FCC 15.247 CERTIFICATION TEST REPORT

FOR THE

PHOENIX2 TRANSMITTER

FCC ID: 2AHYA-3402

WLL REPORT # 17892-01 REV 0

Prepared for:

Senseonics, Inc.
20451 Seneca Meadows Parkway
Germantown, Maryland 20876

Prepared By:

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Testing Certificate AT-1448

FCC 15.247 Certification Test Report

for the

Senseonics, Inc.

FCC ID: 2AHYA-3402

January 10, 2023

WLL Report# 17892-01 Rev 0

Prepared by:

Ryan Mascaro
RF Test Engineer

Reviewed by:

Steven D. Koster
President

Abstract

This report has been prepared on behalf of Senseonics, Inc.to support the attached application for a 2.4GHz Bluetooth Transmitter. The test report and application are submitted for a Frequency Hopping Spread Spectrum (FHSS) Transmitter under Part 15.247 of the FCC Rules and under Innovation Science and Economic Development (ISED) Canada RSS-247, Issue 2 (2/2017). This test Report documents the test configuration and test results for the Senseonics, Inc., FCC ID: 2AHYA-3402. The information provided in this report is only applicable to device herein documented, as the EUT.

The radiated emissions portion of the testing was performed on an Open Area Test Site (OATS) at Washington Laboratories, Ltd., located at 4840 Winchester Boulevard, Suite #5. Frederick, MD 21703. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD.

Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent test laboratory. The Washington Laboratories, Ltd. ISED Canada number is 3035A.

The Senseonics, Inc., FCC ID: 2AHYA-3402 complies with the requirements for a DTS Transmitter under Part 15.247 of the FCC Rules.

Revision History	Description of Change	Date
Rev 0	Initial Release	January 10, 2023

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1 Introduction

1.1 Compliance Statement

The Senseonics, Inc., FCC ID: 2AHYA-3402 complies with the requirements for a DTS Transmitter under Part 15.247 of the FCC Rules.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with C63.10 "ANSI Procedures for Compliance Testing of Unlicensed Wireless Devices". The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation. Table 1 provides the series and results of testing for compliance with for a DTS device; full test results are shown in subsequent report sub-sections.

1.3 Testing Algorithm

The Phoenix2 Transmitter was provided to the test laboratory, in two sample configurations: (1) a conducted (at the antenna port) sample and (2) a wireless radiated sample. The EUT low, center, and high channels were tunable through the support laptop's interface. Prior to all testing, the transmitter power was adjusted [via software] to the desired power level of 4dBm. This setting achieved the reported peak transmit output power denoted in Table 2. The EUT was tested in a manner that produced the worst-case emission levels, which are provided in the test results data section(s) of this report. The applicant also provided a smartphone companion device, that was used to enable the co-located transmitters, contained with the EUT. Before, during, and after each test, it was confirmed that both the 2.4GHz BLE transmitter and the 13.56MHz NFC transmitter were set to an active transmit enabled mode, simultaneously.

1.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Frederick, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent test laboratory. The Washington Laboratories, Ltd. ISED Canada number is 3035A.

1.5 Contract Information

Customer:	Senseonics, Inc.
Purchase Order Number:	20753
Quotation Number:	73671

1.6 Test and Support Personnel

Washington Laboratories, LTD	Ryan Mascaro
Customer Representative	Pavel Beresney

1.7 Test Dates

12/19/2022 – 12/20/2022 (also see Section 4 of this report)

Table 1: Certification Testing Summary and Compliance Results

FCC Rule Part	Description	Result
15.247(a)(2)	6 dB Bandwidth	Pass
15.247 (b)(3)	Transmit Output Power	Pass
15.247(e)	Power Spectral Density	Pass
15.247(d)	Out-of-Band Emissions (Band Edge @ 20 dB below)	Pass
15.205 15.209	General Field Strength Requirements (Restricted Bands & RE Limits)	Pass
15.207	AC Powerline Conducted Emissions	Pass

2 Test Results

2.1 Transmitter Output Power

For a DTS device, FCC Part 15.247 requires the maximum conducted output power to be < 30 dBm (1W).

2.1.1 Measurement Method and Results

This test was performed as specified in ANSI C63.10 (2013), Section 11.9.1.1.

The EUT was evaluated in both a CW mode and a GFSK modulated mode. The EUT produced a higher output power when the transmitter was set to output a modulated signal. As such, the EUT was configured in a GFSK modulated mode for this test. Worst case emissions are reported.

Table 2: Transmitter Output Power – Test Results

Modulation	Mode (Data Rate)	Channel Frequency	Peak Power (dBm)
GFSK	BLE (1Mbps)	2402 MHz	3.931
		2440 MHz	4.163
		2480 MHz	4.284
GFSK	BLE (2Mbps)	2402 MHz	3.969
		2440 MHz	4.196
		2480 MHz	4.309

Figure 1: GFSK (1Mbps) – Low Channel, Peak Power Output

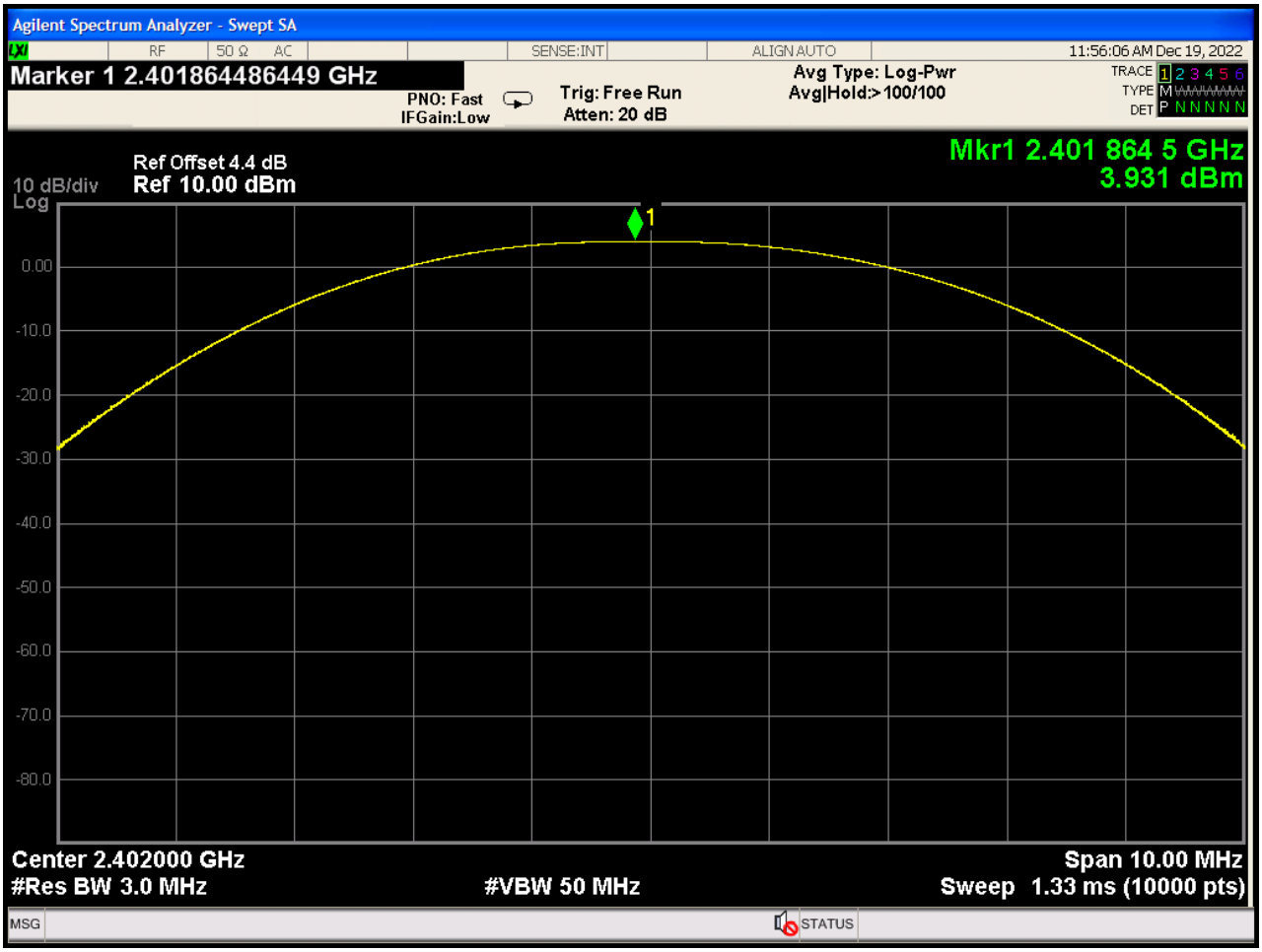


Figure 2: GFSK (1Mbps) – Center Channel, Peak Power Output

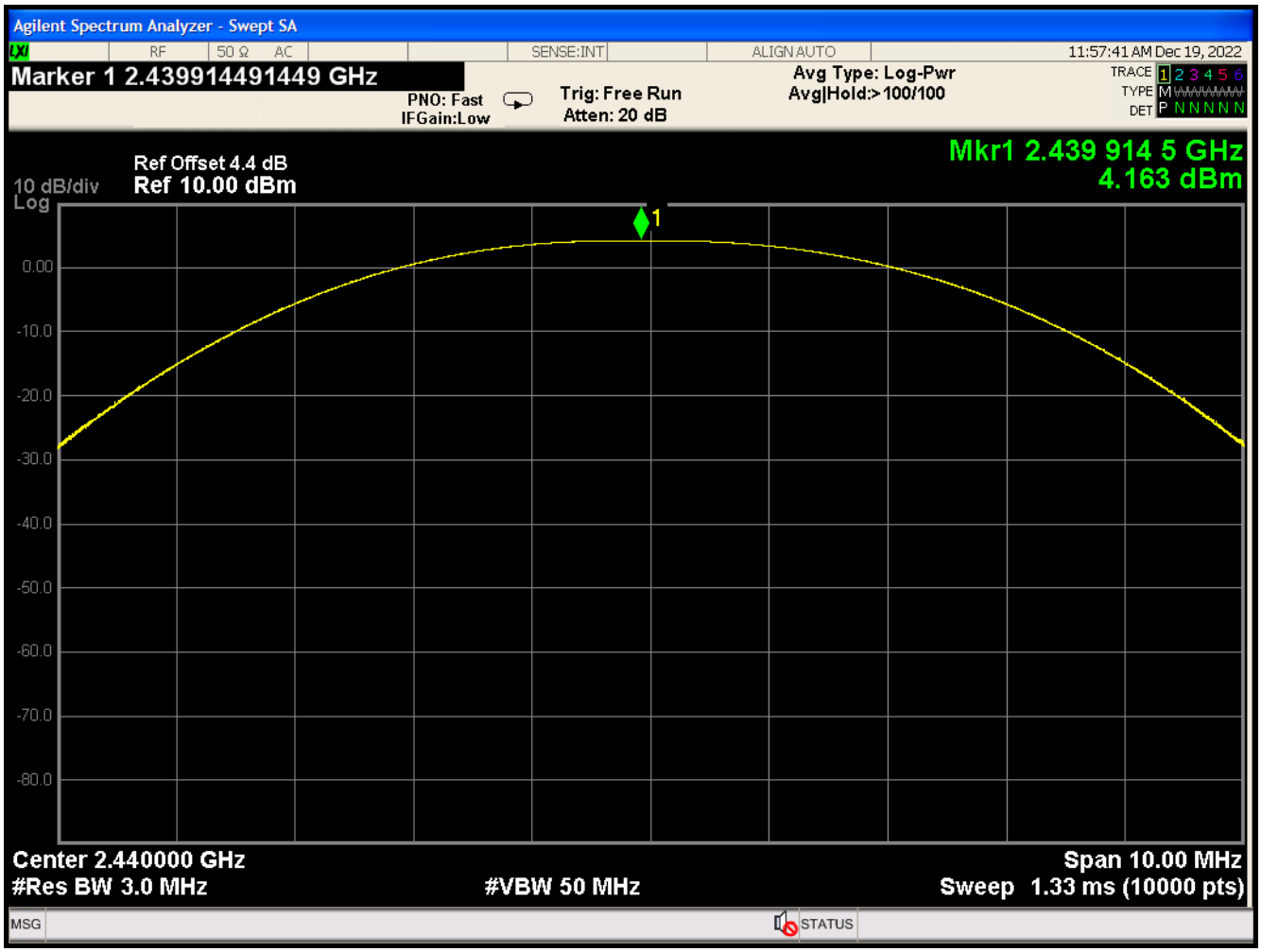


Figure 3: GFSK (1Mbps) – High Channel, Peak Power Output

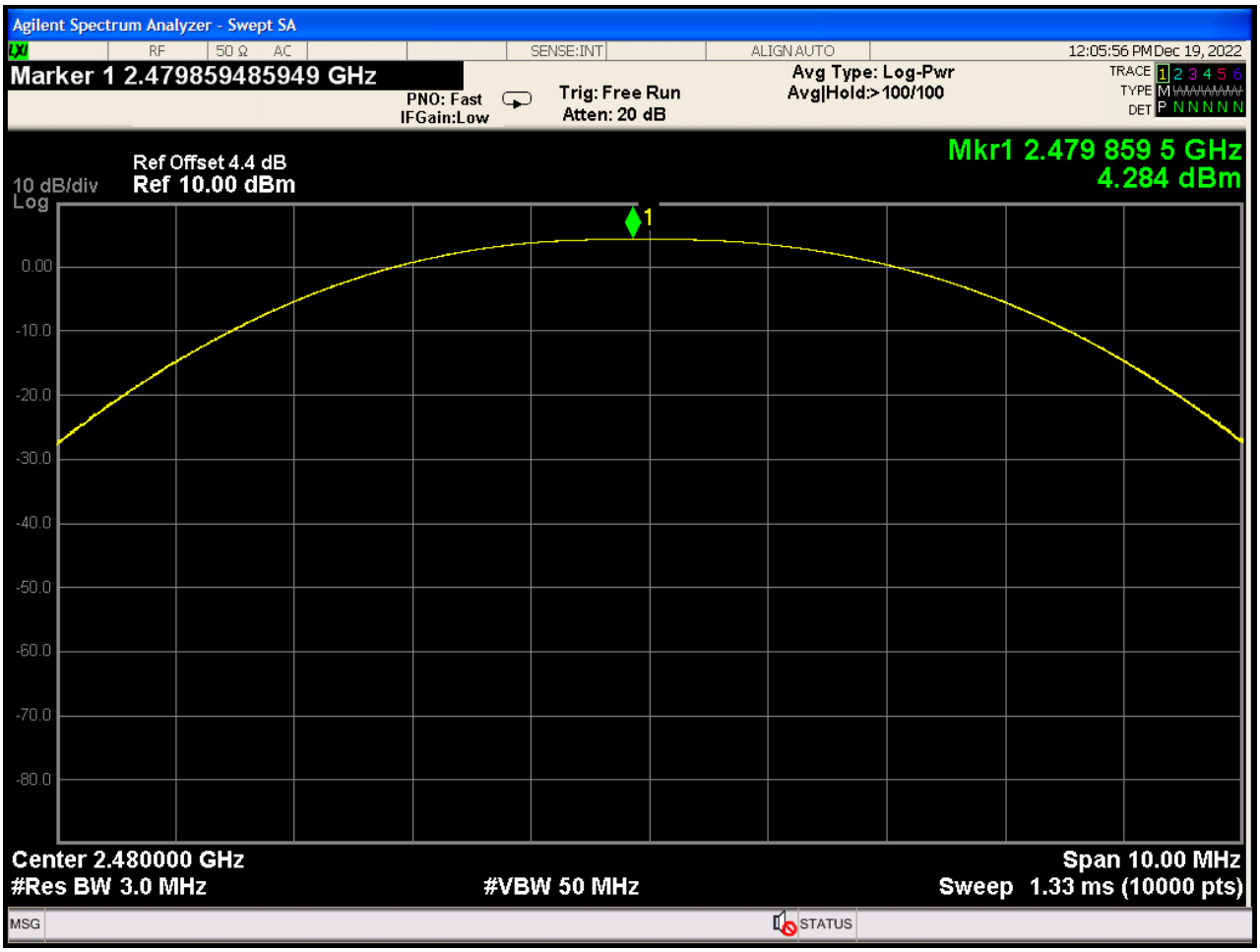


Figure 4: GFSK (2Mbps) – Low Channel, Peak Power Output

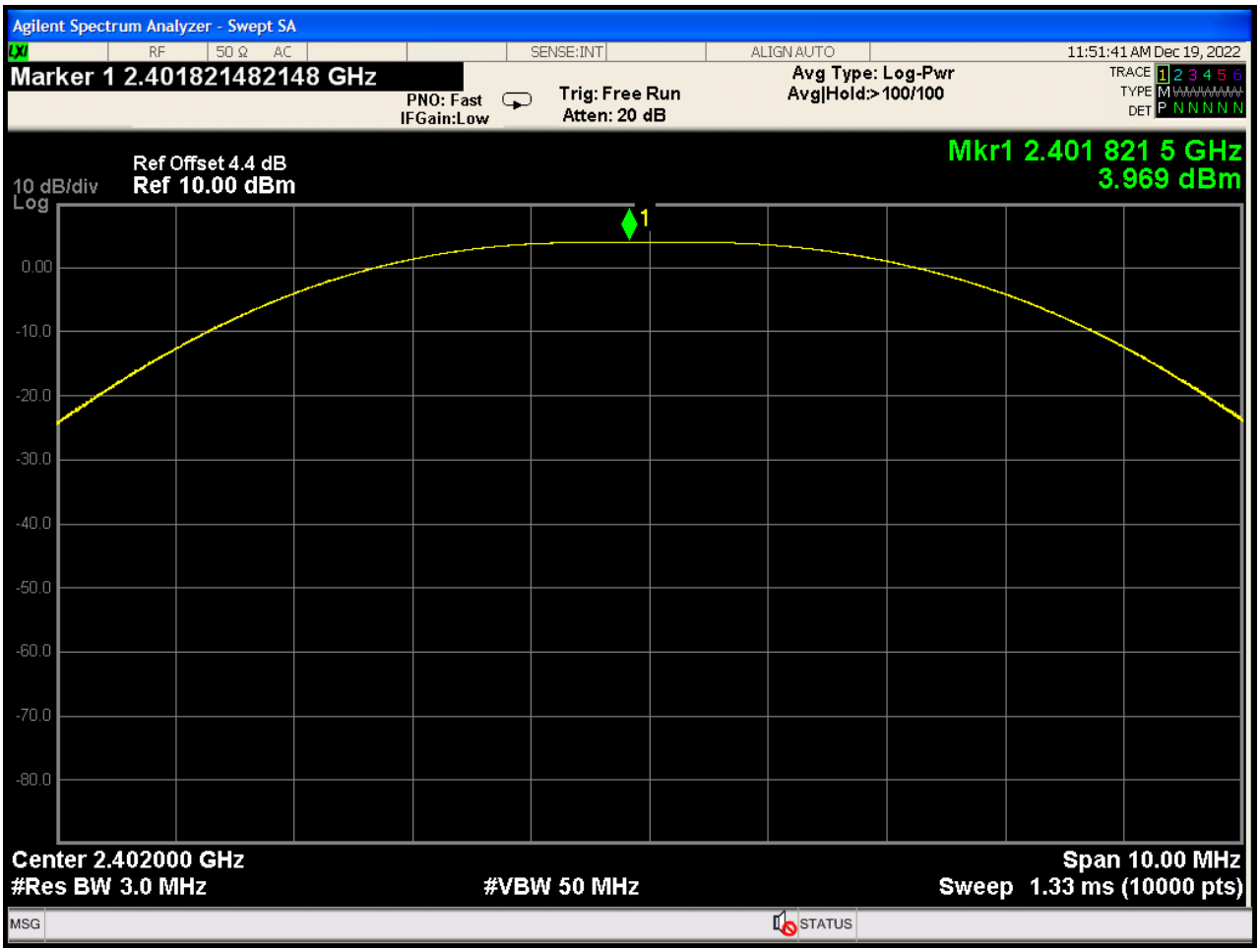


Figure 5: GFSK (2Mbps) – Center Channel, Peak Power Output

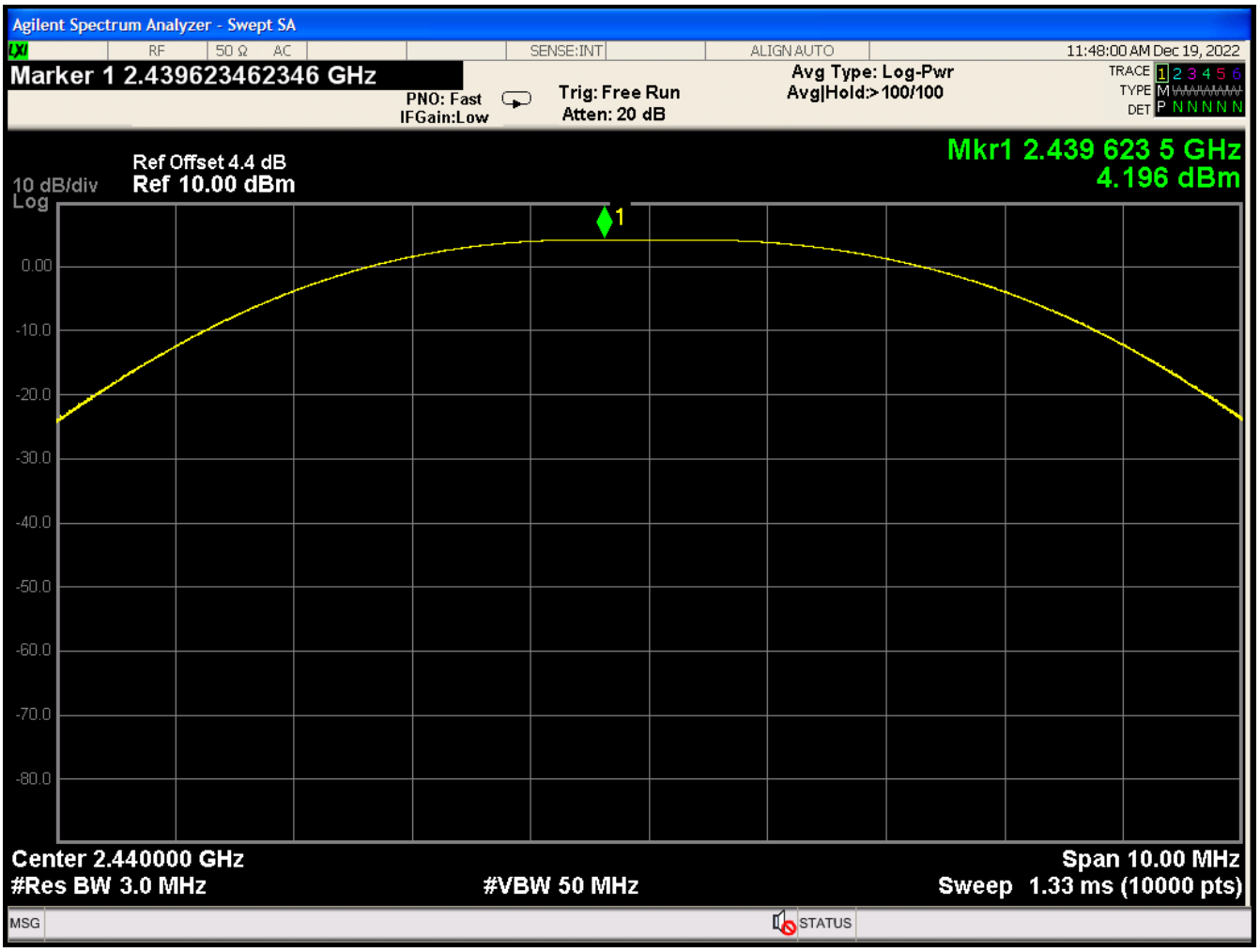
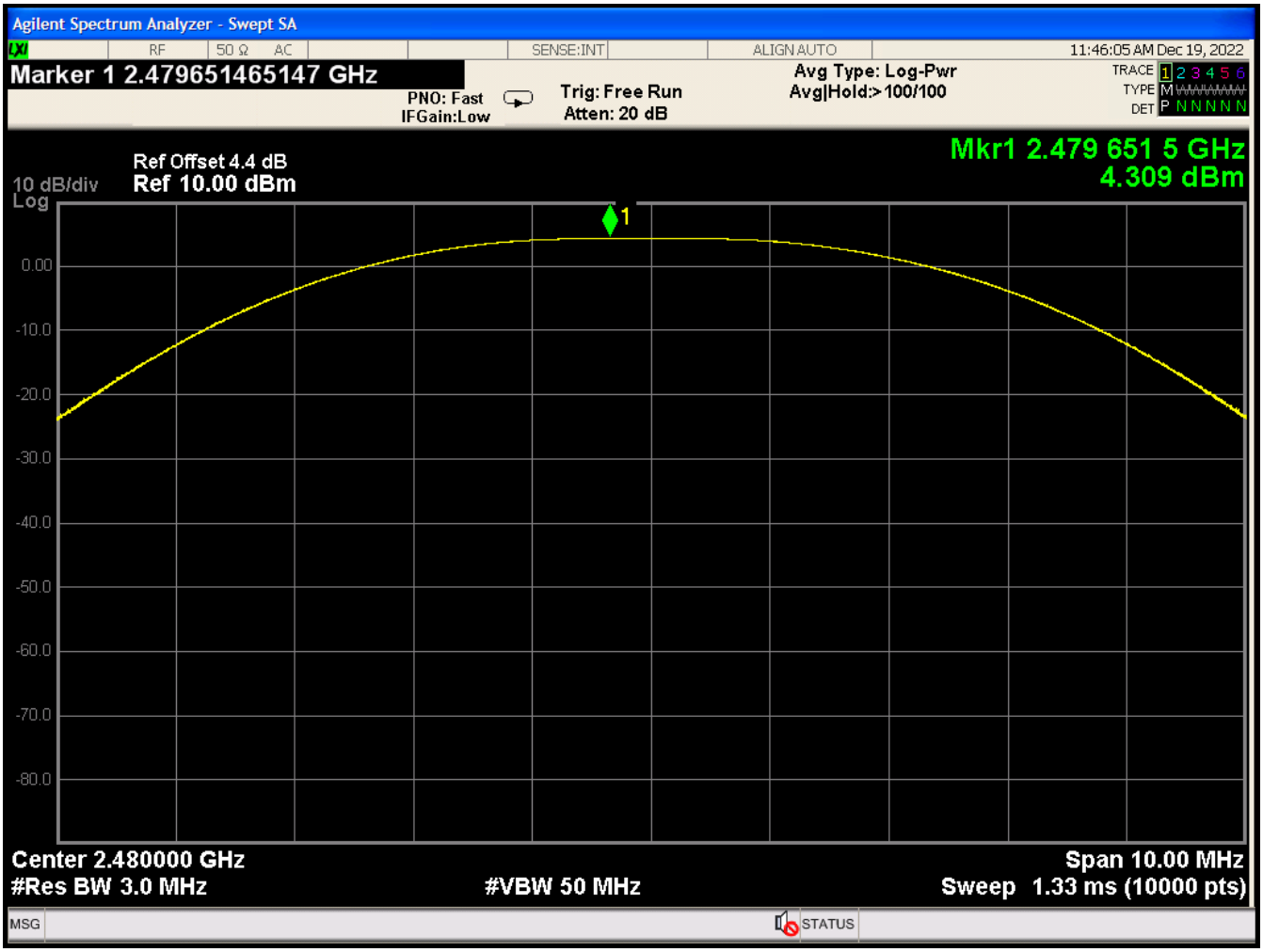


Figure 6: GFSK (2Mbps) – High Channel, Peak Power Output



2.2 Channel Occupied Bandwidth

For a DTS device, FCC Part 15.247 requires the minimum 6 dB bandwidth be at least 500 kHz.

2.2.1 Measurement Method and Results

This test was performed as specified in ANSI C63.10 (2013), Section 11.8.2.

The EUT was configured in a GFSK modulated mode for this test. Worst case emissions are reported.

Table 3: Channel Occupied Bandwidth – Test Results

Modulation	Mode (Data Rate)	Channel Frequency	6dB Bandwidth
GFSK	BLE (1Mbps)	2402 MHz	733.7 kHz
		2440 MHz	752.5 kHz
		2480 MHz	756.1 kHz
GFSK	BLE (2Mbps)	2402 MHz	1.296 MHz
		2440 MHz	1.276 MHz
		2480 MHz	1.327 MHz

Figure 7: GFSK (1Mbps) – Low Channel, Occupied Bandwidth

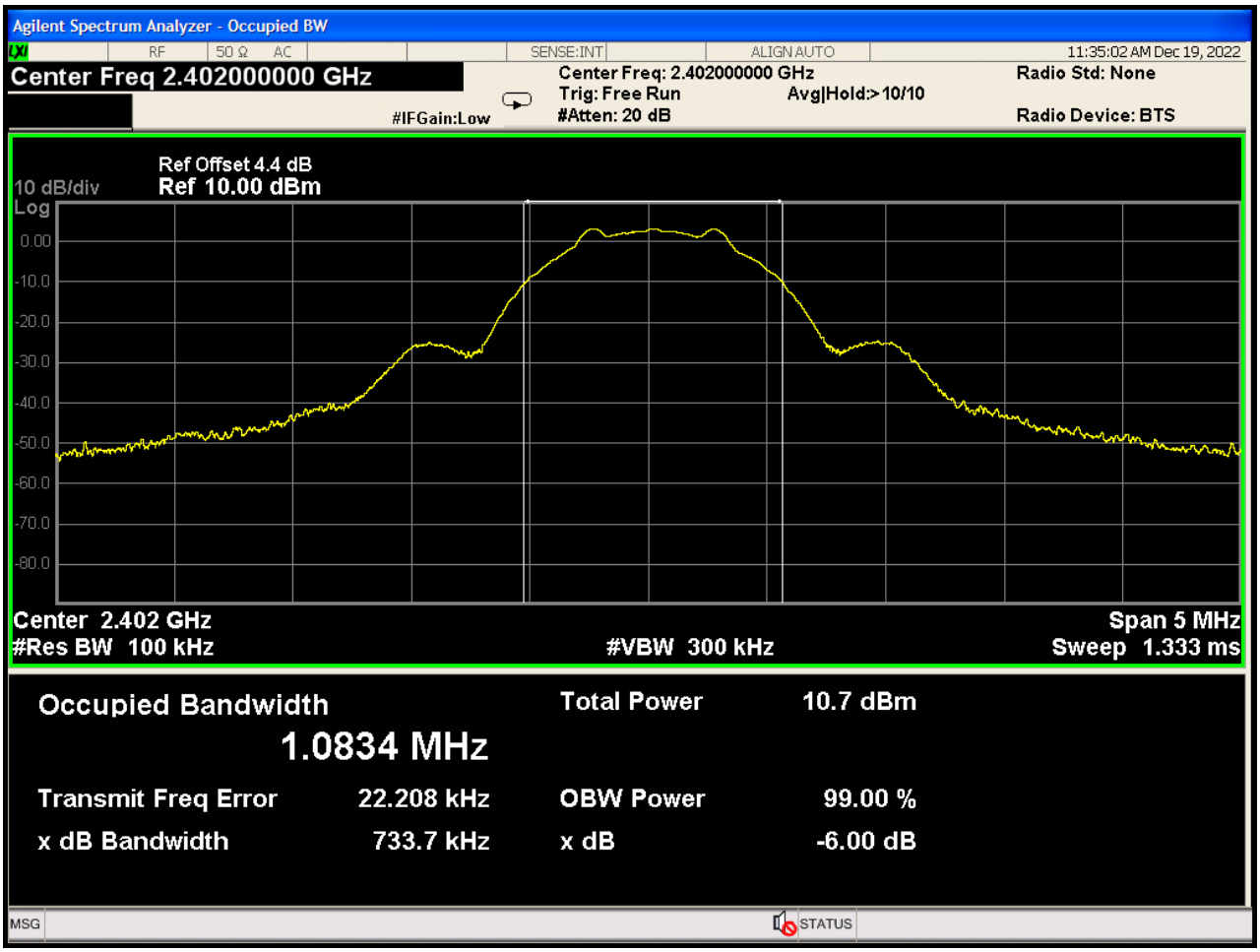


Figure 8: GFSK (1Mbps) – Center Channel, Occupied Bandwidth

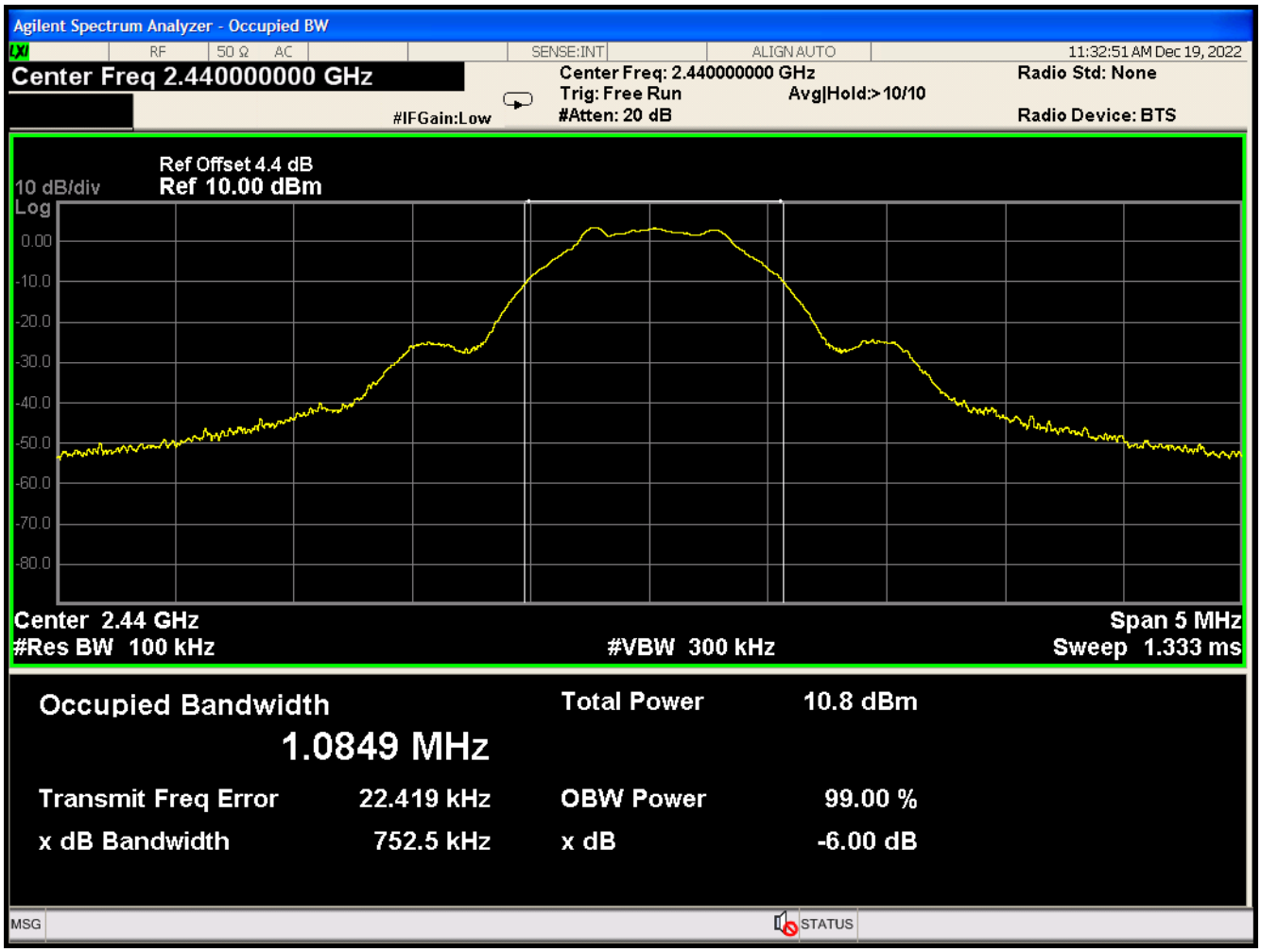


Figure 9: GFSK (1Mbps) – High Channel, Occupied Bandwidth

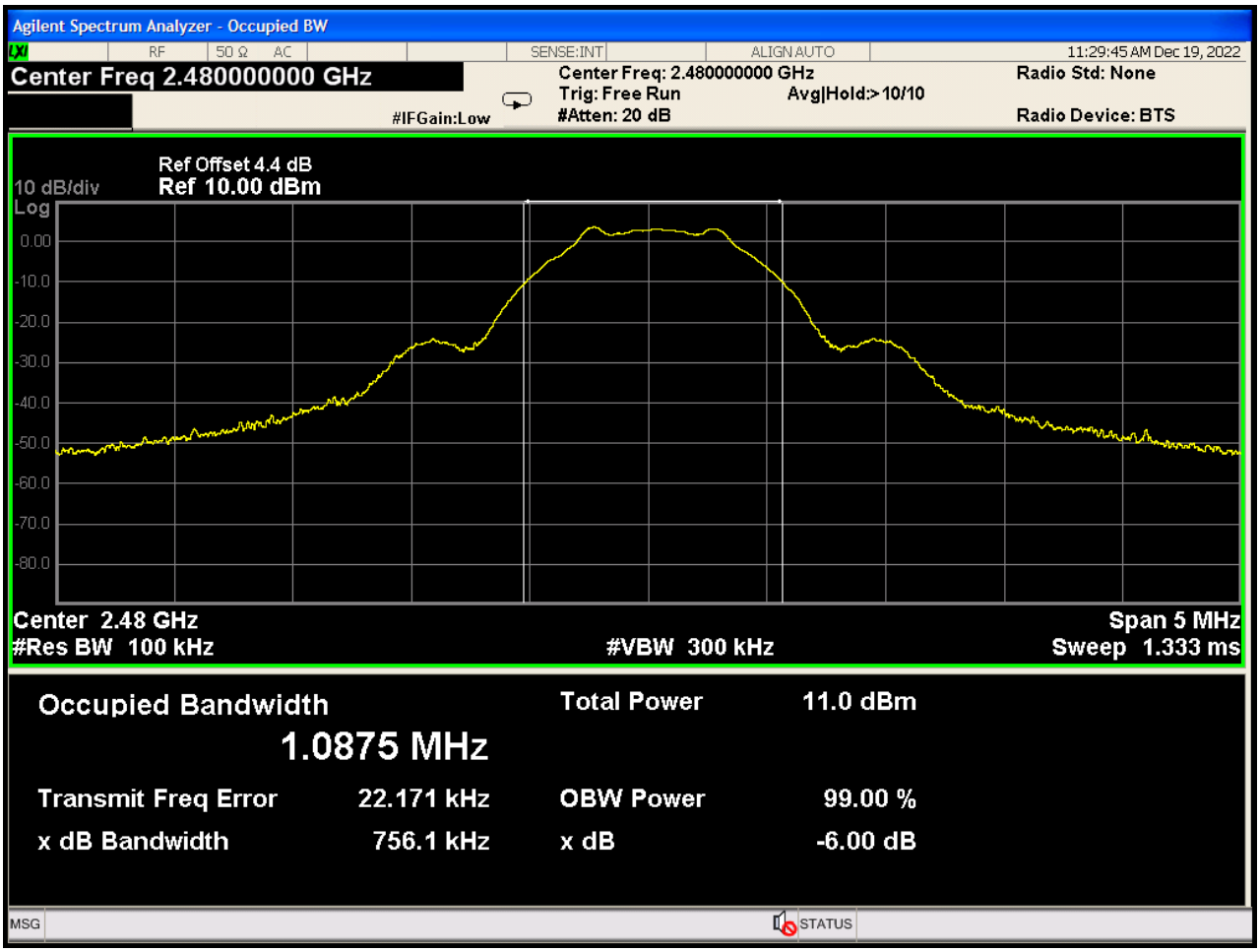


Figure 10: GFSK (2Mbps) – Low Channel, Occupied Bandwidth

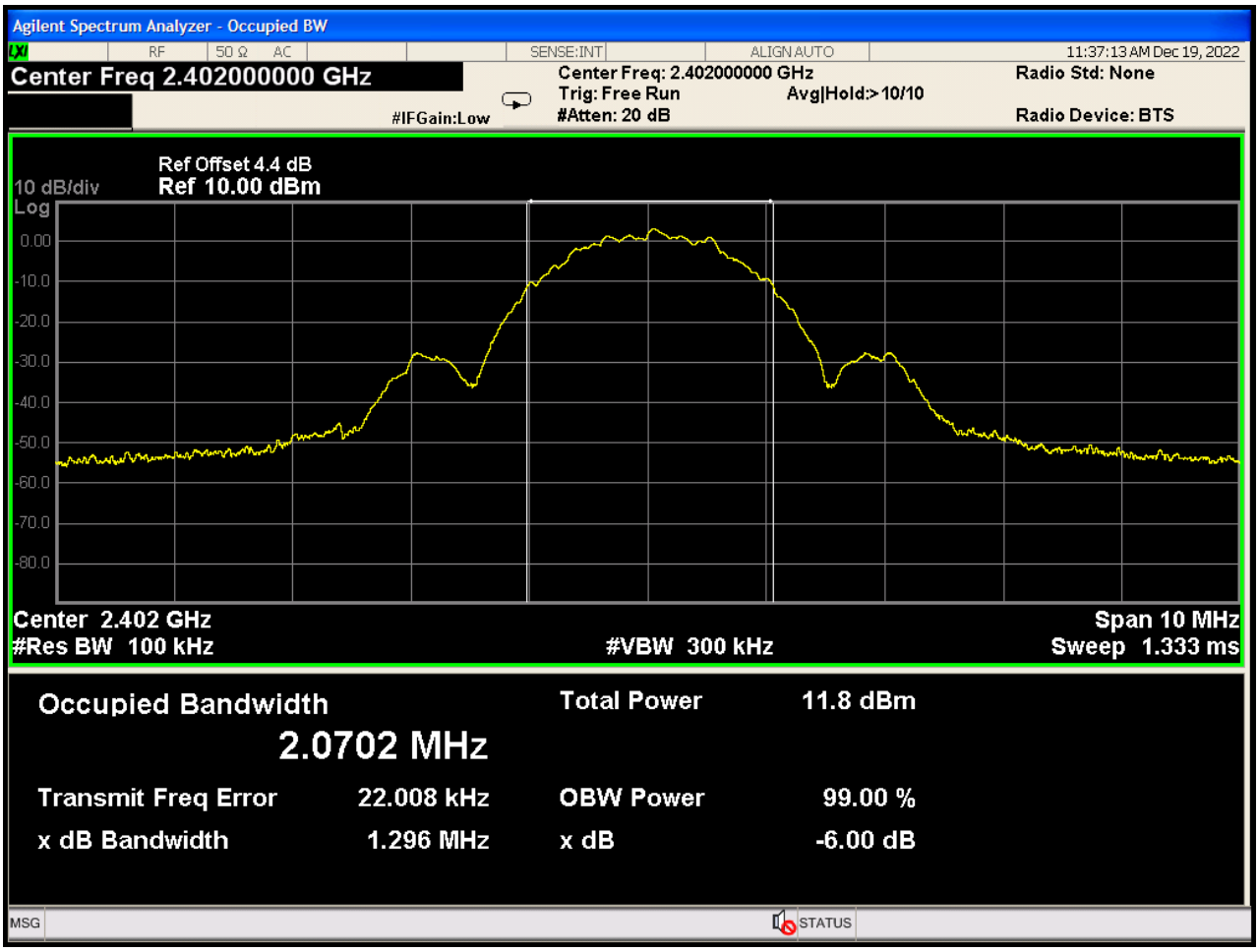


Figure 11: GFSK (2Mbps) – Center Channel, Occupied Bandwidth

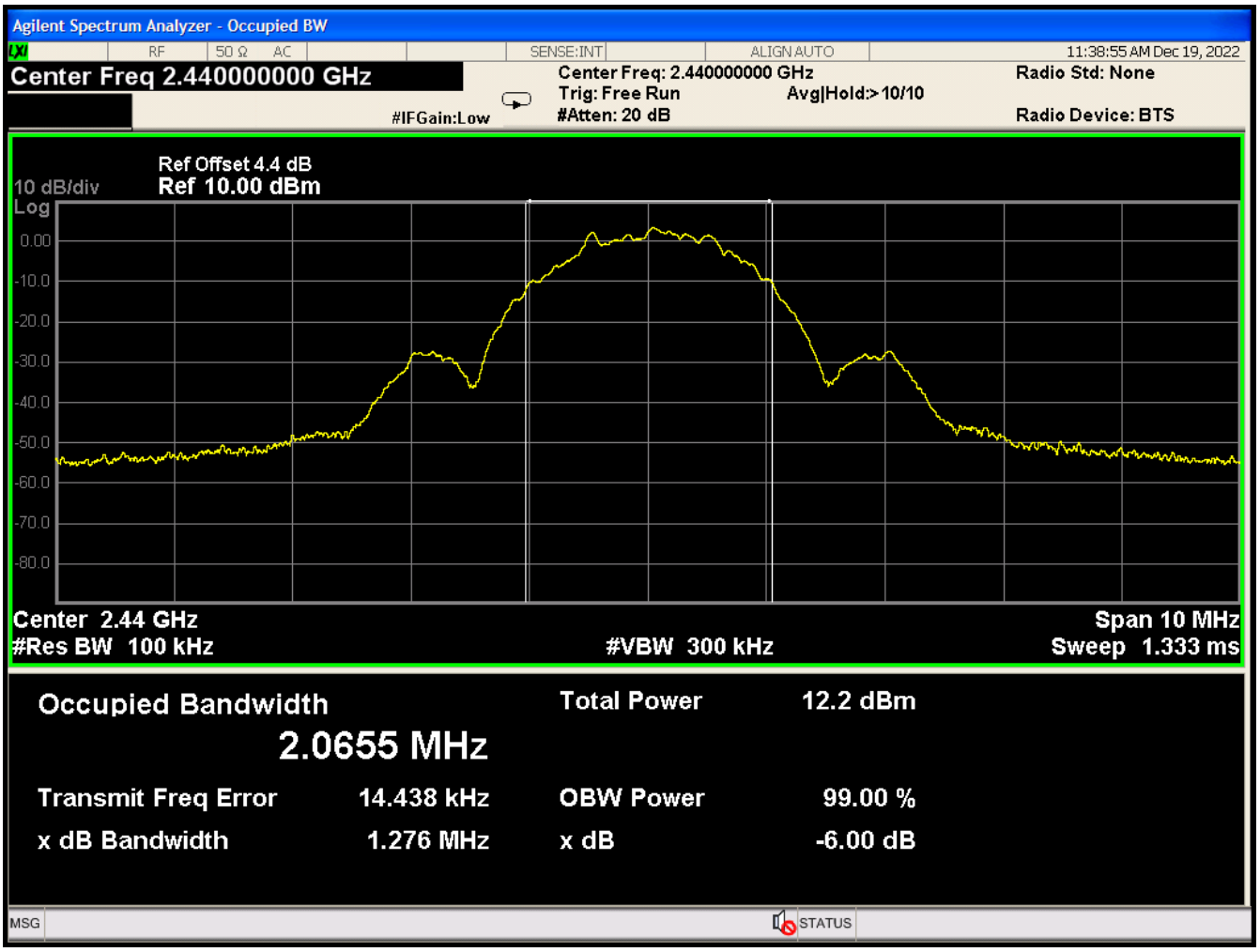
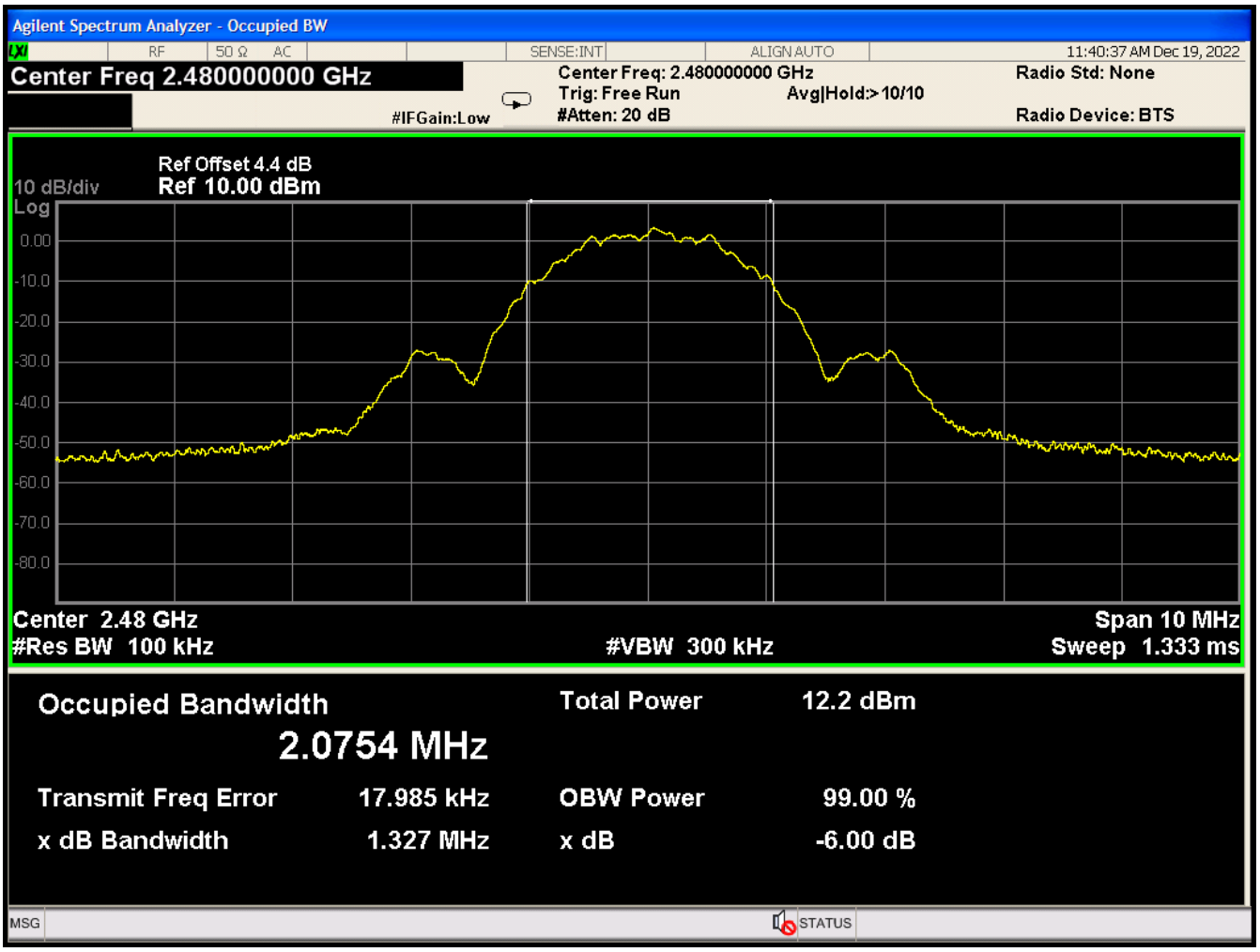


Figure 12: GFSK (2Mbps) – High Channel, Occupied Bandwidth



2.3 Power Spectral Density

For a DTS device, FCC Part 15.247 requires the maximum PSD to be < 8 dBm, in any 3 kHz bandwidth.

2.3.1 Measurement Method

This test was performed as specified in ANSI C63.10 (2013), Section 11.10.2.

The EUT was configured in a GFSK modulated mode for this test. Worst case emissions are reported.

Table 4: Power Spectral Density Summary

Modulation	Mode (Data Rate)	Channel Frequency	Power Spectral Density
GFSK	BLE (1Mbps)	2402 MHz	3.403 dBm
		2440 MHz	3.405 dBm
		2480 MHz	4.168 dBm
GFSK	BLE (2Mbps)	2402 MHz	2.496 dBm
		2440 MHz	2.683 dBm
		2480 MHz	3.364 dBm

Figure 13: GFSK (1Mbps) – Low Channel, Power Spectral Density

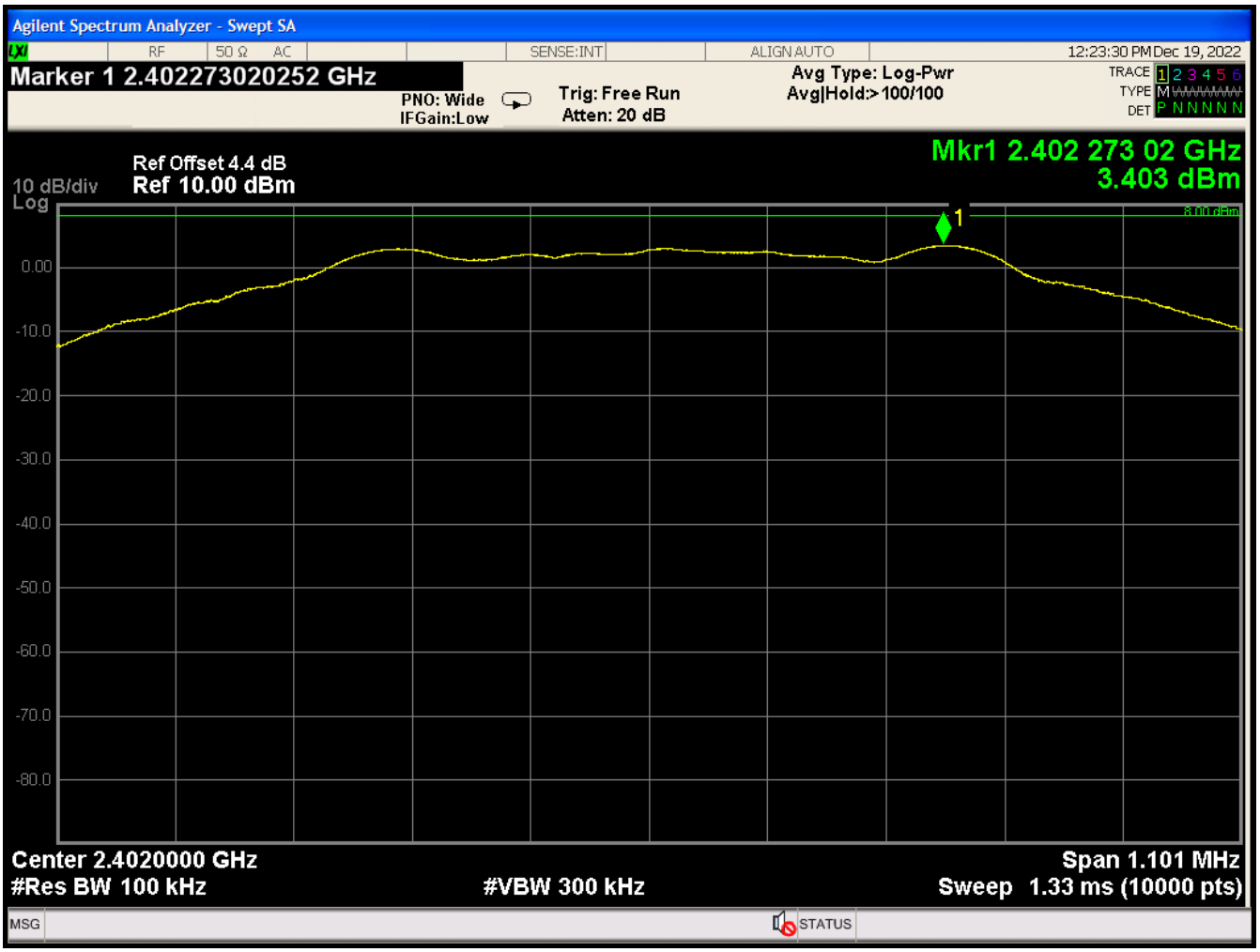


Figure 14: GFSK (1Mbps) – Center Channel, Power Spectral Density

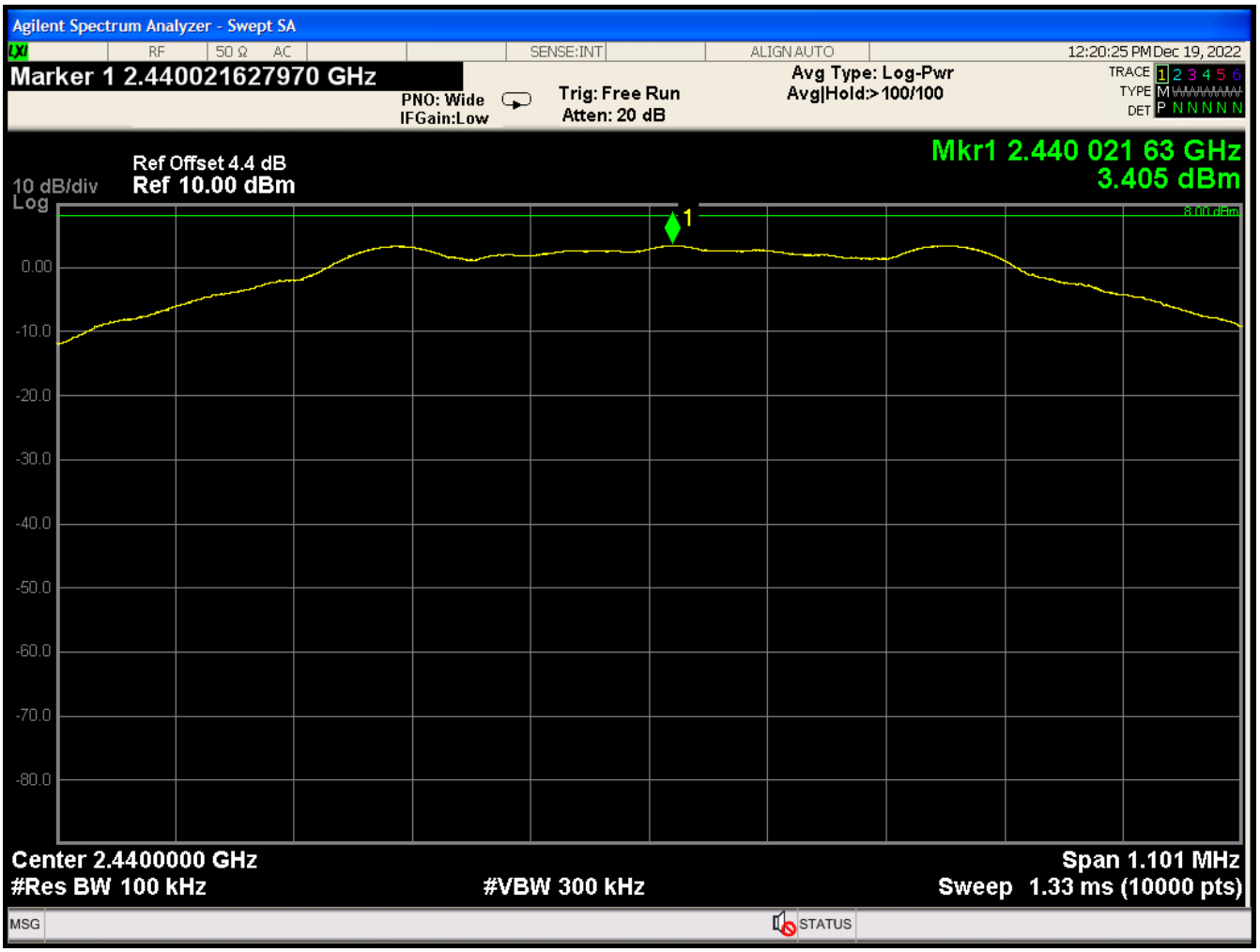


Figure 15: GFSK (1Mbps) – High Channel, Power Spectral Density

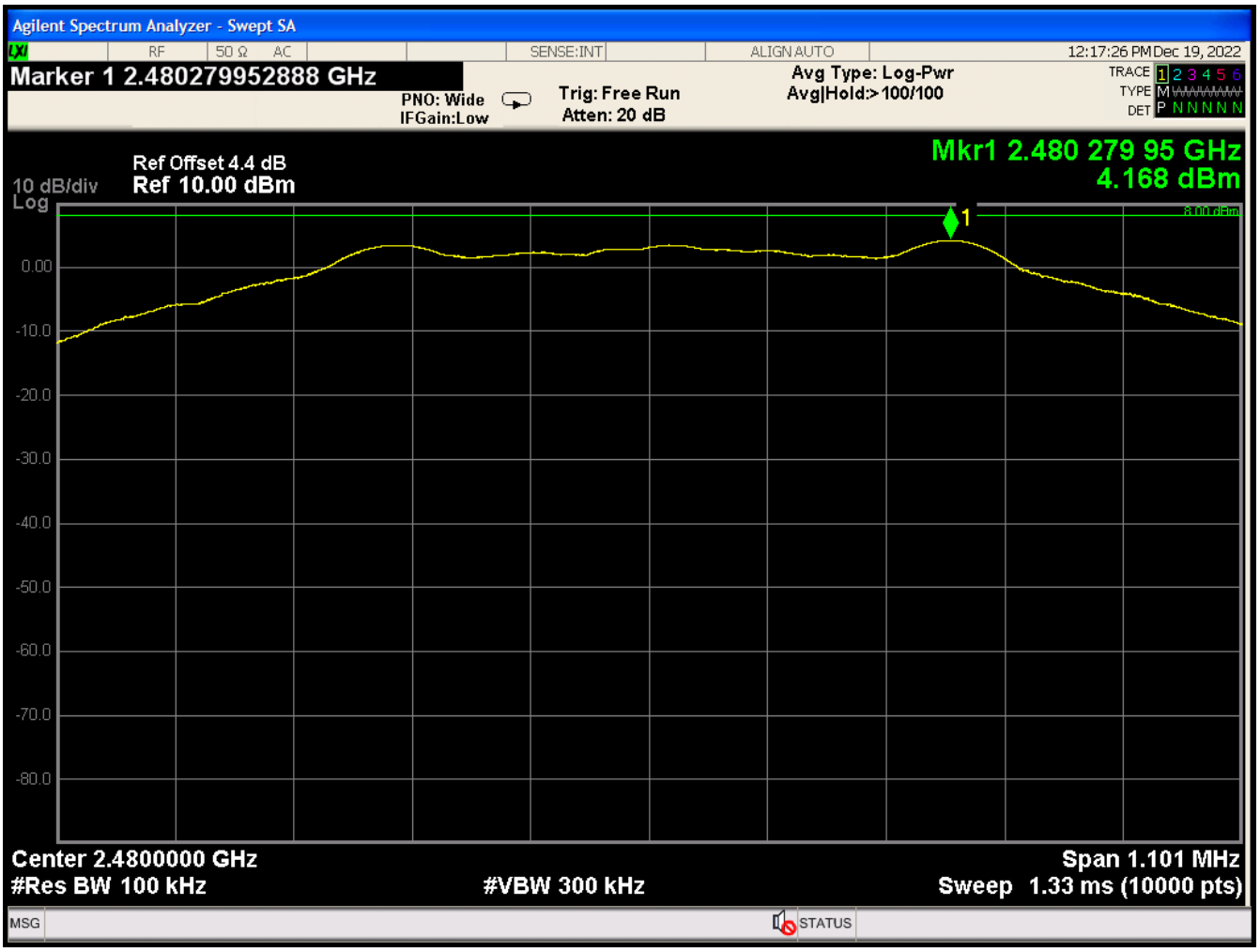


Figure 16: GFSK (2Mbps) – Low Channel, Power Spectral Density

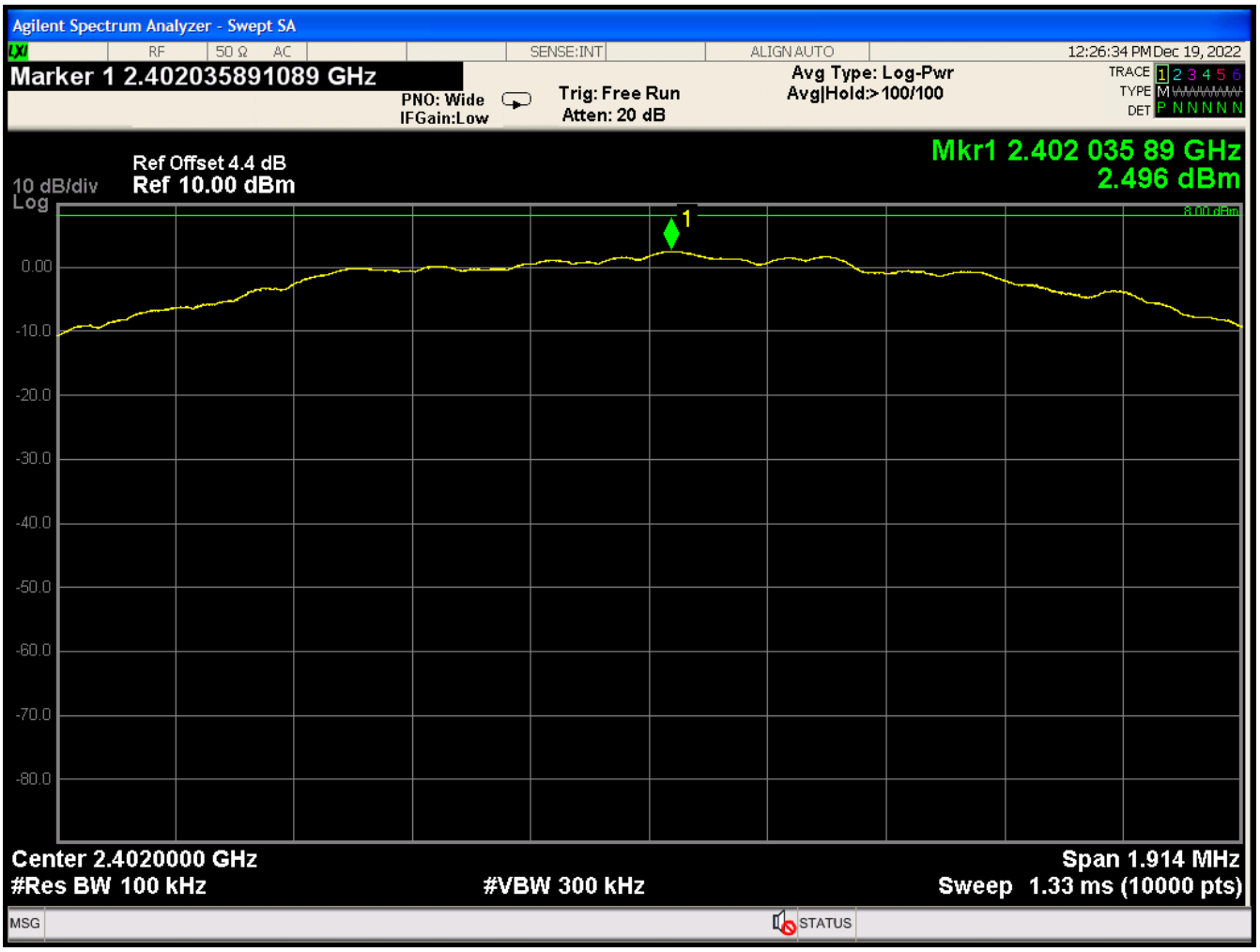


Figure 17: GFSK (2Mbps) – Center Channel, Power Spectral Density

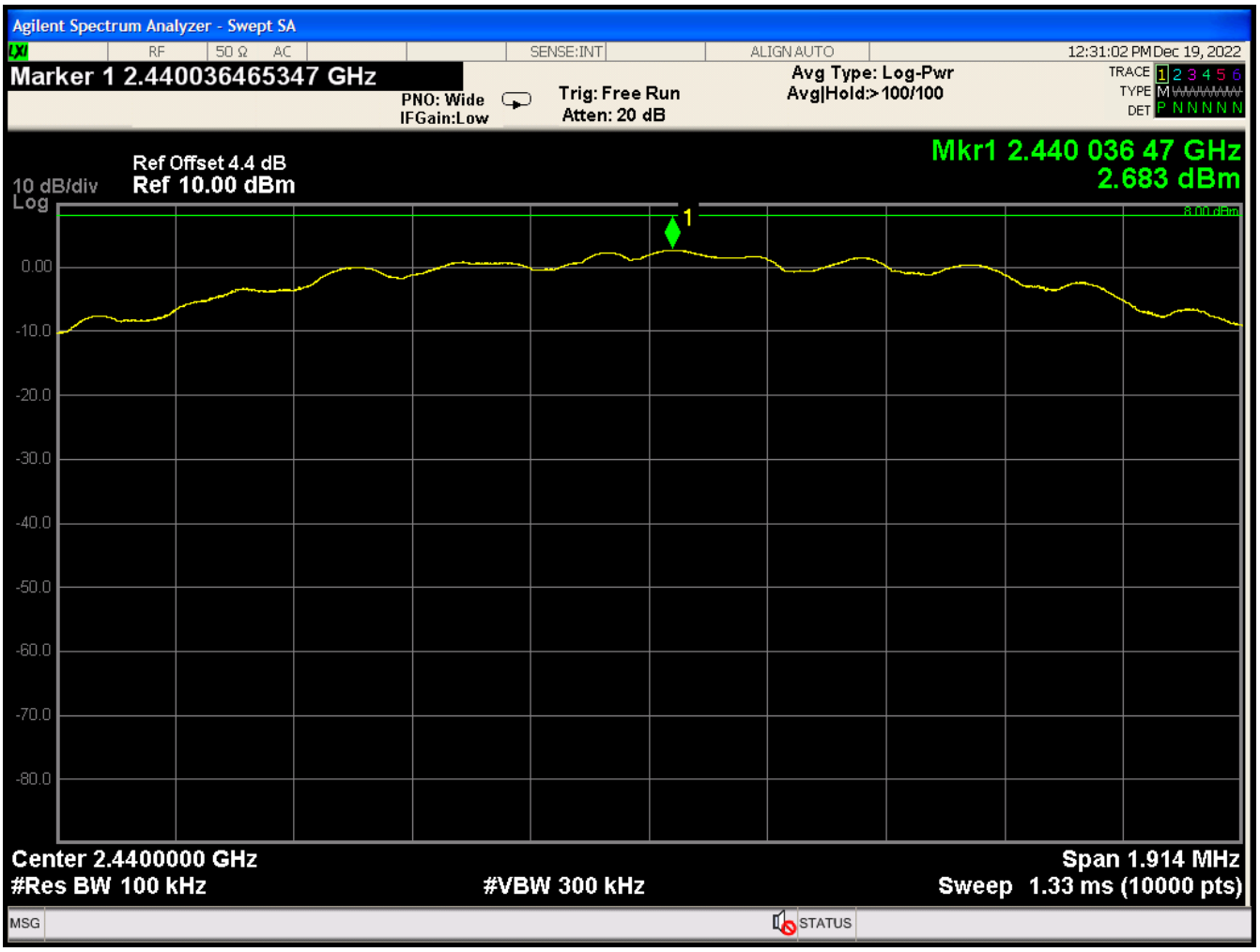
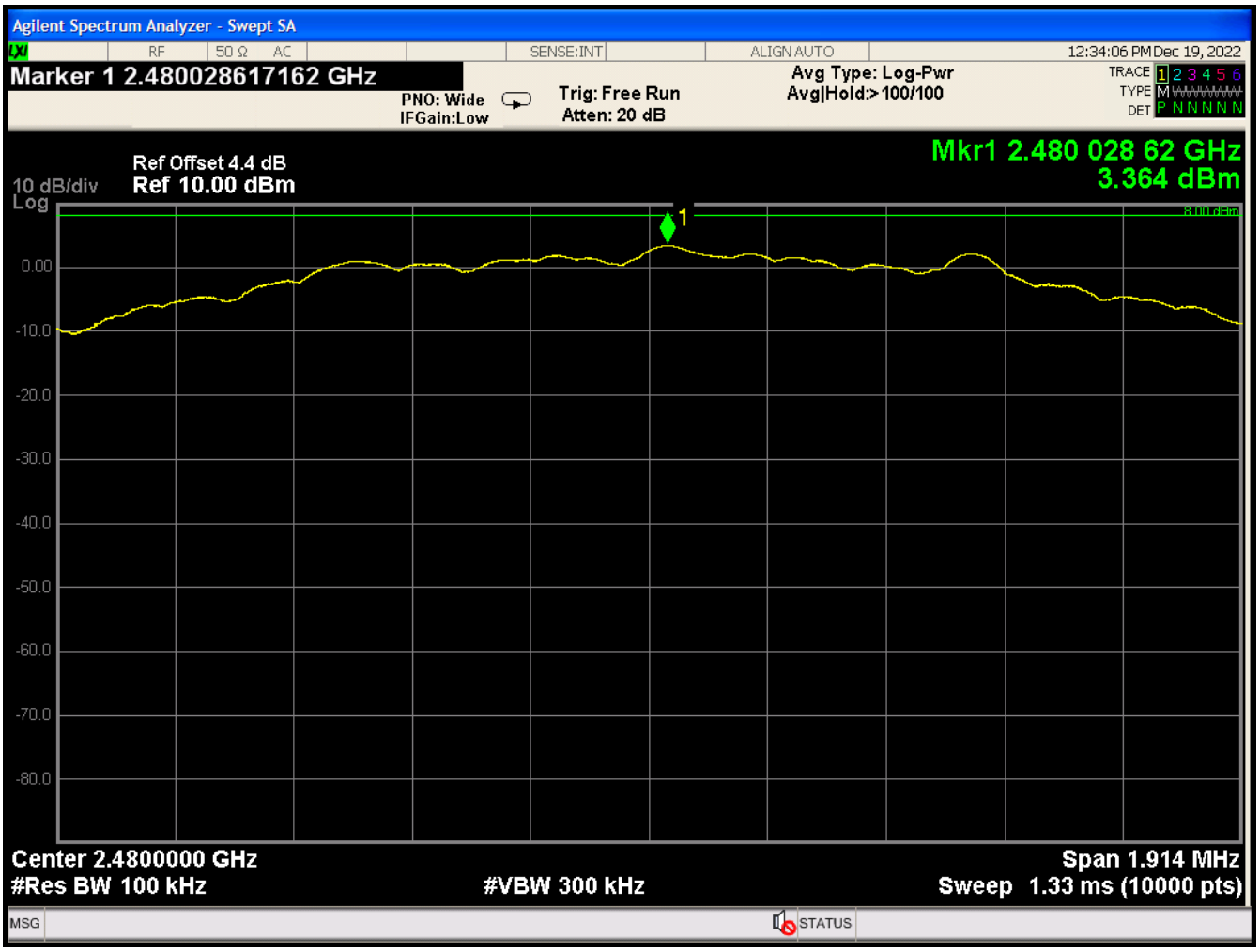


Figure 18: GFSK (2Mbps) – High Channel, Power Spectral Density



2.4 Bandedge Compliance (Antenna Port Conducted)

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.

2.4.1 Measurement Method and Results

Close-up plots of the low cannel, and of the high channel, with respect to the nearest authorized band-edge, are provided below.

The EUT was configured in a GFSK modulated mode for this test. Worst case emissions are reported

Table 5: Bandedge Compliance – Test Results

Modulation	Mode (Data Rate)	Low Channel (2402 MHz)	High Channel (2480 MHz)
GFSK	BLE (1Mbps)	51.369 dB	59.689 dB
GFSK	BLE (2Mbps)	49.967 dB	54.022 dB

Figure 19: GFSK (1Mbps) – Lower Band Edge

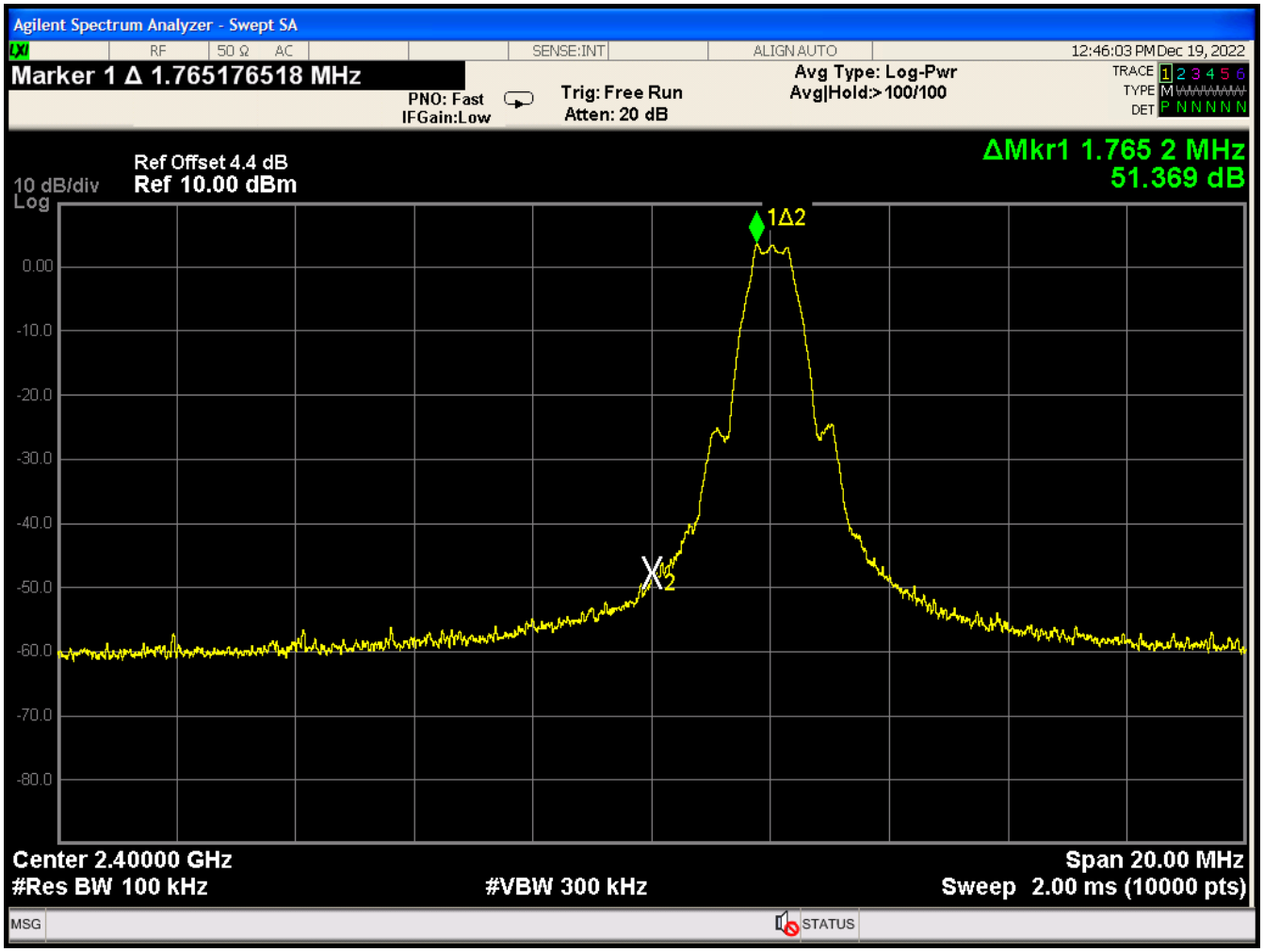


Figure 20: GFSK (1Mbps) – Upper Band Edge

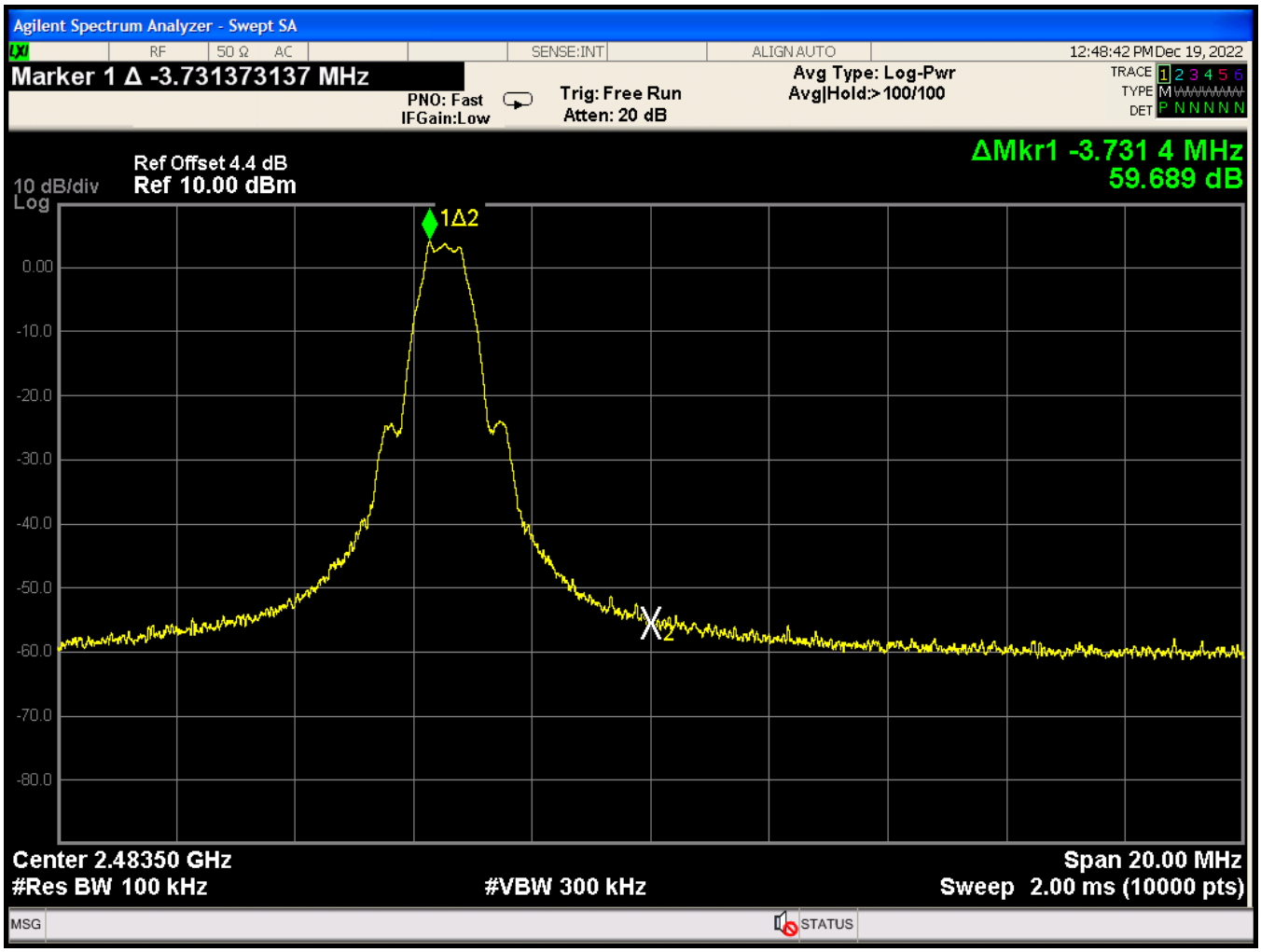


Figure 21: GFSK (2Mbps) – Lower Band Edge

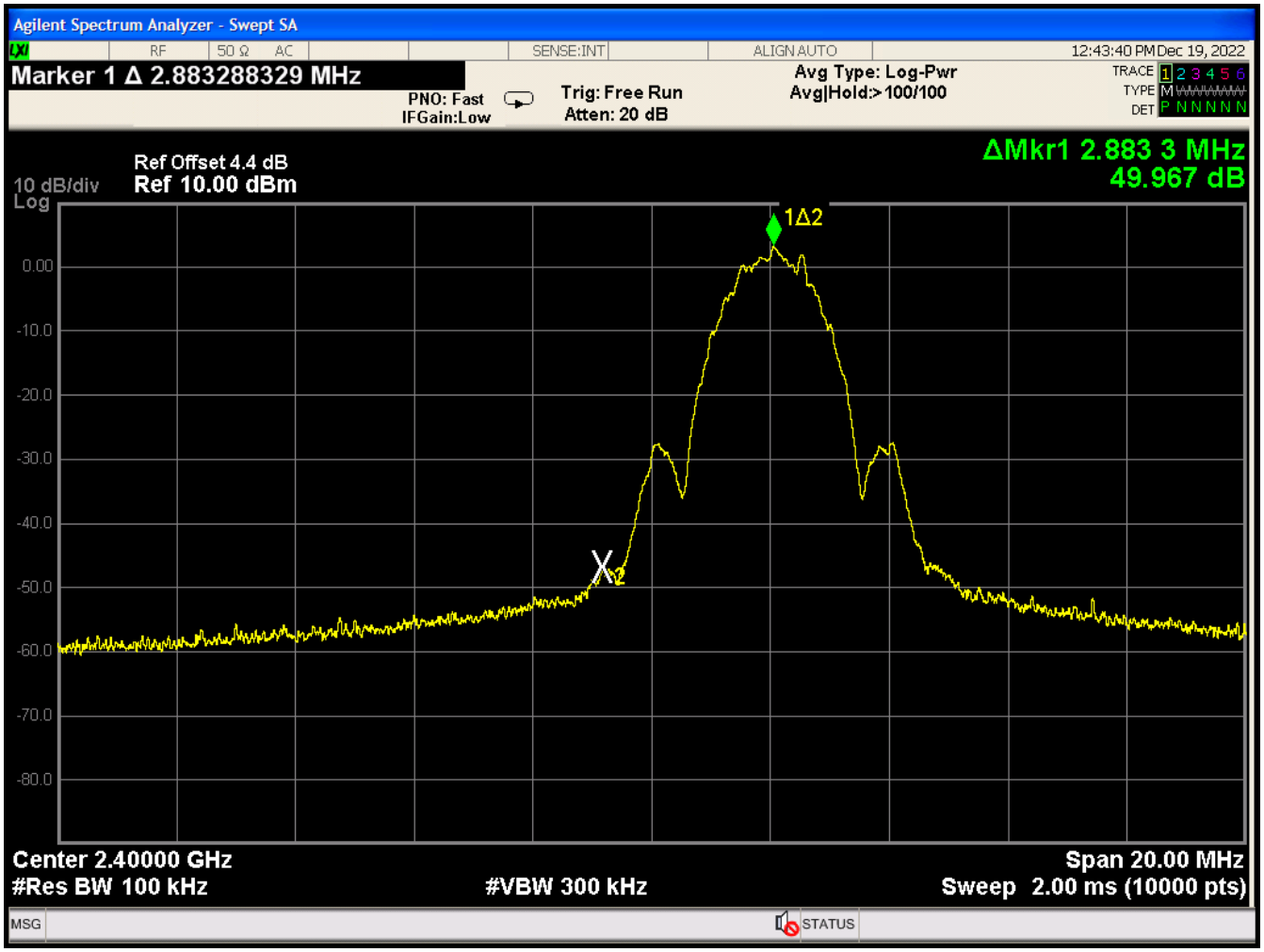
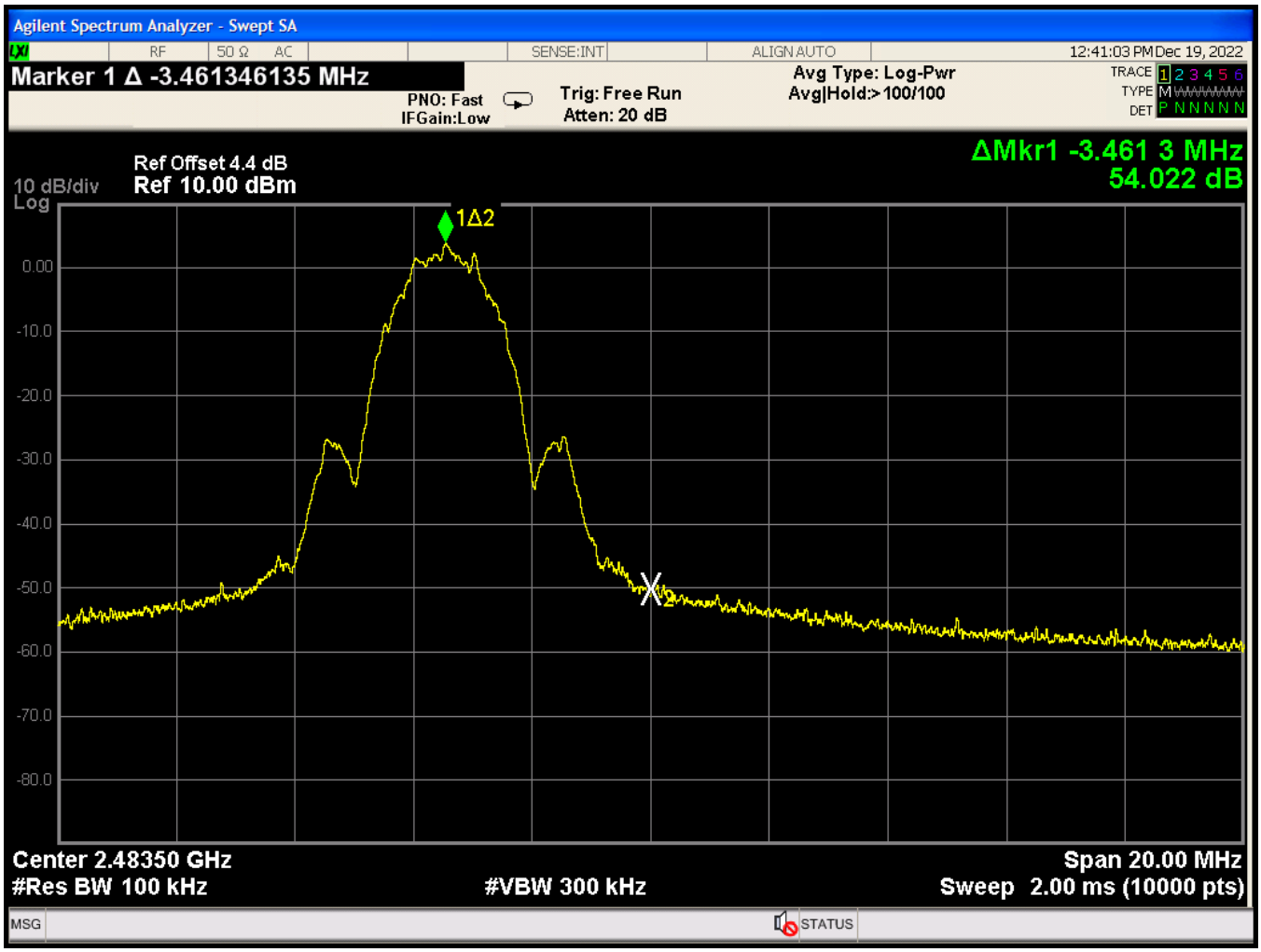


Figure 22: GFSK (2Mbps) – Upper Band Edge



2.5 Conducted 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.

2.5.1 Measurement Method and Results

This test was performed as specified in ANSI C63.10 (2013), Section 11.11.

The EUT was configured in a GFSK modulated mode for this test. Worst case emissions are reported

The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz to 25 GHz, to include the 10th harmonic of the fundamental.

The reduced testing procedures outlined in ANSI C63.10 (2013), Section 5.6.2 and 5.6.2.2 were also employed. The spurious emission test data correlating to the center channel of all three modulation modes is provided below. The worst-case mode (2Mbps) was utilized to provide the spurious emission test data for the low and high channels.

The EUT complies with the requirements for spurious emissions at the antenna port.

The final test data is provided in the following plots.

Figure 23: GFSK (1Mbps) Center Channel, Conducted Spurious – Plot 1

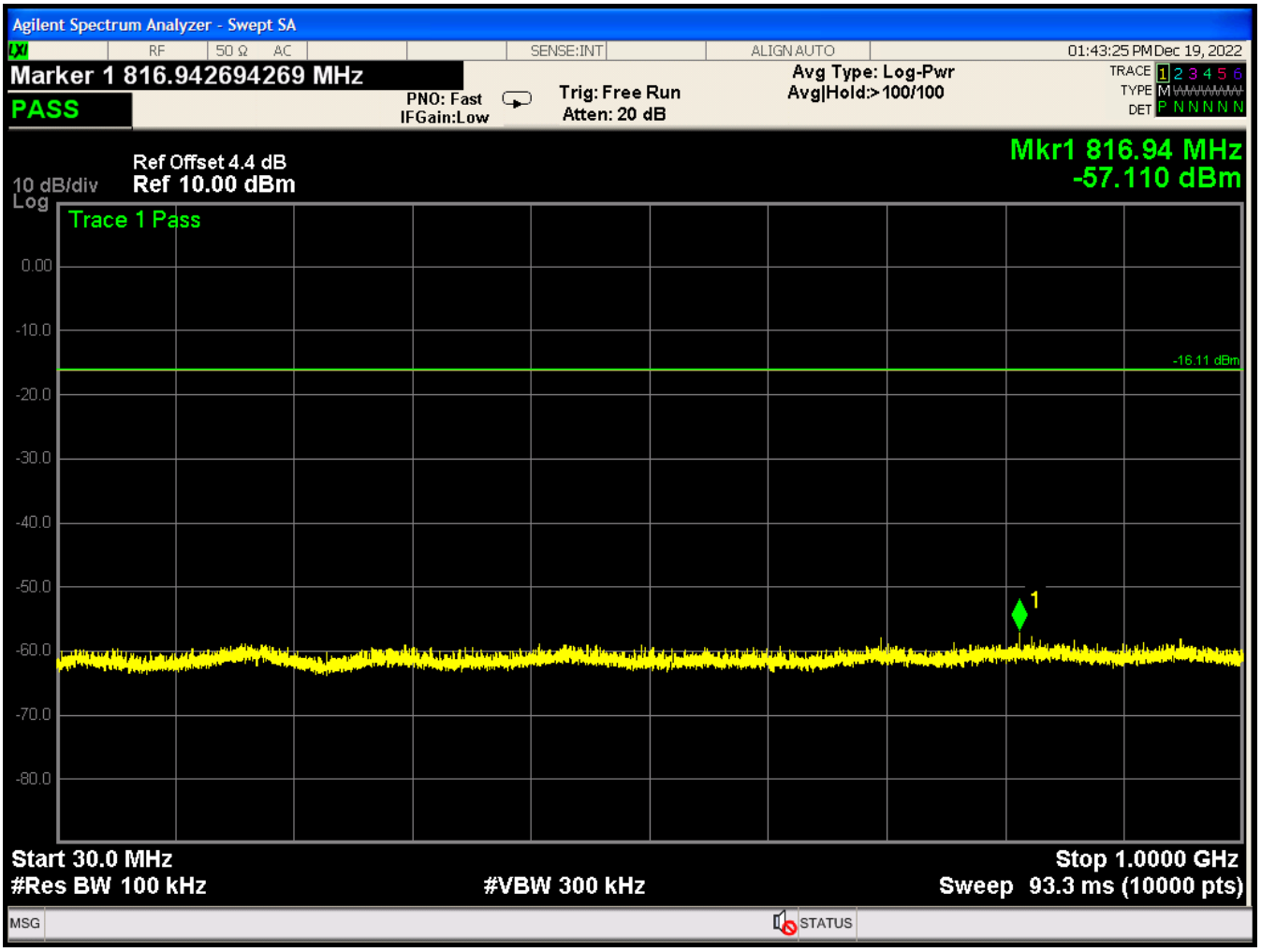


Figure 24: GFSK (1Mbps) Center Channel, Conducted Spurious – Plot 2

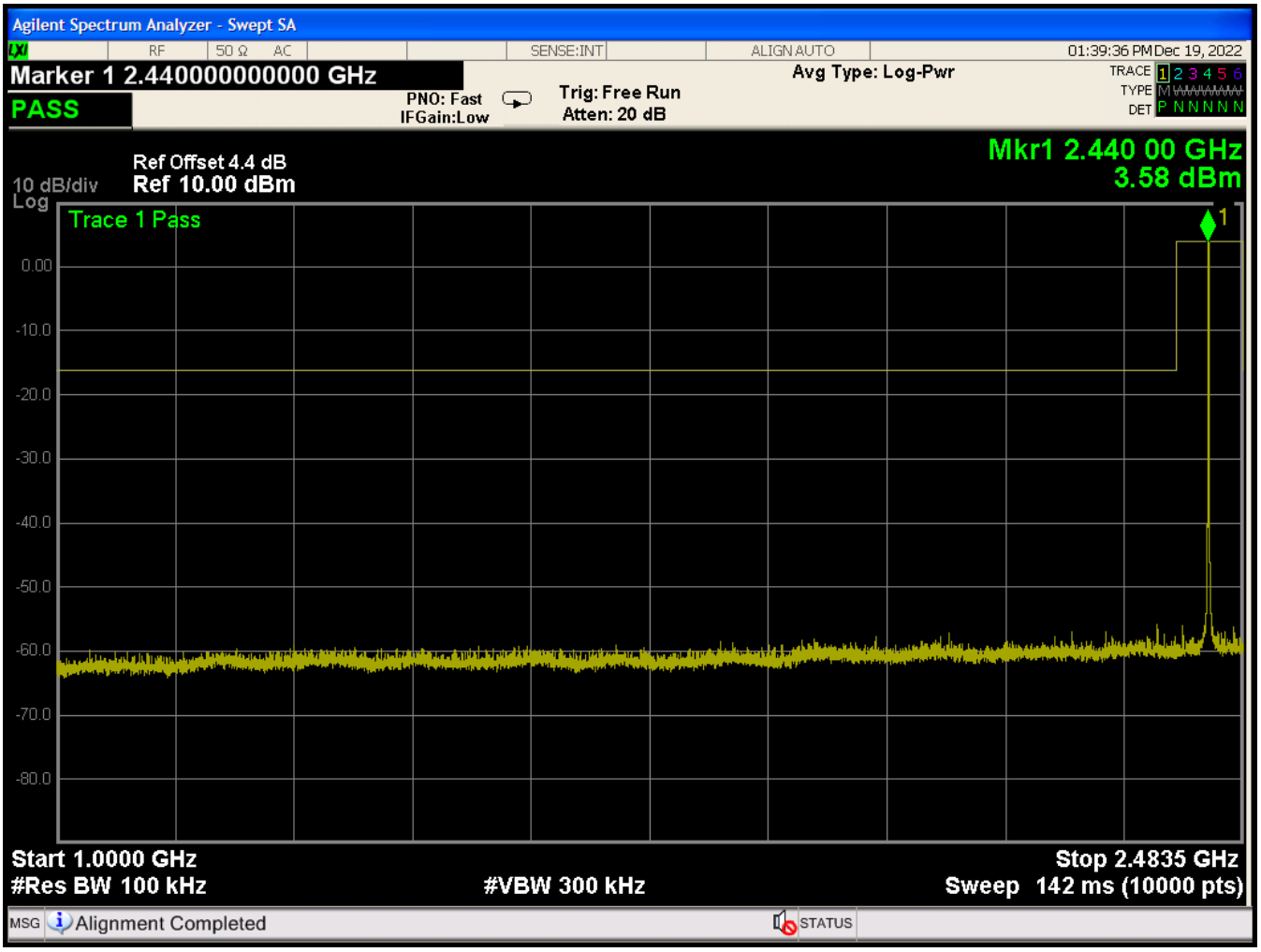


Figure 25: GFSK (1Mbps) Center Channel, Conducted Spurious – Plot 3

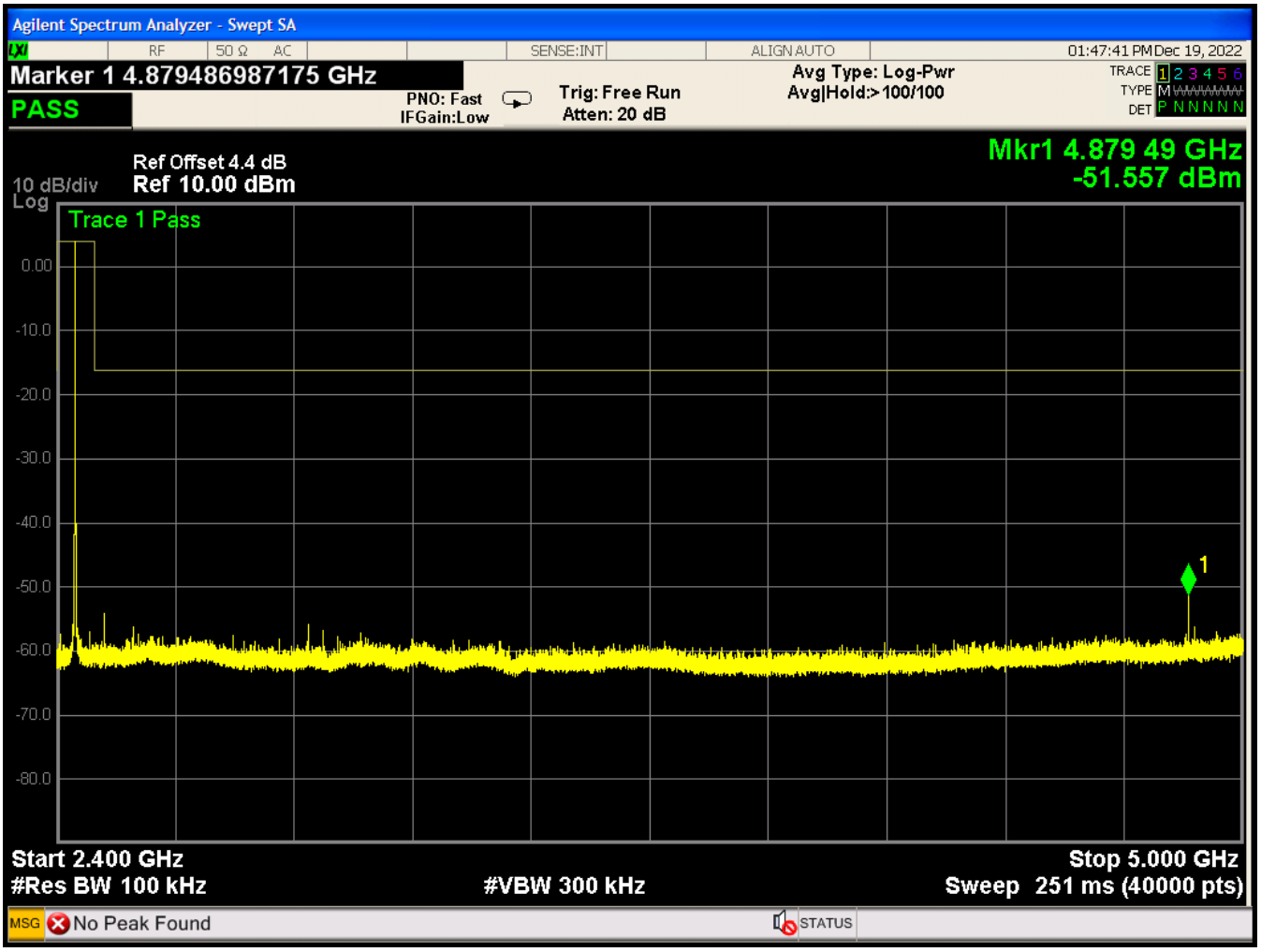


Figure 26: GFSK (1Mbps) Center Channel, Conducted Spurious – Plot 4

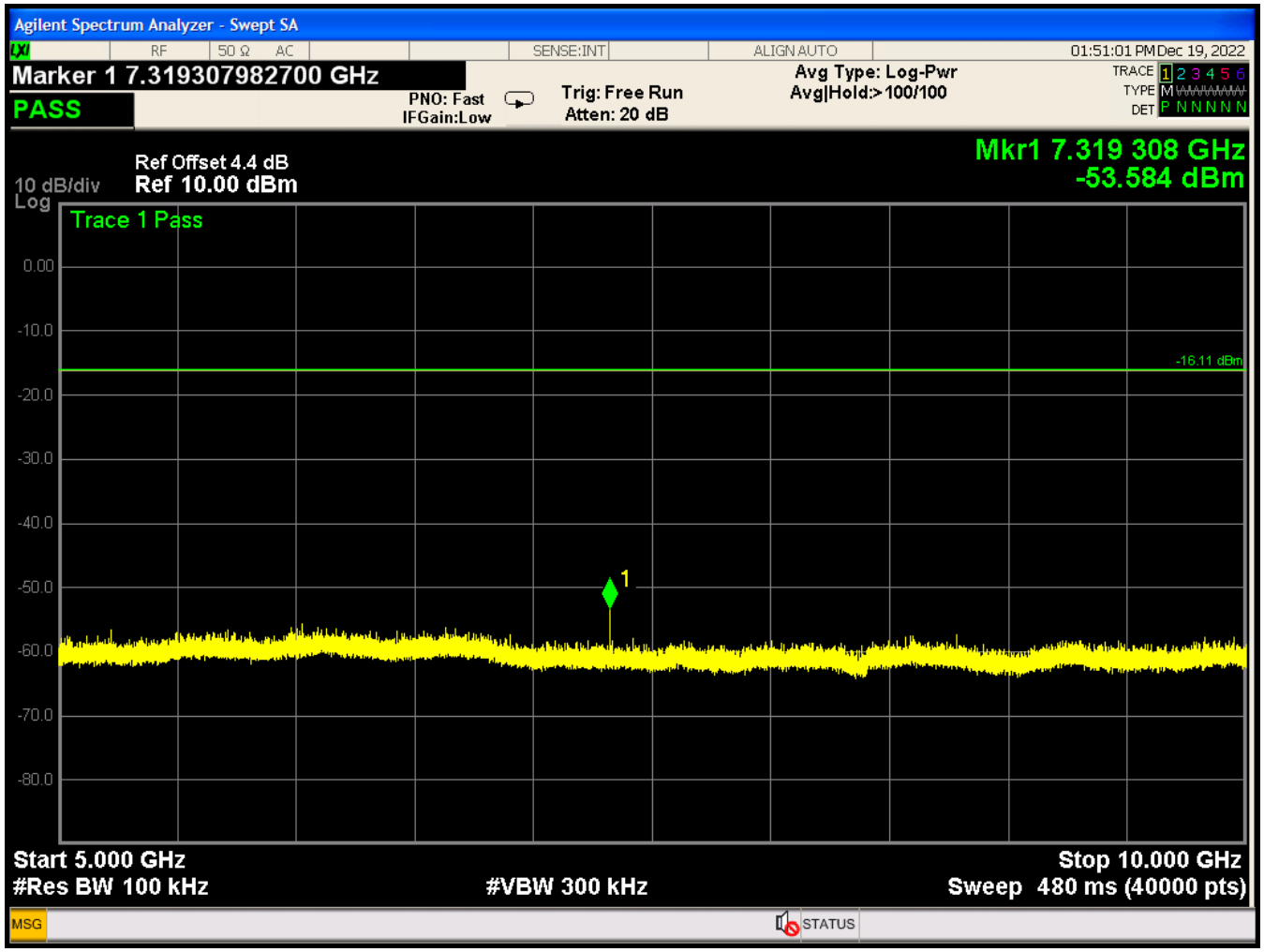


Figure 27: GFSK (1Mbps) Center Channel, Conducted Spurious – Plot 5

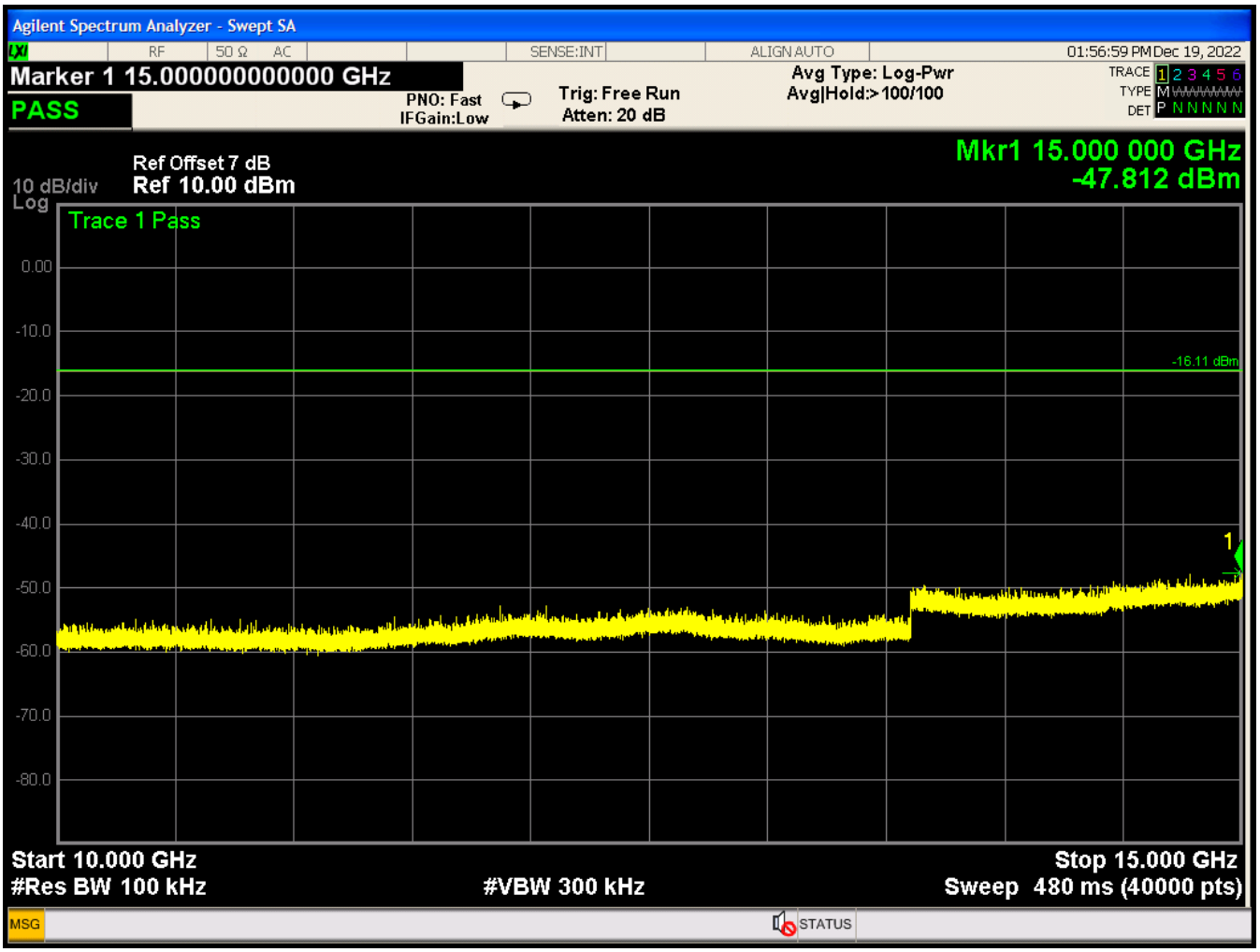


Figure 28: GFSK (1Mbps) Center Channel, Conducted Spurious – Plot 6

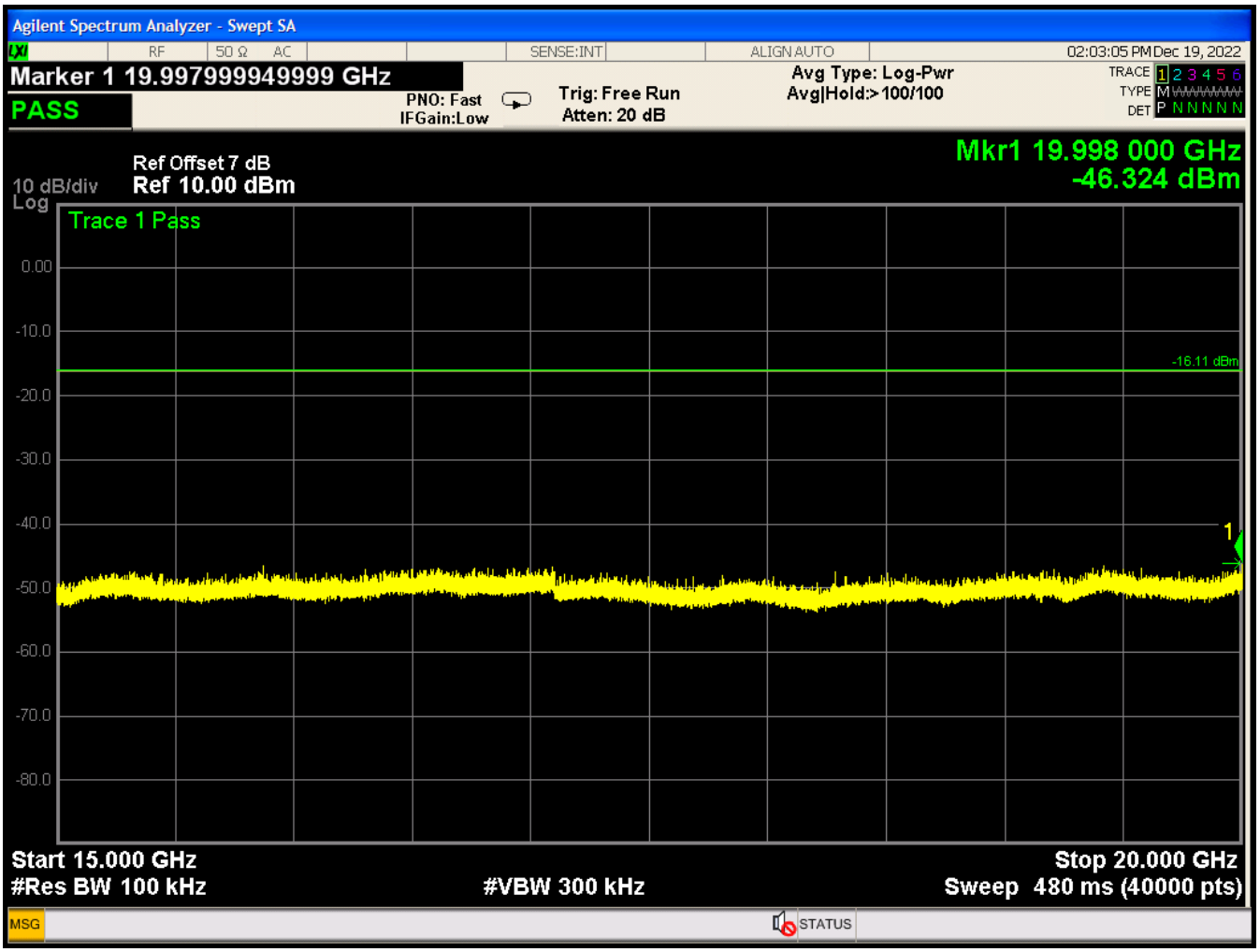


Figure 29: GFSK (1Mbps) Center Channel, Conducted Spurious – Plot 7

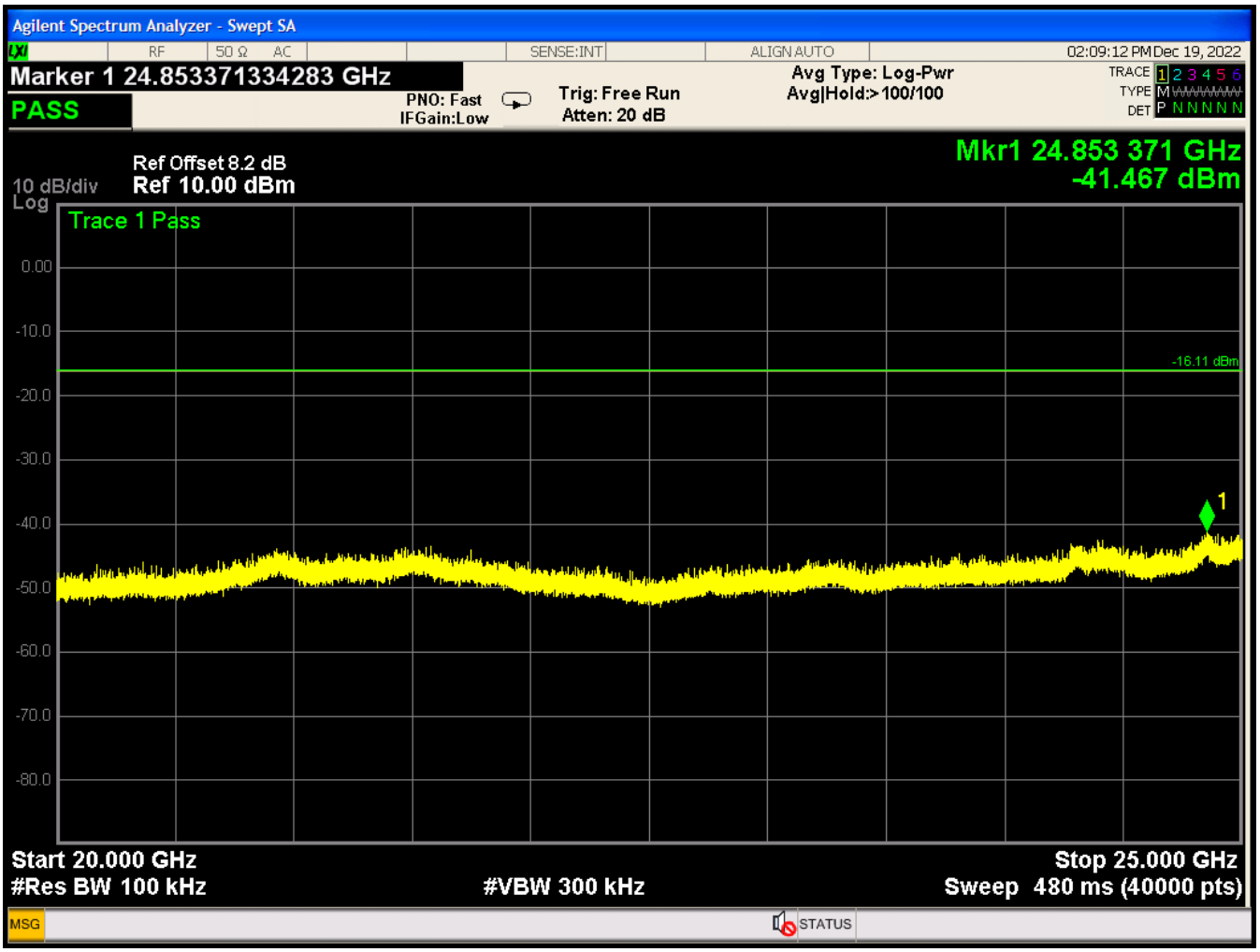


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Figure 30: GFSK (2Mbps) Low Channel, Conducted Spurious – Plot 1

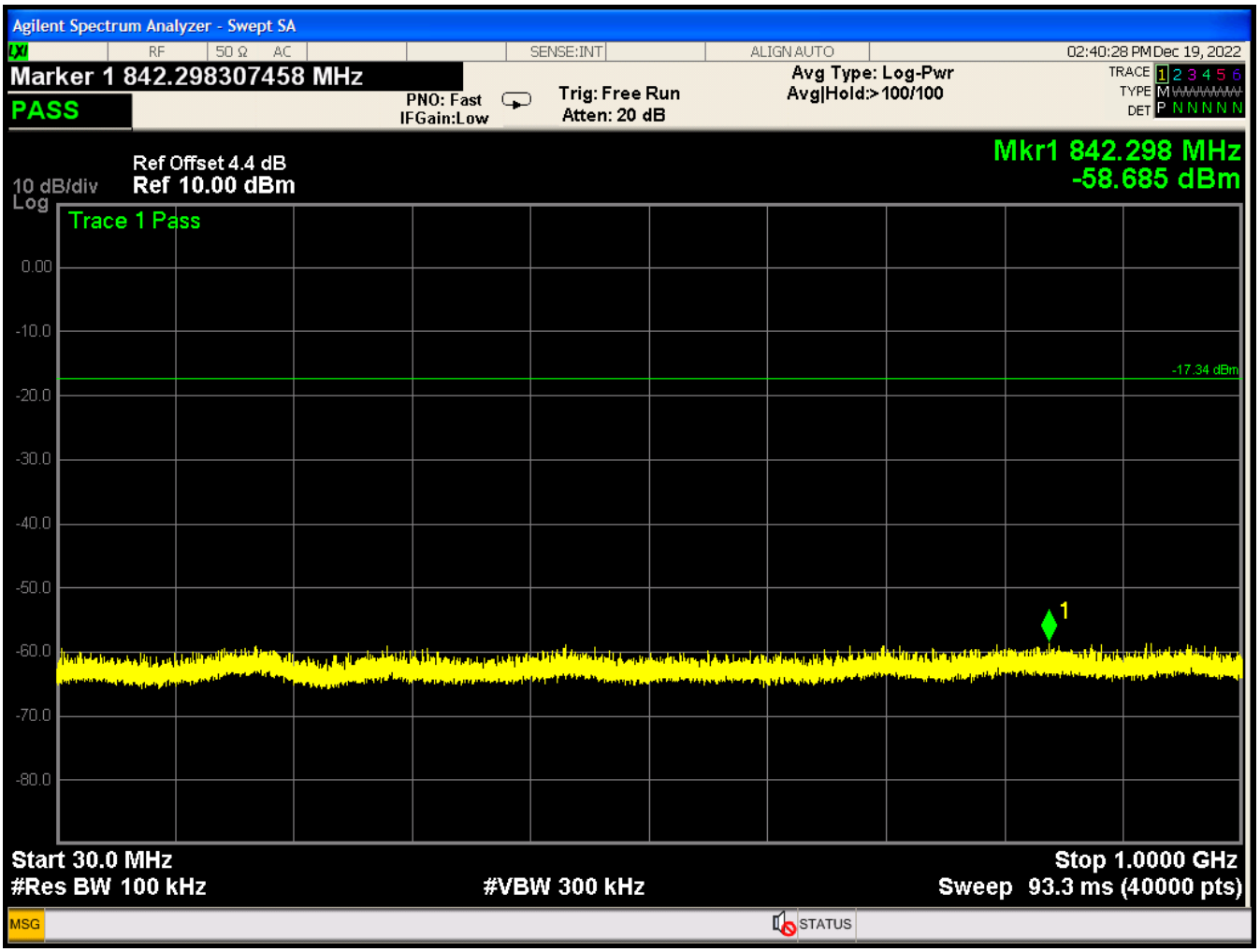


Figure 31 GFSK (2Mbps) Low Channel, Conducted Spurious – Plot 2

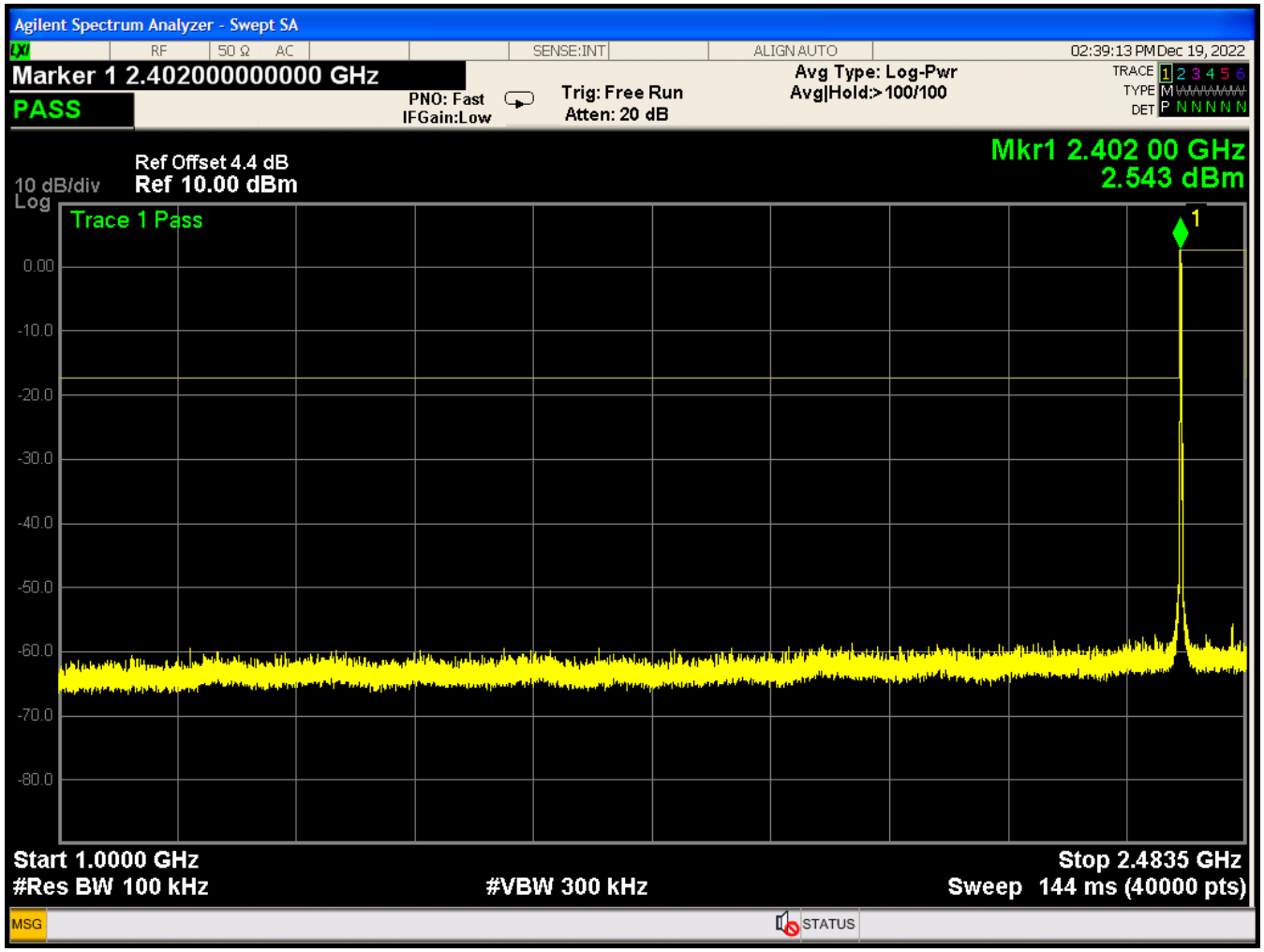


Figure 32: GFSK (2Mbps) Low Channel, Conducted Spurious – Plot 3

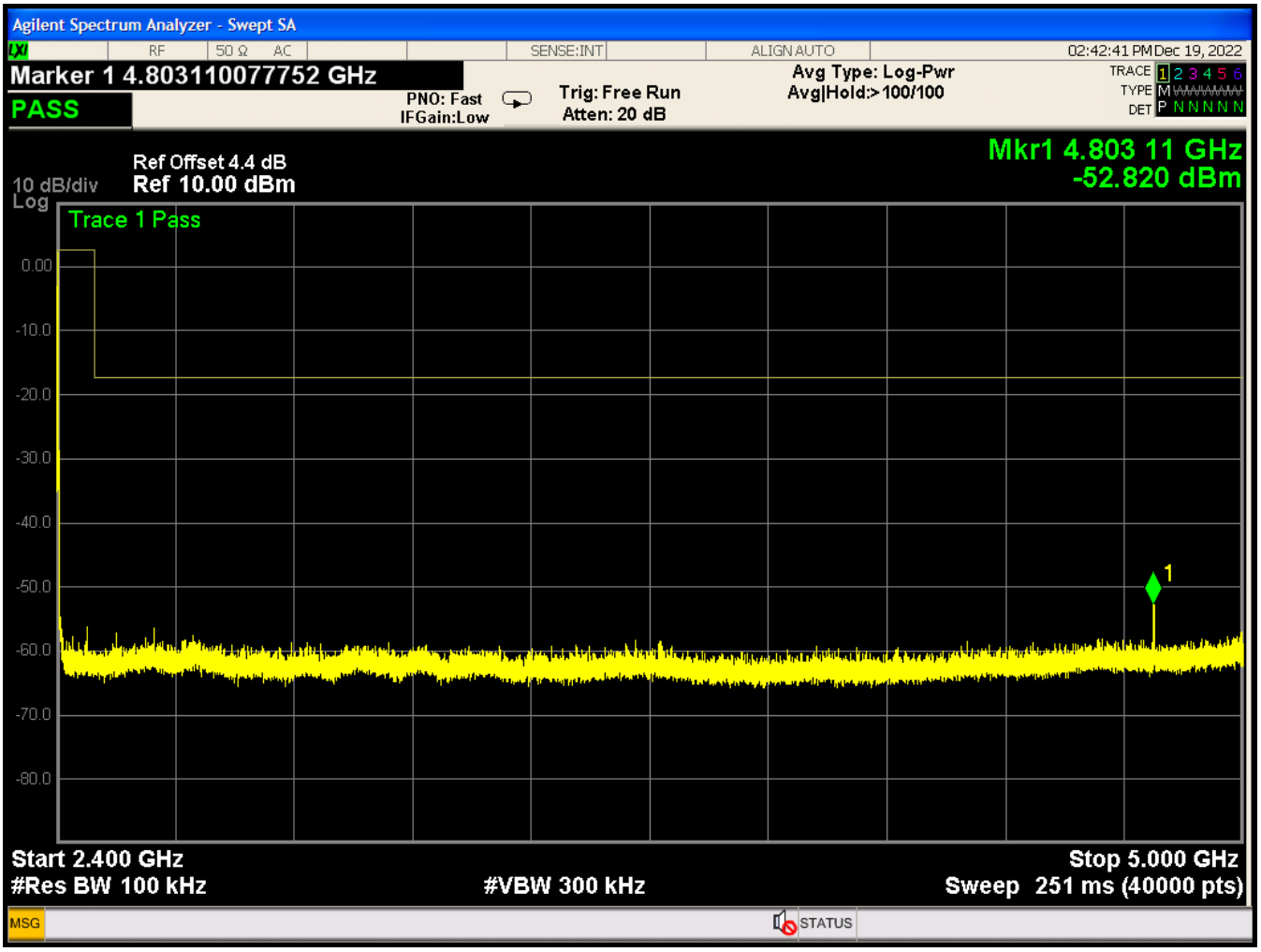


Figure 33: GFSK (2Mbps) Low Channel, Conducted Spurious – Plot 4

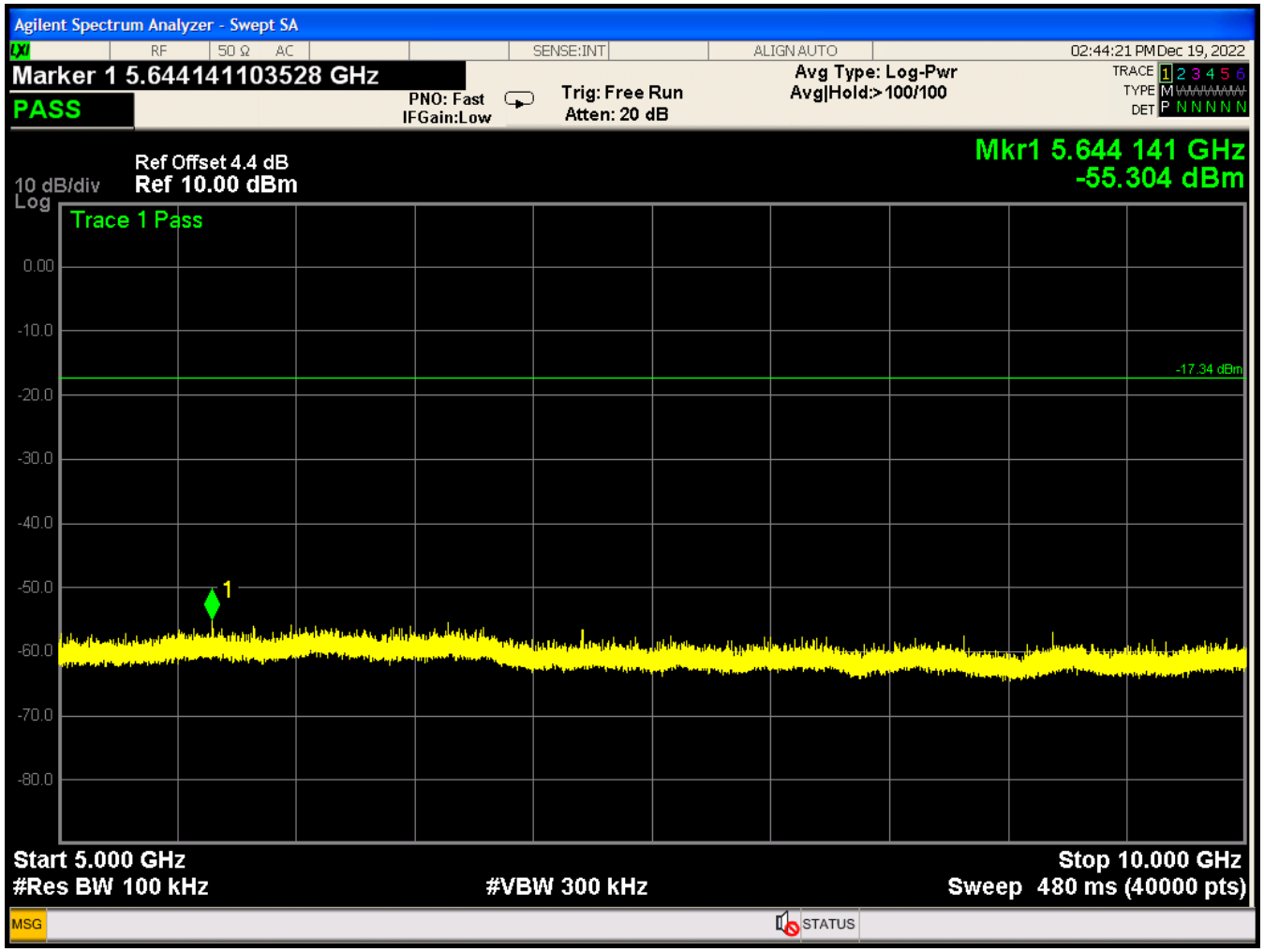


Figure 34: GFSK (2Mbps) Low Channel, Conducted Spurious – Plot 5

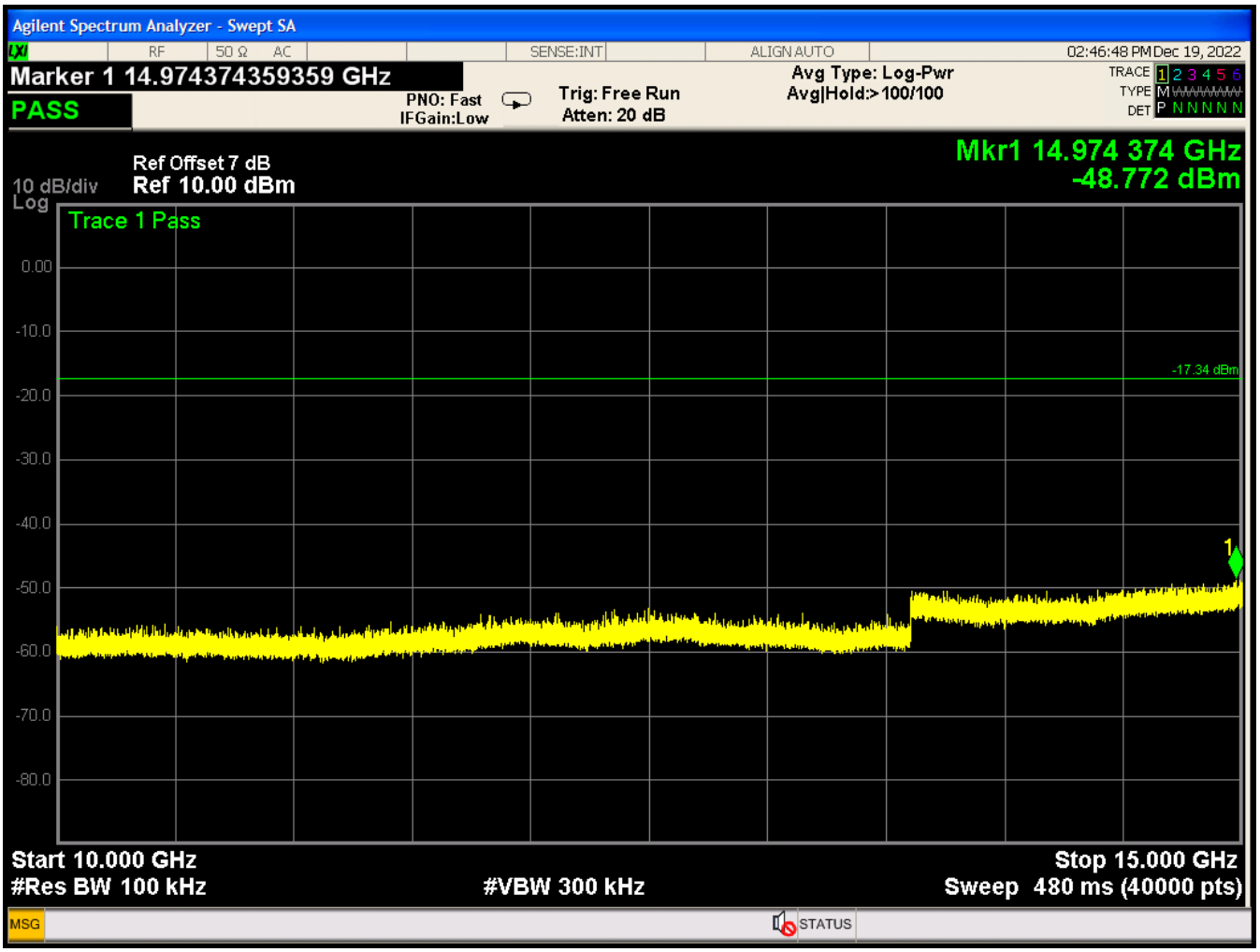


Figure 35: GFSK (2Mbps) Low Channel, Conducted Spurious – Plot 6

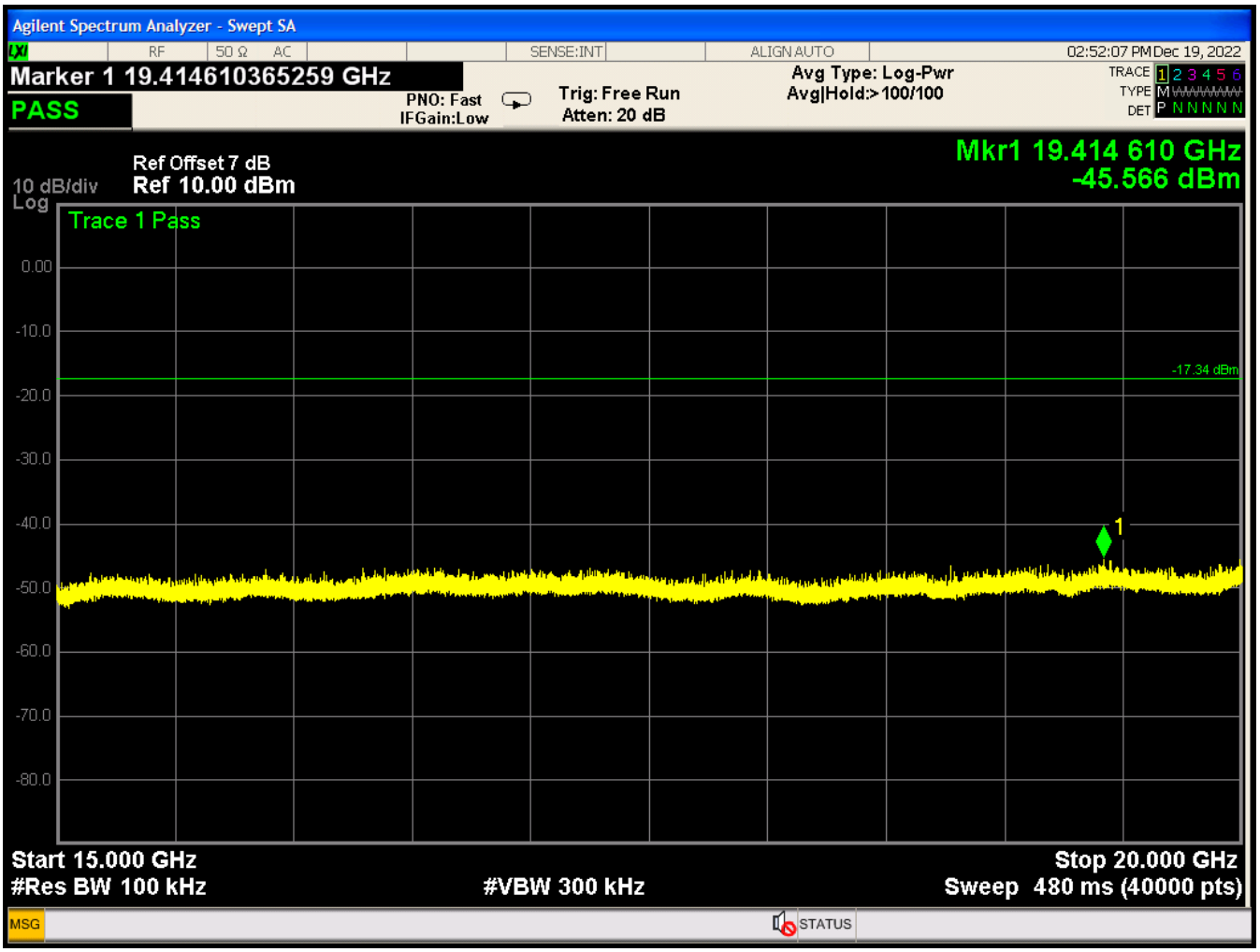


Figure 36: GFSK (2Mbps) Low Channel, Conducted Spurious – Plot 7

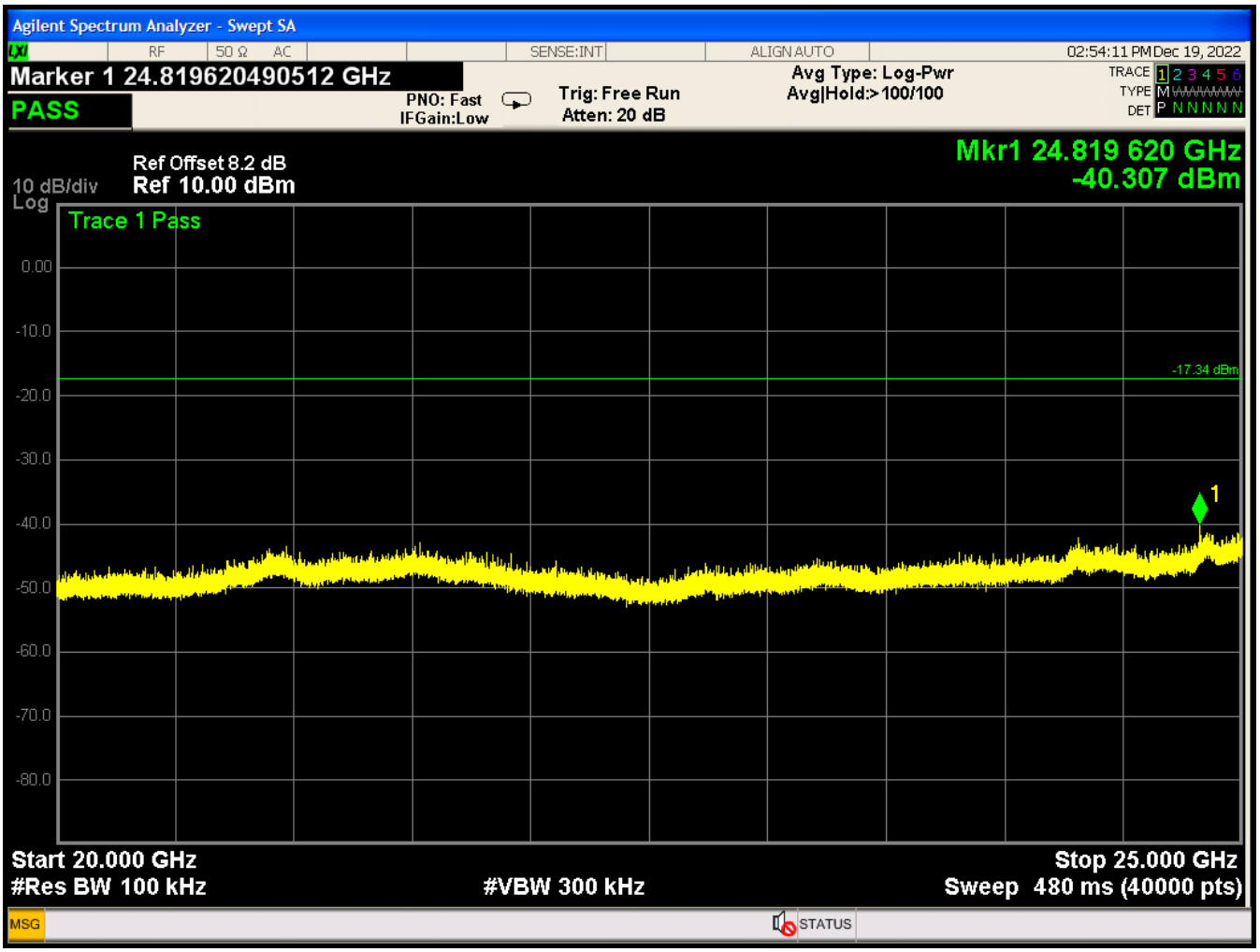


Figure 37: GFSK (2Mbps) Center Channel, Conducted Spurious – Plot 1

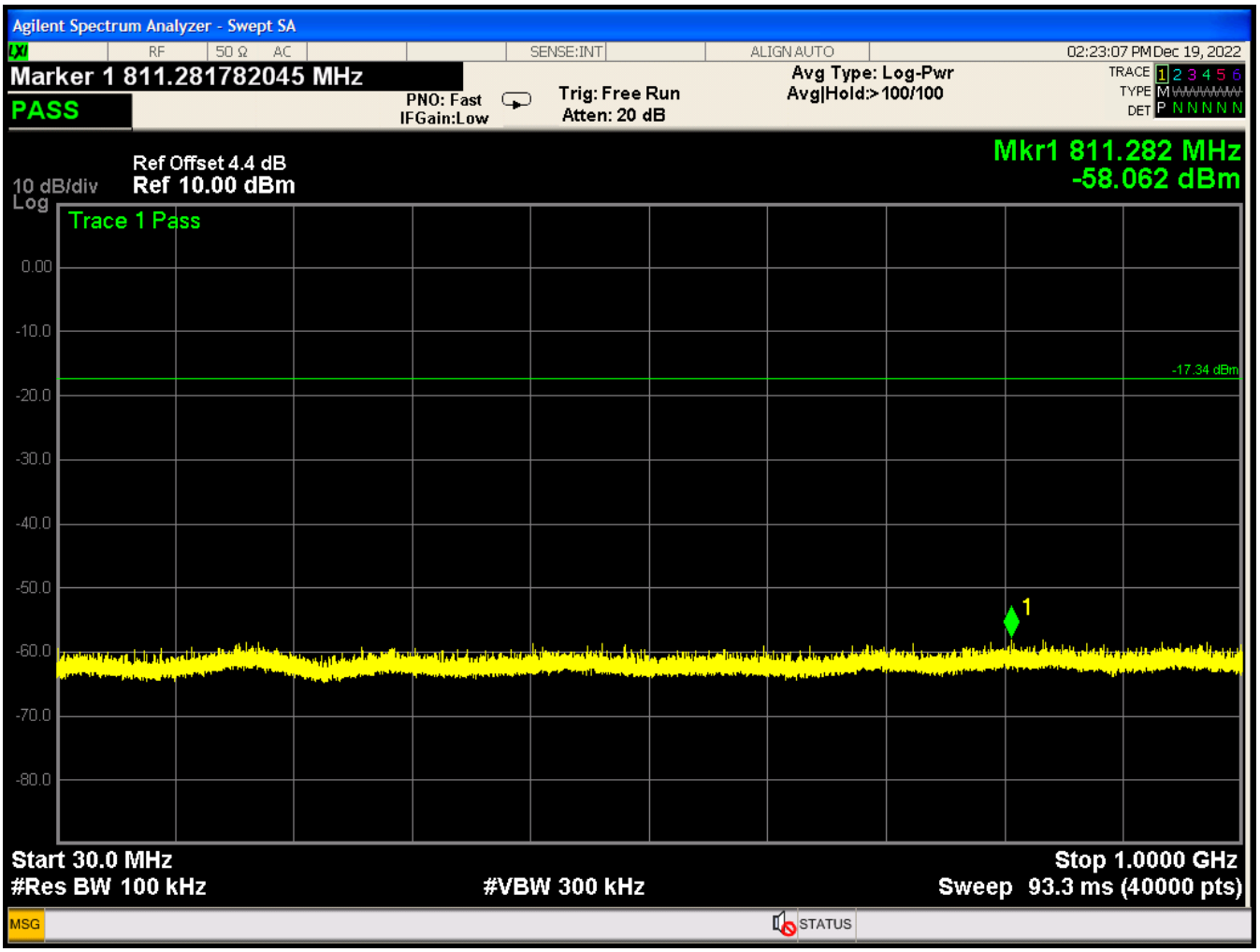


Figure 38: : GFSK (2Mbps) Center Channel, Conducted Spurious – Plot 2

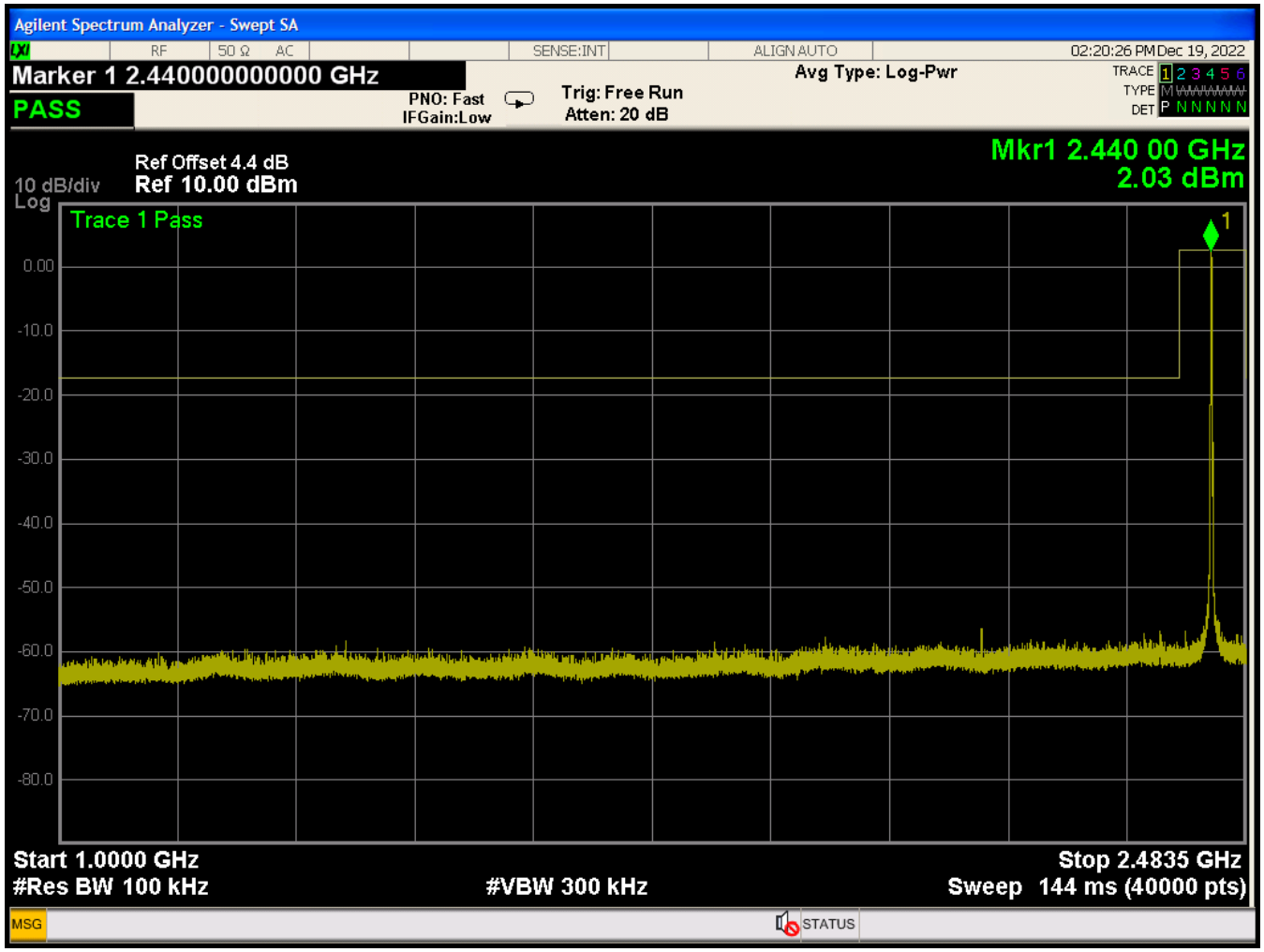


Figure 39: : GFSK (2Mbps) Center Channel, Conducted Spurious – Plot 3

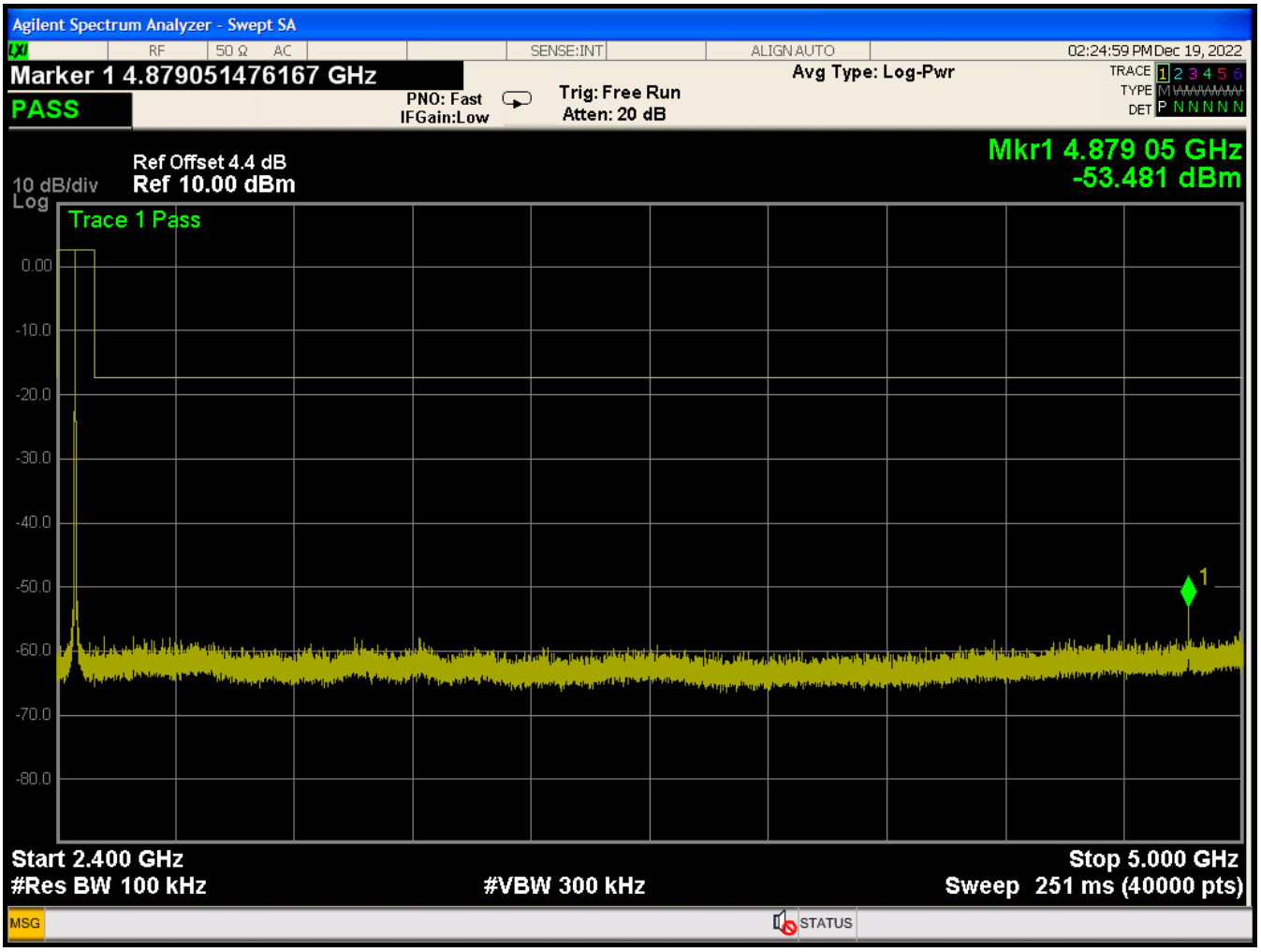


Figure 40: : GFSK (2Mbps) Center Channel, Conducted Spurious – Plot 4

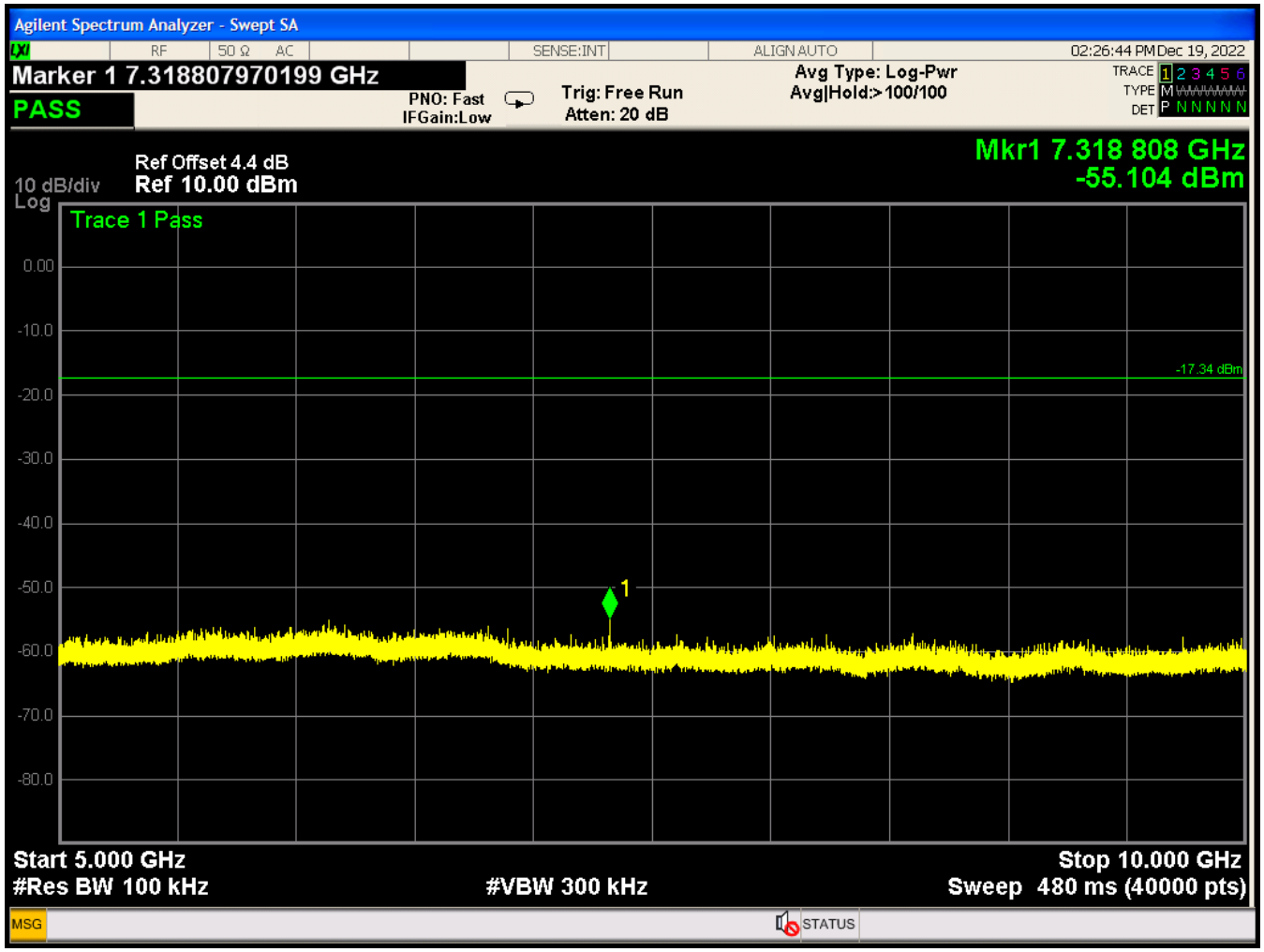


Figure 41: : GFSK (2Mbps) Center Channel, Conducted Spurious – Plot 5

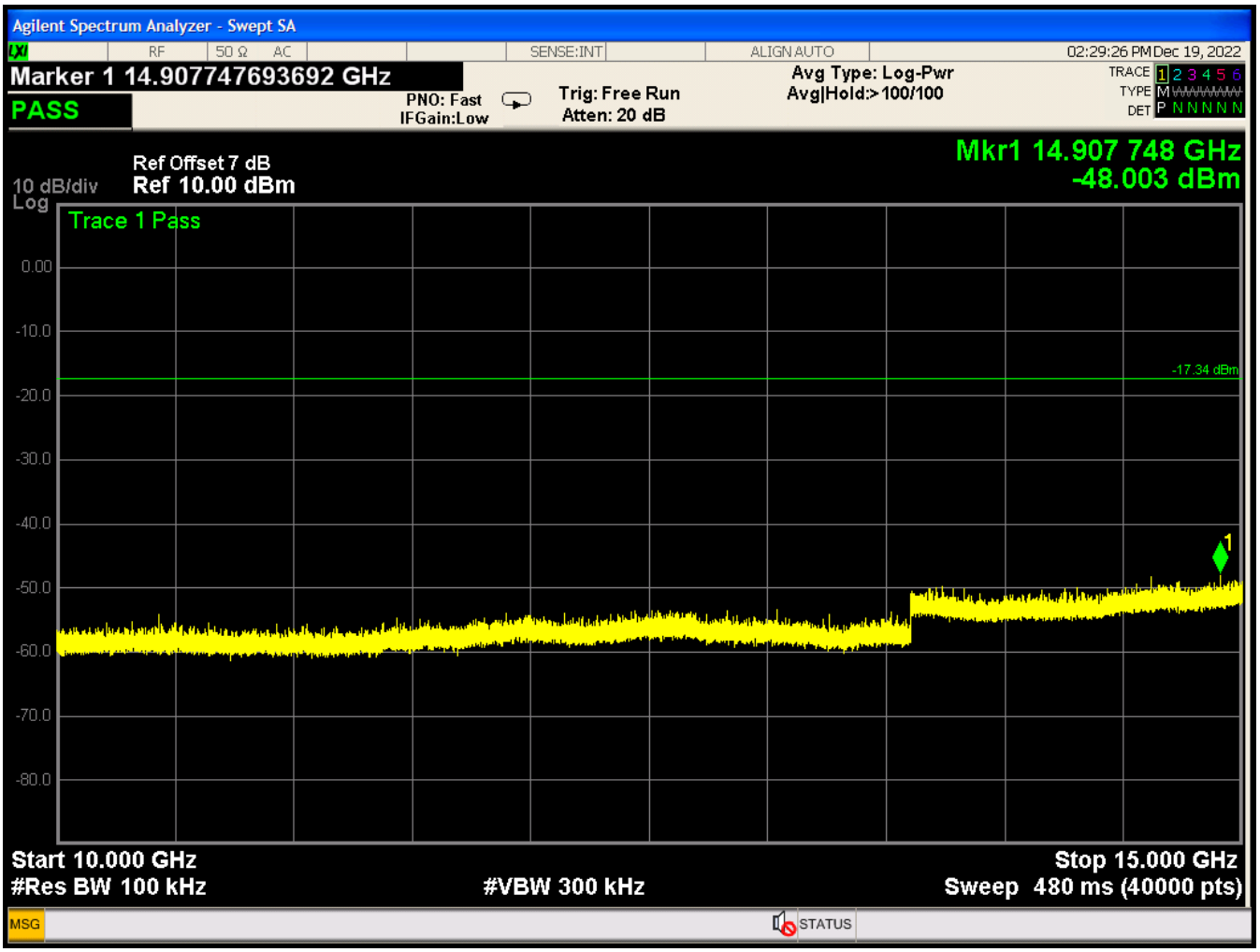


Figure 42: : GFSK (2Mbps) Center Channel, Conducted Spurious – Plot 6

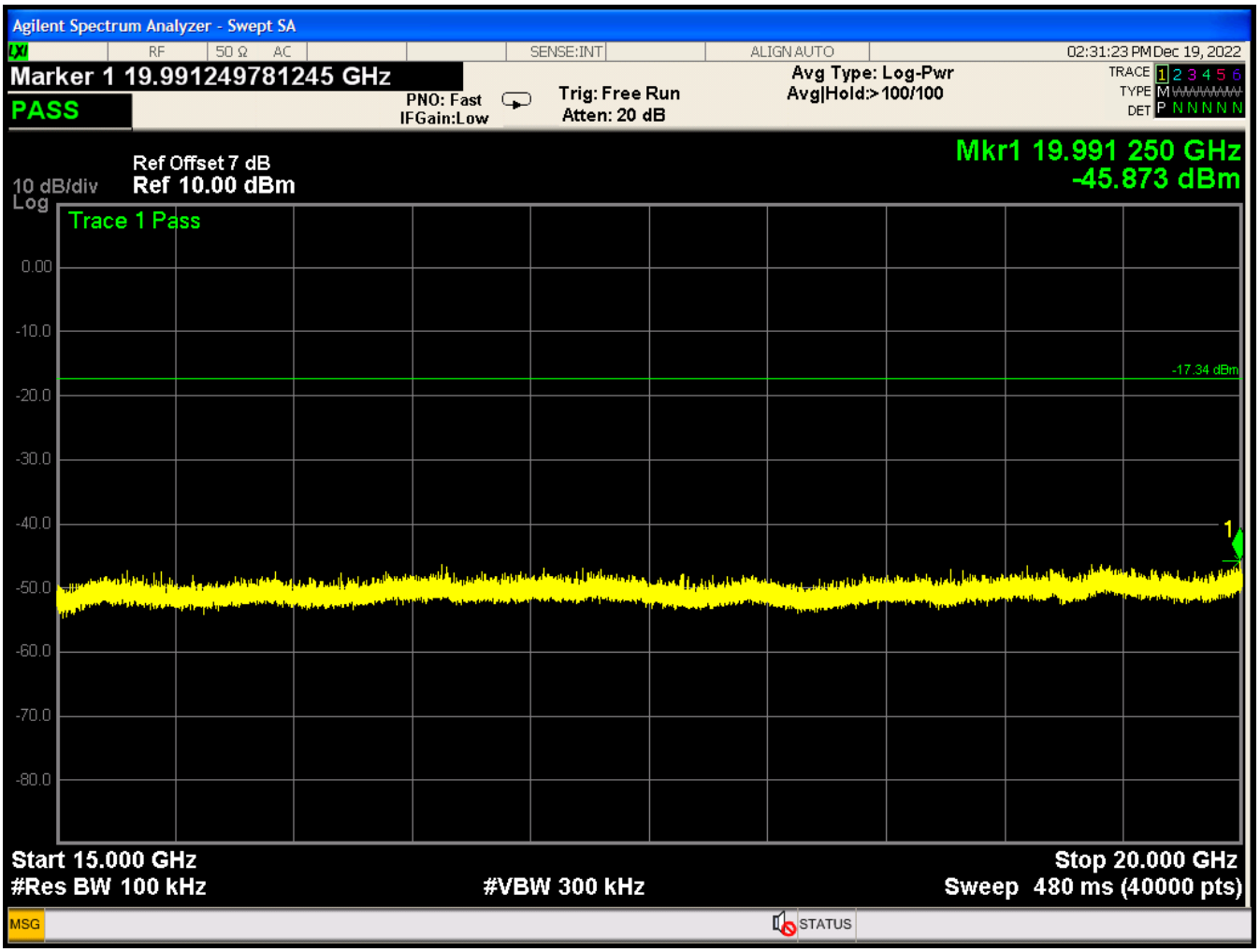


Figure 43: GFSK (2Mbps) Center Channel, Conducted Spurious – Plot 7

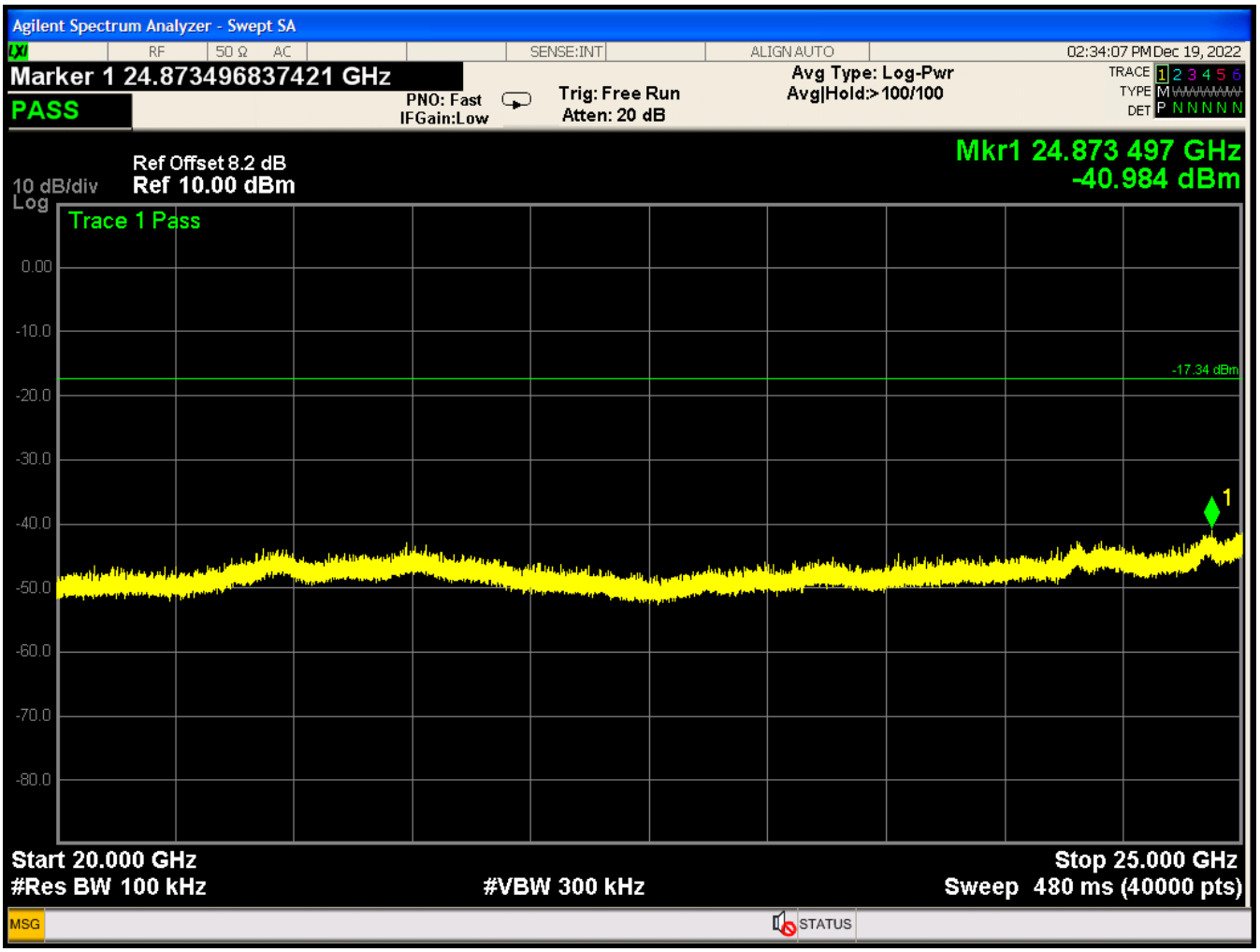


Figure 44: GFSK (2Mbps) High Channel, Conducted Spurious – Plot 1

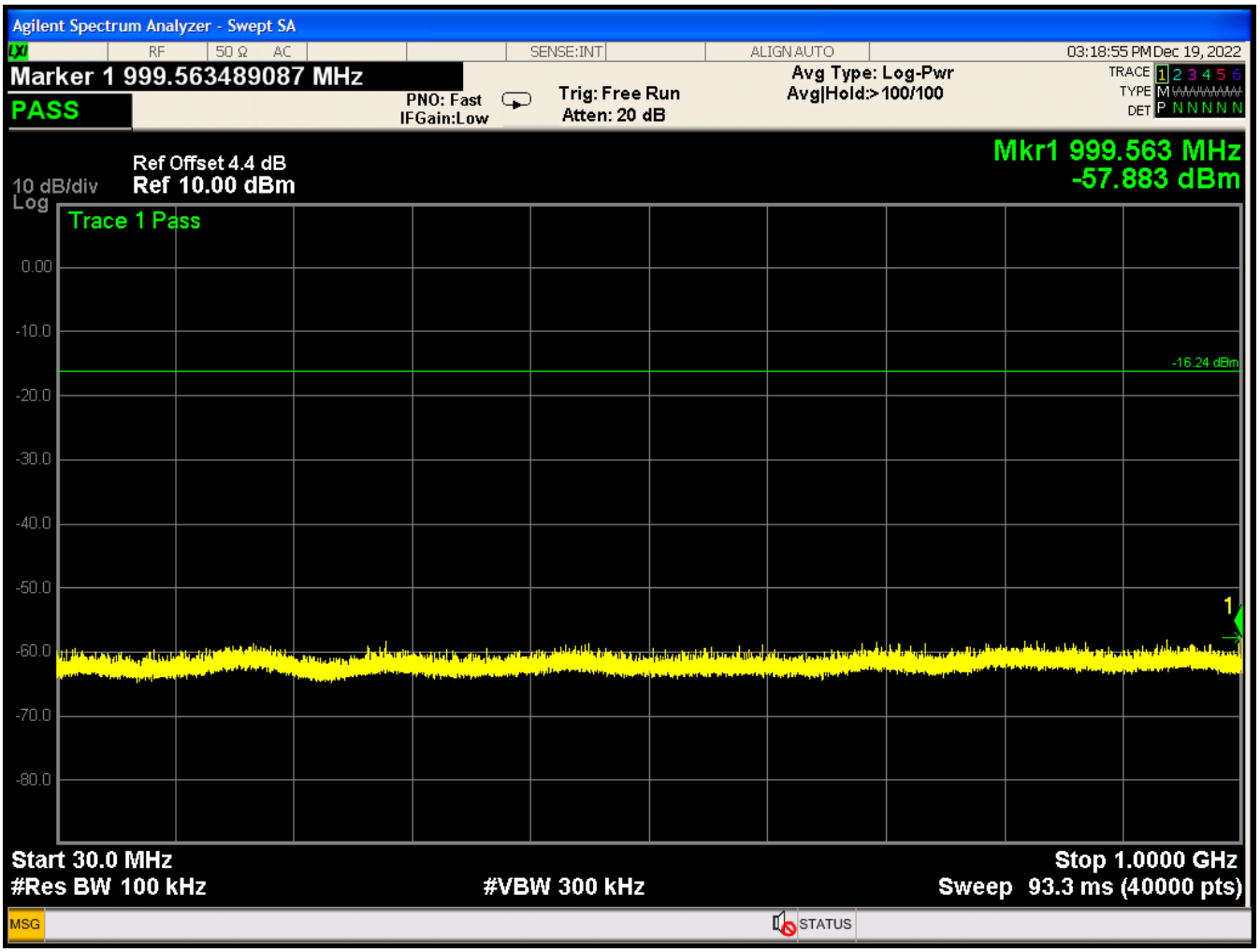


Figure 45: GFSK (2Mbps) High Channel, Conducted Spurious – Plot 2

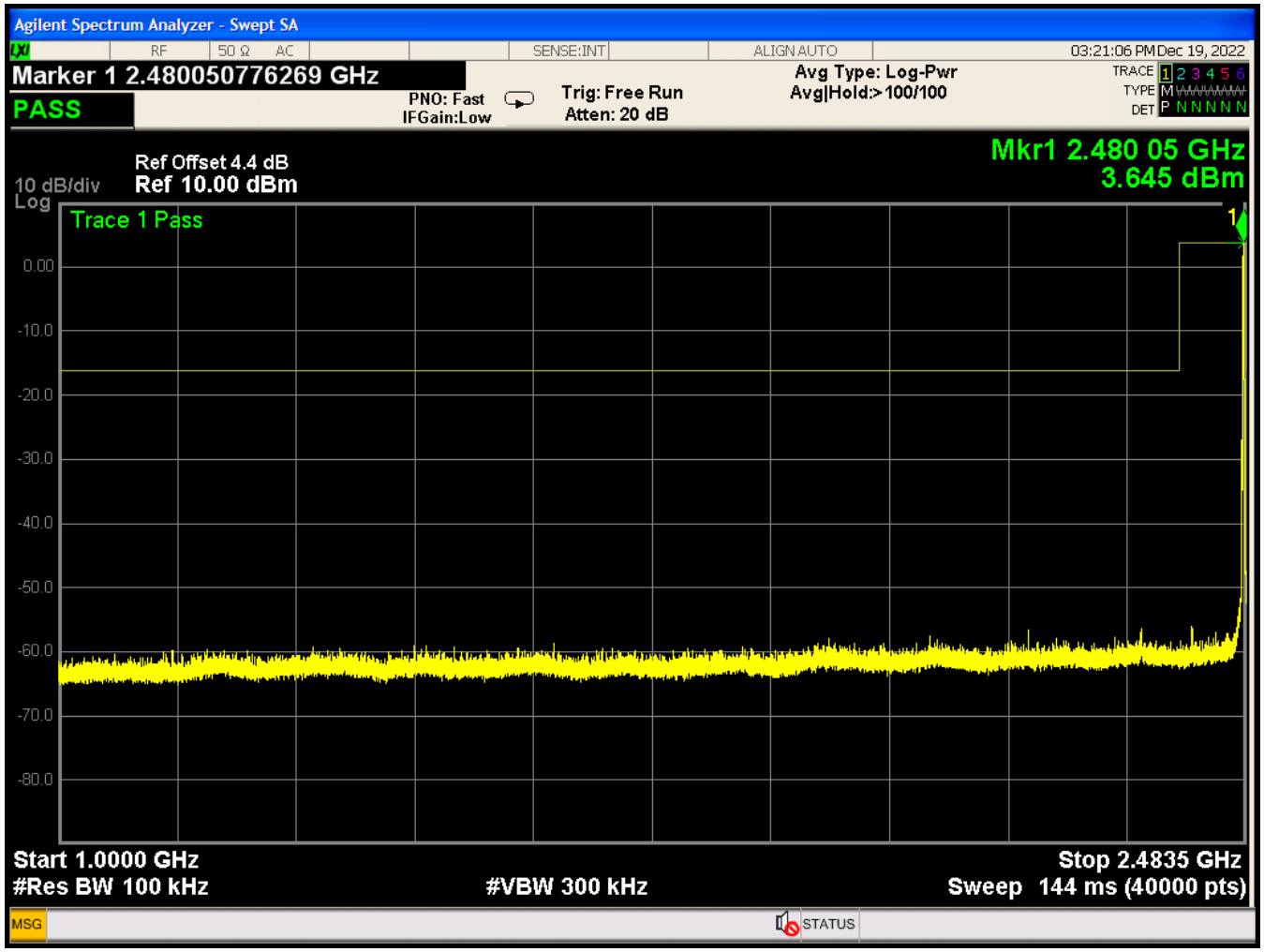


Figure 46: GFSK (2Mbps) High Channel, Conducted Spurious – Plot 3

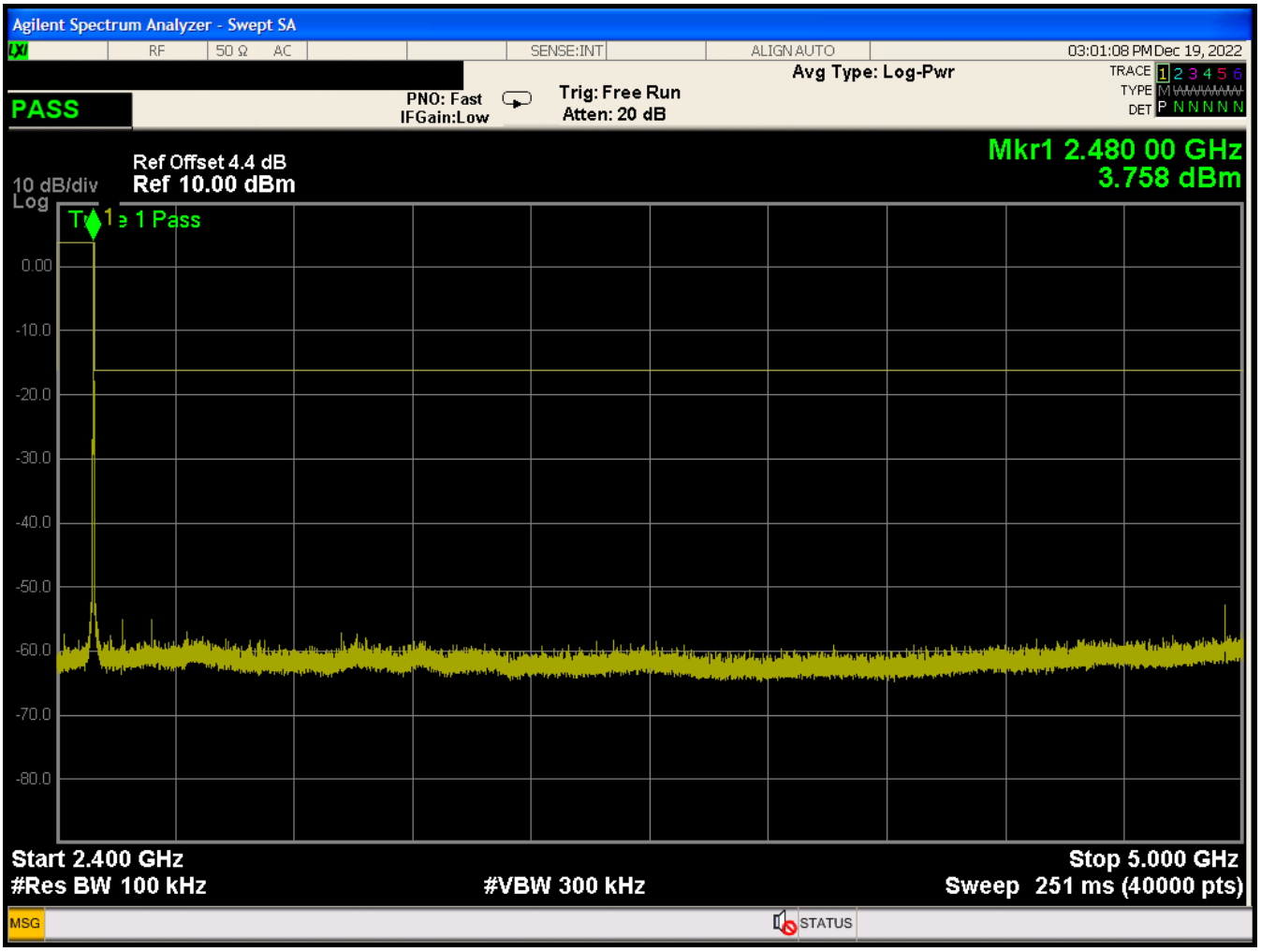


Figure 47: GFSK (2Mbps) High Channel, Conducted Spurious – Plot 4

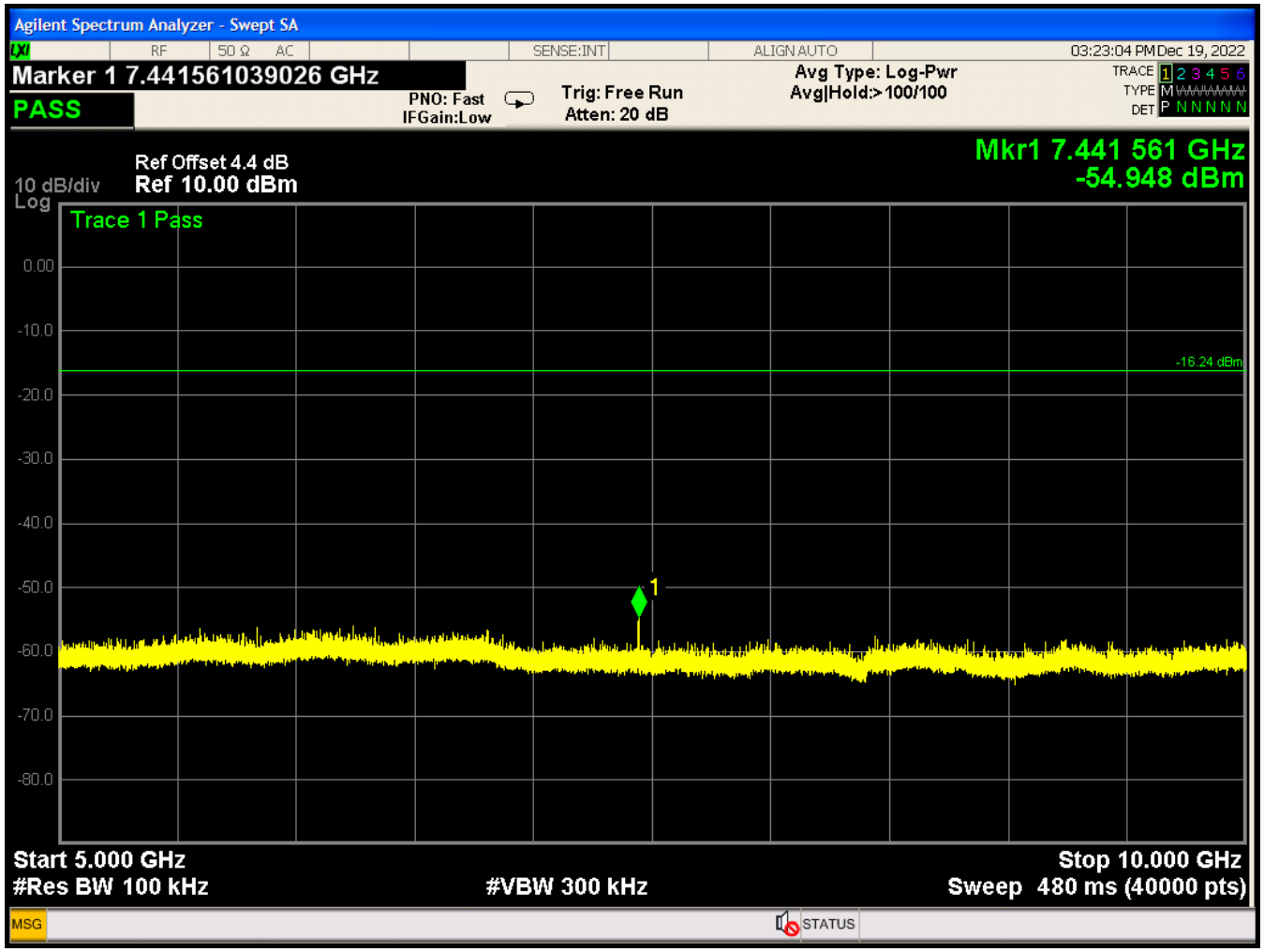


Figure 48: GFSK (2Mbps) High Channel, Conducted Spurious – Plot 5

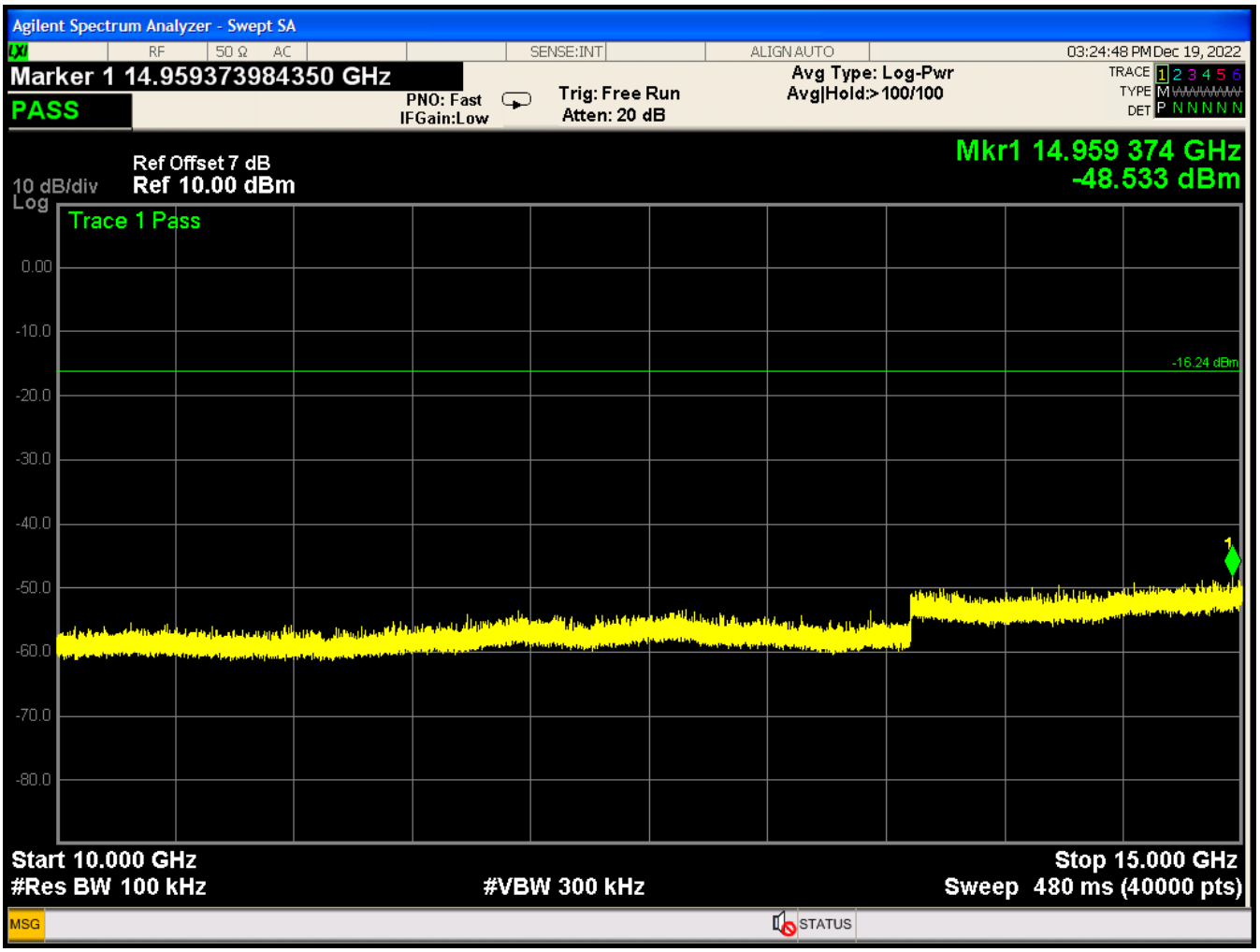


Figure 49: GFSK (2Mbps) High Channel, Conducted Spurious – Plot 6

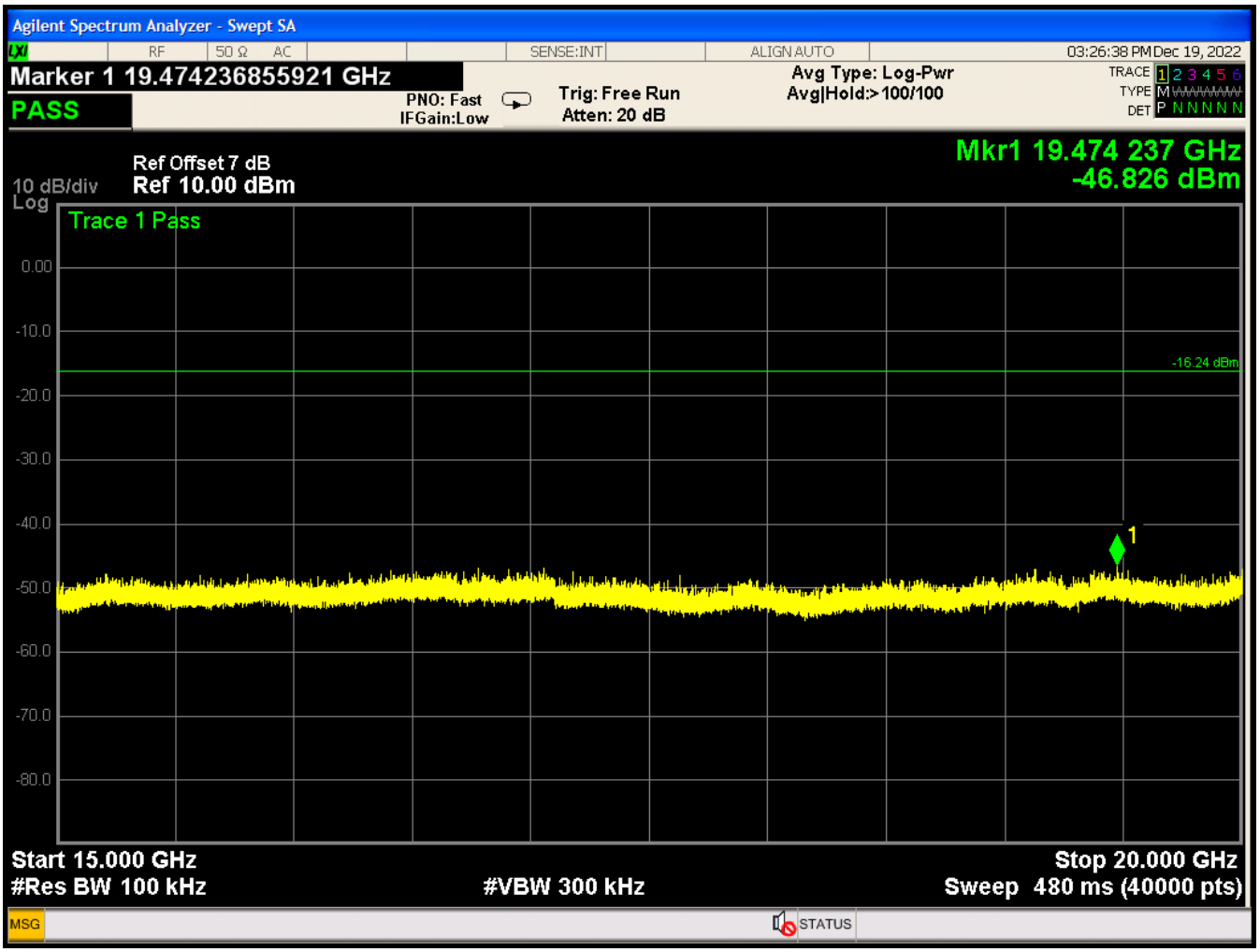
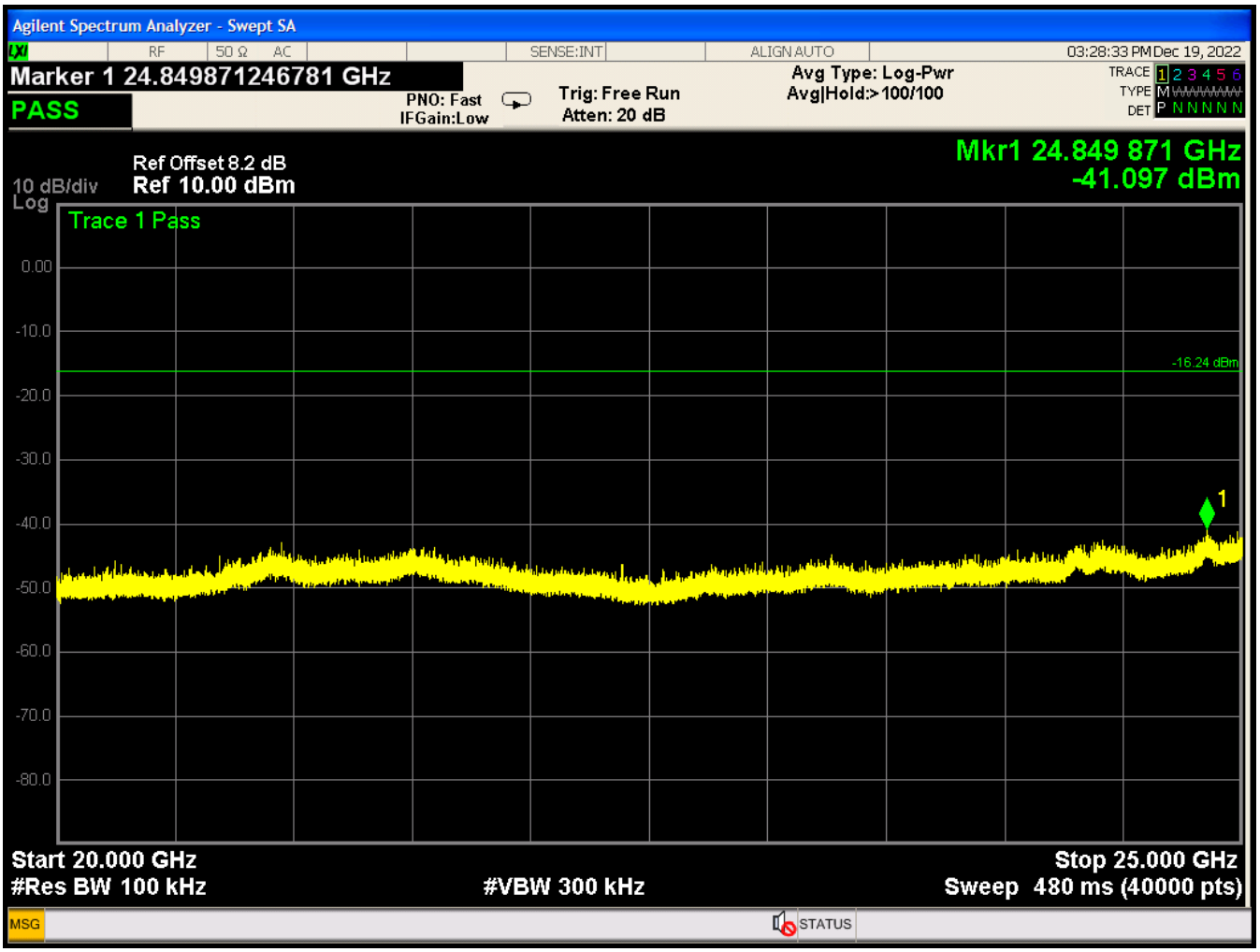


Figure 50: GFSK (2Mbps) High Channel, Conducted Spurious – Plot 7



2.6 General Field Strength Requirements – Radiated Emissions

2.6.1 Requirements

Compliance Standard: FCC Part 15.205 and 15.209

FCC Compliance Limits		
Frequency Range	**3m Limit**	
30 – 88 MHz	100 µV/m (QP)	
88 – 216 MHz	150 µV/m (QP)	
216 – 960 MHz	200 µV/m (QP)	
> 960 MHz	500 µV/m (AVG)	5000 µV/m (Peak)

2.6.2 Test Procedure Summary

The requirements of FCC Part 15 call for the EUT to be placed on a 1m X 1.5m non-conductive motorized turntable at a height of 80cm for radiated testing of frequencies up to 1000 MHz, and a height of 1.5m for testing of frequencies above 1000 MHz. Please note that the radiated emissions measured during this testing, were performed at a 3m Open Area Test Site (OATS).

The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Bi-conical and log periodic broadband antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The frequency range of 30 MHz to 25 GHz was measured for all radiated emissions. If applicable, peripherals will be placed on the table in accordance with ANSI C63.4. Any cables shall be varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak for compliance measurements below 1 GHz. For measurements above 1 GHz, both the peak and average measurement was recorded. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth. Frequencies above 1 GHz were performed using a measurement bandwidth of 1 MHz with a video bandwidth setting of 10 Hz for the average measurement.

To ensure that the support laptop did not interfere with radiated measurements of frequencies above 1GHz, the test laboratory has completely disabled the WiFi capabilities within the computer's bios. For measurements of frequencies below 1000 MHz, the laptop was not used to control the EUT. Rather, a production sample was employed, and it was confirmed that both of the co-located transmitters were enabled during all testing. Overall, the support laptop did not impact the 3m radiated emissions testing.

2.6.3 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is algebraically added to the raw Spectrum Analyzer Voltage in dBµV to obtain the Radiated Electric Field in dBµV/m. This logarithm amplitude is converted to a linear amplitude, then compared to the FCC limit.

Example:

Spectrum Analyzer Voltage:	VdBµV
Antenna Correction Factor:	AFdB/m
Cable Correction Factor:	CFdB
Pre-Amplifier Gain (if applicable):	GdB
Electric Field:	EdBµV/m = VdBµV + AFdB/m + CFdB - GdB
Convert to linear units of measure:	EdBµV/m/20 Inv log

Environmental Conditions During Radiated Emissions Testing

Ambient Temperature:	1.5 °C
Relative Humidity:	60 %

2.6.4 Measurement Method and Results

The EUT was evaluated at the low, center, and high carrier frequency channels, in both available data rates (1Mbps and 2Mbps).

During all of radiated testing, the EUT was configured in a GFSK modulated and the absolute worst case emissions are reported.

Additionally, the EUT was tested while positioned in the worst-case orientation, based the three-axes orthogonal plane evaluation of the fundamental field strength at 3-meters. (see Table 6).

The EUT complies with the requirements this section.

There were no EUT emissions detected in the frequency range of 2483.5 GHz – 25 GHz.

Table 6: Radio Fundamental, EUT Axis Evaluation (2Mbps, High Channel)

Frequency (MHz)	Polarity (H/V)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (dBuV/m)	Detector	Comments
2408.00	V	1.5	94.5	-0.8	93.7	Peak	X-Axis
2480.00	V	1.5	96.2	0.1	96.3	Peak	Y-Axis
2480.00	V	1.5	98.3	0.1	98.4	Peak	Z-Axis
2408.00	H	1.5	97.1	-0.8	96.3	Peak	X-Axis
2480.00	H	1.5	93.7	0.1	93.8	Peak	Y-Axis
2480.00	H	1.5	91.8	0.1	91.9	Peak	Z-Axis

Table 7: Radiated Emissions Test Data – 30 MHz to 1000 MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
81.30	V	0.0	1.2	36.1	-17.3	8.7	100.0	-21.2	QP
135.60	V	0.0	1.2	30.5	-11.5	8.9	150.0	-24.5	QP
162.72	V	0.0	1.2	32.5	-12.7	9.8	150.0	-23.7	QP
216.96	V	0.0	1.2	32.3	-13.9	8.3	200.0	-27.6	QP
244.08	V	0.0	1.2	32.1	-13.1	8.9	200.0	-27.0	QP
271.11	V	0.0	1.2	30.7	-11.1	9.5	200.0	-26.5	QP
298.32	V	0.0	1.2	32.0	-10.9	11.4	200.0	-24.9	QP
515.28	V	0.0	1.2	39.4	-6.2	46.1	200.0	-12.8	QP
81.30	H	0.0	1.2	36.2	-17.3	8.8	100.0	-21.1	QP
135.60	H	0.0	1.2	30.6	-11.5	9.1	150.0	-24.4	QP
162.72	H	0.0	1.2	32.0	-12.7	9.2	150.0	-24.2	QP
216.96	H	0.0	1.2	32.1	-13.9	8.1	200.0	-27.8	QP
244.08	H	0.0	1.2	32.5	-13.1	9.3	200.0	-26.6	QP
271.11	H	0.0	1.2	30.5	-11.1	9.3	200.0	-26.7	QP
298.32	H	0.0	1.2	31.9	-10.9	11.2	200.0	-25.0	QP
515.28	H	0.0	1.2	38.7	-6.2	42.3	200.0	-13.5	QP

For measurements of frequencies below 1000 MHz, the EUT was tuned to the high channel (2480 MHz) and set to a fully-modulated mode using GFSK at 2Mbps. This mode/setting produced the highest conducted peak power values. Changing the data rate, or BLE carrier center frequency, had no impact on the emissions in the frequency range of 30 MHz to 1000 MHz.

For all radiated emissions testing, it was confirmed that the simultaneous transmission of the BLE and NFC co-located transmitters was enabled. That is both radio modules were set to a transmit on state.

Additionally, all of the frequencies denoted in Table 7 were identified via a near-field pre-scan and confirmed to be products of the EUT. However, none of the emissions were detectable at 3m. As such, each of the measurements provided above, were made at the noise floor and the field strength values are that of ambient conditions.

Table 8: Radiated Emissions Test Data – 1 GHz to 25 GHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector	Comments
2390.00	V	0.0	1.5	49.6	-0.9	271.3	5000.0	-25.3	Peak	Low Channel
2390.00	V	0.0	1.5	33.9	-0.9	44.5	500.0	-21.0	AVG	
2483.50	V	0.0	1.5	58.1	0.1	814.0	5000.0	-15.8	Peak	High Channel
2483.50	V	0.0	1.5	43.5	0.1	151.6	500.0	-10.4	AVG	
4804.00	V	0.0	1.5	48.4	9.3	767.4	5000.0	-16.3	Peak	AMB
4804.00	V	0.0	1.5	31.7	9.3	112.2	500.0	-13.0	AVG	AMB
7206.00	V	0.0	1.5	48.0	17.4	1867.8	5000.0	-8.6	Peak	AMB
7206.00	V	0.0	1.5	32.3	17.4	306.4	500.0	-4.3	AVG	AMB
2390.00	H	0.0	1.5	48.2	-0.9	230.9	5000.0	-26.7	Peak	Low Channel
2390.00	H	0.0	1.5	33.0	-0.9	40.1	500.0	-21.9	AVG	
2483.50	H	0.0	1.5	57.9	0.1	795.4	5000.0	-16.0	Peak	High Channel
2483.50	H	0.0	1.5	42.9	0.1	141.4	500.0	-11.0	AVG	
4804.00	H	0.0	1.5	48.2	9.3	749.9	5000.0	-16.5	Peak	AMB
4804.00	H	0.0	1.5	31.6	9.3	110.9	500.0	-13.1	AVG	AMB
7206.00	H	0.0	1.5	48.1	17.4	1889.4	5000.0	-8.5	Peak	AMB
7206.00	H	0.0	1.5	32.2	17.4	302.9	500.0	-4.4	AVG	AMB

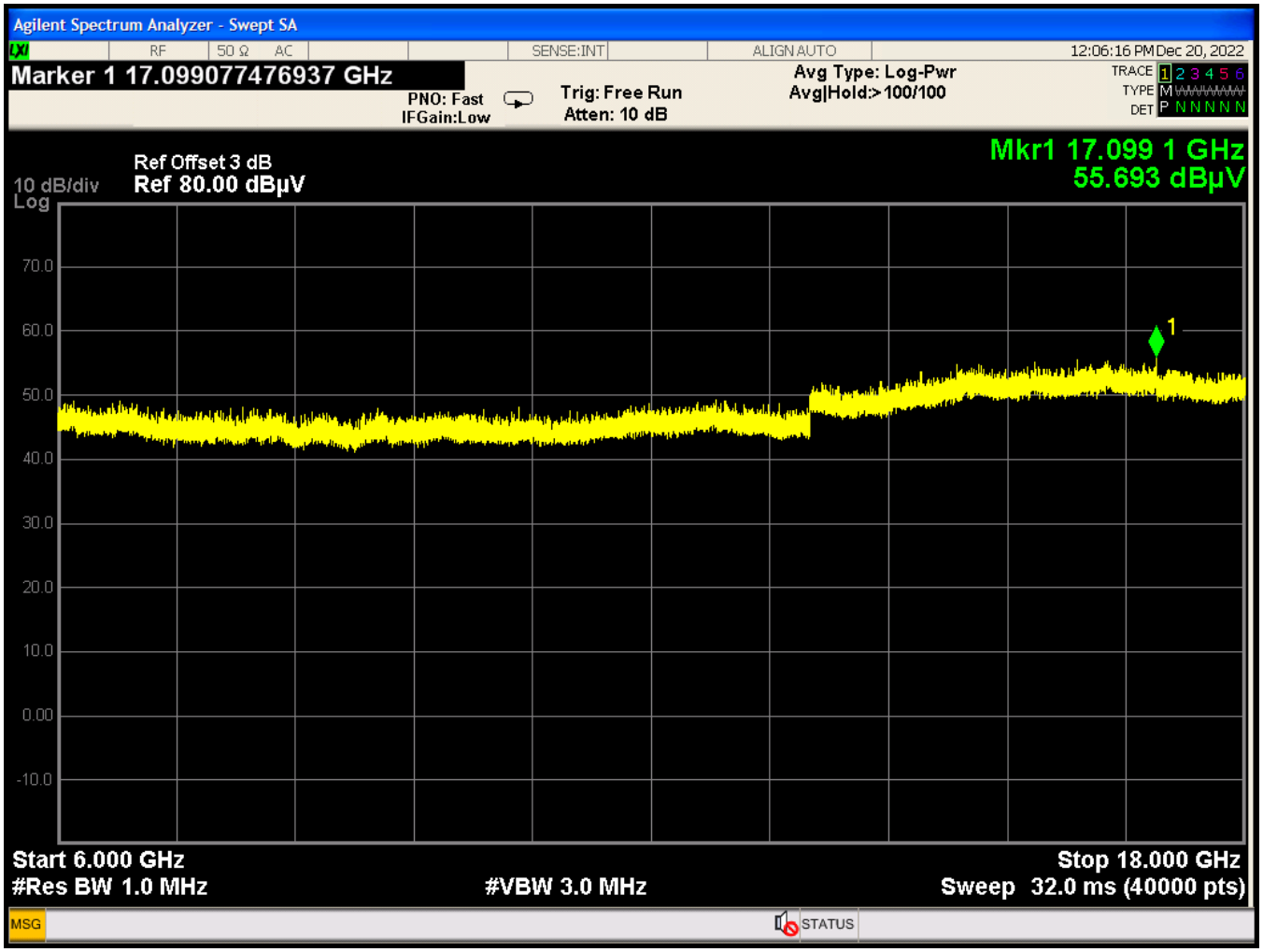
The only EUT emissions (detectable at 3m), in the frequency range of 1GHz to 25GHz, are the BLE transmitter fundamental carrier frequencies. Moreover, the harmonics of the transmitter were not detected during this test.

The BLE transmitter fundamental was evaluated at the low, center, and high channels; at each of the two data rates, 1Mbps and 2Mbps respectively. Changing the data rate, or BLE carrier center frequency, had no impact on the unwanted spurious emissions, during this test. No unwanted spurious emissions were noted.

The 2Mbps mode does produced the worst-case field strength at the restricted band edges denoted in Table 8. The bandedge values presented in Table 8, are the worst-case values when the EUT is tuned the low channel carrier and high channel carrier, for measurements at 2390MHz and 2483.5MHz, respectively.

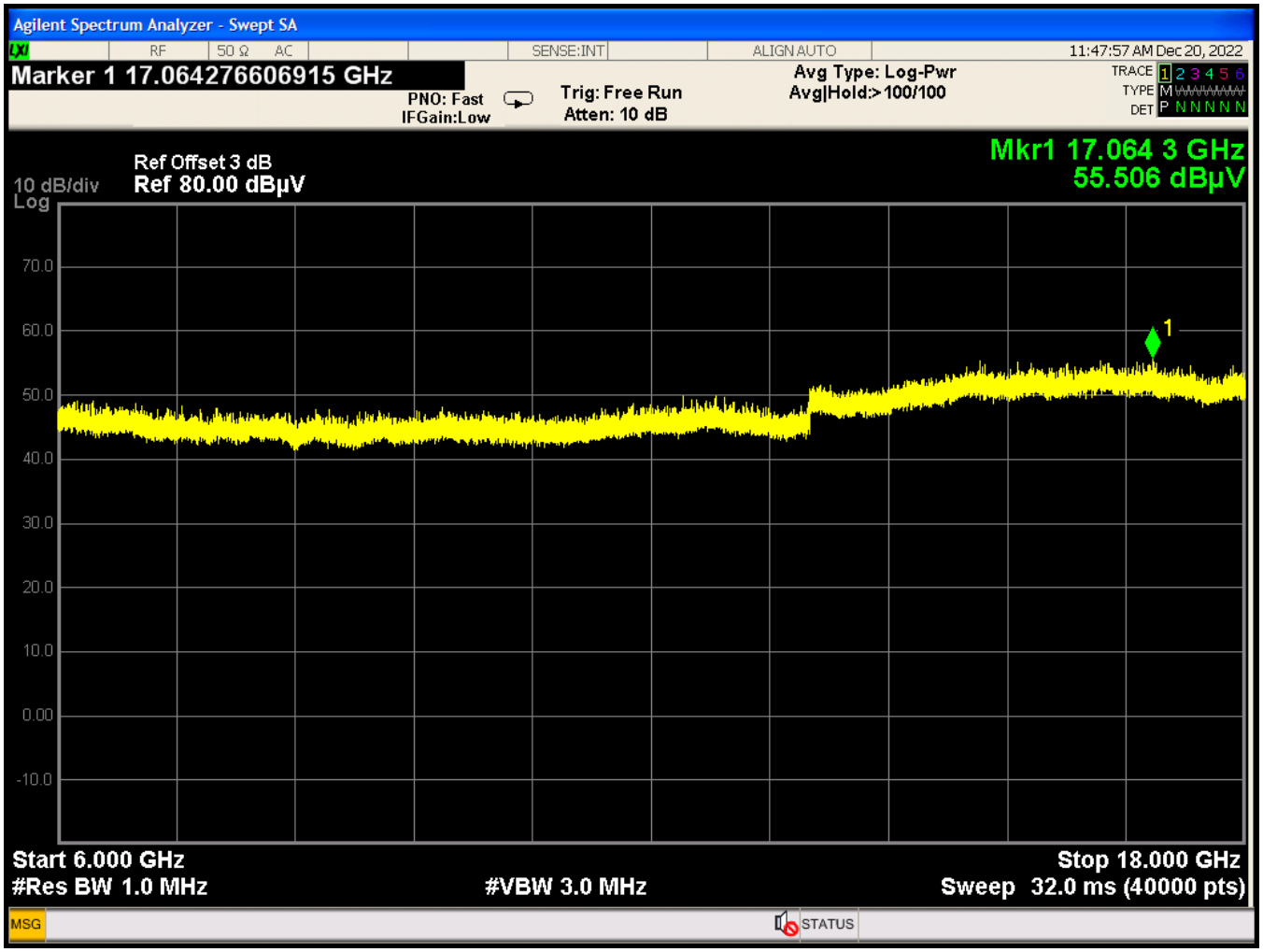
* AMB indicates that the measurement was made at the noise floor and the field strength values are that of ambient conditions.

Figure 51: GFSK (1Mbps), 6 GHz to 18 GHz (Uncorrected Field Strength)



This plot presents the EUT in the 1Mbps mode. Please note that the EUT was also investigated at the low and high channels. There are no EUT unwanted emissions detected when the measurement distance is 3m. Changing the data rate and/or tuning a different channel, has no impact on this measurement. This plot is representative of the EUT emissions – any channel, any data rate.

Figure 52: GFSK (2Mbps), 6 GHz to 18 GHz (Uncorrected Field Strength)



This plot presents the EUT in the 2Mbps mode. Please note that the EUT was also investigated at the low and high channels. There are no EUT unwanted emissions detected when the measurement distance is 3m. Changing the data rate and/or tuning a different channel, has no impact on this measurement. This plot is representative of the EUT emissions – any channel, any data rate.

2.7 AC Powerline Conducted Emissions

2.7.1 Requirements

Compliance Standard: FCC Part 15.207

FCC Compliance Limits				
Frequency Range	Class A		Class B	
	Quasi-peak	Average	Quasi-peak	Average
0.15 – 0.5 MHz	79 dBµV	66 dBµV	66 to 56 dBµV	56 to 46 dBµV
0.5 – 5 MHz	79 dBµV	66 dBµV	56 dBµV	46 dBµV
0.5 – 30 MHz	73 dBµV	60 dBµV	60 dBµV	50 dBµV

2.7.2 Test Procedure

The requirements of FCC Part 15 call for the EUT to be placed on an 80cm-high 1 X 1.5-meter non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 X 2-meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power was supplied to the peripherals through a second LISN. The peripherals were placed on the table in accordance with ANSI C63.4. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak, peak, or average as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth. For average measurements, the post-detector filter was set to 10 Hz.

These emissions must meet the limits specified in §15.207 for quasi-peak and average measurements.

Environmental Conditions During Conducted Emissions Testing

Ambient Temperature:	16 °C
Relative Humidity:	44 %

2.7.3 Conducted Data Reduction and Reporting

The comparison between the Conducted emissions level and the FCC limit is calculated as shown in the following example:

Spectrum Analyzer Voltage: VdBµV(raw)

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Voltage: VdBµV = V dBµV (raw) + LISN dB + CF dB

2.7.4 Test Data

The EUT complies with the Class B Conducted Emissions requirements.

Please note that the EUT ships with a USB charging cable and an AC/DC power adapter.

The EUT cannot charge and transmit at the same time.

When the EUT is coupled to a public mains network, the transmitter is automatically disabled.

The Conducted Emissions test data is provided in the tables below.

Table 9: AC Power Conducted Emissions Test Data

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Avg Corr (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.161	51.4	28.2	9.9	0.6	61.9	38.7	65.4	55.4	-3.5	-13.7
0.199	47.8	25.9	9.9	0.5	58.2	36.3	63.7	53.7	-5.4	-17.3
0.250	44.5	22.5	9.9	0.4	54.9	32.9	61.8	51.8	-6.9	-18.9
0.311	40.8	21.6	9.9	0.4	51.1	31.9	59.9	49.9	-8.8	-18.1
0.513	32.1	13.1	9.9	0.3	42.3	23.4	56.0	46.0	-13.7	-22.6
3.553	23.0	11.9	10.3	0.4	33.7	22.6	56.0	46.0	-22.3	-23.4
PHASE / L1										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Avg Corr (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.157	49.3	27.4	9.9	0.4	59.7	37.8	65.6	55.6	-5.9	-17.8
0.188	47.1	24.6	9.9	0.4	57.4	34.9	64.1	54.1	-6.7	-19.2
0.269	41.0	20.0	9.9	0.3	51.3	30.3	61.1	51.1	-9.9	-20.9
0.315	39.1	19.0	9.9	0.3	49.3	29.2	59.8	49.8	-10.5	-20.6
0.332	38.4	18.3	9.9	0.3	48.6	28.5	59.4	49.4	-10.8	-20.9
0.391	34.6	18.0	9.9	0.3	44.8	28.2	58.0	48.0	-13.2	-19.8
0.634	27.0	12.0	9.9	0.3	37.2	22.2	56.0	46.0	-18.8	-23.8

3 Equipment Under Test

3.1 EUT Identification & Description

The Senseonics, Inc., (FCC ID: 2AHYA-3402) is a body-worn transmitter used for glucose monitoring. The EUT employs a BLE radio and a Near Field Communications (NFC) transmitter. Please reference WL Test Report # 17891-01 for the testing results of the 13.56 MHz NFC portion.

3.2 Test Configuration

The EUT is powered by an internal rechargeable battery. For testing purposes, the EUT can be connected to a laptop for support/control.

Figure 53: Testing Block Diagram (Example Only)

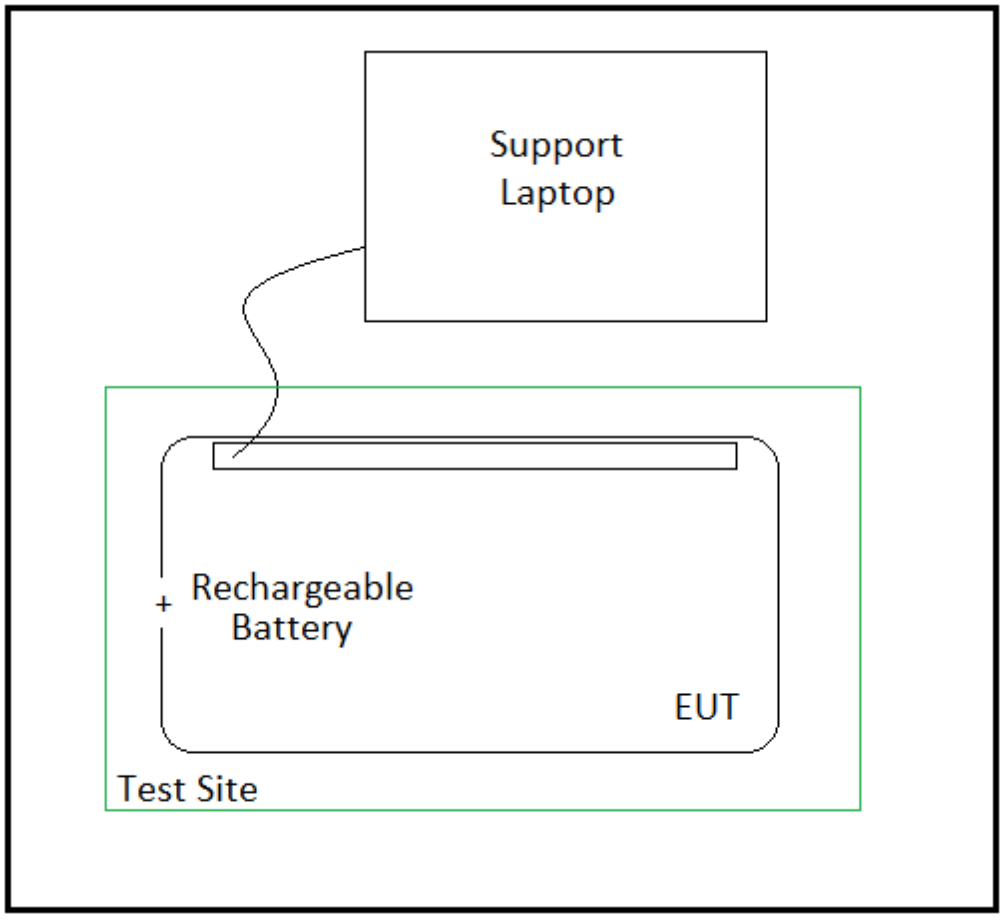


Table 10: Radio Device Summary

Manufacturer and Applicant:	Senseonics, Inc.
FCC ID:	2AHYA-3402
EUT Model Number:	102985-001
FCC Rule Part:	§15.247
TX Frequency Range:	2402 MHz – 2480 MHz
Maximum Peak Output Power:	4.31 dBm (2.7 mW)
Modulation:	GFSK
Date Rate:	1Mbps, 2Mbps
Number of Channels:	40 (declared by applicant)
FCC Emission Designator:	733KF1D (recommended or TCB to correct)
Keying:	Automatic
Type of Information:	Not Declared by Applicant
Antenna Manufacturer:	Johanson Technology (P/N: 2450AT07A0100T)
Antenna Type:	Ceramic Chip Antenna (Peak Gain: 1.0 dBi)
Antenna Connector:	N/A
Calculated EIRP:	2.81 dBm (based on typical gain)
Measured EIRP from F/S:	98.3 dBuV/m + 20LOG(3) – 104.7 = 3.14 dBm EIRP
Interface Cables:	See Table 13
Software/Firmware:	Test Mode, TX Settings: 4dBm via Test Software
Pulsed Transmitter:	No
Power Source & Voltage:	Rechargeable Battery via +5VDC USB Adapter
Highest TX Spurious Emission:	4.879 GHz (Conducted) -51.55 dBm (Peak)
	2483.5 MHz (3m, Radiated); 43.6 dBuV/m (AVG)

Table 11: EUT System Configuration List

Description	Model	Part Number	Shipped with EUT	Revision
Phoenix2 Transmitter	102985-001	102985	N/A	01
DC Power Adapter, USB	AQ03A-050A-R	102207-004	Yes	A
USB Cable	102-1292-BL-00100	102015-001	Yes	A

Table 12: Support Equipment

Item	Model/Part Number	Serial Number
Sensor	Senseonics	101263-037
Laptop	Dell	N/A

Table 13: Cable Configuration

Port Identification	Connector Type	Cable Length	Shielded	Termination Point
Charging Port	USB	< 3m	No	AC Mains

3.3 Measurements

3.3.1 References

ANSI C63.2 (1/2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 (1/2014) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10 (6/2013) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

3.4 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + ...}$$

Where:

uc	= standard uncertainty
a, b, c,..	= individual uncertainty elements
Diva, b, c	= the individual uncertainty element divisor based on the probability distribution
Divisor	= 1.732 for rectangular distribution
Divisor	= 2 for normal distribution
Divisor	= 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where:
U = expanded uncertainty
k = coverage factor
k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)
uc = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 14 below.

Table 14: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	± 2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	± 4.55 dB

4 Test Equipment

Table 15 shows a list of the test equipment used for measurements, along with the calibration information.

Table 15: Test Equipment List

Test Name:	**Benchtop RF Emissions**	Test Date: **12/19/2022**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00823	AGILENT, N9010A	EXA SPECTRUM ANALYZER	5/26/2023
00528	AGILENT, E4446A	SPECTRUM ANALYZER	3/25/2023
00897	TELEDYNE, 921-0101	SMA COAXIAL CABLE	1/21/2023

Test Name:	**AC Mains Conducted Emissions**	Test Date:	**12/19/2022**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00125	SOLAR 8028-50-TS-24-BNC	LISN	9/15/2023
00126	SOLAR 8028-50-TS-24-BNC	LISN	9/15/2023
00895	HP, 11947A	TRANSIENT LIMITER	2/21/2023
00330	WLL CE CABLE	BNC-BNC RF COAXIAL CABLE	5/6/2023

Test Name:	**Radiated Emissions**	Test Date:	**12/20/2022**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00382	SUNOL SCIENCES CORP., JB1	ANTENNA BICONLOG	11/7/2024
00626	ARA, DRG-118/A	HORN ANTENNA	8/20/2023
00823	AGILENT, N9010A	EXA SPECTRUM ANALYZER	5/26/2023
00522	HP, 8449B	RF PRE-AMPLIFIER	5/5/2023
00849	AH SYSTEMS, SAC-18G-16	SMA COAXIAL CABLE	1/21/2023
00065	HP, 8447D	RF PRE-AMPLIFIER	5/6/2023
00865	STORM, 874-0101-036	SMA COAXIAL CABLE	5/5/2023