



FCC / ISSED Test Report

FOR:

Garmin International, Inc.

Model Name:

A03949

Product Description:

Digital transmission system transceiver

FCC ID: IPH-03949

IC ID: 1792A-03949

Applied Rules and Standards:

47 CFR Part 15.247 (DSS)

RSS-247 Issue 2 (FHSs) & RSS-Gen Issue 5

REPORT #: EMC_GARMI-077-20001_15.247_BT_DSS_R1

DATE: 2020-11-19



A2LA Accredited

IC recognized #
3462B-2

CABID: US0187

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1 **Assessment**

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations and the relevant ISED Canada standard RSS-247.

No deviations were ascertained.

Company	Description	Model #
Garmin International, Inc.	Digital transmission system transceiver	A03949

Responsible for Testing Laboratory:

2020-11-19	Compliance	Cindy Li (EMC Lab Manager)	
Date	Section	Name	Signature

Responsible for the Report:

2020-11-19	Compliance	Yuchan Lu (Test Engineer)	
Date	Section	Name	Signature

The test results of this test report relate exclusively to the test item specified in Section 3.

CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
EMC Lab Manager:	Cindy Li
Responsible Project Leader:	Sangeetha Sivaraman

2.2 Identification of the Client

Client's Name:	Garmin International, Inc.
Street Address:	100 Regency Forest, Suite 350
City/Zip Code	Cary, NC 27518
Country	USA

2.3 Identification of the Manufacturer

Manufacturer's Name:	Garmin Corporation
Manufacturers Address:	No. 68, Zhangshu 2nd Rd., Xizhi Dist.,
City/Zip Code	New Taipei City 221,
Country	TAIWAN, R.O.C.

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	A03949
HW Version :	1
SW Version :	1.13
FCC-ID :	IPH-03949
IC-ID:	1792A-03949
FWIN:	A03949
HVIN:	N/A
PMN:	Digital transmission system transceiver
Product Description:	A03949
Frequency Range / number of channels:	Nominal band: 2400 MHz – 2483.5 MHz Center to center: 2402 MHz (ch 0) – 2480 MHz (ch 78), 79 Channels
Radio Information:	<u>Bluetooth:</u> Module Name: Cypress Module Number: BCM20719 Type(s) of Modulation: BDR/EDR: GFSK, $\pi/4$ DQPSK, 8DPSK
Modes of Operation:	Hopping
Antenna Information as declared:	max gain 1.6 dBi
Max. declared output Powers:	Conducted Power 14.33 dBm
Power Supply/ Rated Operating Voltage Range:	Vmin: 3.5 VDC/ Vnom: 3.9 VDC / Vmax: 4.35 VDC
Operating Temperature Range	Low -20°C, Nominal 25°C, High 60°C
Other Radios included in the device:	❖ <u>WLAN</u> • Manufacture: Microchip • Module name/number: ATWILC1000 ❖ <u>LTE</u> • Manufacture: Murata • Module name/number: LBAD0XX1SC • FCC ID: HSW-TY1SC • IC ID: 4492A-TY1SC ❖ <u>BLE, ANT</u> • Manufacture: Cypress

	- Module name/number: BCM20719 ❖ <u>NFC</u> - Manufacture: NXP - Module name/number: SN100T ❖ <u>GNSS/GPS</u> - Manufacture: Garmin proprietary
Sample Revision	☐ Prototype Unit; ☐ Production Unit; ☒ Pre-Production
EUT Dimensions(mm)	253 X 45 X 15

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	3340894753	1	1.13	Radiated Emissions
2	340894642	1	1.13	Conducted RF

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Charging USB Cable	-	-	-

3.4 Support Equipment

SE #	Description
1	AC/DC Converter, Manufacture: PHIHONG, Model: PSAI05R-050Q
2	Laptop, Dell Latitude 7490

3.5 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE#1	Special commands through command window used to configure the Bluetooth radio to low, mid and high channels and co-transmitting with LTE CAT M1 Band 4 mid Channel (1732.5 MHz) provided by the client that will not be available to the end user. For radiated measurements, the internal antenna was connected.
2	EUT#2 + AE#1	Special commands through command window used to configure the Bluetooth radio to low, mid and high channel provided by the client that will not be available to the end user. For conducted measurements, the equipment was connected to 50 ohm RF port of the EUT.

3.6 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on low, mid and high channels and co-transmitting with LTE CAT M1 Band 4 mid Channel (1732.5 MHz).

For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

For conducted measurements, the highest power and the highest duty cycle were used to evaluate the worst case performance of the EUT, including the band edge compliance and TX radiated spurious emissions testing. Maximum peak conducted output power and spectrum bandwidth, were measured in all supported modulation modes for the EUT.

4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 Issue 2 of ISED Canada.

This test report is to support a request for new equipment authorization under the:

- FCC ID: IPH-03949
- IC ID: 1792A-03949

Testing procedures are based on ANSI C63.10:2013 including section 7.8 for FHSS systems.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.247(b)(1) RSS-247 5.4(b)	Maximum Peak Conducted Output Power	Nominal	GFSK DQPSK 8DPSK	■	□	□	Complies
§15.247(d) RSS-247 5.5 RSS-Gen 8.10	Band Edge Compliance	Nominal	GFSK	■	□	□	Complies
§15.247(a)(1) RSS-247 5.1(b)	Spectrum Bandwidth	Nominal	GFSK DQPSK 8DPSK	■	□	□	Complies
§15.247(a)(1) RSS-247 5.1(b)	Carrier Frequency Separation	Nominal	GFSK	■	□	□	Complies
§15.247(a)(1) RSS-247 5.1(d)	Number of Hopping Channels	Nominal	GFSK	■	□	□	Complies
§15.247(a)(1)(iii) RSS-247 5.1(d)	Time of occupancy	Nominal	GFSK	■	□	□	Complies
§15.247(d) §15.209 (a) RSS-Gen 6.13	TX Spurious emissions-Radiated	Nominal	GFSK	■	□	□	Complies
§15.207(a) RSS-Gen 8.8	AC Conducted Emissions	Nominal	GFSK	■	□	□	Complies

Note: NA= Not Applicable; NP= Not Performed.

6 **Measurements**

6.1 **Measurement Uncertainty**

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor $k=1$.

Radiated measurement

9 kHz to 30MHz	± 2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	± 2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	± 2.3 dB (Horn Antenna)

Conducted measurement

RF conducted measurement	± 0.5 dB
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6.2 **Environmental Conditions During Testing:**

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25°C
- Relative humidity: 40-60%

6.3 **Dates of Testing:**

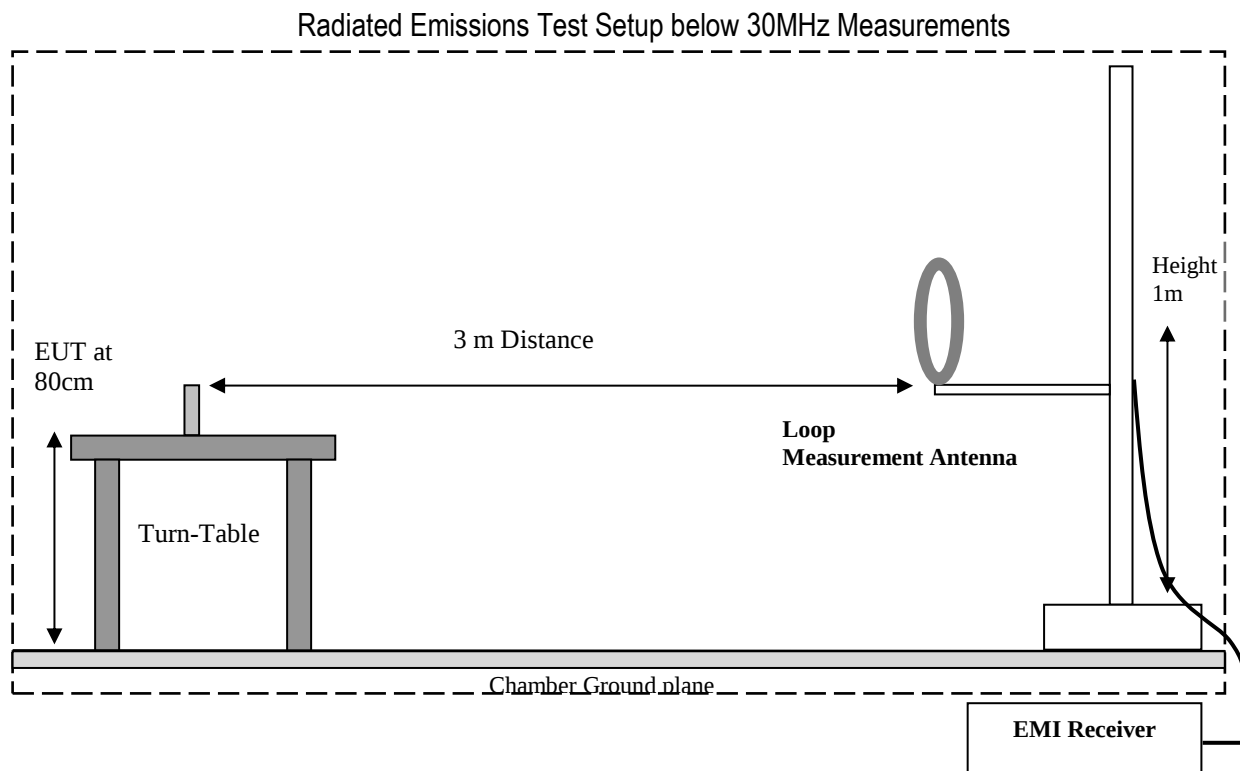
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7 Measurement Procedures

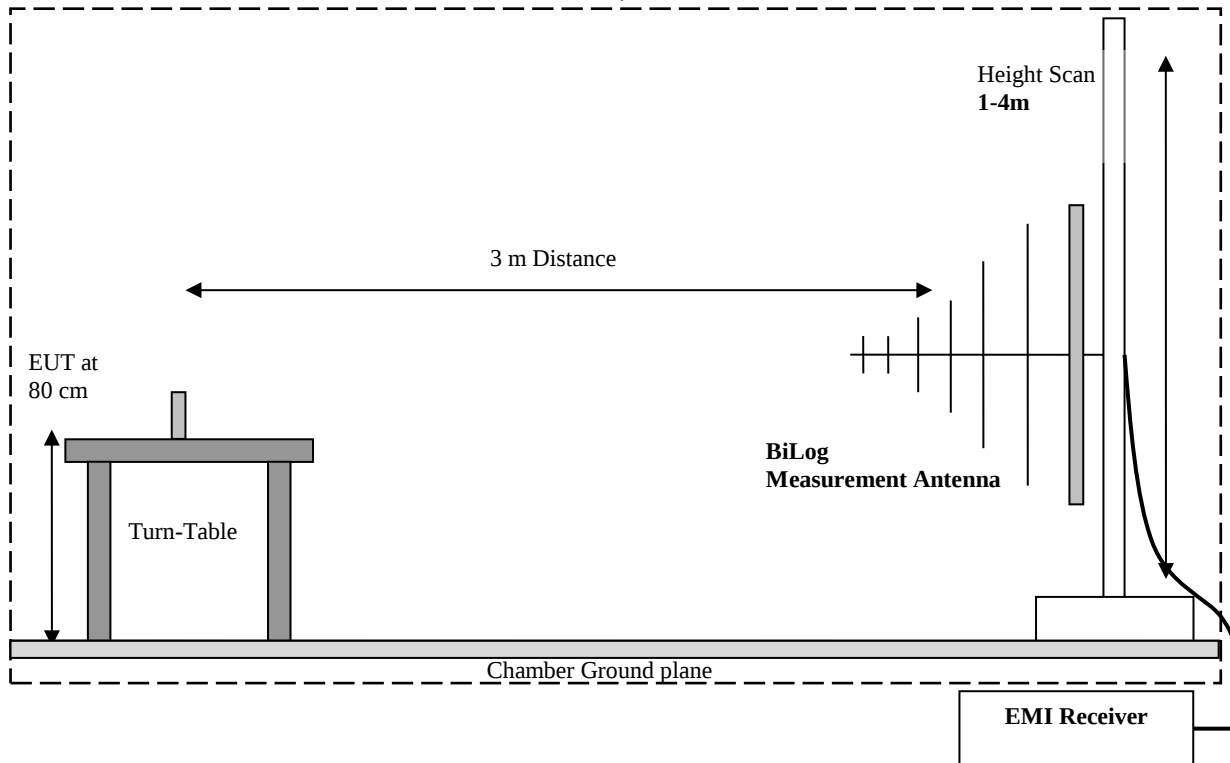
7.1 Radiated Measurement

The radiated measurement is performed according to: ANSI C63.10 (2013)

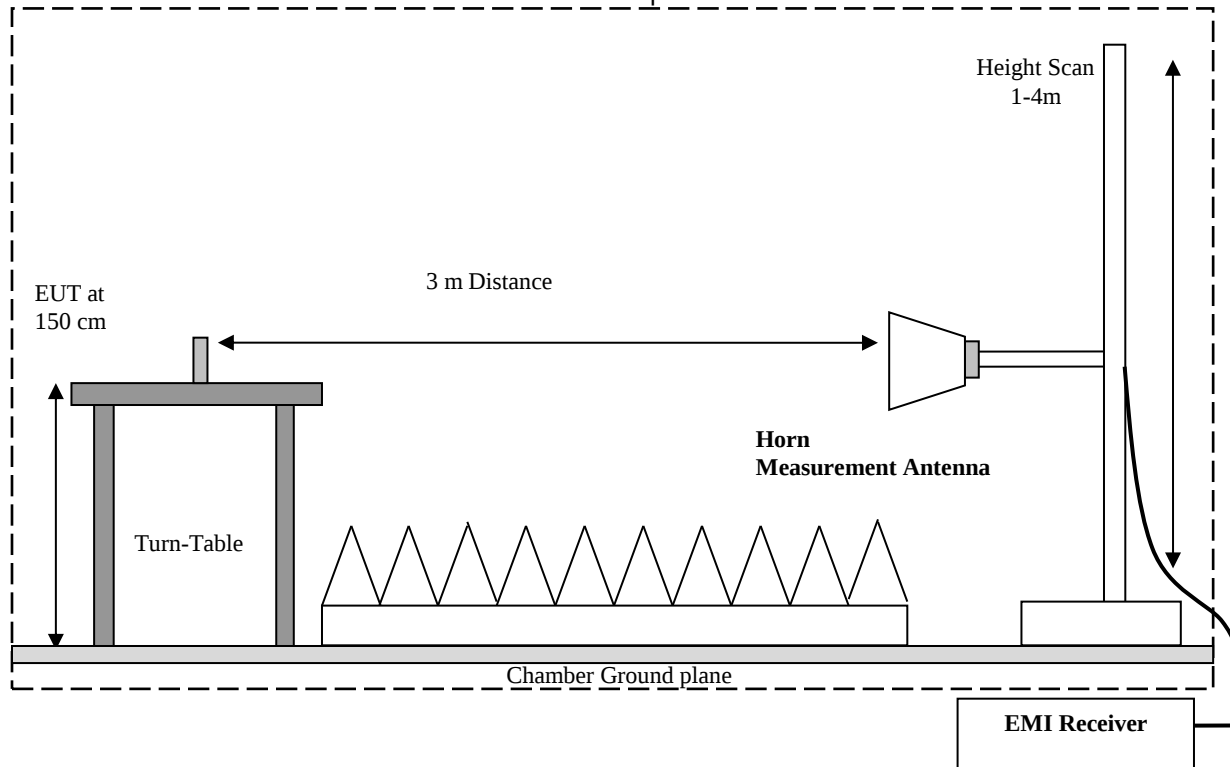
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup above 1GHz Measurements



7.1.1 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

1. Measured reading in dB μ V
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} + \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

Example:

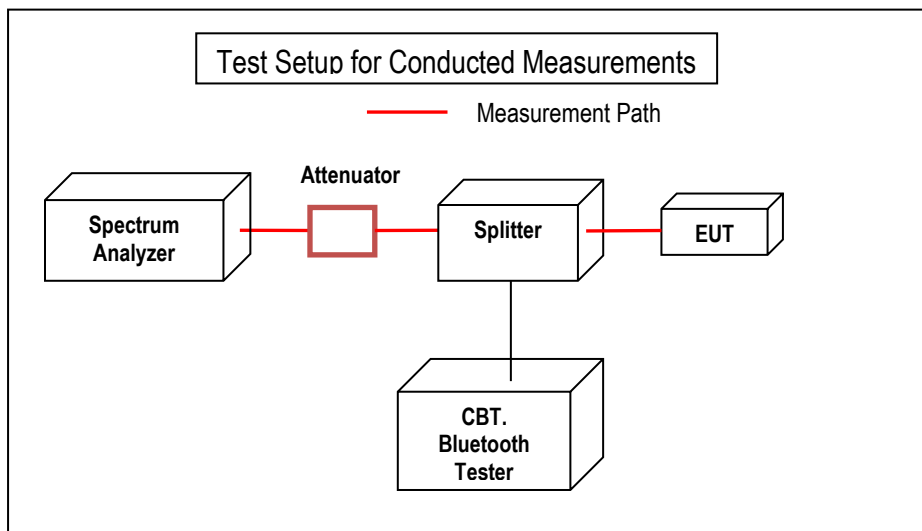
Frequency (MHz)	Measured SA (dB μ V)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dB μ V/m)
1000	80.5	3.5	14	98.0

7.2 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to: ANSI C63.4 (2014)

7.3 RF Conducted Measurement Procedure

Reference: ANSI C63.10 (2013) Section 6.9, 6.10, and 7.8



- Connect the equipment as shown in the above diagram.
- Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
- Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.

8 Test Result Data

8.1 Maximum Peak Conducted Output Power

8.1.1 Measurement according to ANSI C63.10 Section 7.8.5

Spectrum Analyzer settings:

- Span = approximately 5 times the 20 dB bandwidth
- RBW > the 20 dB bandwidth of the emission being measured
- VBW $\geq$ RBW
- Sweep = Auto Couple
- Detector function = Peak
- Trace = Max hold
- Use the marker-peak function to set the marker to the peak of the emission.

8.1.2 Limits:

Maximum Peak Output Power:

FCC §15.247: (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

- (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

IC RSS-247 5.4:

- (b) For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels.

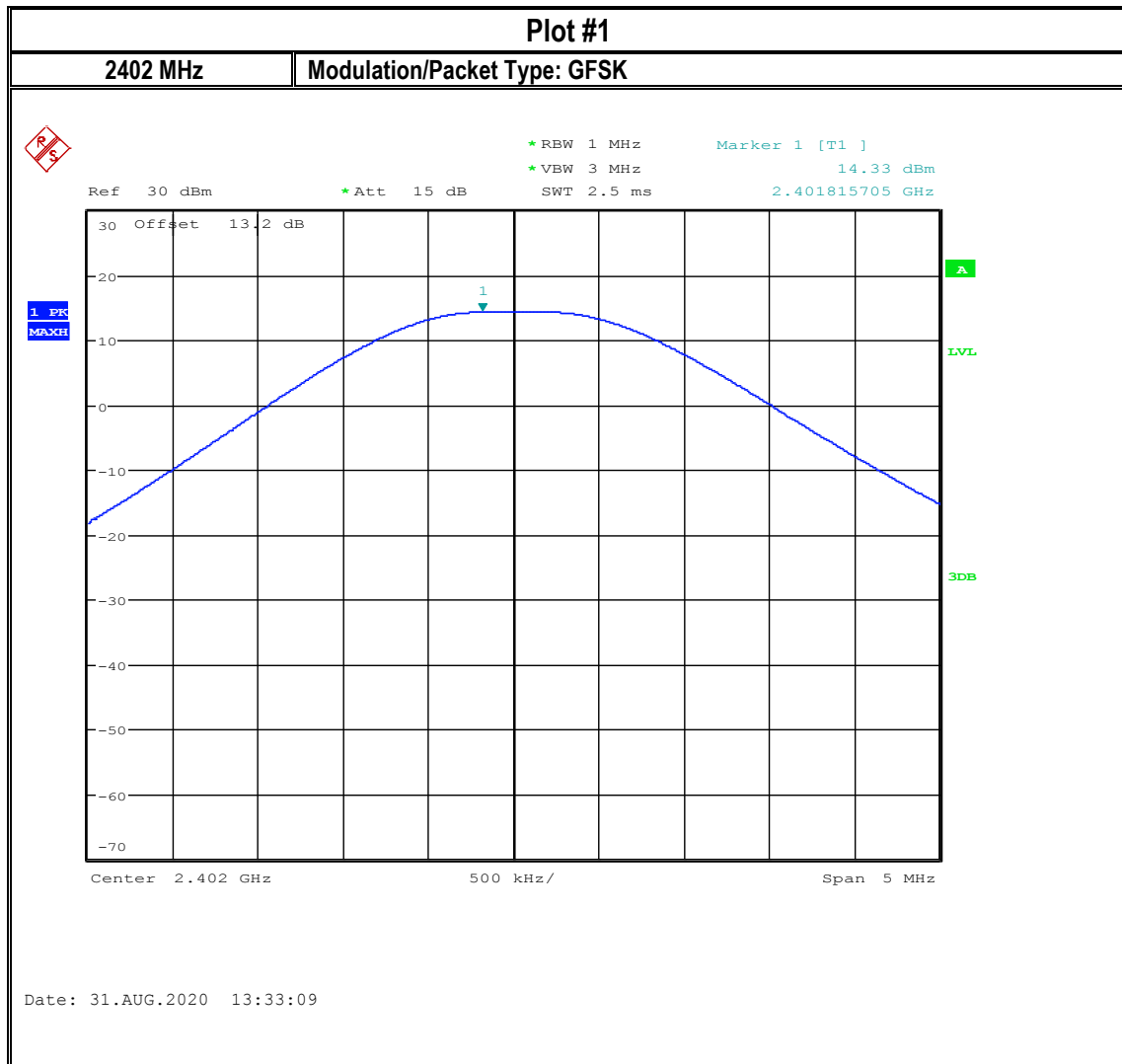
8.1.3 Test conditions and setup:

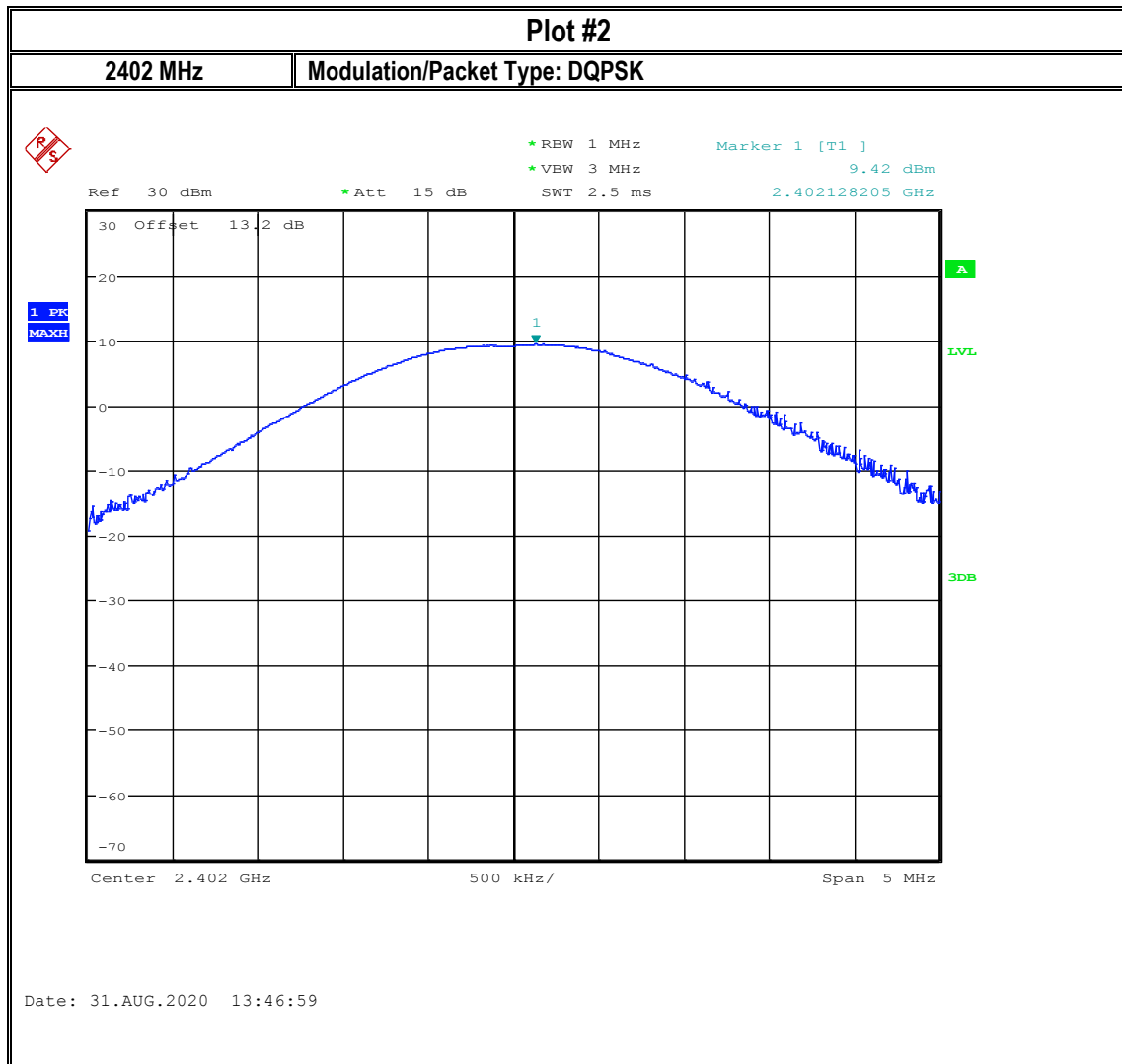
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23° C	2	GFSK, DQPSK, 8DPSK	5 VDC	1.6 dBi

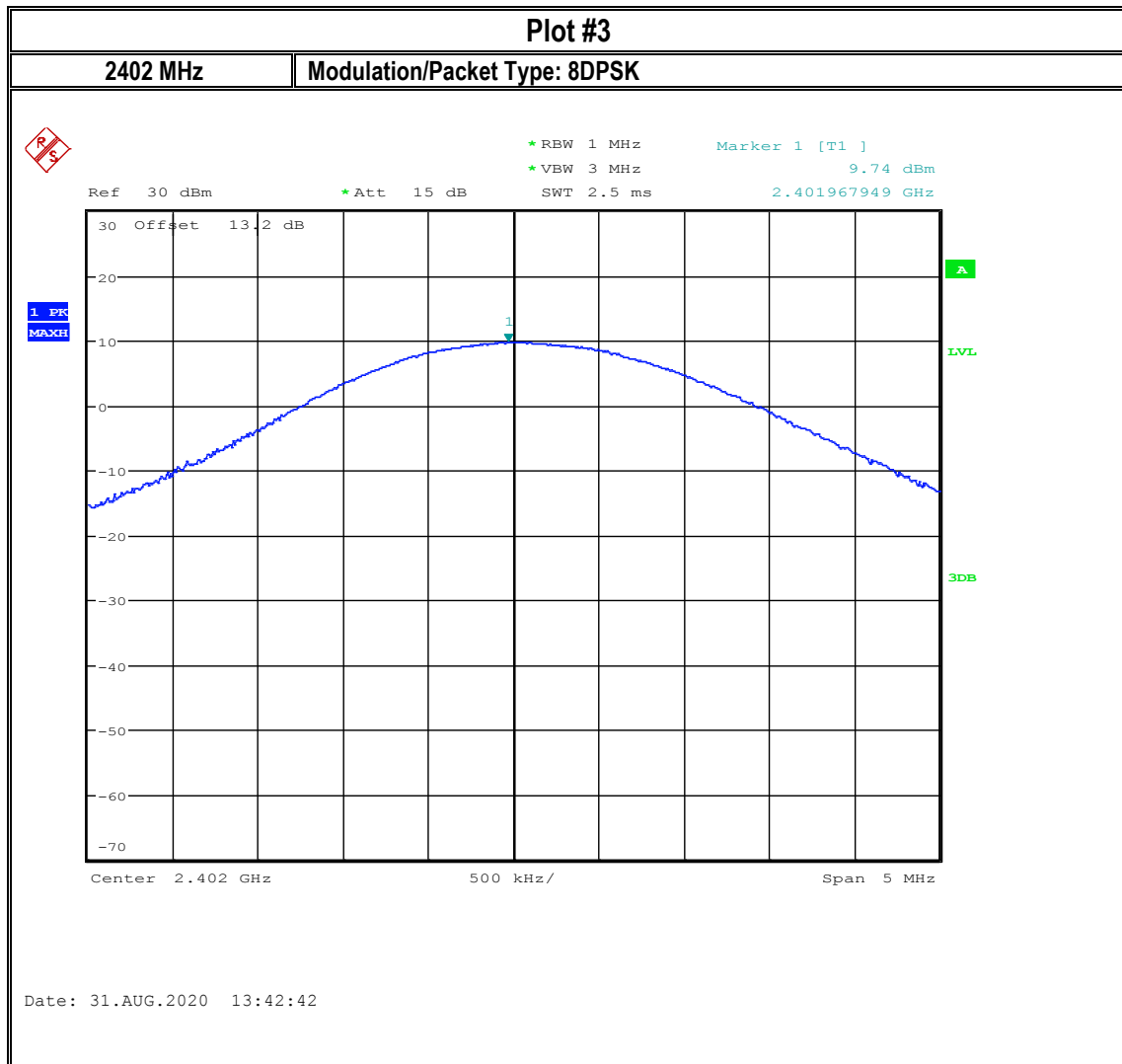
8.1.4 Measurement result:

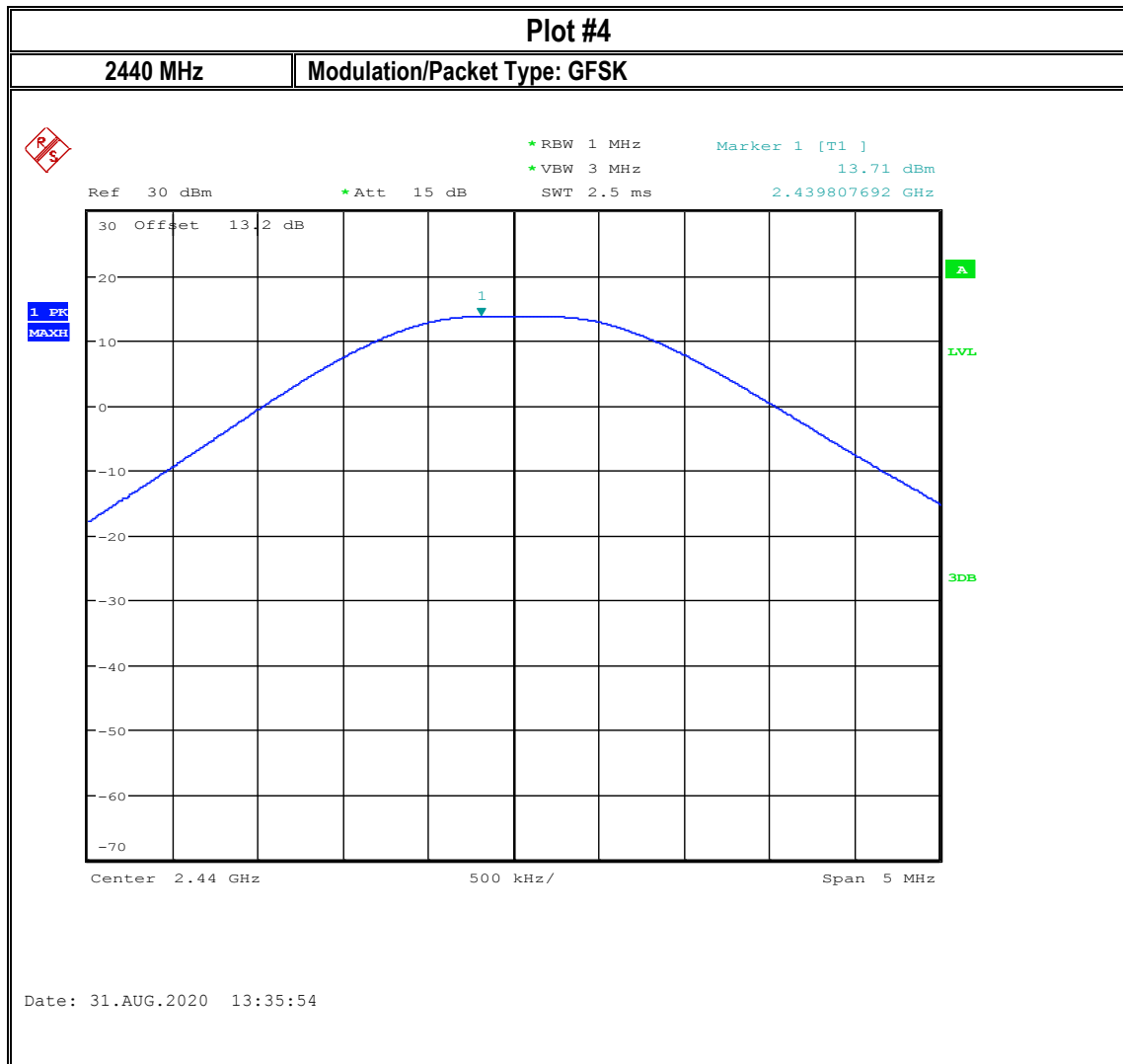
Plot #	Frequency (MHz)	EUT operating mode	Maximum Peak Conducted Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	2402	GFSK	14.33	15.93	30(Pk) / 36(EIRP)	Pass
2	2402	DQPSK	9.42	11.02	30(Pk) / 36(EIRP)	Pass
3	2402	8DPSK	9.74	11.34	30(Pk) / 36(EIRP)	Pass
4	2440	GFSK	13.71	15.31	30(Pk) / 36(EIRP)	Pass
5	2440	DQPSK	9.93	11.53	30(Pk) / 36(EIRP)	Pass
6	2440	8DPSK	10.24	11.84	30(Pk) / 36(EIRP)	Pass
7	2480	GFSK	13.55	15.15	30(Pk) / 36(EIRP)	Pass
8	2480	DQPSK	10.03	11.63	30(Pk) / 36(EIRP)	Pass
9	2480	8DPSK	10.36	11.96	30(Pk) / 36(EIRP)	Pass

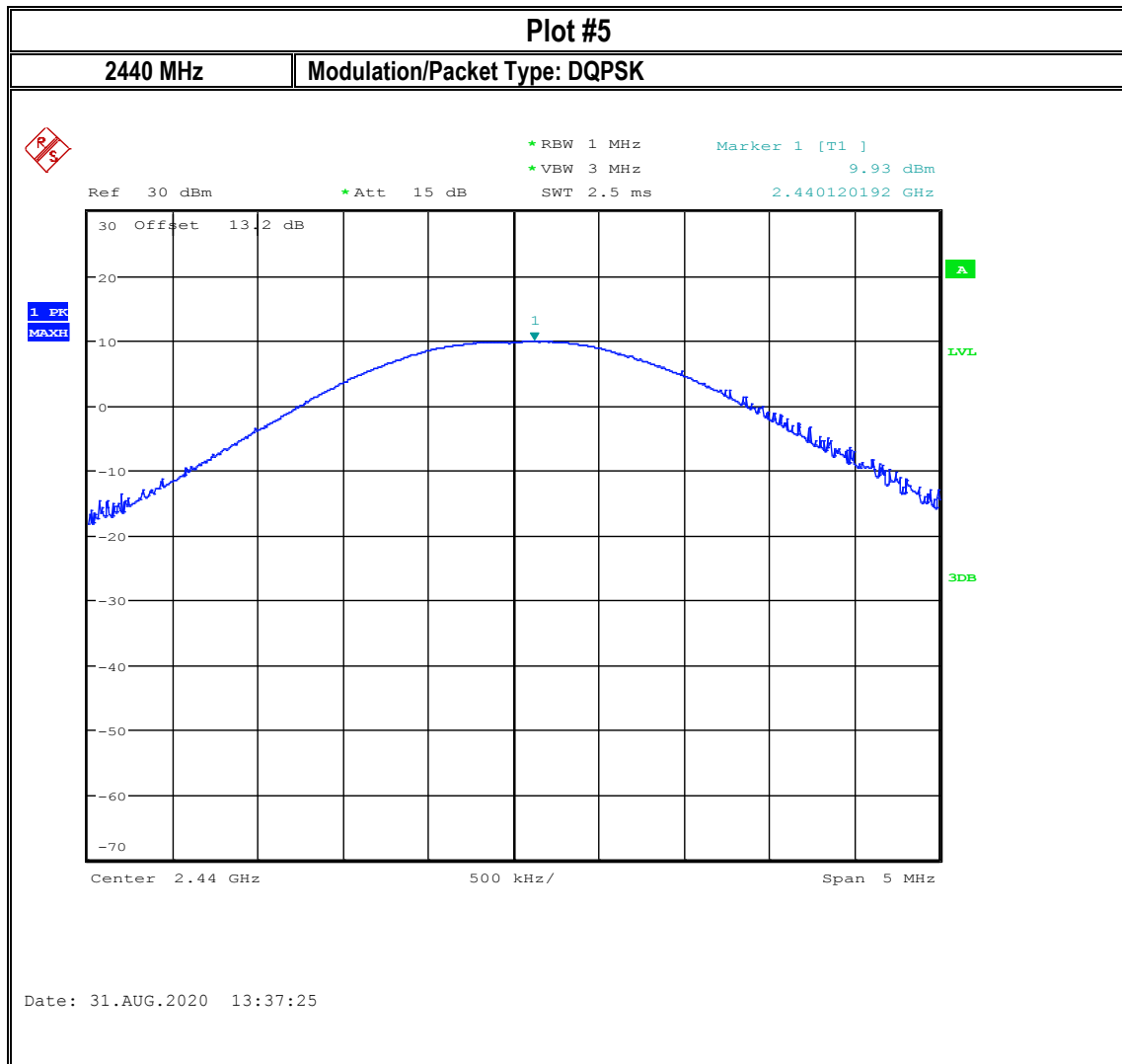
8.1.5 Measurement Plots:

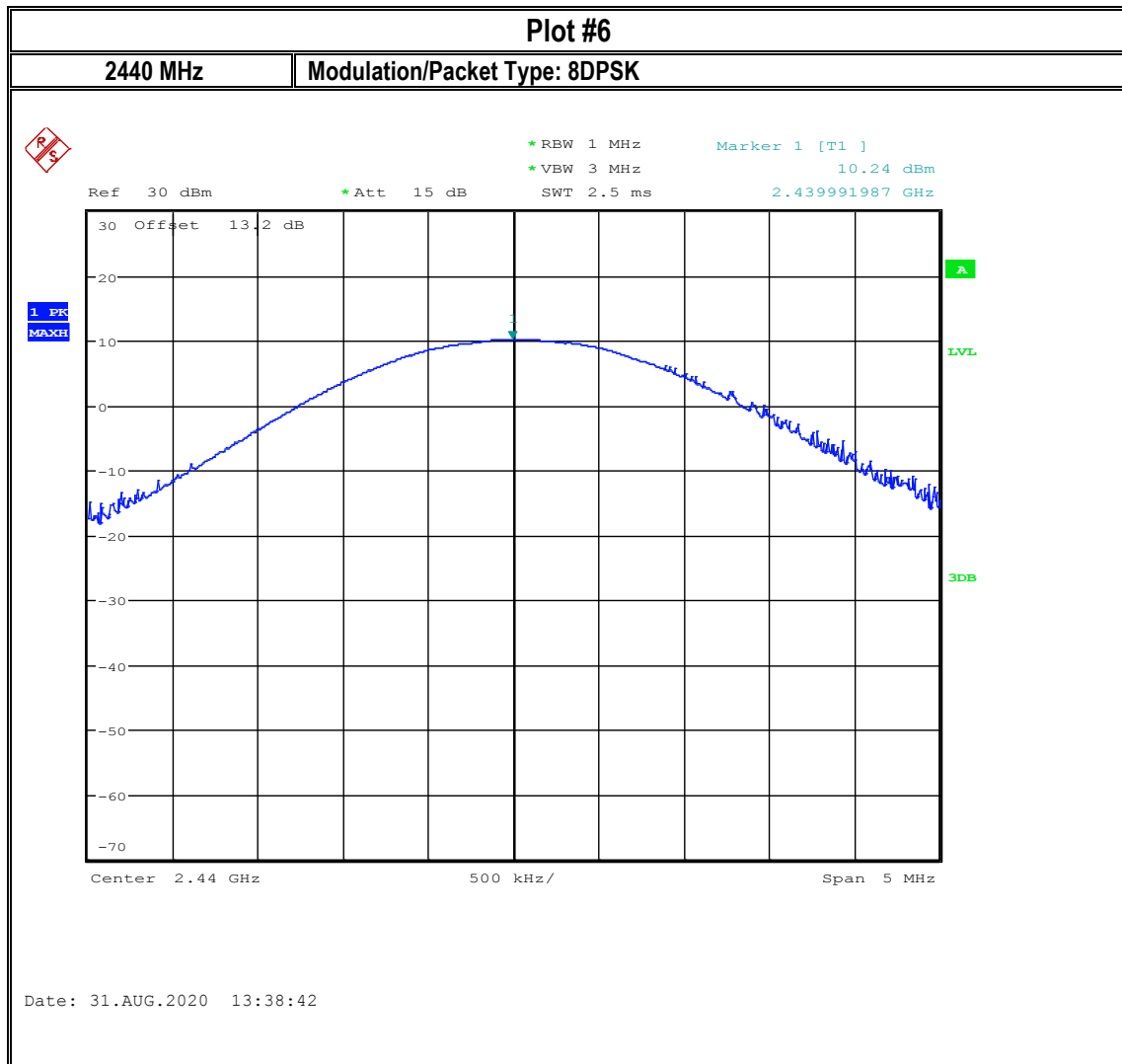


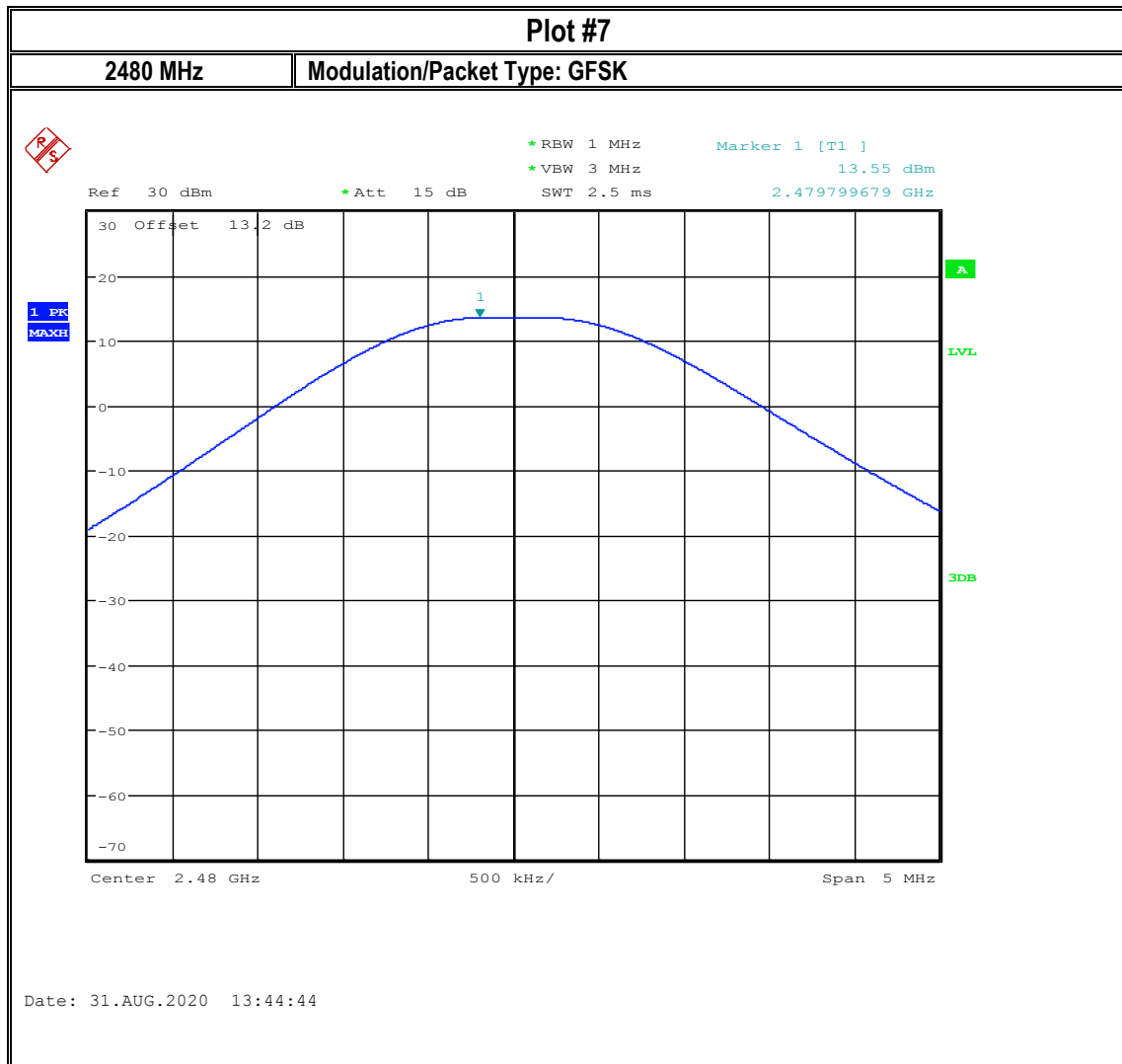


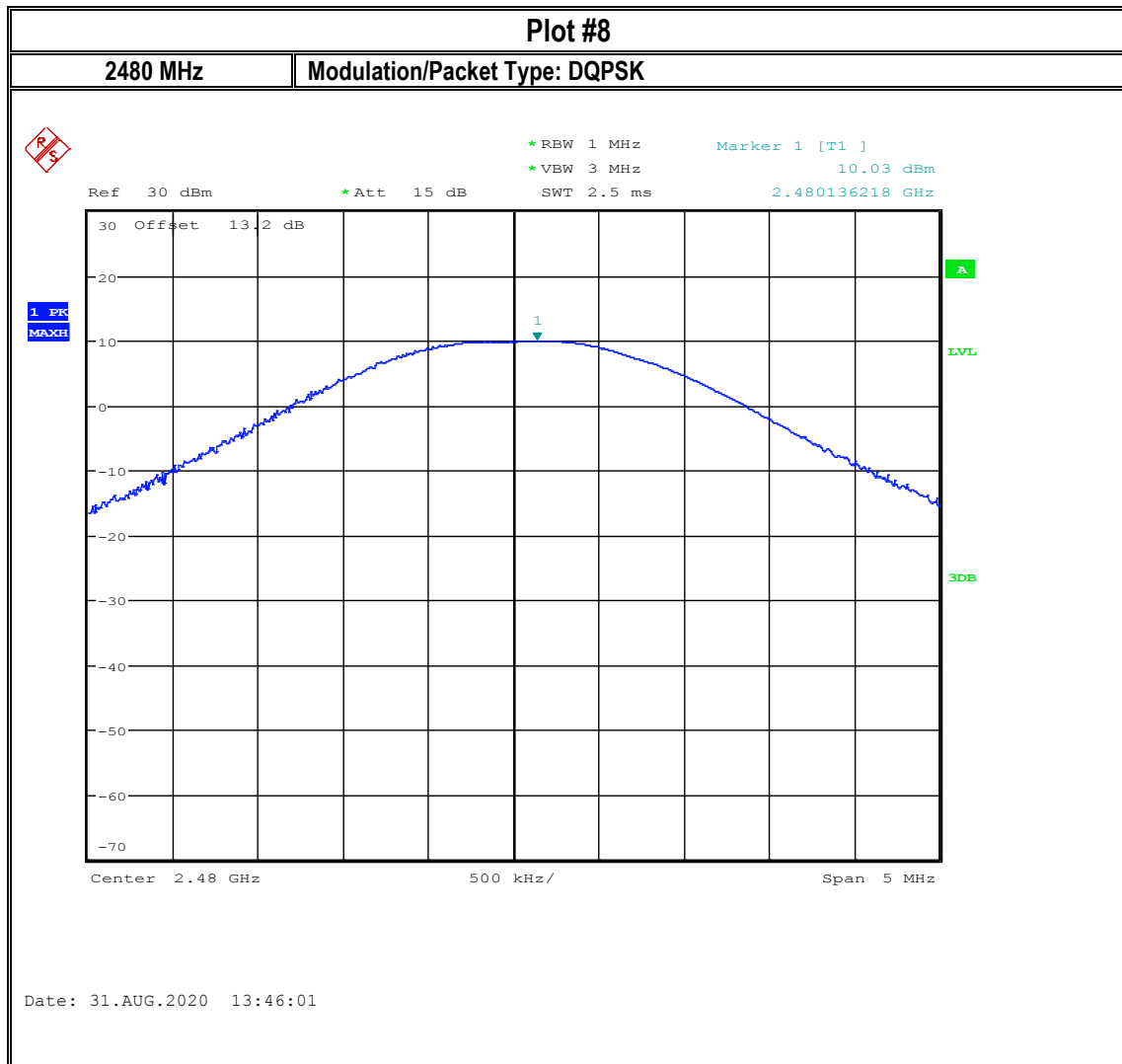


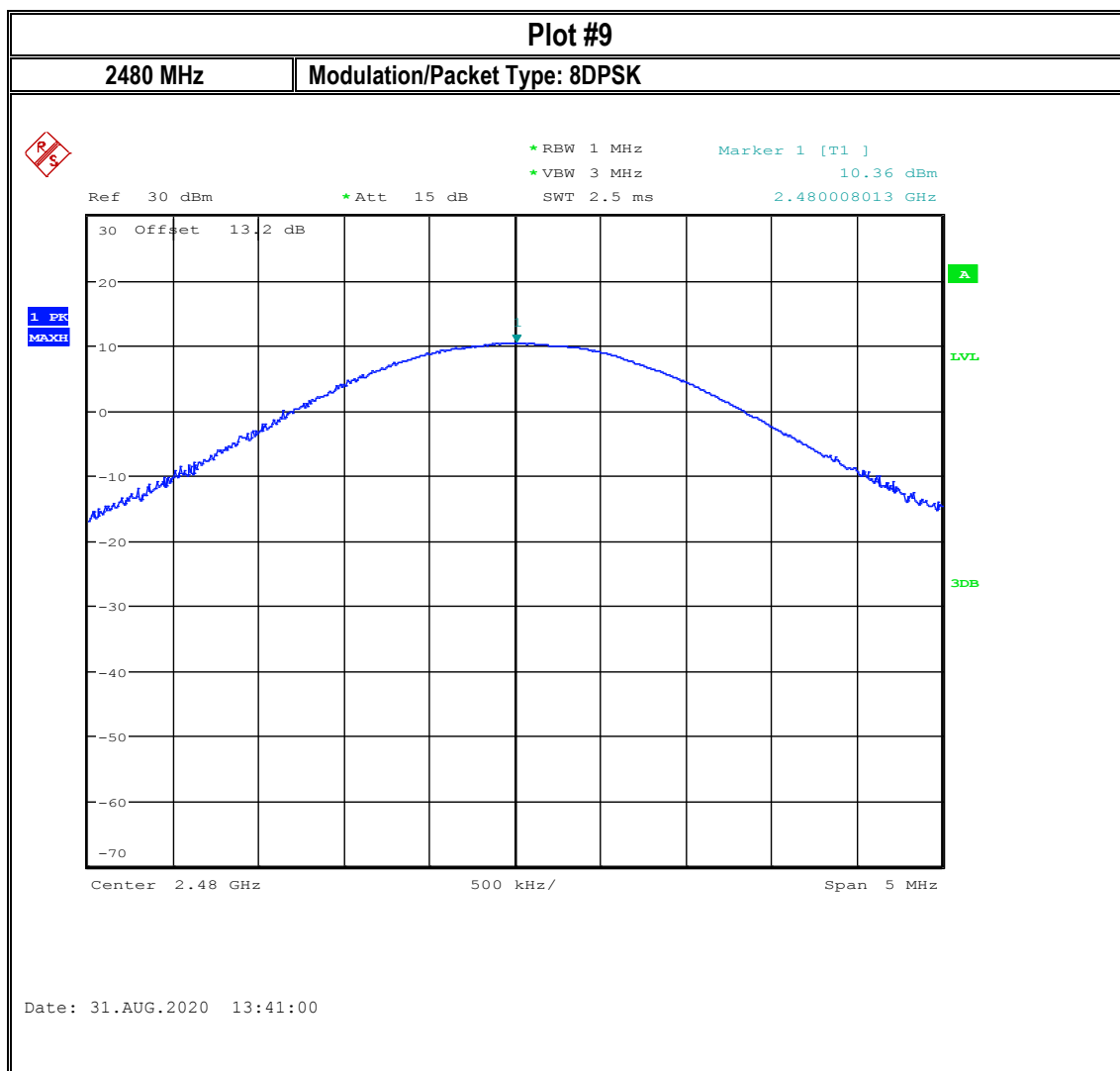












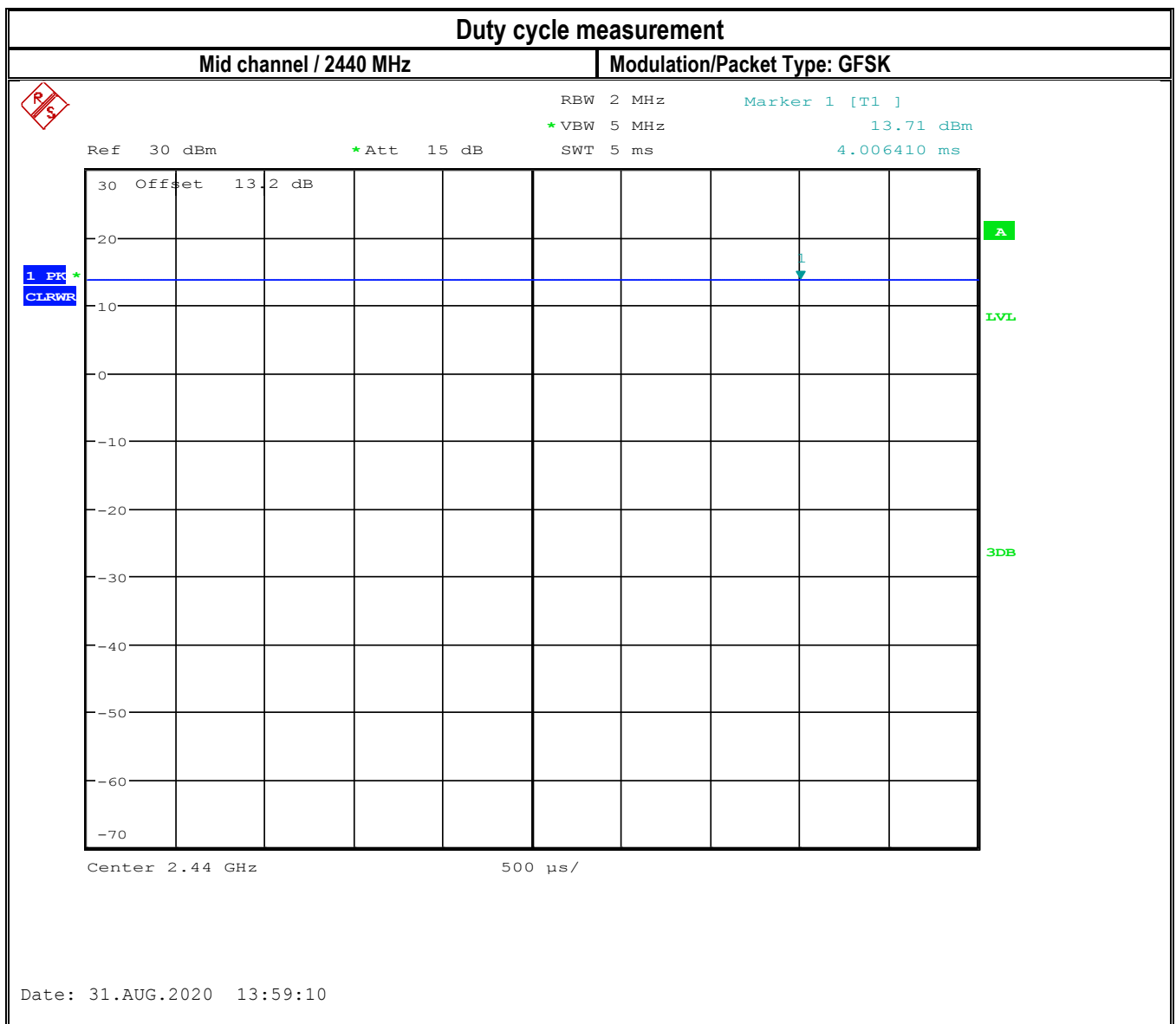
8.2 Duty cycle

8.2.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v05r02

Spectrum Analyzer settings:

- Set the center frequency and of the instrument to the center frequency of the transmission
- Zero span
- Set RBW $\geq$ OBW if possible; otherwise, set RBW to the largest available value
- Detector = Peak or average

8.2.2 Measurement result



Duty cycle =100%

Duty cycle correction factor =0 dB

8.3 Band Edge Compliance

8.3.1 Measurement according to ANSI C63.10 Section 6.10

Spectrum Analyzer settings for non-restricted band edge:

- Span: wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
- RBW $\geq$ 1% of the span
- VBW $\geq$ RBW
- Sweep Time: Auto couple
- Detector = Peak
- Trace = Max hold
- Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge.
- Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
- Now, using the same instrument settings, enable the hopping function of the EUT.
- Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

Spectrum Analyzer settings for restricted band:

- Peak measurements are made using a peak detector and RBW=1 MHz

8.3.2 Limits: Restricted Band FCC 15.209 and RSS-Gen 8.10

- PEAK LIMIT= 74 dB μ V/m @3 m =-21.23 dBm
- AVG. LIMIT= 54 dB μ V/m @3 m =-41.23 dBm
- Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205

Restricted bands of operation:

- Except as shown in CFR 47 Part 15.205 paragraph (d), only spurious emissions are permitted in any of the frequency bands listed below

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

8.3.3 Limits: Non-restricted Band §15.247 and RSS-247 5.5

FCC15.247 (d)

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)).

RSS-247 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

8.3.4 Test conditions and setup:

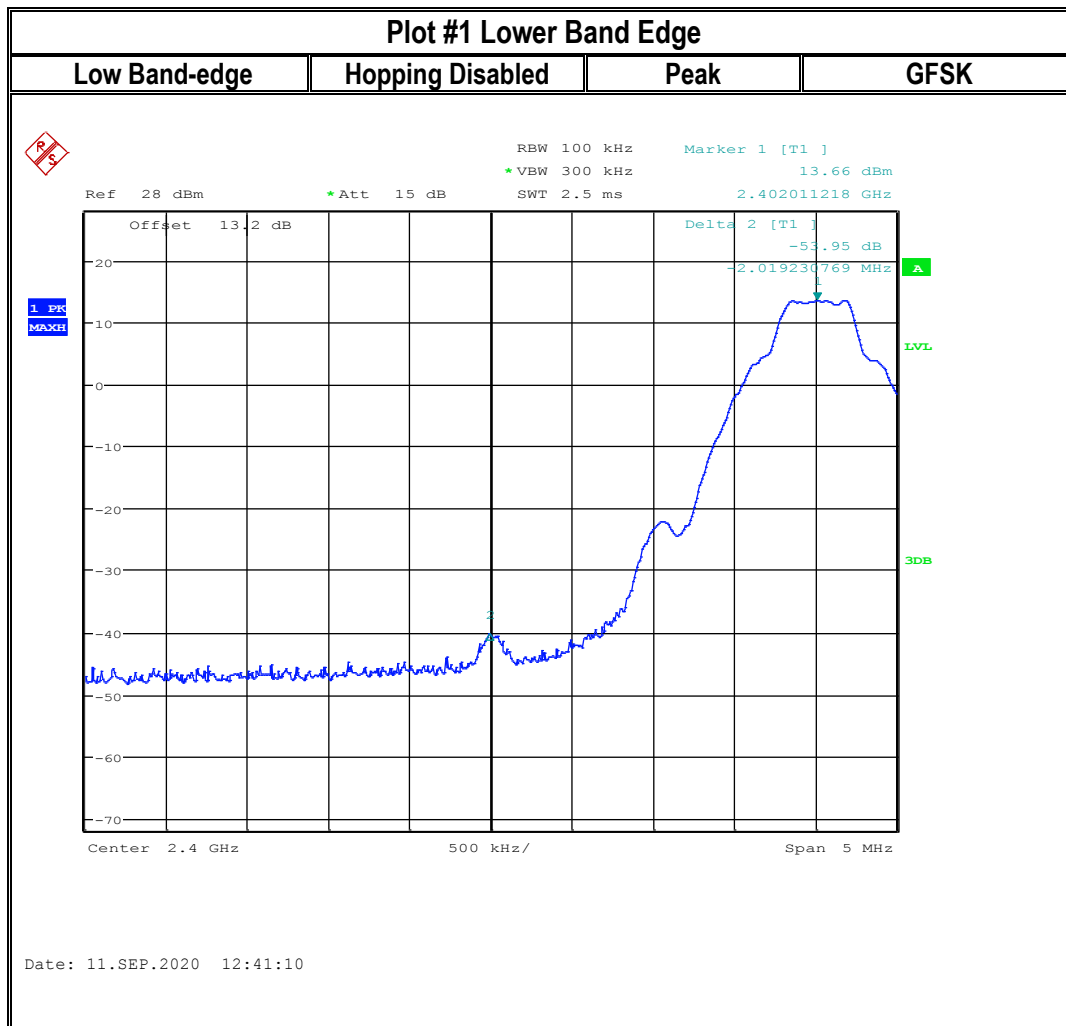
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna gain
22° C	2	GFSK - fixed channel GFSK - hopping	5 VDC	1.6 dBi

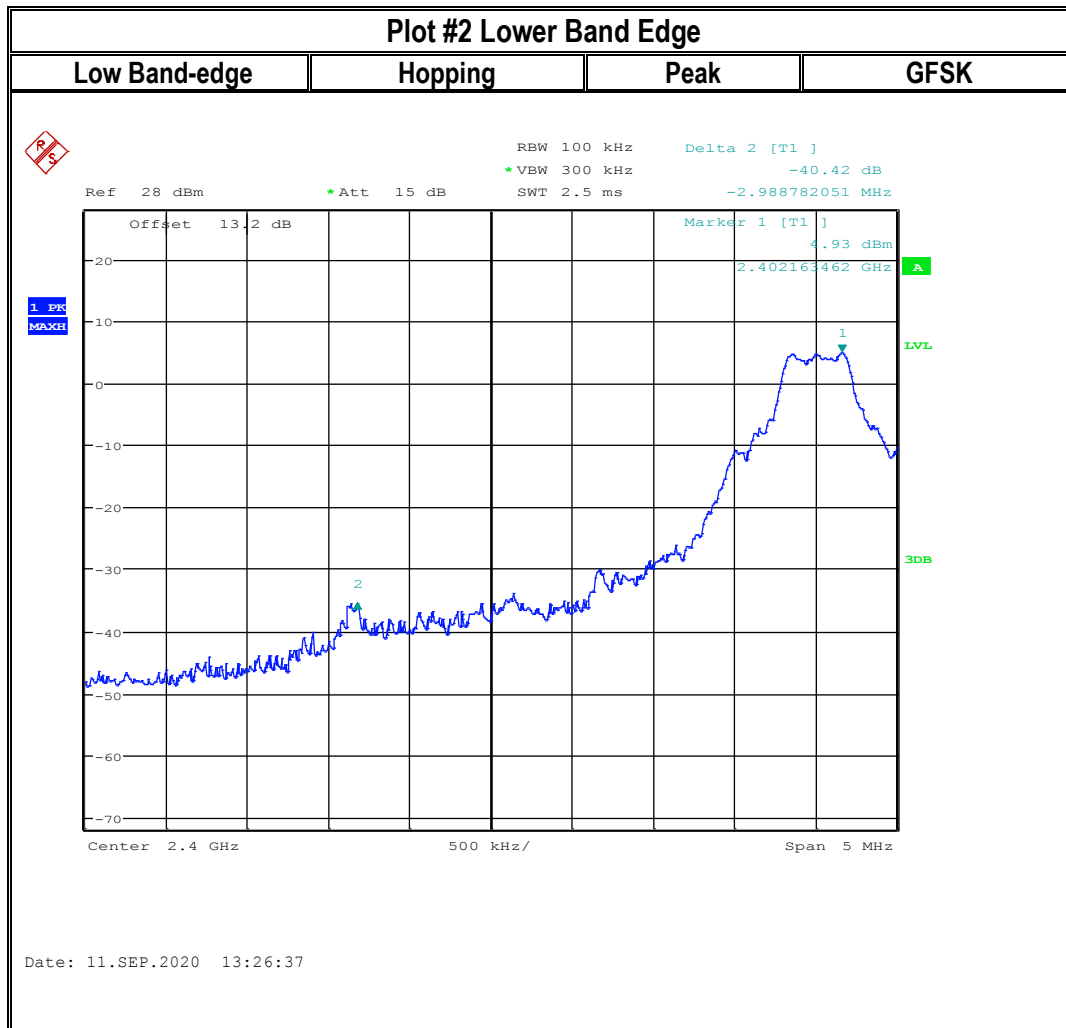
8.3.5 Measurement result:

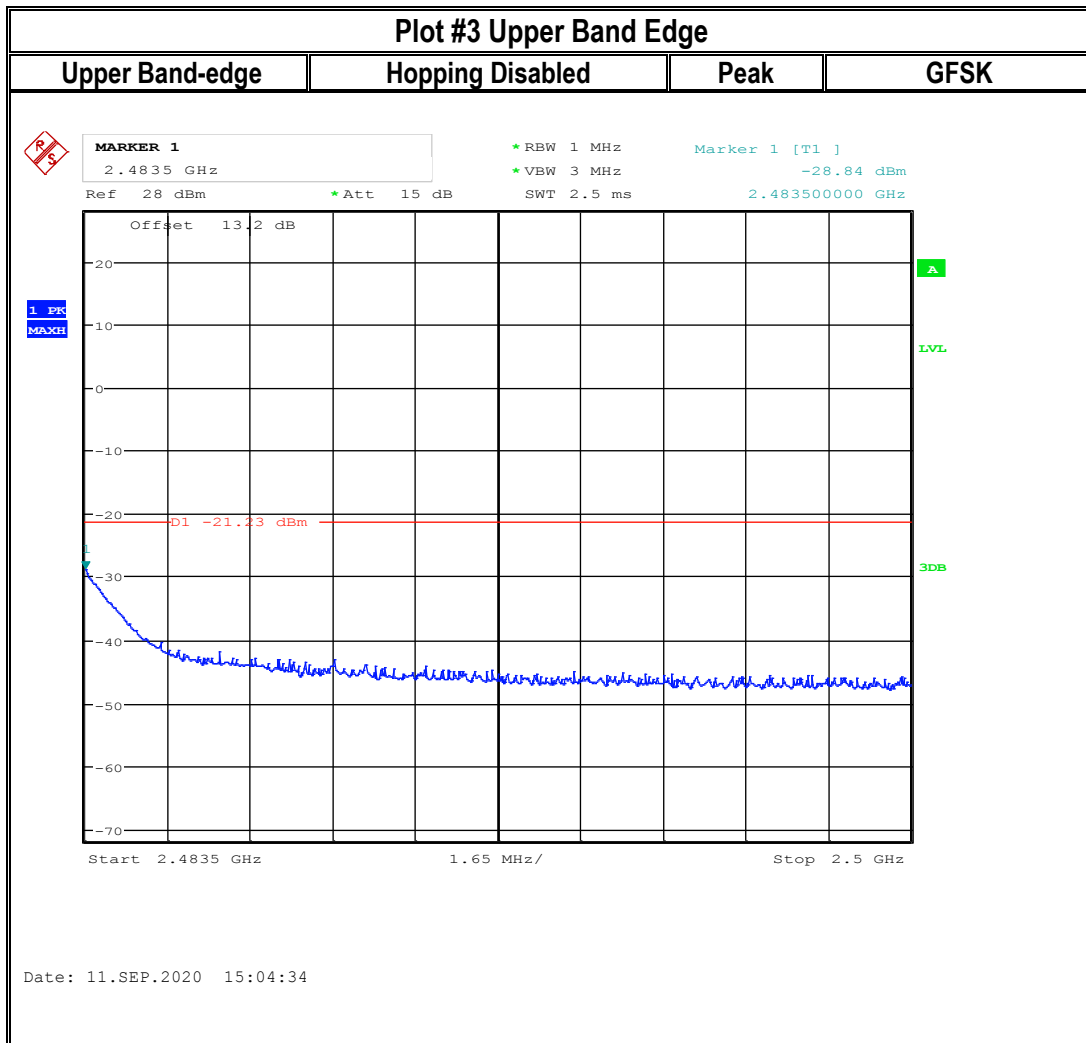
Plot #	EUT operating mode	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
1	GFSK fixed channel	Lower, non-restricted	-53.95	-20	Pass
2	GFSK hopping	Lower, non-restricted	-40.42	-20	Pass

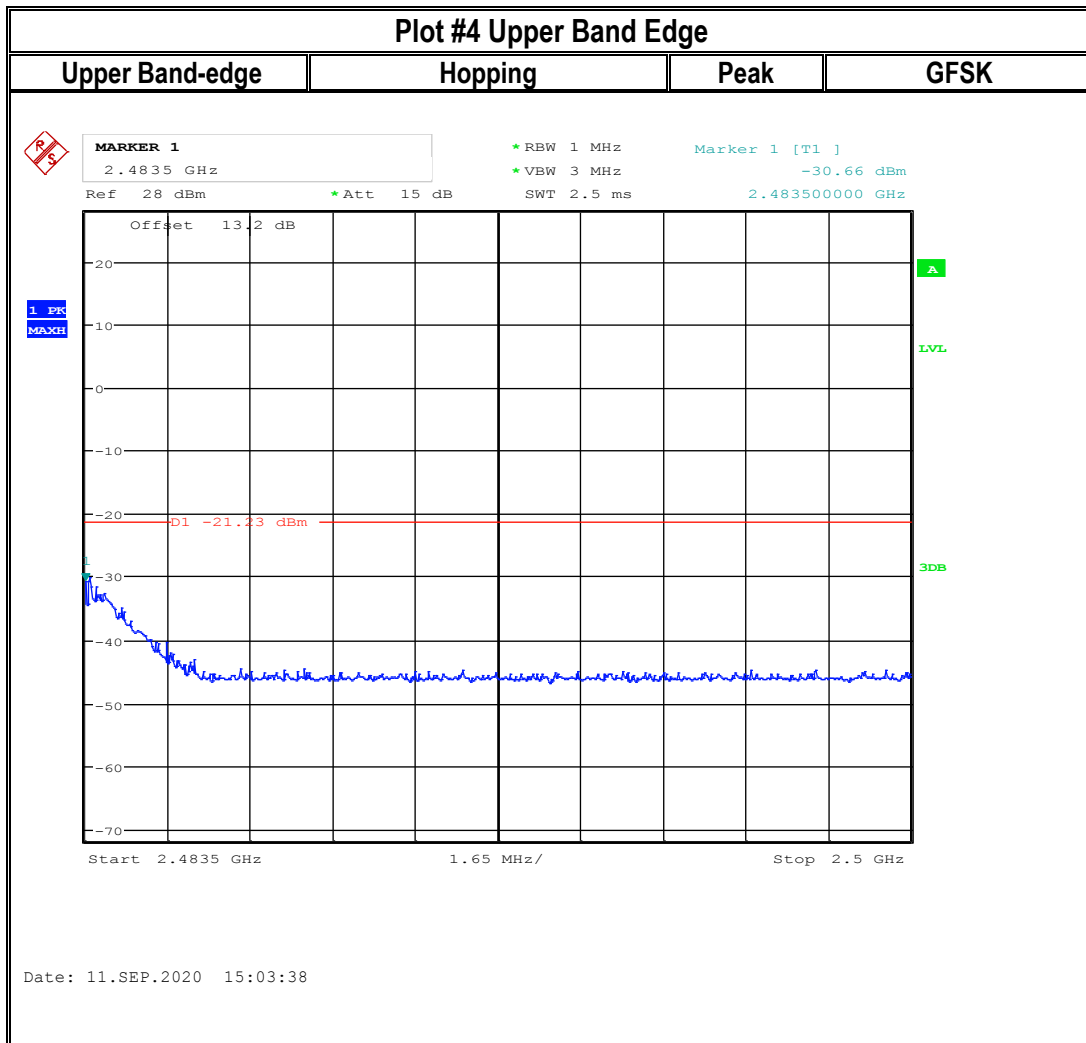
Plot #	EUT operating mode	Band Edge	Measured value	Corrected by duty cycle	Corrected by Antenna gain	Limit (dBm)	Result
3	GFSK fixed channel	Upper restricted peak	-28.84	NA due to peak detector	-27.24	-21.23 Peak	Pass
4	GFSK hopping	Upper restricted peak	-30.66	NA due to peak detector	-29.06	-21.23 Peak	Pass
3	GFSK fixed channel	Upper restricted average	-56.24	-56.24	-54.64	-41.23 AVG	Pass
4	GFSK hopping	Upper restricted average	-56.25	-56.25	-54.65	-41.23 AVG	Pass

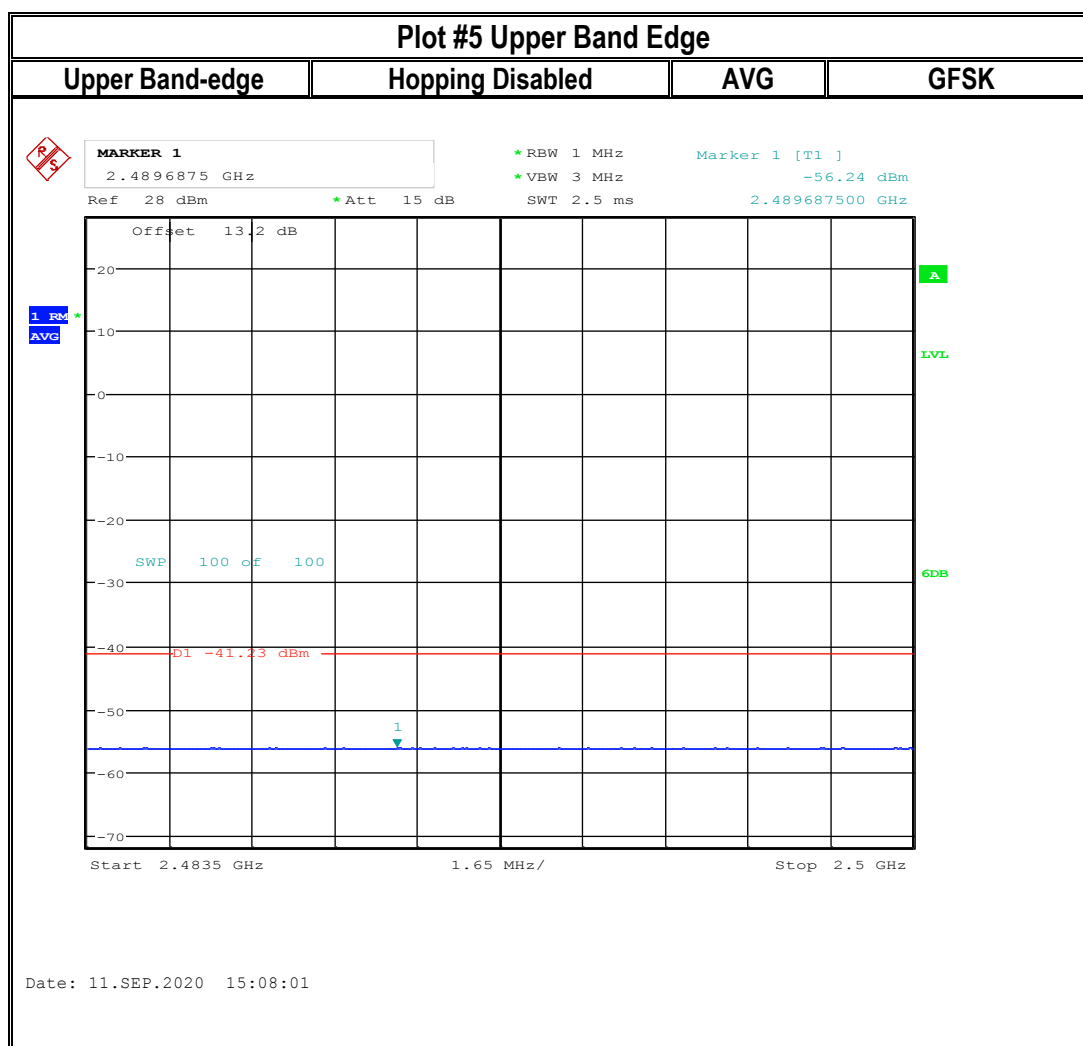
8.3.6 Measurement Plots:

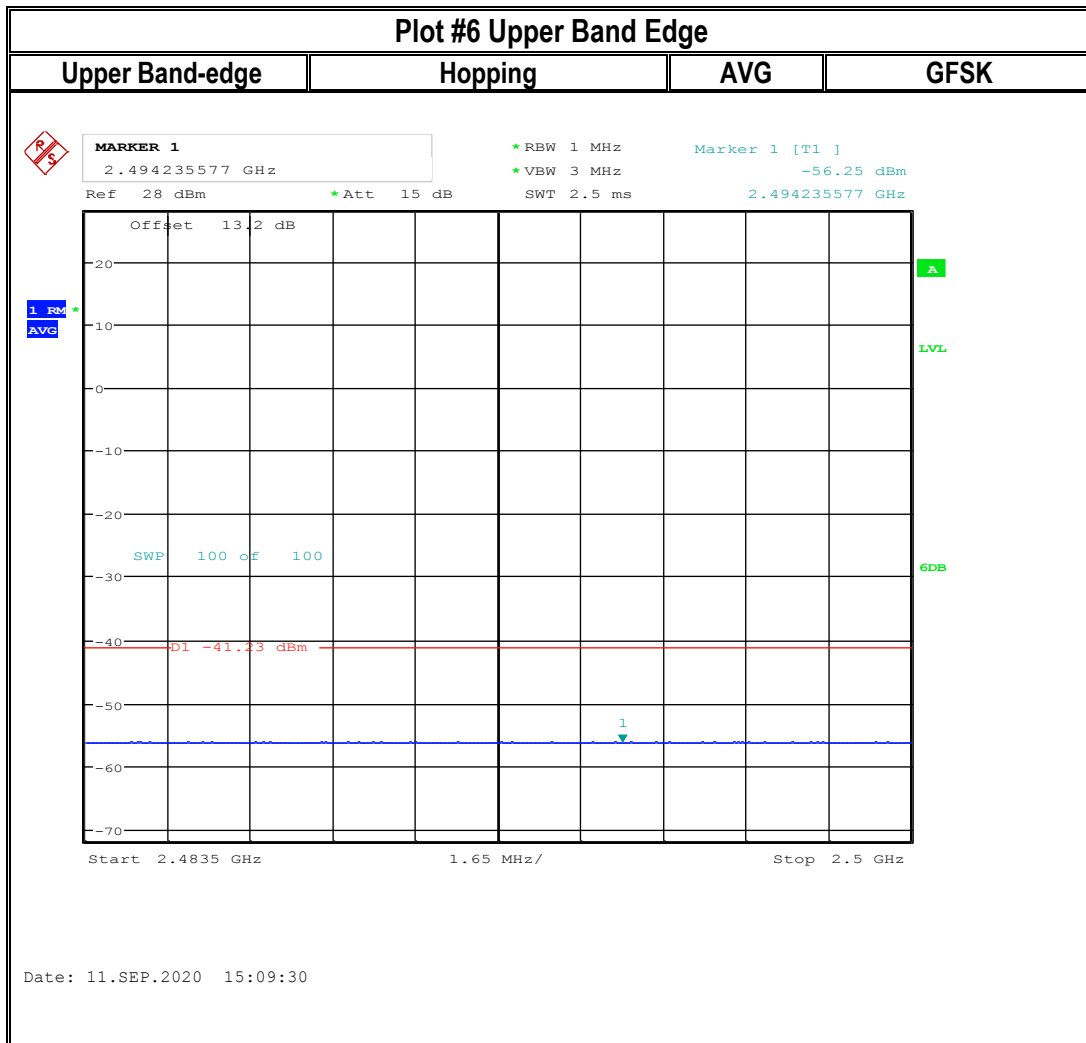












8.4 20dB Bandwidth

8.4.1 Measurement according to ANSI C63.10 Section 6.9.2

Spectrum Analyzer settings:

- Span: approximately 2 to 5 times the 20 dB bandwidth, centered on the hopping channel
- RBW = 1% to 5% of the 20 dB bandwidth
- VBW = 3 x RBW
- Sweep Time = Auto couple
- Detector = Peak
- Trace = Max hold

8.4.2 Limits: FCC §15.247(a)(1), RSS-247 5.1(b)

FCC §15.247(a)(1):

Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

RSS-247 5.1(b):

FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W

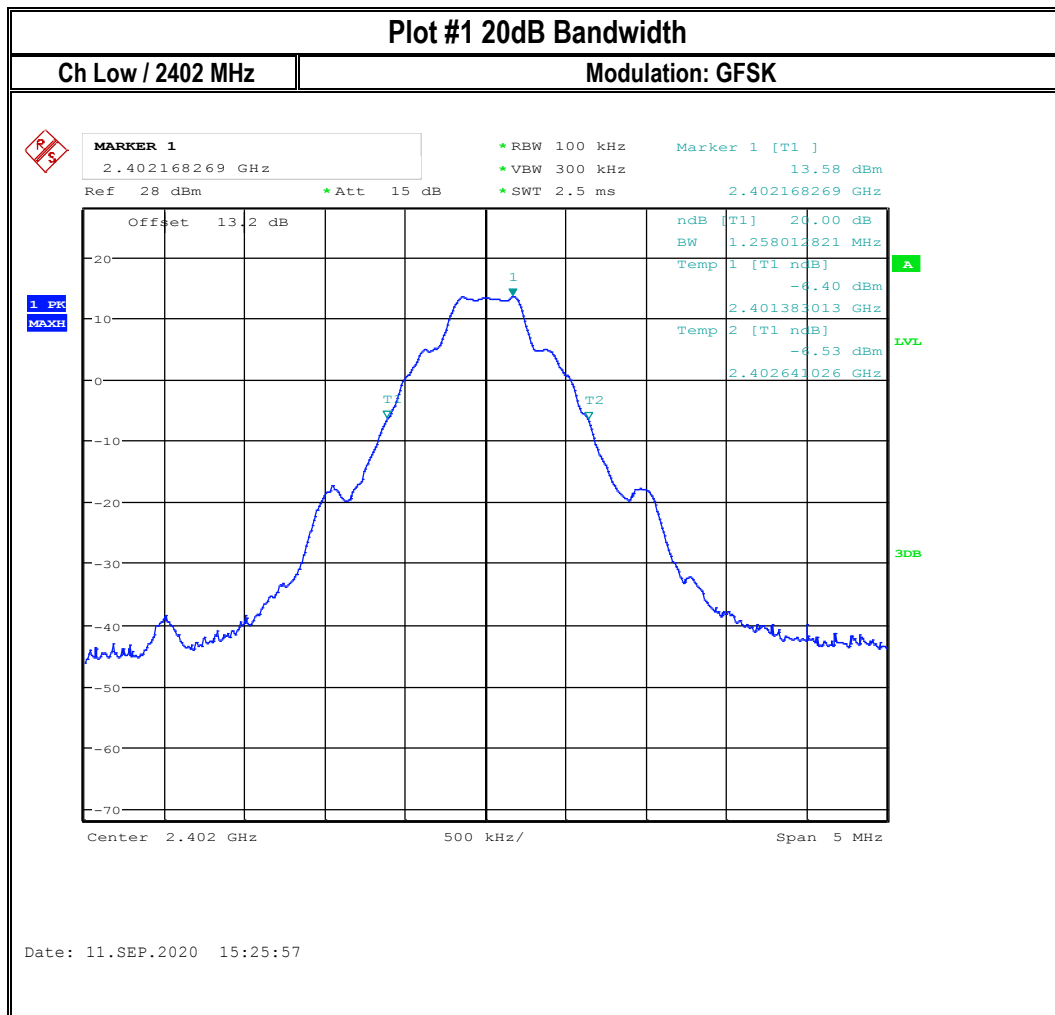
8.4.3 Test conditions and setup:

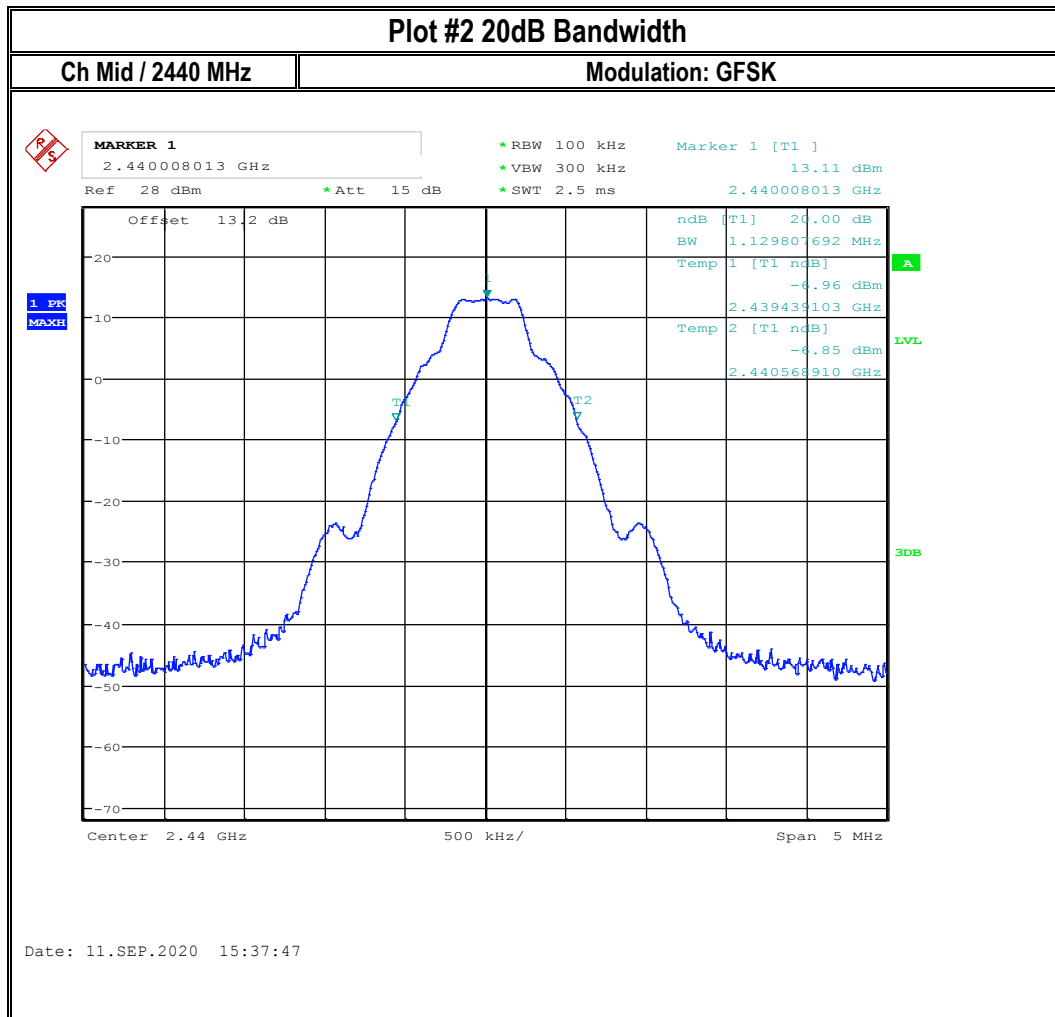
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	2	GFSK, DQPSK, 8DPSK	5 VDC

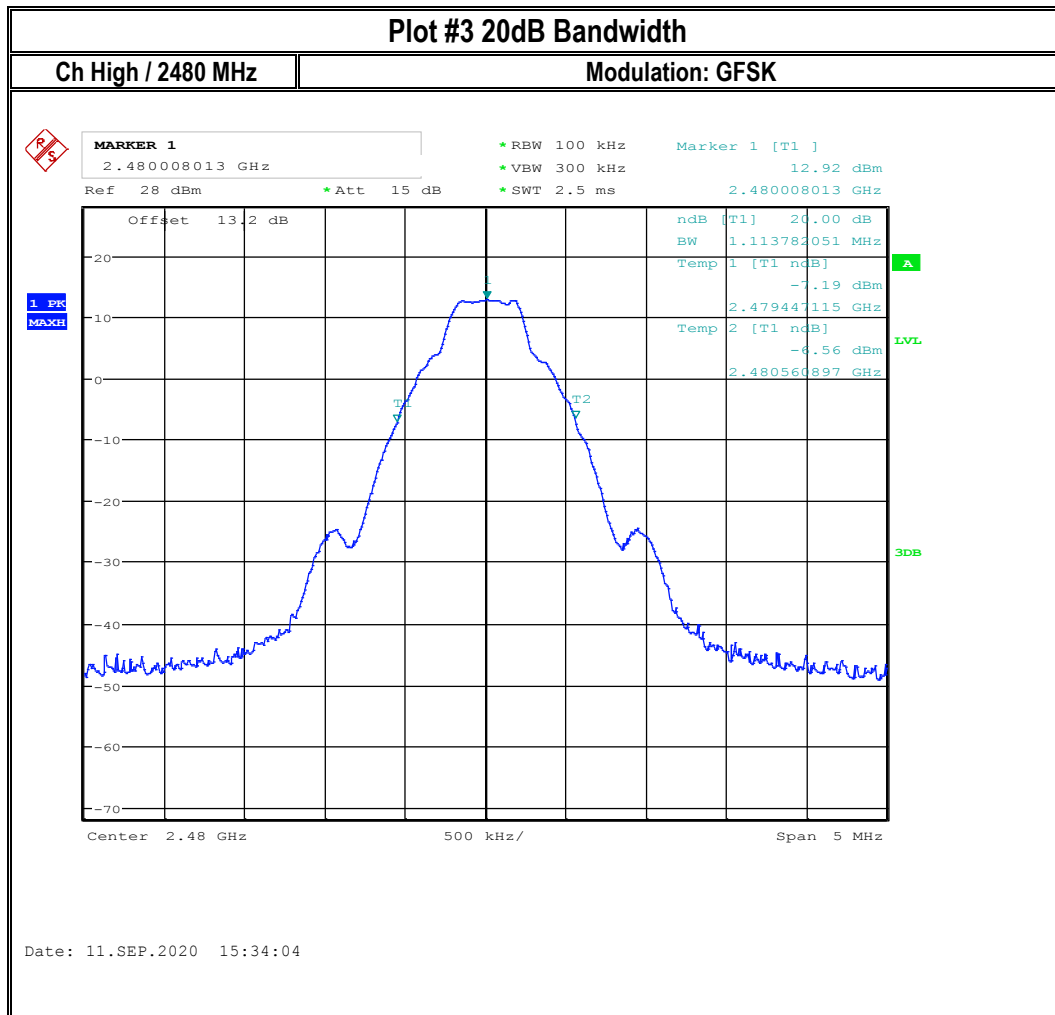
8.4.4 Measurement result:

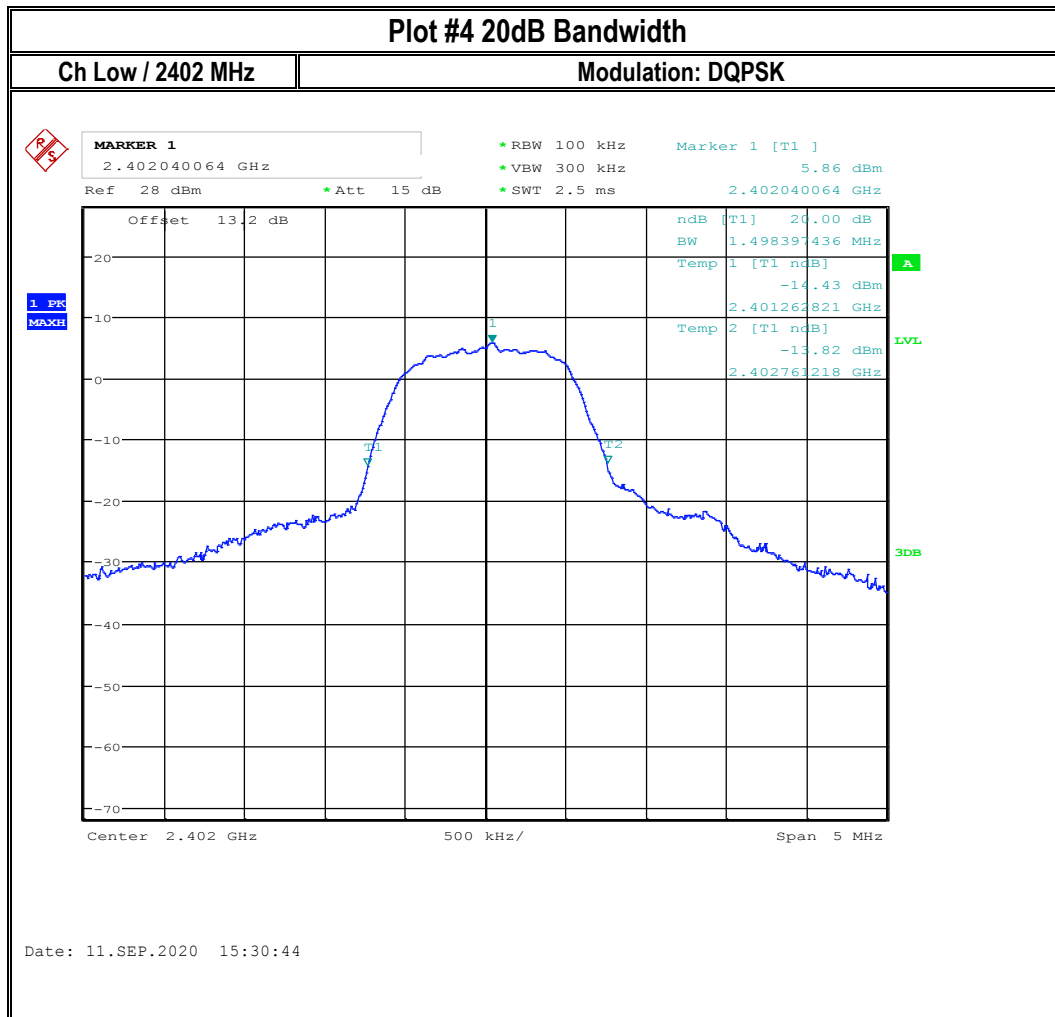
Plot #	EUT operating mode	Channel	20 dB Bandwidth (MHz)
1	GFSK fixed channel	Low	1.258
2	GFSK fixed channel	Mid	1.130
3	GFSK fixed channel	High	1.114
4	DQPSK fixed channel	Low	1.498
5	DQPSK fixed channel	Mid	1.466
6	DQPSK fixed channel	High	1.466
7	8DPSK fixed channel	Low	1.466
8	8DPSK fixed channel	Mid	1.466
9	8DPSK fixed channel	High	1.442

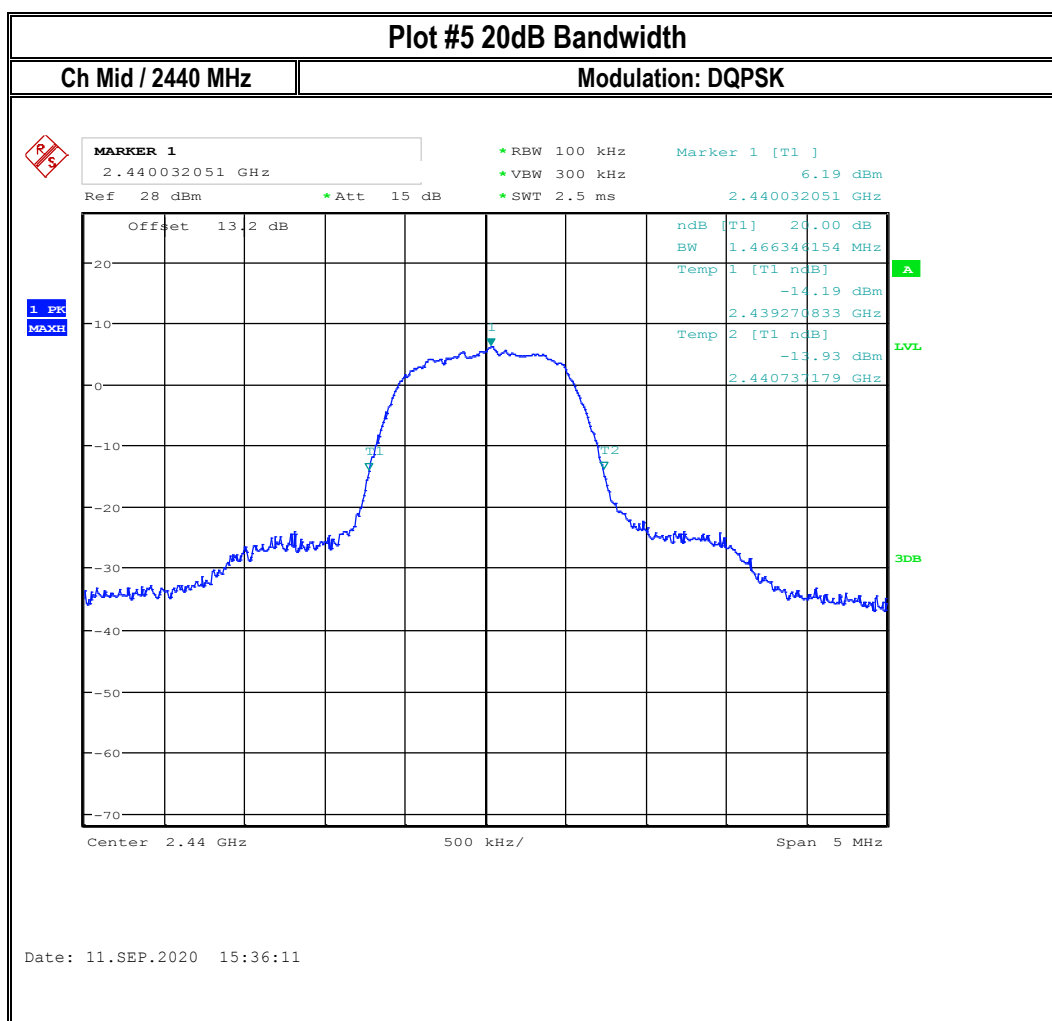
8.4.5 Measurement Plots:

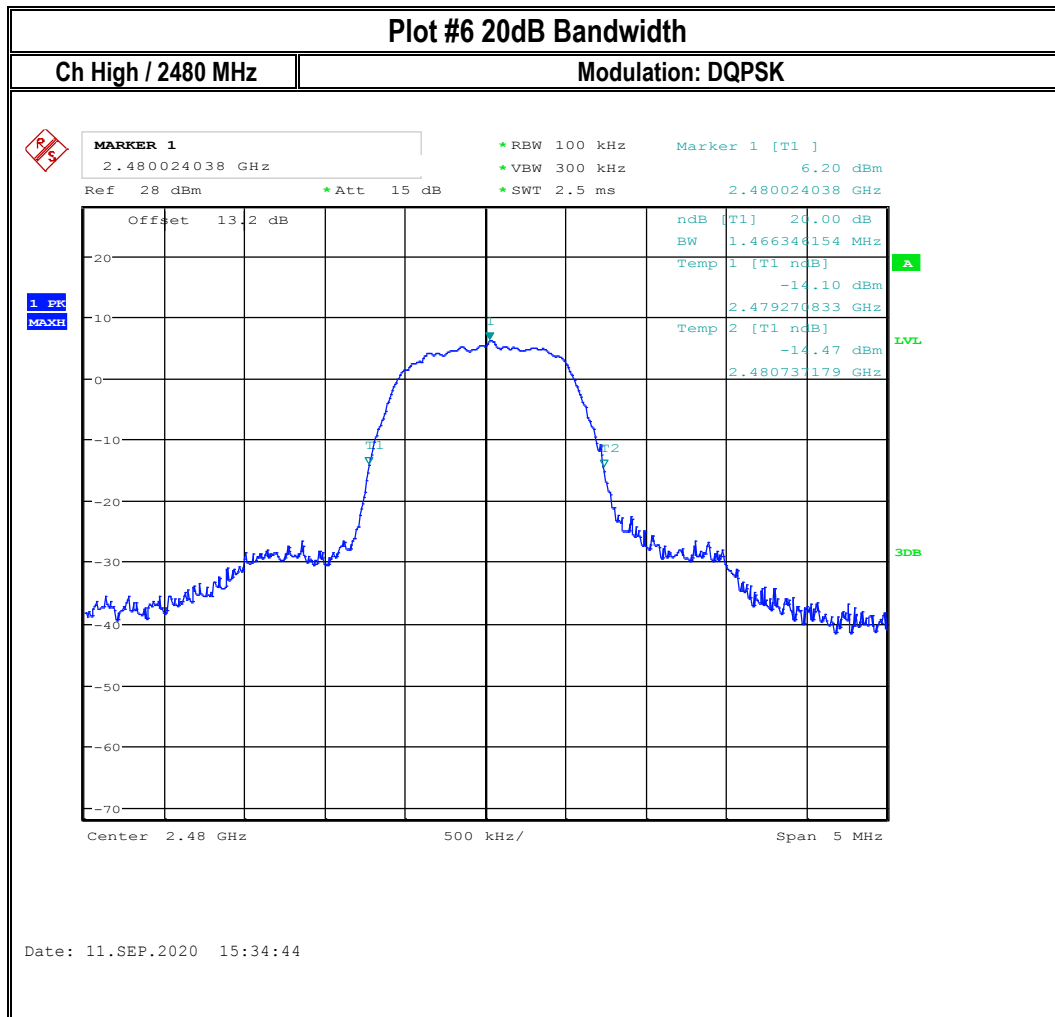


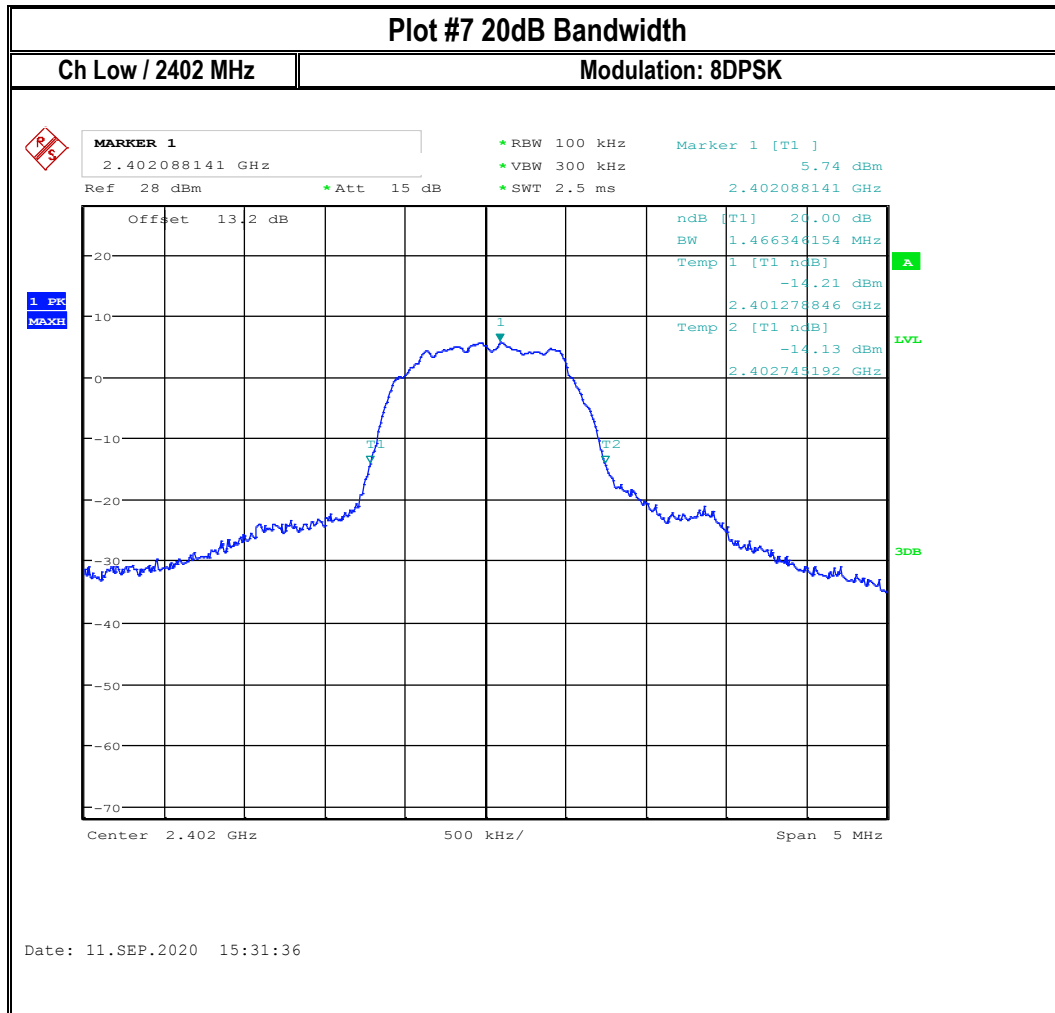


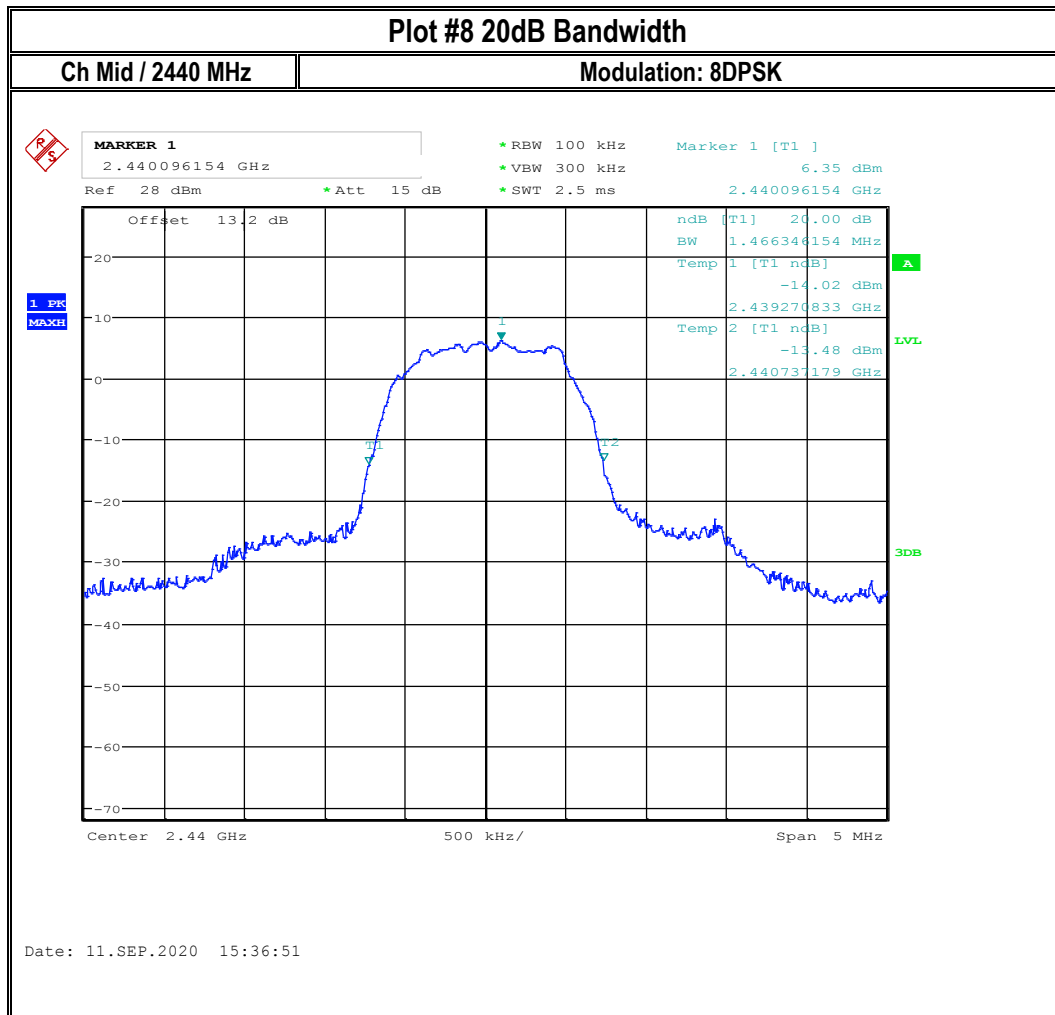


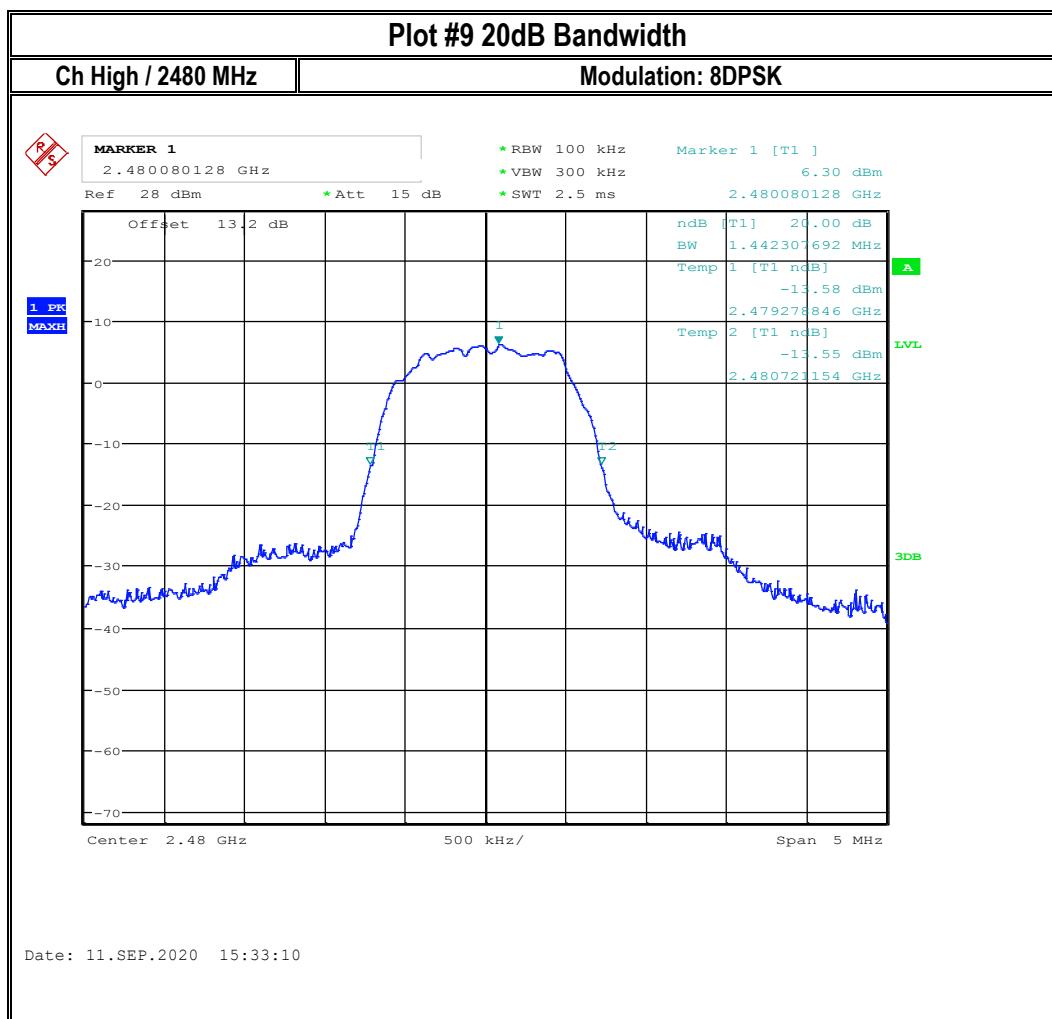












8.5 Carrier Frequency Separation

8.5.1 Measurement according to ANSI C63.10 Section 7.8.2

Spectrum Analyzer settings:

- Span = Wide enough to capture the peaks of the two adjacent channels
- RBW $\geq$ 1% of the span
- VBW $\geq$ RBW or 3 x
- Sweep = Auto couple
- Detector function = Peak
- Trace = Max hold
- Use marker-delta function to determine the separation between the peaks of the two adjacent channels.

8.5.2 Limits: FCC §15.247(a)(1) & RSS-247 5.1(b)

FCC §15.247(a)(1):

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

RSS-247 5.1(b):

FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

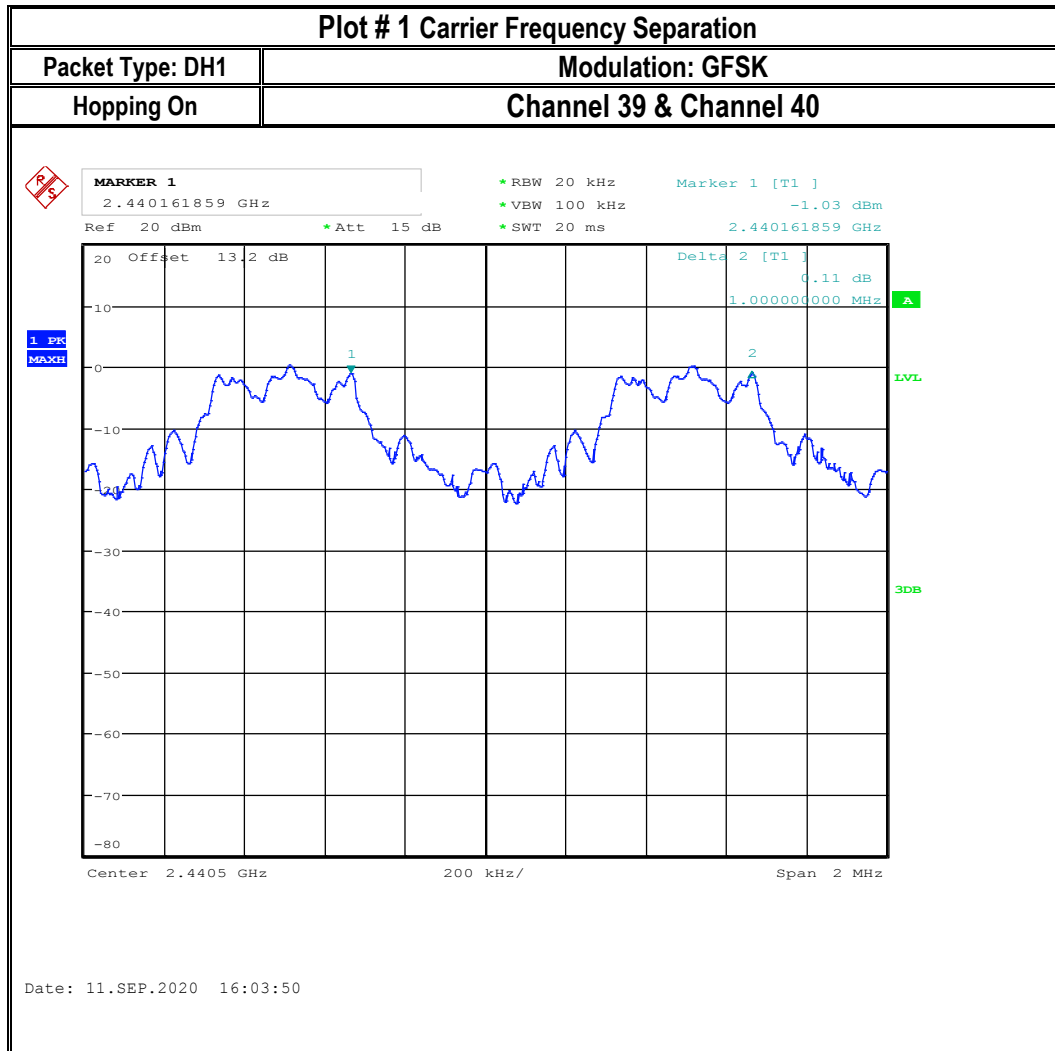
8.5.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	GFSK Hopping	5 VDC

8.5.4 Measurement result:

Plot #	Carrier Frequency Separation (MHz)	Limit (MHz)	Result
1	1.00	$> 2/3 * \text{OBW} = 0.63$	Pass

8.5.5 Measurement Plots:



8.6 Number of hopping channels

8.6.1 Measurement according to ANSI C63.10 Section 7.8.3

Spectrum Analyzer settings:

- Span = the entire frequency band of operation
- RBW $\geq$ 50 KHz
- VBW $\geq$ RBW or 3X
- Sweep = Auto couple
- Detector function = Peak
- Trace = Max hold

8.6.2 Limits: FCC §15.247(a)(1)(ii)(iii) & RSS-247 5.1(d)

At least 15 non-overlapping channels

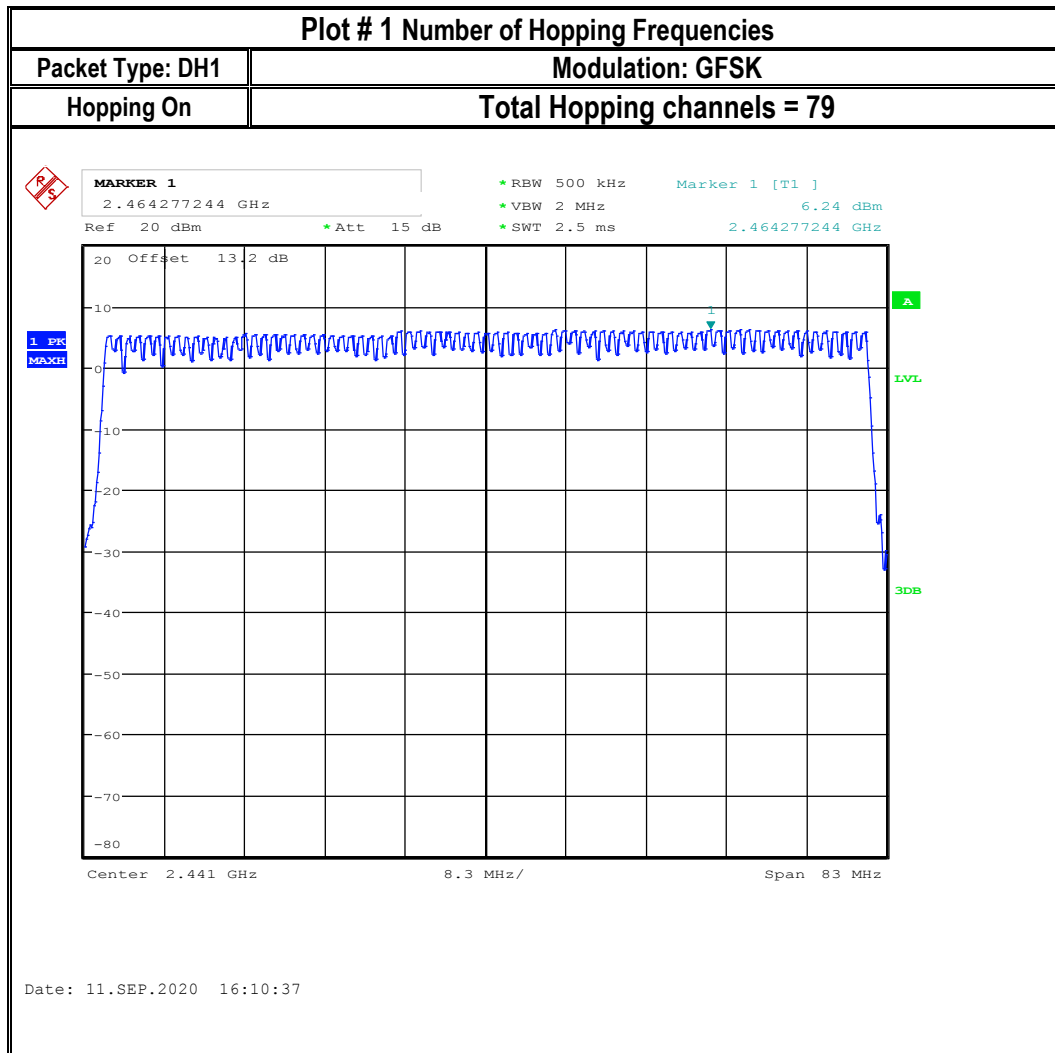
8.6.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	GFSK hopping	5 VDC

8.6.4 Measurement result:

Plot #	Number of Hopping Frequencies	Limit	Result
1	79	15 non-overlapping channels	Pass

8.6.5 Measurement Plots:



8.7 Time of Occupancy (Dwell Time)

8.7.1 Measurement according to ANSI C63.10 Section 7.8.4

Spectrum Analyzer settings:

Duration of Pulse Measurement

- RBW = 1 MHz
- VBW = 3 MHz
- Span = Zero Span
- Sweep Time = 10 ms
- Sweep Mode = Single
- Detector = Peak
- Trigger = Video

Observation Period

- RBW = 1 MHz
- VBW = 3 MHz
- Span = Zero Span
- Sweep Time = 31.6 s
- Sweep Mode = Single
- Detector = Peak
- Trigger = Free Run

Observation Period = 0.4s x No. of hopping channels = 0.4 x 79 = 31.6 s

8.7.2 Limits: FCC §15.247(a)(1)(iii) & RSS-247 5.1(d)

FCC §15.247(a)(1)(iii) & RSS-247:

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

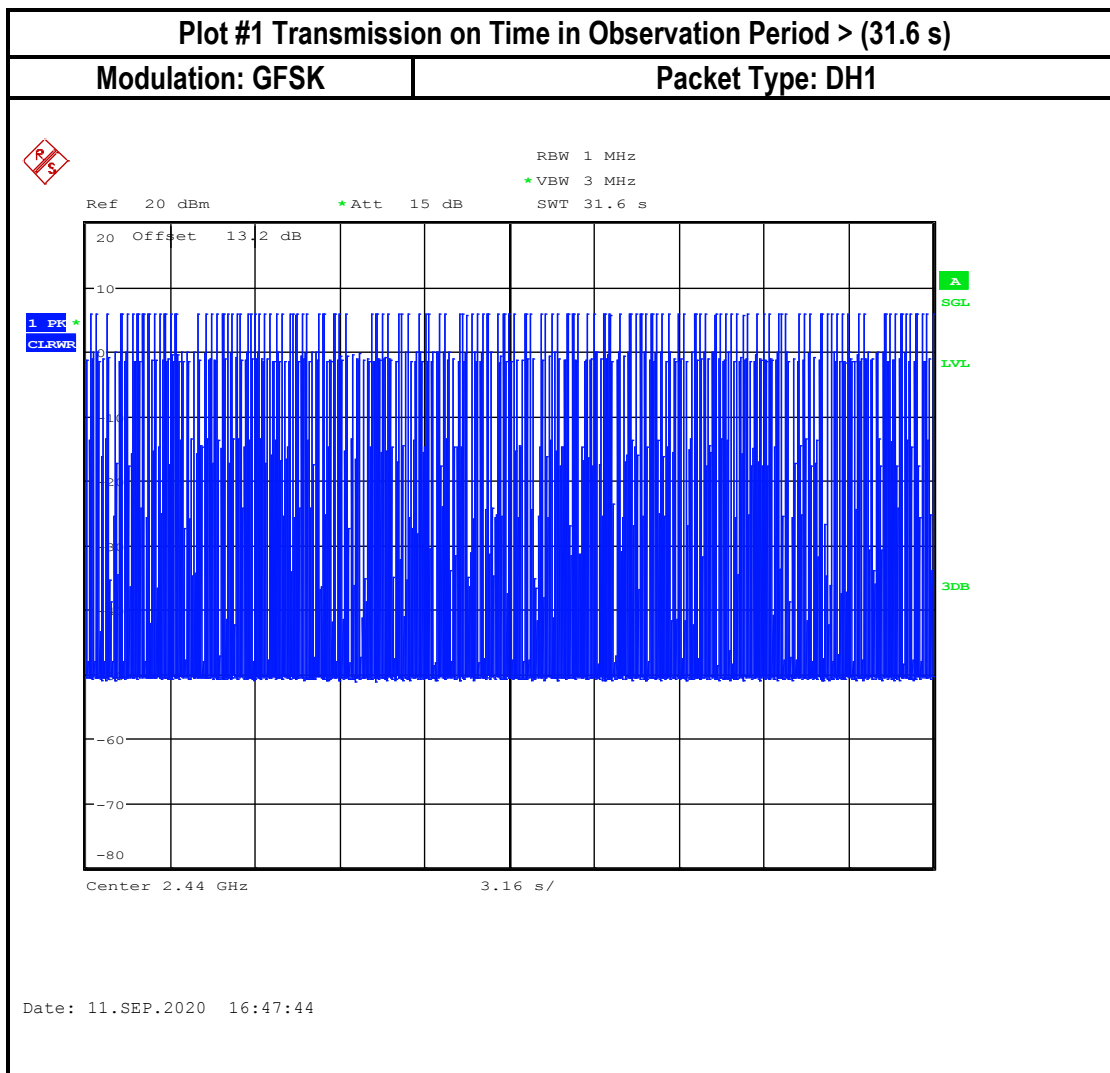
8.7.3 Test conditions and setup:

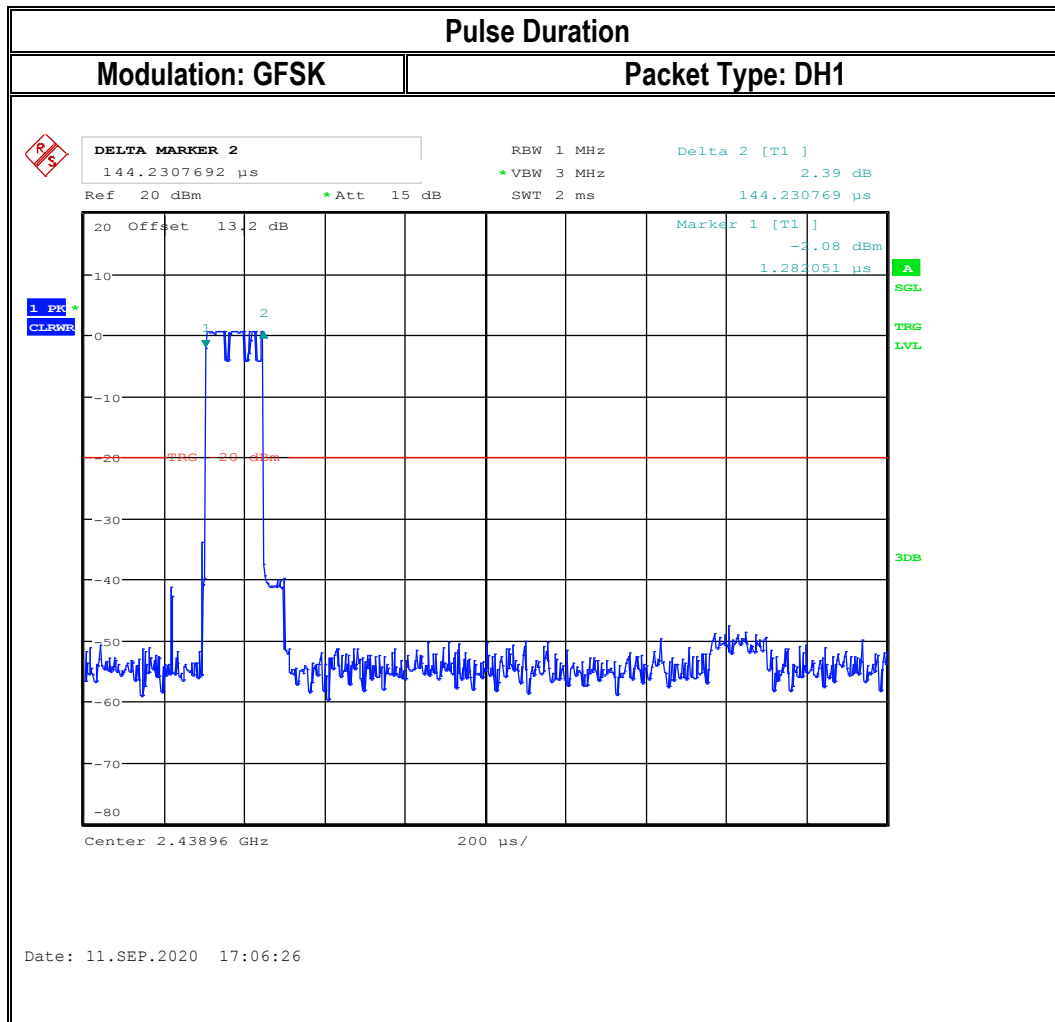
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	GFSK hopping	5 VDC

8.7.4 Measurement result:

Plot #	Modulation	Timing	Number of hops 31.6s	Pulse Width (ms)	Total Dwell Time in 31.6s (ms)	Limit (ms)	Result
1	GFSK	DH1	165.000	0.144	23.76	< 400 in 31.6s	Pass

8.7.5 Measurement Plots:





8.8 Transmitter Spurious Emissions and Restricted Bands

8.8.1 Measurement according to ANSI C63.10

Analyzer Settings:

- Frequency = 9 KHz – 30 MHz
- RBW = 9 KHz
- Detector = Peak

- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW = 120 KHz (<1 GHz)

- Frequency > 1 GHz
- Detector = Peak / Average
- RBW = 1MHz

- Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements.
- The highest (or worst-case) data rate shall be recorded for each measurement.
- For testing frequencies below 30 MHz at distance other than the specified in the standard, the limit conversion is calculated by using the FCC materials for the ANSI 63 committee issued on January, 27 1991.

8.8.2 Limits: FCC 15.247(d)/15.209(a) /RSS-Gen 6.13

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

- 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)).
- PEAK LIMIT= 74dB μ V/m
- AVG. LIMIT= 54dB μ V/m
- Except as shown in CFR 47 Part 15.205 paragraph (d), only spurious emissions are permitted in any of the frequency bands listed below

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

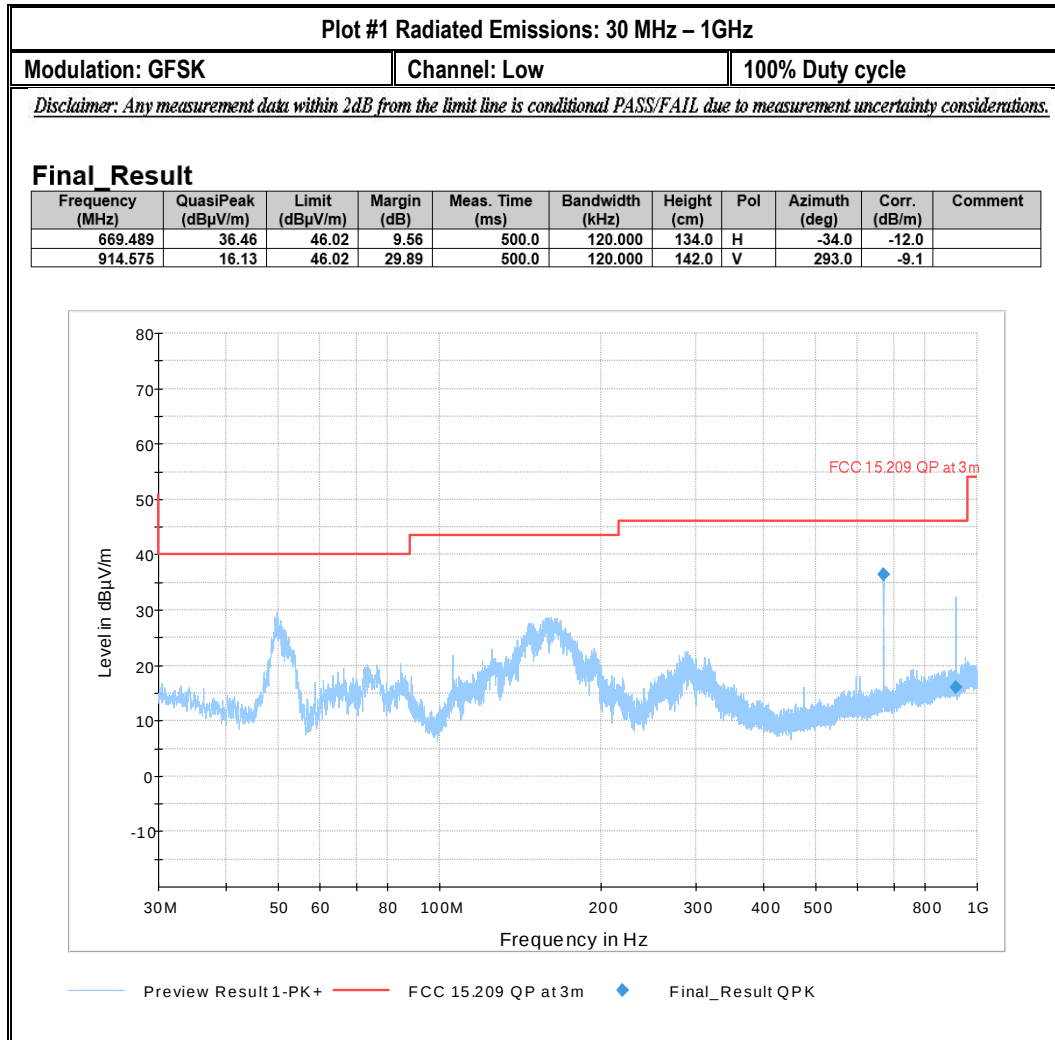
8.8.3 Test conditions and setup:

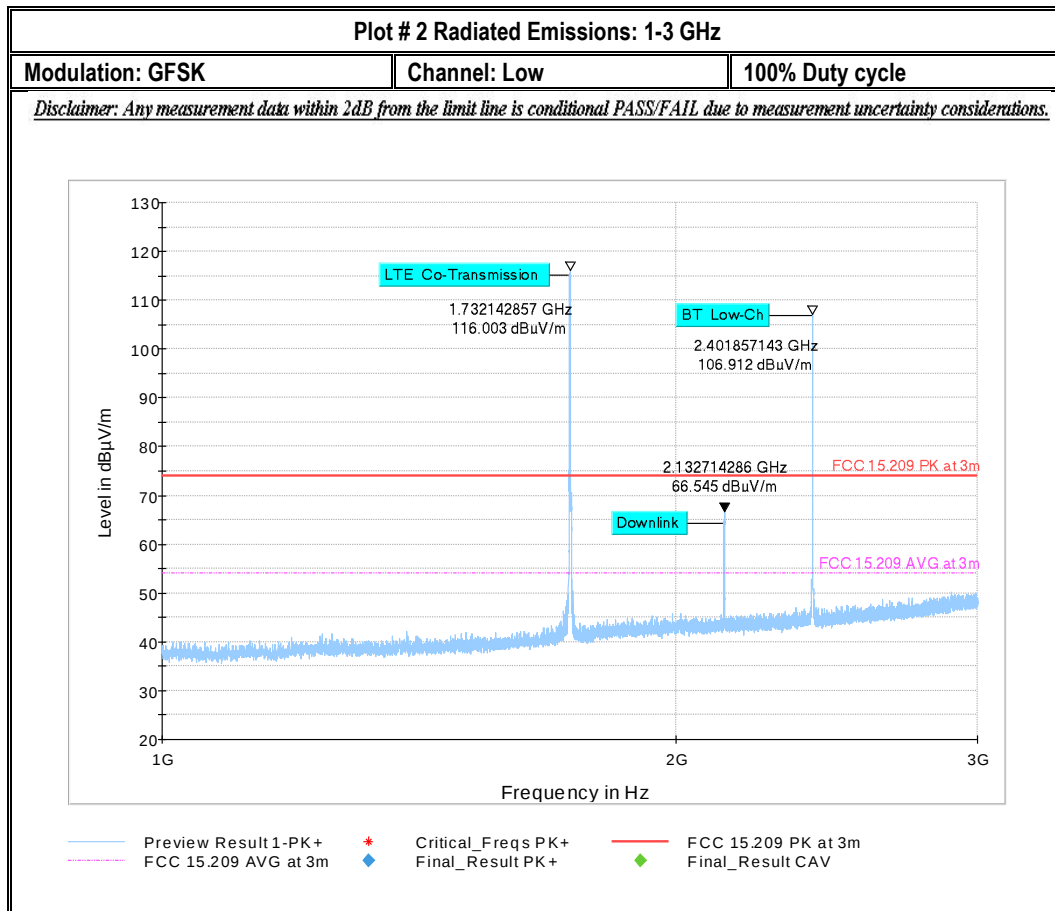
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	GFSK fixed channel	5 VDC

8.8.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
1-3	Low	30 MHz – 18 GHz	See section 8.8.2	Pass
4-8	Mid	9 kHz – 26 GHz	See section 8.8.2	Pass
9-11	High	30 MHz – 18 GHz	See section 8.8.2	Pass

8.8.5 Measurement Plots:





Plot # 3 Radiated Emissions: 3-18 GHz

Modulation: GFSK

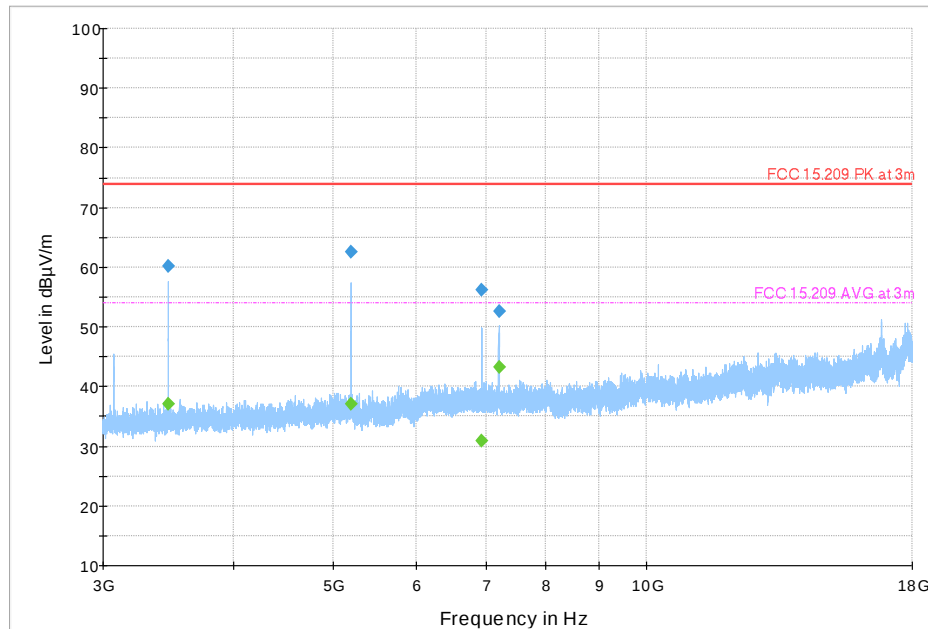
Channel: Low

100% Duty cycle

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

Final Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
3466.750	---	37.03	53.98	16.95	500.0	1000.000	100.0	V	170.0	-8.2	
3466.750	60.17	---	73.98	13.81	500.0	1000.000	100.0	V	170.0	-8.2	
5198.750	62.61	---	73.98	11.37	500.0	1000.000	245.0	V	106.0	-4.4	
5198.750	---	37.17	53.98	16.81	500.0	1000.000	245.0	V	106.0	-4.4	
6930.000	---	30.93	53.98	23.05	500.0	1000.000	133.0	H	28.0	-0.7	
6930.000	56.26	---	73.98	17.72	500.0	1000.000	133.0	H	28.0	-0.7	
7205.250	62.61	---	73.98	21.37	500.0	1000.000	142.0	H	106.0	-1.1	
7205.250	---	43.28	53.98	10.70	500.0	1000.000	142.0	H	106.0	-1.1	



◆ Preview Result 1-PK+ — FCC 15.209 PK at 3m - - - FCC 15.209 AVG at 3m
◆ Final_Result PK+ ◆ Final_Result CAV

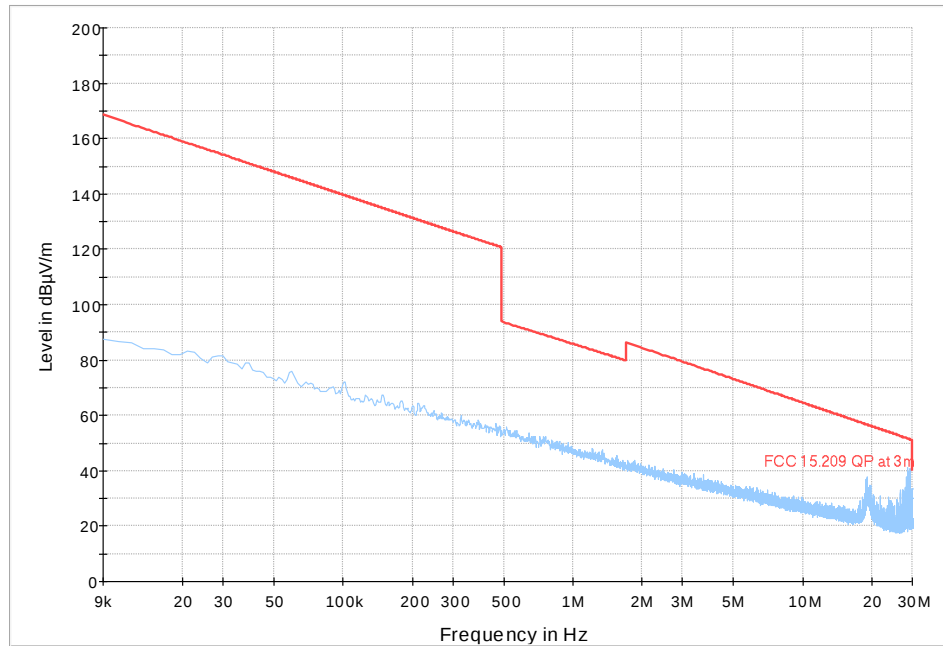
Plot # 4 Radiated Emissions: 9 KHz - 30 MHz

Modulation: GFSK

Channel: Mid

100% Duty cycle

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.



Preview Result 1-PK+ * Critical_Freqs PK+ FCC 15.209 QP at 3m Final_Result QP I

Plot #5 Radiated Emissions: 30 MHz – 1GHz

Modulation: GFSK

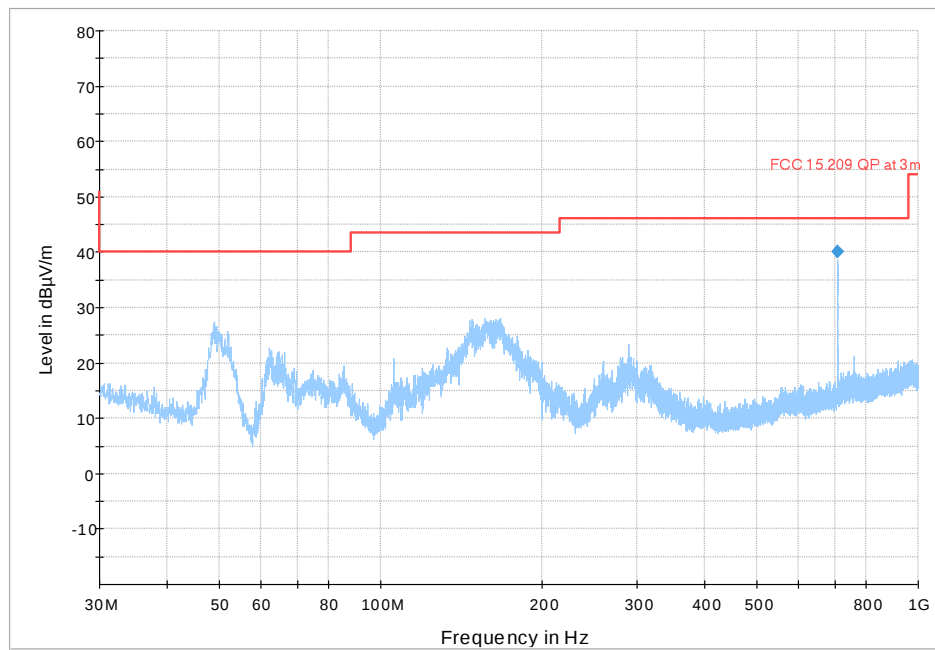
Channel: Mid

100% Duty cycle

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

Final Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
707.157	40.07	46.02	5.95	500.0	120.000	141.0	H	335.0	-11.8	



— Preview Result 1-PK+ — FCC 15.209 QP at 3m ◆ Final_Result QPK

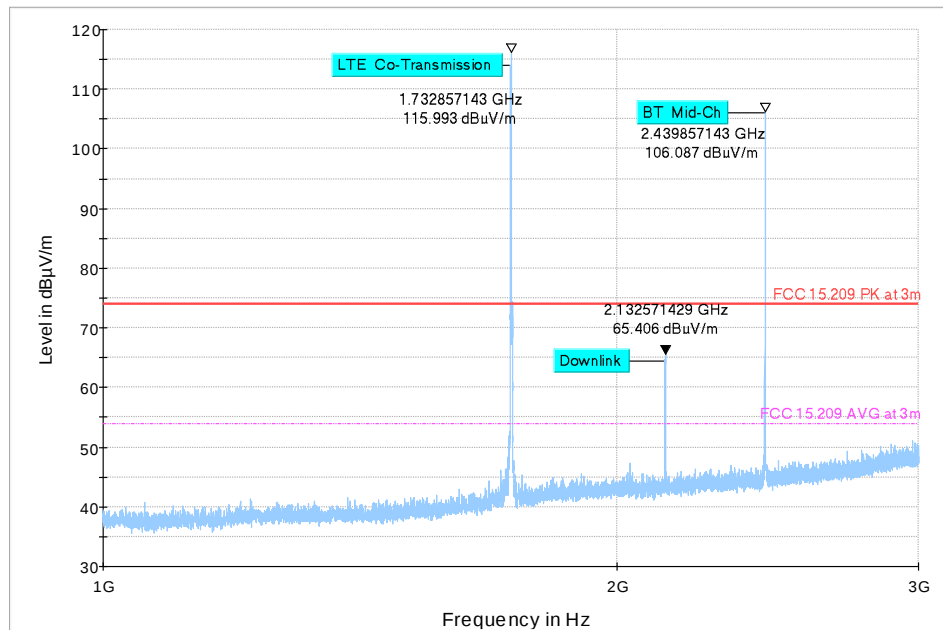
Plot #6 Radiated Emissions: 1-3 GHz

Modulation: GFSK

Channel: Mid

100% Duty cycle

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.



Preview Result 1-PK+ * Critical_Freqs PK+ FCC 15.209 PK at 3m
FCC 15.209 AVG at 3m ◆ Final_Result PK+ ◆ Final_Result CAV

Plot #7 Radiated Emissions: 3-18 GHz

Modulation: GFSK

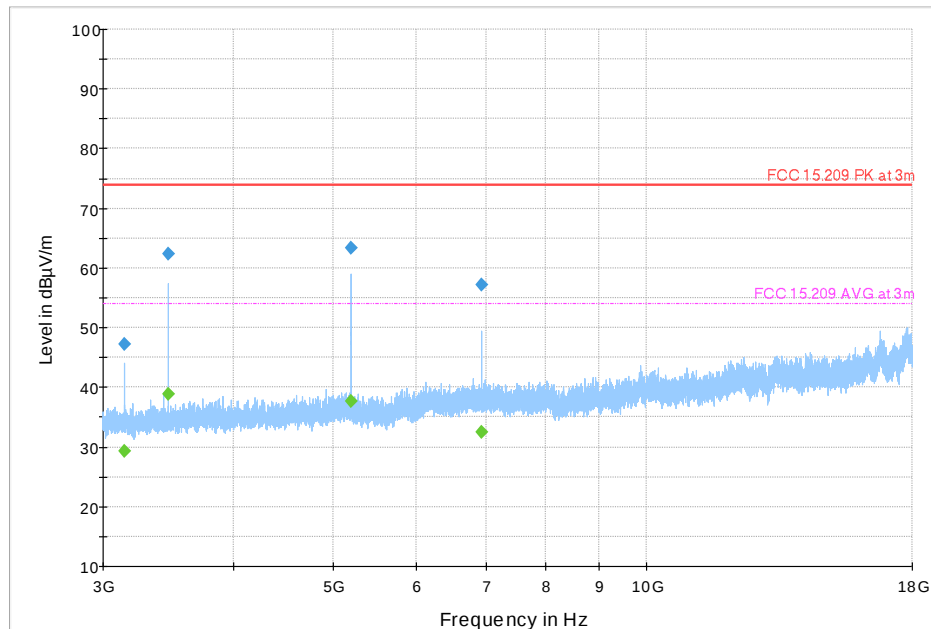
Channel: Mid

100% Duty cycle

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

Final Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
3147.250	---	29.27	53.98	24.71	500.0	1000.000	145.0	H	210.0	-9.2	
3147.250	47.19	---	73.98	26.79	500.0	1000.000	145.0	H	210.0	-9.2	
3465.750	62.44	---	73.98	11.54	500.0	1000.000	287.0	V	186.0	-8.2	
3465.750	---	38.84	53.98	15.14	500.0	1000.000	287.0	V	186.0	-8.2	
5198.750	---	37.62	53.98	16.36	500.0	1000.000	100.0	V	179.0	-4.4	
5198.750	63.27	---	73.98	10.71	500.0	1000.000	100.0	V	179.0	-4.4	
6931.500	57.17	---	73.98	16.81	500.0	1000.000	125.0	H	222.0	-0.7	
6931.500	---	32.47	53.98	21.51	500.0	1000.000	125.0	H	222.0	-0.7	



◆ Preview Result 1-PK+ — FCC 15.209 PK at 3m — FCC 15.209 AVG at 3m
◆ Final_Result CAV — Final_Result PK+

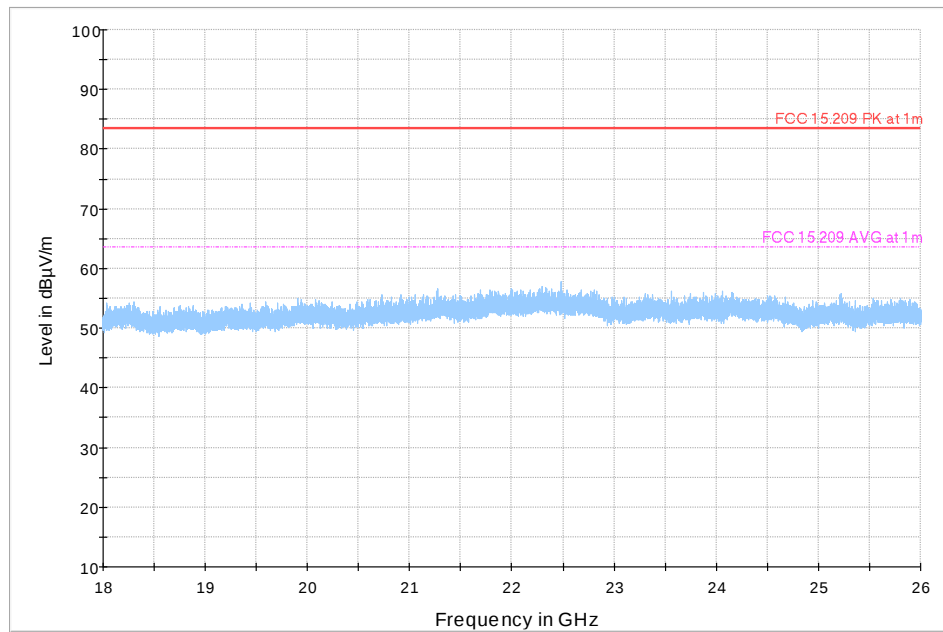
Plot #8 Radiated Emissions: 18-26 GHz

Modulation: GFSK

Channel: Mid

100% Duty cycle

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.



Preview Result 1-PK+ * Critical_Freqs PK+ FCC 15.209 PK at 1m
FCC 15.209 AVG at 1m ◆ Final_Result PK+ ◆ Final_Result CAV

Plot #9 Radiated Emissions: 30 MHz – 1GHz

Modulation: GFSK

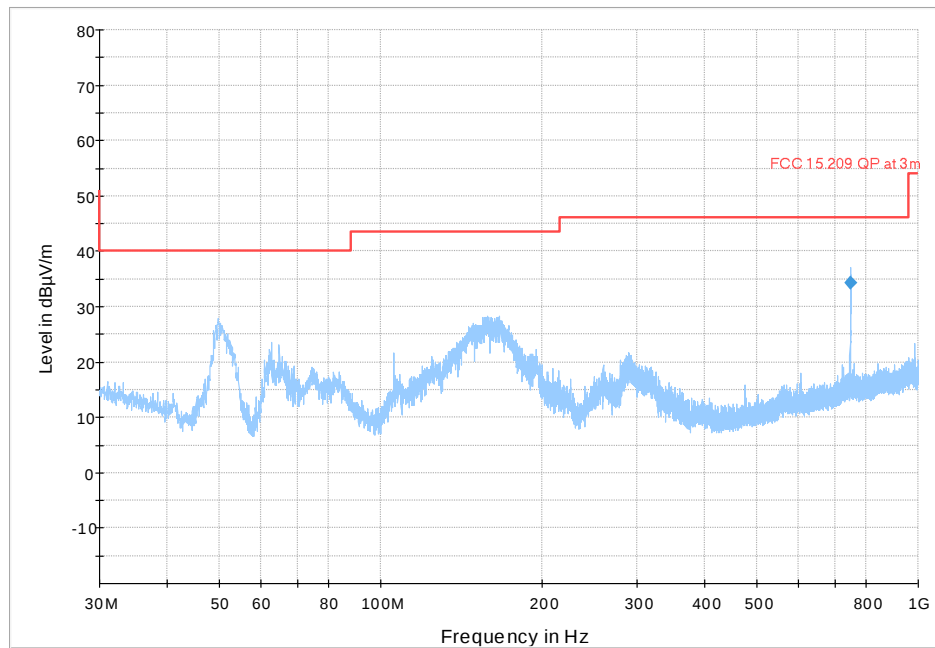
Channel: High

100% Duty cycle

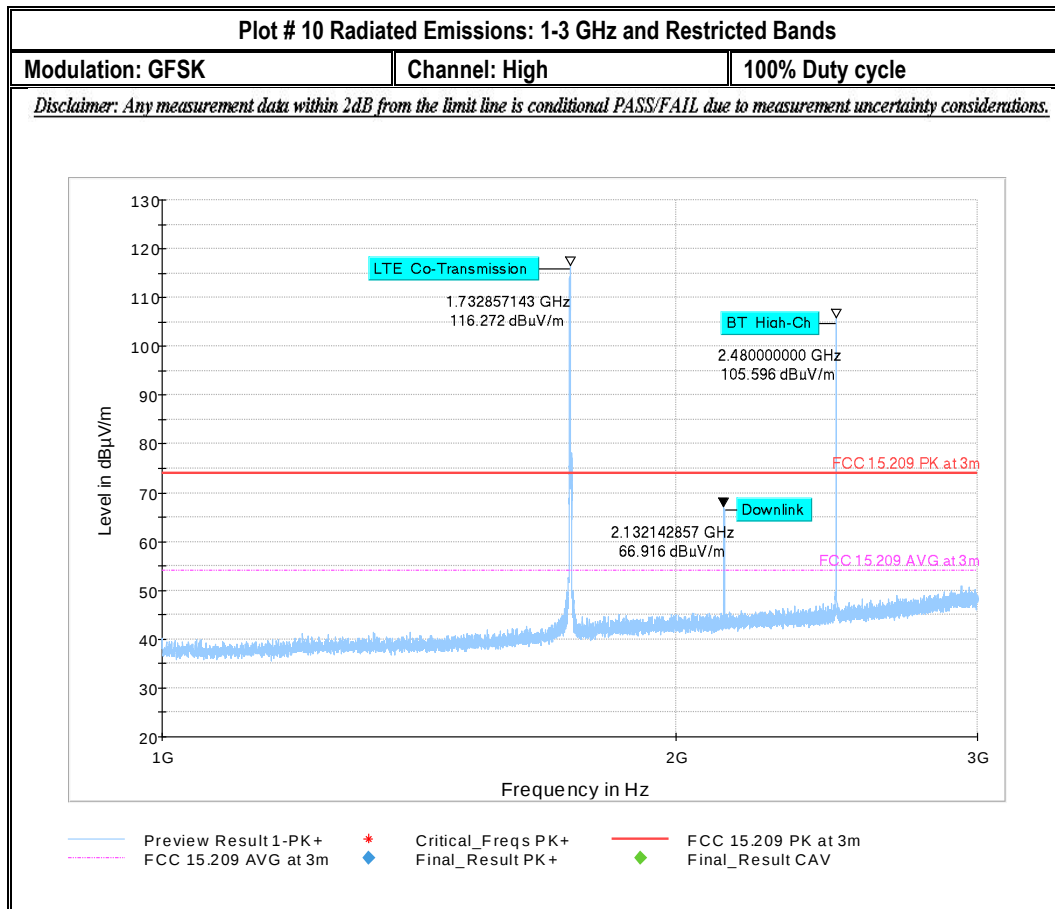
Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

Final Result

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
746.895	34.30	46.02	11.72	500.0	120.000	107.0	H	10.0	-10.9	



Preview Result 1-PK+ FCC 15.209 QP at 3m Final_Result QPK



Plot #11 Radiated Emissions: 3-18 GHz

Modulation: GFSK

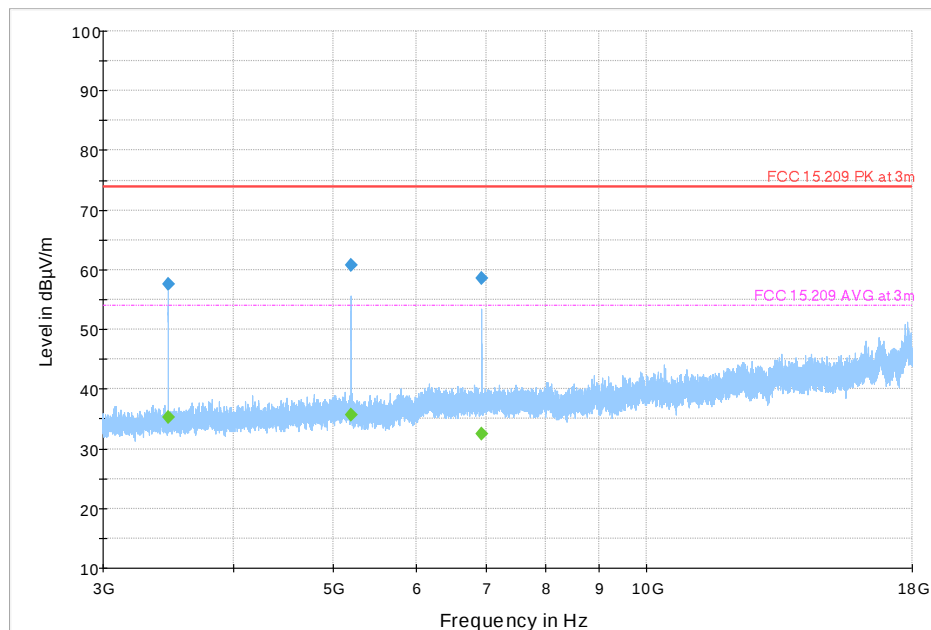
Channel: High

100% Duty cycle

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

Final Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
3465.750	57.58	---	73.98	16.40	500.0	1000.000	134.0	H	154.0	-8.2	
3465.750	---	35.21	53.98	18.77	500.0	1000.000	134.0	H	154.0	-8.2	
5198.500	60.75	---	73.98	13.23	500.0	1000.000	141.0	H	-10.0	-4.4	
5198.500	---	35.78	53.98	18.20	500.0	1000.000	141.0	H	-10.0	-4.4	
6931.250	---	32.50	53.98	21.48	500.0	1000.000	117.0	H	224.0	-0.7	
6931.250	58.60	---	73.98	15.38	500.0	1000.000	117.0	H	224.0	-0.7	



◆ Preview Result 1-PK+ — FCC 15.209 PK at 3m --- FCC 15.209 AVG at 3m
◆ Final Result PK+ ◆ Final Result CAV

8.9 AC Power Line Conducted Emissions

8.9.1 Measurement according to ANSI C63.4

Analyzer Settings:

- RBW = 9 KHz (CISPR Bandwidth)
- Pre-scan Detector = Peak / Average for
- Final Measurements Detector = Quasi-Peak / Average

8.9.2 Limits: FCC 15.207 & RSS-Gen 8.8

(a) Except as shown in paragraphs (b) and (c) of this section of the CFR, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table (1), as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between frequency ranges.

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	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.

8.9.3 Test conditions and setup:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power line (L1, L2, L3, N)	Power Input
22	1	GFSK continuous fixed channel	Line & Neutral	110 V / 60 Hz

8.9.4 Measurement Result:

Plot #	Port	EUT Set-Up #	EUT operating mode	Scan Frequency	Limit	Result
1	AC Mains	1	GFSK continuous fixed channel	150 kHz – 30 MHz	See section 8.8.2	Pass

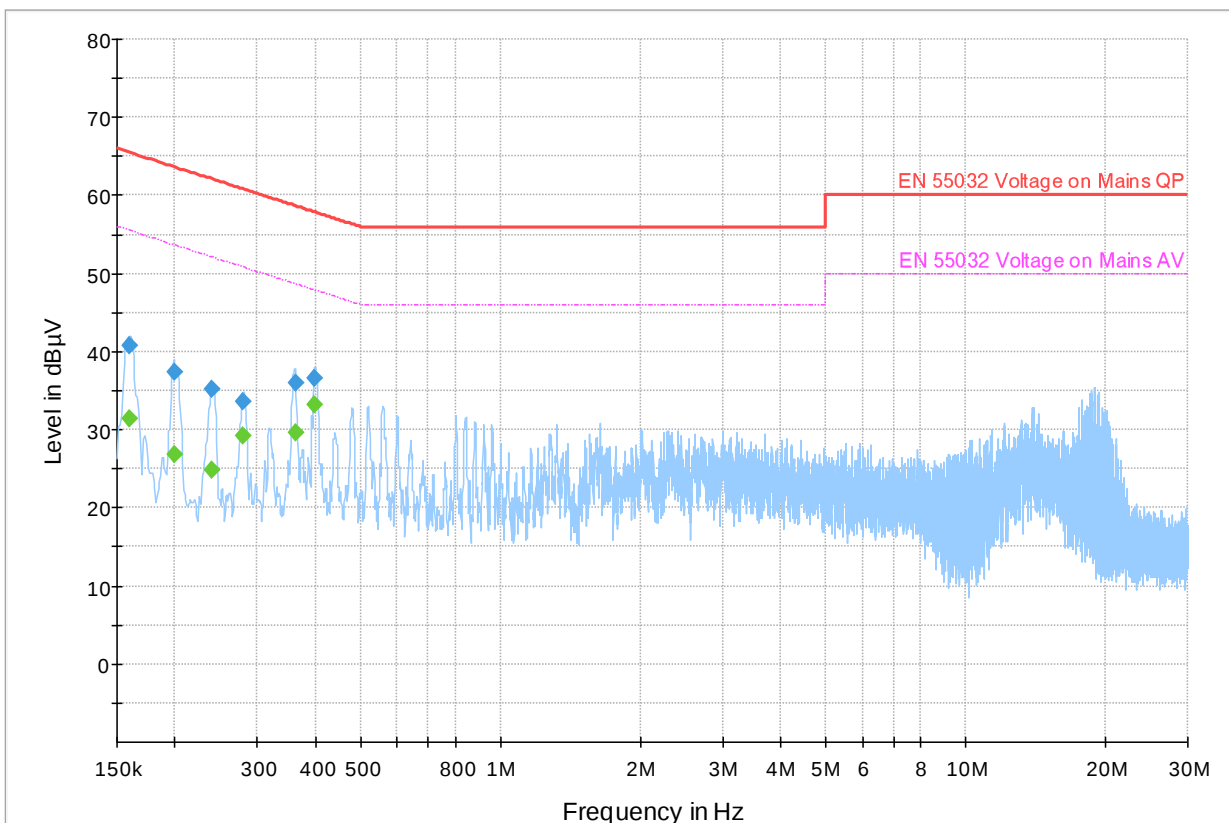
8.9.5 Measurement Plots:

Plot # 1

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

Final_Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)	Comment
0.160	---	31.46	55.49	24.03	500.0	9.000	N	GND	10.4	
0.160	40.74	---	65.49	24.74	500.0	9.000	N	GND	10.4	
0.199	---	26.91	53.65	26.74	500.0	9.000	N	GND	10.2	
0.199	37.47	---	63.65	26.18	500.0	9.000	N	GND	10.2	
0.241	35.11	---	62.08	26.97	500.0	9.000	N	GND	10.2	
0.241	---	24.92	52.08	27.16	500.0	9.000	N	GND	10.2	
0.280	---	29.25	50.81	21.56	500.0	9.000	L1	GND	10.1	
0.280	33.59	---	60.81	27.23	500.0	9.000	L1	GND	10.1	
0.362	---	29.67	48.68	19.01	500.0	9.000	L1	GND	10.0	
0.362	35.91	---	58.68	22.76	500.0	9.000	L1	GND	10.0	
0.399	36.50	---	57.87	21.36	500.0	9.000	L1	GND	10.0	
0.399	---	33.26	47.87	14.60	500.0	9.000	L1	GND	10.0	



◆ Preview Result 1-PK+ Final_Result QPK
 ◆ EN 55032 Voltage on Mains QP Final_Result CAV
 --- EN 55032 Voltage on Mains AV

9 Test setup photos

Setup photos are included in supporting file name: "EMC_GARMI-077-20001_Setup_Photos_R1.pdf"

10 Test Equipment And Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
ACTIVE LOOP ANTENNA	ETS LINDGREN	6507	00161344	3 YEARS	10/26/2017
BILOG ANTENNA	TESEO	CBL 6141B	41106	3 YEARS	11/01/2017
HORN ANTENNA	ETS.LINDGREN	3115	00035111	3 YEARS	04/17/2019
HORN ANTENNA	ETS LINDGREN	3117	00169547	3 YEARS	09/01/2020
HORN ANTENNA	ETS LINDGREN	3116C	00169535	3 YEARS	09/24/2017
WIDEBAND RADIO COMMUNICATION	R&S	CMW500	109825	3 YEARS	02/12/2018
SIGNAL ANALYZER	R&S	FSV 40	101022	2 YEARS	07/15/2019
COMPACT DIGITAL BAROMETER	CONTROL COMPANY	10510-922	200236891	3 YEARS	04/13/2020
DIGITAL THRMOMETER	CONTROL COMPANY	36934-164	191871994	2 YEARS	01/10/2019
LINE IMPEDANCE STABILIZATION NETWORK	FCC	FCC-LISN-50-25-2-08	08014	3 YEARS	07/19/2019

Note: Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels. Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.

11 Revision History

Date	Template Revision	Changes to report	Prepared by
2020-10-20	EMC_GARMI-077-20001_15.247_BT_DSS	Initial Version	Yuchan Lu
2020-11-19	EMC_GARMI-077-20001_15.247_BT_DSS_R1	Changed Marketing name to "N/A"; Changed the client's and manufacture's addresses; Removed the WLAN FCC and IC IDs.	Yuchan Lu

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