TEST REPORT

FCC LTE Test for GCM6201NA
Certification

APPLICANT

REPORT NO.
HCT-RF-2409-FC015

DATE OF ISSUE
September 30, 2024

Tested by
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Applicant	**GCT SEMICONDUCTOR, INC** 11F Construction Financial Building 15, Boramae-ro 5-gil, Dongjak-gu, Seoul, 07071, South Korea
Product Name Model Name	LTE Module GCM6201NA
Date of Test	August 19, 2024 ~ September 20, 2024
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 ID	2ALIY-GCM6201NA
FCC Classification	Licensed Non-Broadcast Station Transmitter (TNB)
Test Standard Used	FCC Rule Part(s) : § 27
Test Results	PASS

REVISION HISTORY

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

Revision No.	Date of Issue	Description
0	September 30, 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).

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MEASUREMENT REPORT

1. GENERAL INFORMATION

Applicant Name:	GCT SEMICONDUCTOR, INC
Address:	11F Construction Financial Building 15, Boramae-ro 5-gil, Dongjak-gu, Seoul, 07071, South Korea
FCC ID:	2ALIY-GCM6201NA
Application Type:	Certification
FCC Classification:	Licensed Non-Broadcast Station Transmitter (TNB)
FCC Rule Part(s):	§ 27
EUT Type:	LTE Module
Model(s):	GCM6201NA
Additional Model(s)	-
Tx Frequency:	1670.7 MHz – 1674.3 MHz (LTE – Band 54 (1.4 MHz)) 1671.5 MHz – 1673.5 MHz (LTE – Band 54 (3 MHz)) 1672.5 MHz (LTE – Band 54 (5 MHz))
Date(s) of Tests:	August 19, 2024 ~ September 20, 2024
Serial number:	351951100003507
PMN (Product Marketing Number)	GCM6201NA
HVIN (Hardware Version Identification Number)	V1.0
FVIN (Firmware Version Identification Number)	V1.0

1.1. MAXIMUM OUTPUT POWER

Mode (MHz)	Tx Frequency (MHz)	Emission Designator	Modulation	Conducted Output Power	
				Max. Power (W)	Max. Power (dBm)
LTE – Band54 (1.4)	1670.7 – 1674.3	1M11G7D	QPSK	0.198	22.97
		1M10W7D	16QAM	0.163	22.12
LTE – Band54 (3)	1671.5 – 1673.5	2M70G7D	QPSK	0.206	23.13
		2M70W7D	16QAM	0.169	22.29
LTE – Band54 (5)	1672.5	4M50G7D	QPSK	0.183	22.63
		4M49W7D	16QAM	0.155	21.90

2. INTRODUCTION

2.1. DESCRIPTION OF EUT

The EUT was a LTE Module with LTE

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, Republic 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	- KDB 971168 D01 v03r01 - Section 5.2.4 - ANSI C63.26-2015 - Section 5.2.1 & 5.2.4.2
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 RF OUTPUT POWER

Test Overview

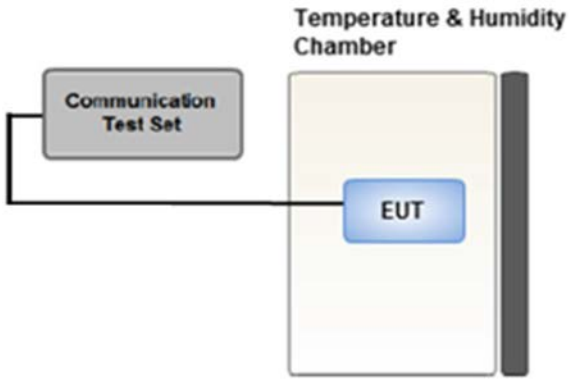
According to ANSI C63.26-2015 Section 5.2.1 when measuring the maximum RF output power from such devices, control over the EUT must be provided either through special test software (provided by manufacturer specifically for compliance testing, but not accessible by an end user) or through use of a base station emulator, communications test set, call box, or similar instrumentation that is capable of establishing a communications link with the EUT to enable control over variable parameters (e.g., output power, OBW, etc.).

In some cases, these instruments also include basic digital spectrum analyzer and/or power meter capabilities that can be utilized to measure the RF output power if the specified detectors and requirements can be realized and the measurement functions have been calibrated.

Test Procedure

1. The RF port of the EUT was connected to the Communication Tester via an RF cable.
2. Conducted average power was measured using a calibrated Radio Communication Tester.
3. EIRP $_{(dBm)}$ = Conducted Power $_{(dBm)}$ + antenna gain $_{(dBi)}$

Test setup



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;

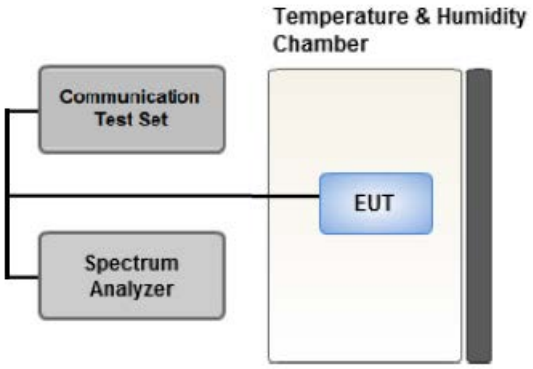
$$\text{Result}_{(dBm)} = Pg_{(dBm)} - \text{cable loss}_{(dB)} + \text{antenna gain}_{(dBi)}$$

   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.

$$EIRP_{(dBm)} = ERP_{(dBm)} + 2.15$$

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:

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

Test Settings(Peak Power)

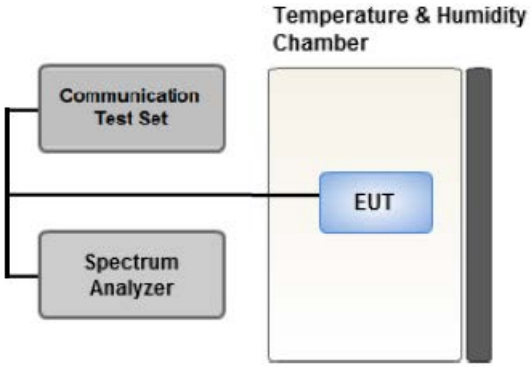
The measurement instrument must have a RBW that is greater than or equal to the OBW of the signal to be measured and a VBW ≥ 3 × RBW.

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.



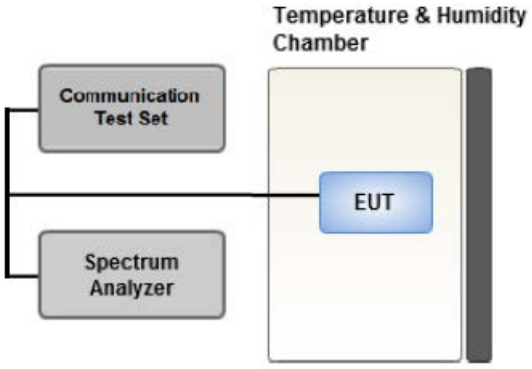
Test setup

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

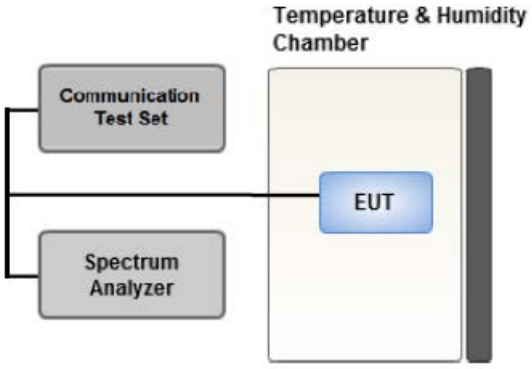
Test Overview

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

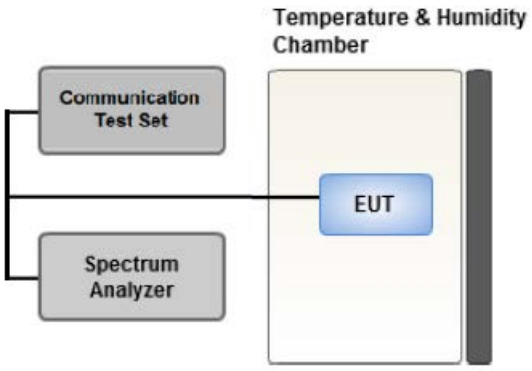
1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW > 1 % of the emission bandwidth
4. VBW > 3 x RBW
5. Detector = RMS
6. Number of sweep points ≥ 2 x Span/RBW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

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.

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.
- JIG was used to test the EUT. (EUT + JIG)
- In the case of radiated spurious emissions, all bandwidth of operation were investigated and the worst case bandwidth results are reported. (Worst case : 3 MHz)
- The worst case is reported with the EUT positioning, modulations, RB sizes and offsets, and channel bandwidth configurations shown in the test data.
- Please refer to the table below.

[Worst case]

Test Description	Modulation	RB size	RB offset	Axis
Effective Isotropic Radiated Power	QPSK, 16QAM	See Section 8.2		
Radiated Spurious and Harmonic Emissions	QPSK	See Section 8.3		Y

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	1.4, 3, 5	Mid	Full RB	0
Peak-To-Average Ratio	QPSK, 16QAM	1.4, 3, 5	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
		1.4, 3, 5	Low, High	Full RB	0
Spurious and Harmonic Emissions at Antenna Terminal	QPSK	1.4, 3, 5	Low, Mid, High	1	0

4. LIST OF TEST EQUIPMENT

Equipment	Model	Manufacture	Serial No.	Due to Calibration	Calibration Interval
RF Switching System	Switch box(1.2 G HPF+LNA)	HCT CO., LTD.,	F1L1	08/21/2025	Annual
RF Switching System	Switch box(3.3 G HPF+LNA)	HCT CO., LTD.,	F1L2	08/21/2025	Annual
RF Switching System	Switch box(LNA)	HCT CO., LTD.,	F1L4	08/21/2025	Annual
RF Switching System	Switch box(6 G HPF+LNA)	HCT CO., LTD.,	F1L7	08/21/2025	Annual
Power Splitter(DC ~ 26.5 GHz)	11667B	Hewlett Packard	5001	04/17/2025	Annual
DC Power Supply	E3632A	Agilent	MY40010147	08/06/2025	Annual
Dipole Antenna	UHAP	Schwarzbeck	01274	03/10/2026	Biennial
Dipole Antenna	UHAP	Schwarzbeck	01288	08/07/2026	Biennial
Chamber	SU-642	ESPEC	93008124	02/19/2025	Annual
Horn Antenna(1 ~ 18 GHz)	BBHA 9120D	Schwarzbeck	147	08/17/2025	Biennial
Horn Antenna(1 ~ 18 GHz)	BBHA 9120D	Schwarzbeck	9120D-1298	09/11/2025	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
Signal Analyzer(10 Hz ~ 26.5 GHz)	N9020A	Agilent	MY52090906	04/19/2025	Annual
ATTENUATOR(20 dB)	8493C	Hewlett Packard	17280	04/17/2025	Annual
Spectrum Analyzer(10 Hz ~ 40 GHz)	FSV40	REOHDE & SCHWARZ	100931	08/06/2025	Annual
Base Station	8960 (E5515C)	Agilent	MY48360800	08/05/2025	Annual
Loop Antenna(9 kHz ~ 30 MHz)	FMZB1513	Schwarzbeck	1513-333	03/07/2026	Biennial
Trilog Broadband Antenna	VULB9168	Schwarzbeck	895	08/28/2026	Biennial
Trilog Broadband Antenna	VULB9168	Schwarzbeck	1135	08/19/2026	Biennial
Wideband Radio Communication Tester	MT8821C	Anritsu Corp.	6262094331	11/17/2024	Annual
Wideband Radio Communication Tester	MT8820C	Anritsu Corp.	6201026545	12/11/2024	Annual
SIGNAL GENERATOR (100 kHz ~ 40 GHz)	SMB100A	REOHDE & SCHWARZ	177633	07/26/2025	Annual
Signal Analyzer(5 Hz ~ 40.0 GHz)	N9030B	KEYSIGHT	MY55480167	05/17/2025	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, § 27.53(k)	< 43 + 10log10 (P[Watts]) at Band Edge and for all out-of-band emissions	PASS
Conducted Output Power	§ 2.1046	N/A	-
Peak- to- Average Ratio	§ 27.50	< 13 dB	PASS
Frequency stability / variation of ambient temperature	§ 2.1055, § 27.54	Emission must remain in band	PASS

6.2 Test Condition : Radiated Test

Test Description	FCC Part Section(s)	Test Limit	Test Result
Equivalent Isotropic Radiated Power	§ 27.50(f)(2)	< 4 Watts max. EIRP	PASS
Radiated Spurious and Harmonic Emissions	§ 2.1053, § 27.53(k)	< 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 CONDUCTED OUTPUT POWER

Bandwidth	Modulation	RB Size	RB Offset	Max.Average Power (dBm)			Target MPR (dB)	Target Power
				60262	60280	60298		
				1670.7 MHz	1672.5 MHz	1674.3 MHz		
1.4 MHz	QPSK	1	0	22.79	22.79	**22.97**	0	23
		1	3	22.09	22.09	22.34	0	23
		1	5	22.77	22.71	22.96	0	23
		3	0	22.67	22.57	22.75	0	23
		3	1	22.28	22.22	22.53	0	23
		3	3	22.60	22.49	22.86	0	23
		6	0	21.61	21.60	21.83	1	22
	16QAM	1	0	21.87	21.97	22.09	1	22
		1	3	21.19	21.38	21.50	1	22
		1	5	21.89	21.79	22.12	1	22
		3	0	21.62	21.68	21.77	1	22
		3	1	21.26	21.39	21.59	1	22
		3	3	21.60	21.62	21.92	1	22
		6	0	20.63	20.74	20.97	2	21

Bandwidth	Modulation	RB Size	RB Offset	Max.Average Power (dBm)			Target MPR (dB)	Target Power
				60270	60280	60290		
				1671.5 MHz	1672.5 MHz	1673.5 MHz		
3 MHz	QPSK	1	0	22.92	22.87	22.87	0	23
		1	7	22.66	22.68	22.69	0	23
		1	14	22.77	23.04	**23.13**	0	23
		8	0	21.74	21.85	21.80	1	22
		8	3	22.09	22.07	22.14	1	22
		8	7	22.13	22.02	22.08	1	22
		15	0	22.11	22.13	22.15	1	22
	16QAM	1	0	22.07	22.05	22.09	1	22
		1	7	21.83	21.95	21.83	1	22
		1	14	22.06	22.19	22.29	1	22
		8	0	20.80	20.89	20.84	2	21
		8	3	20.96	21.12	21.22	2	21
		8	7	21.03	21.06	21.04	2	21
		15	0	20.93	21.12	21.09	2	21

Bandwidth	Modulation	RB Size	RB Offset	Max.Average Power (dBm)	Target MPR (dB)	Target Power
				60280		
				1672.5 MHz		
5 MHz	QPSK	1	0	22.49	0	23
		1	12	22.17	0	23
		1	24	**22.63**	0	23
		12	0	21.39	1	22
		12	6	21.45	1	22
		12	11	21.54	1	22
		25	0	21.74	1	22
	16QAM	1	0	21.59	1	22
		1	12	21.36	1	22
		1	24	21.90	1	22
		12	0	20.36	2	21
		12	6	20.46	2	21
		12	11	20.49	2	21
		25	0	20.70	2	21

8.2 Effective Isotropic Radiated Power

Bandwidth	Modulation	Max.Average Power (dBm)			ANT Gain (dBi)	E.I.R.P (dBm)			Limit (dBm)
		60262	60280	60298		60262	60280	60298	
		1670.7 MHz	1672.5 MHz	1674.3 MHz		1670.7 MHz	1672.5 MHz	1674.3 MHz	
1.4 MHz	QPSK	22.79	22.79	22.97	4.00	26.79	26.79	26.97	36.00
	16QAM	21.89	21.97	22.12		25.89	25.97	26.12	

Bandwidth	Modulation	Max.Average Power (dBm)			ANT Gain (dBi)	E.I.R.P (dBm)			Limit (dBm)
		60270	60280	60290		60270	60280	60290	
		1671.5 MHz	1672.5 MHz	1673.5 MHz		1671.5 MHz	1672.5 MHz	1673.5 MHz	
3 MHz	QPSK	22.92	23.04	23.13	4.00	26.92	27.04	27.13	36.00
	16QAM	22.07	22.19	22.29		26.07	26.19	26.29	

Bandwidth	Modulation	Max.Average Power (dBm)	ANT Gain (dBi)	E.I.R.P (dBm)	Limit (dBm)
		60280		60280	
		1672.5 MHz		1672.5 MHz	
5 MHz	QPSK	22.63	4.00	26.63	36.00
	16QAM	21.90		25.90	

Test Note

EIRP $_{(dBm)}$ = Max. Conducted Power $_{(dBm)}$ + antenna gain $_{(dBi)}$

8.3 RADIATED SPURIOUS EMISSIONS

▣ MODE: LTE B54

▣ MODULATION SIGNAL: 3 MHz QPSK

▣ DISTANCE: 3 meters

▣ LIMIT: -13 dBm

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	RB	
								Size	Offset
60270 (1671.5)	3 343.00	-30.34	12.37	-44.67	2.96	H	-35.26	1	14
	5 014.50	-29.81	12.57	-36.02	3.70	H	-27.15		
	6 686.00	-44.43	11.87	-44.73	4.40	H	-37.26		
60280 (1672.5)	3 345.00	-31.46	12.37	-45.79	2.96	H	-36.38	1	14
	5 017.50	-29.55	12.56	-35.67	3.69	V	-26.80		
	6 690.00	-48.71	11.88	-49.12	4.41	H	-41.65		
60290 (1673.5)	3 347.00	-24.31	12.37	-38.64	2.96	H	-29.23	1	14
	5 020.50	-31.00	12.56	-37.12	3.69	H	-28.25		
	6 694.00	-46.67	11.89	-47.09	4.41	H	-39.61		

8.3 PEAK-TO-AVERAGE RATIO

Band	Band Width	Frequency (MHz)	Modulation	Resource Block Size	Resource Block Offset	Data (dB)
54	1.4 MHz	1672.5	QPSK	6	0	5.74
			16-QAM			6.41
	3 MHz		QPSK	15		5.63
			16-QAM			6.51
	5 MHz		QPSK	25		5.83
			16-QAM			6.32

Note:

1. Plots of the EUT's Peak- to- Average Ratio are shown Page 41 ~ 46.

8.4 OCCUPIED BANDWIDTH

Band	Band Width	Frequency (MHz)	Modulation	Resource Block Size	Resource Block Offset	Data (MHz)
54	1.4 MHz	1672.5	QPSK	6	0	1.1110
			16-QAM			1.1016
	3 MHz		QPSK	15		2.7006
			16-QAM			2.7019
	5 MHz		QPSK	25		4.5028
			16-QAM			4.4943

Note:

1. Plots of the EUT's Occupied Bandwidth are shown Page 47 ~ 52.

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)
54	1.4	1670.7	3.3409	34.222	-71.260	-37.038	-13.00
		1672.5	3.3447	34.222	-70.684	-36.462	
		1674.3	3.3481	34.222	-68.646	-34.424	
	3	1671.5	3.3409	34.222	-69.756	-35.534	
		1672.5	3.3431	34.222	-69.970	-35.748	
		1673.5	3.3452	34.222	-70.681	-36.459	
	5	1672.5	3.3414	34.222	-70.526	-36.304	

Note:

1. Plots of the EUT's Conducted Spurious Emissions are shown Page 53 ~ 59.
2. Conducted Spurious Emissions was Tested QPSK Modulation, Resource Block Size 1 and Resource Block Offset 0
3. Duty Cycle factor already applied on the factor.
   - Duty Cycle factor(dB) = 3.979
   - Factor(dB) = Duty Cycle factor + Cable Loss + Ext. Attenuator + Power Splitter
   - Result(dBm) = Reading + Factor

Frequency Range (GHz)	Factor [dB]
0.03 – 1	31.579
1 – 5	34.222
5 – 10	34.944
10 – 15	35.550
15 – 20	35.914
Above 20(26.5)	36.489

8.6 BAND EDGE

- Plots of the EUT's Band Edge are shown Page 60 ~ 77.

8.7 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE

▣ MODE: LTE 54

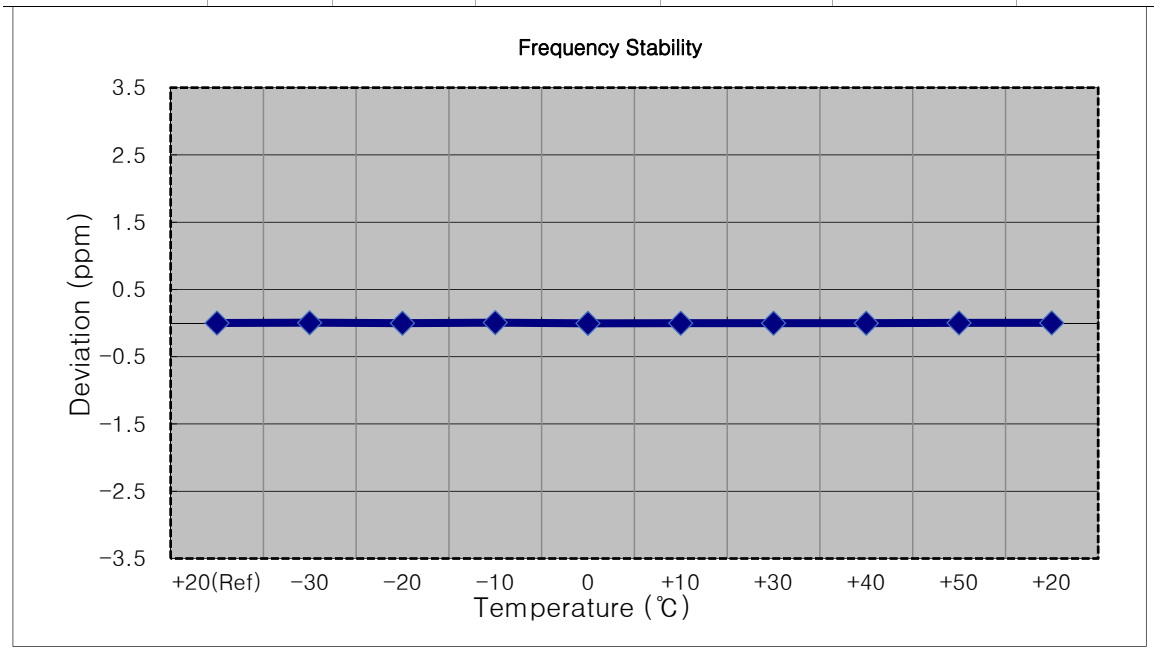
▣ OPERATING FREQUENCY: 1670,700,000 Hz

▣ CHANNEL: 60262 (1.4 MHz)

▣ REFERENCE VOLTAGE: 3.300 VDC

▣ DEVIATION LIMIT: Emission must remain in band

Voltage	Power	Temp.	Frequency	Frequency	Deviation	ppm
(%)	(VDC)	(℃)	(Hz)	Error (Hz)	(%)	
100 %	3.300	+20(Ref)	1670 699 998	0.0	0.000 000	0.000
100 %		-30	1670 700 004	6.4	0.000 000	0.004
100 %		-20	1670 699 993	-5.1	0.000 000	-0.003
100 %		-10	1670 700 009	11.4	0.000 001	0.007
100 %		0	1670 699 991	-6.5	0.000 000	-0.004
100 %		+10	1670 699 994	-4.1	0.000 000	-0.002
100 %		+30	1670 699 992	-5.5	0.000 000	-0.003
100 %		+40	1670 699 994	-3.7	0.000 000	-0.002
100 %		+50	1670 700 001	3.5	0.000 000	0.002
Batt. Endpoint	2.800	+20	1670 700 001	2.6	0.000 000	0.002



▣ MODE: LTE 54

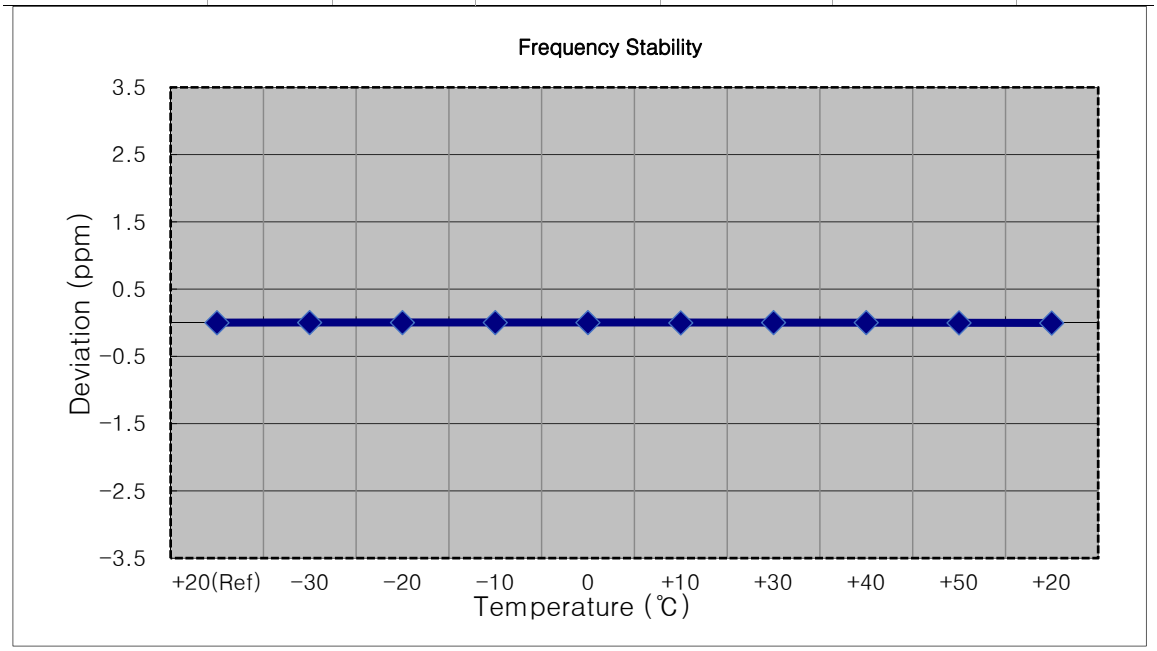
▣ OPERATING FREQUENCY: 1671,500,000 Hz

▣ CHANNEL: 60270 (3 MHz)

▣ REFERENCE VOLTAGE: 3.300 VDC

▣ DEVIATION LIMIT: Emission must remain in band

Voltage	Power	Temp.	Frequency	Frequency	Deviation	ppm
(%)	(VDC)	(°C)	(Hz)	Error (Hz)	(%)	
100 %	3.300	+20(Ref)	1671 500 000	0.0	0.000 000	0.000
100 %		-30	1671 500 005	4.8	0.000 000	0.003
100 %		-20	1671 500 004	4.3	0.000 000	0.003
100 %		-10	1671 500 005	4.6	0.000 000	0.003
100 %		0	1671 500 003	3.3	0.000 000	0.002
100 %		+10	1671 499 996	-3.9	0.000 000	-0.002
100 %		+30	1671 500 004	3.9	0.000 000	0.002
100 %		+40	1671 500 005	5.3	0.000 000	0.003
100 %		+50	1671 499 996	-4.5	0.000 000	-0.003
Batt. Endpoint	2.800	+20	1671 499 995	-5.1	0.000 000	-0.003



▣ MODE: LTE 54

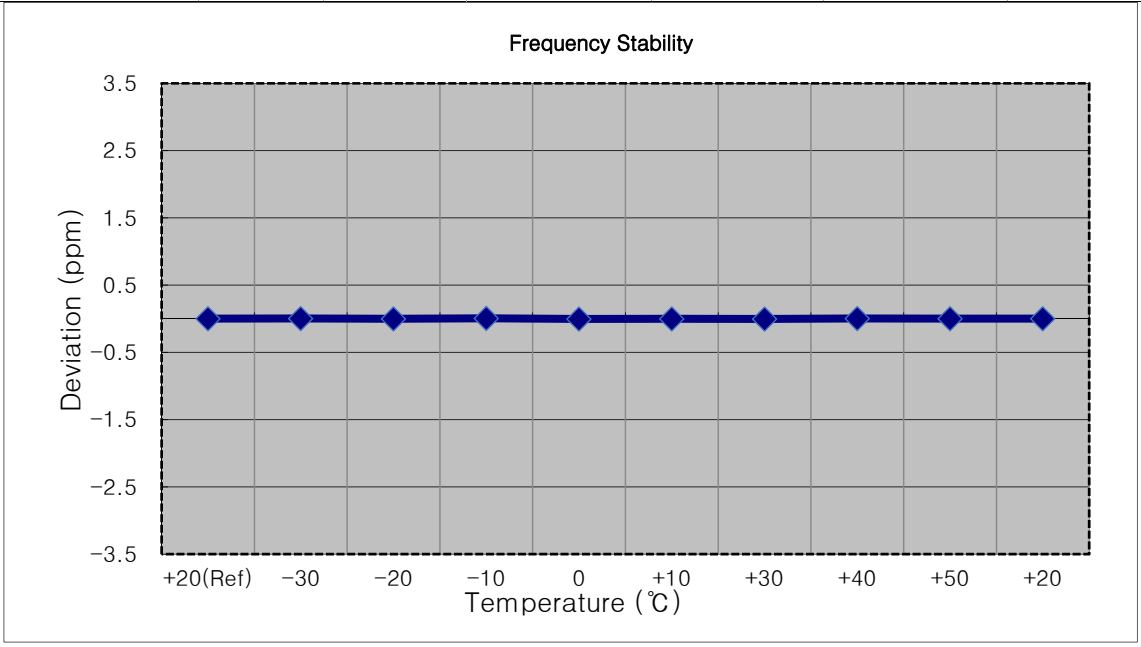
▣ OPERATING FREQUENCY: 1672,500,000 Hz

▣ CHANNEL: 60280 (5 MHz)

▣ REFERENCE VOLTAGE: 3.300 VDC

▣ DEVIATION LIMIT: Emission must remain in band

Voltage	Power	Temp.	Frequency	Frequency	Deviation	ppm
(%)	(VDC)	(°C)	(Hz)	Error (Hz)	(%)	
694%	3.300	+20(Ref)	1672 499 999	0.0	0.000 000	0.000
-420%		-30	1672 500 006	6.9	0.000 000	0.004
1024%		-20	1672 499 995	-3.9	0.000 000	-0.002
-566%		-10	1672 500 009	10.1	0.000 001	0.006
-396%		0	1672 499 993	-5.6	0.000 000	-0.003
-614%		+10	1672 499 995	-3.8	0.000 000	-0.002
342%		+30	1672 499 993	-6.3	0.000 000	-0.004
274%		+40	1672 500 002	3.3	0.000 000	0.002
246%		+50	1672 500 002	2.7	0.000 000	0.002
Batt. Endpoint	2.800	+20	1672 500 002	2.5	0.000 000	0.002



▣ MODE: LTE 54

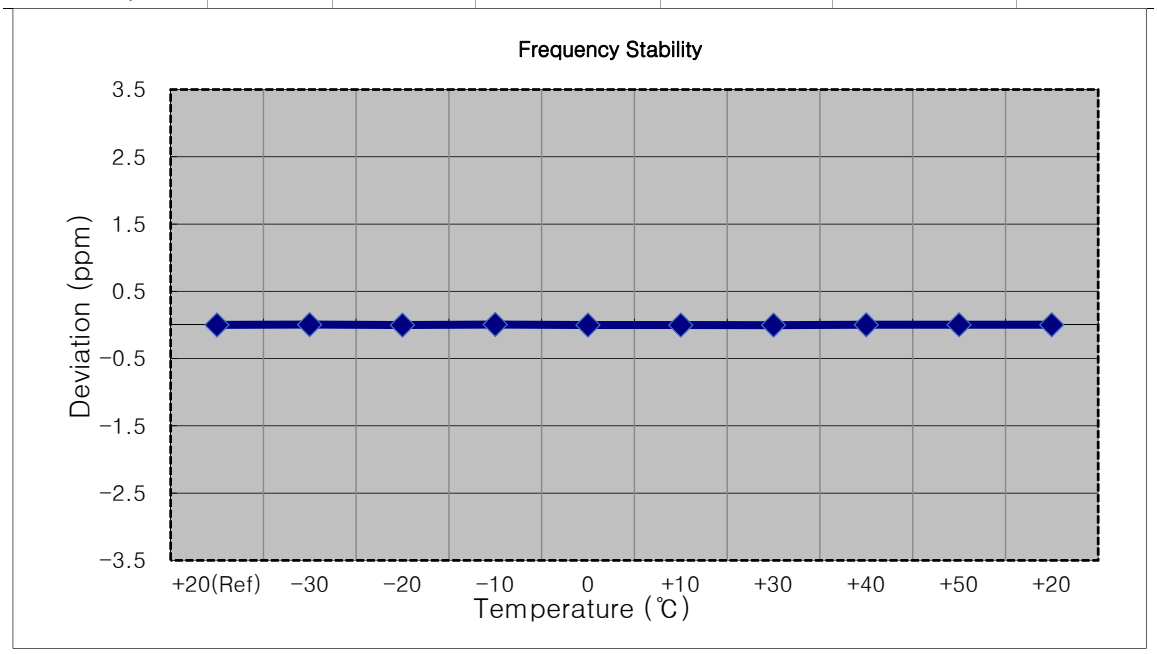
▣ OPERATING FREQUENCY: 1672,500,000 Hz

▣ CHANNEL: 60280 (1.4 MHz)

▣ REFERENCE VOLTAGE: 3.300 VDC

▣ DEVIATION LIMIT: Emission must remain in band

Voltage	Power	Temp.	Frequency	Frequency	Deviation	ppm
(%)	(VDC)	(℃)	(Hz)	Error (Hz)	(%)	
100 %	3.300	+20(Ref)	1672 500 000	-0.4	0.000 000	0.000
100 %		-30	1672 500 007	6.9	0.000 000	0.004
100 %		-20	1672 499 996	-3.9	0.000 000	-0.002
100 %		-10	1672 500 010	10.1	0.000 001	0.006
100 %		0	1672 499 994	-5.8	0.000 000	-0.003
100 %		+10	1672 499 996	-3.7	0.000 000	-0.002
100 %		+30	1672 499 994	-6.0	0.000 000	-0.004
100 %		+40	1672 500 003	3.4	0.000 000	0.002
100 %		+50	1672 500 003	2.7	0.000 000	0.002
Batt. Endpoint	2.800	+20	1672 500 003	2.6	0.000 000	0.002



▣ MODE: LTE 54

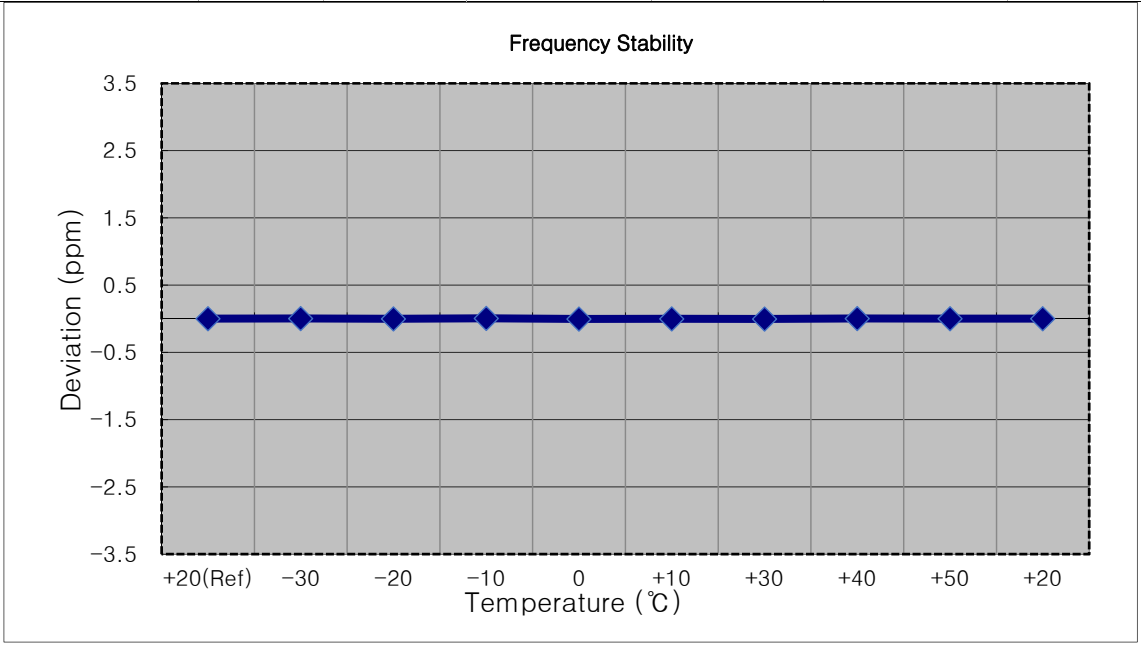
▣ OPERATING FREQUENCY: 1672,500,000 Hz

▣ CHANNEL: 60280 (3 MHz)

▣ REFERENCE VOLTAGE: 3.300 VDC

▣ DEVIATION LIMIT: Emission must remain in band

Voltage	Power	Temp.	Frequency	Frequency	Deviation	ppm
(%)	(VDC)	(°C)	(Hz)	Error (Hz)	(%)	
100 %		+20(Ref)	1672 500 002	0.0	0.000 000	0.000
100 %		-30	1672 500 009	6.9	0.000 000	0.004
100 %		-20	1672 499 998	-4.1	0.000 000	-0.002
100 %		-10	1672 500 012	10.4	0.000 001	0.006
100 %	3.300	0	1672 499 996	-5.7	0.000 000	-0.003
100 %		+10	1672 499 998	-4.1	0.000 000	-0.002
100 %		+30	1672 499 996	-6.0	0.000 000	-0.004
100 %		+40	1672 500 005	3.2	0.000 000	0.002
100 %		+50	1672 500 005	2.9	0.000 000	0.002
Batt. Endpoint	2.800	+20	1672 500 005	2.7	0.000 000	0.002



▣ MODE: LTE 54

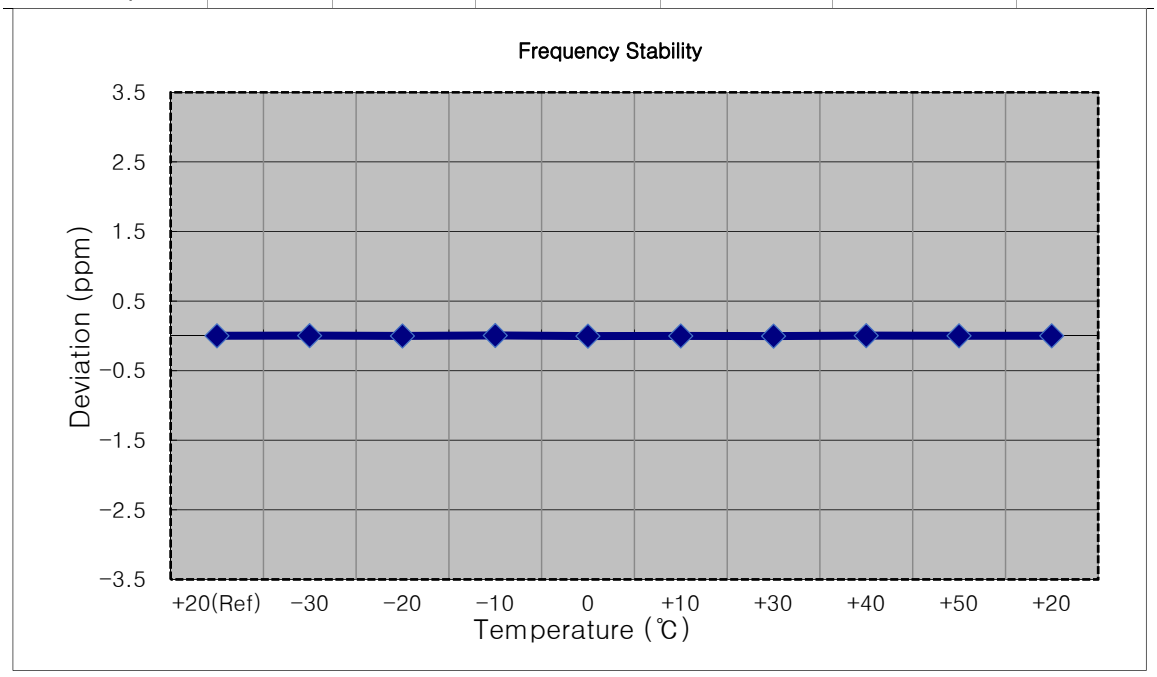
▣ OPERATING FREQUENCY: 1674,300,000 Hz

▣ CHANNEL: 60262 (1.4 MHz)

▣ REFERENCE VOLTAGE: 3.300 VDC

▣ DEVIATION LIMIT: Emission must remain in band

Voltage	Power	Temp.	Frequency	Frequency	Deviation	ppm
(%)	(VDC)	(℃)	(Hz)	Error (Hz)	(%)	
100 %	3.300	+20(Ref)	1674 300 001	-0.4	0.000 000	0.000
100 %		-30	1674 300 008	6.7	0.000 000	0.004
100 %		-20	1674 299 997	-4.0	0.000 000	-0.002
100 %		-10	1674 300 011	10.2	0.000 001	0.006
100 %		0	1674 299 996	-5.5	0.000 000	-0.003
100 %		+10	1674 299 997	-3.9	0.000 000	-0.002
100 %		+30	1674 299 995	-6.2	0.000 000	-0.004
100 %		+40	1674 300 004	3.4	0.000 000	0.002
100 %		+50	1674 300 004	2.9	0.000 000	0.002
Batt. Endpoint	2.800	+20	1674 300 003	2.4	0.000 000	0.001



▣ MODE: LTE 54

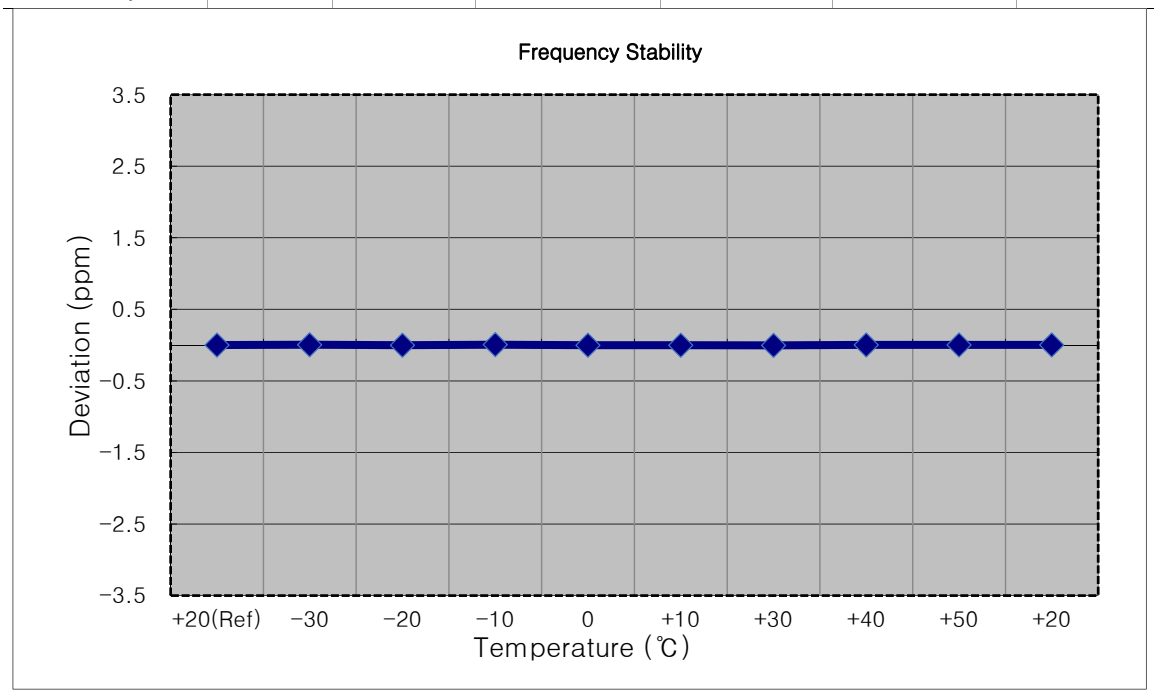
▣ OPERATING FREQUENCY: 1673,500,000 Hz

▣ CHANNEL: 60290 (3 MHz)

▣ REFERENCE VOLTAGE: 3.300 VDC

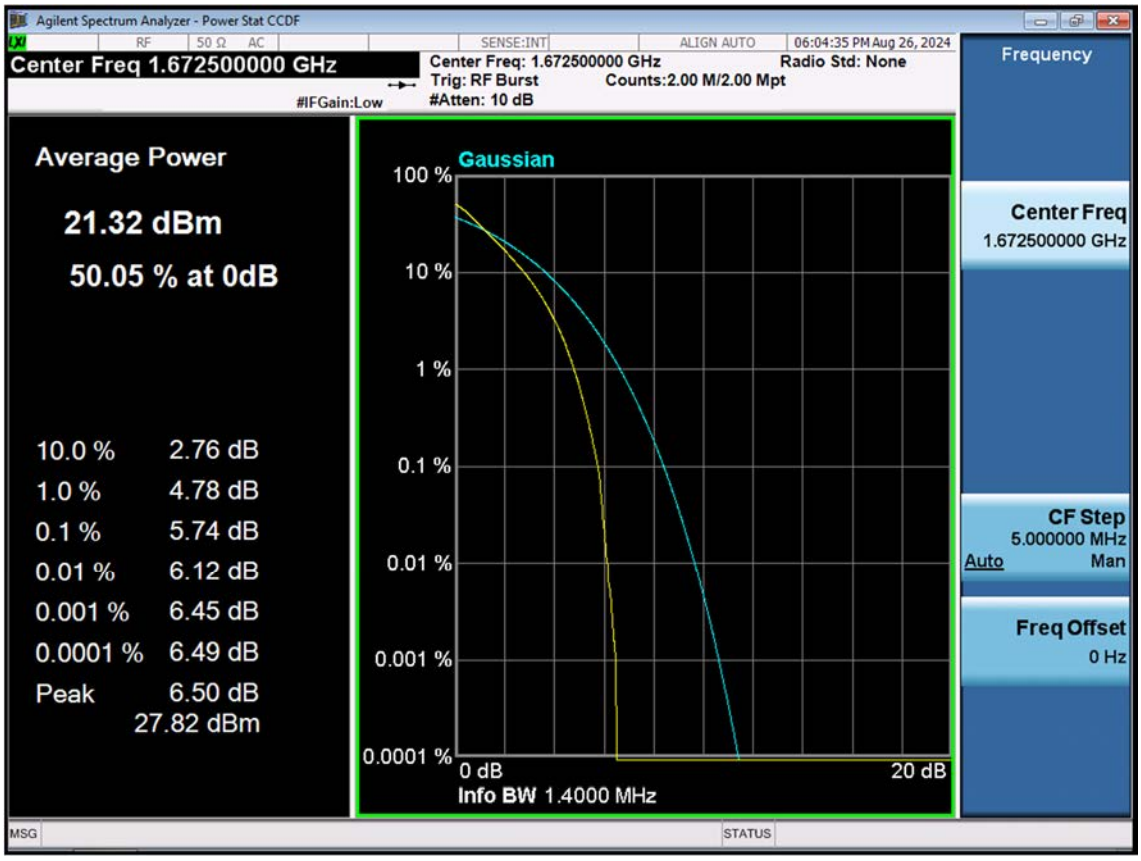
▣ DEVIATION LIMIT: Emission must remain in band

Voltage	Power	Temp.	Frequency	Frequency	Deviation	ppm
(%)	(VDC)	(℃)	(Hz)	Error (Hz)	(%)	
100 %	3.300	+20(Ref)	1673 499 998	0.0	0.000 000	0.000
100 %		-30	1673 500 005	6.9	0.000 000	0.004
100 %		-20	1673 499 994	-4.0	0.000 000	-0.002
100 %		-10	1673 500 008	10.3	0.000 001	0.006
100 %		0	1673 499 993	-5.5	0.000 000	-0.003
100 %		+10	1673 499 994	-3.8	0.000 000	-0.002
100 %		+30	1673 499 992	-6.2	0.000 000	-0.004
100 %		+40	1673 500 001	3.3	0.000 000	0.002
100 %		+50	1673 500 001	2.7	0.000 000	0.002
Batt. Endpoint	2.800	+20	1673 500 001	2.6	0.000 000	0.002

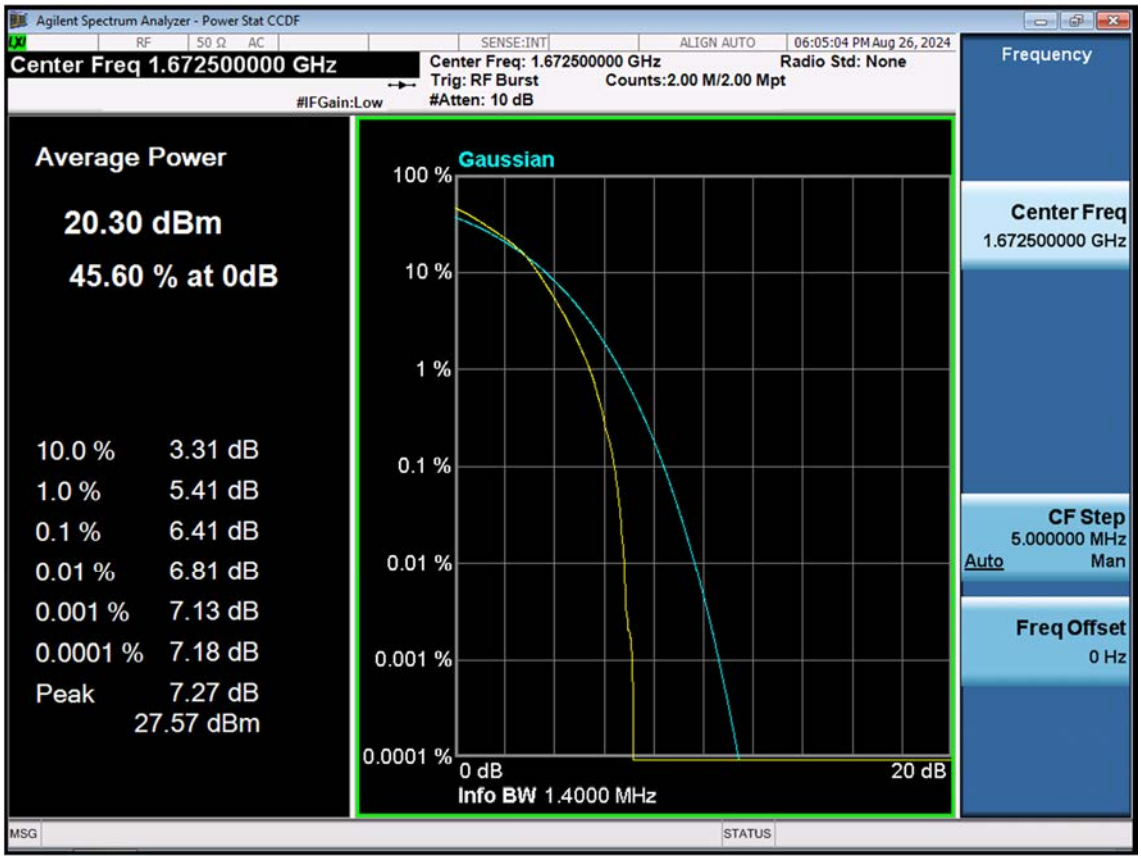


9. TEST PLOTS

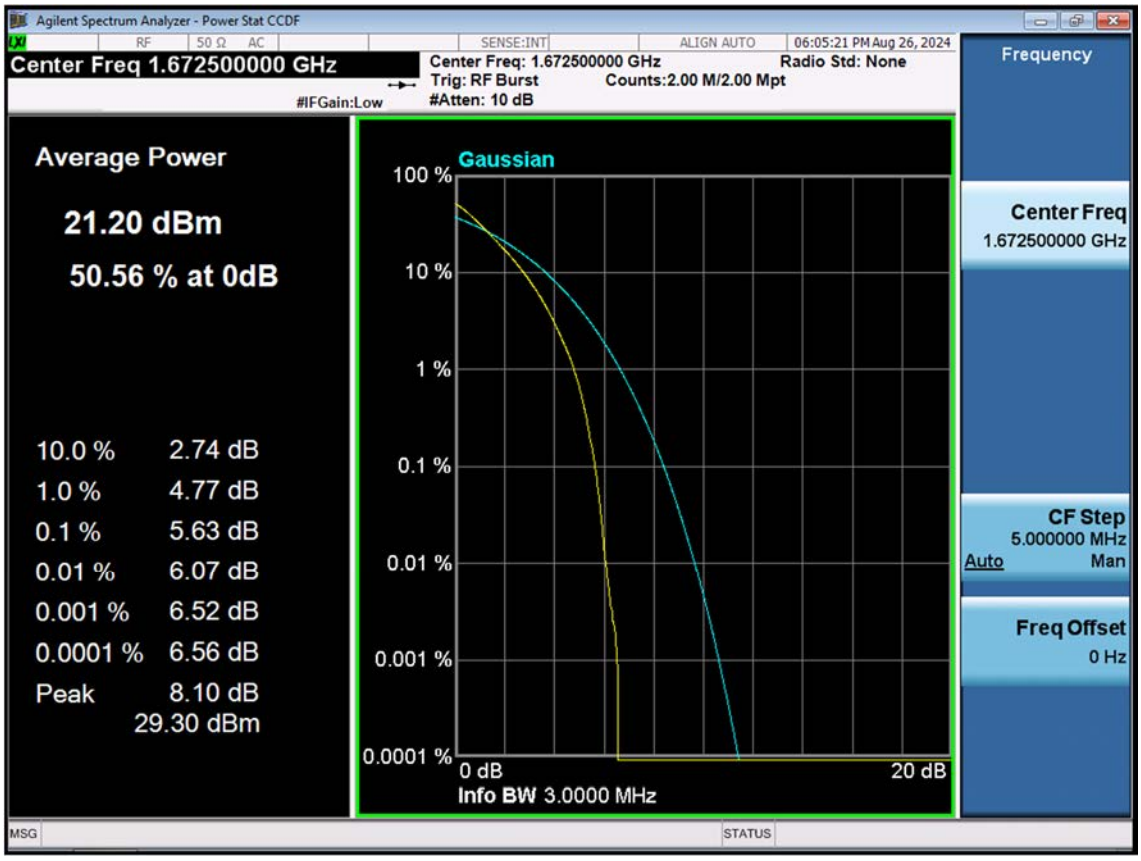
LTE B54_1.4 M_PAR_Mid_QPSK_FullRB



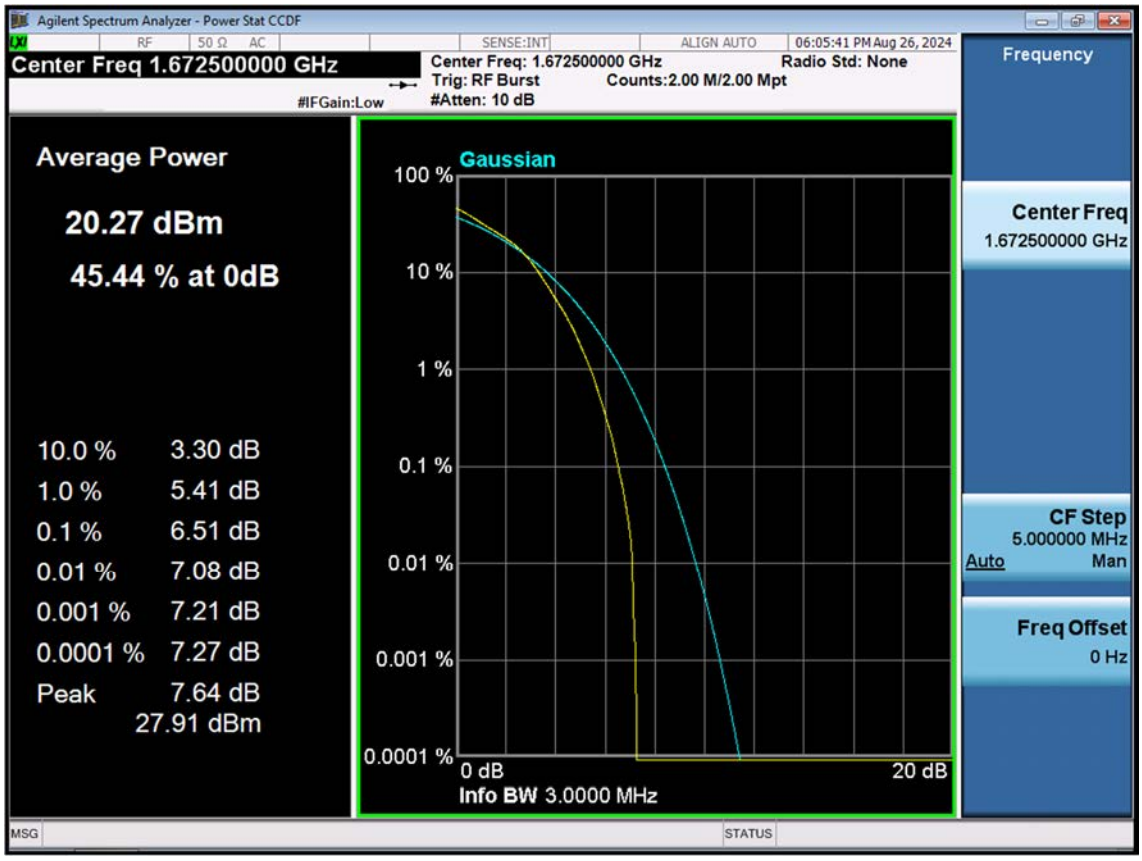
LTE B54_1.4 M_PAR_Mid_16QAM_FullRB



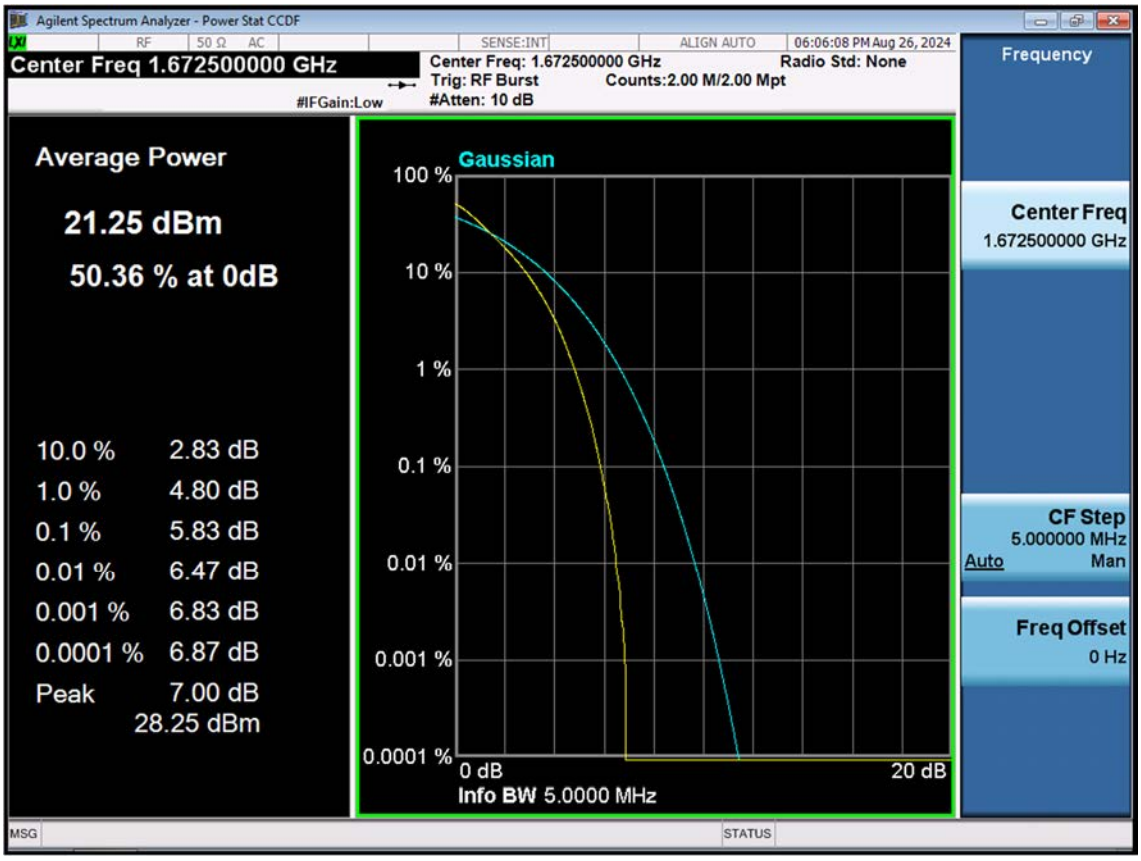
LTE B54_3 M_PAR_Mid_QPSK_FullRB



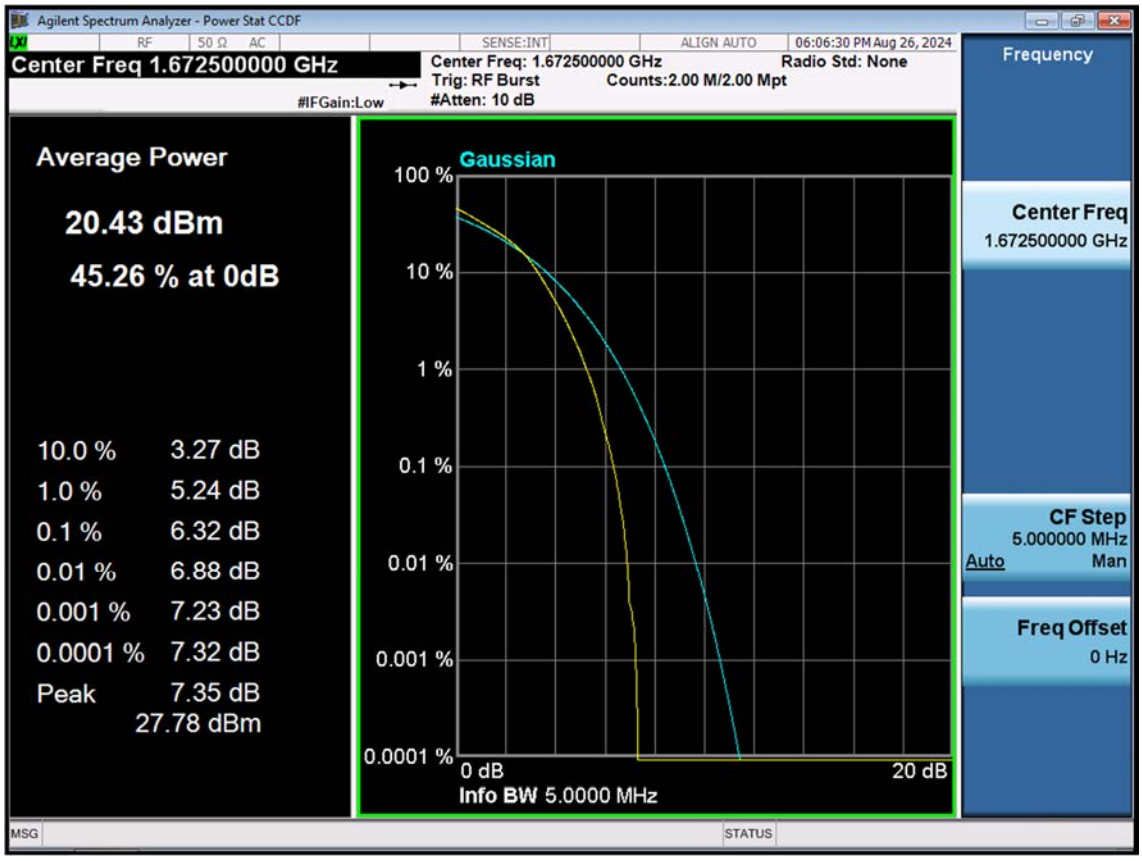
LTE B54_3 M_PAR_Mid_16QAM_FullRB



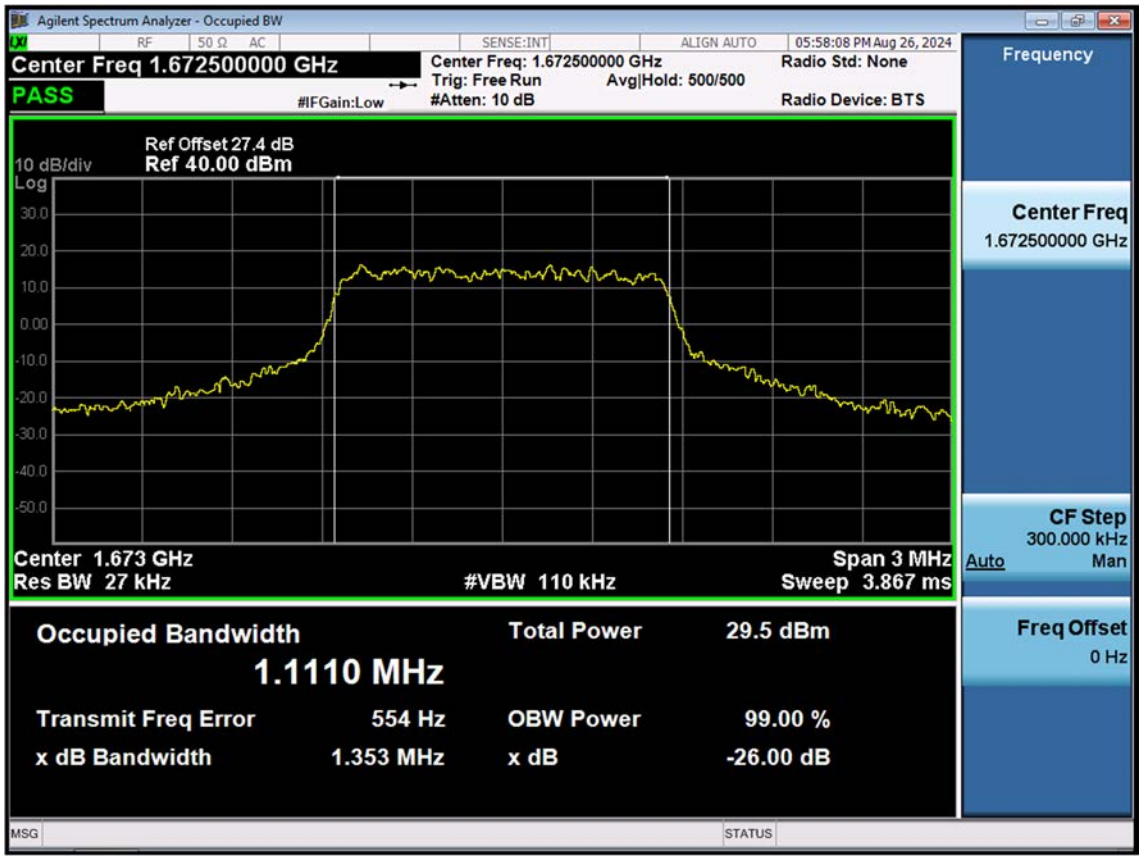
LTE B54_5 M_PAR_Mid_QPSK_FullRB



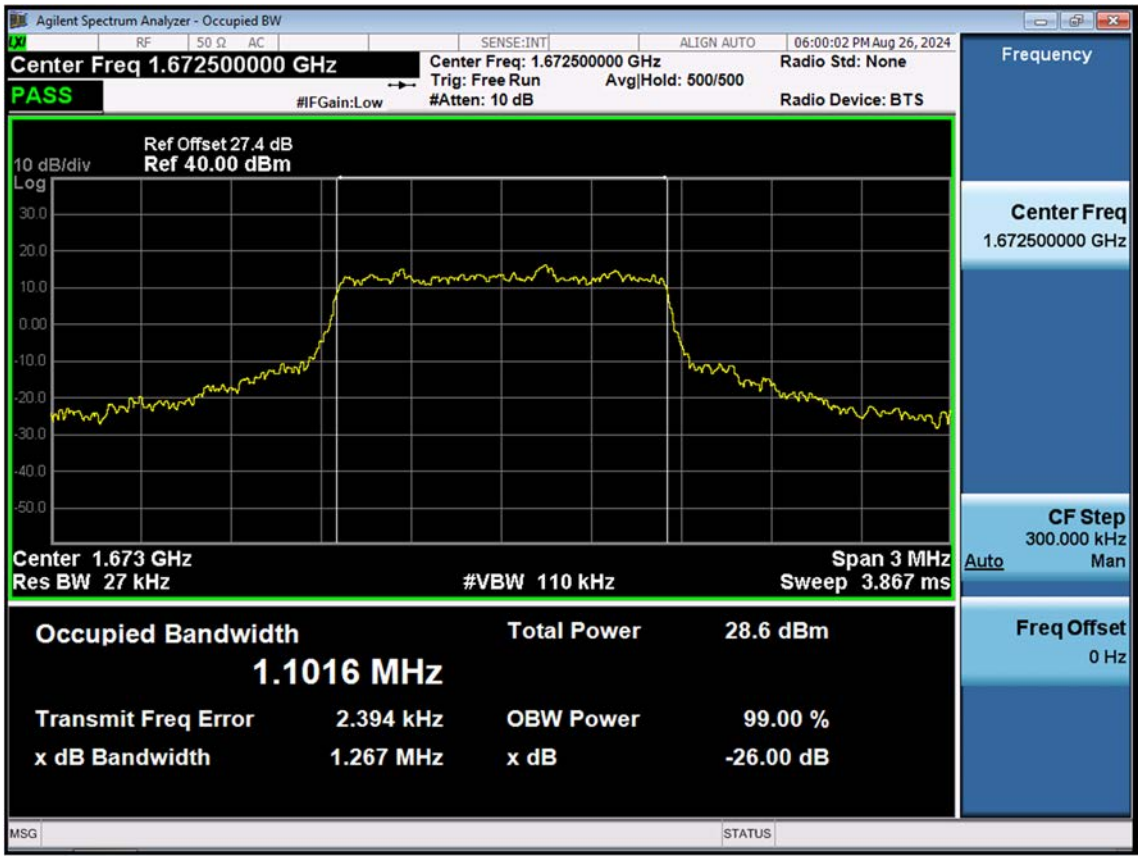
LTE B54_5 M_PAR_Mid_16QAM_FullRB



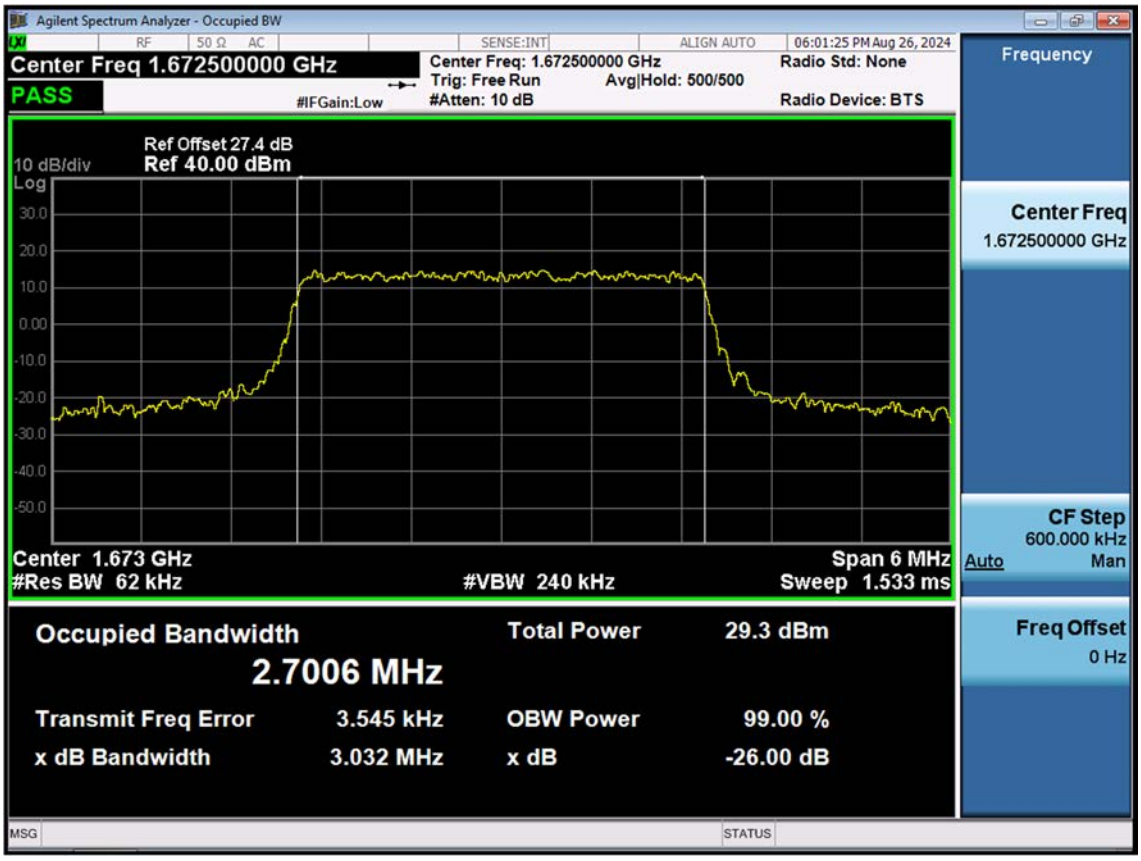
LTE B54_1.4 M_OBW_Mid_QPSK_FullRB



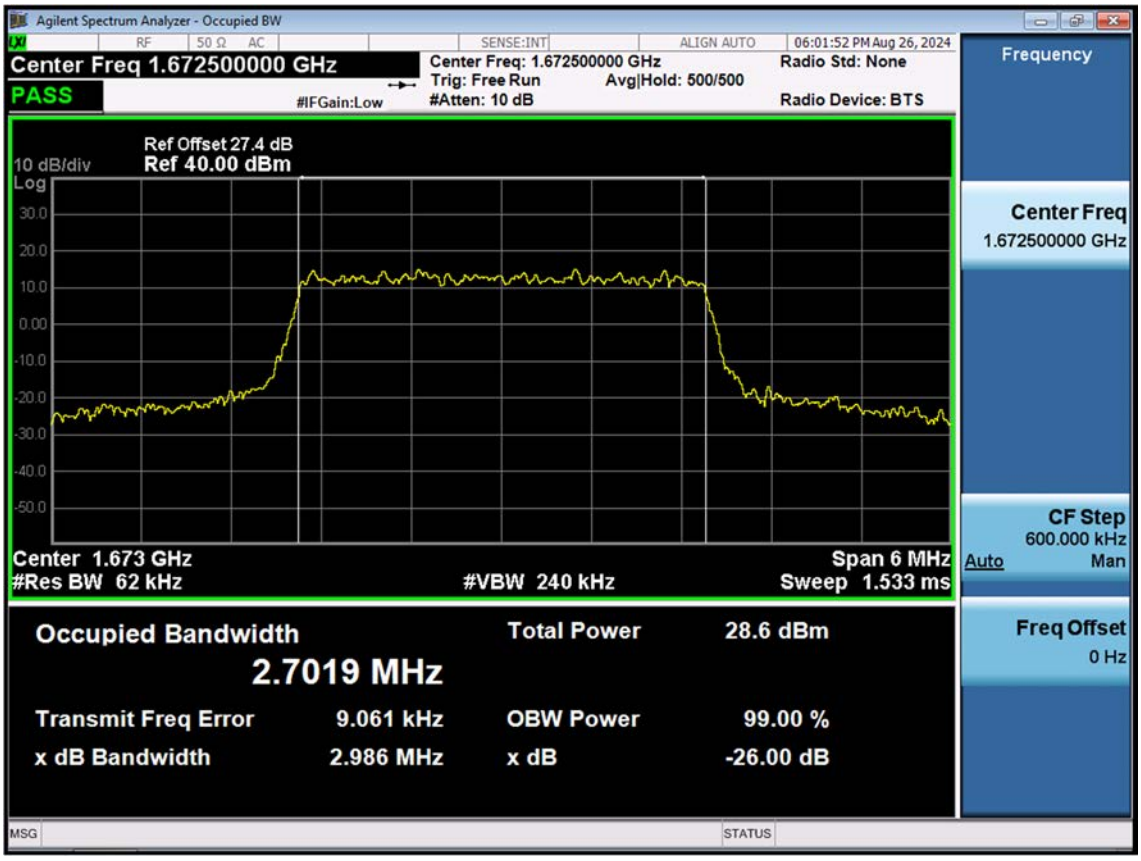
LTE B54_1.4 M_OBW_Mid_16QAM_FullRB



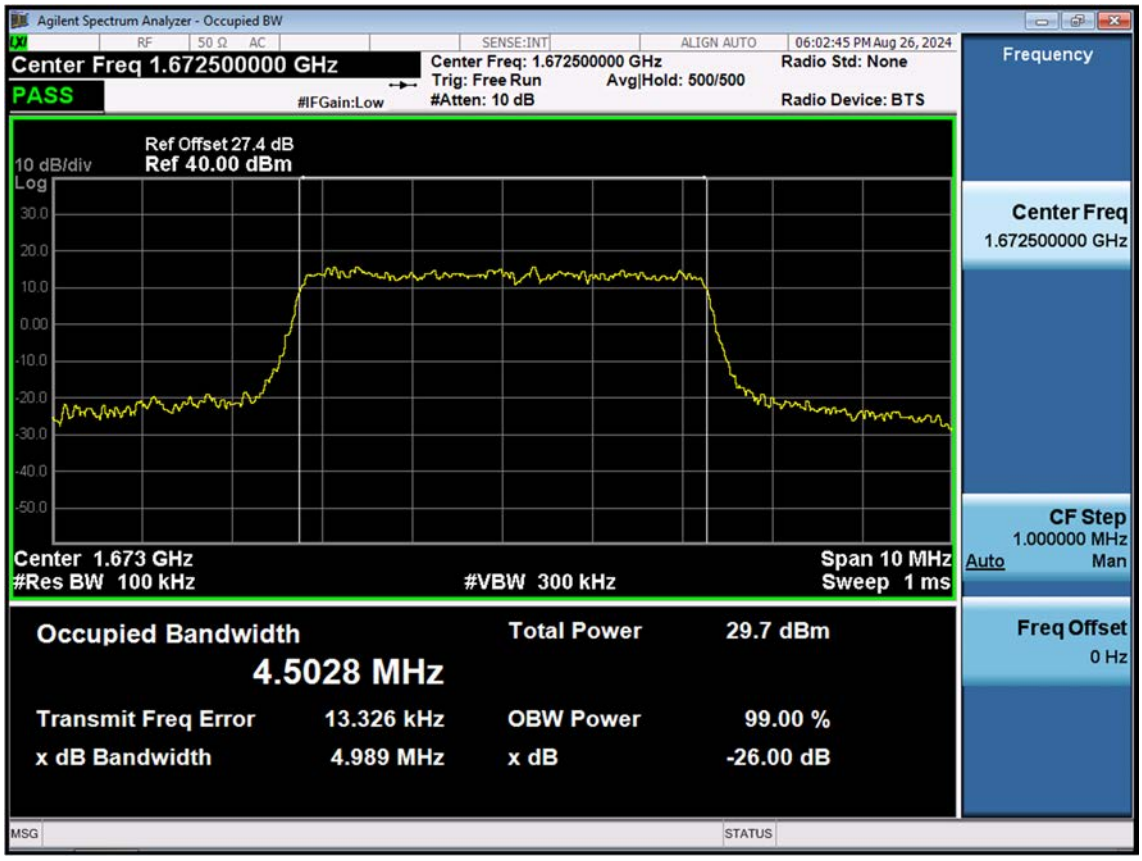
LTE B54_3 M_OBW_Mid_QPSK_FullRB



LTE B54_3 M_OBW_Mid_16QAM_FullRB



LTE B54_5 M_OBW_Mid_QPSK_FullRB



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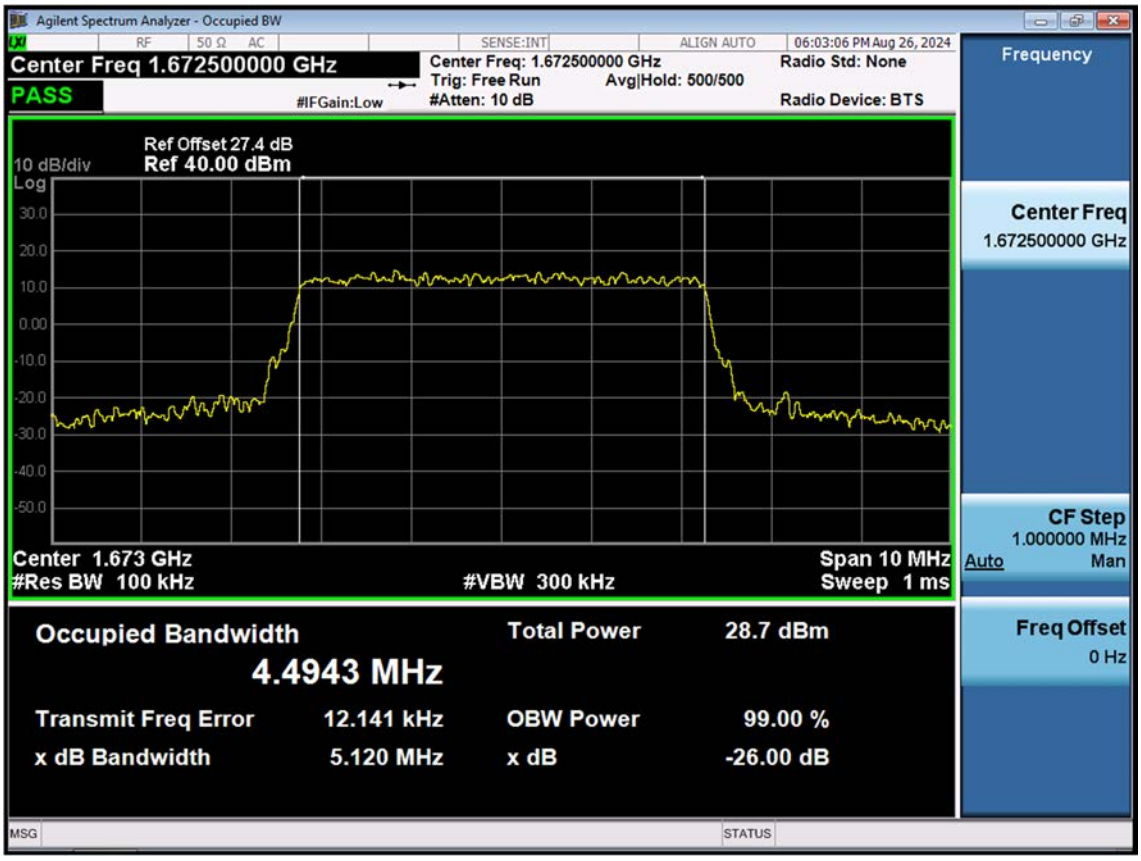
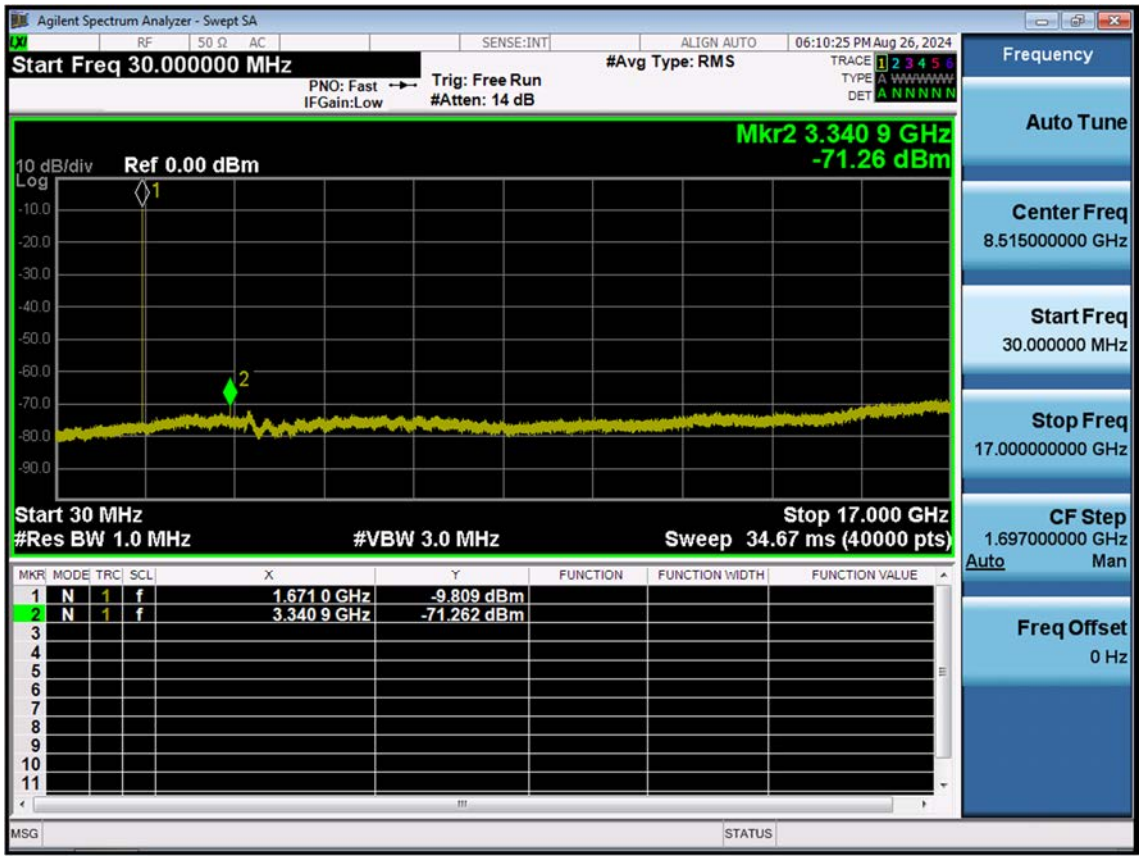
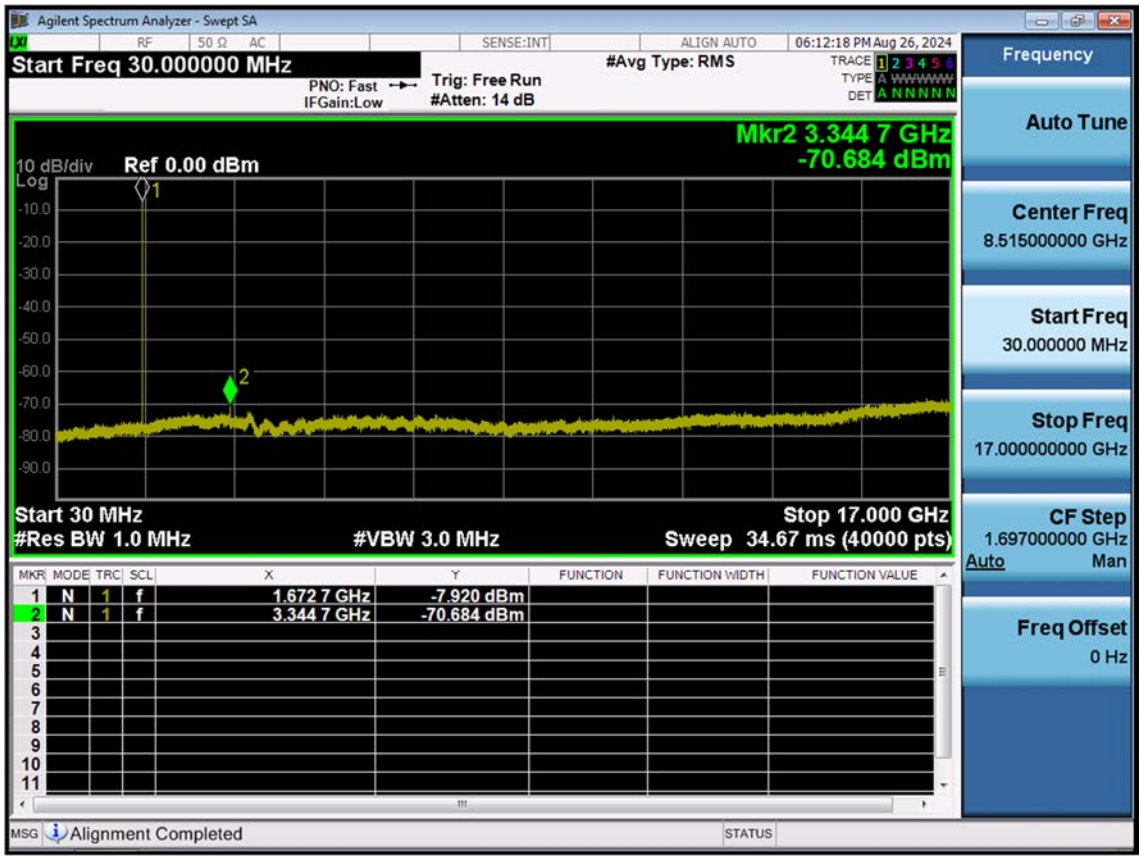


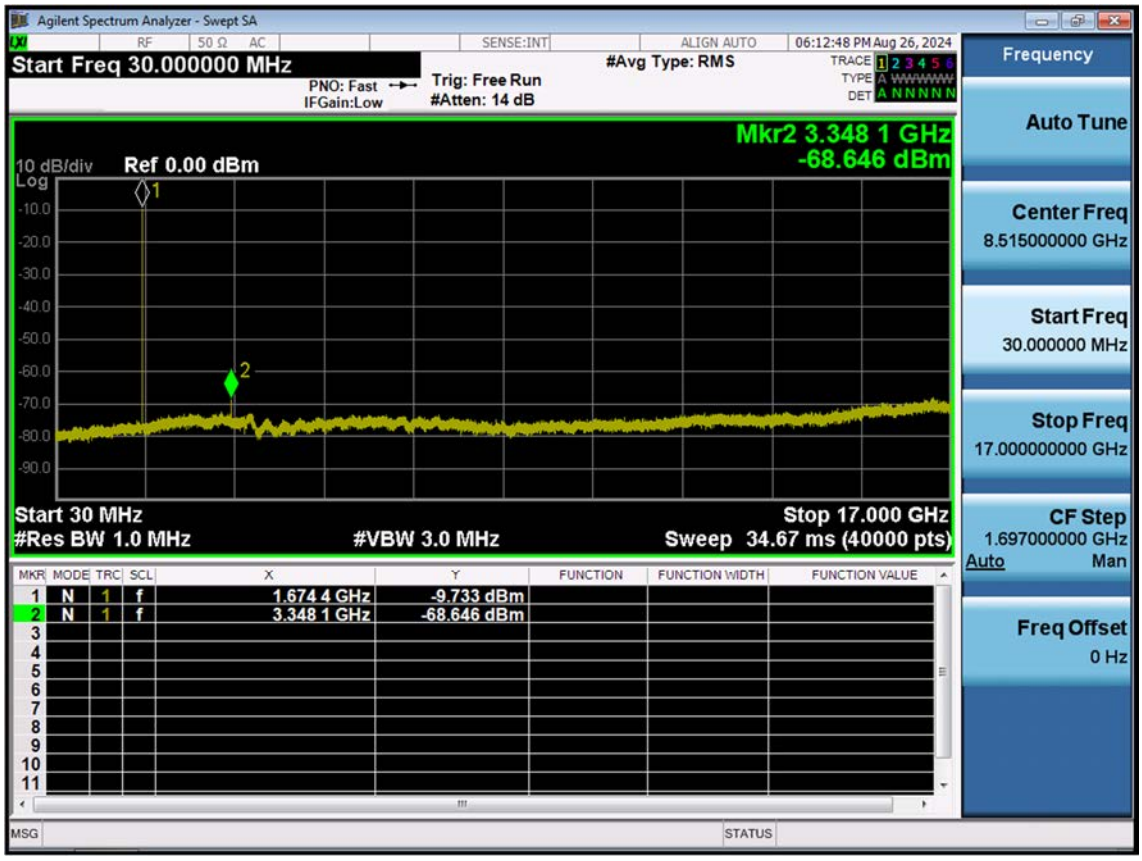
LTE B54_1.4 M_Conducted Spurious(30 M-17 G)_Low_QPSK_1RB



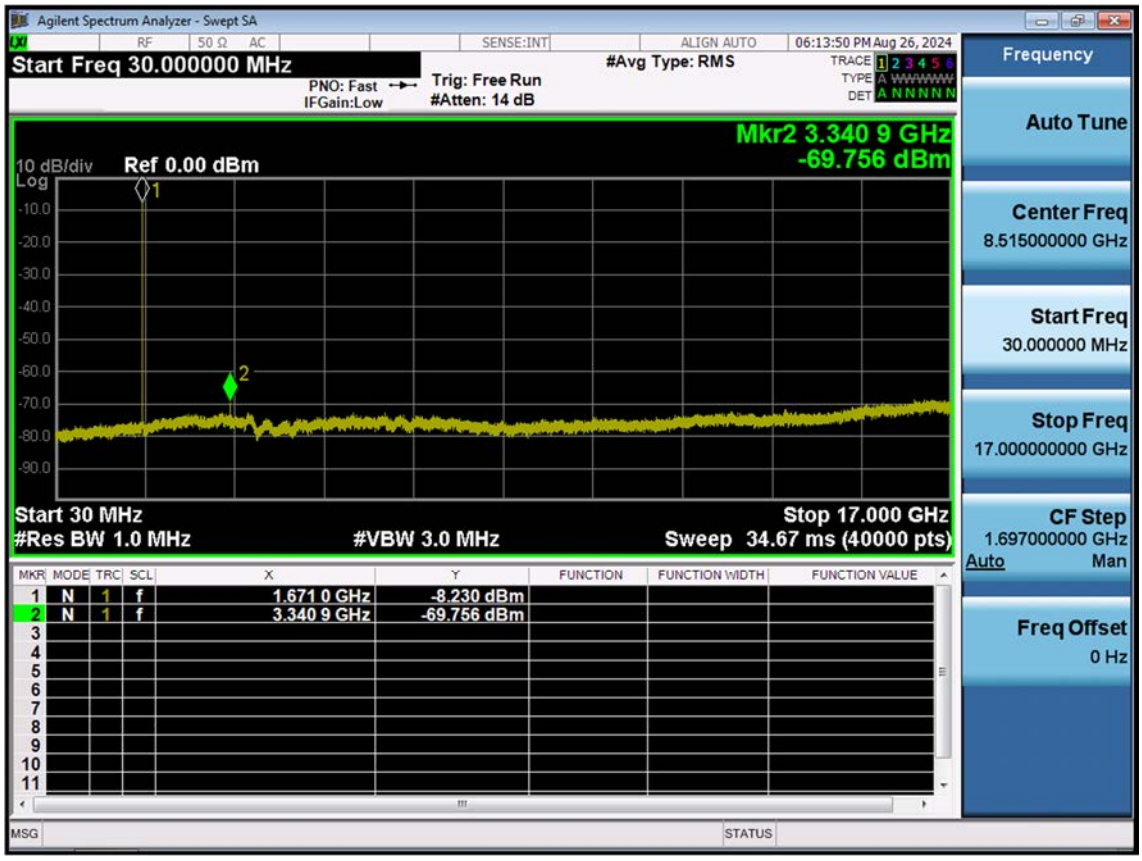
LTE B54_1.4 M_Conducted Spurious(30 M-17 G)_Mid_QPSK_1RB



LTE B54_1.4 M_Conducted Spurious(30 M-17 G)_High_QPSK_1RB



LTE B54_3 M_Conducted Spurious(30 M-17 G)_Low_QPSK_1RB



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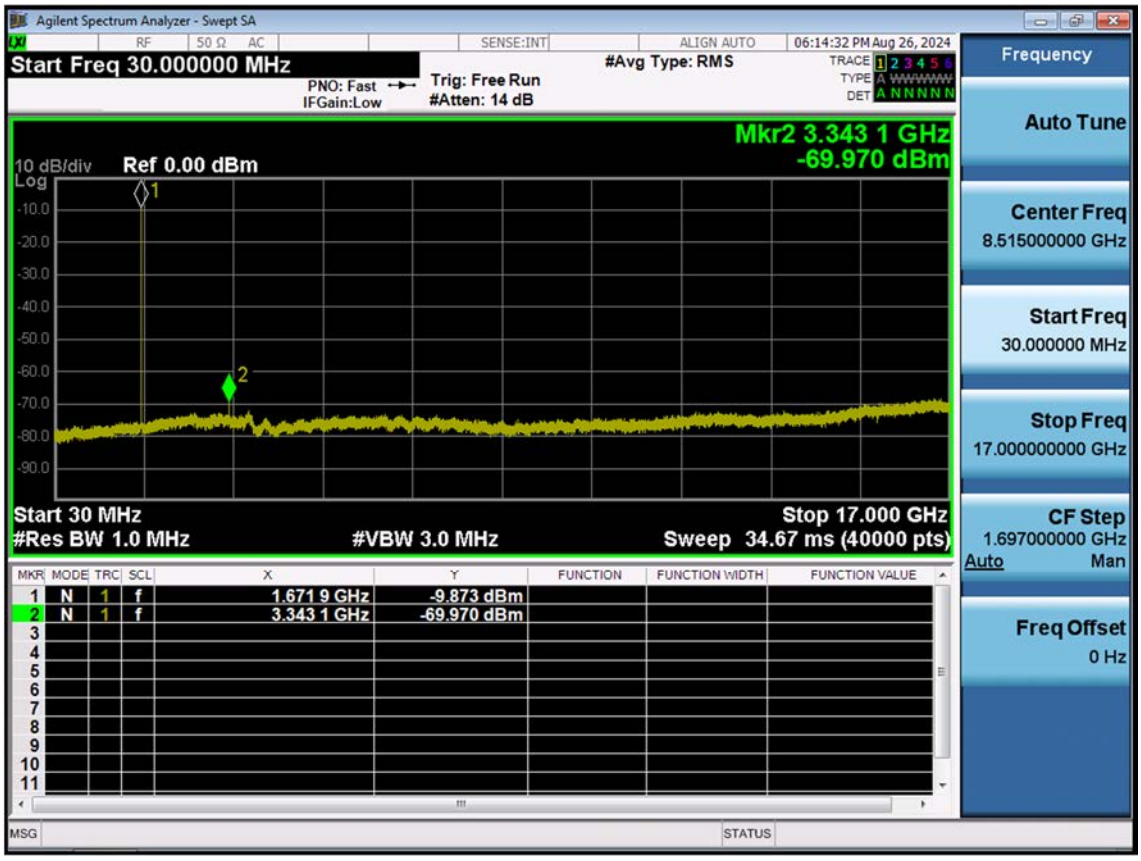

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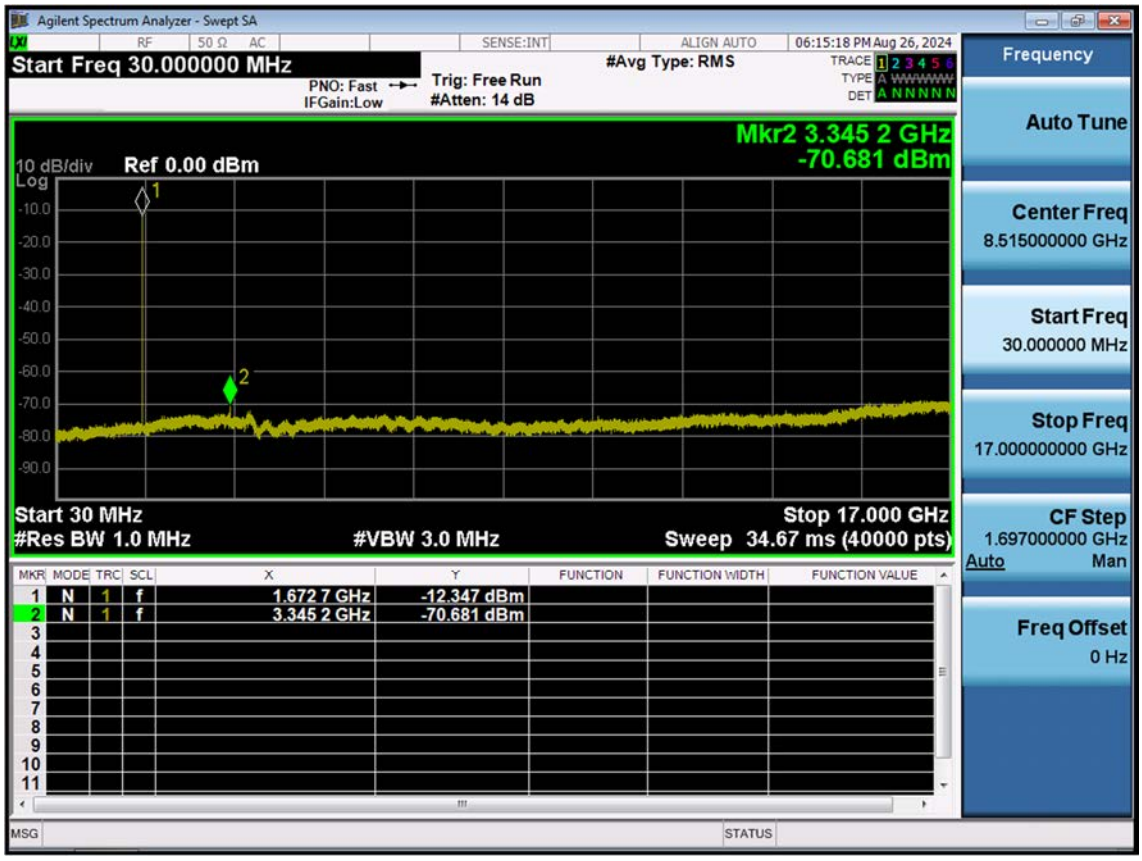
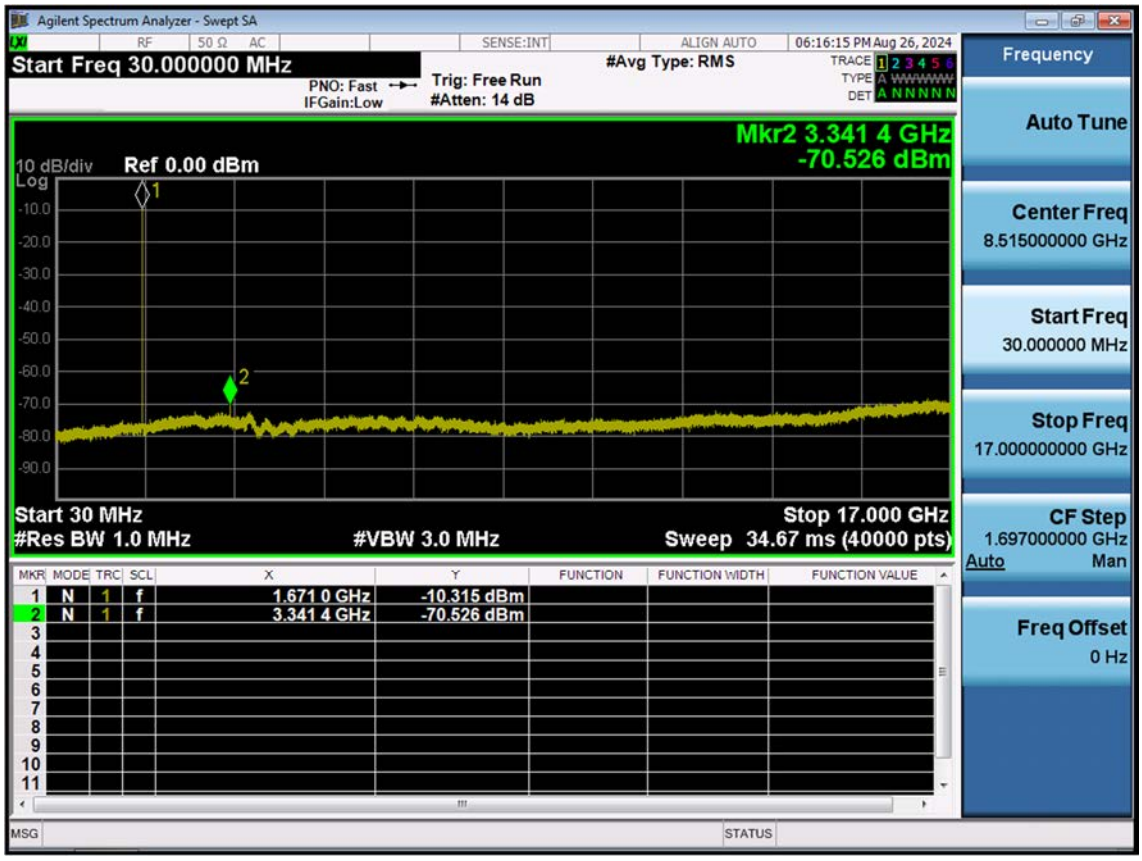
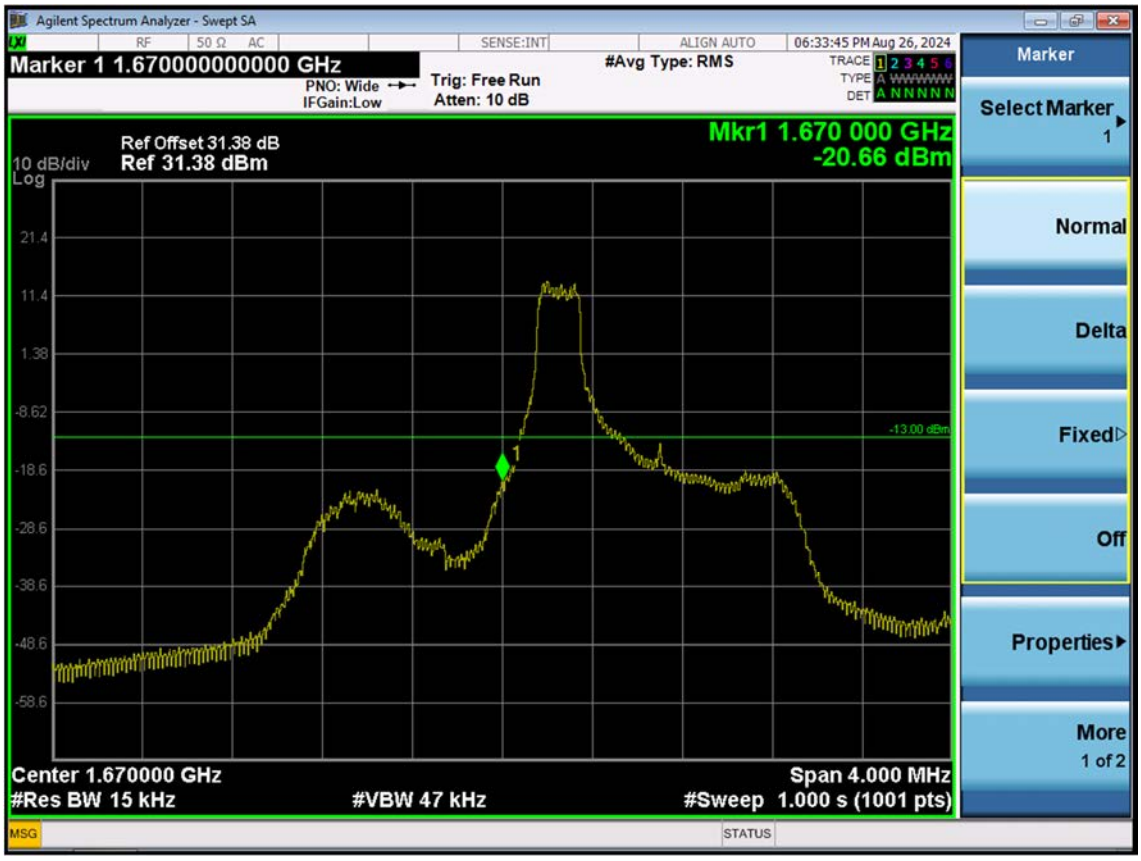


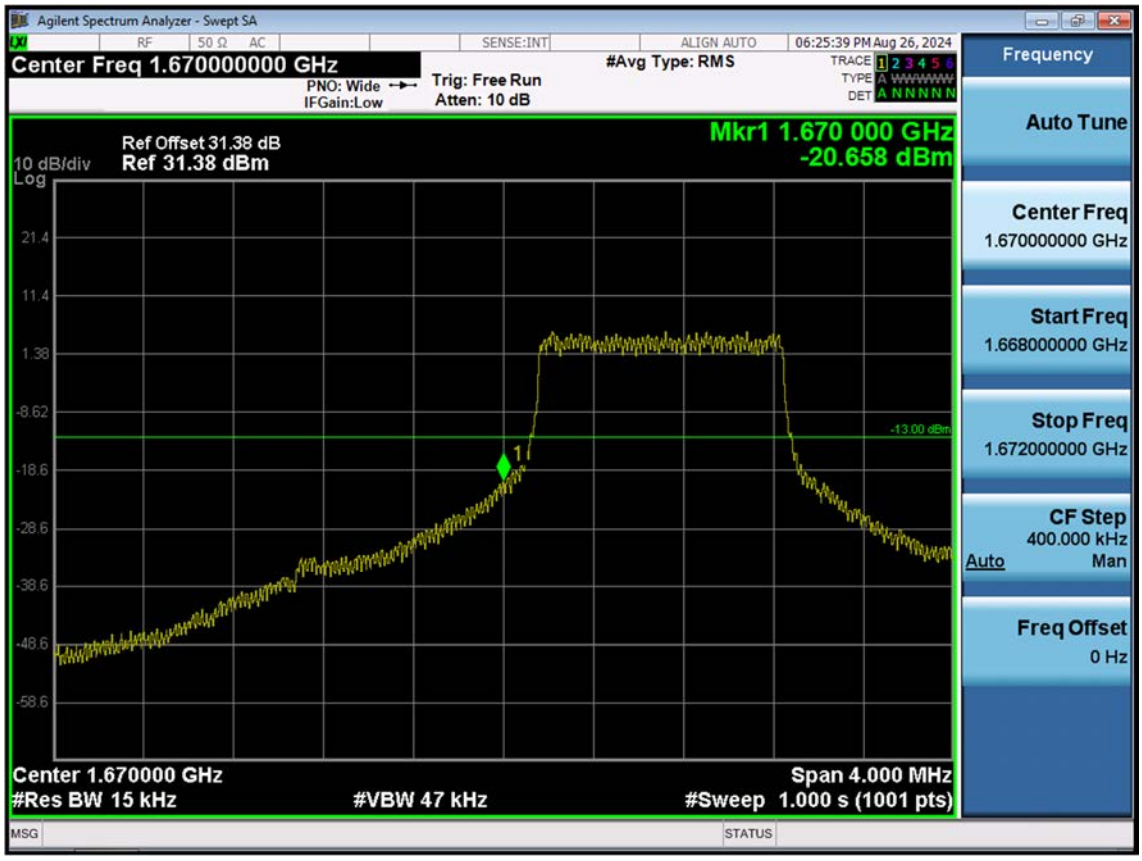
LTE B54_5 M_Conducted Spurious(30 M-17 G)_Mid_QPSK_1RB



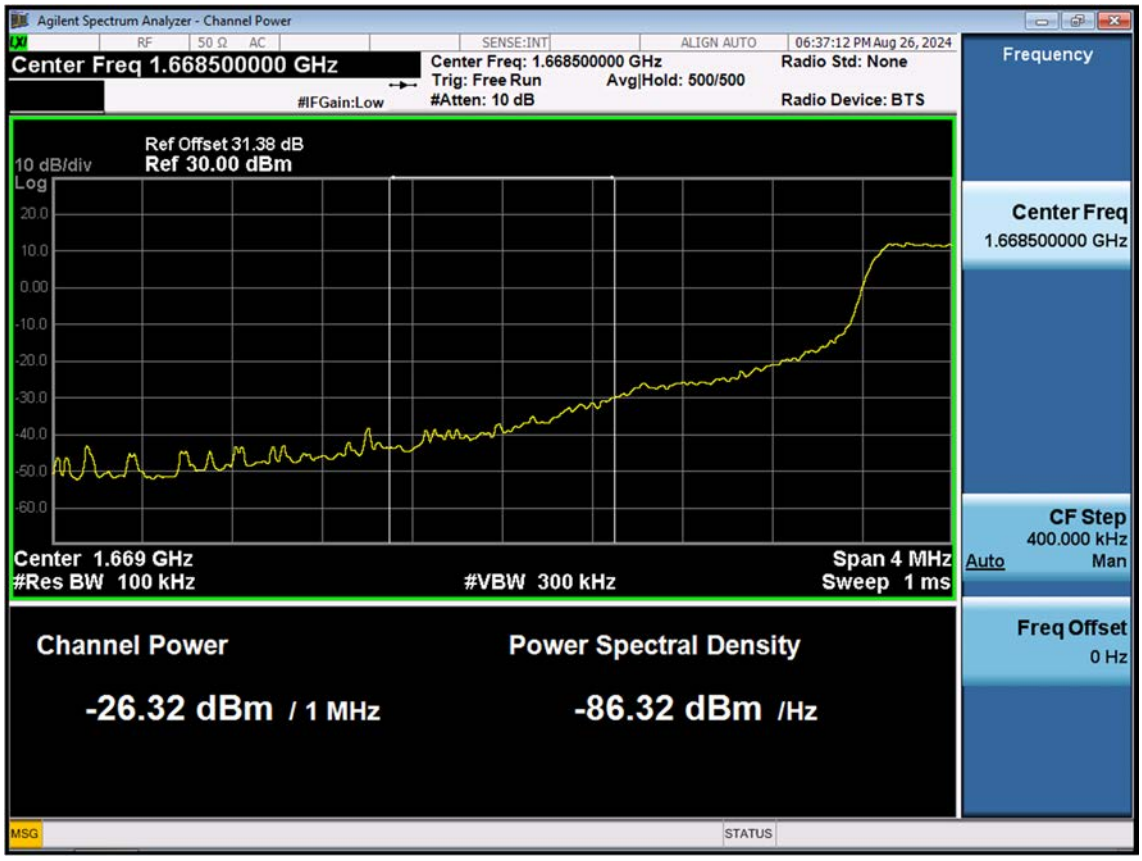
LTE B54_1.4 M_Band Edge_Low_QPSK_1RB



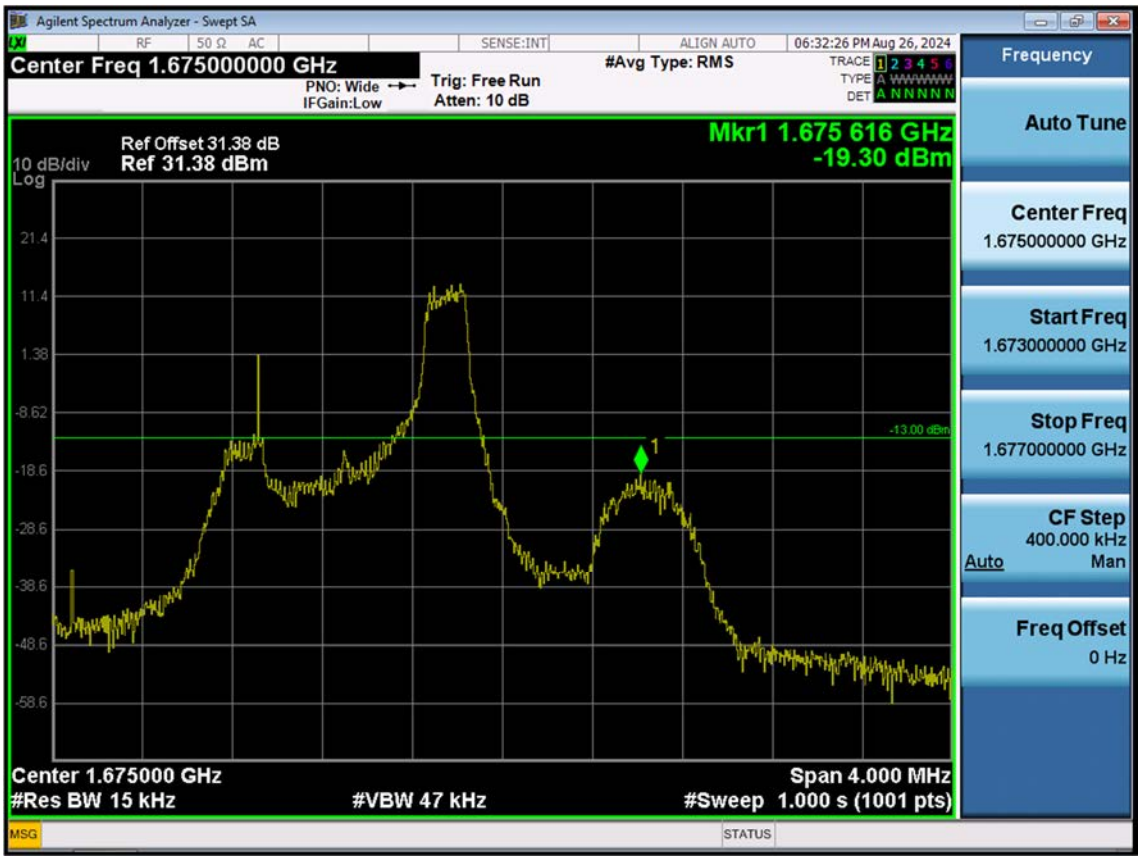
LTE B54_1.4 M_Band Edge_Low_QPSK_FullRB



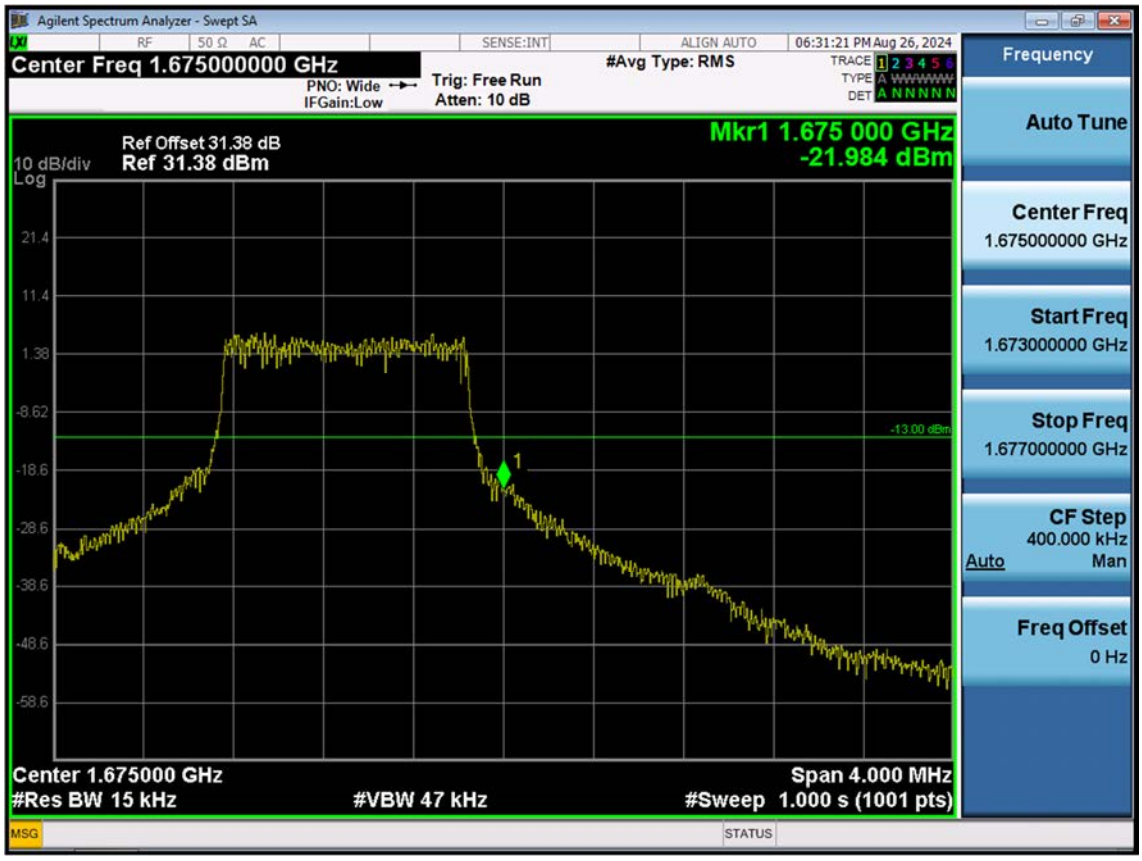
LTE B54_1.4 M_Extended Band Edge_Low_QPSK_FullRB



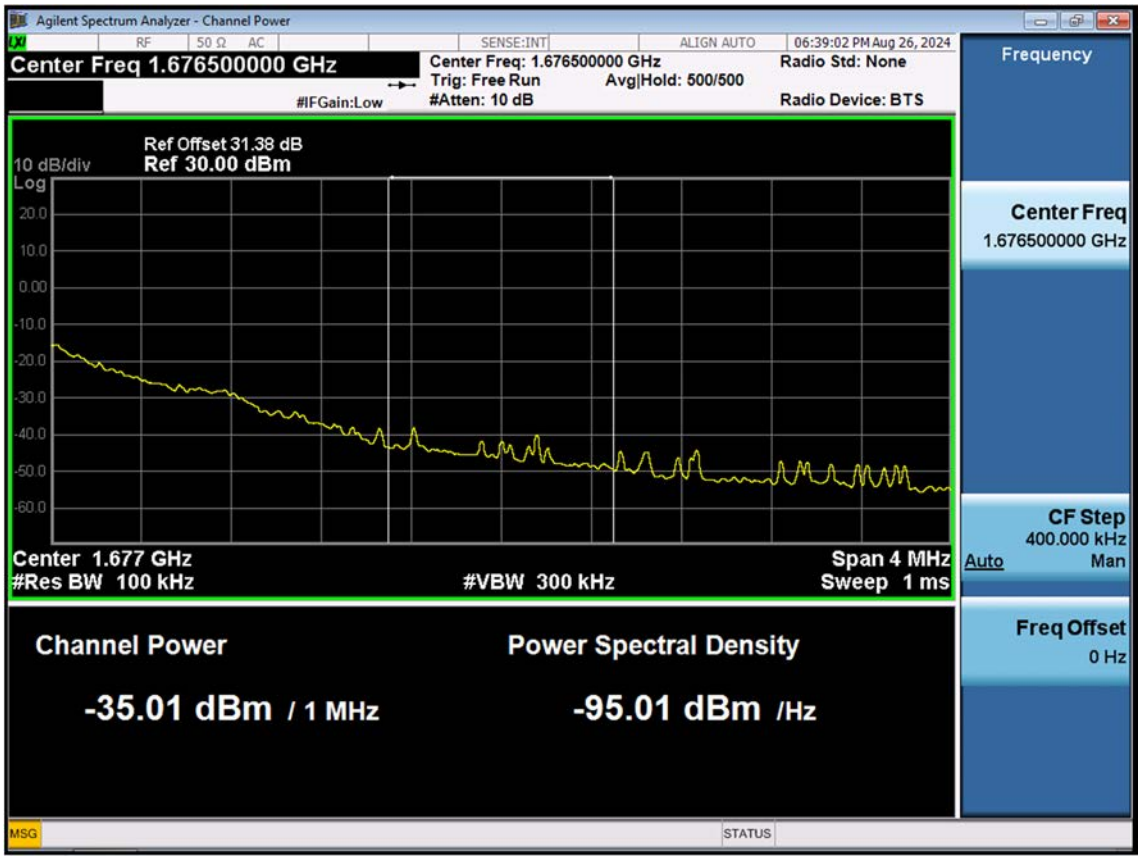
LTE B54_1.4 M_Band Edge_High_QPSK_1RB



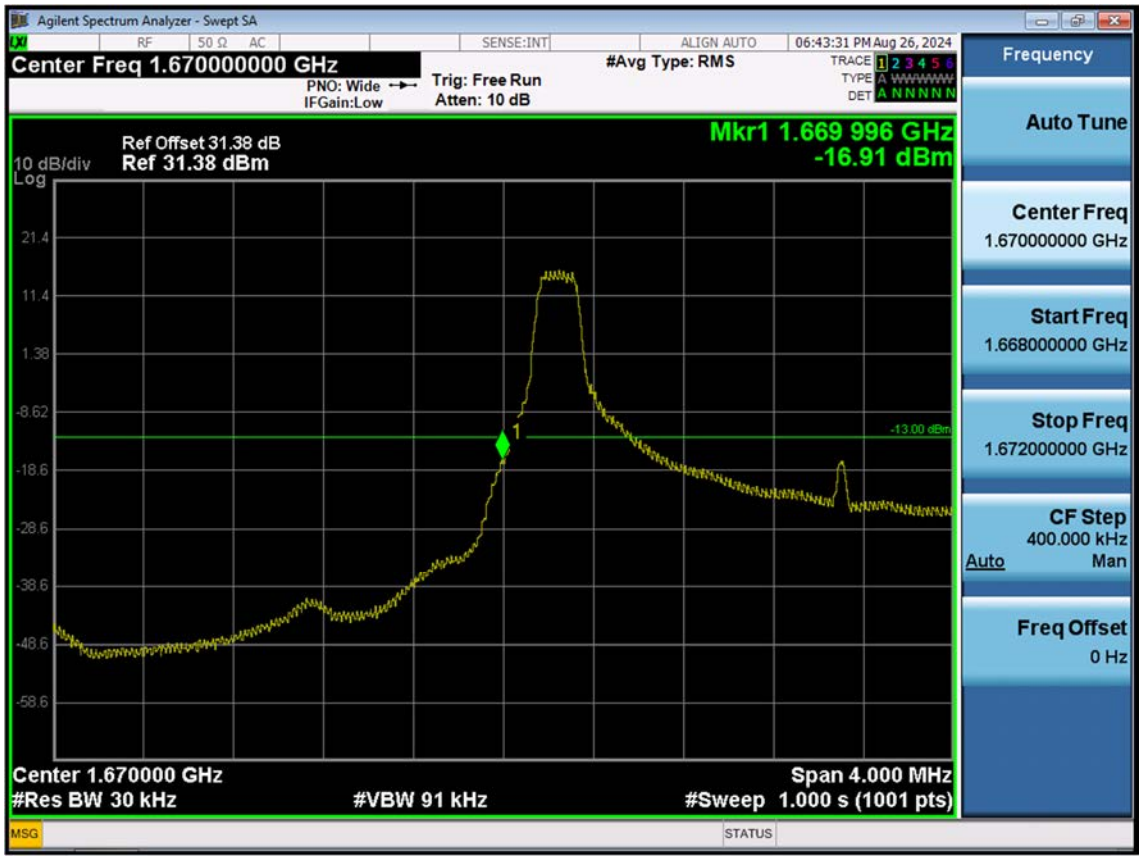
LTE B54_1.4 M_Band Edge_High_QPSK_FullRB



LTE B54_1.4 M_Extended Band Edge_High_QPSK_FullRB

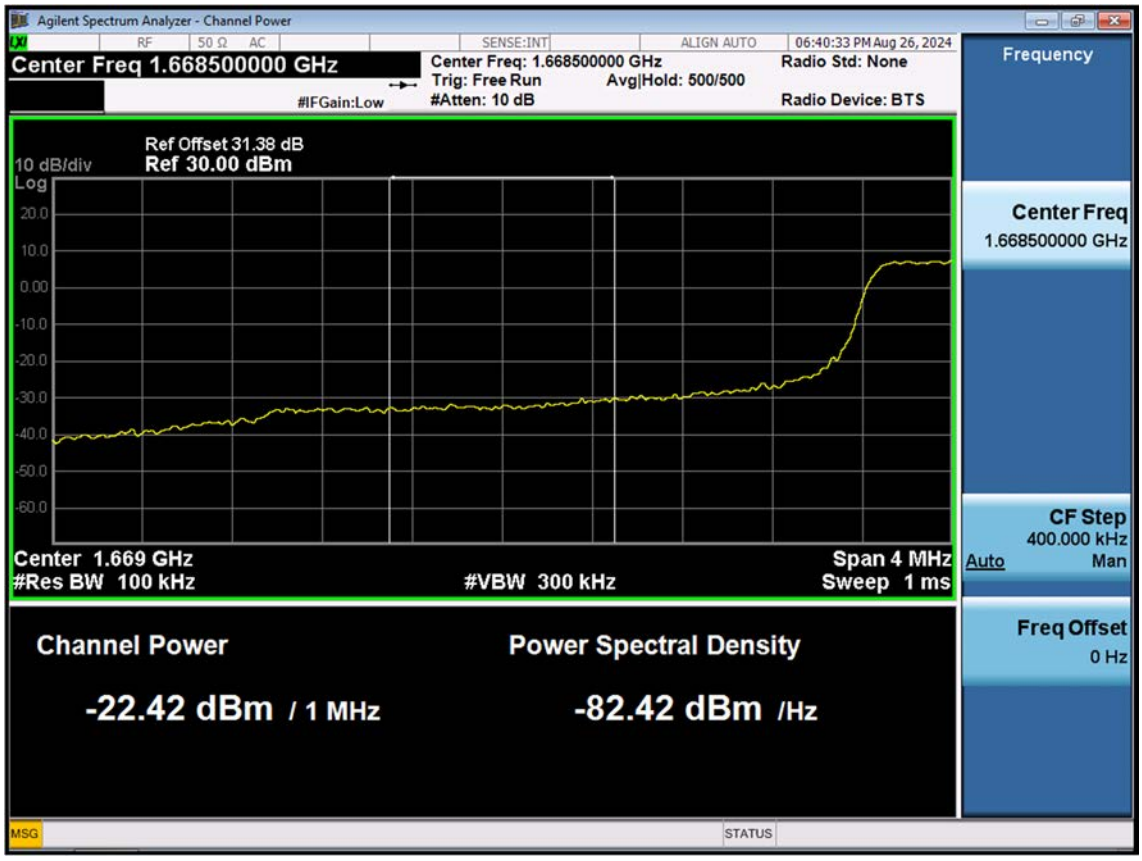


LTE B54_3 M_Band Edge_Low_QPSK_1RB



LTE B54_3 M_Band Edge_Low_QPSK_FullRB

LTE B54_3 M_Extended Band Edge_Low_QPSK_FullRB



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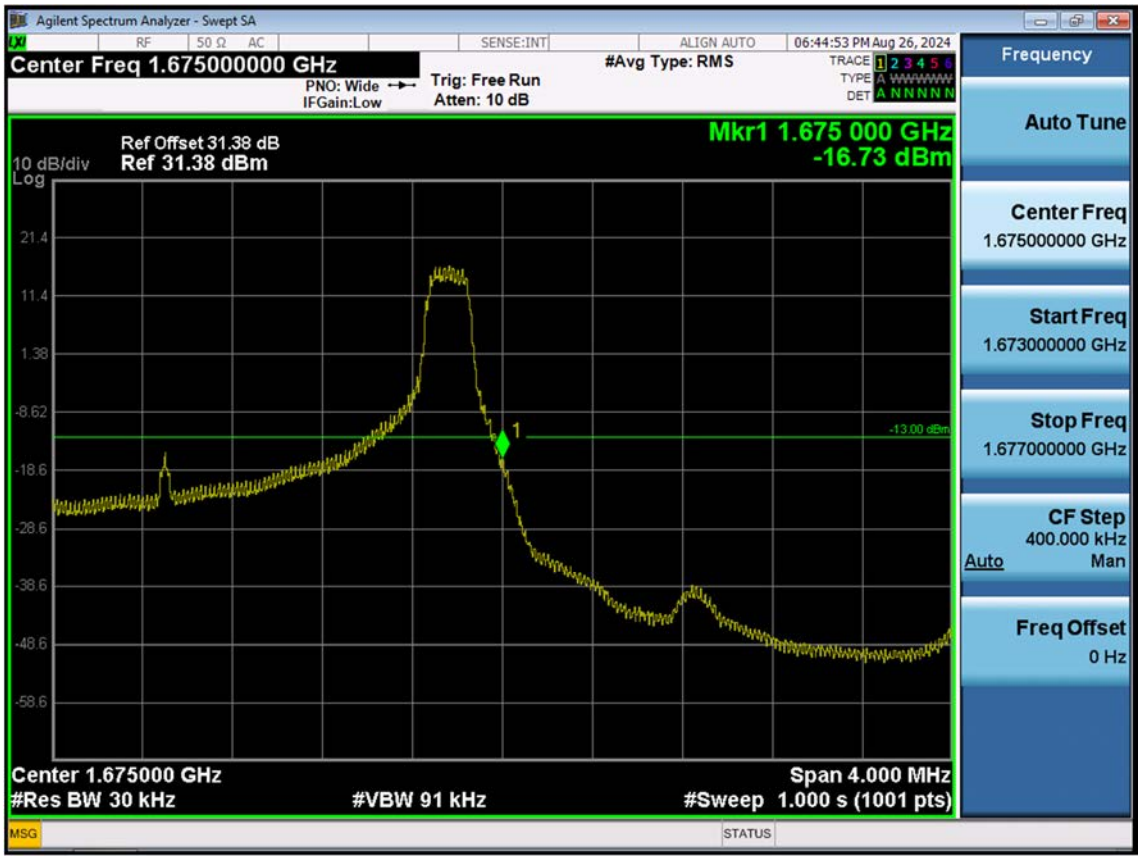
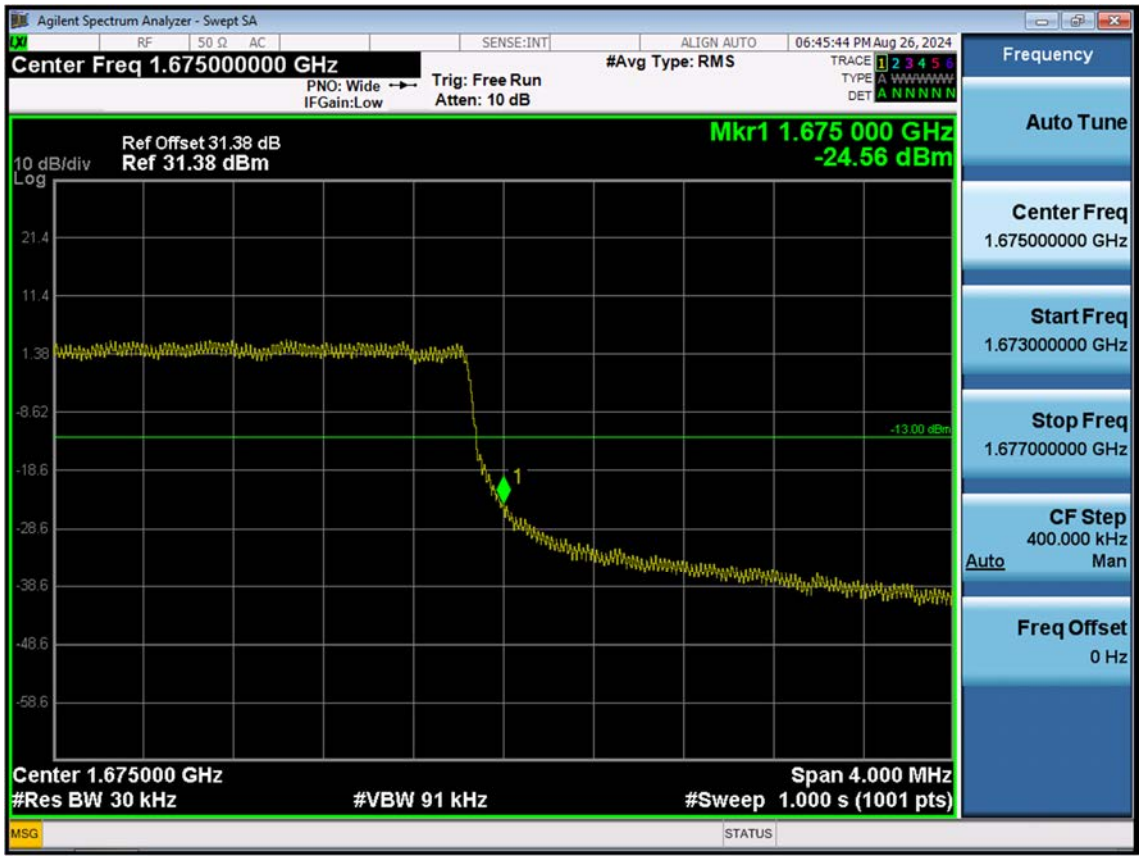
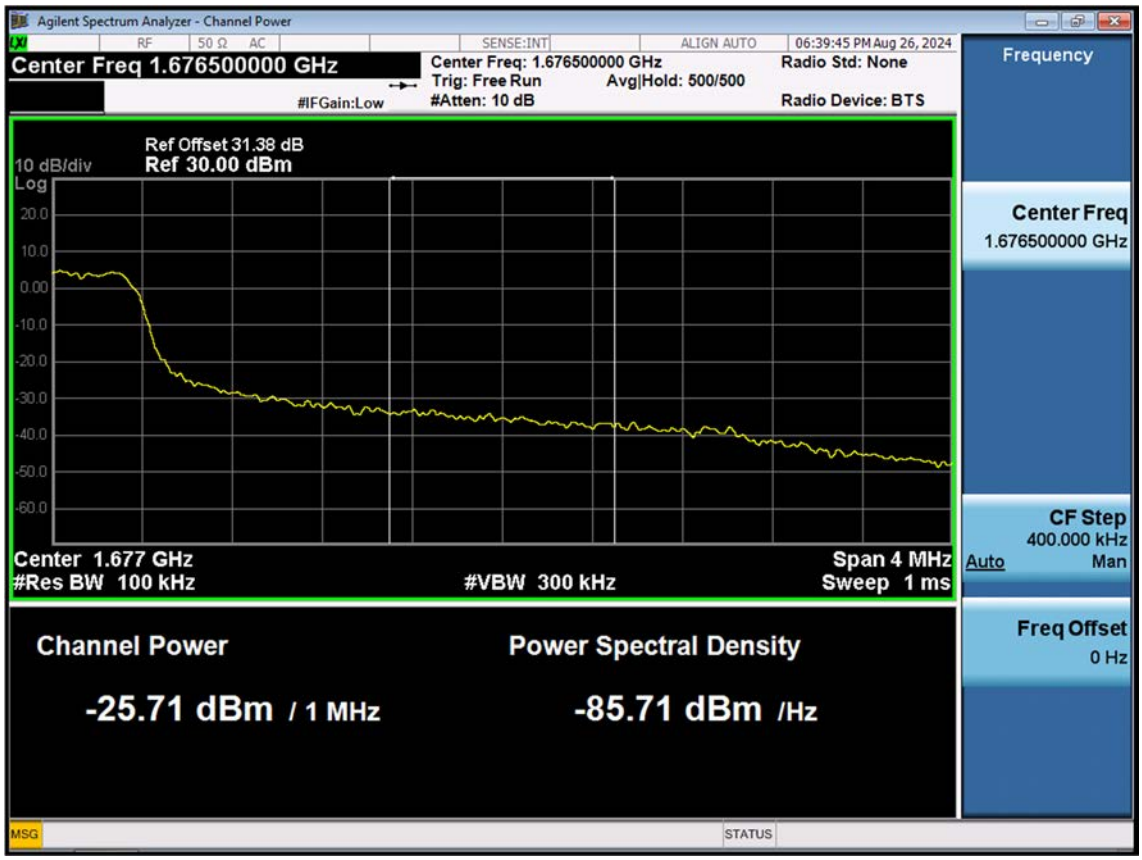


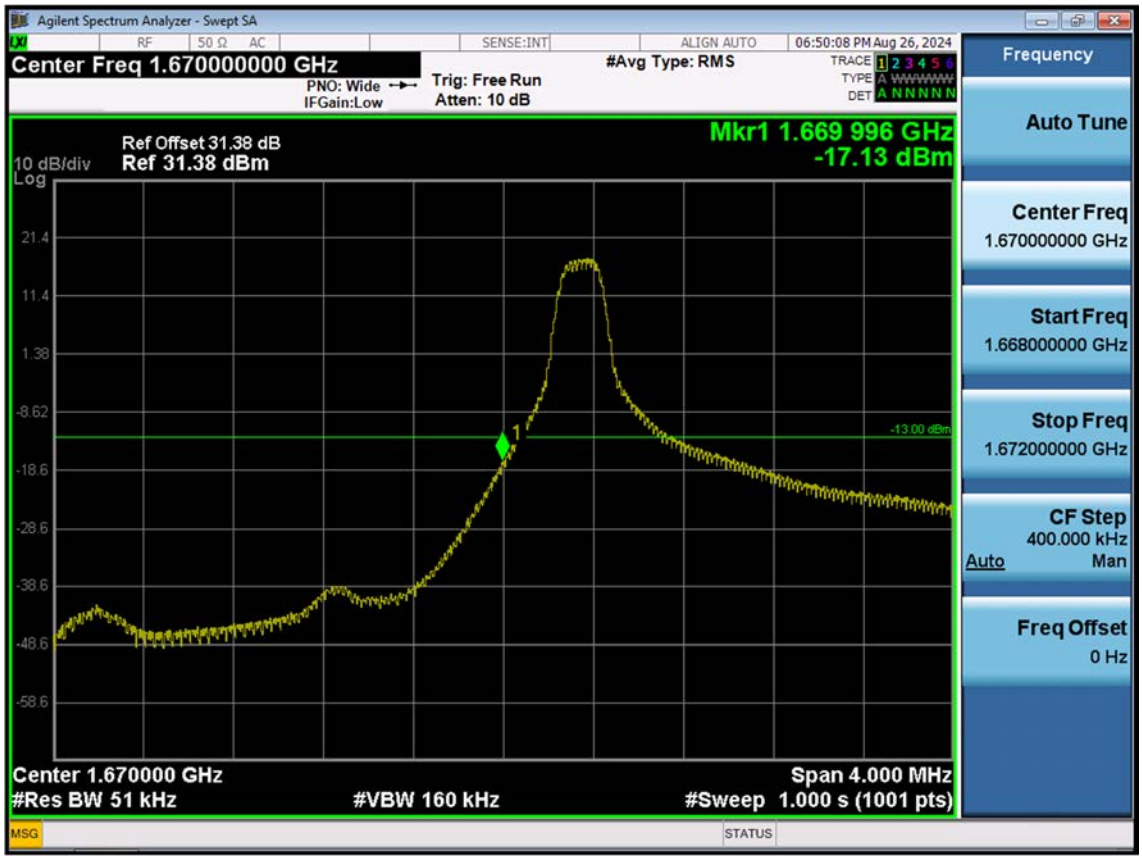
LTE B54_3 M_Band Edge_High_QPSK_FullRB



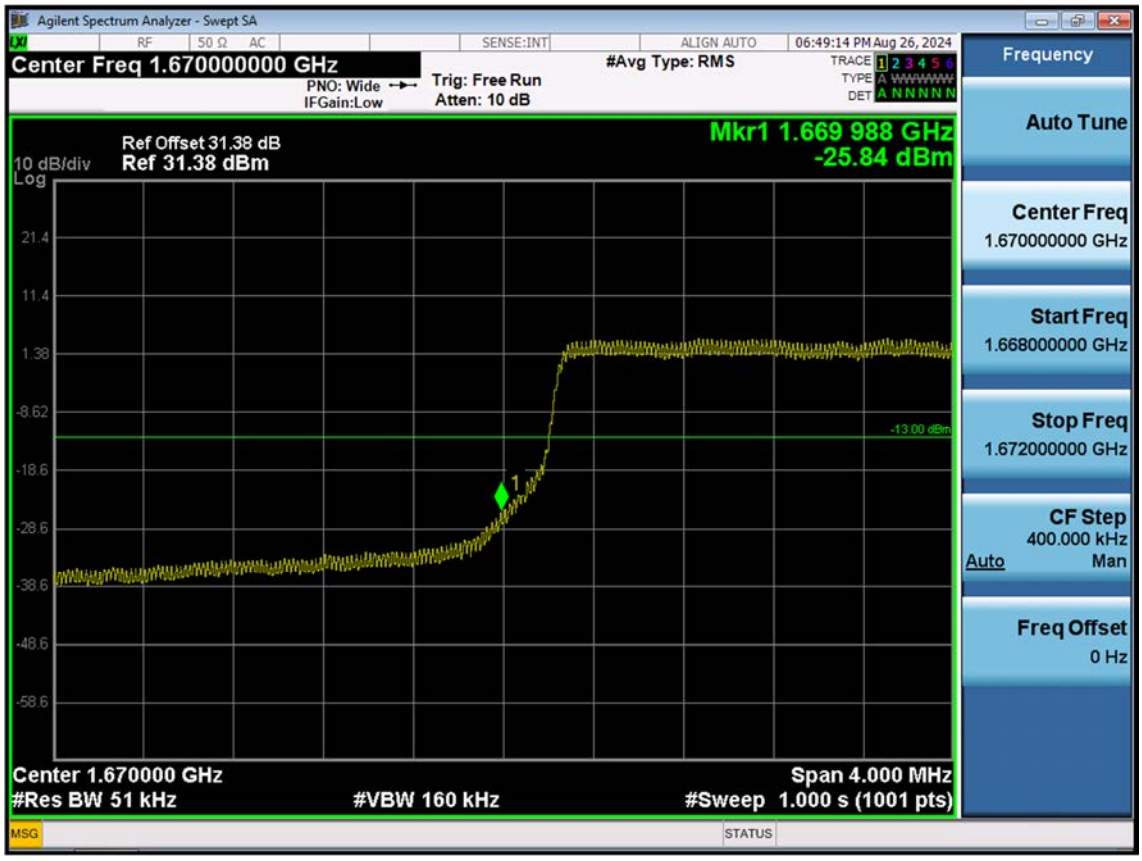
LTE B54_3 M_Extended Band Edge_High_QPSK_FullRB



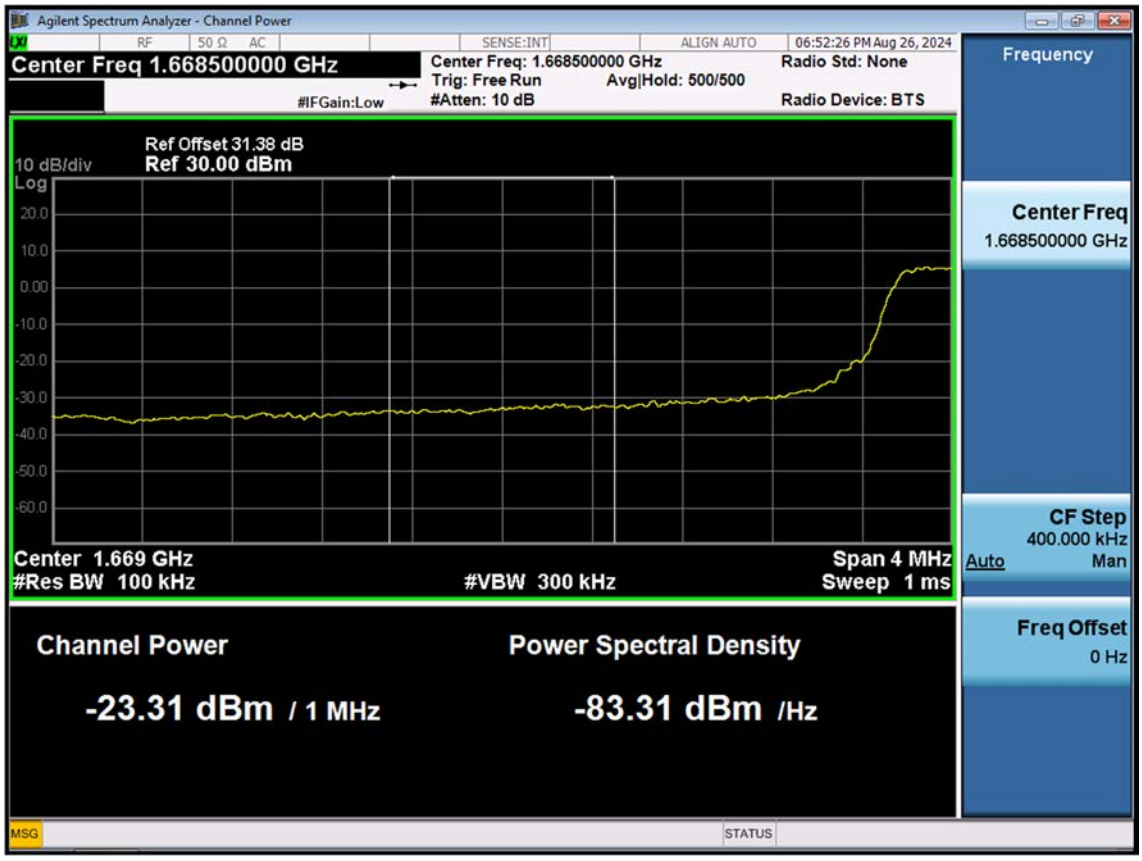
LTE B54_5 M_Band Edge_Low_QPSK_1RB



LTE B54_5 M_Band Edge_Low_QPSK_FullRB



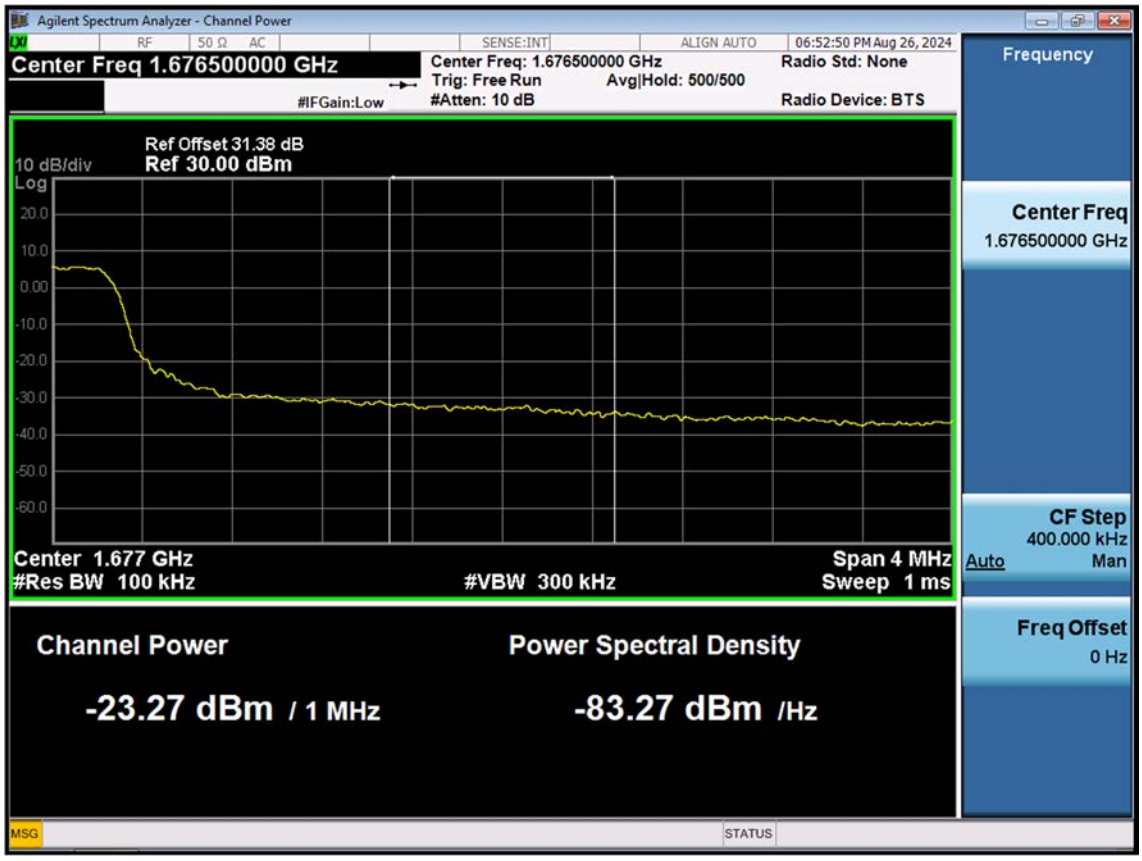
LTE B54_5 M_Extended Band Edge_Low_QPSK_FullRB



LTE B54_5 M_Band Edge_High_QPSK_1RB

LTE B54_5 M_Band Edge_High_QPSK_FullRB

LTE B54_5 M_Extended Band Edge_High_QPSK_FullRB



10. ANNEX A_ TEST SETUP PHOTO

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

No.	Description
1	HCT-RF-2409-FC015-P