NVLAP®
Testing
NVLAP Lab Code 200087-0

Application For
Grant of Certification

FOR

Model: A03568
2402-2480 MHz (DTS)
Broadband Digital Transmission System
FCC ID: IPH-03568
IC: 1792A-03568

FOR

Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062

FCC Designation: US5305
IC Test Site Registration: 3041A-1

Test Report Number: 180910

Authorized Signatory: Scot D Rogers
Scot D. Rogers

NVLAP
Testing
NVLAP Lab Code 200087-0

ROGERS LABS, INC.

4405 West 259th Terrace
Louisburg, KS 66053
Phone / Fax (913) 837-3214

Engineering Test Report For Grant of Certification Application

FOR

47 CFR, PART 15C - Intentional Radiators
47 CFR Paragraph 15.247 and
Industry Canada RSS-GEN and RSS-247
License Exempt Intentional Radiator

For

Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062

Digital Transmission System
Model: A03568

Frequency Range 2402-2480 MHz
FCC ID: IPH-03568
IC: 1792A-03568

Test Date: September 10, 2018

Certifying Engineer: Scot D Rogers

Scot D. Rogers
Rogers Labs, Inc.
4405 West 259th Terrace
Louisburg, KS 66053
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Revisions

Revision 2 Issued February 26, 2019 – text edit pages 7 and 9
Revision 1 Issued November 19, 2018

Foreword

The following information is submitted for consideration in obtaining Grant of Certification for License Exempt Digital Transmission System Intentional Radiator operating under Code of Federal Regulations Title 47 (47 CFR) Paragraph 15.247 and Industry Canada RSS-GEN, Issue 5 and RSS-247 Issue 2, operation in the 2400 – 2483.5 MHz band.

Name of Applicant: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

M/N: A03568

FCC ID: IPH-03568 Industry Canada ID: 1792A-03568

Frequency Range: 2402-2480 MHz

Power and OBW:

Digital Modulation

Mode1 (GFSK) output power Peak 0.027 W, Average 0.021, (99% Occupied 923.1 kHz)

Mode2 (GFSK) output power Peak 0.027 W, Average 0.020, (99% Occupied 927.9 kHz)

Mode3 (π/4-DQPSK) output power Peak 0.015 W, Average 0.011, (99% Occupied 1290.1 kHz)

Mode4 (GMSK) output power Peak 0.026 W, Average 0.023, (99% Occupied 1097.8 kHz)

802.11b/g/n

Mode5 802.11b output power Peak 0.192 W, Average 0.018, (99% Occupied 13,942 kHz)

Mode6 802.11g output power Peak 0.151 W, Average 0.021, (99% Occupied 17,692 kHz)

Mode7 802.11n output power Peak 0.147 W, Average 0.022, (99% Occupied 18,269 kHz)

Opinion / Interpretation of Results

Tests Performed	Margin (dB)	Results
Emissions 15.205, RSS-GEN	-5.2	Complies
Emissions as per 47 CFR paragraphs 2 and 15.207	-10.0	Complies
Emissions as per 47 CFR paragraphs 2 and 15.209	-12.9	Complies
Harmonic Emissions per 47 CFR 15.247	-4.5	Complies
Power Spectral Density per 47 CFR 15.247	-1.0	Complies

Equipment Tested

Equipment	Model / PN	Serial Number
EUT	A03568	39765 17451
EUT#2	A03568	39765 18030
USB cable	320-01143-00	N/A
Laptop Computer	Latitude E6320	FCN03Q1
USB Printer	Dell 0N5819	5D1SL61
AC Adapter	362-00091-00	N/A
AC Adapter	362-00087-00	N/A
DC Adapter (CLA)	013-00434-00	N/A
DC Power Supply	BK 1745A	209C13

Test results in this report relate only to the items tested

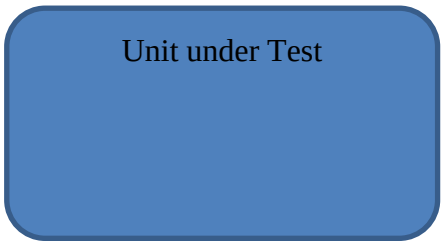
Equipment Function

The EUT is a body worn portable digital device. The device incorporates sensors to log movement and other functions and includes transmitter functions for communication with compatible equipment. The design provides a single unique connections point for use of the USB interface cable and offers no other interface options as presented below in the configuration diagrams. The transmitters provide operation capability across the 2402-2480 MHz frequency band. The design provides wireless communications with compatible GFSK, GMSK, π/4-DQPSK, and 802.11b/g/n equipment. The product operates from internal rechargeable battery only and requires battery recharge through provided USB interface cable and compatible USB power source. The design utilizes internal fixed antenna system and offers no provision for antenna replacement or modification. Two samples were provided for testing, one representative of production design, and the other modified for testing purposes replacing the integral antennas with RF connection port. The test samples were provided with test software (version 0.22 with Tx ver 2.87) enabling testing personnel the ability to enable transmitter functions on defined modulations and channels. The antenna modification offered testing facility the ability to connect test equipment to the temporary antenna port for antenna port conducted emission testing. The EUT was arranged as described by the manufacturer emulating typical user configurations for testing purposes. For testing purposes, the EUT received powered from freshly charged internal battery and configured to operate in available modes. As requested by the manufacturer and required by regulations, the equipment was tested for compliance using the available configurations with the worst-case data presented. The test software enabled extremely high duty cycles for testing purposes. The production product will not operate at these high of duty cycles as battery life is depleted. This report documents the performed testing and results for applicable configurations and product modes of operation. Test results in this report relate only to the products described in this report.

The design provides wireless communications in many modes. Operational modes referenced in this report include: mode 1 (GFSK), mode 2 (GFSK), mode 3 (π/4 DQPSK), mode 4 (GMSK), mode 5 802.11b, mode 6 802.11g, and mode 7 802.11n, providing wireless interface capabilities with compatible equipment.

Equipment Configuration

1) Unit operating off internal battery



2) Unit connected to Computer USB port through cable assembly (GPN: 320-01143-00)

3) Unit connected to AC Adapter (362-00091-00) through cable assembly (GPN: 320-01143-00)

4) Unit connected to AC Adapter (362-00087-00) through cable assembly (GPN: 320-01143-00)

5) Unit connected to DC Adapter (013-00434-00) through cable assembly (GPN: 320-01143-00)

6) Transmitting data through wireless 2.4 GHz communication and power from internal battery

Application for Certification

(1) Manufacturer: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

(2) Identification: M/N: A03568
FCC ID: IPH-03568 IC: 1792A-03568

(3) Instruction Book:
Refer to Exhibit for Instruction Manual.

(4) Description of Circuit Functions:
Refer to Exhibit of Operational Description.

(5) Block Diagram with Frequencies:
Refer to Exhibit of Operational Description.

(6) Report of Measurements:
Report of measurements follows in this Report.

(7) Photographs: Construction, Component Placement, etc.:
Refer to Exhibit for photographs of equipment.

(8) List of Peripheral Equipment Necessary for operation. The equipment operates from internal rechargeable Li-Ion battery and provides unique connector for use with associated USB interface cable. The EUT provides cable and wireless communication options as documented and presented in this filing.

(9) Transition Provisions of 47 CFR 15.37 are not requested.

(10) Not Applicable. The unit is not a scanning receiver.

(11) Not Applicable. The EUT does not operate in the 59 – 64 GHz frequency band.

(12) The equipment is not software defined and this section is not applicable.

(13) Applications for certification of U-NII devices in the 5.15-5.35 GHz and the 5.47-5.85 GHz bands must include a high-level operational description of the security procedures that control the radio frequency operating parameters and ensure that unauthorized modifications cannot be made. This requirement is not applicable to his DTS device.

(14) Contain at least one drawing or photograph showing the test set-up for each of the required types of tests applicable to the device for which certification is requested. These drawings or photographs must show enough detail to confirm other information contained in the test report. Any photographs used must be focused originals without glare or dark spots and must clearly show the test configuration used. This information is provided in this report and Test Setup Exhibits provided with the application filing.

Applicable Standards & Test Procedures

The following information is submitted in accordance with the eCFR Federal Communications Code of Federal Regulations, dated September 10, 2018, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, and applicable parts of paragraph 15, Part 15C Paragraph 15.247, and Industry Canada RSS-GEN Issue 5, and RSS-247 Issue 2. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in ANSI C63.10-2013. This report documents compliance for the EUT operations as Digital Transmission system equipment.

Testing Procedures

AC Line Conducted Emission Test Procedure

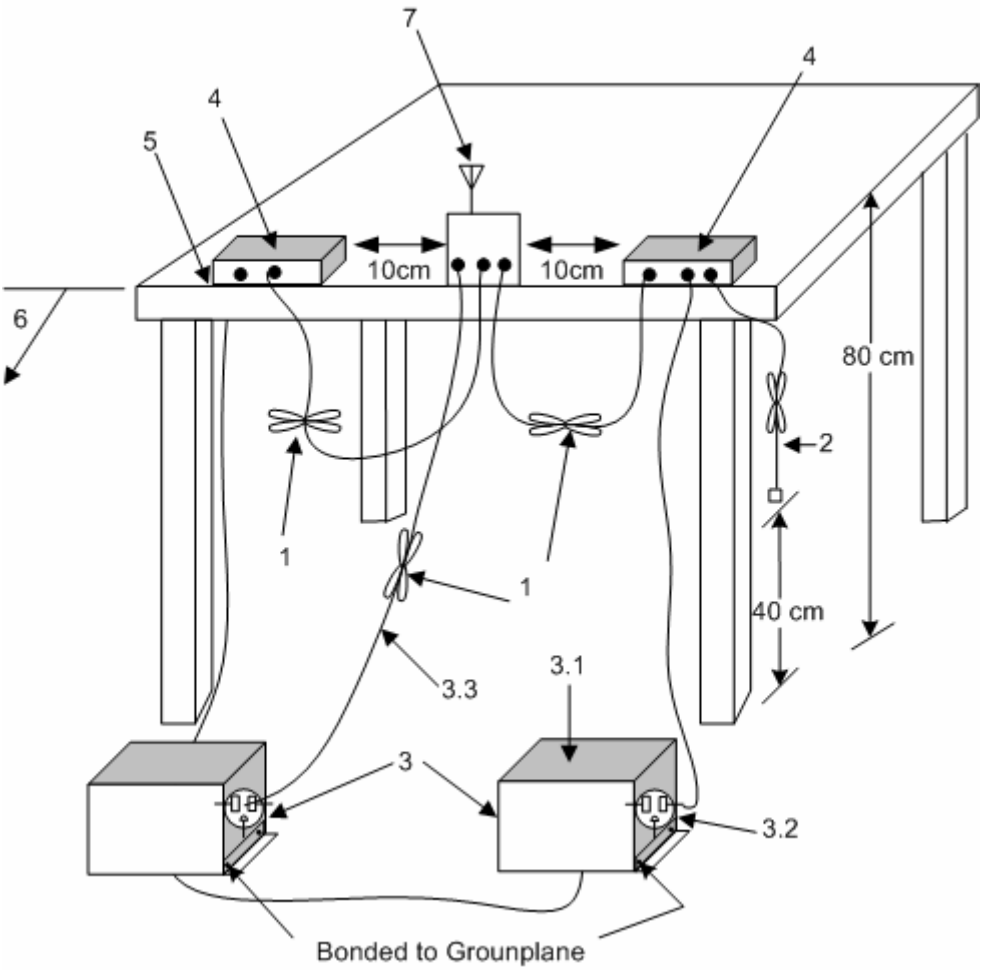
Testing for the AC line-conducted emissions was performed as required in 47CFR 15C, RSS-247 and specified in ANSI C63.10-2013. The test setup, including the EUT, was arranged in the test configurations as presented during testing. The test configuration was placed on a 1 x 1.5-meter bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50-µHy choke. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table. Refer to diagram one showing typical test arrangement and photographs in exhibits for EUT placement used during testing.

Radiated Emission Test Procedure

Radiated emissions testing was performed as required in 47 CFR 15, RSS-247 and specified in ANSI C63.10-2013. The EUT was placed on a rotating 0.9 x 1.2-meter platform, elevated as required above the ground plane at a distance of 3 meters from the FSM antenna. EMI energy was maximized by equipment placement permitting orientation in three orthogonal axes, raising and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before data was taken using a spectrum analyzer. The frequency spectrum from 9 kHz to 25,000 MHz was searched for during preliminary investigation. Refer to diagrams two and three showing typical test arrangement and photographs in the test setup exhibits for specific EUT placement during testing.

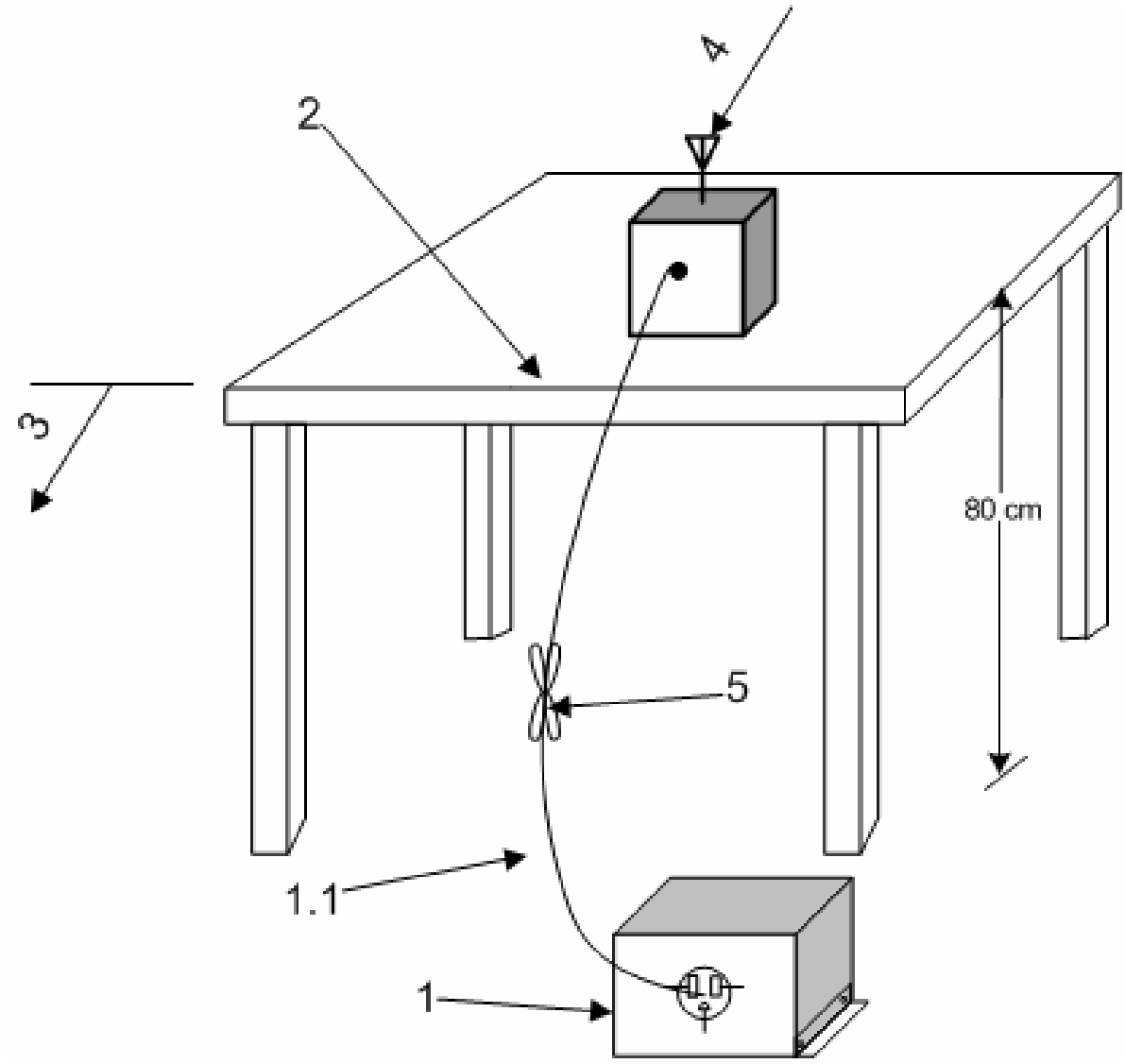
Antenna Port Conducted Emission Test Procedure

The EUT was assembled as required for operation and placed on a benchtop located in a shielded enclosure. This configuration provided the ability to connect test equipment to the provided test antenna port Antenna Port conducted emissions testing was performed as presented in the regulations and specified in ANSI C63.10-2013. The active antenna port of the device was connected to appropriate attenuation and test equipment including spectrum analyzer and/or power meter. Refer to diagram four showing typical test arrangement and photographs in the test setup exhibits for specific EUT placement during testing.



1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long see (see 6.2.3.1).
2. I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m (see 6.2.2).
3. EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3).
   3.1 All other equipment powered from additional LISN(s).
   3.2 Multiple-outlet strip can be used for multiple power cords of non-EUT equipment.
   3.3 LISN at least 80 cm from nearest part of EUT chassis.
4. Non-EUT components of EUT system being tested.
5. Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop (see 6.2.3.1).
6. Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane (see 6.2.2 for options).
7. Antenna may be integral or detachable. If detachable, the antenna shall be attached for this test.

Diagram 1 Test arrangement for Conducted emissions



1—A LISN is optional for radiated measurements between 30 MHz and 1000 MHz but not allowed for measurements below 30 MHz and above 1000 MHz (see 6.3.1). If used, then connect EUT to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. The LISN may be placed on top of, or immediately beneath, the reference ground plane (see 6.2.2 and 6.2.3.2).
1.1—LISN spaced at least 80 cm from the nearest part of the EUT chassis.
2—Antenna can be integral or detachable, depending on the EUT (see 6.3.1).
3—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long (see 6.3.1).
4—For emission measurements at or below 1 GHz, the table height shall be 80 cm. For emission measurements above 1 GHz, the table height shall be 1.5 m for measurements, except as otherwise specified (see 6.3.1 and 6.6.3.1).

Diagram 2 Test arrangement for radiated emissions of tabletop equipment

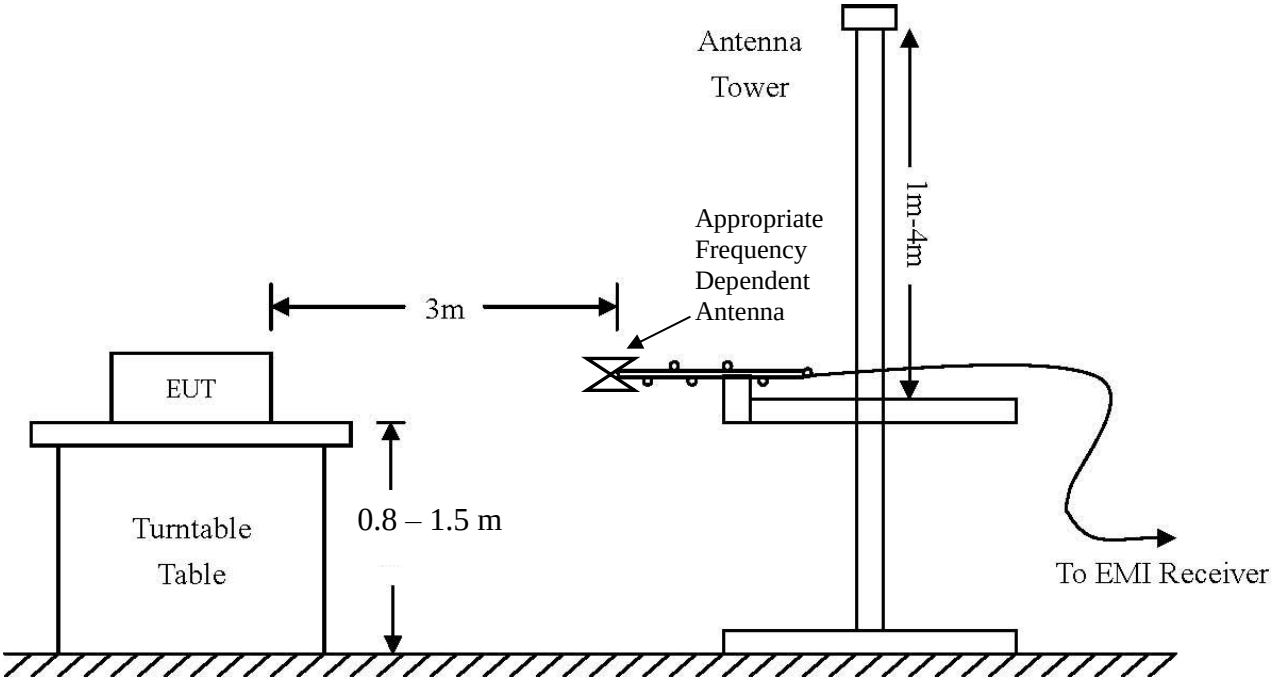


Diagram 3 Test arrangement for radiated emissions tested on Open Area Test Site (OATS)

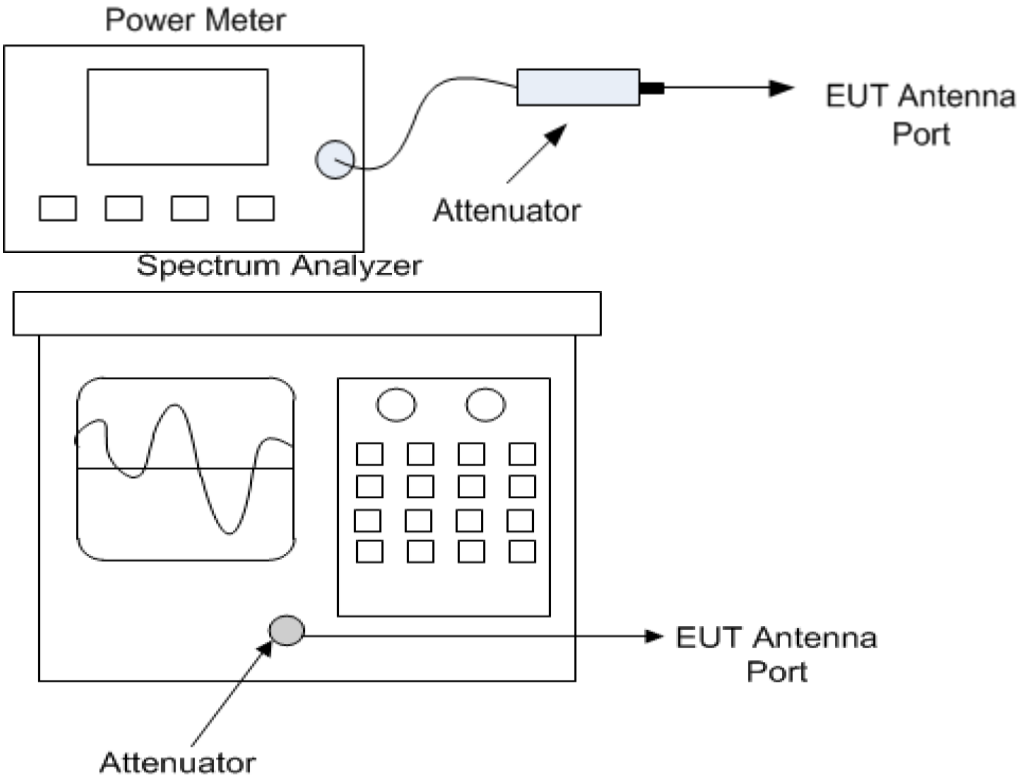


Diagram 4 Test arrangement for Antenna Port Conducted emissions

Test Site Locations

Conducted EMI	AC line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS
Radiated EMI	The radiated emissions tests were performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS
Registered Site #	FCC Site: US5305 and Industry Canada Registration: 3041A-1
NVLAP Accreditation	Lab code 200087-0

Units of Measurements

Conducted EMI	Data is in dBµV; dB referenced to one microvolt
Radiated EMI	Data is in dBµV/m; dB/m referenced to one microvolt per meter

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured
A.F. = Receive antenna factor, Gain = amplification gains and/or cable losses
RFS (dBµV/m @ 3m) = FSM (dBµV) + A.F. (dB) - Gain (dB)

Environmental Conditions

Ambient Temperature	22.4° C
Relative Humidity	48%
Atmospheric Pressure	1017.3 mb

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with the 47 CFR Part 15C, RSS-Gen, and RSS-247 emission requirements. There were no deviations to the specifications.

List of Test Equipment

Equipment	Manufacturer	Model (SN)	Band	Cal Date(m/d/y)	Due
☒ LISN	FCC	FCC-LISN-50-2-10(1PA) (160611)	.15-30MHz	5/2/2018	5/2/2019
☒ LISN	Compliance Design	FCC-LISN-2.Mod.cd,	.15-30MHz	10/24/2017	10/24/2018
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(L10M)(303073)	9kHz-40 GHz	10/24/2017	10/24/2018
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303069)	9kHz-40 GHz	10/24/2017	10/24/2018
☐ Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303071)	9kHz-40 GHz	10/24/2017	10/24/2018
☒ Cable	Belden	RG-58 (L1-CAT3-11509)	9kHz-30 MHz	10/24/2017	10/24/2018
☒ Cable	Belden	RG-58 (L2-CAT3-11509)	9kHz-30 MHz	10/24/2017	10/24/2018
☐ Antenna	ARA	BCD-235-B (169)	20-350MHz	10/24/2017	10/24/2018
☐ Antenna	EMCO	3147 (40582)	200-1000MHz	10/24/2017	10/24/2018
☒ Antenna	ETS-Lindgren	3117 (200389)	1-18 GHz	5/2/2018	5/2/2020
☐ Antenna	Com Power	AH-118 (10110)	1-18 GHz	10/24/2017	10/24/2019
☒ Antenna	Com Power	AH-840 (101046)	18-40 GHz	5/15/2017	5/15/2019
☒ Antenna	Com Power	AL-130 (121055)	.001-30 MHz	10/24/2017	10/24/2018
☒ Antenna	Sunol	JB-6 (A100709)	30-1000 MHz	10/24/2017	10/24/2018
☒ Analyzer	Rohde & Schwarz	ESU40 (100108)	20Hz-40GHz	5/2/2018	5/2/2019
☐ Analyzer	Rohde & Schwarz	ESW44 (101534)	20Hz-44GHz	12/22/2017	12/22/2018
☐ Analyzer	Rohde & Schwarz	FS-Z60, 90, 140, and 220	40GHz-220GHz	12/22/2017	12/22/2019
☐ Analyzer	HP	8591EM (3628A00871)	9kHz-1.8GHz	5/2/2018	5/2/2019
☐ Analyzer	HP	8562A (3051A05950)	9kHz-125GHz	5/2/2018	5/2/2019
☐ Analyzer	HP External Mixers	11571, 11970	25GHz-110GHz	5/2/2018	5/2/2019
☒ Amplifier	Com-Power	PA-010 (171003)	100Hz-30MHz	10/24/2017	10/24/2018
☒ Amplifier	Com-Power	CPPA-102 (01254)	1-1000 MHz	10/24/2017	10/24/2018
☒ Amplifier	Com-Power	PAM-118A (551014)	0.5-18 GHz	10/24/2017	10/24/2018
☒ Power Meter	Agilent	N1911A with N1921A	0.05-40 GHz	5/2/2018	5/2/2019
☐ Generator	Rohde & Schwarz	SMB100A6 (100150)	20Hz-6 GHz	5/2/2018	5/2/2019
☐ Generator	Rohde & Schwarz	SMBV100A6 (260771)	20Hz-6 GHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	BRC50722 (009).9G notch	30-1800 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	HPM50114 (017)1.5G HPF	30-18000 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	HPM50117 (063) 3G HPF	30-18000 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	HPM50105 (059) 6G HPF	30-18000 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	BRM50702 (172) 2G notch	30-1800 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	BRC50703 (G102) 5G notch	30-1800 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	BRC50705 (024) 5G notch	30-1800 MHz	5/2/2018	5/2/2019
☒ Attenuator	Mini-Circuits	VAT-3W2+ (1735)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1436)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-3W2+ (14362)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1445)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-3W2+ (14452)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-6W2+ (1438)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-6W2+ (1736)	30-6000 MHz	5/2/2018	5/2/2019
☒ Weather station	Davis	6312 (A70927D44N)		10/24/2017	10/24/2018

Intentional Radiators

The following information is submitted in support demonstration of compliance with the requirements of 47 CFR, Subpart C, paragraph 15.247 and Industry Canada RSS-247 and RSS-Gen the following information is submitted.

Antenna Requirements

The EUT incorporates integral antenna system and offers no provision for connection to alternate antenna system. The antenna connection point complies with the unique antenna connection requirements. There are no deviations or exceptions to the specification.

Restricted Bands of Operation

Spurious emissions falling in the restricted frequency bands of operation were measured at the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were investigated at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. Peak and average amplitudes of frequencies above 1000 MHz were compared to the required limits with worst-case data presented below. Test procedures of ANSI C63.10-2013 were used during testing. No other significant emission was observed which fell into the restricted bands of operation. Computed emission values consider the received radiated field strength, receive antenna correction factor, amplifier gain stage, and test system cable losses.

Table 1 Radiated Emissions in Restricted Frequency Bands Data (mode 1)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2390.0	46.6	N/A	34.0	45.1	N/A	32.6	54.0
2483.5	54.8	N/A	40.0	49.1	N/A	34.6	54.0
4804.0	50.5	N/A	42.2	46.3	N/A	39.2	54.0
4880.0	50.4	N/A	40.5	48.1	N/A	35.8	54.0
4960.0	50.2	N/A	41.6	98.3	N/A	37.6	54.0
7206.0	52.3	N/A	40.5	49.5	N/A	39.2	54.0
7320.0	56.8	N/A	48.8	53.2	N/A	41.7	54.0
7440.0	55.5	N/A	46.9	52.4	N/A	39.9	54.0
12010.0	56.0	N/A	43.3	54.6	N/A	41.3	54.0
12200.0	58.0	N/A	45.1	57.8	N/A	44.8	54.0
12400.0	57.9	N/A	44.6	57.7	N/A	44.7	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 2 Radiated Emissions in Restricted Frequency Bands Data (mode 2)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2390.0	45.6	N/A	33.0	44.2	N/A	31.3	54.0
2483.5	54.0	N/A	38.7	46.4	N/A	33.4	54.0
4804.0	49.3	N/A	38.9	49.1	N/A	38.8	54.0
4880.0	50.2	N/A	40.7	49.2	N/A	38.0	54.0
4960.0	50.5	N/A	42.3	49.6	N/A	39.8	54.0
7206.0	51.0	N/A	37.9	50.6	N/A	38.0	54.0
7320.0	55.6	N/A	46.5	52.5	N/A	40.9	54.0
7440.0	54.3	N/A	44.7	52.6	N/A	40.2	54.0
12010.0	56.0	N/A	42.9	55.7	N/A	43.0	54.0
12200.0	57.7	N/A	45.0	58.2	N/A	44.9	54.0
12400.0	57.4	N/A	44.4	57.1	N/A	44.2	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 3 Radiated Emissions in Restricted Frequency Bands Data (mode 3)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2390.0	44.4	N/A	31.2	43.3	N/A	30.4	54.0
2483.5	67.0	N/A	42.9	61.1	N/A	35.8	54.0
4804.0	47.7	N/A	34.2	47.1	N/A	34.3	54.0
4880.0	47.4	N/A	34.4	47.5	N/A	34.3	54.0
4960.0	47.2	N/A	34.2	46.8	N/A	34.2	54.0
7206.0	51.8	N/A	37.9	50.6	N/A	37.9	54.0
7320.0	51.0	N/A	38.5	50.9	N/A	38.5	54.0
7440.0	51.2	N/A	38.3	51.4	N/A	38.4	54.0
12010.0	57.0	N/A	43.0	56.5	N/A	43.0	54.0
12200.0	57.8	N/A	44.8	57.7	N/A	44.8	54.0
12400.0	57.6	N/A	44.0	56.9	N/A	44.0	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 4 Radiated Emissions in Restricted Frequency Bands Data (mode 4)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2390.0	53.5	N/A	32.7	48.6	N/A	30.8	54.0
2483.5	61.7	N/A	38.2	55.5	N/A	33.6	54.0
4804.0	47.6	N/A	33.9	50.5	N/A	39.3	54.0
4880.0	48.1	N/A	35.4	50.8	N/A	39.0	54.0
4960.0	49.3	N/A	36.3	49.8	N/A	37.7	54.0
7206.0	50.6	N/A	37.3	51.7	N/A	38.6	54.0
7320.0	52.0	N/A	38.6	53.3	N/A	39.7	54.0
7440.0	52.0	N/A	39.1	53.2	N/A	39.7	54.0
12010.0	56.5	N/A	43.6	56.2	N/A	43.1	54.0
12200.0	57.8	N/A	44.8	57.7	N/A	44.8	54.0
12400.0	57.1	N/A	44.0	57.2	N/A	44.0	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 5 Harmonic Radiated Emissions in Restricted Bands Data (mode 5, 802.11b)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2390.0	57.0	N/A	36.7	52.6	N/A	32.6	54.0
2483.5	58.8	N/A	32.8	54.2	N/A	31.1	54.0
4824.0	47.0	N/A	34.0	47.4	N/A	34.2	54.0
4874.0	47.4	N/A	34.5	47..5	N/A	34.7	54.0
4924.0	46.7	N/A	34.1	47.2	N/A	34.0	54.0
7236.0	50.3	N/A	37.8	50.8	N/A	37.8	54.0
7311.0	52.1	N/A	38.6	51.7	N/A	38.6	54.0
7386.0	50.7	N/A	38.2	51.0	N/A	38.3	54.0
12060.0	56.3	N/A	43.2	56.5	N/A	43.2	54.0
12185.0	58.0	N/A	45.0	57.7	N/A	45.0	54.0
12310.0	57.8	N/A	45.1	58.2	N/A	45.2	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 6 Harmonic Radiated Emissions in Restricted Bands Data (mode 6, 802.11g)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2390.0	65.0	N/A	42.5	59.5	N/A	38.9	54.0
2483.5	64.9	N/A	43.2	59.2	N/A	38.5	54.0
4824.0	47.4	N/A	34.2	47.8	N/A	34.2	54.0
4874.0	47.8	N/A	34.7	48.0	N/A	35.0	54.0
4924.0	47.5	N/A	34.0	47.1	N/A	33.8	54.0
7236.0	50.7	N/A	37.7	50.6	N/A	37.7	54.0
7311.0	51.2	N/A	38.5	51.2	N/A	38.5	54.0
7386.0	51.3	N/A	38.2	50.9	N/A	38.2	54.0
12060.0	56.1	N/A	43.3	55.9	N/A	43.2	54.0
12185.0	58.0	N/A	44.9	57.7	N/A	44.9	54.0
12310.0	57.6	N/A	45.1	57.9	N/A	45.2	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 7 Harmonic Radiated Emissions in Restricted Bands Data (mode 7, 802.11n)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2390.0	64.6	N/A	44.0	60.1	N/A	41.0	54.0
2483.5	64.1	N/A	43.7	57.3	N/A	38.6	54.0
4824.0	46.7	N/A	34.1	47.3	N/A	34.1	54.0
4874.0	47.9	N/A	34.5	47.2	N/A	34.3	54.0
4924.0	46.8	N/A	33.9	46.9	N/A	33.9	54.0
7236.0	50.7	N/A	37.8	50.4	N/A	37.6	54.0
7311.0	51.1	N/A	38.3	51.4	N/A	38.4	54.0
7386.0	50.4	N/A	38.0	51.1	N/A	38.0	54.0
12060.0	55.4	N/A	42.8	56.1	N/A	43.0	54.0
12185.0	58.4	N/A	44.9	57.6	N/A	44.7	54.0
12310.0	57.8	N/A	45.1	57.9	N/A	45.1	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Summary of Results for Radiated Emissions in Restricted Bands

The EUT demonstrated compliance with the radiated emissions requirements of 47 CFR Part 15C RSS-Gen, and RSS-247 Intentional Radiators. The EUT worst-case operation mode demonstrated a minimum radiated emission margin of -5.2 dB below the requirements in restricted frequency bands. Peak, Quasi-peak, and average amplitudes were checked for compliance with the regulations. Worst-case emissions are reported with other emissions found in the restricted frequency bands at least 20 dB below the requirements.

AC Line Conducted EMI Procedure

The EUT was arranged in typical equipment configurations as offered by manufacturer and presented above in equipment configuration. AC Line Conducted emission testing was performed with the EUT placed on a 1 x 1.5-meter bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The LISN was positioned on the floor of the screen room 80-cm from the rear of the EUT. Testing for the AC line-conducted emissions followed the procedures of ANSI C63.10-2013. The EUT was configured as presented in the AC Line conducted configurations as directed by the manufacture and presented above in equipment configuration. The AC adapter for the EUT was connected to the LISN for AC line-conducted emissions testing. A second LISN was positioned on the floor of the screen room 80-cm from the rear of the supporting equipment of the test configuration. All power cords except the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor, internal to the LISN. Power line conducted emissions testing was carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequencies of each of the emissions, which demonstrated the highest amplitudes. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz and data recorded.

Refer to figures one and two showing plots of configuration #2, the EUT – USB Computer interface AC Line conducted emissions. Refer to figures three and four for plots of configuration #3, the AC Adapter configuration worst-case line conducted emissions. Refer to figures five and six for plots of configuration #4, the AC Adapter configuration worst-case line conducted emissions.

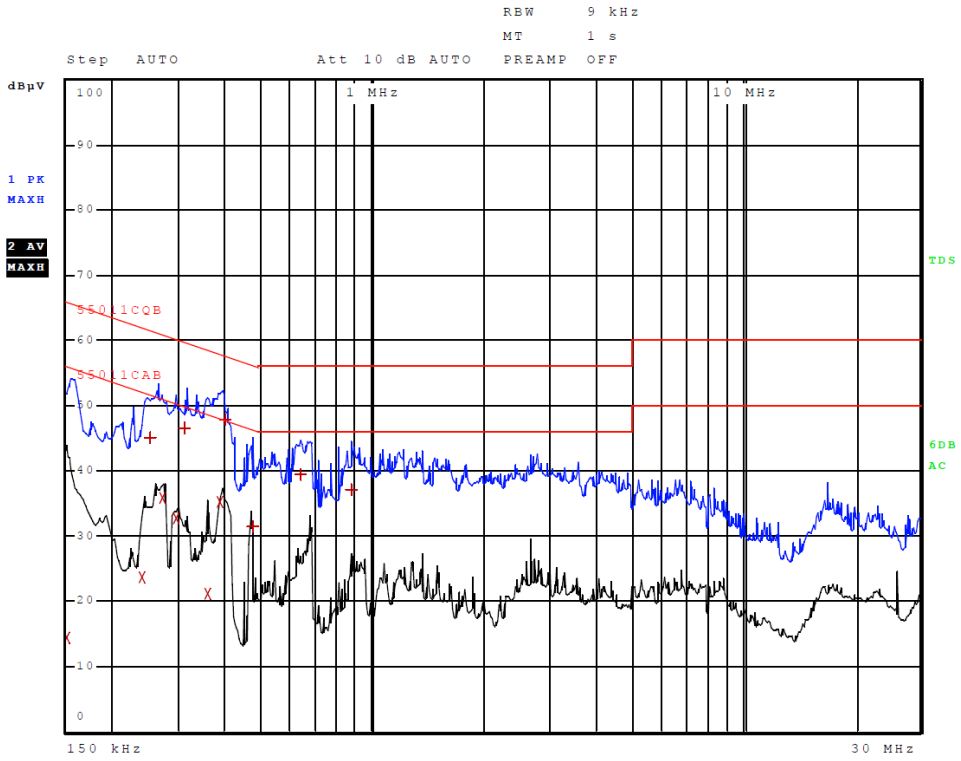


Figure 1 AC Line Conducted emissions of EUT line 1 (#2, EUT – Computer)

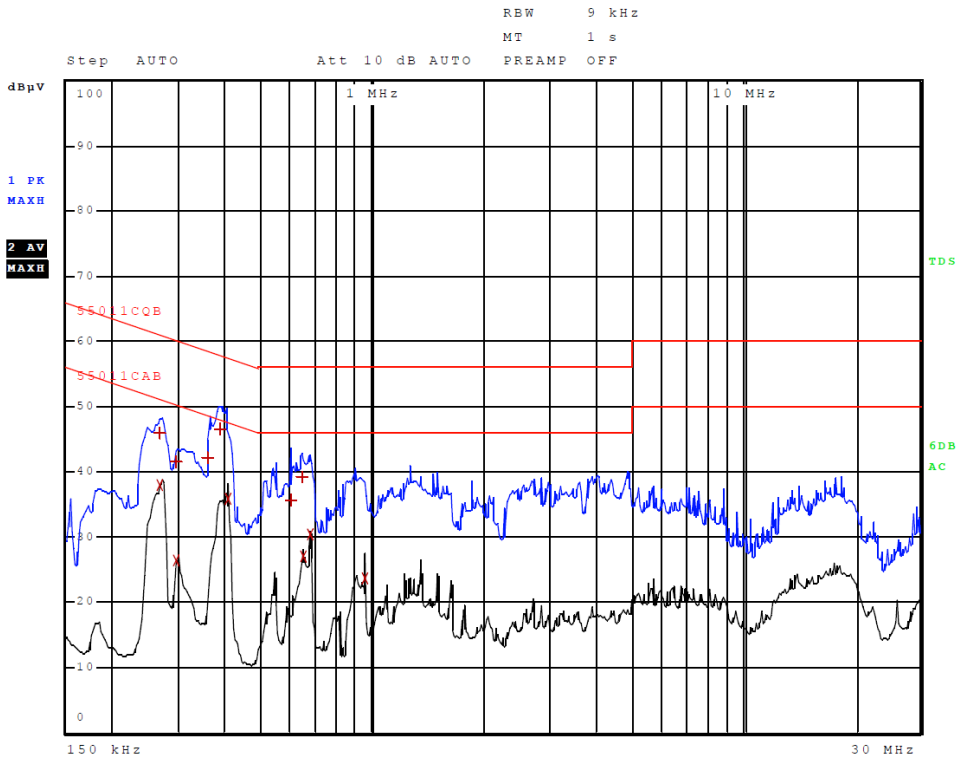


Figure 2 AC Line Conducted emissions of EUT line 2 (#2, EUT – Computer)

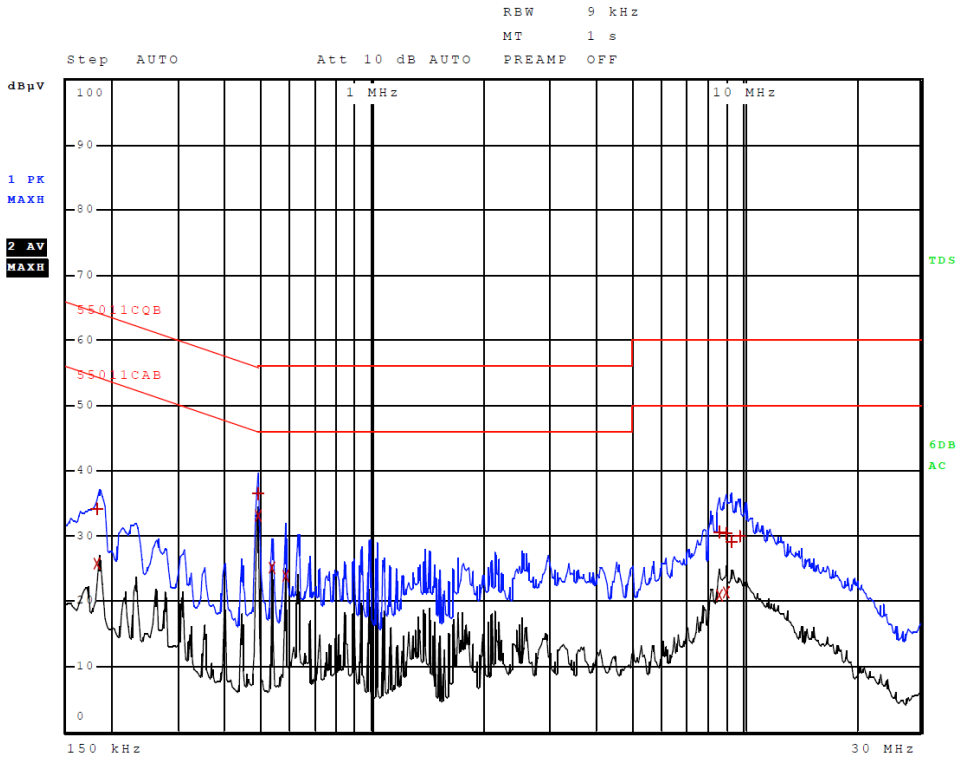


Figure 3 AC Line Conducted emissions of EUT line 1 (#3, EUT – 362-00091-00)

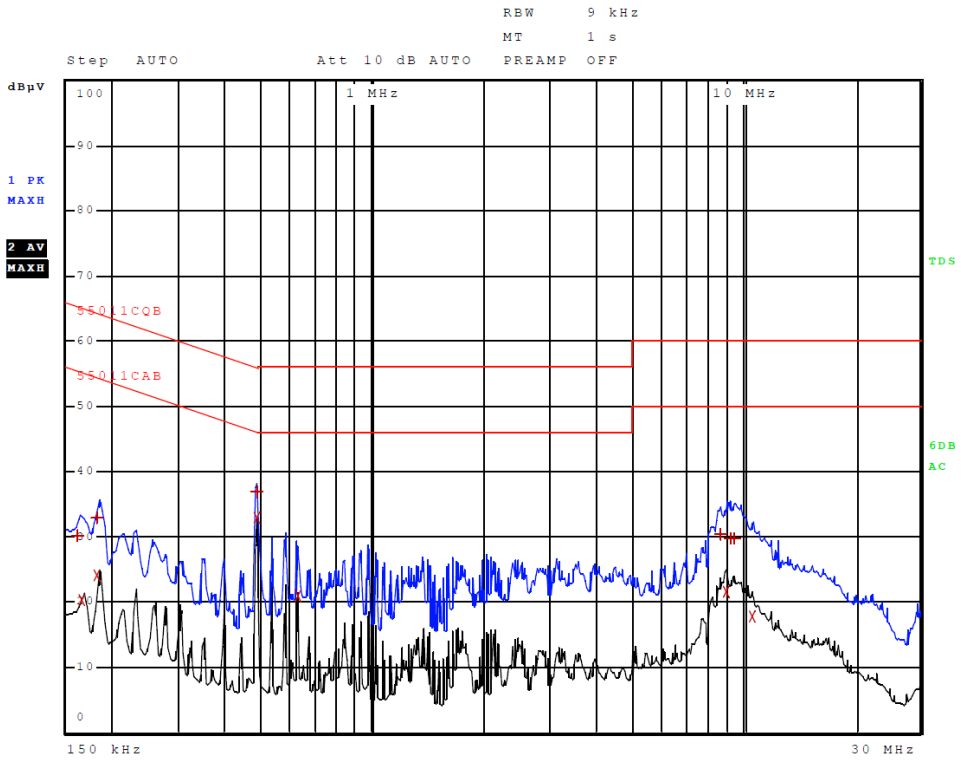


Figure 4 AC Line Conducted emissions of EUT line 2 (#3, EUT – 362-00091-00)

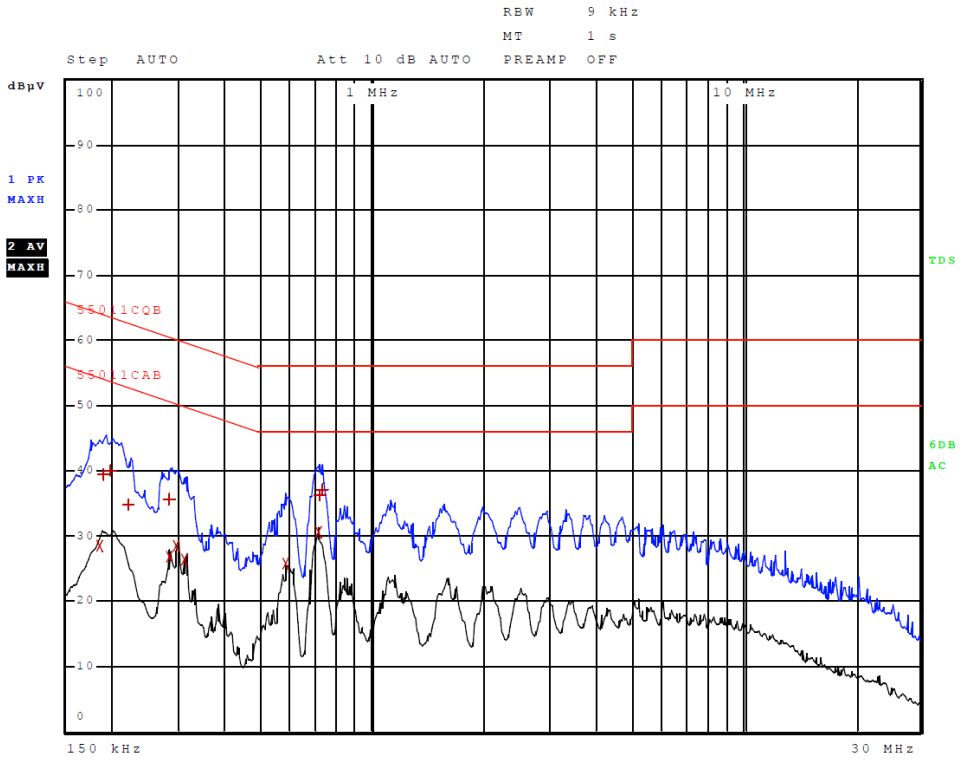


Figure 5 AC Line Conducted emissions of EUT line 1 (#4, EUT – 362-00087-00)

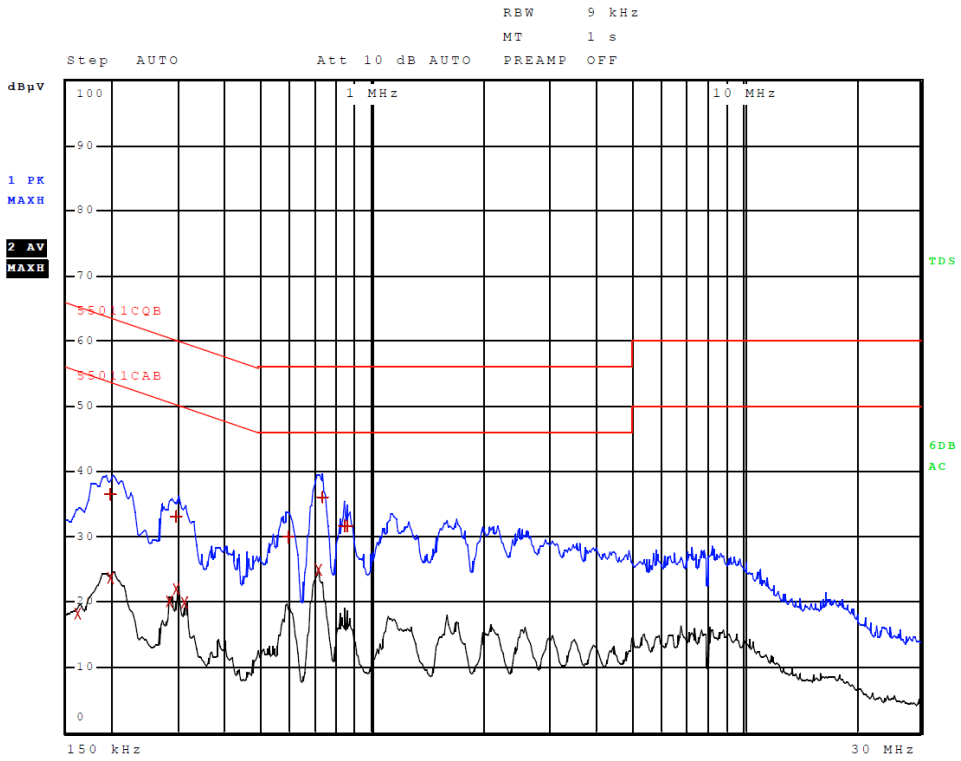


Figure 6 AC Line Conducted emissions of EUT line 2 (#4, EUT – 362-00087-00)

Table 8 AC Line Conducted Emissions Data L1 (#2, EUT – Computer)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
2	150.000000000 kHz	14.40	Average	-41.60
2	242.000000000 kHz	23.60	Average	-28.43
1	254.000000000 kHz	45.10	Quasi Peak	-16.52
2	274.000000000 kHz	35.84	Average	-15.16
2	298.000000000 kHz	32.69	Average	-17.61
1	314.000000000 kHz	46.52	Quasi Peak	-13.34
2	358.000000000 kHz	21.16	Average	-27.61
2	390.000000000 kHz	35.28	Average	-12.78
1	398.000000000 kHz	47.85	Quasi Peak	-10.04
1	470.000000000 kHz	31.45	Quasi Peak	-25.06
1	638.000000000 kHz	39.41	Quasi Peak	-16.59
1	870.000000000 kHz	36.99	Quasi Peak	-19.01

Other emissions present had amplitudes at least 20 dB below the limit.

Table 9 AC Line Conducted Emissions Data L2 (#2, EUT – Computer)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	270.000000000 kHz	45.85	Quasi Peak	-15.27
2	270.000000000 kHz	37.93	Average	-13.18
1	298.000000000 kHz	41.45	Quasi Peak	-18.85
2	298.000000000 kHz	26.44	Average	-23.86
1	362.000000000 kHz	42.19	Quasi Peak	-16.49
1	390.000000000 kHz	46.59	Quasi Peak	-11.47
2	406.000000000 kHz	35.91	Average	-11.82
1	598.000000000 kHz	35.58	Quasi Peak	-20.42
1	642.000000000 kHz	39.11	Quasi Peak	-16.89
2	650.000000000 kHz	27.00	Average	-19.00
2	678.000000000 kHz	30.35	Average	-15.65
2	954.000000000 kHz	23.70	Average	-22.30

Other emissions present had amplitudes at least 20 dB below the limit.

Table 10 AC Line Conducted Emissions Data L1 (#3, EUT – 362-00091-00)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	182.000000000 kHz	34.22	Quasi Peak	-30.18
2	182.000000000 kHz	25.81	Average	-28.58
2	490.000000000 kHz	33.18	Average	-12.99
1	490.000000000 kHz	36.53	Quasi Peak	-19.64
2	534.000000000 kHz	25.13	Average	-20.87
2	582.000000000 kHz	23.75	Average	-22.25
1	8.592000000 MHz	30.59	Quasi Peak	-29.41
2	8.640000000 MHz	20.83	Average	-29.17
2	8.984000000 MHz	21.30	Average	-28.70
1	8.996000000 MHz	30.28	Quasi Peak	-29.72
1	9.268000000 MHz	29.02	Quasi Peak	-30.98
1	9.752000000 MHz	29.99	Quasi Peak	-30.01

Other emissions present had amplitudes at least 20 dB below the limit.

Table 11 AC Line Conducted Emissions Data L2 (#3, – 362-00091-00)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	162.000000000 kHz	30.24	Quasi Peak	-35.12
2	166.000000000 kHz	20.37	Average	-34.79
1	182.000000000 kHz	32.87	Quasi Peak	-31.52
2	182.000000000 kHz	24.08	Average	-30.32
2	486.000000000 kHz	32.93	Average	-13.30
1	486.000000000 kHz	36.84	Quasi Peak	-19.40
2	626.000000000 kHz	20.86	Average	-25.14
1	8.716000000 MHz	30.37	Quasi Peak	-29.63
2	8.968000000 MHz	21.45	Average	-28.55
1	9.228000000 MHz	29.70	Quasi Peak	-30.30
1	9.468000000 MHz	29.66	Quasi Peak	-30.34
2	10.568000000 MHz	17.82	Average	-32.18

Other emissions present had amplitudes at least 20 dB below the limit.

Table 12 AC Line Conducted Emissions Data L1 (#4, EUT – 362-00087-00)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
2	186.000000000 kHz	28.42	Average	-25.79
1	190.000000000 kHz	39.38	Quasi Peak	-24.65
1	198.000000000 kHz	40.06	Quasi Peak	-23.63
1	222.000000000 kHz	34.87	Quasi Peak	-27.87
2	282.000000000 kHz	26.69	Average	-24.07
1	286.000000000 kHz	35.56	Quasi Peak	-25.08
2	298.000000000 kHz	28.56	Average	-21.74
2	314.000000000 kHz	26.37	Average	-23.49
2	582.000000000 kHz	25.69	Average	-20.31
2	714.000000000 kHz	30.50	Average	-15.50
1	718.000000000 kHz	36.25	Quasi Peak	-19.75
1	730.000000000 kHz	37.02	Quasi Peak	-18.98

Other emissions present had amplitudes at least 20 dB below the limit.

Table 13 AC Line Conducted Emissions Data L2 (#4, – 362-00087-00)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
2	162.000000000 kHz	18.25	Average	-37.11
1	198.000000000 kHz	36.51	Quasi Peak	-27.18
2	198.000000000 kHz	23.58	Average	-30.12
2	282.000000000 kHz	20.15	Average	-30.61
2	298.000000000 kHz	22.01	Average	-28.28
1	298.000000000 kHz	33.14	Quasi Peak	-27.16
2	314.000000000 kHz	19.88	Average	-29.99
1	590.000000000 kHz	29.88	Quasi Peak	-26.12
2	714.000000000 kHz	24.82	Average	-21.18
1	730.000000000 kHz	36.08	Quasi Peak	-19.92
1	838.000000000 kHz	31.67	Quasi Peak	-24.33
1	854.000000000 kHz	31.62	Quasi Peak	-24.38

Other emissions present had amplitudes at least 20 dB below the limit.

Summary of Results for AC Line Conducted Emissions

The EUT demonstrated compliance with the AC Line Conducted Emissions requirements of 47CFR Part 15C, RSS-247 and RSS-Gen. The EUT computer configuration#2 worst-case configuration demonstrated a minimum margin of -10.0 dB below the requirement. The EUT configurations #3 and #4 worst-case configuration demonstrated a minimum margin of -12.9 dB below the requirement. Other emissions were present with amplitudes at least 20 dB below the limit and worst-case amplitudes recorded.

General Radiated Emissions Procedure

The EUT was arranged in a typical equipment configuration and operated through all available mode during testing. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Each radiated emission was then maximized at the OATS location before final radiated measurements were performed. Final data was taken with the EUT located on the OATS at 3 meters distance between the EUT and the receiving antenna. The frequency spectrum from 9 kHz to 25,000 MHz was searched for general radiated emissions. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Loop from 9 kHz to 30 MHz, Broadband Biconical from 30 to 200 MHz, Biconilog from 30 to 1000 MHz, Log Periodic from 200 MHz to 1 GHz and or double Ridge or pyramidal horns and mixers above 1 GHz, notch filters and appropriate amplifiers and external mixers were utilized.

Table 14 General Radiated Emissions Data

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
59.5	23.2	18.7	N/A	31.5	26.3	N/A	40.0
64.9	23.8	19.9	N/A	30.5	25.0	N/A	40.0
80.0	29.1	21.8	N/A	32.5	27.1	N/A	40.0
119.4	21.8	16.3	N/A	23.3	17.1	N/A	40.0
122.0	22.2	16.6	N/A	21.2	14.0	N/A	40.0
142.2	28.9	23.6	N/A	22.0	16.7	N/A	40.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Summary of Results for General Radiated Emissions

The EUT demonstrated compliance with the radiated emissions requirements of 47 CFR Part 15C paragraph 15.209, RSS-247 and RSS-GEN Intentional Radiators. The EUT demonstrated a minimum margin of -12.9 dB below the requirements. Other emissions were present with amplitudes at least 20 dB below the Limits.

Operation in the Band 2400 – 2483.5 MHz

Test procedures of ANSI C63.10-2013 and KDB 558074 v05 were used during transmitter testing. Test sample #2 was provided for testing antenna port conducted emissions. This sample was modified by replacing the internal antenna with a 50-ohm antenna port connector and attenuator for testing purposes. The transmitter peak and average power was measured at the antenna port using a wideband RF power meter as described in KDB 558074 and C63.10-2013. The peak Power Spectral Density (PKPSD) was measured as defined in KDB 558074 and C63.10-2013. DTS Emission bandwidth was measured as described in KDB 558074 and C63.10-2013. The amplitude of each harmonic and general radiated emission was measured on the OATS at distance of 3 meters from the FSM antenna (radiated emission testing was performed on sample #1 representative of production equipment with integral antenna). The EUT was positioned on supporting turntable elevated as required above the ground plane, at a distance of 3 meters from the FSM antenna. Radiated emission investigations were performed from 9 kHz to 25,000 MHz. Each radiated emission was maximized by varying the FSM antenna height and polarization, and by rotating the turntable. The worst-case amplitude of each emission was then recorded from the analyzer display. The peak and quasi-peak amplitude of frequencies below 1000 MHz were measured using a spectrum analyzer. The peak and average amplitude of frequencies above 1000 MHZ were measured using a spectrum analyzer. A Loop antenna was used for measuring emissions from 0.009 to 30 MHz, Biconilog Antenna for 30 to 1000 MHz, Double-Ridge, and/or Pyramidal Horn Antennas from 1 GHz to 25 GHz. Radiated Emissions were measured in dBµV/m @ 3 meters. Plots were taken of transmitter performance (using sample #2) for reference in this and other documentation.

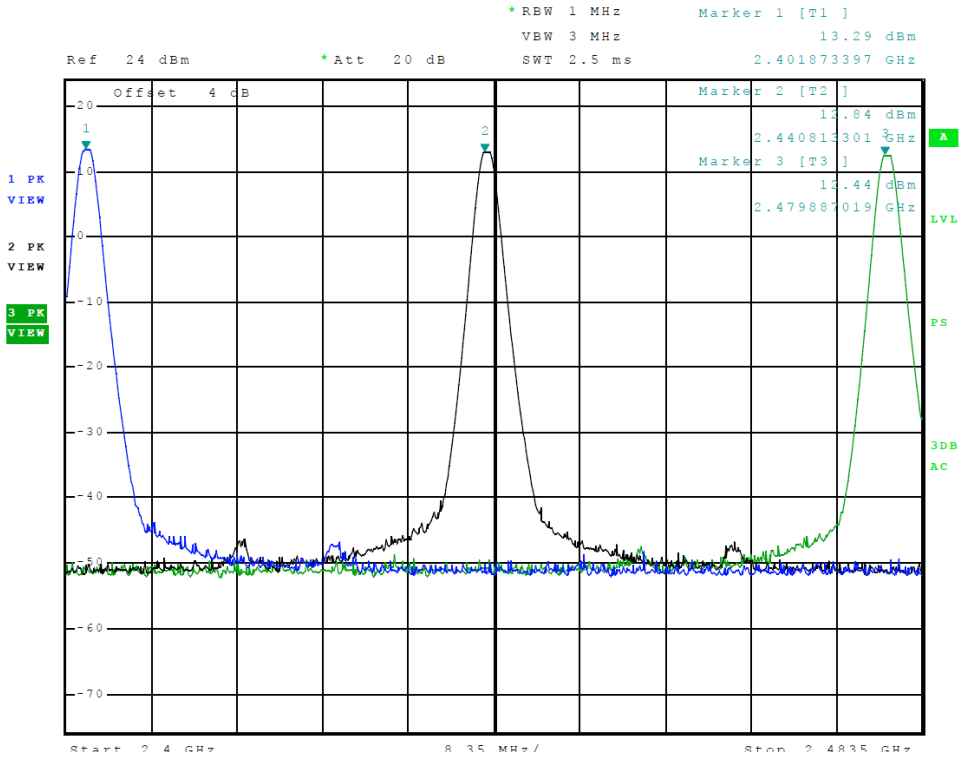


Figure 7 Plot of Transmitter Emissions Operation in 2402-2480 MHz (mode 1, GFSK)

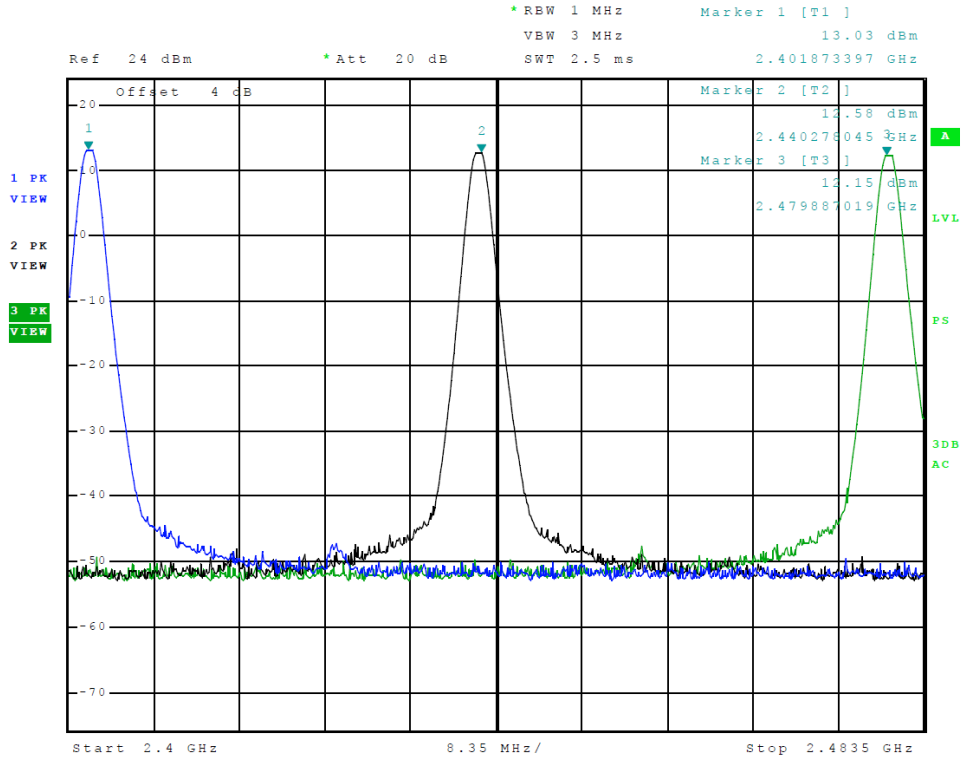


Figure 8 Plot of Transmitter Emissions Operation in 2402-2480 MHz (mode 2, GFSK)

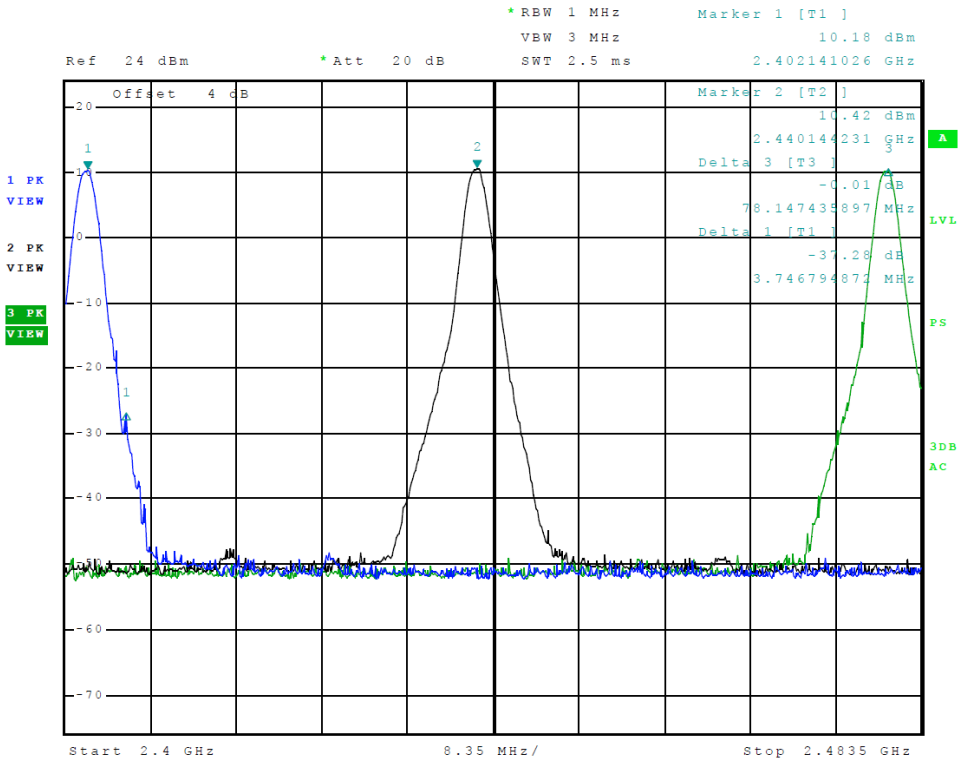


Figure 9 Plot of Transmitter Emissions Operation in 2402-2480 MHz (mode 3, π/4-DQPSK)

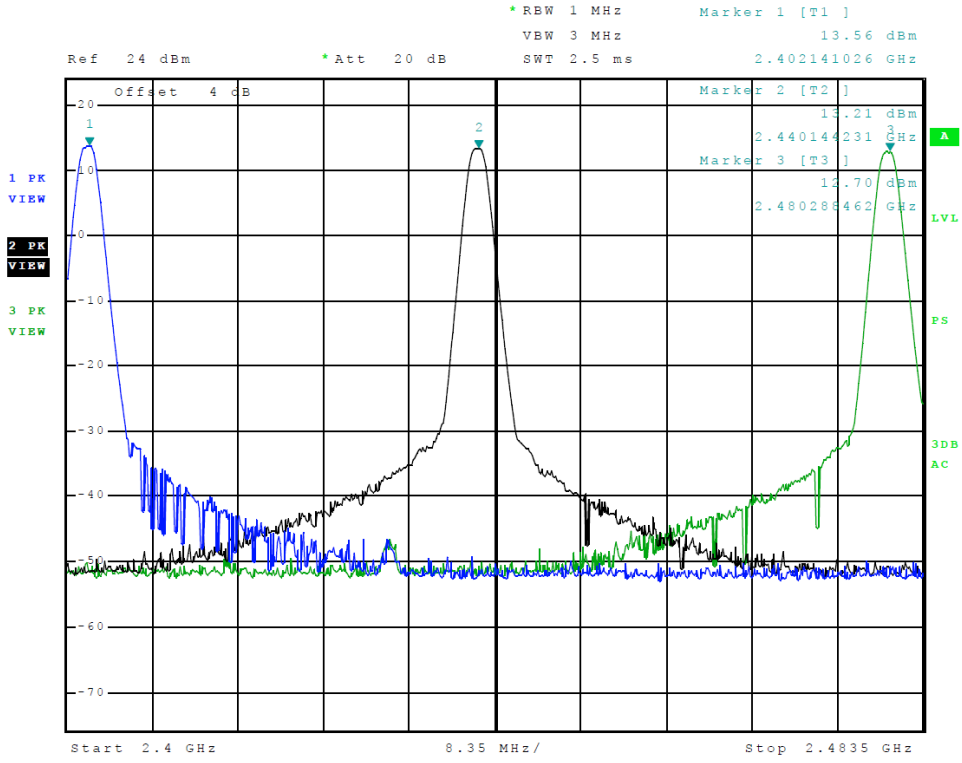


Figure 10 Plot of Transmitter Emissions Operation in 2402-2480 MHz (mode 4, GMSK)

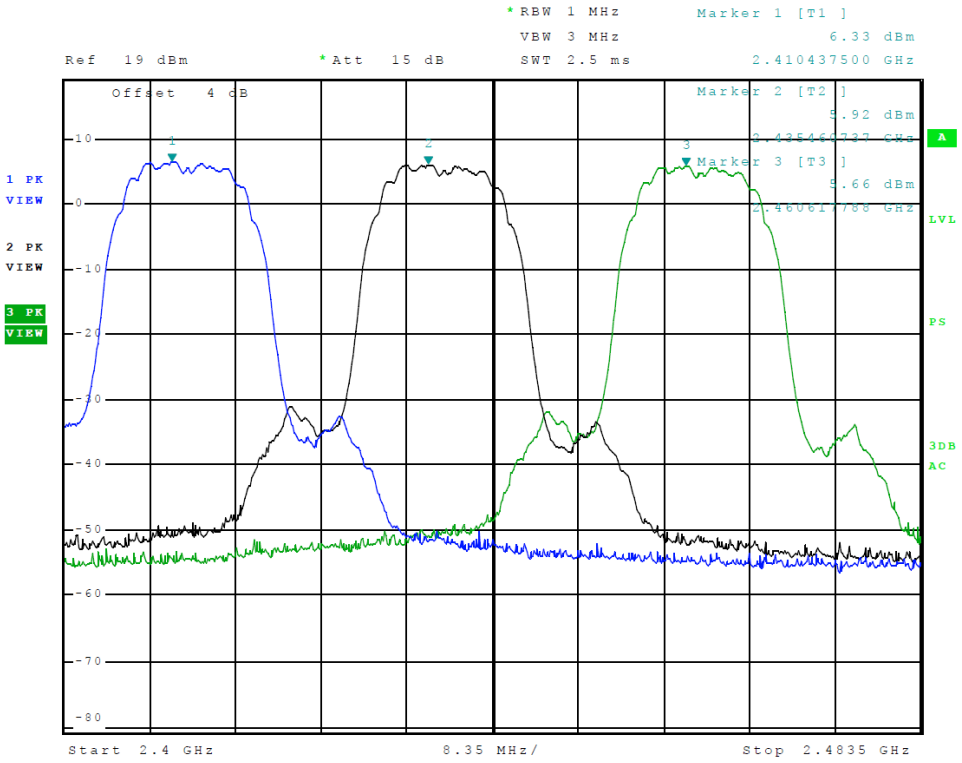


Figure 11 Plot of Transmitter Emissions in Operational Frequency (mode 5, 802.11b)

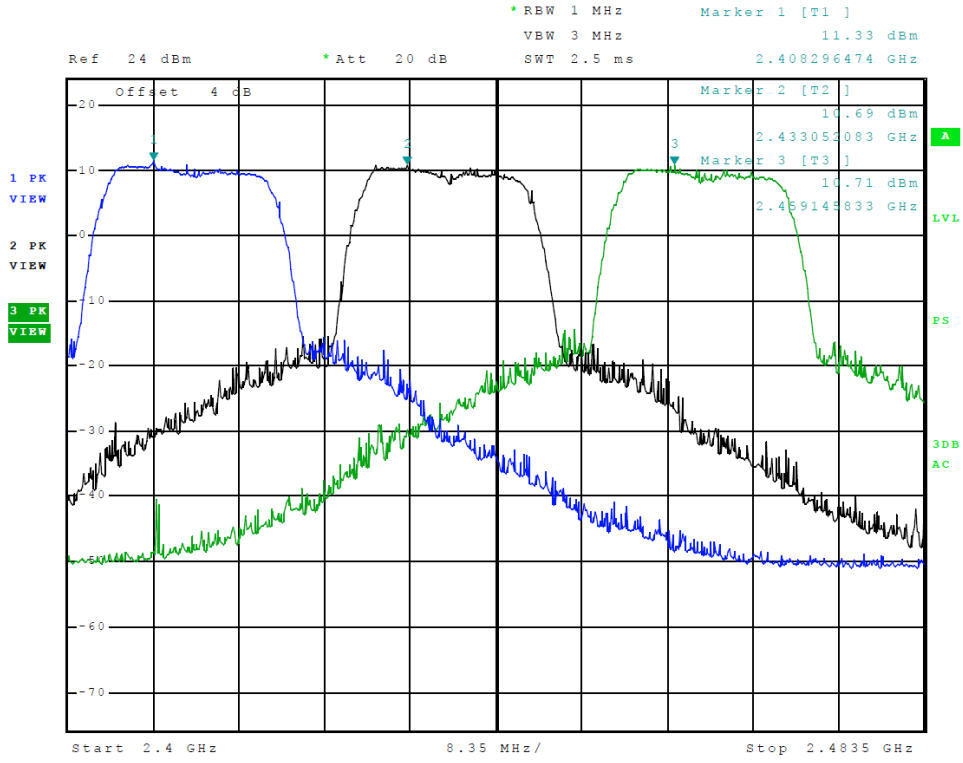


Figure 12 Plot of Transmitter Emissions in Operational Frequency (mode 6, 802.11g)

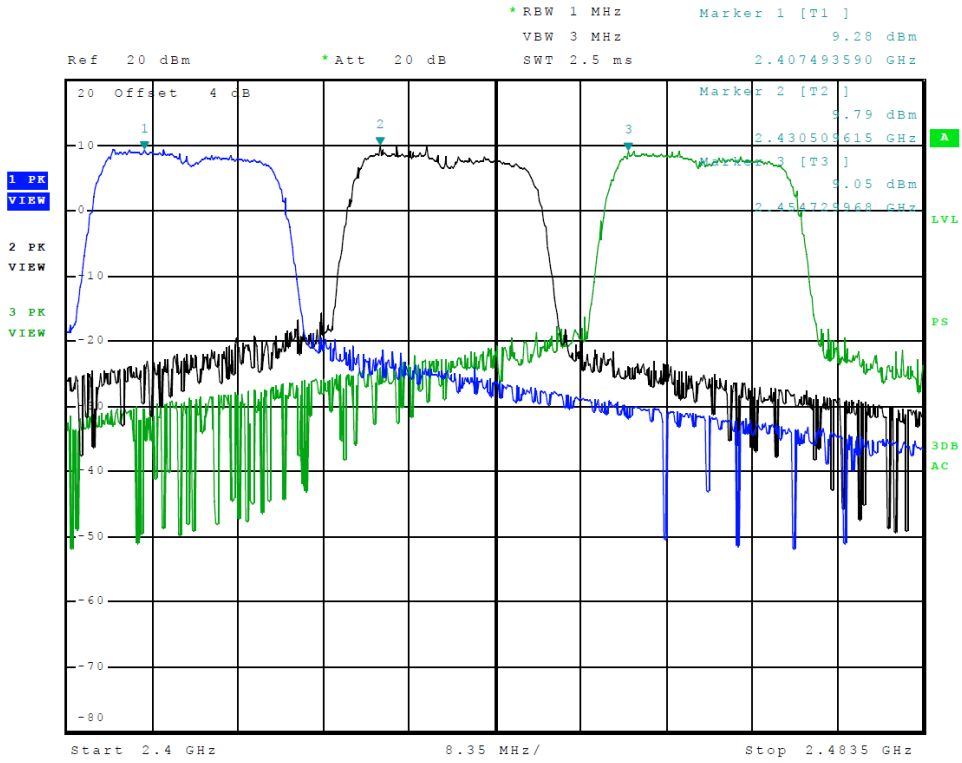


Figure 13 Plot of Transmitter Emissions in Operational Frequency (mode 7, 802.11n)

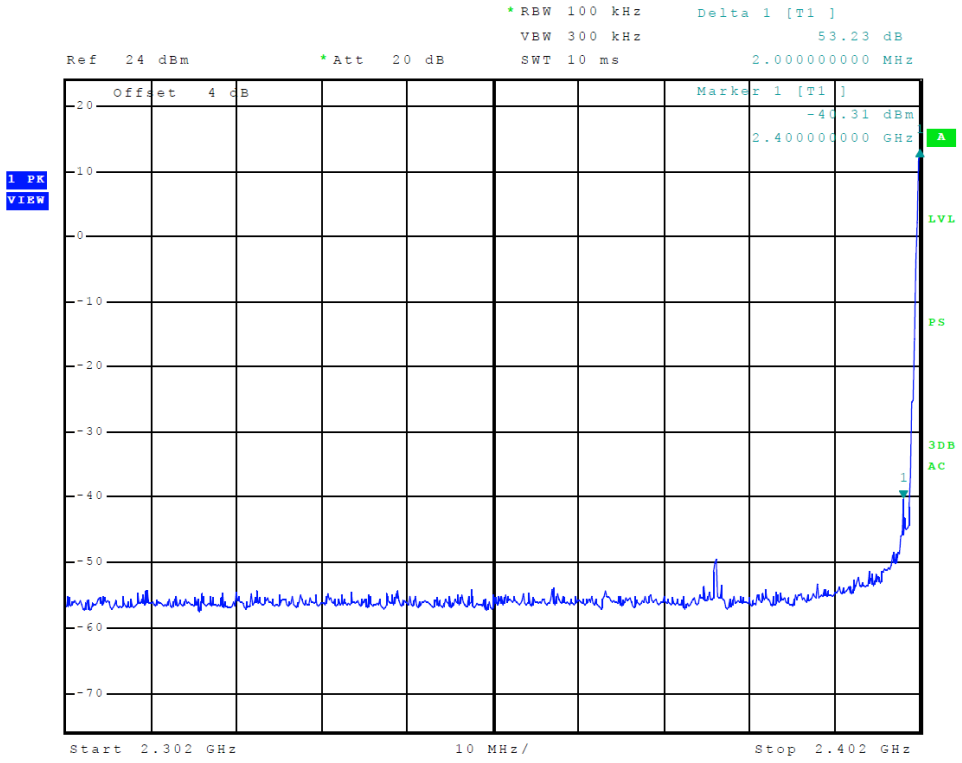


Figure 14 Plot of Transmitter Emissions Low Band Edge (mode 1, GFSK)

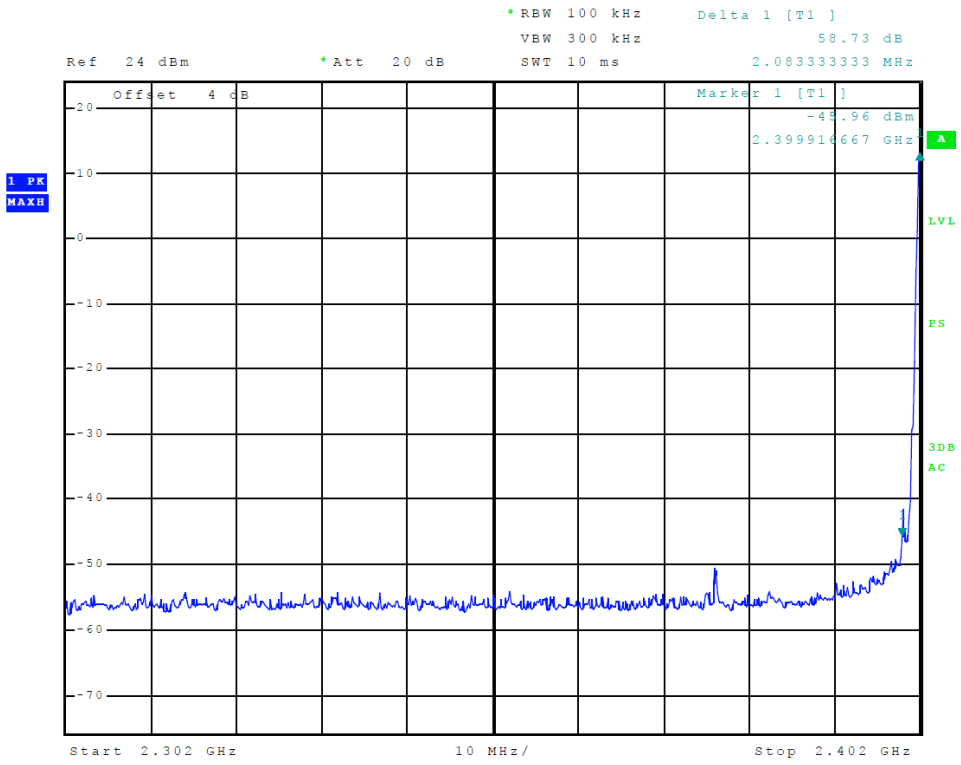


Figure 15 Plot of Transmitter Emissions Low Band Edge (mode 2, GFSK)

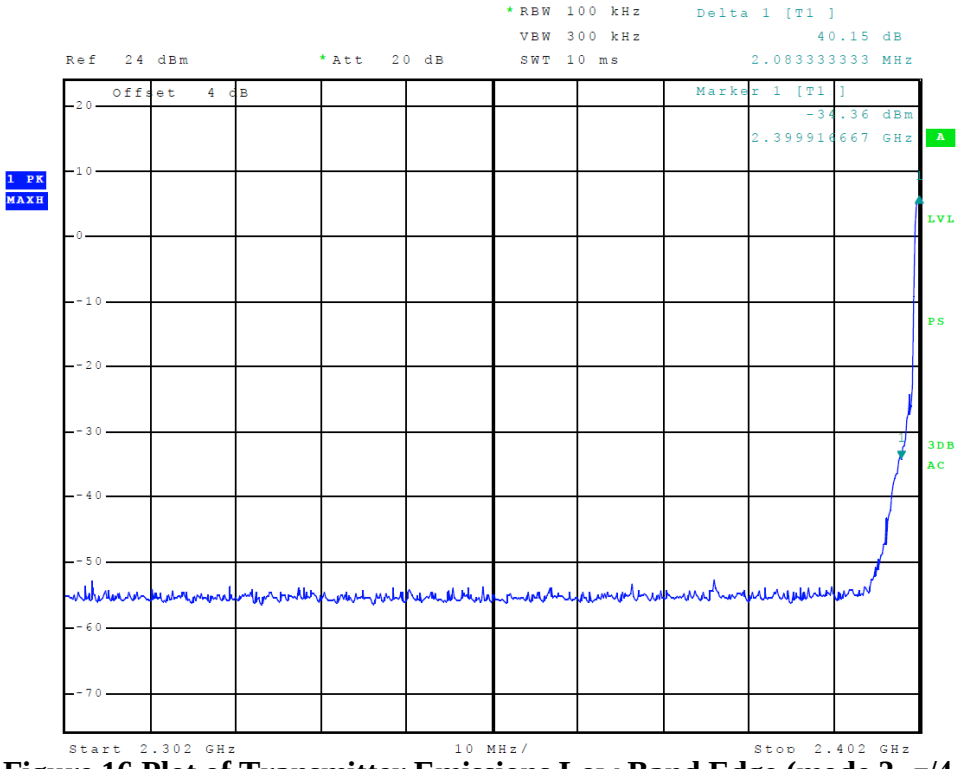


Figure 16 Plot of Transmitter Emissions Low Band Edge (mode 3, π/4-DQPSK)

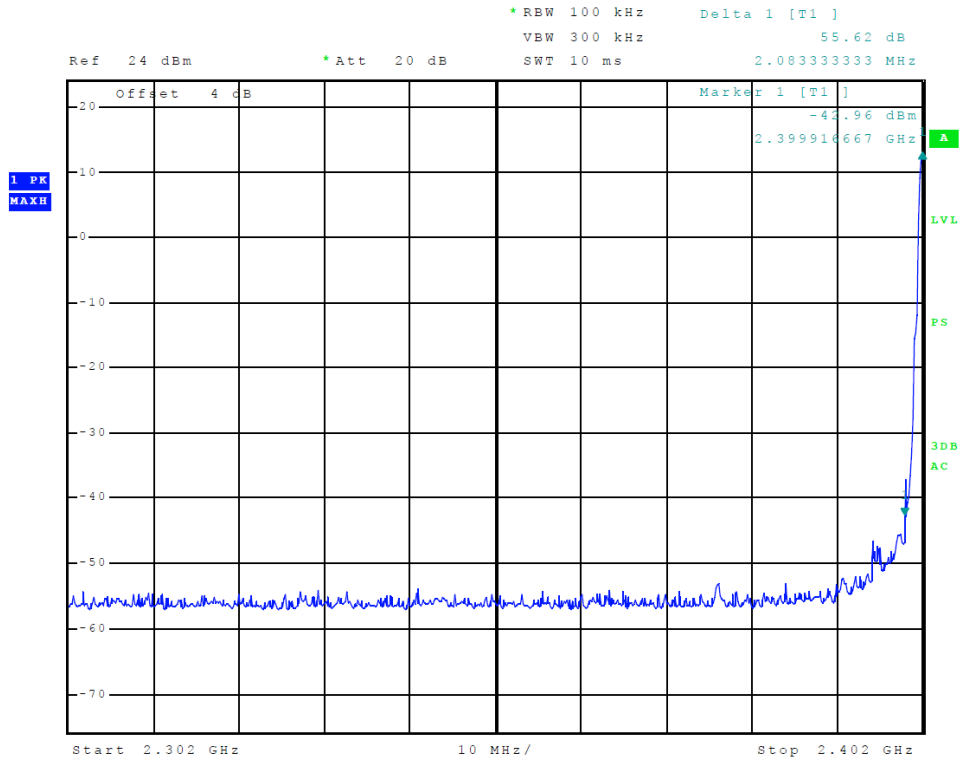


Figure 17 Plot of Transmitter Emissions Low Band Edge (mode 4, GMSK)

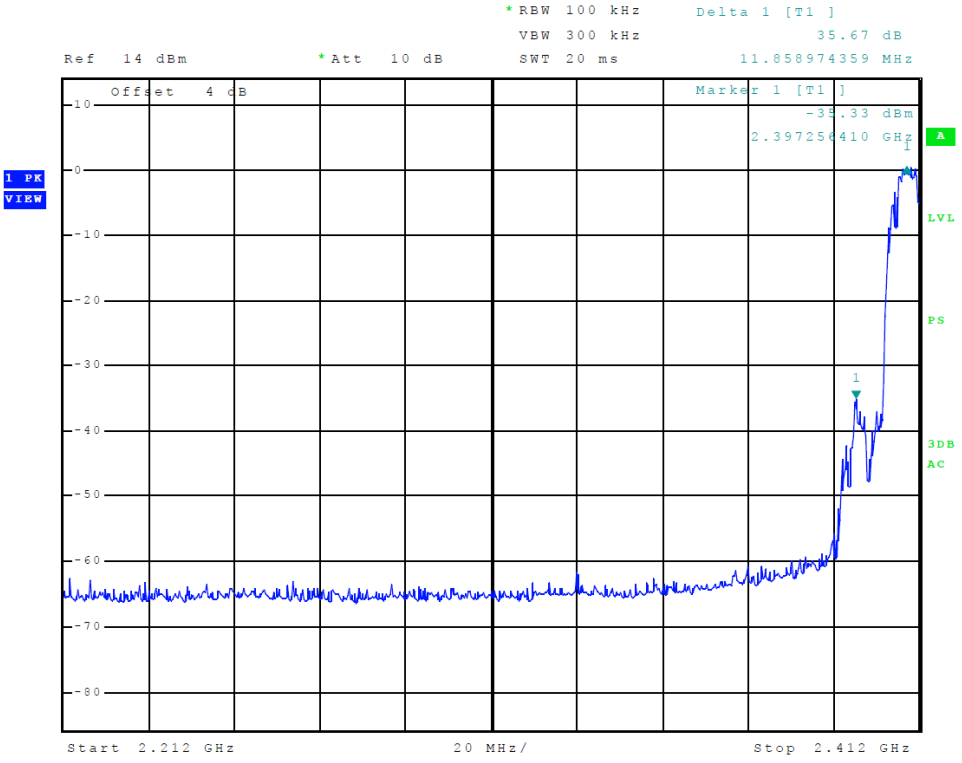


Figure 18 Plot of Transmitter Emissions Low Band Edge (mode 5, 802.11b)

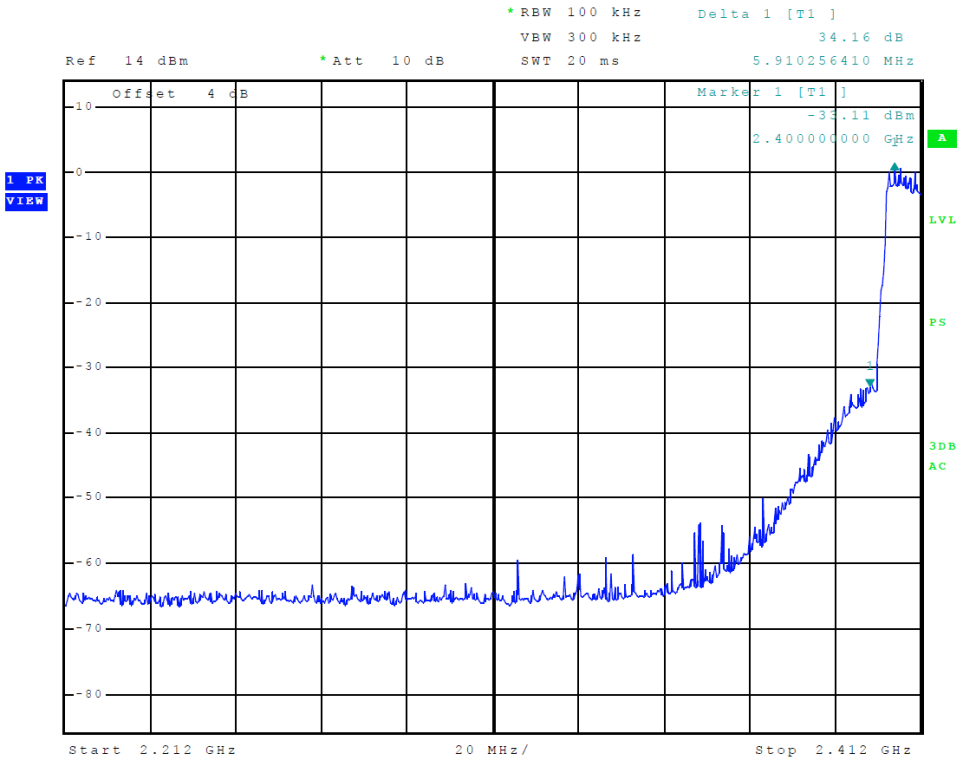


Figure 19 Plot of Transmitter Emissions Low Band Edge (mode 6, 802.11g)

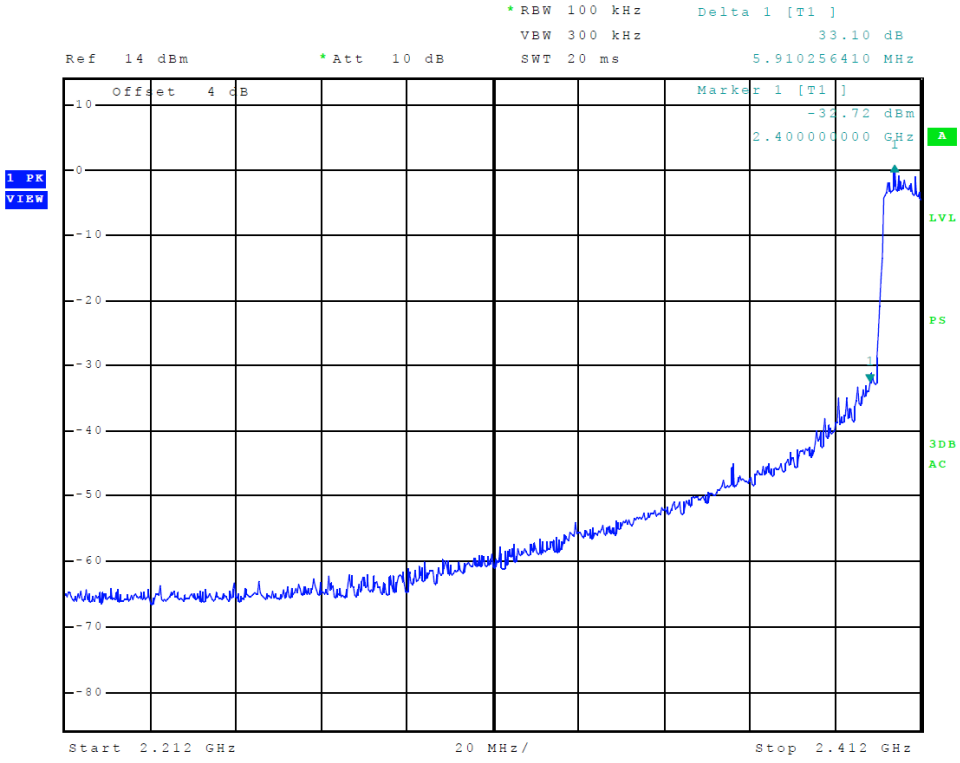


Figure 20 Plot of Transmitter Emissions Low Band Edge (mode 7, 802.11n)

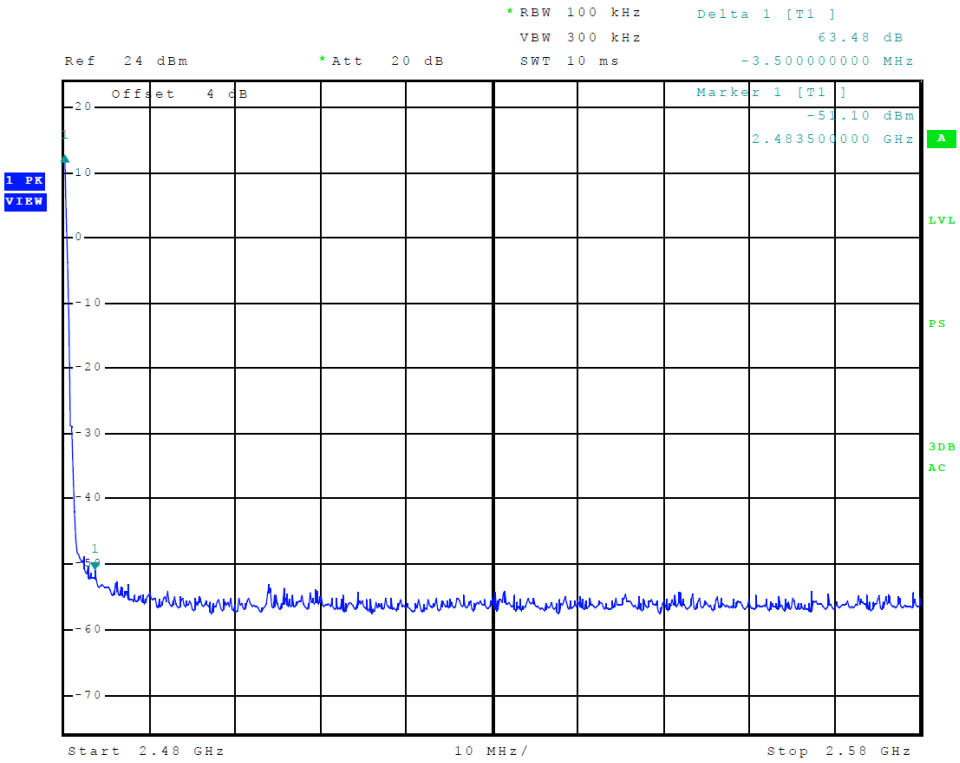


Figure 21 Plot of Transmitter Emissions High Band Edge (mode 1, GFSK)

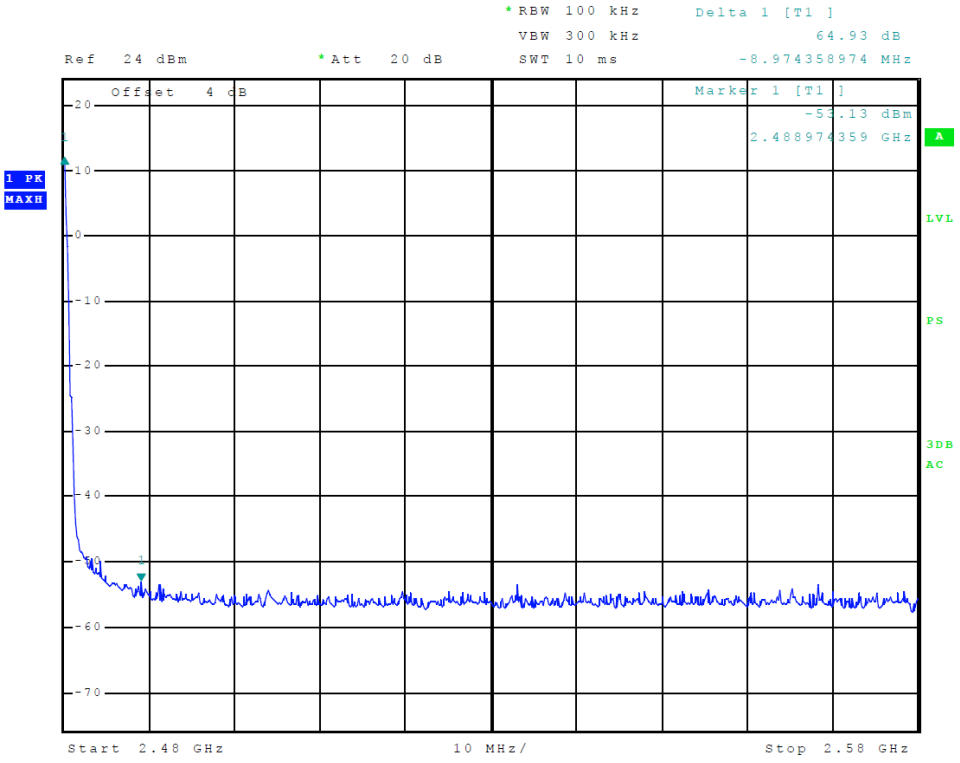


Figure 22 Plot of Transmitter Emissions High Band Edge (mode 2, GFSK)

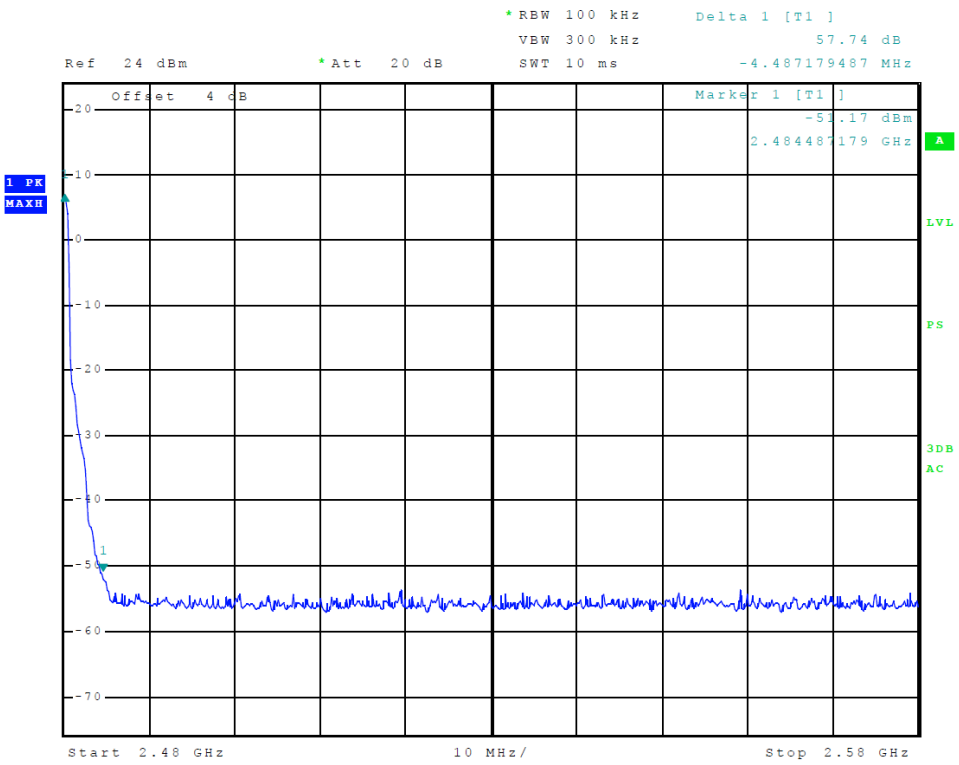


Figure 23 Plot of Transmitter Emissions High Band Edge (mode 3, π/4-DQPSK)

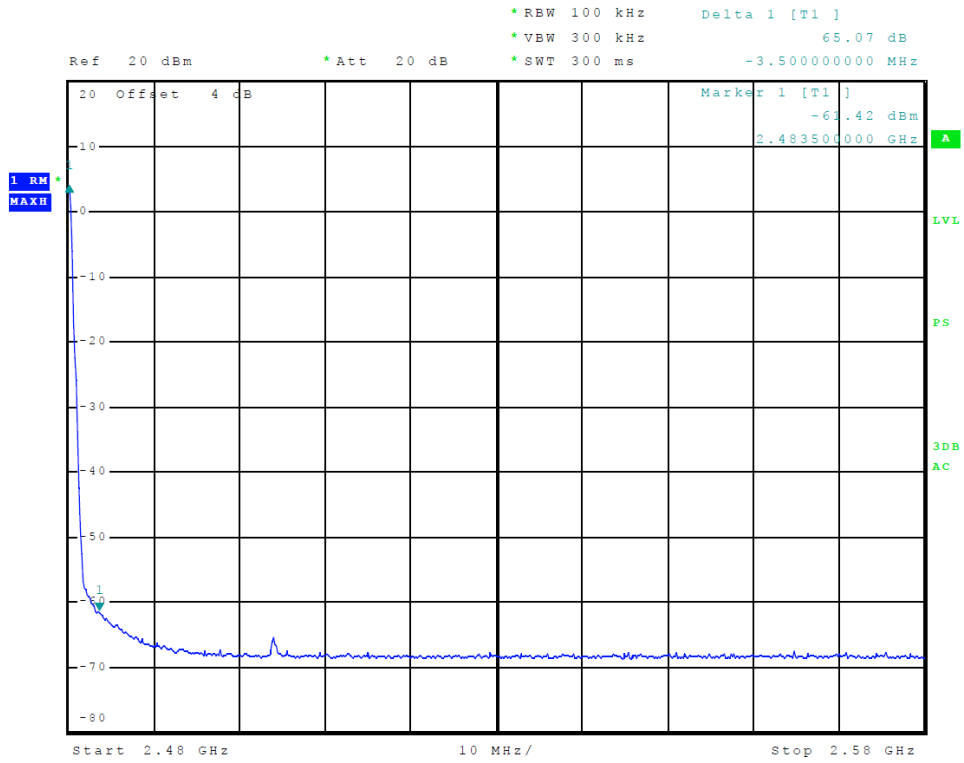


Figure 24 Plot of Transmitter Emissions High Band Edge (mode 4, GMSK)

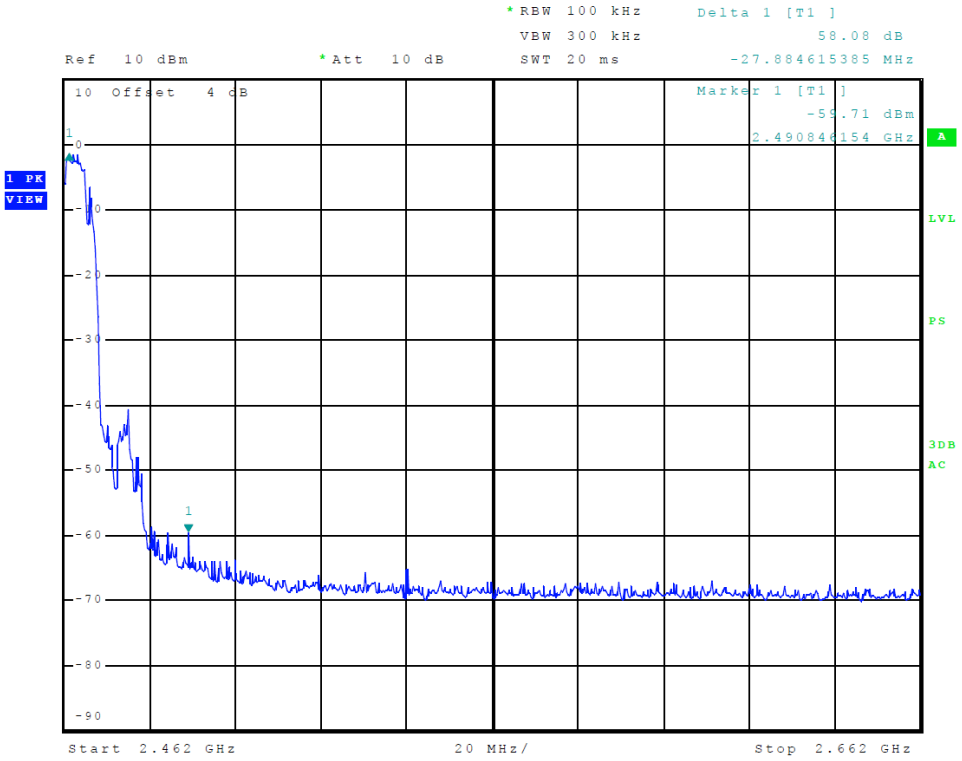


Figure 25 Plot of Transmitter Emissions High Band Edge (mode 5, 802.11b)

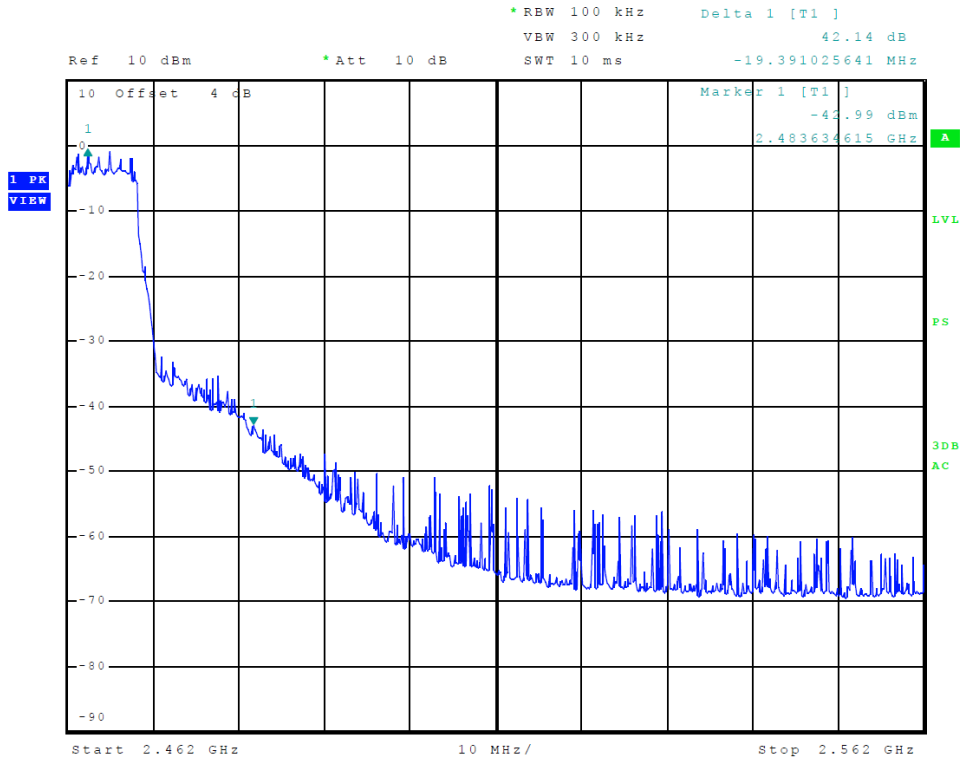


Figure 26 Plot of Transmitter Emissions High Band Edge (mode 6, 802.11g)

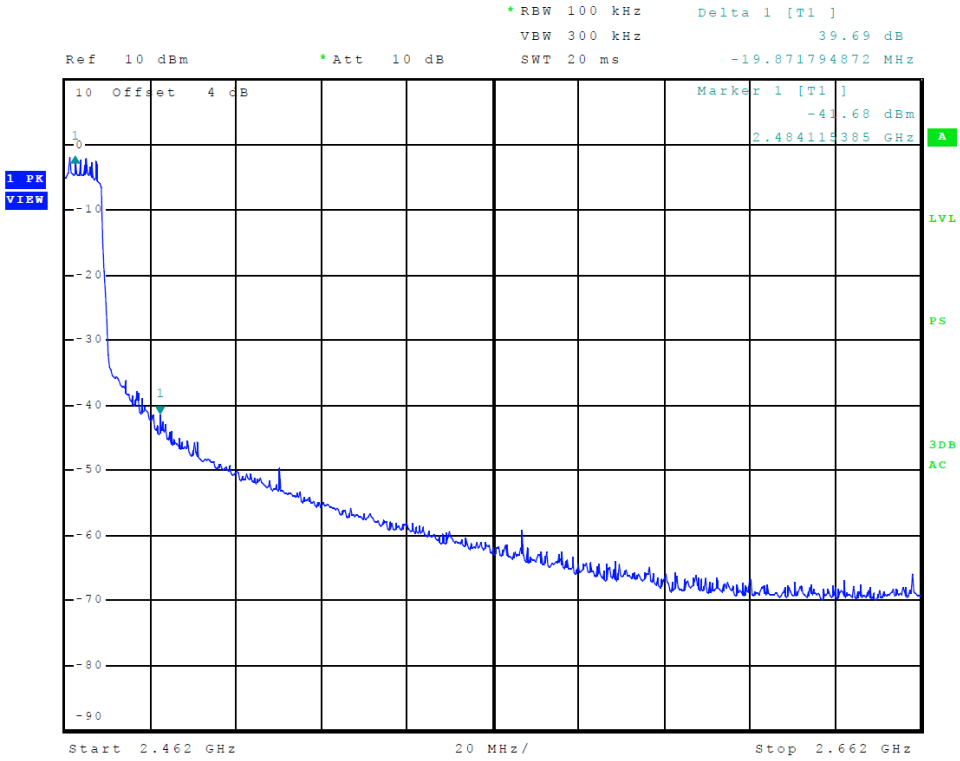


Figure 27 Plot of Transmitter Emissions High Band Edge (mode 7, 802.11n)

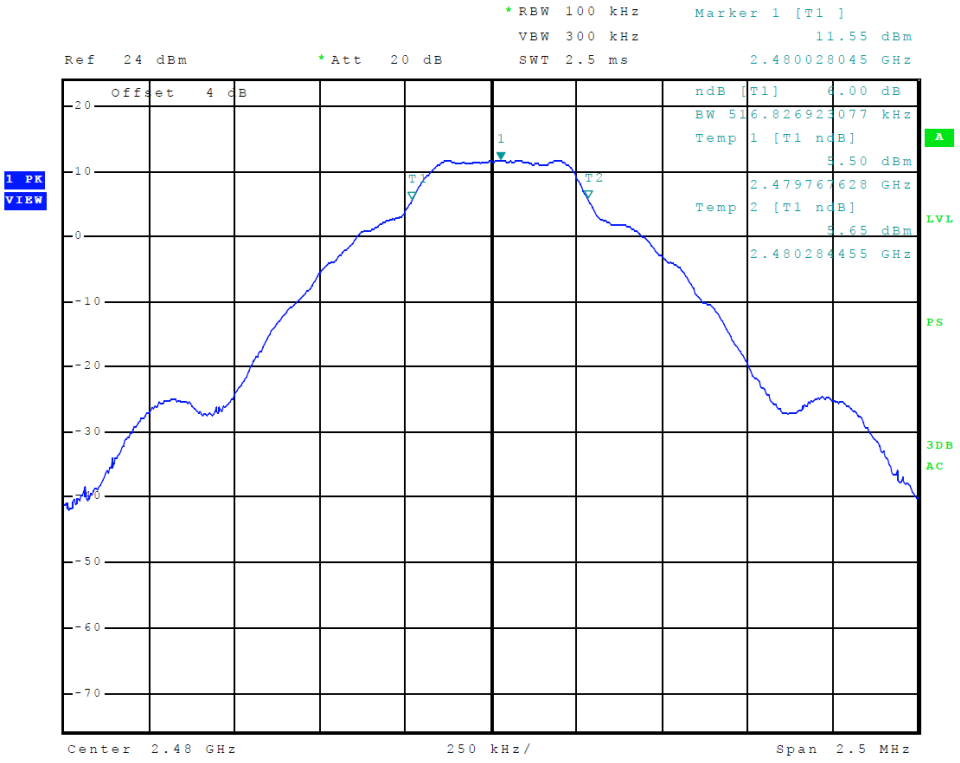


Figure 28 Plot of Transmitter Emissions 6-dB Occupied Bandwidth (mode 1, GFSK)

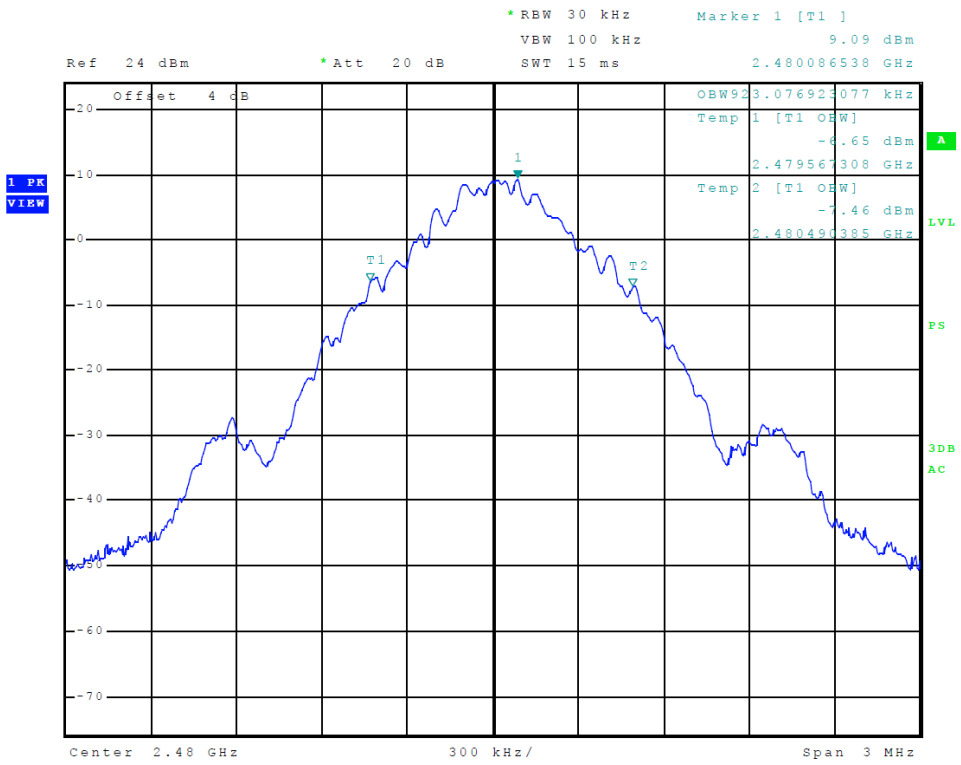


Figure 29 Plot of Transmitter Emissions 99% Occupied Bandwidth (mode 1, GFSK)

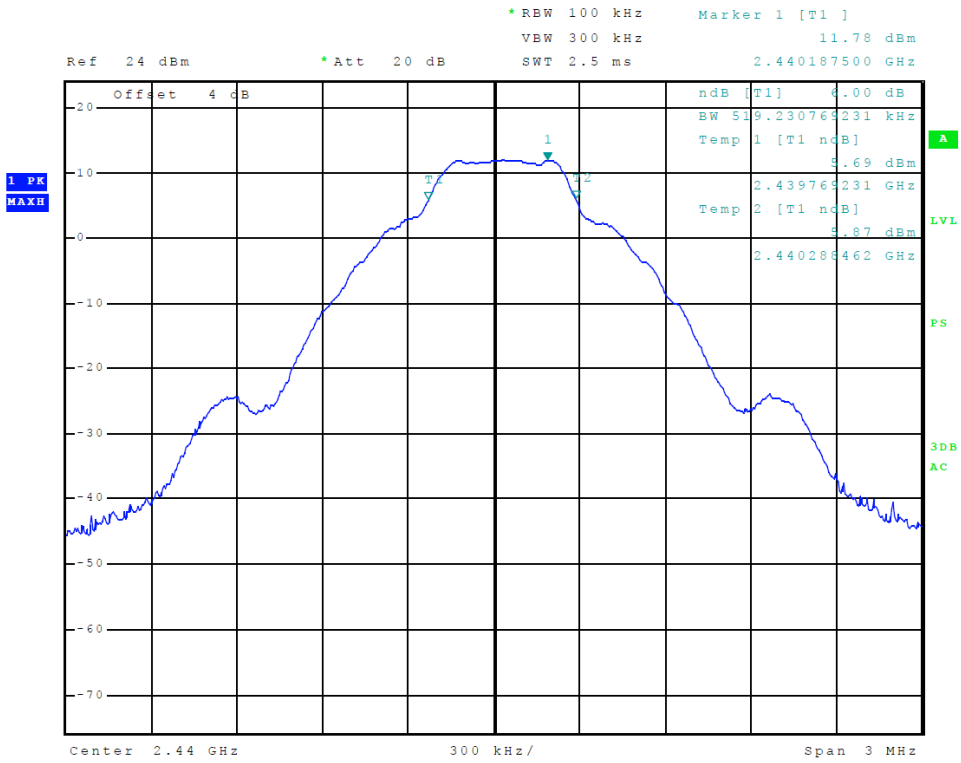


Figure 30 Plot of Transmitter Emissions 6-dB Occupied Bandwidth (mode 2, GFSK)

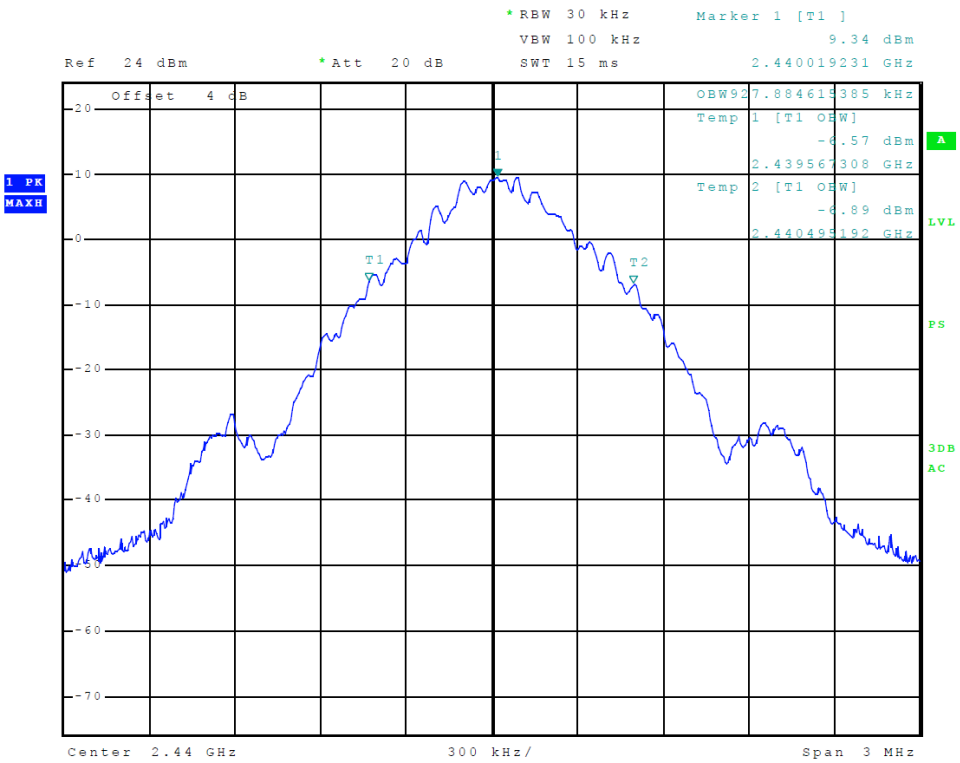


Figure 31 Plot of Transmitter Emissions 99% Occupied Bandwidth (mode 2, GFSK)

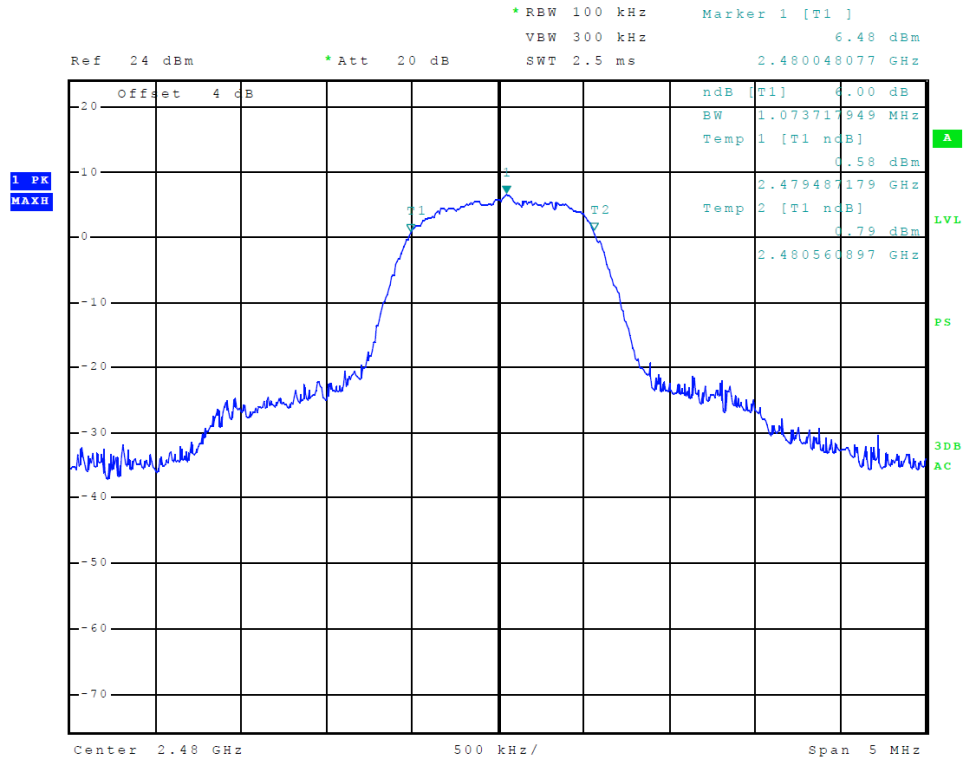


Figure 32 Plot of Transmitter Emissions 6-dB Occupied Bandwidth (mode 3, π/4-DQPSK)

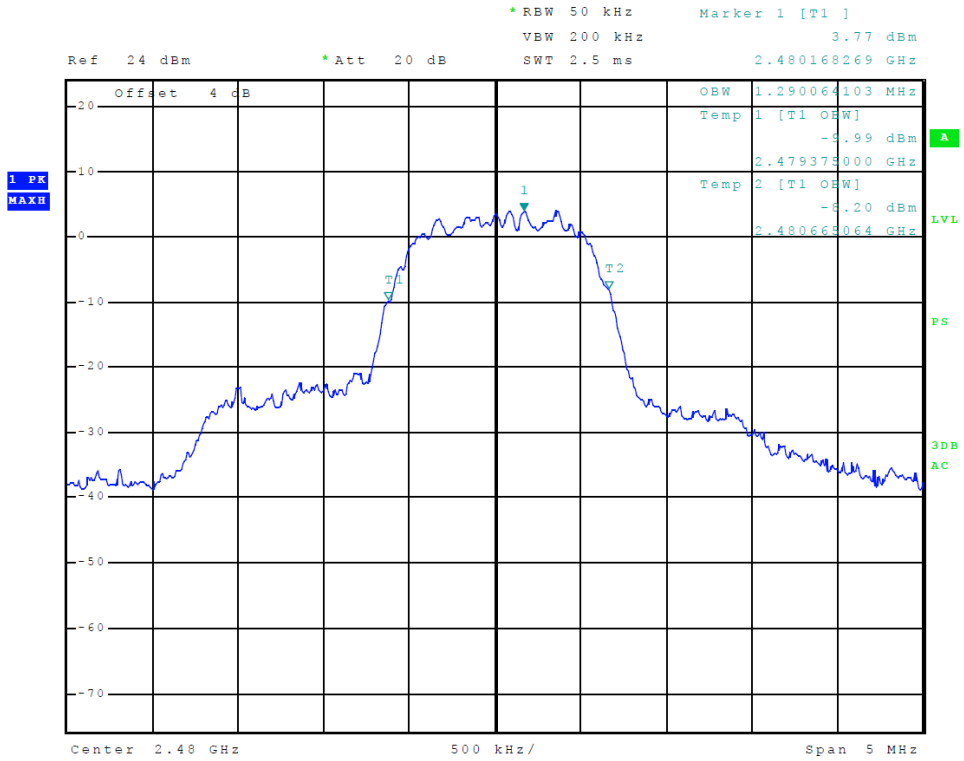


Figure 33 Plot of Transmitter Emissions 99% Occupied Bandwidth (mode 3, π/4-DQPSK)

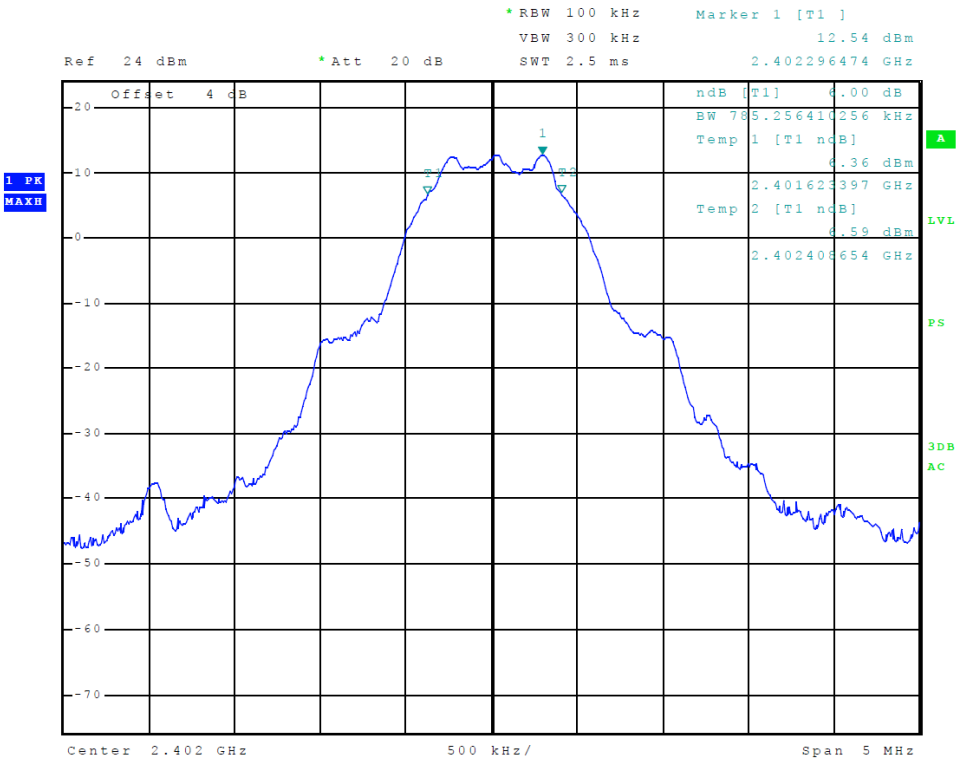


Figure 34 Plot of Transmitter Emissions 6-dB Occupied Bandwidth (mode 4, GMSK)

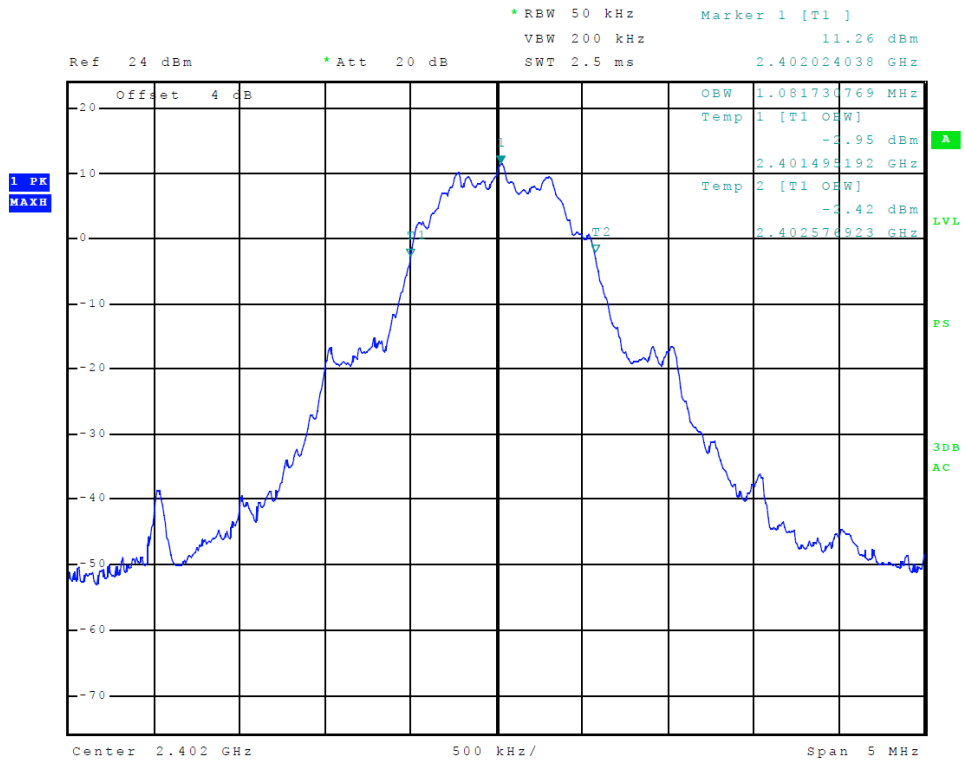


Figure 35 Plot of Transmitter Emissions 99% Occupied Bandwidth (mode 4, GMSK)

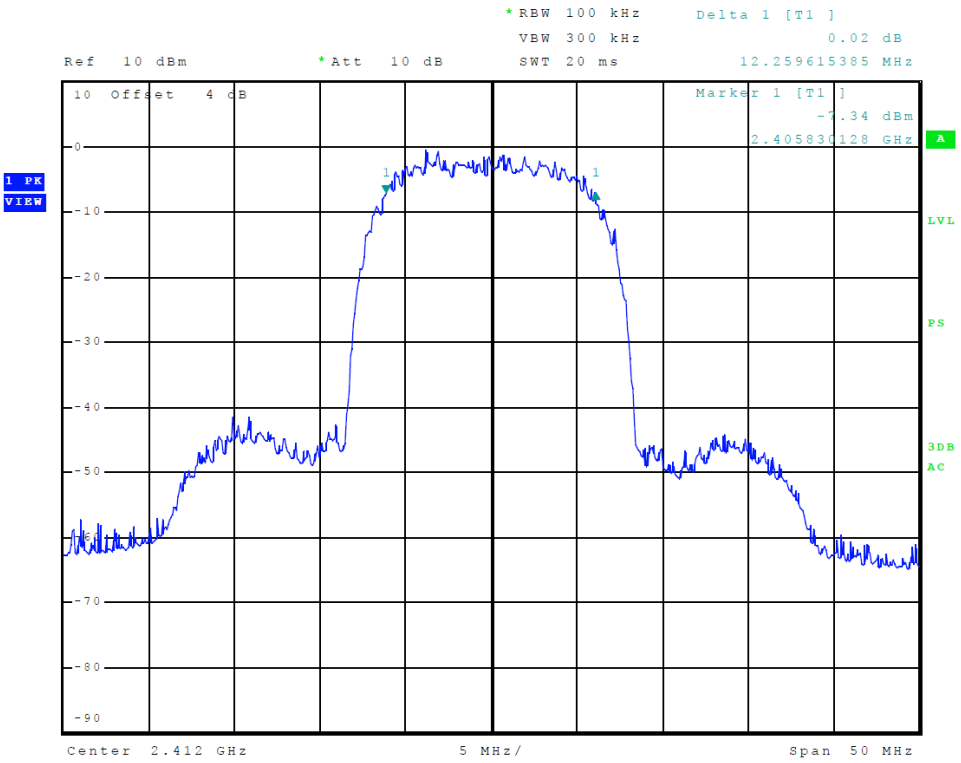


Figure 36 Plot of Transmitter Emissions 6-dB Occupied Bandwidth (mode 5, 802.11b)

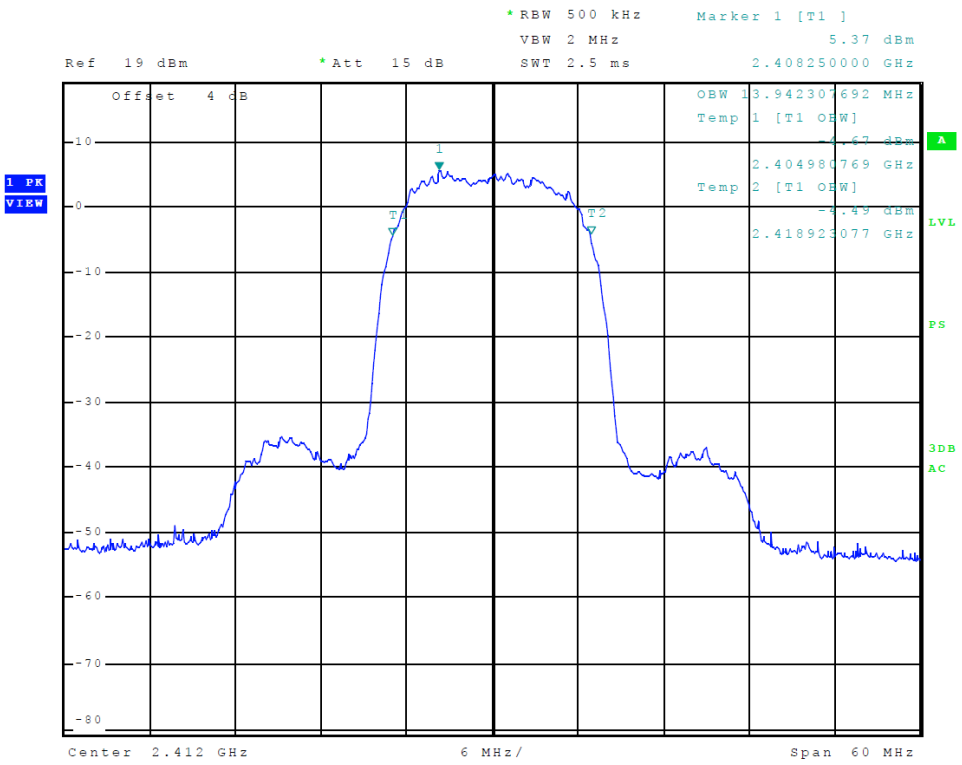


Figure 37 Plot of Transmitter Emissions 99% Occupied Bandwidth (mode 5, 802.11b)

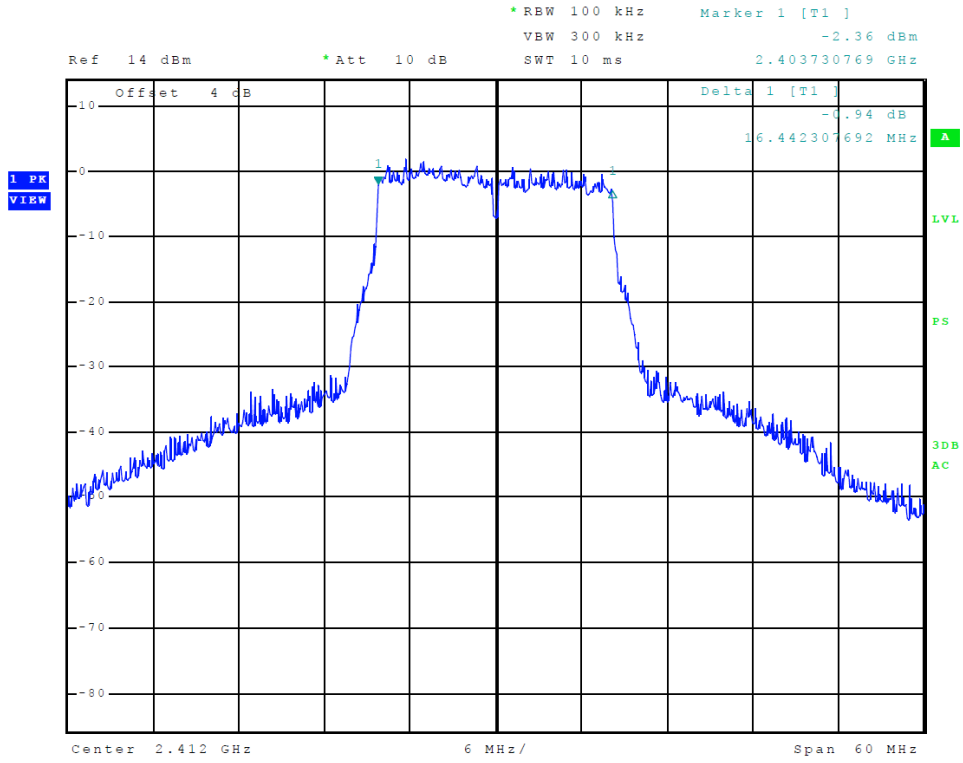


Figure 38 Plot of Transmitter Emissions 6-dB Occupied Bandwidth (mode 6, 802.11g)

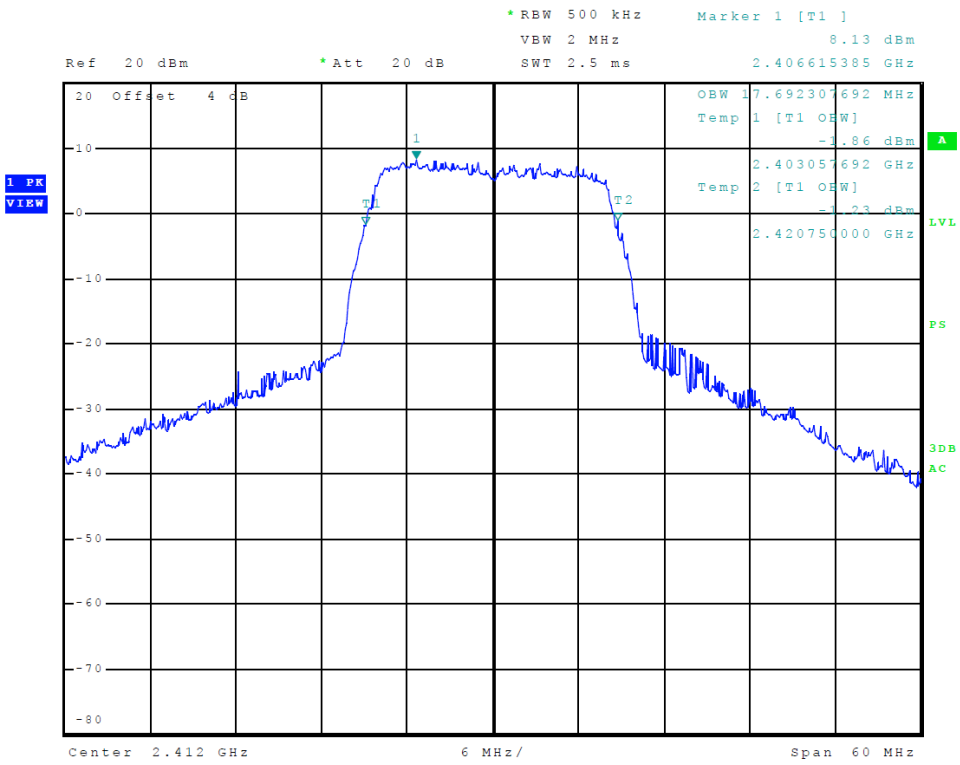


Figure 39 Plot of Transmitter Emissions 99% Occupied Bandwidth (mode 6, 802.11g)

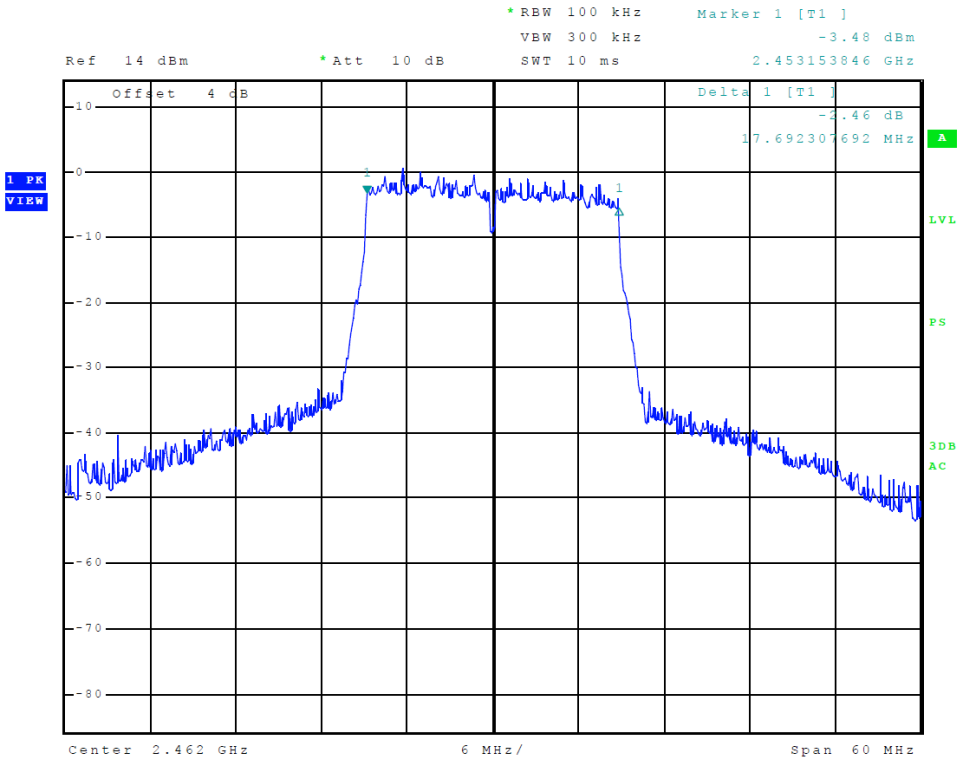


Figure 40 Plot of Transmitter Emissions 6-dB Occupied Bandwidth (mode 7, 802.11n)

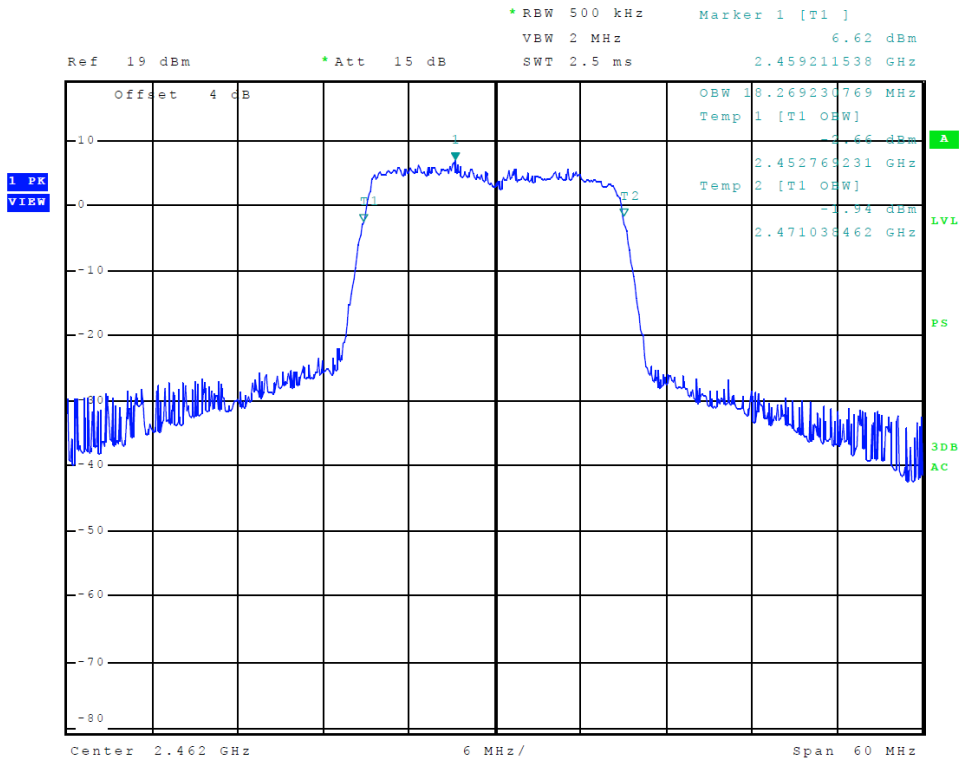


Figure 41 Plot of Transmitter Emissions 99% Occupied Bandwidth (mode 7, 802.11n)

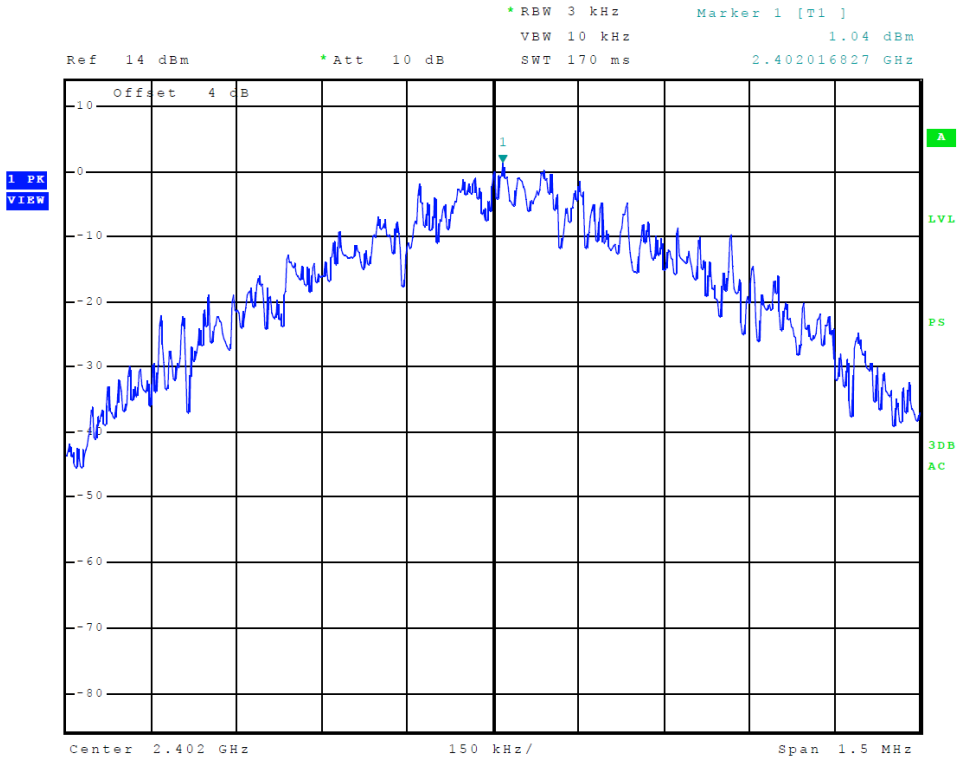


Figure 42 Plot of Transmitter Power Spectral Density (mode 1, GFSK)

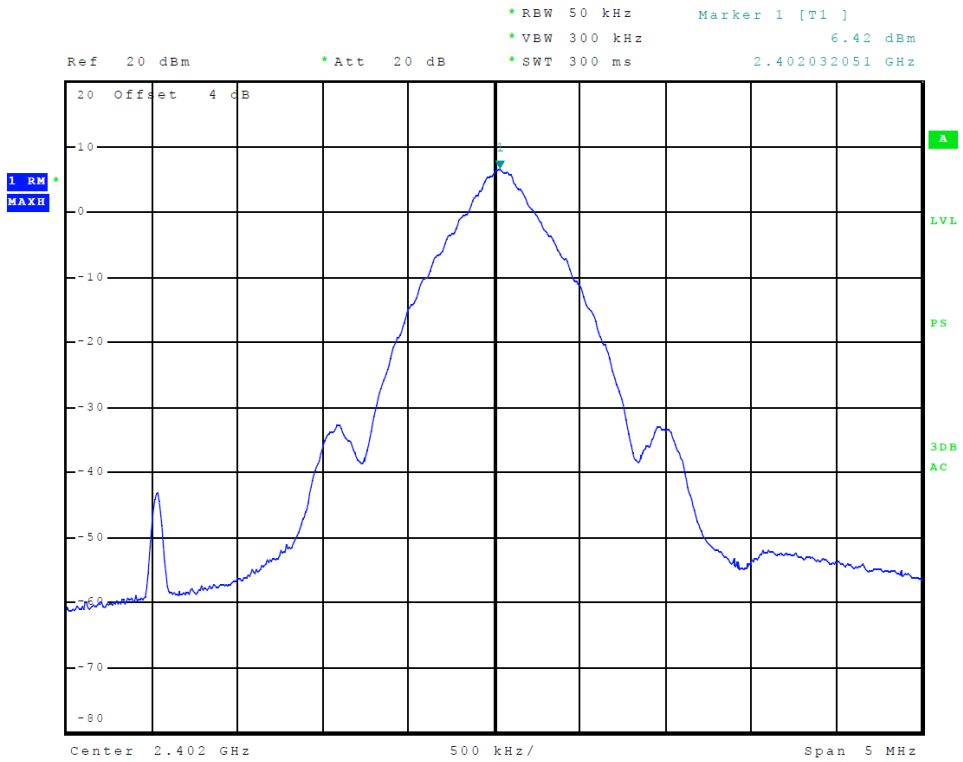


Figure 43 Plot of Transmitter Power Spectral Density (mode 2, GFSK)

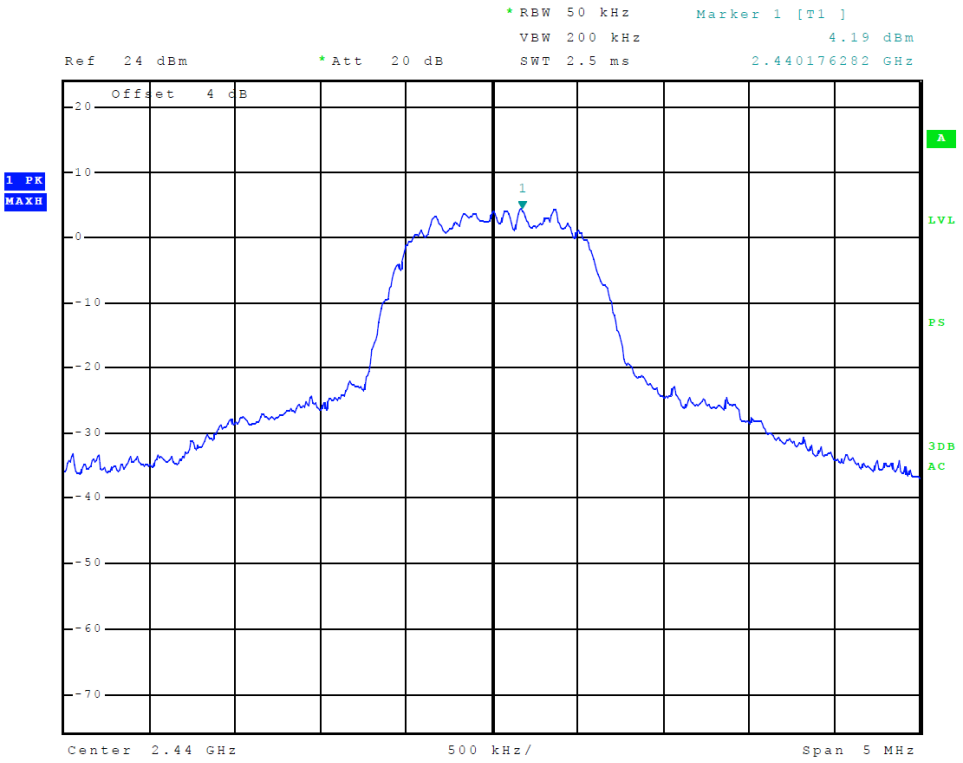


Figure 44 Plot of Transmitter Power Spectral Density (mode 3, π/4-DQPSK)

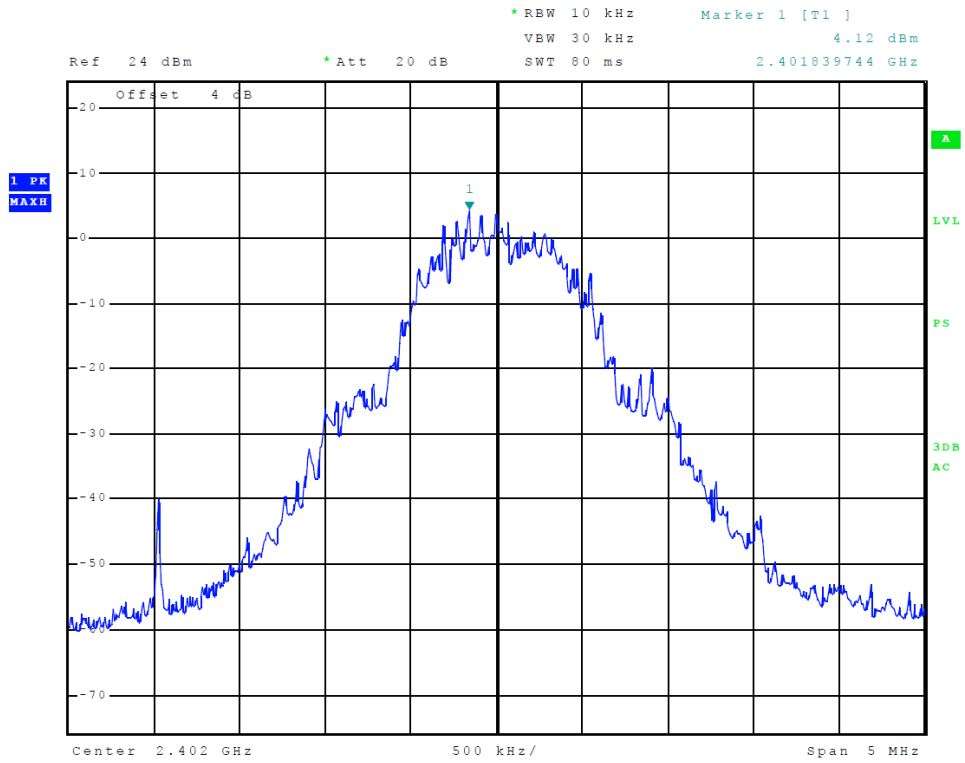


Figure 45 Plot of Transmitter Power Spectral Density (mode 4, GMSK)

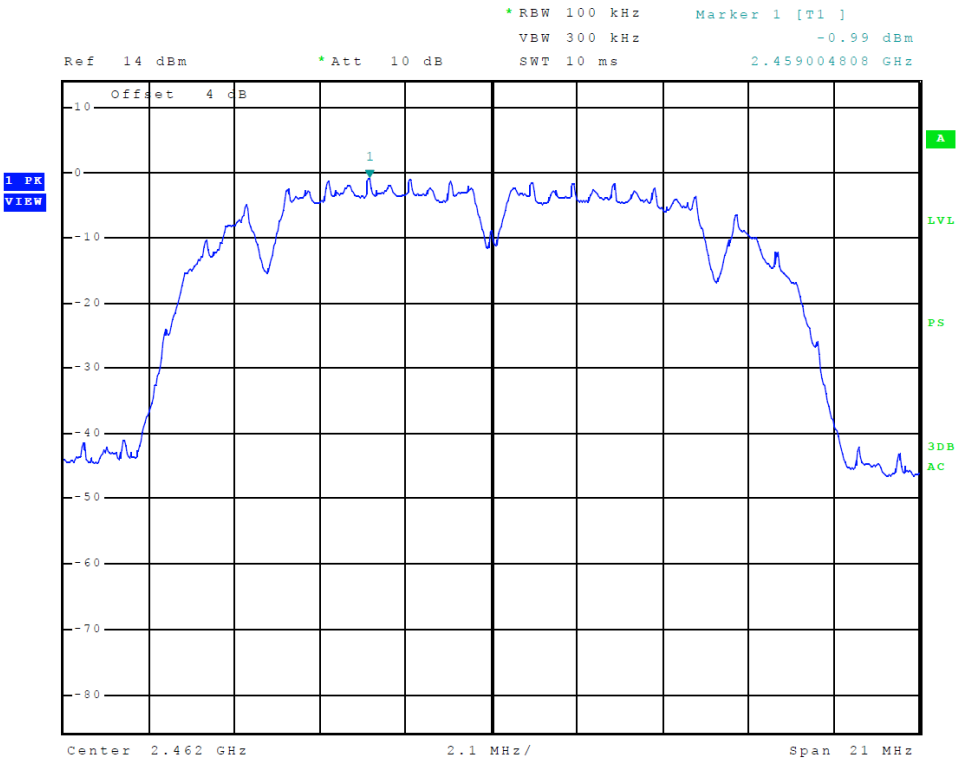


Figure 46 Plot of Transmitter Power Spectral Density (mode 5, 802.11b)

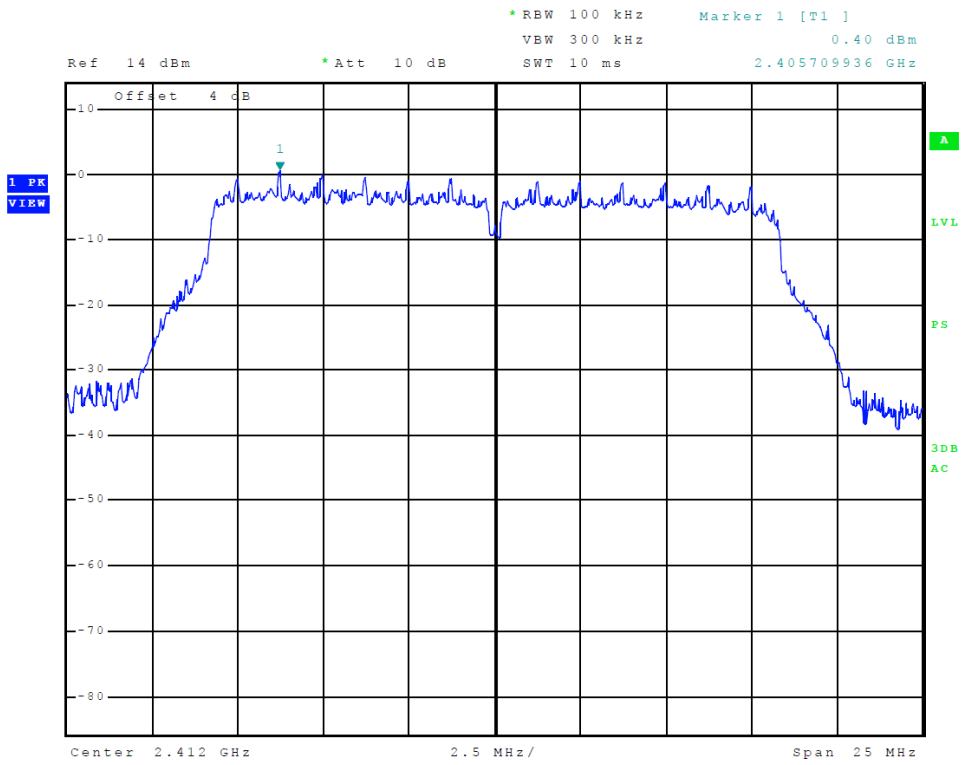


Figure 47 Plot of Transmitter Power Spectral Density (mode 6, 802.11g)

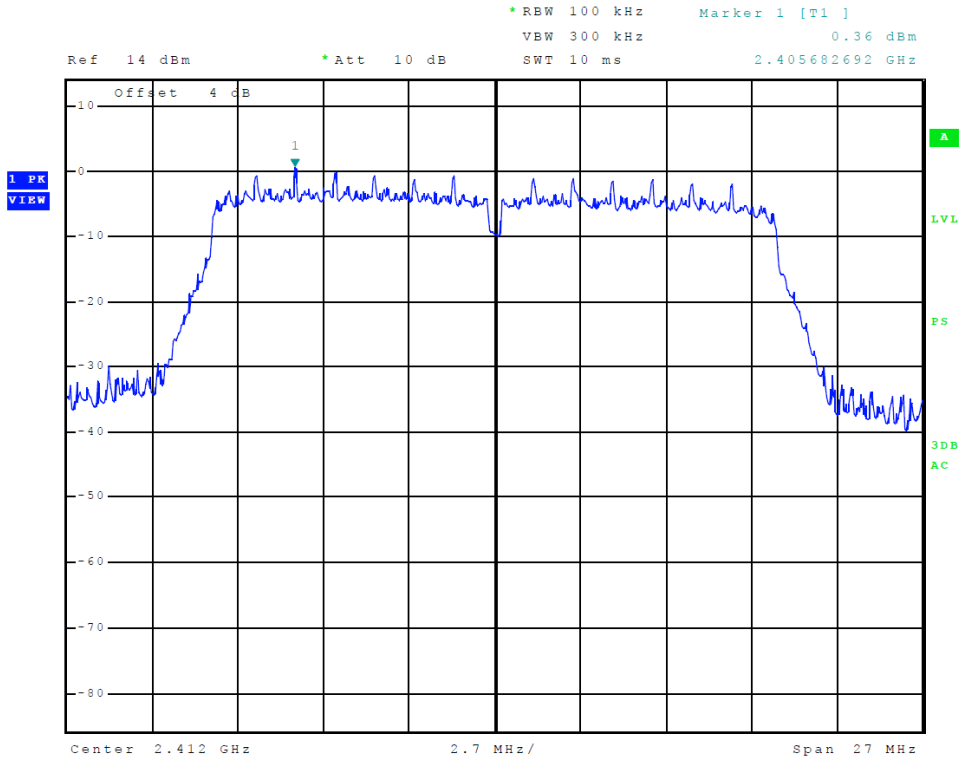


Figure 48 Plot of Transmitter Power Spectral Density (mode 7, 802.11n)

Transmitter Emissions Data

Table 15 Transmitter Radiated Emissions (mode 1, GFSK)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	--	--	--	--	--
4804.0	50.5	42.2	46.3	39.2	54.0
7206.0	52.3	40.5	49.5	39.2	54.0
9608.0	56.7	45.5	51.3	39.3	54.0
12010.0	56.0	43.3	54.6	41.3	54.0
14412.0	57.3	44.5	57.3	44.5	54.0
16814.0	61.1	48.0	61.4	48.1	54.0
2440.0	--	--	--	--	--
4880.0	50.4	40.5	48.1	35.8	54.0
7320.0	56.8	48.8	53.2	41.7	54.0
9760.0	56.5	44.6	54.9	41.8	54.0
12200.0	58.0	45.1	57.8	44.8	54.0
14640.0	59.3	46.5	59.3	46.5	54.0
17080.0	61.3	48.2	61.2	48.3	54.0
2480.0	--	--	--	--	--
4960.0	50.2	41.6	98.3	37.6	54.0
7440.0	55.5	46.9	52.4	39.9	54.0
9920.0	56.0	43.5	55.2	42.0	54.0
12400.0	57.9	44.6	57.7	44.7	54.0
14880.0	59.2	46.1	59.4	46.0	54.0
17360.0	61.3	48.0	61.4	47.9	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 16 Transmitter Radiated Emissions (mode 2, GFSK)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	--	--	--	--	--
4804.0	49.3	38.9	49.1	38.8	54.0
7206.0	51.0	37.9	50.6	38.0	54.0
9608.0	54.4	41.5	54.3	41.6	54.0
12010.0	56.0	42.9	55.7	43.0	54.0
14412.0	57.7	44.4	57.3	44.5	54.0
16814.0	60.8	47.9	61.3	48.1	54.0
2440.0	--	--	--	--	--
4880.0	50.2	40.7	49.2	38.0	54.0
7320.0	55.6	46.5	52.5	40.9	54.0
9760.0	55.2	42.4	53.5	41.1	54.0
12200.0	57.7	45.0	58.2	44.9	54.0
14640.0	59.2	46.4	59.4	46.4	54.0
17080.0	61.6	48.4	61.4	48.4	54.0
2480.0	--	--	--	--	--
4960.0	50.5	42.3	49.6	39.8	54.0
7440.0	54.3	44.7	52.6	40.2	54.0
9920.0	55.1	42.8	53.6	41.1	54.0
12400.0	57.4	44.4	57.1	44.2	54.0
14880.0	59.1	46.4	59.4	46.4	54.0
17360.0	61.9	48.4	61.5	48.4	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 17 Transmitter Radiated Emissions (mode 3, π/4-DQPSK)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	--	--	--	--	--
4804.0	47.7	34.2	47.1	34.3	54.0
7206.0	51.8	37.9	50.6	37.9	54.0
9608.0	54.4	41.2	54.0	41.2	54.0
12010.0	57.0	43.0	56.5	43.0	54.0
14412.0	57.8	44.6	57.9	44.5	54.0
16814.0	61.4	48.2	60.9	48.1	54.0
2440.0	--	--	--	--	--
4880.0	47.4	34.4	47.5	34.3	54.0
7320.0	51.0	38.5	50.9	38.5	54.0
9760.0	53.9	41.1	54.1	41.2	54.0
12200.0	57.8	44.8	57.7	44.8	54.0
14640.0	59.3	46.5	59.9	46.5	54.0
17080.0	61.8	48.3	61.5	48.3	54.0
2480.0	--	--	--	--	--
4960.0	47.2	34.2	46.8	34.2	54.0
7440.0	51.2	38.3	51.4	38.4	54.0
9920.0	54.0	41.1	54.5	41.1	54.0
12400.0	57.6	44.0	56.9	44.0	54.0
14880.0	59.2	46.5	59.2	46.5	54.0
17360.0	61.2	48.5	61.6	48.5	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 18 Transmitter Radiated Emissions (mode 4, GMSK)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	--	--	--	--	--
4804.0	47.6	33.9	50.5	39.3	54.0
7206.0	50.6	37.3	51.7	38.6	54.0
9608.0	52.4	39.8	54.1	41.3	54.0
12010.0	56.5	43.6	56.2	43.1	54.0
14412.0	58.2	45.4	57.9	44.6	54.0
16814.0	61.5	48.3	61.6	48.0	54.0
2440.0	--	--	--	--	--
4880.0	48.1	35.4	50.8	39.0	54.0
7320.0	52.0	38.6	53.3	39.7	54.0
9760.0	54.5	41.4	54.5	41.4	54.0
12200.0	57.8	44.8	57.7	44.8	54.0
14640.0	59.1	46.5	59.4	46.5	54.0
17080.0	61.7	48.3	61.2	48.3	54.0
2480.0	--	--	--	--	--
4960.0	49.3	36.3	49.8	37.7	54.0
7440.0	52.0	39.1	53.2	39.7	54.0
9920.0	54.2	41.3	54.3	41.3	54.0
12400.0	57.1	44.0	57.2	44.0	54.0
14880.0	59.3	46.3	59.3	46.3	54.0
17360.0	61.8	48.4	61.4	48.5	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 19 Transmitter Radiated Emission (mode 5, 802.11b)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2412.0	--	--	--	--	--
4824.0	47.0	34.0	47.4	34.2	54.0
7236.0	50.3	37.8	50.8	37.8	54.0
9648.0	54.4	41.2	54.2	41.4	54.0
12060.0	56.3	43.2	56.5	43.2	54.0
14472.0	57.8	44.8	58.2	44.8	54.0
16884.0	61.4	48.1	61.1	48.1	54.0
2437.0	--	--	--	--	--
4874.0	47.4	34.5	47..5	34.7	54.0
7311.0	52.1	38.6	51.7	38.6	54.0
9748.0	54.8	41.4	54.8	41.4	54.0
12185.0	58.0	45.0	57.7	45.0	54.0
14622.0	59.2	46.3	59.1	46.3	54.0
17059.0	61.2	48.8	61.9	48.8	54.0
2462.0	--	--	--	--	--
4924.0	46.7	34.1	47.2	34.0	54.0
7386.0	50.7	38.2	51.0	38.3	54.0
9848.0	54.2	41.3	54.7	41.3	54.0
12310.0	57.8	45.1	58.2	45.2	54.0
14772.0	59.9	46.4	59.6	46.4	54.0
17234.0	62.2	49.1	62.2	49.2	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 20 Transmitter Radiated Emission (mode 6, 802.11g)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2412.0	--	--	--	--	--
4824.0	47.4	34.2	47.8	34.2	54.0
7236.0	50.7	37.7	50.6	37.7	54.0
9648.0	53.8	41.1	54.0	41.3	54.0
12060.0	56.1	43.3	55.9	43.2	54.0
14472.0	57.7	44.8	58.1	44.7	54.0
16884.0	60.6	48.1	61.1	48.1	54.0
2437.0	--	--	--	--	--
4874.0	47.8	34.7	48.0	35.0	54.0
7311.0	51.2	38.5	51.2	38.5	54.0
9748.0	54.2	41.2	54.6	41.5	54.0
12185.0	58.0	44.9	57.7	44.9	54.0
14622.0	59.1	46.2	59.2	46.3	54.0
17059.0	61.6	48.5	62.0	49.3	54.0
2462.0	--	--	--	--	--
4924.0	47.5	34.0	47.1	33.8	54.0
7386.0	51.3	38.2	50.9	38.2	54.0
9848.0	54.4	41.3	54.1	41.4	54.0
12310.0	57.6	45.1	57.9	45.2	54.0
14772.0	59.0	46.4	59.4	46.3	54.0
17234.0	61.8	49.1	62.1	49.0	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 21 Transmitter Radiated Emission (mode 7, 802.11n)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2412.0	--	--	--	--	--
4824.0	46.7	34.1	47.3	34.1	54.0
7236.0	50.7	37.8	50.4	37.6	54.0
9648.0	54.6	41.3	54.1	41.0	54.0
12060.0	55.4	42.8	56.1	43.0	54.0
14472.0	58.1	44.8	57.3	44.7	54.0
16884.0	61.1	47.4	61.1	47.3	54.0
2437.0	--	--	--	--	--
4874.0	47.9	34.5	47.2	34.3	54.0
7311.0	51.1	38.3	51.4	38.4	54.0
9748.0	53.3	40.8	54.1	40.8	54.0
12185.0	58.4	44.9	57.6	44.7	54.0
14622.0	59.4	46.3	58.9	46.3	54.0
17059.0	62.2	49.4	62.1	49.5	54.0
2462.0	--	--	--	--	--
4924.0	46.8	33.9	46.9	33.9	54.0
7386.0	50.4	38.0	51.1	38.0	54.0
9848.0	54.0	40.9	53.9	40.9	54.0
12310.0	57.8	45.1	57.9	45.1	54.0
14772.0	59.3	46.3	59.5	46.3	54.0
17234.0	61.8	48.7	61.7	48.7	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 22 Transmitter Antenna Port Data (modes 1, 2, 3, and 4)

Frequency MHz	Antenna Port Output Peak / Average (Watts)	99% Occupied Bandwidth (kHz)	6-dB Occupied Bandwidth (kHz)	Peak Power Spectral Density (dBm)
Mode 1 (GFSK)				
2402	0.027 / 0.021	908.7	516.8	1.0
2440	0.023 / 0.019	855.8	516.8	0.5
2480	0.021 / 0.018	923.1	516.8	0.2
Mode 2 (GFSK)				
2402	0.027 / 0.020	836.5	514.4	7.0
2440	0.023 / 0.018	927.9	519.2	5.2
2480	0.021 / 0.016	927.9	514.4	3.5
Mode 3 (π/4 DQPSK)				
2402	0.015 / 0.010	1,250.0	1,081.7	3.1
2440	0.013 / 0.011	1,282.1	1,089.7	4.2
2480	0.013 / .0010	1,290.1	1,073.7	3.8
Mode 4 (GMSK)				
2402	0.026 / 0.023	1081.7	785.3	6.4
2440	0.025 / 0.021	1081.7	785.3	6.1
2480	0.023 / 0.019	1097.8	785.3	5.5

Table 23 Transmitter Antenna Port Data (modes 5, 6, and 7)

Frequency MHz	Antenna Port Output Peak / Average (Watts)	99% Occupied Bandwidth (kHz)	6-dB Occupied Bandwidth (kHz)	Peak Power Spectral Density (dBm)
Mode 5 802.11b				
2412	0.192 / 0.018	13,942.3	12,259.6	-0.6
2437	0.188 / 0.017	13,942.3	12,019.2	-0.5
2462	0.185 / 0.016	13,942.3	12,019.2	-1.0
Mode 6 802.11g				
2412	0.145 / 0.021	17,692.3	16,442.3	0.4
2437	0.151 / 0.021	17,500.0	16,442.7	0.0
2462	0.141 / 0.021	17,596.2	16,442.3	-0.4
Mode 7 802.11n				
2412	0.147 / 0.022	18,269.2	17,596.2	0.4
2437	0.145 / 0.021	18,269.2	17,403.8	0.1
2462	0.142 / 0.021	18,269.2	17,692.3	-0.3

Summary of Results for Transmitter Radiated Emissions of Intentional Radiator

The EUT demonstrated compliance with the radiated and conducted emission requirements of 47CFR Part 15.247, RSS-GEN, and RSS-247 Digital Transmission Systems. Peak Output power of 0.192 Watts was measured at the antenna port and average output power of 0.023 Watts. The peak power spectral density measured at the antenna port presented a minimum margin of -1.0 dB below the requirements. The EUT demonstrated a minimum margin of -4.5 dB below the harmonic emissions requirements. There were no other significantly measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the requirements. There were no other deviations or exceptions to the requirements.

Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Additional Test Equipment List
- Annex C Rogers Qualifications
- Annex D Rogers Labs Certificate of Accreditation

Annex A Measurement Uncertainty Calculations

The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16–4. Result of measurement uncertainty calculations are recorded below. Component and process variability of production devices similar to those tested may result in additional deviations. The manufacturer has the sole responsibility of continued compliance.

Measurement	Expanded Measurement Uncertainty $U_{(lab)}$
3 Meter Horizontal 0.009-1000 MHz Measurements	4.16
3 Meter Vertical 0.009-1000 MHz Measurements	4.33
3 Meter Measurements 1-18 GHz	5.14
3 Meter Measurements 18-40 GHz	5.16
10 Meter Horizontal Measurements 0.009-1000 MHz	4.15
10 Meter Vertical Measurements 0.009-1000 MHz	4.32
AC Line Conducted	1.75
Antenna Port Conducted power	1.17
Frequency Stability	1.00E-11
Temperature	1.6˚C
Humidity	3%

Annex B Additional Test Equipment List

List of Test Equipment	Calibration Date (m/d/y)	Due
Antenna: Schwarzbeck Model: BBA 9106/VHBB 9124 (9124-627)	5/2/2018	5/2/2019
Antenna: Schwarzbeck Model: VULP 9118 A (VULP 9118 A-534)	5/2/2018	5/2/2019
Antenna: EMCO 6509	10/24/2016	10/24/2018
Antenna: EMCO 3143 (9607-1277) 20-1200 MHz	5/2/2018	5/2/2019
Antenna: EMCO Dipole Set 3121C	2/23/2018	2/23/2019
Antenna: C.D. B-101	2/23/2018	2/23/2019
Antenna: Solar 9229-1 & 9230-1	2/23/2018	2/23/2019
Cable: Belden 8268 (L3)	10/24/2017	10/24/2018
Cable: Time Microwave: 4M-750HF290-750	10/24/2017	10/24/2018
Frequency Counter: Leader LDC-825 (8060153	5/2/2018	5/2/2019
Oscilloscope Scope: Tektronix 2230	2/23/2018	2/23/2019
Wattmeter: Bird 43 with Load Bird 8085	2/23/2018	2/23/2019
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/23/2018	2/23/2019
R.F. Generator: SMB100A6 s/n 100623	5/2/2018	5/2/2019
R.F. Generator: SBMBV100A s/n: 260771	5/2/2018	5/2/2019
R.F. Generators: HP 606A, HP 8614A, HP 8640B	2/23/2018	2/23/2019
R.F. Power Amp 65W Model: 470-A-1010	2/23/2018	2/23/2019
R.F. Power Amp 50W M185- 10-501	2/23/2018	2/23/2019
R.F. Power Amp A.R. Model: 10W 1010M7	2/23/2018	2/23/2019
R.F. Power Amp EIN Model: A301	2/23/2018	2/23/2019
LISN: Compliance Eng. Model 240/20	5/2/2018	5/2/2019
LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08	5/2/2018	5/2/2019
Audio Oscillator: H.P. 201CD	2/23/2018	2/23/2019
ESD Test Set 2010i	2/23/2018	2/23/2019
Oscilloscope Scope: Tektronix MDO 4104	2/23/2018	2/23/2019
EMC Transient Generator HVT TR 3000	2/23/2018	2/23/2019
AC Power Source (Ametech, California Instruments)	2/23/2018	2/23/2019
Fast Transient Burst Generator Model: EFT/B-101	2/23/2018	2/23/2019
Field Intensity Meter: EFM-018	2/23/2018	2/23/2019
KEYTEK Ecat Surge Generator	2/23/2018	2/23/2019
ESD Simulator: MZ-15	2/23/2018	2/23/2019
Shielded Room not required		

Annex C Rogers Qualifications

Scot D. Rogers, Engineer

Rogers Labs, Inc.

Mr. Rogers has approximately 27 years' experience in the field of electronics. Engineering experience includes six years in the automated controls industry and remaining years working with the design, development and testing of radio communications and electronic equipment.

Positions Held

Systems Engineer:	A/C Controls Mfg. Co., Inc.	6 Years
Electrical Engineer:	Rogers Consulting Labs, Inc.	5 Years
Electrical Engineer:	Rogers Labs, Inc.	Current

Educational Background

1) Bachelor of Science Degree in Electrical Engineering from Kansas State University.

2) Bachelor of Science Degree in Business Administration Kansas State University.

3) Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming.

Scot D Rogers
Scot D. Rogers

Annex D Rogers Labs Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200087-0

Rogers Labs, Inc.
Louisburg, KS

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2018-02-21 through 2019-03-31
Effective Dates

For the National Voluntary Laboratory Accreditation Program