

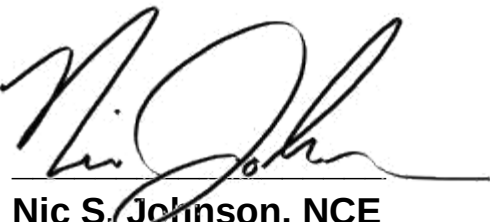
Revised repAmended
FCC/ISED Test Report

Prepared for: Garmin International Inc

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

Product: A04233

Test Report No: R20210608-22-E1B

Approved by: 
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Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: 15 December 2021

Total Pages: 61

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REVISION PAGE

Rev. No.	Date	Description
0	28 October 2021	Original – NJohnson Prepared by KVepuri/FLane
A	24 November 2021	Update cover page, Section 1.0, 2.1, 3.4, 4.0, captions to Figures 12 and 13 -NJ
B	15 December 2021	1. Added Conducted Spurious section to the report 2. Added duty cycle correction in section 4.3 3. Frequency range is indicated for emissions measurements. 4. Average Band-edge measurements were updated. -KV/FL

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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 (Please see the checked box below for the rule part used):

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) ISSED RSS-Gen, Issue 5
- (3) ISSED RSS-247, Issue 2

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(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 5.5	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 4, Section 7.2	Conducted Emissions	Pass

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



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2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	A04233
EUT Received	10 June 2021
EUT Tested	17 September 2021- 9 December 2021
Serial No.	00820 (conducted antenna port measurements); 00479 (radiated measurements);
Operating Band	2400 – 2483.5 MHz
Device Type	☒ GMSK ☒ GFSK
Power Supply / Voltage	MN: PSAF10R-050Q SN: P183100953A1 / 5 VDC

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:

For Bluetooth Transmissions:

Channel	Frequency
Low	2402 MHz
Mid	2440/2441 MHz
High	2480 MHz

These are the only representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table 1. See the operational description for a list of all channel frequency and designations.

2.3 DESCRIPTION OF SUPPORT UNITS

None

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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 $35 \pm 4\%$
Temperature of $22 \pm 3^\circ$ 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	Fox Lane	Test Engineer	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 (26.5GHz)	N9038A	MY56400083	May 5, 2020	May 5, 2022
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	April 14, 2020	April 14, 2022
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	February 1, 2021	February 1, 2022
Trilithic High Pass Filter*	6HC330	23042	April 14, 2020	April 14, 2022
EMCO Horn Antenna	3115	6415	March 16, 2020	March 16, 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
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	April 14, 2020	April 14, 2022
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	April 14, 2020	April 14, 2022
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	April 14, 2020	April 14, 2022
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	April 14, 2020	April 14, 2022
N connector bulkhead (control room)*	PE9128	NCEEBH2	April 14, 2020	April 14, 2022
TDK Emissions Lab Software	V11.25	700307	NA	NA

*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 MEASUREMENTS

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.

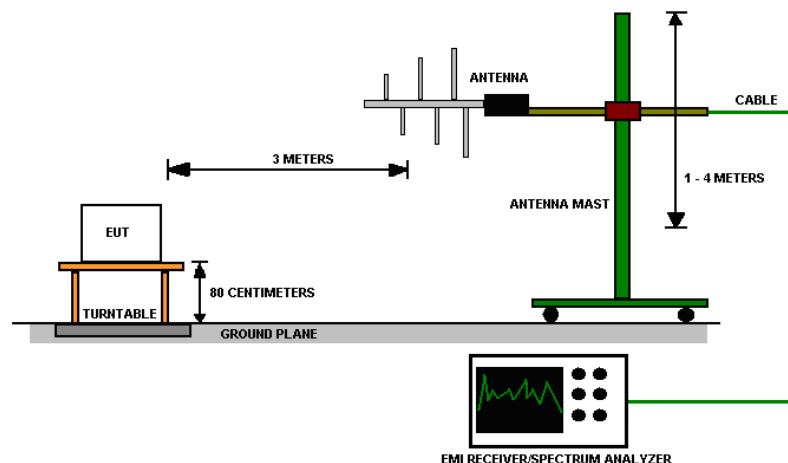


Figure 2 - Radiated Emissions Test Setup

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4.0 RESULTS

DTS Radio Measurements							
CHANNEL	Transmitter	Occupied Bandwidth (kHz)	6 dB Bandwidth (kHz)	PEAK OUTPUT POWER (dBm)	PEAK OUTPUT POWER (mW)	PSD (dBm)	RESULT
Low	GMSK	1090	570.90	1.548	1.428	-14.329	PASS
Mid	GMSK	1090	568.00	1.873	1.539	-14.386	PASS
High	GMSK	1100	555.20	1.980	1.578	-14.302	PASS
Low	GFSK	993.14	500.40	1.397	1.379	-7.474	PASS
Mid	GFSK	989.53	504.80	1.093	1.286	-7.34	PASS
High	GFSK	996.23	500.30	1.347	1.364	-7.477	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	2400.00	56.09	109.39	53.30	20.00	PASS
Low	GFSK	2400.00	55.63	109.14	53.51	20.00	PASS
High	GMSK	2483.50	56.86	109.16	52.30	20.00	PASS
High	GFSK	2483.50	56.54	109.06	52.52	20.00	PASS
Peak and Average 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	2390.00	52.35	Peak	73.98	21.64	PASS
Low	GFSK	2390.00	51.67	Peak	73.98	22.31	PASS
High	GMSK	2483.50	53.37	Peak	73.98	20.61	PASS
High	GFSK	2483.50	52.88	Peak	73.98	21.11	PASS
Low	GMSK	2390.00	43.57	Average**	53.98	10.41	PASS
Low	GFSK	2390.00	40.35	Average**	53.98	13.63	PASS
High	GMSK	2483.50	43.95	Average**	53.98	10.03	PASS
High	GFSK	2483.50	40.72	Average**	53.98	13.27	PASS
*Limit shown is the peak limit taken from FCC Part 15.209							
**Average Highest out of band level = SA Average Level + DCCF. C63.10 Sec. 11.12.2.5.2							
See Sec 4.3 for more information on DCCF							



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4.1 OUTPUT POWER

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 allowed peak 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 data is in the table in results section 4.0.
3. All the measurements were found to be compliant.



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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 data is in the table in results section 4.0.
3. All the measurements were found to be compliant.

4.3 DUTY CYCLE

Test Method:

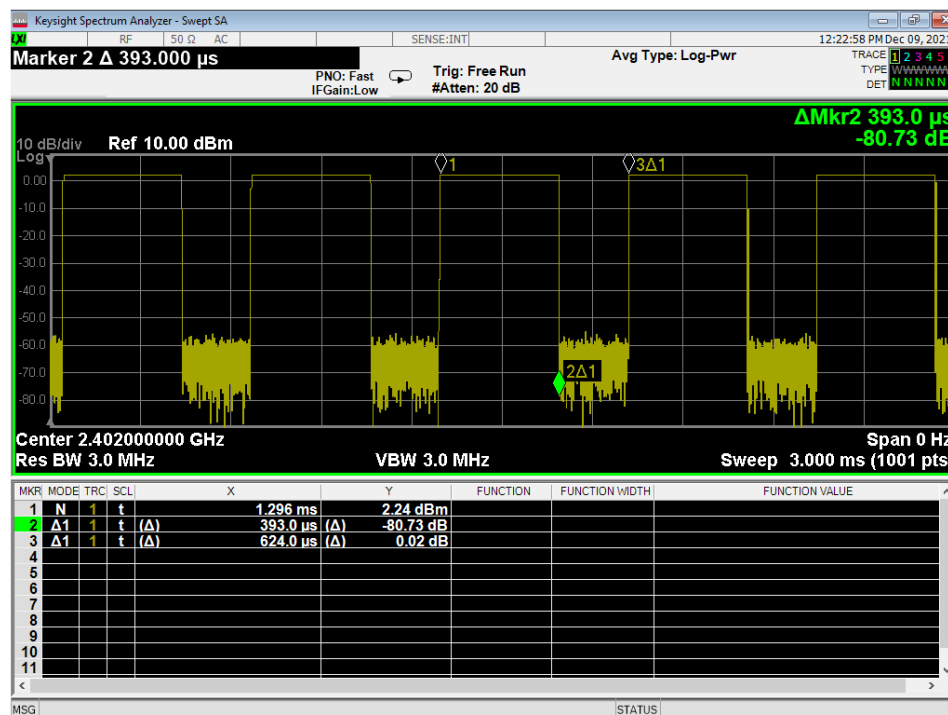


Figure 3 – Duty Cycle, GMSK

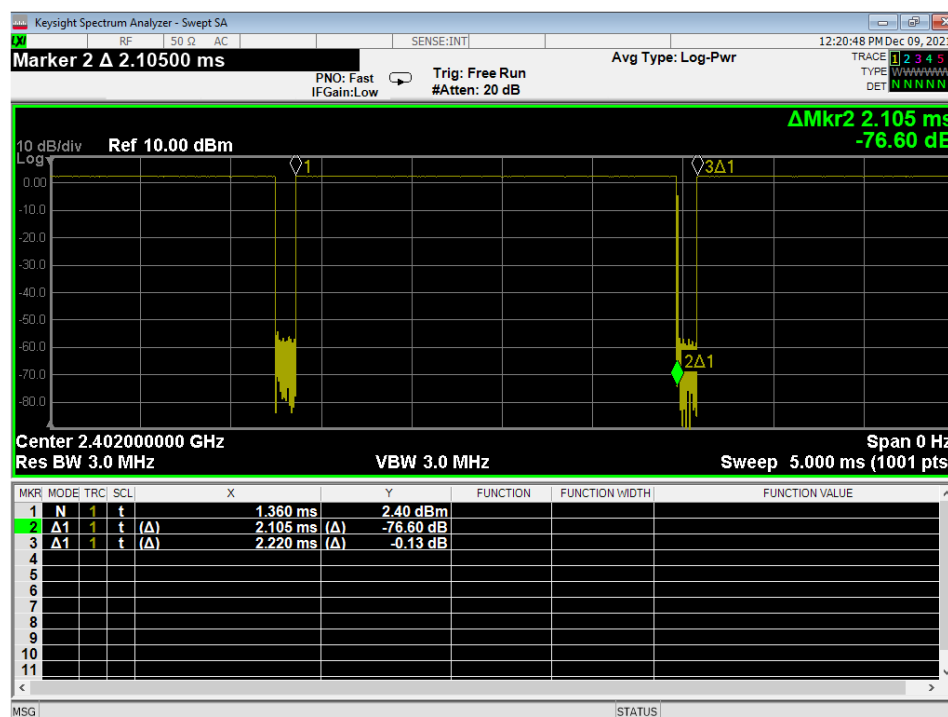


Figure 4 – Duty Cycle, GFSK



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GMSK

DCCF (Duty Cycle Correction Factor) = $20 * \text{Log}(\text{Duty Cycle} / 100)$

$$4.02 = 20 * \text{Log}(1/(62.98 / 100))$$

GFSK

DCCF (Duty Cycle Correction Factor) = $20 * \text{Log}(\text{Duty Cycle} / 100)$

$$0.46 = 20 * \text{Log}(1/(94.82 / 100))$$

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 ($\mu\text{V/m}$)	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) = $20 * \log * \text{Emission level } (\mu\text{V/m})$.
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.



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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 to 25 GHz
- 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.
- h. The transmitter was also tested while transmitter simultaneously with the approved radio module. If any intermodulation products that were found were reported in the tabular data.

Test setup:

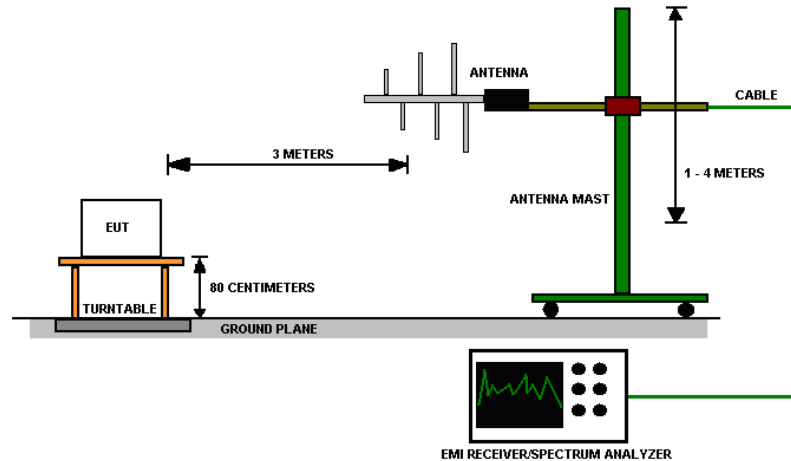


Figure 5 - Radiated Emissions Test Setup

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:

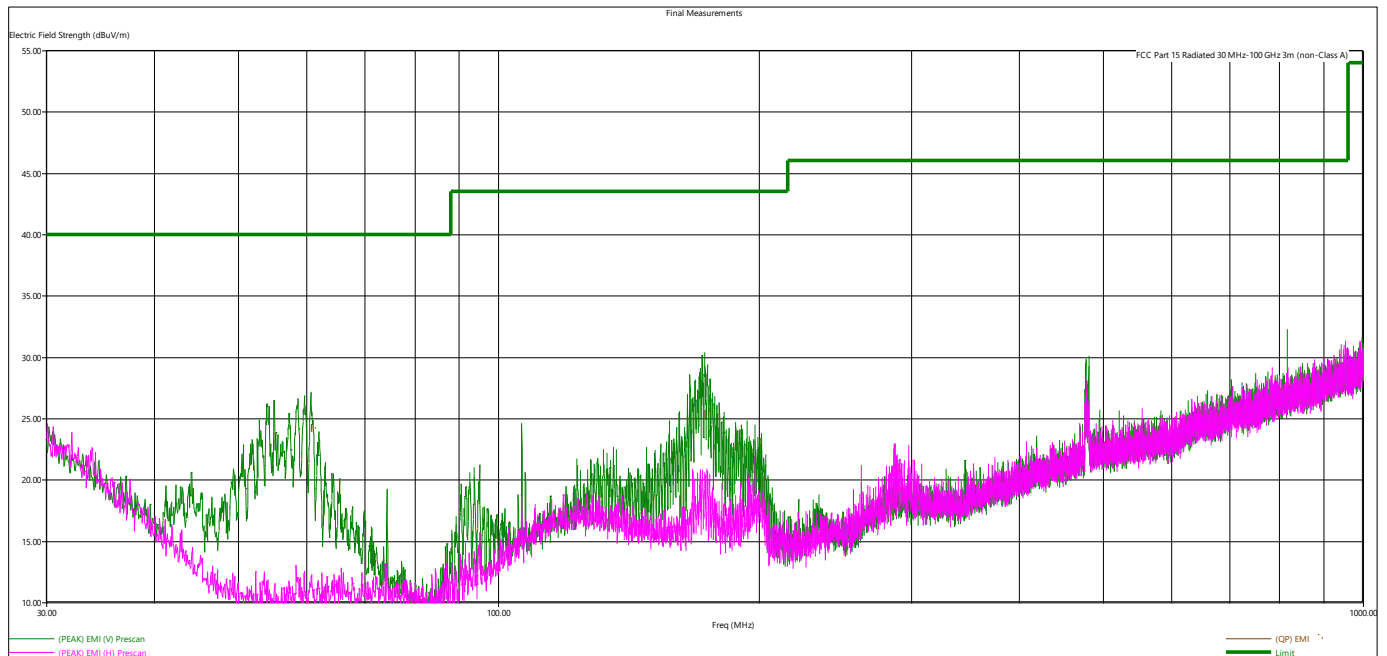


Figure 6 - Radiated Emissions Plot, Receive

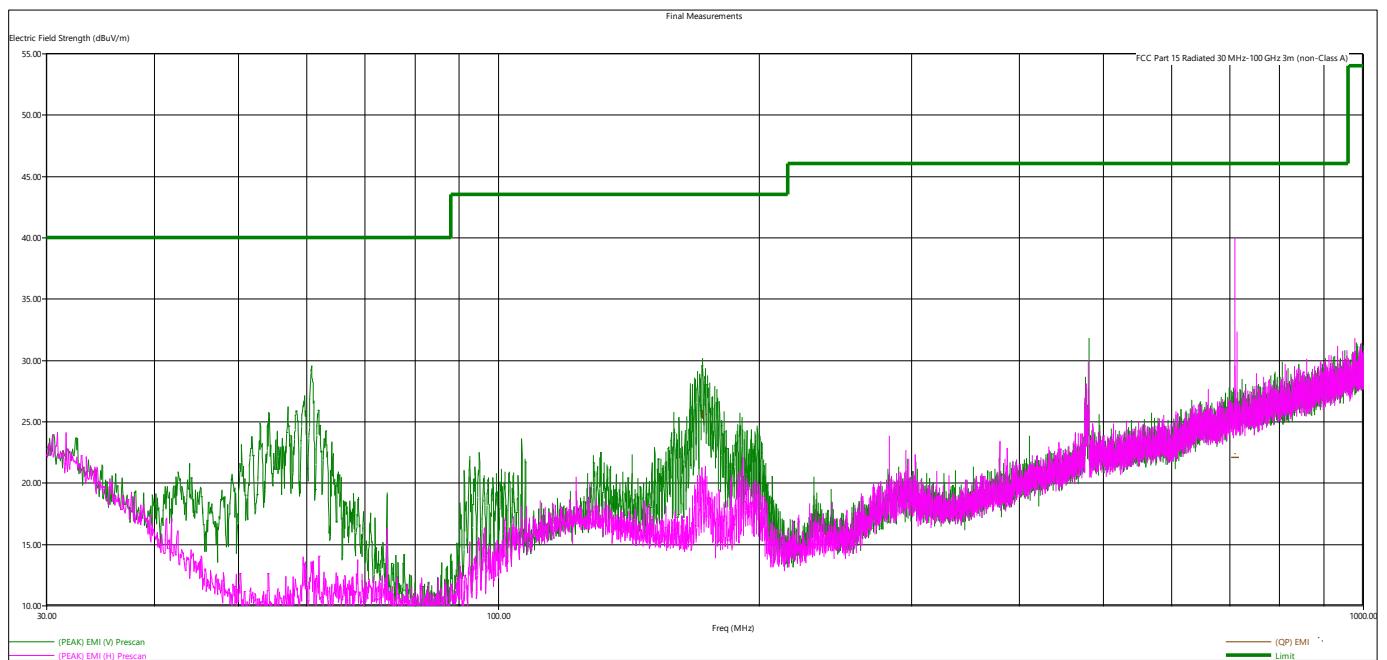


Figure 7 - Radiated Emissions Plot, Low Channel, GMSK

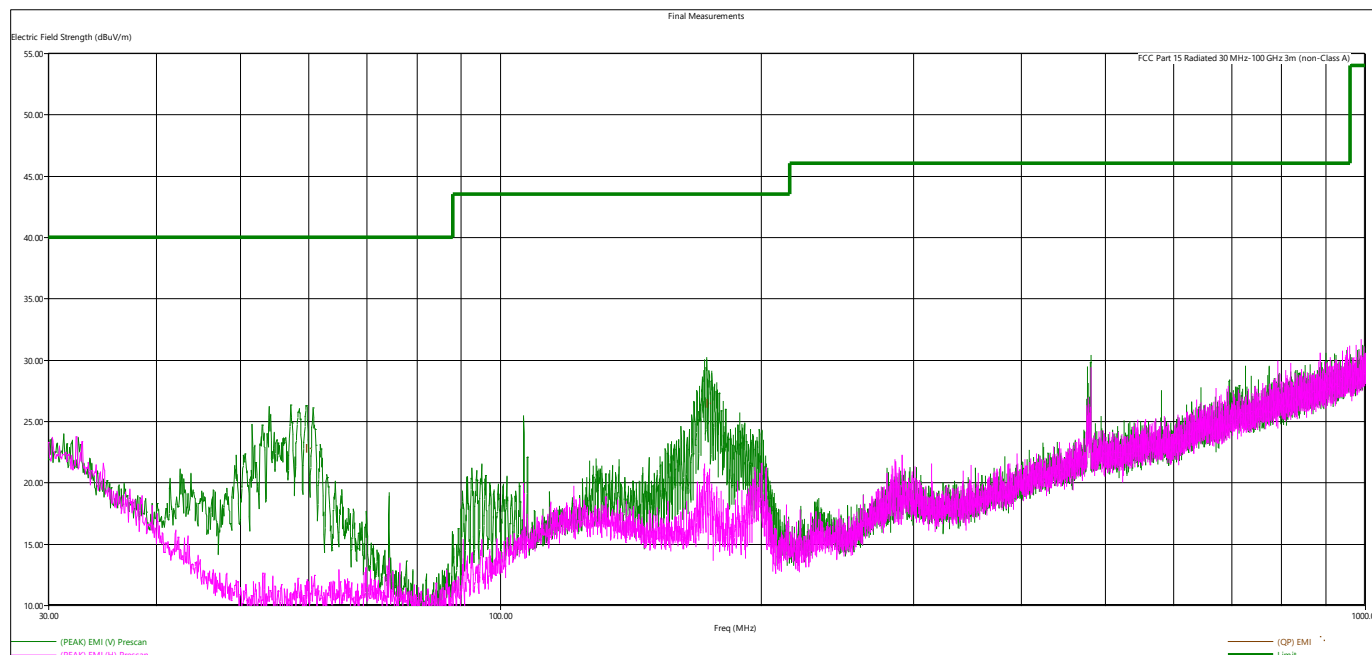


Figure 8 - Radiated Emissions Plot, Low Channel, GFSK

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

Quasi-Peak Measurements, GMSK-GFSK, 30 MHz -1 GHz								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBuV/m	dBuV/m	dB	cm.	deg.			
710.51952	22.03	46.02	23.99	360	338	H	Low	GMSK
172.04112	25.52	43.52	18.00	106	73	V	Low	GMSK
59.60136	22.71	40.00	17.29	107	202	V	Low	GFSK
173.11968	26.38	43.52	17.14	113	53	V	Low	GFSK
60.5988	24.15	40.00	15.85	119	210	V	Receiver	
173.27688	25.31	43.52	18.21	106	85	V	Receiver	

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



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Peak Measurements, GMSK-GFSK, 1 GHz-25 GHz

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBμV/m	dBμV/m	dB	cm.	deg.			
2401.762000	93.10	NA	NA	169	144	H	Low	GMSK
2441.770000	91.30	NA	NA	120	150	H	Mid	GMSK
2480.140000	86.54	NA	NA	152	153	H	High	GMSK
2402.108000	92.65	NA	NA	168	148	H	Low	GFSK
2441.066000	92.32	NA	NA	126	148	H	Mid	GFSK
2480.142000	87.19	NA	NA	121	154	H	High	GFSK
1729.580000	35.48	73.98	38.50	160	3	V	Receive	
2441.084000	40.15	73.98	33.83	239	42	V	Receive	

Average Measurements, GMSK-GFSK, 1 GHz-25 GHz

Frequency	Uncorrected* Level	Corrected Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBμV/m	dBμV/m	dBμV/m	dB	cm.	deg.			
2401.762000	86.66	90.68	NA	NA	169	144	H	Low	GMSK
2441.770000	84.84	88.86	NA	NA	120	150	H	Mid	GMSK
2480.140000	80.42	84.44	NA	NA	152	153	H	High	GMSK
2402.108000	91.06	91.52	NA	NA	168	148	H	Low	GFSK
2441.066000	90.92	91.38	NA	NA	126	148	H	Mid	GFSK
2480.142000	84.99	85.45	NA	NA	121	154	H	High	GFSK
1729.580000	22.47	22.47	53.98	31.51	160	3	V	Receive	
2441.084000	24.65	24.65	53.98	29.33	239	42	V	Receive	

Corrected Level = Uncorrected Level + DCCF from section 4.3

*Uncorrected here only refers to DCCF, cables and antenna factors are already accounted for.

**All the spurious emissions values were at least 6 dB lower than the applicable limits. Worst case measurements were reported.



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4.5 CONDUCTED SPURIOUS EMISSIONS

Test Method: ANSI C63.10-2013, Section 7.8.8

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 20dB below the fundamental. 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:

All the spurious emissions values were at least 6 dB lower than the applicable limits. Worst case measurements were reported.

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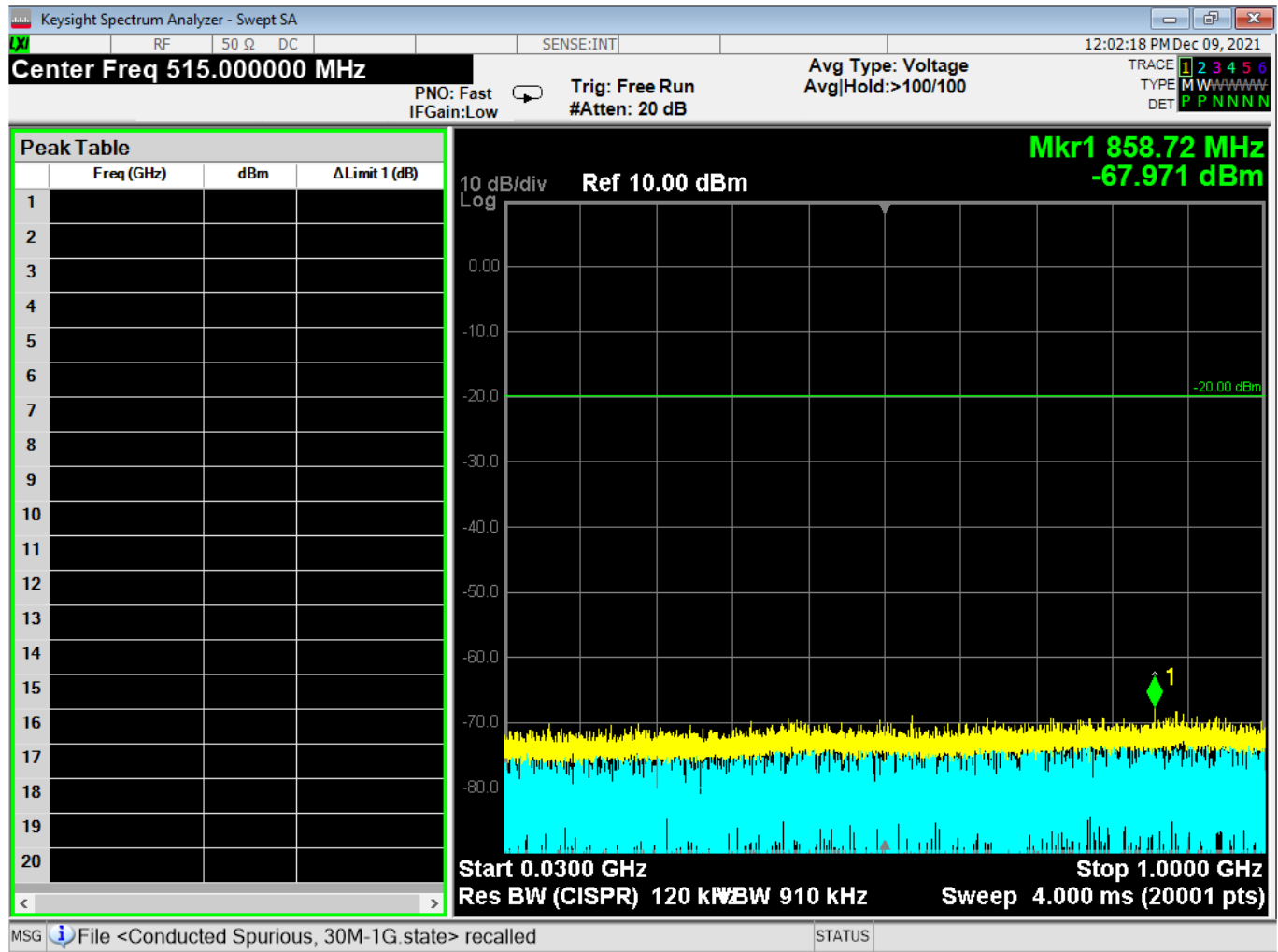


Figure 9 - Radiated Emissions Plot, GFSK, 30M – 1G

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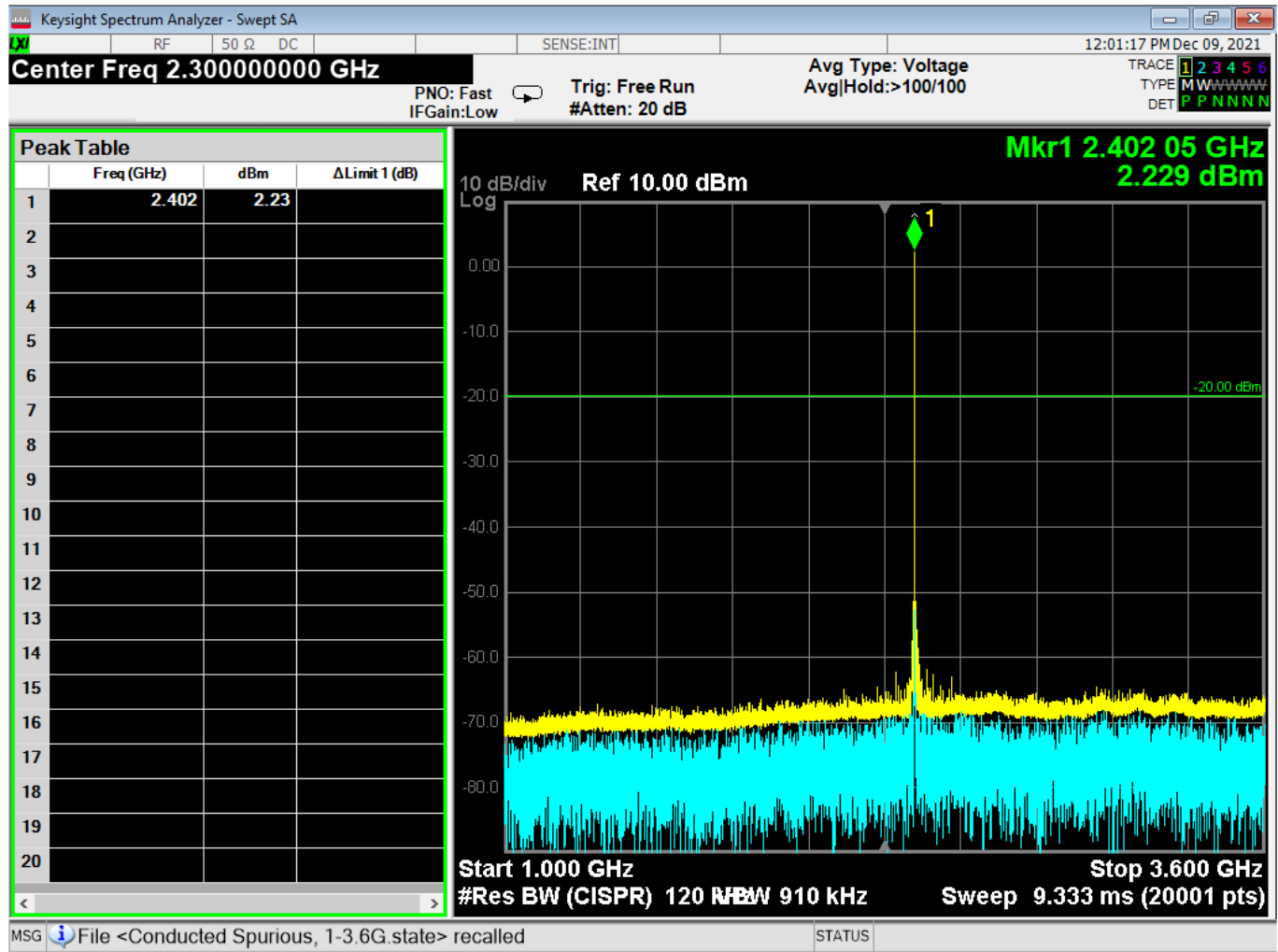


Figure 10 - Radiated Emissions Plot, GFSK, 1G – 3.6G

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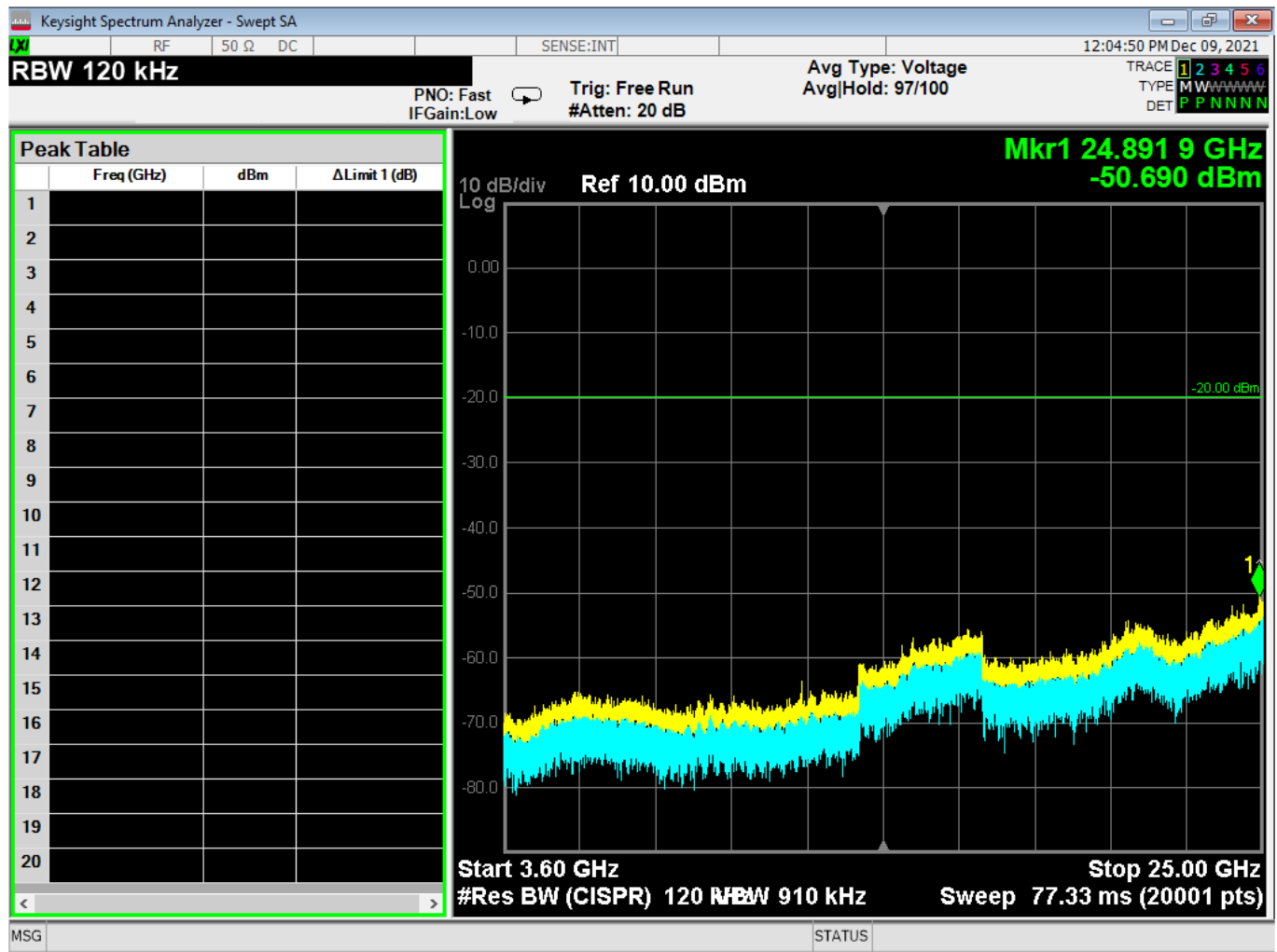


Figure 11 - Radiated Emissions Plot, GFSK, 3.6G – 25G

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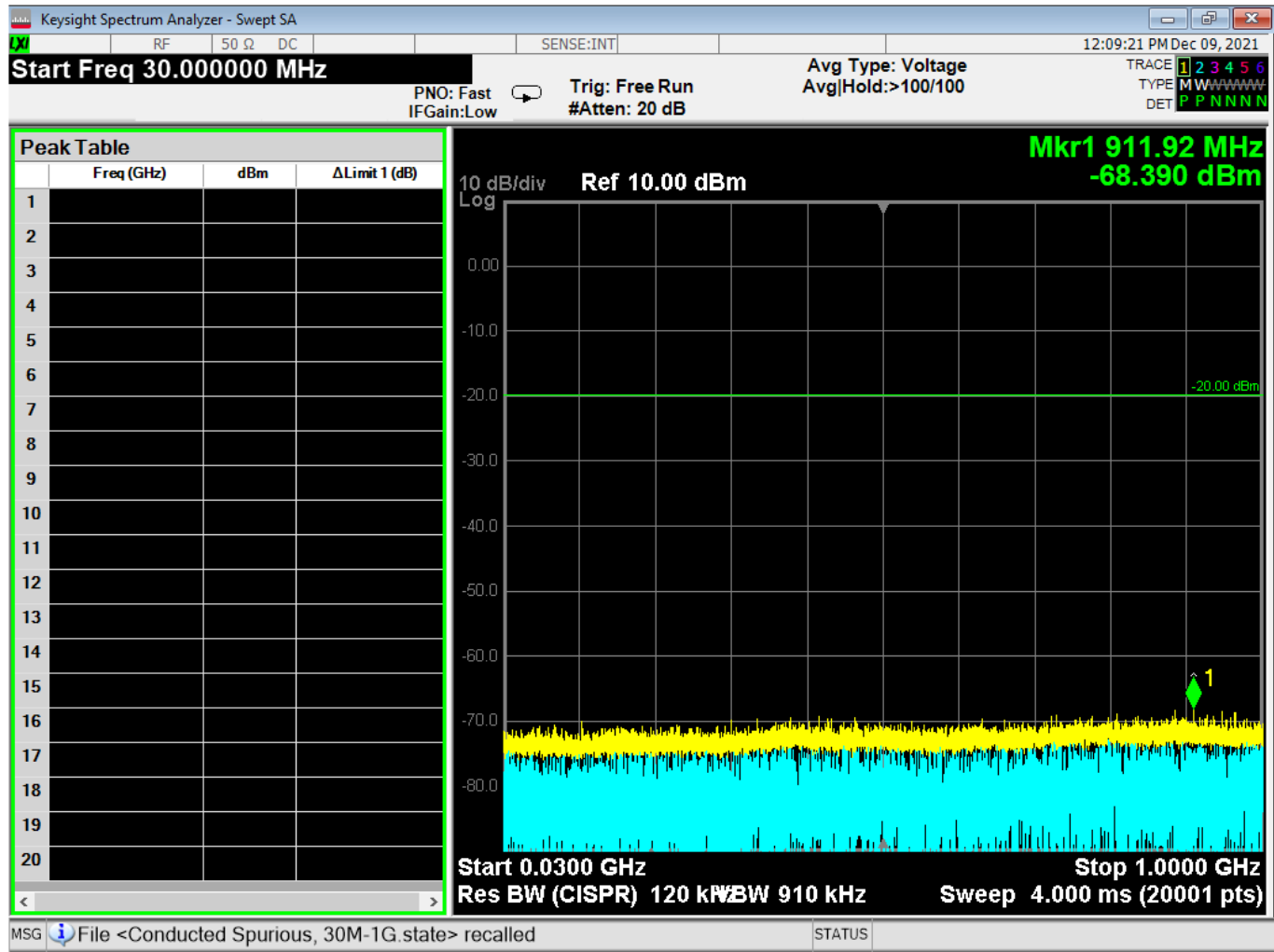


Figure 12 - Radiated Emissions Plot, GMSK, 30M – 1G

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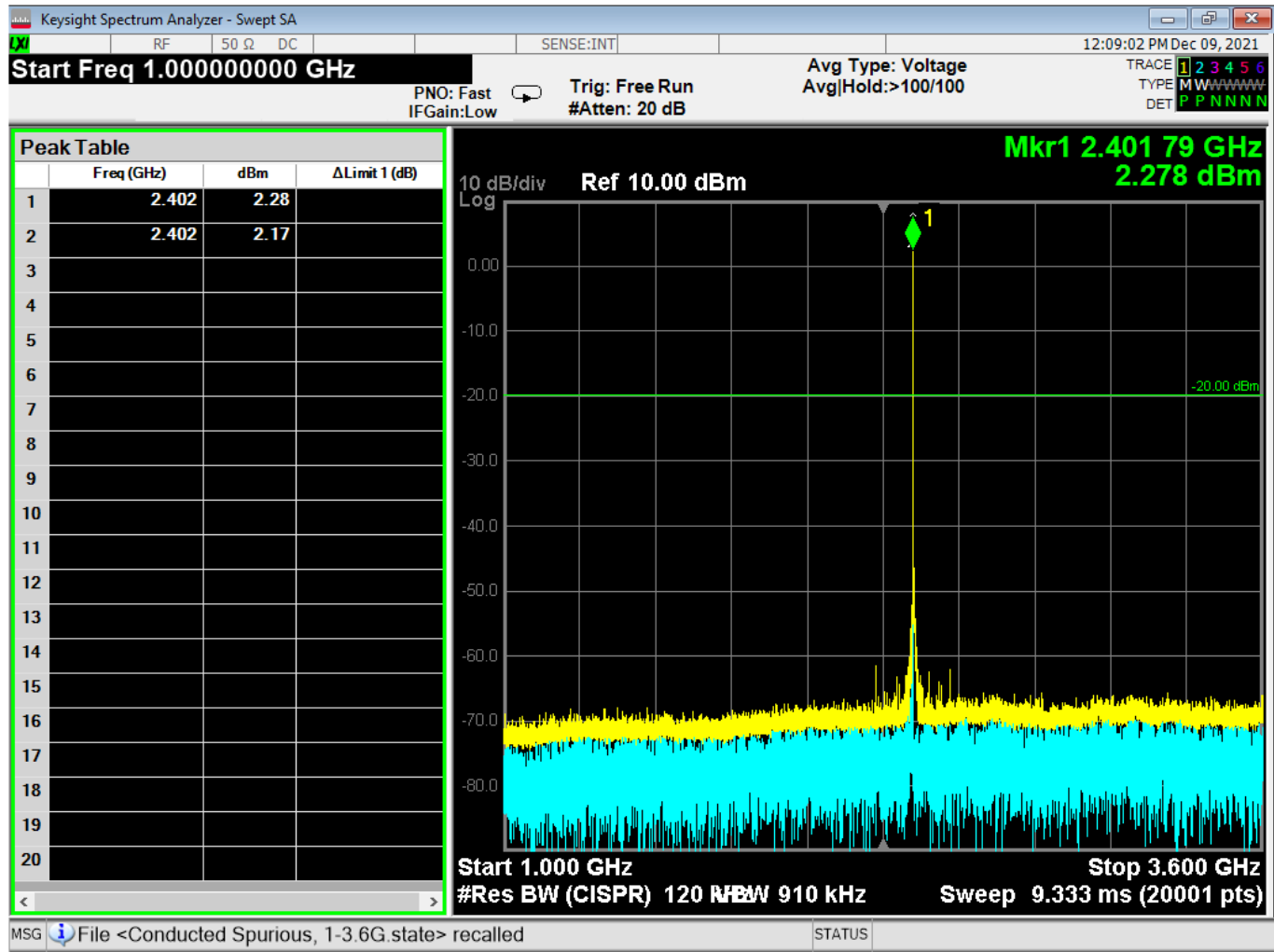


Figure 13 - Radiated Emissions Plot, GMSK, 1G – 3.6G

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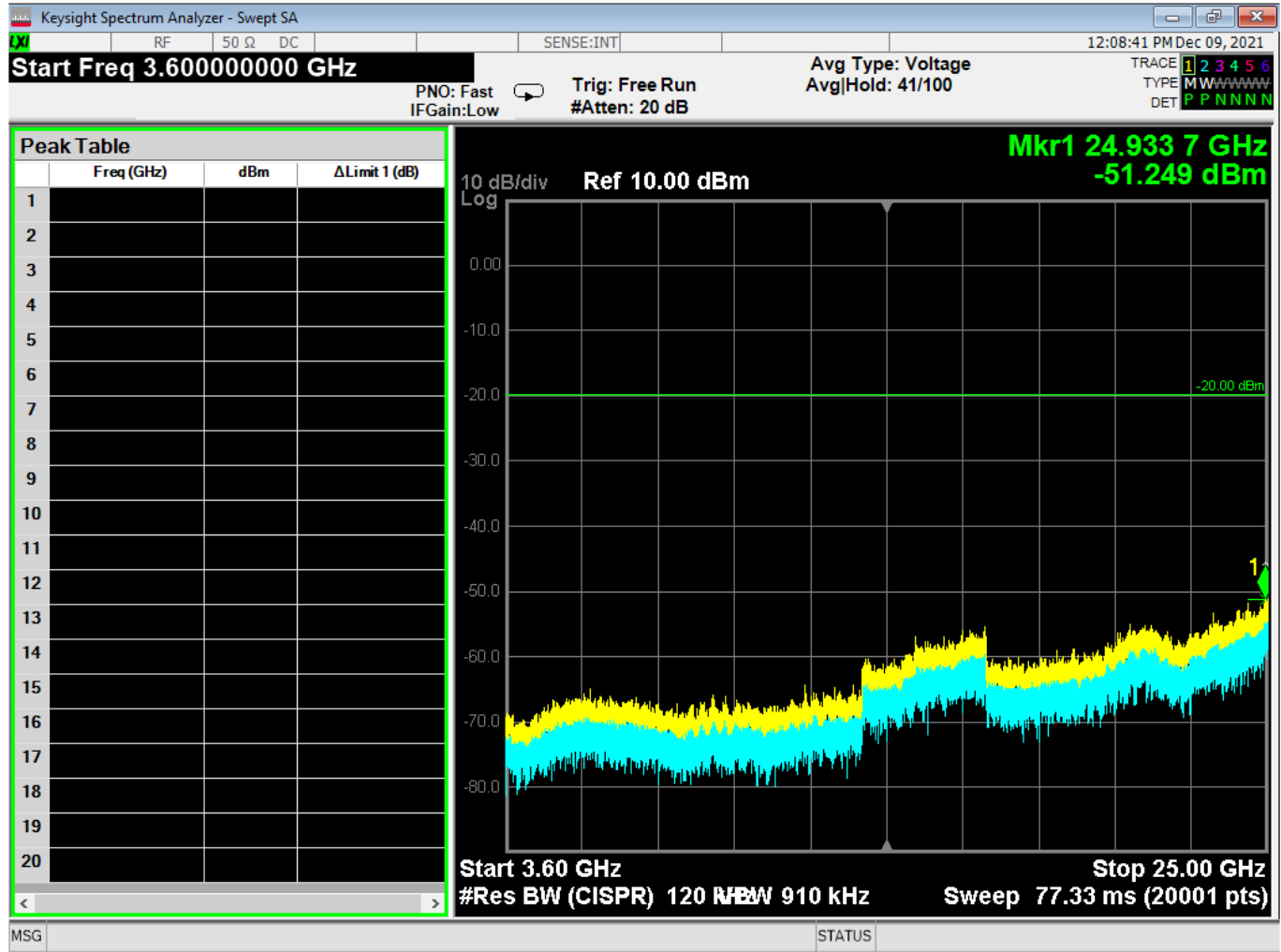


Figure 14 - Radiated Emissions Plot, GMSK, 3.6G – 25G



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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:

For emissions outside of the allowed band of operation (2400.0MHz – 2480.0MHz), 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:

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. All data is in the table in results section 4.0.
3. 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.
4. 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.



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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:

4. All the Power Spectral Density (PSD) plots can be found in the Appendix C.
5. All the measurements were found to be compliant.
6. The measurements are reported on the graph.

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:

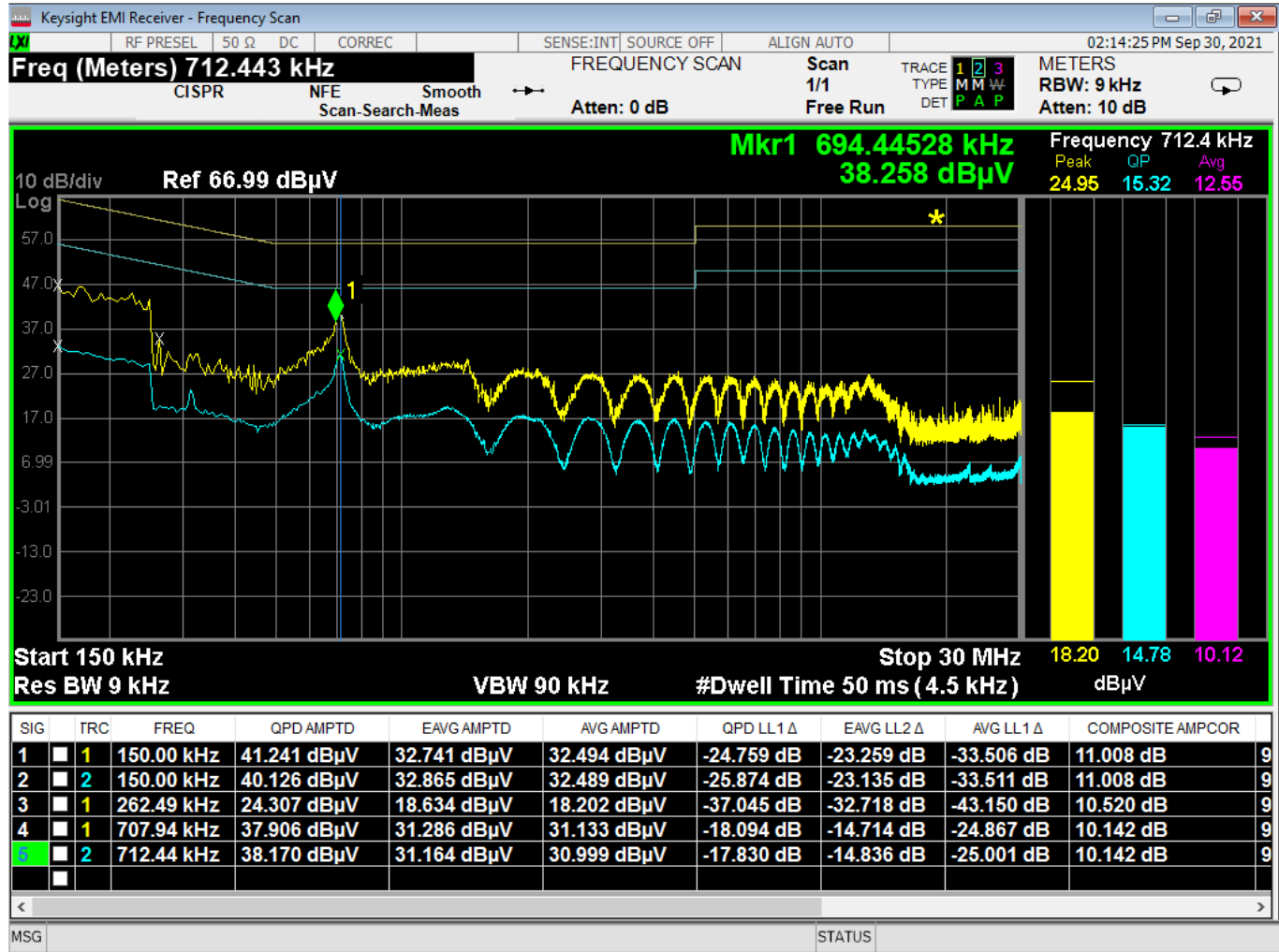


Figure 15 - Conducted Emissions Plot, Line

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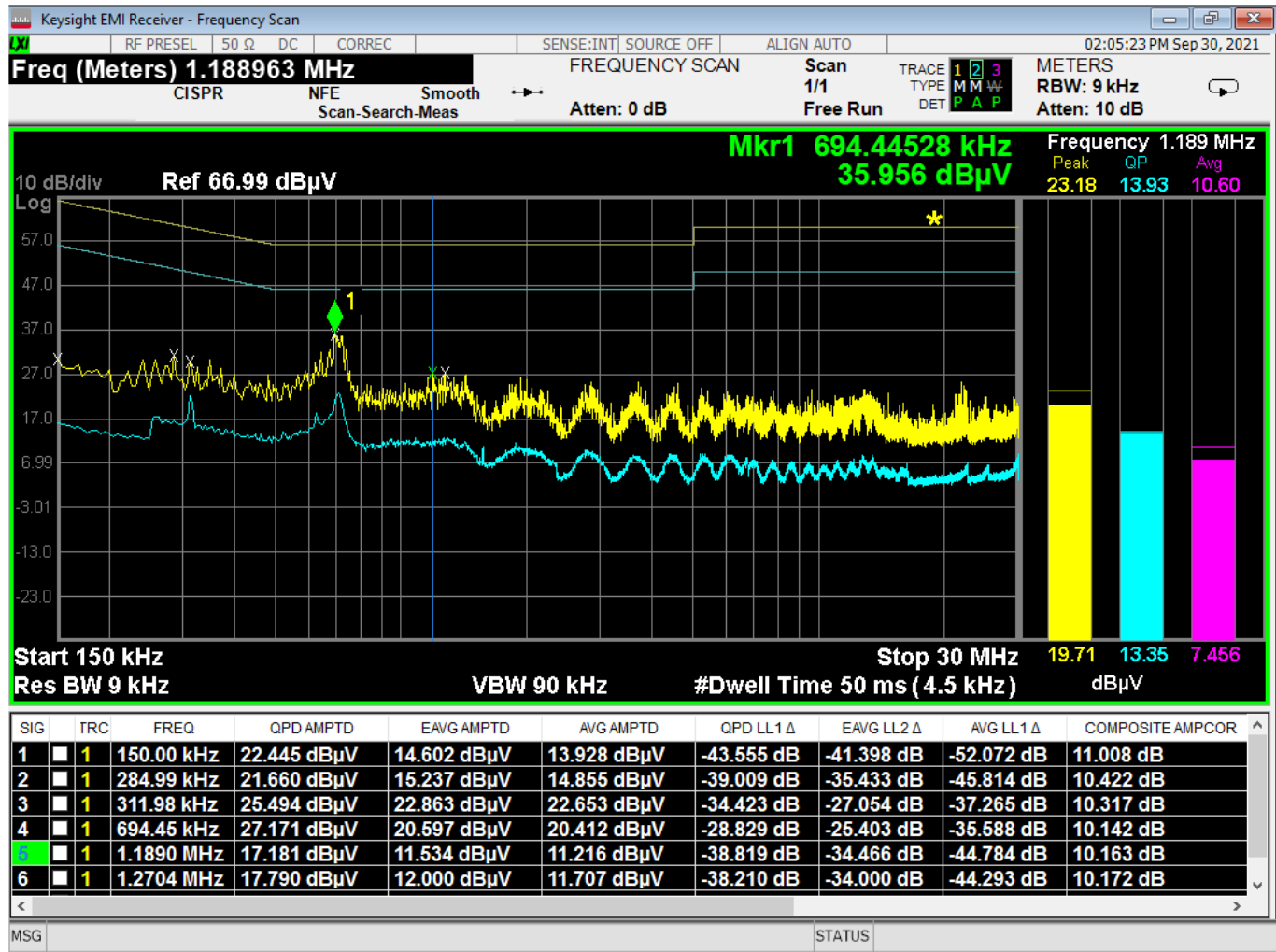


Figure 16 - Conducted Emissions Plot, Neutral



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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 dB μ V 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 dB μ V/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

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



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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;

$$EIRP \text{ (Watts)} = [Field \text{ Strength (V/m)} \times antenna \text{ distance (m)}]^2 / 30$$

$$Power \text{ (watts)} = 10^{[Power \text{ (dBm)}/10]} / 1000$$

$$Voltage \text{ (dB}\mu\text{V)} = Power \text{ (dBm)} + 107 \text{ (for } 50\Omega \text{ measurement systems)}$$

$$Field \text{ Strength (V/m)} = 10^{[Field \text{ Strength (dB}\mu\text{V/m)} / 20]} / 10^6$$

$$Gain = 1 \text{ (numeric gain for isotropic radiator)}$$

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

$$EIRP = [FS(V/m) \times d^2]/30 = FS [0.3] \quad \text{for } d = 3$$

$$EIRP(dBm) = FS(dB\mu V/m) - 10(\log 10^9) + 10\log[0.3] = FS(dB\mu V/m) - 95.23$$

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



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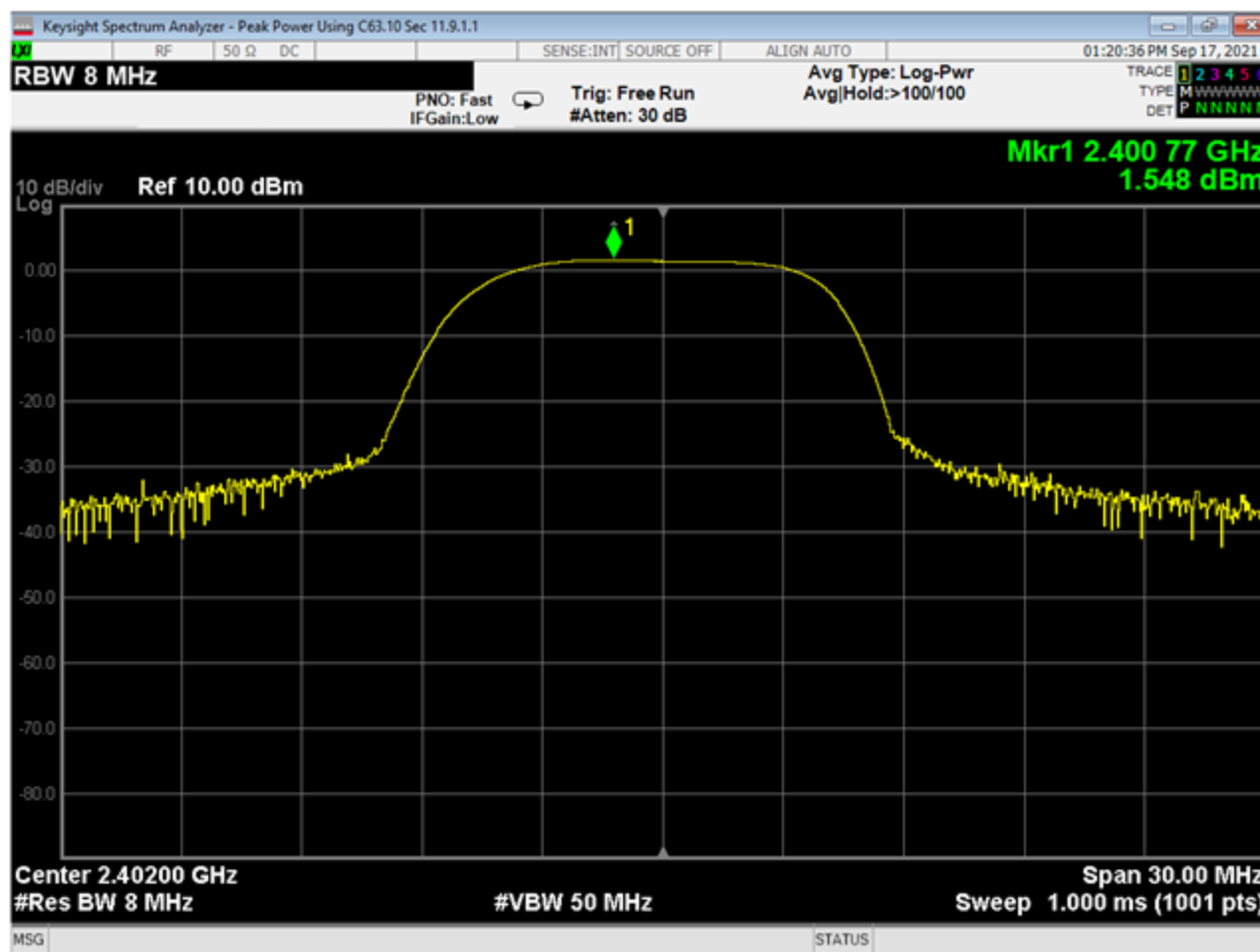
APPENDIX B – MEASUREMENT UNCERTAINTY

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

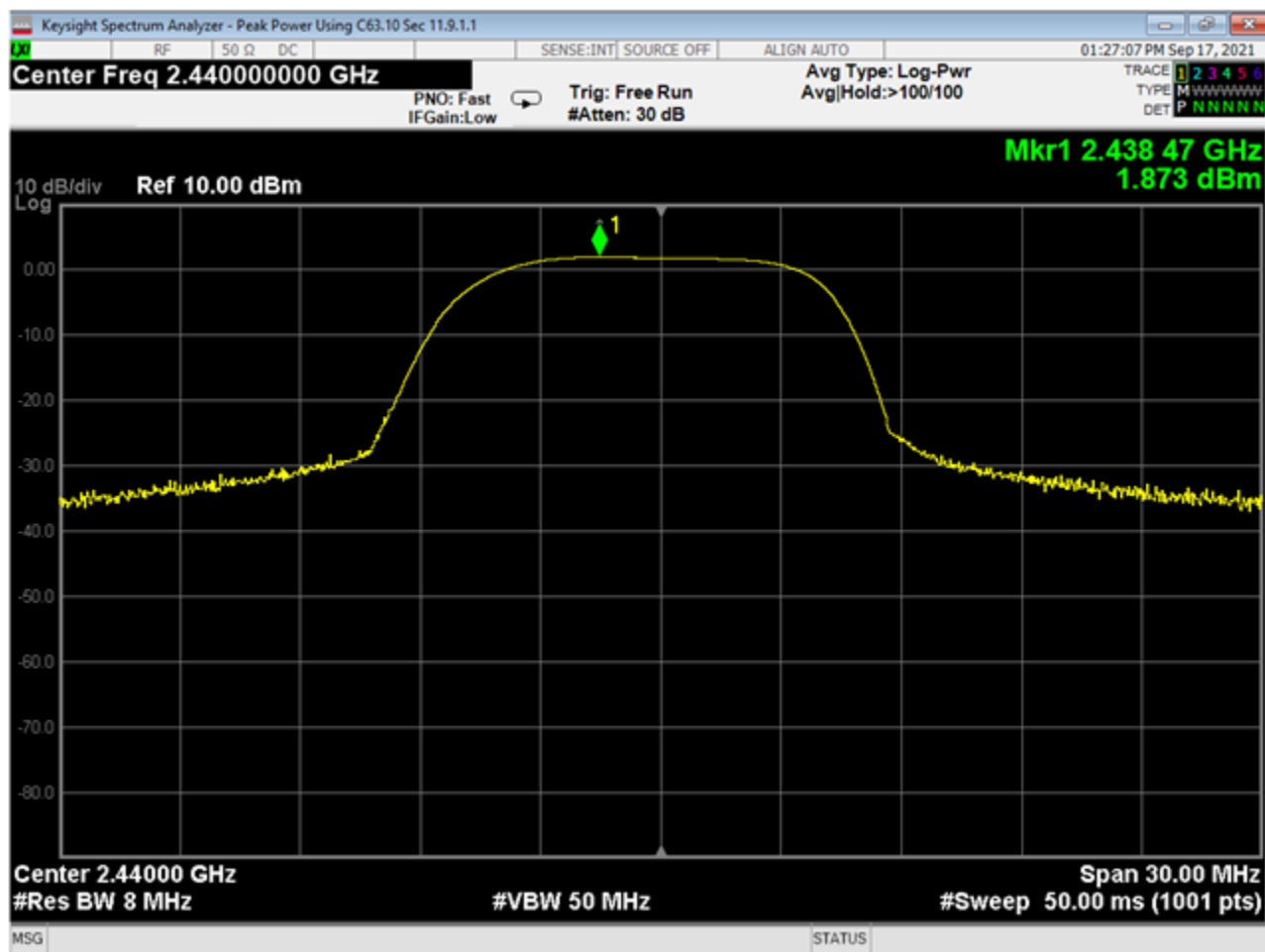
Expanded uncertainty values are calculated to a confidence level of 95%.

APPENDIX C – GRAPHS AND TABLES

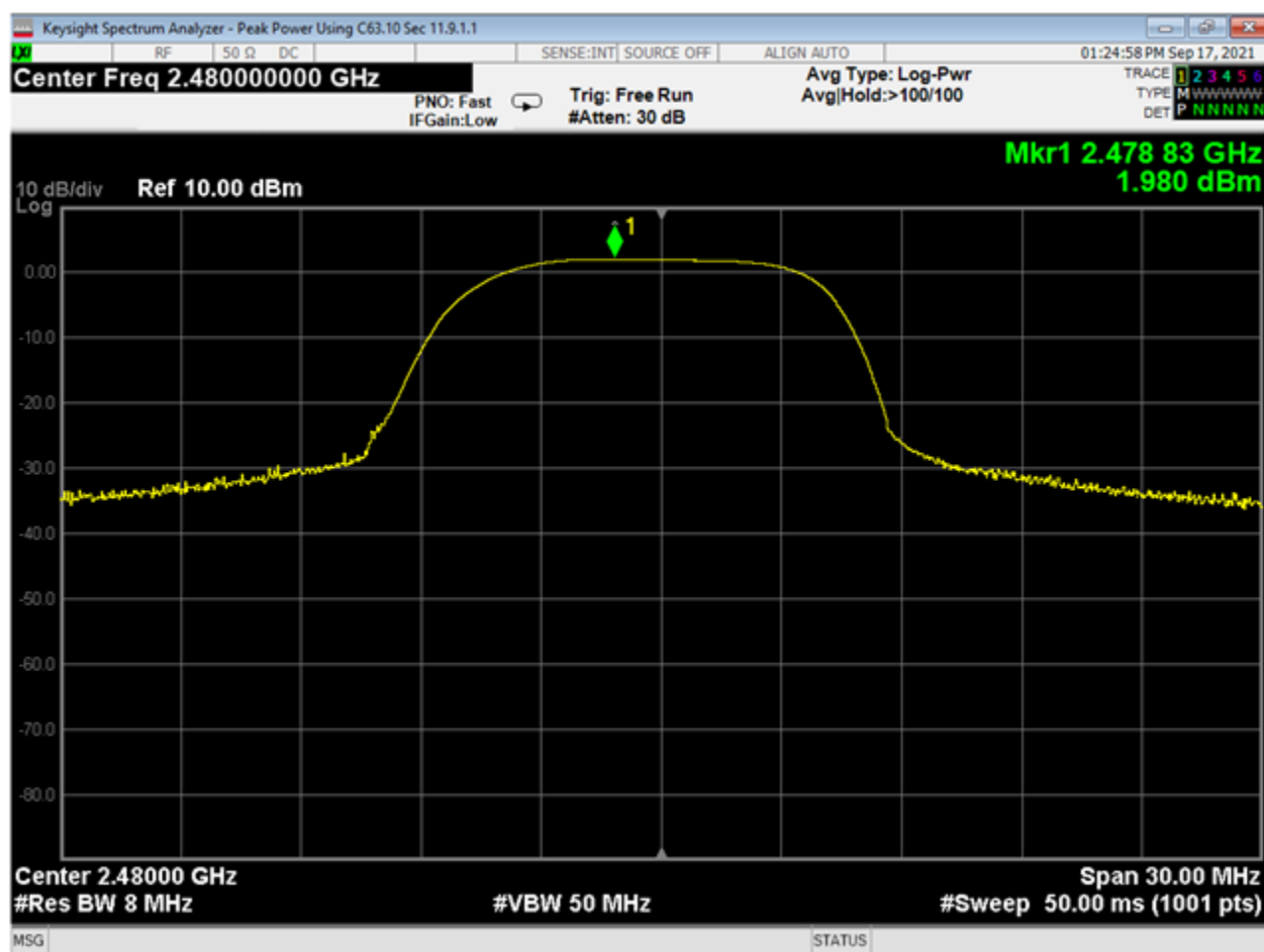


01 Peak Power, Low Channel, GMSK

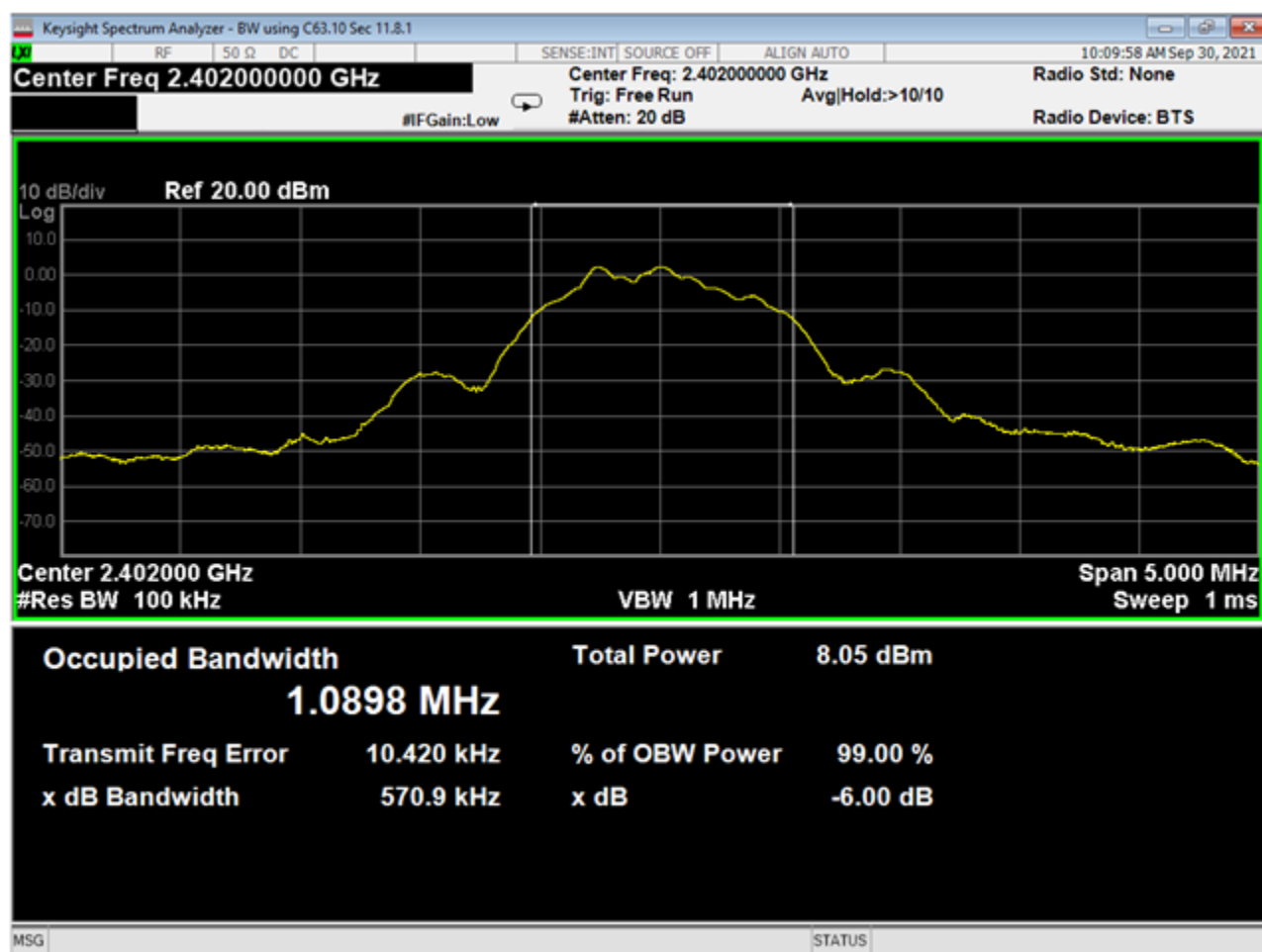
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02 Peak Power, Mid Channel, GMSK

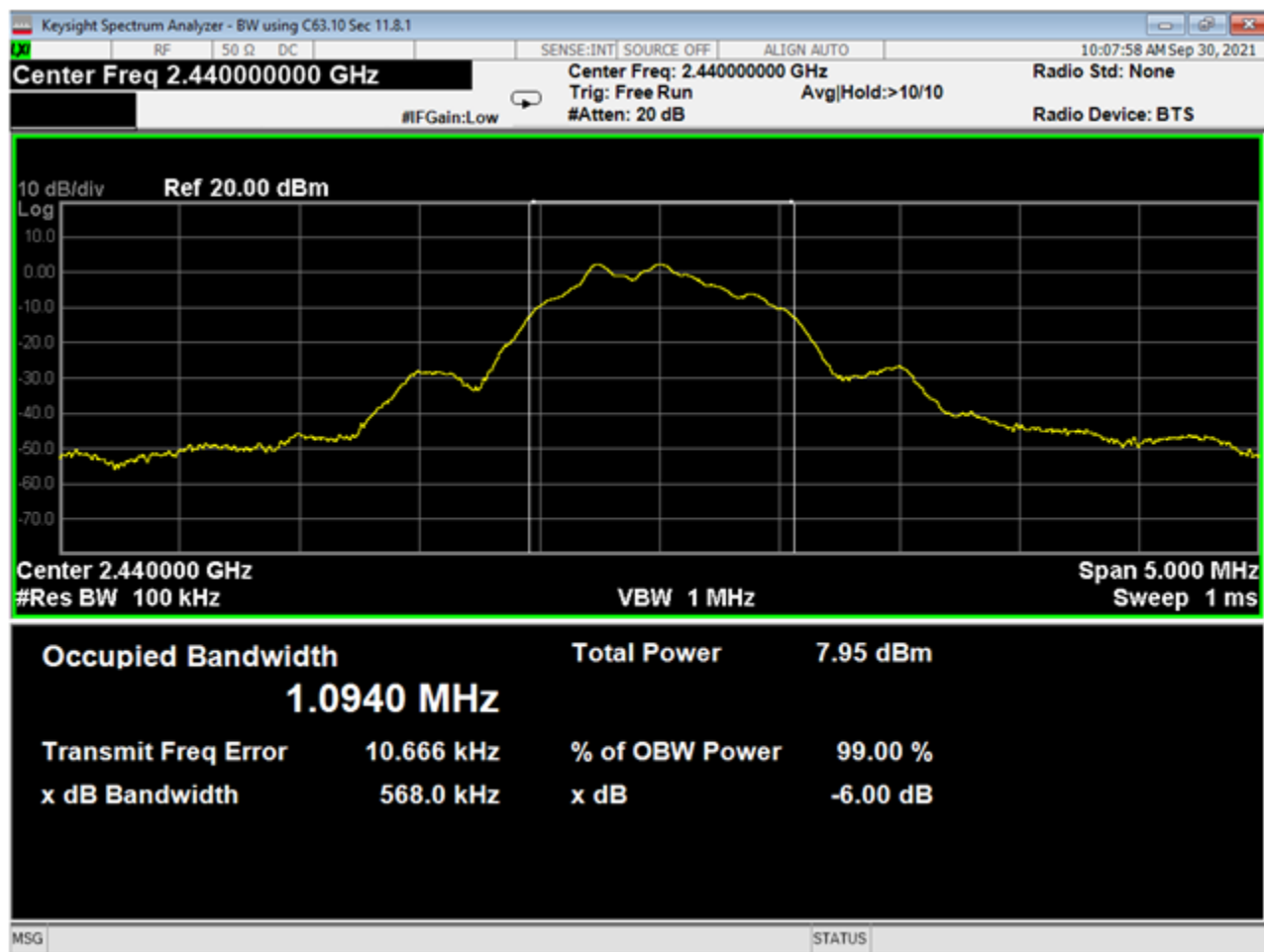


03 Peak Power, High Channel, GMSK



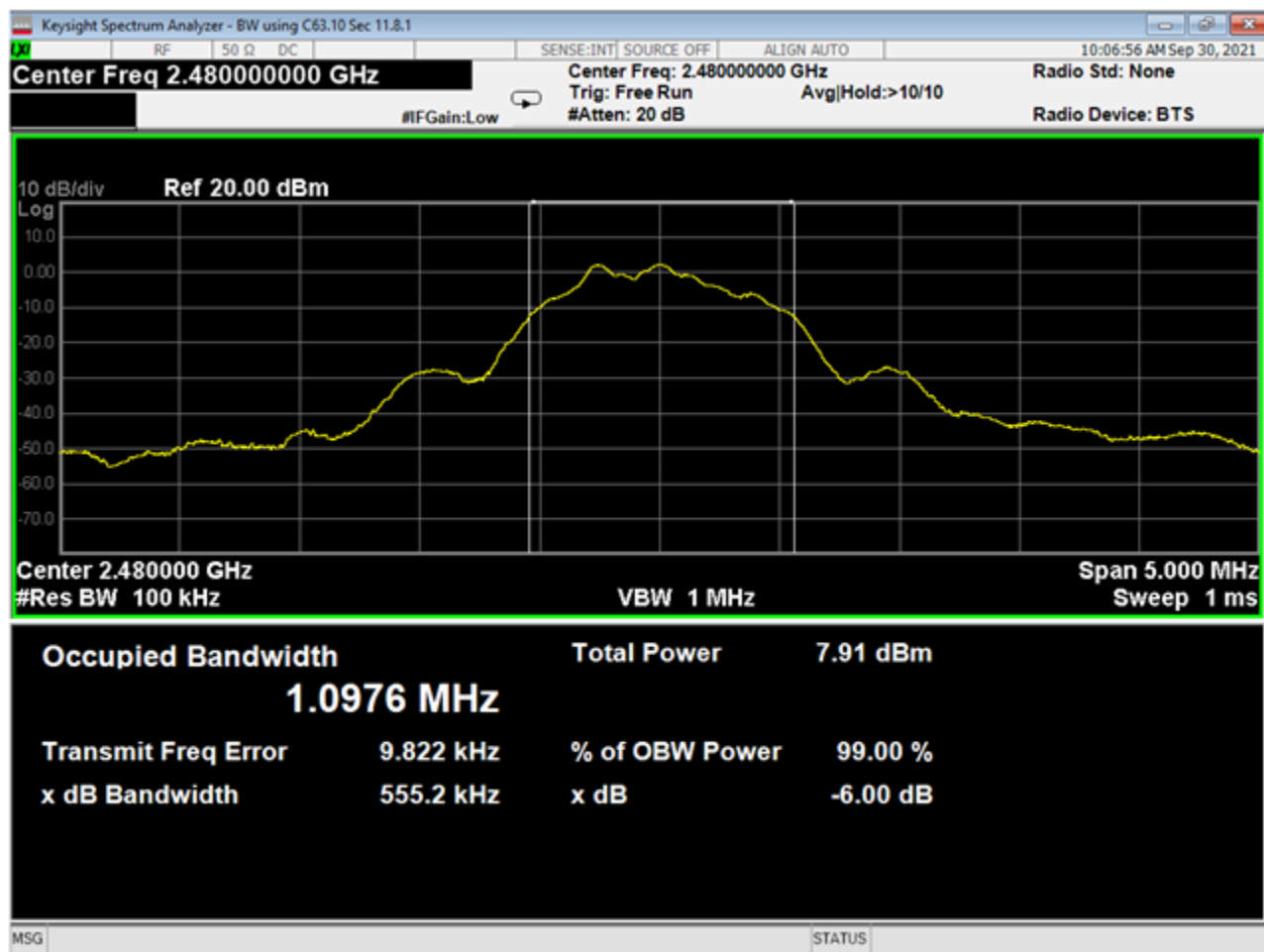
04 Bandwidth, Low Channel, GMSK

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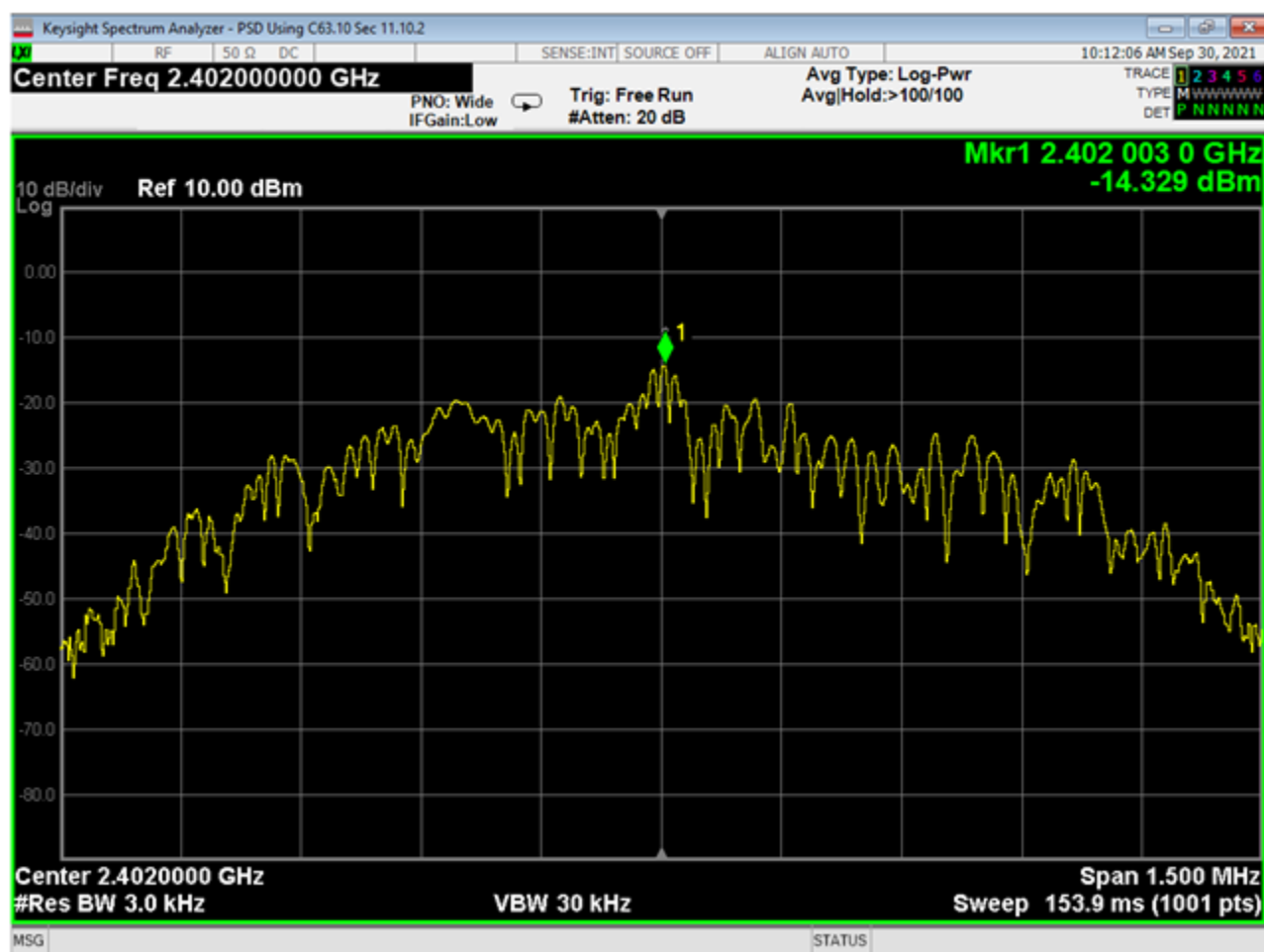


05 Bandwidth, Mid Channel, GMSK

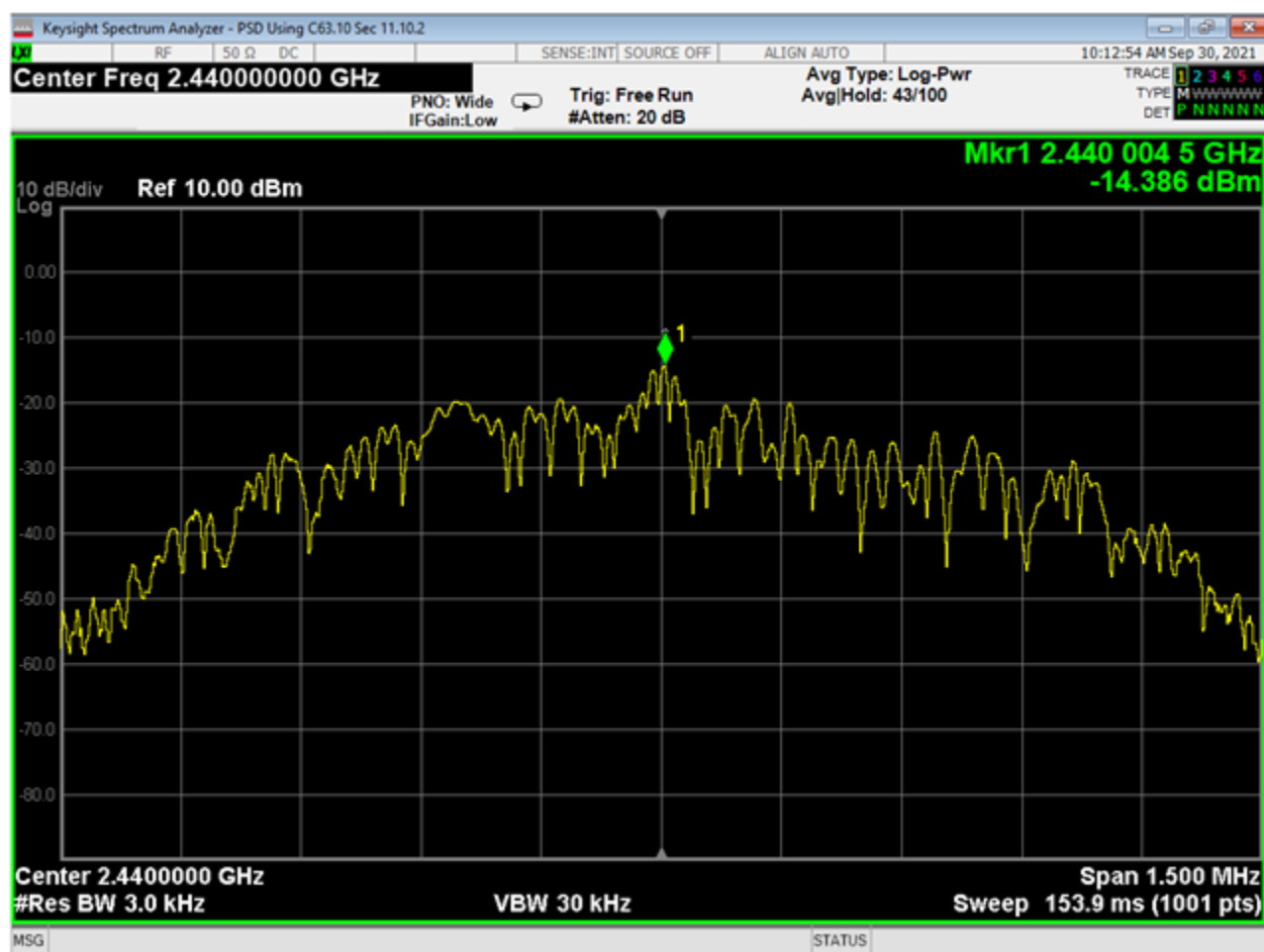
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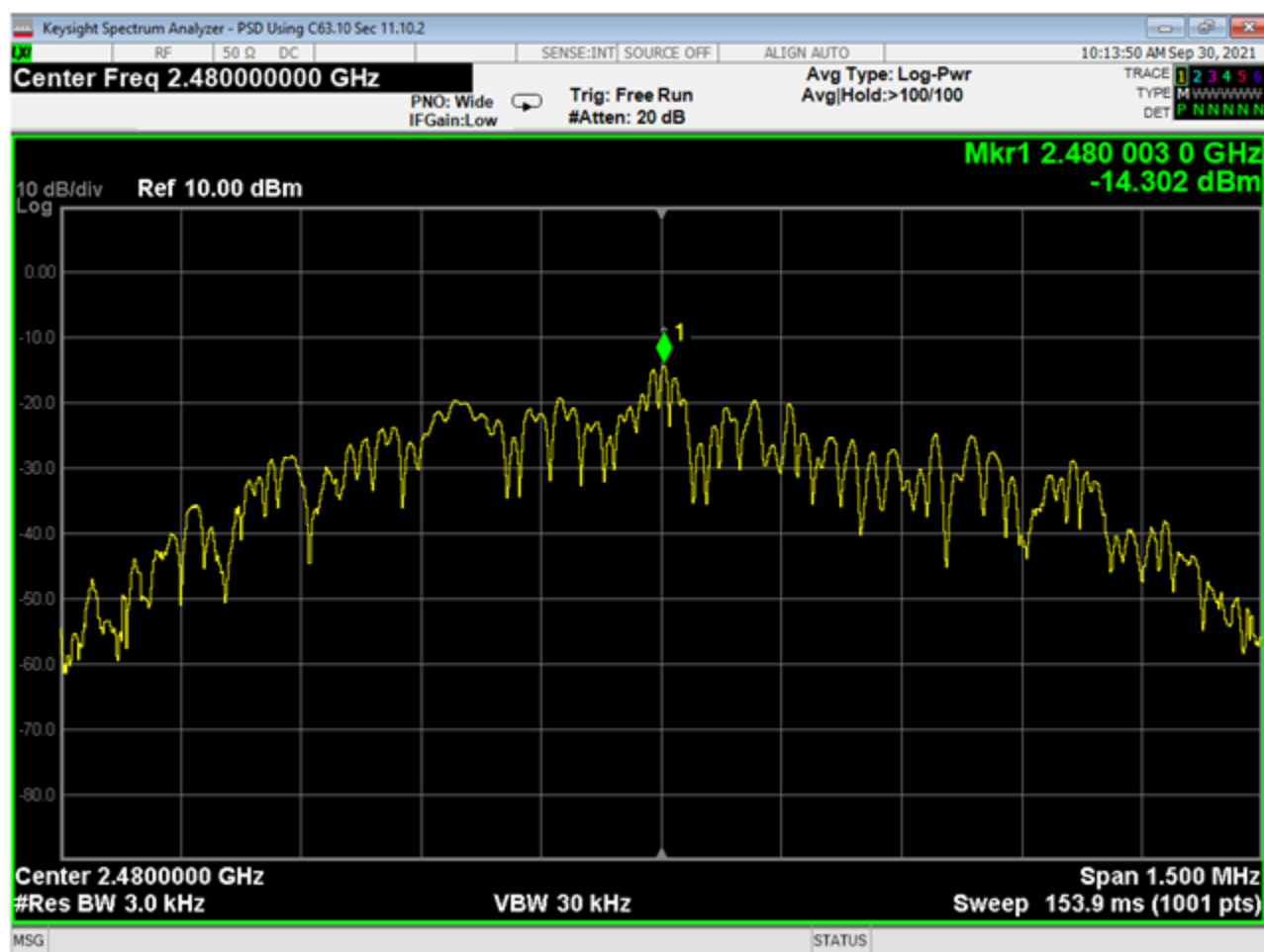
06 Bandwidth, High Channel, GMSK



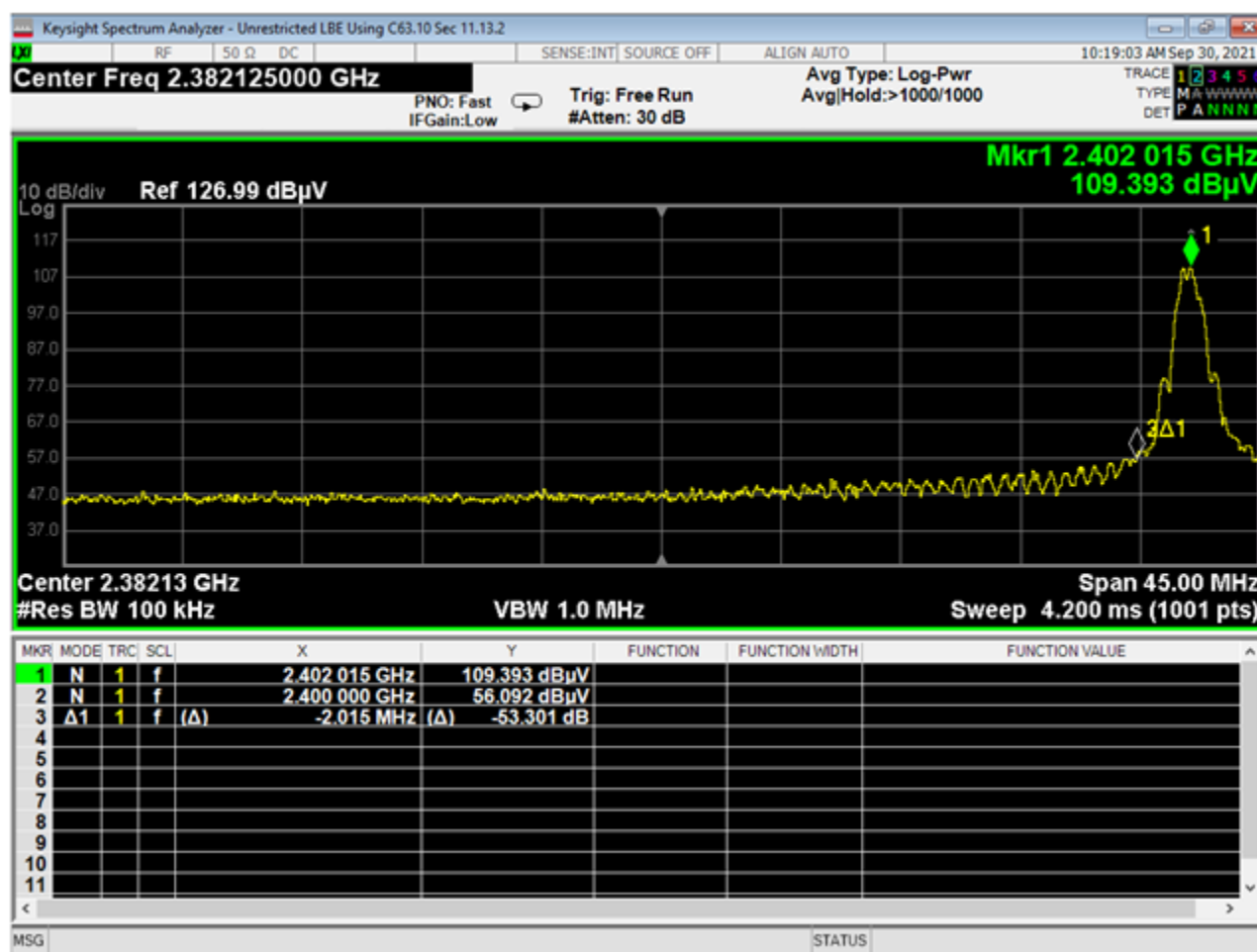
07 Power Spectral Density, Low Channel, GMSK



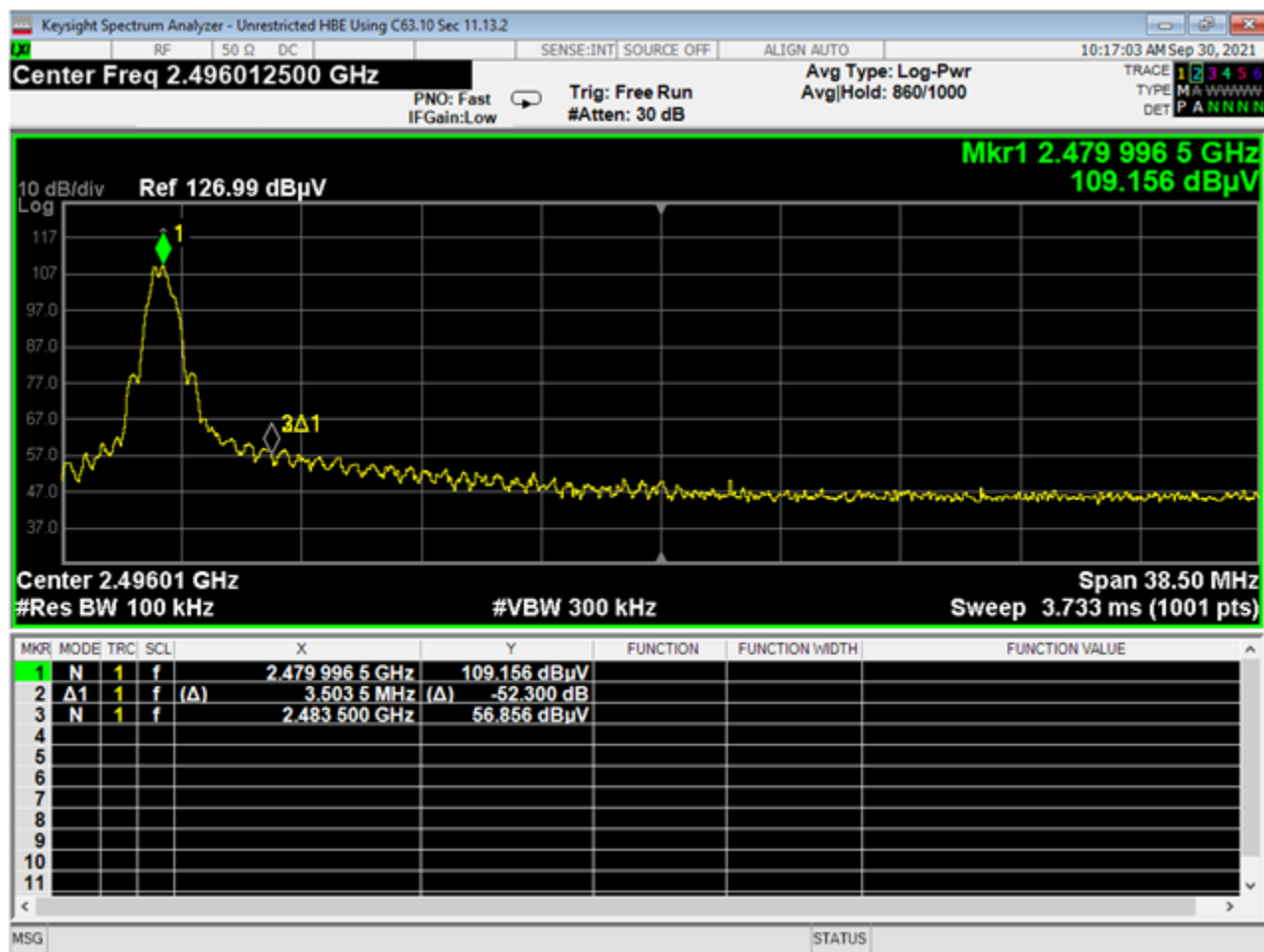
08 Power Spectral Density, Mid Channel, GMSK



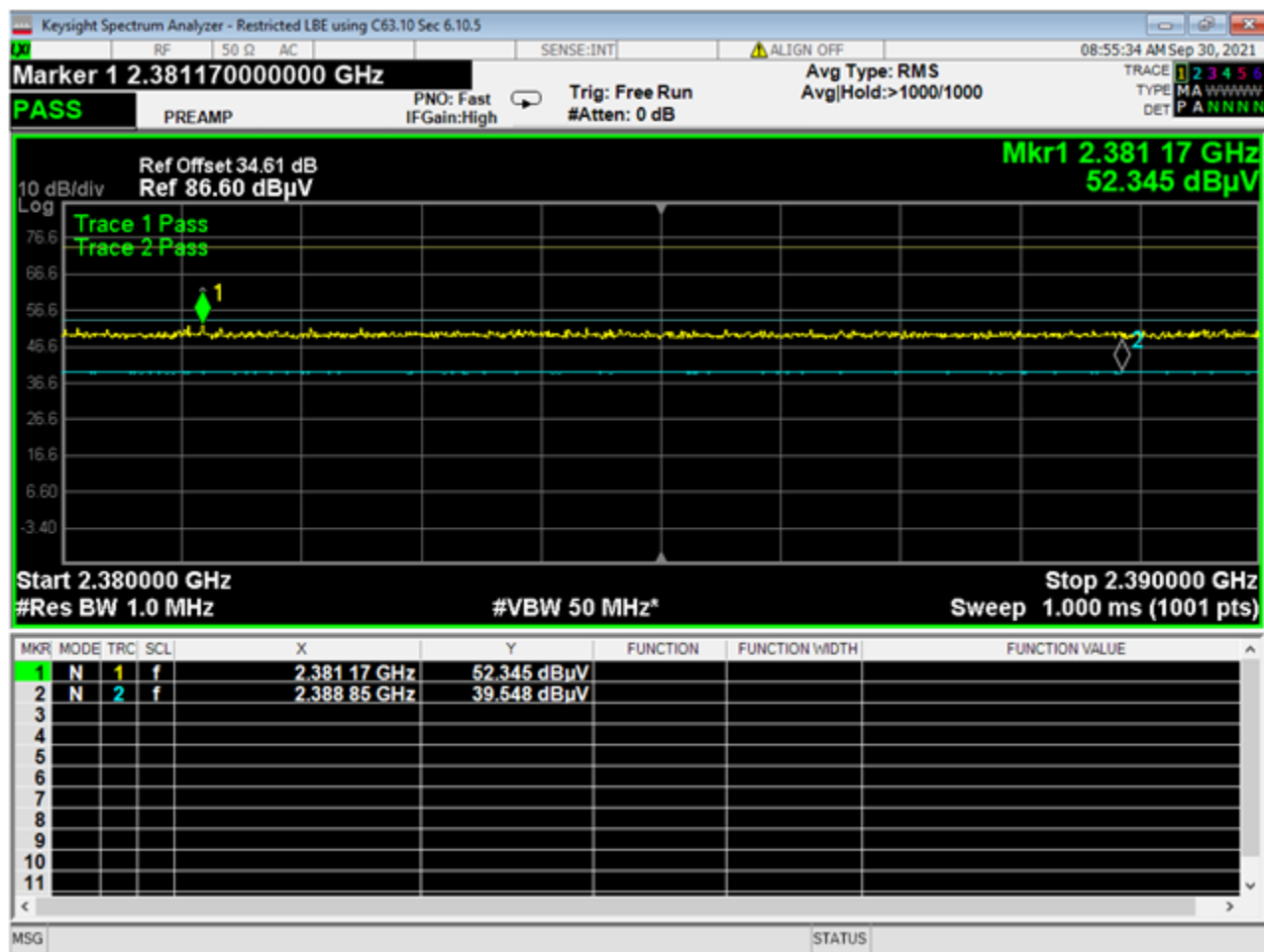
09 Power Spectral Density, High Channel, GMSK



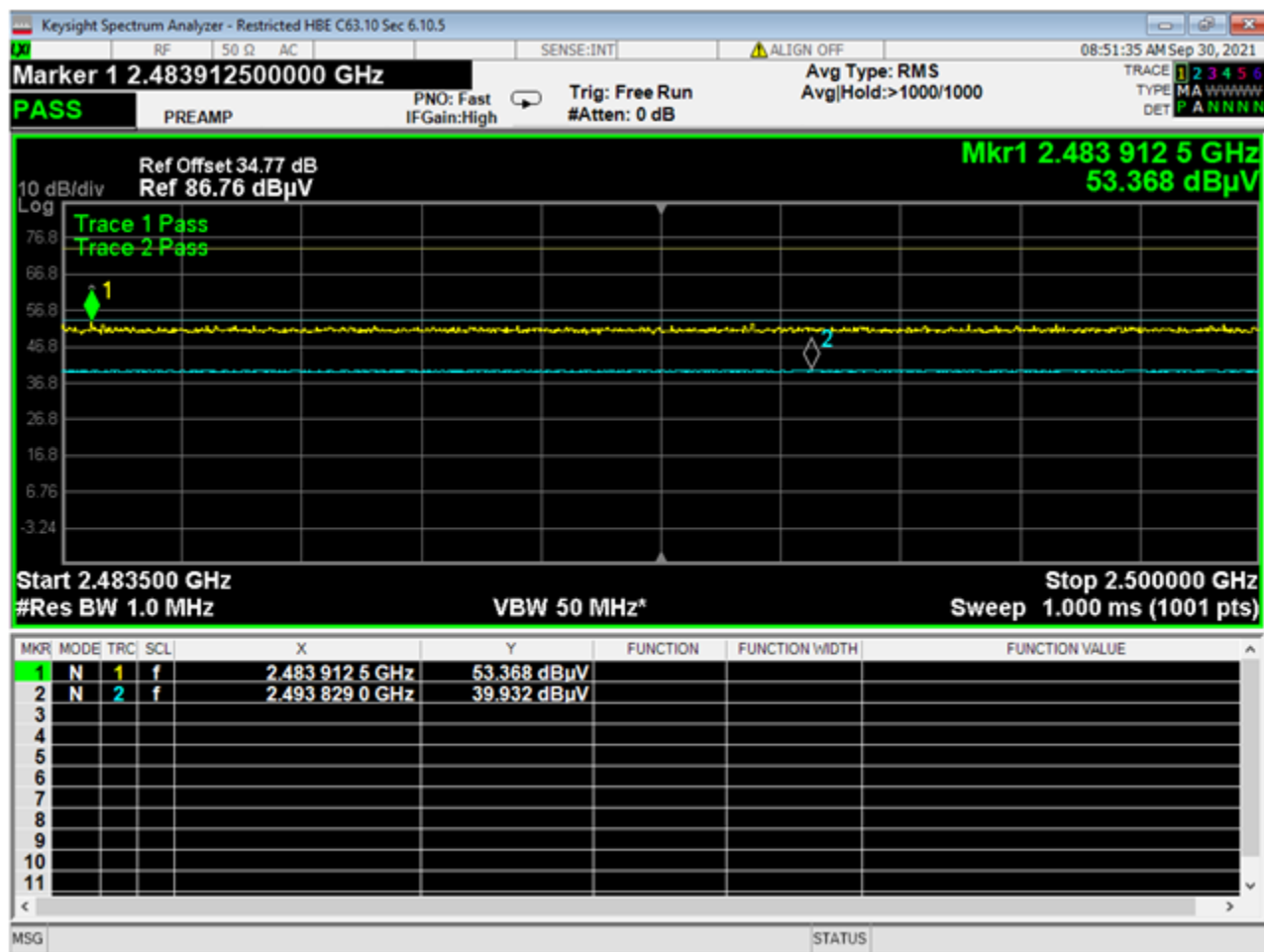
10 Unrestricted Lower Band Edge, GMSK



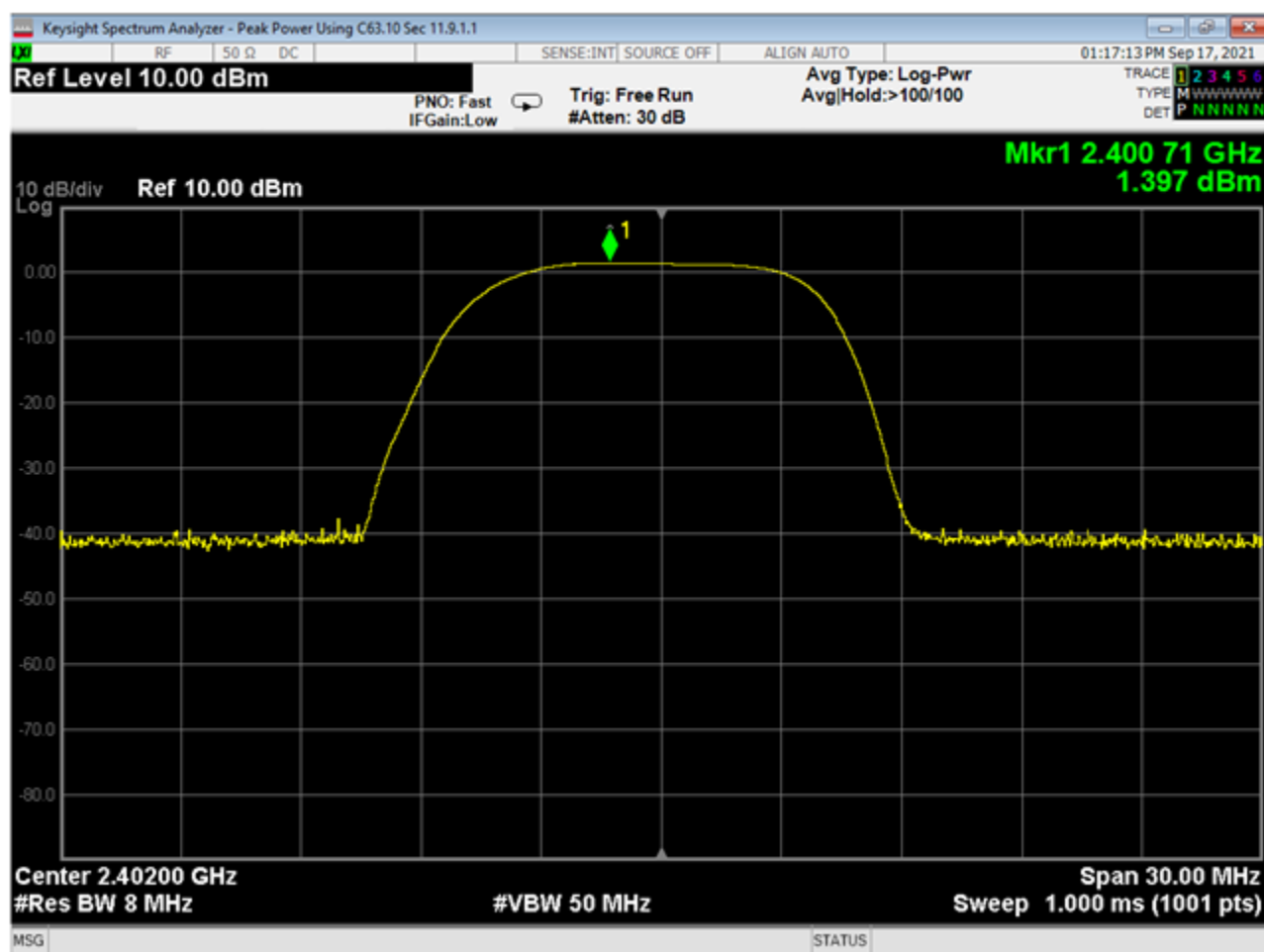
11 unrestricted Higher Band Edge, GMSK



12 Restricted Lower Band Edge, GMSK

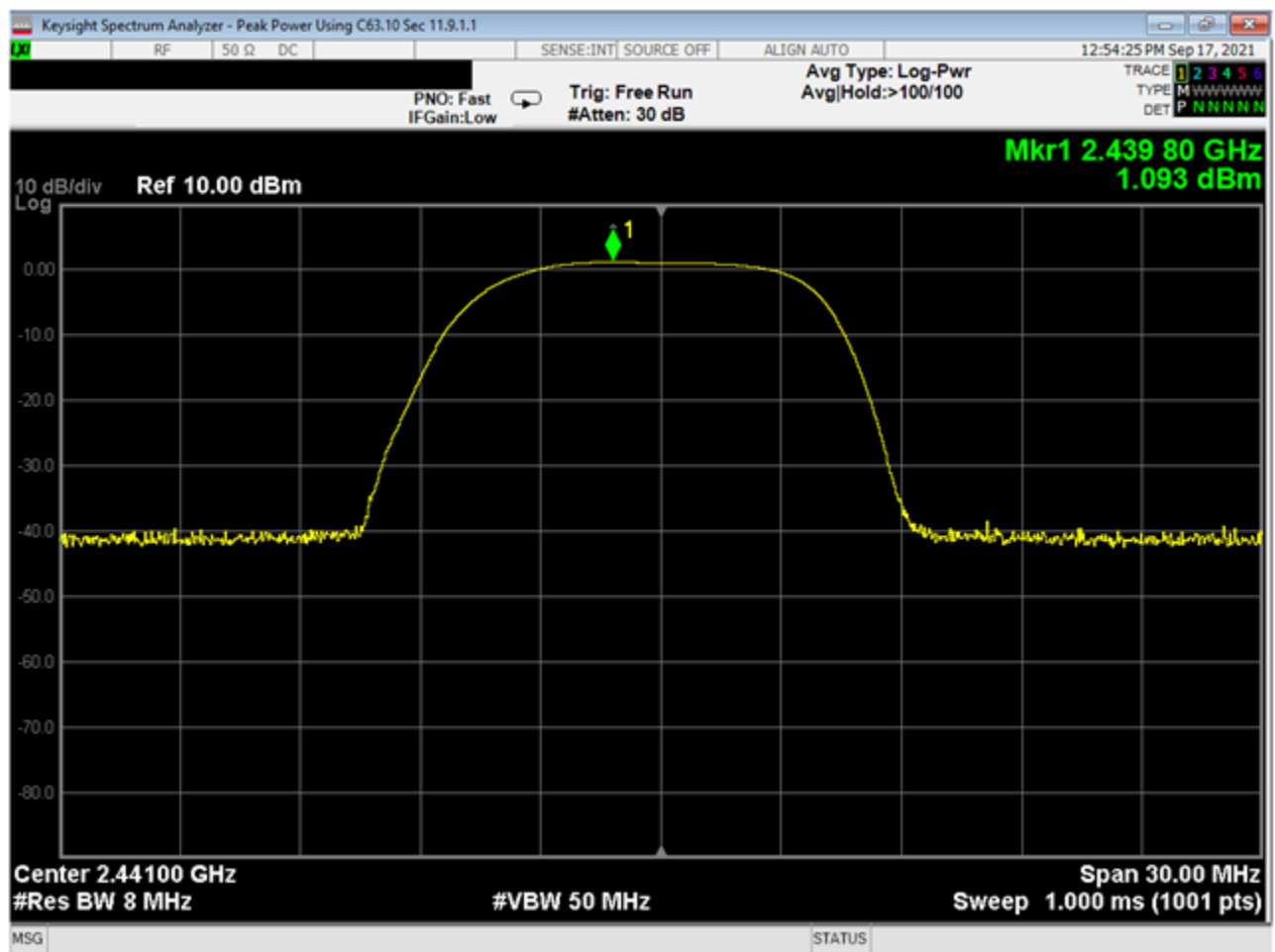


13 Restricted Higher Band Edge, GMSK

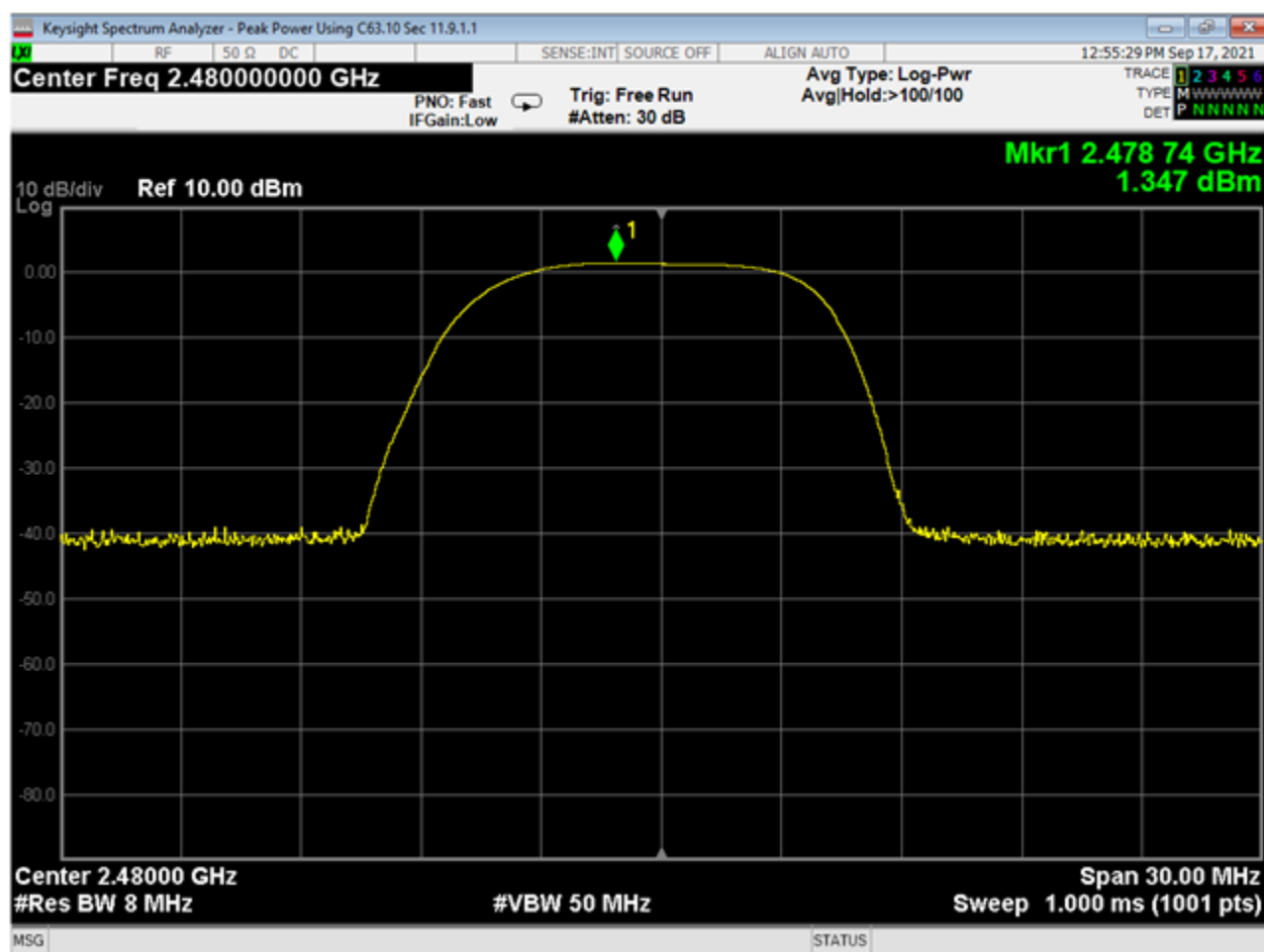


14 Peak Power, Low Frequency, GFSK

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15 Peak Power, Mid Frequency, GFSK



16 Peak Power, High Frequency, GFSK

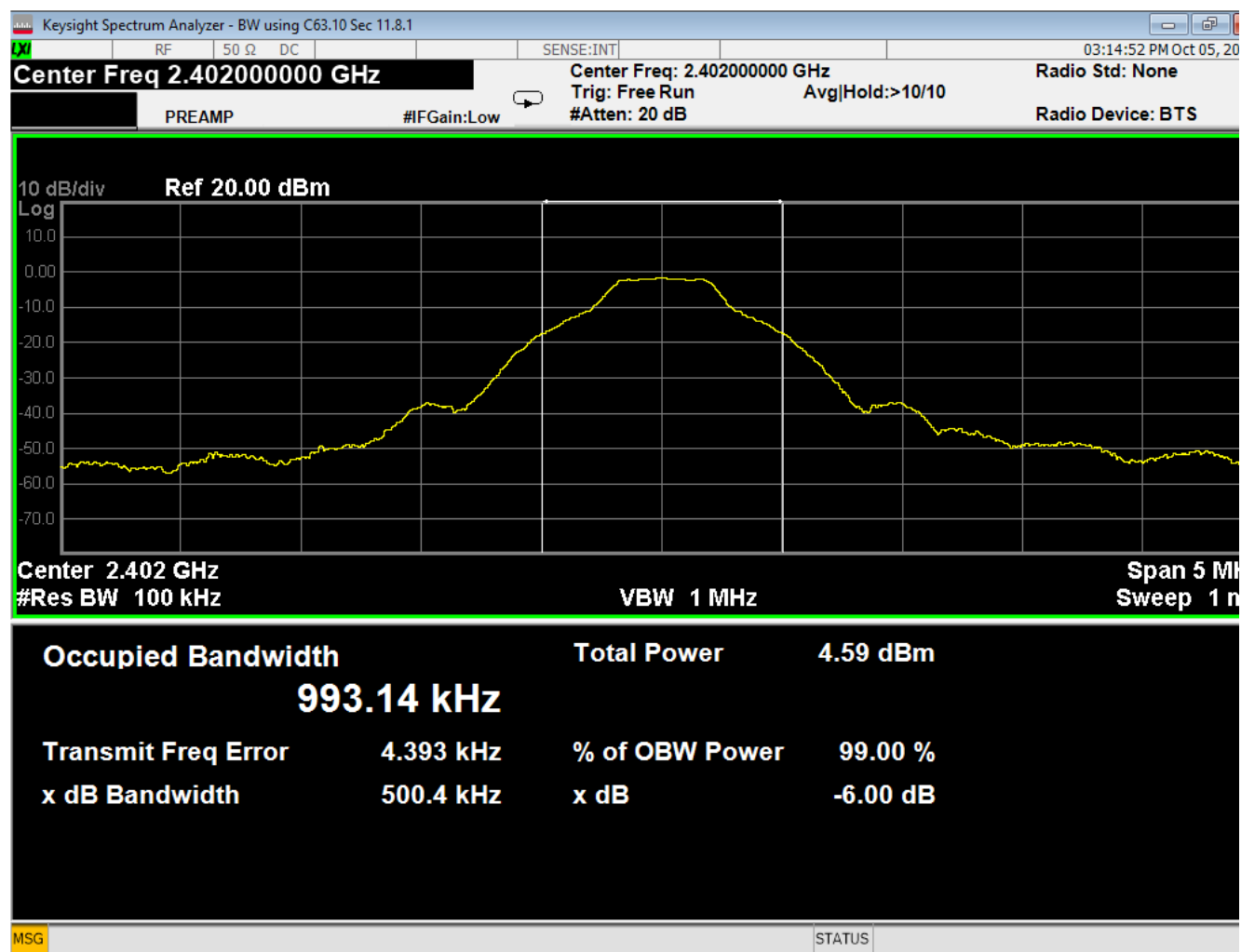


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17 Bandwidth, Low Frequency, GFSK

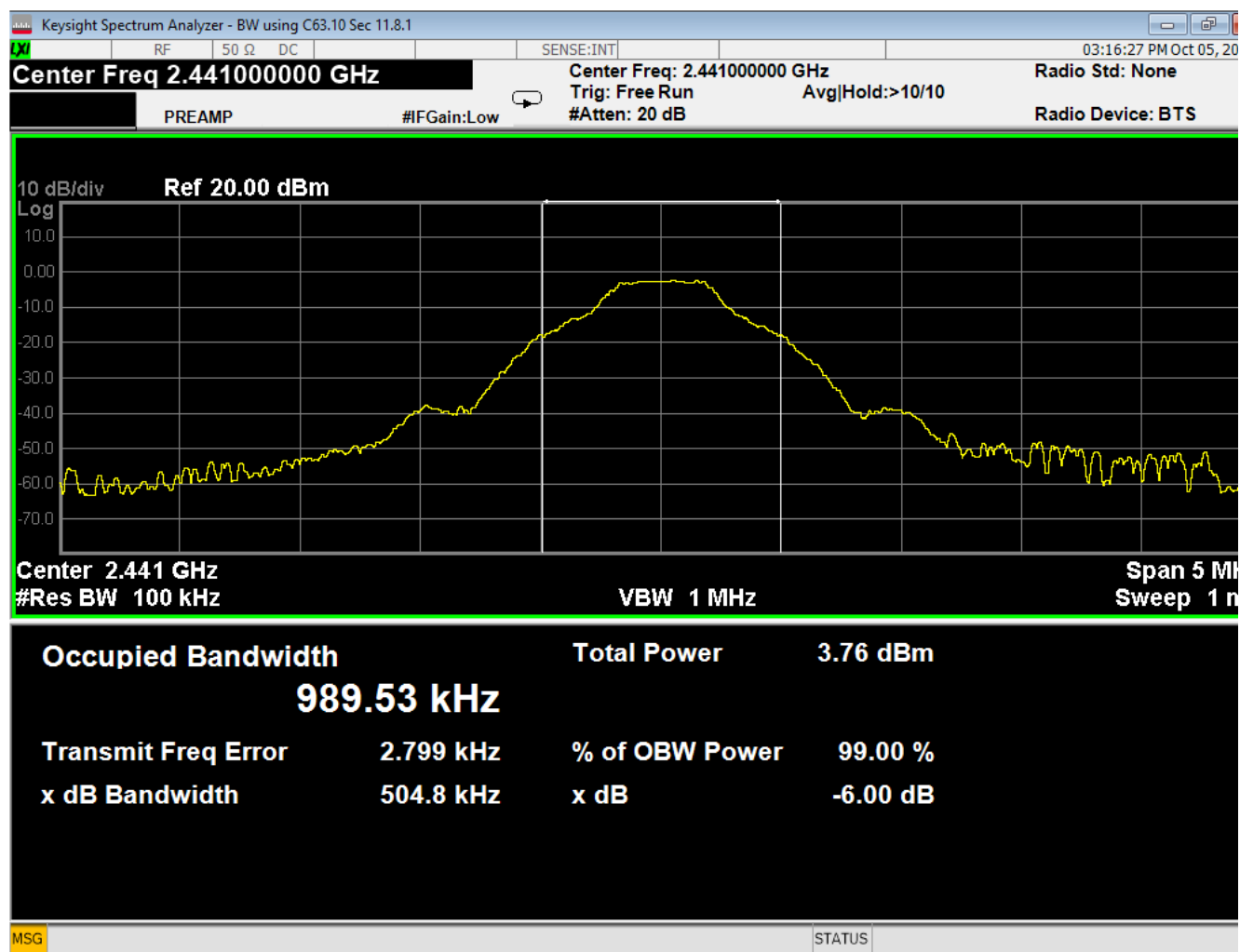


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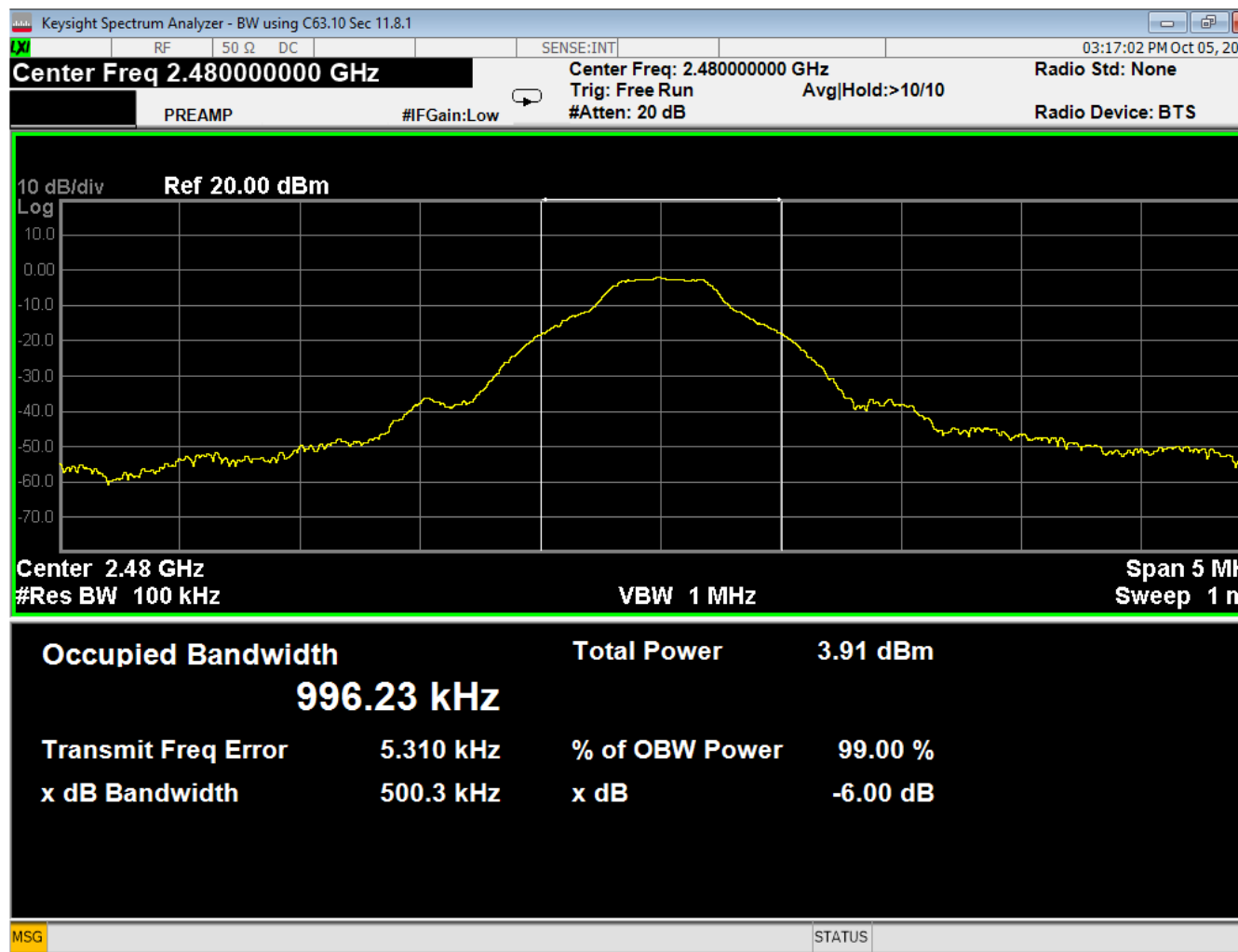
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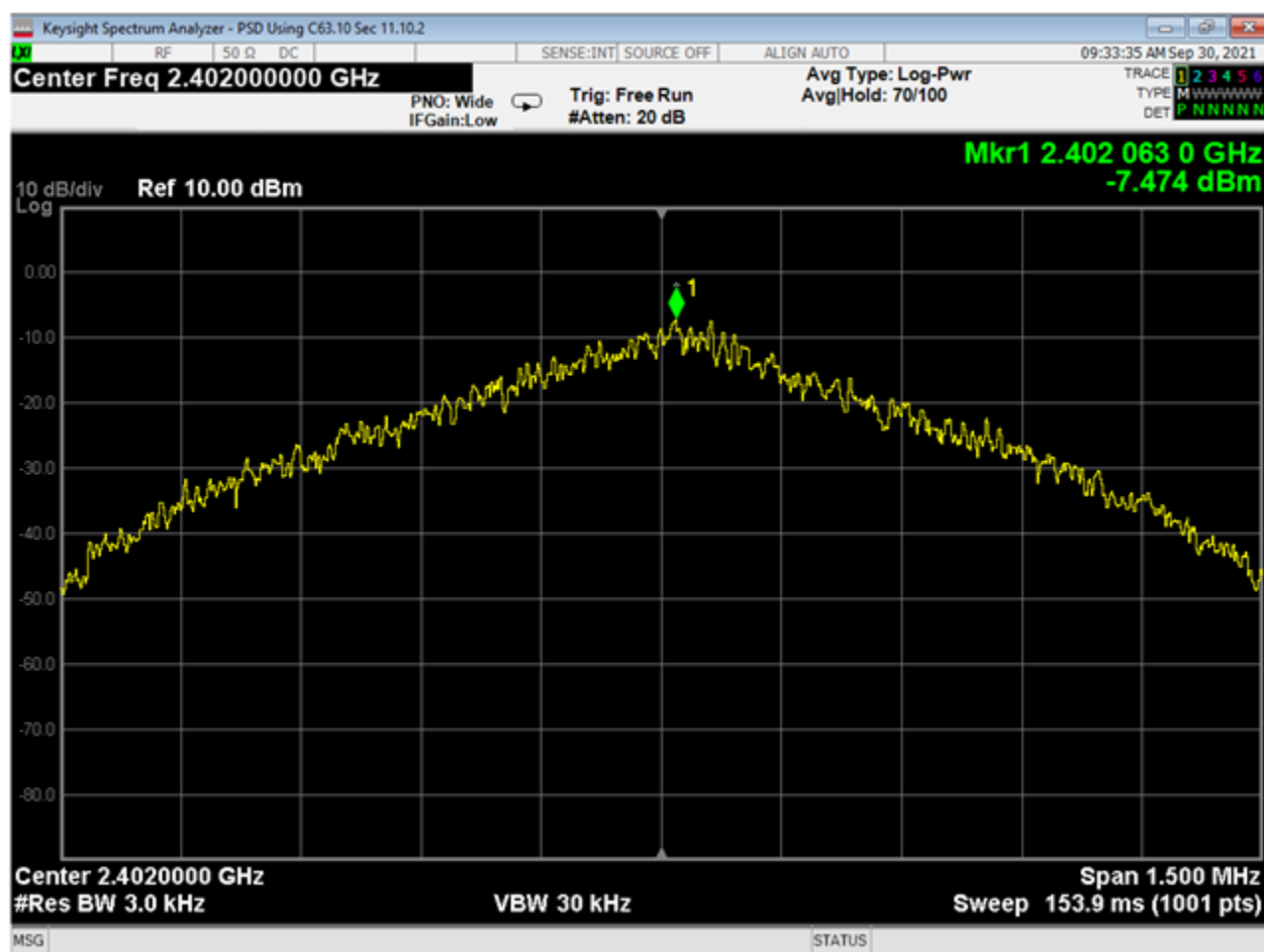
18 Bandwidth, Mid Frequency, GFSK



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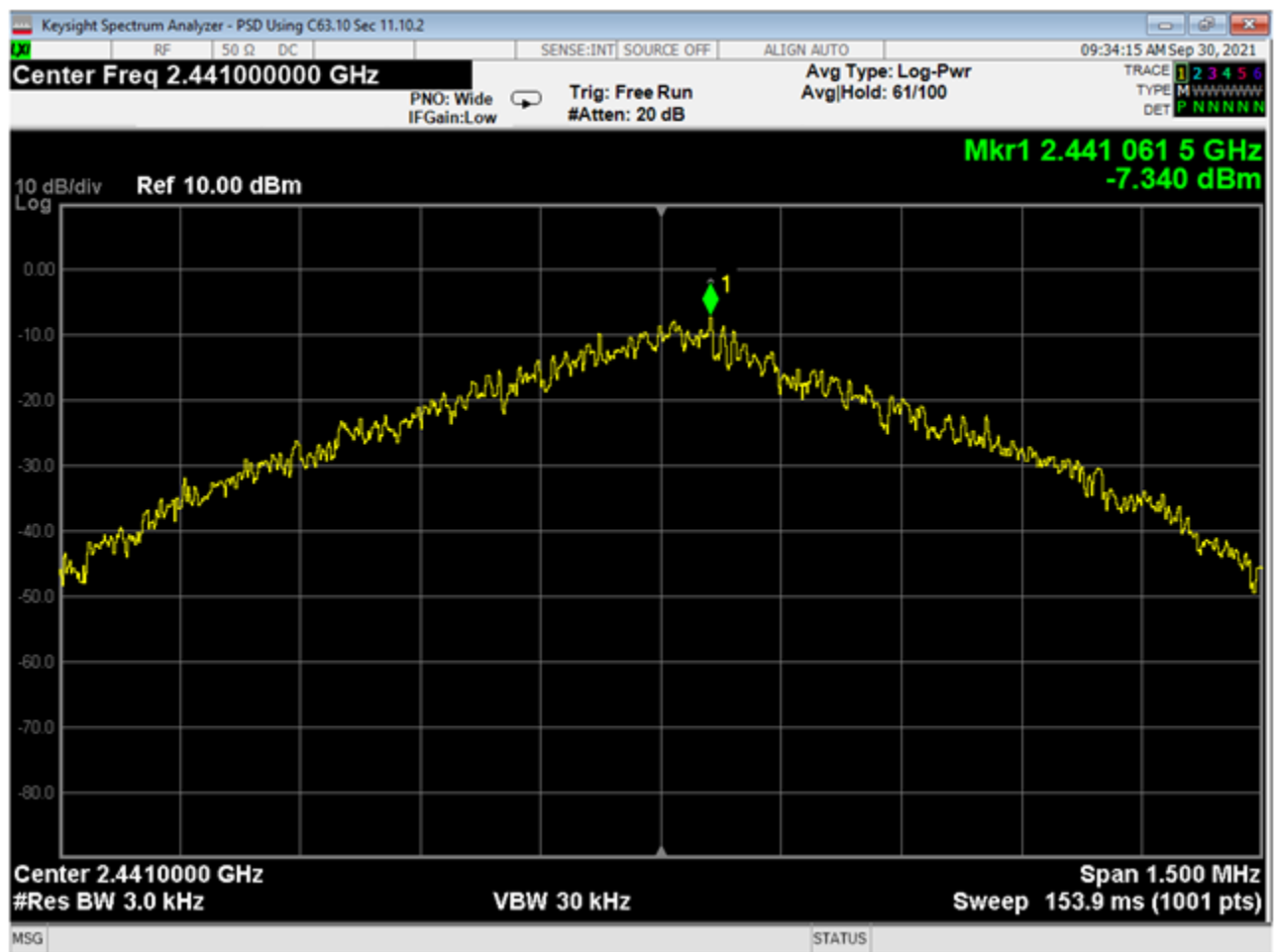


19 Bandwidth, High Frequency, GFSK

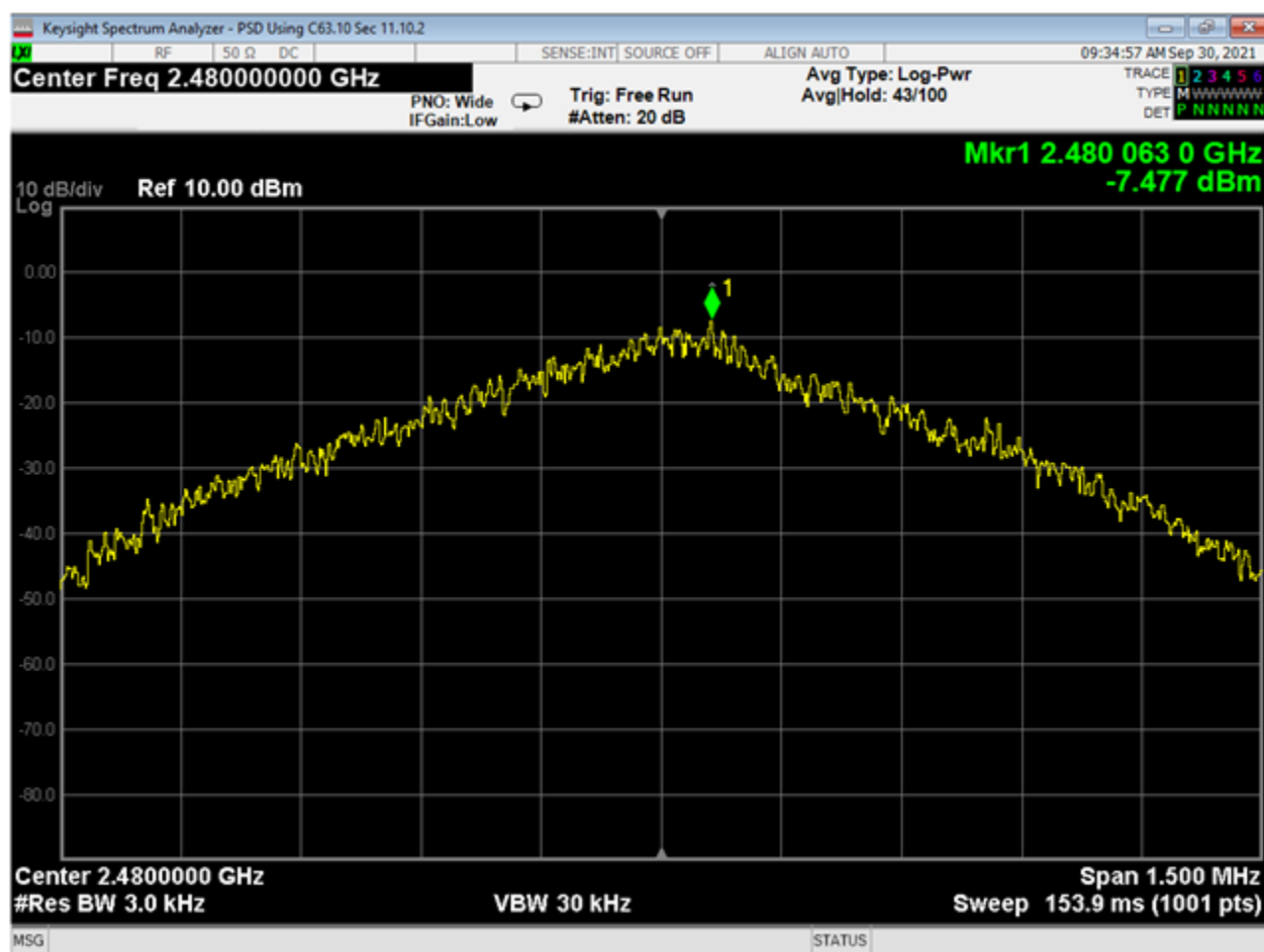


20 Power Spectral Density, Low Frequency, GFSK

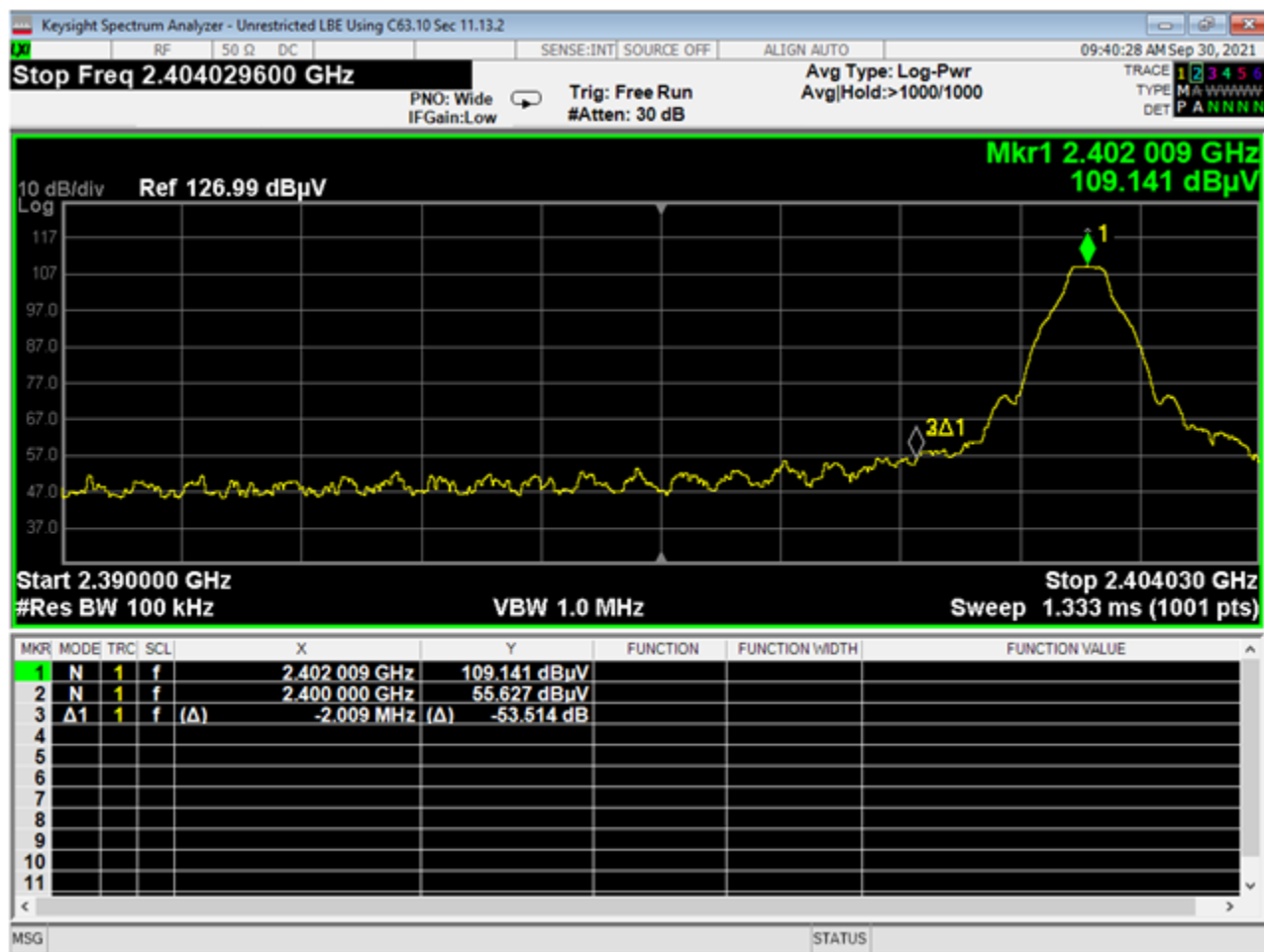
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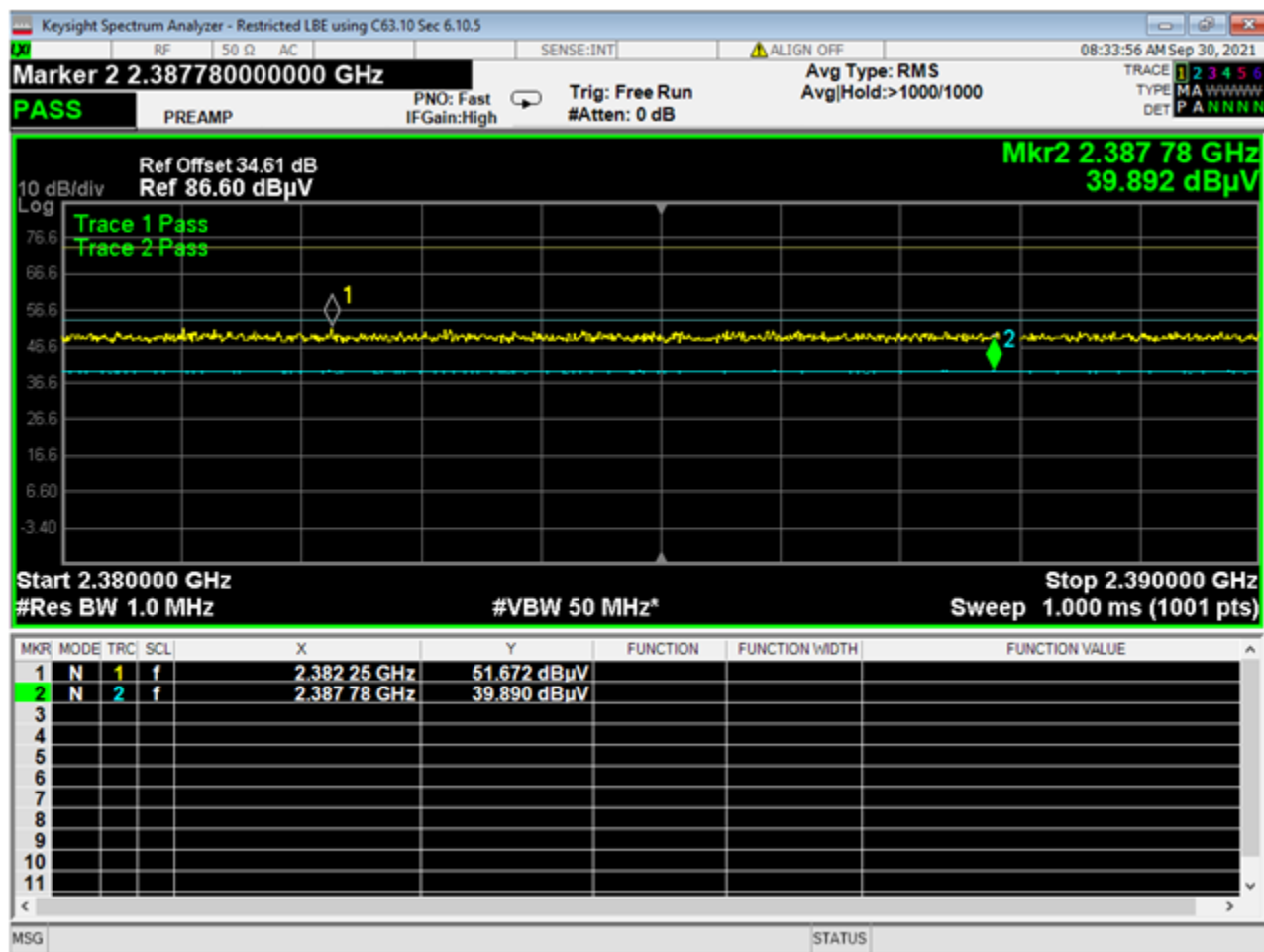
21 Power Spectral Density, Mid Frequency, GFSK



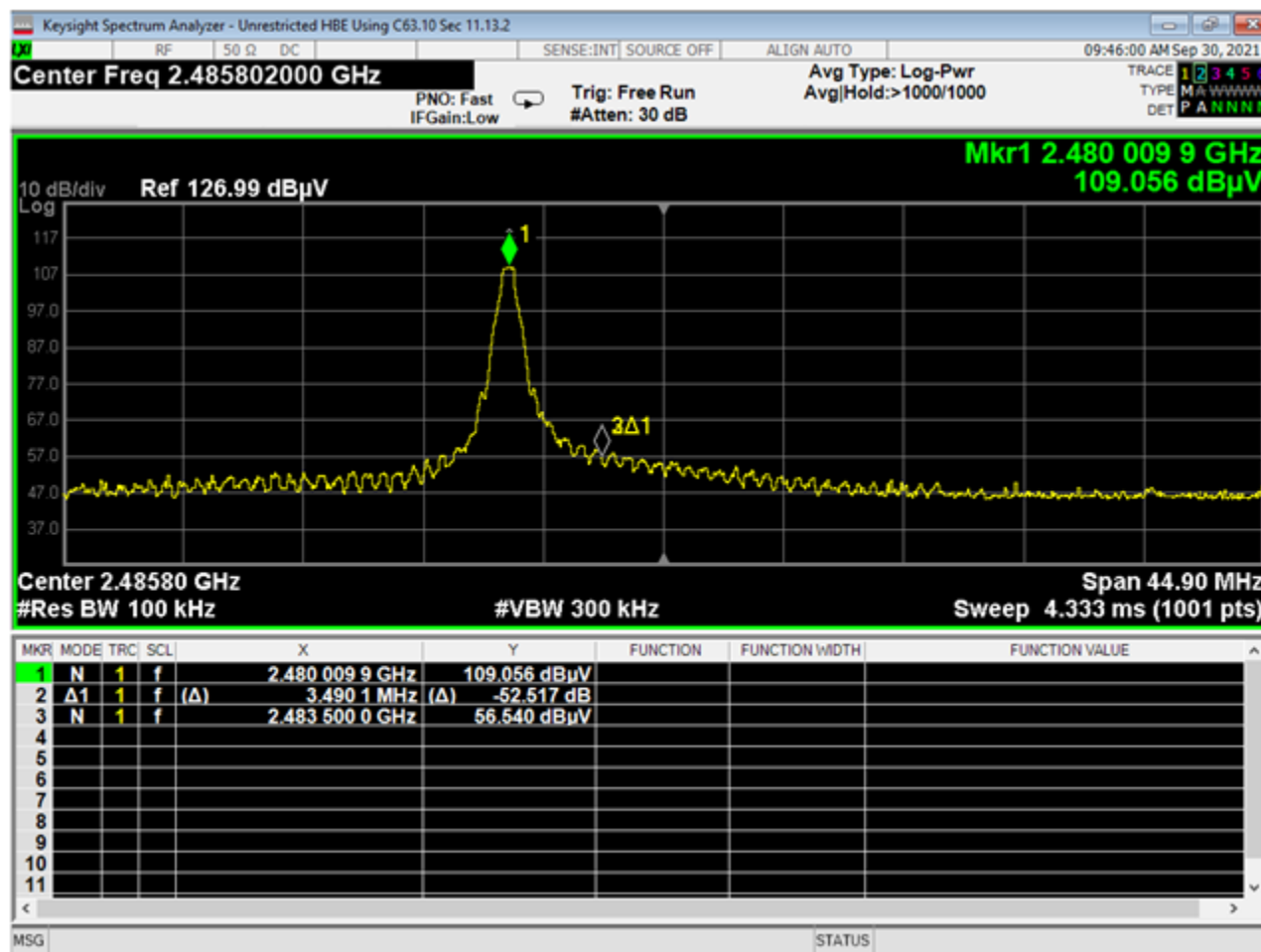
22 Power Spectral Density, High Frequency, GFSK



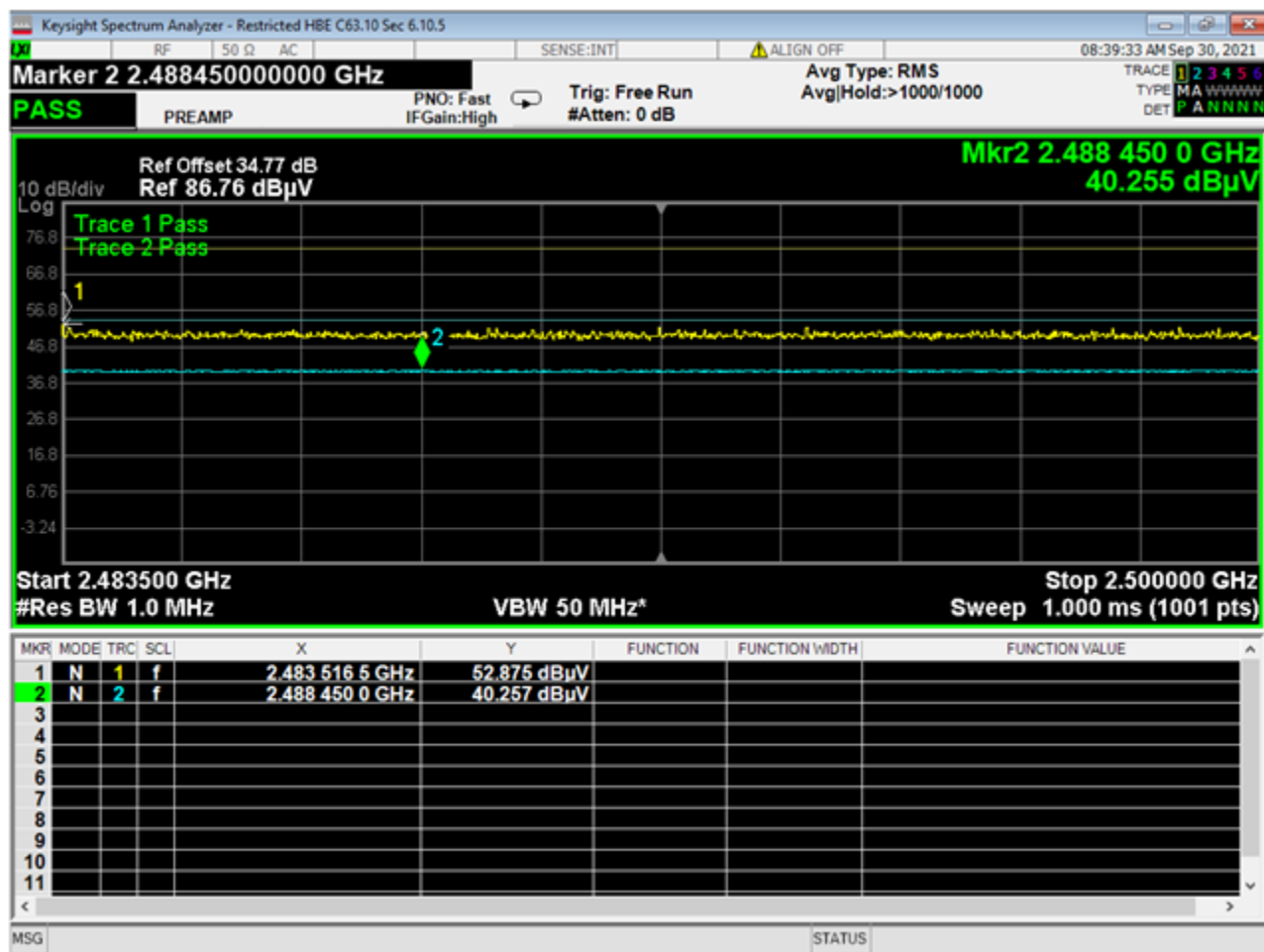
23 Unrestricted Lower Band Edge, GFSK



24 Restricted Lower Band Edge, GFSK



25 Unrestricted Higher Band Edge, GFSK



26 Restricted Higher Band Edge, GFSK



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