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FCC/ISED Test Report

Prepared for: **Garmin International Inc.**

Address: **1200 E. 151st Street**
Olathe, Kansas, 66062, USA

Product: **A03626**

Test Report No: **R20191022-26-01B**

Approved by:

Nic S. Johnson, NCE
Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: **26 May 2020**

Total Pages: **42**

ilac-MRA A2LA ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	27 March 2020	Original – NJohnson Prepared by KVepuri/CFarrington
A	17 April 2020	Updated calibration table. Subtracted antenna gain from PSD measurements Includes NCEE Labs report R20191022-26-01 and its amendment in full. -NJ
B	26 May 2020	Subtracted antenna gain from power measurements Includes NCEE Labs report R20191022-26-01A and its amendment in full. -NJ

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. The EUT has been tested according to the following specifications:

APPLIED STANDARDS AND REGULATIONS		
Standard Section	**Test Type**	**Result**
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	NA
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Peak output power	Pass
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 4, Section 7.1	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 4, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 11.13	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 4, Section 7.1	Conducted Emissions	Pass

See Section 4 for details on the test methods used for each test.

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

EUT	A03626
EUT Received	25 November 2019
EUT Tested	25 November 2019 - 2 March 2020
Serial No.	3322745536
Operating Band	2400 – 2483.5 MHz
Device Type	GMSK
Power Supply	Internal Battery/ Charger: Garmin (Phi Hong) MN: LAC046

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency
Low	2402 MHz
Mid	2440 MHz
High	2480 MHz

These are the only three representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, middle and highest frequency channels.

The EUT was tested for spurious emissions while running off of battery power.

2.3 DESCRIPTION OF SUPPORT UNITS

None

3.0 LABORATORY DESCRIPTION

3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number:	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
NCC CAB Identification No:	US0177

Environmental conditions varied slightly throughout the tests:
Relative humidity of 35 ± 4%
Temperature of 22 ± 3° Celsius

3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE
1	Nic Johnson	Technical Manager	Review/editing
2	Karthik Vepuri	Test Engineer	Testing and report
3	Caleb Farrington	Test Engineer	Testing and report
4	Fox Lane	Test Technician	Testing and report
5	April Inamura	Test Technician	Testing and report

Notes:
All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.

3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer	N9038A	MY59050109	23 Apr 2019	23 Apr 2021
Keysight EXA Signal Analyzer	N9010A	MY56070862	14 Dec 2018	14 Dec 2020
Rohde & Schwarz Test Receiver	ES126	100037	30 Jan 2018	30 Jan 2021
SunAR RF Motion	JB1	A082918-1	15 Oct 2018	15 Oct 2020
EMCO Horn Antenna	3115	6416	10 Mar 2020	10 Mar 2022
EMCO Horn Antenna	3116	2576	09 Mar 2020	09 Mar 2022
EMCO Horn Antenna	3115	6416	26 Jan 2018	26 Jan 2021
EMCO Horn Antenna	3116	2576	26 Jan 2018	26 Jan 2021
Rohde & Schwarz Preamplifier	TS-PR18	3545700803	09 Mar 2018*	09 Mar 2021*
Trilithic High Pass Filter	6HC330	23042	09 Mar 2018*	09 Mar 2021*
Rohde & Schwarz LISN	ESH3-Z5	836679/010	26 Jul 2018	26 Jul 2019
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)	MFR-57500	01-07-002	09 Mar 2018*	09 Mar 2021*
RF Cable (antenna to 10m chamber bulkhead)	FSCM 64639	01E3872	09 Mar 2018*	09 Mar 2021*
RF Cable (10m chamber bulkhead to control room bulkhead)	FSCM 64639	01E3874	09 Mar 2018*	09 Mar 2021*
RF Cable (Control room bulkhead to RF switch)	FSCM 64639	01E3871	09 Mar 2018*	09 Mar 2021*
RF Cable (RF switch to test receiver)	FSCM 64639	01F1206	09 Mar 2018*	09 Mar 2021*
RF switch – Rohde and Schwarz	TS-RSP	1113.5503.14	09 Mar 2018*	09 Mar 2021*
N connector bulkhead (10m chamber)	PE9128	NCEEBH1	09 Mar 2018*	09 Mar 2021*
N connector bulkhead (control room)	PE9128	NCEEBH2	09 Mar 2018*	09 Mar 2021*

*Internal Characterization

Notes:
All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

4.0 DETAILED RESULTS

4.1 DUTY CYCLE

Test Method: NA

4.2 OUTPUT POWER

Test Method: ANSI C63.10:

1. Section(s) 11.9.1.1 “RBW ≥ DTS Bandwidth”

Limits of power measurements:
The maximum allowed peak output power is 30 dBm.

Test procedures:
The EUT was measured at 3m with 8 MHz RBW and 50 MHz VBW.

Deviations from test standard:
No deviation.

Test setup:

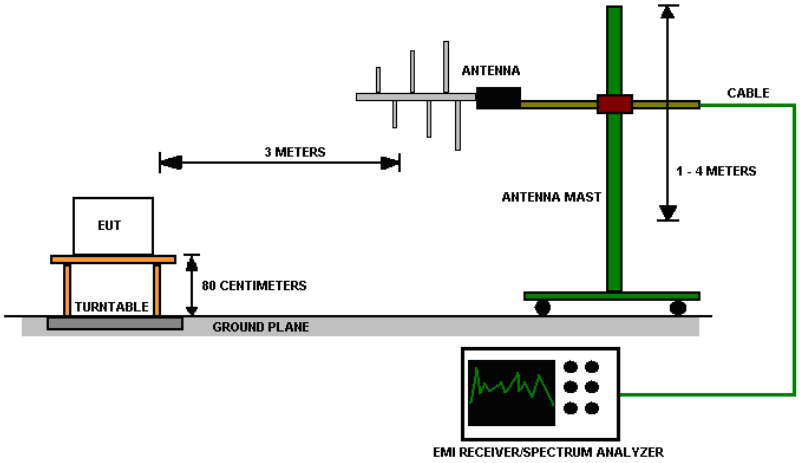


Figure 1 – Peak Output Power Measurements Test Setup

EUT operating conditions:
The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.

Test results:

The uncertainty for radiated peak power measurements is ±4.4 dB

Peak Output Power

CHANNEL	CHANNEL FREQUENCY (MHz)	EIRP PEAK OUTPUT POWER (dBm)	EIRP PEAK OUTPUT POWER (mW)	CONDUCTED PEAK OUTPUT POWER (dBm)	RESULT	TRANSMITTER
Low	2402	4.61	2.89	2.11	PASS	GMSK
Mid	2440	5.79	3.79	3.29	PASS	GMSK
High	2480	9.84	9.63	7.34	PASS	GMSK

*Peak conducted power = Peak EIRP power – antenna gain. Antenna gain = 2.5 dBi

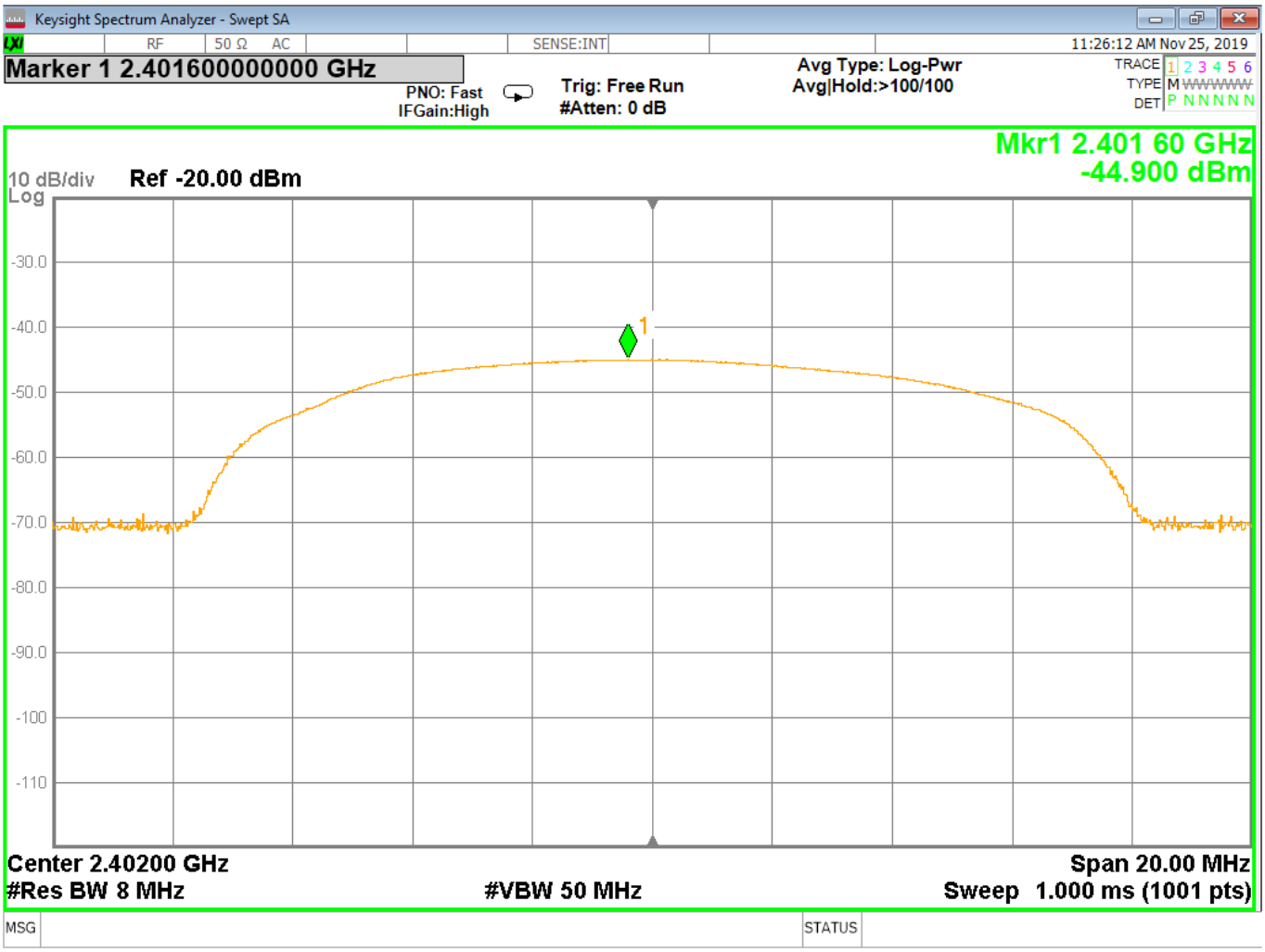


Figure 2 – Output Power, Low Channel, GMSK

EIRP Peak Output Power = -44.900 + 107 – 95.23 + AF + CL = 4.61

Output power = -44.900 dBm

AF = Antenna Factor = 28.36

CL = Cable Loss = 7.6

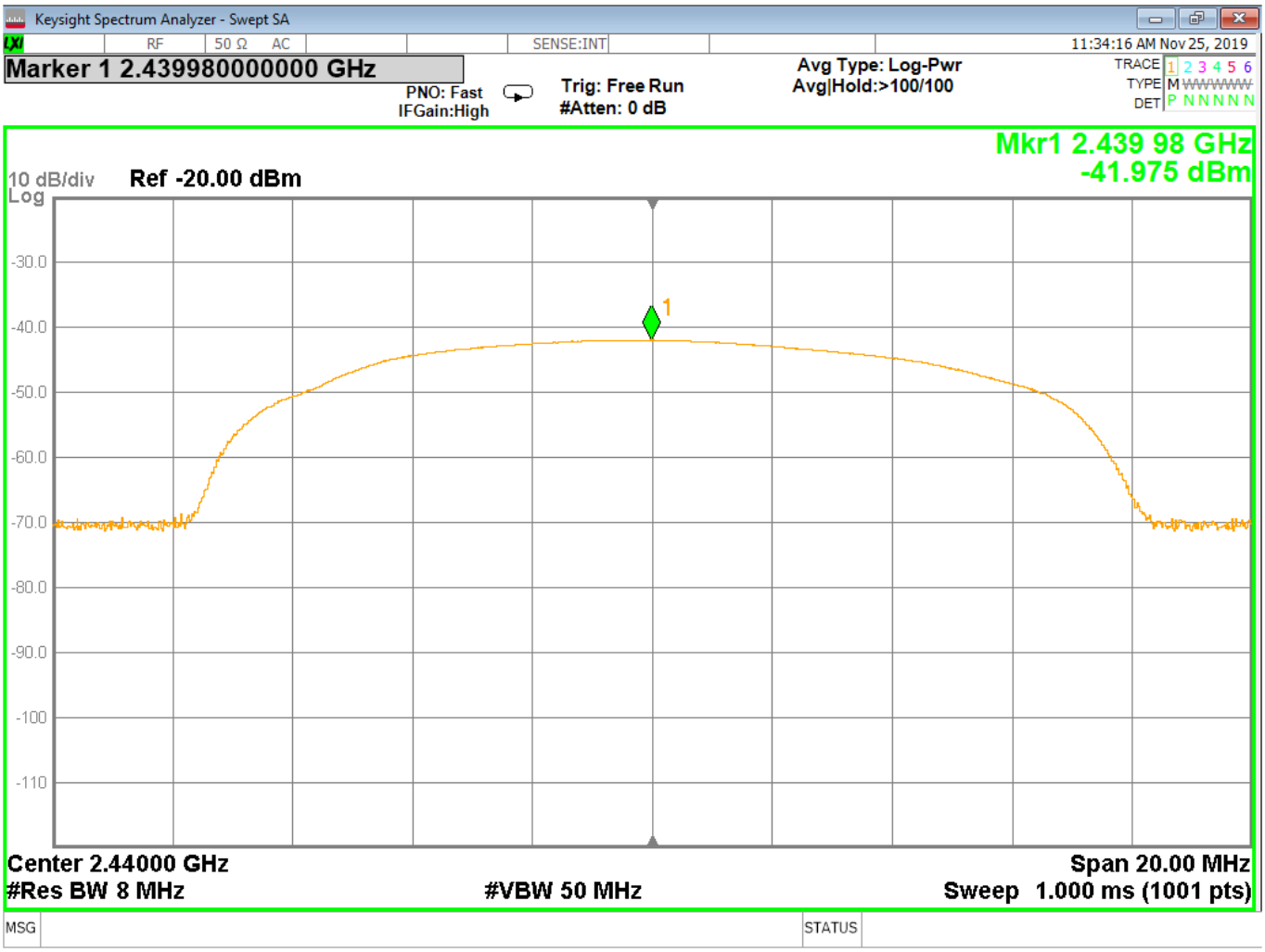


Figure 3 – Output Power, Mid Channel, GMSK

EIRP Peak Output Power = -41.975 + 107 – 95.23 + AF + CL = 5.795

Output power = -41.975dBm

AF = Antenna Factor = 28.3

CL = Cable Loss = 7.7

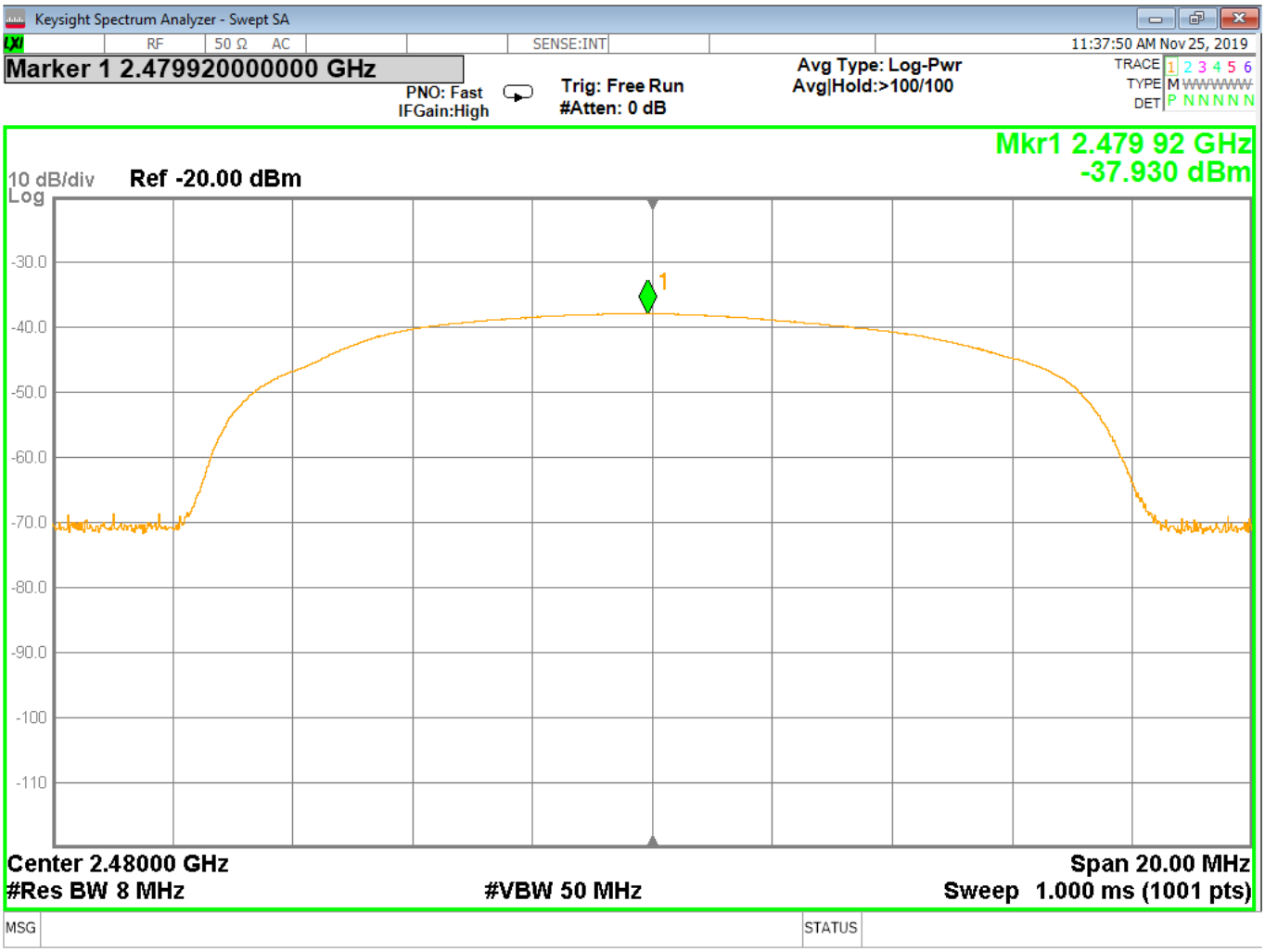


Figure 4 – Output Power, High Channel, GMSK

EIRP Peak Output Power = -37.930 + 107 – 95.23 + AF + CL = 9.84

Output power = -37.930 dBm

AF = Antenna Factor = 28.3

CL = Cable Loss = 7.7

4.3 BANDWIDTH

Test Method: ANSI C63.10,

1. Section(s) 11.8.2 “DTS Bandwidth, Option 2”
2. 6.9.2 “Occupied bandwidth—relative measurement procedure”
3. 6.9.3 “Occupied bandwidth—power bandwidth (99%) measurement procedure”

Limits of bandwidth measurements:
The 99% occupied bandwidth is displayed.

The 6dB bandwidth of the signal must be greater than 500 kHz.

Test procedures:
The EUT was measured at 3 meters. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 27 kHz RBW and 270 kHz VBW.

The measurement was recorded using the occupied bandwidth measurement mode on a spectrum analyzer. The 6 dB bandwidth was recorded using this function as well.

Deviations from test standard:
No deviation

Test setup:

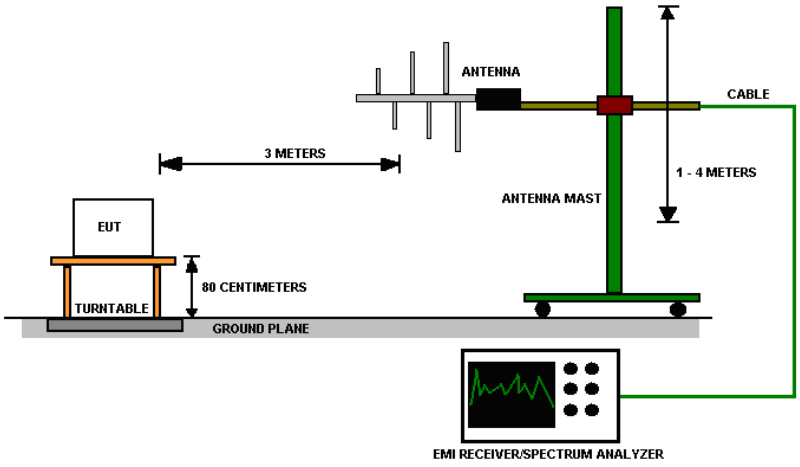


Figure 5 – Peak Output Power Measurements Test Setup

EUT operating conditions:
The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.

Test results:

Occupied Bandwidth

CHANNEL	Mode	CHANNEL FREQUENCY (MHz)	OBW (KHz)
Low	GMSK	2402	1039.7
Mid	GMSK	2440	1034.7
High	GMSK	2480	1033.3

6dB Bandwidth

CHANNEL	Mode	CHANNEL FREQUENCY (MHz)	OBW (KHz)	RESULT
Low	GMSK	2402	667.7	PASS
Mid	GMSK	2440	665.8	PASS
High	GMSK	2480	666.6	PASS

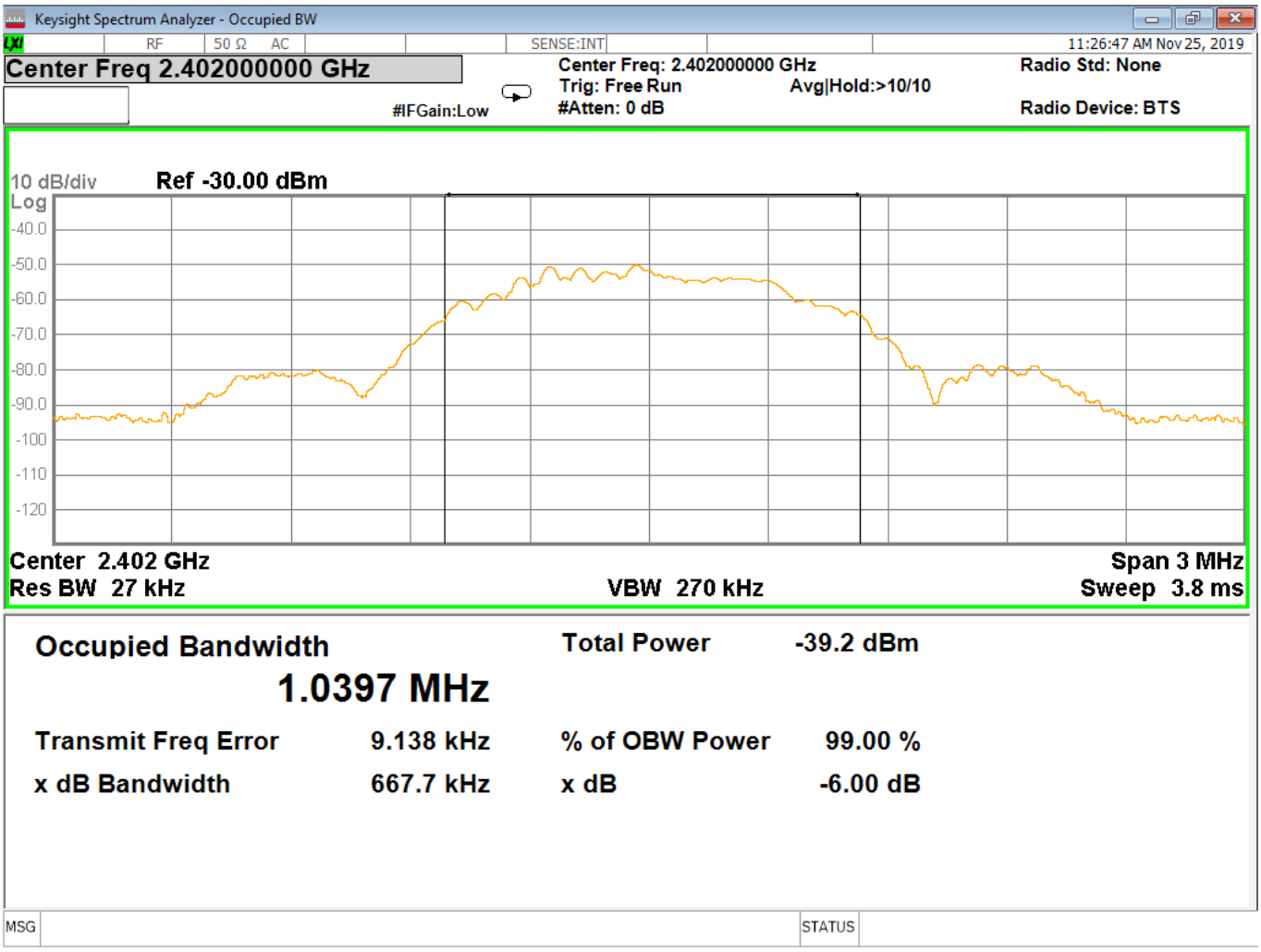


Figure 6 - Bandwidth, Low Channel, GMSK

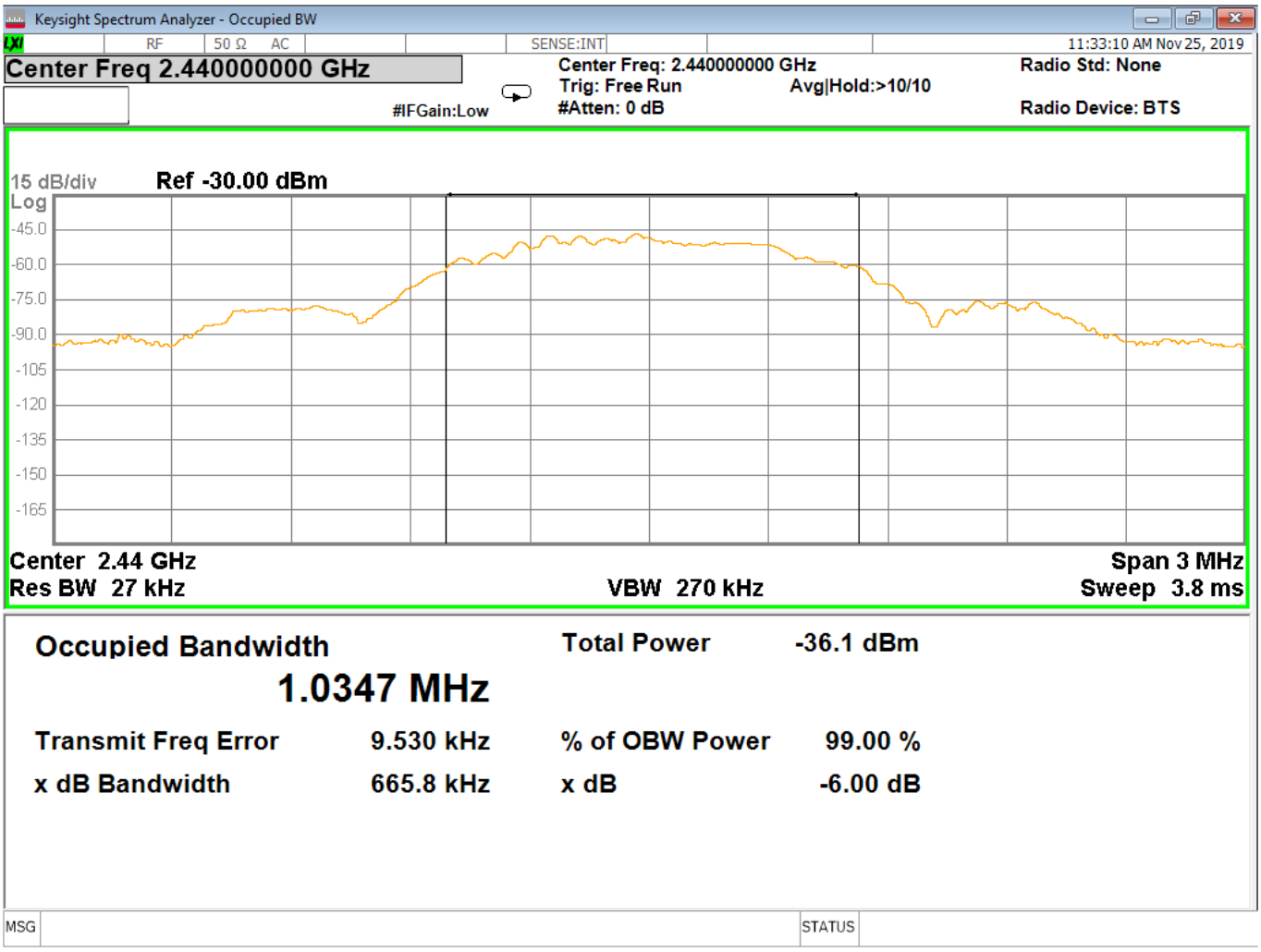


Figure 7 - Bandwidth, Mid Channel, GMSK

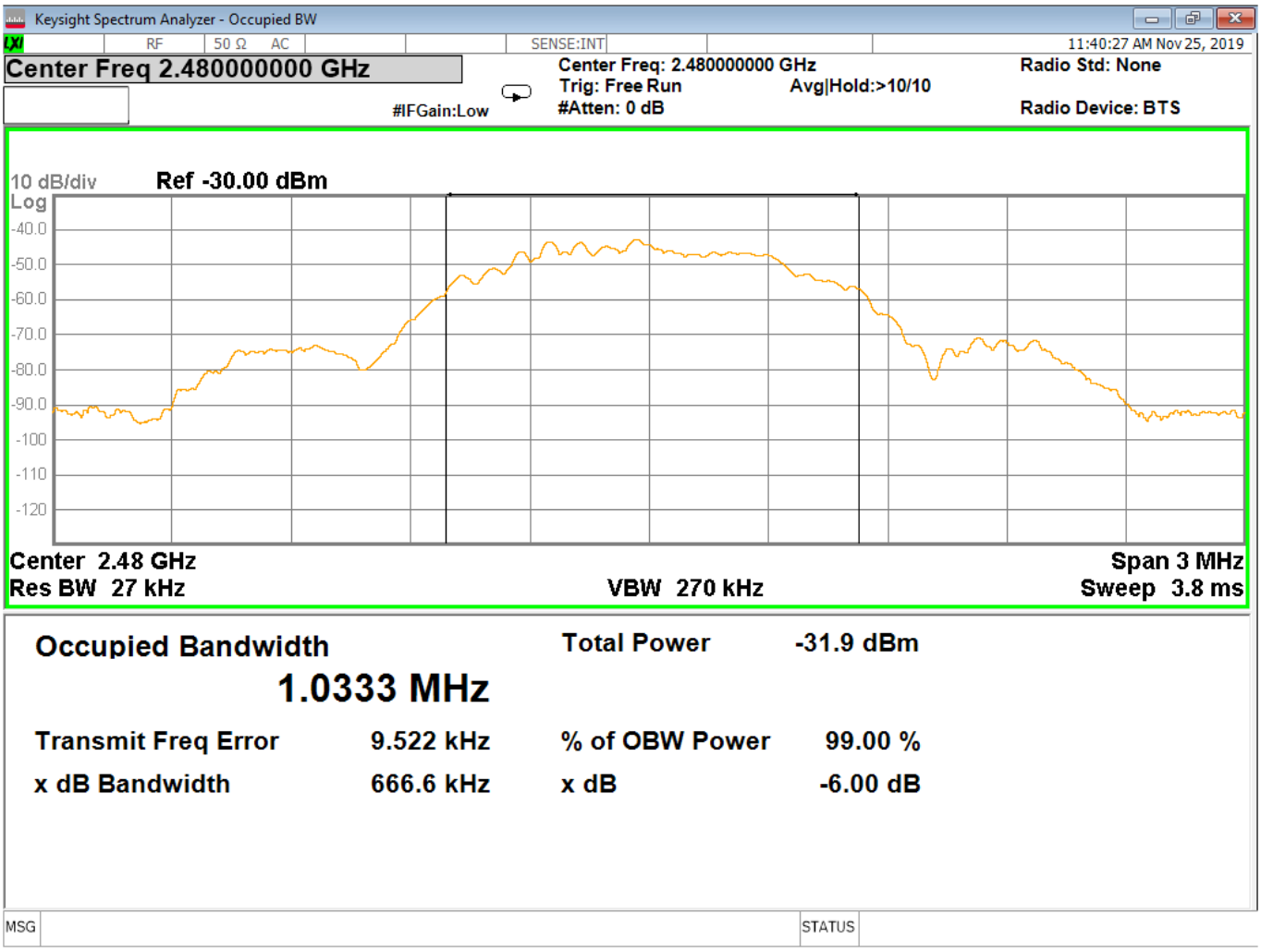


Figure 8 - Bandwidth, High Channel, GMSK

4.4 RADIATED EMISSIONS

Test Method: ANSI C63.10:2013:

1. Section 6.5, “Radiated emissions from unlicensed wireless devices in the frequency range of 30 MHz to 1000 MHz”
2. Section 6.6, “Radiated emissions from unlicensed wireless devices above 1 GHz”
3. Section 11.11, “Measurement in nonrestricted frequency bands”
4. Section 11.12, “Emissions in restricted bands”

Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note about requirement from FCC Part 15.247(d) and RSS-247, Section 5.5:
In addition to the limits shown above, all emissions were also required to be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. All measurements were performed with a 1 MHz bandwidth, but the bandwidth conversion from 1 MHz to 100 kHz would be equally applied to the highest emission and the spurious emissions, so it would not effect the delta measurement.

Since the fundamental emissions was at least 20 dB over the spurious emissions limits from 15.209 and all spurious emissions were below the 15.209 limit, this requirement was met.

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

Test procedures:

a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements form 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

No deviation.

Test setup:

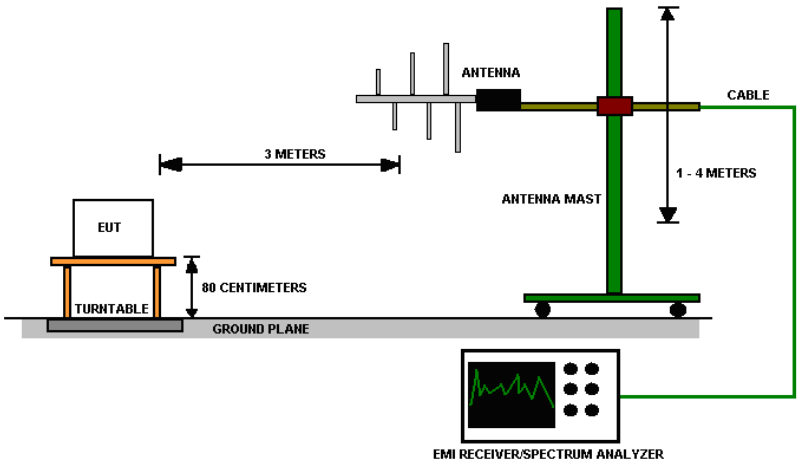


Figure 9 - Radiated Emissions Test Setup

EUT operating conditions
The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.

Test results:

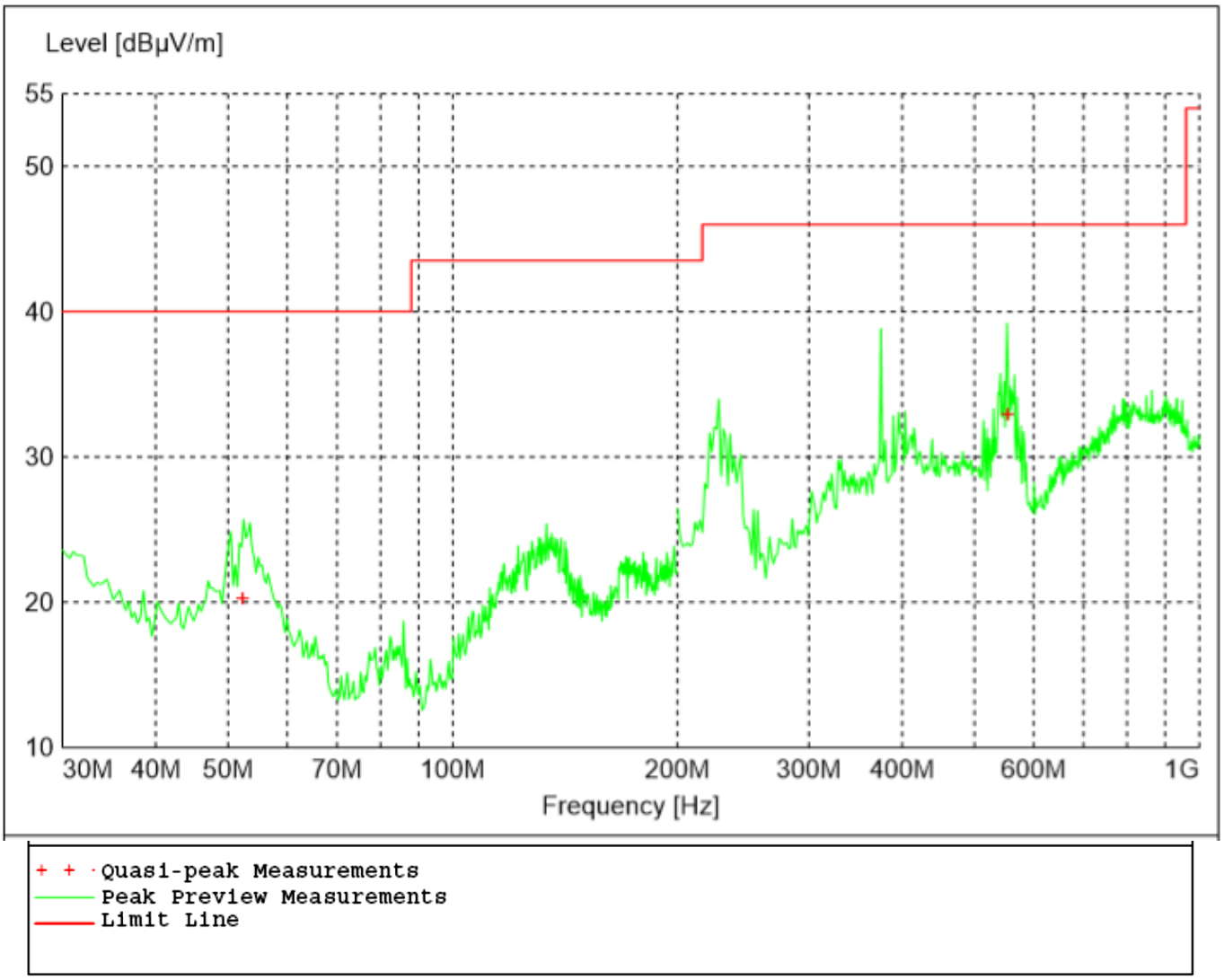


Figure 10 - Radiated Emissions Plot, GMSK

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value

Table 1 - Radiated Emissions Quasi-peak Measurements, GMSK

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
52.25000	20.24	40	19.8	111.0	9	VERT
553.92000	32.91	46	13.1	98.0	350	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 2 - Radiated Emissions Average Measurements, GMSK

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2402.000000	88.32	N/A	N/A	150	223	H
2440.000000	91.74	N/A	N/A	150	223	H
2480.000000	95.89	N/A	N/A	150	223	H

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 3 - Radiated Emissions Peak Measurements, GMSK

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2402.000000	93.68	N/A	N/A	150	223	H
2440.000000	96.98	N/A	N/A	150	223	H
2480.000000	101.06	N/A	N/A	150	223	H

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

4.5 POWER SPECTRAL DENSITY

Test Method: ANSI C63.10,
1. Section 11.10.2 “Method PKPSD (peak PSD)”

Limits of power measurements:
The maximum PSD allowed is 8 dBm.

Test procedures:
1. The EUT was measured at a distance of 3 meters.

2. The resolution bandwidth was set to 3 kHz and the video bandwidth was set to 10 kHz to capture the signal. The analyzer used a peak detector in max hold mode.

Test setup:

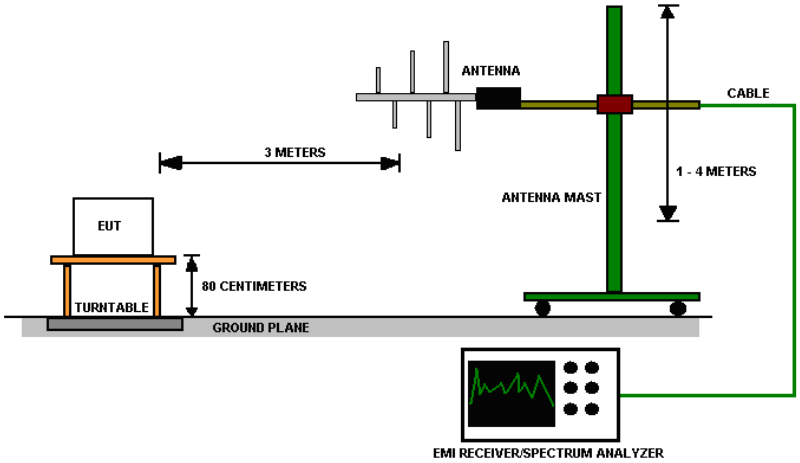


Figure 11 – Power Spectral Density Measurements Test Setup

EUT operating conditions:
The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.

Test results:

Power Spectral Density

CHANNEL	MODE	CHANNEL FREQUENCY (MHz)	PEAK EIRP PSD(dBm)	PEAK Conducted PSD(dBm)*	Limit (dBm)	RESULT
Low	GMSK	2402	-13.153	-15.65	8.00	PASS
Mid	GMSK	2441	-9.989	-12.489	8.00	PASS
High	GMSK	2480	-5.951	-8.45	8.00	PASS

*Peak Conducted = Peak EIRP – antenna gain
Antenna gain = 2.5 dBi

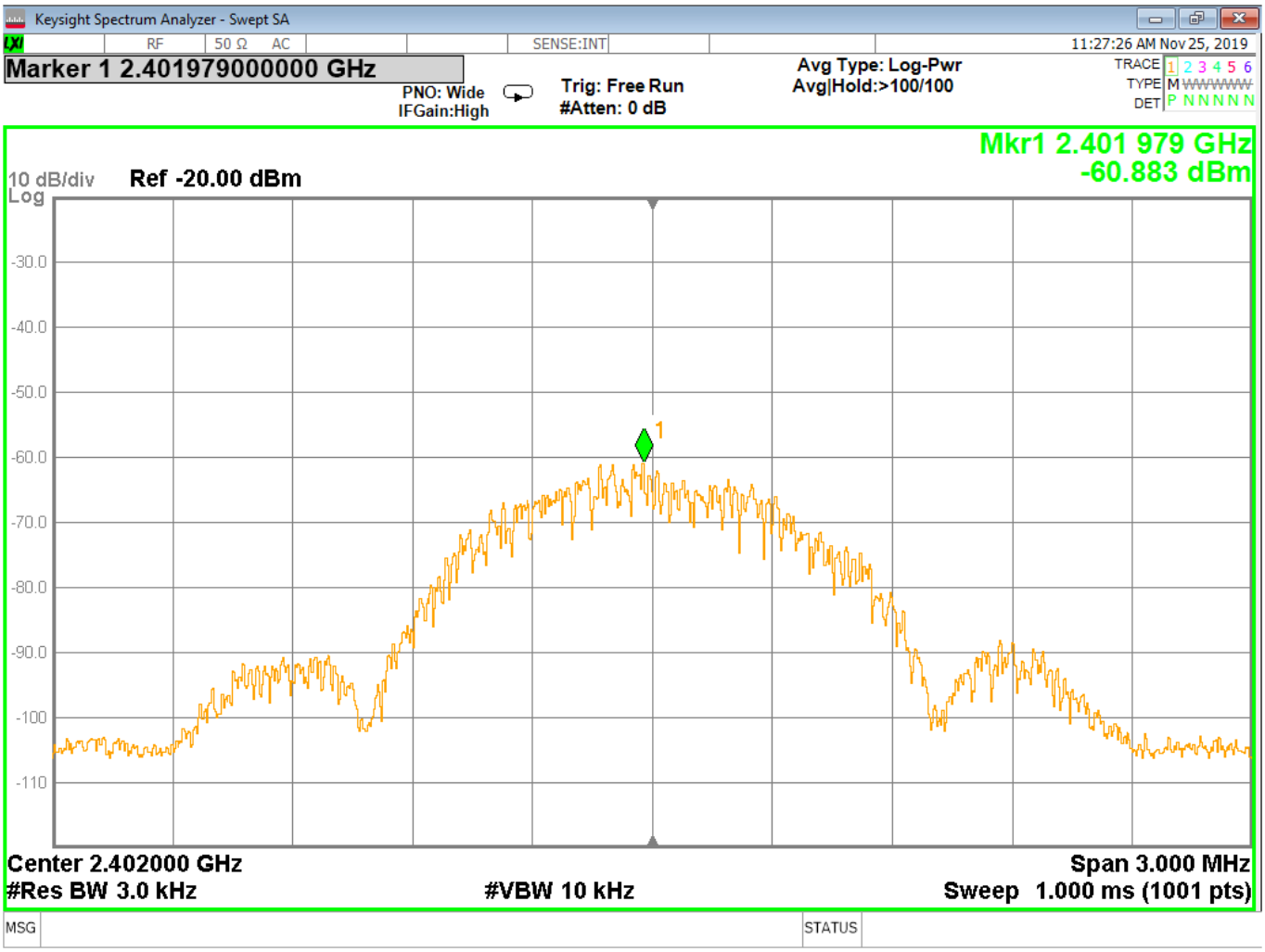


Figure 12 - Power Spectral Density, Low Channel, GMSK

Corrected Peak PSD = -60.883 + 107 – 95.23 + AF + CL = -13.153

Peak PSD = -60.883 dBm

AF = Antenna Factor = 28.36

CL = Cable Loss = 7.6

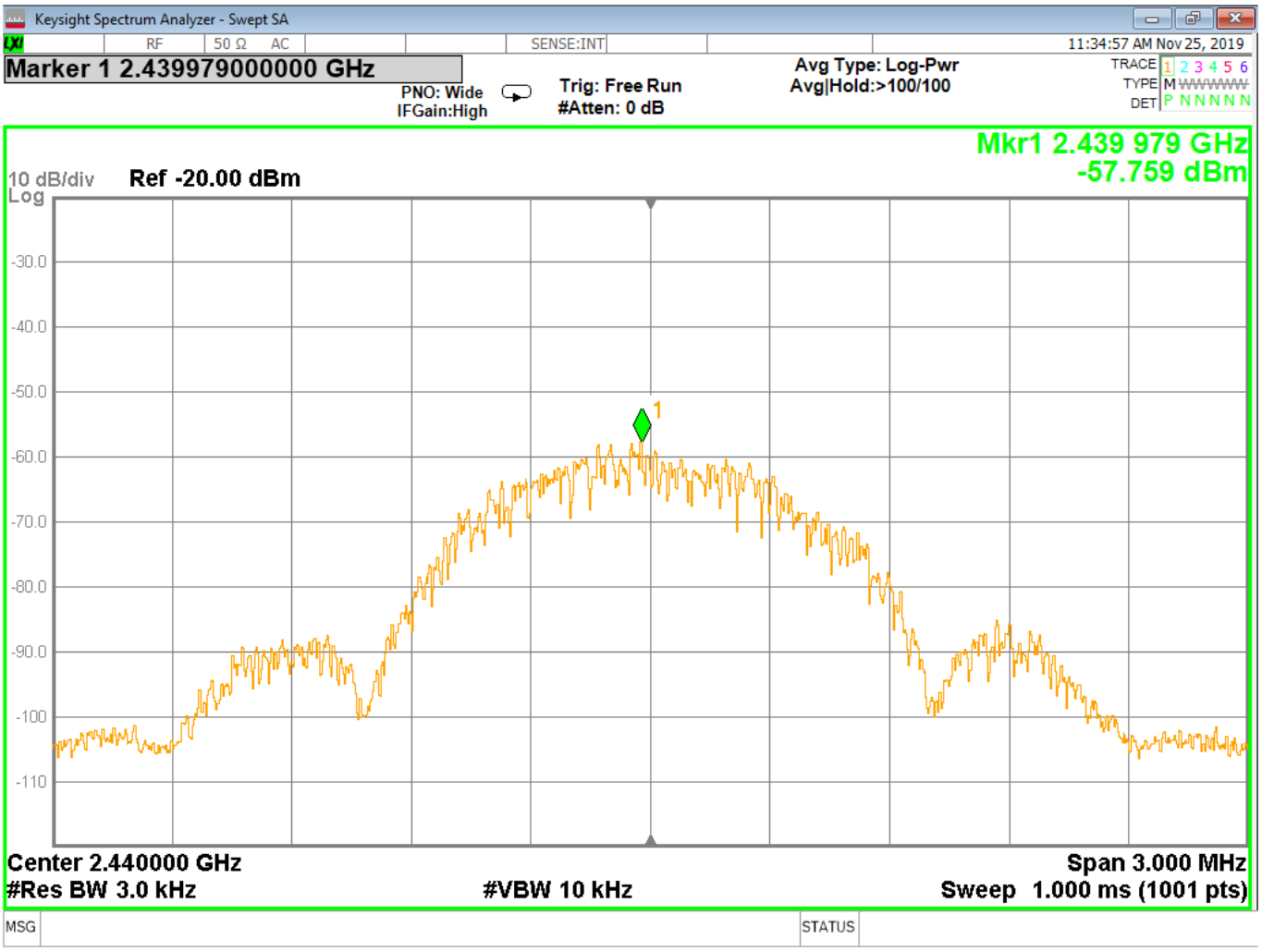


Figure 13 - Power Spectral Density, Mid Channel, GMSK

Corrected Peak PSD = -57.759 +107 – 95.23 + AF + CL = -9.989

Peak PSD = -57.759 dBm

AF = Antenna Factor = 28.3

CL = Cable Loss = 7.7

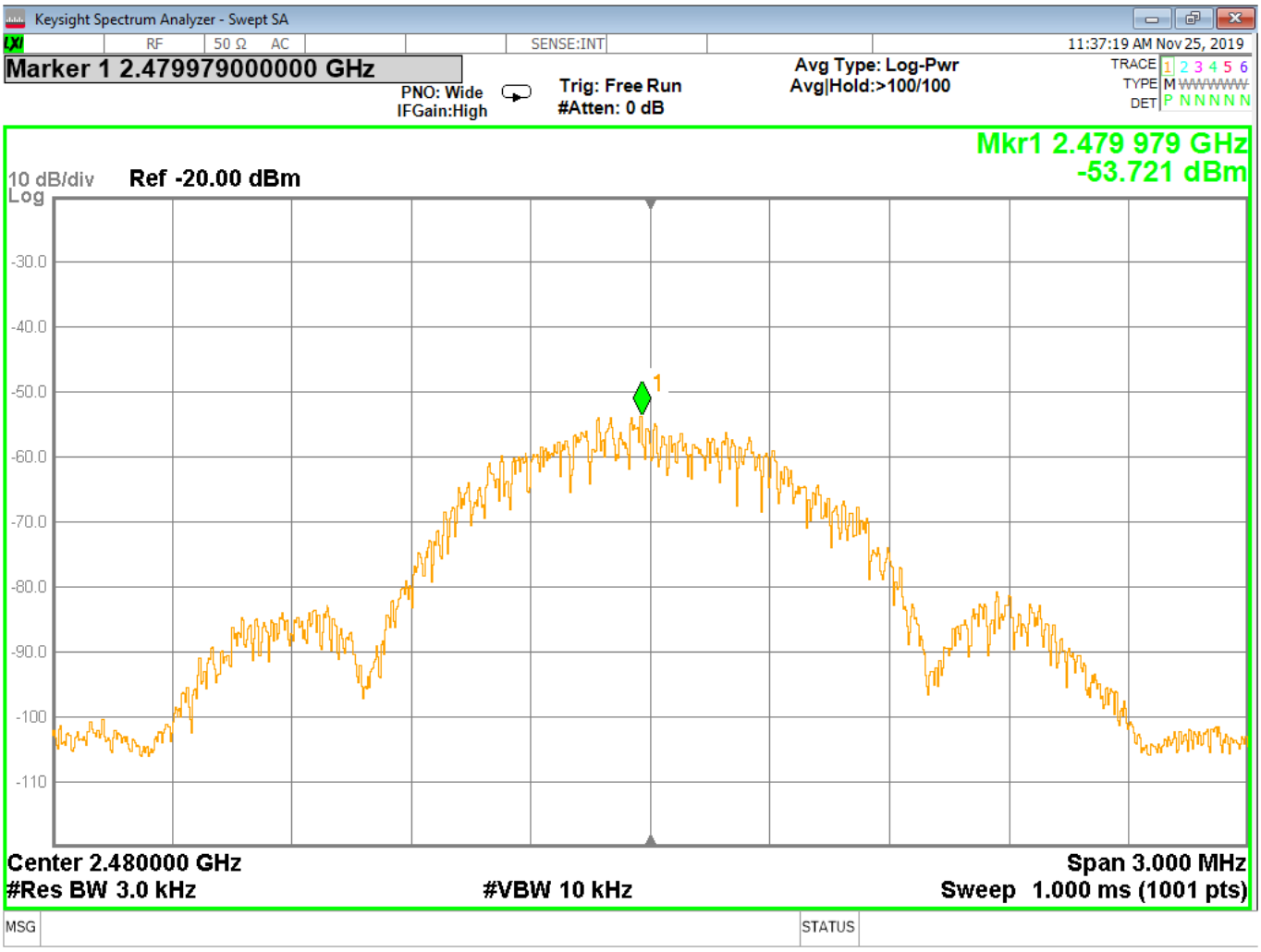


Figure 14 - Power Spectral Density, High Channel, GMSK

Corrected Peak PSD = -53.721 + 107 – 95.23 + AF + CL = -5.951

Peak PSD = -53.721 dBm

AF = Antenna Factor = 28.3

CL = Cable Loss = 7.7

4.6 BAND-EDGES

Test Method: ANSI C63.10-2013, Section(s) 11.13.2, 6.10.6

Limits of band-edge measurements:
For emissions outside of the allowed band of operation, the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

Test procedures:
Measurements were performed at a distance of 3 meters. The resolution bandwidth was set to 100kHz and the EMI receiver was used to scan from the band-edge to the fundamental frequency with a peak detector. The highest emissions level beyond the band-edge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209.

To calculate the level at the band-edge frequencies, the difference between the peak and the band edge level was subtracted from the peak radiated value at the fundamental. This value was compared to the 15.209 radiated limits for compliance.

Deviations from test standard:
No deviation.

Test setup:

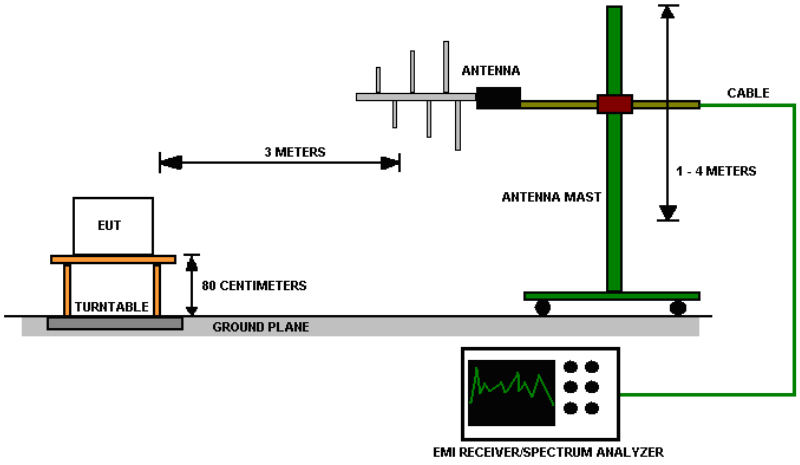


Figure 15 – Band-Edge Measurement Test Setup

EUT operating conditions:
The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.

Test results:

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level dBm	Relative Fundamental dBm	Delta (dB)	Min Delta (dB)	Result
Low, Continuous (restricted)	GMSK	2390	-88.515	-46.202	42.313	39.68	PASS
High, Continuous (restricted)	GMSK	2483.5	-88.515	-38.993	49.522	47.06	PASS
Low, Continuous (unrestricted)	GMSK	2400	-88	-46.202	41.798	20	PASS
High, Continuous (unrestricted)	GMSK	2483.5	-88	-38.993	49.007	20	PASS

*Minimum delta = [highest fundamental peak field strength from Section 4.2] – [Part 15.209 radiated emissions limit.]

From Section 4.2

Fundamental frequency reference values:

CHANNEL	Mode	Peak Field Strength (dBuV/m)	Field Strength Limit (dBuV/m)	Min Delta (dBc)	Result
Low	GMSK	93.68	54.00	39.68	PASS
High	GSMK	101.06	54.00	47.06	PASS

*Min Delta = Peak Field Strength – Field Strength Limit

FCC Part 15.249 requires the attenuation of all emissions outside of the specified band to be at least 50 dB or below the 15.209 limits, whichever is the lesser. In this case, the 15.209 limits were the lesser and used to show compliance.

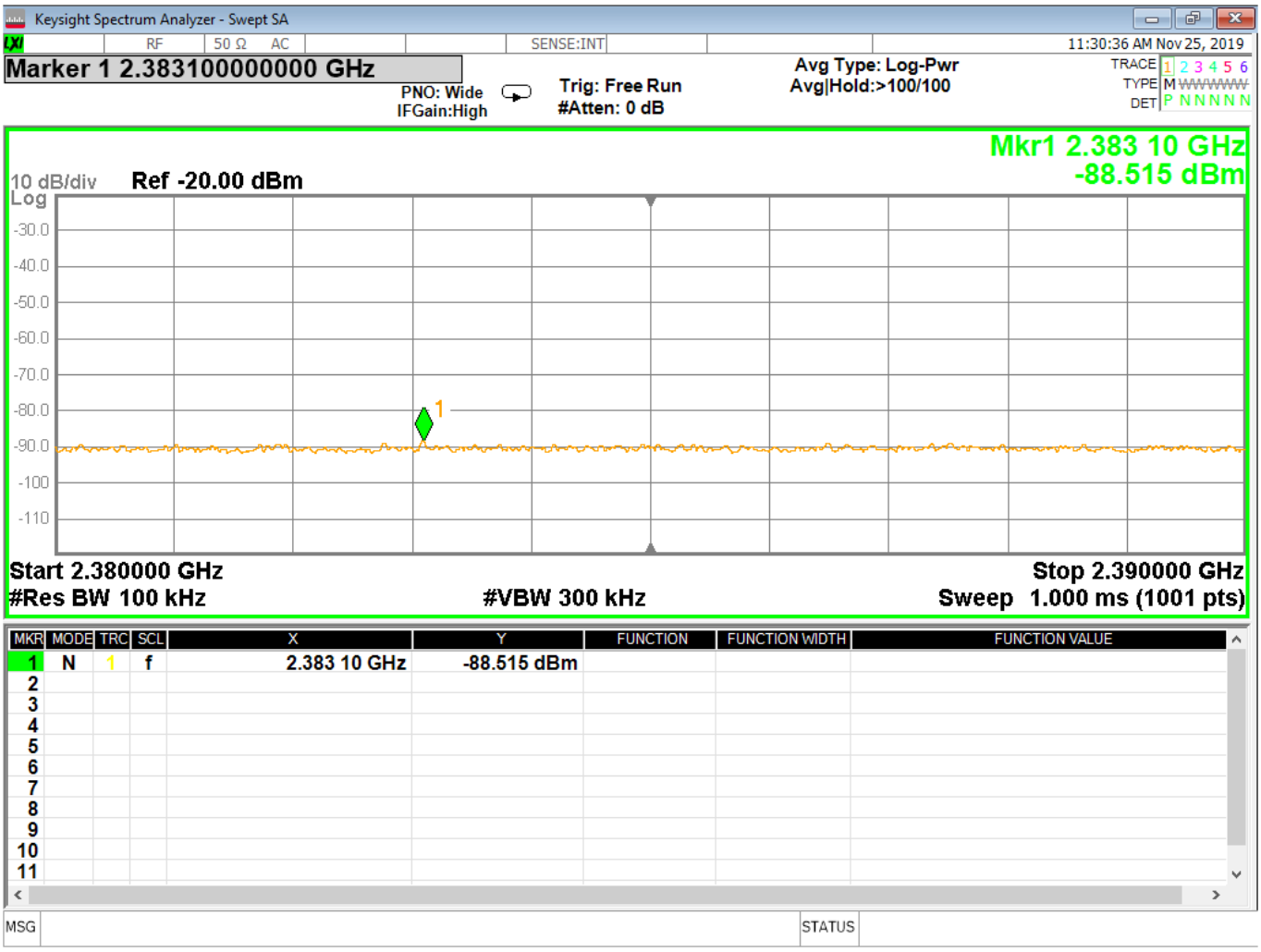


Figure 16 - Band-edge Measurement, Low Channel, Restricted Frequency, Peak, GMSK

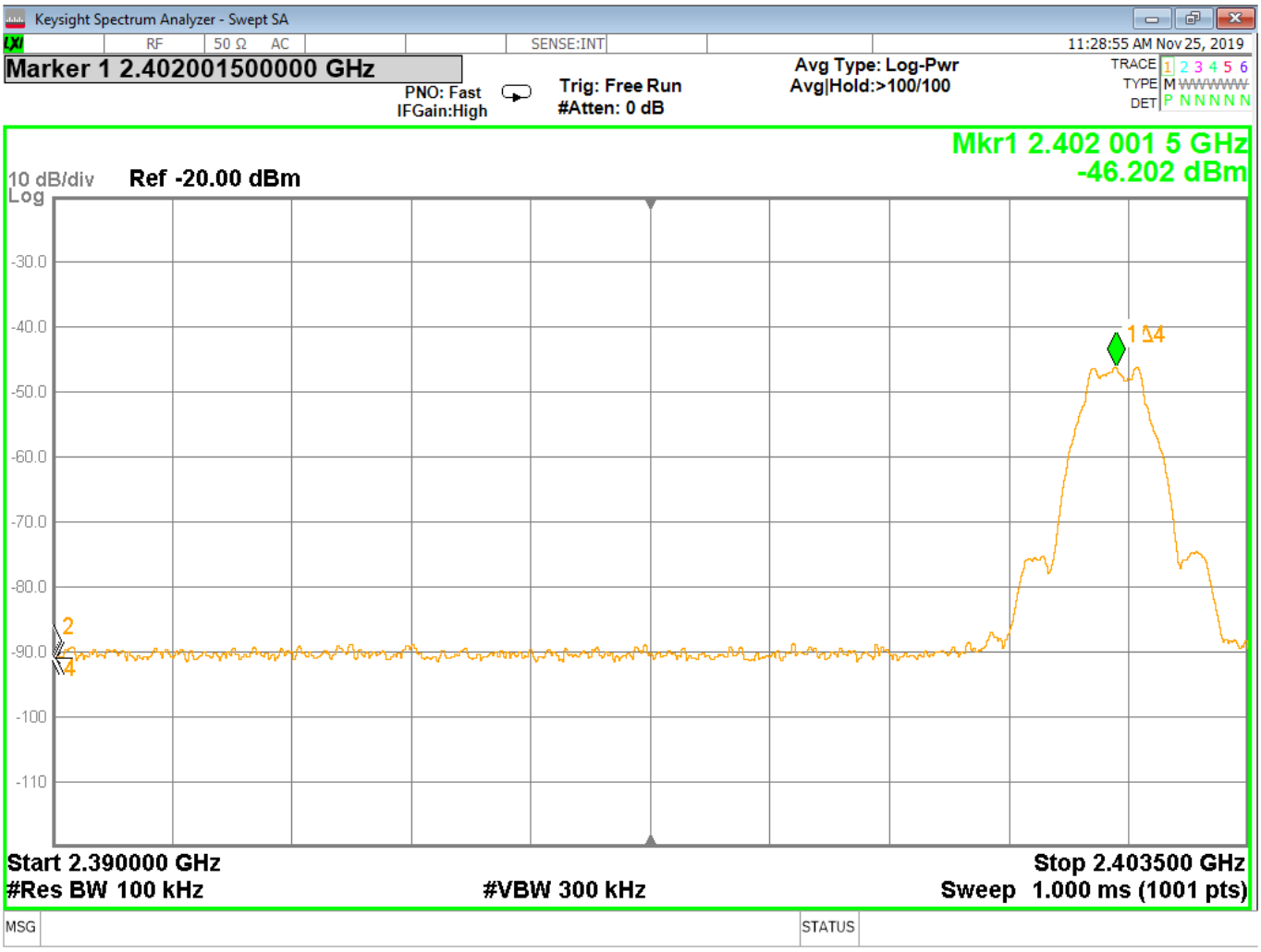


Figure 17 - Band-edge Measurement, Low Channel, Fundamental, Peak, GMSK

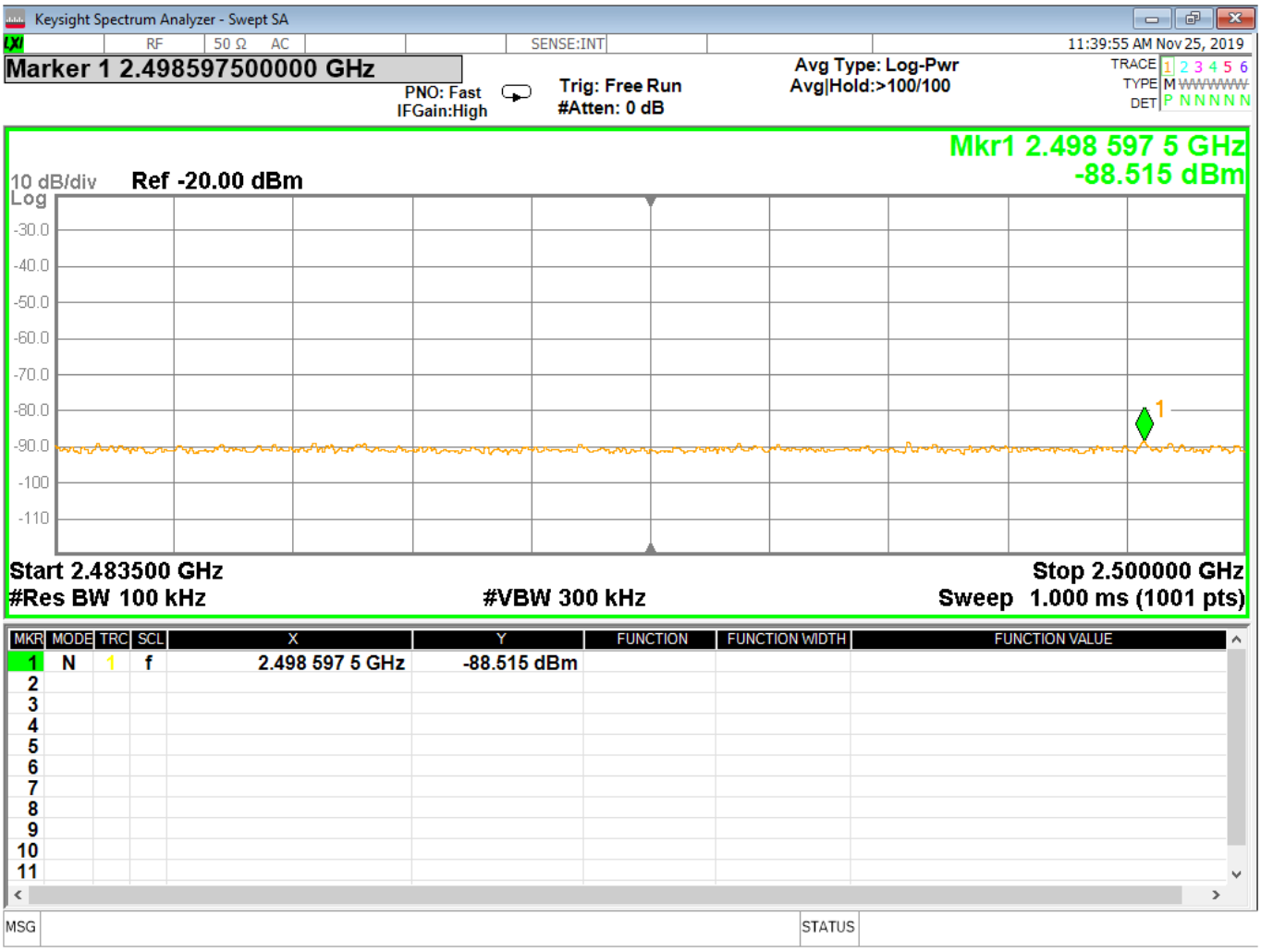


Figure 18 - Band-edge Measurement, High Channel, Restricted Frequency, Peak, GMSK

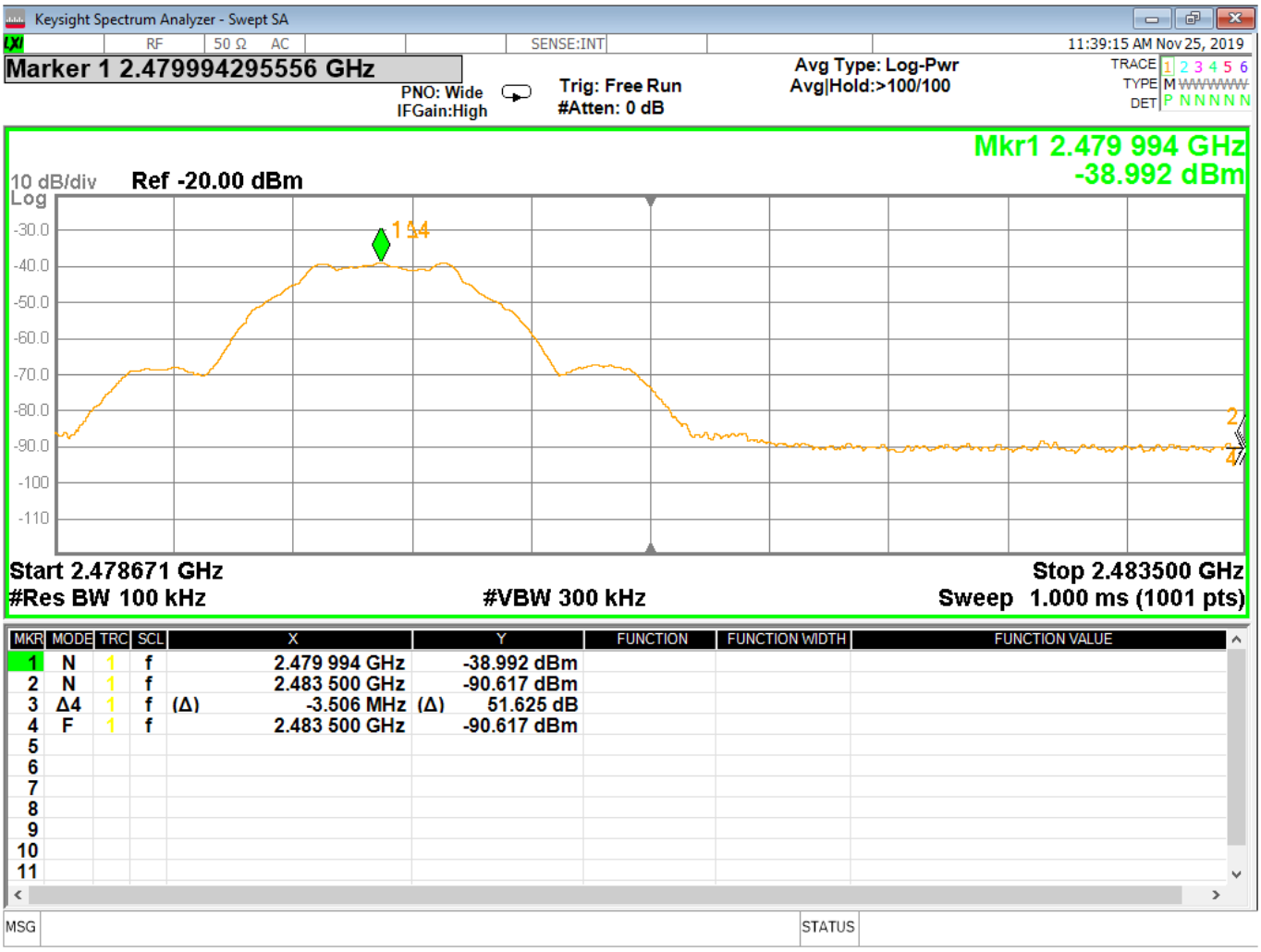


Figure 19 - Band-edge Measurement, High Channel, Fundamental, Peak, GMSK

4.7 CONDUCTED AC MAINS EMISSIONS

Test Method: ANSI C63.10-2013, Section(s) 6.2

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

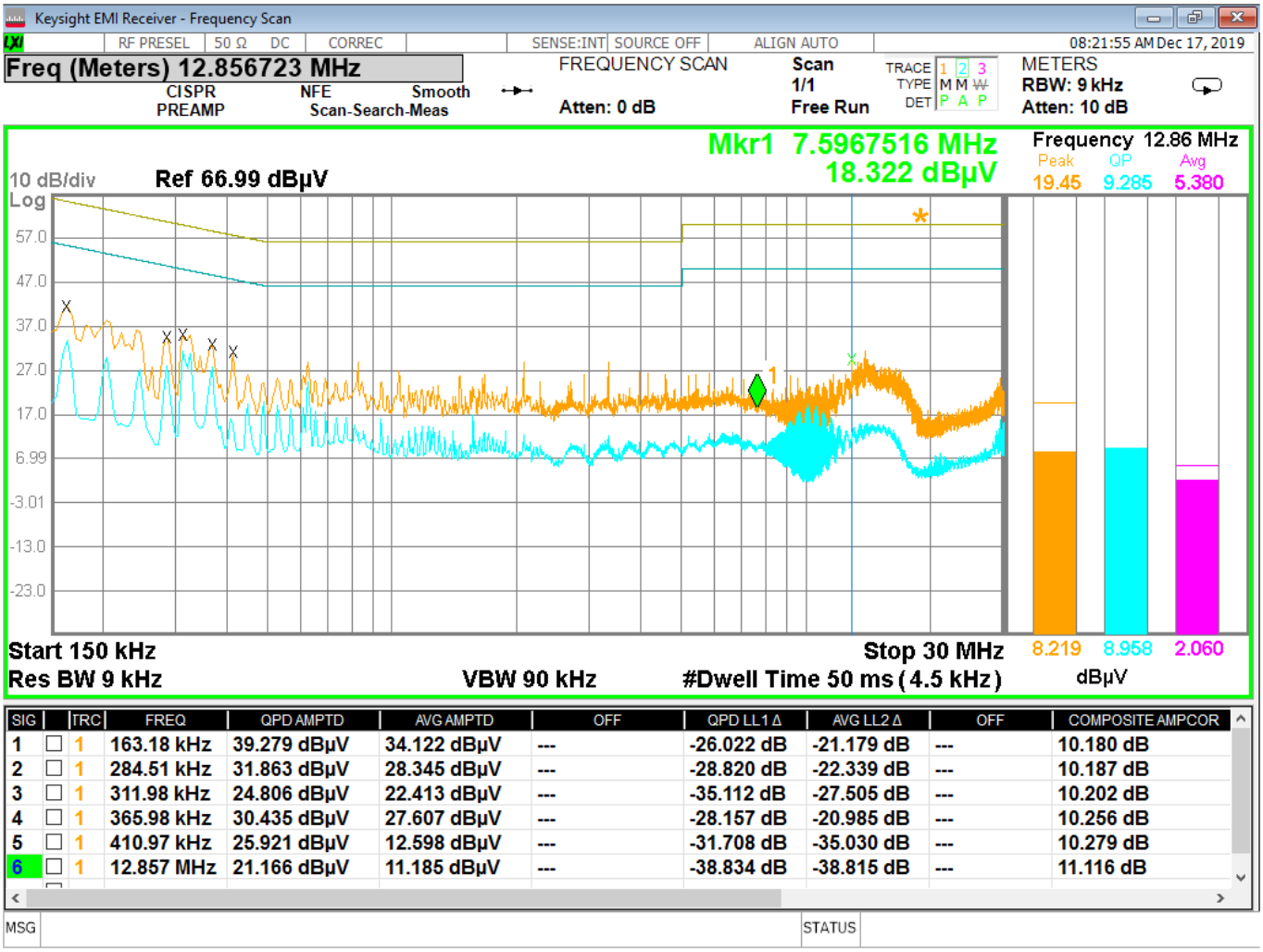
Test Procedures:

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
d. Results were compared to the 15.207 limits.

Deviation from the test standard:
No deviation

EUT operating conditions:
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the middle channel.

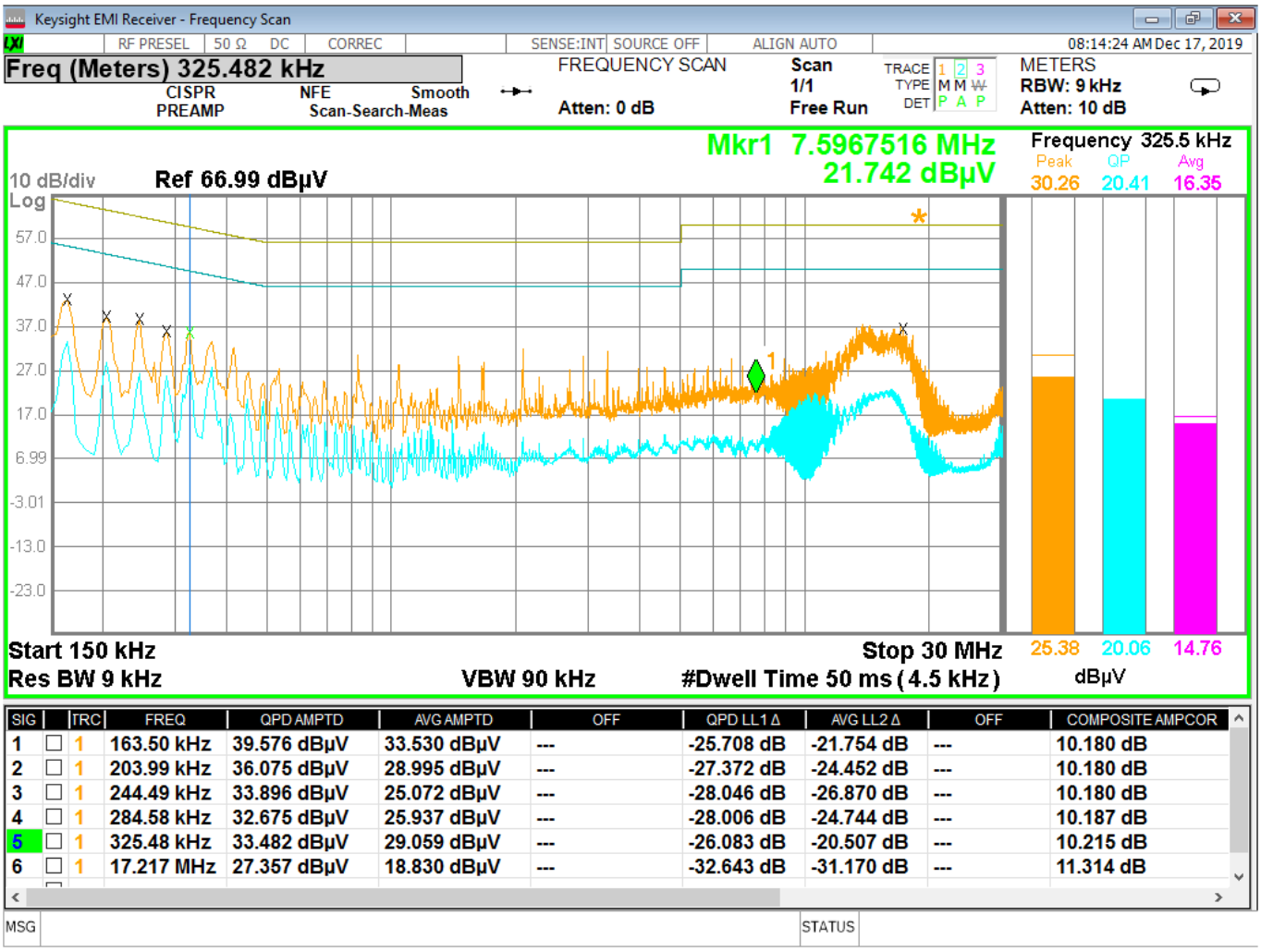
Test Results:



SIG		TRC	FREQ	QPD AMPTD	AVG AMPTD	OFF	QPD LL1 Δ	AVG LL2 Δ	OFF	COMPOSITE AMPCOR
1	☐	1	163.18 kHz	39.279 dBµV	34.122 dBµV	---	-26.022 dB	-21.179 dB	---	10.180 dB
2	☐	1	284.51 kHz	31.863 dBµV	28.345 dBµV	---	-28.820 dB	-22.339 dB	---	10.187 dB
3	☐	1	311.98 kHz	24.806 dBµV	22.413 dBµV	---	-35.112 dB	-27.505 dB	---	10.202 dB
4	☐	1	365.98 kHz	30.435 dBµV	27.607 dBµV	---	-28.157 dB	-20.985 dB	---	10.256 dB
5	☐	1	410.97 kHz	25.921 dBµV	12.598 dBµV	---	-31.708 dB	-35.030 dB	---	10.279 dB
6	☐	1	12.857 MHz	21.166 dBµV	11.185 dBµV	---	-38.834 dB	-38.815 dB	---	11.116 dB

Figure 20 - Conducted Emissions Plot, Line

All Measurements were found to be at least 10 dB below the limits.



SIG		TRC	FREQ	QPD AMPTD	AVG AMPTD	OFF	QPD LL1 Δ	AVG LL2 Δ	OFF	COMPOSITE AMPCOR
1	☐	1	163.50 kHz	39.576 dBµV	33.530 dBµV	---	-25.708 dB	-21.754 dB	---	10.180 dB
2	☐	1	203.99 kHz	36.075 dBµV	28.995 dBµV	---	-27.372 dB	-24.452 dB	---	10.180 dB
3	☐	1	244.49 kHz	33.896 dBµV	25.072 dBµV	---	-28.046 dB	-26.870 dB	---	10.180 dB
4	☐	1	284.58 kHz	32.675 dBµV	25.937 dBµV	---	-28.006 dB	-24.744 dB	---	10.187 dB
5	☐	1	325.48 kHz	33.482 dBµV	29.059 dBµV	---	-26.083 dB	-20.507 dB	---	10.215 dB
6	☐	1	17.217 MHz	27.357 dBµV	18.830 dBµV	---	-32.643 dB	-31.170 dB	---	11.314 dB

Figure 21 - Conducted Emissions Plot, Neutral

All Measurements were found to be at least 10 dB below the limits.

The plot shows the composite maximum value of both the line and neutral conductors. It shows the worse-case at each frequency.

APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]^2 / 30

Power (watts) = 10^[Power (dBm)/10] / 1000

Voltage (dBµV) = Power (dBm) + 107 (for 50Ω measurement systems)

Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator)

Conversion from 3m field strength to EIRP (d=3):

EIRP = [FS(V/m) x d^2]/30 = FS [0.3] for d = 3

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBµV/m) - 95.23

10log(10^9) is the conversion from micro to milli

APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB

Expanded uncertainty values are calculated to a confidence level of 95%.

REPORT END