4740 Discovery Drive | Lincoln, NE 68521
tel- 402.323.6233 | tel -888.657.6860 | fax - 402.323.6238
info@nceelabs.com | http://nceelabs.com

FCC/ISED Test Report

Prepared for: **Garmin International, Inc.**

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

Product: **AC4308**

Test Report No: **R20211005-21-E14B**

Approved by:

Fox Lane
EMC Test Engineer

DATE: **May 16, 2022**

Total Pages: **62**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	5 March 2022	Original – KVepuri / NJohnson Prepared by GLarsen, SProbst and FLane
A	12 May 2022	Added DCCF values to tabular data Added comments to section 4.5 Added comments to section 4.4
B	16 May 2022	Added standard to test results Removed references to data leveraging

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. Summary of test results presented in this report correspond to the following section:

FCC Part 15.247

The EUT has been tested according to the following specifications:

(1) US Code of Federal Regulations, Title 47, Part 15
(2) ISED RSS-Gen, Issue 5
(3) ISED RSS-247, Issue 2
(4) RSS 210 Issue 10

APPLIED STANDARDS AND REGULATIONS		
Standard Section	**Test Type**	**Result**
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	Pass
FCC Part 15.247(b)(3) RSS-247 Issue 2 Section 5.4(d)	Peak output power	Pass
FCC Part 15.247(a)(2) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 5, Section 7.3	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 5, Section 8.9, RSS 210 Issue 10 Section 7.1/7.2/7.3	Transmitter Radiated Emissions	Pass
FCC Part 15.247(e) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 5.5 RSS 210 Issue 10 Section 7.1/7.2/7.3	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 5, Section 8.8	Conducted Emissions	Pass

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	AC4308
EUT Received	6 December 2021
Test Dates	8 December 2021- 25 February 2022
Serial No.	3392435319 (Radiated Measurements) 3392435300 (Conducted Measurements)
Operating Band	2400 – 2483.5 MHz
Device Type	☒ GMSK ☐ GFSK ☐ BT BR ☐ BT EDR 2MB ☐ BT EDR 3MB ☐ 802.11x
Power Supply / Voltage	Internal Battery/ 5VDC Charger: Garmin (Phi Hong) MN: PSAI10R-050Q (Representative Power Supply)

Device was tested alongside a similar unit. Worst case was reported.

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

2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:

GMSK 1MB Transmissions:

Channel	Frequency
Low	2402 MHz
Mid	2440 MHz
High	2480 MHz

GMSK 2MB Transmissions:

Channel	Frequency
Low	2404 MHz
Mid	2440 MHz
High	2478 MHz

These are the only 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.

2.3 DESCRIPTION OF SUPPORT UNITS

None

3.0 LABORATORY AND GENERAL TEST 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	Fox Lane	Test Engineer	Testing and Report
2	Karthik Vepuri	Test Engineer	Review/Editing and Report
3	Blake Winter	Test Engineer	Testing
4	Grace Larsen	Test Technician	Testing and Report
5	Samuel Probst	Test Technician	Testing and Report
6	Matthew Emory	Test Technician	Testing

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 (44GHz)	N9038A	MY59050109	July 21, 2021	July 21, 2023
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	May 5, 2020	May 5, 2022
Keysight EXA Signal Analyzer	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022
EMCO Horn Antenna	3115	6416	July 28, 2021	July 28, 2022
EMCO Horn Antenna	3116	2576	March 9, 2020	March 9, 2022
Com-Power LISN 50µH / 250µH - 50Ω	LI-220C	20070017	September 22, 2020	September 22, 2022
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	February 1, 2021	February 1, 2023
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	April 14, 2020	April 14, 2022
Trilithic High Pass Filter*	6HC330	23042	April 14, 2020	April 14, 2022
ETS – Lindgren- VSWR on 10m Chamber	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2023
NCEE Labs-NSA on 10m Chamber	10m Semi-anechoic chamber-NSA	NCEE-001	October 25, 2019	October 25, 2022
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	April 14, 2020	April 14, 2022
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)**	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)**	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Characterization

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

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

Measurement type presented in this report (Please see the checked box below):

Conducted ☒

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Figure 1 - Bandwidth Measurements Test Setup

Radiated ☒

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

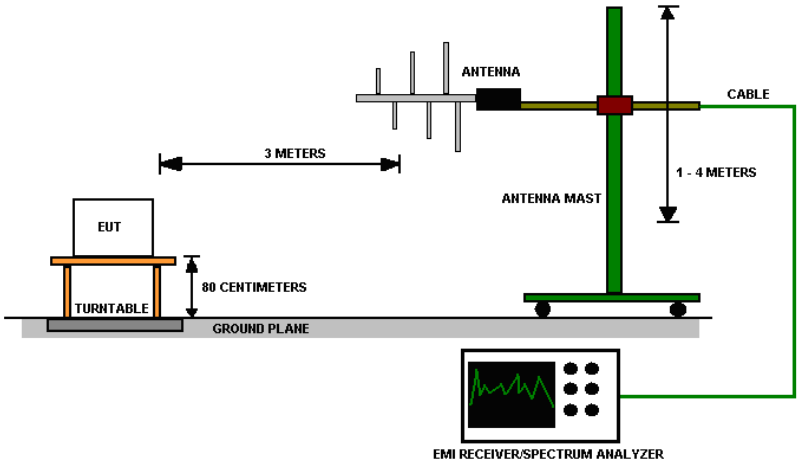


Figure 2 - Radiated Emissions Test Setup

4.0 RESULTS

DTS Radio Measurements					
CHANNEL	**Transmitter**	**Occupied Bandwidth (MHz)**	**6 dB Bandwidth (MHz)**	**PSD (dBm)**	**RESULT**
Low	GMSK 1MB	1080.20	709.30	-12.982	PASS
Mid	GMSK 1MB	1073.60	689.10	-13.271	PASS
High	GMSK 1MB	1075.80	708.50	-13.513	PASS
Low	GMSK 2Mb	2085.10	1169.00	-15.097	PASS
Mid	GMSK 2Mb	2089.20	1163.00	-14.982	PASS
High	GMSK 2Mb	2094.30	1175.00	-15.038	PASS
Occupied Bandwidth = N/A; 6 dB Bandwidth Limit > 500 kHz		Peak Output Power Limit = 30 dBm; PSD Limit = 8 dBm			

Unrestricted Band-Edge							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Relative Highest out of band level (dBuV)**	**Relative Fundamental (dBuV)**	**Delta (dB)**	**Min Delta (dB)**	**Result**
Low	GMSK 1MB	2400.00	58.62	109.34	50.72	30.00	PASS
Low	GMSK 2MB	2400.00	54.33	109.69	55.36	30.00	PASS
High	GMSK 1MB	2483.50	56.67	108.94	52.28	30.00	PASS
High	GMSK 2MB	2483.50	52.66	109.27	56.61	30.00	PASS

Peak Restricted Band-Edge							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Highest out of band level (dBuV/m @ 3m)**	**Measurement Type**	**Limit (dBuV/m @ 3m)**	**Margin**	**Result**
Low	GMSK 1MB	2390.00	57.801	Peak	73.98	16.179	PASS
Low	GMSK 2MB	2390.00	57.487	Peak	73.98	16.493	PASS
High	GMSK 1MB	2483.50	64.899	Peak	73.98	9.081	PASS
High	GMSK 2MB	2483.50	58.329	Peak	73.98	15.651	PASS
*Limit shown is the peak limit taken from FCC Part 15.209							

DTS Radio Measurements						
CH	**Transmitter**	**RAW AVERAGE OUTPUT POWER (dBm)**	**DCCF (For Power)**	**AVERAGE OUTPUT POWER (dBm)**	**AVERAGE OUTPUT POWER (mW)**	**RESULT**
Low	GMSK 1MB	-.99	3.87	2.88	1.94	PASS
Mid	GMSK 1MB	-1.26	3.87	2.61	1.82	PASS
High	GMSK 1MB	-1.67	3.87	2.20	1.66	PASS
Low	GMSK 2Mb	-3.50	6.56	3.06	2.02	PASS
Mid	GMSK 2Mb	-3.58	6.56	2.98	1.99	PASS
High	GMSK 2Mb	-3.82	6.56	2.74	1.88	PASS
Peak Output Power Limit = 125mW; Average Output Power = (Raw Average Output Power) + (DCCF For Power)						

Average Restricted Band-Edge									
CH	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Raw Average Highest out of band level (dBuV/m @ 3m)**	**DCCF (For Emissions)**	**Average Highest out of band level (dBuV/m @ 3m)****	**Measurement Type**	**Limit (dBuV/m @ 3m)***	**Margin**	**Result**
Low	GMSK 1MB	2390.00	39.72	-7.74	47.46	Average	53.98	11.558	PASS
Low	GMSK 2MB	2390.00	44.99	-7.74	52.73	Average	53.98	11.369	PASS
High	GMSK 1MB	2483.50	36.11	-13.11	49.12	Average	53.98	7.864	PASS
High	GMSK 2MB	2483.50	39.96	-13.11	53.07	Average	53.98	7.000	PASS
*Limit shown is the average limit taken from FCC Part 15.209 **Average Highest out of band level = SA Average Level – DCCF (For Emissions). C63.10 Sec. 11.12.2.5.2 See Sec 4.3 for more information on DCCF									

4.1 OUTPUT POWER

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, Sec. 11.9.2.2.4

Limits of power measurements:
For FCC Part 15.247 Device:
The maximum allowed output power is 30 dBm.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the output power plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

4.2 BANDWIDTH

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of bandwidth measurements:

For FCC Part 15.247 Device:
The 99% occupied bandwidth is for informational purpose only. The 6dB bandwidth of the signal must be greater than 500 kHz.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the bandwidth plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

4.3 DUTY CYCLE

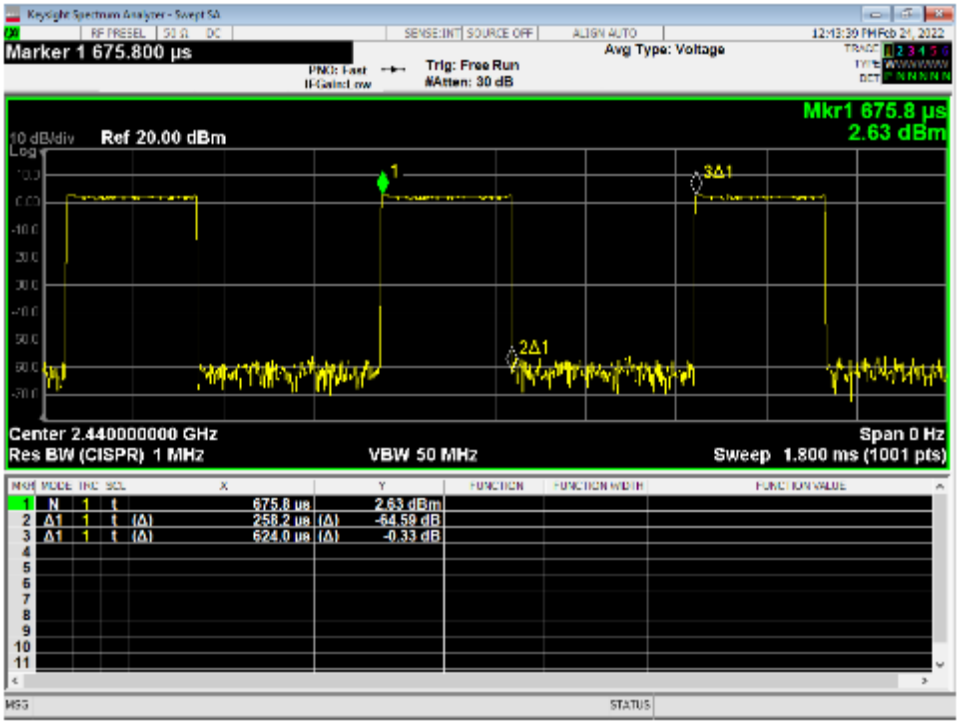


Figure 3 –Duty Cycle, GMSK 1MB

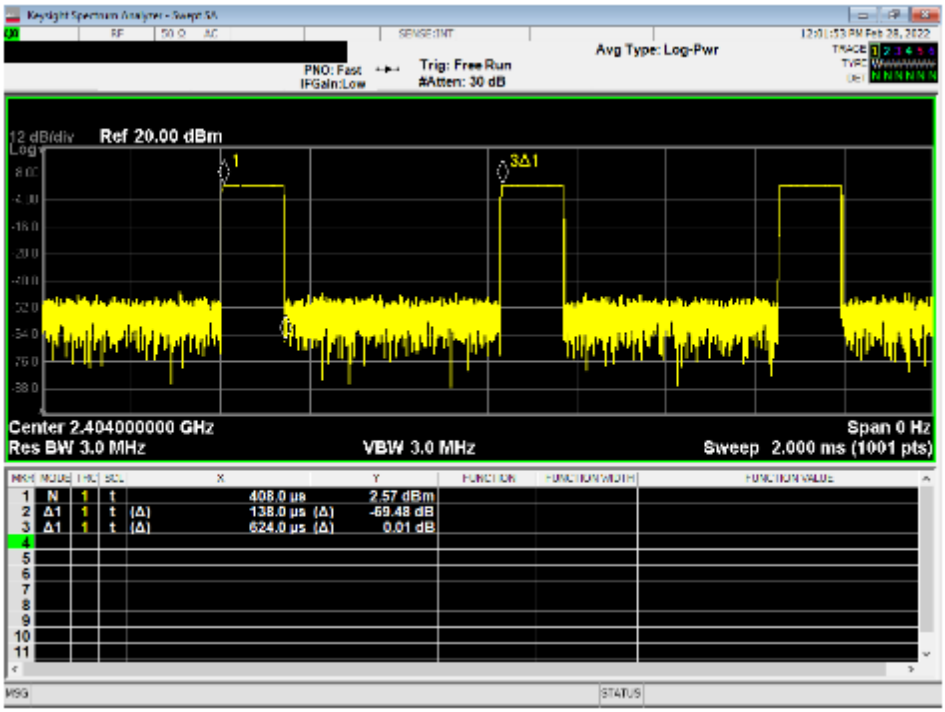


Figure 4 –Duty Cycle, GMSK 2MB

GMSK 1MB

DCCF For Emissions (Duty Cycle Correction Factor) = 20 * Log(Duty Cycle)
-7.74 = 20 * Log(41.4 / 100)

DCCF For Power (Duty Cycle Correction Factor) = 10 * Log(1 / (Duty Cycle))
3.87 = 10 * Log(1 / (41.4 / 100))

GMSK 2MB

DCCF For Emissions (Duty Cycle Correction Factor) = 20 * Log(Duty Cycle)
-13.11 = 20 * Log(22.1 / 100)

DCCF For Power (Duty Cycle Correction Factor) = 10 * Log(1 / (Duty Cycle))
6.56 = 10 * Log(1 / (1 / 0.221))

4.4 RADIATED EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.5, 6.6

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:
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.
4. The EUT was tested for spurious emissions while running off of battery power and external USB power. The worse-case emissions were produced while running off of USB power, so results from this mode are presented.

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 from 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.

g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

Test setup:

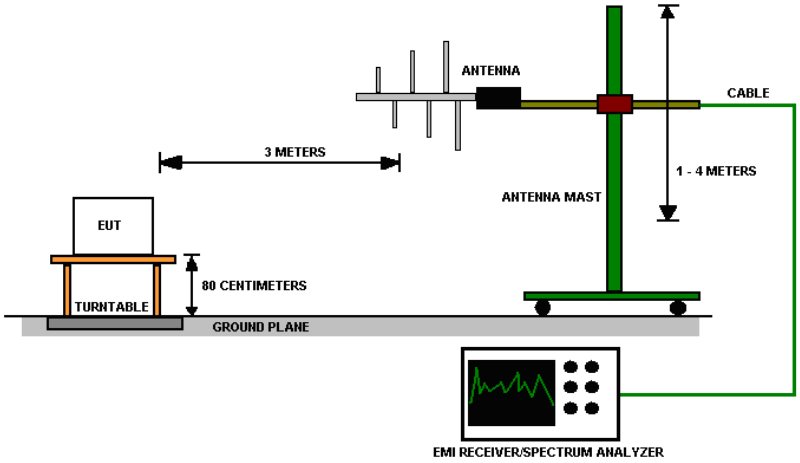


Figure 5 - Radiated Emissions Test Setup

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.

EUT operating conditions
Details can be found in section 2.1 of this report.

Test results:

EUT Was investigated for intermodulation. No intermodulation products were found and were thus not reported.

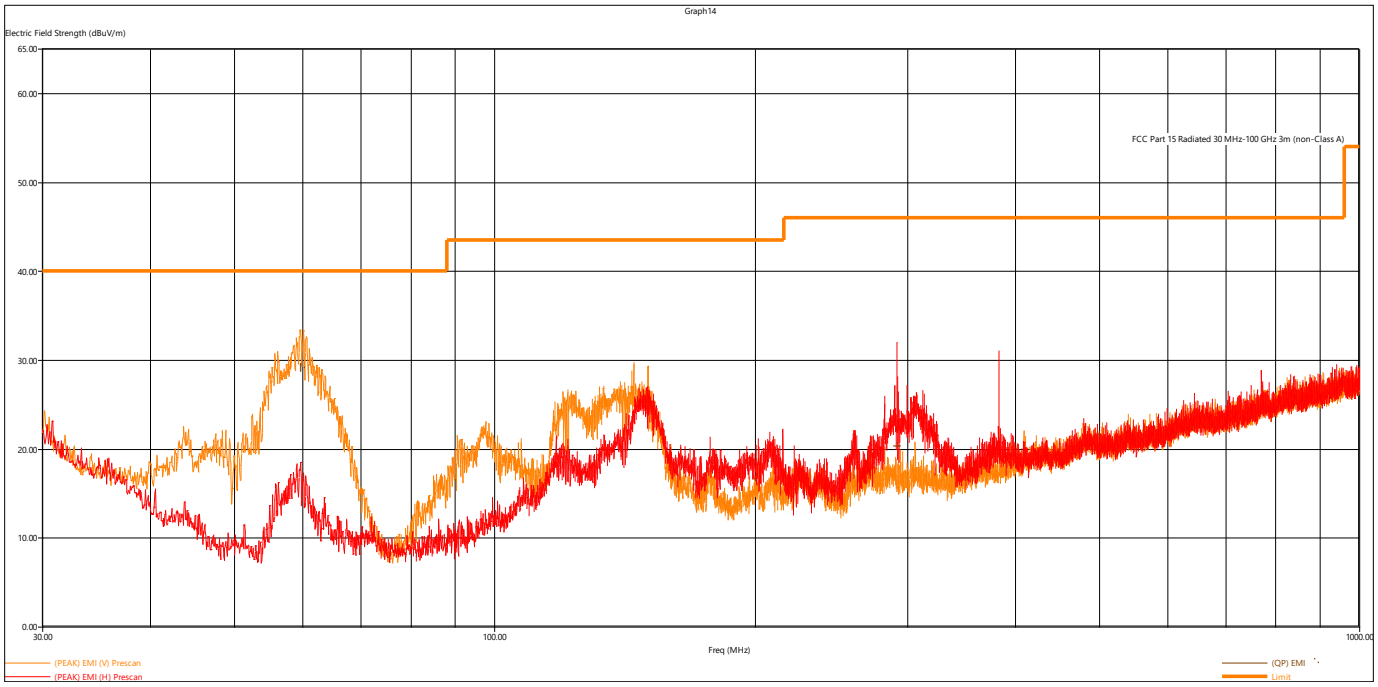


Figure 6 - Radiated Emissions Plot, Receive

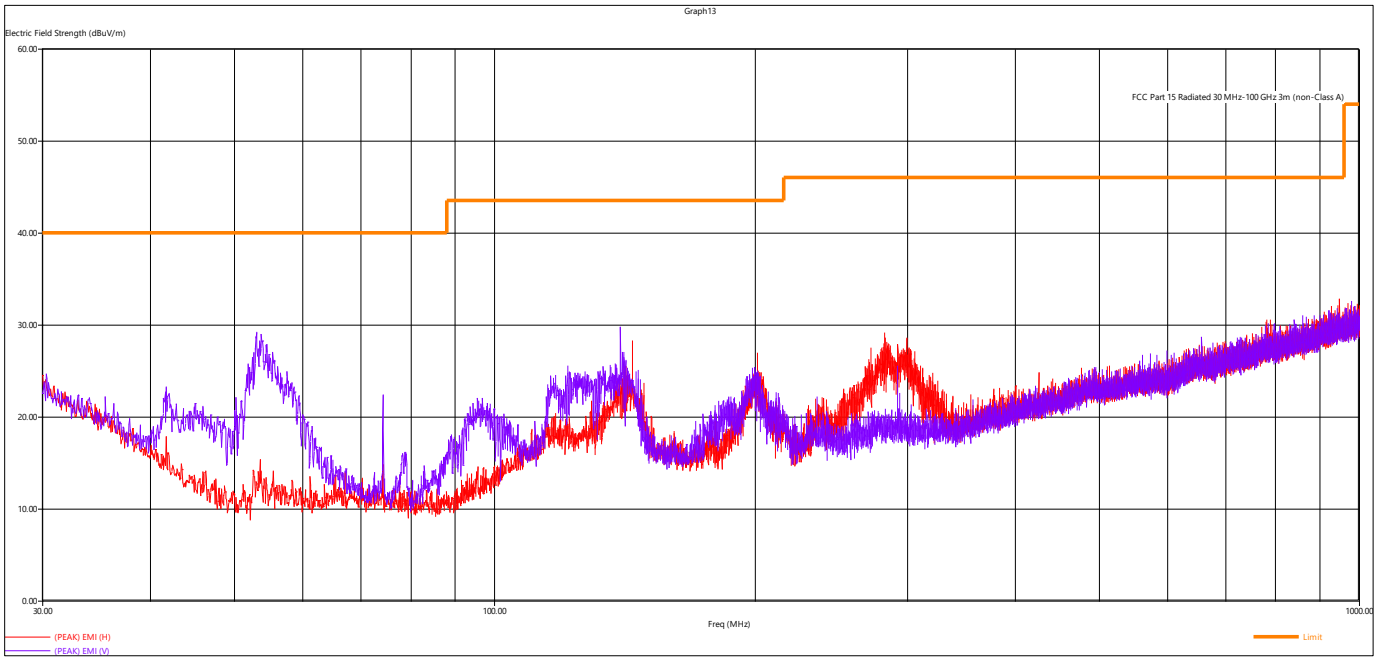


Figure 7 - Radiated Emissions Plot, GMSK 1MB

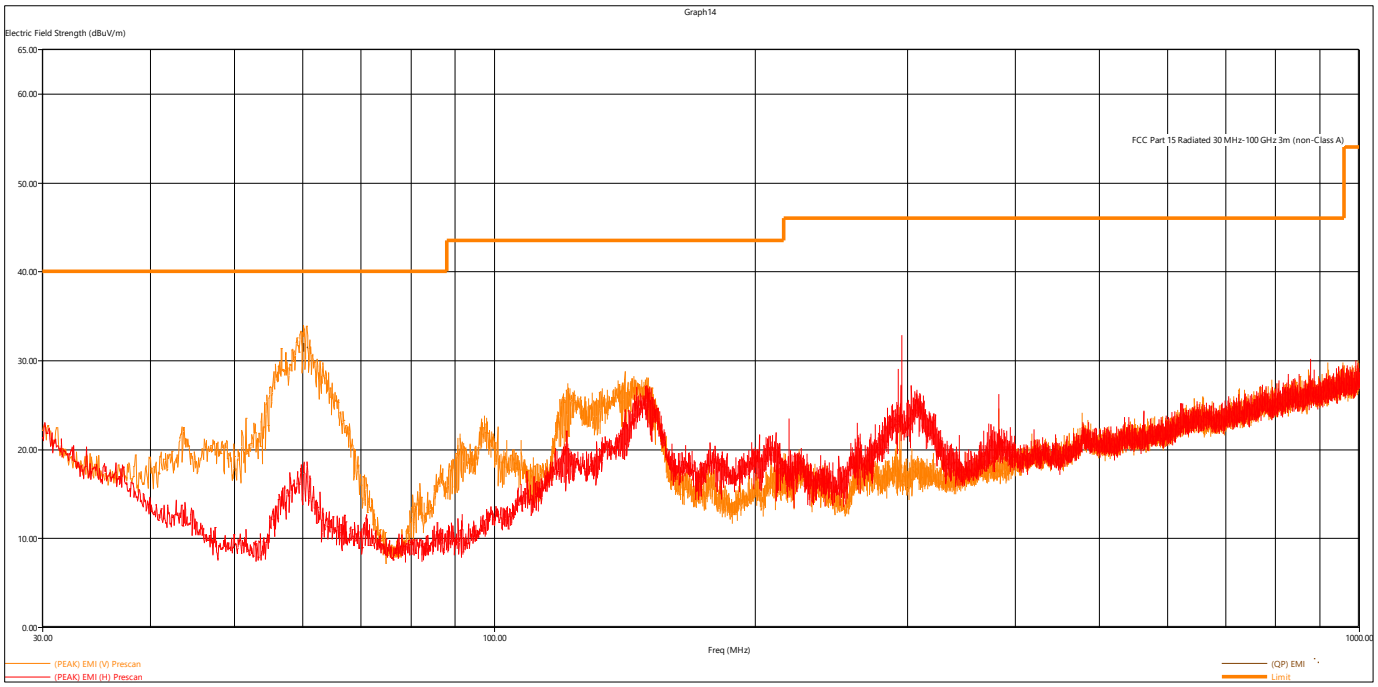


Figure 8 - Radiated Emissions Plot, GMSK 2MB

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 = Limit value - Emission level

Quasi-Peak Measurements, GMSK								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Modulation**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
60.154320	31.39	40.00	8.61	106.00	258.00	V	Low	GMSK 2MB
291.543120	20.33	46.02	25.69	121.00	187.00	H	Receive	
59.587440	29.09	40.00	10.91	110.00	223.00	V	Receive	

Peak Measurements								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Modulation**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
2401.784000	97.11	NA	NA	454.00	112.00	H	Low	GMSK 1MB
2439.776000	97.96	NA	NA	127.00	115.00	H	Mid	GMSK 1MB
2479.590000	98.34	NA	NA	485.00	119.00	H	High	GMSK 1MB
2403.508000	97.64	NA	NA	110.00	115.00	H	Low	GMSK 2MB
2439.994000	97.97	NA	NA	128.00	114.00	H	Mid	GMSK 2MB
2477.476000	99.03	NA	NA	133.00	119.00	H	High	GMSK 2MB
All other emissions were found to be at least 6dB below limit line								

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

Average Measurements								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Modulation**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
2401.784000	89.37	NA	NA	454.00	112.00	H	Low	GMSK 1MB
2439.776000	90.22	NA	NA	127.00	115.00	H	Mid	GMSK 1MB
2479.590000	90.60	NA	NA	485.00	119.00	H	High	GMSK 1MB
2403.508000	84.53	NA	NA	110.00	115.00	H	Low	GMSK 2MB
2439.994000	84.86	NA	NA	128.00	114.00	H	Mid	GMSK 2MB
2477.476000	85.92	NA	NA	133.00	119.00	H	High	GMSK 2MB
*Average Level = Peak level + DCCF (For Emissions), See Sec 4.3 for more information on DCCF All other emissions were found to be at least 6dB below limit line								

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

4.5 CONDUCTED SPURIOUS EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.7

Limits of spurious emissions:

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

Test procedures:

The highest emissions level was measured and recorded. All spurious measurements were evaluated to 30dB below the fundamental. More details can be found in section 3.4 of this report. The line shown in the plots is not a limit line, it is a reference line placed at -20dBm.

Deviations from test standard:
Test was performed with 120kHz RBW

Test setup:
Test setup details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

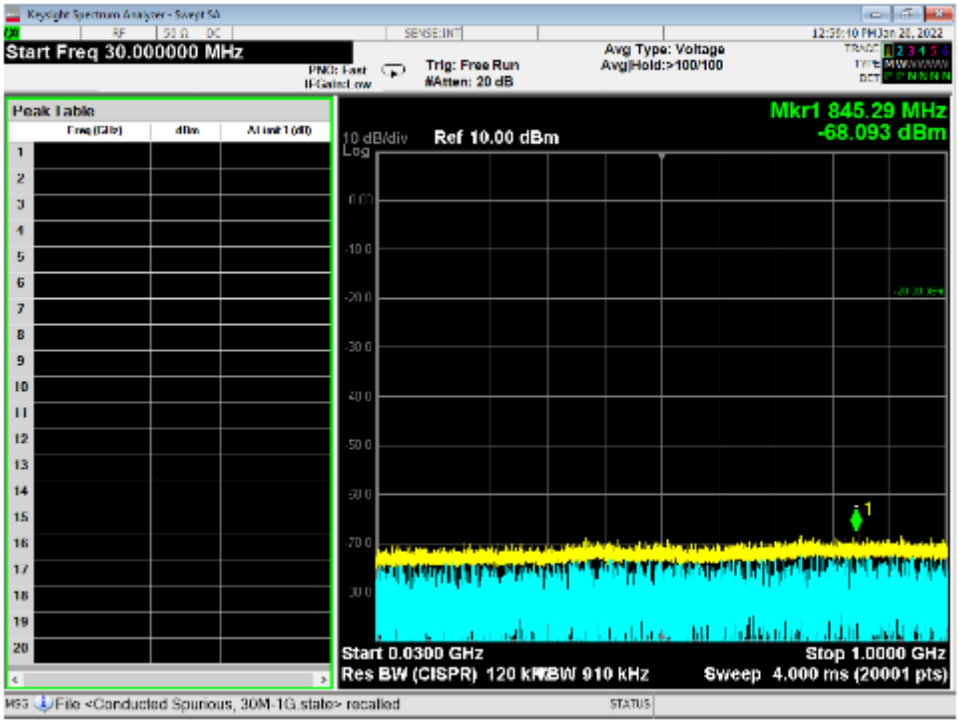


Figure 9 - Radiated Emissions Plot, GMSK 1MB, 30M – 1G

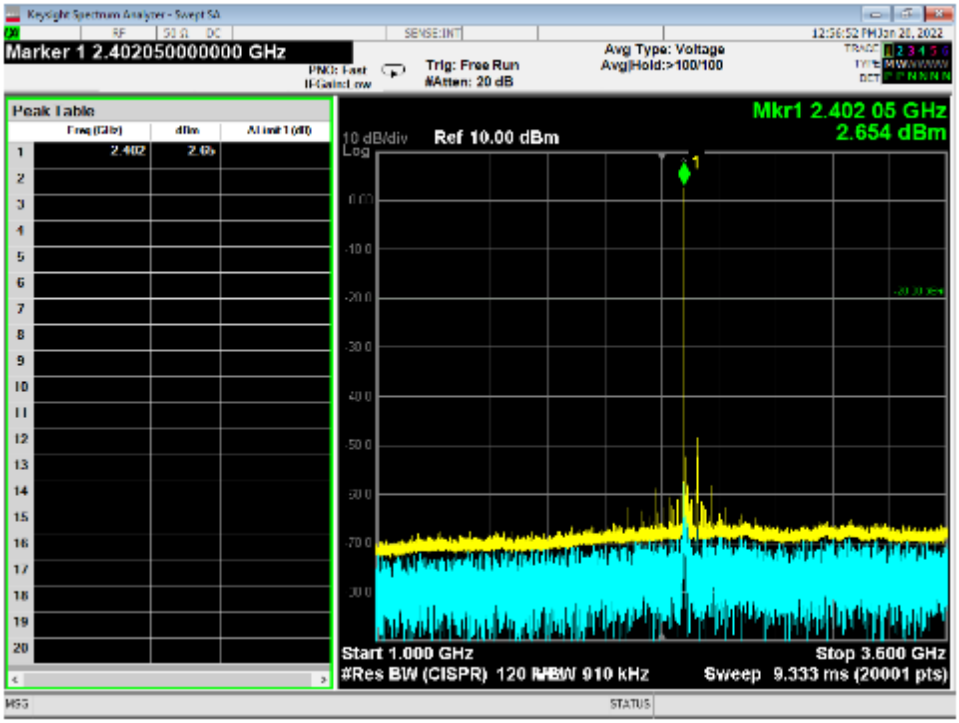


Figure 10 - Radiated Emissions Plot, GMSK 1MB, 1G – 3.6G

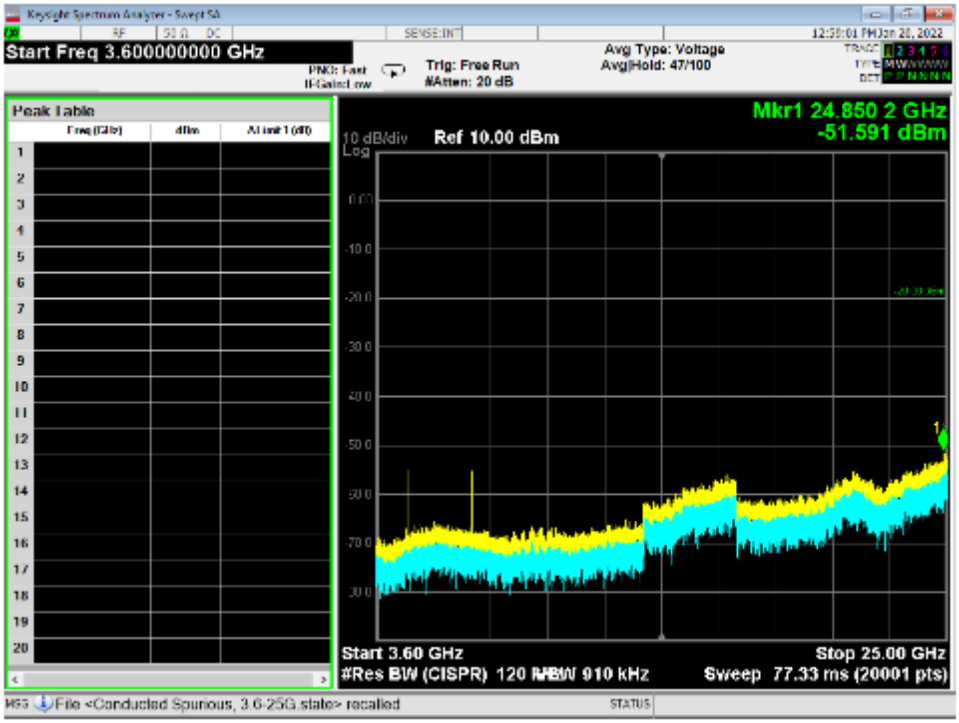


Figure 11 - Radiated Emissions Plot, GMSK 1MB, 3.6G – 25G

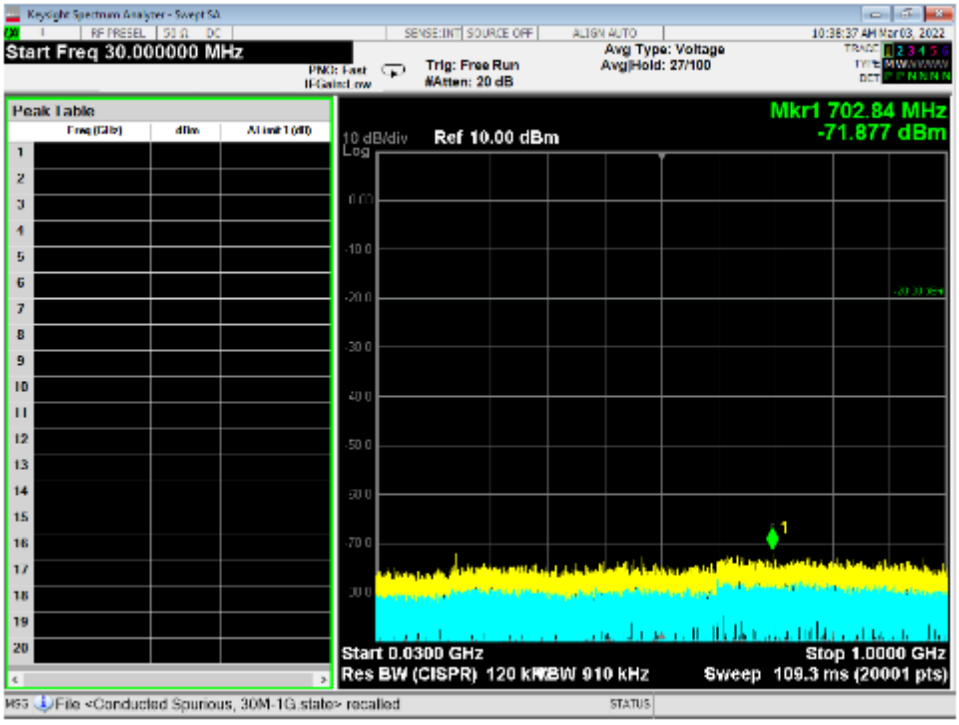


Figure 12 - Radiated Emissions Plot, GMSK 1MB, 30M – 1G

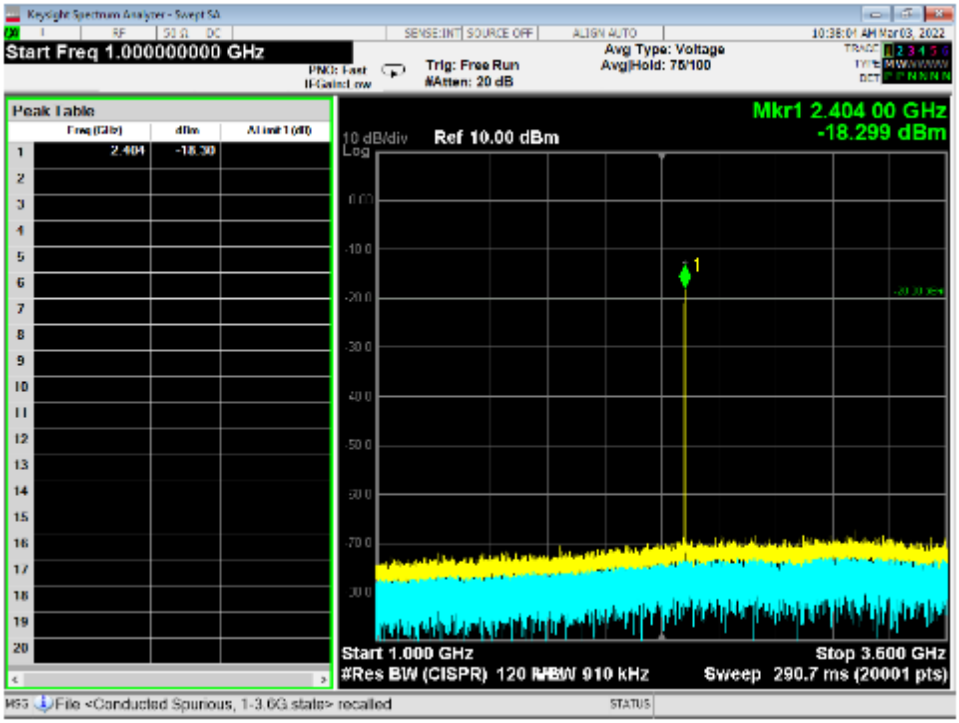


Figure 13 - Radiated Emissions Plot, GMSK 1MB, 1G – 3.6G

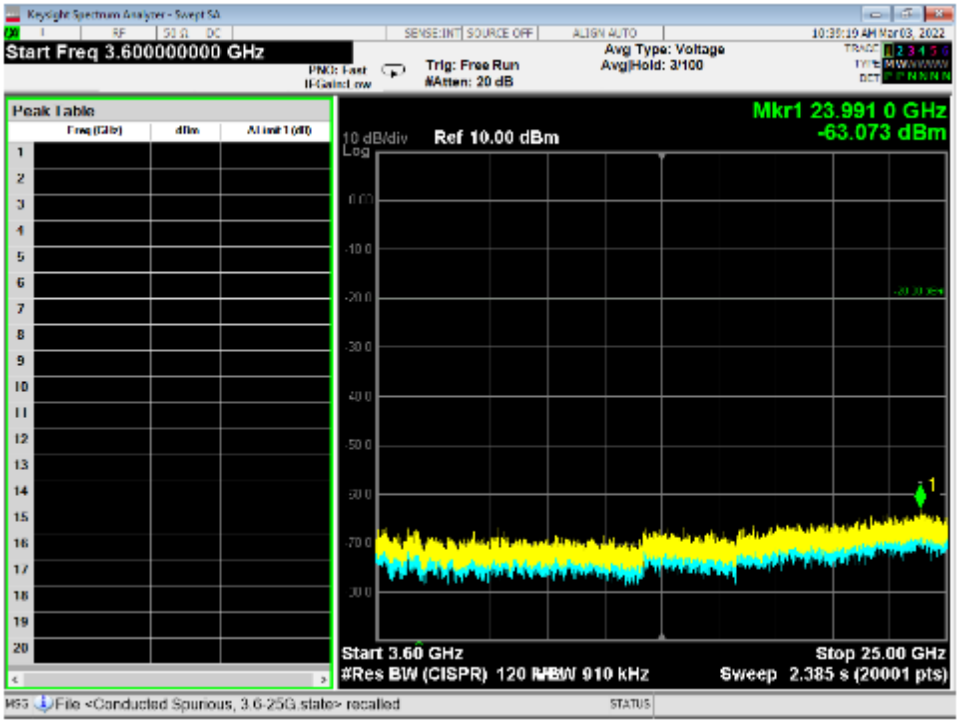


Figure 14 - Radiated Emissions Plot, GMSK 1MB, 3.6G – 25G

4.6 BAND EDGES

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of band-edge measurements:
For FCC Part 15.247 Device:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))

Test procedures:

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. More details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the band edge plots can be found in the Appendix C.
2. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
3. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209. The limit shown in the graph accounts for the antenna gain of the device.

4.7 POWER SPECTRAL DENSITY

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of power measurements:

For FCC Part 15.247 Device:
The maximum PSD allowed is 8 dBm.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the Power Spectral Density (PSD) plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

4.8 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.

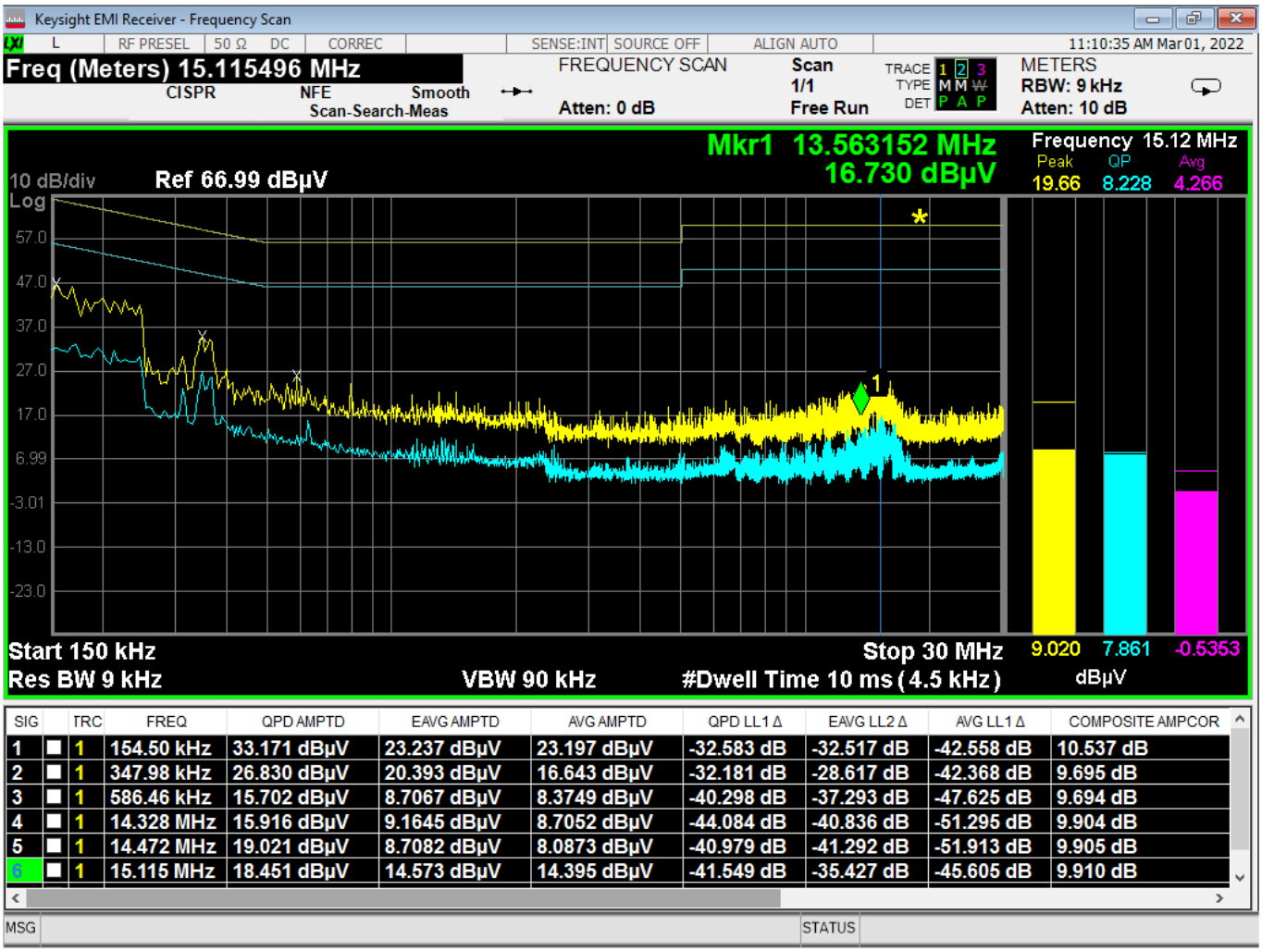
Test Procedures:

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

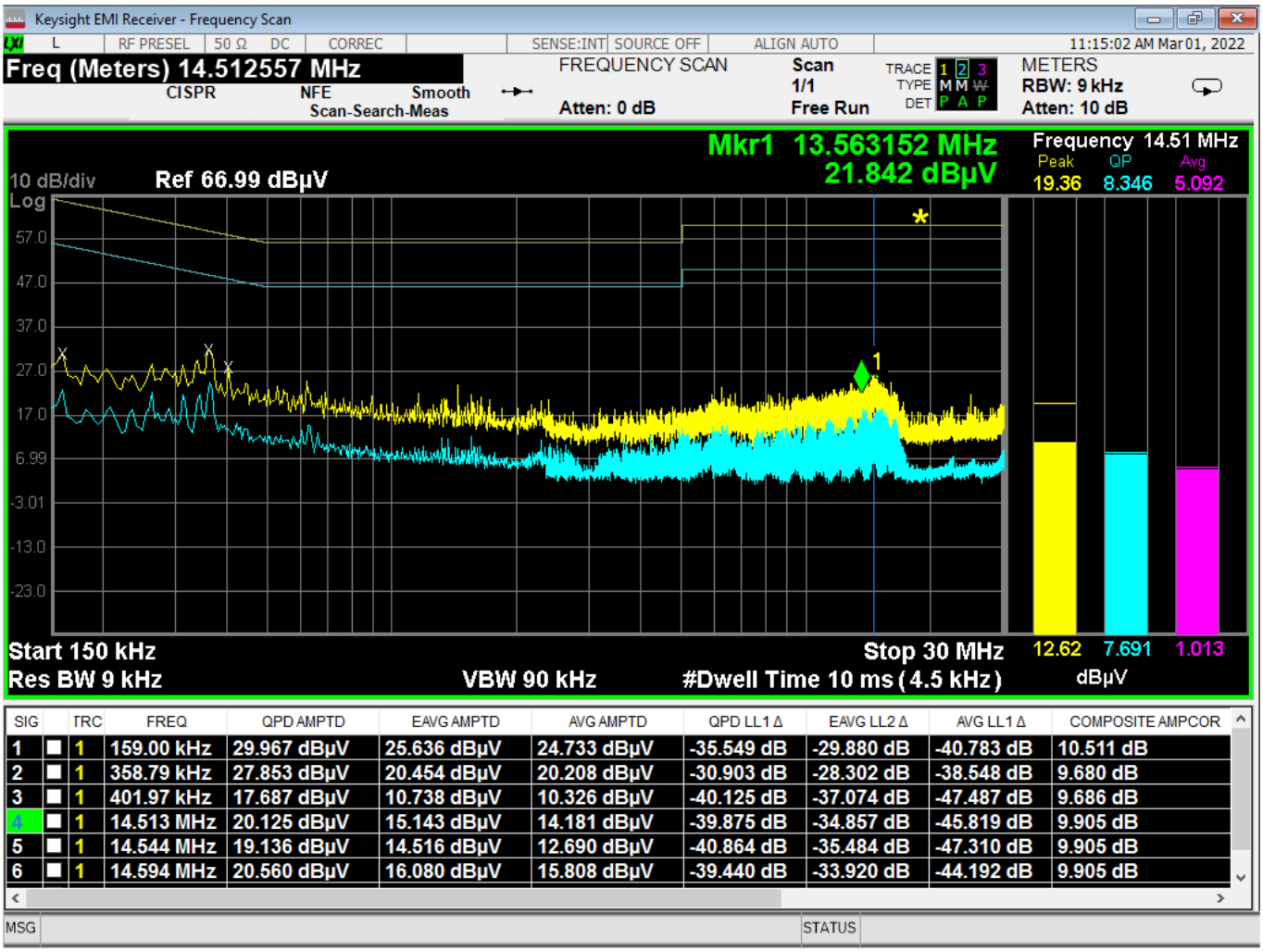
EUT operating conditions:
Details can be found in section 2.1 of this report.

Test Results:



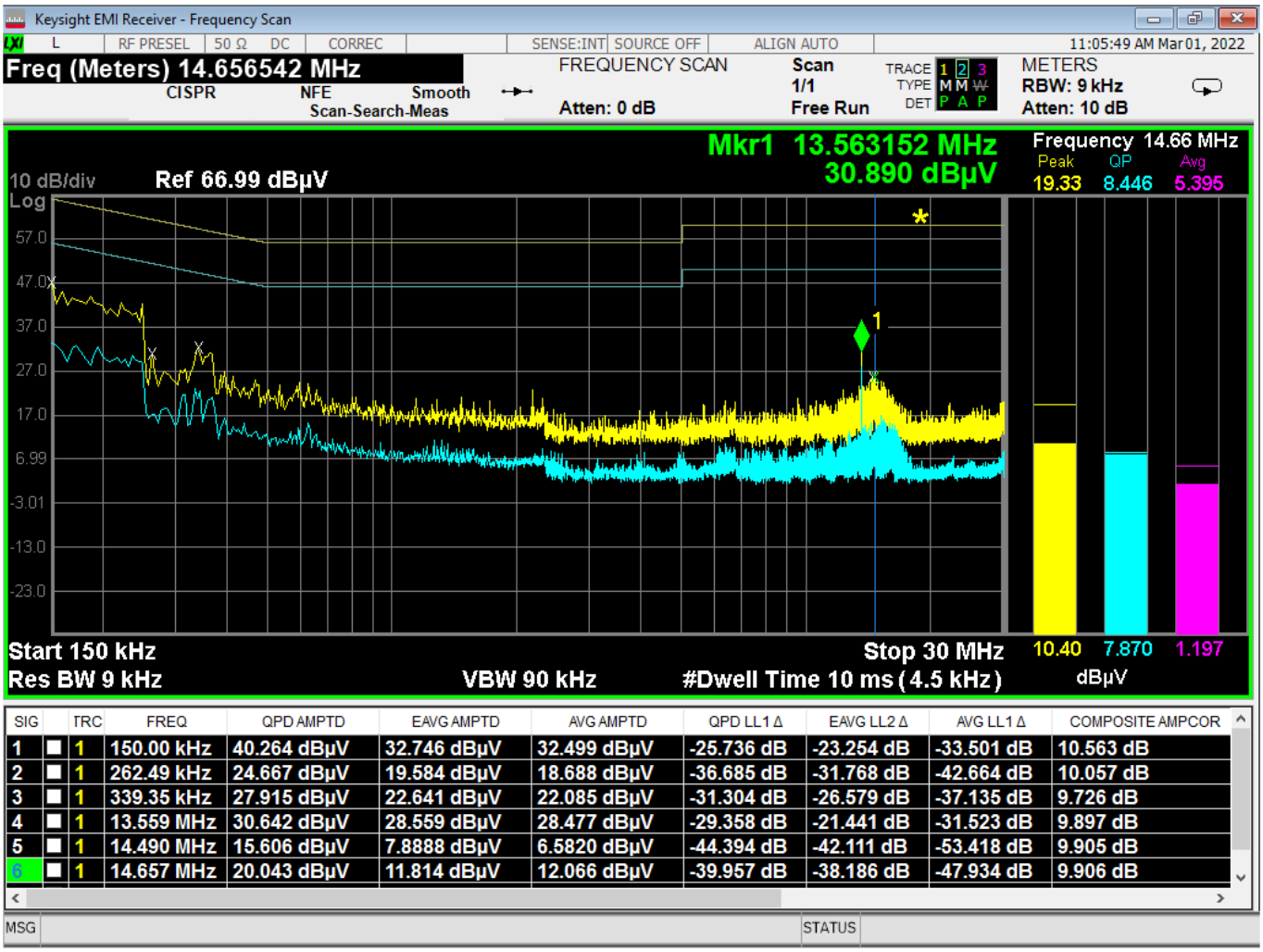
SIG	TRC	FREQ	QPD AMPTD	EAVG AMPTD	AVG AMPTD	QPD LL1 Δ	EAVG LL2 Δ	AVG LL1 Δ	COMPOSITE AMPCOR
1	1	154.50 kHz	33.171 dBµV	23.237 dBµV	23.197 dBµV	-32.583 dB	-32.517 dB	-42.558 dB	10.537 dB
2	1	347.98 kHz	26.830 dBµV	20.393 dBµV	16.643 dBµV	-32.181 dB	-28.617 dB	-42.368 dB	9.695 dB
3	1	586.46 kHz	15.702 dBµV	8.7067 dBµV	8.3749 dBµV	-40.298 dB	-37.293 dB	-47.625 dB	9.694 dB
4	1	14.328 MHz	15.916 dBµV	9.1645 dBµV	8.7052 dBµV	-44.084 dB	-40.836 dB	-51.295 dB	9.904 dB
5	1	14.472 MHz	19.021 dBµV	8.7082 dBµV	8.0873 dBµV	-40.979 dB	-41.292 dB	-51.913 dB	9.905 dB
6	1	15.115 MHz	18.451 dBµV	14.573 dBµV	14.395 dBµV	-41.549 dB	-35.427 dB	-45.605 dB	9.910 dB

Figure 15 - Conducted Emissions Plot, Line, TX



SIG		TRC	FREQ	QPD AMPTD	EAVG AMPTD	AVG AMPTD	QPD LL1 Δ	EAVG LL2 Δ	AVG LL1 Δ	COMPOSITE AMPCOR
1	■	1	159.00 kHz	29.967 dBµV	25.636 dBµV	24.733 dBµV	-35.549 dB	-29.880 dB	-40.783 dB	10.511 dB
2	■	1	358.79 kHz	27.853 dBµV	20.454 dBµV	20.208 dBµV	-30.903 dB	-28.302 dB	-38.548 dB	9.680 dB
3	■	1	401.97 kHz	17.687 dBµV	10.738 dBµV	10.326 dBµV	-40.125 dB	-37.074 dB	-47.487 dB	9.686 dB
4	■	1	14.513 MHz	20.125 dBµV	15.143 dBµV	14.181 dBµV	-39.875 dB	-34.857 dB	-45.819 dB	9.905 dB
5	■	1	14.544 MHz	19.136 dBµV	14.516 dBµV	12.690 dBµV	-40.864 dB	-35.484 dB	-47.310 dB	9.905 dB
6	■	1	14.594 MHz	20.560 dBµV	16.080 dBµV	15.808 dBµV	-39.440 dB	-33.920 dB	-44.192 dB	9.905 dB

Figure 16 - Conducted Emissions Plot, Neutral, TX



SIG	TRC	FREQ	QPD AMPTD	EAVG AMPTD	AVG AMPTD	QPD LL1 Δ	EAVG LL2 Δ	AVG LL1 Δ	COMPOSITE AMPCOR
1	1	150.00 kHz	40.264 dBµV	32.746 dBµV	32.499 dBµV	-25.736 dB	-23.254 dB	-33.501 dB	10.563 dB
2	1	262.49 kHz	24.667 dBµV	19.584 dBµV	18.688 dBµV	-36.685 dB	-31.768 dB	-42.664 dB	10.057 dB
3	1	339.35 kHz	27.915 dBµV	22.641 dBµV	22.085 dBµV	-31.304 dB	-26.579 dB	-37.135 dB	9.726 dB
4	1	13.559 MHz	30.642 dBµV	28.559 dBµV	28.477 dBµV	-29.358 dB	-21.441 dB	-31.523 dB	9.897 dB
5	1	14.490 MHz	15.606 dBµV	7.8888 dBµV	6.5820 dBµV	-44.394 dB	-42.111 dB	-53.418 dB	9.905 dB
6	1	14.657 MHz	20.043 dBµV	11.814 dBµV	12.066 dBµV	-39.957 dB	-38.186 dB	-47.934 dB	9.906 dB

Figure 17 - Conducted Emissions Plot, Line, IDLE

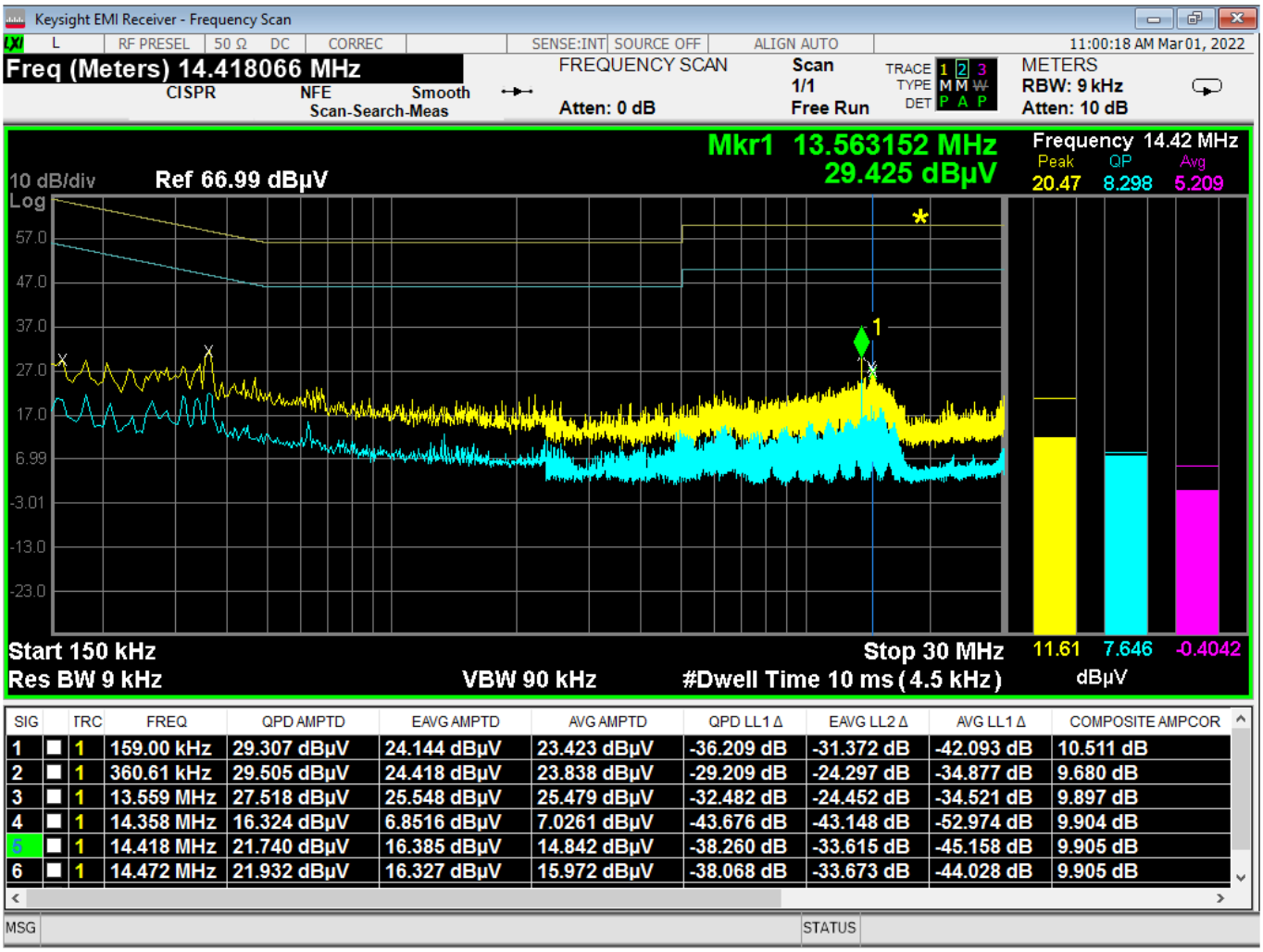


Figure 18 - Conducted Emissions Plot, Neutral, IDLE

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

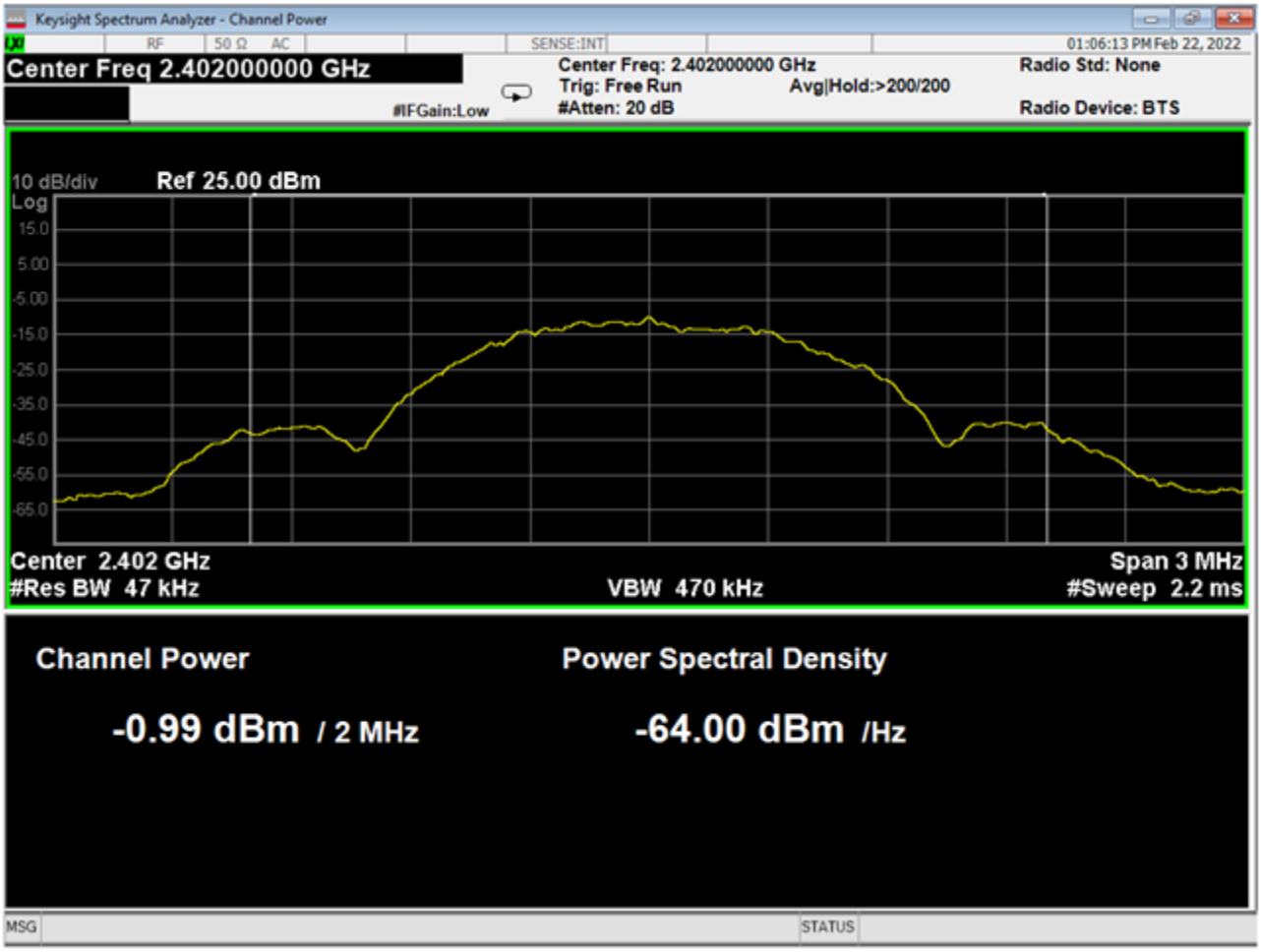
APPENDIX B – MEASUREMENT UNCERTAINTY

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

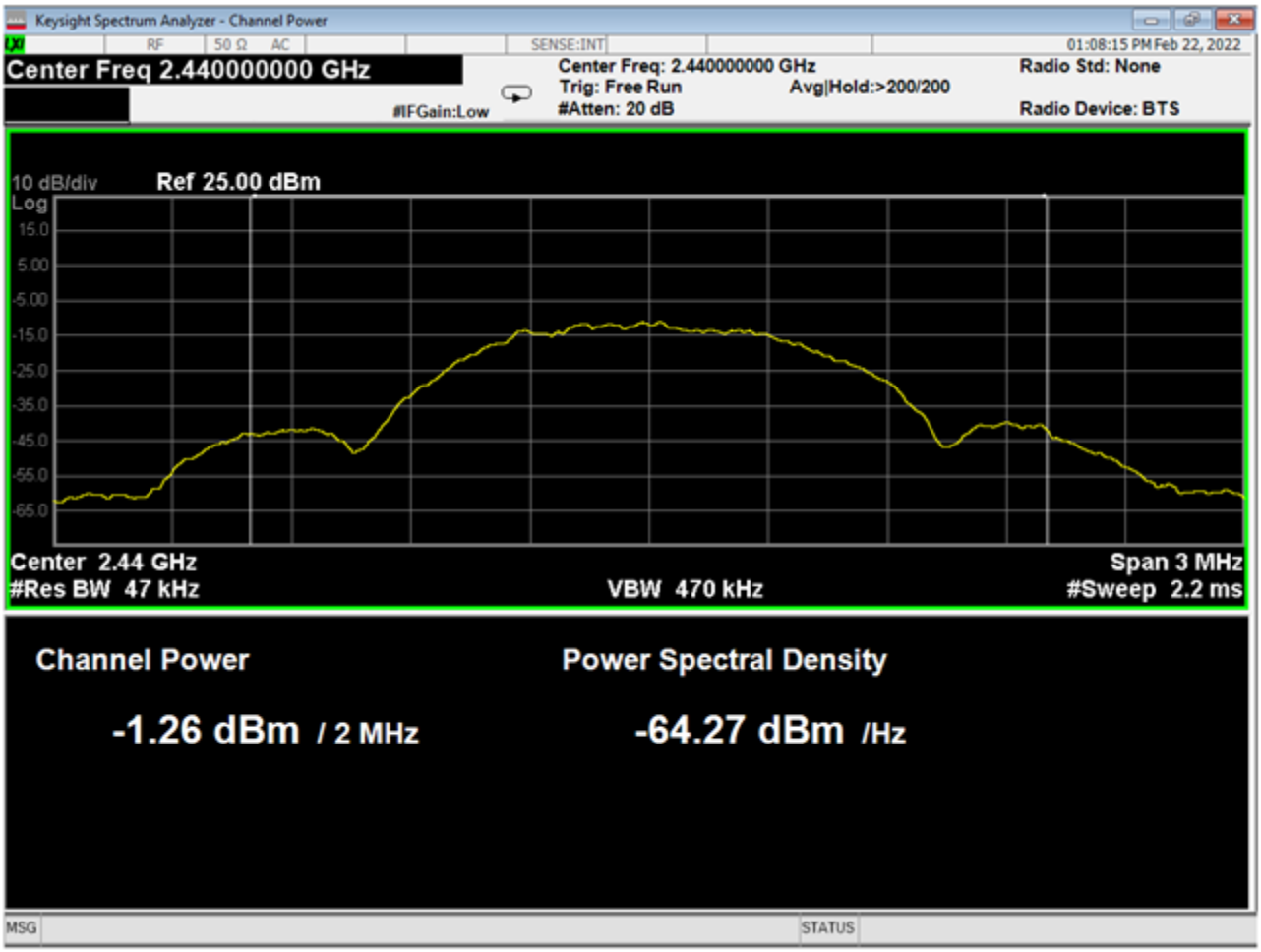
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB

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

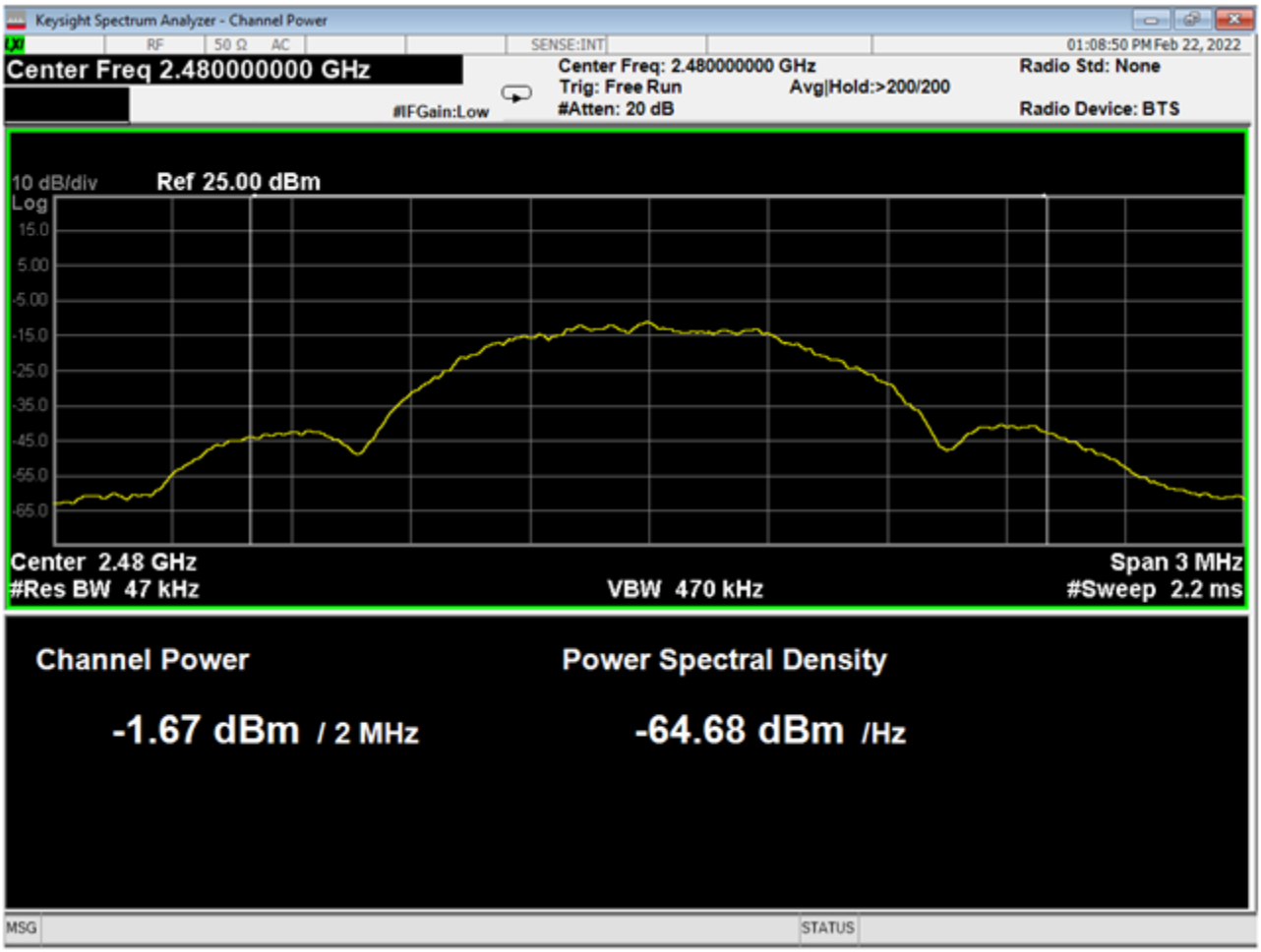
APPENDIX C – GRAPHS AND TABLES



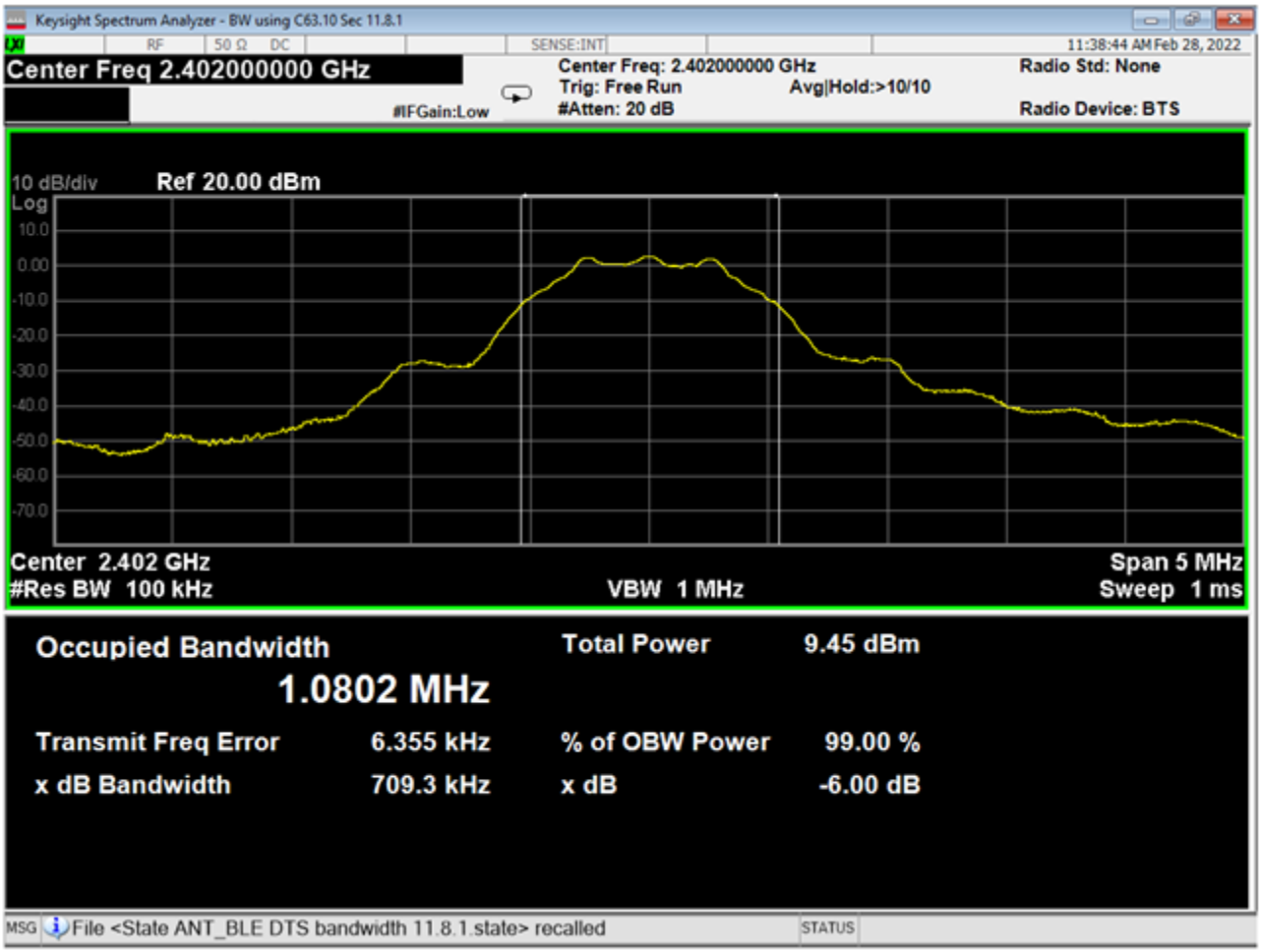
01 Average Output Power, Low Channel, GMSK 1MB



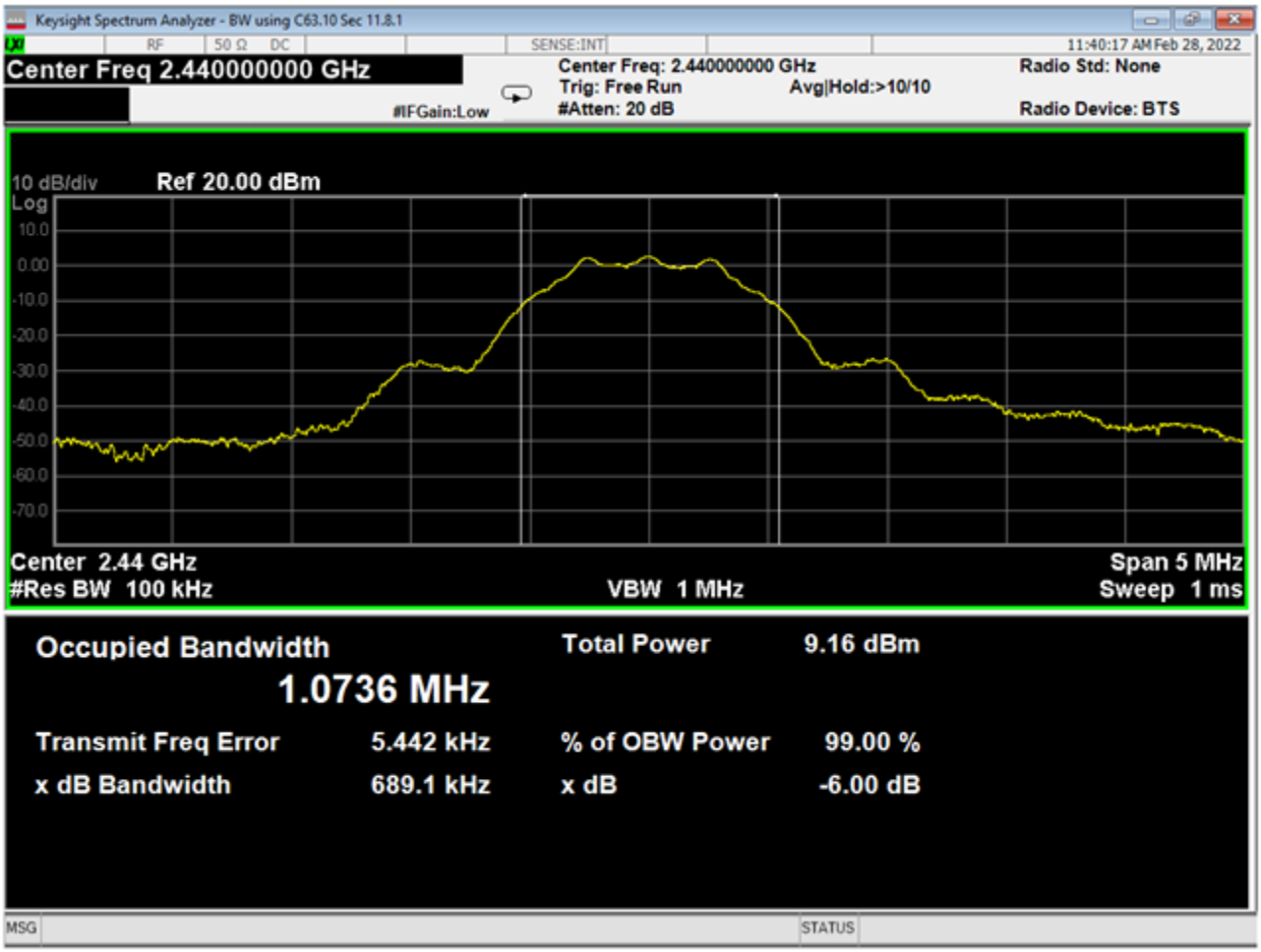
02 Average Output Power, Mid Channel, GMSK 1MB



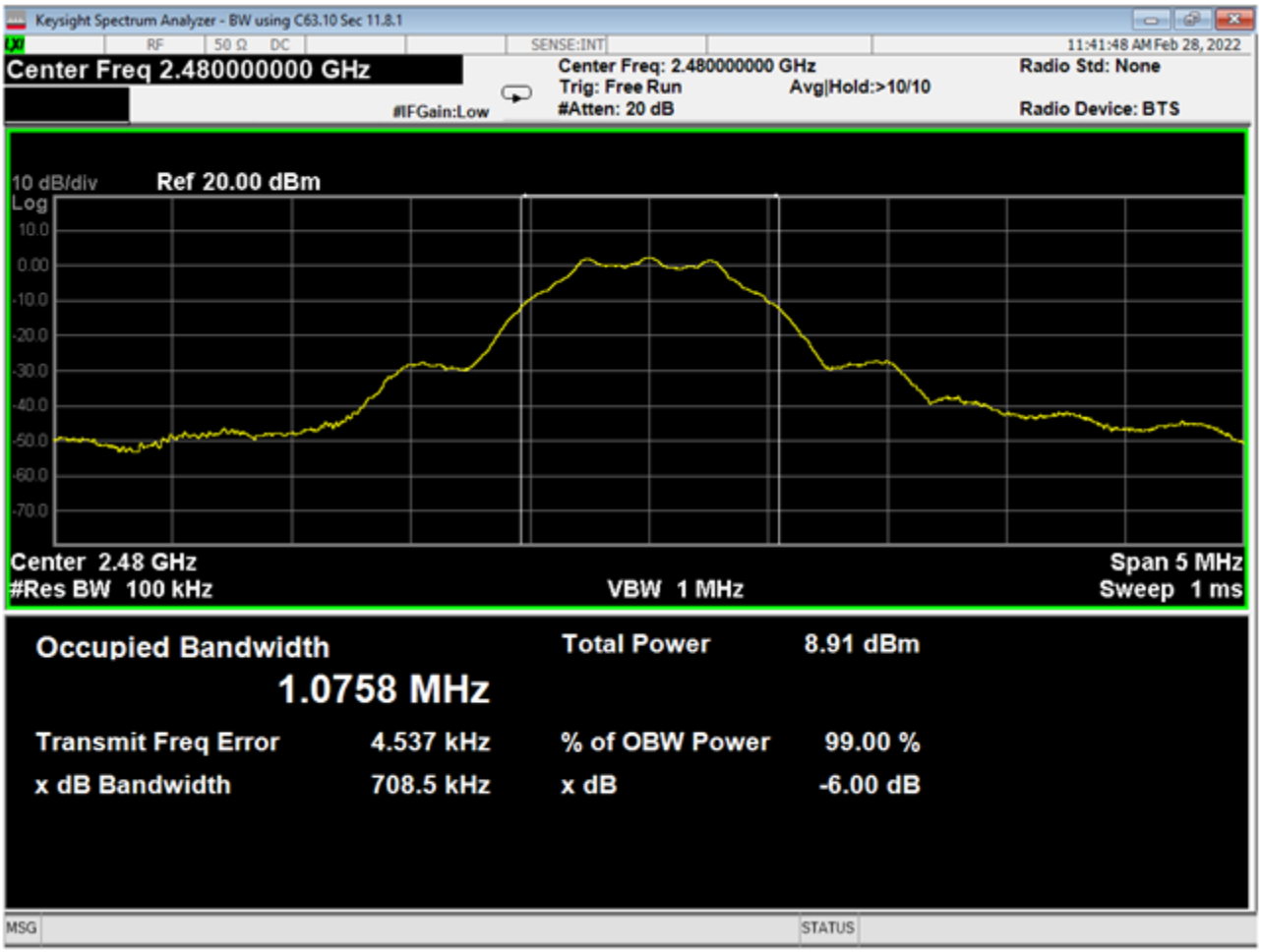
03 Average Output Power, High Channel, GMSK 1MB



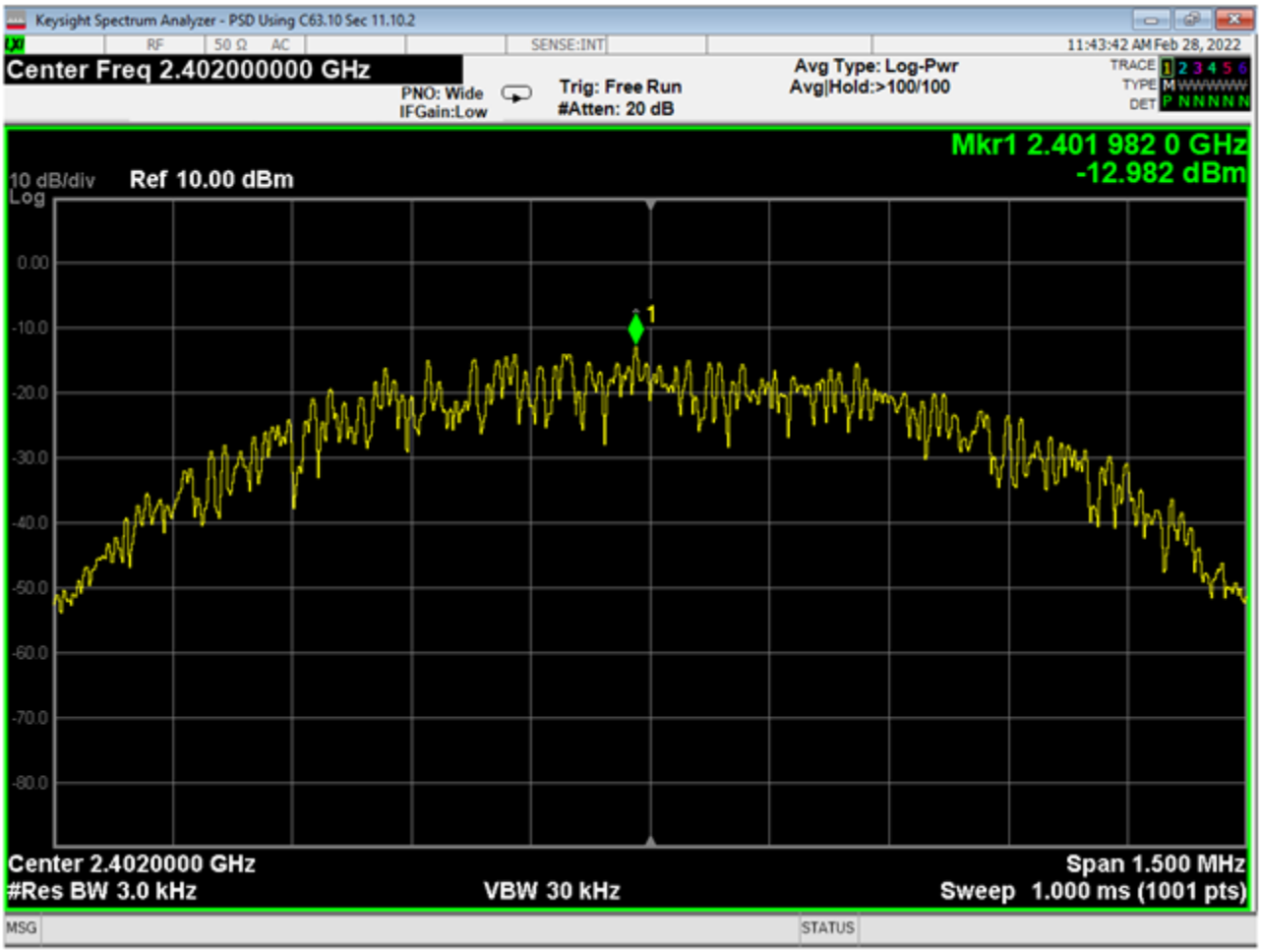
04 Bandwidth, Low Channel, GMSK 1MB



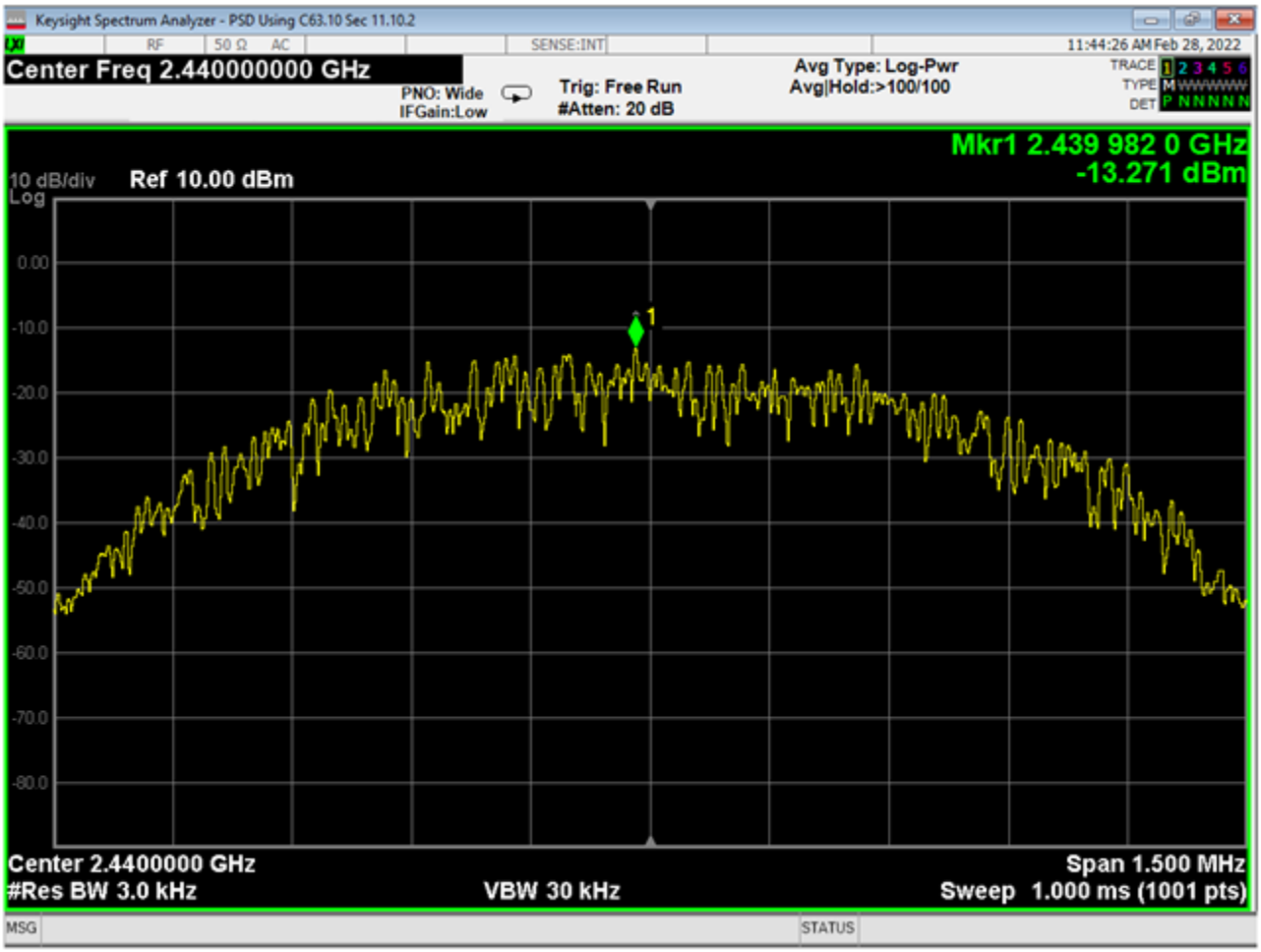
05 Bandwidth, Mid Channel, GMSK 1MB



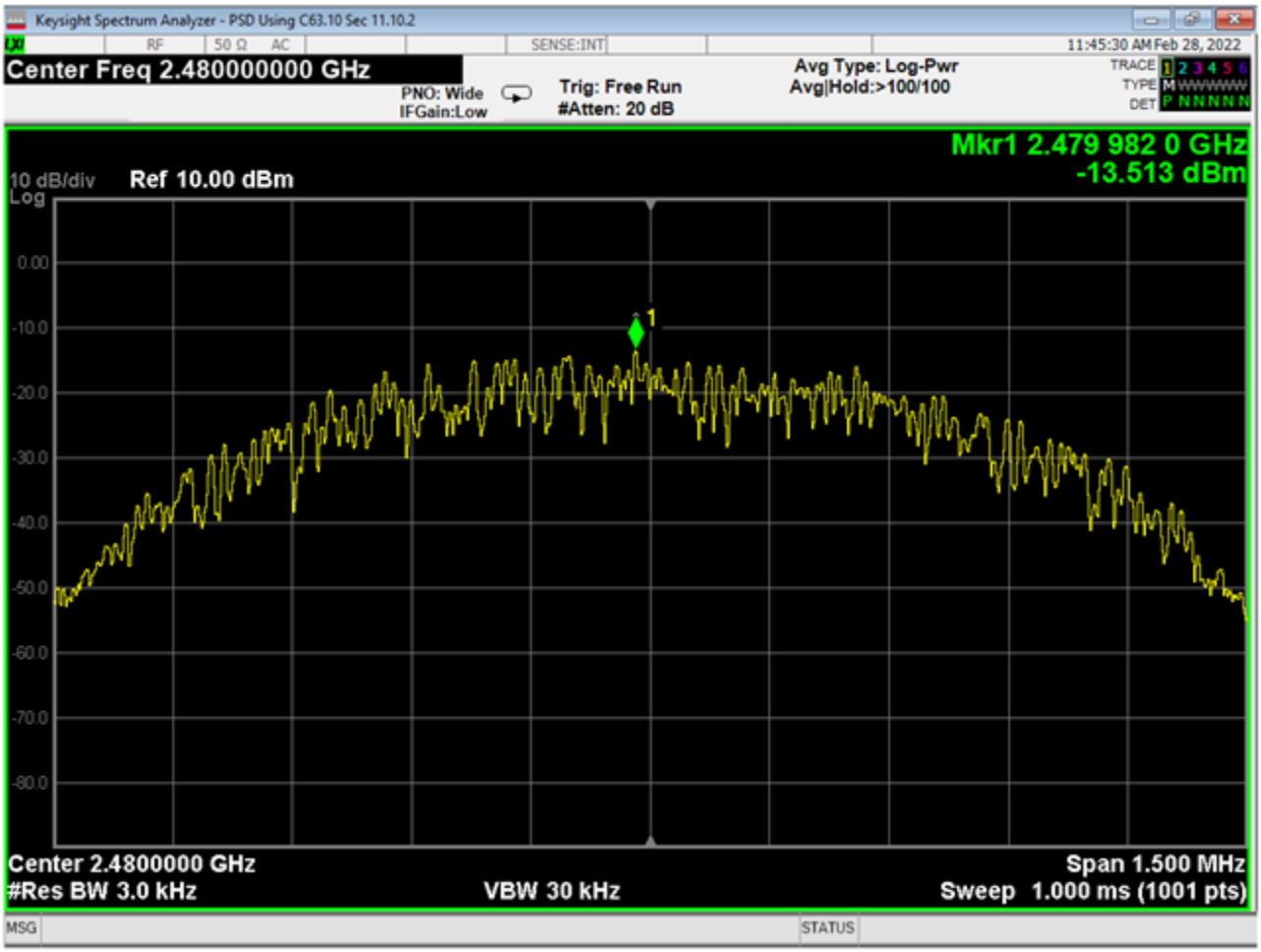
06 Bandwidth, High Channel, GMSK 1MB



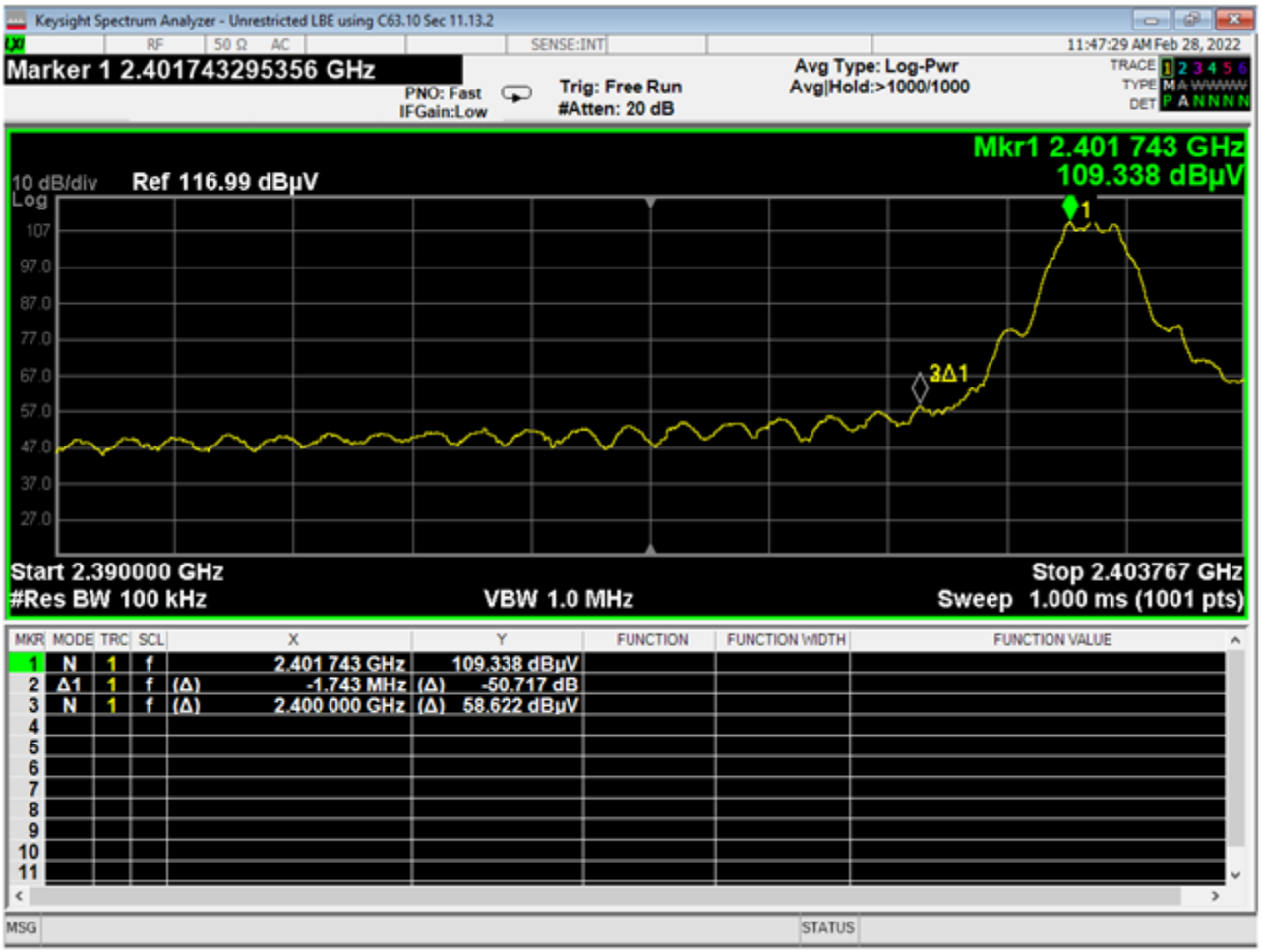
07 PSD, Low Channel, GMSK 1MB



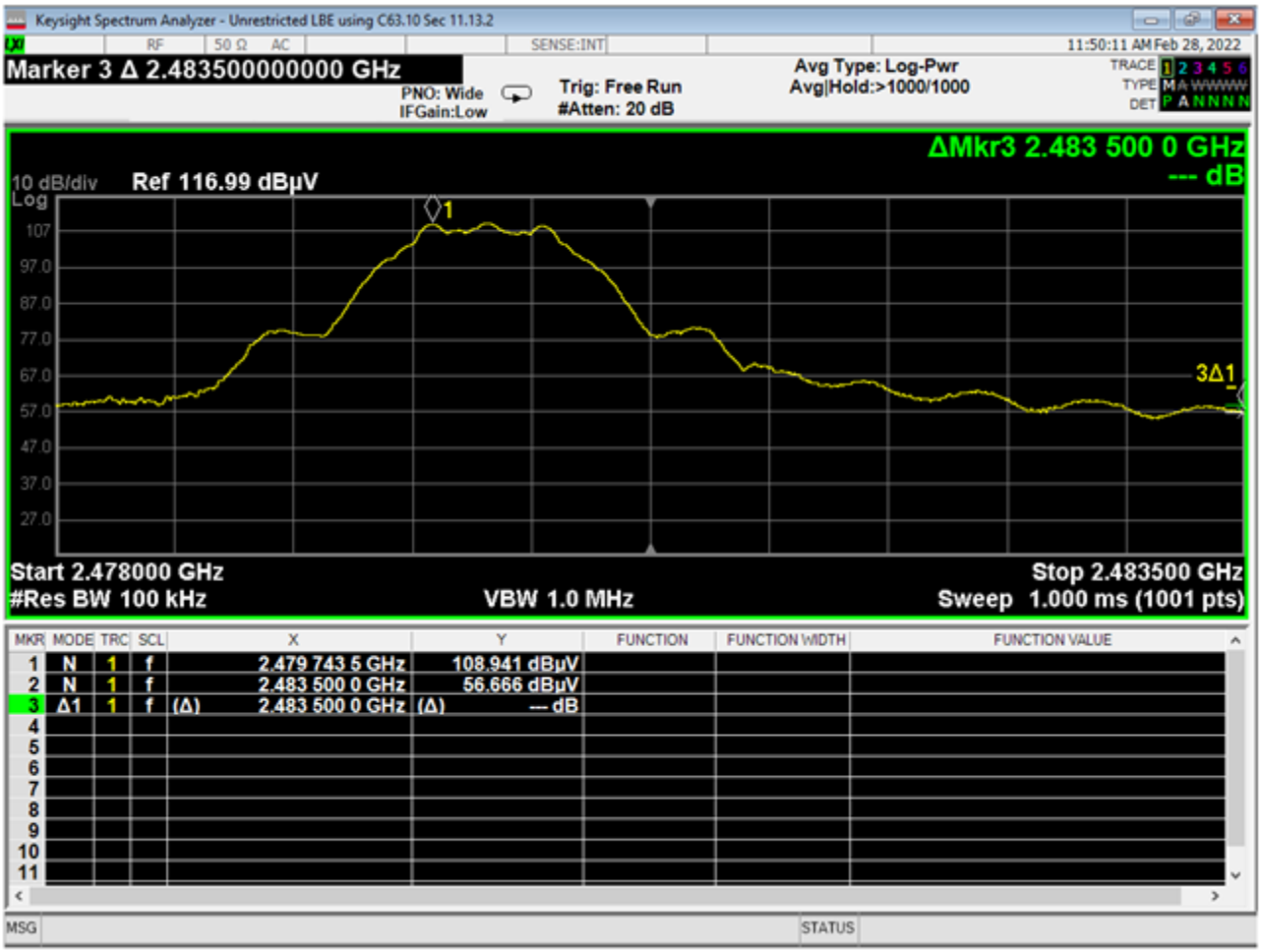
08 PSD, Mid Channel, GMSK 1MB



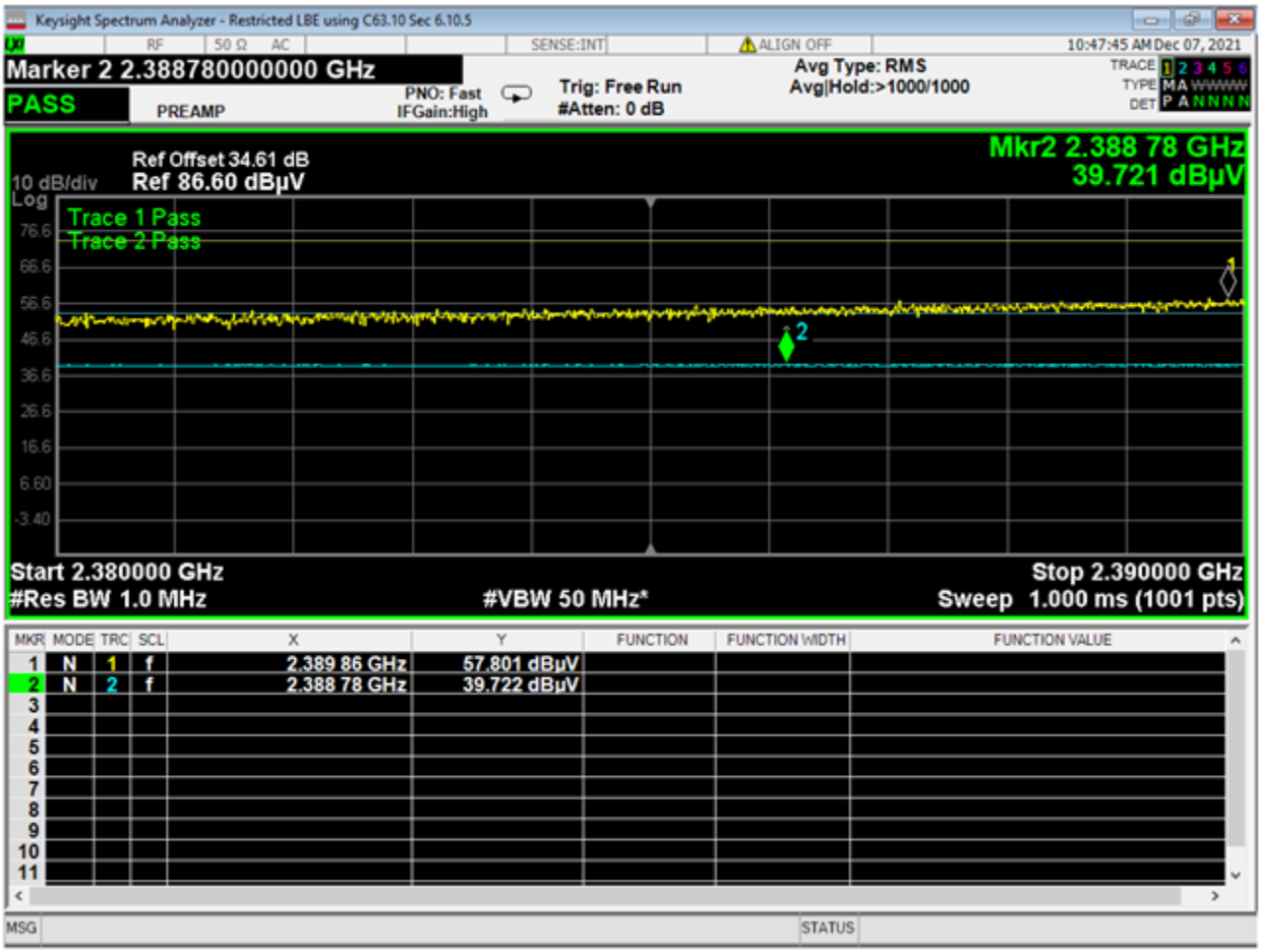
09 PSD, High Channel, GMSK 1MB



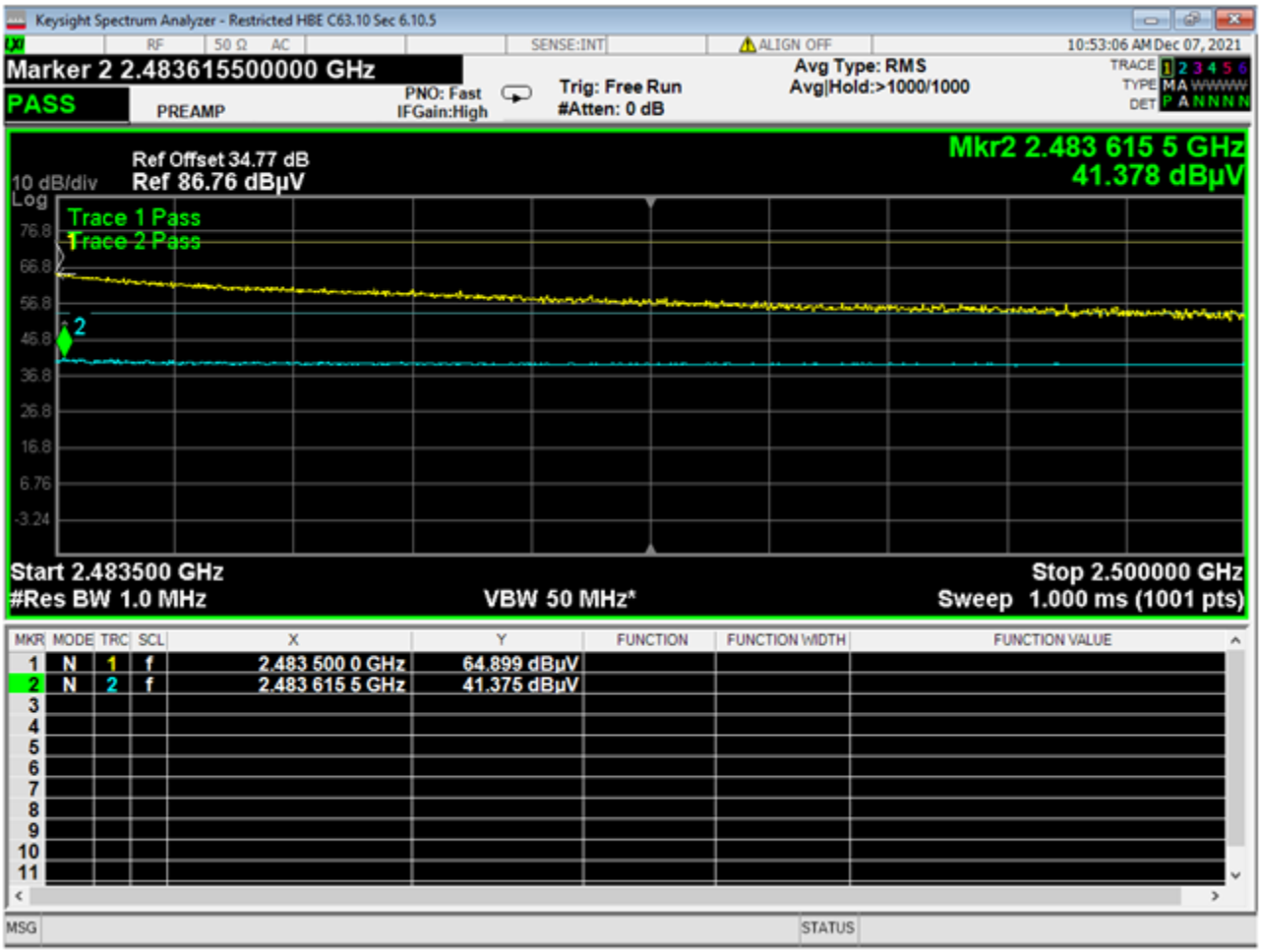
10 Lower Bandedge, Unrestricted, GMSK 1MB



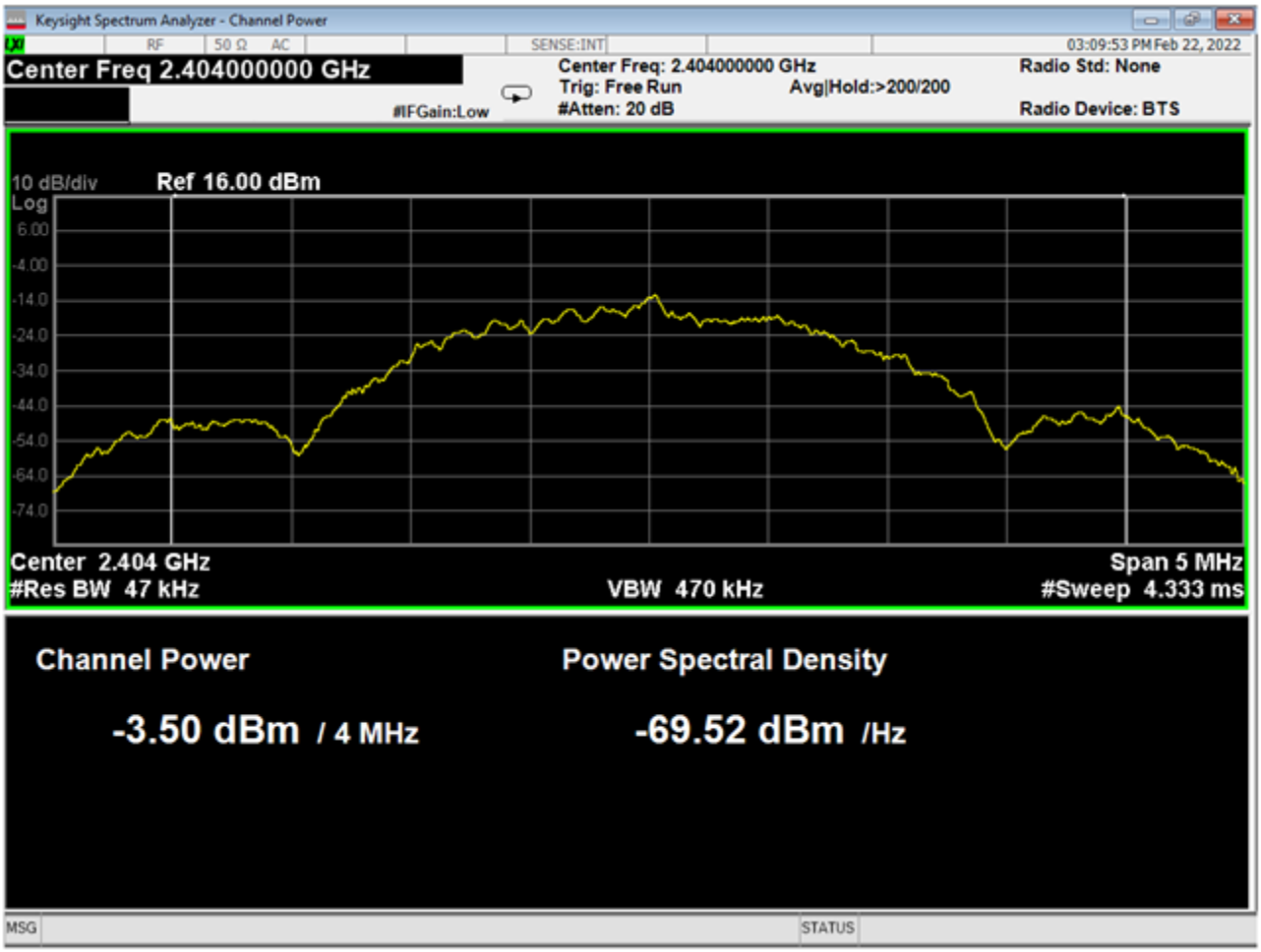
11 High Bandedge, Unrestricted, GMSK 1MB



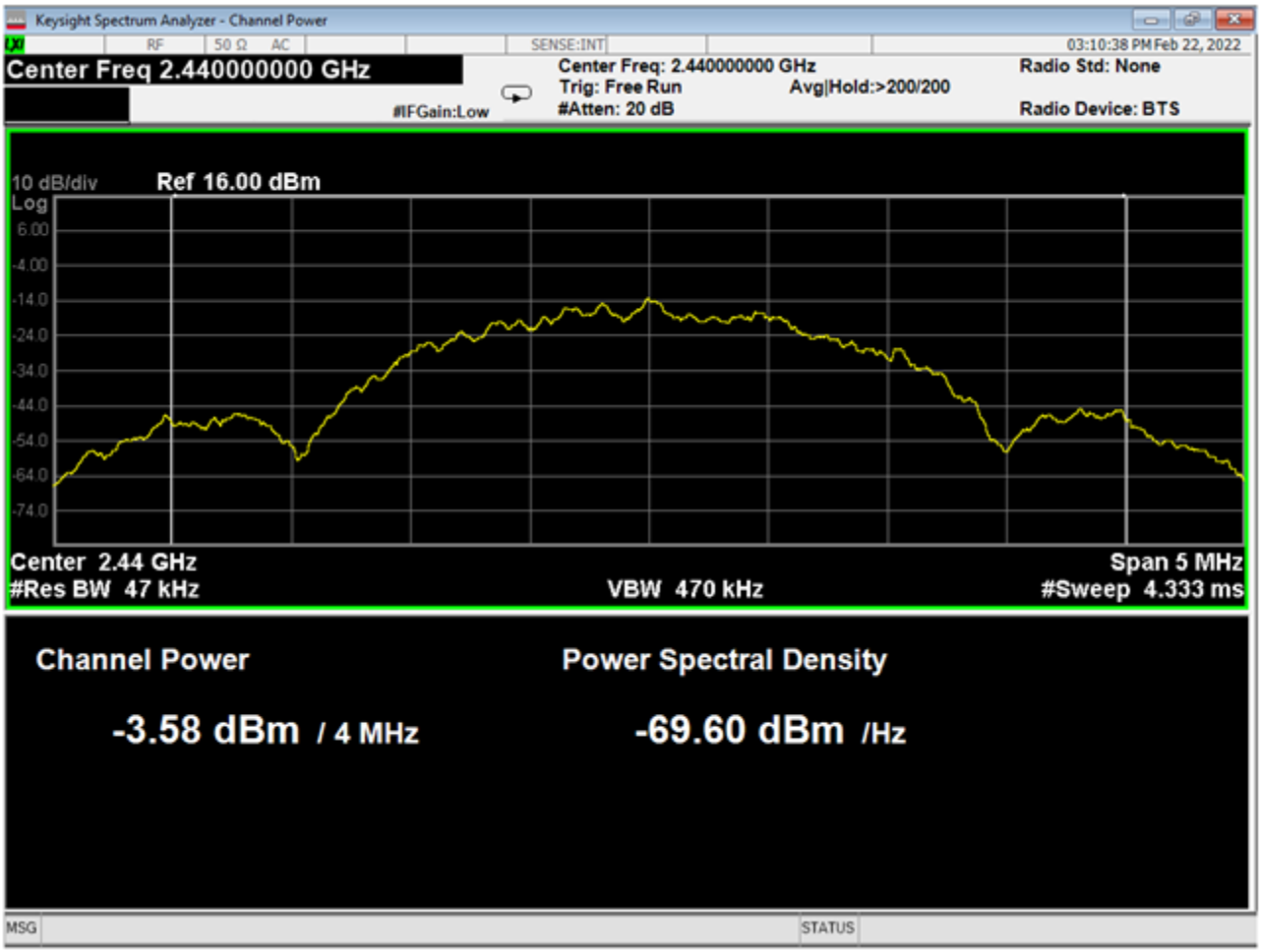
12 Lower Bandedge, Restricted, GMSK 1MB



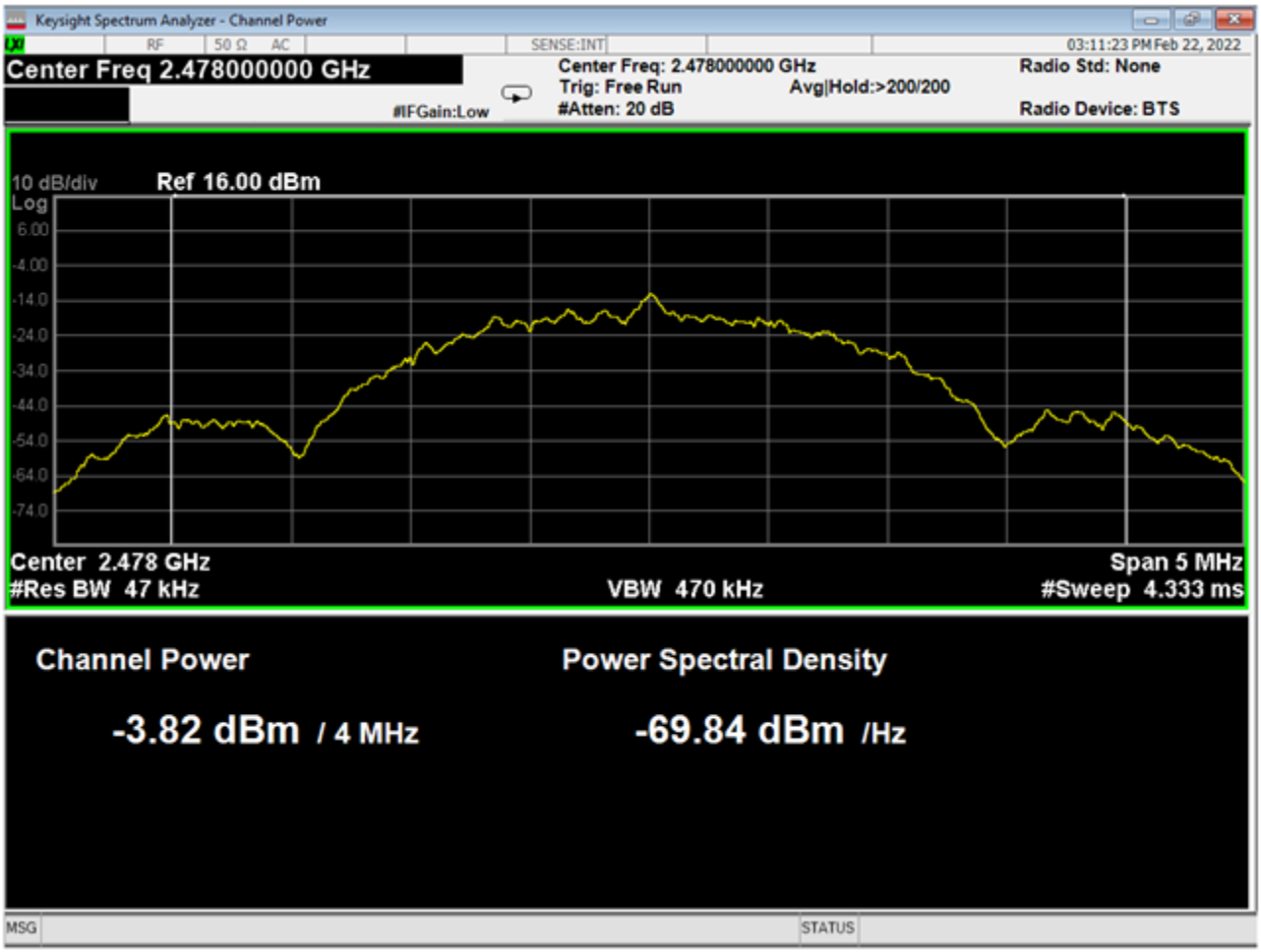
13 High Bandedge, Restricted, GMSK 1MB



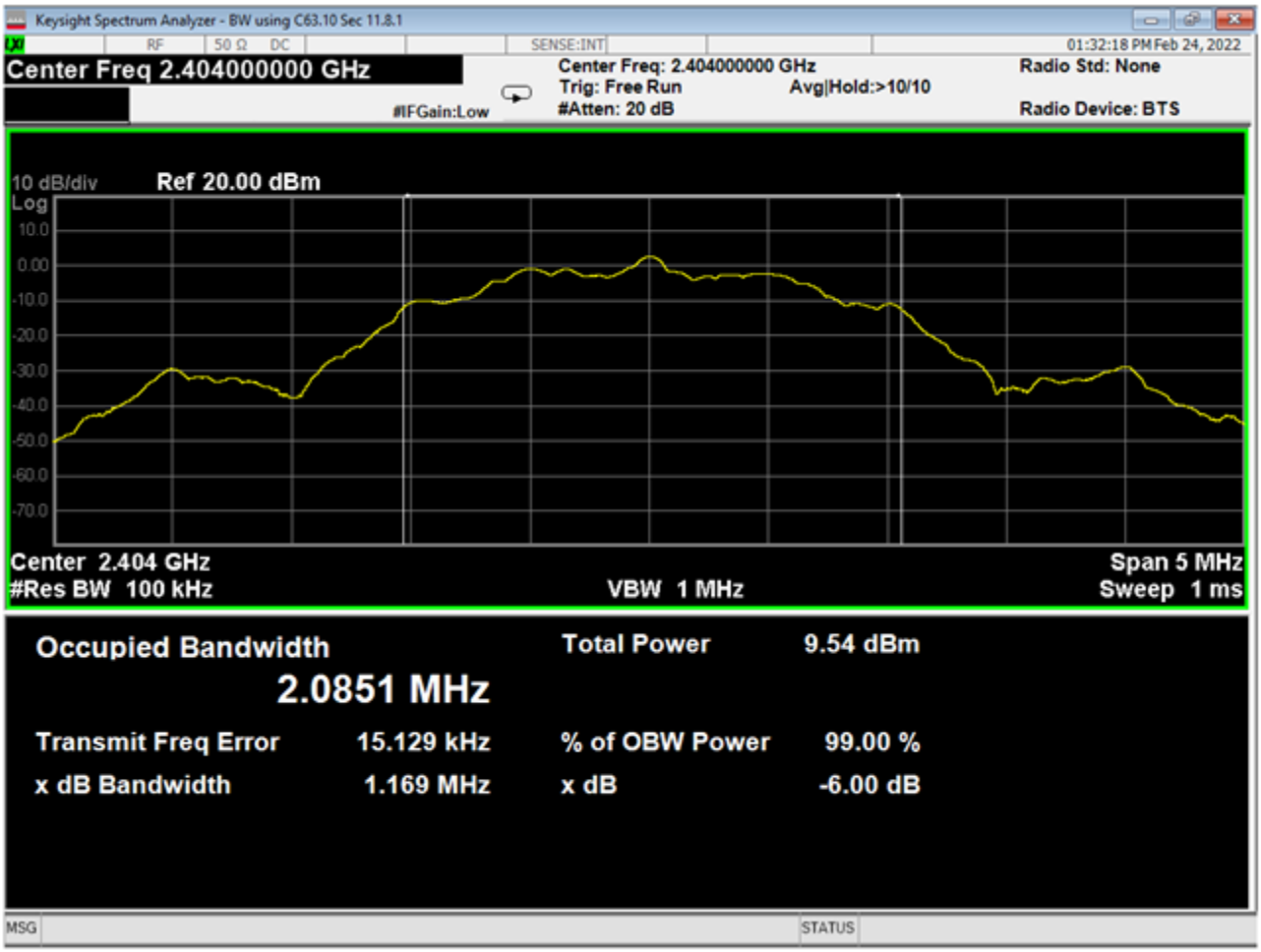
14 Average Output Power, Low Channel, GMSK 2MB



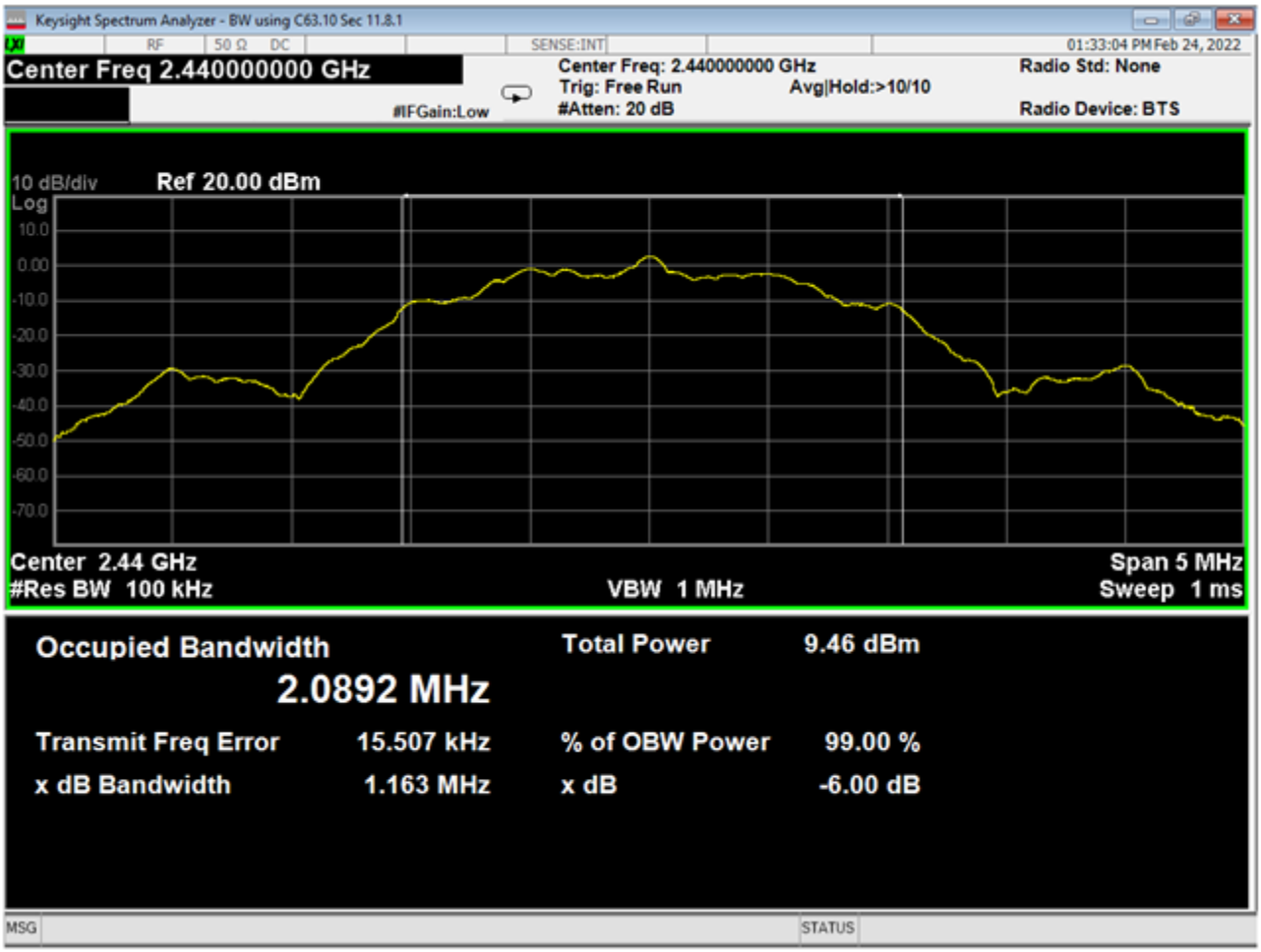
15 Average Output Power, Mid Channel, GMSK 2MB



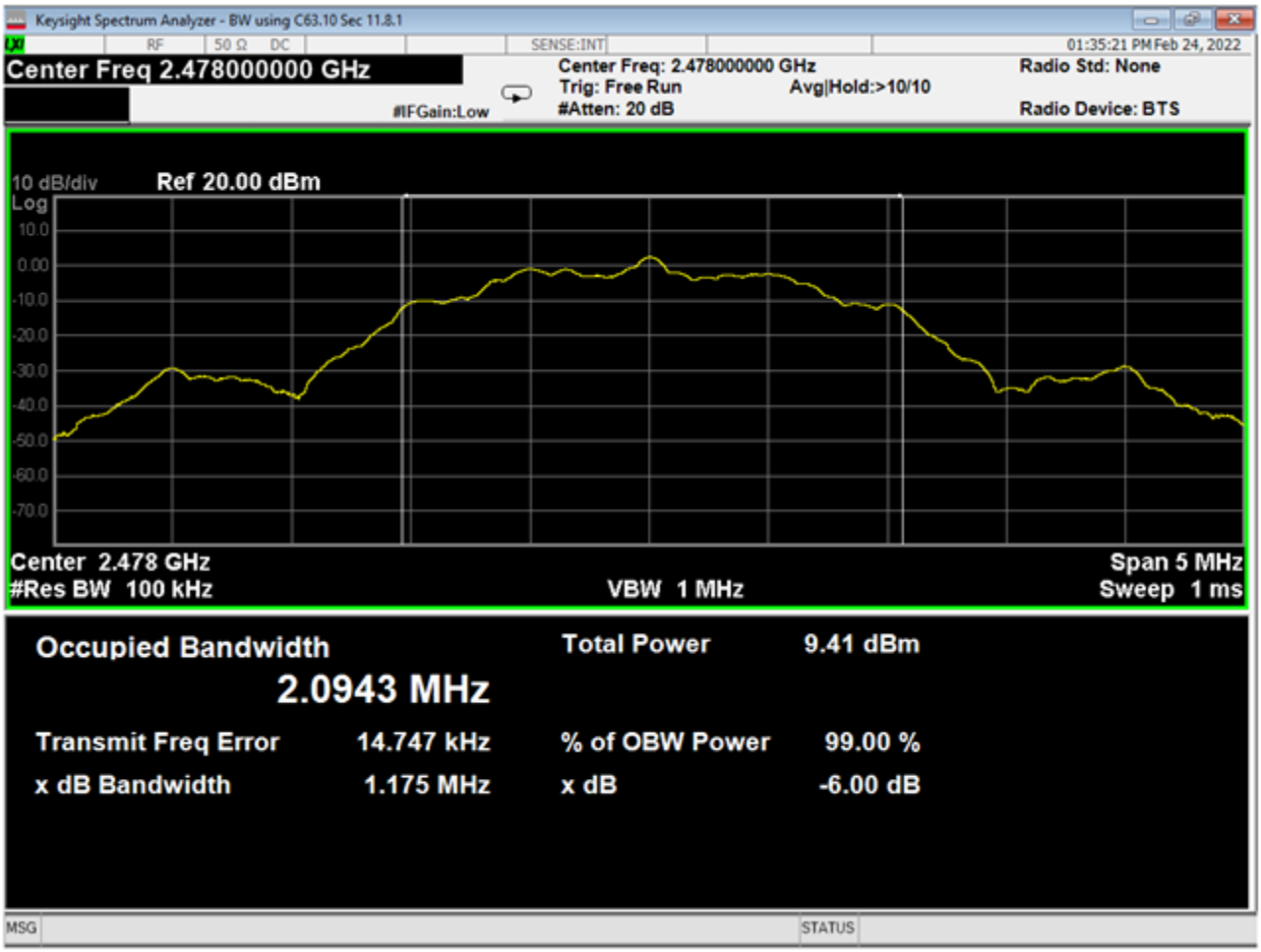
16 Average Output Power, High Channel, GMSK 2MB



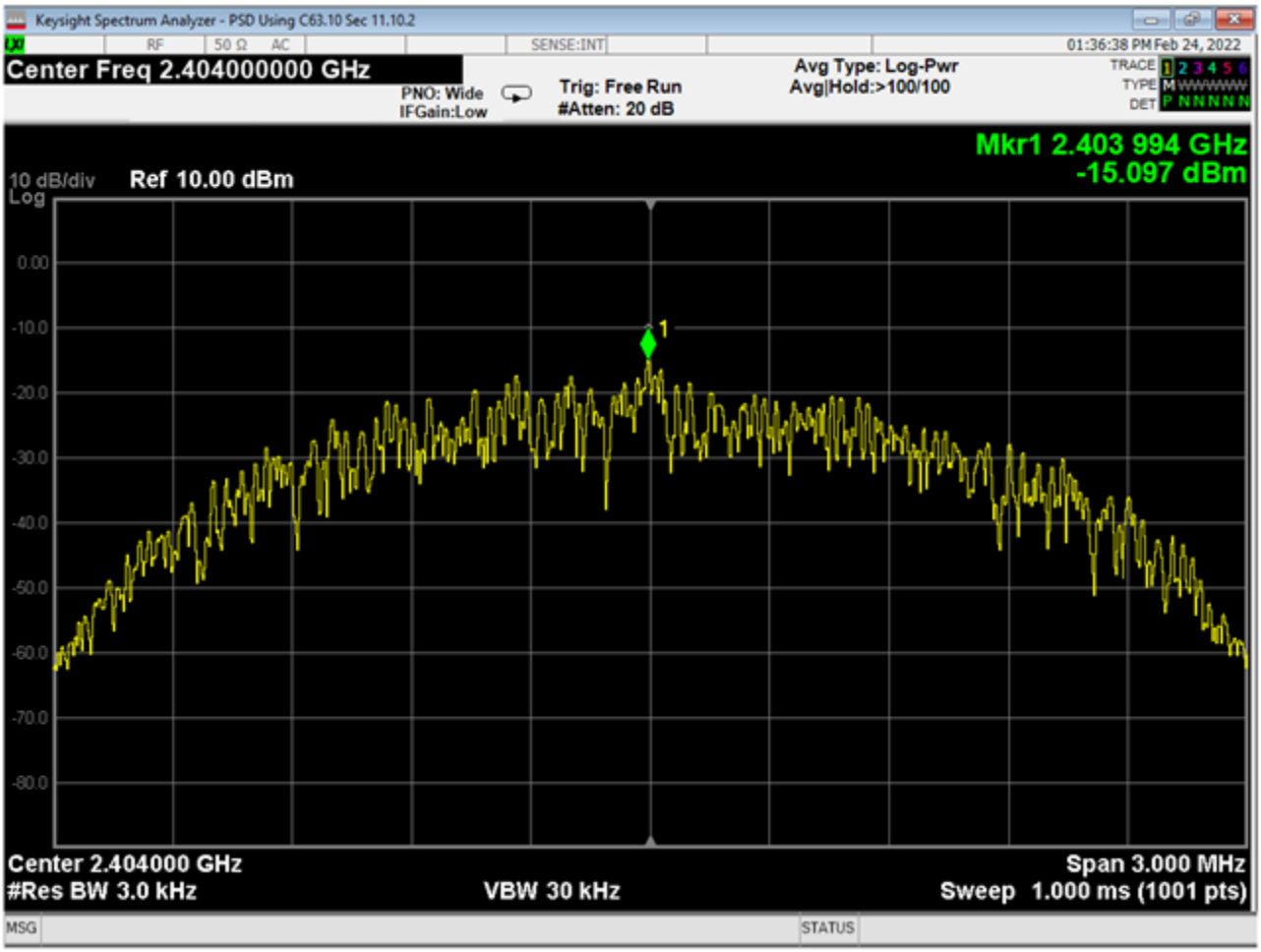
17 Bandwidth, Low Channel, GMSK 2MB



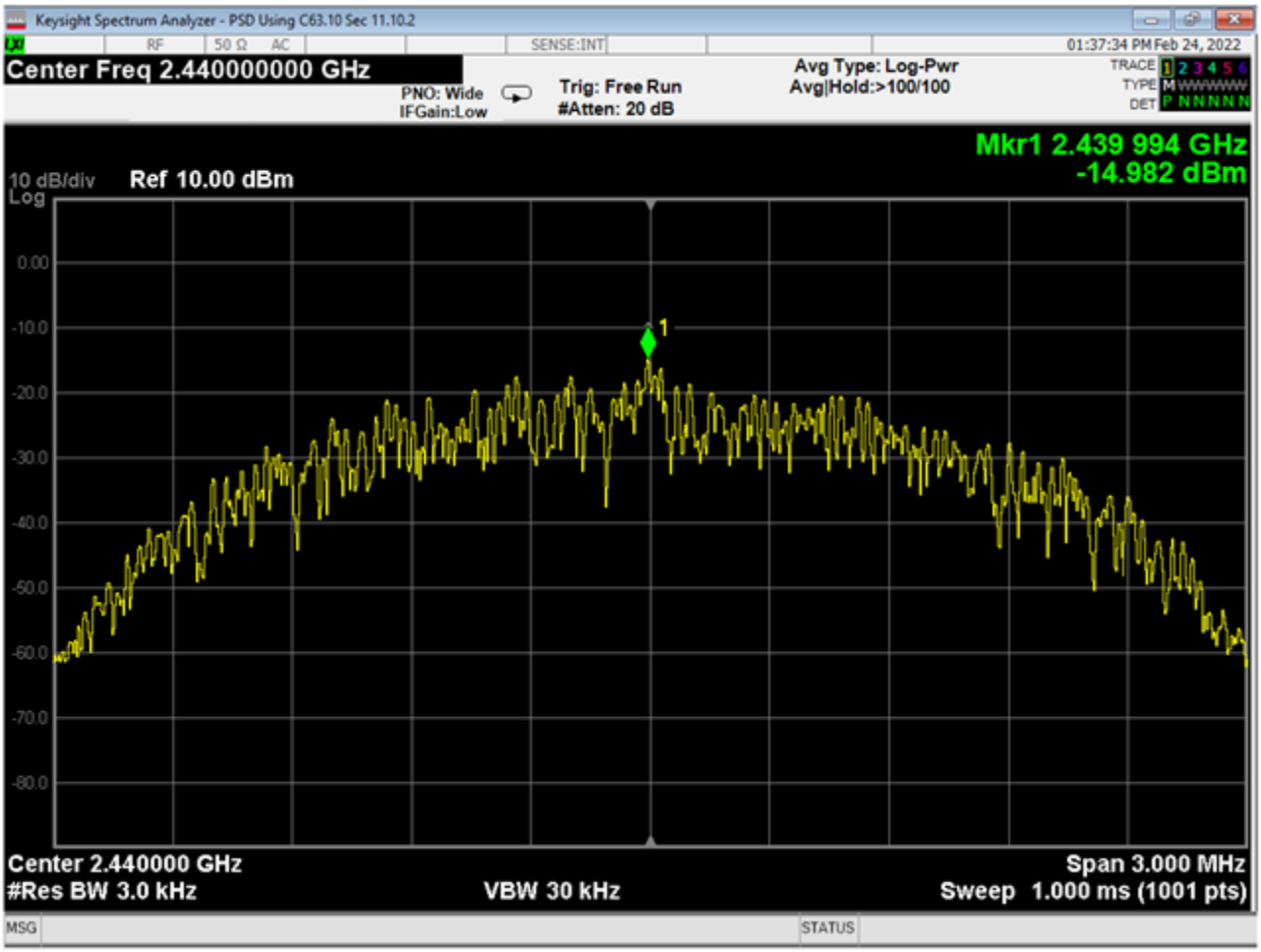
18 Bandwidth, Mid Channel, GMSK 2MB



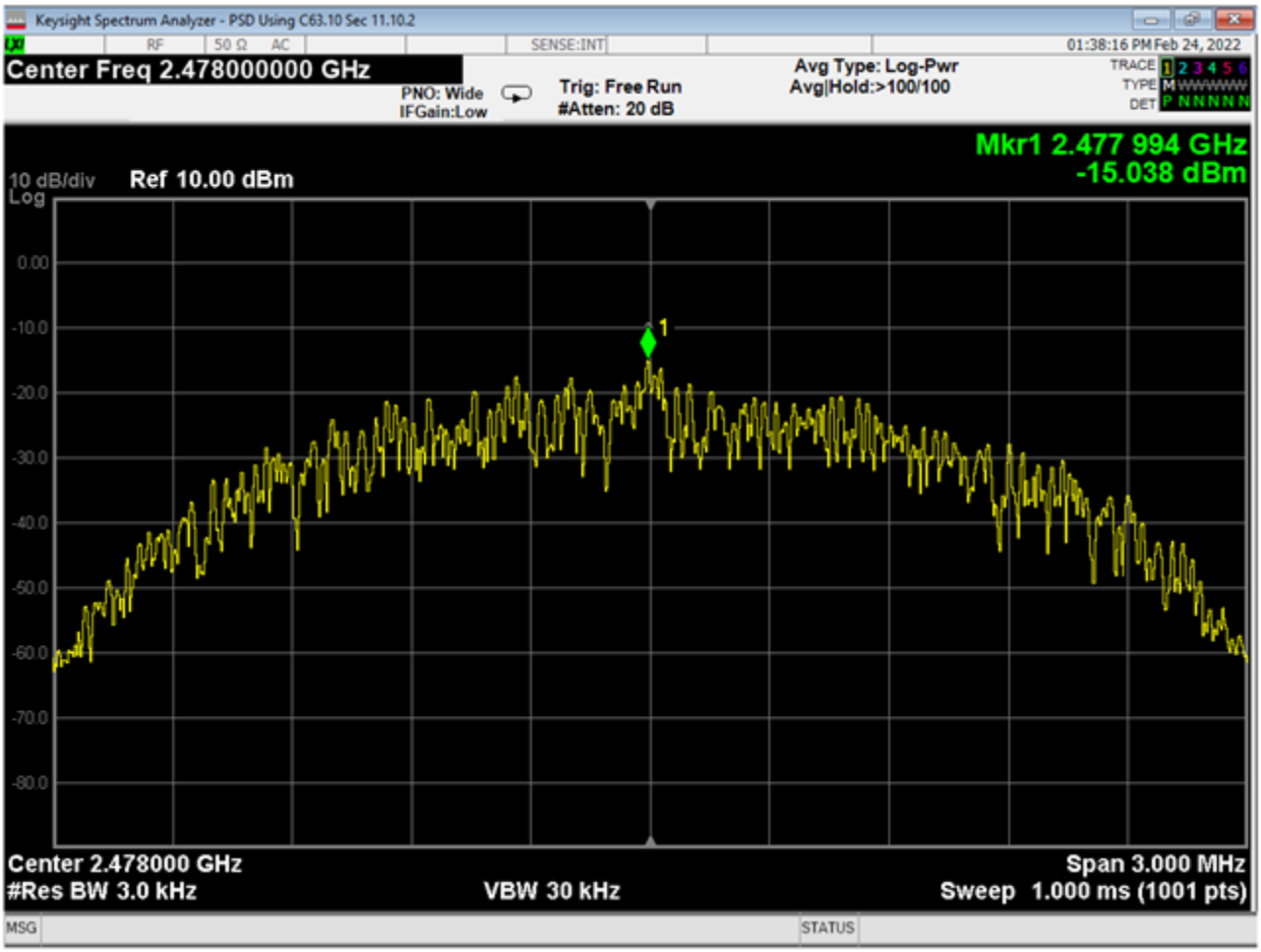
19 Bandwidth, High Channel, GMSK 2MB



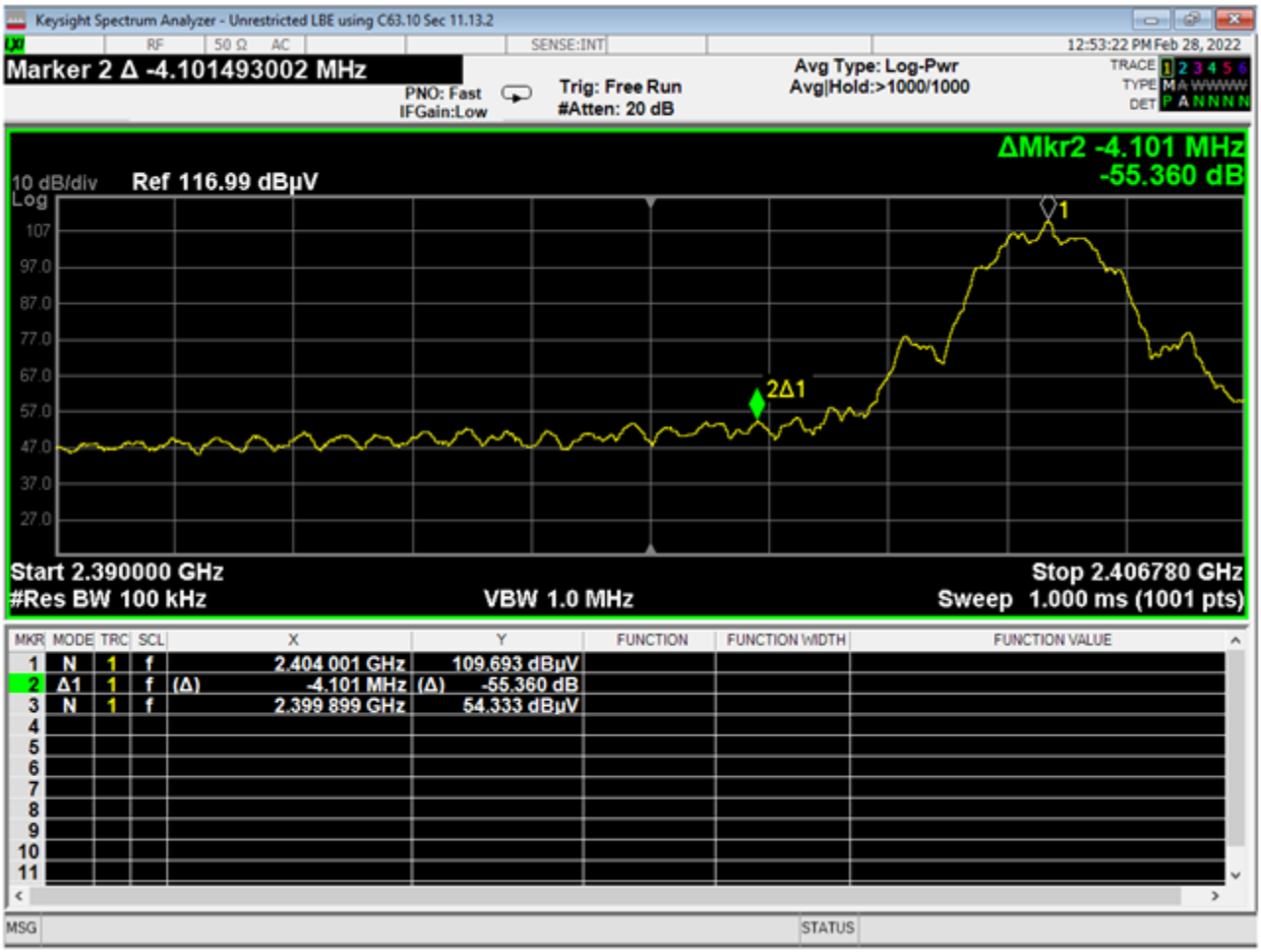
20 PSD, Low Channel, GMSK 2MB



21 PSD, Mid Channel, GMSK 2MB

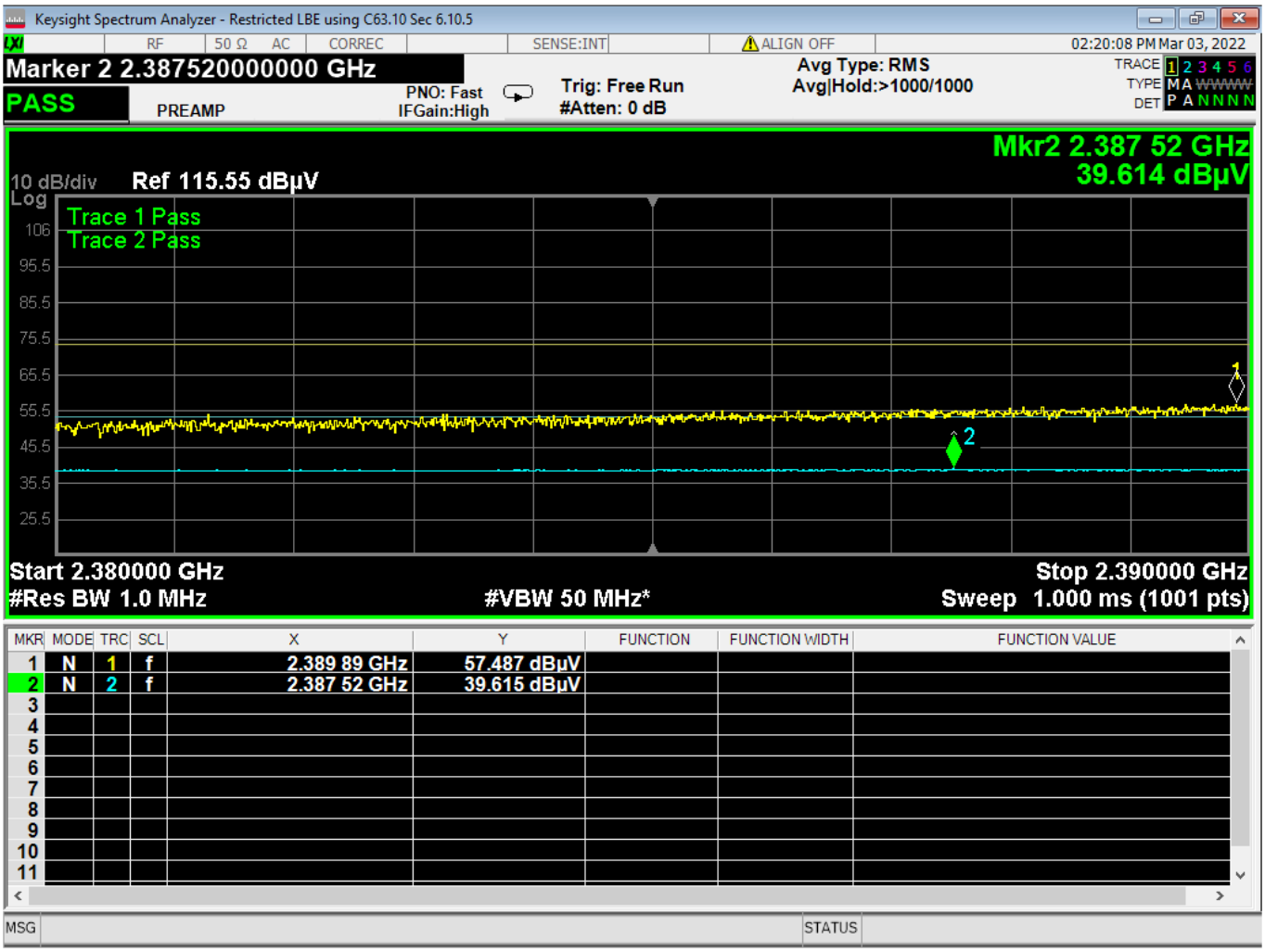


22 PSD, High Channel, GMSK 2MB

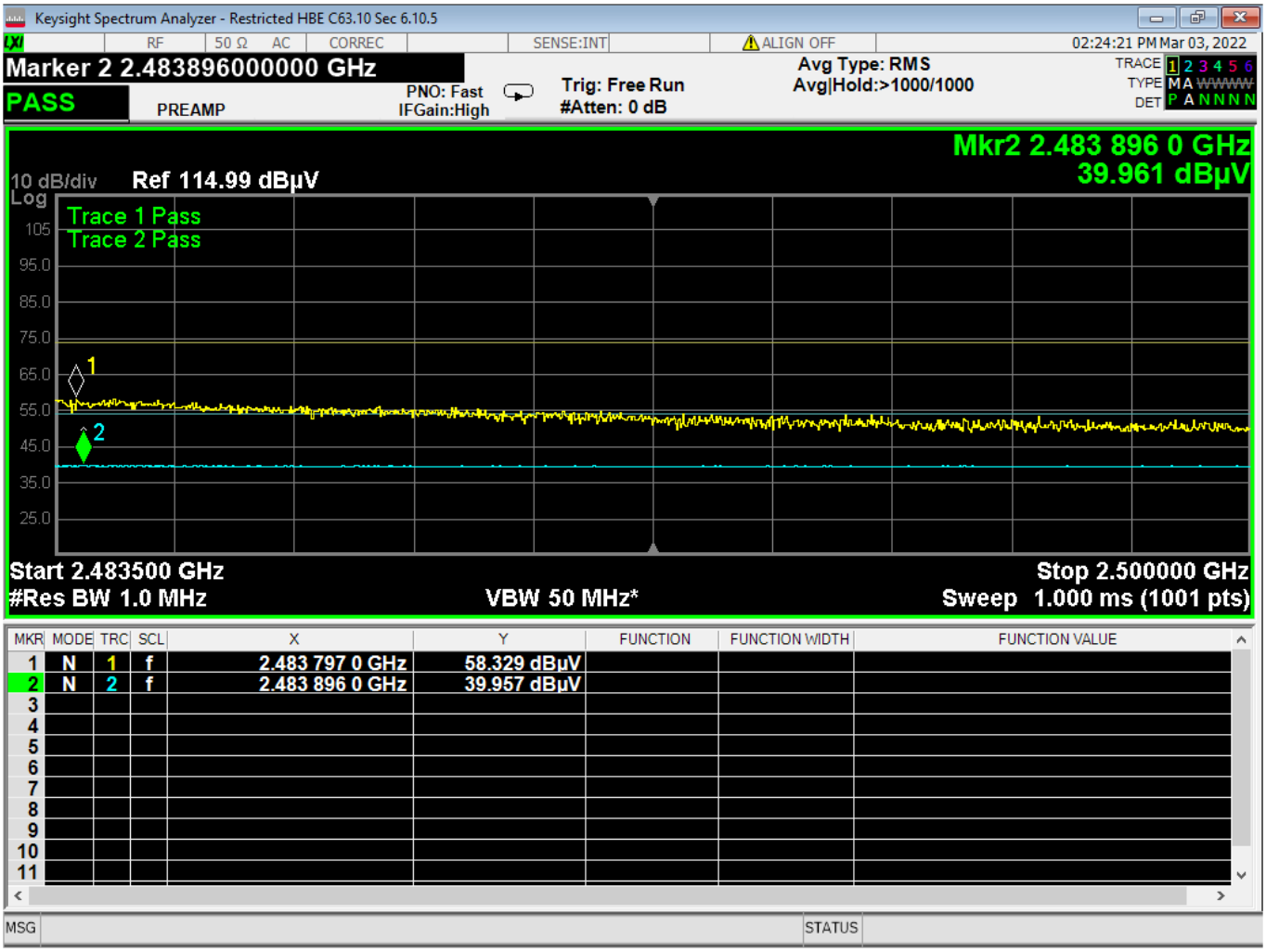


23 Lower Bandedge, Unrestricted, GMSK 2MB

24 High Bandedge, Unrestricted, GMSK 2MB



25 Lower Bandedge, Restricted, GMSK 2MB



26 High Bandedge, Restricted, GMSK 2MB

REPORT END