

FCC LTE REPORT

Certification

Applicant Name:
SAMSUNG Electronics Co., Ltd.

Date of Issue:
June 15, 2021

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-2105-FC027-R1

FCC ID: A3LSMG990U

APPLICANT: SAMSUNG Electronics Co., Ltd.

Model(s): SM-G990U
 Additional Model(s): SM-G990U1/DS, SM-G990U1
 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	1M10G7D	QPSK	0.105	20.20
		1M09W7D	16QAM	0.090	19.56
		1M10W7D	64QAM	0.070	18.45
		1M09W7D	256QAM	0.035	15.45
LTE – Band5 (3)	825.5 – 847.5	2M71G7D	QPSK	0.106	20.24
		2M70W7D	16QAM	0.092	19.62
		2M70W7D	64QAM	0.071	18.49
		2M70W7D	256QAM	0.035	15.48
LTE – Band5 (5)	826.5 – 846.5	4M51G7D	QPSK	0.097	19.87
		4M52W7D	16QAM	0.086	19.33
		4M51W7D	64QAM	0.067	18.28
		4M51W7D	256QAM	0.033	15.17
LTE – Band5 (10)	829.0 – 844.0	8M93G7D	QPSK	0.110	20.40
		8M99W7D	16QAM	0.097	19.88
		8M97W7D	256QAM	0.074	18.68
		8M95W7D	64QAM	0.035	15.40

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 No.: HCT-RF-2105-FC027-R1

REVIEWED BY



Report prepared by : Jae Mun Do
Engineer of Telecommunication Testing Center

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

This test results were applied only to the test methods required by the standard.

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

The above Test Report is the accredited test result by (KS Q) ISO/IEC 17025 and KOLAS(Korea Laboratory Accreditation Scheme), which signed the ILAC-MRA. (HCT Accreditation No.: KT197)

* The report shall not be reproduced except in full(only partly) without approval of the laboratory.

Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-RF-2105-FC027	May 26, 2021	- First Approval Report
HCT-RF-2105-FC027-R1	June 15, 2021	- Revised the Additional model(s). (SM-G990U1 added)

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

Table of Contents

REVIEWED BY	2
1. GENERAL INFORMATION	5
2. INTRODUCTION	6
2.1. DESCRIPTION OF EUT	6
2.2. MEASURING INSTRUMENT CALIBRATION	6
2.3. TEST FACILITY	6
3. DESCRIPTION OF TESTS.....	7
3.1 TEST PROCEDURE	7
3.2 RADIATED POWER.....	8
3.3 RADIATED SPURIOUS EMISSIONS	9
3.4 OCCUPIED BANDWIDTH.	10
3.5 SPURIOUS AND HARMONIC EMISSIONS AT ANTENNA TERMINAL	11
3.6 BAND EDGE	12
3.7 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE	13
3.8 WORST CASE(RADIATED TEST)	14
3.9 WORST CASE(CONDUCTED TEST)	15
4. LIST OF TEST EQUIPMENT	16
5. MEASUREMENT UNCERTAINTY	17
6. SUMMARY OF TEST RESULTS	18
7. SAMPLE CALCULATION	19
8. TEST DATA	21
8.1 EFFECTIVE RADIATED POWER.....	21
8.2 RADIATED SPURIOUS EMISSIONS	23
8.3 OCCUPIED BANDWIDTH	24
8.4 CONDUCTED SPURIOUS EMISSIONS	25
8.5 BAND EDGE	25
8.6 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE	26
9. TEST PLOTS.....	30
10. ANNEX A_ TEST SETUP PHOTO.....	83

MEASUREMENT REPORT

1. GENERAL INFORMATION

Applicant Name:	SAMSUNG Electronics Co., Ltd.
Address:	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
FCC ID:	A3LSMG990U
Application Type:	Certification
FCC Classification:	PCS Licensed Transmitter Held to Ear (PCE)
FCC Rule Part(s):	§22, §2
EUT Type:	Mobile Phone
Model(s):	SM-G990U
Additional Model(s):	SM-G990U1/DS, SM-G990U1
Tx Frequency:	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))
Date(s) of Tests:	April 19, 2021 ~ May 18, 2021
Serial number:	Radiated: R3CR315S6MD Conducted: R3CR3117FBH

2. INTRODUCTION

2.1. DESCRIPTION OF EUT

The EUT was a Mobile Phone with GSM/GPRS/EGPRS/UMTS, CDMA(BC0, 1, 10) and LTE, Sub6.

It also supports IEEE 802.11 a/b/g/n/ac/ax (HT20/40/80), Bluetooth, BT LE, NFC, WPT, mmWave(n260/261).

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 10th 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;

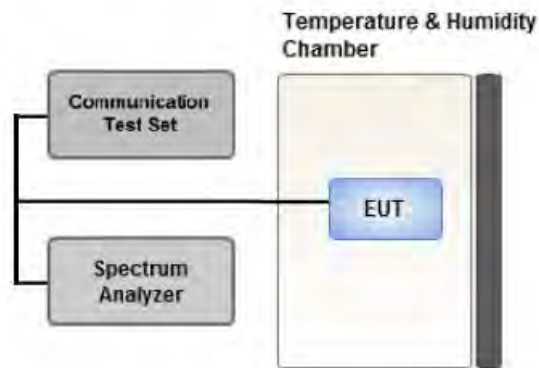
$$\text{Result}_{(\text{dBm})} = P_{g(\text{dBm})} - \text{cable loss}_{(\text{dB})} + \text{antenna gain}_{(\text{dBi})}$$

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

If the fundamental 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.

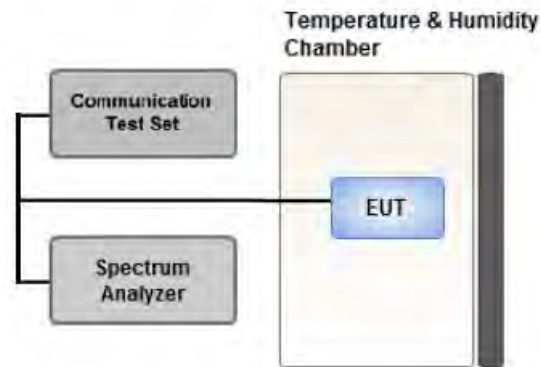
The conducted occupied bandwidth used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.

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

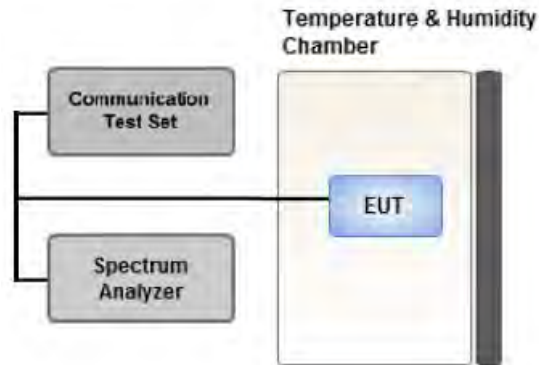
Test Overview

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

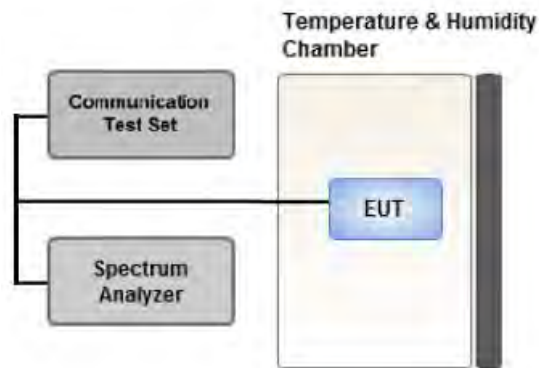
Test Notes

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. (In the case of radiated spurious emissions, only the B.W result that confirmed the maximum radiated power was reported.)
- The worst case is reported with the EUT positioning, modulations, and paging service configurations shown in the test data.
- SM-G990U & additional models were tested and the worst case results are reported. (Worst case : SM-G990U)

[Worst case]

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

3.9 WORST CASE(CONDUCTED TEST)

- All modes of operation were investigated and the worst case configuration results are reported.
- SM-G990U & additional models were tested and the worst case results are reported.

(Worst case : SM-G990U)

[Worst case]

Test Description	Modulation	Bandwidth (MHz)	Frequency	RB size	RB offset
Occupied Bandwidth	QPSK, 16QAM, 64QAM, 256QAM	1.4, 3, 5, 10	Mid	Full RB	0
Band Edge	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
		1.4, 3, 5, 10	Low, High	Full RB	0
Spurious and Harmonic Emissions at Antenna Terminal	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	-	03/02/2021	Annual	03/02/2022
T&M SYSTEM	FBSR-02B(WHK3.3/18G-10EF)/H.P.F	-	03/02/2021	Annual	03/02/2022
Hewlett Packard	11667B / Power Splitter(DC~26.5 GHz)	11275	04/07/2021	Annual	04/07/2022
Hewlett Packard	E3632A/DC Power Supply	MY40004427	09/16/2020	Annual	09/16/2021
Schwarzbeck	UHAP/ Dipole Antenna	557	04/05/2021	Biennial	04/05/2023
Schwarzbeck	UHAP/ Dipole Antenna	558	04/05/2021	Biennial	04/05/2023
ESPEC	SU-642 / Chamber	93008124	03/15/2021	Annual	03/15/2022
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	10/13/2020	Biennial	10/13/2022
Schwarzbeck	BBHA 9170/ Horn Antenna(15~40GHz)	BBHA9170124	02/11/2020	Biennial	02/11/2022
Agilent	N9020A/Signal Analyzer(10Hz~26.5GHz)	MY50200093	11/17/2020	Annual	11/17/2021
Hewlett Packard	8493C/ATTENUATOR(20dB)	17280	06/04/2020	Annual	06/04/2021
REOHDE & SCHWARZ	FSV40/Spectrum Analyzer(10Hz~40GHz)	100931	10/14/2020	Annual	10/14/2021
Agilent	8960 (E5515C)/ Base Station	MY48360800	08/26/2020	Annual	08/26/2021
Schwarzbeck	FMZB1513/ Loop Antenna(9kHz~30MHz)	1513-333	03/19/2020	Biennial	03/19/2022
Schwarzbeck	VULB9160/ Bilog Antenna	3150	03/03/2021	Biennial	03/03/2023
Schwarzbeck	VULB9168/ Hybrid Antenna	760	02/22/2021	Biennial	02/22/2023
Anritsu Corp.	MT8821C/Wideband Radio Communication Tester	6262116770	07/22/2020	Annual	07/22/2021
Anritsu Corp.	MT8820C/Wideband Radio Communication Tester	6201026545	01/07/2021	Annual	01/07/2022
REOHDE & SCHWARZ	SMB100A/ SIGNAL GENERATOR (100kHz~40GHz)	177633	07/13/2020	Annual	07/13/2021
KEYSIGHT	N9030B / Signal Analyzer(5Hz~40.0GHz)	MY55480167	06/04/2020	Annual	06/04/2021
HCT CO., LTD.,	FCC LTE Mobile Conducted RF Automation Test Software	-	-	-	-

Note:

- Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.
- 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_{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

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

QAM 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	-31.66	32.02	-10.42	1.40	V	< 7.00	0.105	20.20
		16-QAM	-32.30	31.38	-10.42	1.40	V		0.090	19.56
		64-QAM	-33.41	30.27	-10.42	1.40	V		0.070	18.45
		256-QAM	-36.41	27.27	-10.42	1.40	V		0.035	15.45
836.5		QPSK	-32.41	31.73	-10.40	1.41	V		0.098	19.92
		16-QAM	-33.11	31.03	-10.40	1.41	V		0.084	19.22
		64-QAM	-34.13	30.01	-10.40	1.41	V		0.066	18.20
		256-QAM	-37.18	26.96	-10.40	1.41	V		0.033	15.15
848.3		QPSK	-33.82	30.56	-10.38	1.42	V		0.075	18.76
		16-QAM	-34.45	29.93	-10.38	1.42	V		0.065	18.13
		64-QAM	-35.42	28.96	-10.38	1.42	V		0.052	17.16
		256-QAM	-38.57	25.81	-10.38	1.42	V		0.025	14.01

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	-31.63	32.06	-10.42	1.40	V	< 7.00	0.106	20.24
		16-QAM	-32.25	31.44	-10.42	1.40	V		0.092	19.62
		64-QAM	-33.38	30.31	-10.42	1.40	V		0.071	18.49
		256-QAM	-36.39	27.30	-10.42	1.40	V		0.035	15.48
836.5		QPSK	-32.41	31.73	-10.40	1.41	V		0.098	19.92
		16-QAM	-32.96	31.18	-10.40	1.41	V		0.087	19.37
		64-QAM	-34.02	30.12	-10.40	1.41	V		0.068	18.31
		256-QAM	-37.14	27.00	-10.40	1.41	V		0.033	15.19
847.5		QPSK	-33.65	30.68	-10.39	1.42	V		0.077	18.88
		16-QAM	-34.23	30.10	-10.39	1.42	V		0.068	18.30
		64-QAM	-35.27	29.06	-10.39	1.42	V		0.053	17.26
		256-QAM	-38.42	25.91	-10.39	1.42	V		0.026	14.11

Freq (MHz)	Mod/ Bandwidth	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit	ERP	
								W	W	dBm
826.5	LTE B5/ 5 MHz	QPSK	-32.18	31.57	-10.42	1.40	V	< 7.00	0.095	19.76
		16-QAM	-32.79	30.96	-10.42	1.40	V		0.082	19.15
		64-QAM	-33.84	29.91	-10.42	1.40	V		0.064	18.10
		256-QAM	-36.87	26.88	-10.42	1.40	V		0.032	15.07
836.5		QPSK	-32.46	31.68	-10.40	1.41	V		0.097	19.87
		16-QAM	-33.00	31.14	-10.40	1.41	V		0.086	19.33
		64-QAM	-34.05	30.09	-10.40	1.41	V		0.067	18.28
		256-QAM	-37.16	26.98	-10.40	1.41	V		0.033	15.17
846.5		QPSK	-33.45	30.79	-10.39	1.42	V		0.079	18.98
		16-QAM	-34.09	30.15	-10.39	1.42	V		0.068	18.34
		64-QAM	-35.09	29.15	-10.39	1.42	V		0.054	17.34
		256-QAM	-38.17	26.07	-10.39	1.42	V		0.027	14.26

Freq (MHz)	Mod/ Bandwidth	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit	ERP	
								W	W	dBm
829.0	LTE B5/ 10 MHz	QPSK	-31.69	32.21	-10.41	1.40	V	< 7.00	0.110	20.40
		16-QAM	-32.21	31.69	-10.41	1.40	V		0.097	19.88
		64-QAM	-33.41	30.49	-10.41	1.40	V		0.074	18.68
		256-QAM	-36.69	27.21	-10.41	1.40	V		0.035	15.40
836.5		QPSK	-32.19	31.95	-10.40	1.41	V		0.103	20.14
		16-QAM	-32.59	31.55	-10.40	1.41	V		0.094	19.74
		64-QAM	-33.94	30.20	-10.40	1.41	V		0.069	18.39
		256-QAM	-37.32	26.82	-10.40	1.41	V		0.032	15.01
844.0		QPSK	-32.90	31.19	-10.39	1.41	V		0.087	19.39
		16-QAM	-33.36	30.73	-10.39	1.41	V		0.078	18.93
		64-QAM	-34.65	29.44	-10.39	1.41	V		0.058	17.64
		256-QAM	-37.93	26.16	-10.39	1.41	V		0.027	14.36

8.2 RADIATED SPURIOUS EMISSIONS

- ▣ MODE: LTE B5
- ▣ MODULATION SIGNAL: 10 MHz QPSK
- ▣ DISTANCE: 3 meters

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	Limit
20450 (829.0)	1 658.00	-51.46	9.58	-61.46	2.01	V	-53.89	-13.00
	2 487.00	-51.97	10.65	-56.01	2.49	V	-47.85	-13.00
	3 316.00	-57.58	12.38	-58.56	2.91	V	-49.09	-13.00
20525 (836.5)	1 673.00	-52.84	9.65	-62.61	2.01	H	-54.97	-13.00
	2 509.50	-50.30	10.75	-54.02	2.50	H	-45.77	-13.00
	3 346.00	-58.38	12.48	-59.37	2.92	H	-49.81	-13.00
20600 (844.0)	1 688.00	-51.32	9.73	-61.00	2.03	H	-53.30	-13.00
	2 532.00	-49.52	10.80	-52.74	2.50	V	-44.44	-13.00
	3 376.00	-58.44	12.60	-59.57	2.93	V	-49.90	-13.00

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	1.0974
			16-QAM			1.0870
			64-QAM			1.0953
			256-QAM			1.0900
	3 MHz		QPSK	15		2.7099
			16-QAM			2.7012
			64-QAM			2.6952
			256-QAM			2.7017
	5 MHz		QPSK	25		4.5054
			16-QAM			4.5163
			64-QAM			4.5090
			256-QAM			4.5083
	10 MHz		QPSK	50		8.9293
			16-QAM			8.9884
			64-QAM			8.9649
			256-QAM			8.9509

Note:

1. Plots of the EUT's Occupied Bandwidth are shown Page 55 ~ 70.

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	3.7129	27.976	-67.267	-39.291	-13.00
		836.5	3.6730	27.976	-67.154	-39.178	
		848.3	3.6890	27.976	-67.033	-39.057	
	3	825.5	3.7024	27.976	-67.345	-39.369	
		836.5	3.7274	27.976	-67.201	-39.225	
		847.5	3.7084	27.976	-67.337	-39.361	
	5	826.5	3.6710	27.976	-67.432	-39.456	
		836.5	3.6910	27.976	-67.034	-39.058	
		846.5	3.7005	27.976	-67.111	-39.135	
	10	829.0	3.7144	27.976	-67.159	-39.183	
		836.5	3.6820	27.976	-67.202	-39.226	
		844.0	3.6830	27.976	-67.513	-39.537	

Note:

1. Plots of the EUT's Conducted Spurious Emissions are shown Page 71 ~ 82.
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

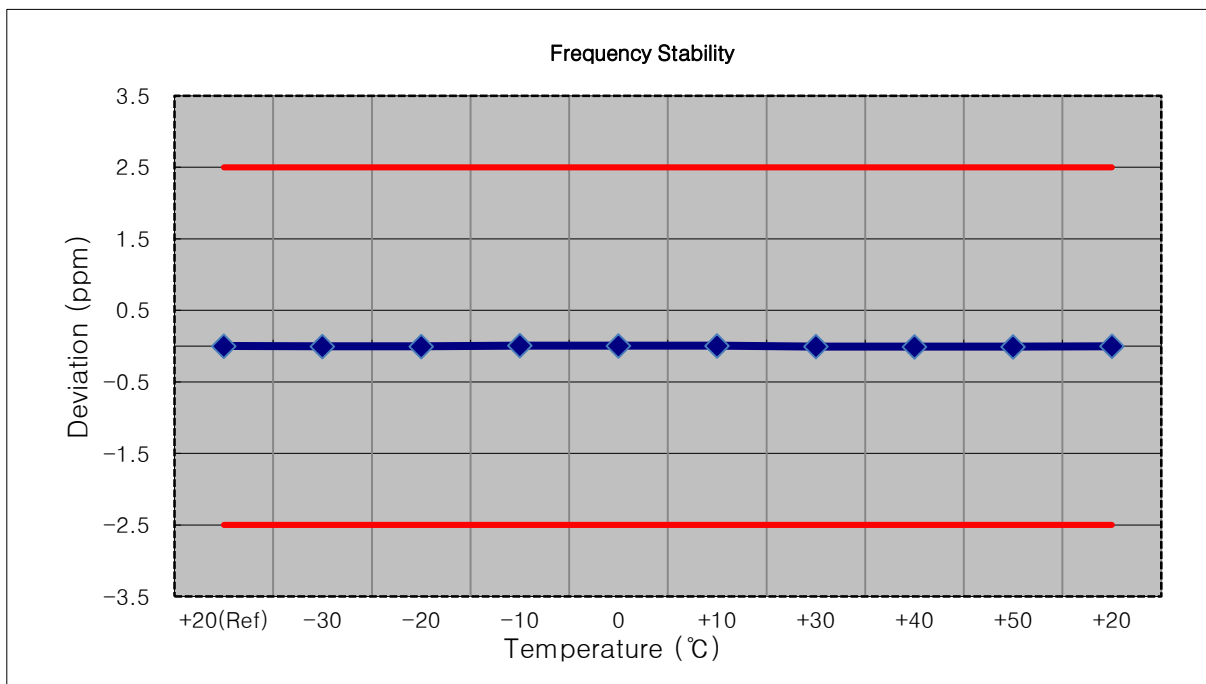
8.5 BAND EDGE

- Plots of the EUT's Band Edge are shown Page 31 ~ 54.

8.6 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE

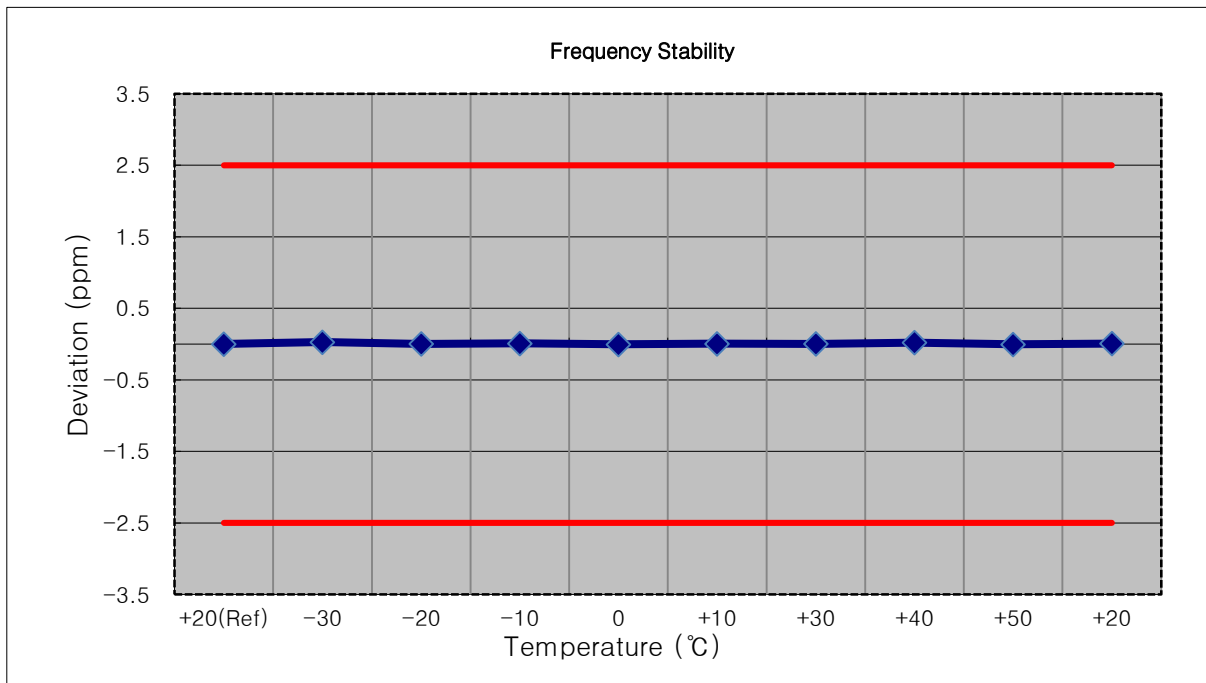
- ▣ MODE: LTE B5
- ▣ OPERATING FREQUENCY: 836,500,000 Hz
- ▣ CHANNEL: 20525 (1.4 MHz)
- ▣ REFERENCE VOLTAGE: 3.880 VDC
- ▣ DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.880	+20(Ref)	836 500 003	0.0	0.000 000	0.000
100%		-30	836 500 000	-2.6	0.000 000	-0.003
100%		-20	836 499 999	-3.7	0.000 000	-0.004
100%		-10	836 500 008	5.7	0.000 001	0.007
100%		0	836 500 006	3.4	0.000 000	0.004
100%		+10	836 500 007	4.8	0.000 001	0.006
100%		+30	836 499 997	-5.6	-0.000 001	-0.007
100%		+40	836 499 995	-7.3	-0.000 001	-0.009
100%		+50	836 499 995	-7.5	-0.000 001	-0.009
Batt. Endpoint		3.650	+20	836 500 001	-1.9	0.000 000



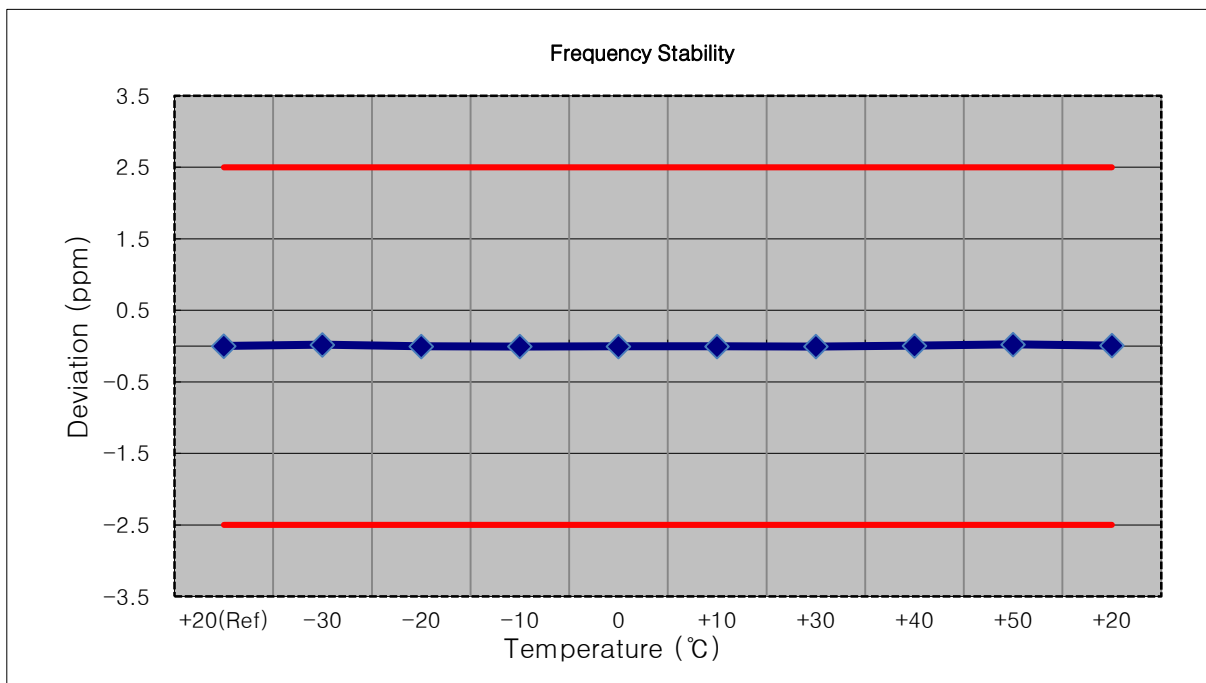
- ▣ MODE: LTE B5
- ▣ OPERATING FREQUENCY: 836,500,000 Hz
- ▣ CHANNEL: 20525(3MHz)
- ▣ REFERENCE VOLTAGE: 3.880 VDC
- ▣ DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.880	+20(Ref)	836 500 018	0.0	0.000 000	0.000
100%		-30	836 500 041	23.3	0.000 003	0.028
100%		-20	836 500 020	2.5	0.000 000	0.003
100%		-10	836 500 025	7.0	0.000 001	0.008
100%		0	836 500 013	-4.2	-0.000 001	-0.005
100%		+10	836 500 022	4.3	0.000 001	0.005
100%		+30	836 500 021	3.0	0.000 000	0.004
100%		+40	836 500 035	17.8	0.000 002	0.021
100%		+50	836 500 015	-2.9	0.000 000	-0.003
Batt. Endpoint		3.650	+20	836 500 024	6.1	0.000 001



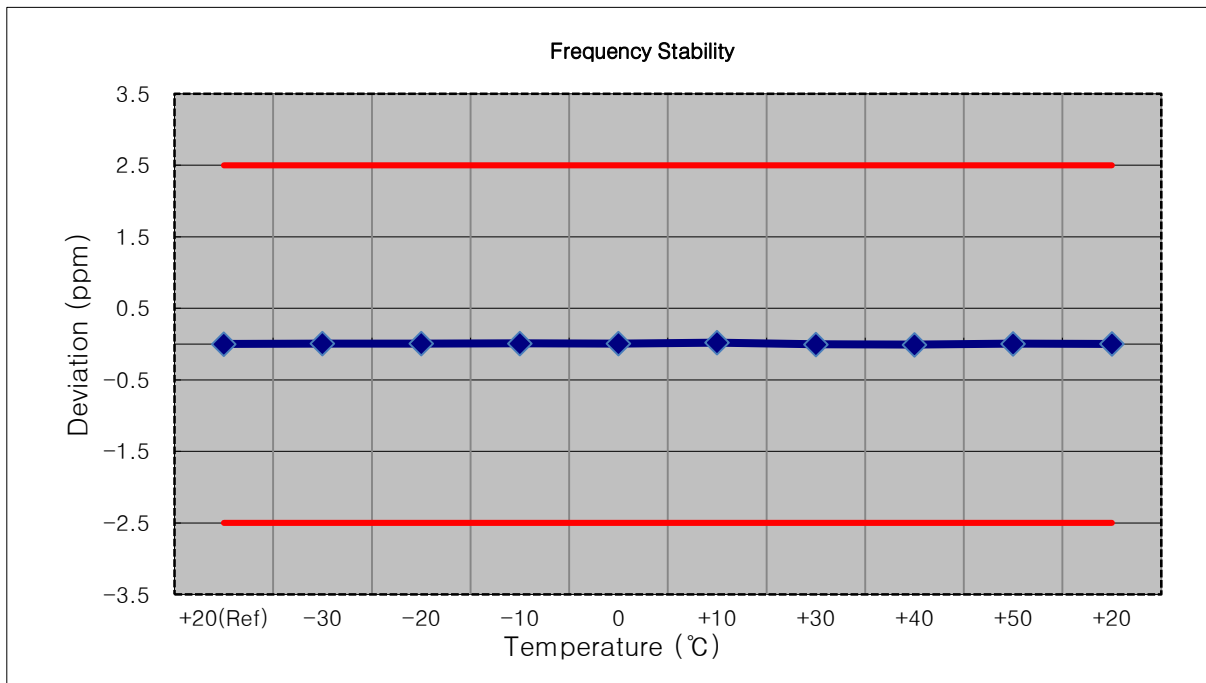
- ▣ MODE: LTE B5
- ▣ OPERATING FREQUENCY: 836,500,000 Hz
- ▣ CHANNEL: 20525(5MHz)
- ▣ REFERENCE VOLTAGE: 3.880 VDC
- ▣ DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.880	+20(Ref)	836 500 002	0.0	0.000 000	0.000
100%		-30	836 500 018	15.9	0.000 002	0.019
100%		-20	836 499 999	-3.9	0.000 000	-0.005
100%		-10	836 499 998	-4.5	-0.000 001	-0.005
100%		0	836 499 998	-4.1	0.000 000	-0.005
100%		+10	836 500 000	-2.7	0.000 000	-0.003
100%		+30	836 499 998	-4.4	-0.000 001	-0.005
100%		+40	836 500 007	4.9	0.000 001	0.006
100%		+50	836 500 021	18.1	0.000 002	0.022
Batt. Endpoint		3.650	+20	836 500 009	6.4	0.000 001



- ▣ MODE: LTE B5
- ▣ OPERATING FREQUENCY: 836,500,000 Hz
- ▣ CHANNEL: 20525(10MHz)
- ▣ REFERENCE VOLTAGE: 3.880 VDC
- ▣ DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.880	+20(Ref)	836 500 008	0.0	0.000 000	0.000
100%		-30	836 500 015	6.7	0.000 001	0.008
100%		-20	836 500 015	6.6	0.000 001	0.008
100%		-10	836 500 016	8.0	0.000 001	0.010
100%		0	836 500 013	5.4	0.000 001	0.006
100%		+10	836 500 024	16.3	0.000 002	0.019
100%		+30	836 500 005	-3.4	0.000 000	-0.004
100%		+40	836 500 001	-7.0	-0.000 001	-0.008
100%		+50	836 500 012	4.0	0.000 000	0.005
Batt. Endpoint		3.650	+20	836 500 011	2.7	0.000 000



9. TEST PLOTS

1.4M_BandEdge_Lowest Channel_QPSK_FullRB(1)



1.4M_BandEdge_Lowest Channel_QPSK_FullRB(2)



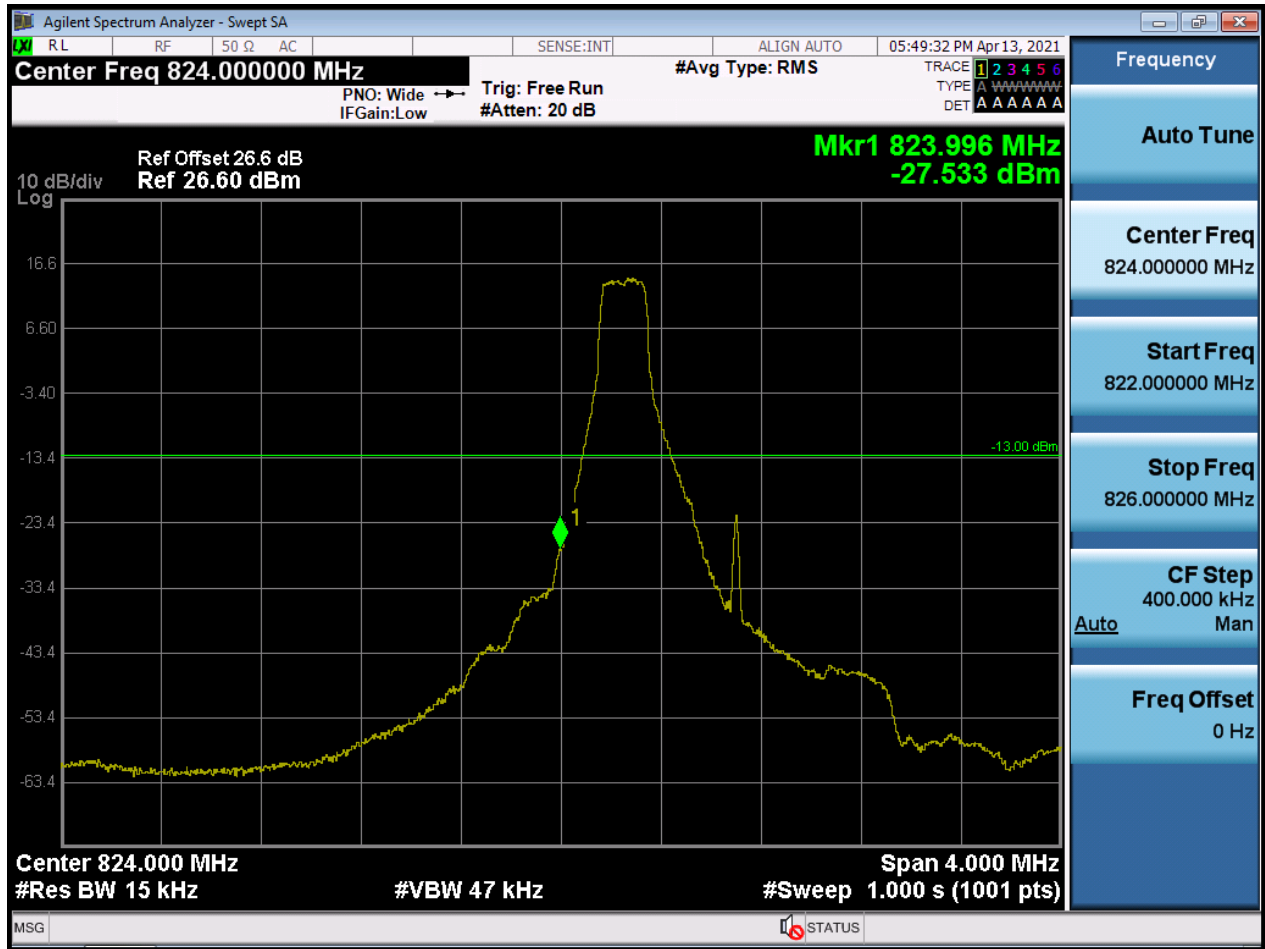
1.4M_BandEdge_Highest Channel_QPSK_FullIRB(1)



1.4M_BandEdge_Highest Channel_QPSK_FullIRB(2)



1.4M_BandEdge_Lowest Channel_QPSK_1RB



1.4M_BandEdge_Highest Channel_QPSK_1RB



3M_BandEdge_Lowest Channel_QPSK_FullRB(1)



3M_BandEdge_Lowest Channel_QPSK_FullRB(2)



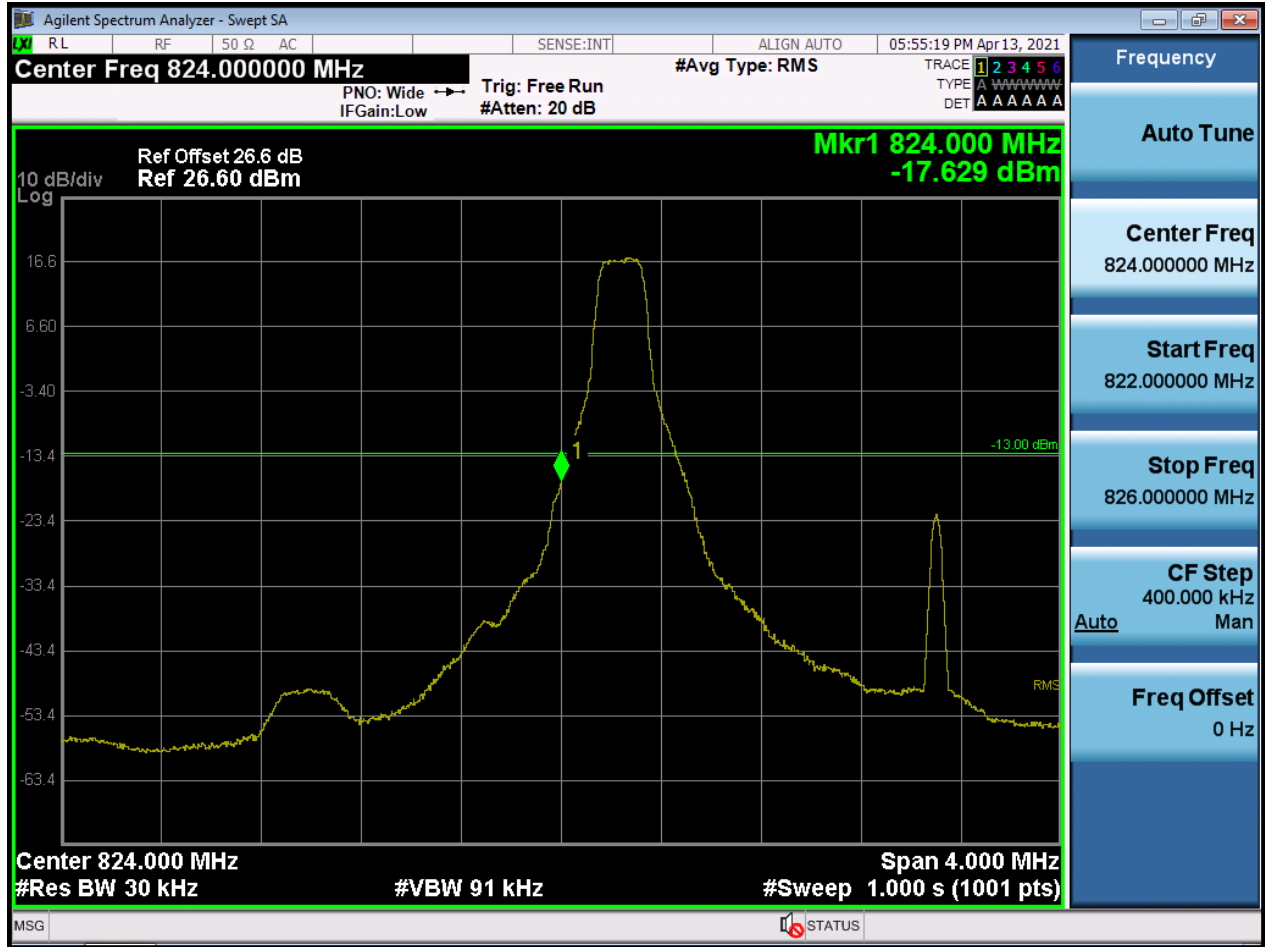
3M_BandEdge_Highest Channel_QPSK_FullIRB(1)



3M_BandEdge_Highest Channel_QPSK_FullIRB(2)



3M_BandEdge_Lowest Channel_QPSK_1RB



3M_BandEdge_Highest Channel_QPSK_1RB



5M_BandEdge_Lowest Channel_QPSK_FullRB(1)



5M_BandEdge_Lowest Channel_QPSK_FullRB(2)



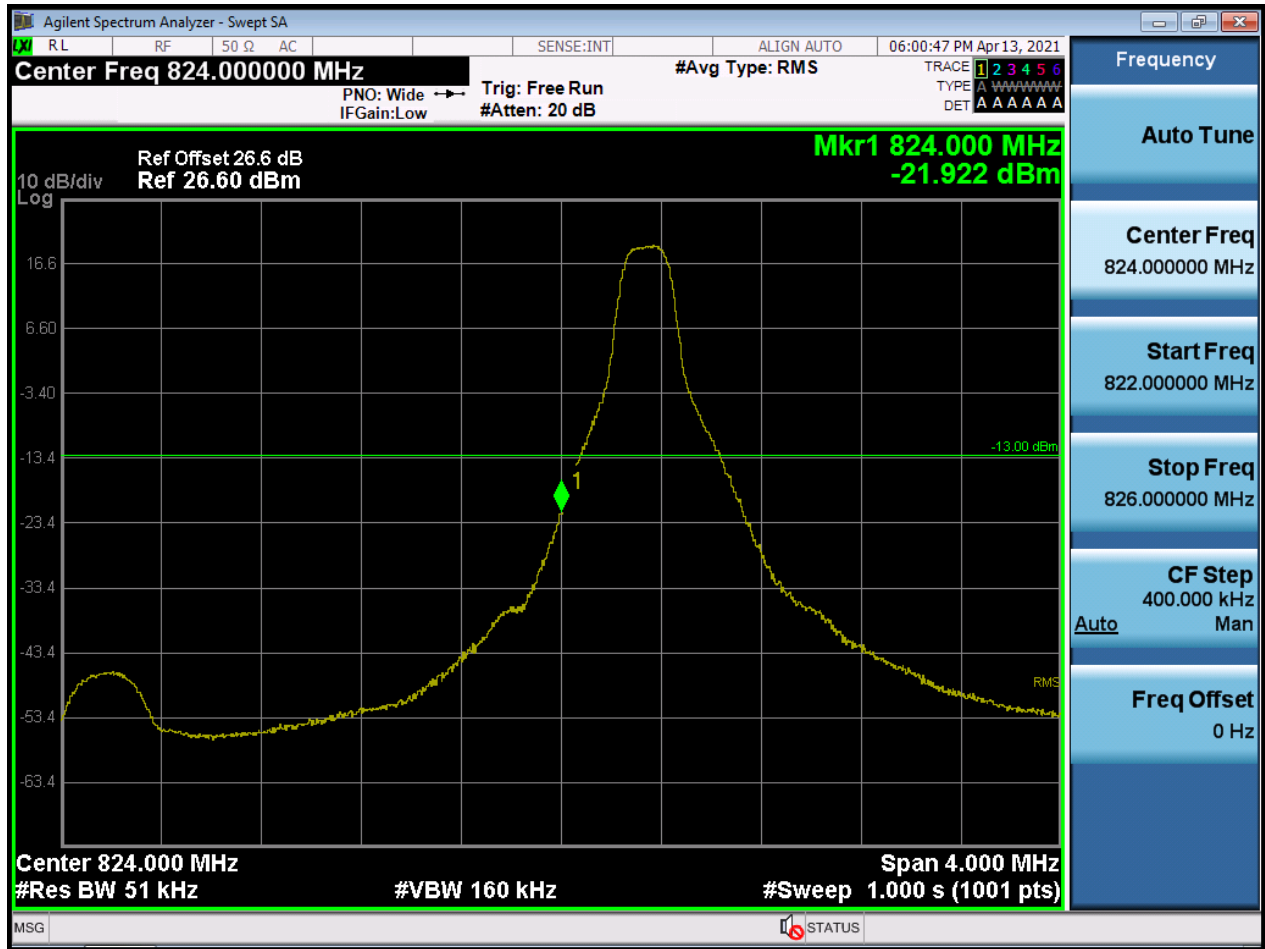
5M_BandEdge_Highest Channel_QPSK_FullIRB(1)



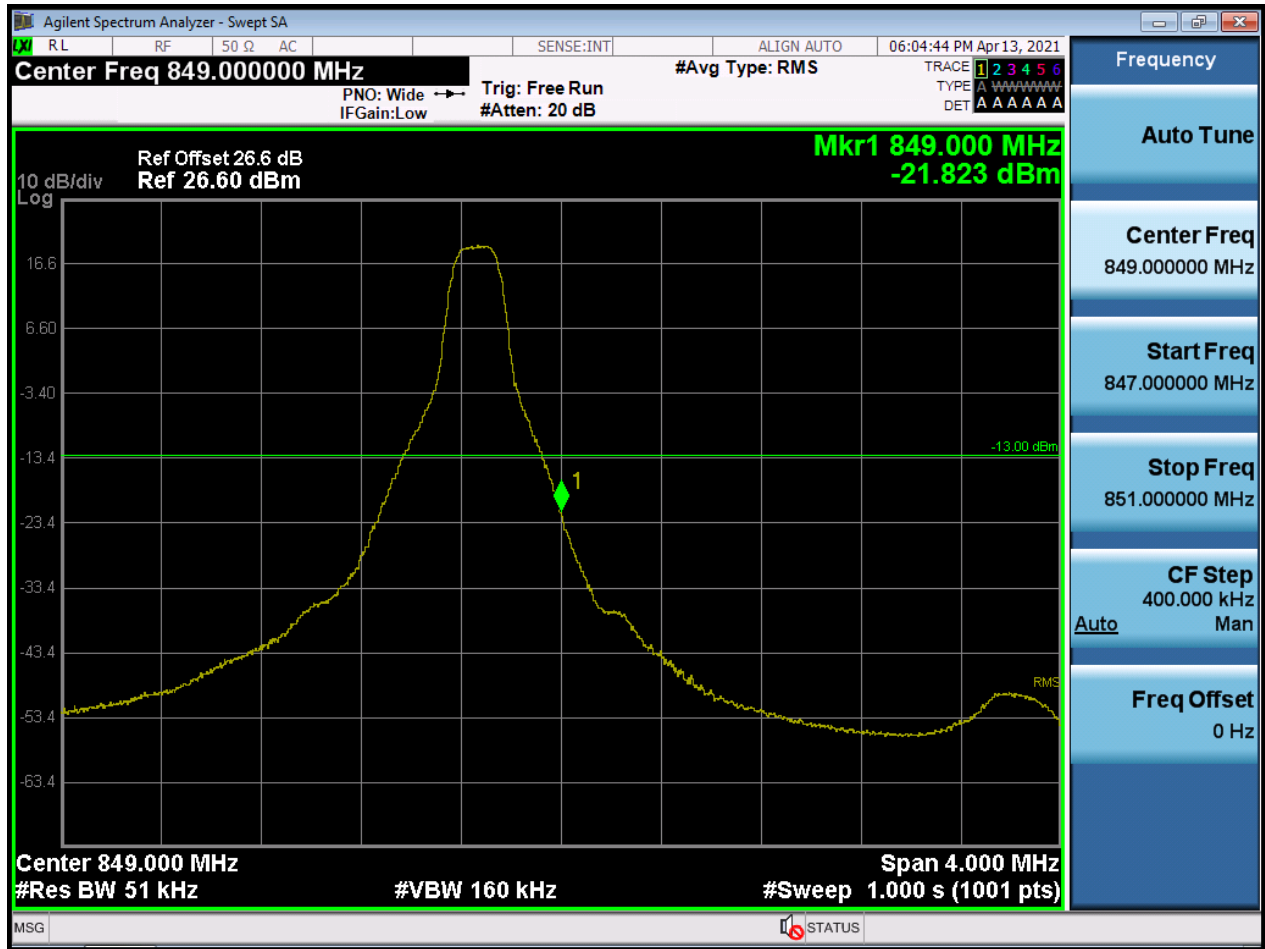
5M_BandEdge_Highest Channel_QPSK_FullIRB(2)



5M_BandEdge_Lowest Channel_QPSK_1RB



5M_BandEdge_Highest Channel_QPSK_1RB



10M_BandEdge_Lowest Channel_QPSK_FullIRB(1)



10M_BandEdge_Lowest Channel_QPSK_FullIRB(2)



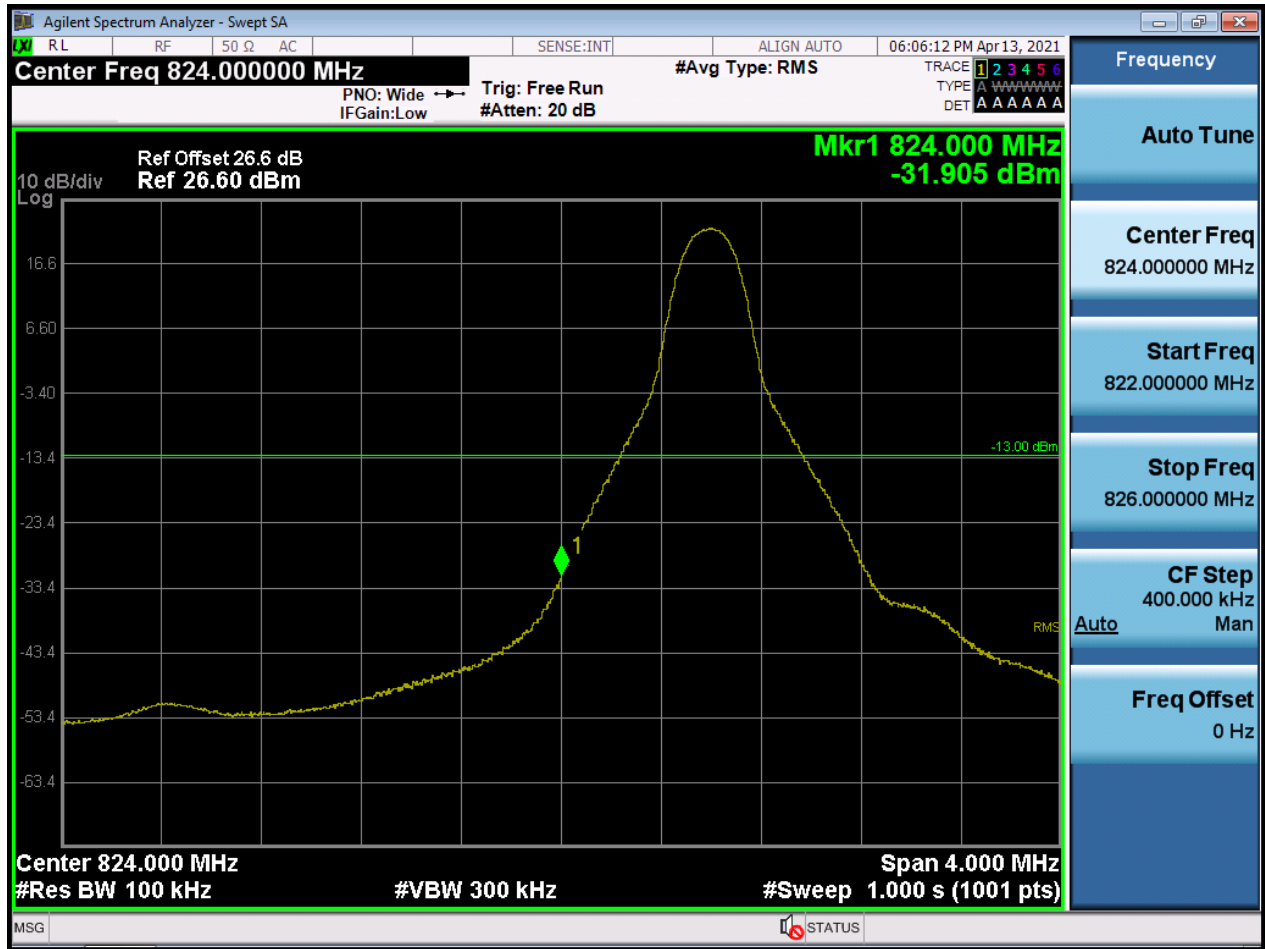
10M_BandEdge_Highest Channel_QPSK_FullRB(1)



10M_BandEdge_Highest Channel_QPSK_FullRB(2)



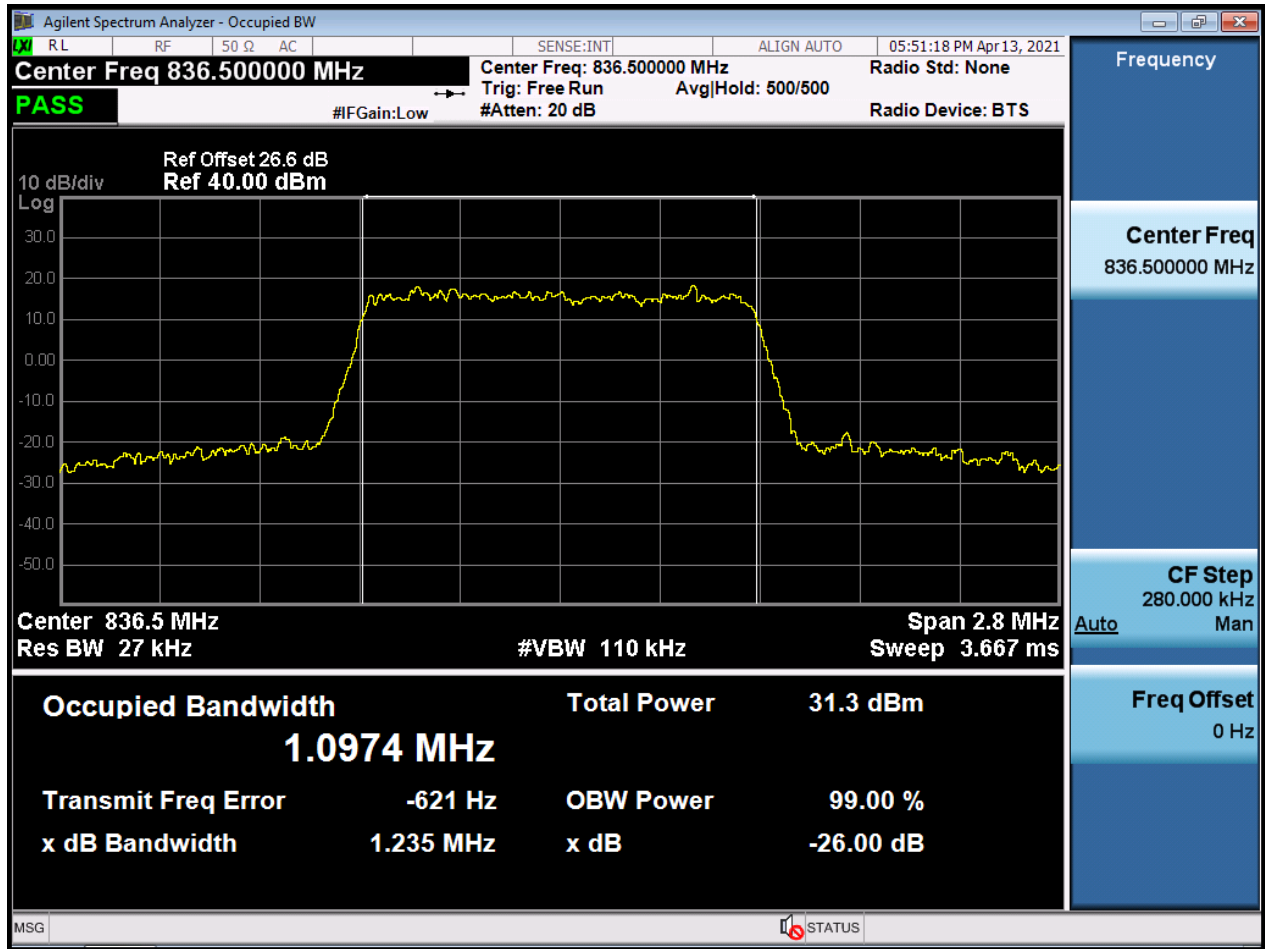
10M_BandEdge_Lowest Channel_QPSK_1RB



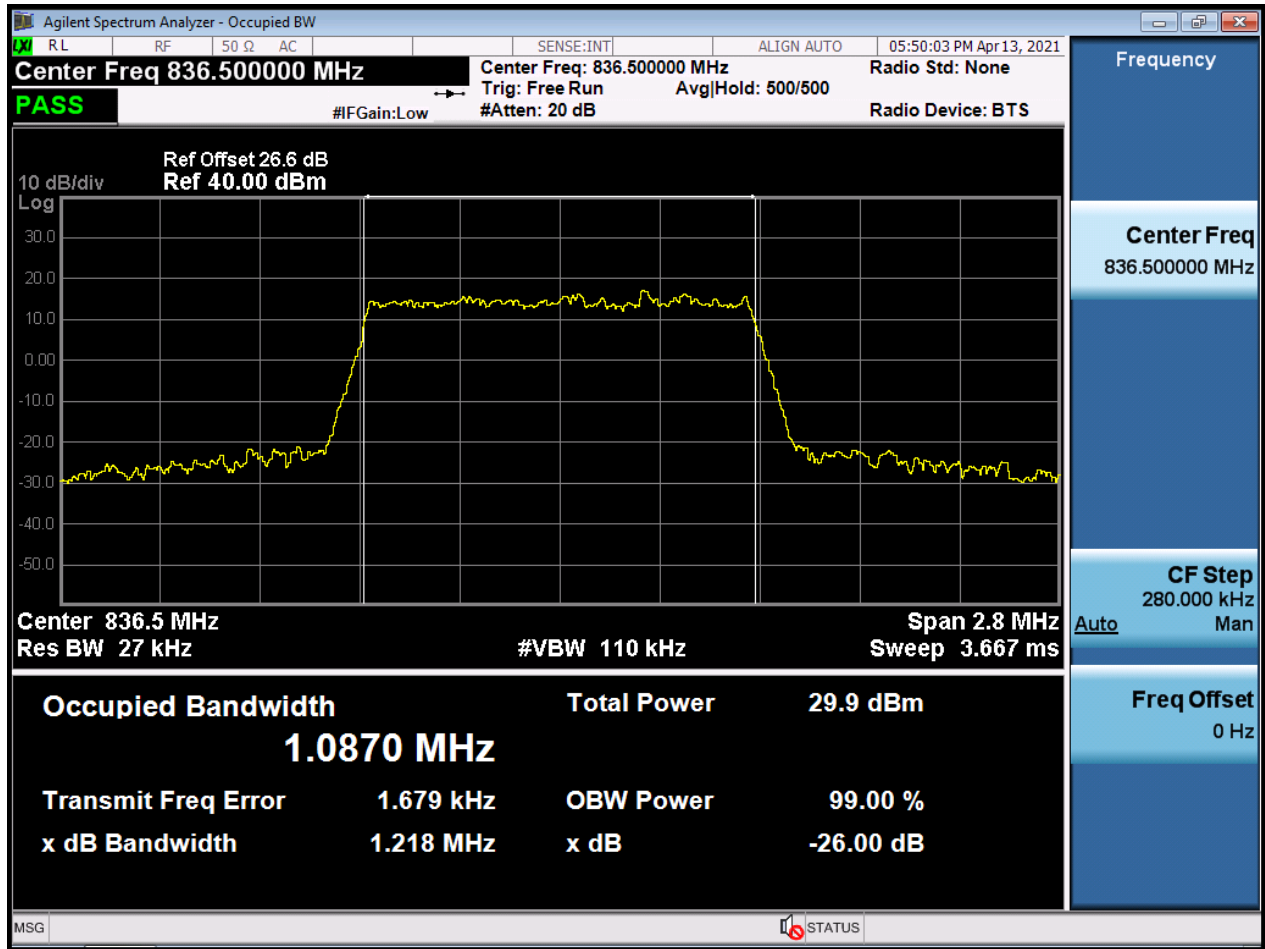
10M_BandEdge_Highest Channel_QPSK_1RB



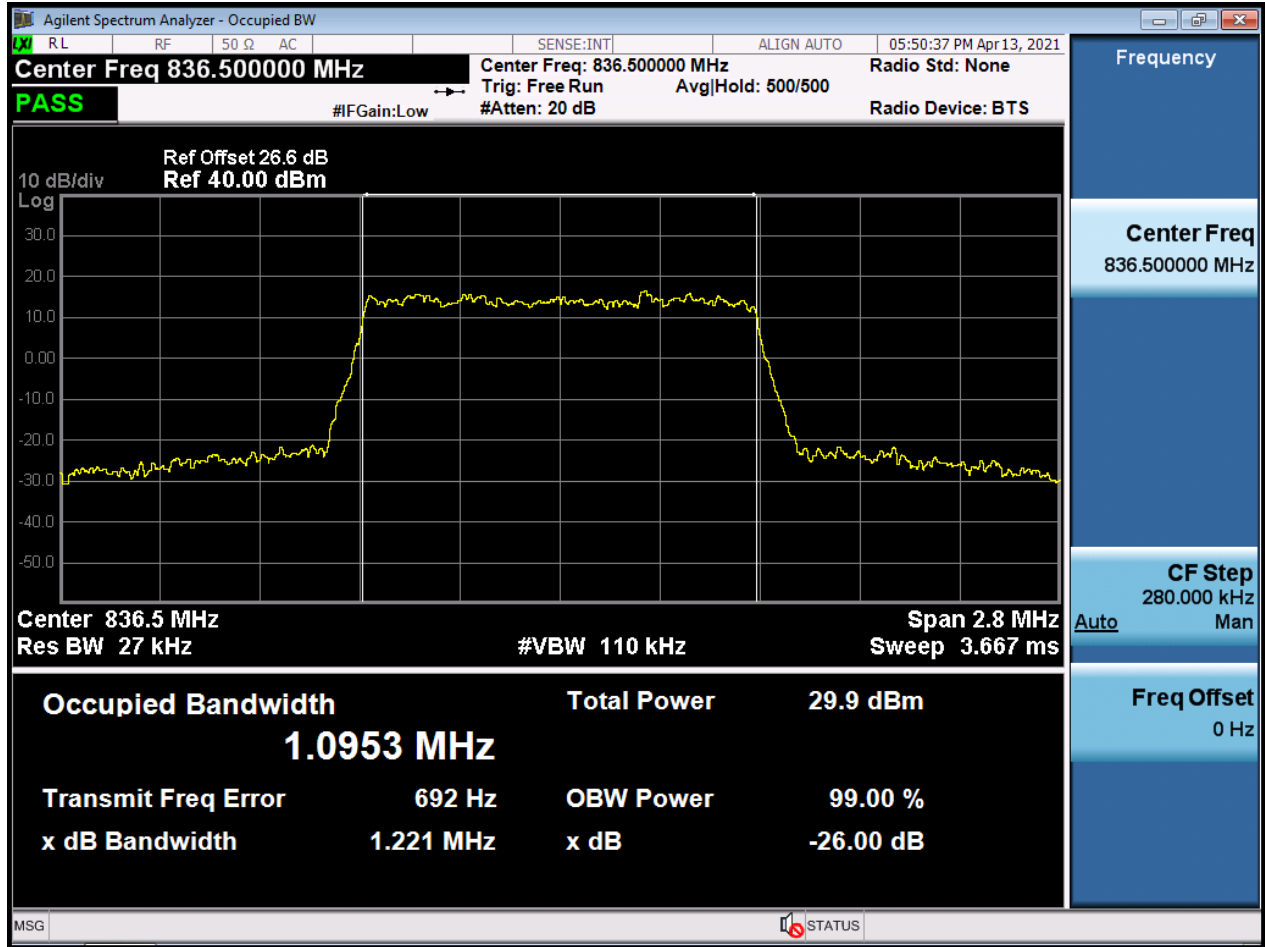
1.4M_OBW_Mid Channel_QPSK_FullRB



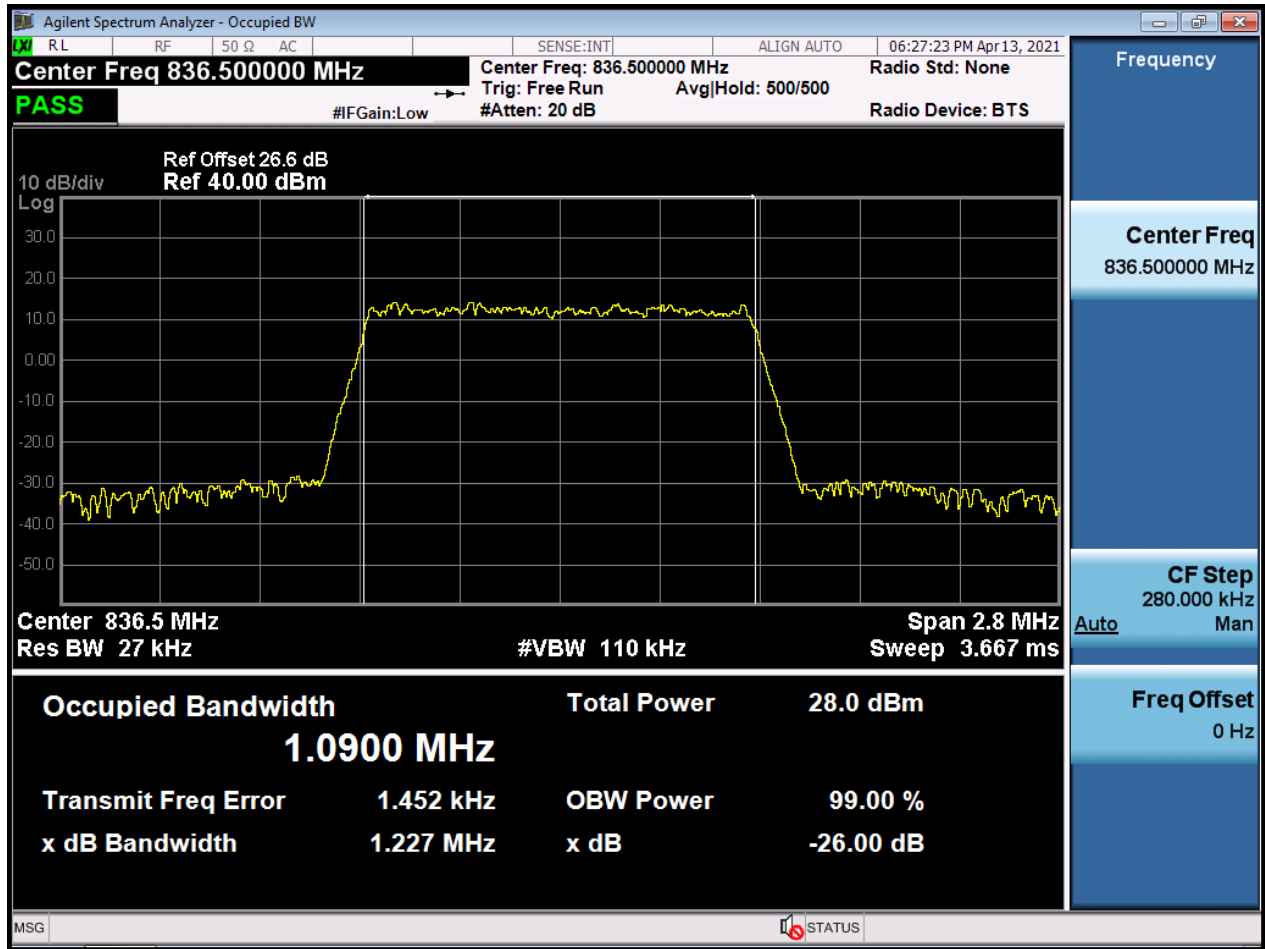
1.4M_OBW_Mid Channel_16QAM_FullIRB



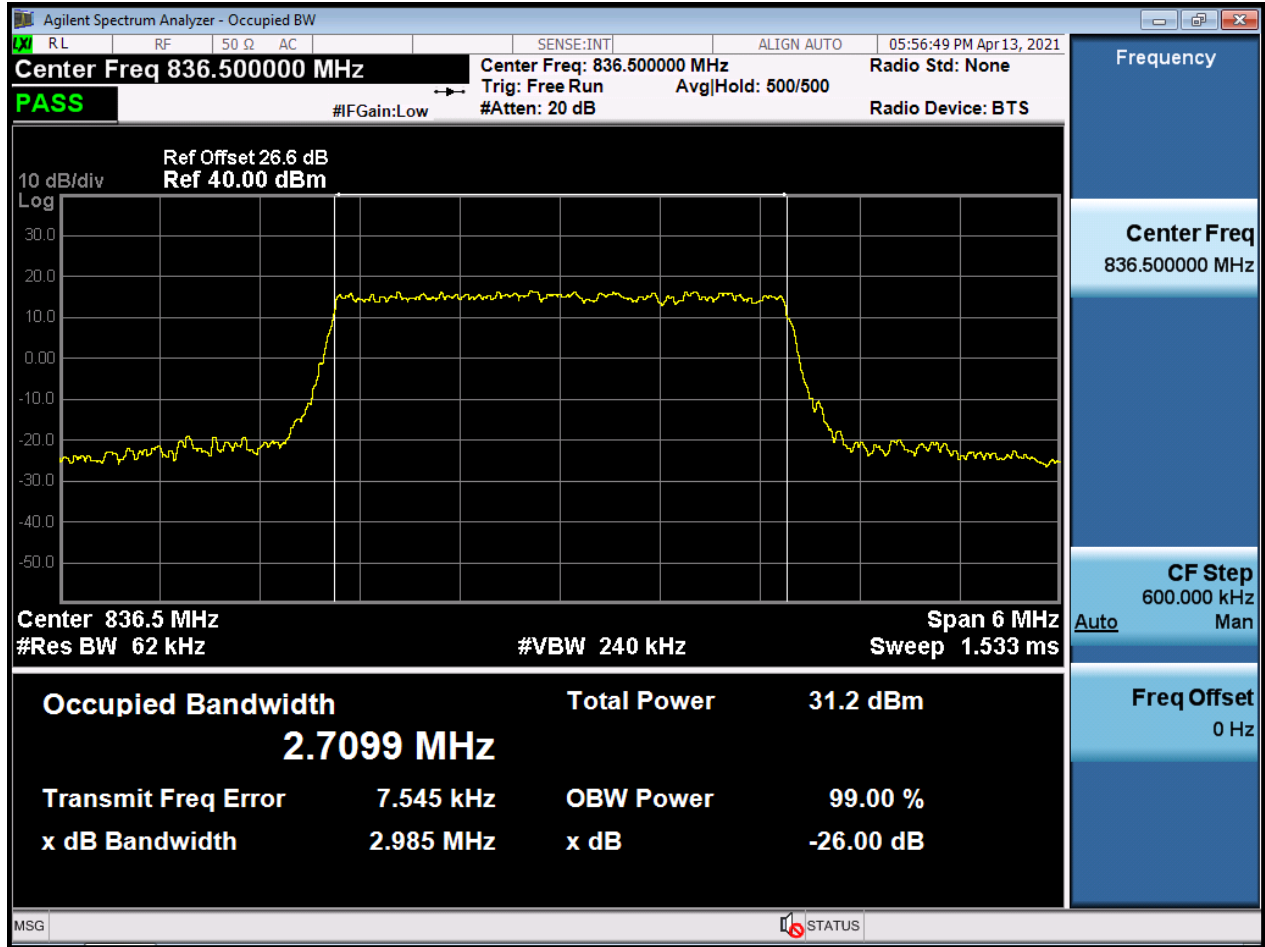
1.4M_OBW_Mid Channel_64QAM_FullRB



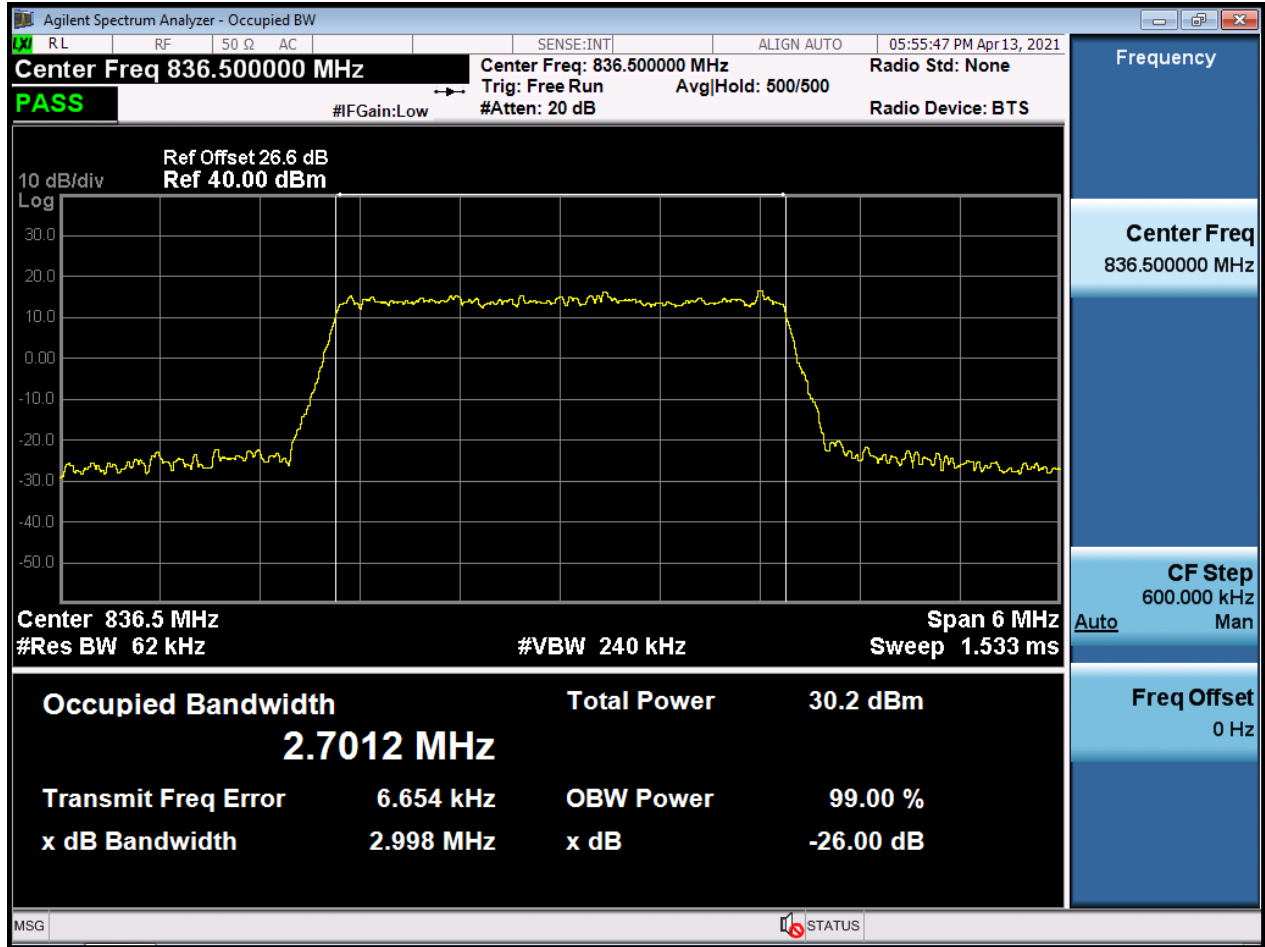
1.4M_OBW_Mid Channel_256QAM_FullRB



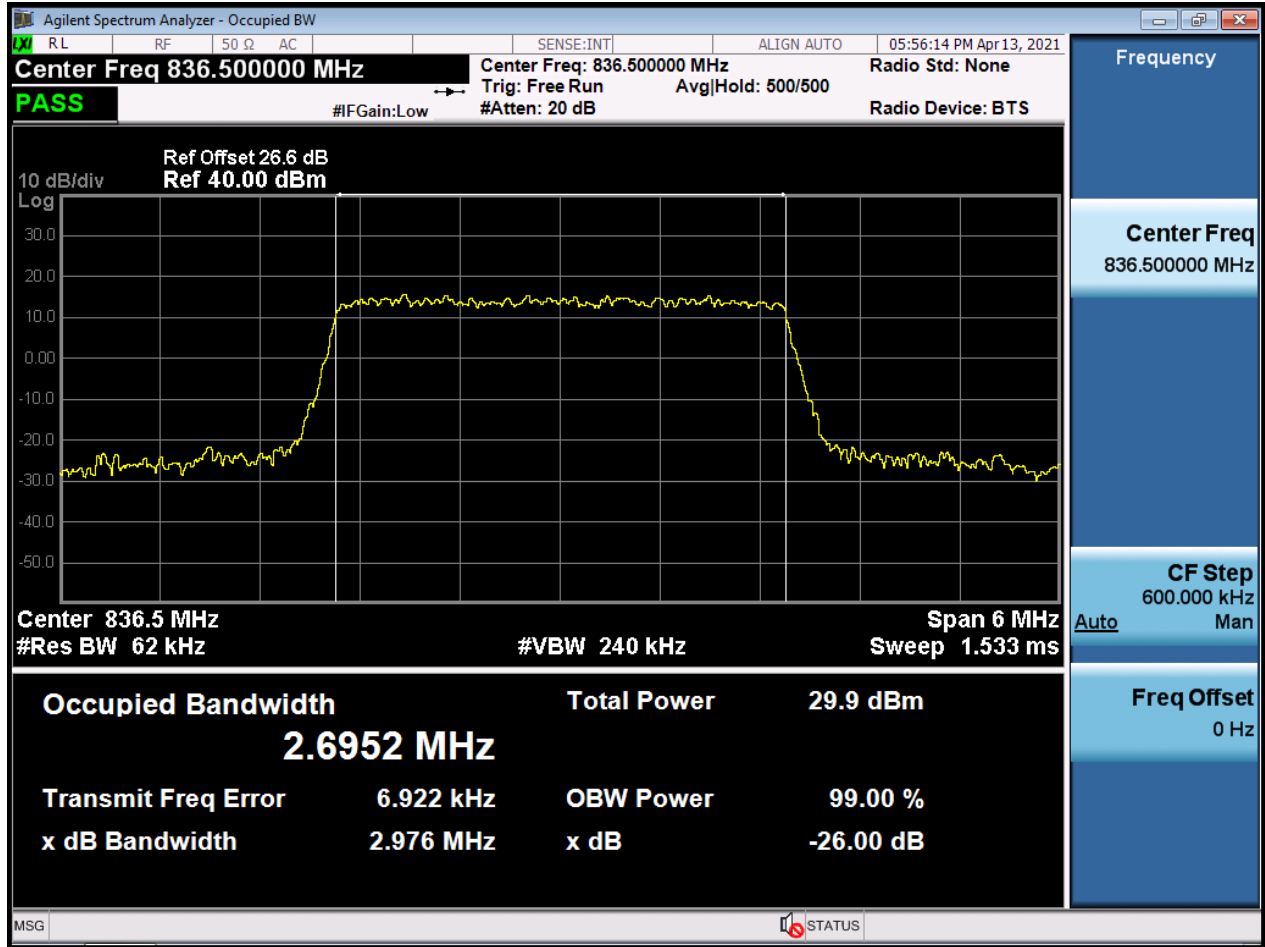
3M_OBW_Mid Channel_QPSK_FullRB



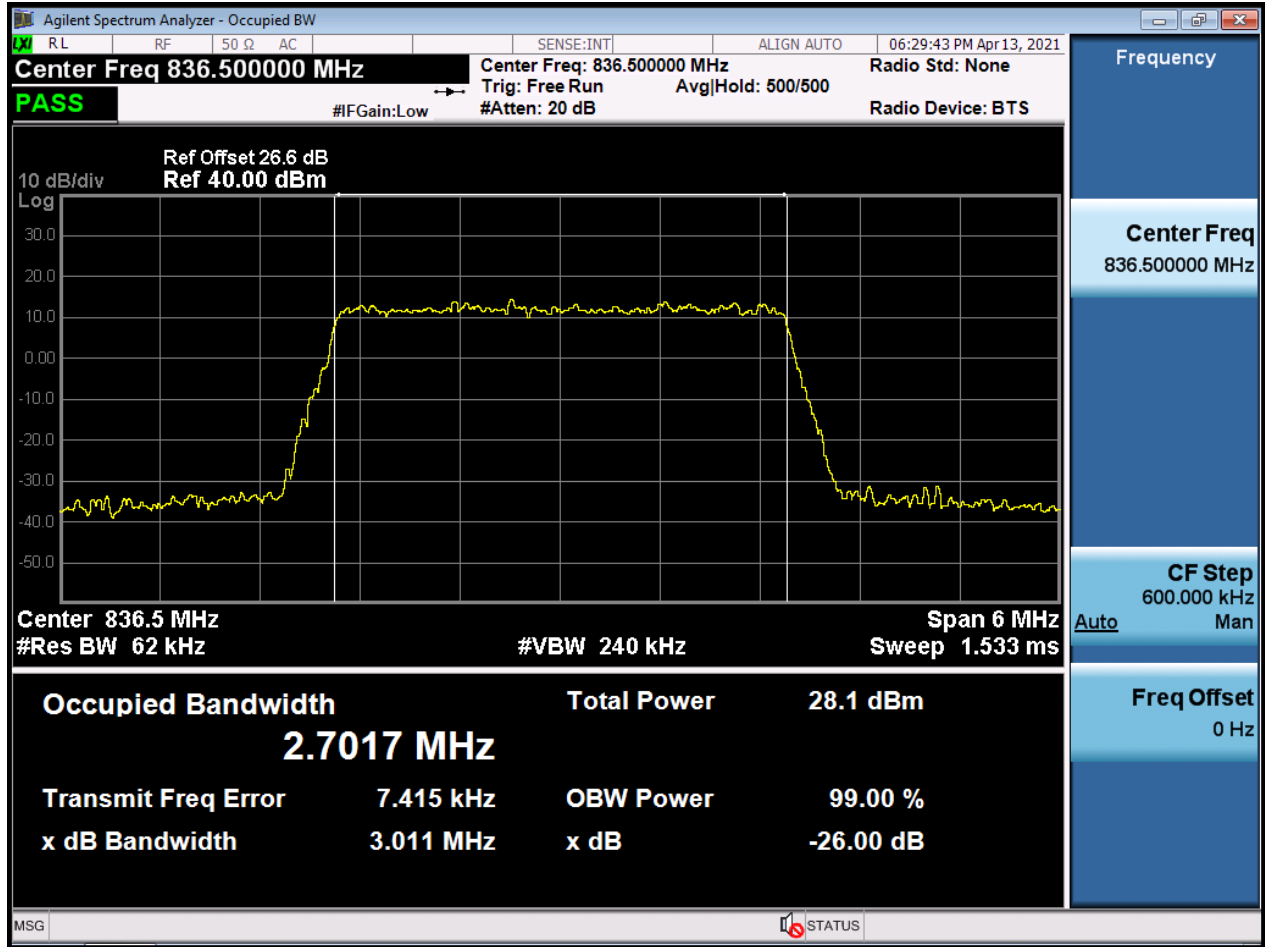
3M_OBW_Mid Channel_16QAM_FullRB



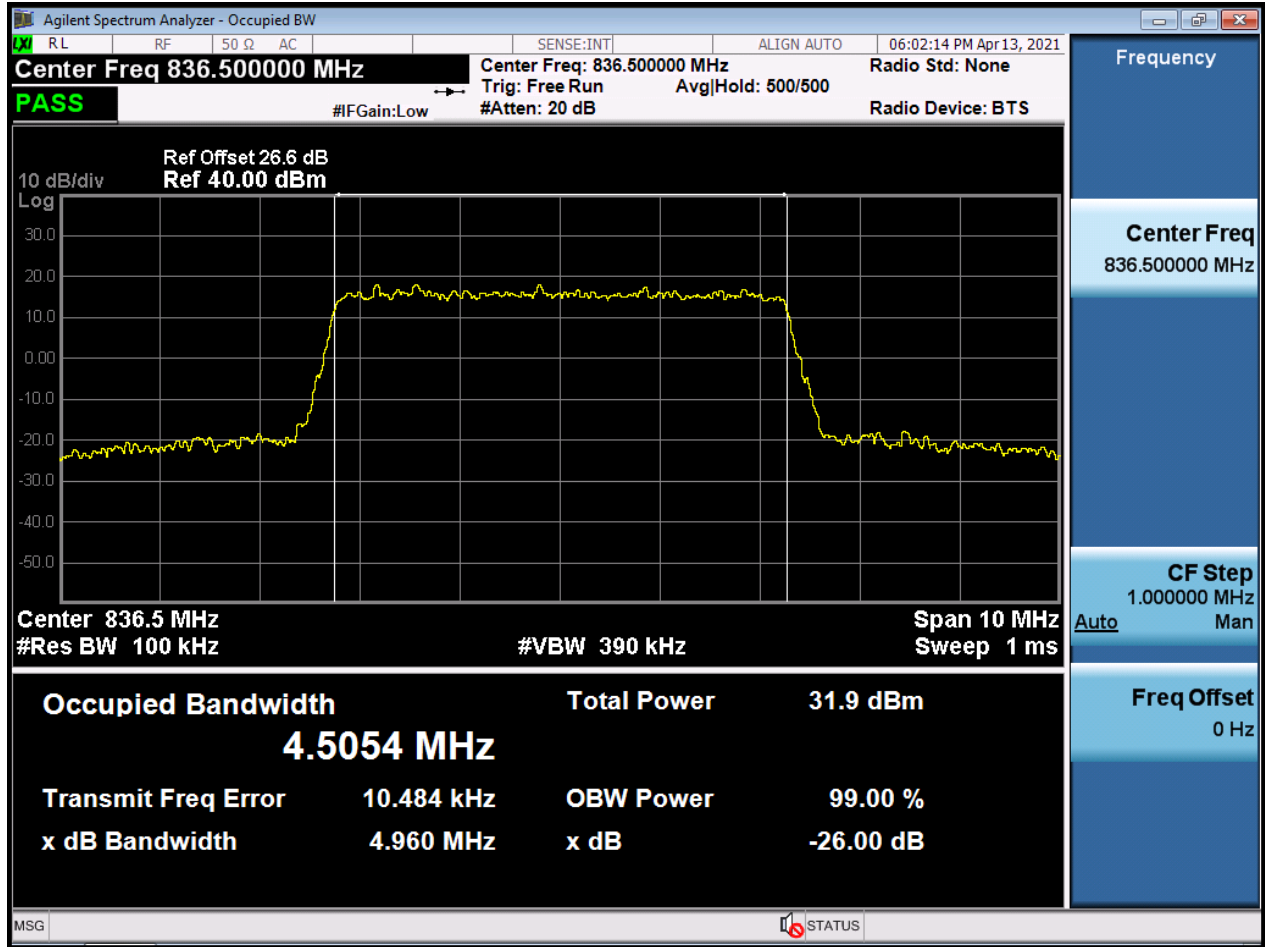
3M_OBW_Mid Channel_64QAM_FullRB



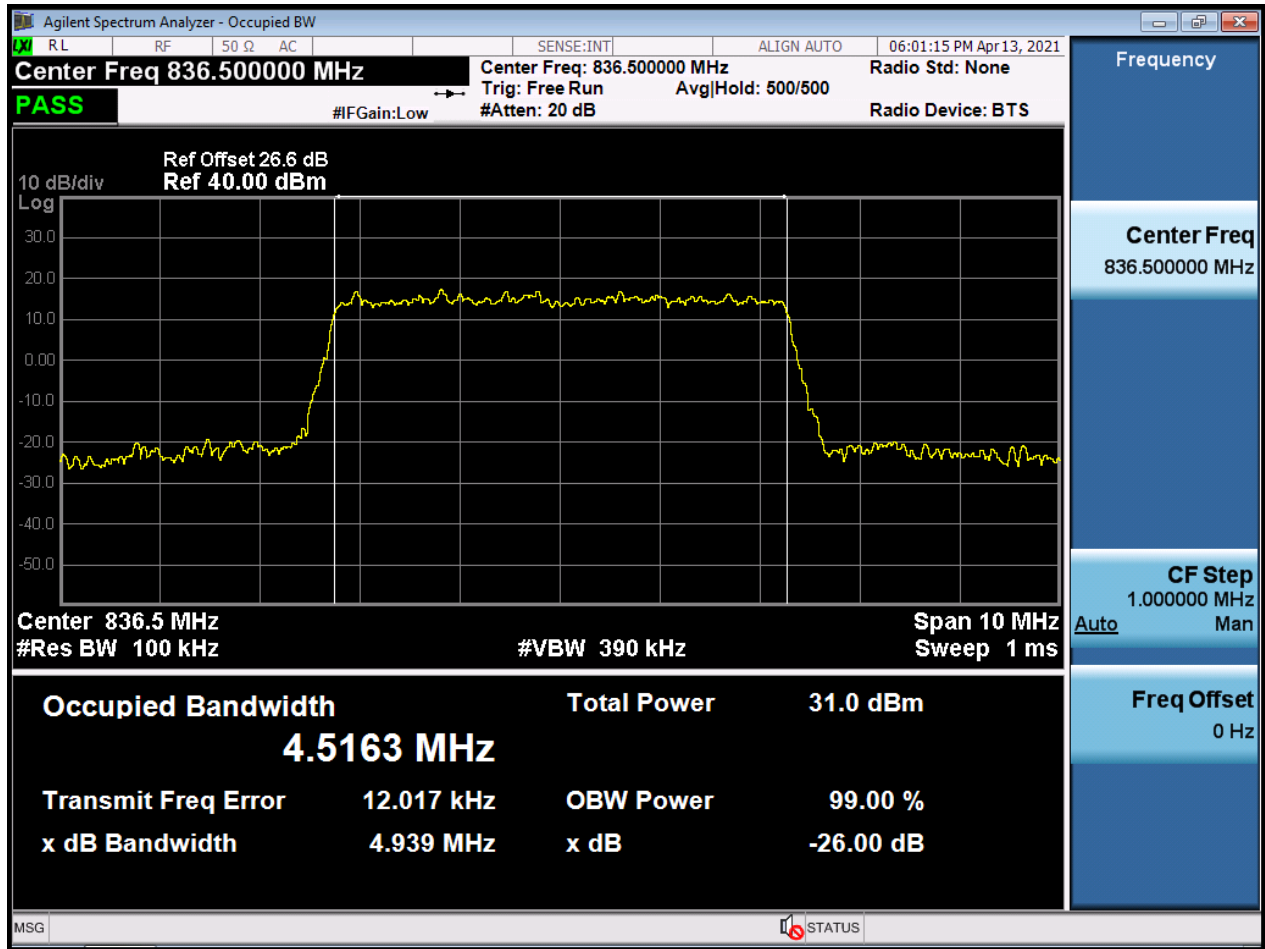
3M_OBW_Mid Channel_256QAM_FullRB



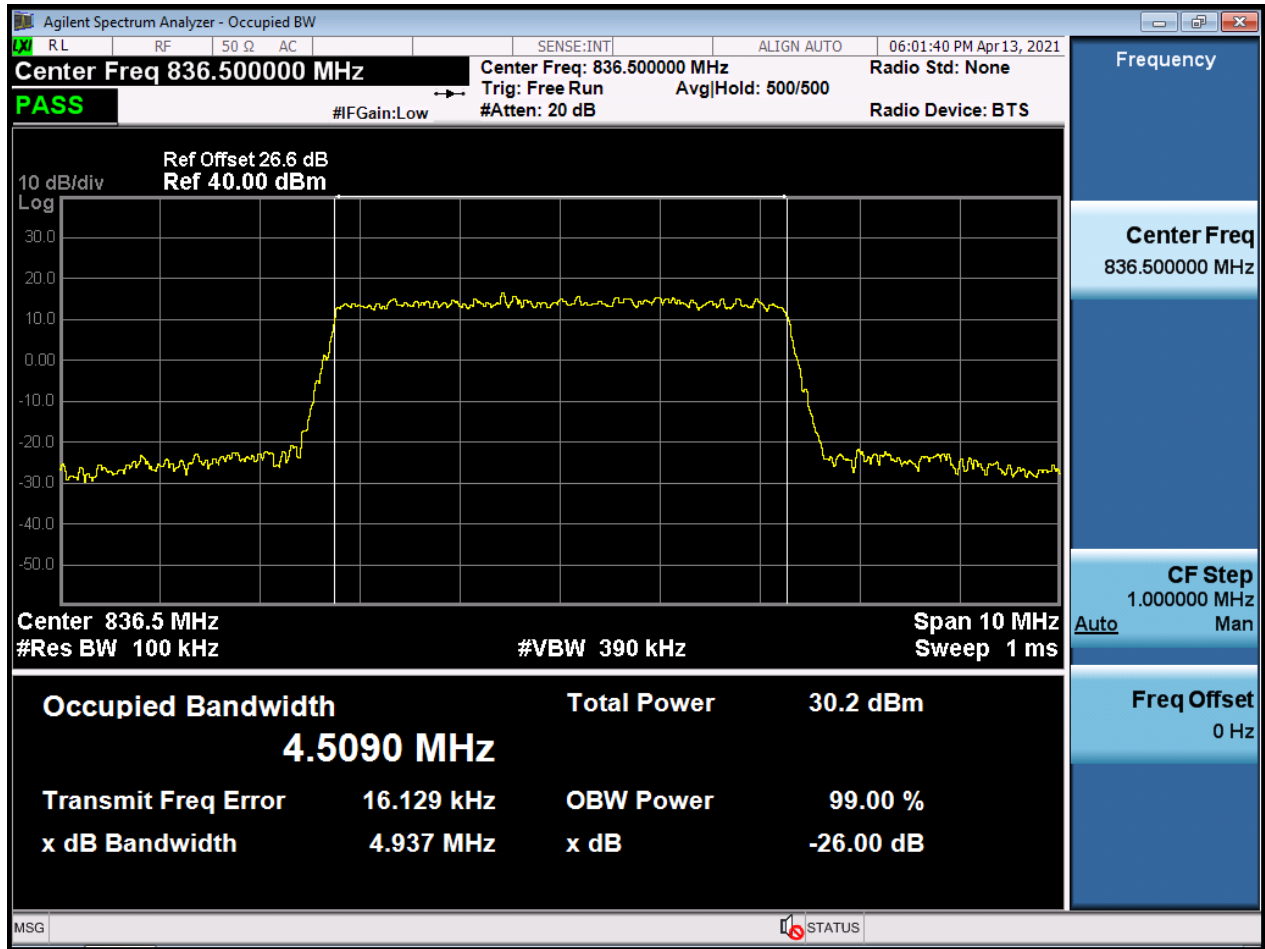
5M_OBW_Mid Channel_QPSK_FullRB



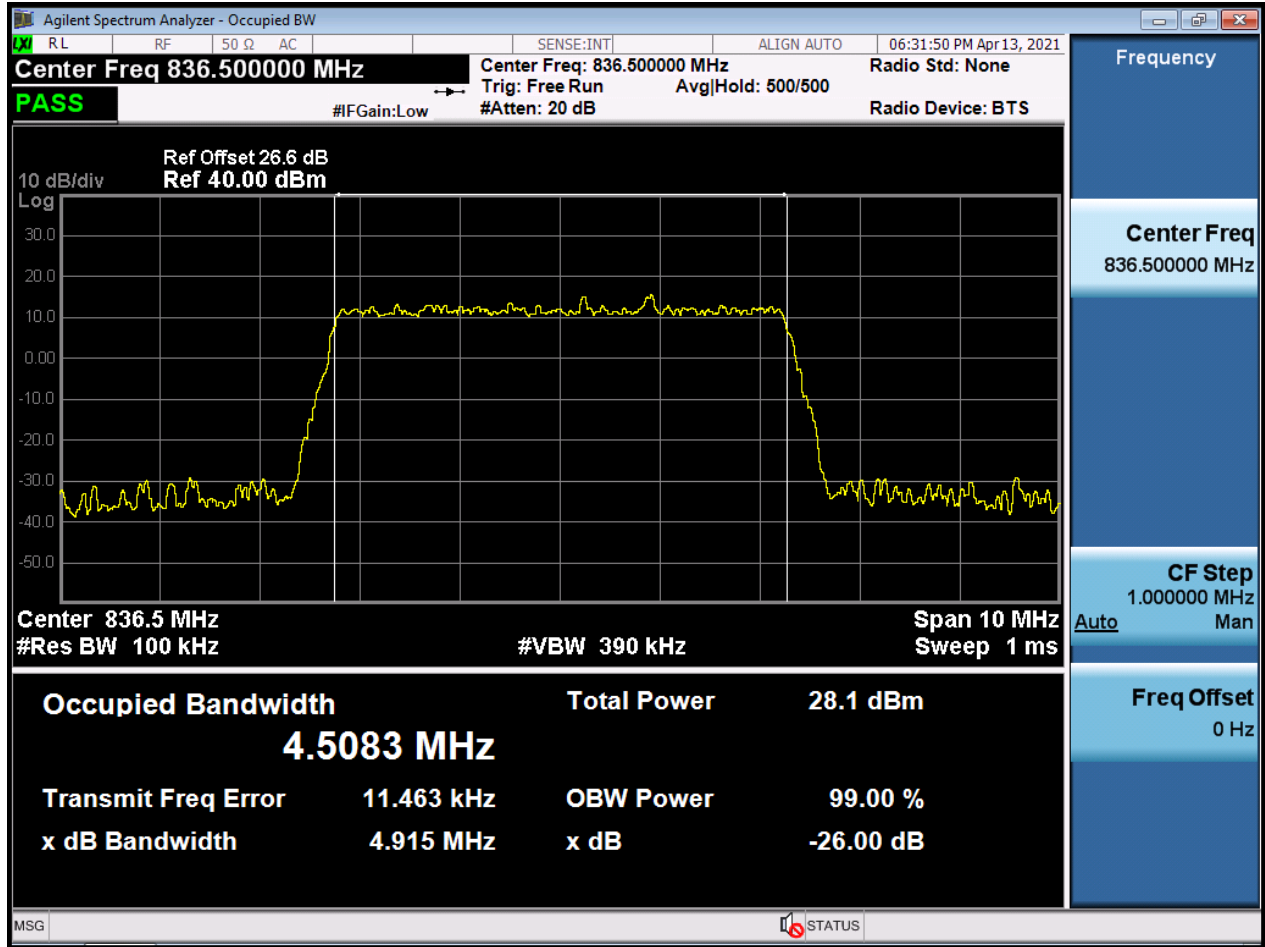
5M_OBW_Mid Channel_16QAM_FullIRB



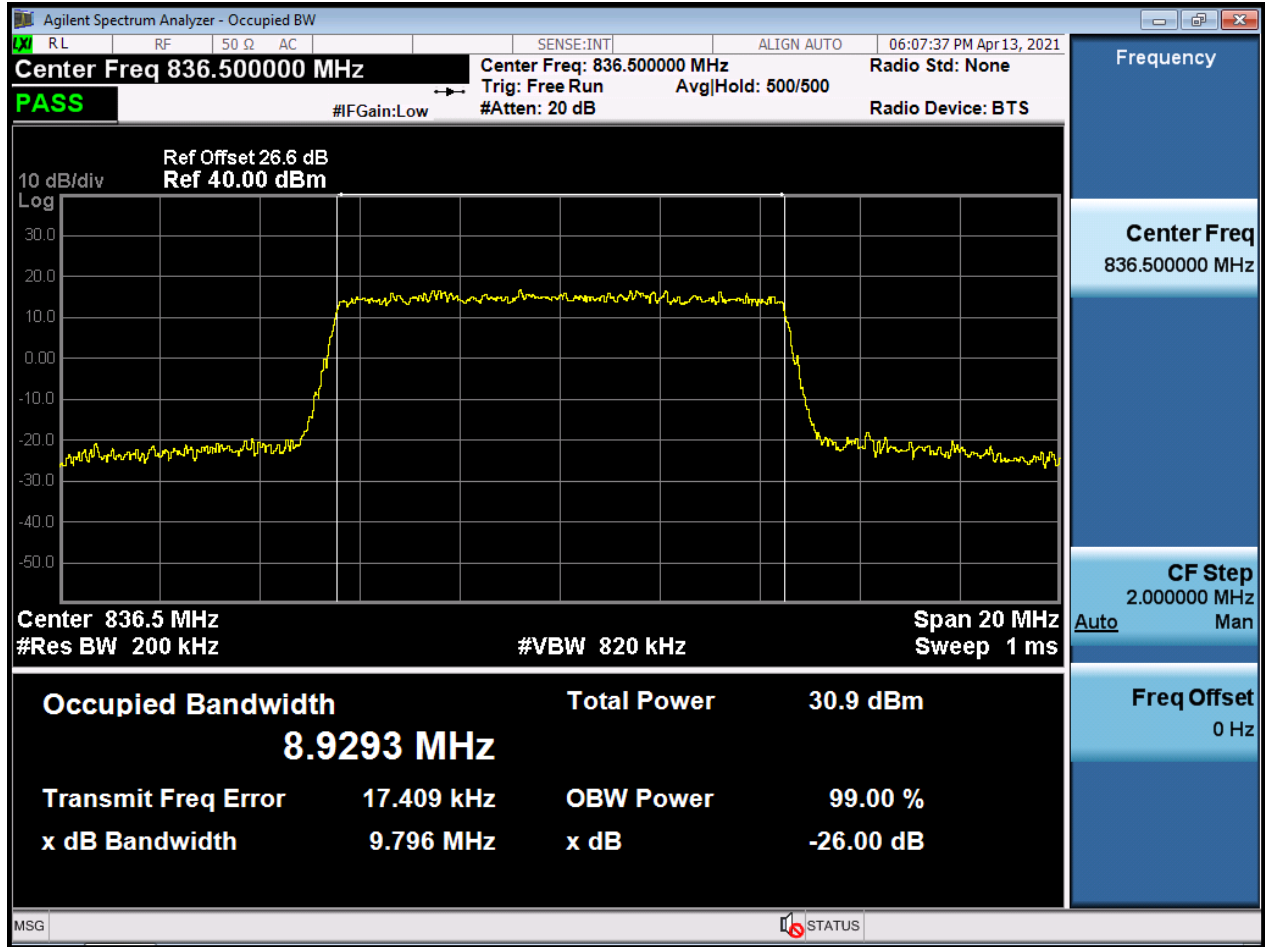
5M_OBW_Mid Channel_64QAM_FullIRB



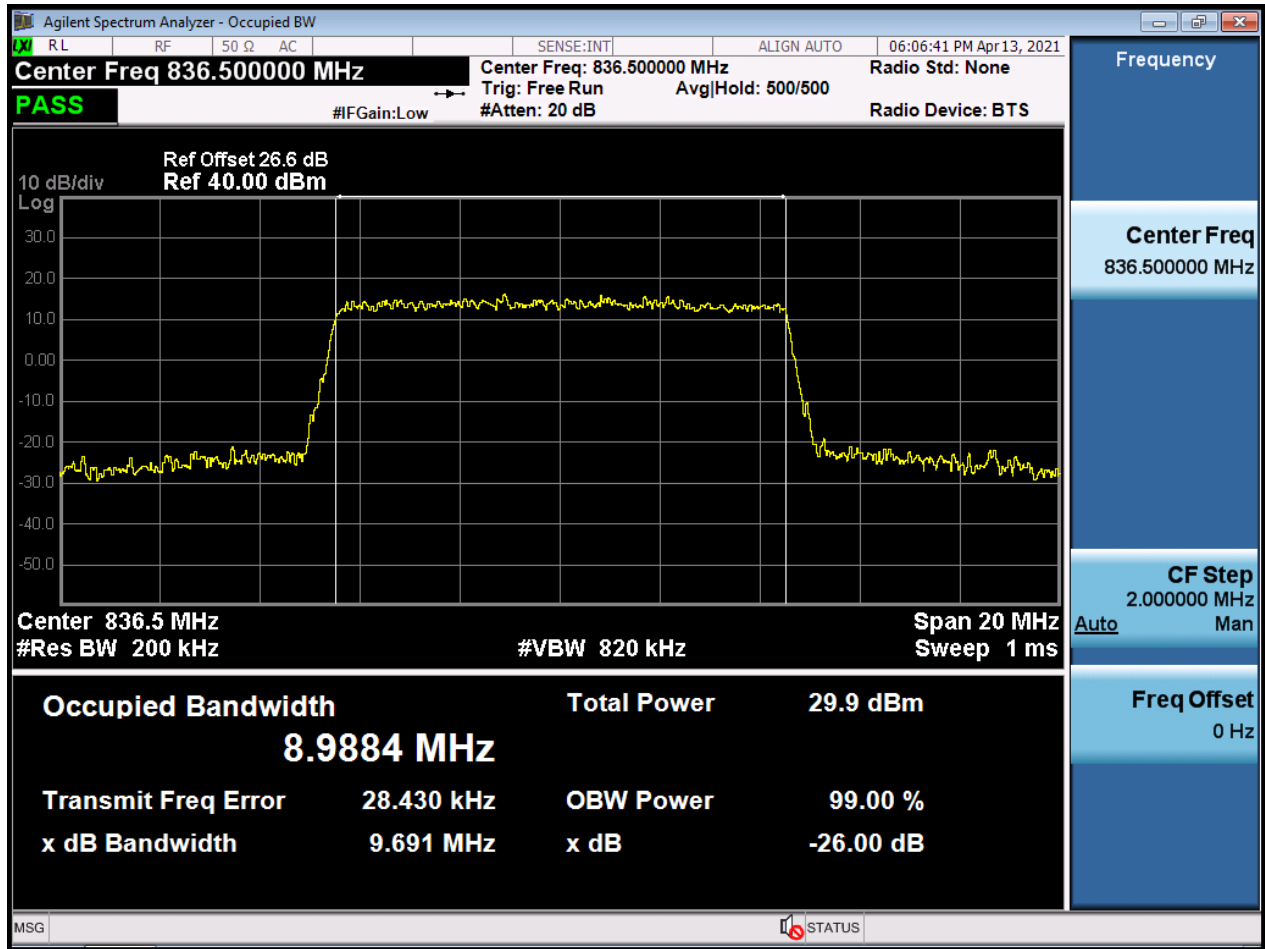
5M_OBW_Mid Channel_256QAM_FullRB



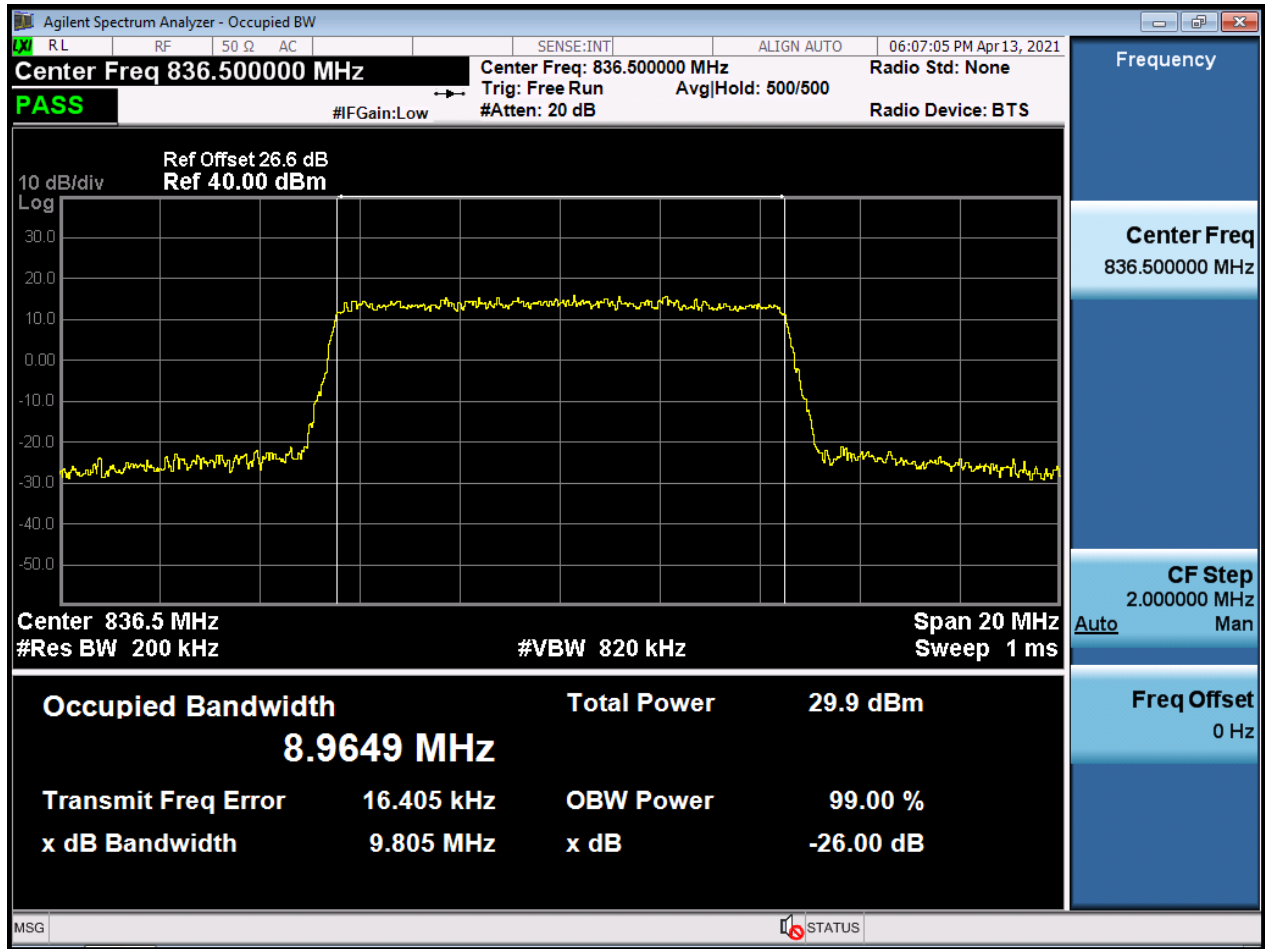
10M_OBW_Mid Channel_QPSK_FullIRB



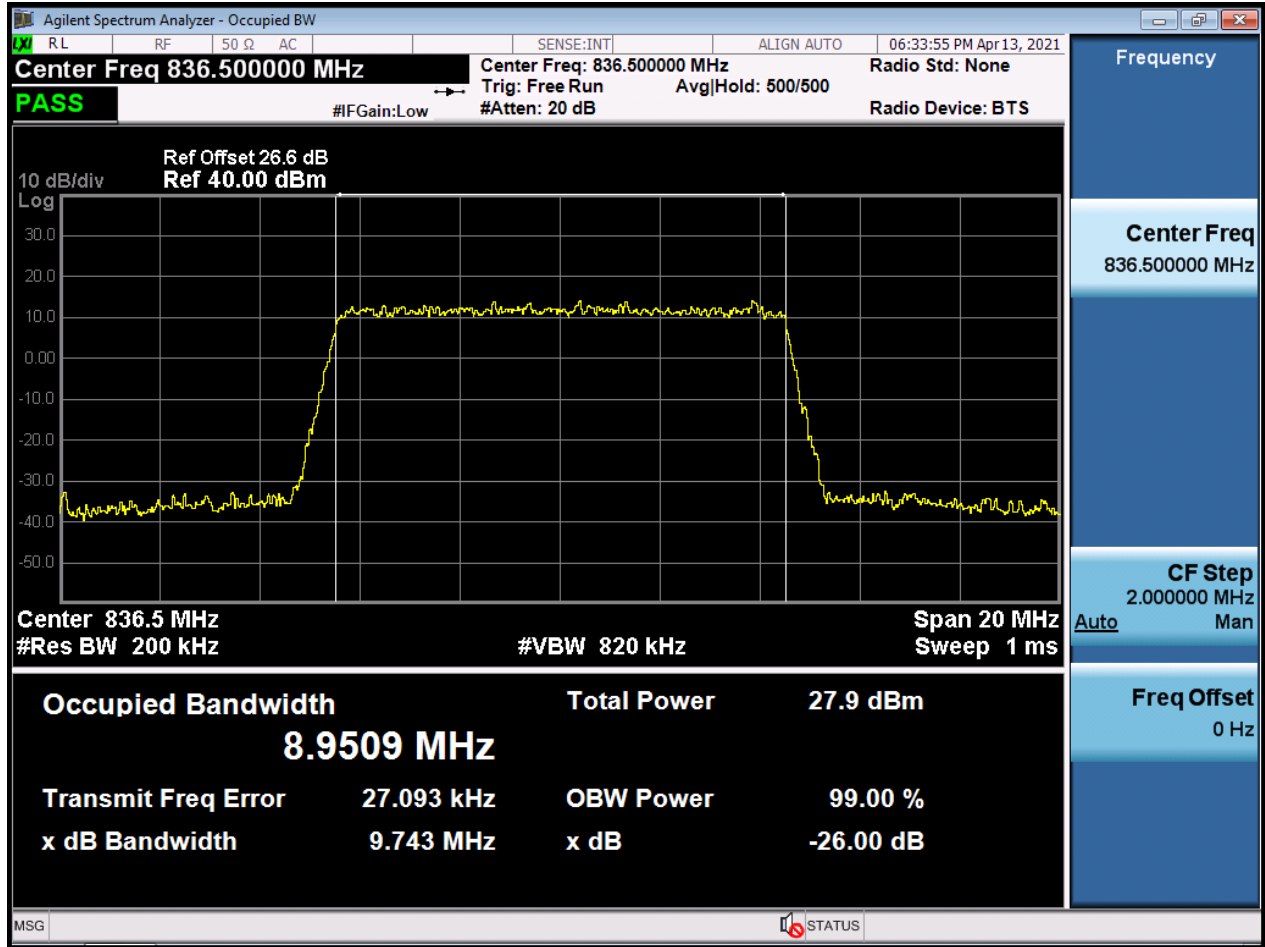
10M_OBW_Mid Channel_16QAM_FullRB



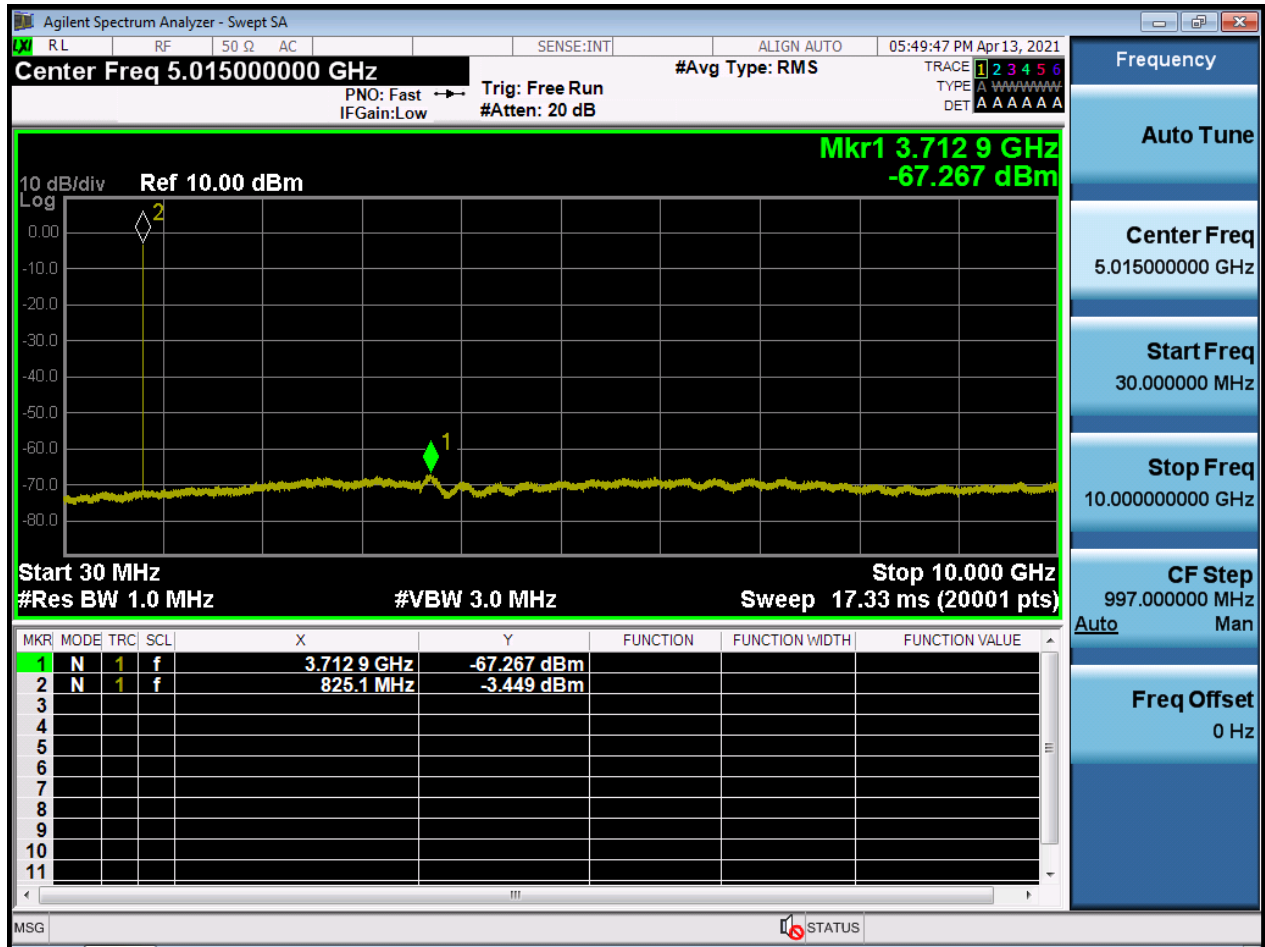
10M_OBW_Mid Channel_64QAM_FullRB



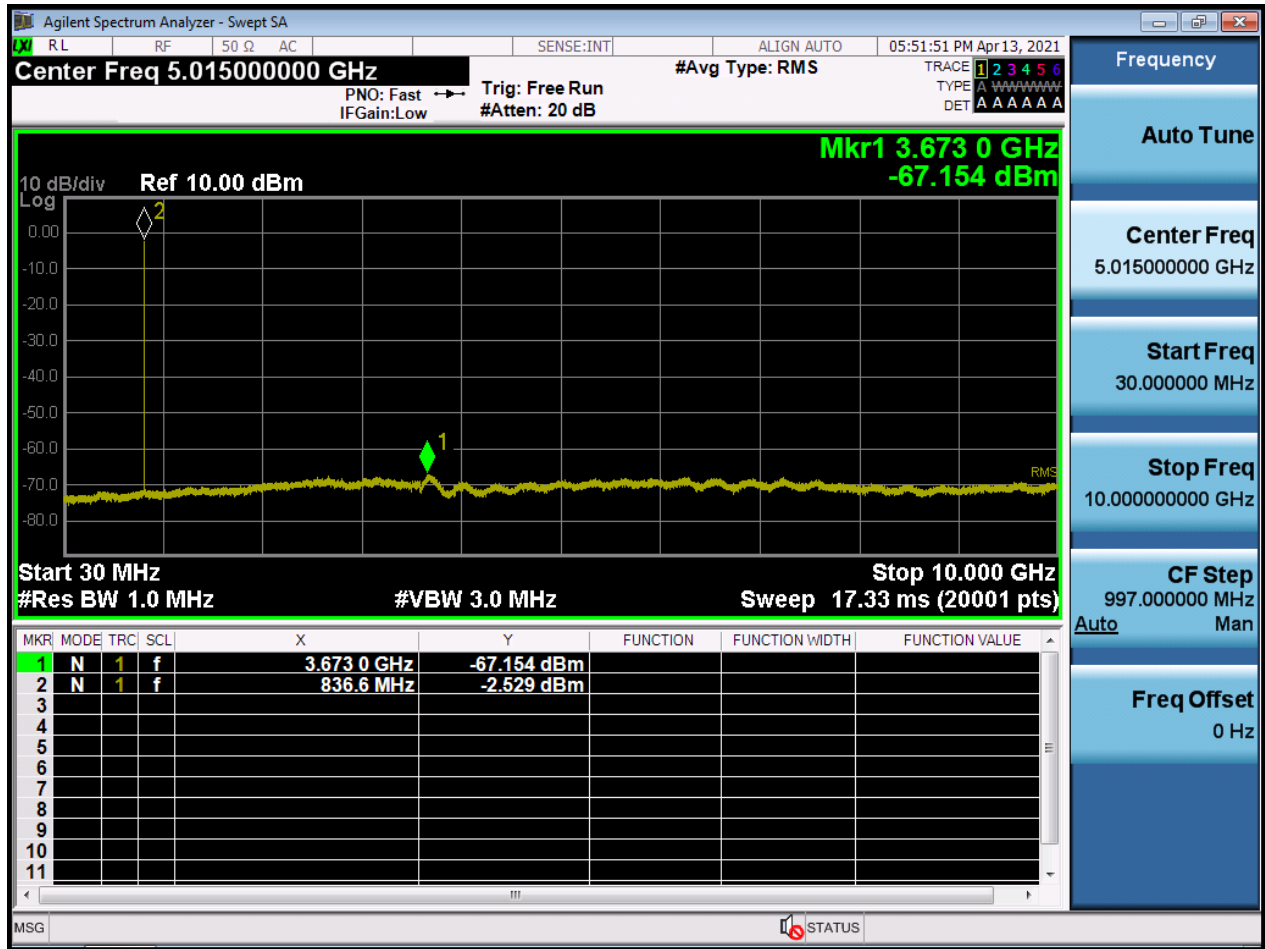
10M_OBW_Mid Channel_256QAM_FullIRB



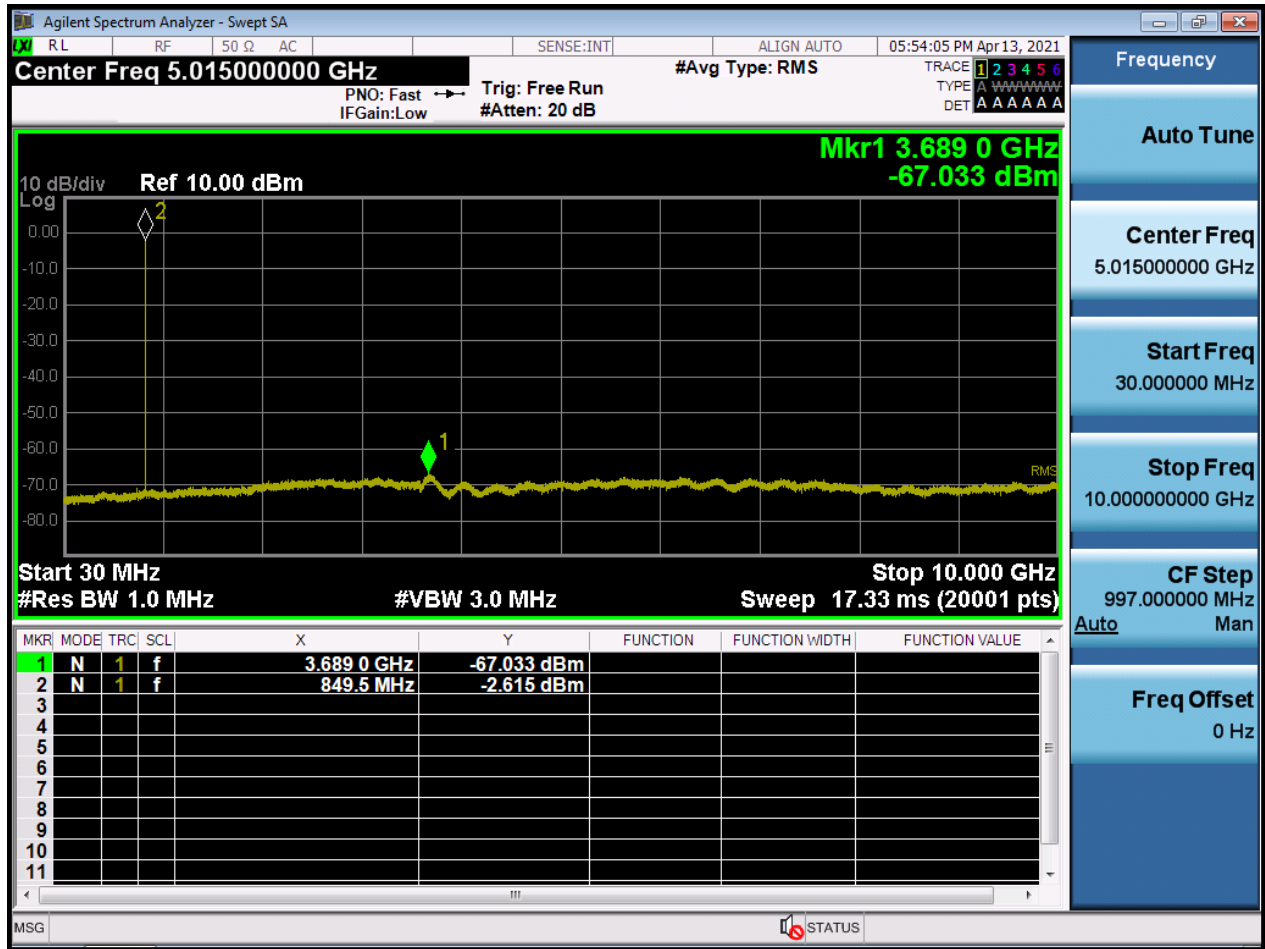
1.4M_CSE(30M-10G)_Lowest Channel_QPSK_1RB



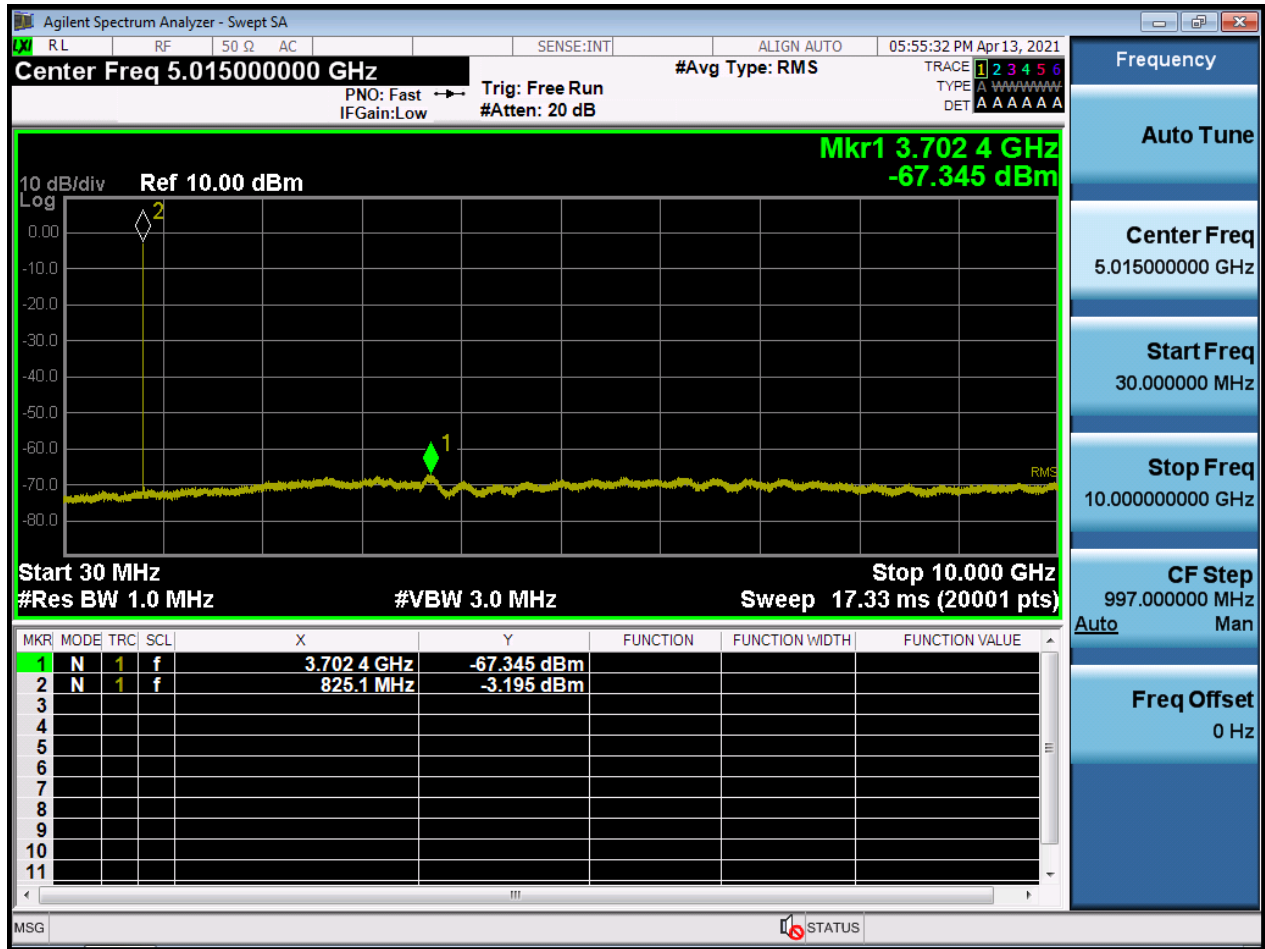
1.4M_CSE(30M-10G)_Mid Channel_QPSK_1RB



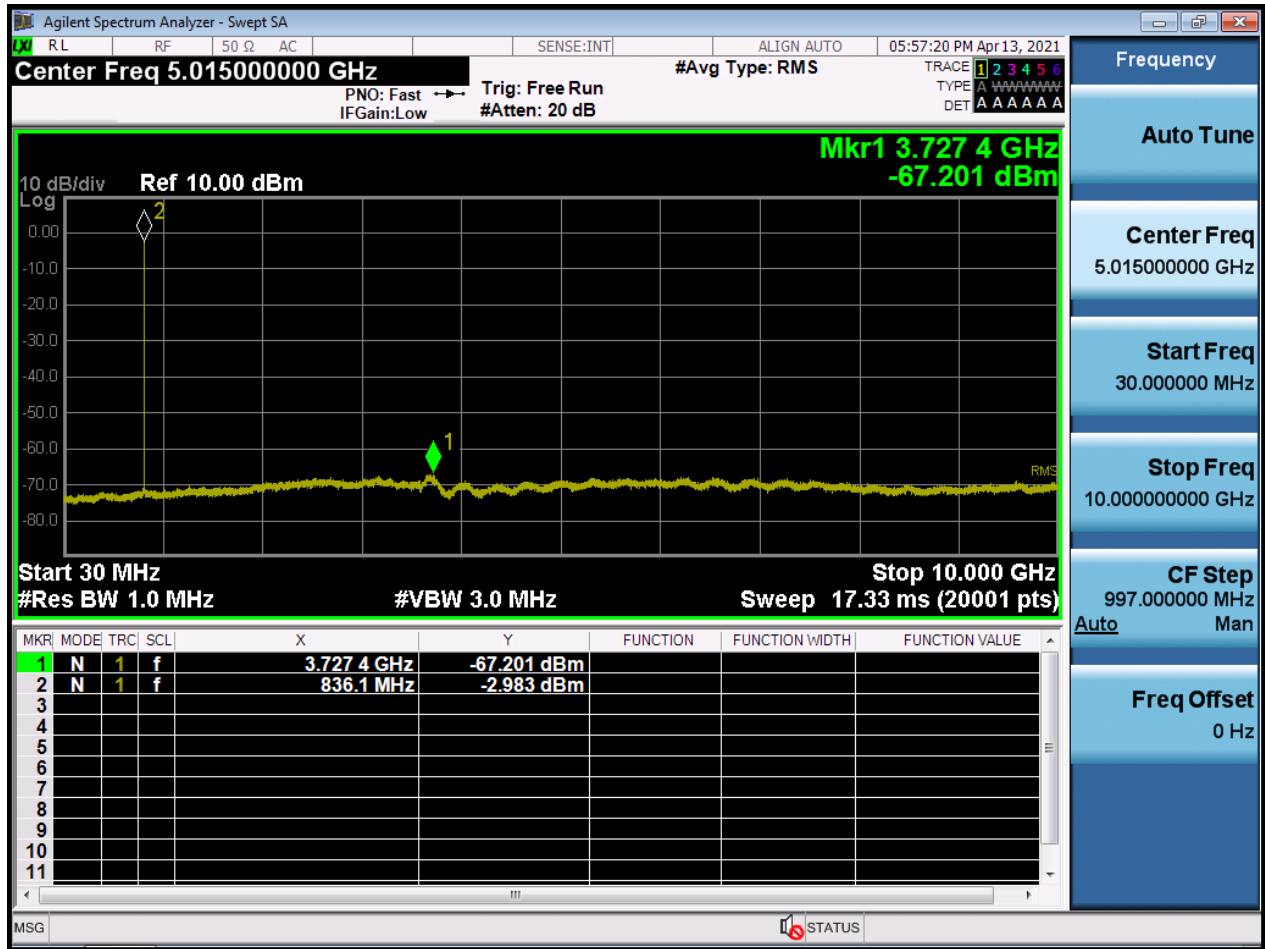
1.4M_CSE(30M-10G)_Highest Channel_QPSK_1RB



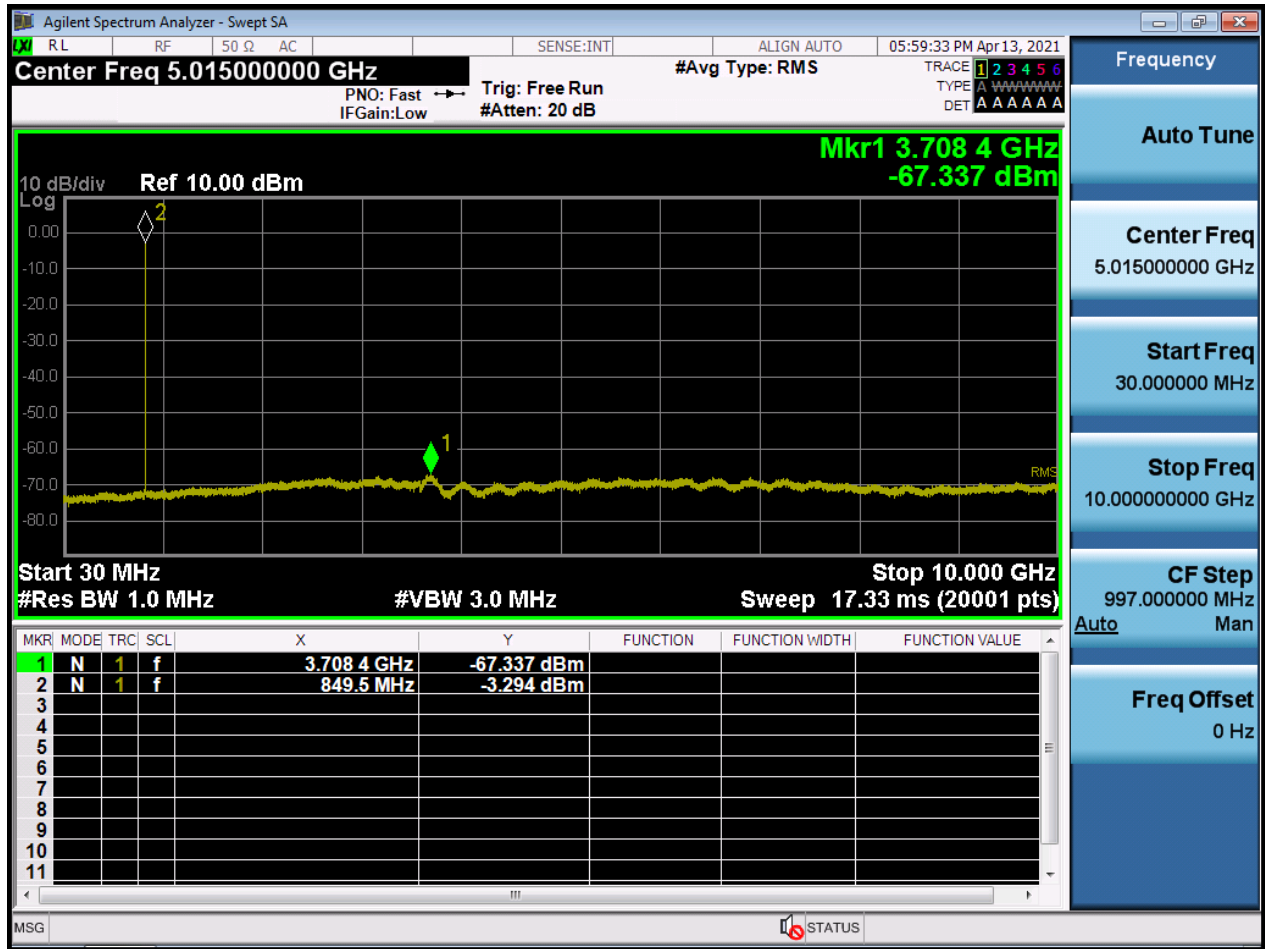
3M_CSE(30M-10G)_Lowest Channel_QPSK_1RB



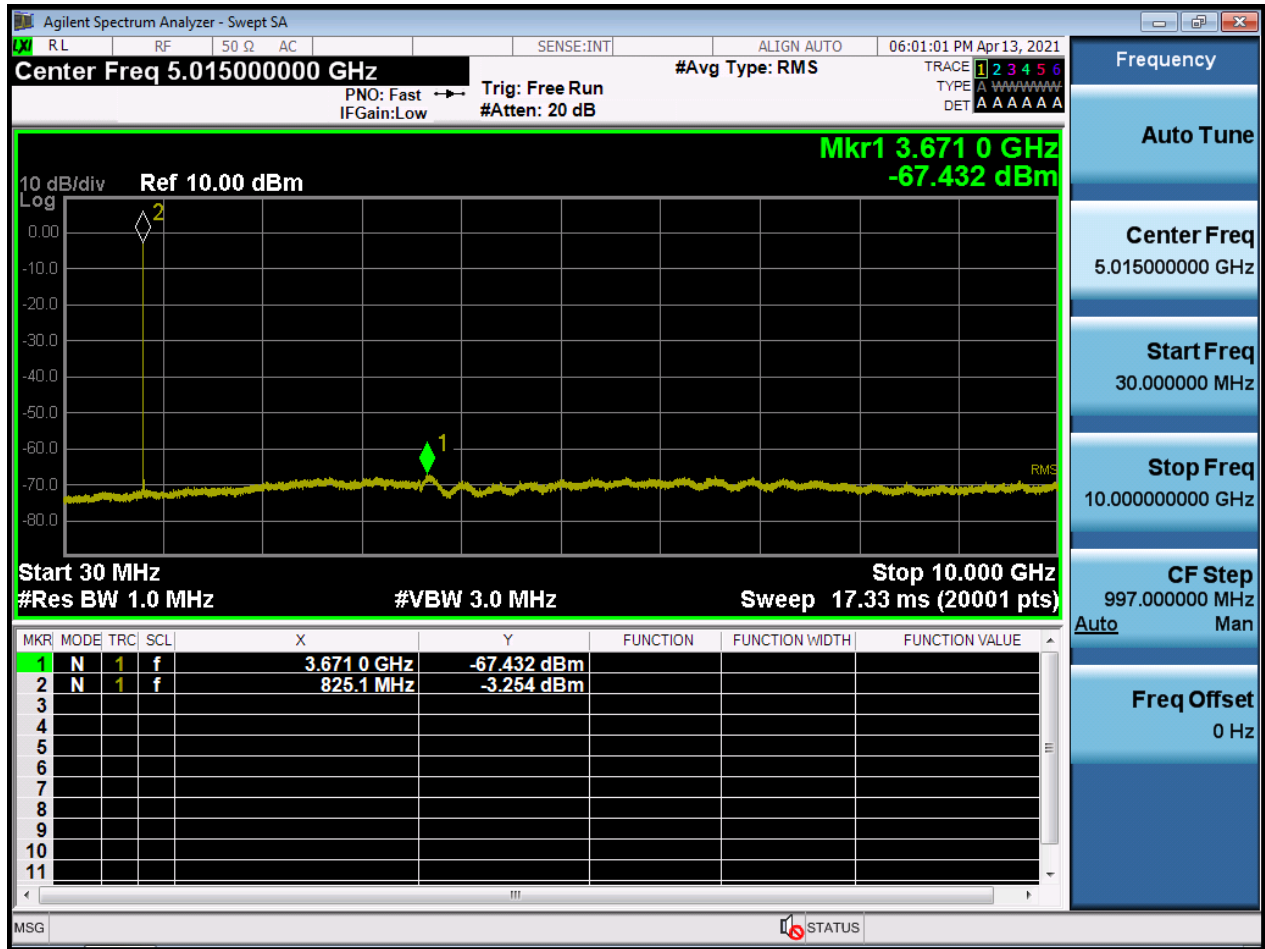
3M_CSE(30M-10G)_Mid Channel_QPSK_1RB



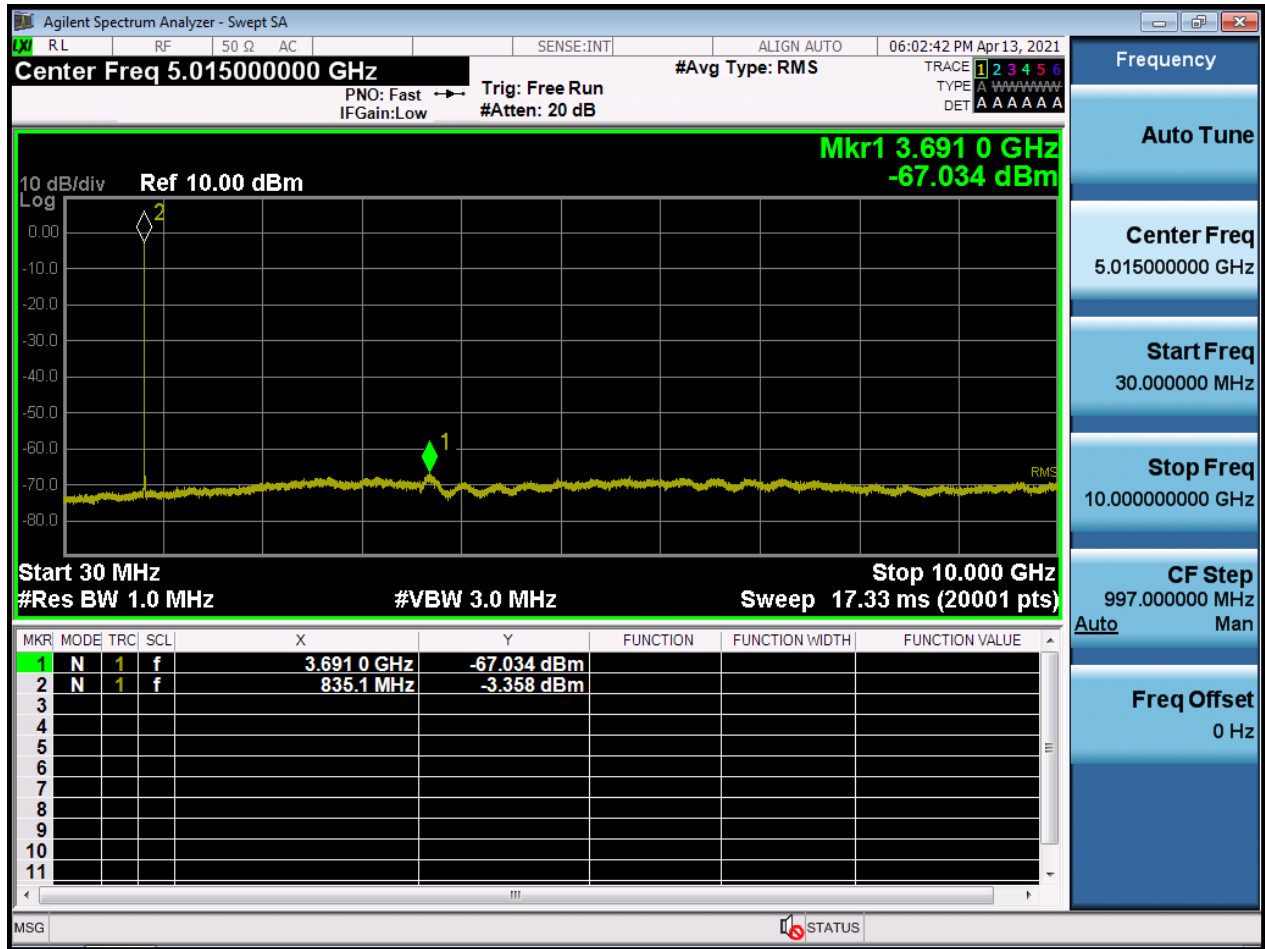
3M_CSE(30M-10G)_Highest Channel_QPSK_1RB



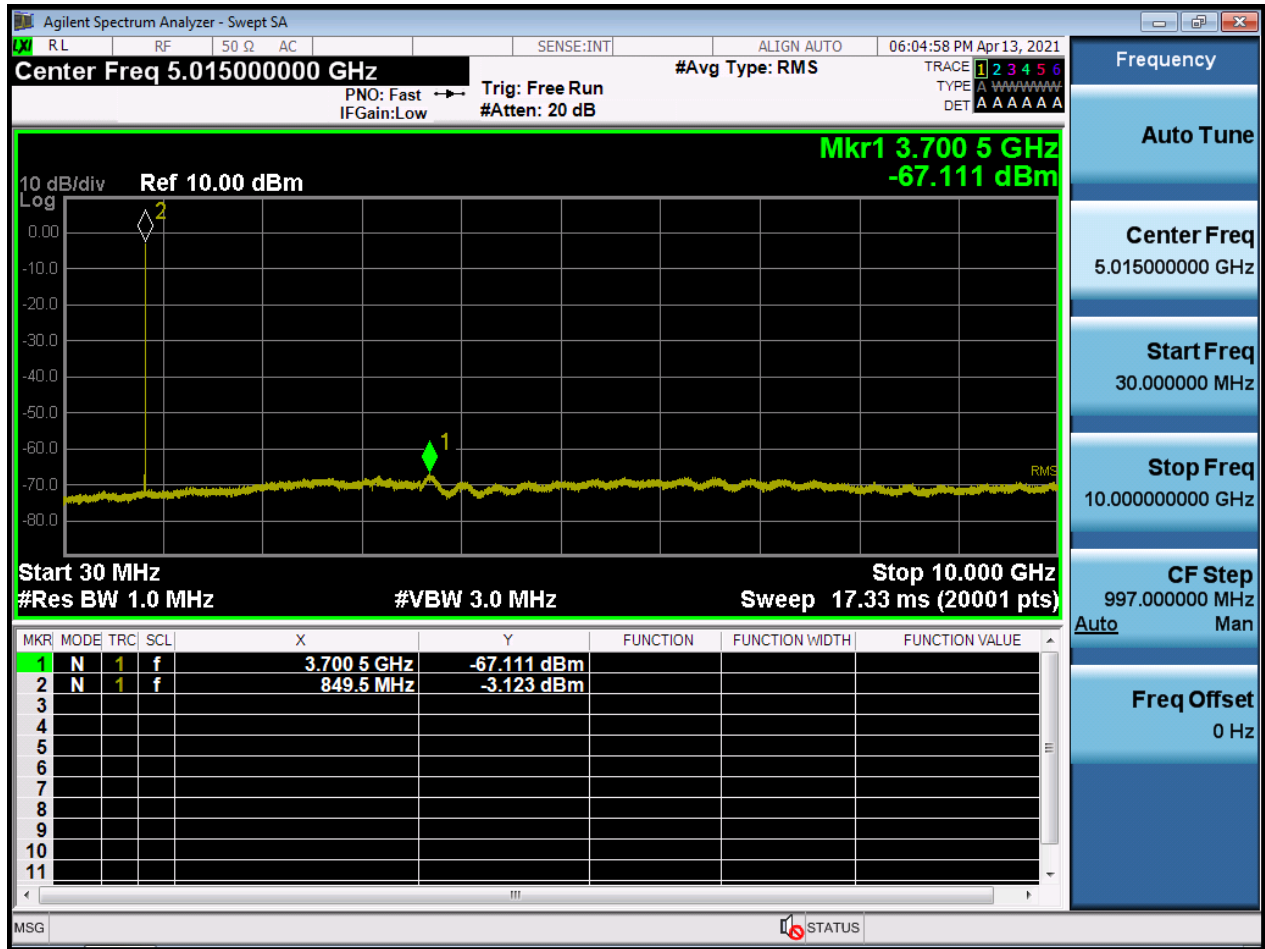
5M_CSE(30M-10G)_Lowest Channel_QPSK_1RB



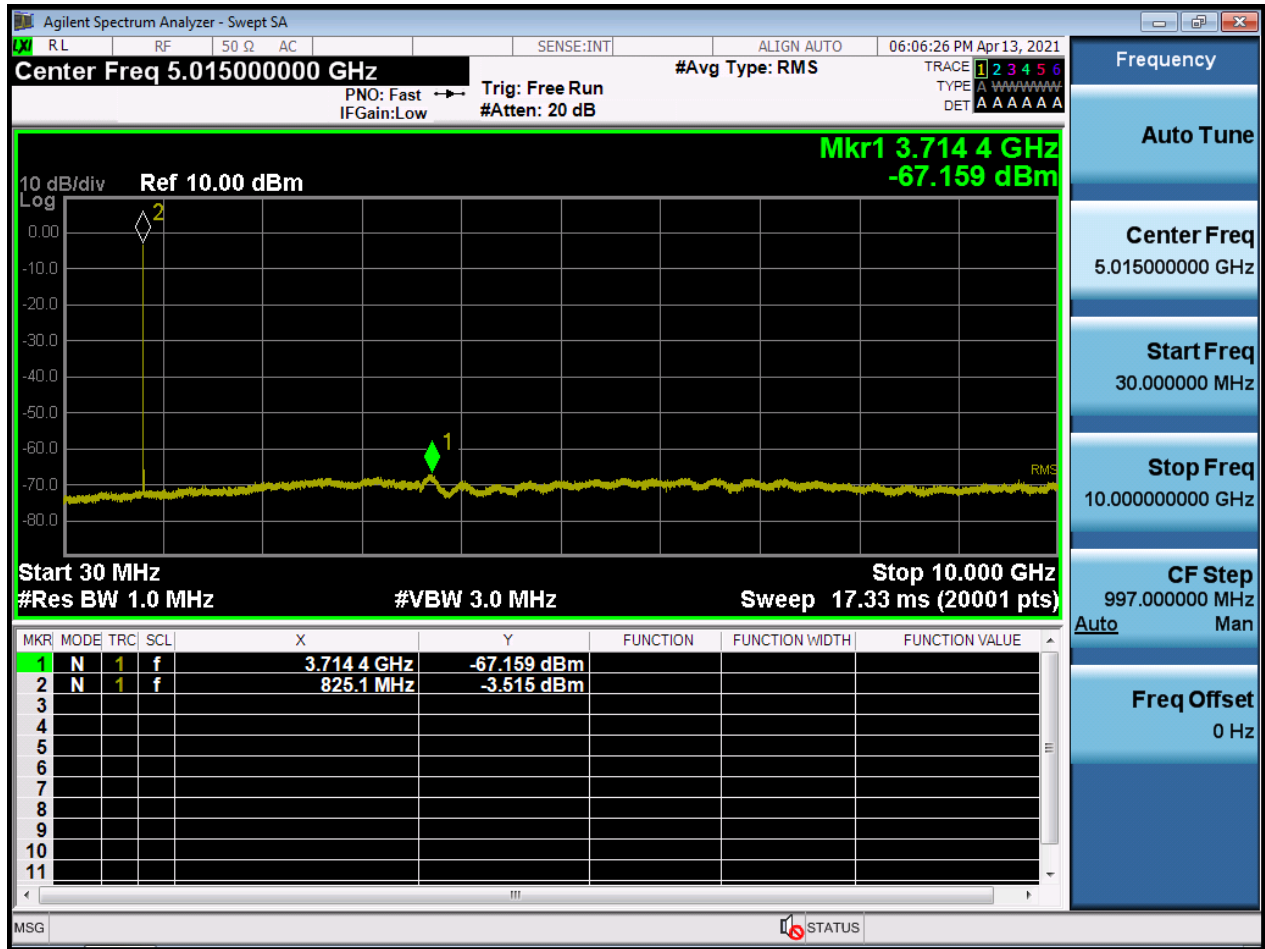
5M_CSE(30M-10G)_Mid Channel_QPSK_1RB



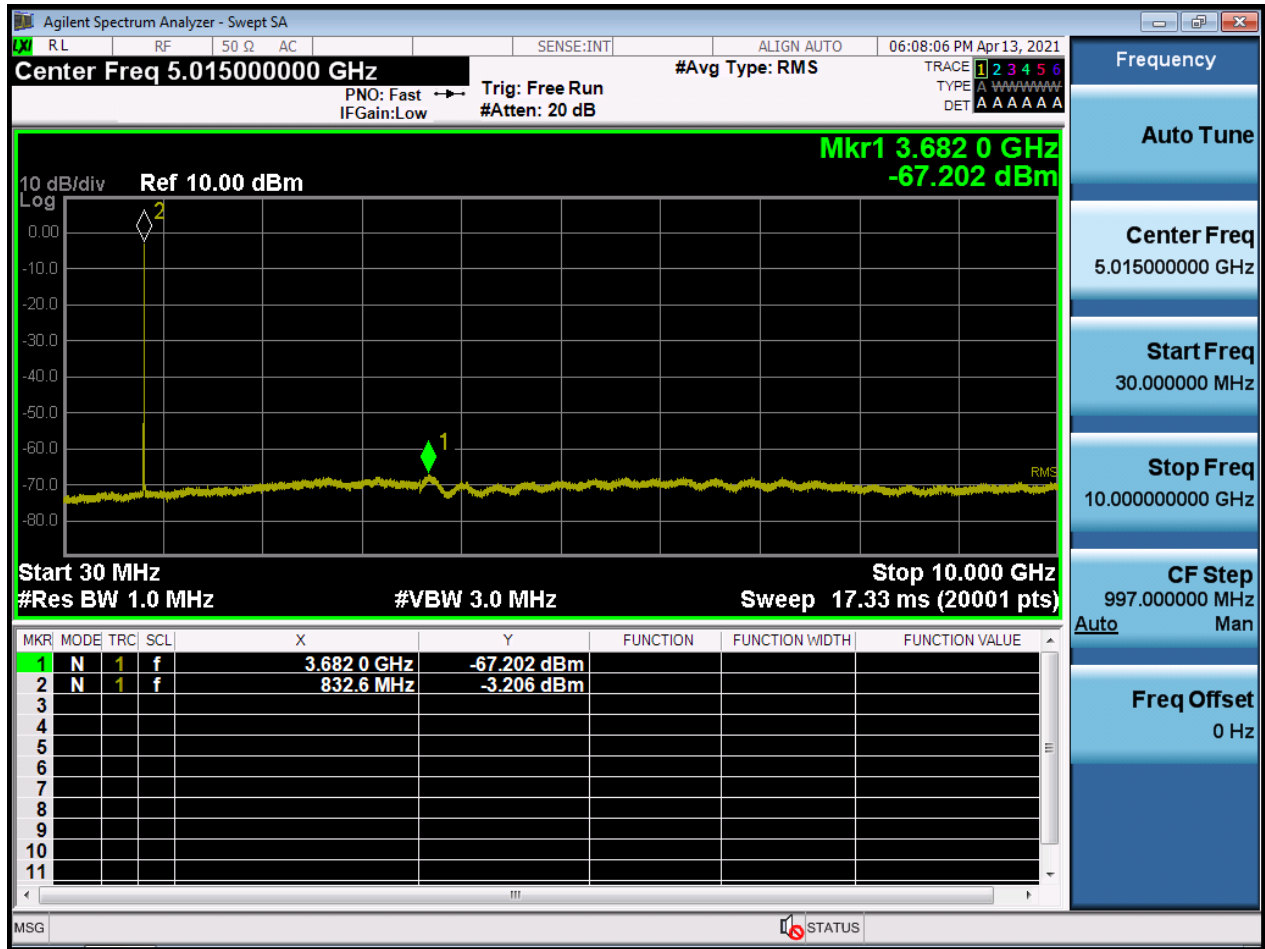
5M_CSE(30M-10G)_Highest Channel_QPSK_1RB



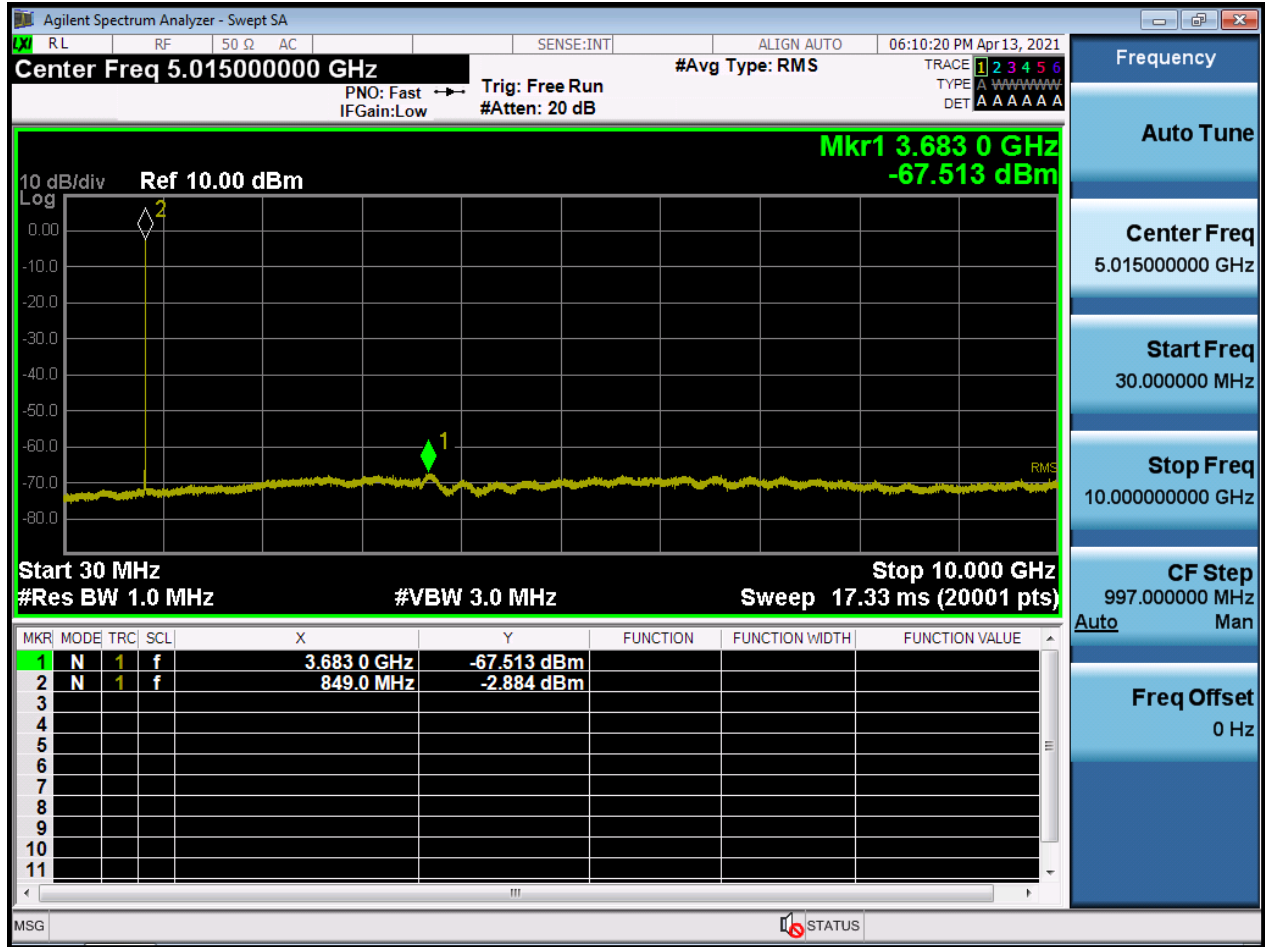
10M_CSE(30M-10G)_Lowest Channel_QPSK_1RB



10M_CSE(30M-10G)_Mid Channel_QPSK_1RB



10M_CSE(30M-10G)_Highest Channel_QPSK_1RB



10. ANNEX A_ TEST SETUP PHOTO

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

No.	Description
1	HCT-RF-2105-FC027-P