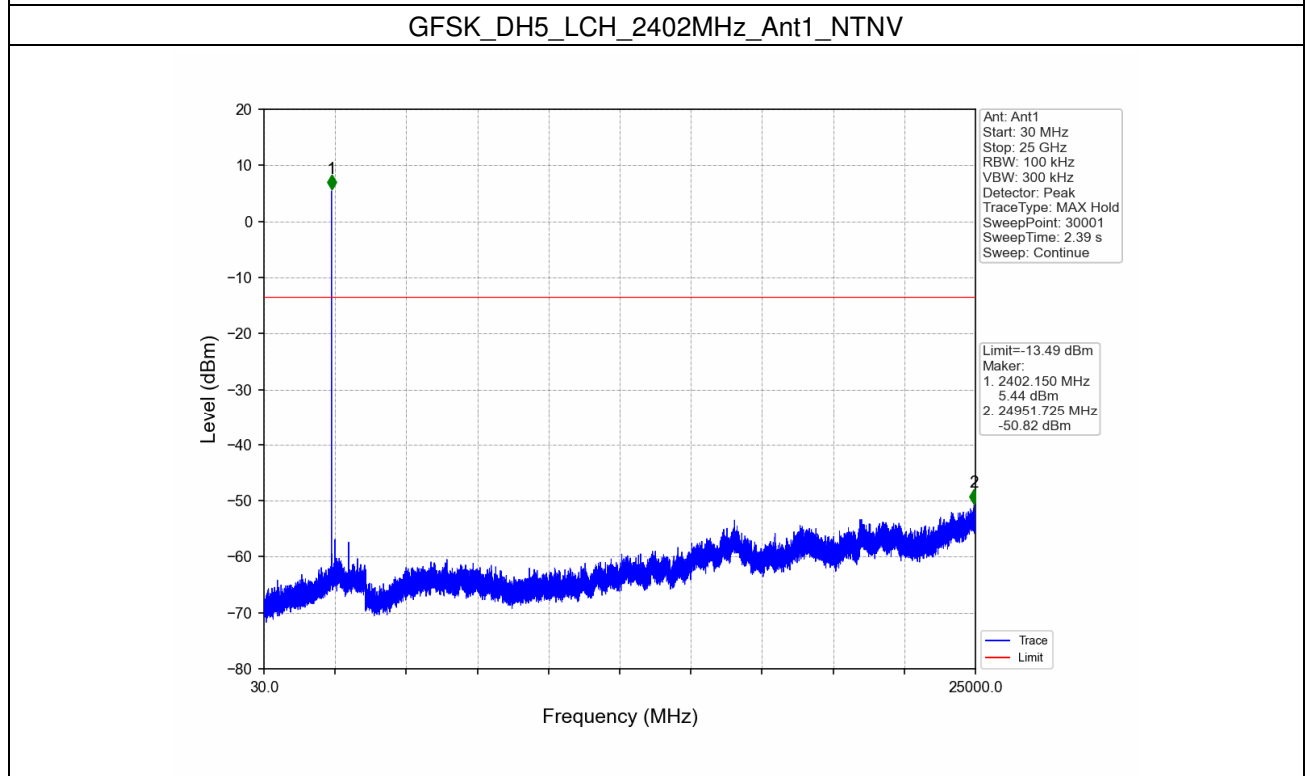
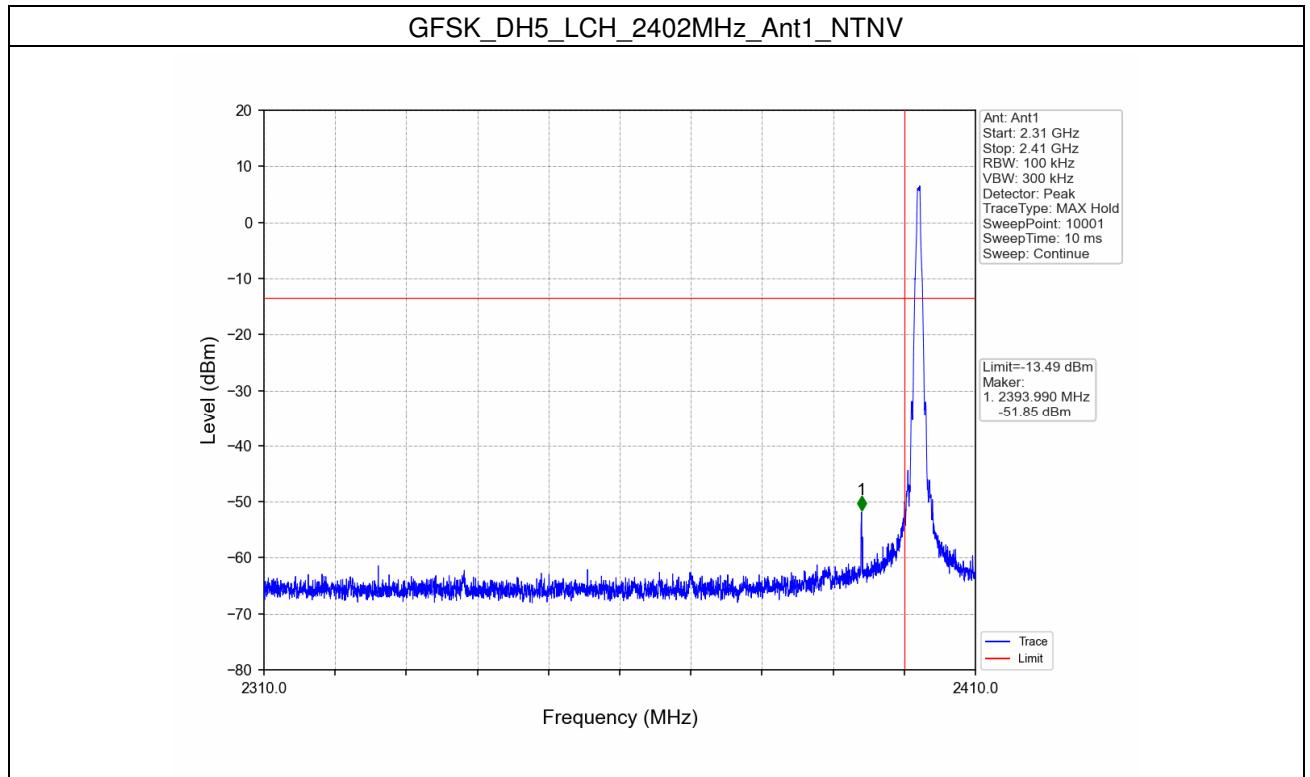
Mode	TX Type	Frequency (MHz)	Packet Type	Ant	Level of Reference (dBm)	Limit (dBm)	Verdict
GFSK	SISO	2402	DH5	1	6.51	-13.49	Pass
		2441	DH5	1	6.51	-13.49	Pass
		2480	DH5	1	6.51	-13.49	Pass
		HOPP	DH5	1	6.51	-13.49	Pass
Pi/4DQPSK	SISO	2402	2DH5	1	6.63	-13.37	Pass
		2441	2DH5	1	6.63	-13.37	Pass
		2480	2DH5	1	6.63	-13.37	Pass
		HOPP	2DH5	1	6.63	-13.37	Pass
8DPSK	SISO	2402	3DH5	1	6.79	-13.21	Pass
		2441	3DH5	1	6.79	-13.21	Pass
		2480	3DH5	1	6.79	-13.21	Pass
		HOPP	3DH5	1	6.79	-13.21	Pass

Note1: Refer to FCC Part 15.247 (d) and ANSI C63.10-2013, the channel contains the maximum PSD level was used to establish the reference level.

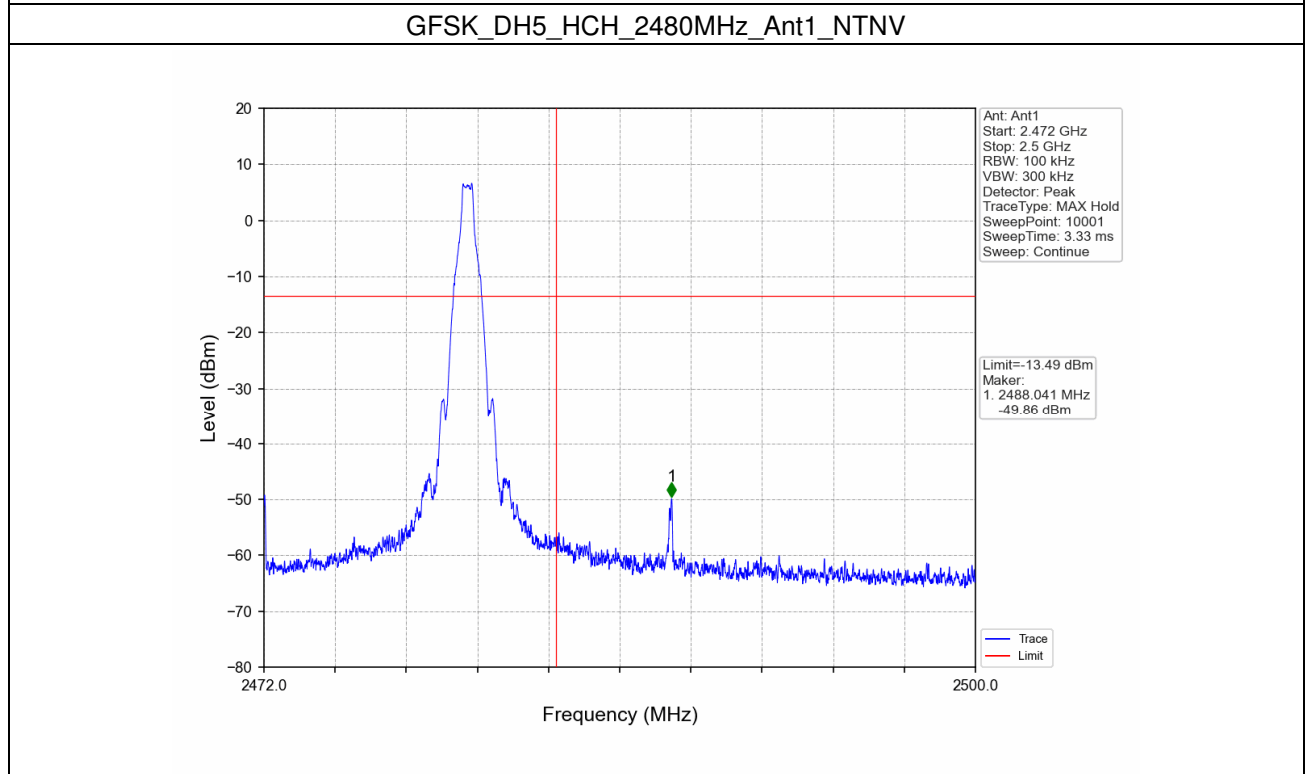
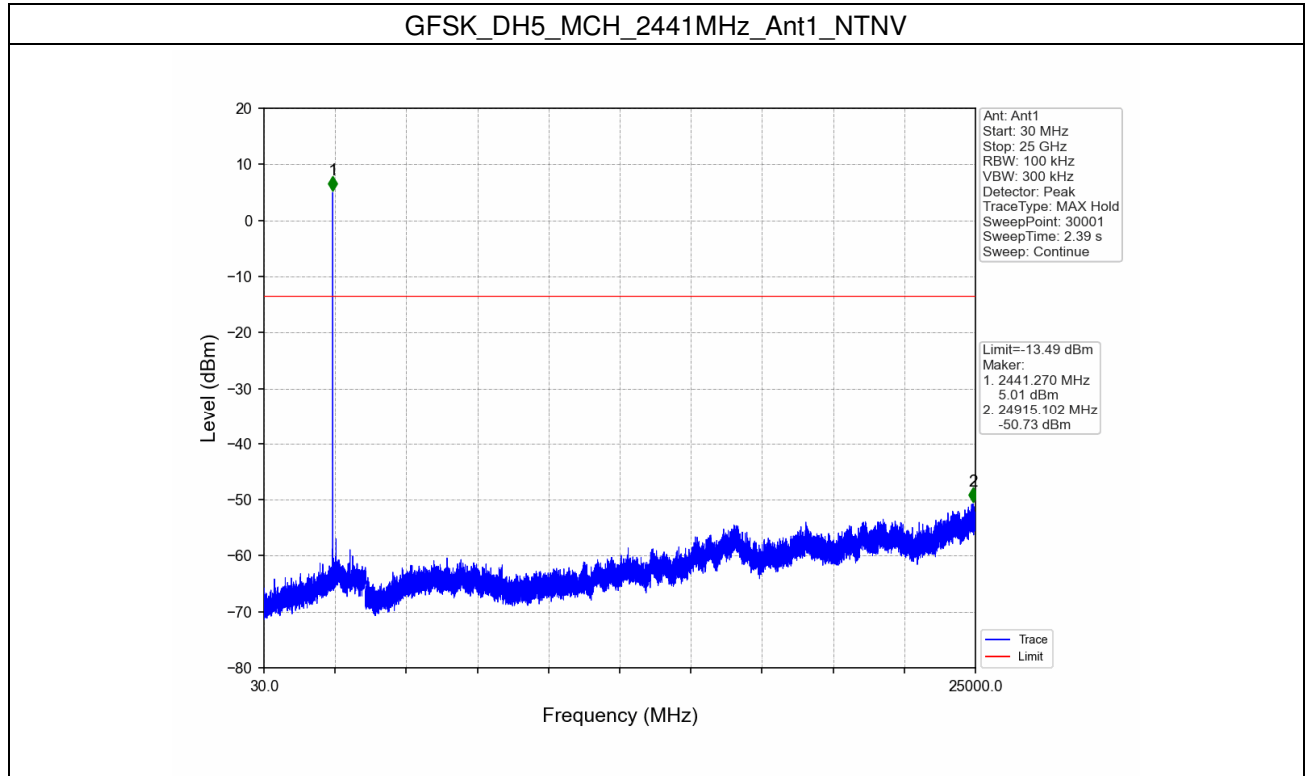


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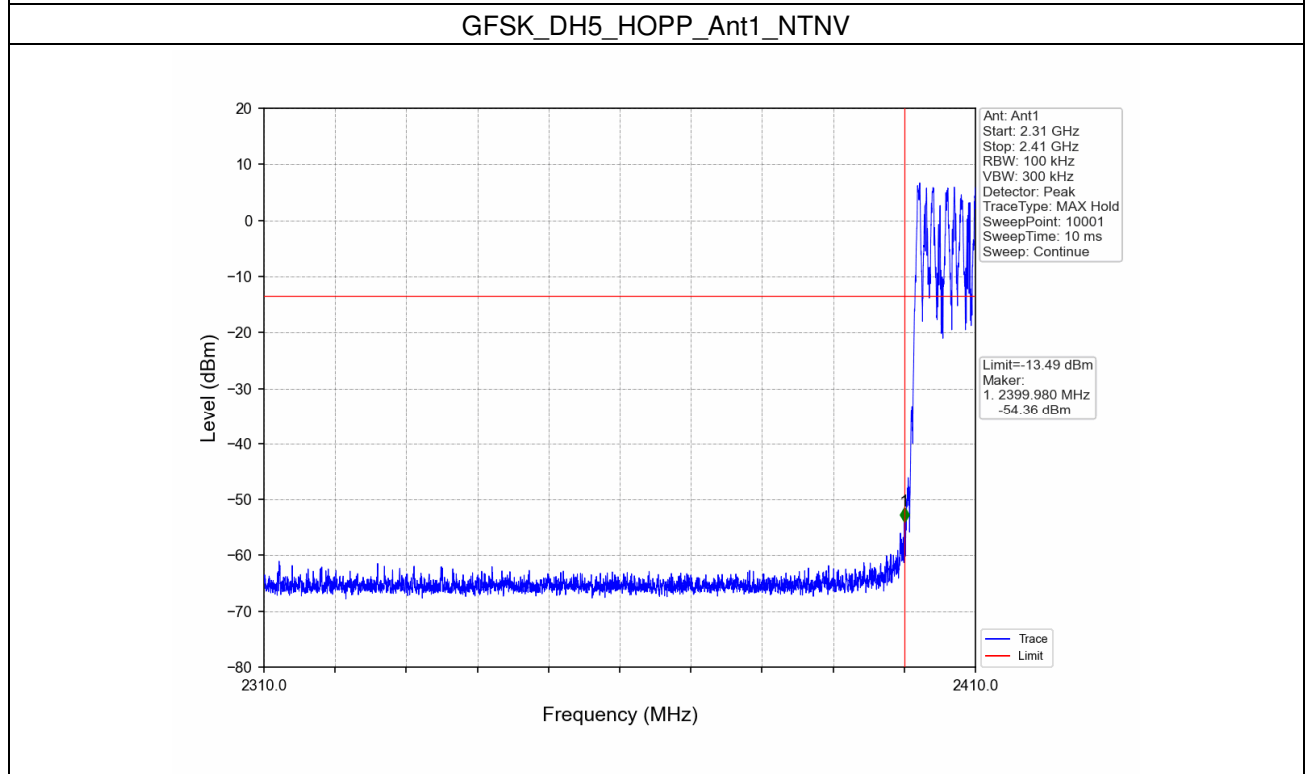
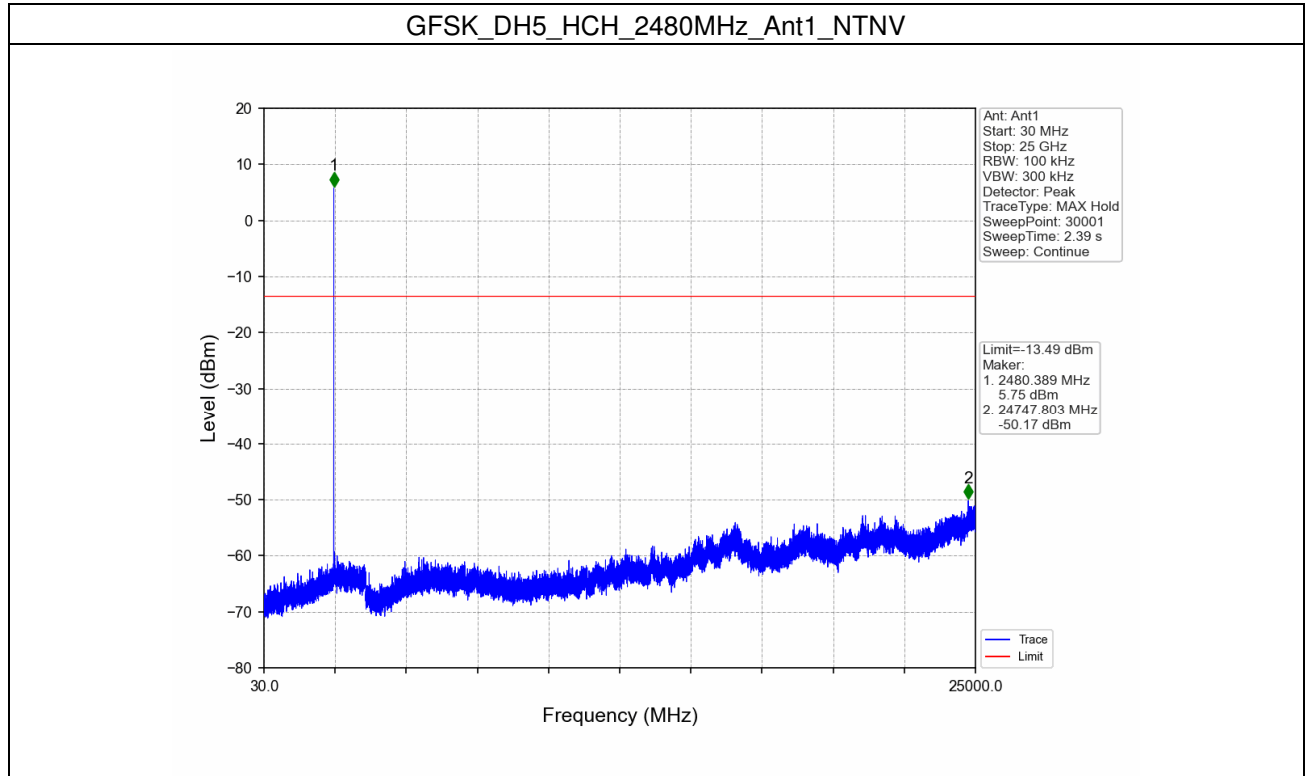
6.2.2 Test Graph



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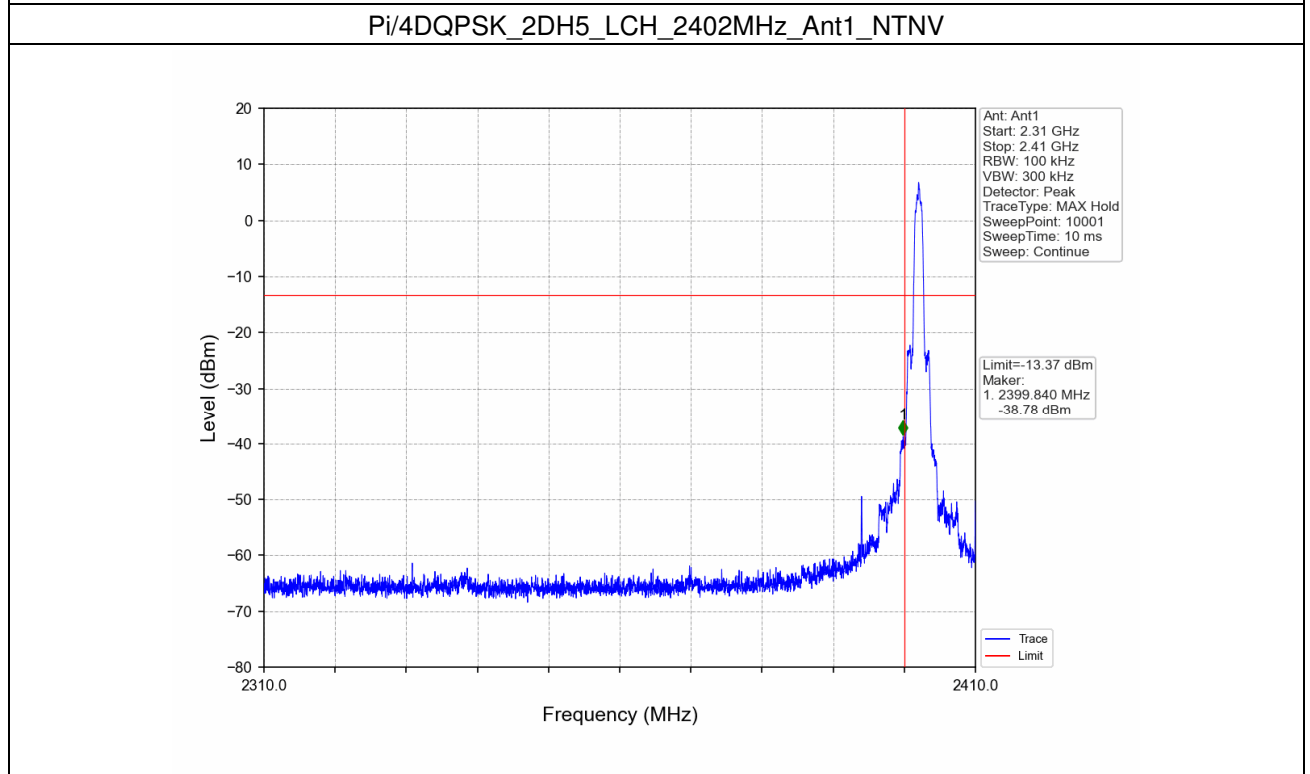
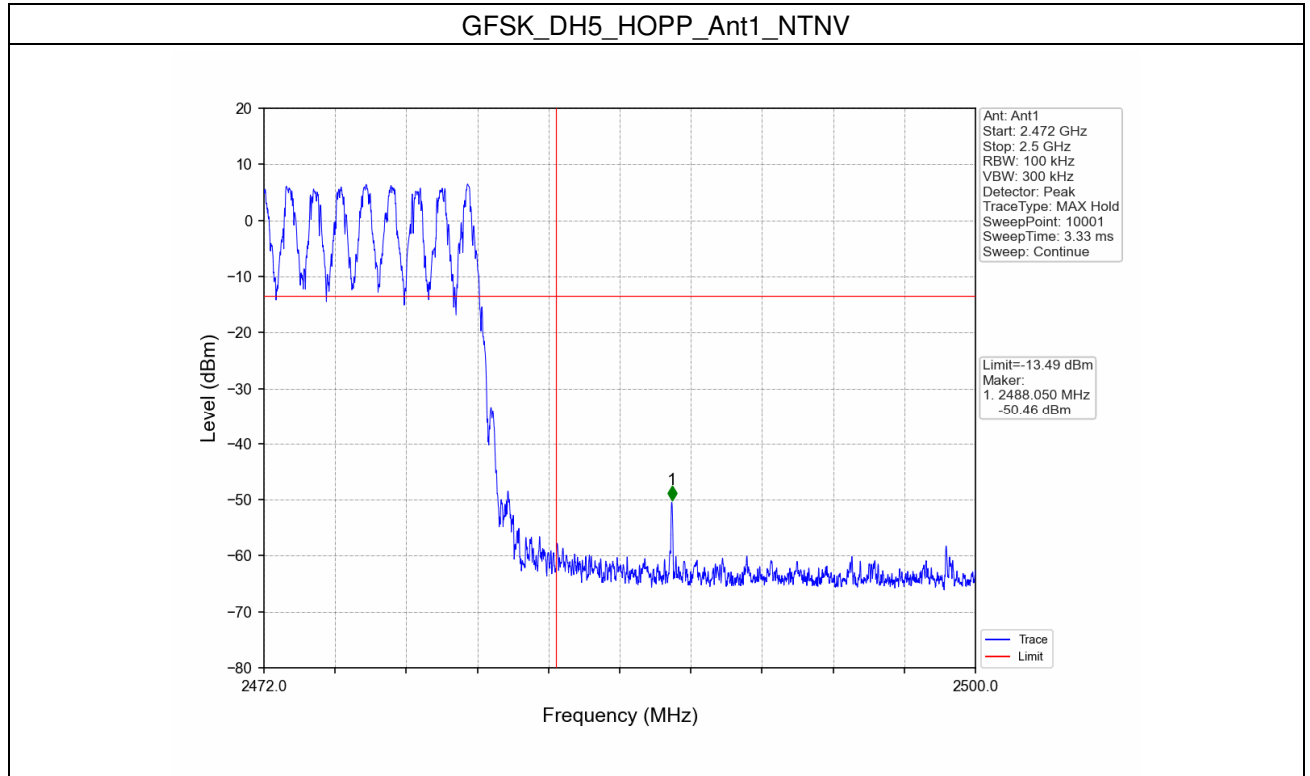


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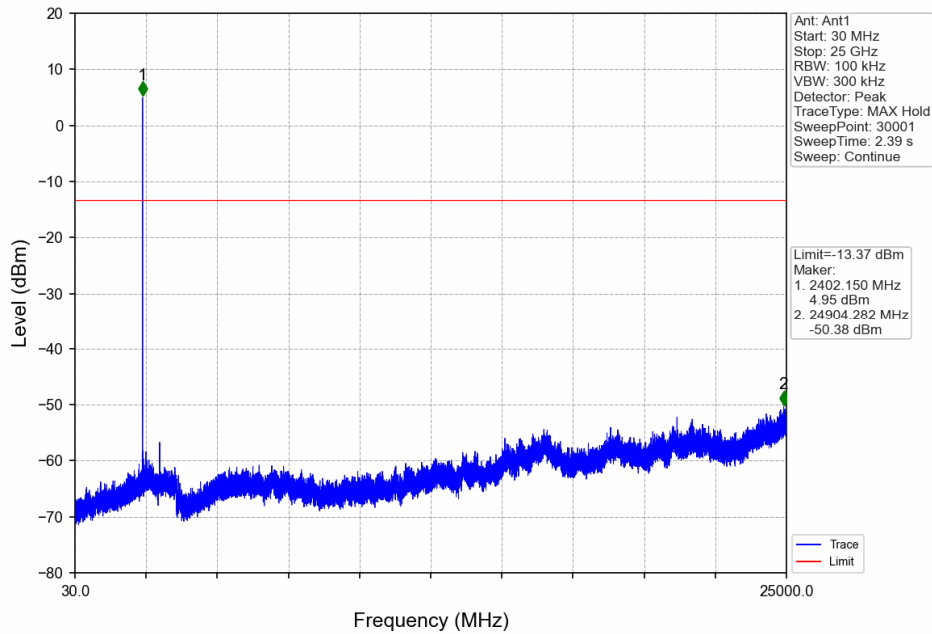
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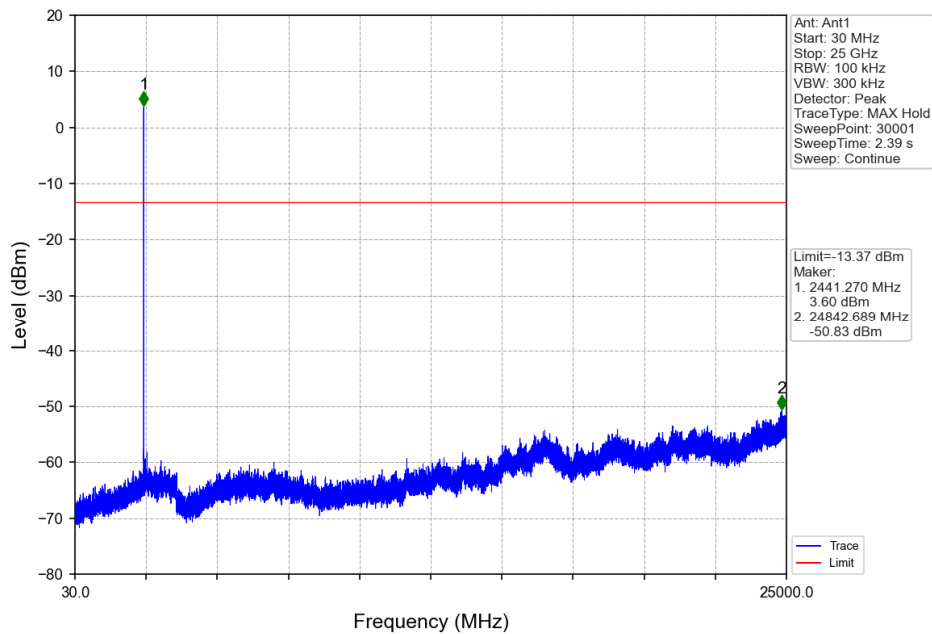
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Pi/4QPSK_2DH5_LCH_2402MHz_Ant1_NTNV



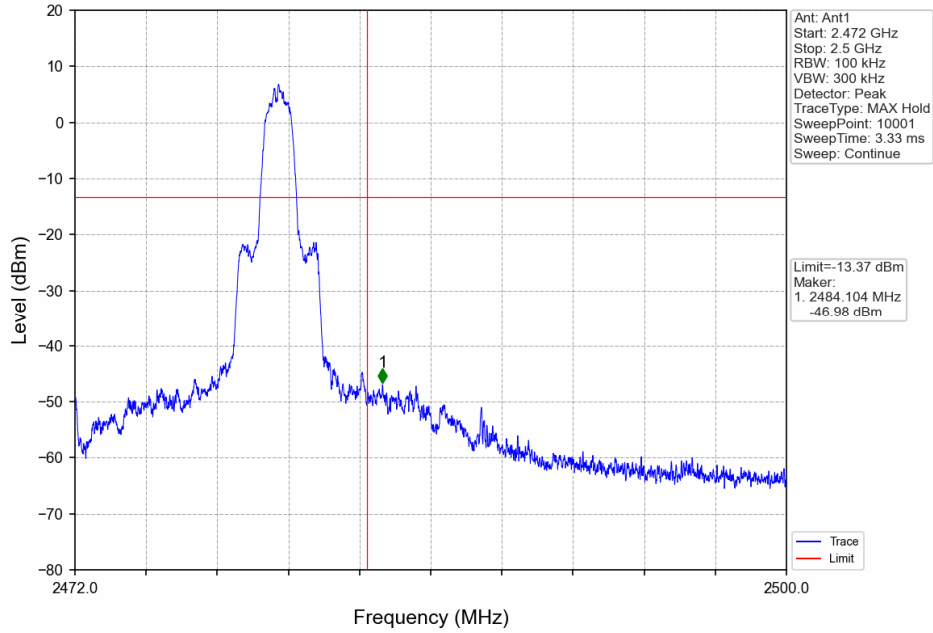
Pi/4QPSK_2DH5_MCH_2441MHz_Ant1_NTNV



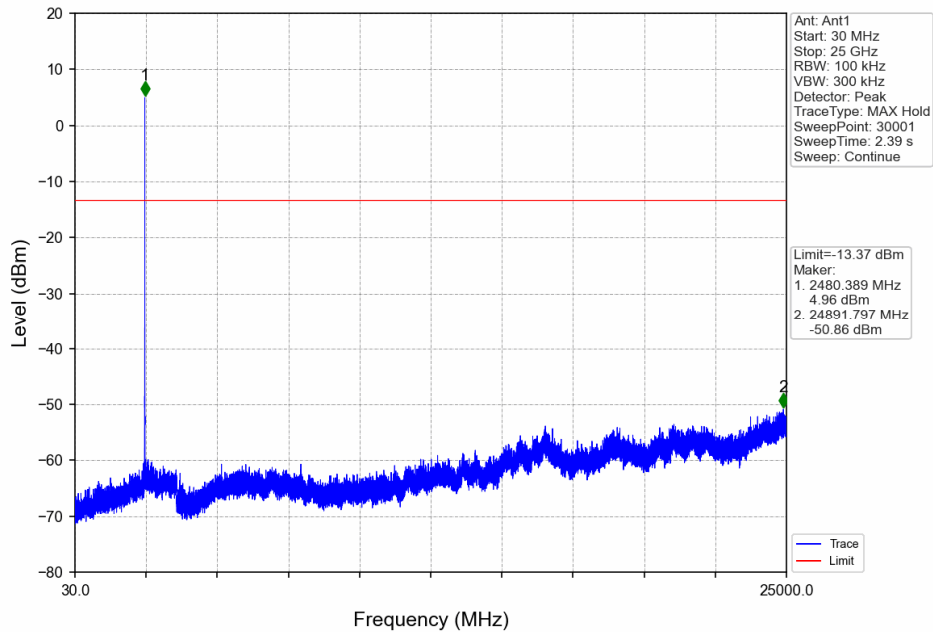
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Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV

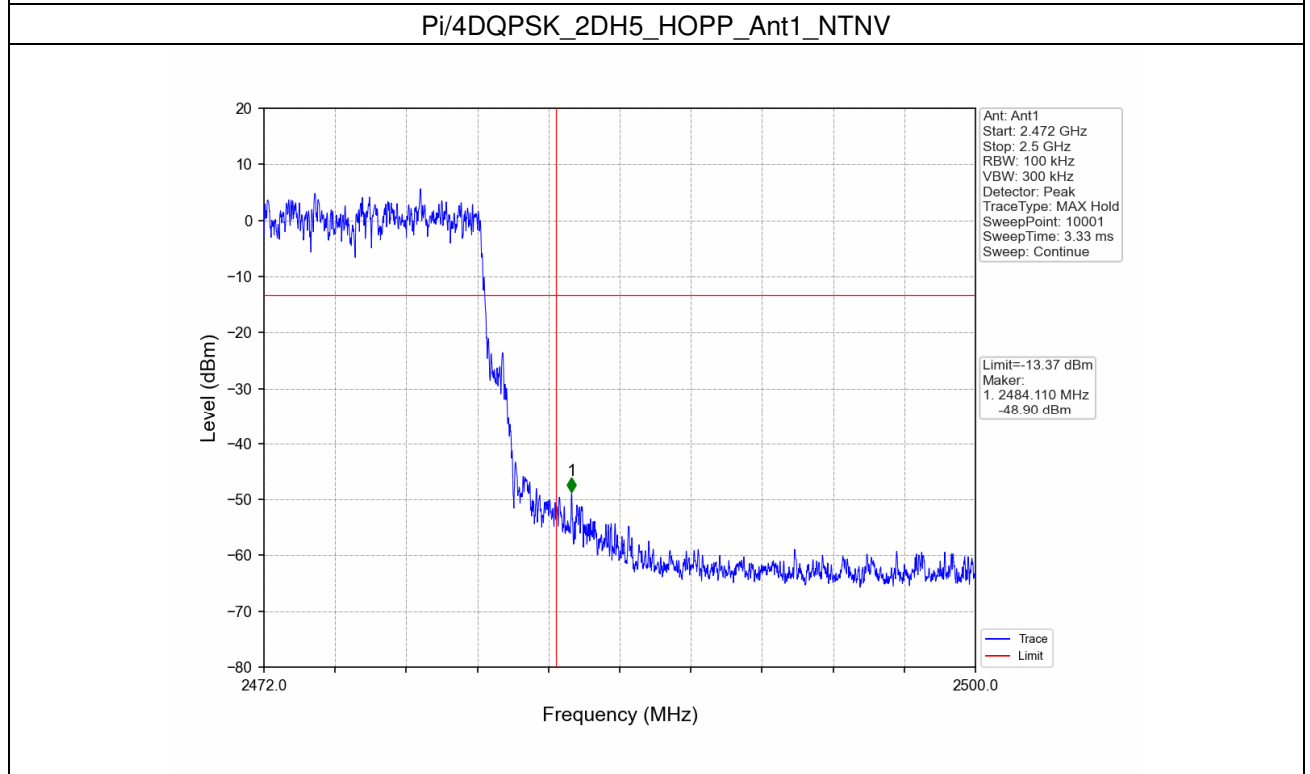
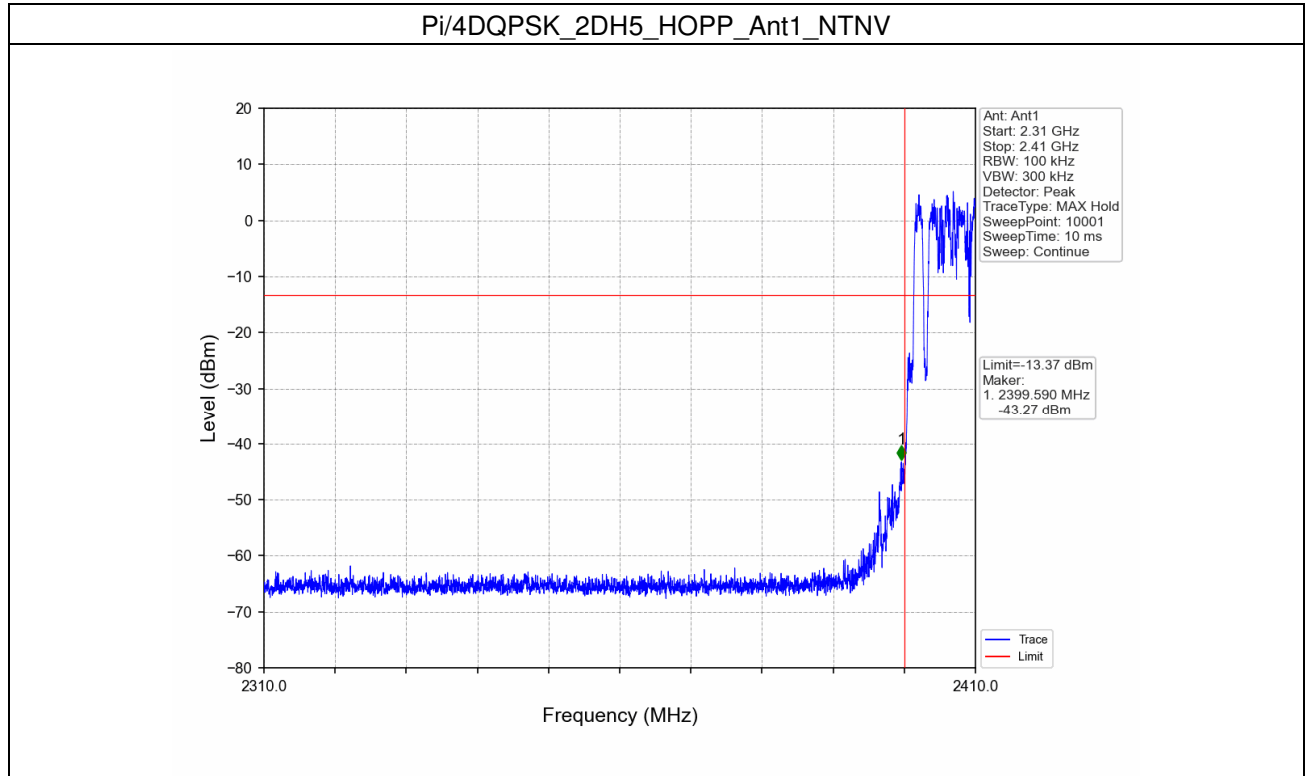


Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV

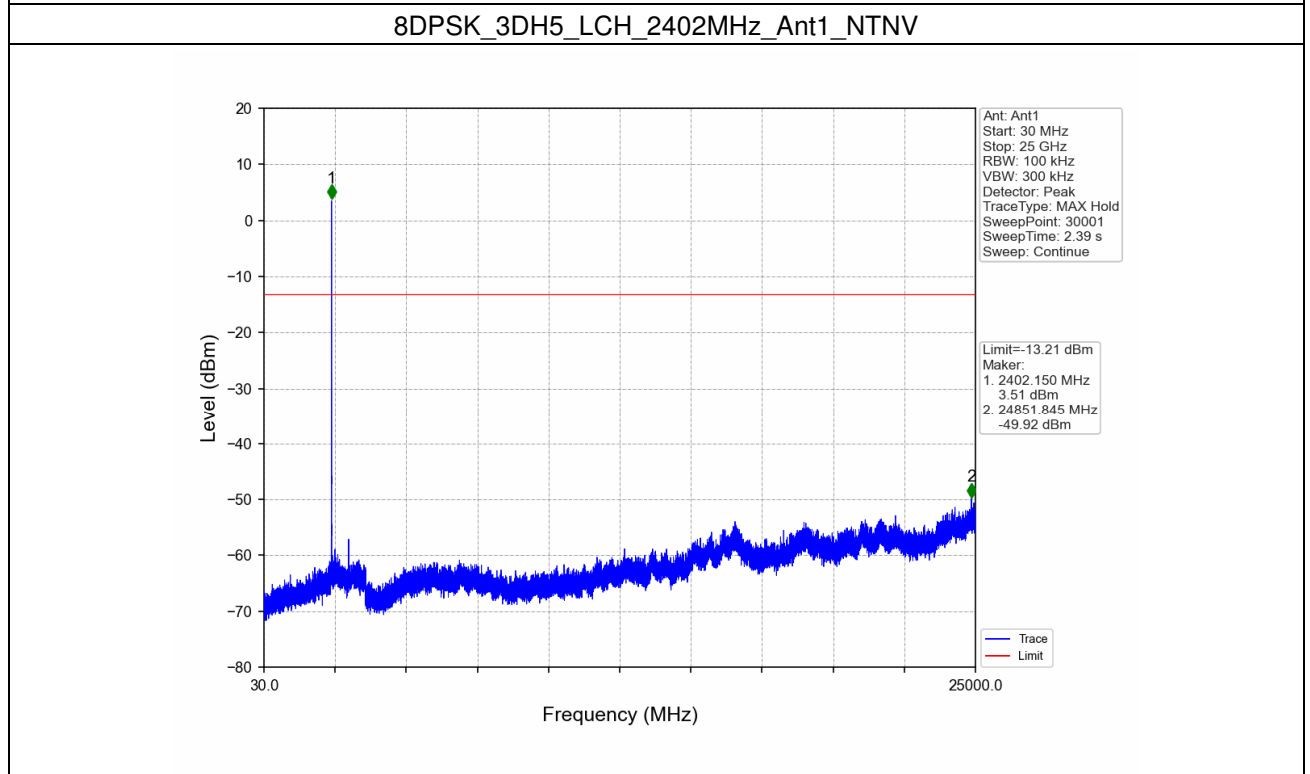
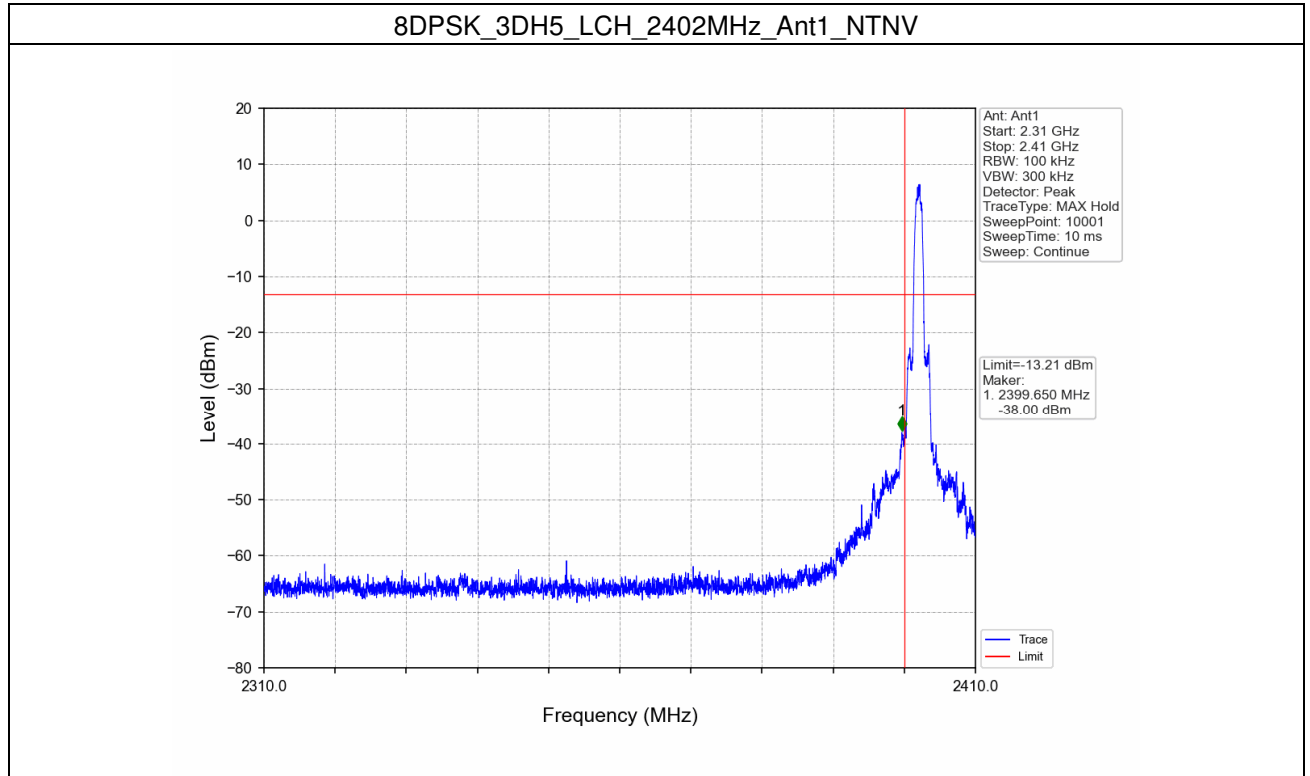


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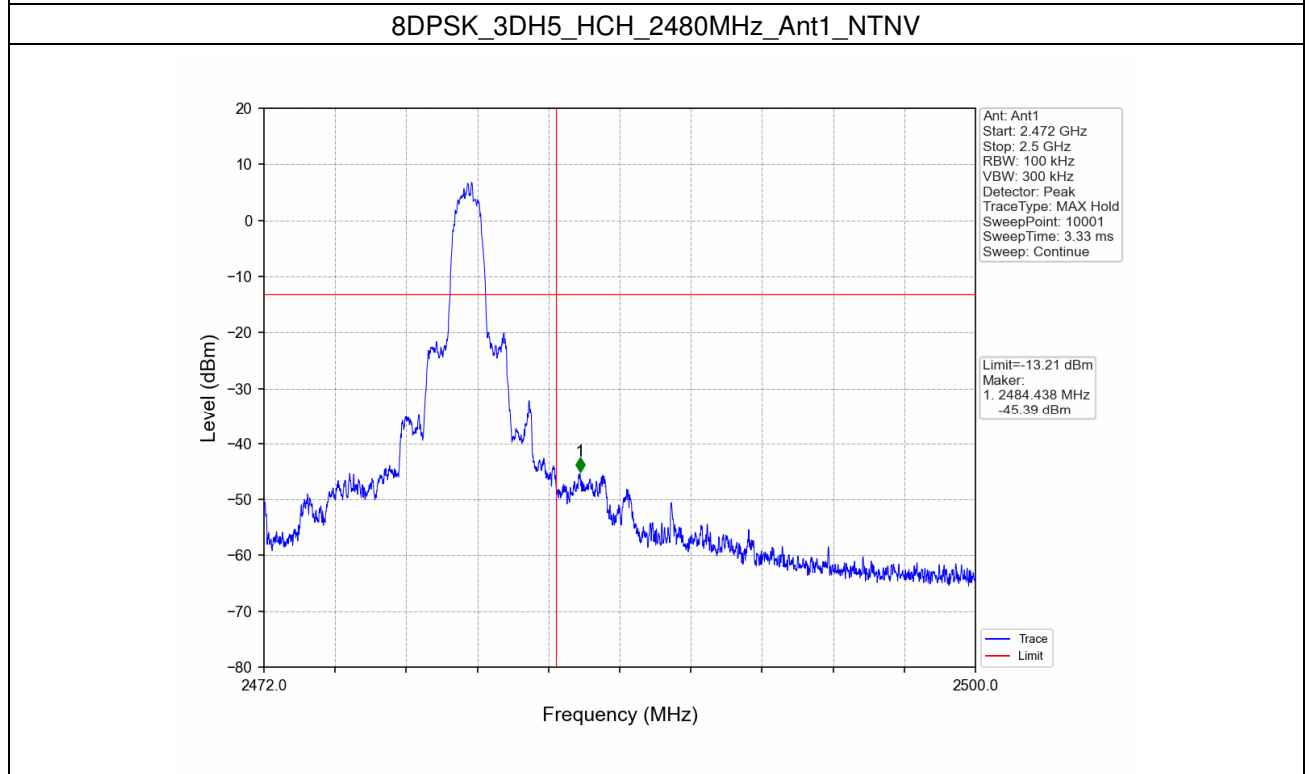
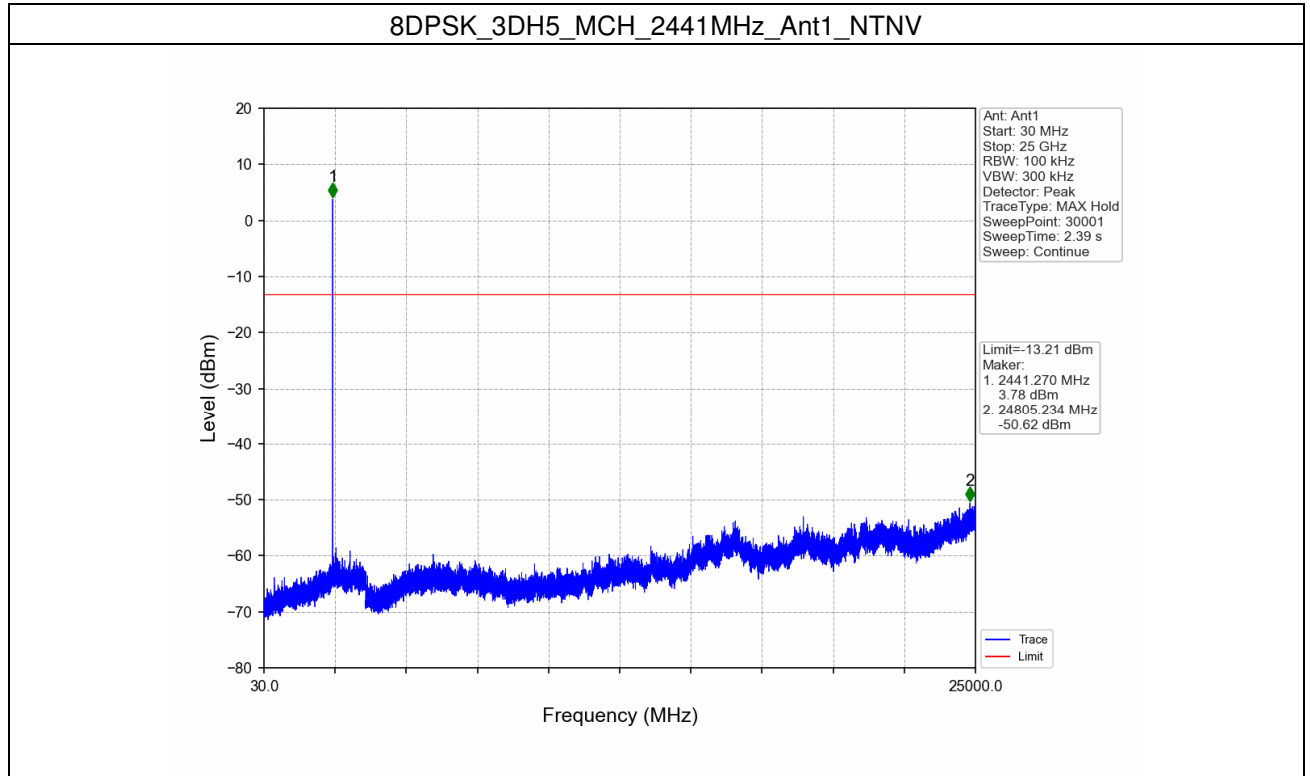


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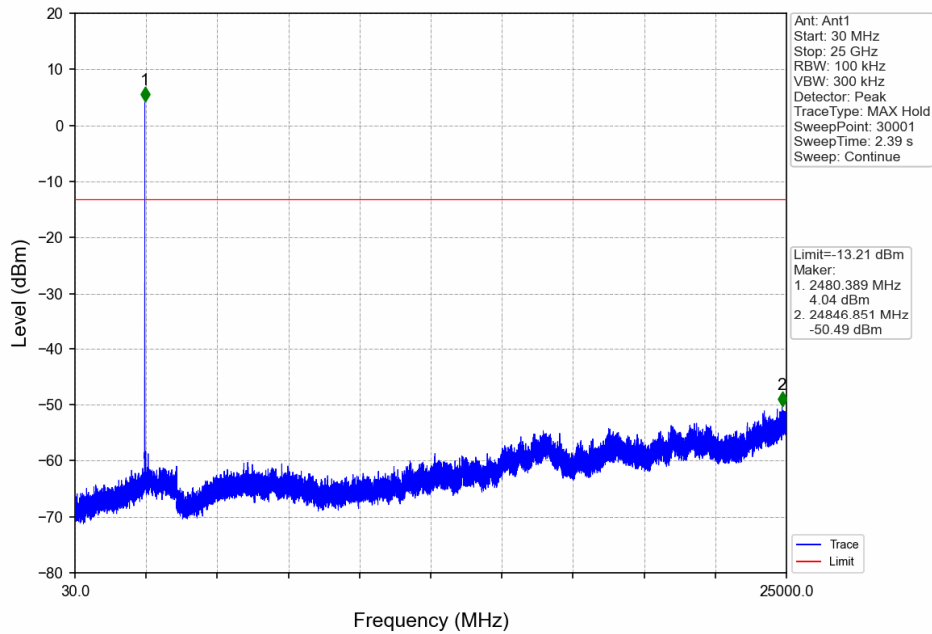
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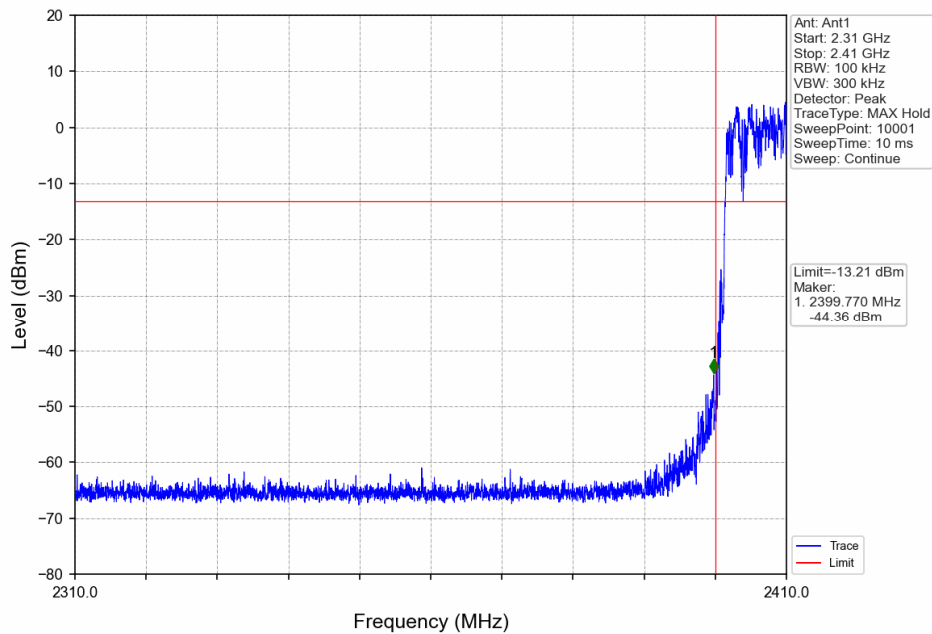
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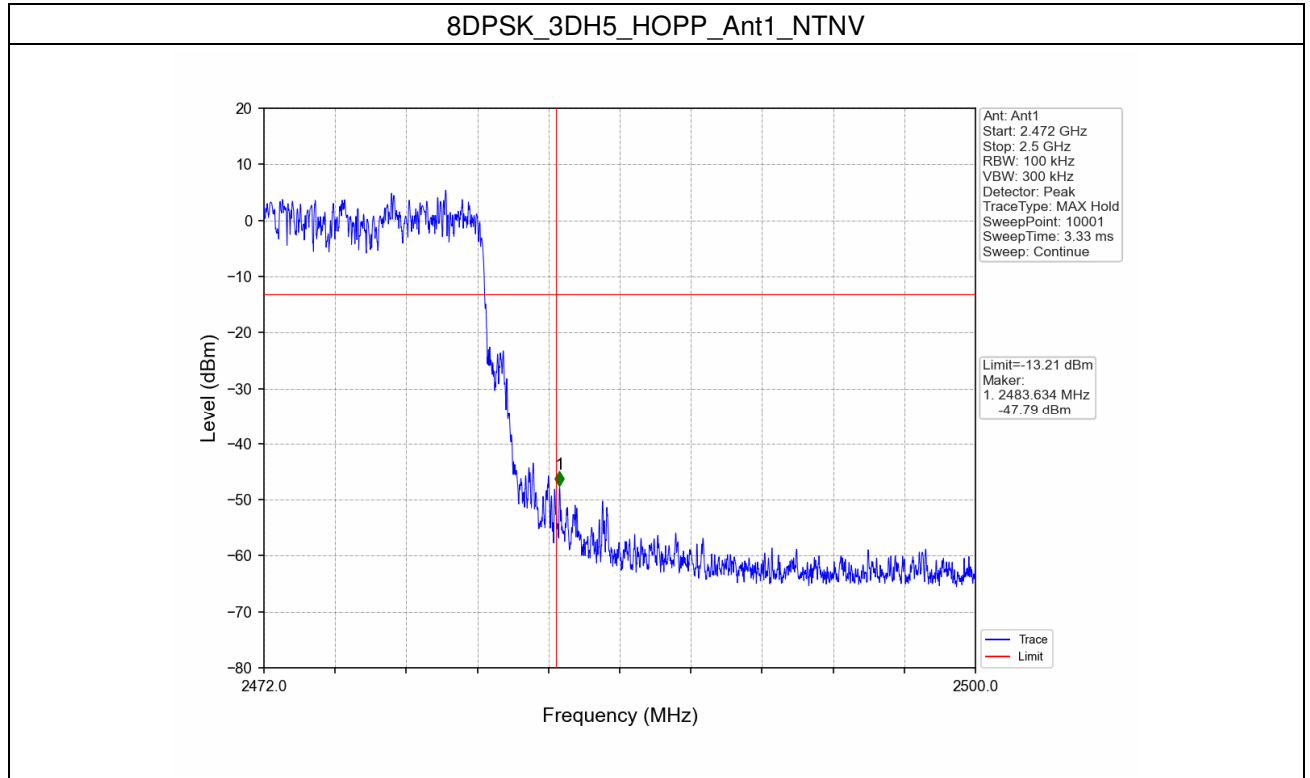
8DPSK_3DH5_HCH_2480MHz_Ant1_NTNV



8DPSK_3DH5_HOPP_Ant1_NTNV



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