

# FCC LTE REPORT

## Certification

**Applicant Name:**

SAMSUNG Electronics Co., Ltd.

**Date of Issue:**

January 16, 2020

**Address:**

129, Samsung-ro, Yeongtong-gu,  
 Suwon-si, Gyeonggi-do, 16677, Rep. of Korea

**Location:**

HCT CO., LTD.,  
 74, Seoicheon-ro 578beon-gil, Majang-myeon,  
 Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA

**Report No.:** HCT-RF-2001-FC034

**FCC ID:** A3LSMG988B

**APPLICANT:** SAMSUNG Electronics Co., Ltd.

Model(s): SM-G988B/DS  
 Additional Model(s): SM-G988B  
 EUT Type: Mobile Phone  
 FCC Classification: PCS Licensed Transmitter Held to Ear (PCE)  
 FCC Rule Part(s): §22, §2

Mode (MHz)	Tx Frequency (MHz)	Emission Designator	Modulation	ERP	
				Max. Power (W)	Max. Power (dBm)
LTE – Band5 (1.4)	824.7 – 848.3	1M09G7D	QPSK	0.076	18.81
		1M11W7D	16QAM	0.063	18.00
		1M10W7D	64QAM	0.050	16.96
		1M10W7D	256QAM	0.025	13.95
LTE – Band5 (3)	825.5 – 847.5	2M72G7D	QPSK	0.088	19.42
		2M71W7D	16QAM	0.072	18.59
		2M71W7D	64QAM	0.058	17.60
		2M72W7D	256QAM	0.028	14.53
LTE – Band5 (5)	826.5 – 846.5	4M52G7D	QPSK	0.090	19.53
		4M52W7D	16QAM	0.074	18.69
		4M53W7D	64QAM	0.058	17.61
		4M51W7D	256QAM	0.029	14.60
LTE – Band5 (10)	829.0 – 844.0	9M02G7D	QPSK	0.093	19.66
		9M02W7D	16QAM	0.076	18.83
		9M01W7D	64QAM	0.060	17.81
		9M00W7D	256QAM	0.030	14.80

The measurements shown in this report were made in accordance with the procedures specified in CFR47 section §2.947. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998, 21 U.S.C. 853(a)



**Report prepared by : Kwon Jeong**  
**Engineer of Telecommunication Testing Center**



**Report approved by : Jong Seok Lee**  
**Manager of Telecommunication Testing Center**

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## Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-RF-2001-FC034	January 16, 2020	- First Approval Report

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.

This laboratory is not accredited for the test results marked \*.

The above Test Report is the accredited test result by KOLAS(Korea Laboratory Accreditation Scheme), which signed the ILAC-MRA.(HCT Accreditation No.: KT197)

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# MEASUREMENT REPORT

## 1. GENERAL INFORMATION

<b>Applicant Name:</b>	SAMSUNG Electronics Co., Ltd.
<b>Address:</b>	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
<b>FCC ID:</b>	A3LSMG988B
<b>Application Type:</b>	Certification
<b>FCC Classification:</b>	PCS Licensed Transmitter Held to Ear (PCE)
<b>FCC Rule Part(s):</b>	§22, §2
<b>EUT Type:</b>	Mobile Phone
<b>Model(s):</b>	SM-G988B/DS
<b>Additional Model(s):</b>	SM-G988B
<b>Tx Frequency:</b>	824.7 MHz – 848.3 MHz (LTE – Band 5 (1.4 MHz)) 825.5 MHz – 847.5 MHz (LTE – Band 5 (3 MHz)) 826.5 MHz – 846.5 MHz (LTE – Band 5 (5 MHz)) 829.0 MHz – 844.0 MHz (LTE – Band 5 (10 MHz))
<b>Date(s) of Tests:</b>	November 18, 2019 ~ January 10, 2020

## **2. INTRODUCTION**

### **2.1. DESCRIPTION OF EUT**

The EUT was a Mobile Phone with GSM/GPRS/EGPRS/UMTS and LTE.

It also supports IEEE 802.11 a/b/g/n/ac/ax (HT20/40/80), Bluetooth, BT LE, NFC, ANT+, Power Sharing

### **2.2. MEASURING INSTRUMENT CALIBRATION**

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

### **2.3. TEST FACILITY**

The Fully-anechoic chamber and conducted measurement facility used to collect the radiated data are located at the **74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA.**

### 3. DESCRIPTION OF TESTS

#### 3.1 TEST PROCEDURE

Test Description	Test Procedure Used
Occupied Bandwidth	- KDB 971168 D01 v03r01 – Section 4.3 - ANSI C63.26-2015 – Section 5.4.4
Band Edge	- KDB 971168 D01 v03r01 – Section 6.0 - ANSI C63.26-2015 – Section 5.7
Spurious and Harmonic Emissions at Antenna Terminal	- KDB 971168 D01 v03r01 – Section 6.0 - ANSI C63.26-2015 – Section 5.7
Conducted Output Power	- N/A (See SAR Report)
Frequency stability	- ANSI C63.26-2015 – Section 5.6
Effective Radiated Power/ Effective Isotropic Radiated Power	- KDB 971168 D01 v03r01 – Section 5.2 & 5.8 - ANSI/TIA-603-E-2016 – Section 2.2.17
Radiated Spurious and Harmonic Emissions	- KDB 971168 D01 v03r01 – Section 6.2 - ANSI/TIA-603-E-2016 – Section 2.2.12

### 3.2 RADIATED POWER

#### Test Overview

Radiated tests are performed in the Fully-anechoic chamber.

The equipment under test is placed on a non-conductive table 3-meters away from the receive antenna in accordance with ANSI/TIA-603-E-2016 Clause 2.2.17.

#### Test Settings

1. Radiated power measurements are performed using the signal analyzer's "channel power" measurement capability for signals with continuous operation.
2. RBW = 1 – 5% of the expected OBW, not to exceed 1MHz
3. VBW ≥ 3 x RBW
4. Span = 1.5 times the OBW
5. No. of sweep points > 2 x span / RBW
6. Detector = RMS
7. Trigger is set to "free run" for signals with continuous operation with the sweep times set to "auto".
8. The integration bandwidth was roughly set equal to the measured OBW of the signal for signals with continuous operation.
9. Trace mode = trace averaging (RMS) over 100 sweeps
10. The trace was allowed to stabilize

#### Test Note

1. The turntable is rotated through 360 degrees, and the receiving antenna scans in order to determine the level of the maximized emission.
2. A half wave dipole is then substituted in place of the EUT. For emissions above 1GHz, a horn antenna is substituted in place of the EUT. The substitute antenna is driven by a signal generator and the previously recorded signal was duplicated.

The power is calculated by the following formula;

$$P_{d(dBm)} = P_{g(dBm)} - \text{cable loss}_{(dB)} + \text{antenna gain}_{(dB)}$$

Where:  $P_d$  is the dipole equivalent power and  $P_g$  is the generator output power into the substitution antenna.

3. The maximum value is calculated by adding the forward power to the calibrated source plus its appropriate gain value. These steps are repeated with the receiving antenna in both vertical and horizontal polarization. the difference between the gain of the horn and an isotropic antenna are taken into consideration
4. The EUT was tested in three orthogonal planes(X, Y, Z) and in all possible test configurations and positioning.
5. All measurements are performed as RMS average measurements while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies.

### 3.3 RADIATED SPURIOUS EMISSIONS

#### Test Overview

Radiated tests are performed in the Fully-anechoic chamber.

Radiated Spurious Emission Measurements at 3 meters by Substitution Method according to ANSI/TIA-603-E-2016.

#### Test Settings

1. RBW = 100kHz for emissions below 1GHz and 1MHz for emissions above 1GHz
2. VBW  $\geq 3 \times$  RBW
3. Span = 1.5 times the OBW
4. No. of sweep points  $> 2 \times$  span / RBW
5. Detector = Peak
6. Trace mode = Max Hold
7. The trace was allowed to stabilize
8. Test channel : Low/ Middle/ High
9. Frequency range : We are performed all frequency to 10<sup>th</sup> harmonics from 9 kHz.

#### Test Note

1. Measurements value show only up to 3 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin  $> 20$  dB from the applicable limit) and considered that's already beyond the background noise floor.
2. The EUT was tested in three orthogonal planes(X, Y, Z) and in all possible test configurations and positioning. The worst case emissions are reported with the EUT positioning, modulations, RB sizes and offsets, and channel bandwidth configurations shown in the test data
3. For spurious emissions above 1GHz, a horn antenna is substituted in place of the EUT. The substitute antenna is driven by a signal generator and the previously recorded signal was duplicated. The spurious emissions is calculated by the following formula;

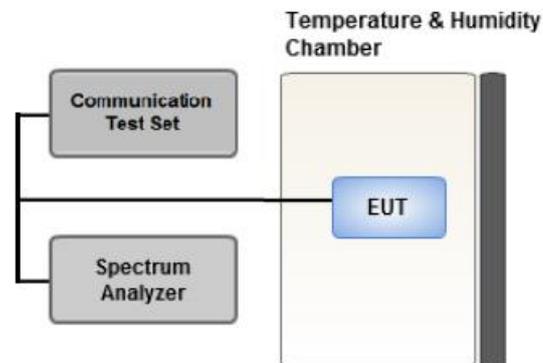
$$\text{Result}_{(\text{dBm})} = P_{g(\text{dBm})} - \text{cable loss}_{(\text{dB})} + \text{antenna gain}_{(\text{dBi})}$$

Where:  $P_g$  is the generator output power into the substitution antenna.

If the fundalmatal frequency is below 1GHz, RF output power has been converted to EIRP.

$$\text{EIRP}_{(\text{dBm})} = \text{ERP}_{(\text{dBm})} + 2.15$$

### 3.4 OCCUPIED BANDWIDTH.



**Test setup**

The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5 % of the total mean power of a given emission.

The EUT makes a call to the communication simulator.

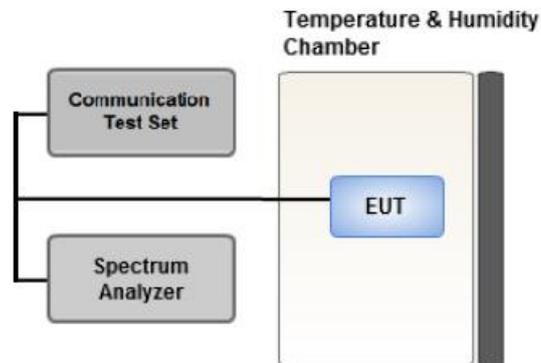
The conducted occupied bandwidth used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.

The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency. Use OBW measurement function of Spectrum analyzer to measure 99 % occupied bandwidth

#### **Test Settings**

1. The signal analyzer's automatic bandwidth measurement capability was used to perform the 99% occupied bandwidth and the 26dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 1 – 5% of the expected OBW
3. VBW  $\geq$  3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize
8. If necessary, steps 2 – 7 were repeated after changing the RBW such that it would be within 1 – 5% of the 99% occupied bandwidth observed in Step 7

### 3.5 SPURIOUS AND HARMONIC EMISSIONS AT ANTENNA TERMINAL



**Test setup**

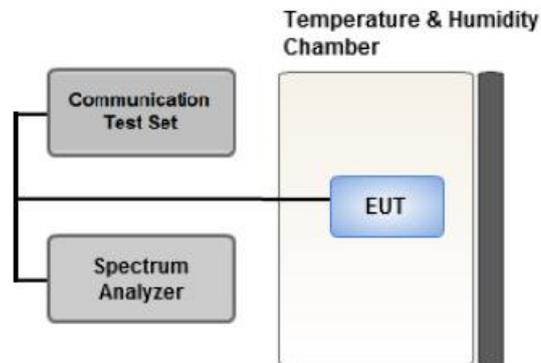
#### **Test Overview**

The level of the carrier and the various conducted spurious and harmonic frequencies is measured by means of a calibrated spectrum analyzer. The spectrum is scanned from the lowest frequency generated in the equipment up to a frequency including its 10th harmonic. All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.

#### **Test Settings**

1. RBW = 1 MHz
2. VBW  $\geq$  3 MHz
3. Detector = RMS
4. Trace Mode = trace average
5. Sweep time = auto
6. Number of points in sweep  $\geq$  2 x Span / RBW

### 3.6 BAND EDGE



Test setup

#### Test Overview

All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.

#### Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW > 1% of the emission bandwidth
4. VBW > 3 x RBW
5. Detector = RMS
6. Number of sweep points  $\geq 2 \times \text{Span/RBW}$
7. Trace mode = trace average
8. Sweep time = auto couple
9. The trace was allowed to stabilize

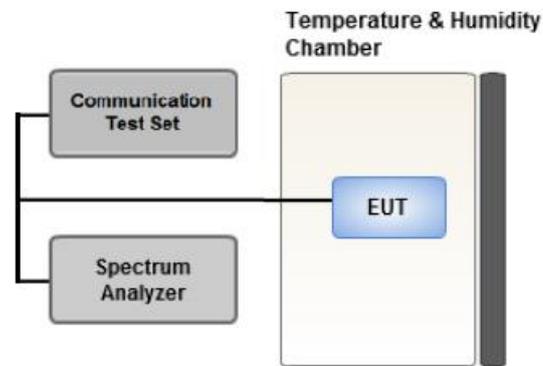
#### Test Notes

According to FCC 22.917, 24.238, 27.53 specified that power of any emission outside of The authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least  $43 + 10 \log(P)$  dB. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

All measurements were done at 2 channels(low and high operational frequency range.)

The band edge measurement used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.

### 3.7 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE



**Test setup**

#### **Test Overview**

Frequency stability testing is performed in accordance with the guidelines of ANSI C63.26-2015.

The frequency stability of the transmitter is measured by:

1. Temperature:

The temperature is varied from -30°C to +50°C in 10°C increments using an environmental chamber.

2. Primary Supply Voltage:

- Unless otherwise specified, vary primary supply voltage from 85% to 115% of the nominal value for other than hand carried battery equipment.

- For hand carried, battery powered equipment, reduce the primary ac or dc supply voltage to the battery operating end point, which shall be specified by the manufacturer.

#### **Test Settings**

1. The carrier frequency of the transmitter is measured at room temperature

(20°C to provide a reference).

2. The equipment is turned on in a "standby" condition for fifteen minutes before applying power to the transmitter. Measurement of the carrier frequency of the transmitter is made within one minute after applying power to the transmitter.

3. Frequency measurements are made at 10°C intervals ranging from -30°C to +50°C. A period of at least one half-hour is provided to allow stabilization of the equipment at each temperature level.

**3.8 WORST CASE(RADIATED TEST)**

- The EUT was tested in three orthogonal planes(X, Y, Z) and in all possible test configurations and positioning.
  - All modes of operation were investigated and the worst case configuration results are reported.
  - The worst case is reported with the EUT positioning, modulations, and paging service configurations shown in the test data.
  - SM-G988B/DS & additional models were tested and the worst case results are reported.
- (Worst case : SM-G988B/DS)

[ Worst case ]

Test Description	Modulation	RB size	RB offset	Axis
Effective Radiated Power	QPSK, 16QAM, 64QAM, 256QAM	1	0	X
Radiated Spurious and Harmonic Emissions	QPSK	1	0	X

**3.9 WORST CASE(CONDUCTED TEST)**

- Worst case : Of all modulation, We have tested modulation of the high Conducted Output Power.

Conducted Output Power value can be confirmed on the SAR report.

- SM-G988B/DS & additional models were tested and the worst case results are reported.

(Worst case : SM-G988B/DS)

[ Worst case ]

Test Description	Modulation	Bandwidth (MHz)	Frequency	RB size	RB offset
<b>Occupied Bandwidth</b>	QPSK, 16QAM, 64QAM, 256QAM	1.4, 3, 5, 10	Mid	Full RB	0
<b>Band Edge</b>	QPSK	1.4	Low	1	0
			High	1	5
		3	Low	1	0
			High	1	14
		5	Low	1	0
			High	1	24
		10	Low	1	0
			High	1	49
		15	Low	1	0
			High	1	74
		1.4, 3, 5, 10	Low, High	Full RB	0
<b>Spurious and Harmonic Emissions at Antenna Terminal</b>	QPSK	1.4, 3, 5, 10	Low, Mid, High	1	0

#### 4. LIST OF TEST EQUIPMENT

Manufacture	Model/ Equipment	Serial Number	Calibration Date	Calibrati on Interval	Calibration Due
T&M SYSTEM	FBSR-02B(WHK1.2/15G-10EF)/H.P.F	-	06/10/2019	Annual	06/10/2020
T&M SYSTEM	FBSR-02B(WHK3.3/18G-10EF)/H.P.F	-	06/10/2019	Annual	06/10/2020
Hewlett Packard	11667B / Power Splitter(DC~26.5 GHz)	11275	05/03/2019	Annual	05/03/2020
Agilent	E3632A/DC Power Supply	MY40004326	07/01/2019	Annual	07/01/2020
Schwarzbeck	UHAP/ Dipole Antenna	557	03/29/2019	Biennial	03/29/2021
Schwarzbeck	UHAP/ Dipole Antenna	558	03/29/2019	Biennial	03/29/2021
ESPEC	SU-642 / Chamber	93000717	08/14/2019	Annual	08/14/2020
Schwarzbeck	BBHA 9120D/ Horn Antenna(1~18GHz)	147	08/29/2019	Biennial	08/29/2021
Schwarzbeck	BBHA 9120D/ Horn Antenna(1~18GHz)	9120D-1298	09/25/2019	Biennial	09/25/2021
Schwarzbeck	BBHA 9170/ Horn Antenna(15~40GHz)	BBHA9170342	04/29/2019	Biennial	04/29/2021
Schwarzbeck	BBHA 9170/ Horn Antenna(15~40GHz)	BBHA9170124	01/28/2019	Biennial	01/28/2021
Agilent	N9020A/Signal Analyzer(10Hz~26.5GHz)	MY51110063	05/08/2019	Annual	05/08/2020
Hewlett Packard	8493C/ATTENUATOR(20dB)	17280	06/04/2019	Annual	06/04/2020
REOHDE & SCHWARZ	FSV40/Spectrum Analyzer(10Hz~40GHz)	100931	10/14/2019	Annual	10/14/2020
Agilent	8960 (E5515C)/ Base Station	MY48360800	08/27/2019	Annual	08/27/2020
Schwarzbeck	FMZB1513/ Loop Antenna(9kHz~30MHz)	1513-175	08/23/2018	Biennial	08/23/2020
Schwarzbeck	VULB9160/ Bilog Antenna	9160-3368	08/09/2018	Biennial	08/09/2020
Schwarzbeck	VULB9160/ Hybrid Antenna	760	03/22/2019	Biennial	03/22/2021
Anritsu Corp.	MT8821C/Wideband Radio Communication Tester	6201502997	08/09/2019	Annual	08/09/2020
Anritsu Corp.	MT8820C/Wideband Radio Communication Tester	6201026545	01/30/2019	Annual	01/30/2020
REOHDE & SCHWARZ	SMB100A/ SIGNAL GENERATOR (100kHz~40GHz)	177633	07/15/2019	Annual	07/15/2020
REOHDE & SCHWARZ	ESU40 / EMI TEST RECEIVER	100524	05/17/2019	Annual	05/17/2020
HCT CO., LTD.,	FCC LTE Mobile Conducted RF Automation Test Software	-	-	-	-

**Note:**

1. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.
2. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

## 5. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4:2014. All measurement uncertainty values are shown with a coverage factor of  $k = 2$  to indicate a 95 % level of confidence. The measurement data shown herein meets or exceeds the  $U_{\text{CISPR}}$  measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty ( $\pm$ dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70
Radiated Disturbance (18 GHz ~ 40 GHz)	5.05

## 6. SUMMARY OF TEST RESULTS

### 6.1 Test Condition : Conducted Test

Test Description	FCC Part Section(s)	Test Limit	Test Result
Occupied Bandwidth	§2.1049	N/A	PASS
Band Edge / Spurious and Harmonic Emissions at Antenna Terminal.	§2.1051, §22.917(a)	< 43 + 10log10 (P[Watts]) at Band Edge and for all out-of-band emissions	PASS
Conducted Output Power	§2.1046	N/A	<u>See Note1</u>
Frequency stability / variation of ambient temperature	§2.1055, §22.355	< 2.5 ppm	PASS

Note:

1. See SAR Report
2. The same samples were used for SAR and EMC

### 6.2 Test Condition : Radiated Test

Test Description	FCC Part Section(s)	Test Limit	Test Result
Effective Radiated Power	§22.913(a)(5)	< 7 Watts max. ERP	PASS
Radiated Spurious and Harmonic Emissions	§2.1053, §22.917(a)	< 43 + 10log10 (P[Watts]) for all out-of band emissions	PASS

## 7. SAMPLE CALCULATION

### 7.1 ERP Sample Calculation

Ch./ Freq.		Measured Level(dBm)	Substitute Level(dBm)	Ant. Gain (dBd)	C.L	Pol.	ERP	
channel	Freq.(MHz)						W	dBm
128	824.20	-21.37	38.40	-10.61	0.95	H	0.483	26.84

$$\text{ERP} = \text{Substitute LEVEL(dBm)} + \text{Ant. Gain} - \text{CL(Cable Loss)}$$

- 1) The EUT mounted on a non-conductive turntable is 2.5 meter above test site ground level.
- 2) During the test , the turn table is rotated until the maximum signal is found.
- 3) Record the field strength meter's level.
- 4) Replace the EUT with dipole/Horn antenna that is connected to a calibrated signal generator.
- 5) Increase the signal generator output till the field strength meter's level is equal to the item (3).
- 6) The signal generator output level with Ant. Gain and cable loss are the rating of effective radiated power.

### 7.2 EIRP Sample Calculation

Ch./ Freq.		Measured Level(dBm)	Substitute Level(dBm)	Ant. Gain (dBi)	C.L	Pol.	EIRP	
channel	Freq.(MHz)						W	dBm
20175	1,732.50	-15.75	18.45	9.90	1.76	H	0.456	26.59

$$\text{EIRP} = \text{Substitute LEVEL(dBm)} + \text{Ant. Gain} - \text{CL(Cable Loss)}$$

- 1) The EUT mounted on a non-conductive turntable is 2.5 meter above test site ground level.
- 2) During the test , the turn table is rotated until the maximum signal is found.
- 3) Record the field strength meter's level.
- 4) Replace the EUT with dipole/Horn antenna that is connected to a calibrated signal generator.
- 5) Increase the signal generator output till the field strength meter's level is equal to the item (3).
- 6) The signal generator output level with Ant. Gain and cable loss are the rating of equivalent isotropic radiated power.

7.3. Emission Designator

GSM Emission Designator

Emission Designator = 249KGXW  
GSM BW = 249 kHz  
G = Phase Modulation  
X = Cases not otherwise covered  
W = Combination (Audio/Data)

EDGE Emission Designator

Emission Designator = 249KG7W  
GSM BW = 249 kHz  
G = Phase Modulation  
7 = Quantized/Digital Info  
W = Combination (Audio/Data)

WCDMA Emission Designator

Emission Designator = 4M17F9W  
WCDMA BW = 4.17 MHz  
F = Frequency Modulation  
9 = Composite Digital Info  
W = Combination (Audio/Data)

QPSK Modulation

Emission Designator = 4M48G7D  
LTE BW = 4.48 MHz  
G = Phase Modulation  
7 = Quantized/Digital Info  
D = Data transmission; telemetry; telecommand

16QAM Modulation

Emission Designator = 4M48W7D  
LTE BW = 4.48 MHz  
W = Amplitude/Angle Modulated  
7 = Quantized/Digital Info  
D = Data transmission; telemetry; telecommand

64QAM Modulation

Emission Designator = 4M48W7D  
LTE BW = 4.48 MHz  
W = Amplitude/Angle Modulated  
7 = Quantized/Digital Info  
D = Data transmission; telemetry; telecommand

## 8. TEST DATA

### 8.1 EFFECTIVE RADIATED POWER

Freq (MHz)	Mod/ Bandwidth	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit W	ERP	
									W	dBm
824.7	LTE B5/ 1.4 MHz	QPSK	-33.28	30.33	-10.24	1.28	H	< 7.00	0.076	18.81
		16-QAM	-34.09	29.52	-10.24	1.28	H		0.063	18.00
		64-QAM	-35.13	28.48	-10.24	1.28	H		0.050	16.96
		256-QAM	-38.14	25.47	-10.24	1.28	H		0.025	13.95
836.5		QPSK	-33.92	30.26	-10.19	1.29	H		0.076	18.78
		16-QAM	-34.70	29.48	-10.19	1.29	H		0.063	18.00
		64-QAM	-35.79	28.39	-10.19	1.29	H		0.049	16.91
		256-QAM	-38.74	25.44	-10.19	1.29	H		0.025	13.96
848.3		QPSK	-33.89	30.10	-10.14	1.30	H		0.073	18.66
		16-QAM	-34.68	29.31	-10.14	1.30	H		0.061	17.87
		64-QAM	-35.70	28.29	-10.14	1.30	H		0.048	16.85
		256-QAM	-38.76	25.23	-10.14	1.30	H		0.024	13.79

Freq (MHz)	Mod/ Bandwidth	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit W	ERP	
									W	dBm
825.5	LTE B5/ 3 MHz	QPSK	-33.26	30.38	-10.24	1.28	H	< 7.00	0.077	18.86
		16-QAM	-34.08	29.56	-10.24	1.28	H		0.064	18.04
		64-QAM	-35.13	28.51	-10.24	1.28	H		0.050	16.99
		256-QAM	-38.18	25.46	-10.24	1.28	H		0.025	13.94
836.5		QPSK	-33.28	30.90	-10.19	1.29	H		0.088	19.42
		16-QAM	-34.11	30.07	-10.19	1.29	H		0.072	18.59
		64-QAM	-35.10	29.08	-10.19	1.29	H		0.058	17.60
		256-QAM	-38.17	26.01	-10.19	1.29	H		0.028	14.53
847.5		QPSK	-33.98	30.05	-10.15	1.30	H		0.072	18.60
		16-QAM	-34.73	29.30	-10.15	1.30	H		0.061	17.85
		64-QAM	-35.78	28.25	-10.15	1.30	H		0.048	16.80
		256-QAM	-38.87	25.16	-10.15	1.30	H		0.024	13.71

Freq (MHz)	Mod/ Bandwidth	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit W	ERP	
									W	dBm
826.5	LTE B5/ 5 MHz	QPSK	-33.27	30.44	-10.24	1.28	H	< 7.00	0.078	18.93
		16-QAM	-34.06	29.65	-10.24	1.28	H		0.065	18.14
		64-QAM	-35.09	28.62	-10.24	1.28	H		0.051	17.11
		256-QAM	-38.10	25.61	-10.24	1.28	H		0.026	14.10
836.5		QPSK	-33.17	31.01	-10.19	1.29	H		0.090	19.53
		16-QAM	-34.01	30.17	-10.19	1.29	H		0.074	18.69
		64-QAM	-35.09	29.09	-10.19	1.29	H		0.058	17.61
		256-QAM	-38.10	26.08	-10.19	1.29	H		0.029	14.60
846.5		QPSK	-33.99	30.24	-10.15	1.30	H		0.076	18.79
		16-QAM	-34.80	29.43	-10.15	1.30	H		0.063	17.98
		64-QAM	-35.82	28.41	-10.15	1.30	H		0.050	16.96
		256-QAM	-38.82	25.41	-10.15	1.30	H		0.025	13.96

6	Mod/ Bandwidth	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit W	ERP	
									W	dBm
829.0	LTE B5/ 10 MHz	QPSK	-33.19	30.62	-10.22	1.28	H	< 7.00	0.082	19.12
		16-QAM	-34.02	29.79	-10.22	1.28	H		0.067	18.29
		64-QAM	-35.10	28.71	-10.22	1.28	H		0.053	17.21
		256-QAM	-38.12	25.69	-10.22	1.28	H		0.026	14.19
836.5		QPSK	-33.04	31.14	-10.19	1.29	H		0.093	19.66
		16-QAM	-33.87	30.31	-10.19	1.29	H		0.076	18.83
		64-QAM	-34.89	29.29	-10.19	1.29	H		0.060	17.81
		256-QAM	-37.90	26.28	-10.19	1.29	H		0.030	14.80
844.0		QPSK	-33.93	30.21	-10.16	1.30	H		0.075	18.75
		16-QAM	-34.77	29.37	-10.16	1.30	H		0.062	17.91
		64-QAM	-35.82	28.32	-10.16	1.30	H		0.049	16.86
		256-QAM	-38.89	25.25	-10.16	1.30	H		0.024	13.79

### 8.3 RADIATED SPURIOUS EMISSIONS

- ▣ OPERATING FREQUENCY: 824.70 MHz
- ▣ MEASURED OUTPUT POWER: 20.96 dBm = 0.125 W
- ▣ MODE: LTE B5
- ▣ MODULATION SIGNAL: 1.4 MHz QPSK
- ▣ DISTANCE: 3 meters
- ▣ LIMIT:  $43 + 10 \log_{10}(W) =$  33.96 dBc

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	dBc
20407 (824.7)	1,649.40	-51.78	9.50	-62.54	1.84	H	-54.88	75.85
	2,474.10	-46.95	10.60	-51.88	2.29	H	-43.57	64.53
	3,298.80	-56.60	12.30	-58.54	2.69	V	-48.93	69.89
20525 (836.5)	1,673.00	-52.14	9.65	-62.90	1.86	H	-55.11	76.07
	2,509.50	-42.88	10.75	-47.99	2.32	H	-39.56	60.52
	3,346.00	-57.01	12.48	-58.66	2.70	H	-48.89	69.85
20643 (848.3)	1,696.60	-52.52	9.77	-62.95	1.87	V	-55.06	76.02
	2,544.90	-42.23	10.88	-46.34	2.32	H	-37.78	58.75
	3,393.20	-57.81	12.65	-59.76	2.71	V	-49.82	70.79

- ▣ OPERATING FREQUENCY: 836.50 MHz
- ▣ MEASURED OUTPUT POWER: 21.57 dBm = 0.144 W
- ▣ MODE: LTE B5
- ▣ MODULATION SIGNAL: 3 MHz QPSK
- ▣ DISTANCE: 3 meters
- ▣ LIMIT:  $43 + 10 \log_{10}(W) =$  34.57 dBc

Ch	Freq (MHz)	Measured Level (dBi)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	dBc
20415 (825.5)	1,651.00	-51.91	9.50	-62.67	1.84	H	-55.01	76.59
	2,476.50	-44.49	10.60	-49.42	2.29	H	-41.11	62.68
	3,302.00	-56.98	12.30	-58.92	2.69	H	-49.31	70.88
20525 (836.5)	1,673.00	-52.44	9.65	-63.20	1.86	H	-55.41	76.98
	2,509.50	-42.87	10.75	-47.98	2.32	H	-39.55	61.13
	3,346.00	-57.46	12.48	-59.11	2.70	H	-49.34	70.91
20635 (847.5)	1,695.00	-51.99	9.77	-62.43	1.87	H	-54.53	76.10
	2,542.50	-41.64	10.85	-45.50	2.32	H	-36.97	58.55
	3,390.00	-57.53	12.65	-59.48	2.71	H	-49.54	71.12

- ▣ OPERATING FREQUENCY: 836.50 MHz
- ▣ MEASURED OUTPUT POWER: 21.68 dBm = 0.147 W
- ▣ MODE: LTE B5
- ▣ MODULATION SIGNAL: 5 MHz QPSK
- ▣ DISTANCE: 3 meters
- ▣ LIMIT:  $43 + 10 \log_{10}(W) =$  34.68 dBc

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	dBc
20425 (826.5)	1,653.00	-51.46	9.54	-62.26	1.85	H	-54.57	76.25
	2,479.50	-43.71	10.60	-48.52	2.30	H	-40.22	61.90
	3,306.00	-57.87	12.33	-59.86	2.69	H	-50.22	71.91
20525 (836.5)	1,673.00	-52.63	9.65	-63.39	1.86	H	-55.60	77.28
	2,509.50	-43.13	10.75	-48.24	2.32	H	-39.81	61.50
	3,346.00	-57.65	12.48	-59.30	2.70	H	-49.53	71.21
20625 (846.5)	1,693.00	-52.64	9.73	-63.26	1.87	H	-55.40	77.09
	2,539.50	-42.43	10.85	-46.29	2.32	H	-37.76	59.45
	3,386.00	-57.67	12.63	-59.67	2.72	H	-49.76	71.44

- ▣ OPERATING FREQUENCY: 836.50 MHz
- ▣ MEASURED OUTPUT POWER: 21.81 dBm = 0.152 W
- ▣ MODE: LTE B5
- ▣ MODULATION SIGNAL: 10 MHz QPSK
- ▣ DISTANCE: 3 meters
- ▣ LIMIT:  $43 + 10 \log_{10} (W) =$  34.81 dBc

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	dBc
20450 (829.0)	1,658.00	-52.22	9.58	-63.06	1.85	H	-55.33	77.15
	2,487.00	-45.09	10.65	-50.23	2.30	H	-41.88	63.70
	3,316.00	-56.81	12.38	-58.66	2.68	H	-48.96	70.78
20525 (836.5)	1,673.00	-52.14	9.65	-62.90	1.86	H	-55.11	76.92
	2,509.50	-43.76	10.75	-48.87	2.32	H	-40.44	62.26
	3,346.00	-57.24	12.48	-58.89	2.70	H	-49.12	70.93
20600 (844.0)	1,688.00	-51.99	9.73	-62.61	1.87	H	-54.75	76.57
	2,532.00	-42.50	10.80	-47.24	2.33	H	-38.77	60.59
	3,376.00	-56.15	12.60	-58.16	2.72	H	-48.28	70.09

**8.3 OCCUPIED BANDWIDTH**

Band	Band Width	Frequency (MHz)	Modulation	Resource Block Size	Resource Block Offset	Data ( MHz )
5	1.4 MHz	836.5	QPSK	6	0	1.0944
			16-QAM			1.1059
			64-QAM			1.1012
			256-QAM			1.0973
	3 MHz		QPSK	15		2.7239
			16-QAM			2.7122
			64-QAM			2.7107
			256-QAM			2.7157
	5 MHz		QPSK	25		4.5175
			16-QAM			4.5242
			64-QAM			4.5274
			256-QAM			4.5080
	10 MHz		QPSK	50		9.0169
			16-QAM			9.0235
			64-QAM			9.0072
			256-QAM			8.9968

**Note:**

1. Plots of the EUT's Occupied Bandwidth are shown Page 33 ~ 48.

**8.4 CONDUCTED SPURIOUS EMISSIONS**

Band	Band Width (MHz)	Frequency (MHz)	Frequency of Maximum Harmonic (GHz)	Factor (dB)	Measurement Maximum Data (dBm)	Result (dBm)	Limit (dBm)
5	1.4	824.7	3.7079	27.976	-67.233	-39.257	-13.00
		836.5	3.6925	27.976	-67.221	-39.245	
		848.3	3.6885	27.976	-67.278	-39.302	
	3	825.5	3.6980	27.976	-67.346	-39.370	
		836.5	3.6885	27.976	-67.411	-39.435	
		847.5	3.7204	27.976	-67.314	-39.338	
	5	826.5	3.6955	27.976	-67.366	-39.390	
		836.5	3.7000	27.976	-67.347	-39.371	
		846.5	3.7219	27.976	-67.117	-39.141	
	10	829.0	3.7000	27.976	-67.118	-39.142	
		836.5	3.7209	27.976	-67.524	-39.548	
		844.0	3.6785	27.976	-67.193	-39.217	

**Note:**

1. Plots of the EUT's Conducted Spurious Emissions are shown Page 73 ~ 84.
2. Conducted Spurious Emissions was Tested QPSK Modulation, Resource Block Size 1 and Resource Block Offset 0
3. Result (dBm) = Measurement Maximum Data (dBm) + Factor (dB)
4. Factor(dB) = Cable Loss + Attenuator + Power Splitter

Frequency Range (GHz)	Factor [dB]
0.03 – 1	25.270
1 – 5	27.976
5 – 10	28.591
10 – 15	29.116
15 – 20	29.489
Above 20	30.131

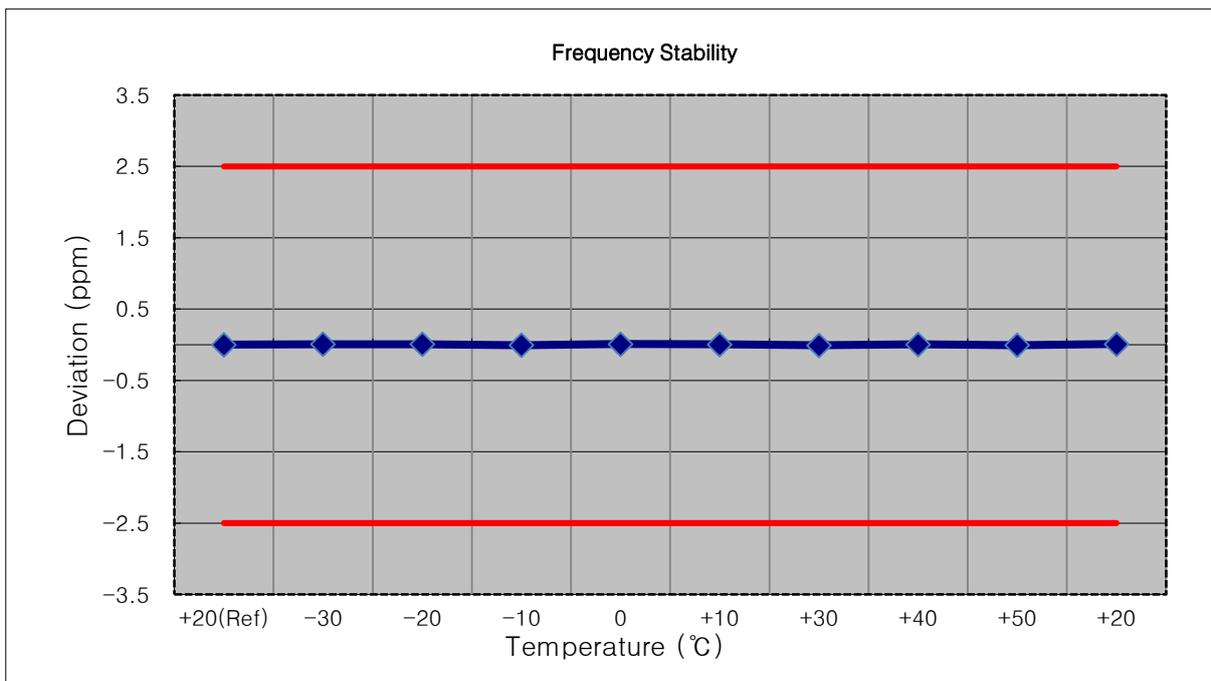
**8.5 BAND EDGE**

- Plots of the EUT's Band Edge are shown Page 49 ~ 72.

**8.6 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE**

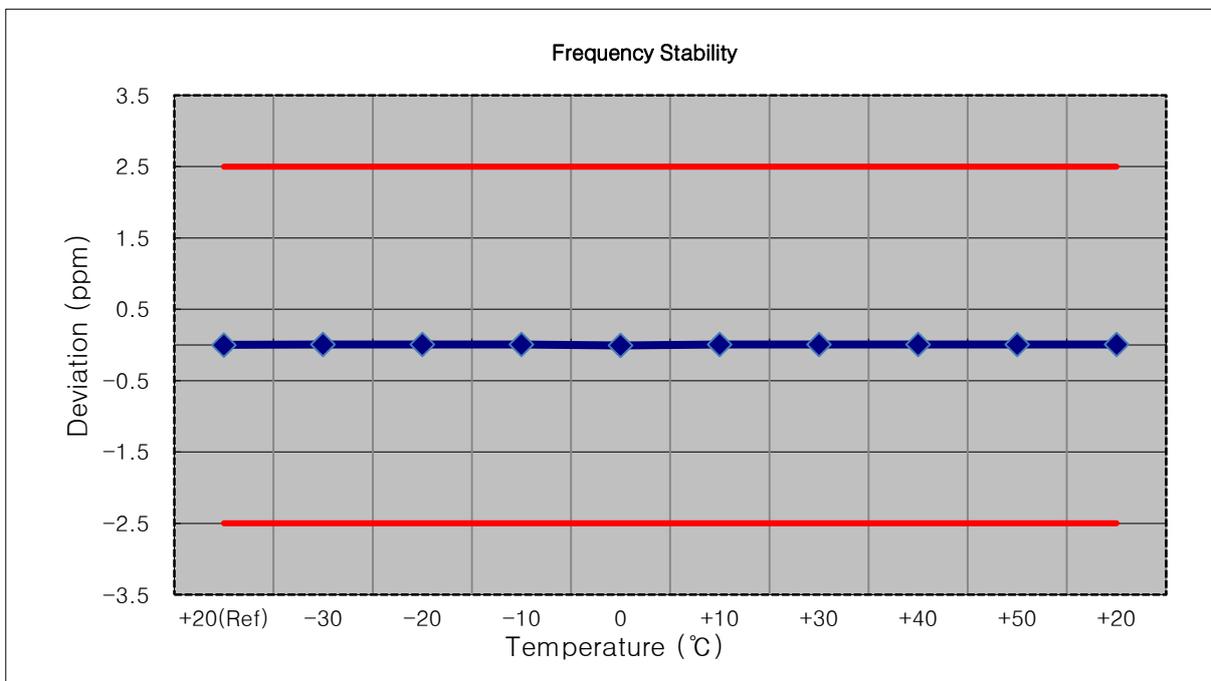
- ▣ MODE: LTE B5
- ▣ OPERATING FREQUENCY: 836,500,000 Hz
- ▣ CHANNEL: 20525 (1.4 MHz)
- ▣ REFERENCE VOLTAGE: 3.86 VDC
- ▣ DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.860	+20(Ref)	836 499 994	0.0	0.000 000	0.000
100%		-30	836 499 999	5.3	0.000 001	0.006
100%		-20	836 500 000	6.2	0.000 001	0.007
100%		-10	836 499 989	-5.4	-0.000 001	-0.006
100%		0	836 500 001	6.9	0.000 001	0.008
100%		+10	836 499 998	4.3	0.000 001	0.005
100%		+30	836 499 987	-6.7	-0.000 001	-0.008
100%		+40	836 499 999	4.9	0.000 001	0.006
100%		+50	836 499 988	-5.8	-0.000 001	-0.007
Batt. Endpoint		3.600	+20	836 500 002	8.0	0.000 001



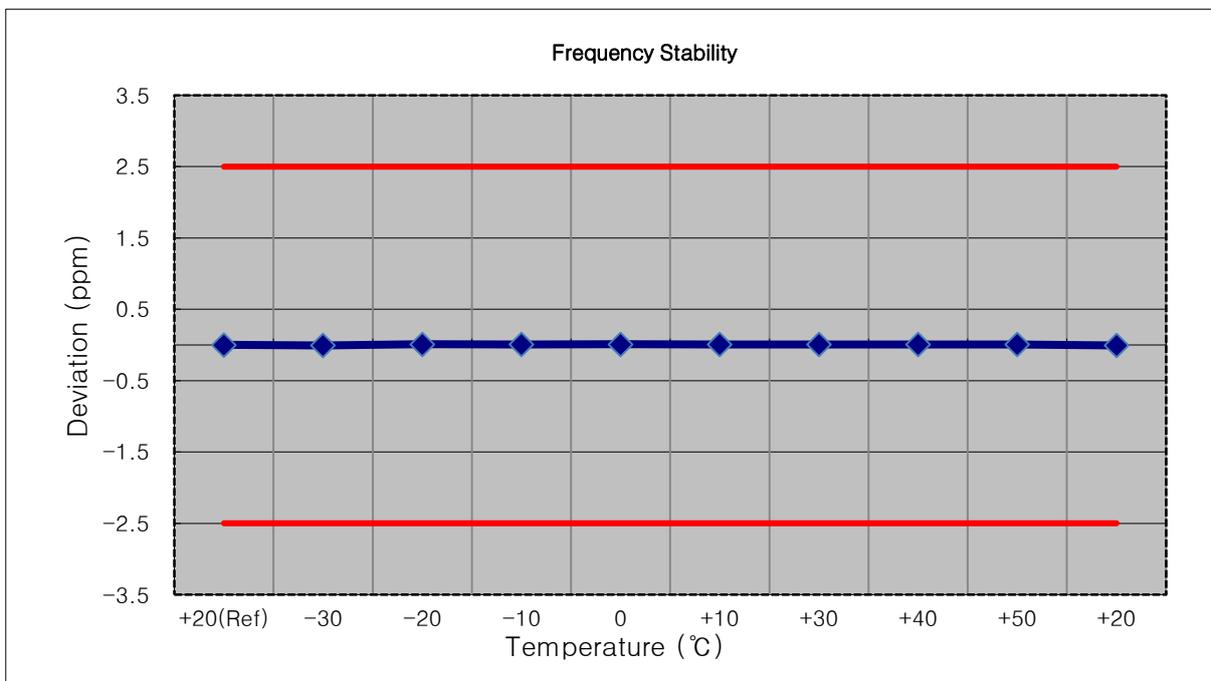
- ▣ MODE: LTE B5
- ▣ OPERATING FREQUENCY: 836,500,000 Hz
- ▣ CHANNEL: 20525 (3 MHz)
- ▣ REFERENCE VOLTAGE: 3.86 VDC
- ▣ DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.860	+20(Ref)	836 500 006	0.0	0.000 000	0.000
100%		-30	836 500 011	5.3	0.000 001	0.006
100%		-20	836 500 012	5.8	0.000 001	0.007
100%		-10	836 500 012	5.8	0.000 001	0.007
100%		0	836 500 001	-5.1	-0.000 001	-0.006
100%		+10	836 500 011	5.5	0.000 001	0.007
100%		+30	836 500 012	6.0	0.000 001	0.007
100%		+40	836 500 011	5.3	0.000 001	0.006
100%		+50	836 500 011	5.1	0.000 001	0.006
Batt. Endpoint		3.600	+20	836 500 012	5.9	0.000 001



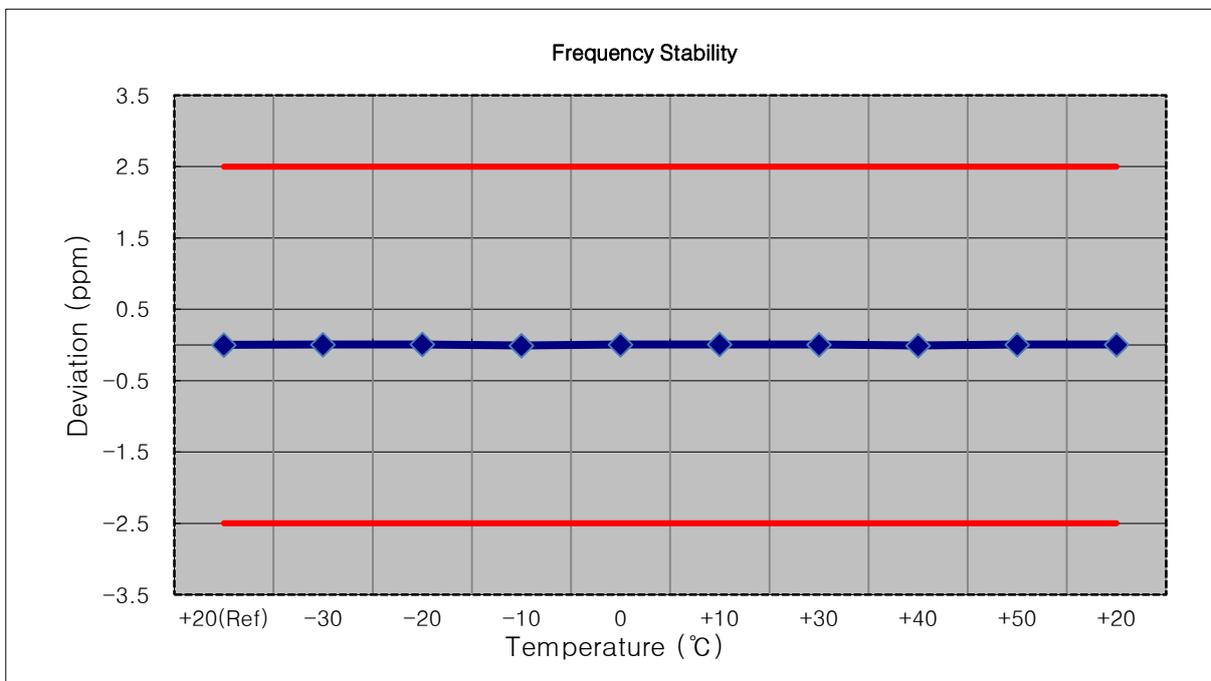
- ▣ MODE: LTE B5
- ▣ OPERATING FREQUENCY: 836,500,000 Hz
- ▣ CHANNEL: 20525 (5 MHz)
- ▣ REFERENCE VOLTAGE: 3.86 VDC
- ▣ DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.860	+20(Ref)	836 500 006	0.0	0.000 000	0.000
100%		-30	836 500 002	-4.6	-0.000 001	-0.005
100%		-20	836 500 013	7.1	0.000 001	0.008
100%		-10	836 500 013	6.3	0.000 001	0.008
100%		0	836 500 014	7.3	0.000 001	0.009
100%		+10	836 500 013	6.4	0.000 001	0.008
100%		+30	836 500 012	5.5	0.000 001	0.007
100%		+40	836 500 012	5.7	0.000 001	0.007
100%		+50	836 500 013	6.3	0.000 001	0.008
Batt. Endpoint		3.600	+20	836 500 001	-5.3	-0.000 001



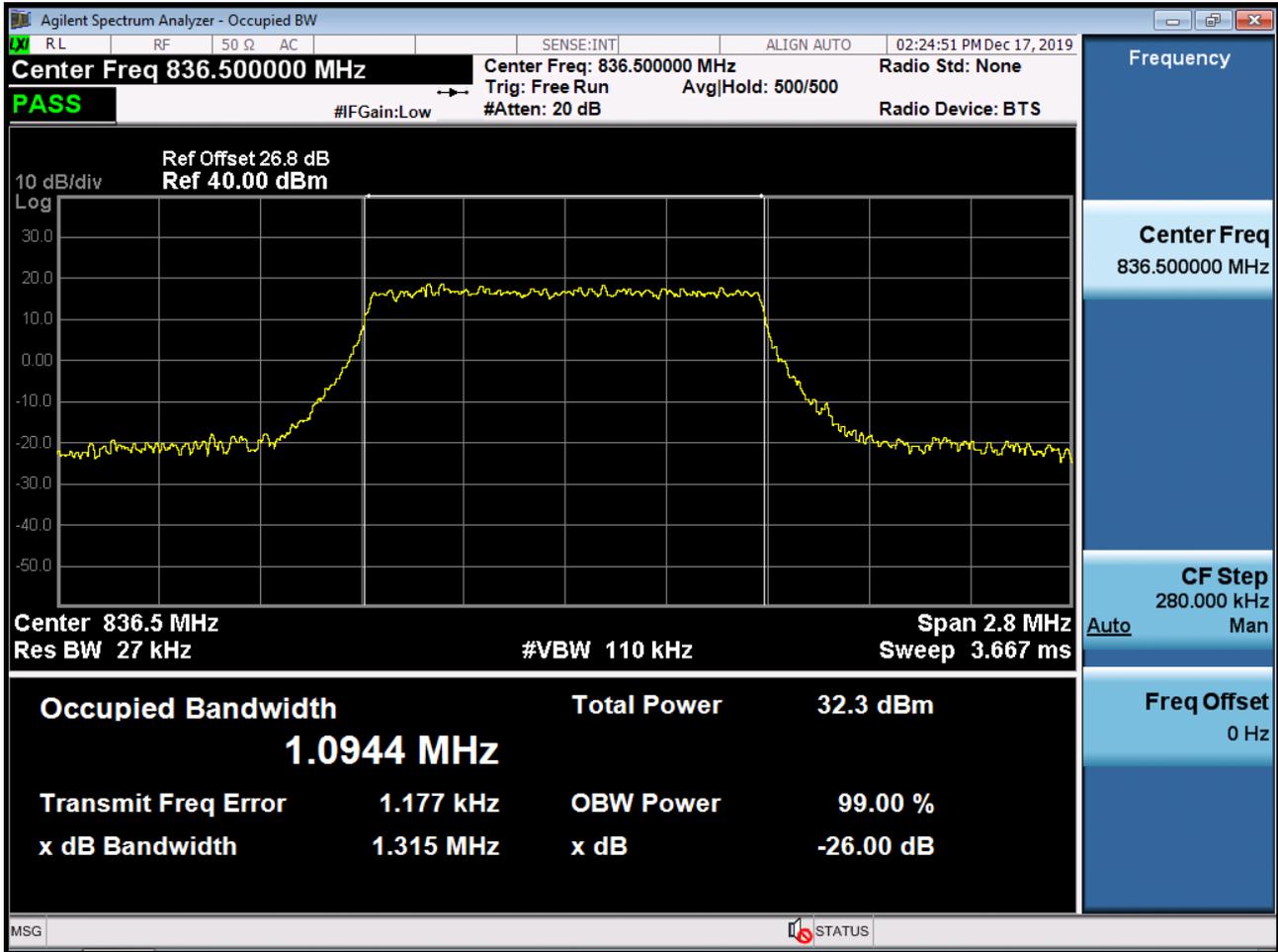
- ▣ MODE: LTE B5
- ▣ OPERATING FREQUENCY: 836,500,000 Hz
- ▣ CHANNEL: 20525 (10 MHz)
- ▣ REFERENCE VOLTAGE: 3.86 VDC
- ▣ DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.860	+20(Ref)	836 500 007	0.0	0.000 000	0.000
100%		-30	836 500 011	4.0	0.000 000	0.005
100%		-20	836 500 012	5.8	0.000 001	0.007
100%		-10	836 500 000	-7.1	-0.000 001	-0.008
100%		0	836 500 011	4.5	0.000 001	0.005
100%		+10	836 500 013	6.1	0.000 001	0.007
100%		+30	836 500 011	3.9	0.000 000	0.005
100%		+40	836 500 000	-6.3	-0.000 001	-0.008
100%		+50	836 500 012	4.9	0.000 001	0.006
Batt. Endpoint		3.600	+20	836 500 011	4.8	0.000 001

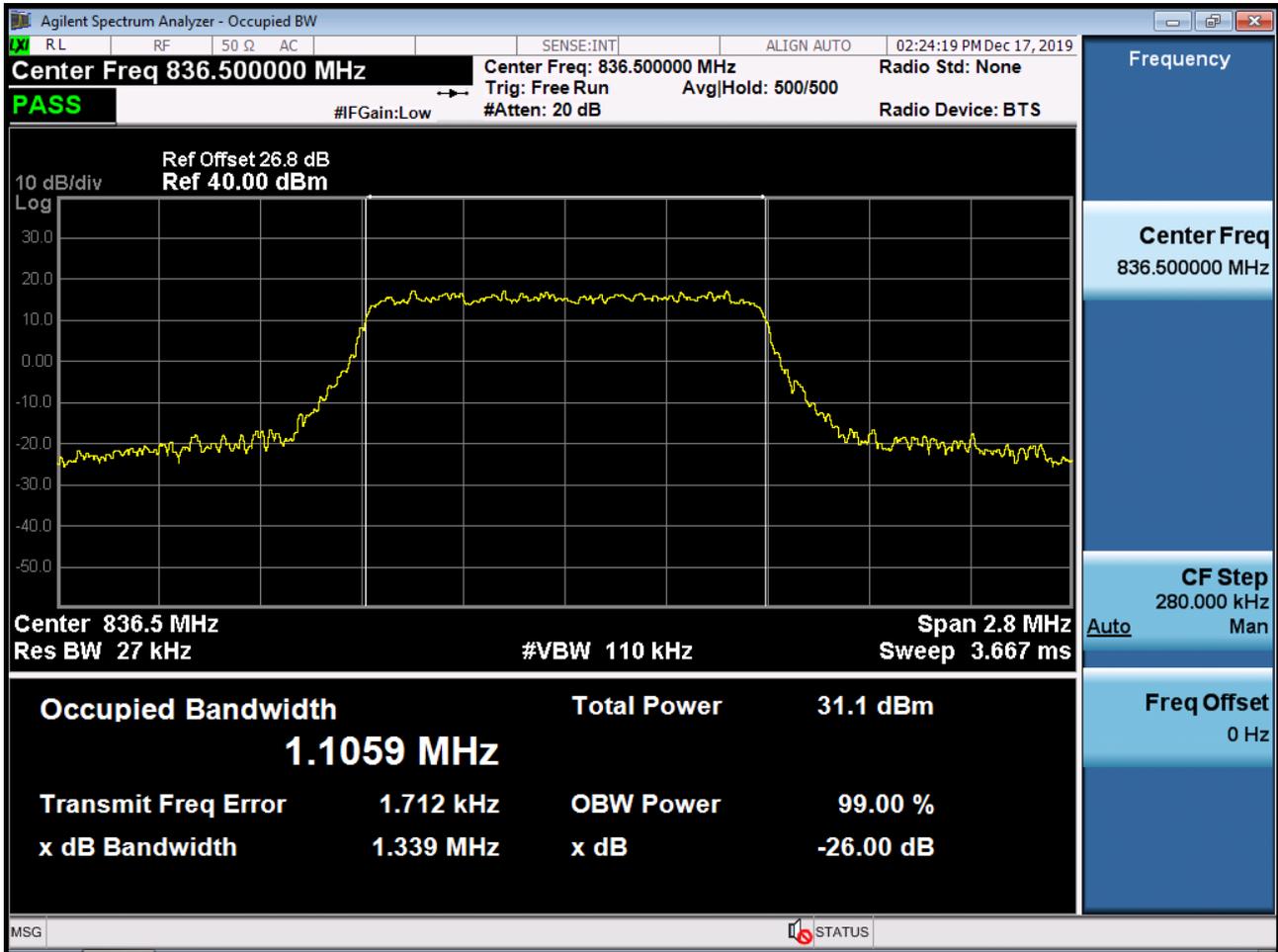


## 9. TEST PLOTS

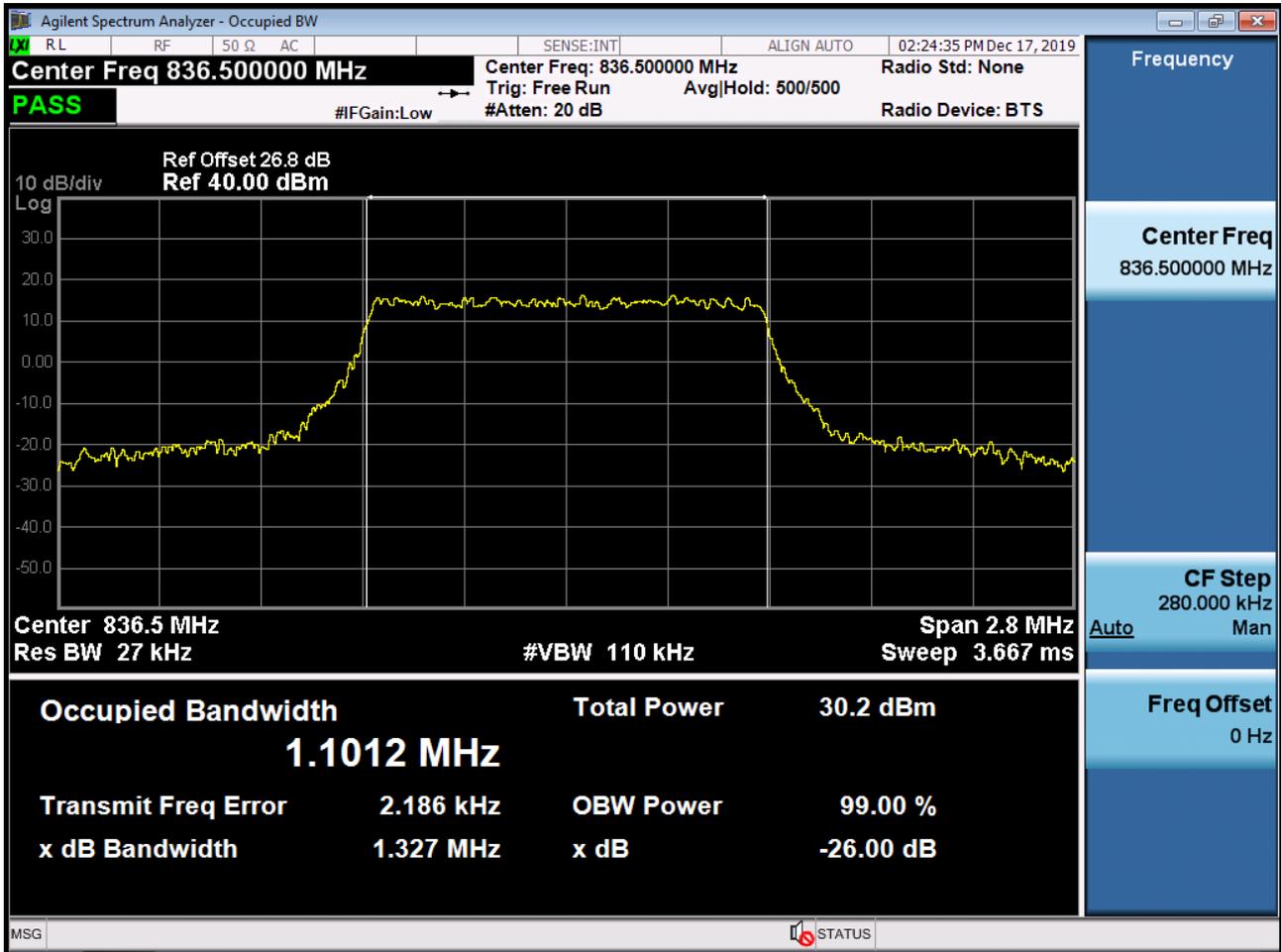
BAND 5. Occupied Bandwidth Plot (1.4M BW Ch.20525 QPSK\_RB6\_0)



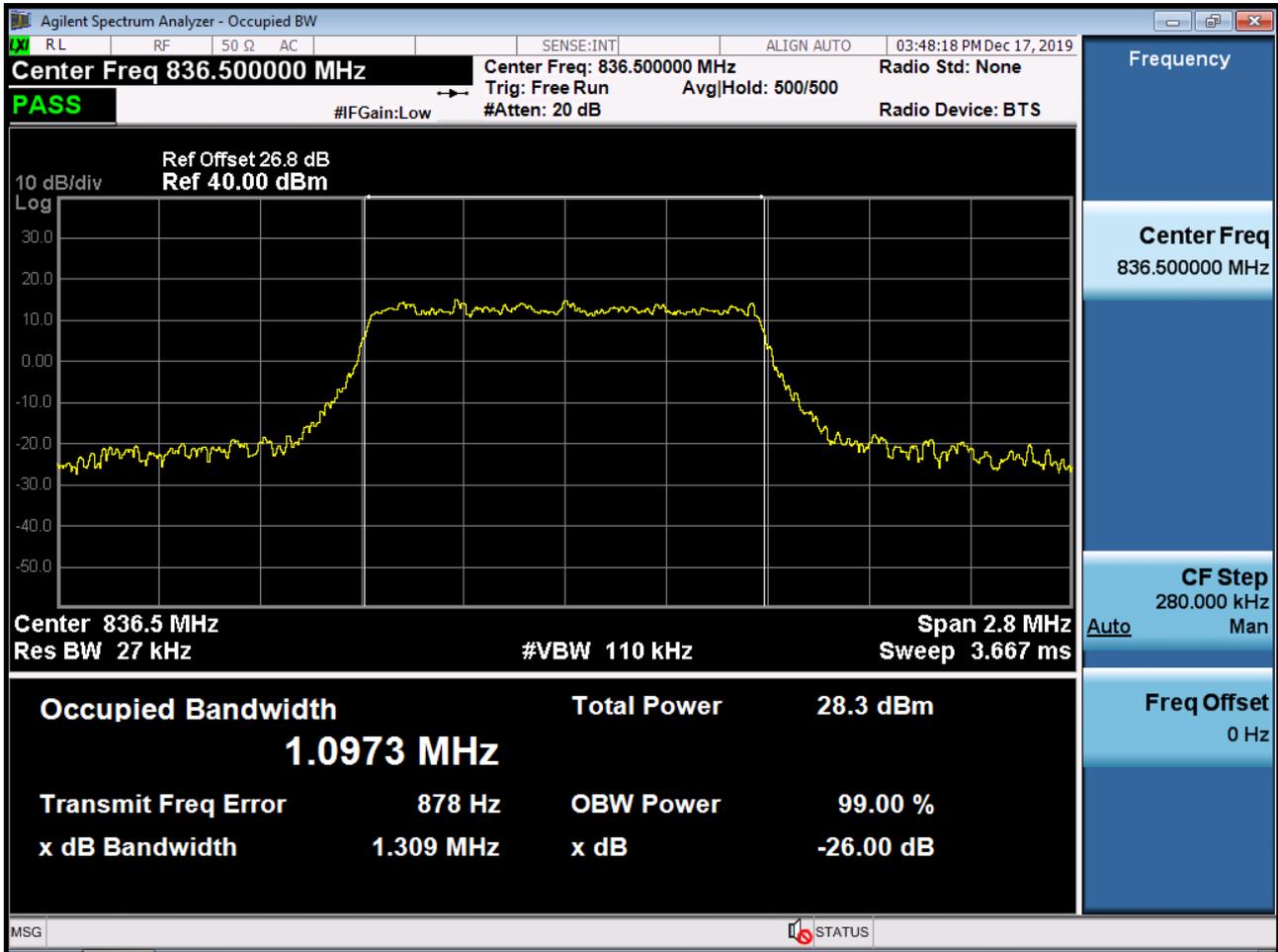
BAND 5. Occupied Bandwidth Plot (1.4M BW Ch.20525 16QAM\_RB6\_0)



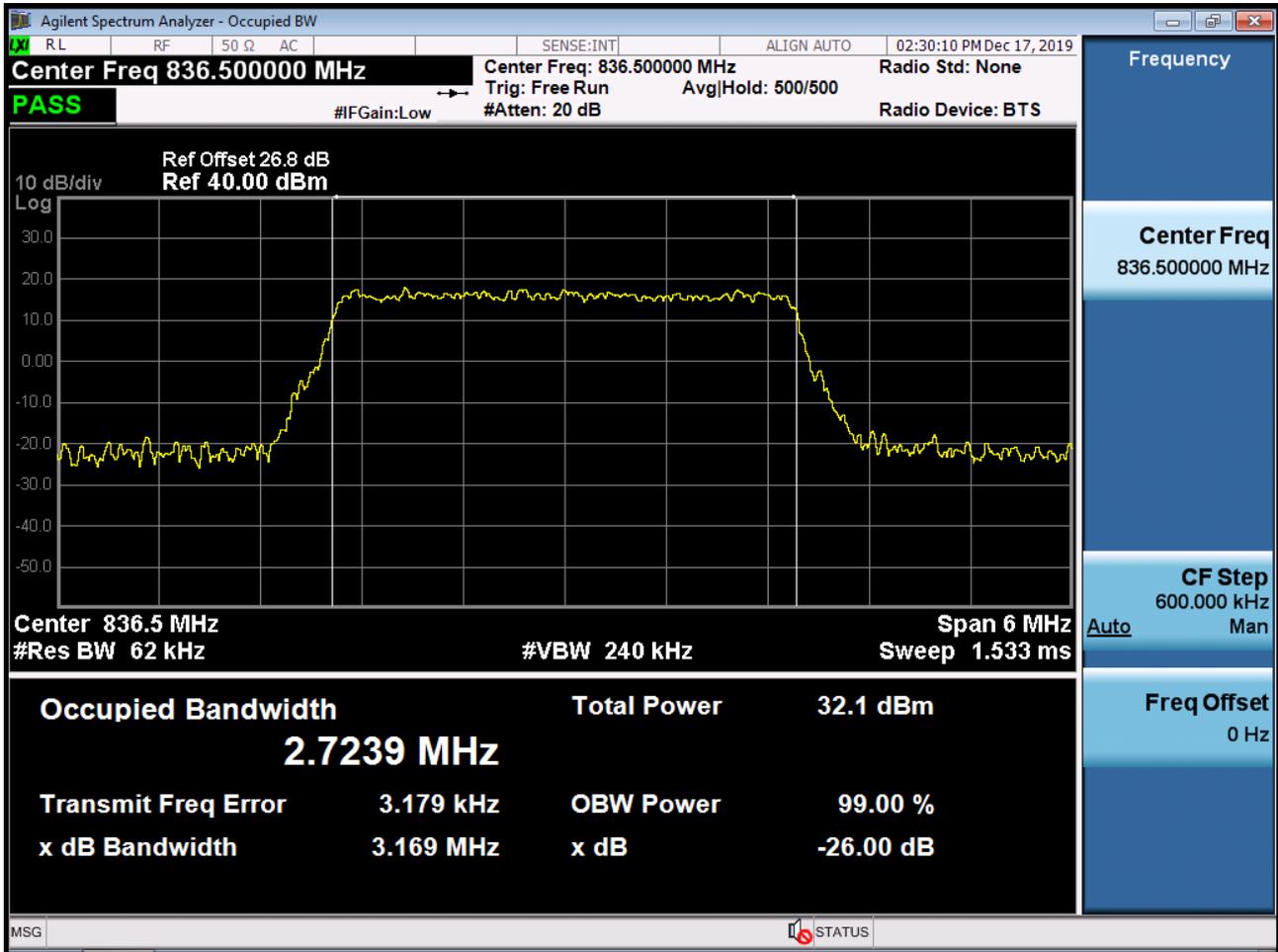
BAND 5. Occupied Bandwidth Plot (1.4M BW Ch.20525 64QAM\_RB6\_0)



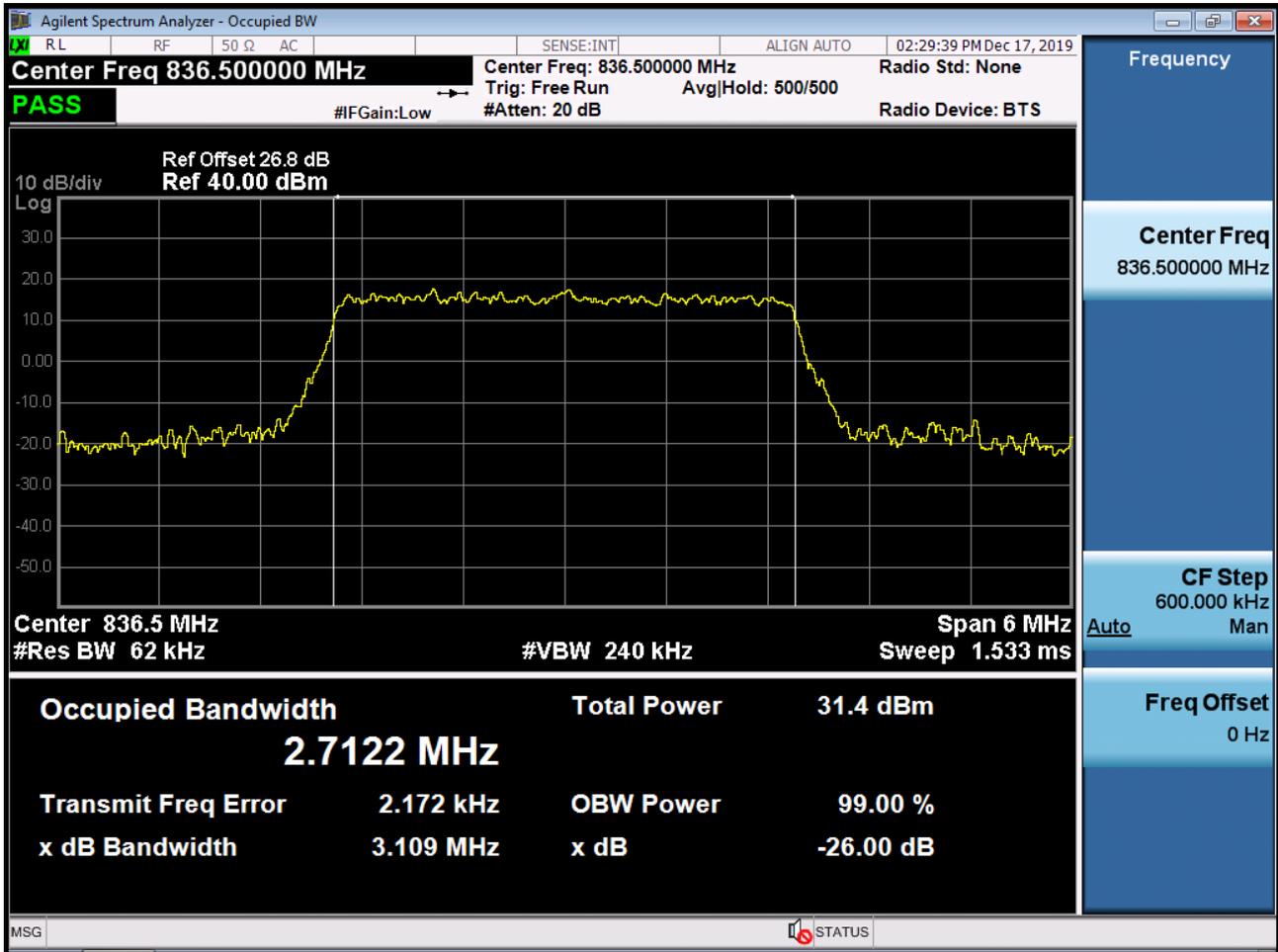
BAND 5. Occupied Bandwidth Plot (1.4M BW Ch.20525 256QAM\_RB6\_0)



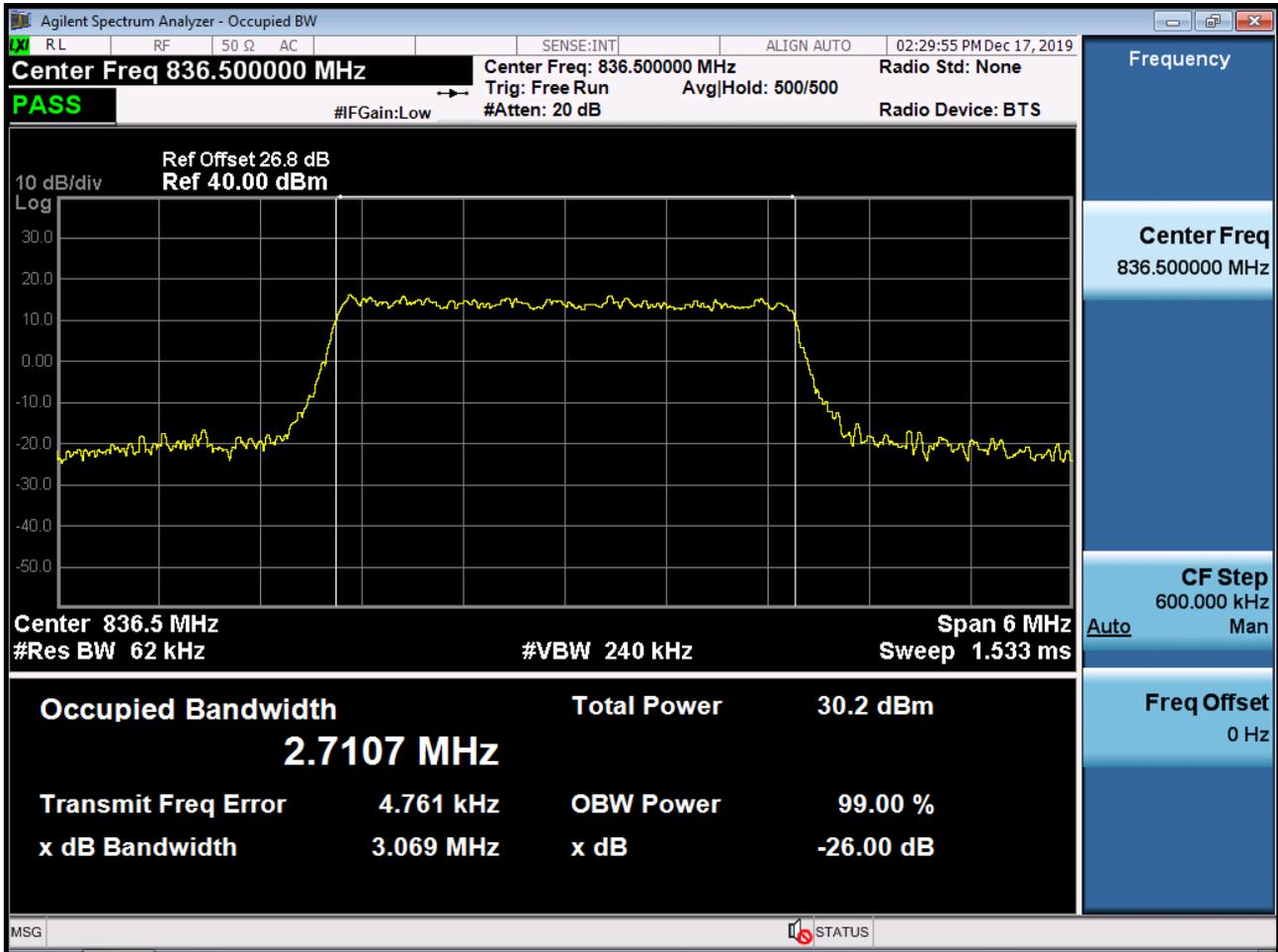
BAND 5. Occupied Bandwidth Plot (3M BW Ch.20525 QPSK\_RB15\_0)



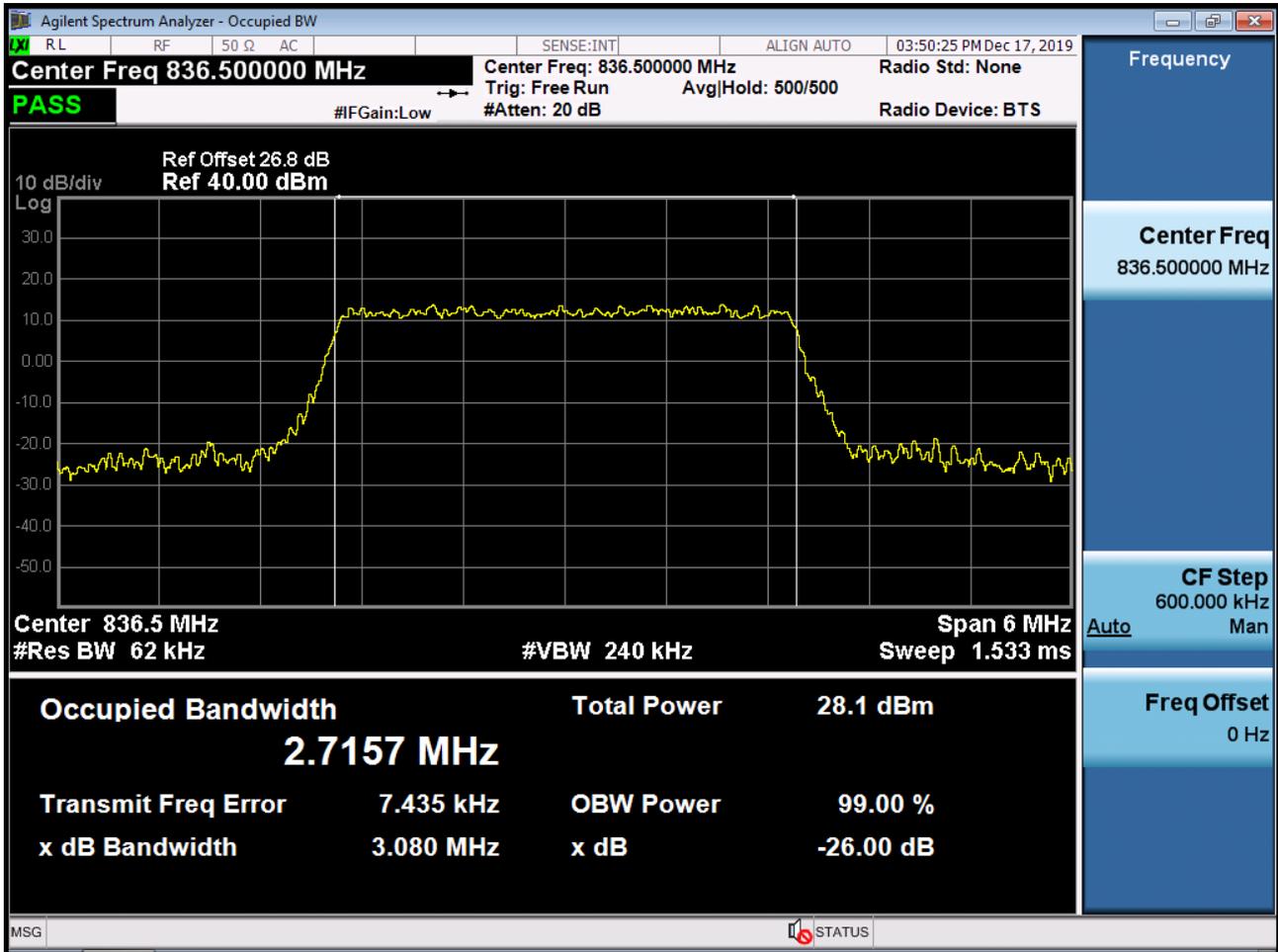
BAND 5. Occupied Bandwidth Plot (3M BW Ch.20525 16QAM\_RB15\_0)



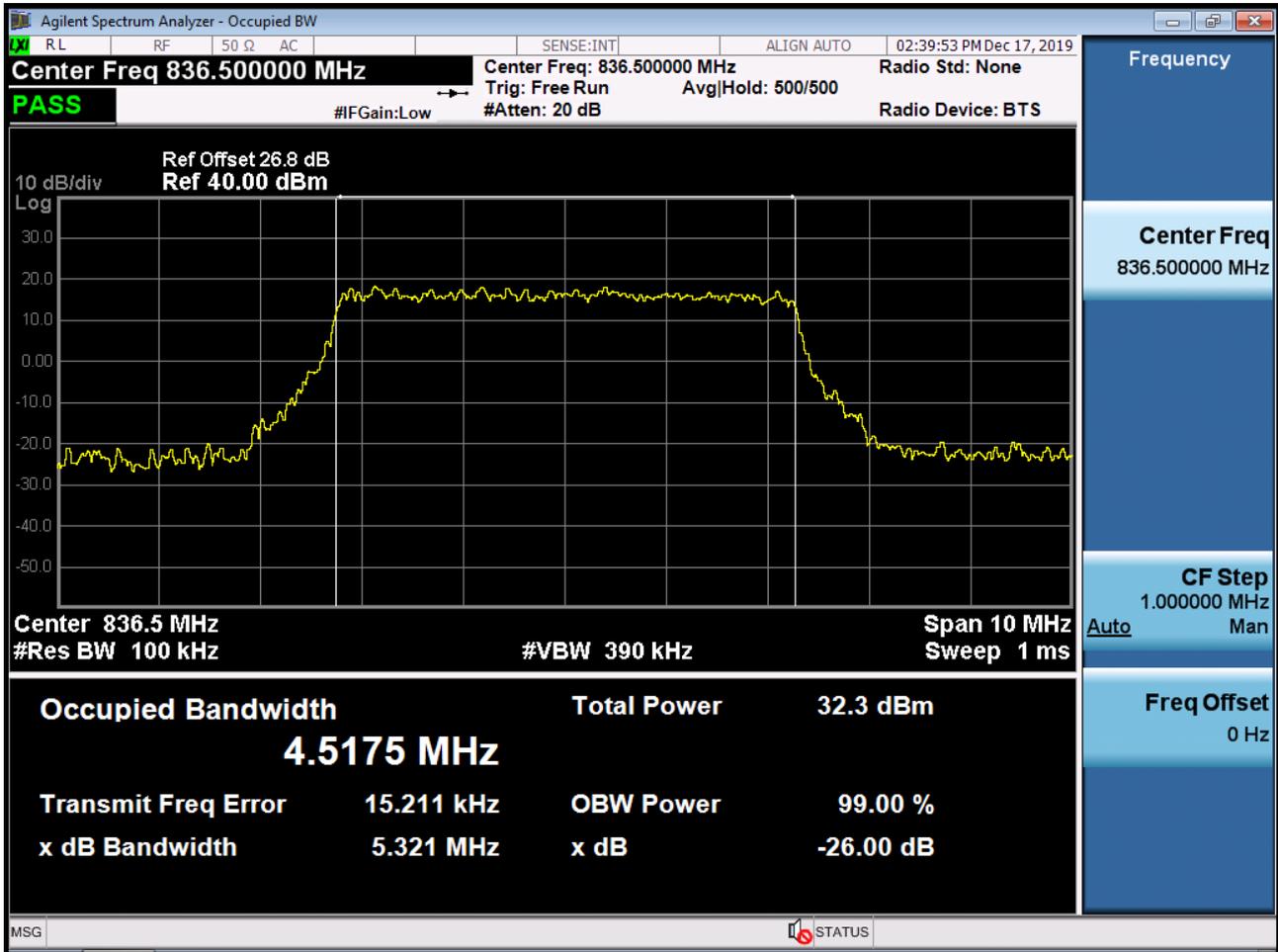
BAND 5. Occupied Bandwidth Plot (3M BW Ch.20525 64QAM\_RB15\_0)



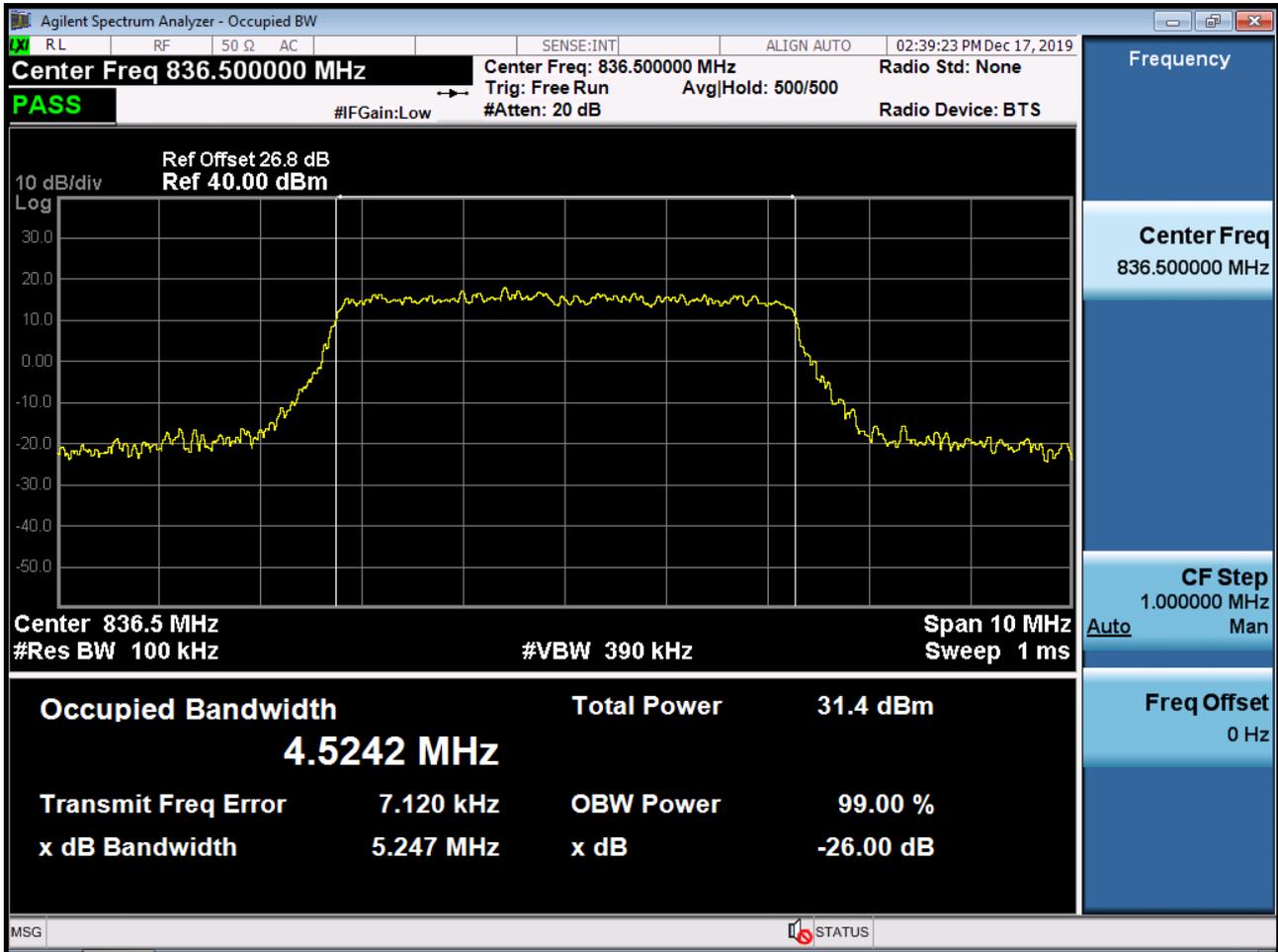
BAND 5. Occupied Bandwidth Plot (3M BW Ch.20525 256QAM\_RB15\_0)



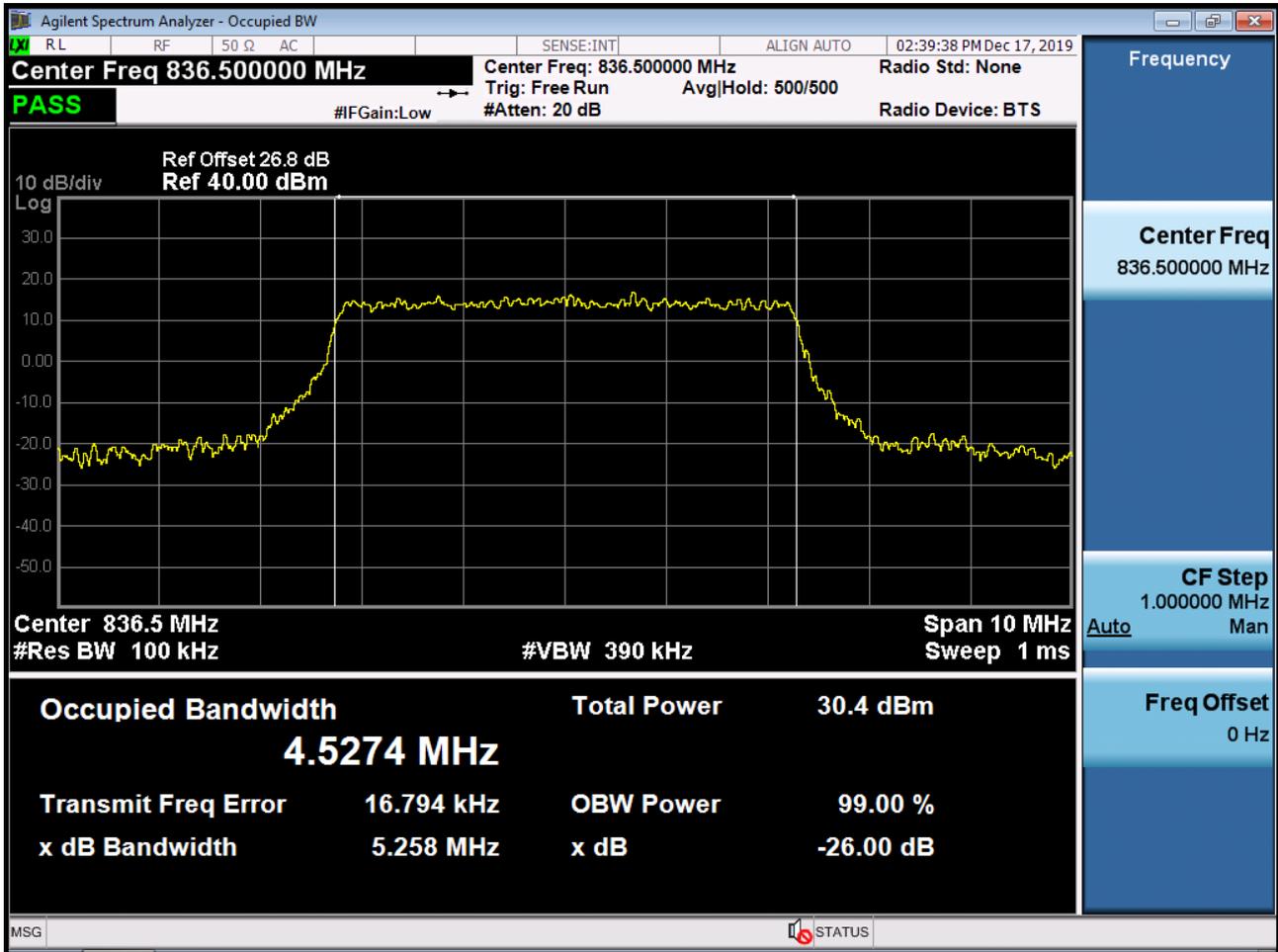
BAND 5. Occupied Bandwidth Plot (5M BW Ch.20525 QPSK\_RB25\_0)



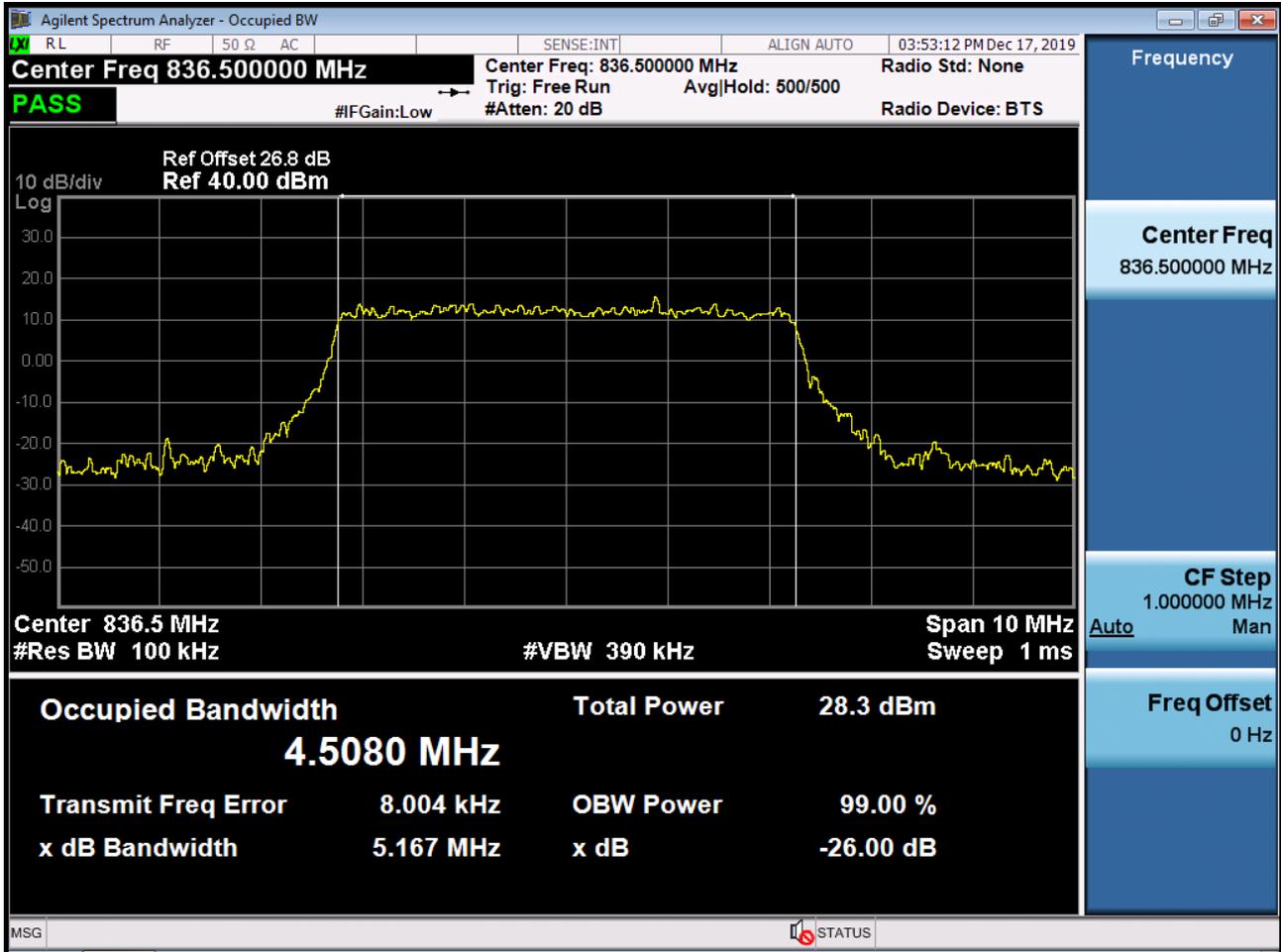
BAND 5. Occupied Bandwidth Plot (5M BW Ch.20525 16QAM\_RB25\_0)



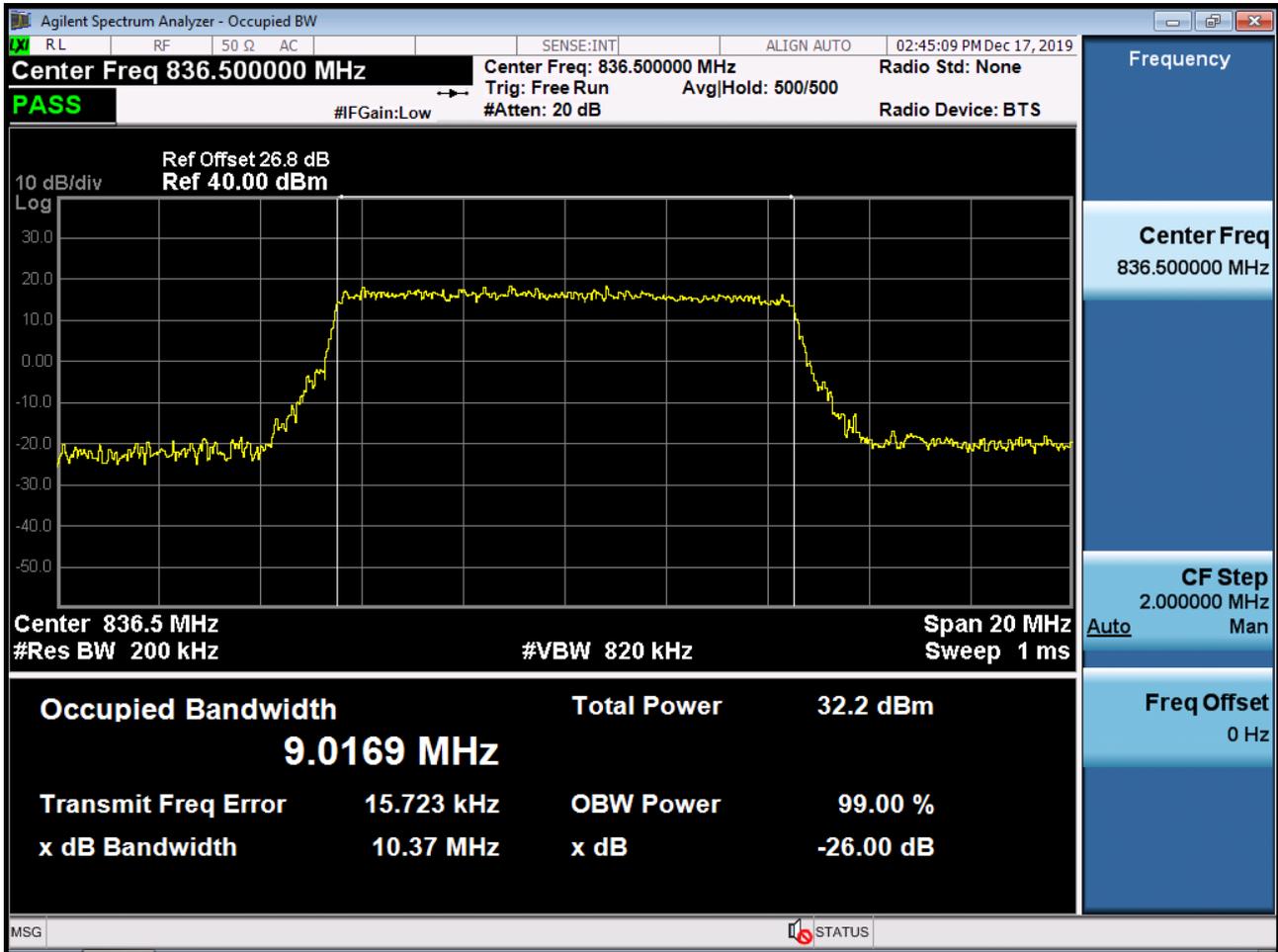
BAND 5. Occupied Bandwidth Plot (5M BW Ch.20525 64QAM\_RB25\_0)



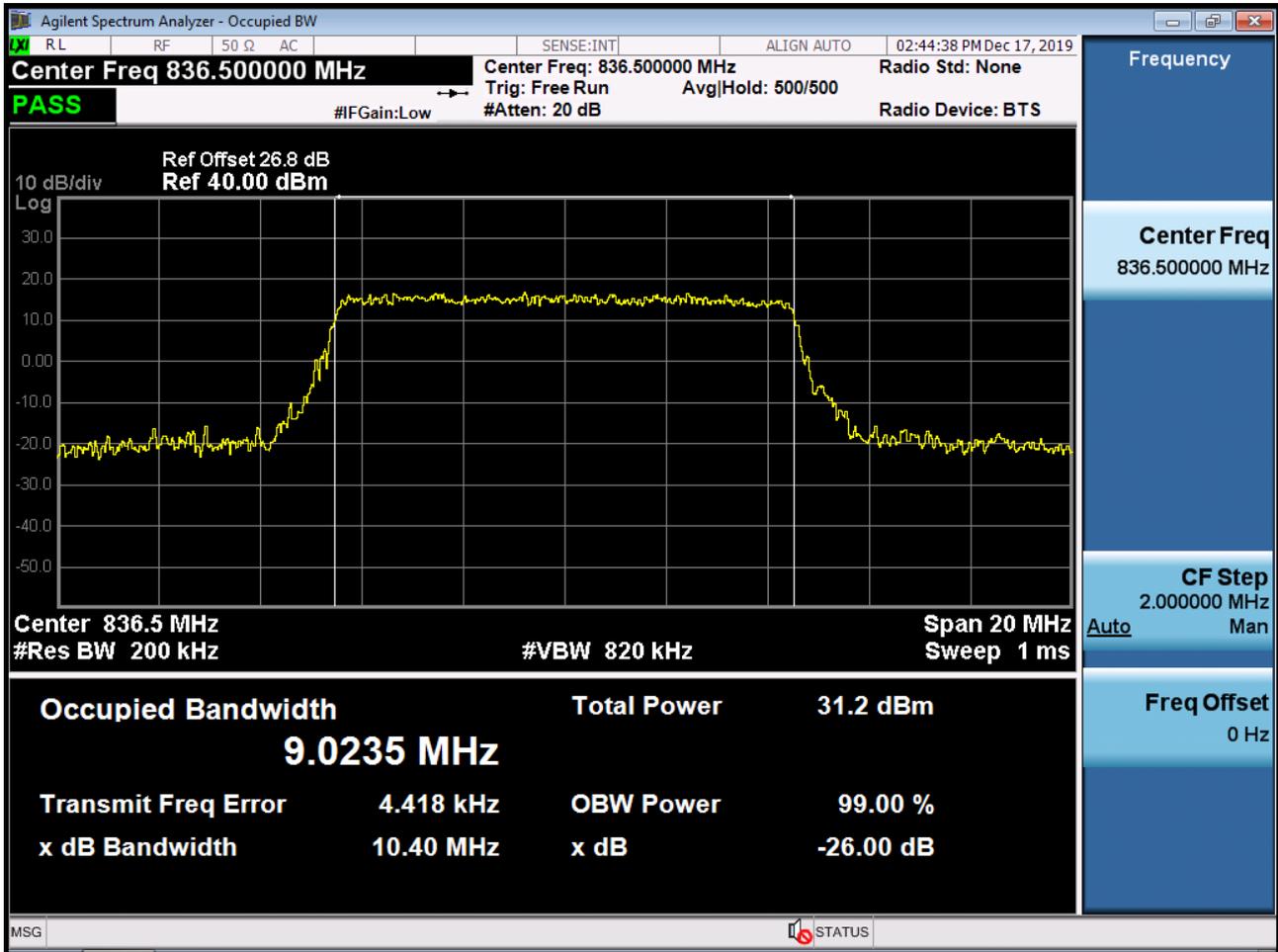
BAND 5. Occupied Bandwidth Plot (5M BW Ch.20525 256QAM\_RB25\_0)



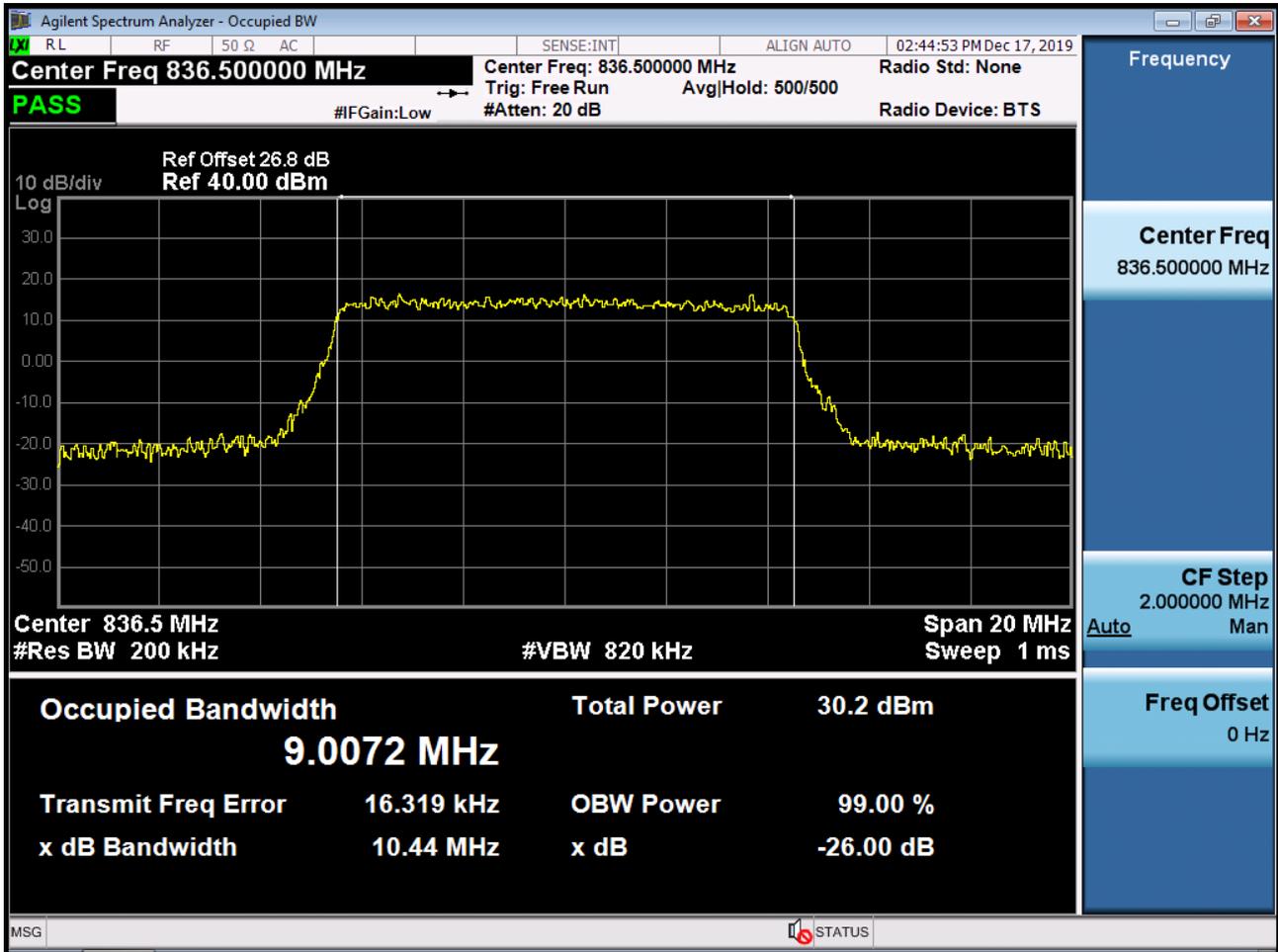
BAND 5. Occupied Bandwidth Plot (10M BW Ch.20525 QPSK\_RB50\_0)



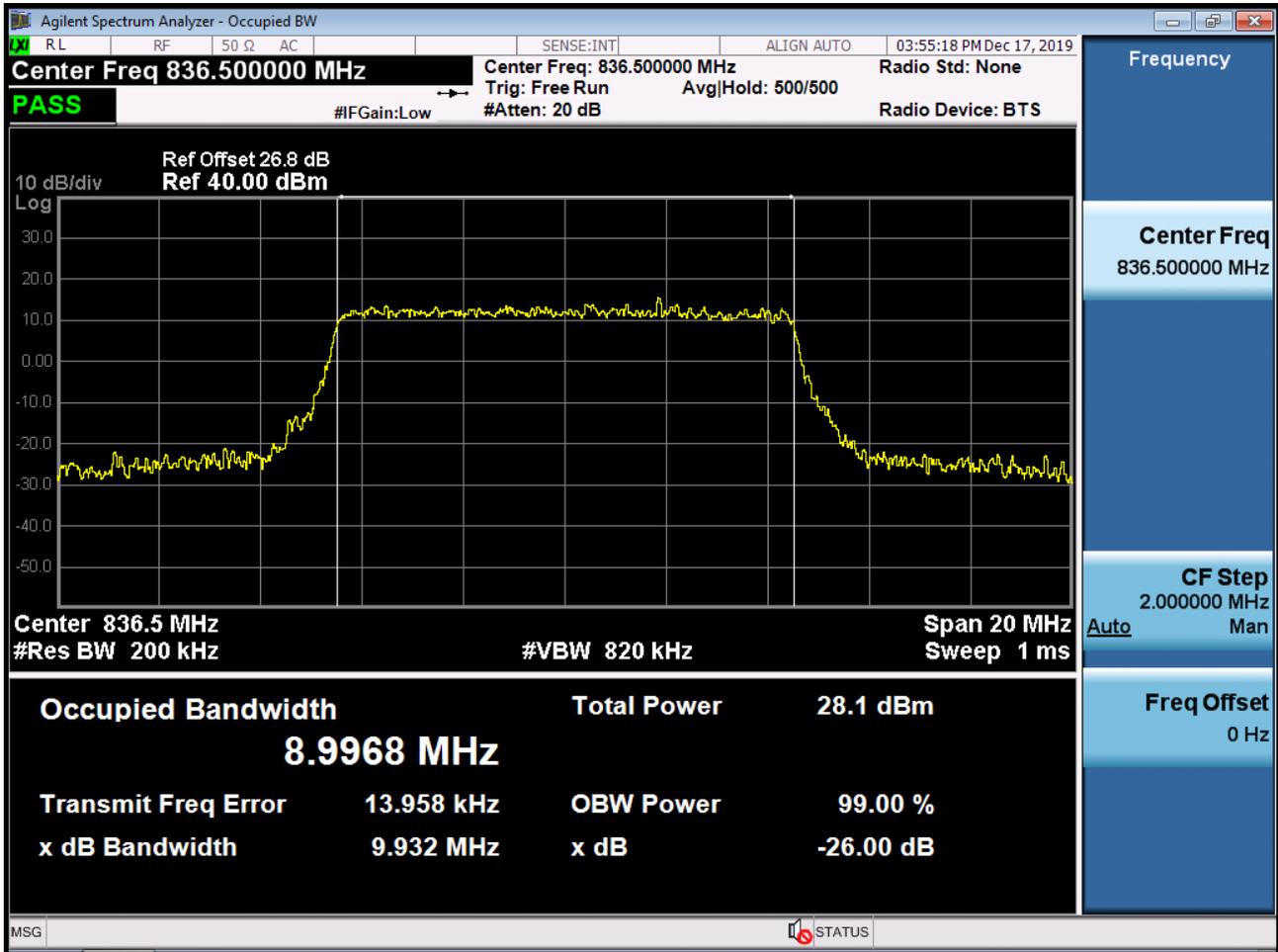
BAND 5. Occupied Bandwidth Plot (10M BW Ch.20525 16QAM\_RB50\_0)



BAND 5. Occupied Bandwidth Plot (10M BW Ch.20525 64QAM\_RB50\_0)



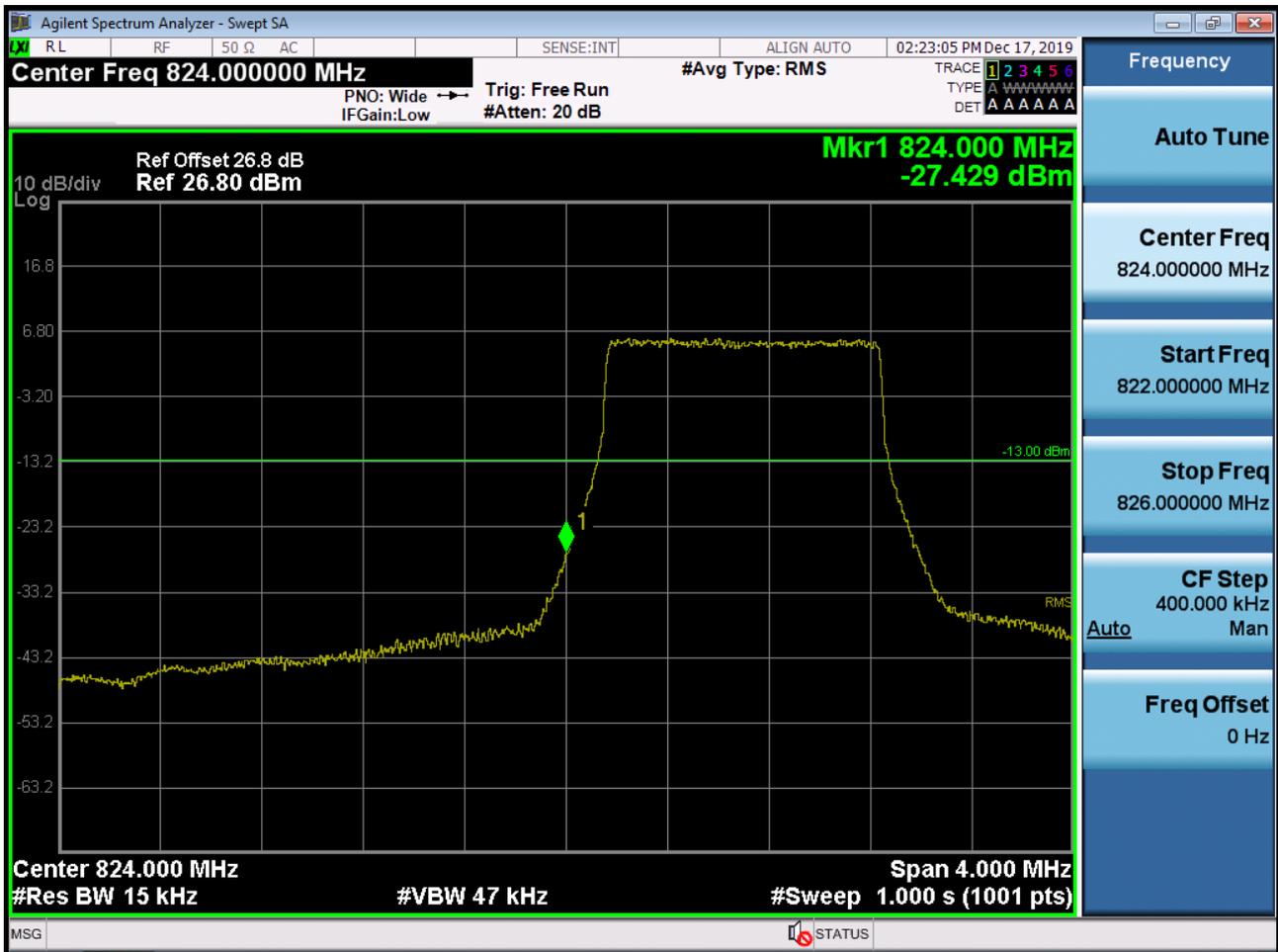
BAND 5. Occupied Bandwidth Plot (10M BW Ch.20525 256QAM\_RB50\_0)



BAND 5. Lower Band Edge Plot (1.4M BW Ch.20407 QPSK\_RB1\_Offset 0)



BAND 5. Lower Band Edge Plot (1.4M BW Ch.20407 QPSK\_RB6\_Offset 0)



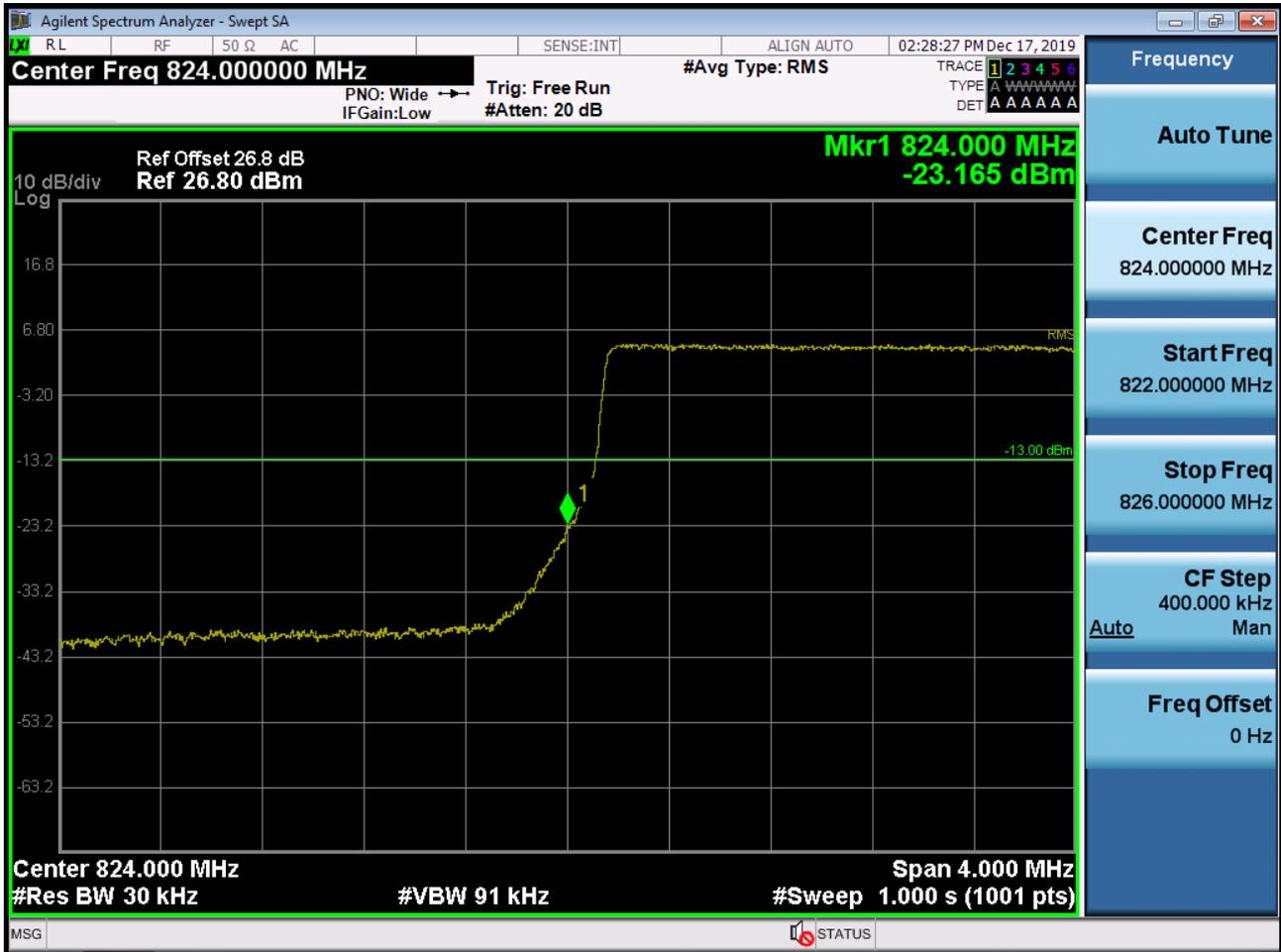
BAND 5. Lower Extended Band Edge Plot (1.4M BW Ch.20407 QPSK\_RB6\_0)



BAND 5. Lower Band Edge Plot (3M BW Ch.20415 QPSK\_RB1\_Offset 0)



BAND 5. Lower Band Edge Plot (3M BW Ch.20415 QPSK\_RB15\_Offset 0)



BAND 5. Lower Extended Band Edge Plot (3M BW Ch.20415 QPSK\_RB15\_0)



BAND 5. Lower Band Edge Plot (5M BW Ch.20425 QPSK\_RB1\_Offset 0)



BAND 5. Lower Band Edge Plot (5M BW Ch.20425 QPSK\_RB25\_Offset 0)



BAND 5. Lower Extended Band Edge Plot (5M BW Ch.20425 QPSK\_RB25\_0)



BAND 5. Lower Band Edge Plot (10M BW Ch.20450 QPSK\_RB1\_Offset 0)



BAND 5. Lower Band Edge Plot (10M BW Ch.20450 QPSK\_RB50\_Offset 0)



BAND 5. Lower Extended Band Edge Plot (10M BW Ch.20450 QPSK\_RB50\_0)



BAND 5. Upper Band Edge Plot (1.4M BW Ch.20643 QPSK\_RB1\_Offset 5)







BAND 5. Upper Band Edge Plot (3M BW Ch.20635 QPSK\_RB1\_Offset 14)





BAND 5. Upper Extended Band Edge Plot (3M BW Ch.20635 QPSK\_RB15\_0)





BAND 5. Upper Band Edge Plot (5M BW Ch.20625 QPSK\_RB25\_Offset 0)



BAND 5. Upper Extended Band Edge Plot (5M BW Ch.20625 QPSK\_RB25\_0)

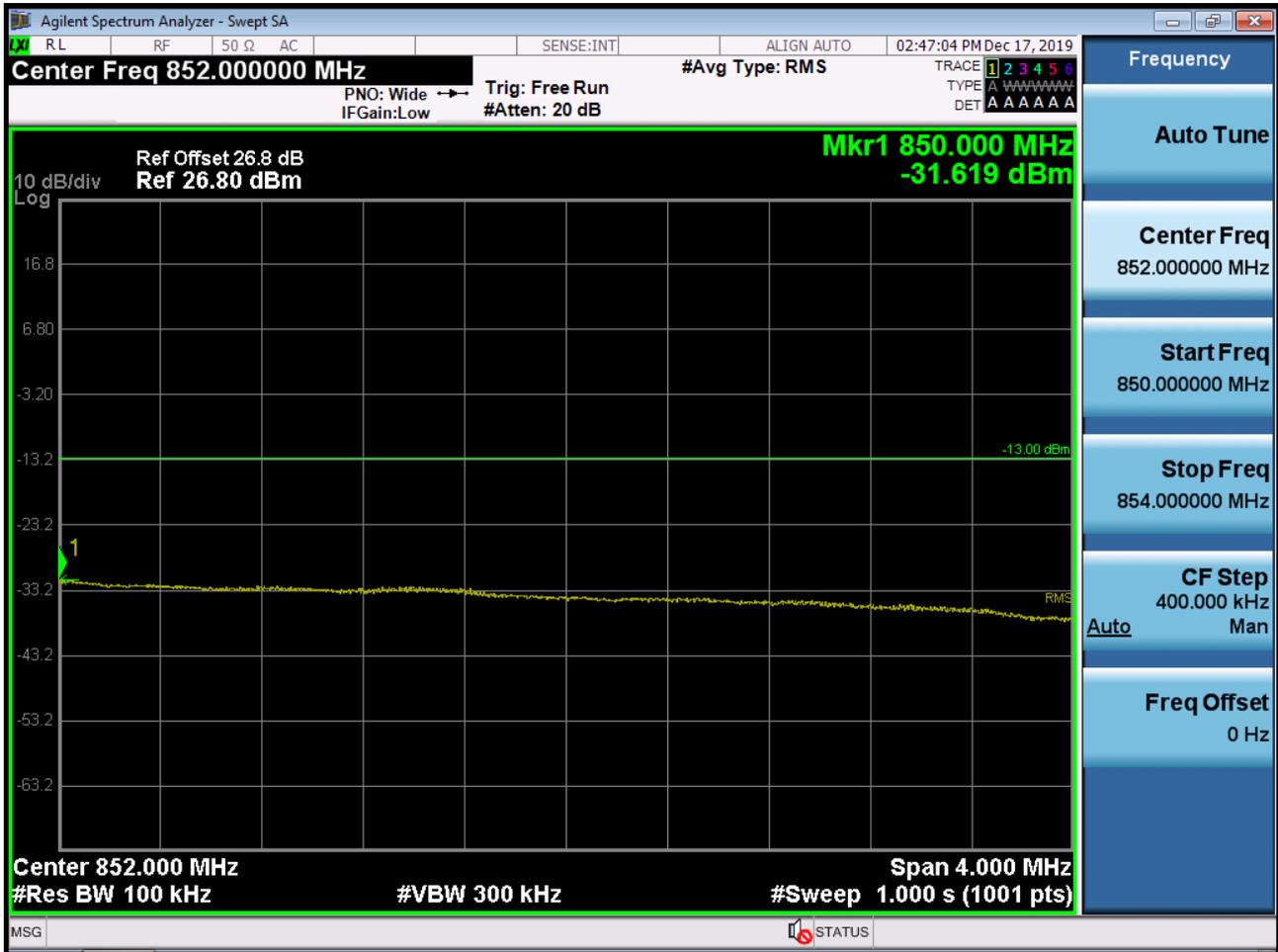


BAND 5. Upper Band Edge Plot (10M BW Ch.20600 QPSK\_RB1\_Offset 49)

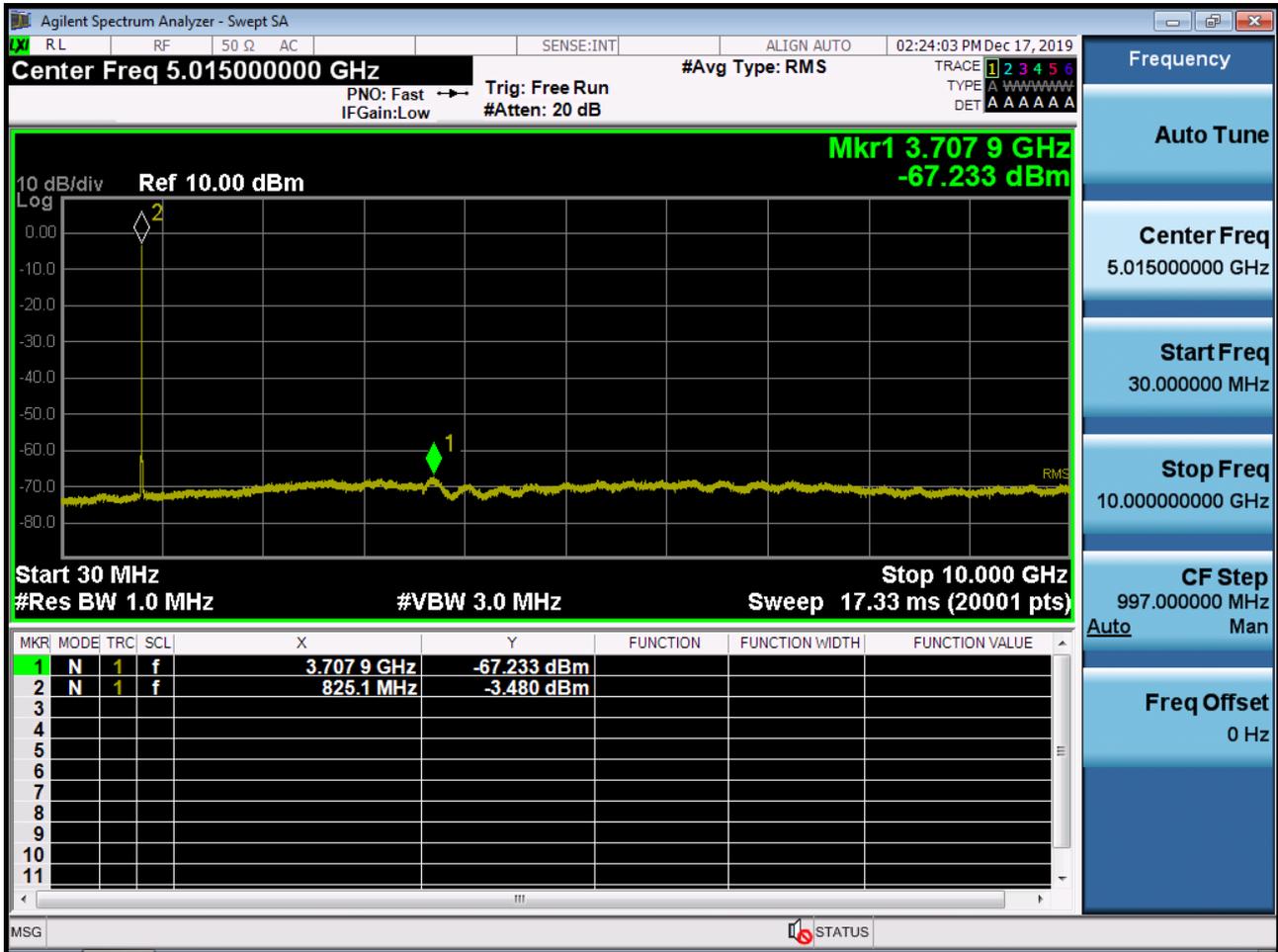




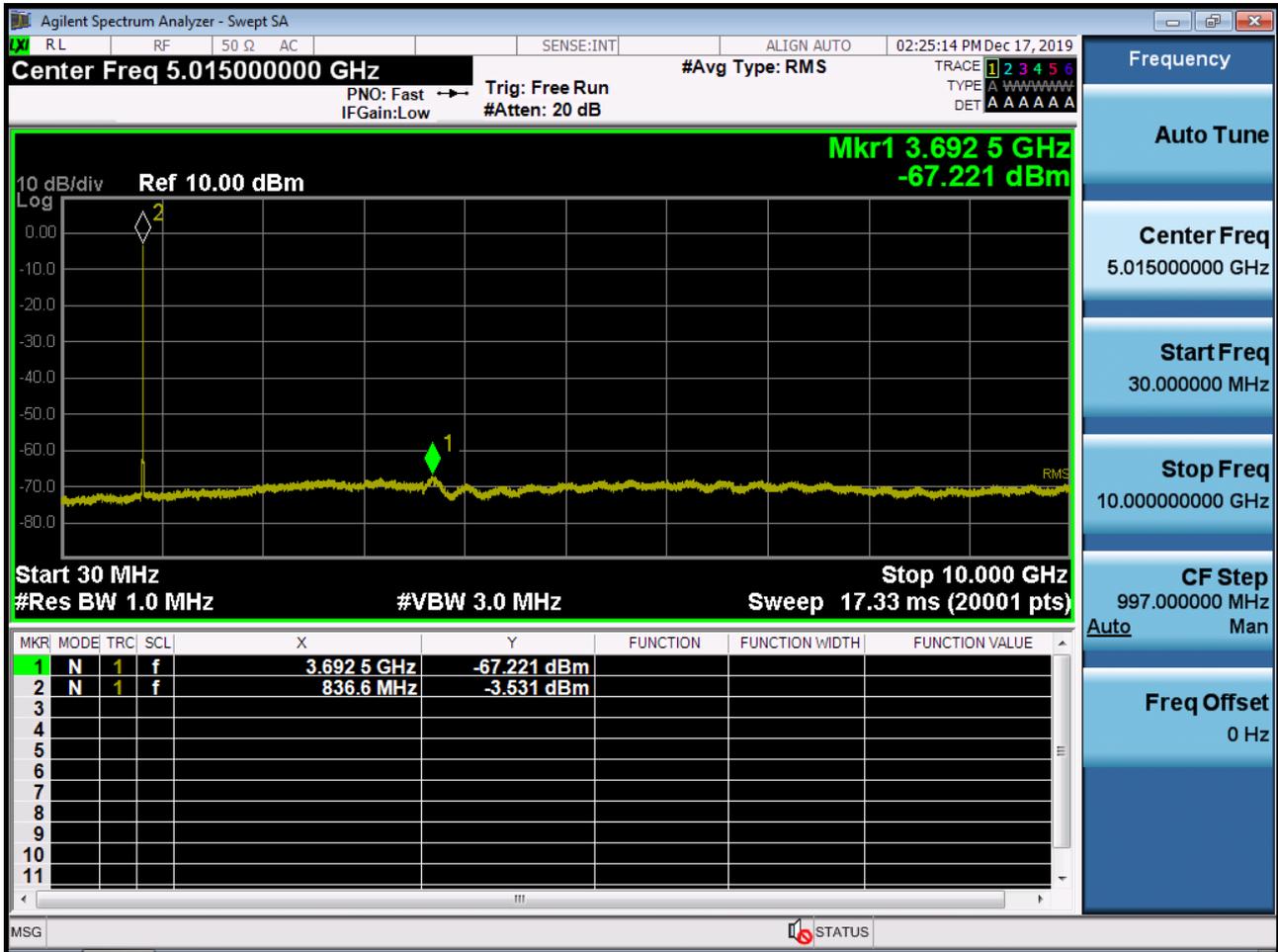
BAND 5. Upper Extended Band Edge Plot (10M BW Ch.20600 QPSK\_RB50\_0)



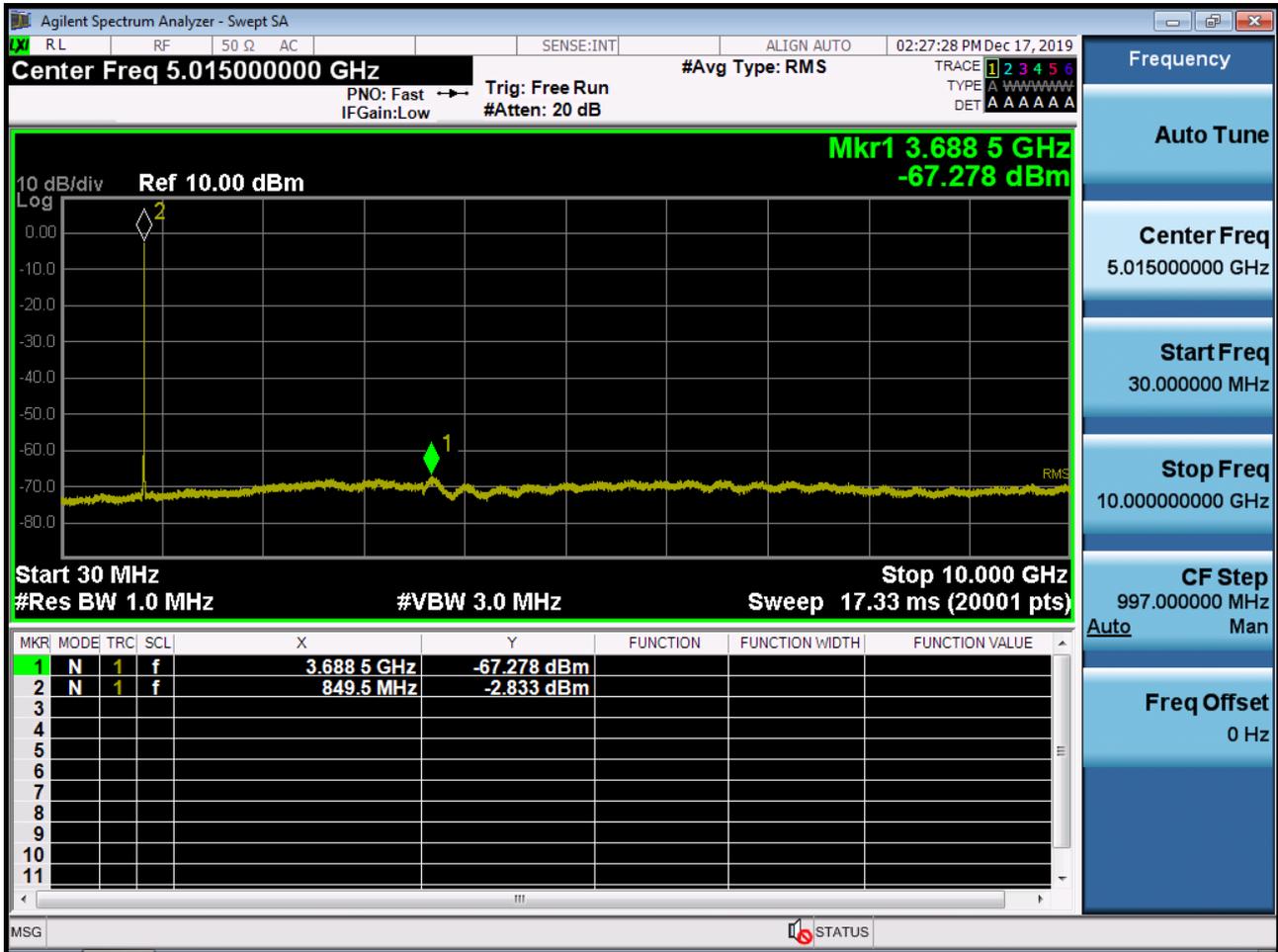
BAND 5. Conducted Spurious Plot (20407ch\_1.4MHz\_QPSK\_RB 1\_0)



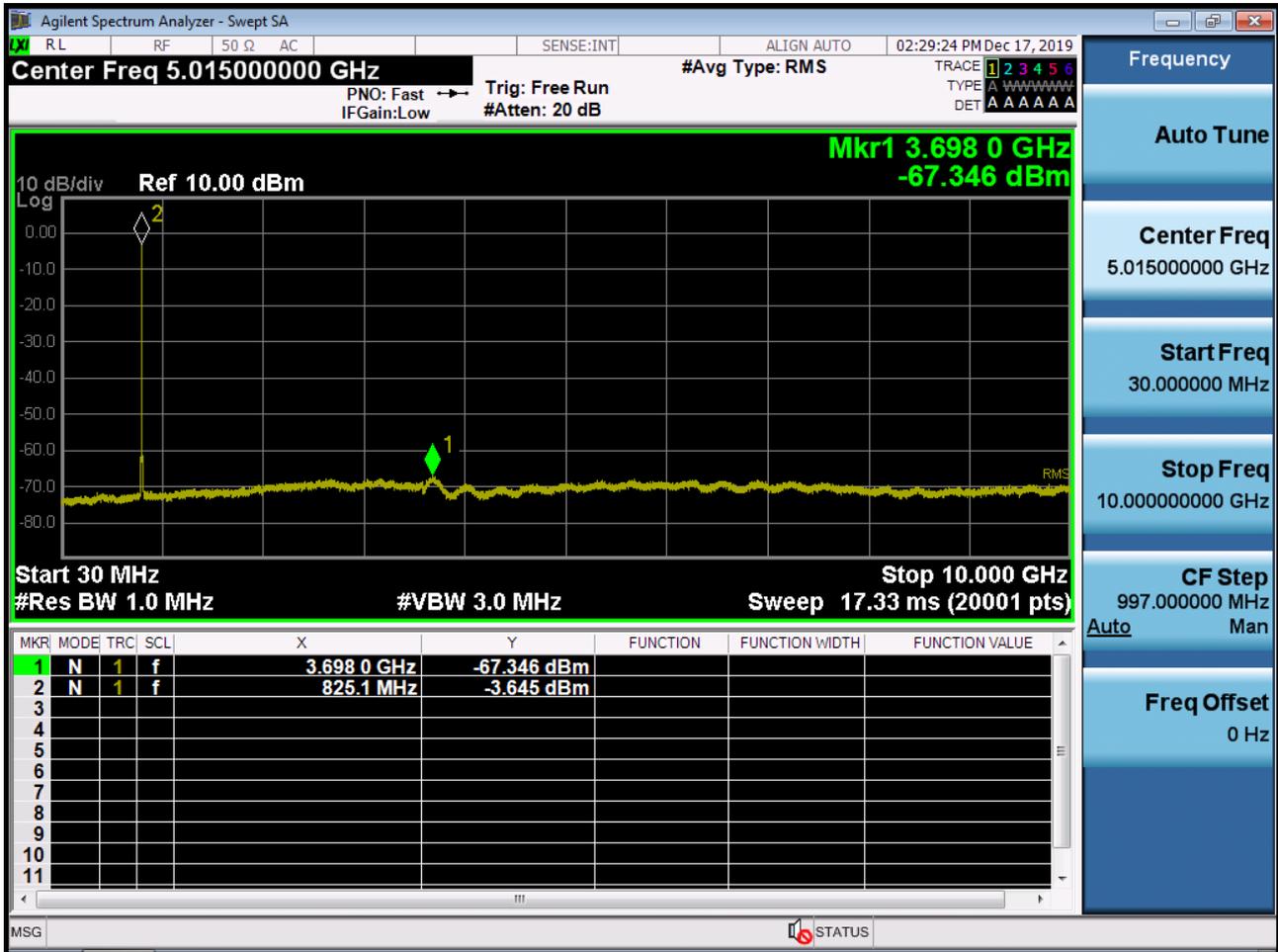
BAND 5. Conducted Spurious Plot (20525ch\_1.4MHz\_QPSK\_RB 1\_0)



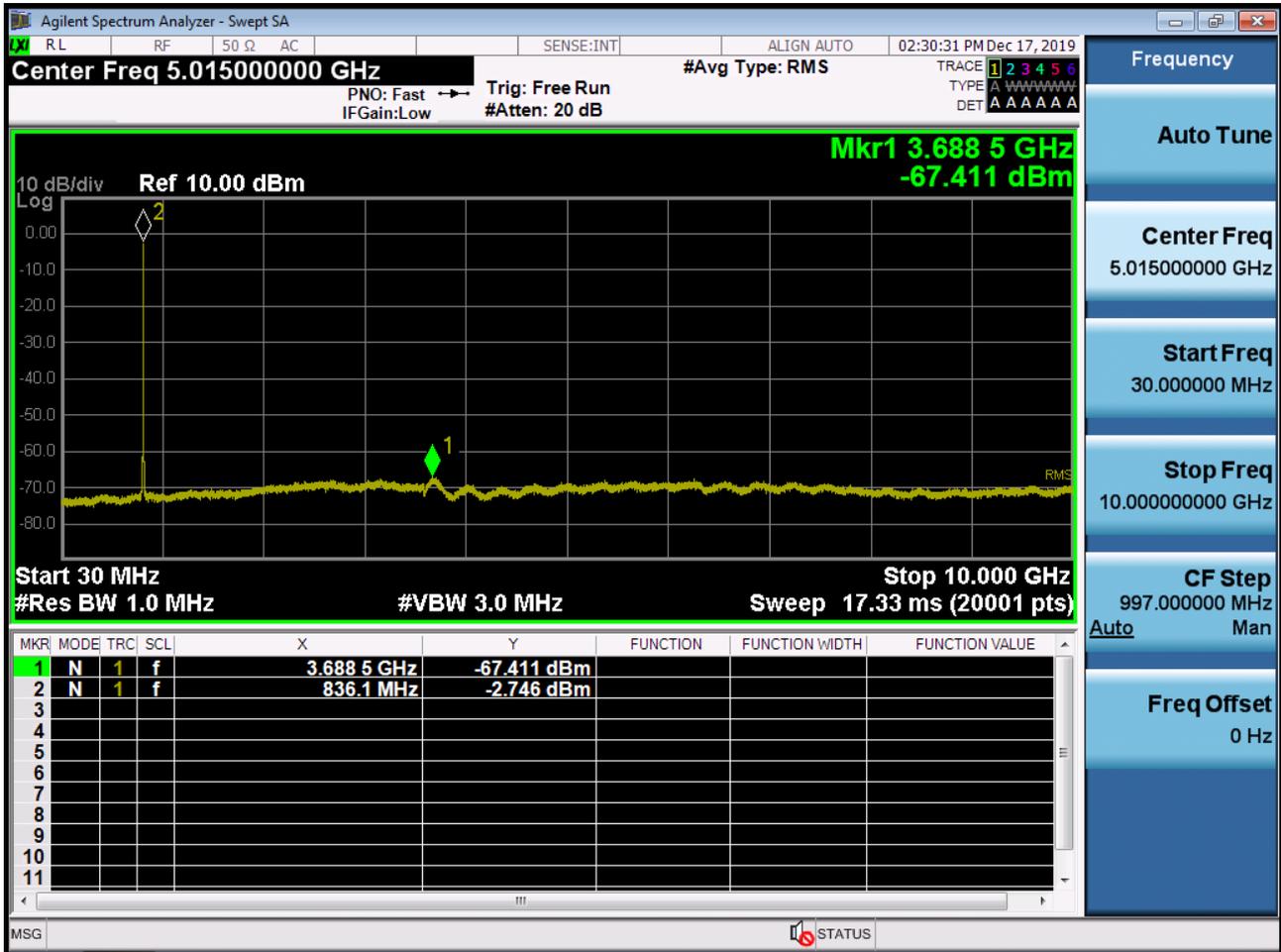
BAND 5. Conducted Spurious Plot (20643ch\_1.4MHz\_QPSK\_RB 1\_0)



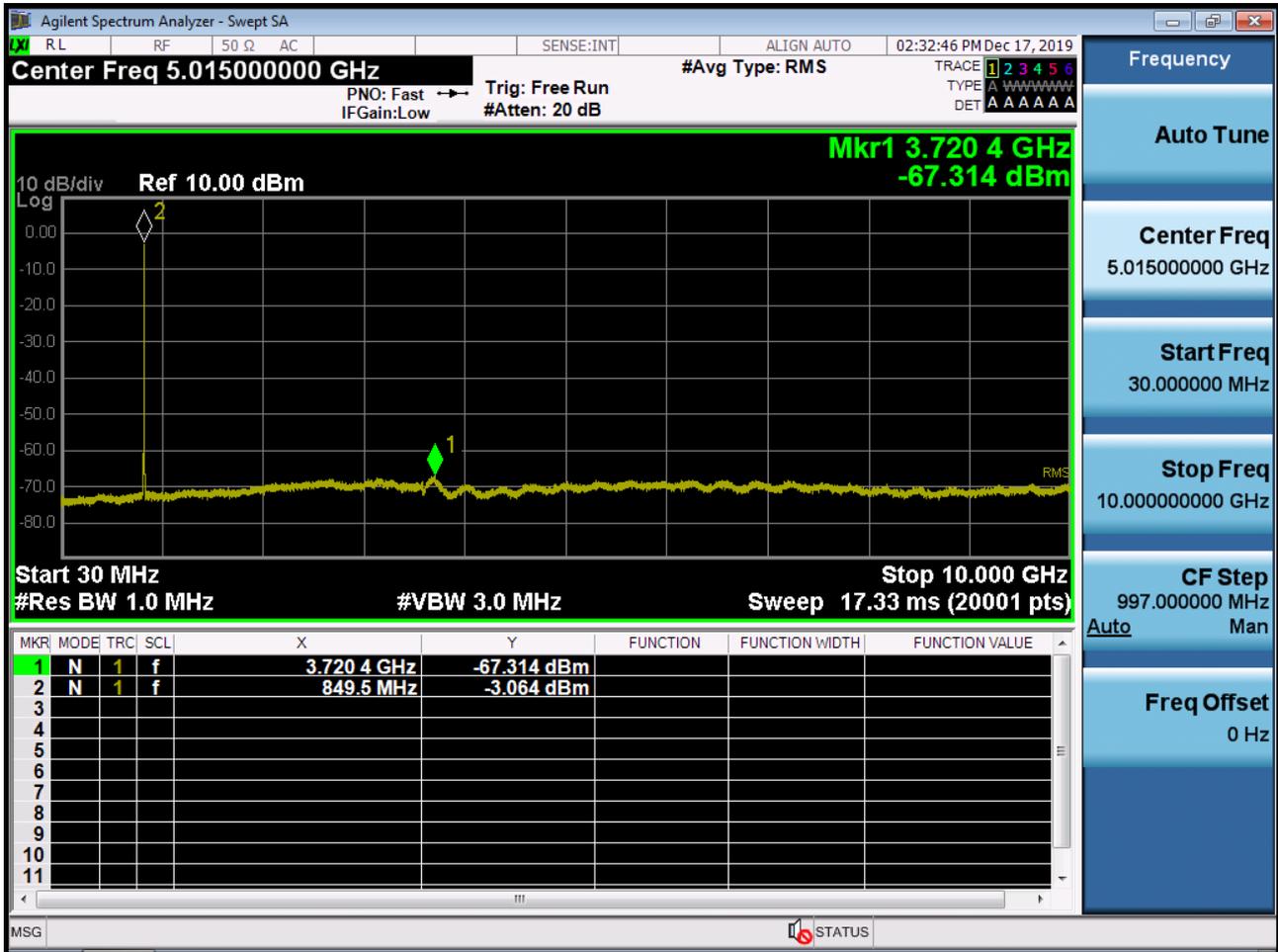
BAND 5. Conducted Spurious Plot (20415ch\_3MHz\_QPSK\_RB 1\_0)



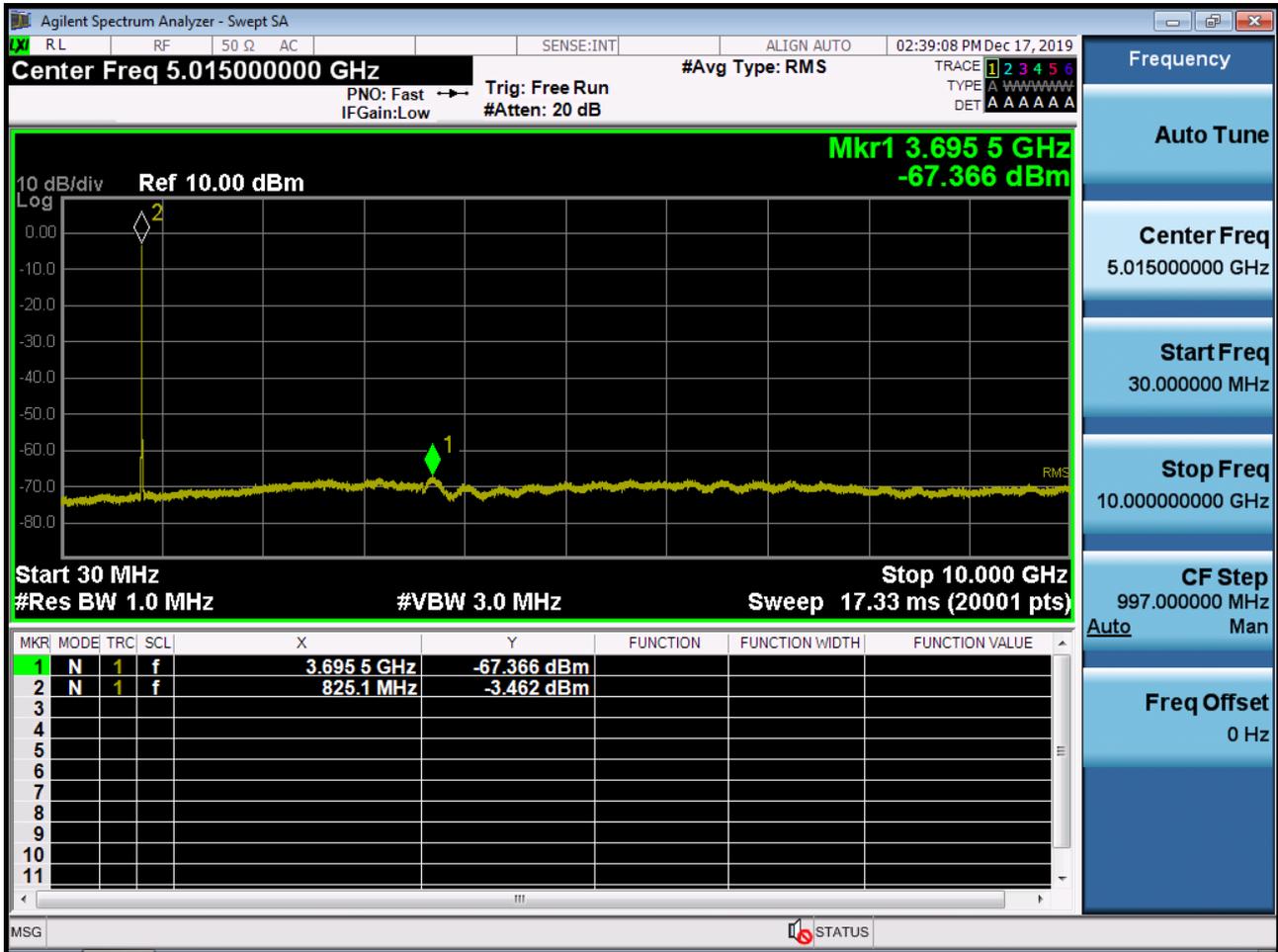
BAND 5. Conducted Spurious Plot (20525ch\_3MHz\_QPSK\_RB 1\_0)



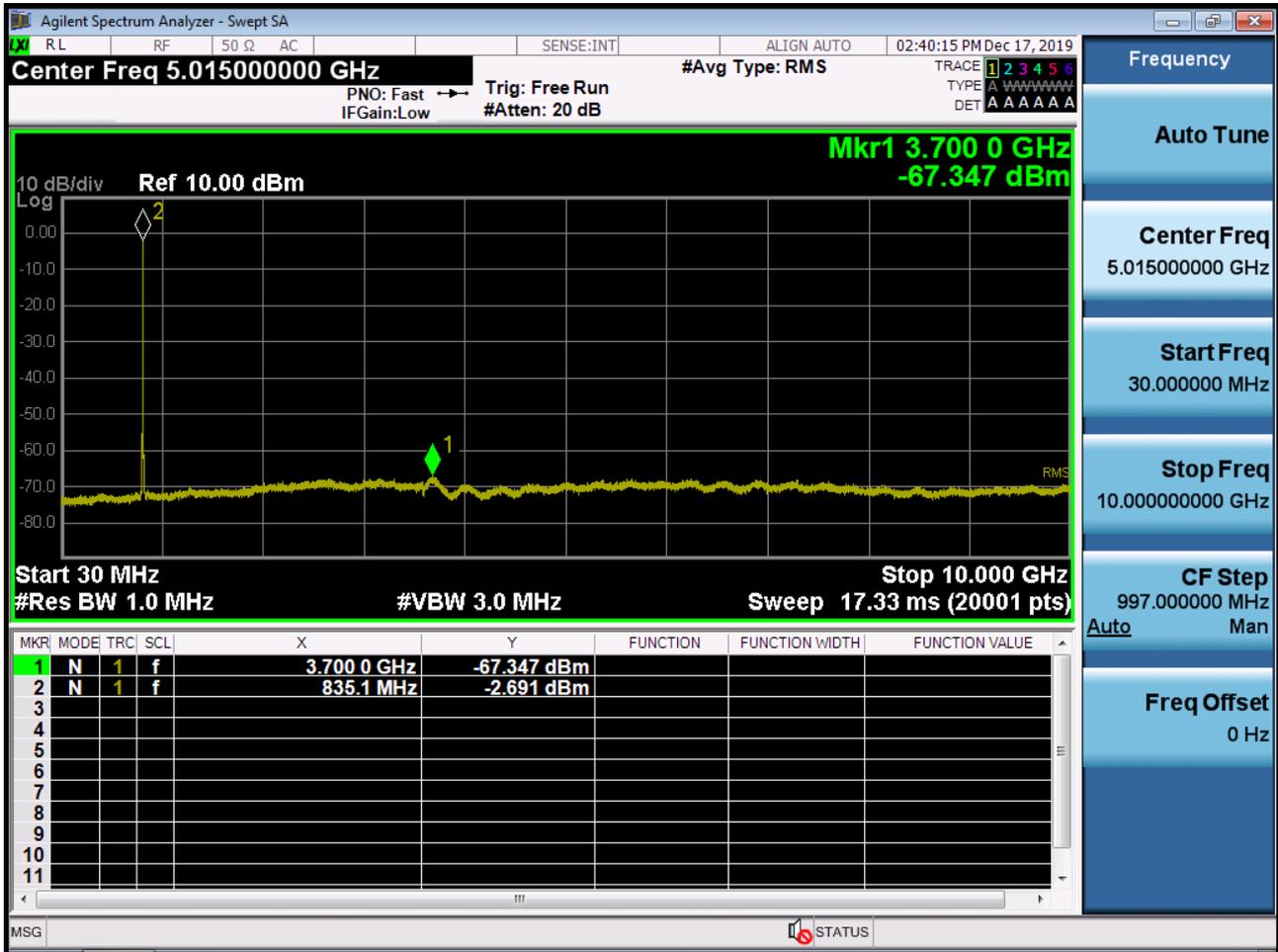
BAND 5. Conducted Spurious Plot (20635ch\_3MHz\_QPSK\_RB 1\_0)



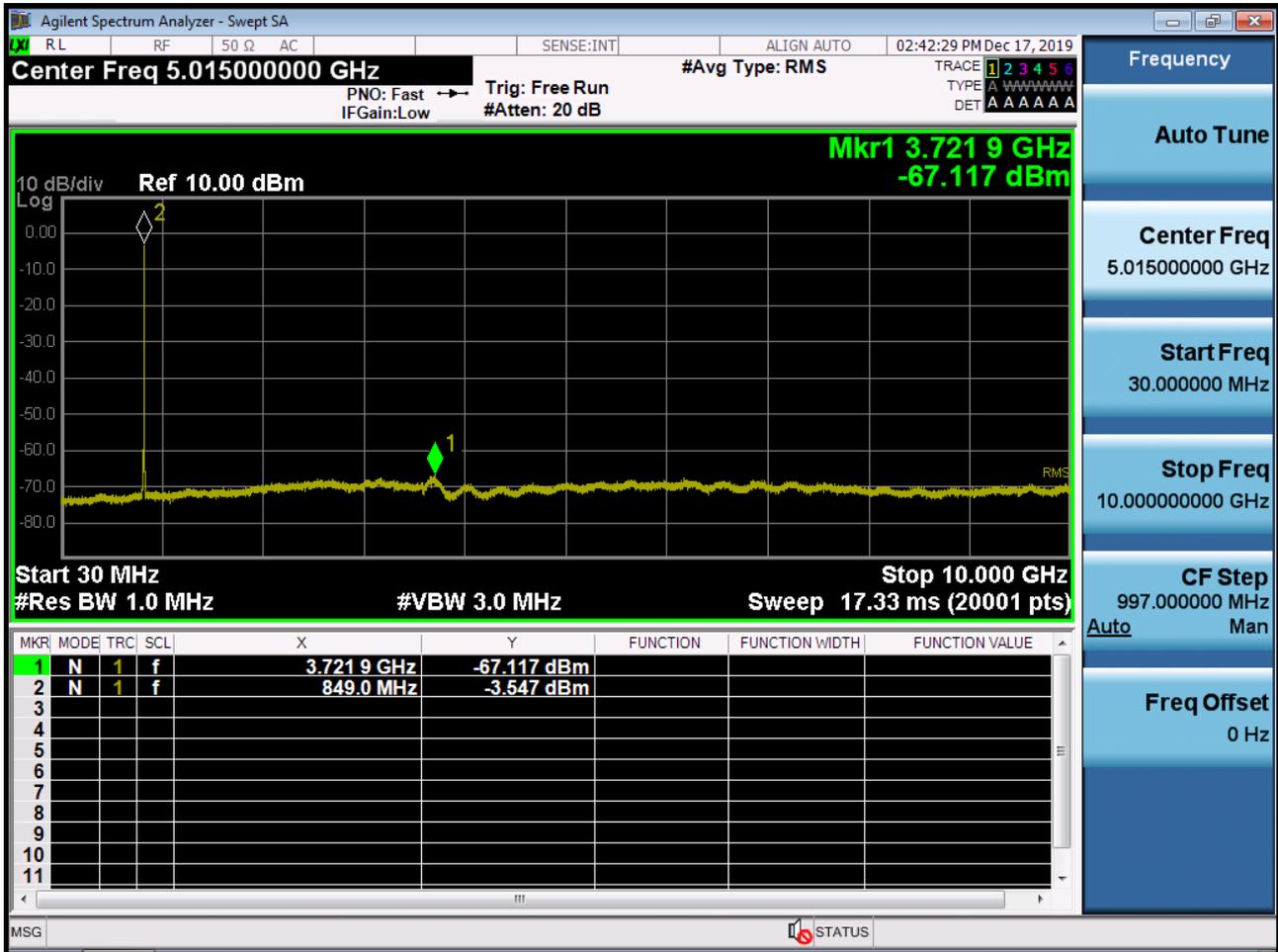
BAND 5. Conducted Spurious Plot (20425ch\_5MHz\_QPSK\_RB 1\_0)



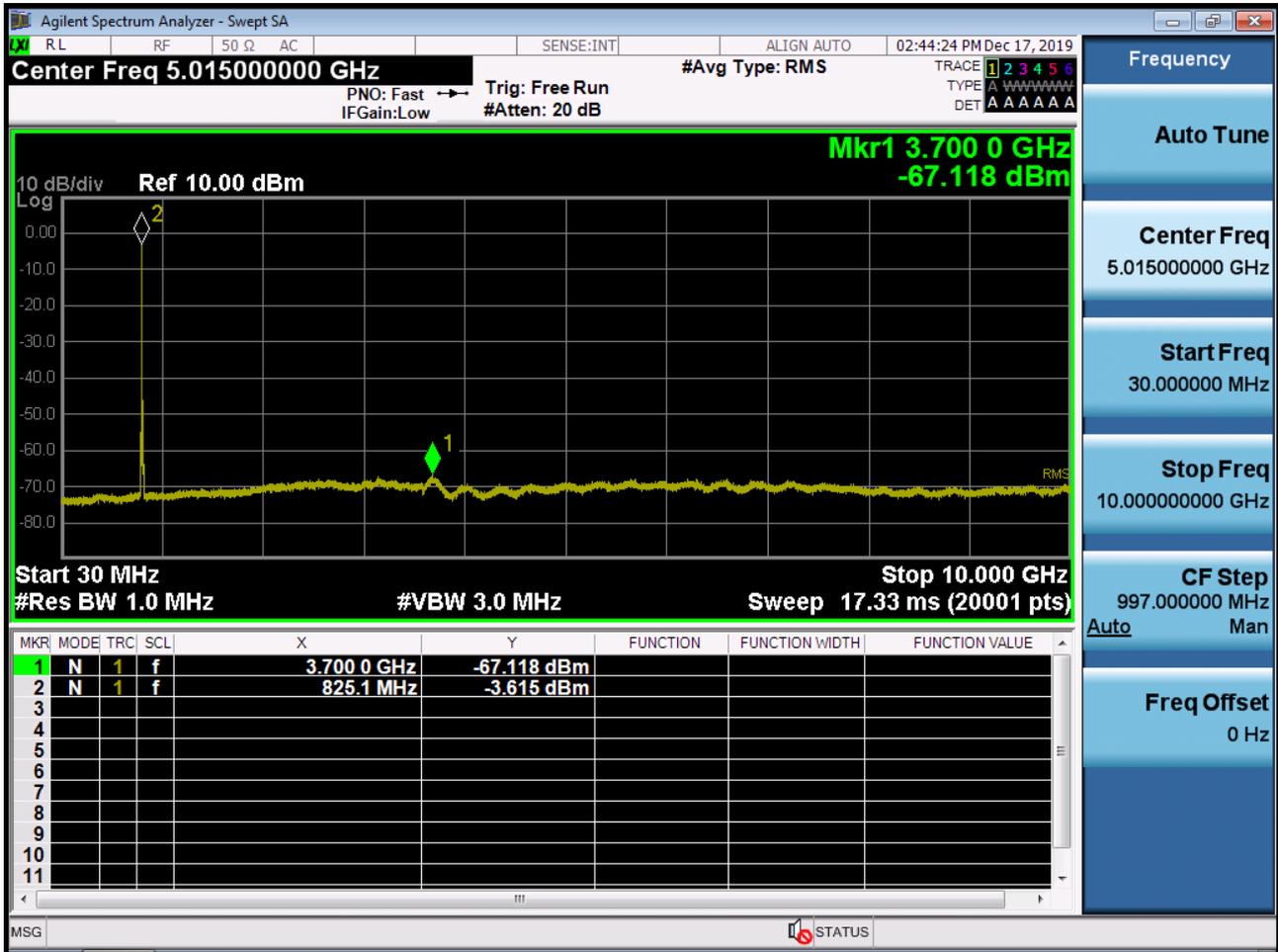
BAND 5. Conducted Spurious Plot (20525ch\_5MHz\_QPSK\_RB 1\_0)



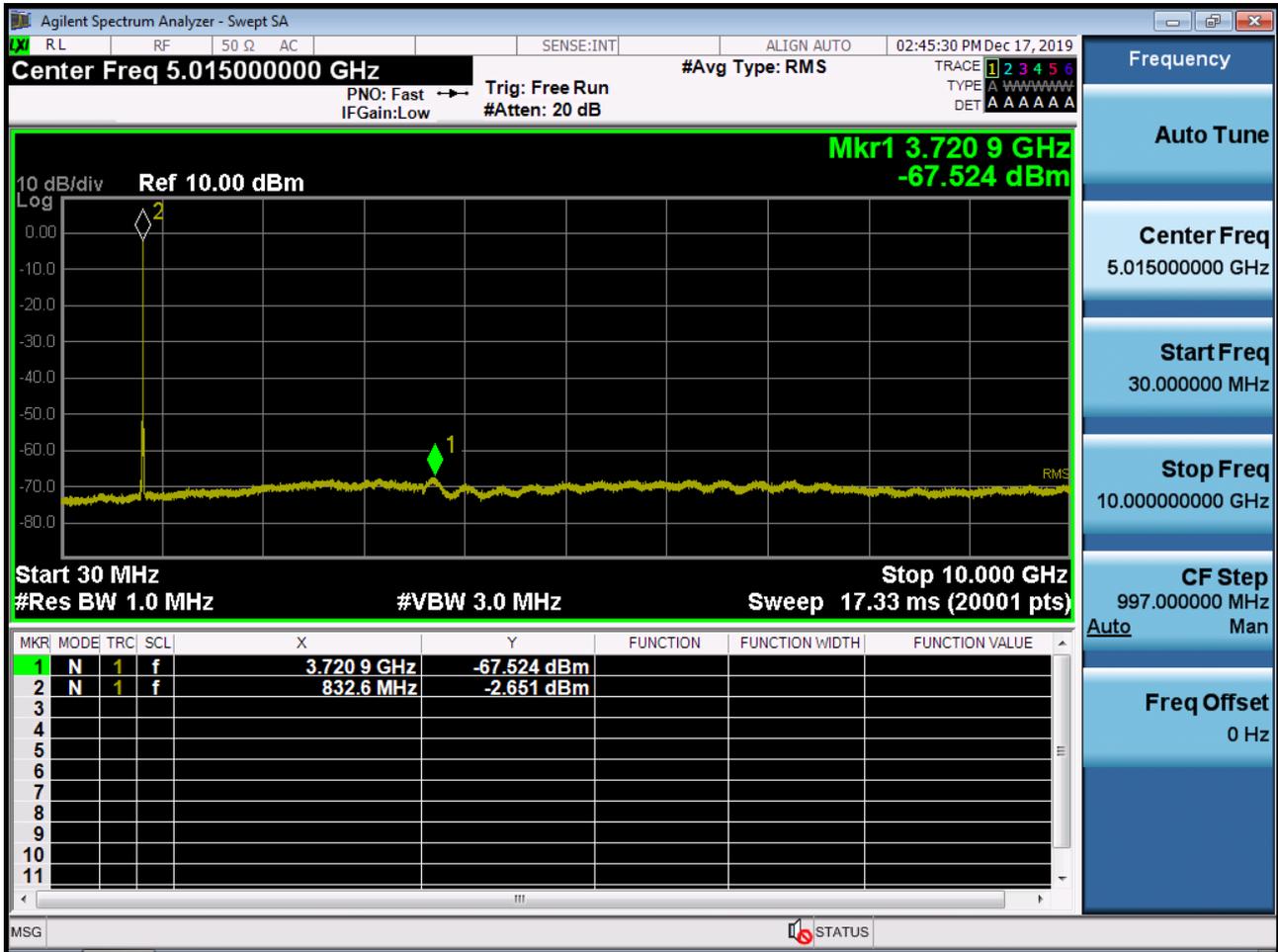
BAND 5. Conducted Spurious Plot (20625ch\_5MHz\_QPSK\_RB 1\_0)



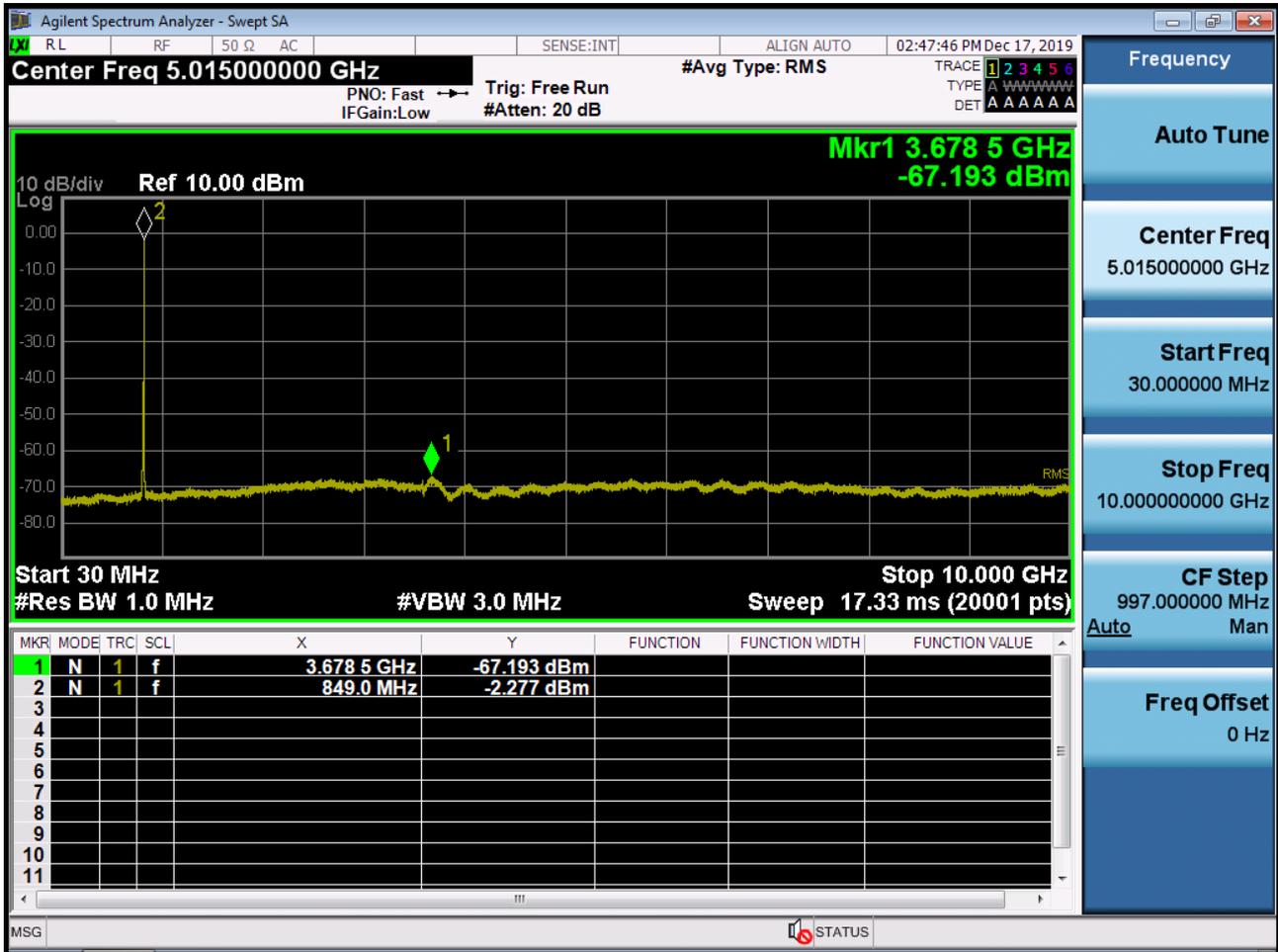
BAND 5. Conducted Spurious Plot (20450ch\_10MHz\_QPSK\_RB 1\_0)



BAND 5. Conducted Spurious Plot (20525ch\_10MHz\_QPSK\_RB 1\_0)



BAND 5. Conducted Spurious Plot (20600ch\_10MHz\_QPSK\_RB 1\_0)



## 10. ANNEX A\_ TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	HCT-RF-2001-FC034-P