Testing and Certification

TEST REPORT

FCC LTE B5 Test for SM-S721U
Certification

APPLICANT
SAMSUNG Electronics Co., Ltd.

REPORT NO.
HCT-RF-2407-FC021

DATE OF ISSUE
July 19, 2024

Tested by Jae Ryang Do	
Technical Manager Jong Seok Lee	

HCT CO., LTD.
BongJai Huh / CEO

HCT CO., LTD. 2-6, 73, 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA Tel. +82 31 645 6300 Fax. +82 31 645 6401

HCT CO.,LTD.
2-6, 73, 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA
Tel. +82 31 645 6300 Fax. +82 31 645 6401

TEST REPORT

REPORT NO.
HCT-RF-2407-FC021

DATE OF ISSUE
July 19, 2024

Additional Model
SM-S721U1

Applicant	**SAMSUNG Electronics Co., Ltd.** 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
Product Name Model Name	Mobile Phone SM-S721U
Date of Test	May 16, 2024 ~ July 19, 2024
FCC ID	A3LSMS721U
Location of Test	■ Permanent Testing Lab ☐ On Site Testing (Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea)
FCC Classification:	PCS Licensed Transmitter Held to Ear (PCE)
Test Standard Used	FCC Rule Part: § 22
Test Results	PASS

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	July 19, 2024	Initial Release

Notice

Content
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) The results shown in this test report only apply to the sample(s), as received, provided by the applicant, unless otherwise stated. The test results have only been applied with the test methods required by the standard(s). The laboratory is not accredited for the test results marked *. Information provided by the applicant is marked **. Test results provided by external providers are marked ***. When confirmation of authenticity of this test report is required, please contact www.hct.co.kr The test results in this test report are not associated with the ((KS Q) ISO/IEC 17025) accreditation by KOLAS (Korea Laboratory Accreditation Scheme) / A2LA (American Association for Laboratory Accreditation) that are under the ILAC (International Laboratory Accreditation Cooperation) Mutual Recognition Agreement (MRA).

CONTENTS

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:	A3LSMS721U
Application Type:	Certification
FCC Classification:	PCS Licensed Transmitter Held to Ear (PCE)
FCC Rule Part(s):	§ 22
EUT Type:	Mobile phone
Model(s):	SM-S721U
Additional Model(s)	SM-S721U1
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:	May 16, 2024 ~ July 19, 2024
Serial number:	Radiated : 67d50ecc63197ece Conducted : R3CX40SV75R

1.1. MAXIMUM OUTPUT POWER

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	0.102	20.08
		1M10W7D	16QAM	0.085	19.29
		1M10W7D	64QAM	0.066	18.21
		1M09W7D	256QAM	0.033	15.16
LTE – Band5 (3)	825.5 – 847.5	2M71G7D	QPSK	0.102	20.09
		2M72W7D	16QAM	0.084	19.25
		2M72W7D	64QAM	0.066	18.22
		2M71W7D	256QAM	0.033	15.16
LTE – Band5 (5)	826.5 – 846.5	4M52G7D	QPSK	0.105	20.22
		4M51W7D	16QAM	0.089	19.49
		4M52W7D	64QAM	0.069	18.36
		4M52W7D	256QAM	0.035	15.41
LTE – Band5 (10)	829.0 – 844.0	9M03G7D	QPSK	0.100	19.99
		9M01W7D	16QAM	0.082	19.12
		9M03W7D	64QAM	0.065	18.14
		9M02W7D	256QAM	0.033	15.19

2. INTRODUCTION

2.1. DESCRIPTION OF EUT

The EUT was a Mobile Phone with GSM/GPRS/EGPRS/UMTS and LTE, Sub 6, mmWave.
It also supports IEEE 802.11 a/b/g/n/ac/ax (20/40/80/160 MHz), Bluetooth(iPA, ePA), BT LE(iPA, ePA), NFC, WPT, WIFI 6E.

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)
Peak- to- Average Ratio	- KDB 971168 D01 v03r01 – Section 5.7 - ANSI C63.26-2015 – Section 5.2.3.4
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 1 MHz
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 1 GHz, 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;

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

   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 = 100 kHz for emissions below 1 GHz and 1 MHz for emissions above 1 GHz
2. VBW ≥ 3 x RBW
3. Span = 1.5 times the OBW
4. No. of sweep points > 2 x 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^{th} 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 1 GHz, 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;

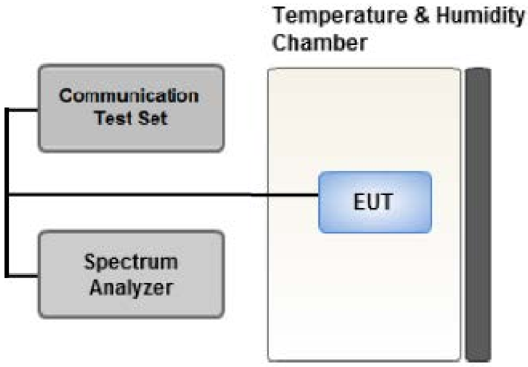
$$\text{Result}_{(dBm)} = \text{Pg}_{(dBm)} - \text{cable loss}_{(dB)} + \text{antenna gain}_{(dBi)}$$

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

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

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

3.4 PEAK- TO- AVERAGE RATIO



Test setup

① CCDF Procedure for PAPR

Test Settings

1. Set resolution/measurement bandwidth ≥ signal's occupied bandwidth;
2. Set the number of counts to a value that stabilizes the measured CCDF curve;
3. Set the measurement interval as follows:
   .- for continuous transmissions, set to 1 ms,
   .- or burst transmissions, employ an external trigger that is synchronized with the EUT burst timing sequence, or use the internal burst trigger with a trigger level that allows the burst to stabilize and set the measurement interval to a time that is less than or equal to the burst duration.
4. Record the maximum PAPR level associated with a probability of 0.1 %.

② Alternate Procedure for PAPR

Use one of the procedures presented in 5.2(ANSI C63.26-2015) to measure the total peak power and record as as P_{Pk}.

Use one of the applicable procedures presented 5.2(ANSI C63.26-2015) to measure the total average power and record as P_{Avg}. Determine the P.A.R. from:

$$P.A.R_{(dB)} = P_{Pk\,(dBm)} - P_{Avg\,(dBm)} \quad (P_{Avg} = \text{Average Power} + \text{Duty cycle Factor})$$

Test Settings(Peak Power)

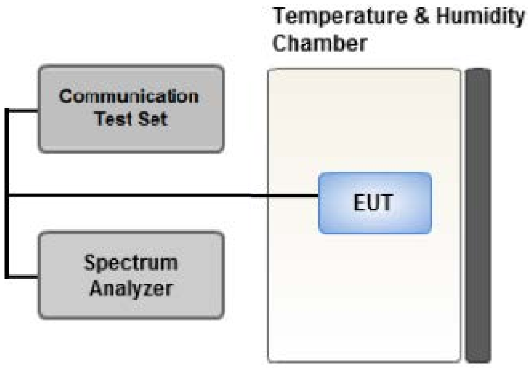
The measurement instrument must have a RBW that is greater than or equal to the OBW of the signal to be measured and a VBW ≥ 3 × RBW.

1. Set the RBW ≥ OBW.
2. Set VBW ≥ 3 × RBW.
3. Set span ≥ 2 × OBW.
4. Sweep time ≥ 10 × (number of points in sweep) × (transmission symbol period).
5. Detector = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the peak amplitude level.

Test Settings(Average Power)

1. Set span to 2 × to 3 × the OBW.
2. Set RBW ≥ OBW.
3. Set VBW ≥ 3 × RBW.
4. Set number of measurement points in sweep ≥ 2 × span / RBW.
5. Sweep time:
   Set ≥ [10 × (number of points in sweep) × (transmission period)] for single sweep (automation-compatible) measurement. The transmission period is the (on + off) time.
6. Detector = power averaging (rms).
7. Set sweep trigger to "free run."
8. Trace average at least 100 traces in power averaging (rms) mode if sweep is set to auto-couple. (To accurately determine the average power over the on and off period of the transmitter, it can be necessary to increase the number of traces to be averaged above 100 or, if using a manually configured sweep time, increase the sweep time.)
9. Use the peak marker function to determine the maximum amplitude level.
10. Add [10 log (1/duty cycle)] to the measured maximum power level to compute the average power during continuous transmission. For example, add [10 log (1/0.25)] = 6 dB if the duty cycle is a constant 25 %.

3.5 OCCUPIED BANDWIDTH.



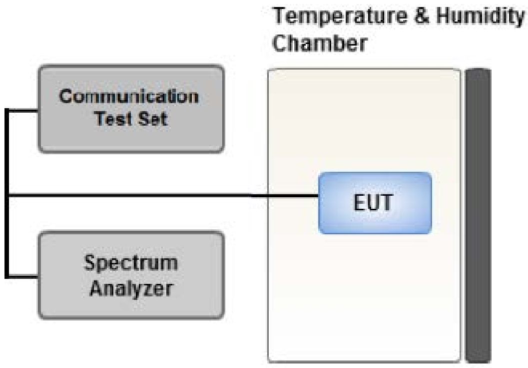
Test setup

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 26 dB 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 ≥ 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

3.6 SPURIOUS AND HARMONIC EMISSIONS AT ANTENNA TERMINAL



Test setup

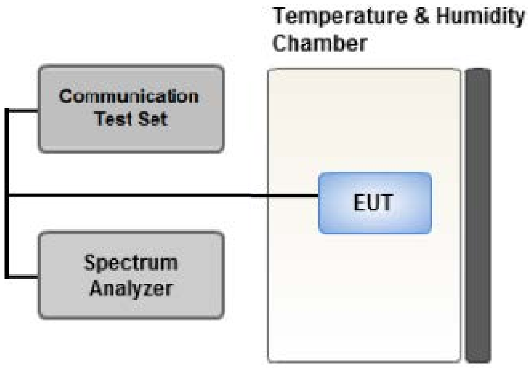
Test Overview

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

3.7 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

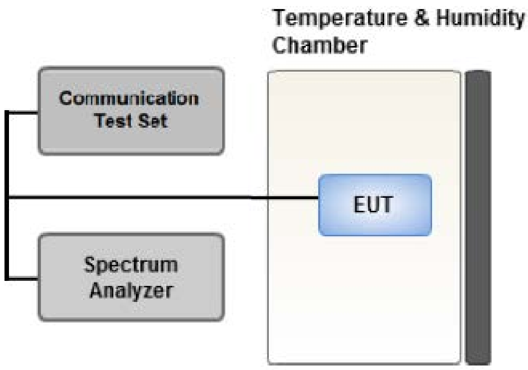
1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW > 1 % of the emission bandwidth
4. VBW > 3 x RBW
5. Detector = RMS
6. Number of sweep points ≥ 2 x Span/RBW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

<u>Test Notes</u>

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.

Where Margin < 1 dB the emission level is either corrected by 10 log(1 MHz/ RB) or the emission is integrated over a 1 MHz bandwidth to determine the final result. When using the integration method the integration window is either centered on the emission or, for emissions at the band edge, centered by an offset of 500 kHz from the block edge so that the integration window is the 1 MHz adjacent to the block edge.

3.8 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.

3.9 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.
  Mode : Stand alone, Stand alone + External accessories (Earphone, AC adapter, etc)
  Worst case : Stand alone
- All simultaneous transmission scenarios of operation were investigated, and the test results showed no additional significant emissions relative to the least restrictive limit were observed.
  Therefore, only the worst case(stand-alone) results were reported.
- In the case of radiated spurious emissions, all bandwidth of operation were investigated and the worst case bandwidth results are reported. (Worst case : 1.4 MHz)
- The worst case is reported with the EUT positioning, modulations, and paging service configurations shown in the test data.
- SM-S721U & additional models were tested and the worst case results are reported.
  (Worst case : SM-S721U)

[Worst case]

Test Description	Modulation	RB size	RB offset	Axis
Effective Radiated Power	QPSK, 16QAM, 64QAM, 256QAM	See Section 8.1		X
Radiated Spurious and Harmonic Emissions	QPSK	See Section 8.2		X

3.10 WORST CASE(CONDUCTED TEST)

- All modes of operation were investigated and the worst case configuration results are reported.

[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
Peak-To-Average Ratio	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

Equipment	Model	Manufacture	Serial No.	Due to Calibration	Calibration Interval
Precision Dipole Antenna	UHAP	Schwarzbeck	01273	03/10/2026	Biennial
Precision Dipole Antenna	UHAP	Schwarzbeck	01274	03/10/2026	Biennial
Horn Antenna(1~18 GHz)	BBHA 9120D	Schwarzbeck	02289	02/14/2026	Biennial
Horn Antenna(1~18 GHz)	BBHA 9120D	Schwarzbeck	9120D-1299	04/27/2025	Biennial
Horn Antenna(15~40 GHz)	BBHA 9170	Schwarzbeck	BBHA9170342	09/29/2024	Biennial
Horn Antenna(15~40 GHz)	BBHA 9170	Schwarzbeck	BBHA9170124	03/28/2025	Biennial
Loop Antenna(9 kHz~30 MHz)	FMZB1513	Rohde & Schwarz	1513-175	01/16/2025	Biennial
Bilog Antenna	VULB9160	Schwarzbeck	3150	03/09/2025	Biennial
Hybrid Antenna	VULB9160	Schwarzbeck	760	02/24/2025	Biennial
RF Switching System	FBSR-06B (1G HPF + LNA)	T&M SYSTEM	F3L1	05/14/2025	Annual
RF Switching System	FBSR-06B (3G HPF + LNA)	T&M SYSTEM	F3L2	05/14/2025	Annual
RF Switching System	FBSR-06B (6G HPF + LNA)	T&M SYSTEM	F3L3	05/14/2025	Annual
RF Switching System	FBSR-06B (LNA)	T&M SYSTEM	F3L4	05/14/2025	Annual
Power Amplifier	CBL18265035	CERNEX	22966	11/17/2024	Annual
Power Amplifier	CBL26405040	CERNEX	25956	02/26/2025	Annual
DC Power Supply	E3632A	Hewlett Packard	MY40004427	08/25/2024	Annual
Power Splitter(DC~26.5 GHz)	11667B	Hewlett Packard	11275	02/29/2025	Annual
Chamber	SU-642	ESPEC	93008124	02/19/2025	Annual
Signal Analyzer(10 Hz~26.5 GHz)	N9020A	Agilent	MY51110063	04/04/2025	Annual
ATTENUATOR(20 dB)	8493C	Hewlett Packard	17280	04/17/2025	Annual
Spectrum Analyzer(10 Hz~40 GHz)	FSV40	REOHDE & SCHWARZ	101436	02/13/2025	Annual
Base Station	8960 (E5515C)	Agilent	MY48360800	08/10/2024	Annual
Wideband Radio Communication Tester	MT8821C	Anritsu Corp.	6262287701	05/16/2025	Annual
Wideband Radio Communication Tester	MT8000A	Anritsu Corp.	6262302511	05/14/2025	Annual
Signal Analyzer(5 Hz~40.0 GHz)	N9030B	KEYSIGHT	MY55480167	05/17/2025	Annual
4-Way Divider	ZC4PD-K1844+	Mini-Circuits	942907	09/19/2024	Annual
FCC LTE Mobile Conducted RF Automation Test Software	-	HCT CO., LTD.,	-	-	-

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_{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 (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.98 (Confidence level about 95 %, k=2)
Radiated Disturbance (9 kHz ~ 30 MHz)	4.36 (Confidence level about 95 %, k=2)
Radiated Disturbance (30 MHz ~ 1 GHz)	5.70 (Confidence level about 95 %, k=2)
Radiated Disturbance (1 GHz ~ 18 GHz)	5.52 (Confidence level about 95 %, k=2)
Radiated Disturbance (18 GHz ~ 40 GHz)	5.66 (Confidence level about 95 %, k=2)
Radiated Disturbance (Above 40 GHz)	5.58 (Confidence level about 95 %, k=2)

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	See Note1
Peak- to- Average Ratio	§ 22.913(d)	< 13 dB	PASS
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

ERP = Substitute LEVEL(dBm) + Ant. Gain – 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

EIRP = Substitute LEVEL(dBm) + Ant. Gain – 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	ERP		RB	
								W	W	dBm	Size	Offset
824.7	LTE B5/ 1.4 MHz	QPSK	-30.56	30.34	-10.05	1.38	H	< 7.00	0.078	18.91	1	5
		16-QAM	-31.34	29.56	-10.05	1.38	H		0.065	18.13		
		64-QAM	-32.38	28.52	-10.05	1.38	H		0.051	17.09		
		256-QAM	-35.37	25.53	-10.05	1.38	H		0.026	14.10		
836.5		QPSK	-30.21	31.08	-10.05	1.40	H		0.092	19.63	1	0
		16-QAM	-30.95	30.34	-10.05	1.40	H		0.077	18.89		
		64-QAM	-31.97	29.32	-10.05	1.40	H		0.061	17.87		
		256-QAM	-34.96	26.33	-10.05	1.40	H		0.031	14.88		
848.3		QPSK	-30.08	31.54	-10.05	1.41	H		0.102	20.08	1	0
		16-QAM	-30.87	30.75	-10.05	1.41	H		0.085	19.29		
		64-QAM	-31.95	29.67	-10.05	1.41	H		0.066	18.21		
		256-QAM	-35.00	26.62	-10.05	1.41	H		0.033	15.16		

Freq (MHz)	Mod/ Bandwidth	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain (dBd)	C.L	Pol	Limit	ERP		RB	
								W	W	dBm	Size	Offset
825.5	LTE B5/ 3 MHz	QPSK	-30.46	30.45	-10.05	1.39	H	< 7.00	0.080	19.01	1	14
		16-QAM	-31.23	29.68	-10.05	1.39	H		0.067	18.24		
		64-QAM	-32.26	28.65	-10.05	1.39	H		0.053	17.21		
		256-QAM	-35.30	25.61	-10.05	1.39	H		0.026	14.17		
836.5		QPSK	-30.27	31.02	-10.05	1.40	H		0.091	19.57	1	0
		16-QAM	-31.01	30.28	-10.05	1.40	H		0.076	18.83		
		64-QAM	-32.04	29.25	-10.05	1.40	H		0.060	17.80		
		256-QAM	-35.08	26.21	-10.05	1.40	H		0.030	14.76		
847.5		QPSK	-30.08	31.55	-10.05	1.41	H		0.102	20.09	1	0
		16-QAM	-30.92	30.71	-10.05	1.41	H		0.084	19.25		
		64-QAM	-31.95	29.68	-10.05	1.41	H		0.066	18.22		
		256-QAM	-35.01	26.62	-10.05	1.41	H		0.033	15.16		

Freq (MHz)	Mod/ Bandwidth	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain (dBd)	C.L	Pol	Limit	ERP		RB	
								W	W	dBm	Size	Offset
826.5	LTE B5/ 5 MHz	QPSK	-30.41	30.49	-10.05	1.39	H	< 7.00	0.080	19.05	1	24
		16-QAM	-31.19	29.71	-10.05	1.39	H		0.067	18.27		
		64-QAM	-32.24	28.66	-10.05	1.39	H		0.053	17.22		
		256-QAM	-35.20	25.70	-10.05	1.39	H		0.027	14.26		
836.5		QPSK	-30.00	31.29	-10.05	1.40	H		0.096	19.84	1	24
		16-QAM	-30.90	30.39	-10.05	1.40	H		0.078	18.94		
		64-QAM	-31.90	29.39	-10.05	1.40	H		0.062	17.94		
		256-QAM	-34.88	26.41	-10.05	1.40	H		0.031	14.96		
846.5		QPSK	-30.00	31.68	-10.05	1.41	H		0.105	20.22	1	0
		16-QAM	-30.73	30.95	-10.05	1.41	H		0.089	19.49		
		64-QAM	-31.86	29.82	-10.05	1.41	H		0.069	18.36		
		256-QAM	-34.81	26.87	-10.05	1.41	H		0.035	15.41		

Freq (MHz)	Mod/ Bandwidth	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain (dBd)	C.L	Pol	Limit	ERP		RB	
								W	W	dBm	Size	Offset
829.0	LTE B5/ 10 MHz	QPSK	-30.20	30.82	-10.05	1.39	H	< 7.00	0.087	19.38	1	49
		16-QAM	-31.06	29.96	-10.05	1.39	H		0.071	18.52		
		64-QAM	-32.02	29.00	-10.05	1.39	H		0.057	17.56		
		256-QAM	-35.00	26.02	-10.05	1.39	H		0.029	14.58		
836.5		QPSK	-30.01	31.28	-10.05	1.40	H		0.096	19.83	1	49
		16-QAM	-30.88	30.41	-10.05	1.40	H		0.079	18.96		
		64-QAM	-31.90	29.39	-10.05	1.40	H		0.062	17.94		
		256-QAM	-34.86	26.43	-10.05	1.40	H		0.032	14.98		
844.0		QPSK	-30.03	31.45	-10.05	1.41	H		0.100	19.99	1	0
		16-QAM	-30.90	30.58	-10.05	1.41	H		0.082	19.12		
		64-QAM	-31.88	29.60	-10.05	1.41	H		0.065	18.14		
		256-QAM	-34.83	26.65	-10.05	1.41	H		0.033	15.19		

8.2 RADIATED SPURIOUS EMISSIONS

- MODE: LTE B5
- MODULATION SIGNAL: 5 MHz QPSK
- DISTANCE: 3 meters

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBd)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	Limit (dBm)	RB	
									Size	Offset
20425 (826.5)	1 653.00	-58.91	9.20	-67.82	2.03	V	-60.65	-13.00	1	24
	2 479.50	-59.40	10.20	-62.65	2.45	V	-54.90	-13.00		
	3 306.00	-61.29	10.90	-63.33	2.92	V	-55.35	-13.00		
20525 (836.5)	1 673.00	-57.97	9.20	-67.15	2.03	V	-59.98	-13.00	1	24
	2 509.50	-59.73	10.30	-64.26	2.50	V	-56.46	-13.00		
	3 346.00	-60.61	10.95	-63.50	2.89	V	-55.44	-13.00		
20625 (846.5)	1 693.00	-58.10	9.40	-66.72	2.00	V	-59.32	-13.00	1	0
	2 539.50	-59.37	10.30	-64.20	2.52	V	-56.42	-13.00		
	3 386.00	-60.46	11.00	-62.94	2.94	V	-54.88	-13.00		

8.3 PEAK-TO-AVERAGE RATIO

Band	Band Width	Frequency (MHz)	Modulation	Resource Block Size	Resource Block Offset	Data (dB)
5	1.4 MHz	836.5	QPSK	6	0	5.23
			16-QAM			5.75
			64-QAM			6.05
			256-QAM			6.76
	3 MHz		QPSK	15		5.29
			16-QAM			5.88
			64-QAM			6.04
			256-QAM			6.66
	5 MHz		QPSK	25		5.26
			16-QAM			5.85
			64-QAM			6.03
			256-QAM			6.67
	10 MHz		QPSK	50		5.30
			16-QAM			5.82
			64-QAM			6.04
			256-QAM			6.66

Note:

1. Plots of the EUT’s Peak- to- Average Ratio are shown Page 36 ~ 51.

8.4 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	1.0997
			16-QAM			1.0955
			64-QAM			1.0982
			256-QAM			1.0919
	3 MHz		QPSK	15		2.7103
			16-QAM			2.7176
			64-QAM			2.7171
			256-QAM			2.7111
	5 MHz		QPSK	25		4.5198
			16-QAM			4.5090
			64-QAM			4.5198
			256-QAM			4.5202
	10 MHz		QPSK	50		9.0324
			16-QAM			9.0117
			64-QAM			9.0339
			256-QAM			9.0236

Note:

1. Plots of the EUT's Occupied Bandwidth are shown Page 52 ~ 67.

8.5 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	3.7039	27.976	-67.274	-39.298	-13.00
		836.5	3.7114	27.976	-67.160	-39.184	
		848.3	3.6910	27.976	-67.241	-39.265	
	3	825.5	3.7024	27.976	-67.209	-39.233	
		836.5	3.6676	27.976	-67.085	-39.109	
		847.5	3.6925	27.976	-67.158	-39.182	
	5	826.5	3.7274	27.976	-67.035	-39.059	
		836.5	3.1830	27.976	-67.390	-39.414	
		846.5	3.6641	27.976	-67.029	-39.053	
	10	829.0	3.6860	27.976	-66.573	-38.597	
		836.5	3.6666	27.976	-67.266	-39.290	
		844.0	3.1616	27.976	-67.078	-39.102	

Note:

1. Plots of the EUT's Conducted Spurious Emissions are shown Page 68 ~ 79.
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(26.5)	30.131

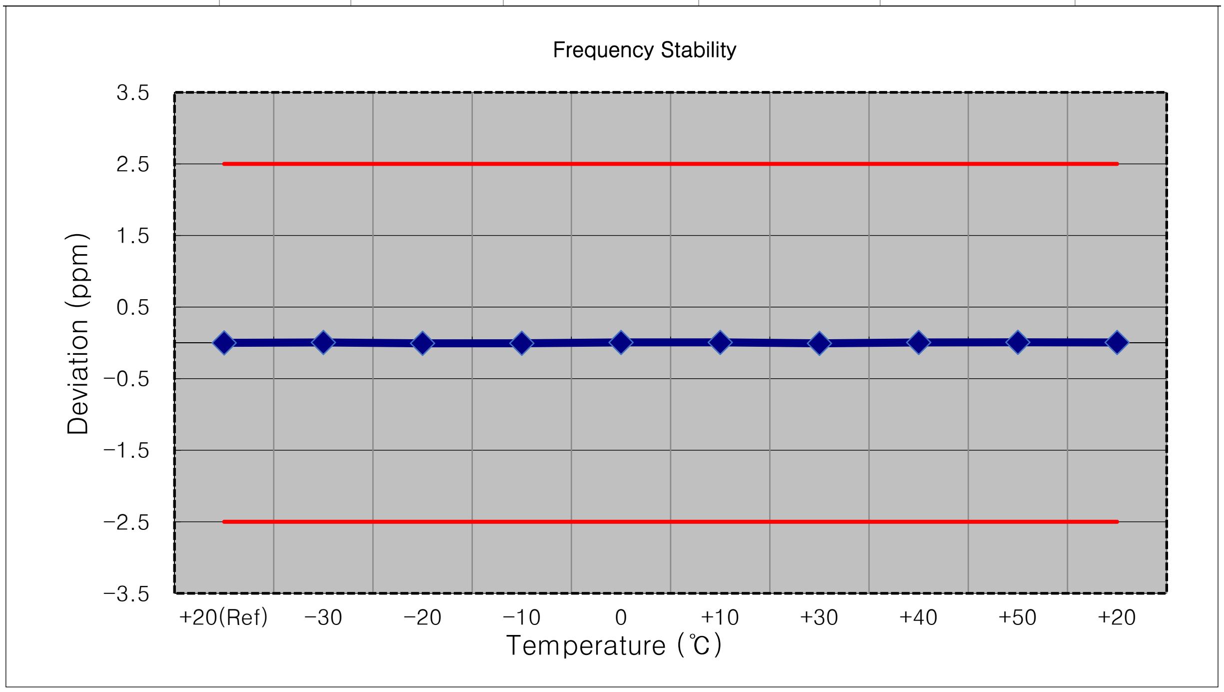
8.6 BAND EDGE

- Plots of the EUT's Band Edge are shown Page 80 ~ 103.

8.7 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE

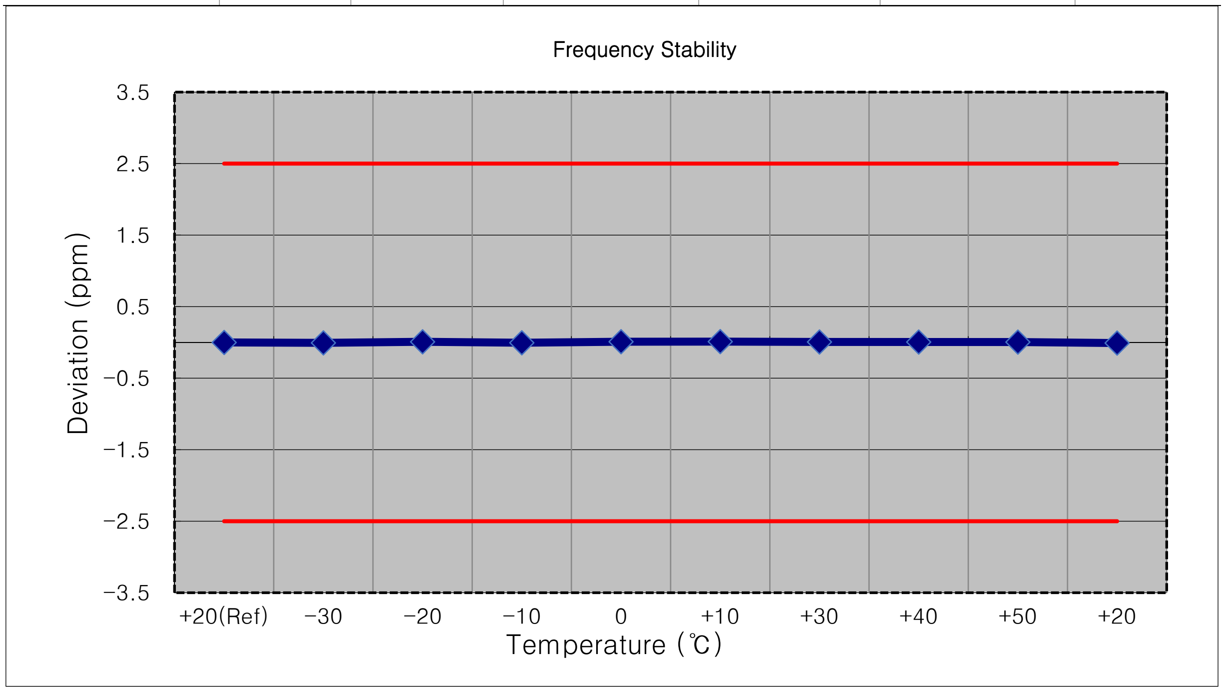
- MODE: LTE B5
- OPERATING FREQUENCY: 836,500,000 Hz
- CHANNEL: 20525 (1.4 MHz)
- REFERENCE VOLTAGE: 3.880 VDC
- DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100 %	3.880	+20(Ref)	836 500 006	0.0	0.000 000	0.000
100 %		-30	836 500 010	4.6	0.000 001	0.005
100 %		-20	836 500 000	-5.3	-0.000 001	-0.006
100 %		-10	836 500 001	-4.8	-0.000 001	-0.006
100 %		0	836 500 011	5.0	0.000 001	0.006
100 %		+10	836 500 011	5.6	0.000 001	0.007
100 %		+30	836 500 000	-5.7	-0.000 001	-0.007
100 %		+40	836 500 010	4.5	0.000 001	0.005
100 %		+50	836 500 012	6.4	0.000 001	0.008
Batt. Endpoint	3.300	+20	836 500 010	4.6	0.000 001	0.005



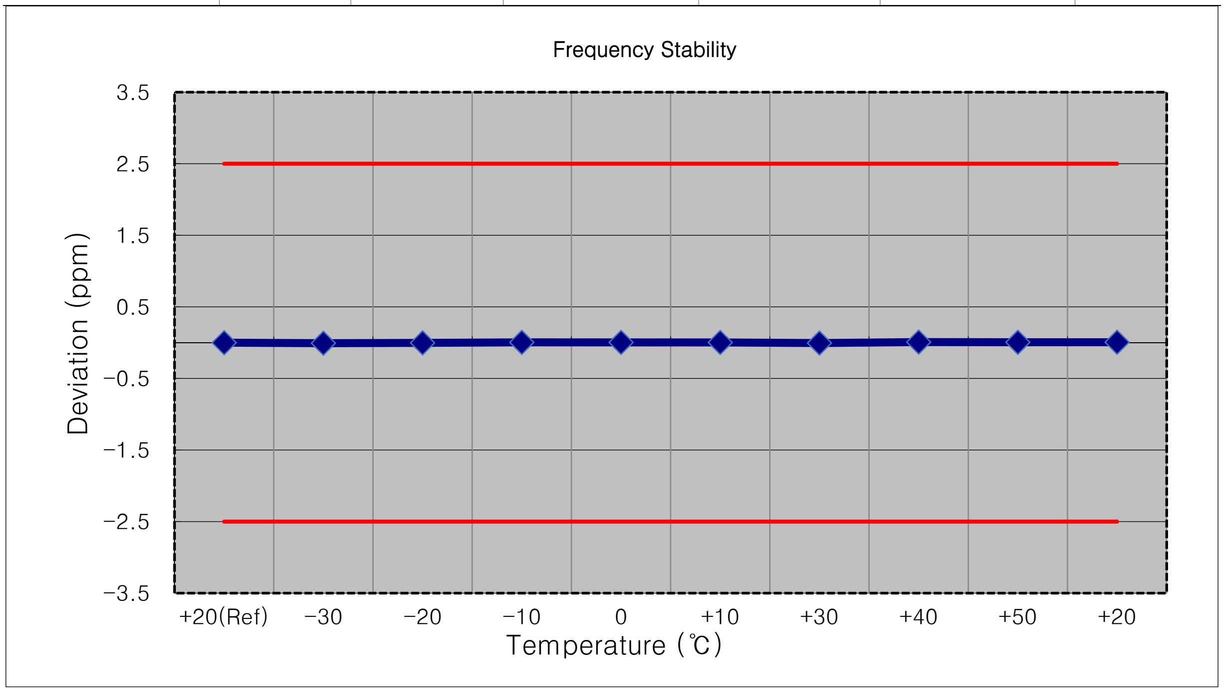
- MODE: LTE B5
- OPERATING FREQUENCY: 836,500,000 Hz
- CHANNEL: 20525(3 MHz)
- REFERENCE VOLTAGE: 3.880 VDC
- DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100 %	3.880	+20(Ref)	836 499 995	0.0	0.000 000	0.000
100 %		-30	836 499 990	-4.9	-0.000 001	-0.006
100 %		-20	836 500 002	7.5	0.000 001	0.009
100 %		-10	836 499 991	-3.7	0.000 000	-0.004
100 %		0	836 500 003	8.4	0.000 001	0.010
100 %		+10	836 500 004	9.7	0.000 001	0.012
100 %		+30	836 500 000	5.7	0.000 001	0.007
100 %		+40	836 500 000	4.9	0.000 001	0.006
100 %		+50	836 499 999	4.3	0.000 001	0.005
Batt. Endpoint	3.300	+20	836 499 987	-7.3	-0.000 001	-0.009



- MODE: LTE B5
- OPERATING FREQUENCY: 836,500,000 Hz
- CHANNEL: 20525(5 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)	836 500 005	0.0	0.000 000	0.000
100 %		-30	836 499 999	-5.9	-0.000 001	-0.007
100 %		-20	836 500 003	-2.1	0.000 000	-0.003
100 %		-10	836 500 009	4.1	0.000 000	0.005
100 %		0	836 500 009	3.4	0.000 000	0.004
100 %		+10	836 500 008	2.9	0.000 000	0.003
100 %		+30	836 500 001	-4.1	0.000 000	-0.005
100 %		+40	836 500 012	7.1	0.000 001	0.008
100 %		+50	836 500 010	5.0	0.000 001	0.006
Batt. Endpoint	3.300	+20	836 500 010	5.2	0.000 001	0.006



▣ MODE: LTE B5

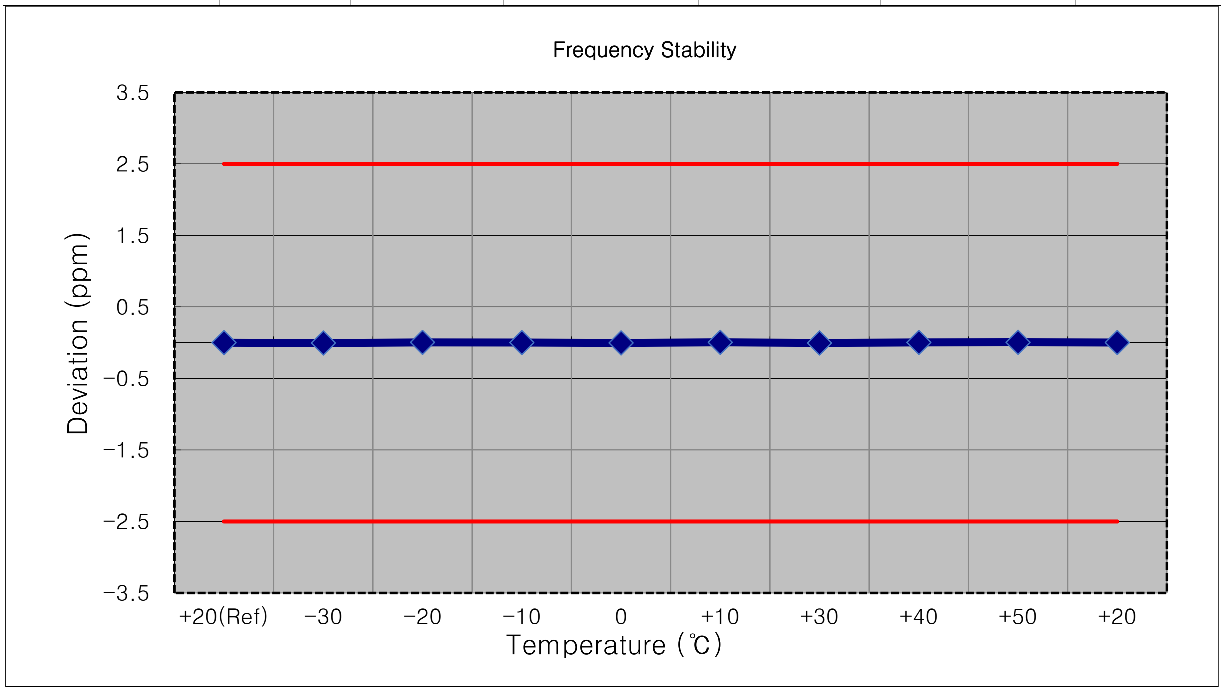
▣ OPERATING FREQUENCY: 836,500,000 Hz

▣ CHANNEL: 20525(10 MHz)

▣ REFERENCE VOLTAGE: 3.880 VDC

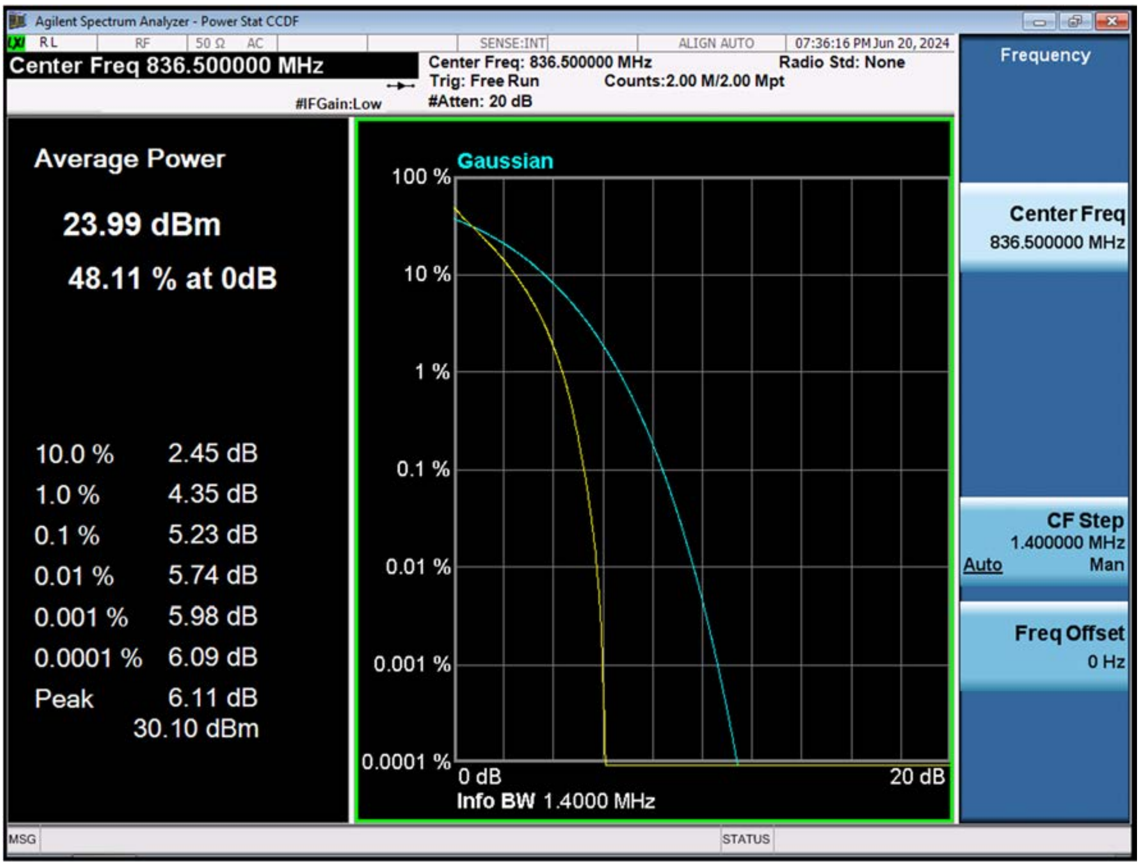
▣ DEVIATION LIMIT: ± 0.000 25 % or 2.5 ppm

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	-3.4	0.000 000	-0.004
100 %		-20	836 500 006	3.4	0.000 000	0.004
100 %		-10	836 500 005	1.9	0.000 000	0.002
100 %		0	836 500 000	-2.5	0.000 000	-0.003
100 %		+10	836 500 007	4.3	0.000 001	0.005
100 %		+30	836 500 000	-2.5	0.000 000	-0.003
100 %		+40	836 500 006	3.3	0.000 000	0.004
100 %		+50	836 500 008	5.1	0.000 001	0.006
Batt. Endpoint	3.300	+20	836 500 005	2.0	0.000 000	0.002

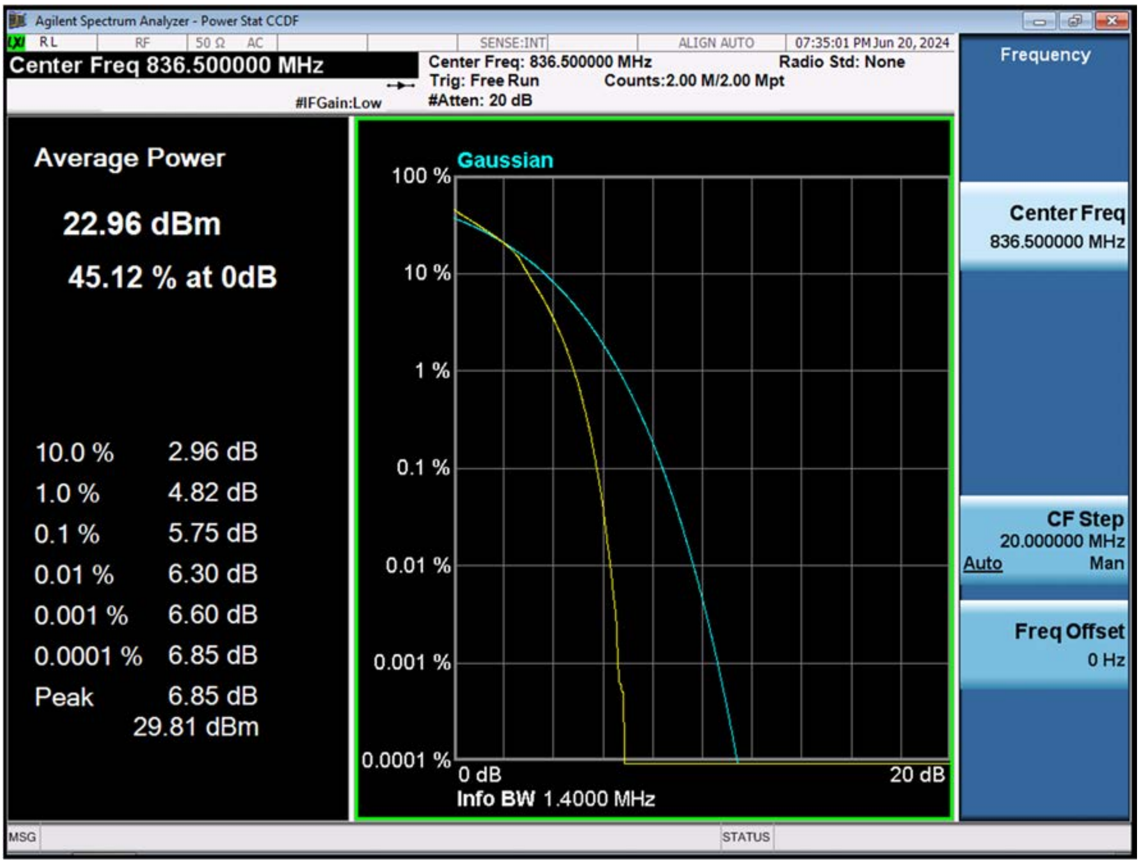


9. TEST PLOTS

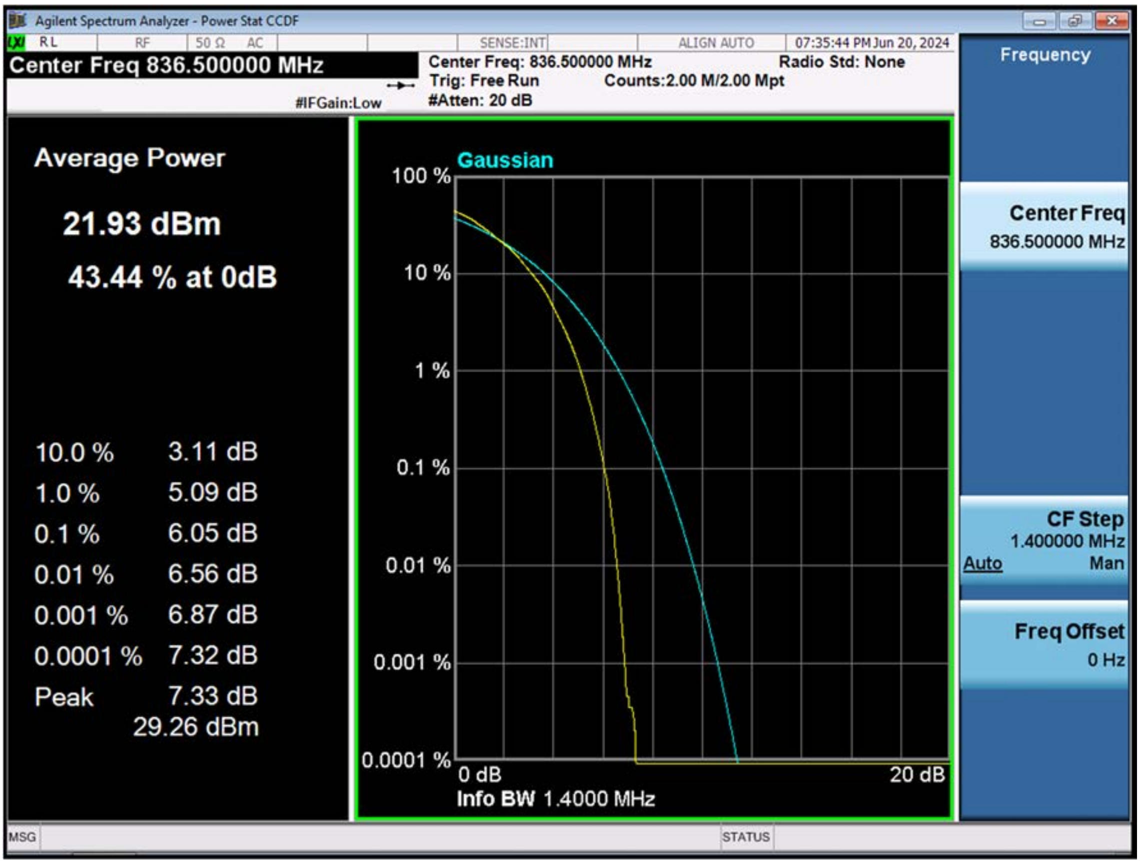
LTE B5_1.4M_PAR_Mid_QPSK_FullRB



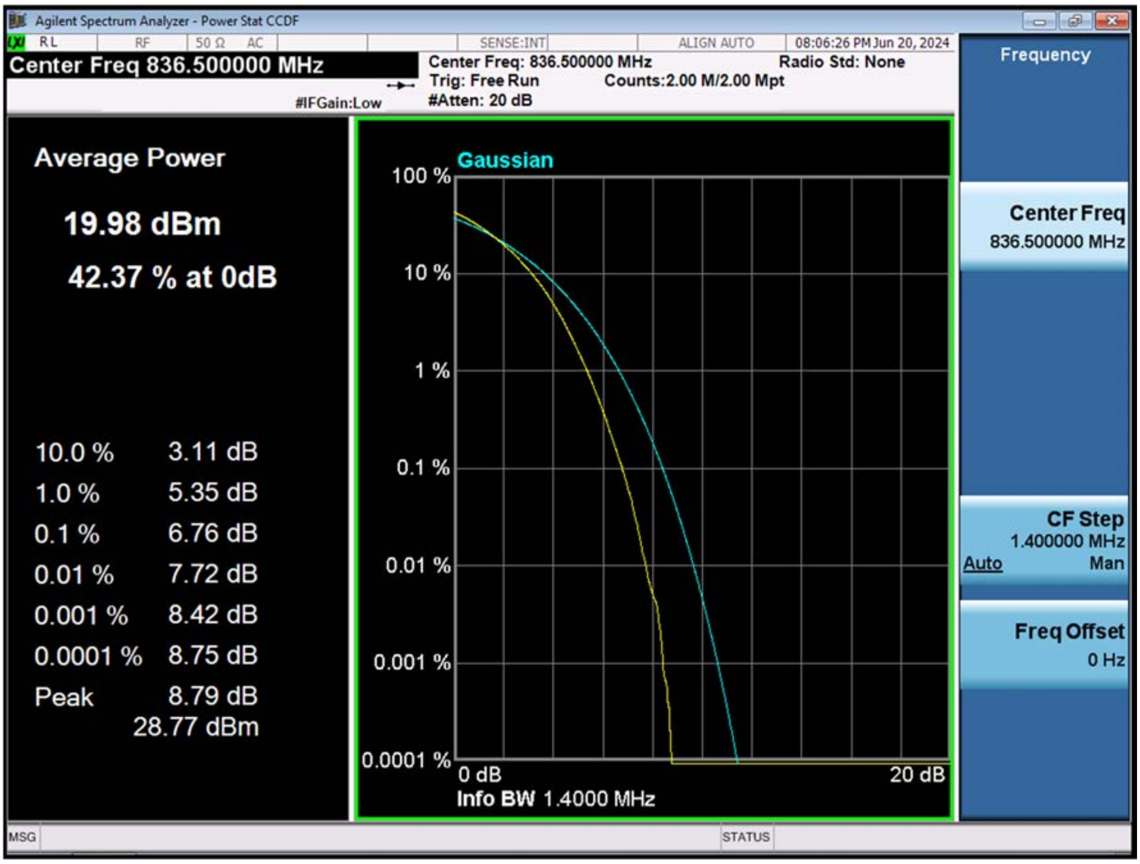
LTE B5_1.4M_PAR_Mid_16QAM_FullRB



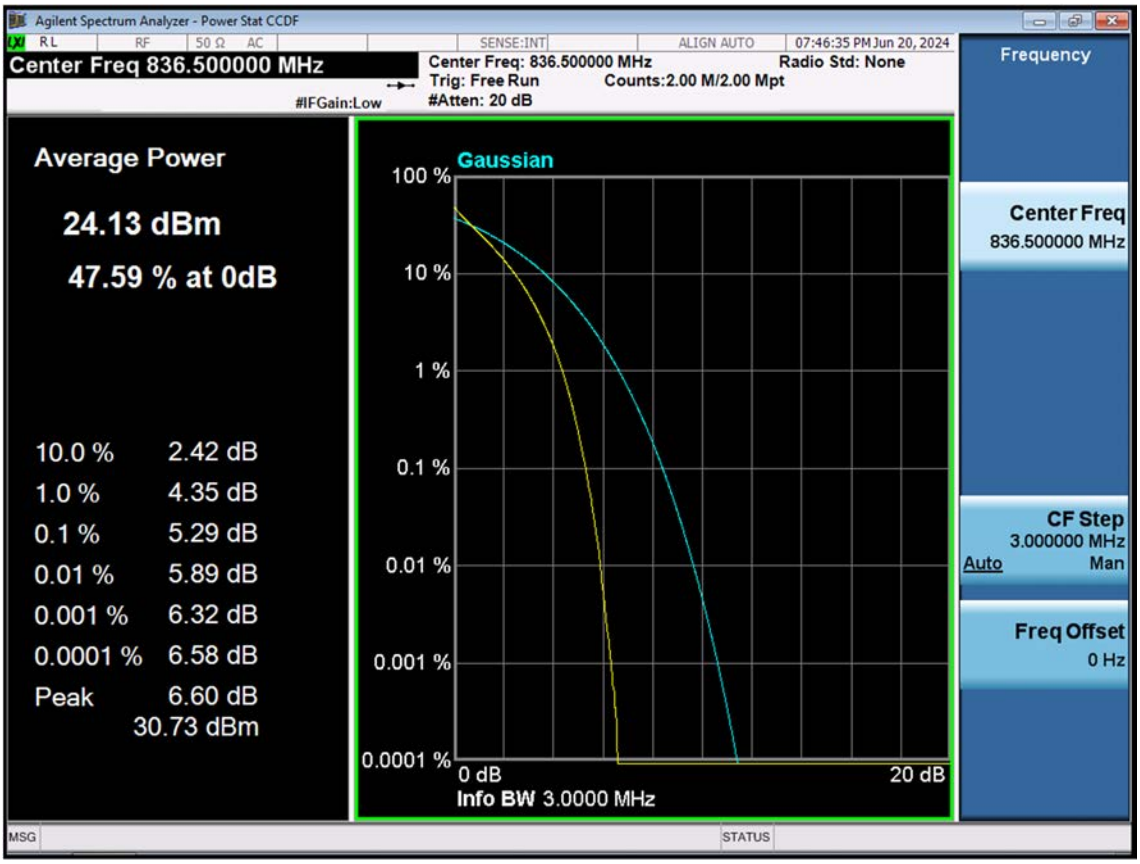
LTE B5_1.4M_PAR_Mid_64QAM_FullRB



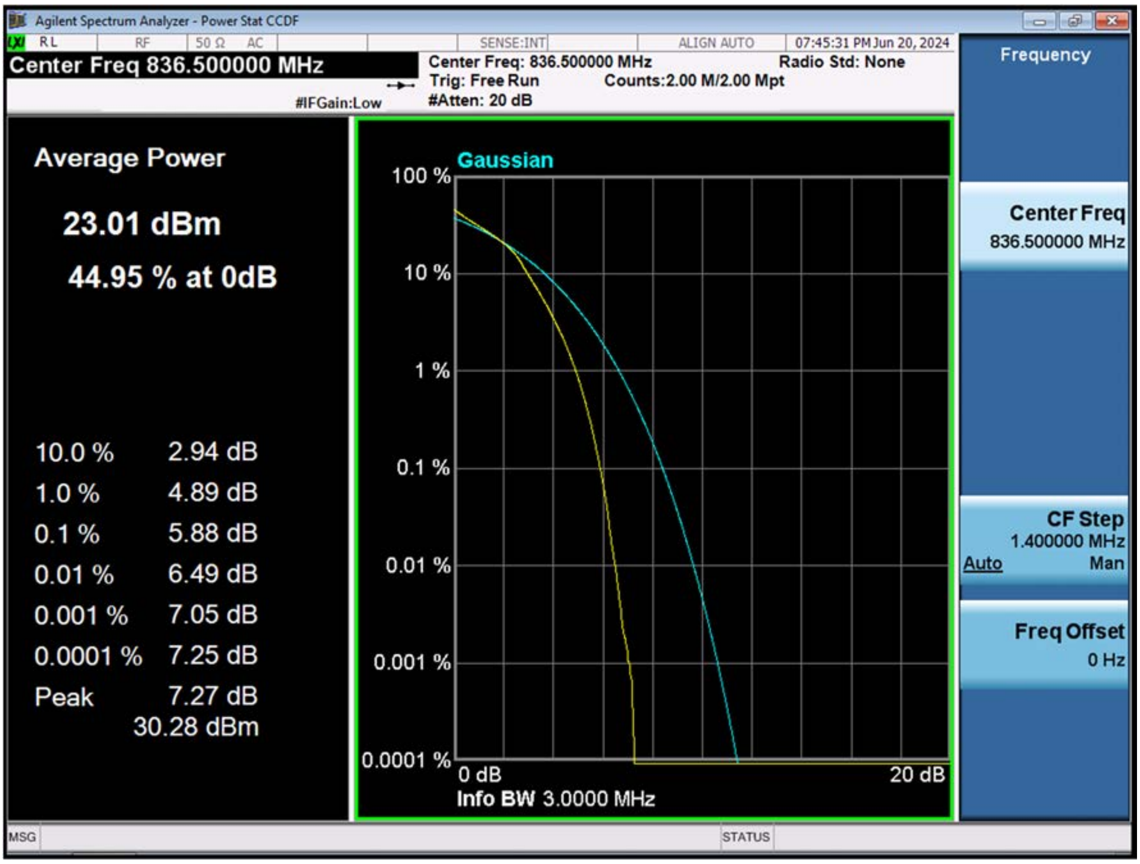
LTE B5_1.4M_PAR_Mid_256QAM_FullRB



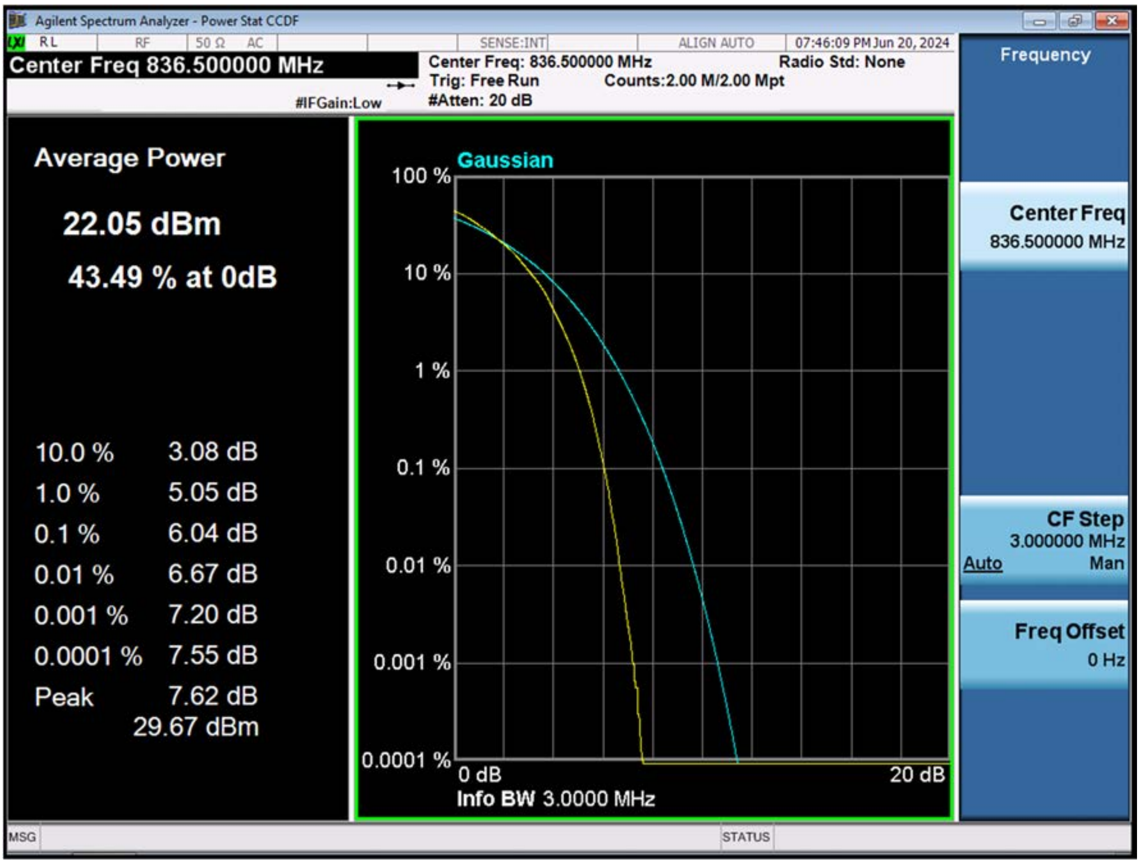
LTE B5_3 M_PAR_Mid_QPSK_FullRB



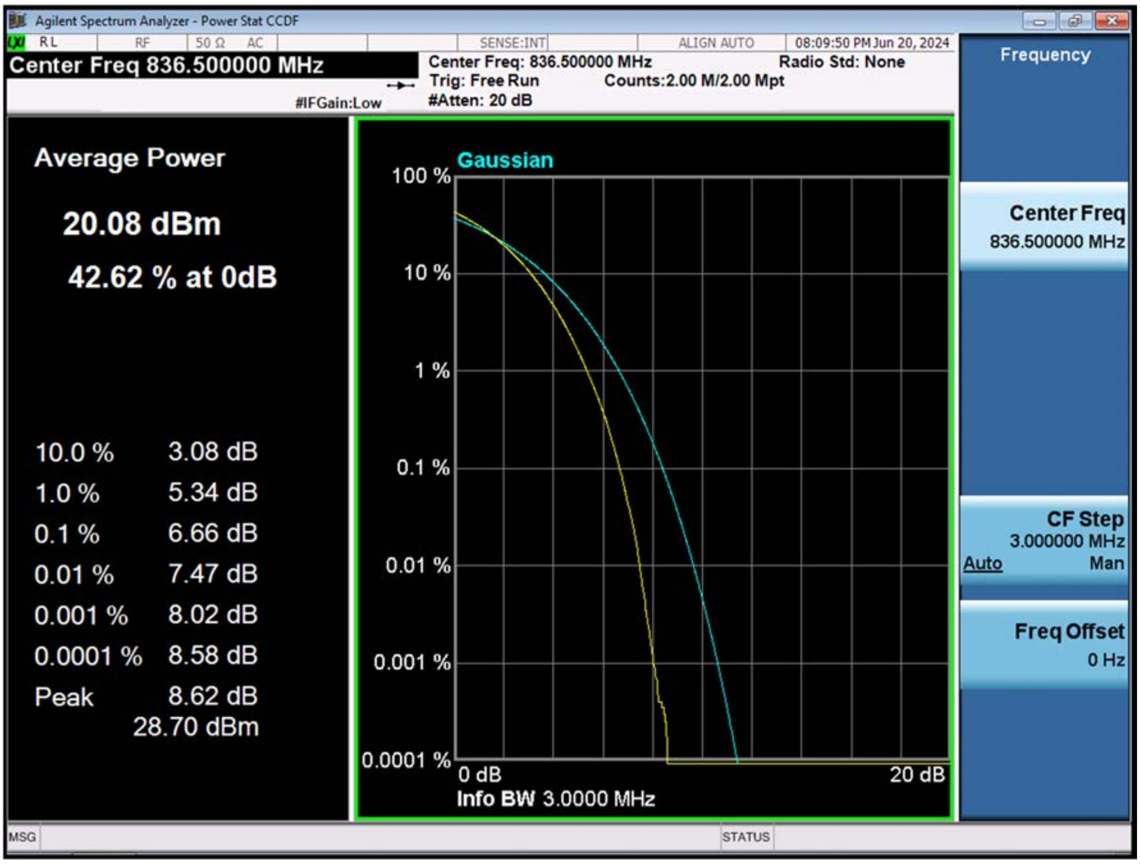
LTE B5_3 M_PAR_Mid_16QAM_FullRB



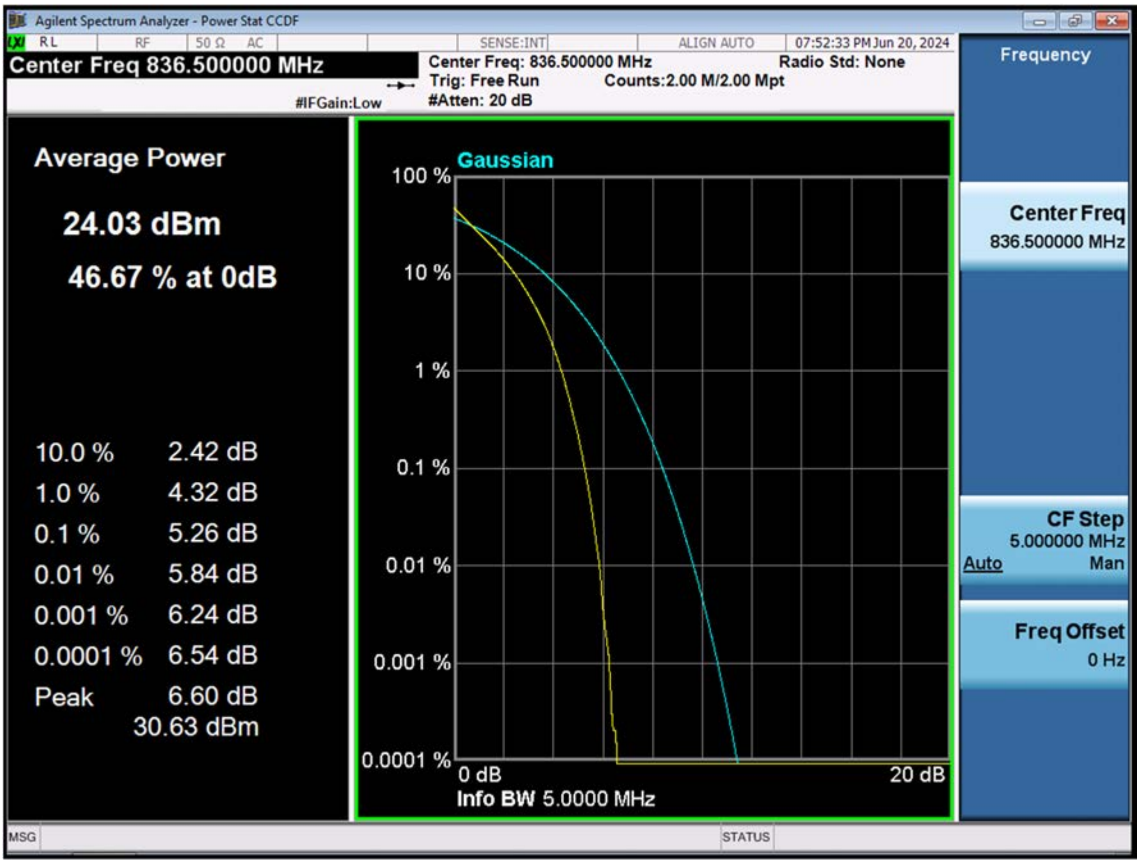
LTE B5_3 M_PAR_Mid_64QAM_FullRB



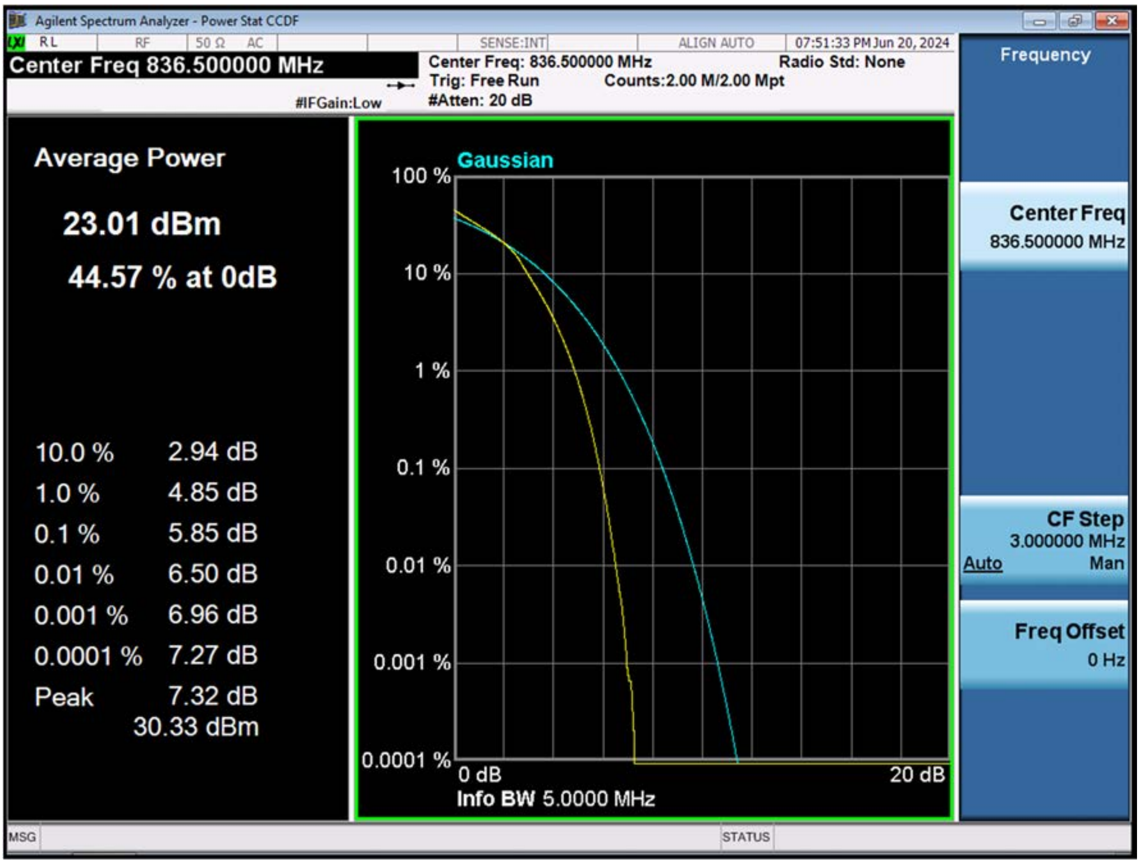
LTE B5_3 M_PAR_Mid_256QAM_FullRB



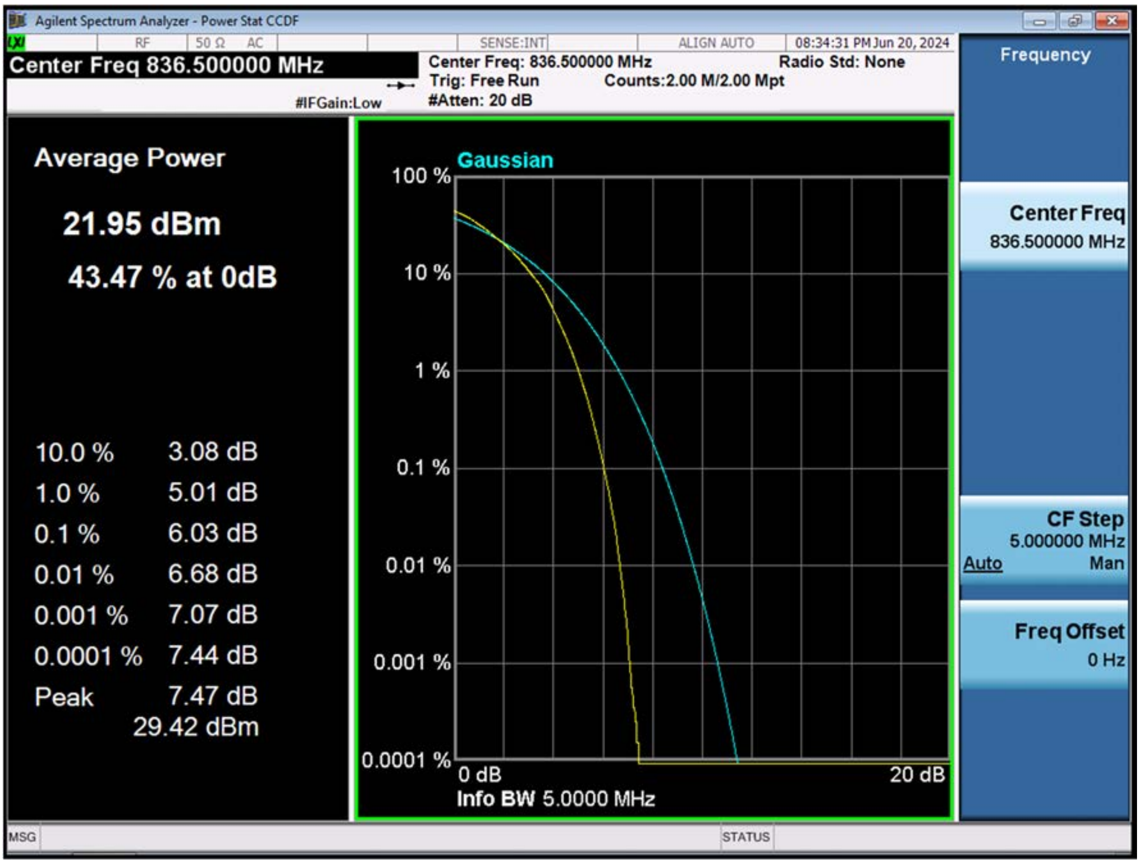
LTE B5_5 M_PAR_Mid_QPSK_FullRB



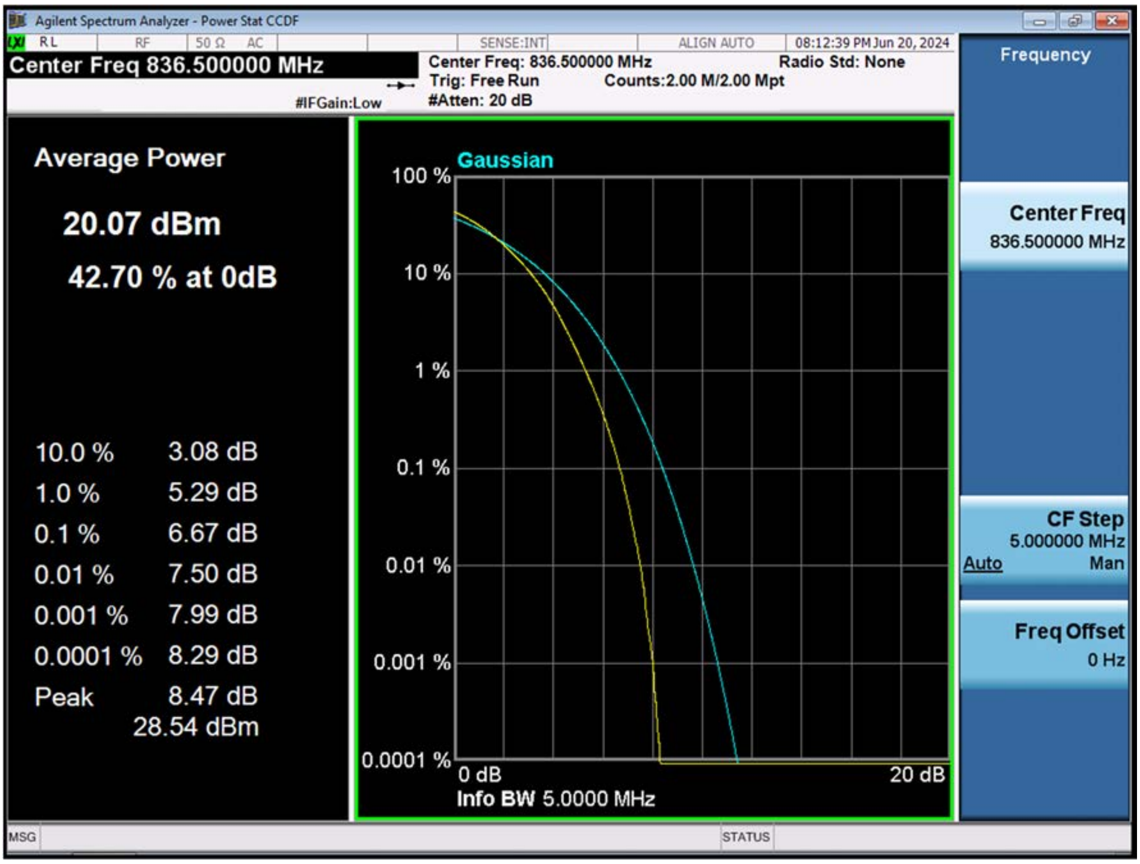
LTE B5_5 M_PAR_Mid_16QAM_FullRB



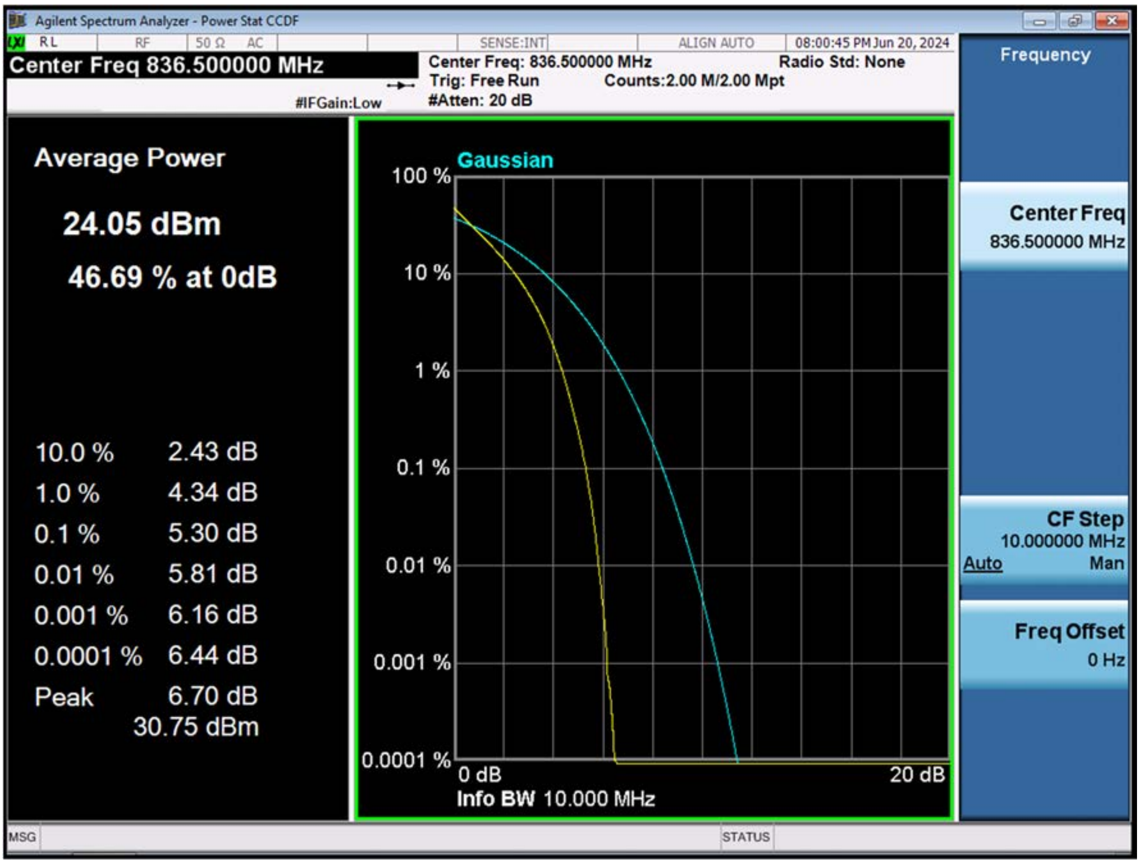
LTE B5_5 M_PAR_Mid_64QAM_FullRB



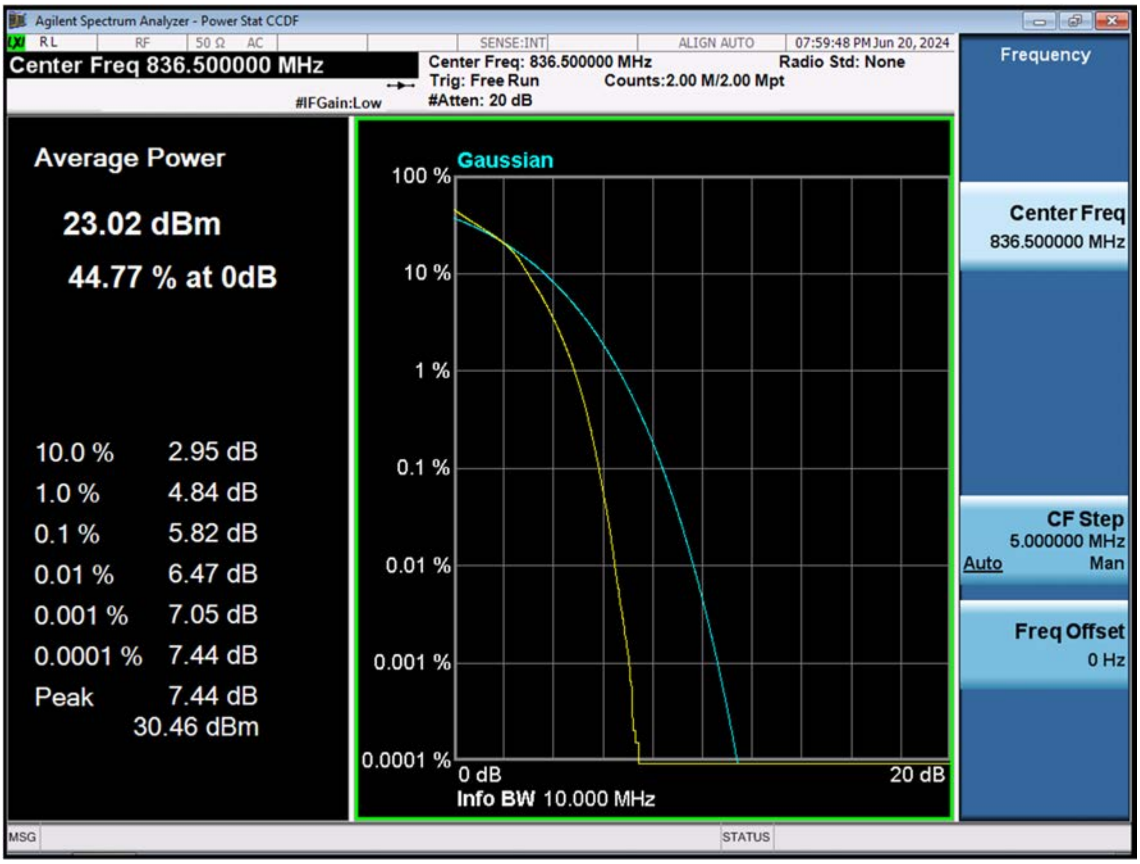
LTE B5_5 M_PAR_Mid_256QAM_FullRB



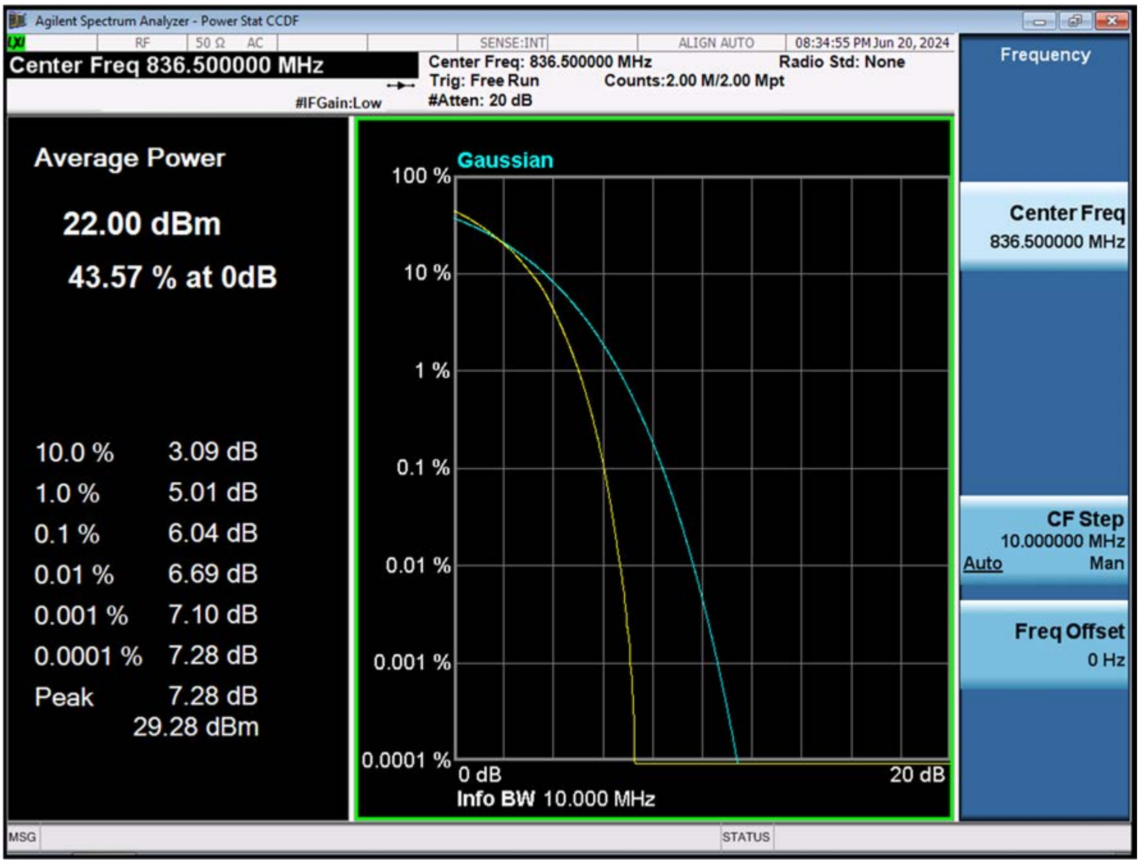
LTE B5_10 M_PAR_Mid_QPSK_FullRB



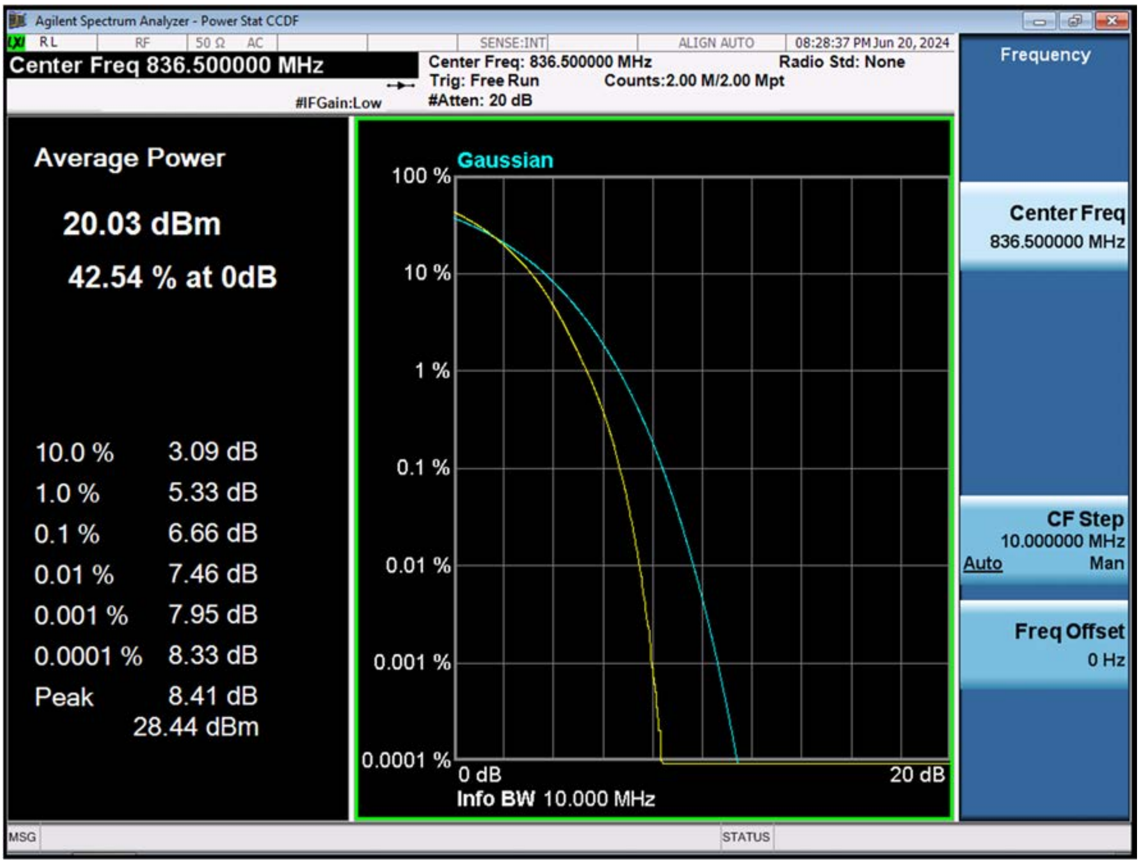
LTE B5_10 M_PAR_Mid_16QAM_FullRB



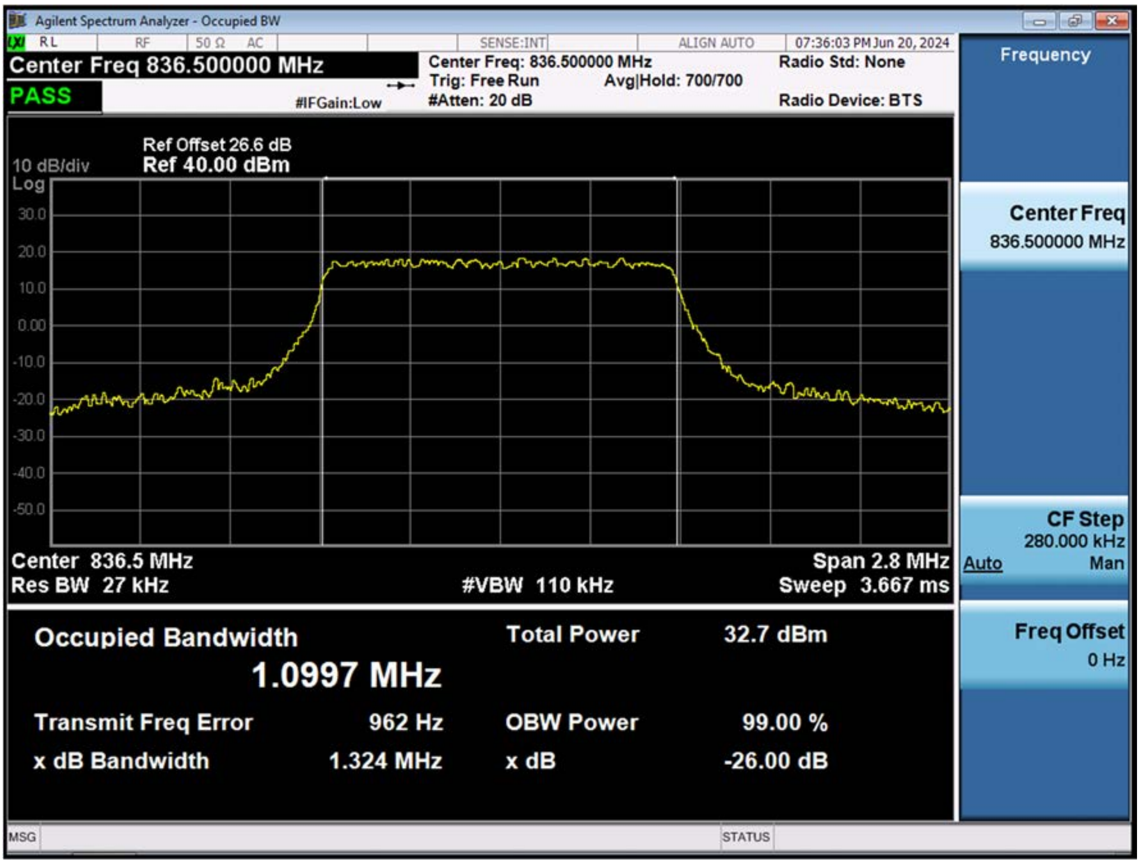
LTE B5_10 M_PAR_Mid_64QAM_FullRB



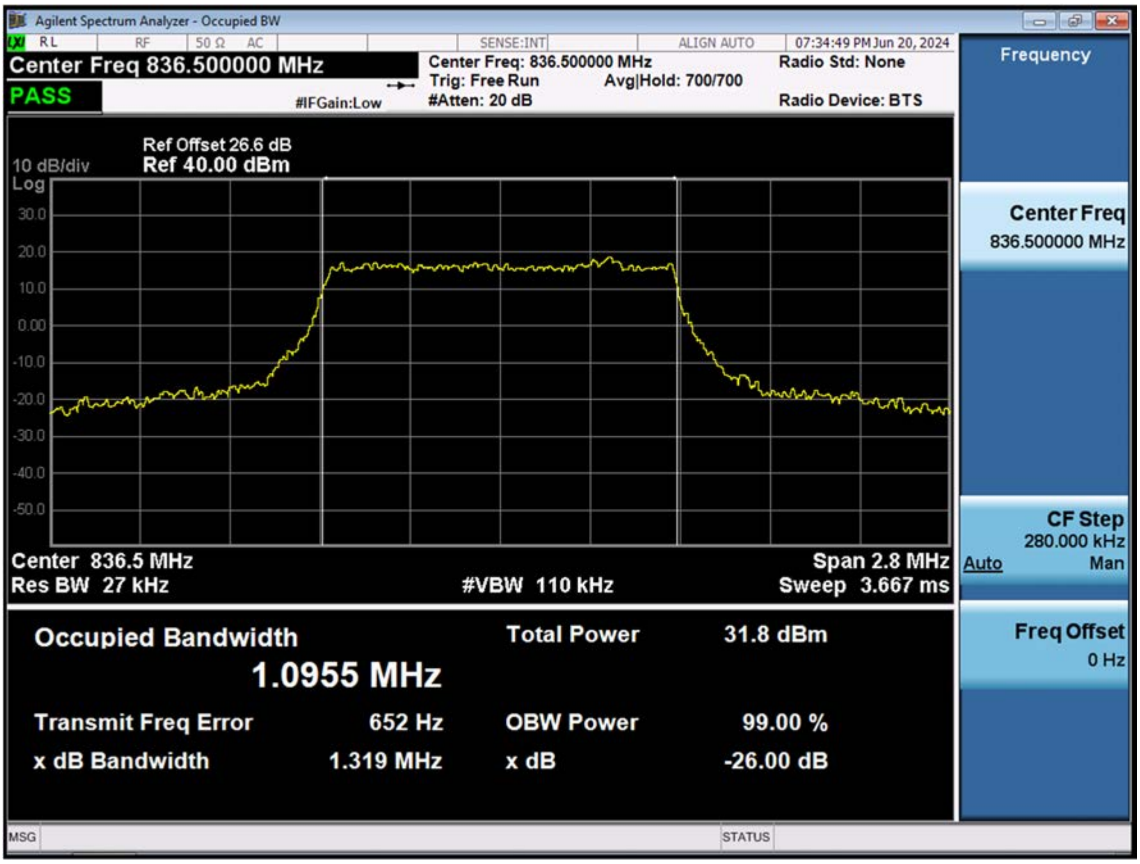
LTE B5_10 M_PAR_Mid_256QAM_FullRB



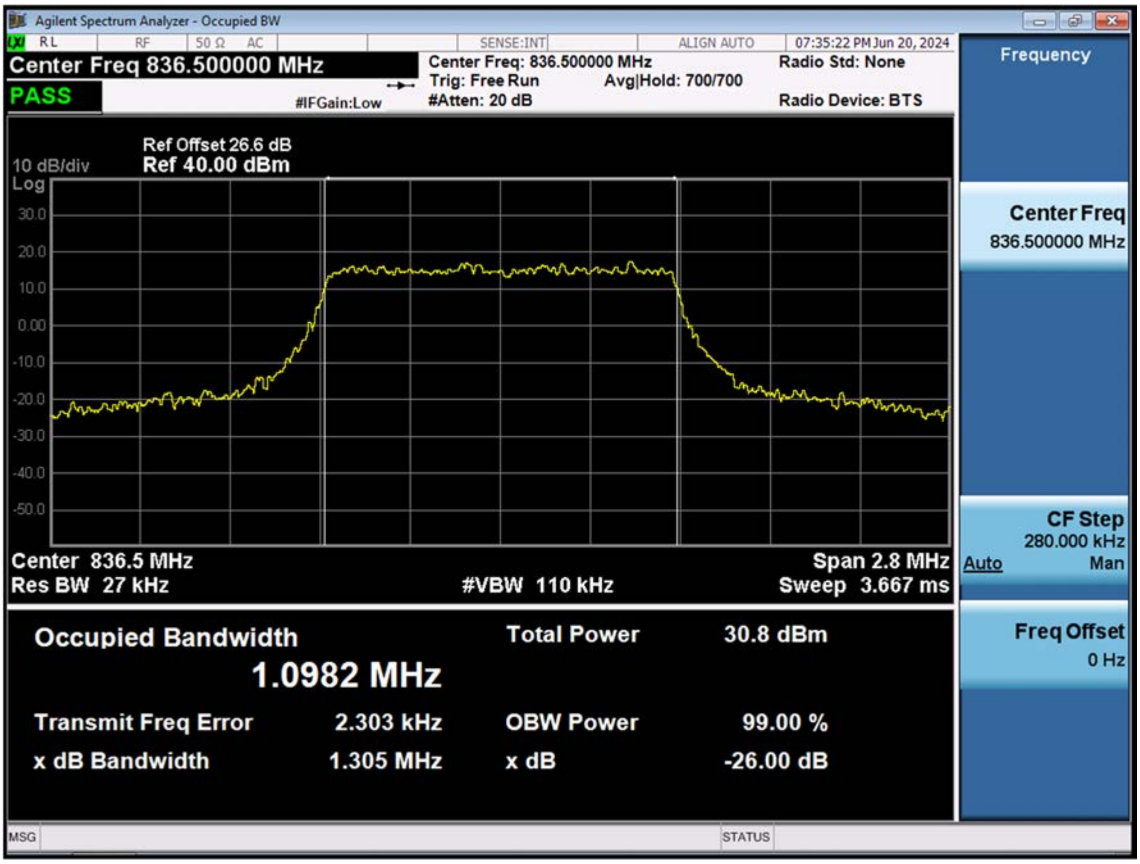
LTE B5_1.4M_OBW_Mid_QPSK_FullRB



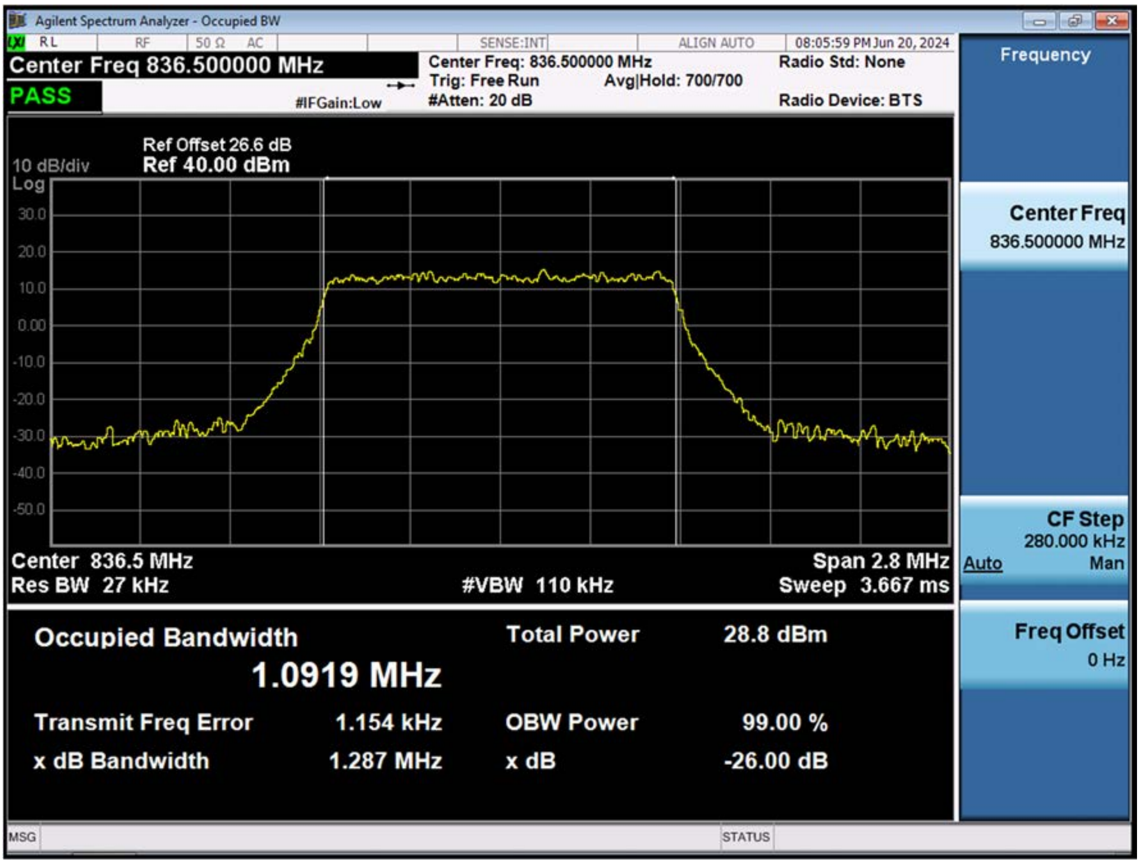
LTE B5_1.4M_OBW_Mid_16QAM_FullRB



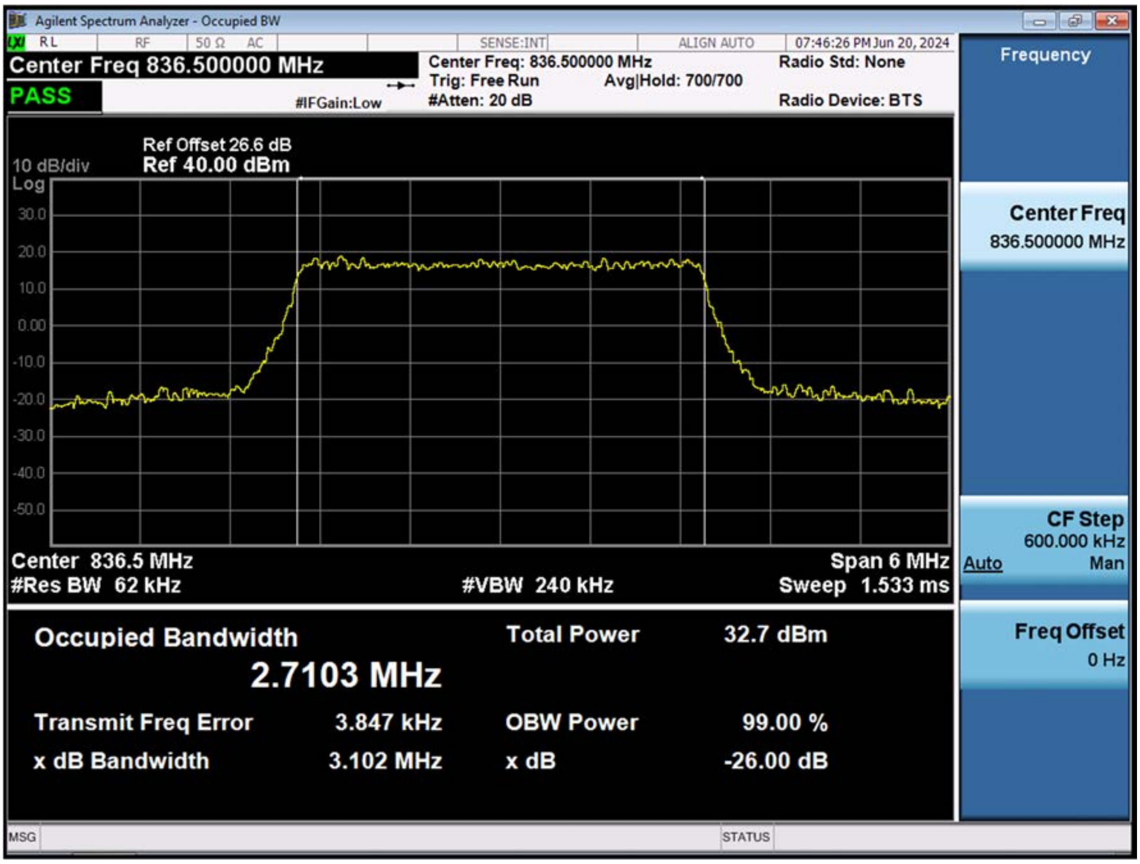
LTE B5_1.4M_OBW_Mid_64QAM_FullRB



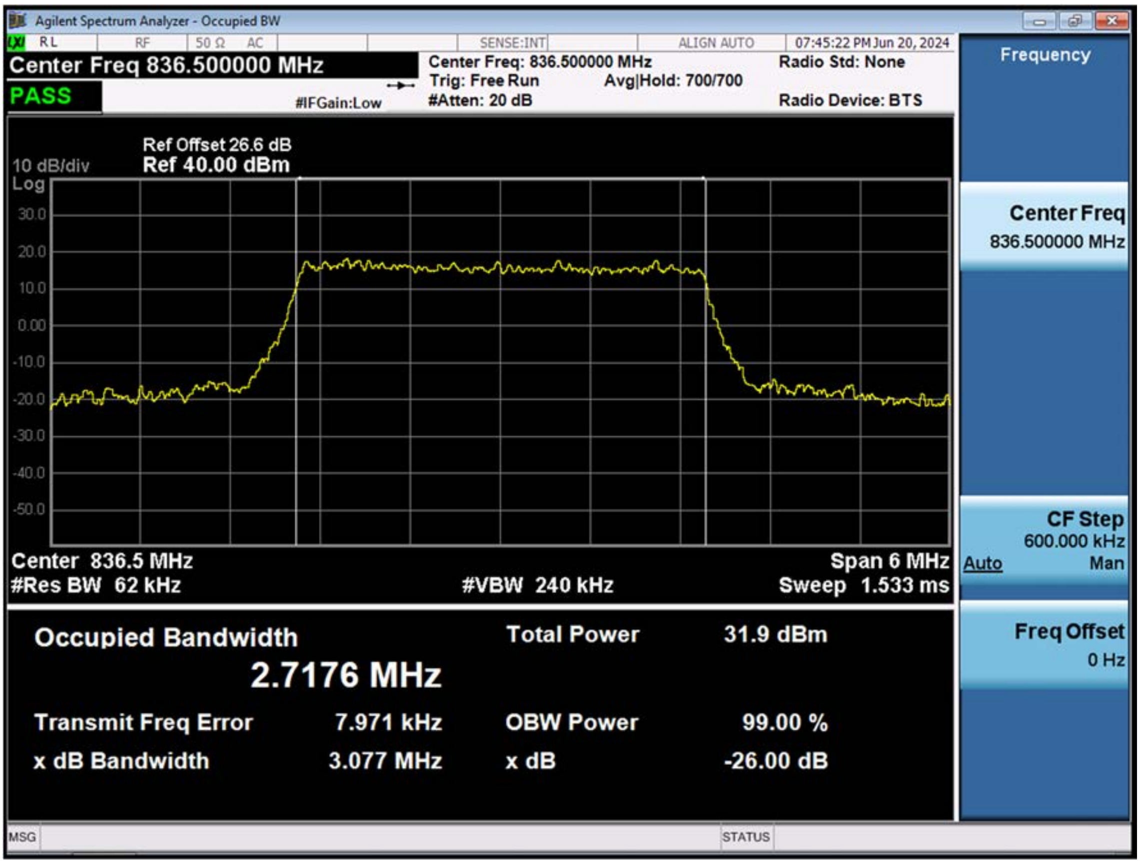
LTE B5_1.4M_OBW_Mid_256QAM_FullRB



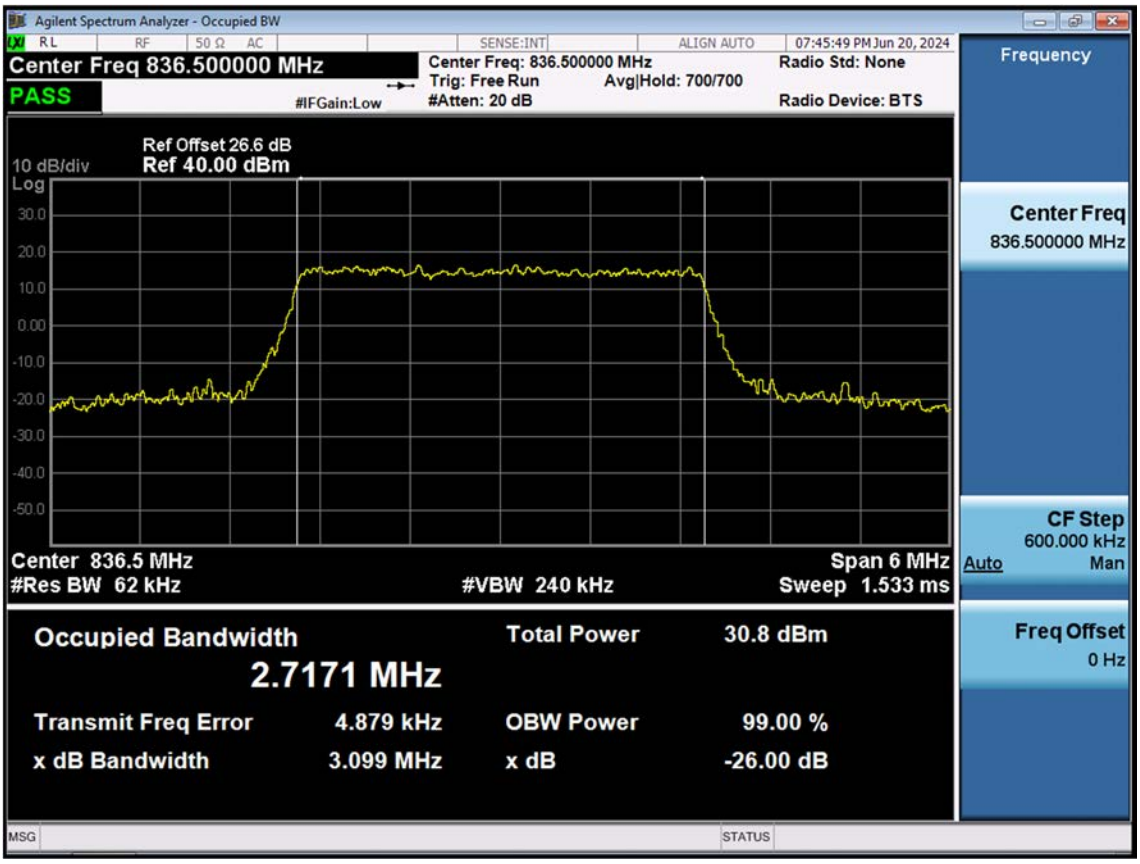
LTE B5_3 M_OBW_Mid_QPSK_FullRB



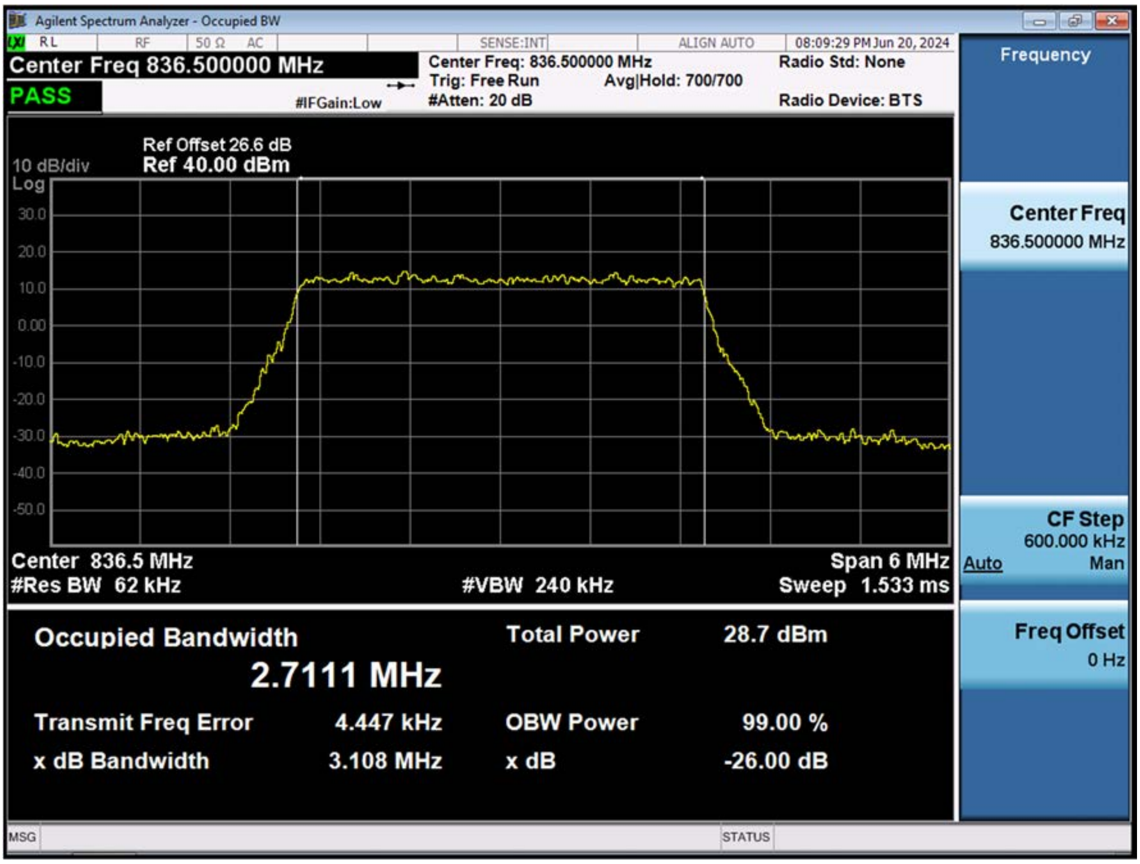
LTE B5_3 M_OBW_Mid_16QAM_FullRB



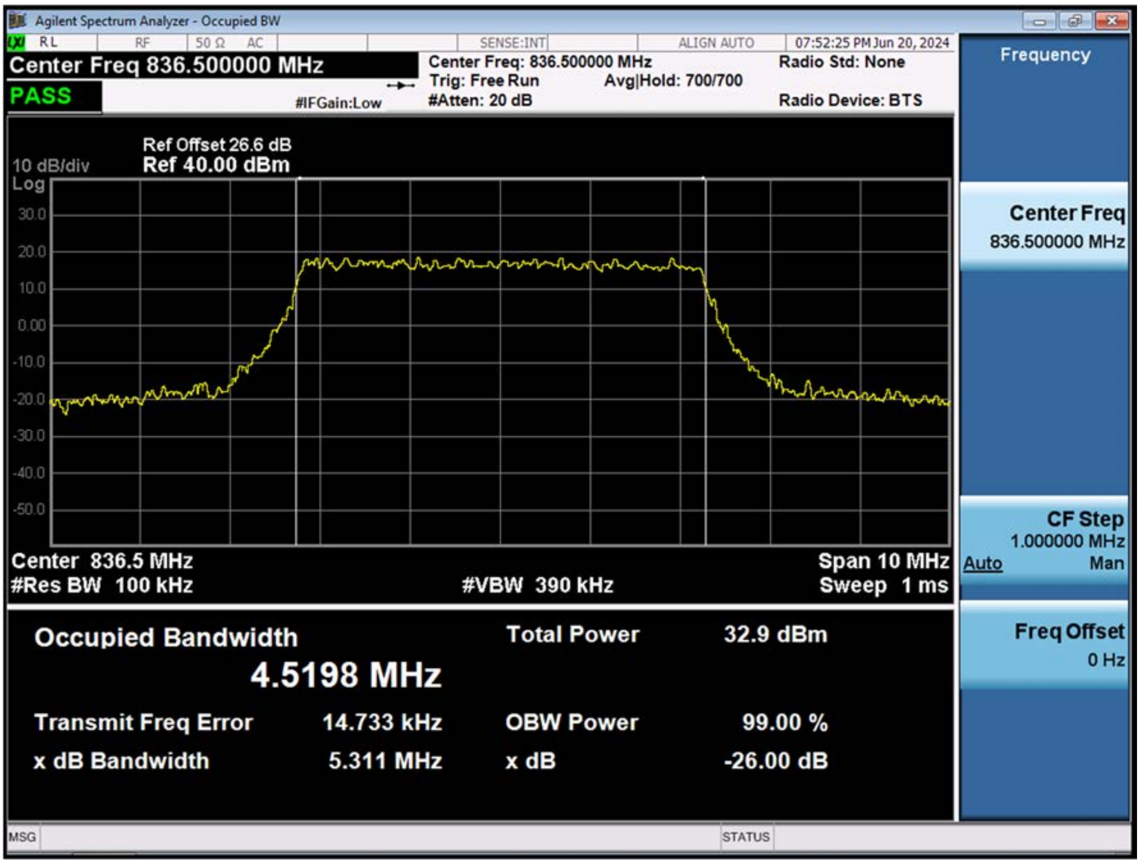
LTE B5_3 M_OBW_Mid_64QAM_FullRB



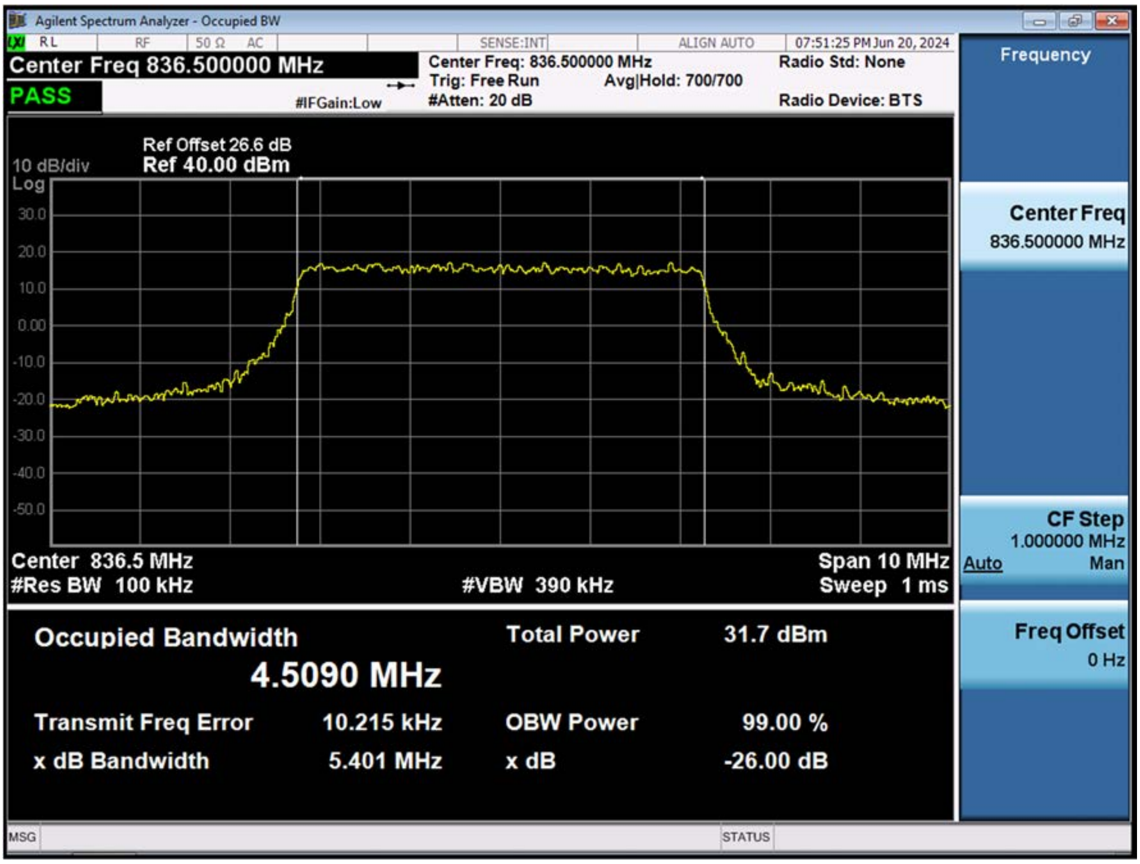
LTE B5_3 M_OBW_Mid_256QAM_FullRB



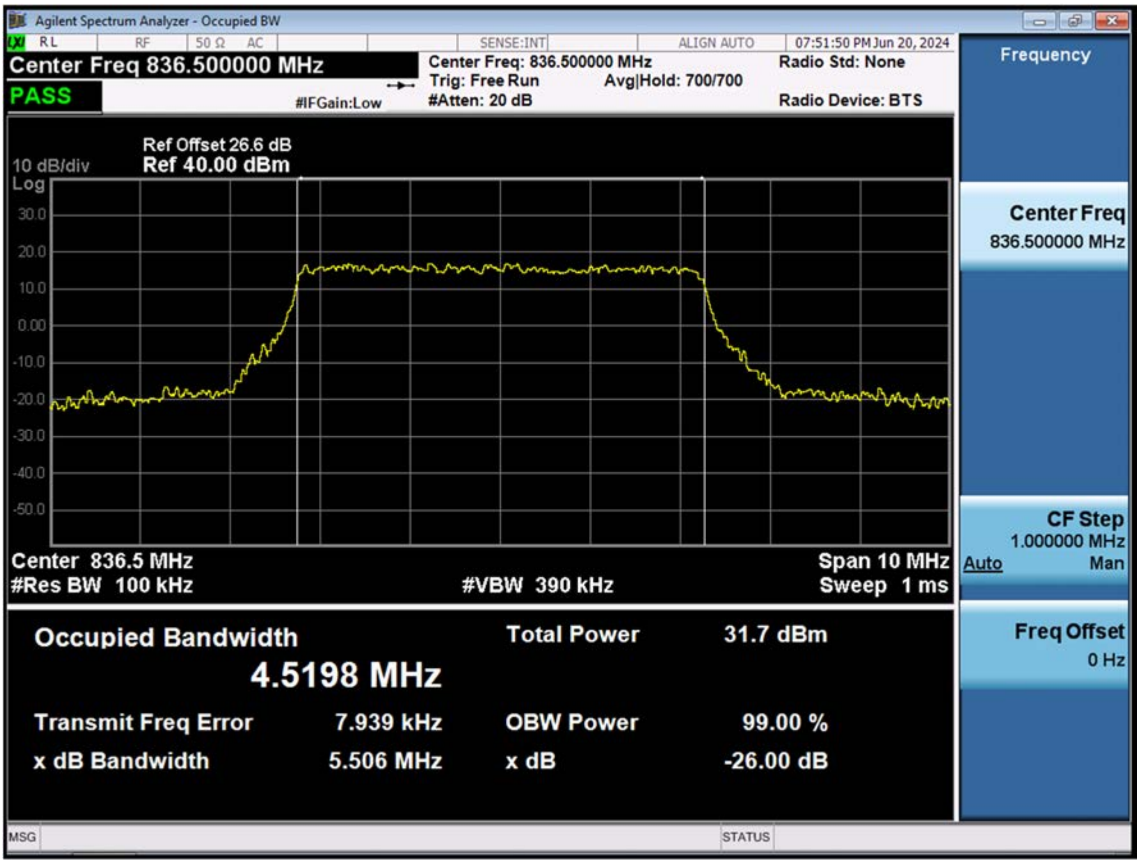
LTE B5_5 M_OBW_Mid_QPSK_FullRB



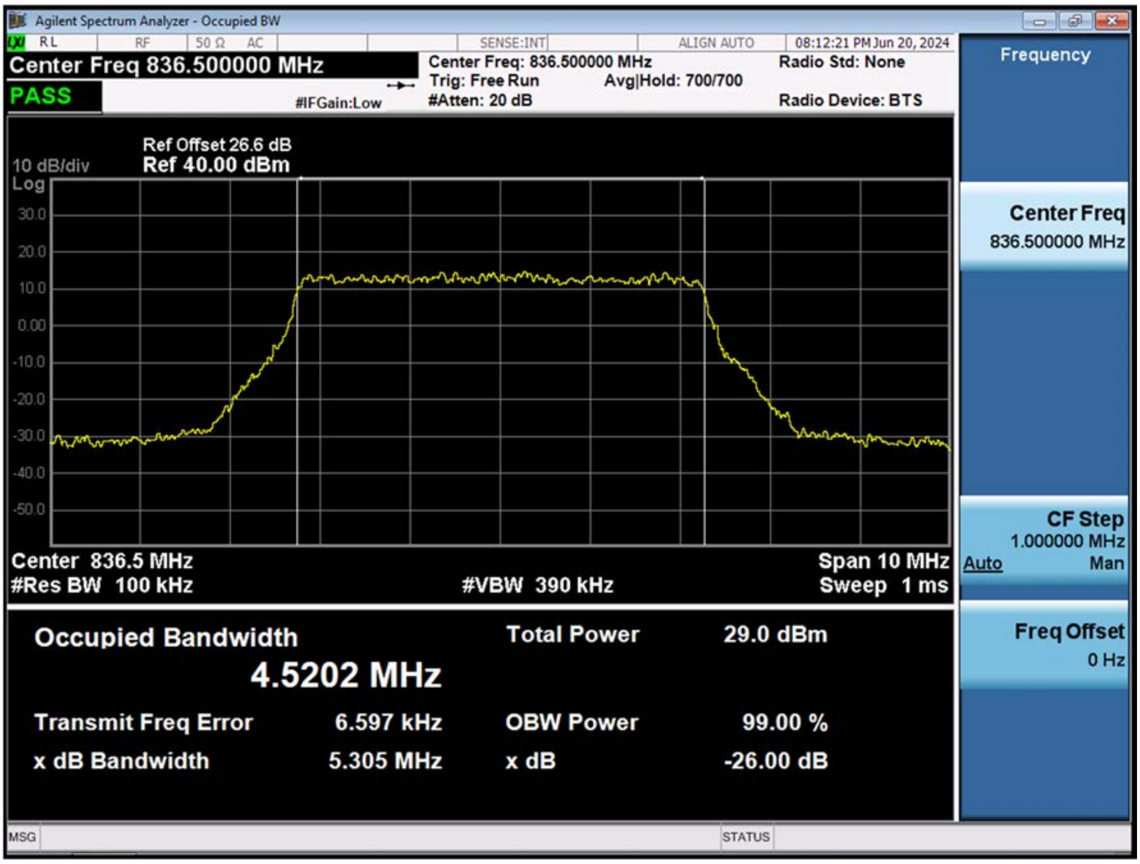
LTE B5_5 M_OBW_Mid_16QAM_FullRB



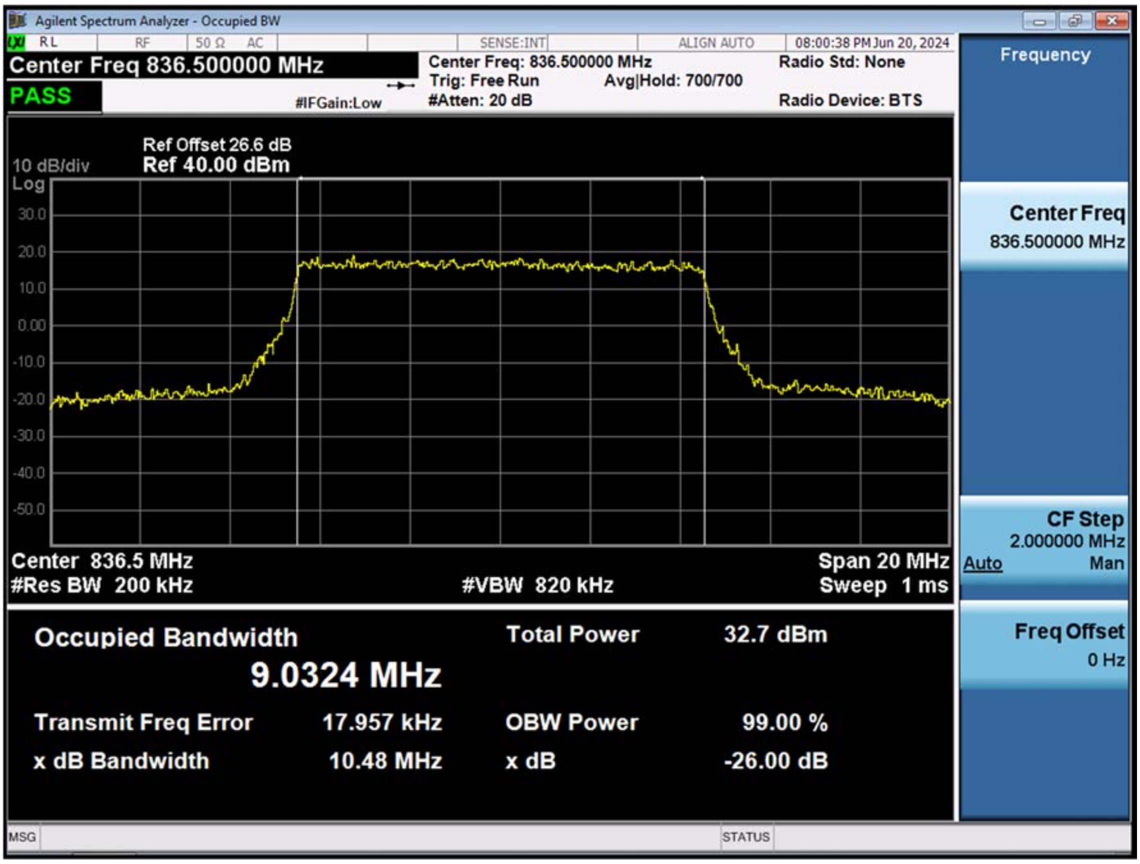
LTE B5_5 M_OBW_Mid_64QAM_FullRB



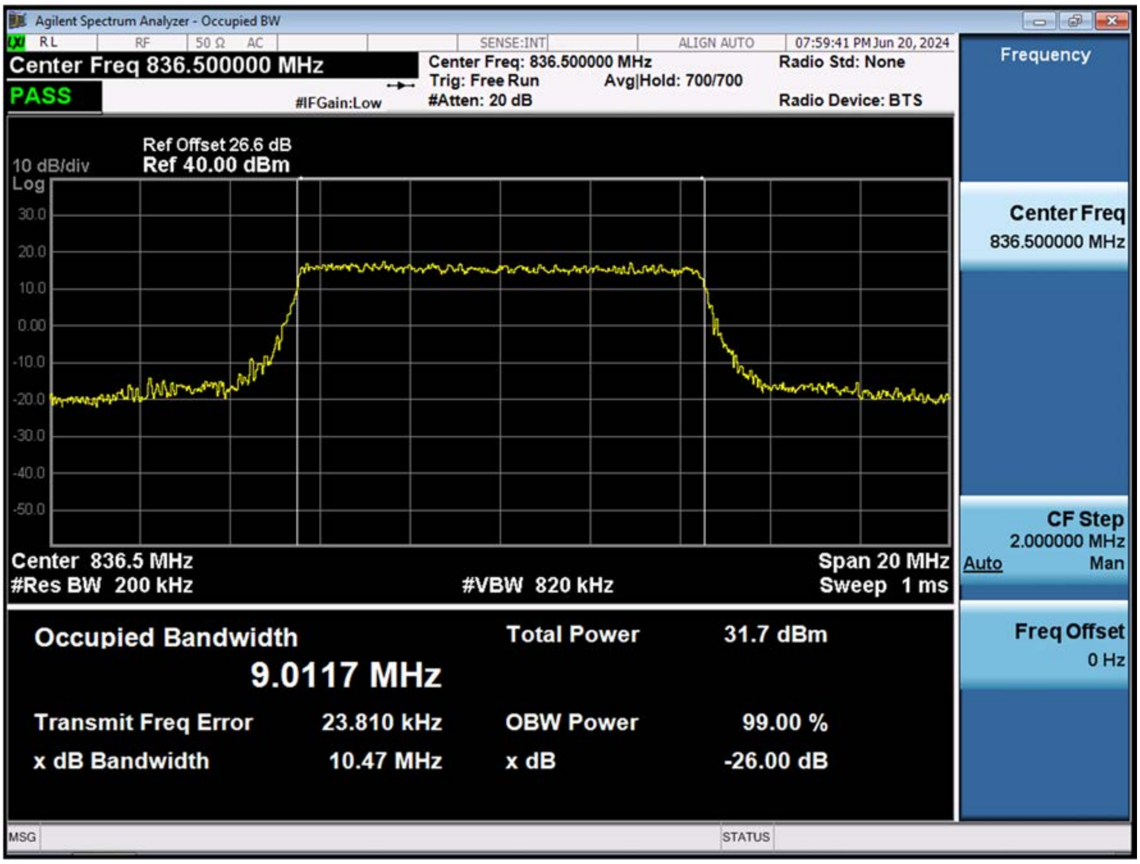
LTE B5_5 M_OBW_Mid_256QAM_FullRB



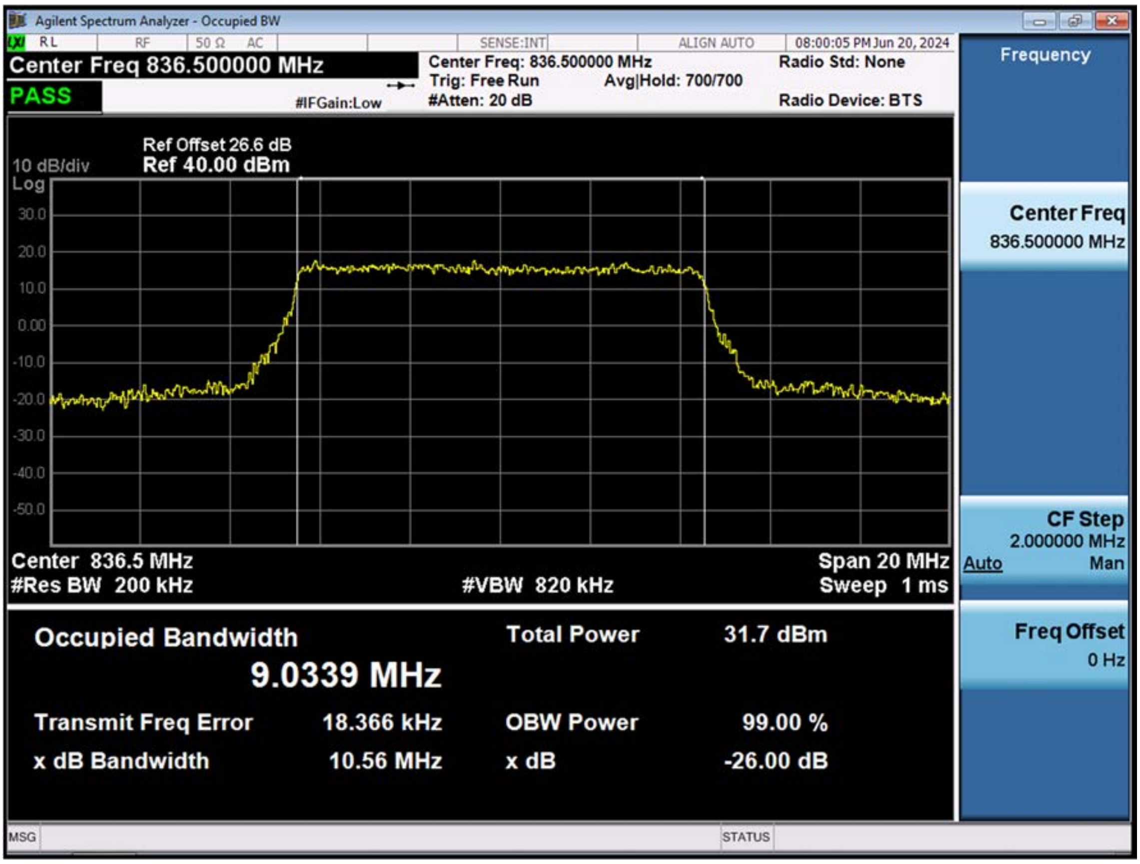
LTE B5_10 M_OBW_Mid_QPSK_FullRB



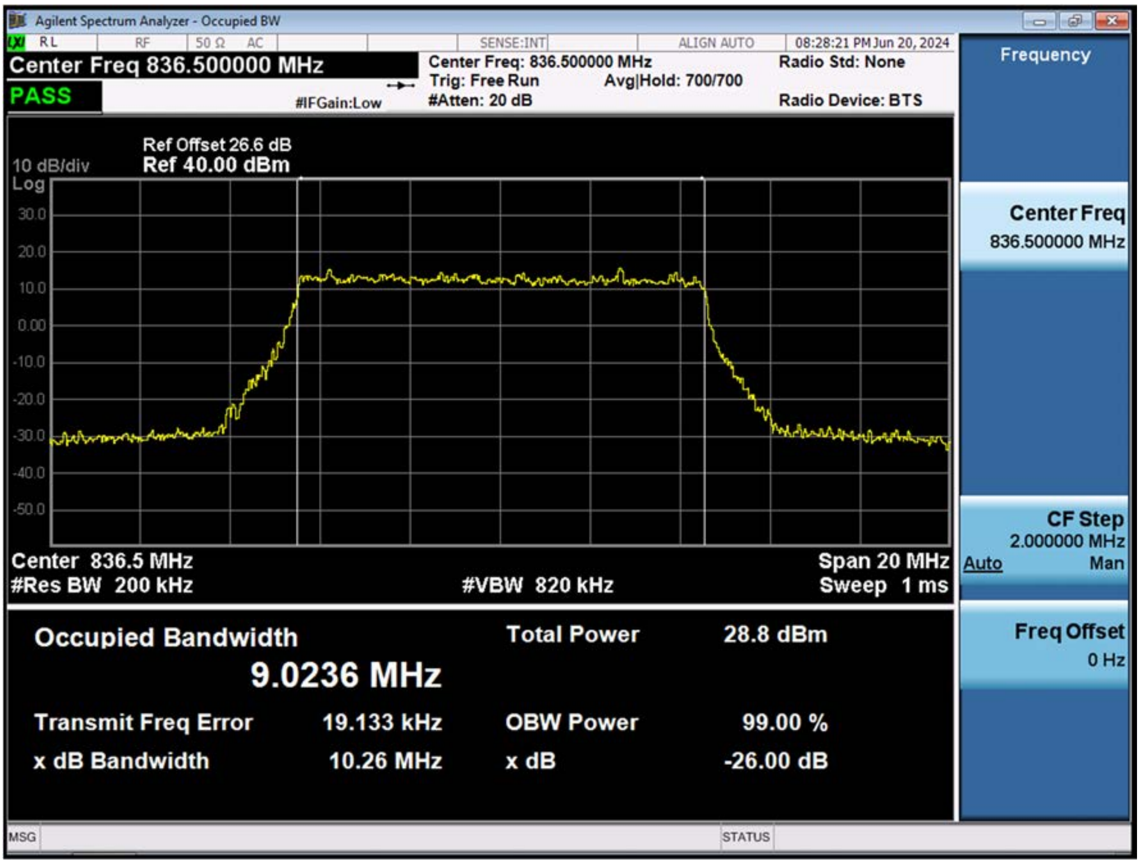
LTE B5_10 M_OBW_Mid_16QAM_FullRB



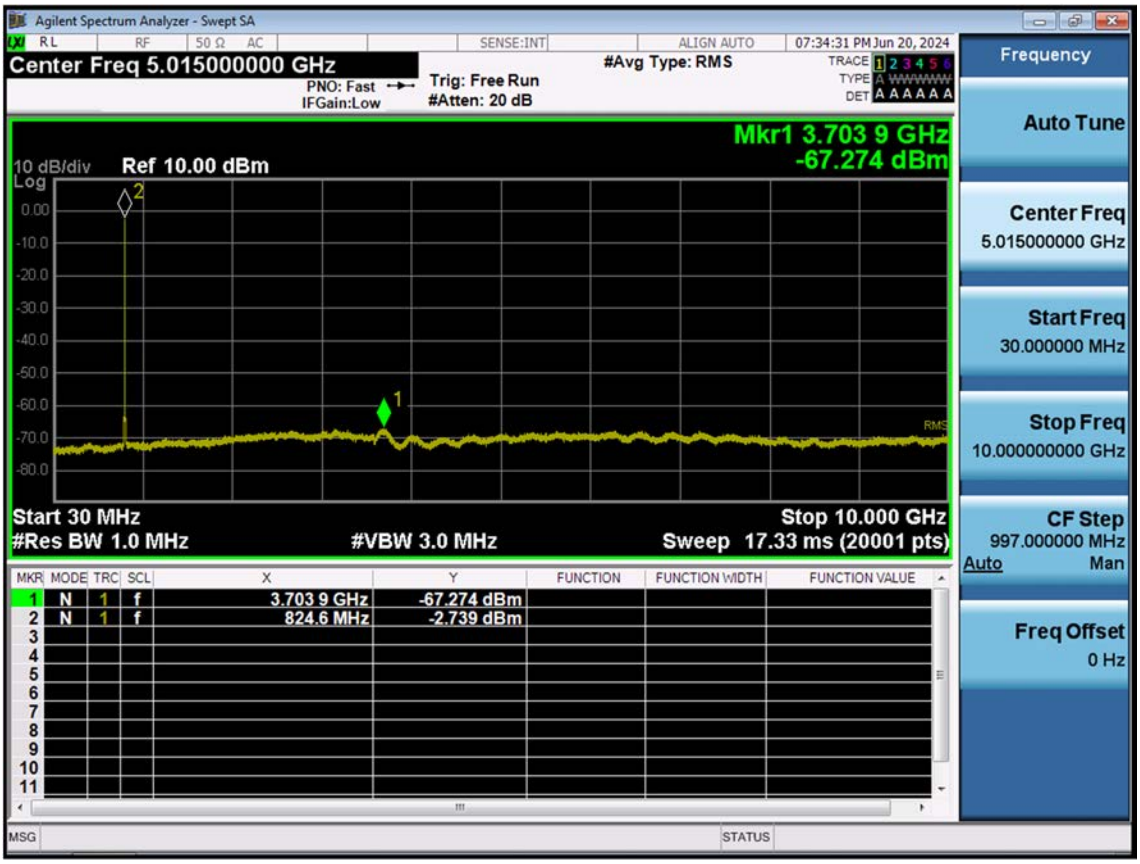
LTE B5_10 M_OBW_Mid_64QAM_FullRB



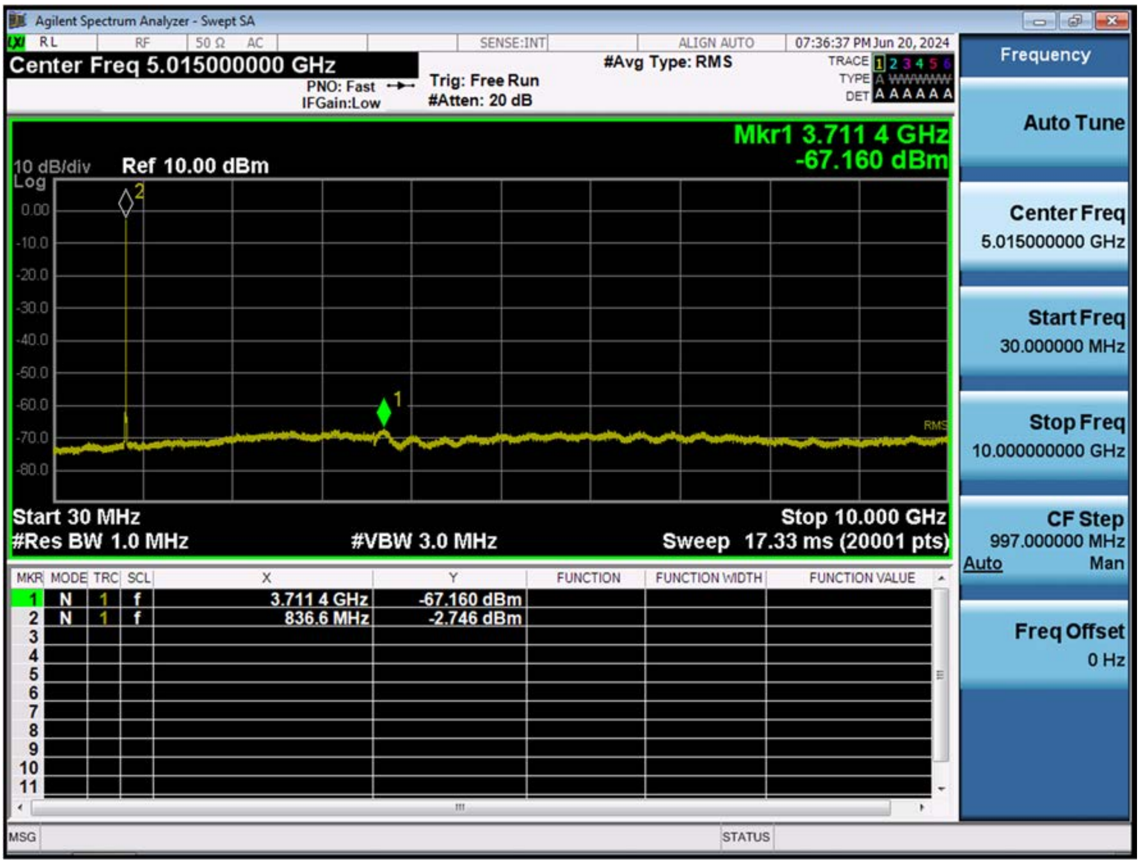
LTE B5_10 M_OBW_Mid_256QAM_FullRB



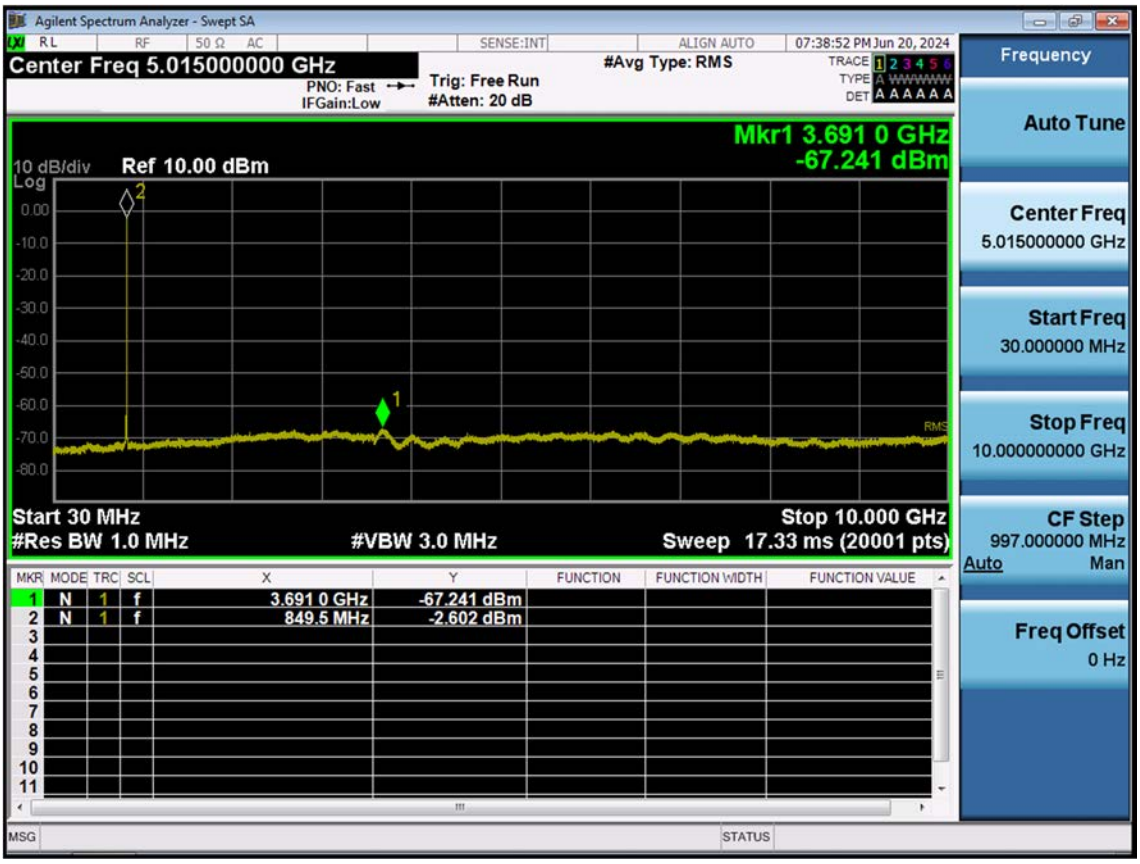
LTE B5_1.4M_Conducted Spurious(30 M-10 G)_Low_QPSK_1RB



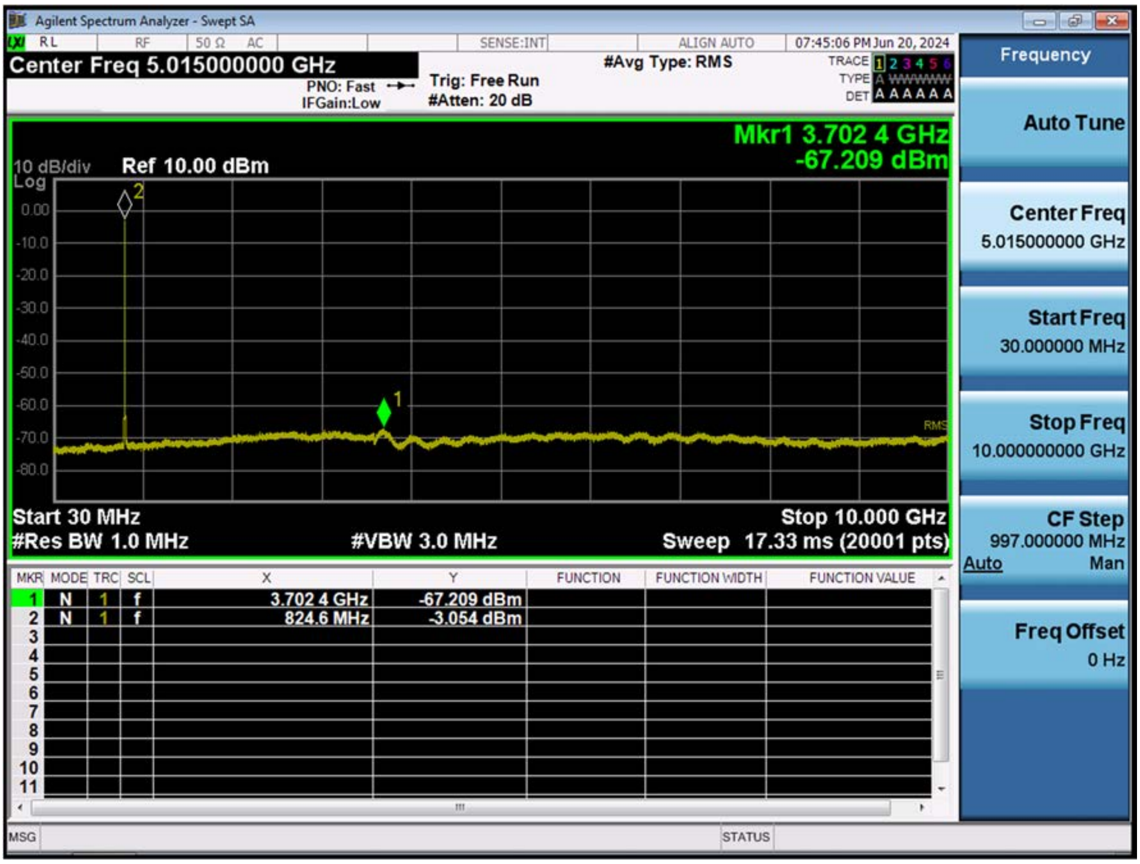
LTE B5_1.4M_Conducted Spurious(30 M-10 G)_Mid_QPSK_1RB



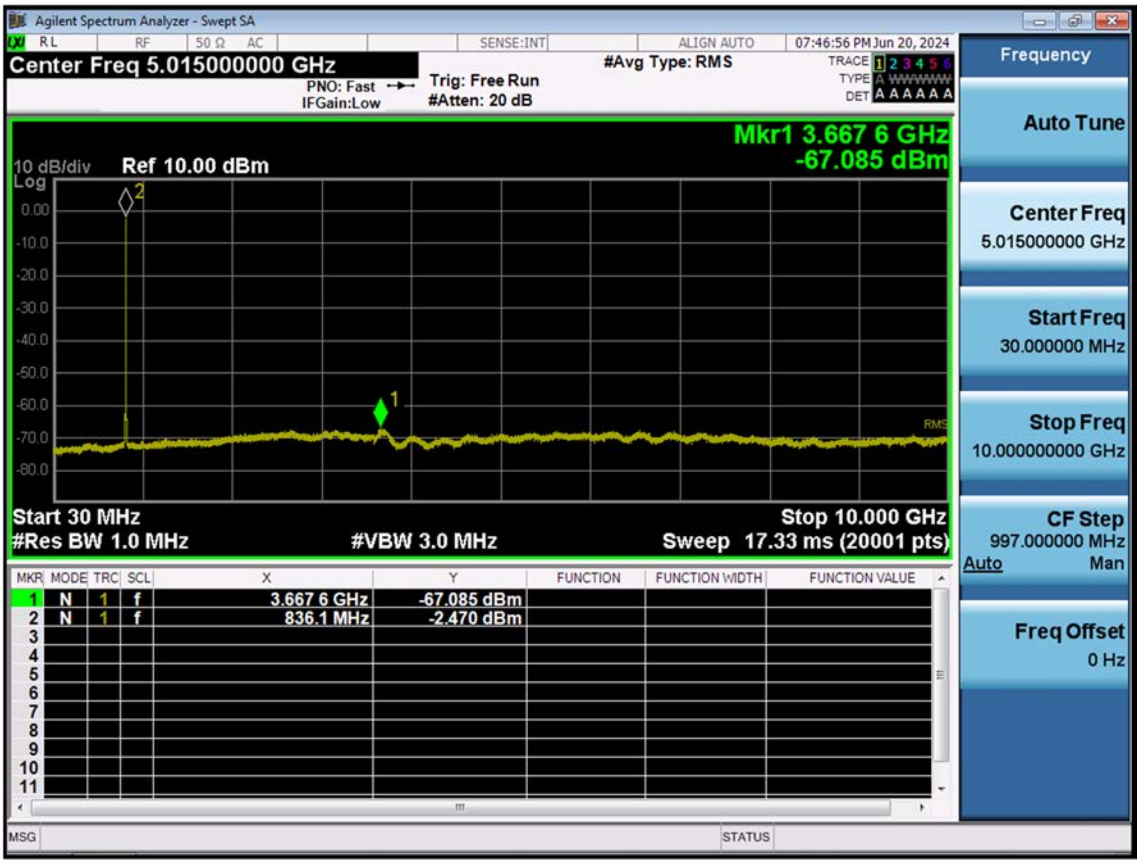
LTE B5_1.4M_Conducted Spurious(30 M-10 G)_High_QPSK_1RB



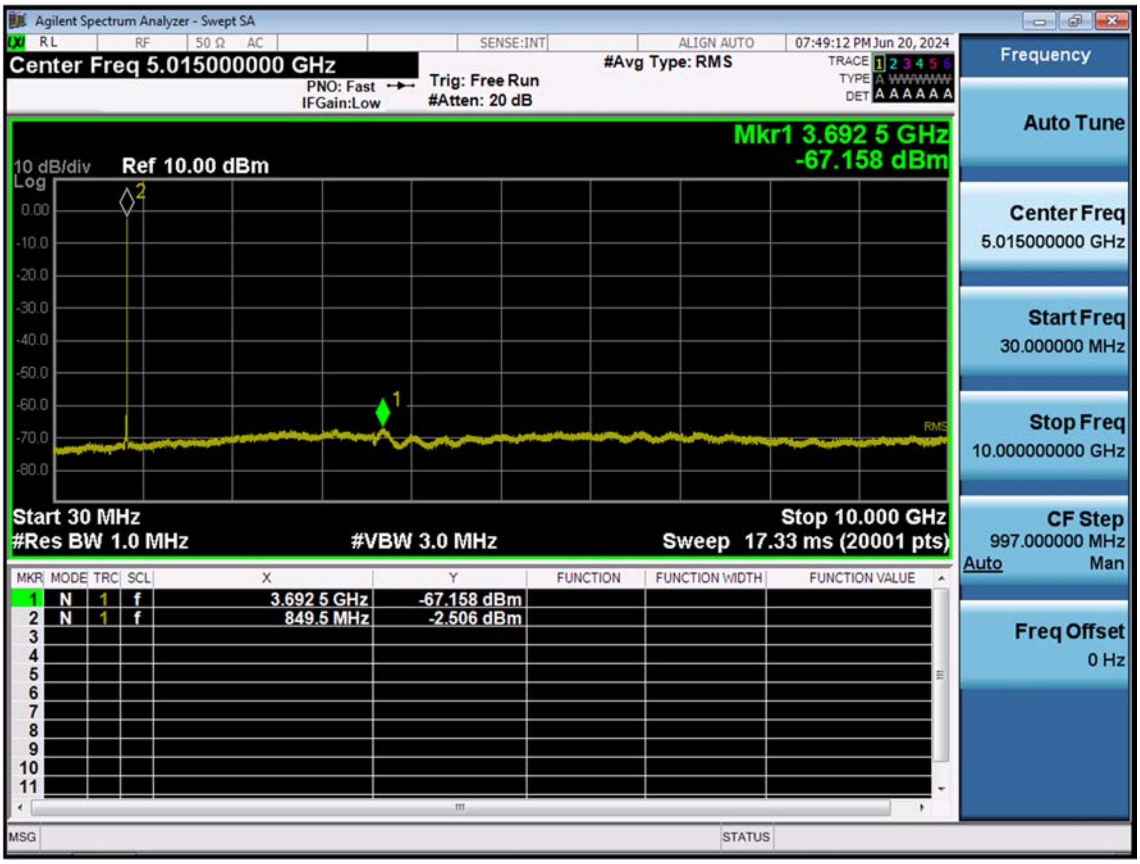
LTE B5_3 M_Conducted Spurious(30 M-10 G)_Low_QPSK_1RB



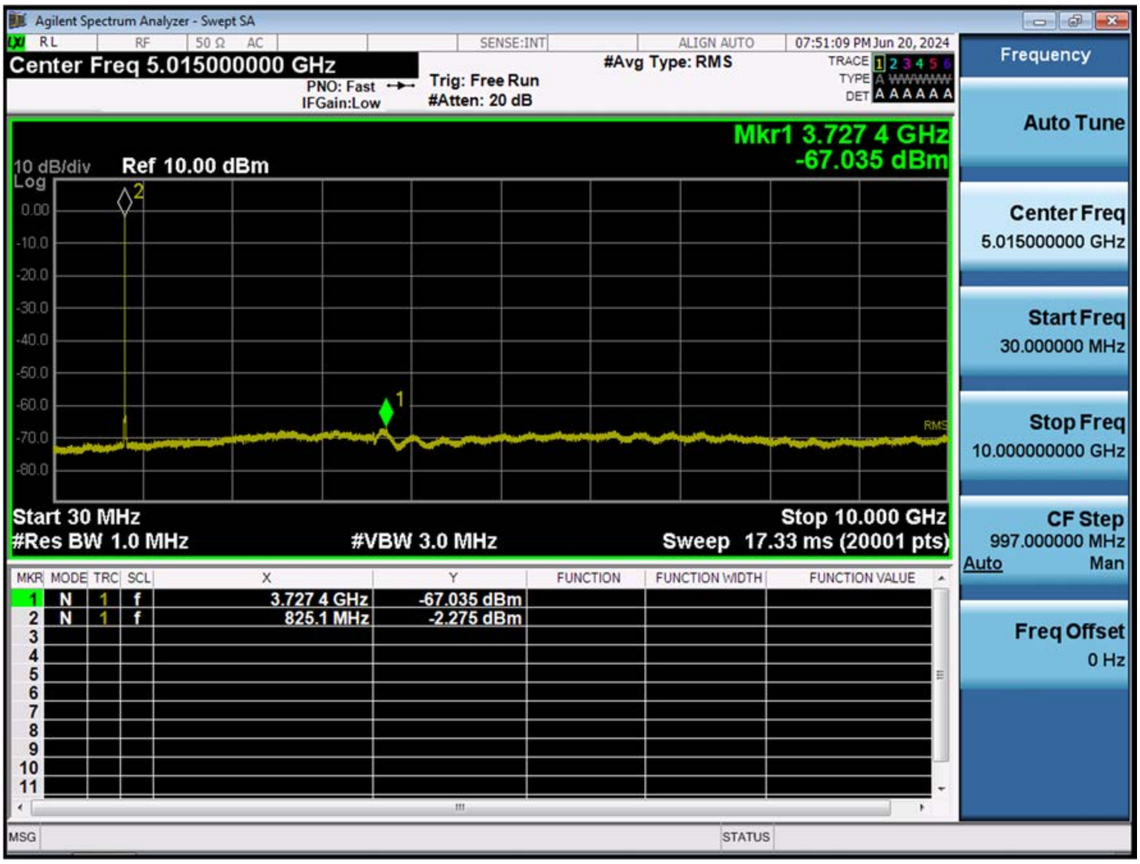
LTE B5_3 M_Conducted Spurious(30 M-10 G)_Mid_QPSK_1RB



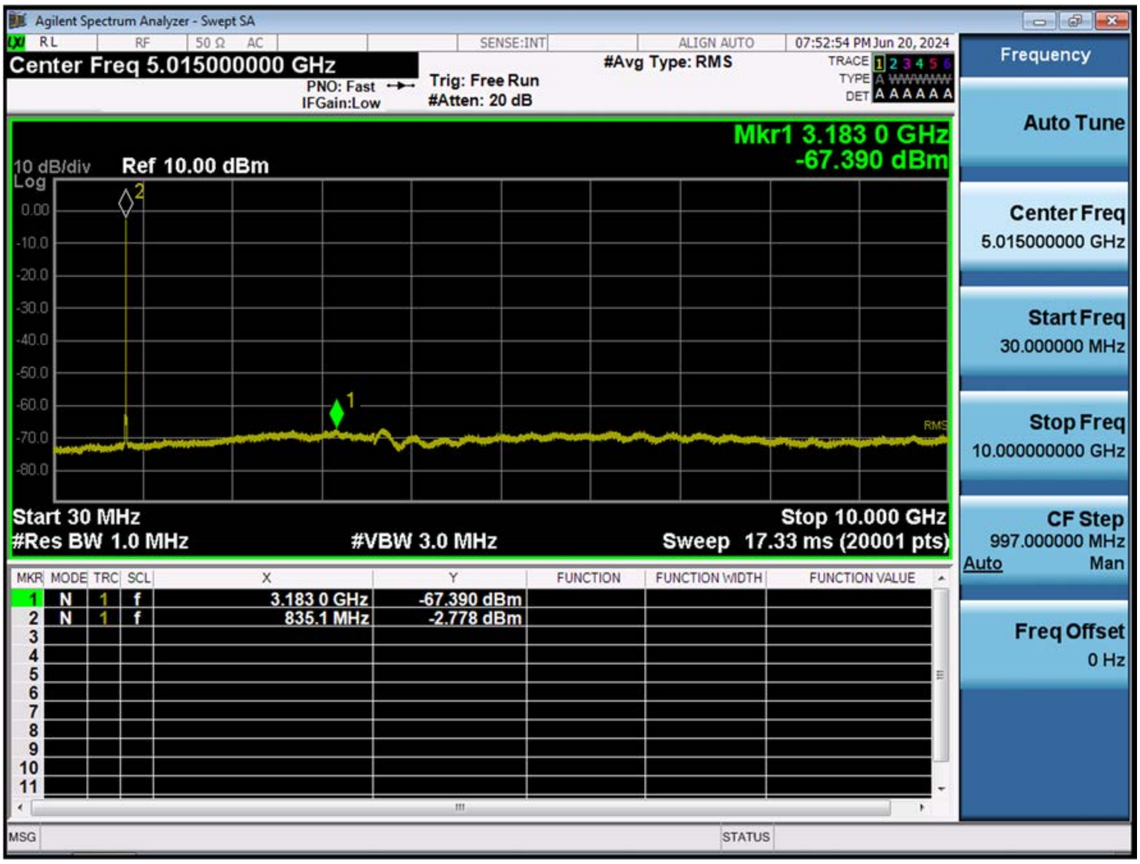
LTE B5_3 M_Conducted Spurious(30 M-10 G)_High_QPSK_1RB



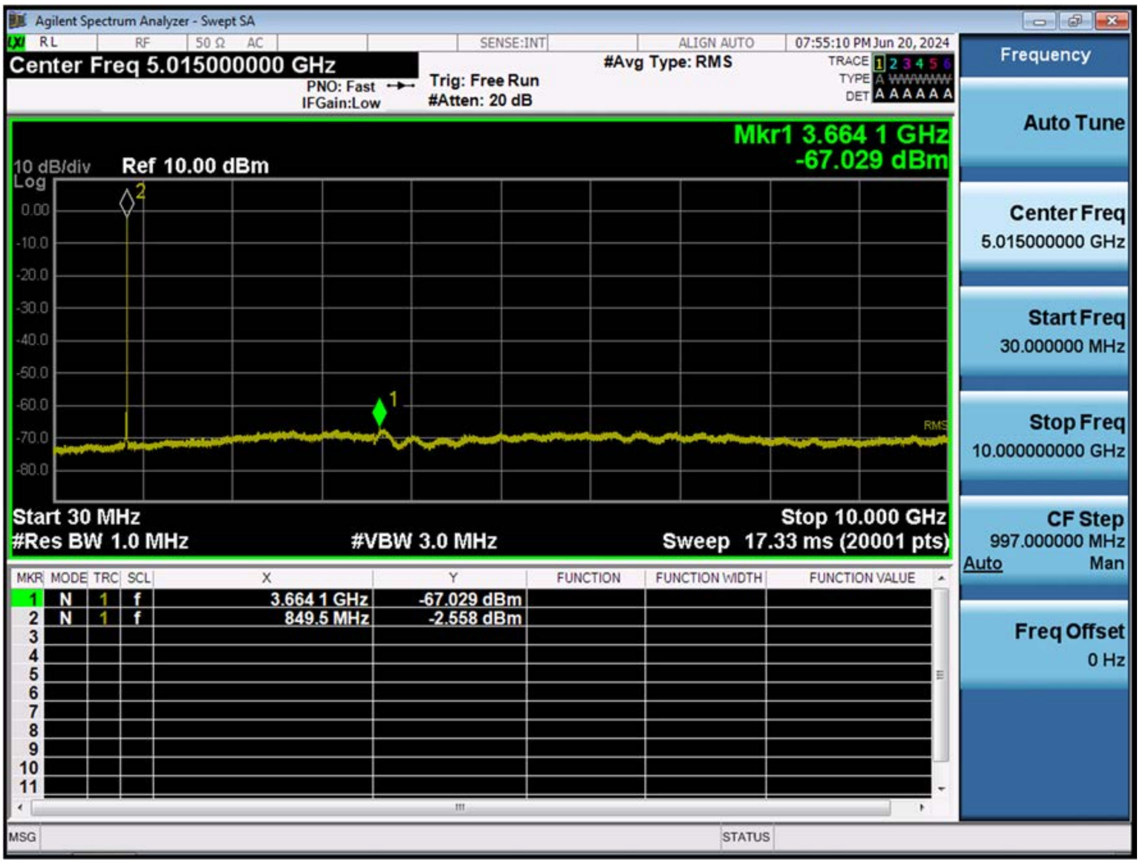
LTE B5_5 M_Conducted Spurious(30 M-10 G)_Low_QPSK_1RB



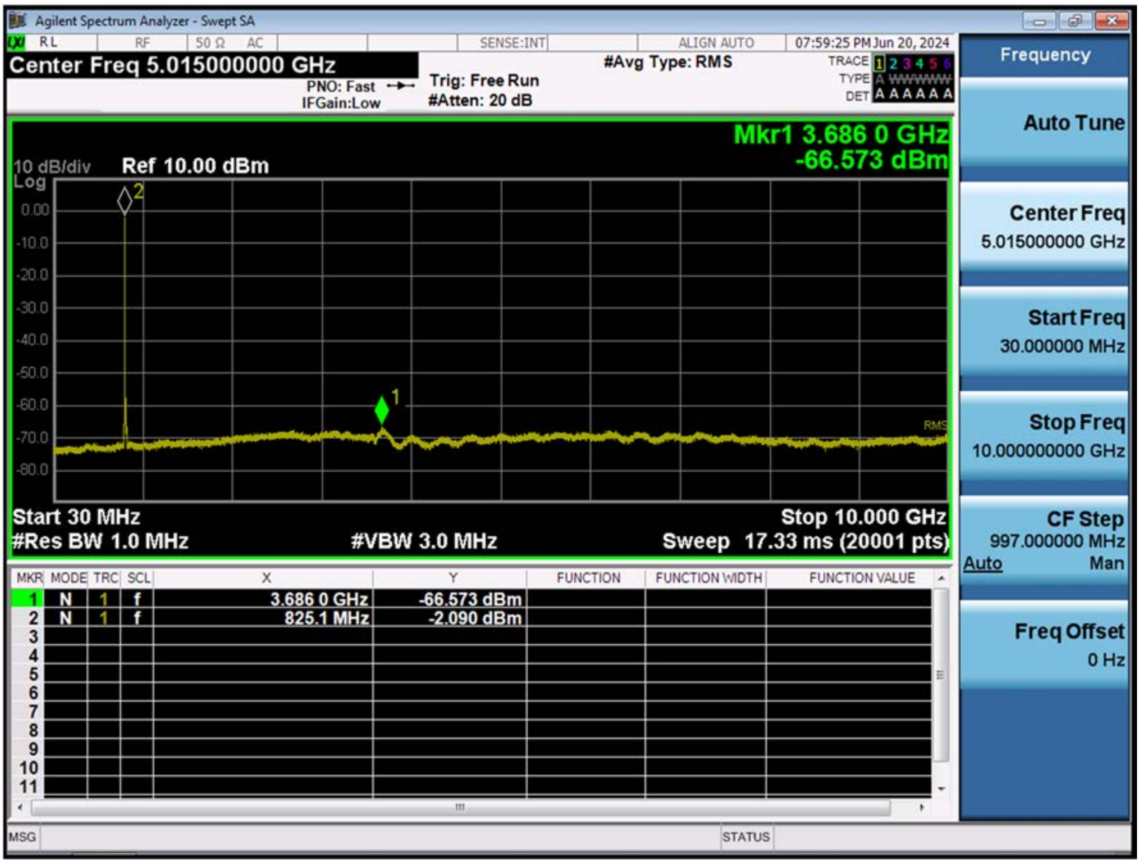
LTE B5_5 M_Conducted Spurious(30 M-10 G)_Mid_QPSK_1RB



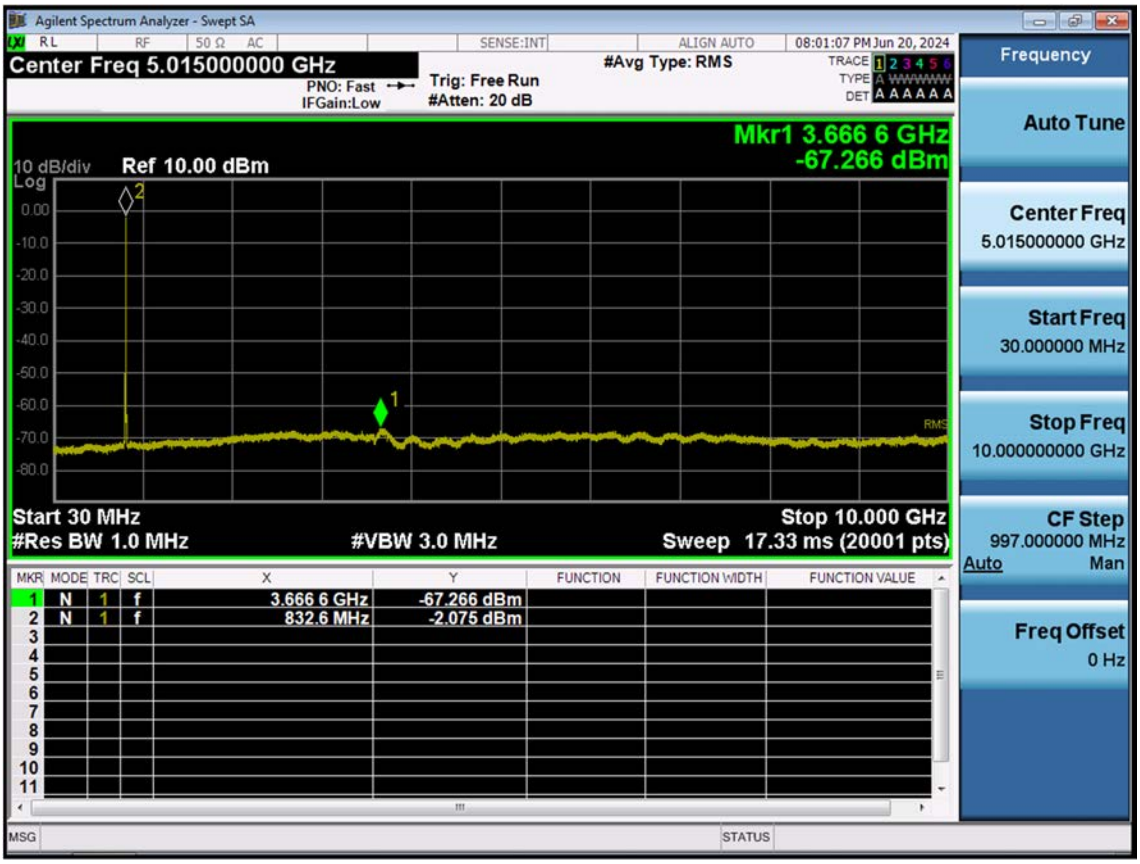
LTE B5_5 M_Conducted Spurious(30 M-10 G)_High_QPSK_1RB



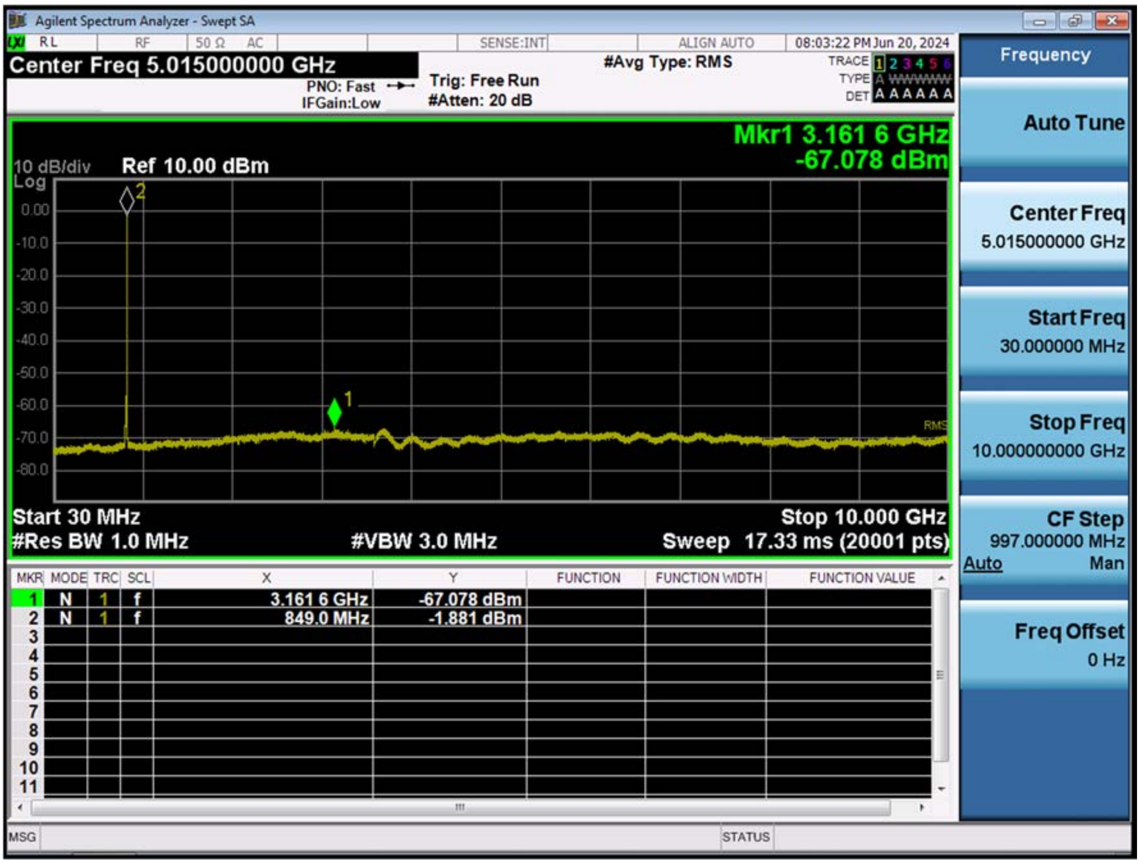
LTE B5_10 M_Conducted Spurious(30 M-10 G)_Low_QPSK_1RB



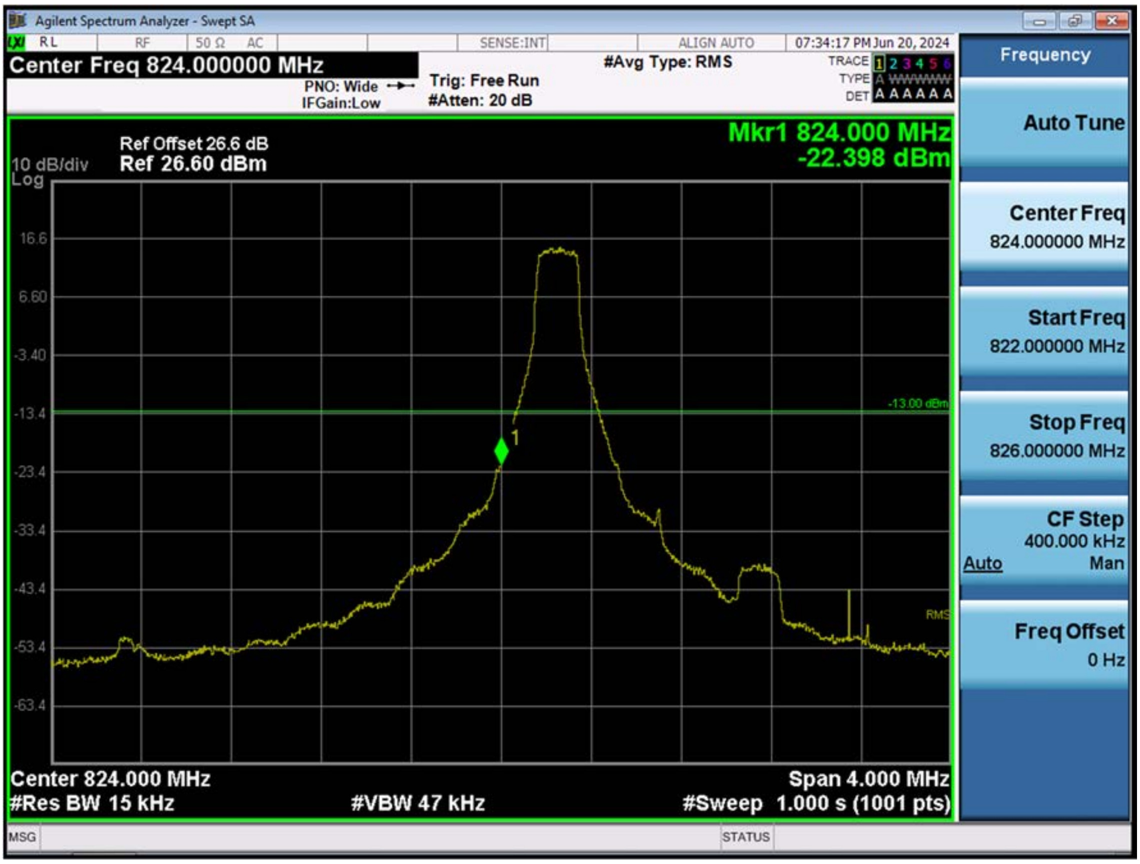
LTE B5_10 M_Conducted Spurious(30 M-10 G)_Mid_QPSK_1RB



LTE B5_10 M_Conducted Spurious(30 M-10 G)_High_QPSK_1RB



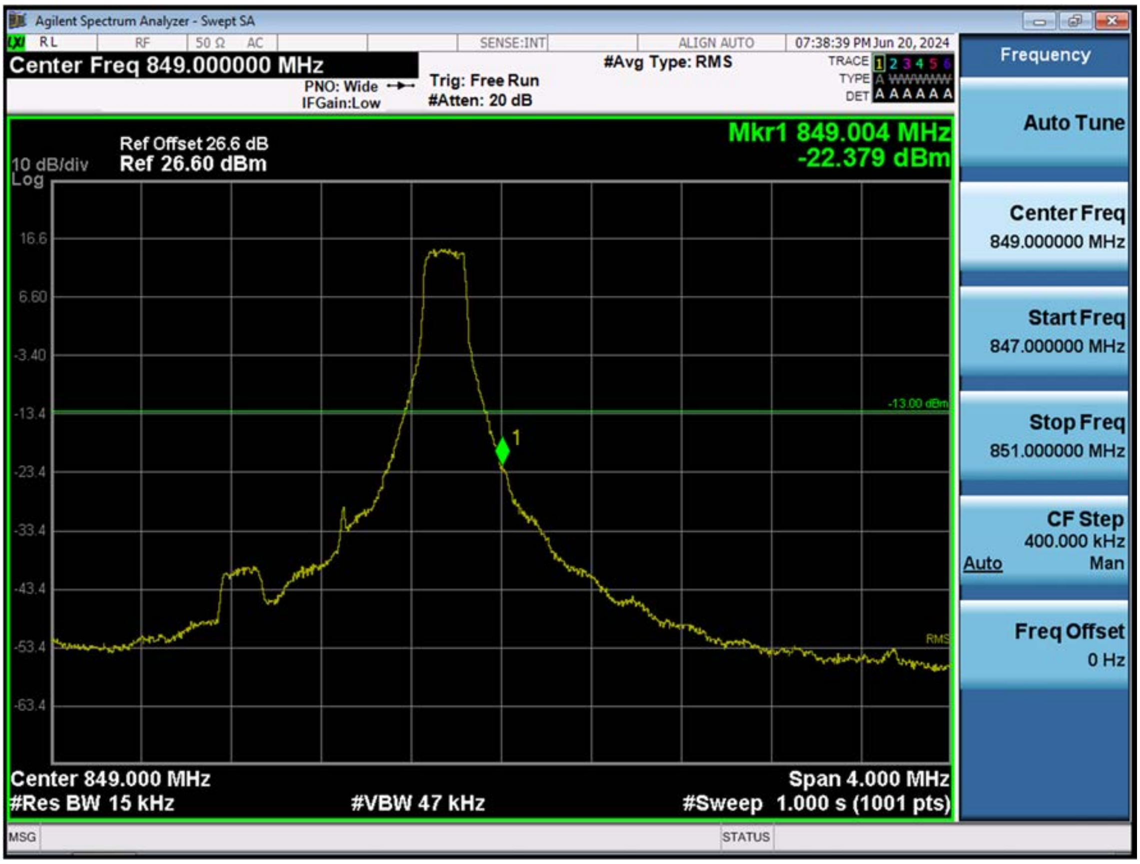
LTE B5_1.4M_Band Edge_Low_QPSK_1RB



LTE B5_1.4M_Band Edge_Low_QPSK_FullRB

LTE B5_1.4M_Extended Band Edge_Low_QPSK_FullRB

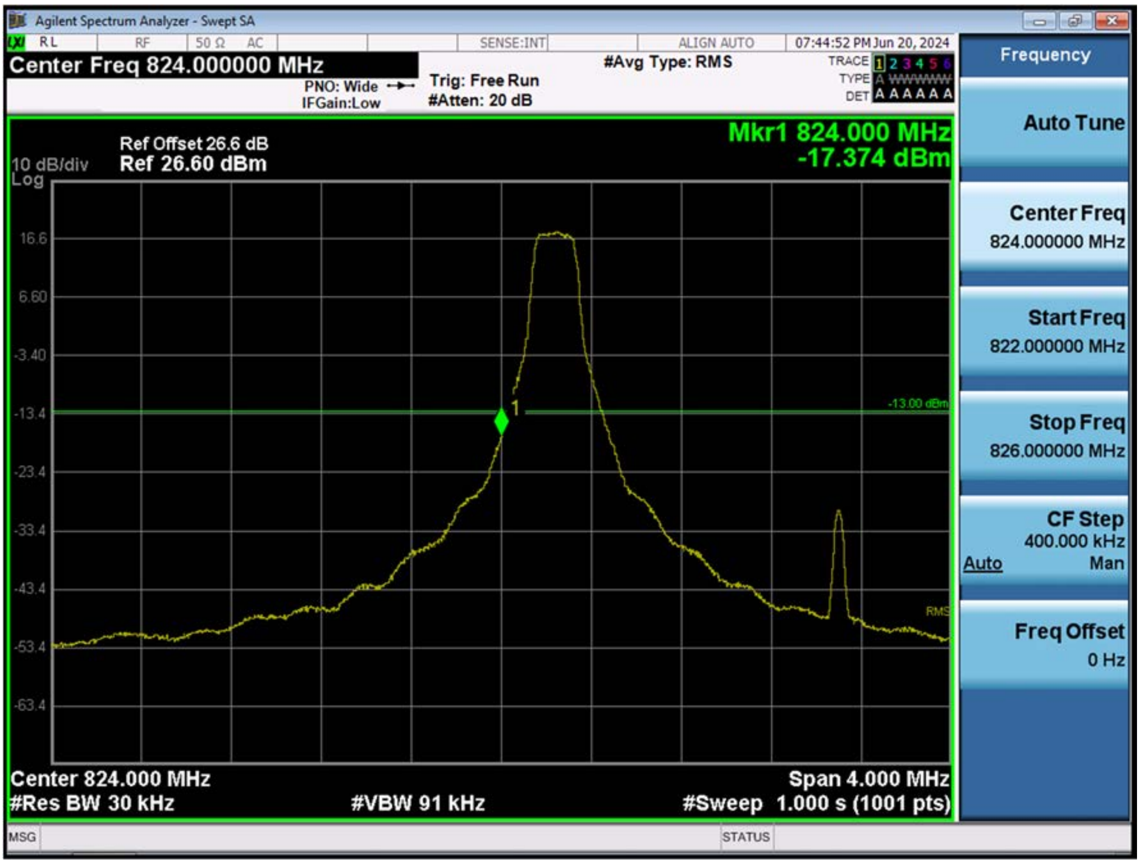
LTE B5_1.4M_Band Edge_High_QPSK_1RB



LTE B5_1.4M_Band Edge_High_QPSK_FullRB

LTE B5_1.4M_Extended Band Edge_High_QPSK_FullRB

LTE B5_3 M_Band Edge_Low_QPSK_1RB



LTE B5_3 M_Band Edge_Low_QPSK_FullRB

LTE B5_3 M_Extended Band Edge_Low_QPSK_FullRB

LTE B5_3 M_Band Edge_High_QPSK_1RB