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HCT

# TEST REPORT

## FCC LTE Test for SM-T725

## Certification

APPLICANT
SAMSUNG Electronics Co., Ltd.

REPORT NO.
HCT-RF-1906-FC017

DATE OF ISSUE
10 June 2019

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FCC LTE Test for SM-T725

REPORT NO.
HCT-RF-1906-FC017

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Other ID
FCC: A3LSMT725U

| | |
|---|---|
| Applicant | SAMSUNG Electronics Co., Ltd.<br>129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea |
| Eut Type<br>Model Name<br>Additional Model(s) | Tablet<br>SM-T725<br>SM-T725N, SM-T727 |
| Date of Receipt | May 10, 2019 |
| FCC Rule Part(s) | §27, §2 |
| FCC Classification | PCS Licensed Transmitter (PCB) |
| Manufacturer | SAMSUNG Electronics Co., Ltd. |

Tested by
Kwon Jeong

Technical Manager
Jong Seok Lee

HCT CO., LTD.
Soo Chan Lee
SooChan Lee / CEO

## EVISION HISTORY

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

| Revision No. | Date of Issue | Description |
|---|---|---|
| 0 | June 10, 2019 | Initial Release |
| | | |
| | | |

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)

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# 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: | A3LSMT725U |
| Application Type: | Certification |
| FCC Classification: | PCS Licensed Transmitter (PCB) |
| FCC Rule Part(s): | § 27, § 2 |
| EUT Type: | Tablet |
| Model(s): | SM-T725 |
| Additional Model(s): | T725N, T727 |
| Keyboard Information | Model : EH-FT720<br>Manufacture: SAMSUNG |
| Charging Doc Information | Model : EE-D3200<br>Manufacture: SAMSUNG |
| Tx Frequency: | 2498.5 – 2687.5 : 5 MHz<br>2501.0 – 2685.0 : 10 MHz<br>2503.5 – 2682.5 : 15 MHz<br>2506.0 – 2680.0 : 20 MHz |
| Date(s) of Tests: | May 10, 2019 ~ June 05, 2019 |

## 1.1. MAXIMUM OUTPUT POWER

| Mode (MHz) | Tx Frequency (MHz) | Emission Designator | Modulation | EIRP | |
|---|---|---|---|---|---|
| | | | | Max. Power (W) | Max. Power (dBm) |
| LTE – Band 41 (5) | 2498.5 – 2687.5 | 4M51G7D | QPSK | 0.282 | 24.50 |
| | | 4M50W7D | 16QAM | 0.231 | 23.64 |
| | | 4M51W7D | 64QAM | 0.187 | 22.71 |
| LTE – Band 41 (10) | 2501.0 – 2685.0 | 8M95G7D | QPSK | 0.279 | 24.46 |
| | | 8M96W7D | 16QAM | 0.230 | 23.61 |
| | | 8M99W7D | 64QAM | 0.185 | 22.66 |
| LTE – Band 41 (15) | 2503.5 – 2682.5 | 13M4G7D | QPSK | 0.244 | 23.88 |
| | | 13M5W7D | 16QAM | 0.200 | 23.02 |
| | | 13M4W7D | 64QAM | 0.160 | 22.04 |
| LTE – Band 41 (20) | 2506.0 – 2680.0 | 18M0G7D | QPSK | 0.263 | 24.20 |
| | | 17M9W7D | 16QAM | 0.217 | 23.36 |
| | | 17M9W7D | 64QAM | 0.172 | 22.35 |

# 2. INTRODUCTION

## 2.1. DESCRIPTION OF EUT

The EUT was a Tablet with GSM/GPRS/EGPRS/UMTS and LTE.
It also supports IEEE 802.11 a/b/g/n/ac (HT20/40/80), ANT+, Bluetooth, BT LE.

## 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<br>- ANSI C63.26-2015 – Section 5.4.4 |
| Channel Edge | - KDB 971168 D01 v03r01 – Section 6.0<br>- ANSI C63.26-2015 – Section 5.7 |
| Spurious and Harmonic Emissions at Antenna Terminal | - KDB 971168 D01 v03r01 – Section 6.0<br>- 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<br>- ANSI C63.26-2015 – Section 5.2.3.4<br>- ANSI C63.26-2015 – Section 5.2.6(only GSM) |
| Frequency stability | - ANSI C63.26-2015 – Section 5.6 |
| Effective Radiated Power/<br>Effective Isotropic Radiated Power | - KDB 971168 D01 v03r01 – Section 5.2 & 5.8<br>- ANSI/TIA-603-E-2016 – Section 2.2.17 |
| Radiated Spurious and Harmonic Emissions | - KDB 971168 D01 v03r01 – Section 6.2<br>- ANSI/TIA-603-E-2016 – Section 2.2.12 |

## 3.2 RADIATED POWER

Test Overview

Radiated tests are performed in the Fully-anechoic chamber.

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

Test Settings

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

Test Note

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

   The power is calculated by the following formula;

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

   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

These steps are repeated with the receiving antenna in both vertical and horizontal polarization. the difference between the gain of the horn and an isotropic antenna are taken into consideration

4. The EUT was tested in three orthogonal planes(X, Y, Z) and in all possible test configurations and positioning.
5. All measurements are performed as RMS average measurements while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies.

## 3.3 RADIATED SPURIOUS EMISSIONS

Test Overview

Radiated tests are performed in the Fully-anechoic chamber.

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

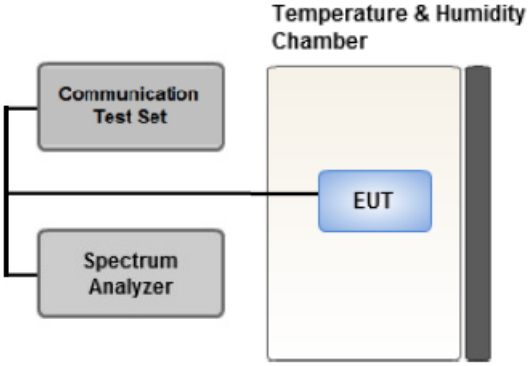
Test Settings

1. RBW = 100kHz for emissions below 1GHz and 1MHz for emissions above 1GHz
2. VBW ≥ 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

## 3.4 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 $P_{Pk}$.

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:

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

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:

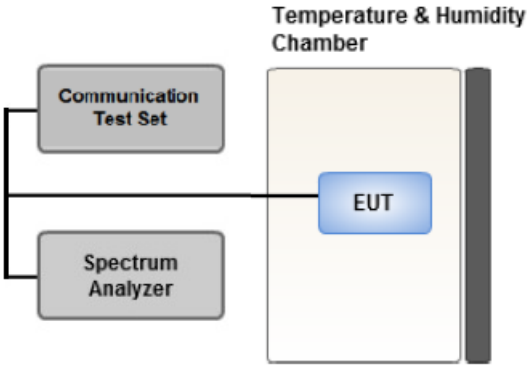
   Set ≥ [10 × (number of points in sweep) × (transmission period)] for single sweep

   (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

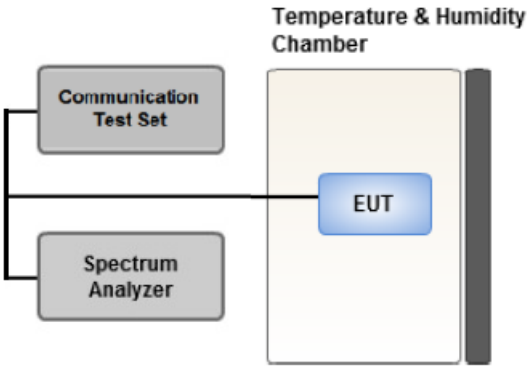
The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5 % of the total mean power of a given emission.

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 26dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 1 – 5% of the expected OBW
3. VBW ≥ 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

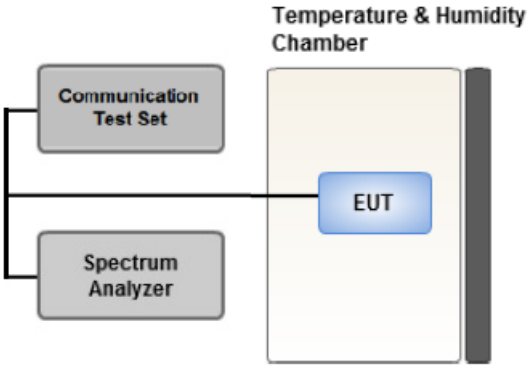
Test Overview

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 = Peak
4. Trace Mode = max hold
5. Sweep time = auto
6. Number of points in sweep ≥ 2 * Span / RBW

## 3.7 CHANNEL 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 channel 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 > 2% 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

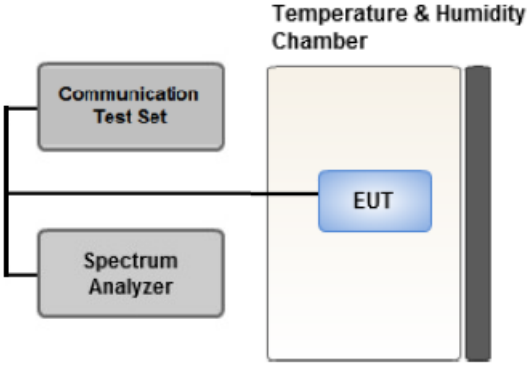
Test Notes

1. The attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz

channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz.

2. All measurements were done at 3 channels.
3. The channel edge measurement used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.

## 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.
- 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.
- All modes of operation were investigated and the worst case configuration results are reported.
- SM-T725 & additional models were tested and the worst case results are reported.
  (Worst case : SM-T725)
- SM-T725 with Stand alone&Keyboard&Charging pad were tested and the worst case results are reported.
  (Worst case : Stand alone)

[ Worst case ]

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

## 3.10 WORST CASE(CONDUCTED TEST)

- Worst case : Of all modulation, We have tested modulation of the high Conducted Output Power.
  Conducted Output Power value can be confirmed on the SAR report.
- SM-T725 & additional models were tested and the worst case results are reported.
  (Worst case : SM-T725)

[ Worst case ]

| Test Description | Modulation | Bandwidth (MHz) | Frequency | RB size | RB offset |
|---|---|---|---|---|---|
| Occupied Bandwidth | QPSK, 16QAM, 64QAM | 5, 10, 15, 20 | Mid | Full RB | 0 |
| Peak-To-Average Radio | QPSK, 16QAM, 64QAM | 5, 10, 15, 20 | Mid | Full RB | 0 |
| Channel Edge | QPSK | 5 | Low | 1 | 0 |
| | | | High | 1 | 24 |
| | | 10 | Low | 1 | 0 |
| | | | High | 1 | 49 |
| | | 15 | Low | 1 | 0 |
| | | | High | 1 | 74 |
| | | 20 | Low | 1 | 0 |
| | | | High | 1 | 99 |
| | | 5, 10, 15, 20 | Low, Mid, High | Full RB | 0 |
| Spurious and Harmonic Emissions at Antenna Terminal | QPSK | 5, 10, 15, 20 | Low, Mid, High | 1 | 0 |

## 4. LIST OF TEST EQUIPMENT

| Manufacture | Model/ Equipment | Serial Number | Calibration Date | Calibration Interval | Calibration Due |
|---|---|---|---|---|---|
| REOHDE & SCHWARZ | SCU 18 / AMPLIFIER | 10094 | 04/16/2019 | Annual | 04/16/2020 |
| Wainwright | WHK1.2/15G-10EF/H.P.F | 4 | 04/02/2019 | Annual | 04/02/2020 |
| Wainwright | WHK3.3/18G-10EF/H.P.F | 2 | 04/02/2019 | Annual | 04/02/2020 |
| Hewlett Packard | 11667B / Power Splitter(DC~26.5 GHz) | 11275 | 05/03/2019 | Annual | 05/03/2020 |
| Agilent | E3632A/DC Power Supply | MY40004326 | 07/05/2018 | Annual | 07/05/2019 |
| Schwarzbeck | UHAP/ Dipole Antenna | 557 | 03/29/2019 | Biennial | 03/29/2021 |
| Schwarzbeck | UHAP/ Dipole Antenna | 558 | 03/29/2019 | Biennial | 03/29/2021 |
| ESPEC | SU-642 / Chamber | 93000718 | 08/07/2018 | Annual | 08/07/2019 |
| Schwarzbeck | BBHA 9120D/ Horn Antenna(1~18GHz) | 147 | 09/14/2018 | Annual | 09/14/2019 |
| Schwarzbeck | BBHA 9120D/ Horn Antenna(1~18GHz) | 9120D-1298 | 10/04/2018 | Annual | 10/04/2019 |
| Schwarzbeck | BBHA 9170/ Horn Antenna(15~40GHz) | BBHA9170342 | 04/29/2019 | Biennial | 04/29/2021 |
| Schwarzbeck | BBHA 9170/ Horn Antenna(15~40GHz) | BBHA9170124 | 01/28/2019 | Biennial | 01/28/2021 |
| Agilent | N9020A/Signal Analyzer(10Hz~26.5GHz) | MY51110063 | 05/08/2019 | Annual | 05/08/2020 |
| Hewlett Packard | 8493C/ATTENUATOR(20dB) | 17280 | 06/21/2018 | Annual | 06/21/2019 |
| REOHDE & SCHWARZ | FSV40/Spectrum Analyzer(10Hz~40GHz) | 100931 | 10/22/2018 | Annual | 10/22/2019 |
| Agilent | 8960 (E5515C)/ Base Station | MY48360800 | 09/27/2018 | Annual | 09/27/2019 |
| Schwarzbeck | FMZB1513/ Loop Antenna(9kHz~30MHz) | 1513-175 | 08/23/2018 | Biennial | 08/23/2020 |
| Schwarzbeck | VULB9160/ Bilog Antenna | 9160-3368 | 08/09/2018 | Biennial | 08/09/2020 |
| Schwarzbeck | VULB9160/ Hybrid Antenna | 760 | 03/22/2019 | Biennial | 03/22/2021 |
| Anritsu Corp. | MT8821C/Wideband Radio Communication Tester | 6201502997 | 08/13/2018 | Annual | 08/13/2019 |
| Anritsu Corp. | MT8820C/Wideband Radio Communication Tester | 6201026545 | 01/30/2019 | Annual | 01/30/2020 |
| REOHDE & SCHWARZ | SMB100A/ SIGNAL GENERATOR (100kHz~40GHz) | 177633 | 07/19/2018 | Annual | 07/19/2019 |
| REOHDE & SCHWARZ | ESU40 / EMI TEST RECEIVER | 100524 | 07/27/2018 | Annual | 07/27/2019 |
| HCT CO., LTD., | FCC LTE Mobile Conducted RF Automation Test Software | - | - | - | - |

Note:

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

# 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 | E |
|---|---|
| Conducted Disturbance (150 kHz ~ 30 MHz) | 1.82 |
| Radiated Disturbance (9 kHz ~ 30 MHz) | 3.40 |
| Radiated Disturbance (30 MHz ~ 1 GHz) | 4.80 |
| Radiated Disturbance (1 GHz ~ 18 GHz) | 5.70 |
| Radiated Disturbance (18 GHz ~ 40 GHz) | 5.71 |

# 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(m)(4) | ■ < 40 + 10log10 (P[Watts]) at Channel edges<br>■ < 43 + 10log10 (P[Watts]) between 5 and X MHz from Channel edges<br>■ < 55 + 10log10 (P[Watts]) beyond X MHz beyond from Channel edges<br>■ < 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz | PASS |
| Conducted Output Power | § 2.1046 | N/A | See Note1 |
| Frequency stability / variation of ambient temperature | § 2.1055, § 27.54 | Emission must remain in band | PASS |

Note:

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

## 6.2 Test Condition : Radiated Test

| Test Description | FCC Part Section(s) | Test Limit | Test Result |
|---|---|---|---|
| Equivalent Isotropic Radiated Power | § 27.50(h)(2) | < 2 Watts max. EIRP | PASS |
| Radiated Spurious and Harmonic Emissions | § 2.1053, § 27.53(m)(4) | < 55 + 10log10 (P[Watts]) | 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 |
| 40620 | 2593.0 | -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

16QAM Modulation

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

64QAM Modulation

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

# 8. TEST DATA

## 8.1 EQUIVALENT ISOTROPIC RADIATED POWER

| Freq (MHz) | Bandwidth | Modulation | Measured Level (dBm) | Substitute Level (dBm) | Ant. Gain(dBi) | C.L | Pol | Limit | EIRP | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | W | W | dBm |
| 2498.5 | LTE B41/ 5 MHz | QPSK | -20.86 | 13.78 | 10.98 | 1.60 | H | < 2.00 | 0.207 | 23.16 |
| | | 16-QAM | -21.81 | 12.83 | 10.98 | 1.60 | H | | 0.166 | 22.21 |
| | | 64-QAM | -22.78 | 11.86 | 10.98 | 1.60 | H | | 0.133 | 21.24 |
| 2593.0 | | QPSK | -21.28 | 13.47 | 11.06 | 1.63 | H | | 0.195 | 22.90 |
| | | 16-QAM | -22.20 | 12.55 | 11.06 | 1.63 | H | | 0.158 | 21.98 |
| | | 64-QAM | -23.22 | 11.53 | 11.06 | 1.63 | H | | 0.125 | 20.96 |
| 2687.5 | | QPSK | -20.28 | 15.00 | 11.15 | 1.65 | H | | 0.282 | 24.50 |
| | | 16-QAM | -21.14 | 14.14 | 11.15 | 1.65 | H | | 0.231 | 23.64 |
| | | 64-QAM | -22.07 | 13.21 | 11.15 | 1.65 | H | | 0.187 | 22.71 |

| Freq (MHz) | Bandwidth | Modulation | Measured Level (dBm) | Substitute Level (dBm) | Ant. Gain(dBi) | C.L | Pol | Limit | EIRP | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | W | W | dBm |
| 2501.0 | LTE B41/ 10 MHz | QPSK | -20.85 | 13.79 | 10.98 | 1.60 | H | < 2.00 | 0.208 | 23.17 |
| | | 16-QAM | -21.80 | 12.84 | 10.98 | 1.60 | H | | 0.167 | 22.22 |
| | | 64-QAM | -22.76 | 11.88 | 10.98 | 1.60 | H | | 0.134 | 21.26 |
| 2593.0 | | QPSK | -21.37 | 13.38 | 11.06 | 1.63 | H | | 0.191 | 22.81 |
| | | 16-QAM | -22.21 | 12.54 | 11.06 | 1.63 | H | | 0.157 | 21.97 |
| | | 64-QAM | -23.24 | 11.51 | 11.06 | 1.63 | H | | 0.124 | 20.94 |
| 2685.0 | | QPSK | -20.20 | 14.96 | 11.15 | 1.65 | H | | 0.279 | 24.46 |
| | | 16-QAM | -21.05 | 14.11 | 11.15 | 1.65 | H | | 0.230 | 23.61 |
| | | 64-QAM | -22.00 | 13.16 | 11.15 | 1.65 | H | | 0.185 | 22.66 |

| Freq (MHz) | Bandwidth | Modulation | Measured Level (dBm) | Substitute Level (dBm) | Ant. Gain(dBi) | C.L | Pol | Limit | EIRP | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | W | W | dBm |
| 2503.5 | LTE B41/ 15 MHz | QPSK | -20.84 | 13.73 | 10.98 | 1.61 | H | < 2.00 | 0.204 | 23.10 |
| | | 16-QAM | -21.78 | 12.79 | 10.98 | 1.61 | H | | 0.164 | 22.16 |
| | | 64-QAM | -22.75 | 11.82 | 10.98 | 1.61 | H | | 0.131 | 21.19 |
| 2593.0 | | QPSK | -21.18 | 13.57 | 11.06 | 1.63 | H | | 0.200 | 23.00 |
| | | 16-QAM | -22.09 | 12.66 | 11.06 | 1.63 | H | | 0.162 | 22.09 |
| | | 64-QAM | -23.10 | 11.65 | 11.06 | 1.63 | H | | 0.128 | 21.08 |
| 2682.5 | | QPSK | -20.66 | 14.37 | 11.15 | 1.64 | H | | 0.244 | 23.88 |
| | | 16-QAM | -21.52 | 13.51 | 11.15 | 1.64 | H | | 0.200 | 23.02 |
| | | 64-QAM | -22.50 | 12.53 | 11.15 | 1.64 | H | | 0.160 | 22.04 |

| Freq (MHz) | Bandwidth | Modulation | Measured Level (dBm) | Substitute Level (dBm) | Ant. Gain(dBi) | C.L | Pol | Limit | EIRP | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | W | W | dBm |
| 2506.0 | LTE B41/ 20 MHz | QPSK | -20.89 | 13.68 | 10.98 | 1.61 | H | < 2.00 | 0.202 | 23.05 |
| | | 16-QAM | -21.79 | 12.78 | 10.98 | 1.61 | H | | 0.164 | 22.15 |
| | | 64-QAM | -22.77 | 11.80 | 10.98 | 1.61 | H | | 0.131 | 21.17 |
| 2593.0 | | QPSK | -21.70 | 13.05 | 11.06 | 1.63 | H | | 0.177 | 22.48 |
| | | 16-QAM | -22.57 | 12.18 | 11.06 | 1.63 | H | | 0.145 | 21.61 |
| | | 64-QAM | -23.56 | 11.19 | 11.06 | 1.63 | H | | 0.115 | 20.62 |
| 2680.0 | | QPSK | -20.34 | 14.69 | 11.15 | 1.64 | H | | 0.263 | 24.20 |
| | | 16-QAM | -21.18 | 13.85 | 11.15 | 1.64 | H | | 0.217 | 23.36 |
| | | 64-QAM | -22.19 | 12.84 | 11.15 | 1.64 | H | | 0.172 | 22.35 |

## 8.2 RADIATED SPURIOUS EMISSIONS

▣ OPERATING FREQUENCY : 2687.50 MHz

▣ MEASURED OUTPUT POWER: 24.50 dBm = 0.282 W

▣ MODE: LTE B41

▣ MODULATION SIGNAL: 5 MHz QPSK

▣ DISTANCE: 1 meters

▣ LIMIT: 55 + 10 log10 (W) = 48.50 dBc

| Ch | Freq (MHz) | Measured Level (dBm) | Ant. Gain (dBi) | Substitute Level (dBm) | C.L | Pol | EIRP (dBm) | dBc |
|---|---|---|---|---|---|---|---|---|
| 39675 (2498.5) | 4,997.00 | -47.58 | 12.89 | -61.27 | 2.47 | V | -50.85 | 75.36 |
| | 7,495.50 | -37.27 | 11.51 | -44.01 | 2.97 | V | -35.47 | 59.97 |
| | 9,994.00 | -45.82 | 11.21 | -48.27 | 3.48 | H | -40.54 | 65.05 |
| 40620 (2593.0) | 5,186.00 | -47.38 | 13.05 | -59.98 | 2.58 | H | -49.51 | 74.01 |
| | 7,779.00 | -41.47 | 11.98 | -48.99 | 2.93 | V | -39.94 | 64.45 |
| | 10,372.00 | -45.69 | 10.96 | -48.68 | 3.62 | H | -41.34 | 65.84 |
| 41565 (2687.5) | 5,375.00 | -41.87 | 13.49 | -55.15 | 2.65 | V | -44.31 | 68.82 |
| | 8,062.50 | -41.41 | 11.46 | -46.23 | 3.05 | H | -37.82 | 62.32 |
| | 10,750.00 | -47.31 | 10.99 | -50.21 | 3.67 | H | -42.89 | 67.39 |

▣ OPERATING FREQUENCY : 2685.00 MHz

▣ MEASURED OUTPUT POWER: 24.46 dBm = 0.279 W

▣ MODE: LTE B41

▣ MODULATION SIGNAL: 10 MHz QPSK

▣ DISTANCE: 1 meters

▣ LIMIT: 55 + 10 log10 (W) = 49.46 dBc

| Ch | Freq (MHz) | Measured Level (dBm) | Ant. Gain (dBi) | Substitute Level (dBm) | C.L | Pol | EIRP (dBm) | dBc |
|---|---|---|---|---|---|---|---|---|
| 39700 (2501.0) | 5,002.00 | -47.38 | 12.89 | -61.07 | 2.47 | H | -50.65 | 75.12 |
| | 7,503.00 | -38.12 | 11.53 | -44.55 | 2.92 | H | -35.95 | 60.41 |
| | 10,004.00 | -47.92 | 11.25 | -50.76 | 3.41 | V | -42.92 | 67.38 |
| 40620 (2593.0) | 5,186.00 | -46.82 | 13.05 | -59.42 | 2.58 | H | -48.95 | 73.41 |
| | 7,779.00 | -40.71 | 11.98 | -48.23 | 2.93 | H | -39.18 | 63.64 |
| | 10,372.00 | -47.47 | 10.96 | -50.46 | 3.62 | H | -43.12 | 67.58 |
| 41540 (2685.0) | 5,370.00 | -41.94 | 13.50 | -55.52 | 2.65 | H | -44.67 | 69.13 |
| | 8,055.00 | -41.35 | 11.46 | -46.24 | 3.05 | H | -37.84 | 62.30 |
| | 10,740.00 | -47.11 | 10.98 | -49.92 | 3.62 | H | -42.56 | 67.02 |

▣ OPERATING FREQUENCY : 2682.50 MHz

▣ MEASURED OUTPUT POWER: 23.88 dBm = 0.244 W

▣ MODE: LTE B41

▣ MODULATION SIGNAL: 15 MHz QPSK

▣ DISTANCE: 1 meters

▣ LIMIT: 55 + 10 log10 (W) = 48.88 dBc

| Ch | Freq (MHz) | Measured Level (dBm) | Ant. Gain (dBi) | Substitute Level (dBm) | C.L | Pol | EIRP (dBm) | dBc |
|---|---|---|---|---|---|---|---|---|
| 39725 (2503.5) | 5,007.00 | -49.74 | 12.86 | -63.87 | 2.49 | H | -53.50 | 77.38 |
| | 7,510.50 | -37.81 | 11.54 | -43.95 | 2.90 | V | -35.31 | 59.19 |
| | 10,014.00 | -47.69 | 11.27 | -50.85 | 3.40 | V | -42.99 | 66.86 |
| | 12,517.50 | -53.24 | 14.23 | -57.55 | 4.05 | V | -47.37 | 71.25 |
| 40620 (2593.0) | 5,186.00 | -46.73 | 13.05 | -59.33 | 2.58 | H | -48.86 | 72.74 |
| | 7,779.00 | -39.87 | 11.98 | -47.39 | 2.93 | V | -38.34 | 62.22 |
| | 10,372.00 | -47.80 | 10.96 | -50.79 | 3.62 | H | -43.45 | 67.33 |
| 41515 (2682.5) | 5,365.00 | -42.57 | 13.51 | -56.22 | 2.64 | H | -45.35 | 69.23 |
| | 8,047.50 | -43.03 | 11.45 | -48.00 | 3.05 | H | -39.60 | 63.48 |
| | 10,730.00 | -48.65 | 10.98 | -51.46 | 3.60 | H | -44.08 | 67.96 |

▣ OPERATING FREQUENCY : 2680.00 MHz

▣ MEASURED OUTPUT POWER: 24.20 dBm = 0.263 W

▣ MODE: LTE B41

▣ MODULATION SIGNAL: 20 MHz QPSK

▣ DISTANCE: 1 meters

▣ LIMIT: 55 + 10 log10 (W) = 49.20 dBc

| Ch | Freq (MHz) | Measured Level (dBm) | Ant. Gain (dBi) | Substitute Level (dBm) | C.L | Pol | EIRP (dBm) | dBc |
|---|---|---|---|---|---|---|---|---|
| 39750 (2506.0) | 5,012.00 | -49.92 | 12.86 | -64.05 | 2.49 | H | -53.68 | 77.88 |
| | 7,518.00 | -38.25 | 11.57 | -43.56 | 2.93 | H | -34.92 | 59.12 |
| | 10,024.00 | -48.48 | 11.29 | -51.31 | 3.48 | H | -43.49 | 67.69 |
| 40620 (2593.0) | 5,186.00 | -48.30 | 13.05 | -60.90 | 2.58 | H | -50.43 | 74.63 |
| | 7,779.00 | -38.40 | 11.98 | -45.92 | 2.93 | H | -36.87 | 61.07 |
| | 10,372.00 | -47.69 | 10.96 | -50.68 | 3.62 | V | -43.34 | 67.54 |
| 41490 (2680.0) | 5,360.00 | -43.58 | 13.51 | -57.30 | 2.63 | H | -46.42 | 70.62 |
| | 8,040.00 | -42.51 | 11.46 | -47.41 | 3.06 | H | -39.01 | 63.20 |
| | 10,720.00 | -49.16 | 10.97 | -51.79 | 3.66 | V | -44.48 | 68.68 |

## 8.3 PEAK-TO-AVERAGE RATIO

| Band | Band Width | Frequency (MHz) | Modulation | Resource Block Size | Resource Block Offset | Data (dB ) |
|---|---|---|---|---|---|---|
| 41 | 5 MHz | 2593.0 | QPSK | 25 | 0 | 4.90 |
| | | | 16-QAM | | | 6.05 |
| | | | 64-QAM | | | 6.53 |
| | 10 MHz | | QPSK | 50 | | 4.97 |
| | | | 16-QAM | | | 6.08 |
| | | | 64-QAM | | | 6.58 |
| | 15 MHz | | QPSK | 75 | | 4.83 |
| | | | 16-QAM | | | 6.03 |
| | | | 64-QAM | | | 6.59 |
| | 20 MHz | | QPSK | 100 | | 4.85 |
| | | | 16-QAM | | | 5.97 |
| | | | 64-QAM | | | 6.55 |

Note:

1. Plots of the EUT's Peak- to- Average Ratio are shown Page 73 ~ 84.

## 8.4 OCCUPIED BANDWIDTH

| Band | Band Width | Frequency (MHz) | Modulation | Resource Block Size | Resource Block Offset | Data ( MHz ) |
|---|---|---|---|---|---|---|
| 41 | 5 MHz | 2593.0 | QPSK | 25 | 0 | 4.5068 |
| | | | 16-QAM | | | 4.4947 |
| | | | 64-QAM | | | 4.5110 |
| | 10 MHz | | QPSK | 50 | | 8.9475 |
| | | | 16-QAM | | | 8.9631 |
| | | | 64-QAM | | | 8.9886 |
| | 15 MHz | | QPSK | 75 | | 13.418 |
| | | | 16-QAM | | | 13.453 |
| | | | 64-QAM | | | 13.414 |
| | 20 MHz | | QPSK | 100 | | 17.956 |
| | | | 16-QAM | | | 17.874 |
| | | | 64-QAM | | | 17.895 |

Note:

1. Plots of the EUT's Occupied Bandwidth are shown Page 61 ~ 72.

## 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) |
|---|---|---|---|---|---|---|---|
| 41 | 5 | 2498.5 | 26.2352 | 30.131 | -66.733 | -36.602 | -25.00 |
| | | 2593.0 | 25.9130 | 30.131 | -66.093 | -35.962 | |
| | | 2687.5 | 25.8173 | 27.976 | -66.476 | -38.500 | |
| | 10 | 2501.0 | 25.8359 | 30.131 | -66.125 | -35.994 | |
| | | 2593.0 | 25.9637 | 30.131 | -66.914 | -36.783 | |
| | | 2685.0 | 26.1184 | 30.131 | -66.641 | -36.510 | |
| | 15 | 2503.5 | 25.1643 | 30.131 | -66.919 | -36.788 | |
| | | 2593.0 | 26.1551 | 30.131 | -66.499 | -36.368 | |
| | | 2682.5 | 5.3789 | 28.591 | -66.731 | -38.140 | |
| | 20 | 2506.0 | 26.3696 | 30.131 | -66.489 | -36.358 | |
| | | 2593.0 | 26.4794 | 30.131 | -66.921 | -36.790 | |
| | | 2680.0 | 3.6935 | 27.976 | -66.548 | -38.572 | |

Note:

1. Plots of the EUT's Conducted Spurious Emissions are shown Page 113 ~ 140.
2. Conducted Spurious Emissions was Tested QPSK Modulation, Resource Block Size 1 and Resource Block Offset 0
3. Result (dBm) = Measurement Maximum Data (dBm) + Factor (dB)
4. Factor(dB) = Cable Loss + Attenuator + Power Splitter

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

8.6 CHANNEL EDGE

| Band Width | Frequency (MHz) | Modulation | RB (Size/ Offset) | 2 495 MHz ~ 2 496 MHz | C.E ~ (C.E +1MHz) | 2 490.5 MHz ~ 2 495 MHz | (C.E + 1 MHz) ~ (C.E + 5 MHz) | Below 2 490.5 MHz | (C.E + 5 MHz) ~ (C.E + X MHz) | Above (C.E + X MHz) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Lower | Upper | Lower | Upper | Lower | Upper | Upper |
| 5 MHz | 2498.5 | QPSK | 25/0 | -25.37 | -25.07 | -26.27 | -24.65 | -36.47 | -35.58 | -35.84 |
| 10 MHz | 2501.0 | QPSK | 50/0 | -25.42 | -25.90 | -28.62 | -25.64 | -31.59 | -30.08 | -38.97 |
| 15 MHz | 2503.5 | QPSK | 75/0 | -27.05 | -26.00 | -30.15 | -27.08 | -32.82 | -29.43 | -41.16 |
| 20 MHz | 2506.0 | QPSK | 100/0 | -27.13 | -25.54 | -30.25 | -28.03 | -33.02 | -29.39 | -42.50 |
| Limit | | | | -13.0 | -10.0 | -13.0 | -10.0 | -25.0 | -13.0 | -25.0 |

| Band Width | Frequency (MHz) | Modulation | Resource Block Size | Resoure Block Offset | C.E ~ (C.E ± 1MHz) | | (C.E ± 1 MHz) ~ (C.E ± 5 MHz) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower | Upper | Lower | Upper |
| 5 MHz | 2593.0 | QPSK | 25 | 0 | -26.45 | -26.39 | -31.46 | -34.11 |
| | 2687.5 | QPSK | 25 | 0 | -27.02 | -26.52 | -24.25 | -25.13 |
| 10 MHz | 2593.0 | QPSK | 50 | 0 | -28.36 | -28.18 | -30.40 | -33.70 |
| | 2685.0 | QPSK | 50 | 0 | -29.22 | -29.34 | -24.74 | -26.08 |
| 15 MHz | 2593.0 | QPSK | 75 | 0 | -28.22 | -28.87 | -32.18 | -34.73 |
| | 2682.5 | QPSK | 75 | 0 | -26.01 | -25.89 | -22.25 | -22.28 |
| 20 MHz | 2593.0 | QPSK | 100 | 0 | -28.11 | -28.62 | -30.67 | -33.62 |
| | 2680.0 | QPSK | 100 | 0 | -25.38 | -25.93 | -21.74 | -22.53 |
| Limit | | | | | -10.0 | | -10.0 | |

| Band Width | Frequency (MHz) | Modulation | Resource Block Size | Resoure Block Offset | (C.E ± 5 MHz) ~ (C.E ± X MHz) | | Above (C.E ± X MHz) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower | Upper | Lower | Upper |
| 5 MHz | 2593.0 | QPSK | 25 | 0 | -39.77 | -40.21 | -40.42 | -40.88 |
| | 2687.5 | QPSK | 25 | 0 | -41.21 | -39.80 | -42.94 | -42.40 |
| 10 MHz | 2593.0 | QPSK | 50 | 0 | -36.55 | -35.81 | -41.37 | -41.15 |
| | 2685.0 | QPSK | 50 | 0 | -30.09 | -30.97 | -45.18 | -42.46 |
| 15 MHz | 2593.0 | QPSK | 75 | 0 | -33.95 | -34.92 | -41.28 | -40.83 |
| | 2682.5 | QPSK | 75 | 0 | -25.19 | -25.24 | -45.34 | -43.70 |
| 20 MHz | 2593.0 | QPSK | 100 | 0 | -33.47 | -34.96 | -42.58 | -41.73 |
| | 2680.0 | QPSK | 100 | 0 | -24.87 | -24.77 | -44.65 | -46.47 |
| Limit | | | | | -13.0 | | -25.0 | |

Note:

1. C.E = Channel Edge
2. X = X is the greater of 6MHz or the actual emission bandwidth.
3. X = 6MHz(5MHz Bandwidth), 10MHz(10MHz Bandwidth), 15MHz(15MHz Bandwidth), 20MHz(20MHz Bandwidth)
4. Plots of the EUT's Channel Edge are shown Page 85 ~ 112. (1RB & Full RB)

## 8.7 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE

▣ MODE: LTE 41

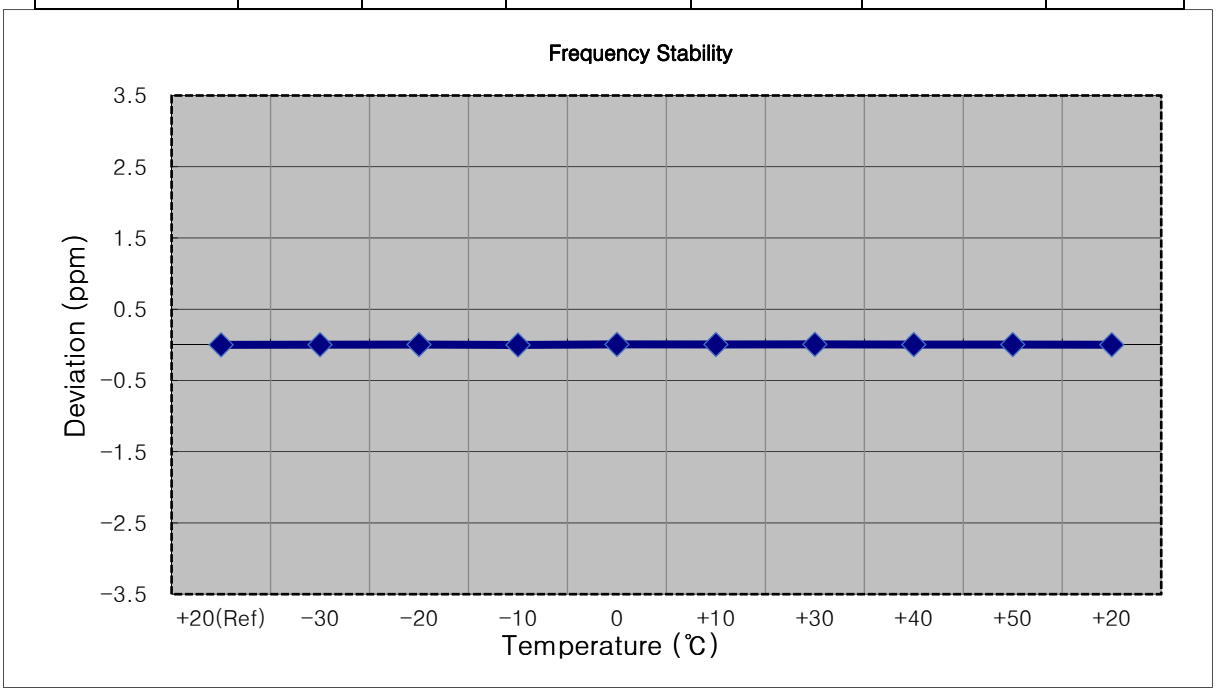
▣ OPERATING FREQUENCY: 2498,500,000 Hz

▣ BANDWIDTH: 39675 (5 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2498 500 006 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2498 500 011 | 5.4 | 0.000 000 | 0.002 |
| 100% | | -20 | 2498 500 016 | 10.0 | 0.000 000 | 0.004 |
| 100% | | -10 | 2498 500 002 | -3.6 | 0.000 000 | -0.001 |
| 100% | | 0 | 2498 500 022 | 16.0 | 0.000 001 | 0.006 |
| 100% | | +10 | 2498 500 018 | 12.5 | 0.000 001 | 0.005 |
| 100% | | +30 | 2498 500 023 | 16.7 | 0.000 001 | 0.007 |
| 100% | | +40 | 2498 500 015 | 9.3 | 0.000 000 | 0.004 |
| 100% | | +50 | 2498 500 016 | 10.0 | 0.000 000 | 0.004 |
| 85% | 3.400 | +20 | 2498 500 010 | 3.9 | 0.000 000 | 0.002 |



▣ MODE: LTE 41

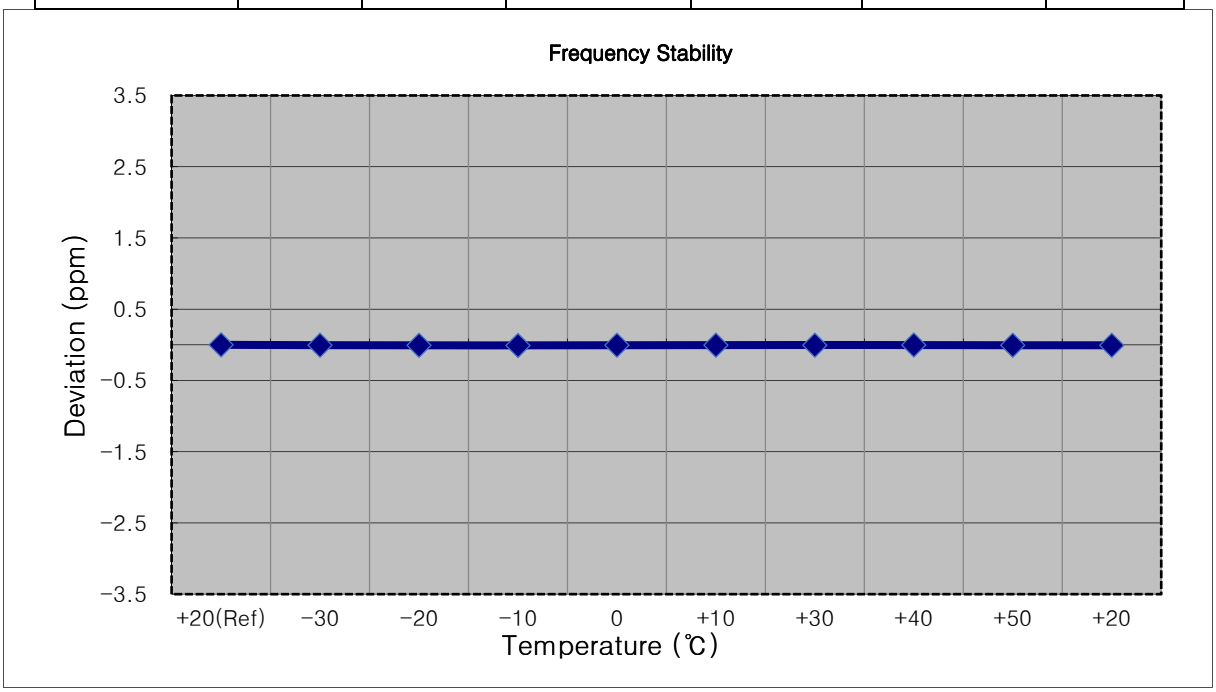
▣ OPERATING FREQUENCY: 2501,000,000 Hz

▣ BANDWIDTH: 39700 (10 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2500 999 991 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2500 999 977 | -14.0 | -0.000 001 | -0.006 |
| 100% | | -20 | 2500 999 975 | -15.9 | -0.000 001 | -0.006 |
| 100% | | -10 | 2500 999 968 | -23.0 | -0.000 001 | -0.009 |
| 100% | | 0 | 2500 999 978 | -12.1 | 0.000 000 | -0.005 |
| 100% | | +10 | 2500 999 981 | -9.5 | 0.000 000 | -0.004 |
| 100% | | +30 | 2500 999 978 | -12.5 | 0.000 000 | -0.005 |
| 100% | | +40 | 2500 999 987 | -3.8 | 0.000 000 | -0.002 |
| 100% | | +50 | 2500 999 976 | -14.7 | -0.000 001 | -0.006 |
| 85% | 3.400 | +20 | 2500 999 974 | -16.2 | -0.000 001 | -0.006 |



▣ MODE: LTE 41

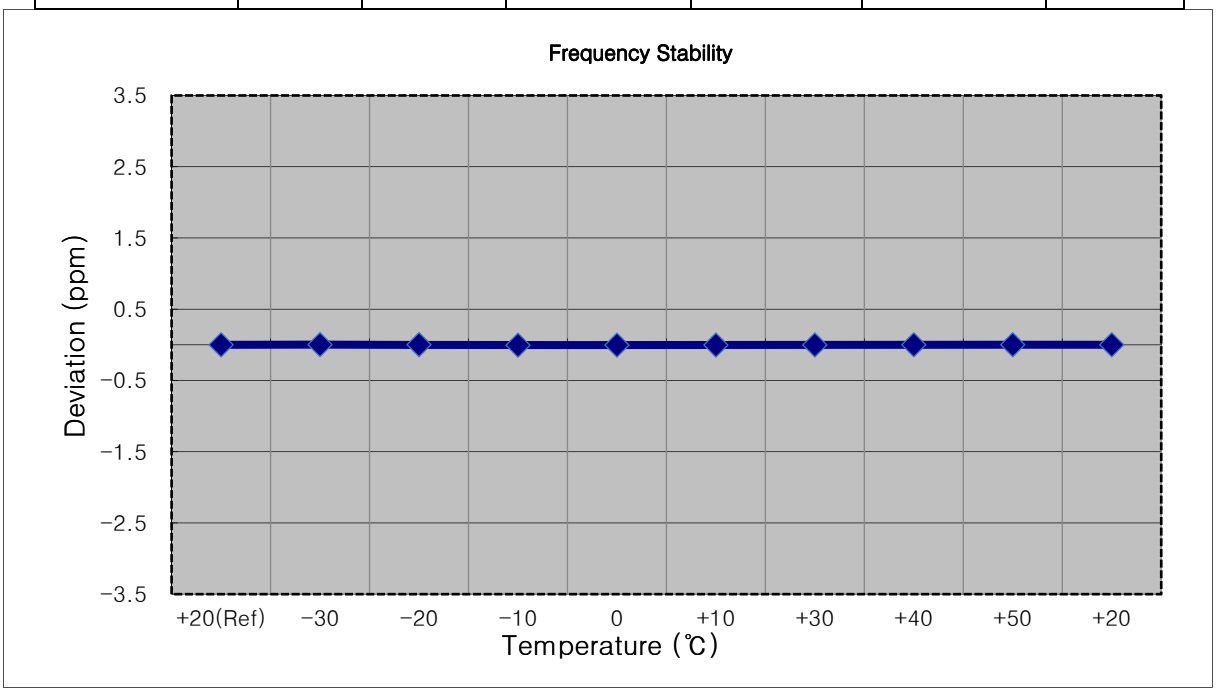
▣ OPERATING FREQUENCY: 2503,500,000 Hz

▣ BANDWIDTH: 39725 (15 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2503 499 995 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2503 500 003 | 8.2 | 0.000 000 | 0.003 |
| 100% | | -20 | 2503 500 001 | 6.4 | 0.000 000 | 0.003 |
| 100% | | -10 | 2503 499 982 | -12.9 | -0.000 001 | -0.005 |
| 100% | | 0 | 2503 499 986 | -8.9 | 0.000 000 | -0.004 |
| 100% | | +10 | 2503 499 987 | -7.4 | 0.000 000 | -0.003 |
| 100% | | +30 | 2503 499 993 | -2.0 | 0.000 000 | -0.001 |
| 100% | | +40 | 2503 499 998 | 3.7 | 0.000 000 | 0.001 |
| 100% | | +50 | 2503 499 999 | 4.0 | 0.000 000 | 0.002 |
| 85% | 3.400 | +20 | 2503 499 997 | 2.2 | 0.000 000 | 0.001 |



▣ MODE: LTE 41

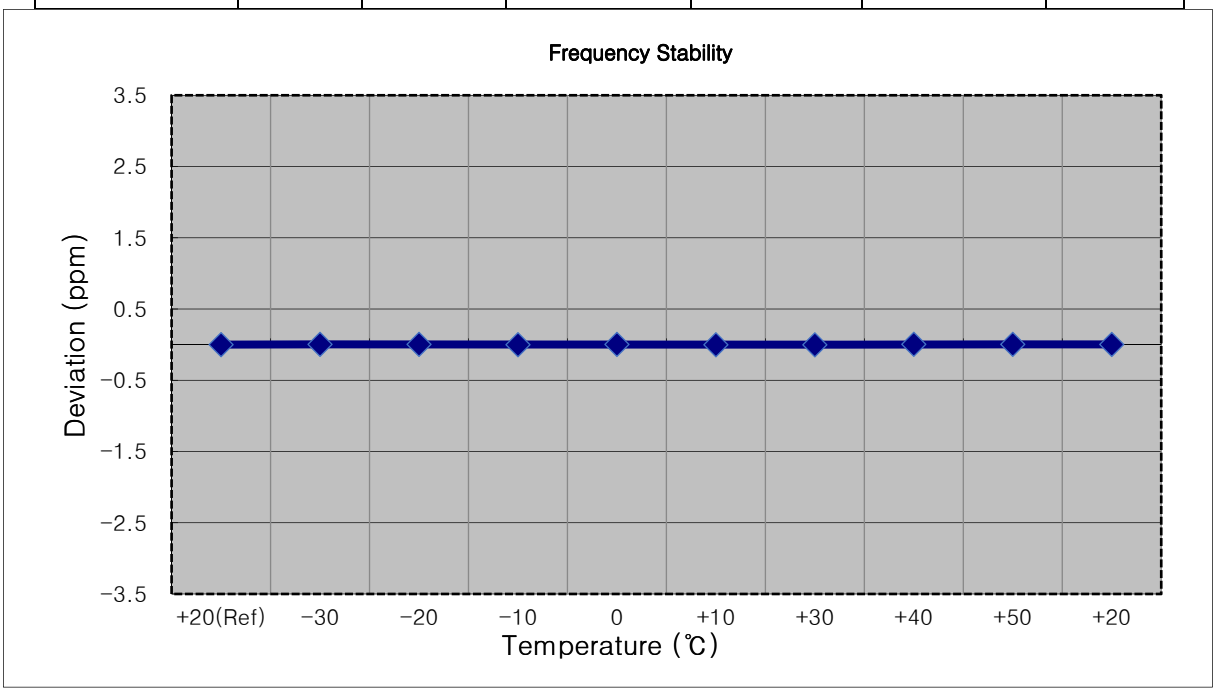
▣ OPERATING FREQUENCY: 2506,000,000 Hz

▣ BANDWIDTH: 39750 (20 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2506 000 012 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2506 000 022 | 10.4 | 0.000 000 | 0.004 |
| 100% | | -20 | 2506 000 023 | 11.6 | 0.000 000 | 0.005 |
| 100% | | -10 | 2506 000 010 | -2.3 | 0.000 000 | -0.001 |
| 100% | | 0 | 2506 000 022 | 10.0 | 0.000 000 | 0.004 |
| 100% | | +10 | 2506 000 009 | -3.3 | 0.000 000 | -0.001 |
| 100% | | +30 | 2506 000 006 | -6.0 | 0.000 000 | -0.002 |
| 100% | | +40 | 2506 000 025 | 12.9 | 0.000 001 | 0.005 |
| 100% | | +50 | 2506 000 023 | 11.0 | 0.000 000 | 0.004 |
| 85% | 3.400 | +20 | 2506 000 020 | 8.2 | 0.000 000 | 0.003 |



▣ MODE: LTE 41

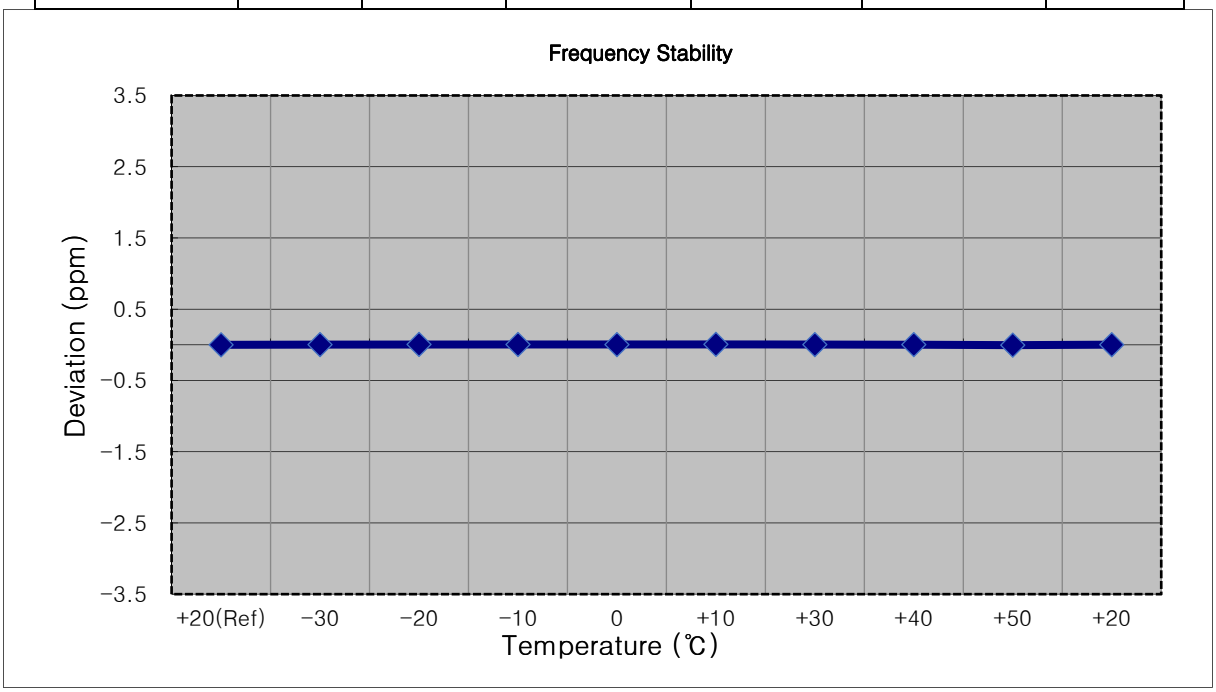
▣ OPERATING FREQUENCY: 2593,000,000 Hz

▣ BANDWIDTH: 40620 (5 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2593 000 019 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2593 000 027 | 8.7 | 0.000 000 | 0.003 |
| 100% | | -20 | 2593 000 035 | 16.9 | 0.000 001 | 0.007 |
| 100% | | -10 | 2593 000 031 | 12.0 | 0.000 000 | 0.005 |
| 100% | | 0 | 2593 000 027 | 8.7 | 0.000 000 | 0.003 |
| 100% | | +10 | 2593 000 037 | 18.9 | 0.000 001 | 0.007 |
| 100% | | +30 | 2593 000 026 | 7.9 | 0.000 000 | 0.003 |
| 100% | | +40 | 2593 000 027 | 8.5 | 0.000 000 | 0.003 |
| 100% | | +50 | 2593 000 008 | -10.9 | 0.000 000 | -0.004 |
| 85% | 3.400 | +20 | 2593 000 024 | 5.0 | 0.000 000 | 0.002 |



▣ MODE: LTE 41

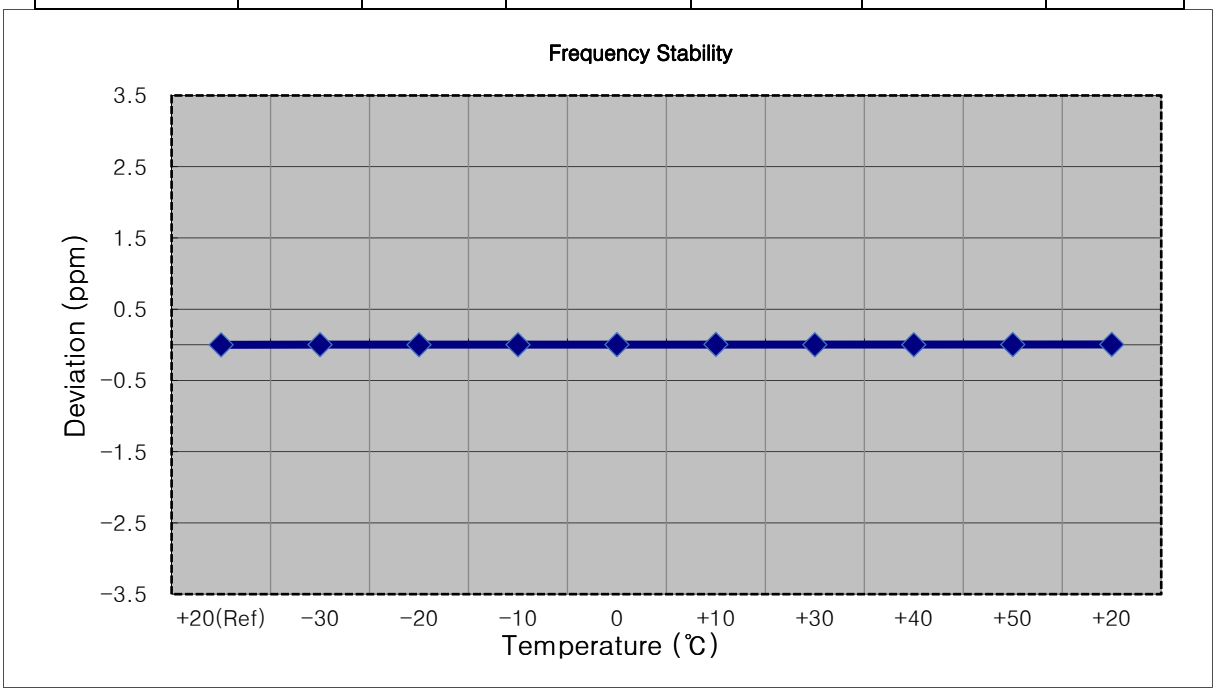
▣ OPERATING FREQUENCY: 2593,000,000 Hz

▣ BANDWIDTH: 40620 (10 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2593 000 008 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2593 000 015 | 6.9 | 0.000 000 | 0.003 |
| 100% | | -20 | 2593 000 011 | 3.1 | 0.000 000 | 0.001 |
| 100% | | -10 | 2593 000 013 | 5.0 | 0.000 000 | 0.002 |
| 100% | | 0 | 2593 000 017 | 9.1 | 0.000 000 | 0.004 |
| 100% | | +10 | 2593 000 024 | 16.1 | 0.000 001 | 0.006 |
| 100% | | +30 | 2593 000 012 | 4.5 | 0.000 000 | 0.002 |
| 100% | | +40 | 2593 000 013 | 5.3 | 0.000 000 | 0.002 |
| 100% | | +50 | 2593 000 019 | 11.2 | 0.000 000 | 0.004 |
| 85% | 3.400 | +20 | 2593 000 022 | 14.5 | 0.000 001 | 0.006 |



▣ MODE: LTE 41

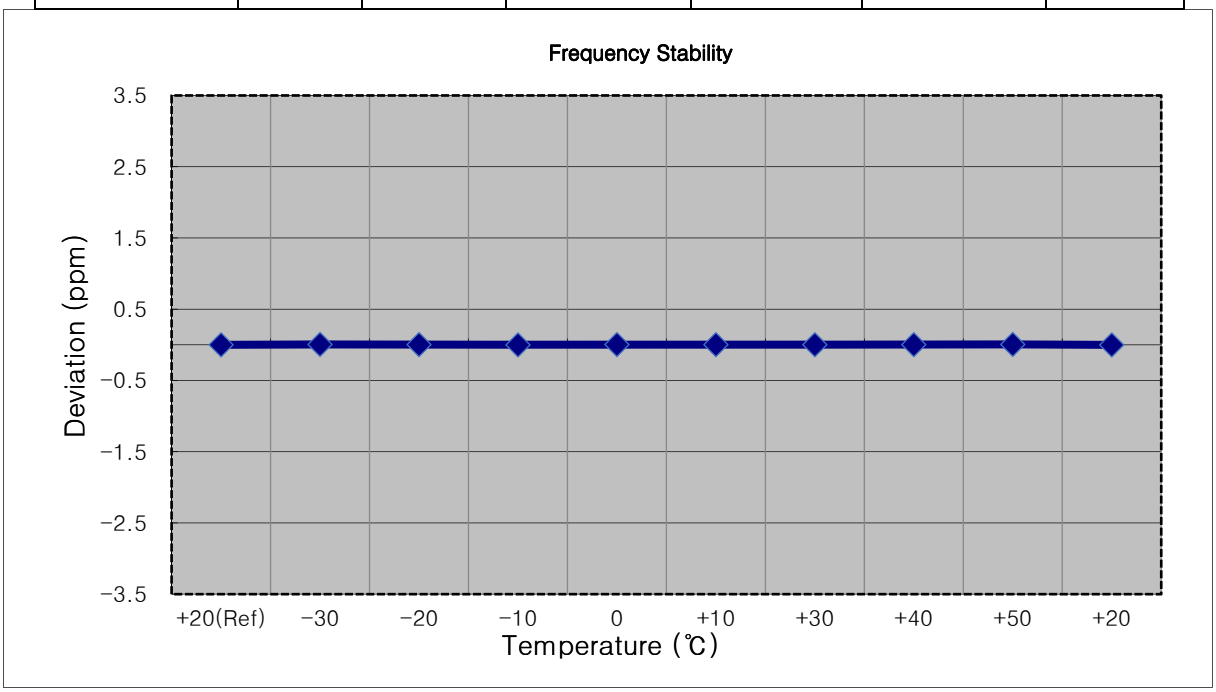
▣ OPERATING FREQUENCY: 2593,000,000 Hz

▣ BANDWIDTH: 40620 (15 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2593 000 013 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2593 000 027 | 13.8 | 0.000 001 | 0.005 |
| 100% | | -20 | 2593 000 022 | 9.7 | 0.000 000 | 0.004 |
| 100% | | -10 | 2593 000 010 | -2.7 | 0.000 000 | -0.001 |
| 100% | | 0 | 2593 000 023 | 10.1 | 0.000 000 | 0.004 |
| 100% | | +10 | 2593 000 019 | 6.3 | 0.000 000 | 0.002 |
| 100% | | +30 | 2593 000 018 | 5.4 | 0.000 000 | 0.002 |
| 100% | | +40 | 2593 000 020 | 7.5 | 0.000 000 | 0.003 |
| 100% | | +50 | 2593 000 028 | 14.9 | 0.000 001 | 0.006 |
| 85% | 3.400 | +20 | 2593 000 010 | -2.6 | 0.000 000 | -0.001 |



▣ MODE: LTE 41

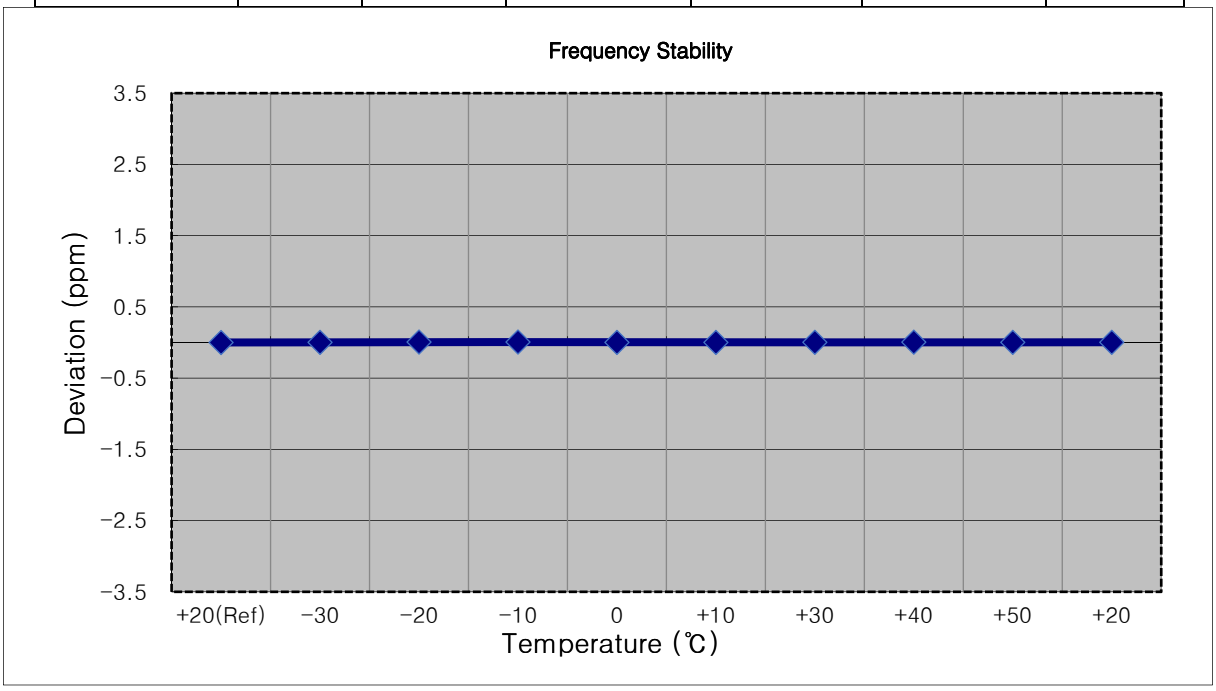
▣ OPERATING FREQUENCY: 2593,000,000 Hz

▣ BANDWIDTH: 40620 (20 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2593 000 003 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2593 000 009 | 5.4 | 0.000 000 | 0.002 |
| 100% | | -20 | 2593 000 020 | 17.1 | 0.000 001 | 0.007 |
| 100% | | -10 | 2593 000 021 | 17.9 | 0.000 001 | 0.007 |
| 100% | | 0 | 2593 000 008 | 4.5 | 0.000 000 | 0.002 |
| 100% | | +10 | 2593 000 008 | 4.8 | 0.000 000 | 0.002 |
| 100% | | +30 | 2593 000 011 | 7.7 | 0.000 000 | 0.003 |
| 100% | | +40 | 2593 000 016 | 12.7 | 0.000 000 | 0.005 |
| 100% | | +50 | 2593 000 009 | 5.3 | 0.000 000 | 0.002 |
| 85% | 3.400 | +20 | 2593 000 011 | 8.0 | 0.000 000 | 0.003 |



▣ MODE: LTE 41

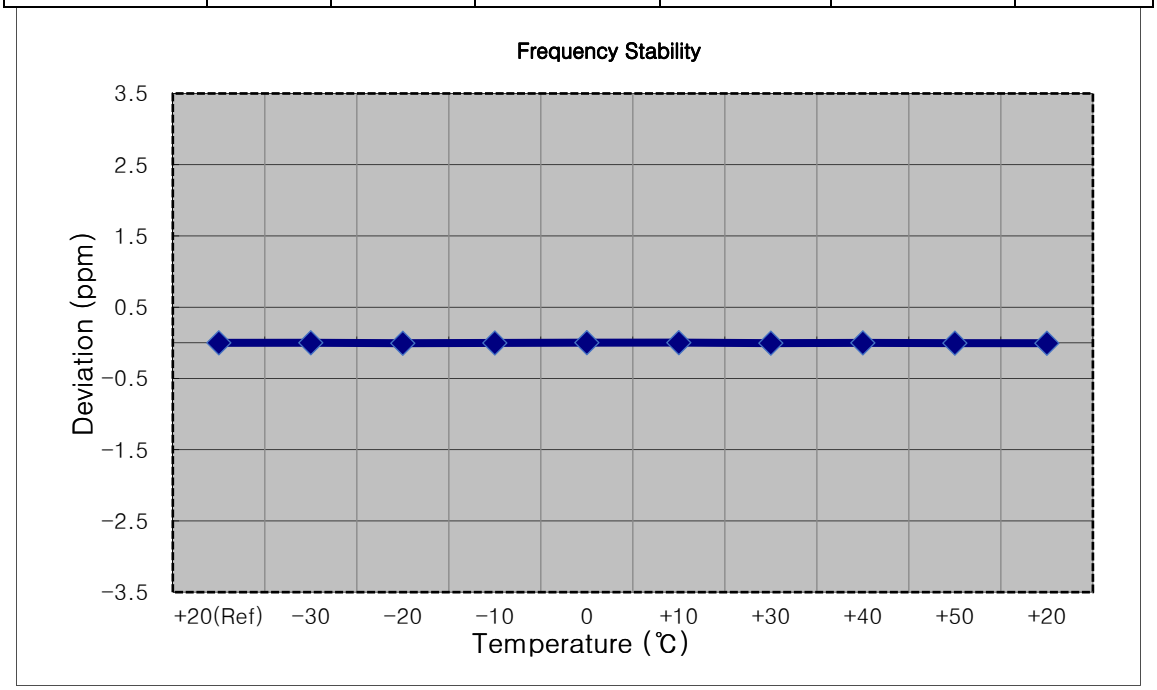
▣ OPERATING FREQUENCY: 2687,500,000 Hz

▣ BANDWIDTH: 41565 (5 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2687 499 998 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2687 500 000 | 2.4 | 0.000 000 | 0.001 |
| 100% | | -20 | 2687 499 984 | -14.2 | -0.000 001 | -0.005 |
| 100% | | -10 | 2687 499 993 | -4.9 | 0.000 000 | -0.002 |
| 100% | | 0 | 2687 500 005 | 6.8 | 0.000 000 | 0.003 |
| 100% | | +10 | 2687 500 005 | 7.4 | 0.000 000 | 0.003 |
| 100% | | +30 | 2687 499 986 | -11.9 | 0.000 000 | -0.004 |
| 100% | | +40 | 2687 499 997 | -1.2 | 0.000 000 | 0.000 |
| 100% | | +50 | 2687 499 987 | -11.4 | 0.000 000 | -0.004 |
| 85% | 3.400 | +20 | 2687 499 983 | -14.8 | -0.000 001 | -0.006 |



▣ MODE: LTE 41

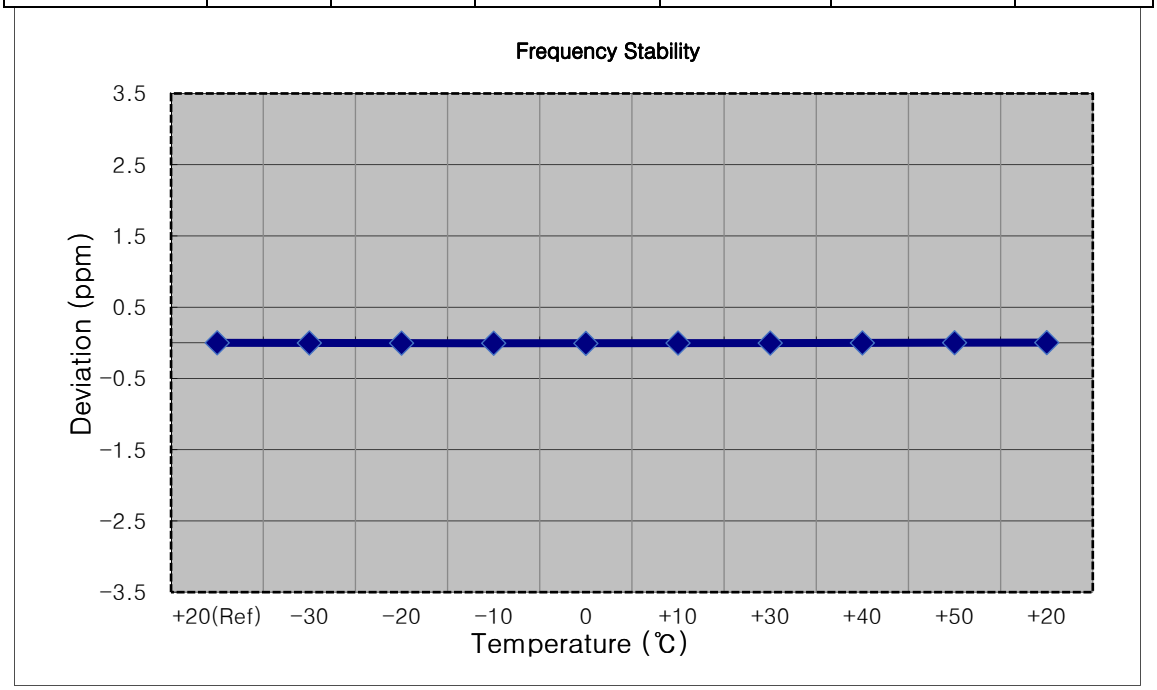
▣ OPERATING FREQUENCY: 2685,000,000 Hz

▣ BANDWIDTH: 41540 (10 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2685 000 005 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2685 000 001 | -4.1 | 0.000 000 | -0.002 |
| 100% | | -20 | 2684 999 995 | -10.3 | 0.000 000 | -0.004 |
| 100% | | -10 | 2684 999 990 | -14.8 | -0.000 001 | -0.006 |
| 100% | | 0 | 2684 999 984 | -21.5 | -0.000 001 | -0.008 |
| 100% | | +10 | 2684 999 997 | -8.0 | 0.000 000 | -0.003 |
| 100% | | +30 | 2684 999 996 | -9.3 | 0.000 000 | -0.003 |
| 100% | | +40 | 2685 000 002 | -3.1 | 0.000 000 | -0.001 |
| 100% | | +50 | 2685 000 011 | 6.0 | 0.000 000 | 0.002 |
| 85% | 3.400 | +20 | 2685 000 013 | 8.1 | 0.000 000 | 0.003 |



▣ MODE: LTE 41

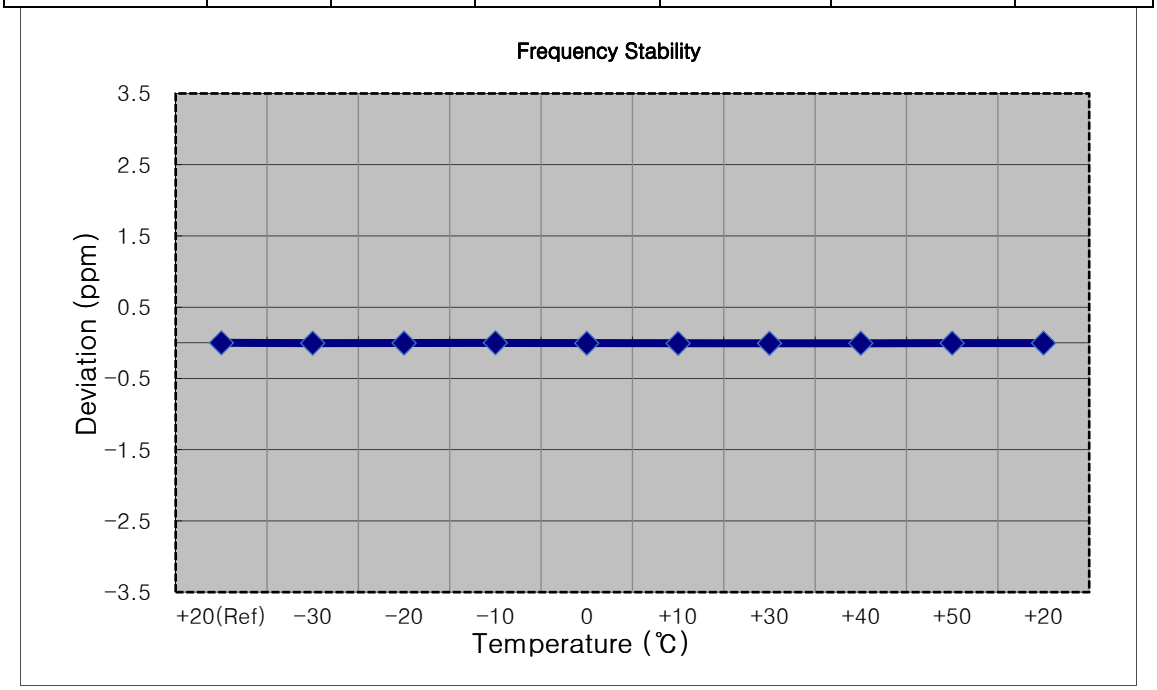
▣ OPERATING FREQUENCY: 2682,500,000 Hz

▣ BANDWIDTH: 41515 (15 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2682 499 986 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2682 499 974 | -12.0 | 0.000 000 | -0.004 |
| 100% | | -20 | 2682 499 978 | -8.7 | 0.000 000 | -0.003 |
| 100% | | -10 | 2682 499 989 | 2.8 | 0.000 000 | 0.001 |
| 100% | | 0 | 2682 499 971 | -15.4 | -0.000 001 | -0.006 |
| 100% | | +10 | 2682 499 968 | -18.5 | -0.000 001 | -0.007 |
| 100% | | +30 | 2682 499 970 | -16.7 | -0.000 001 | -0.006 |
| 100% | | +40 | 2682 499 972 | -14.7 | -0.000 001 | -0.005 |
| 100% | | +50 | 2682 499 976 | -10.0 | 0.000 000 | -0.004 |
| 85% | 3.400 | +20 | 2682 499 977 | -9.2 | 0.000 000 | -0.003 |



▣ MODE: LTE 41

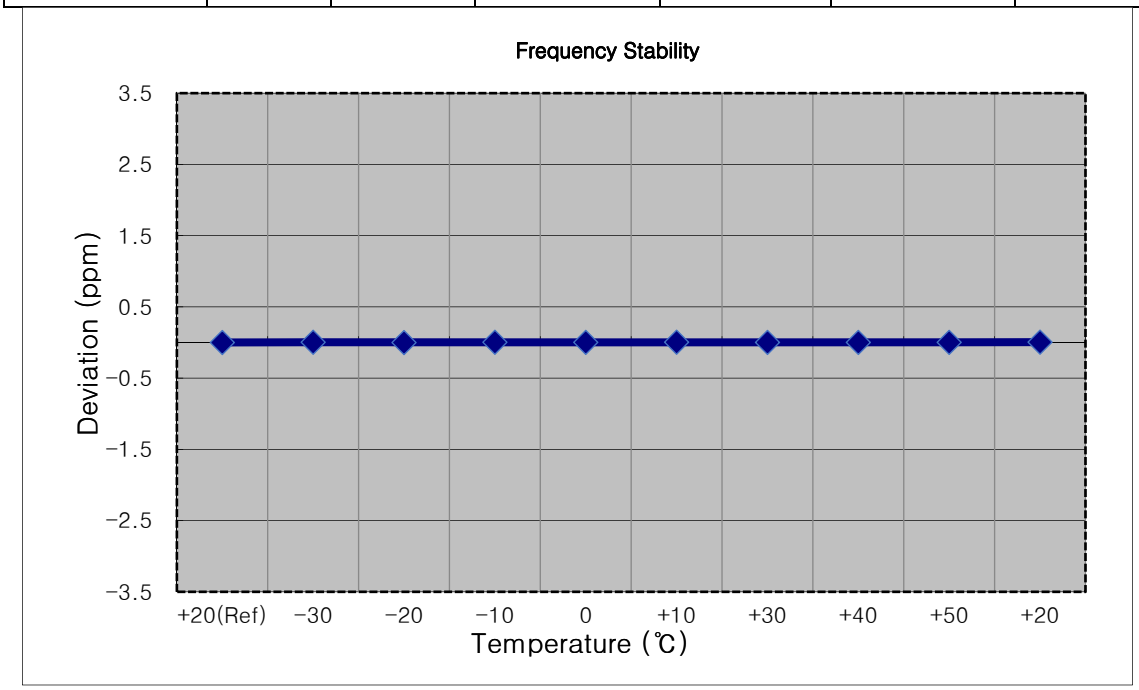
▣ OPERATING FREQUENCY: 2680,000,000 Hz

▣ BANDWIDTH: 41490 (20 MHz)

▣ REFERENCE VOLTAGE: 3.85 VDC

▣ DEVIATION LIMIT: Emission must remain in band

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | ppm |
|---|---|---|---|---|---|---|
| 100% | 3.850 | +20(Ref) | 2680 000 009 | 0.0 | 0.000 000 | 0.000 |
| 100% | | -30 | 2680 000 019 | 10.0 | 0.000 000 | 0.004 |
| 100% | | -20 | 2680 000 008 | -1.7 | 0.000 000 | -0.001 |
| 100% | | -10 | 2680 000 020 | 10.6 | 0.000 000 | 0.004 |
| 100% | | 0 | 2680 000 015 | 5.9 | 0.000 000 | 0.002 |
| 100% | | +10 | 2680 000 021 | 11.9 | 0.000 000 | 0.004 |
| 100% | | +30 | 2680 000 013 | 3.5 | 0.000 000 | 0.001 |
| 100% | | +40 | 2680 000 013 | 3.2 | 0.000 000 | 0.001 |
| 100% | | +50 | 2680 000 016 | 6.3 | 0.000 000 | 0.002 |
| 85% | 3.400 | +20 | 2680 000 023 | 13.4 | 0.000 000 | 0.005 |



## 8.8 GEO-LOCATION MECHANISM

The device uses a geo-location mechanism based on the cellular MCC codes in order to only enable certain LTE bands when the device is not in the USA.

The validation of this mechanism is provided below. The device was configured for cellular communications to a test set and the MCC code was adjusted on the test set between the US MCC and then an MCC code valid for a country where the LTE band is supported.

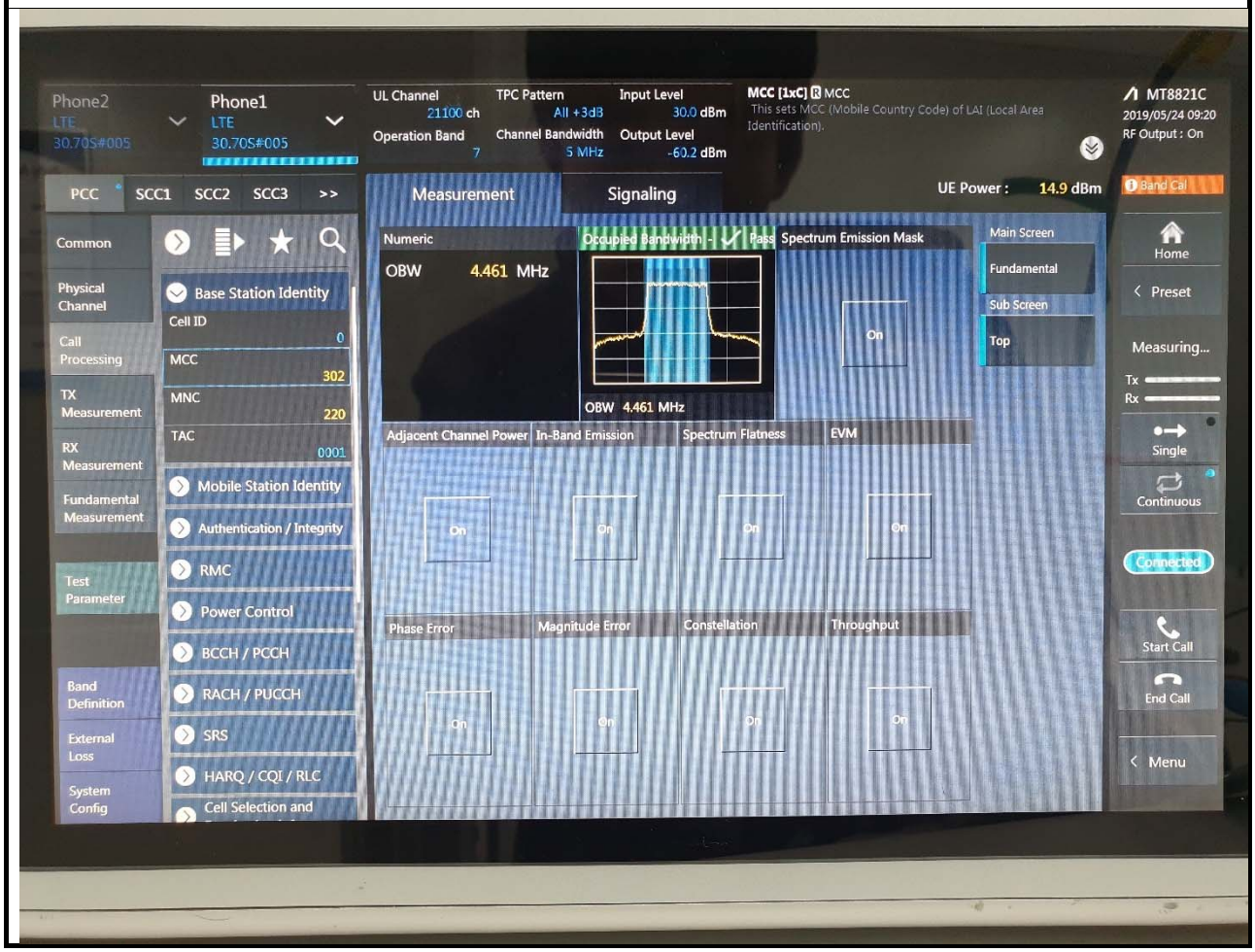
| Band | MCC = USA | MCC = non US |
|---|---|---|
| 7 | Did not connect | Connected (Canada) |
| 38 | Did not connect | Connected (Canada) |
| 40 | Did not connect | Connected (Canada) |
| 41 | Connected | Connected (Canada) |

The verification tests confirmed the operational of the geo-location mechanism.

Verification test

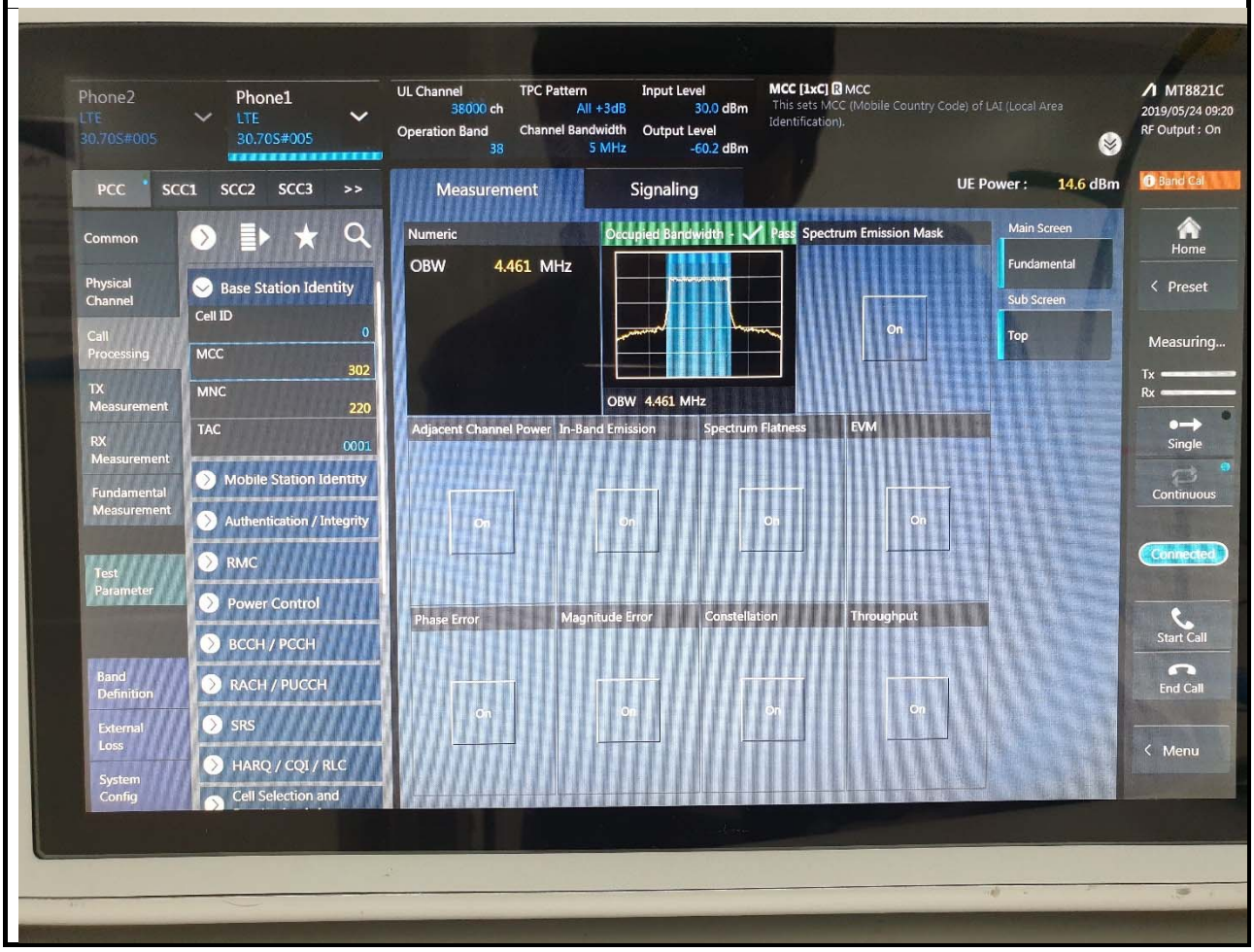
Connected(LTE B7)

(MCC = Canada)



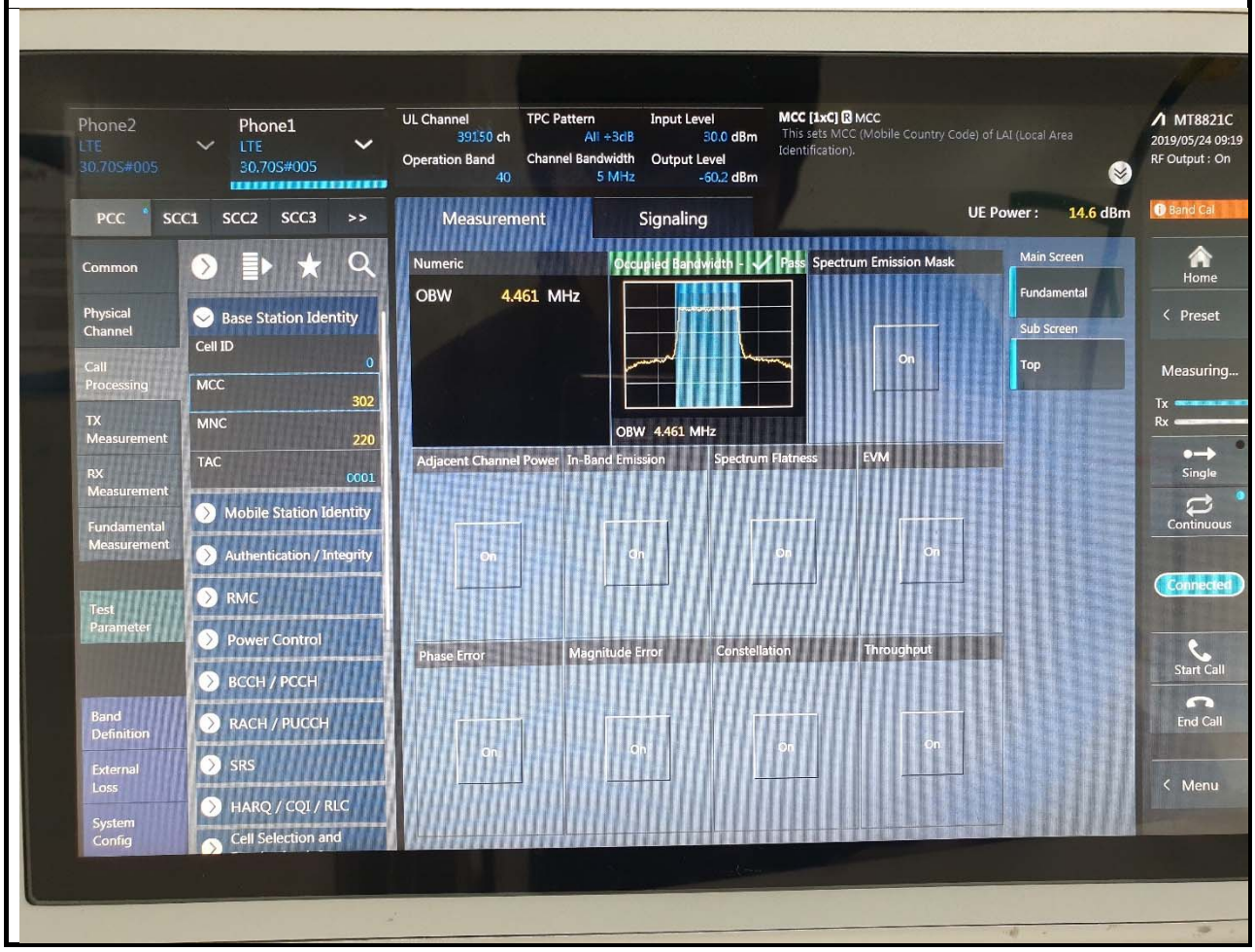
Connected(LTE B38)

(MCC = Canada)



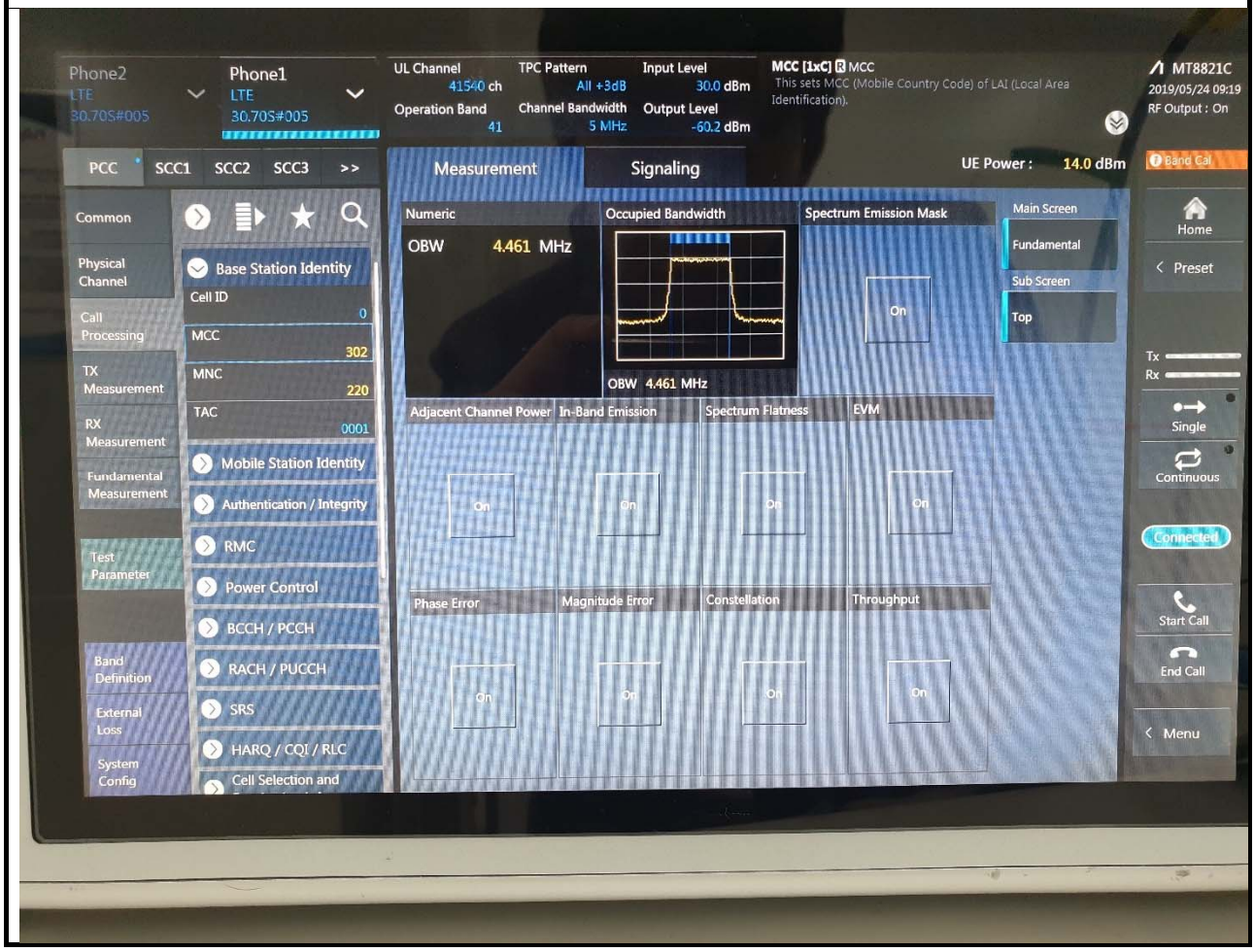
Connected(LTE B40)

(MCC = Canada)



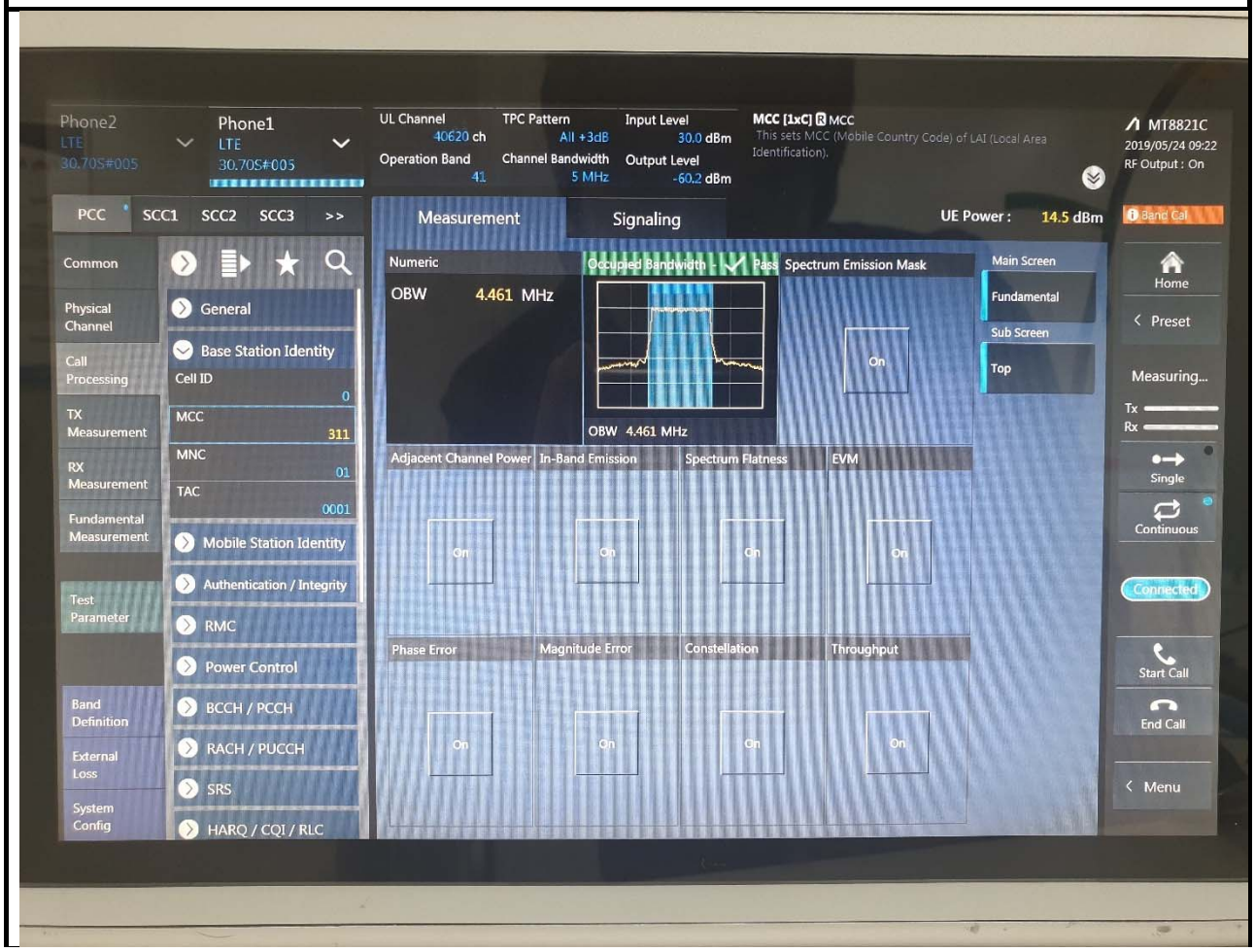
Connected(LTE B41)

(MCC = Canada)



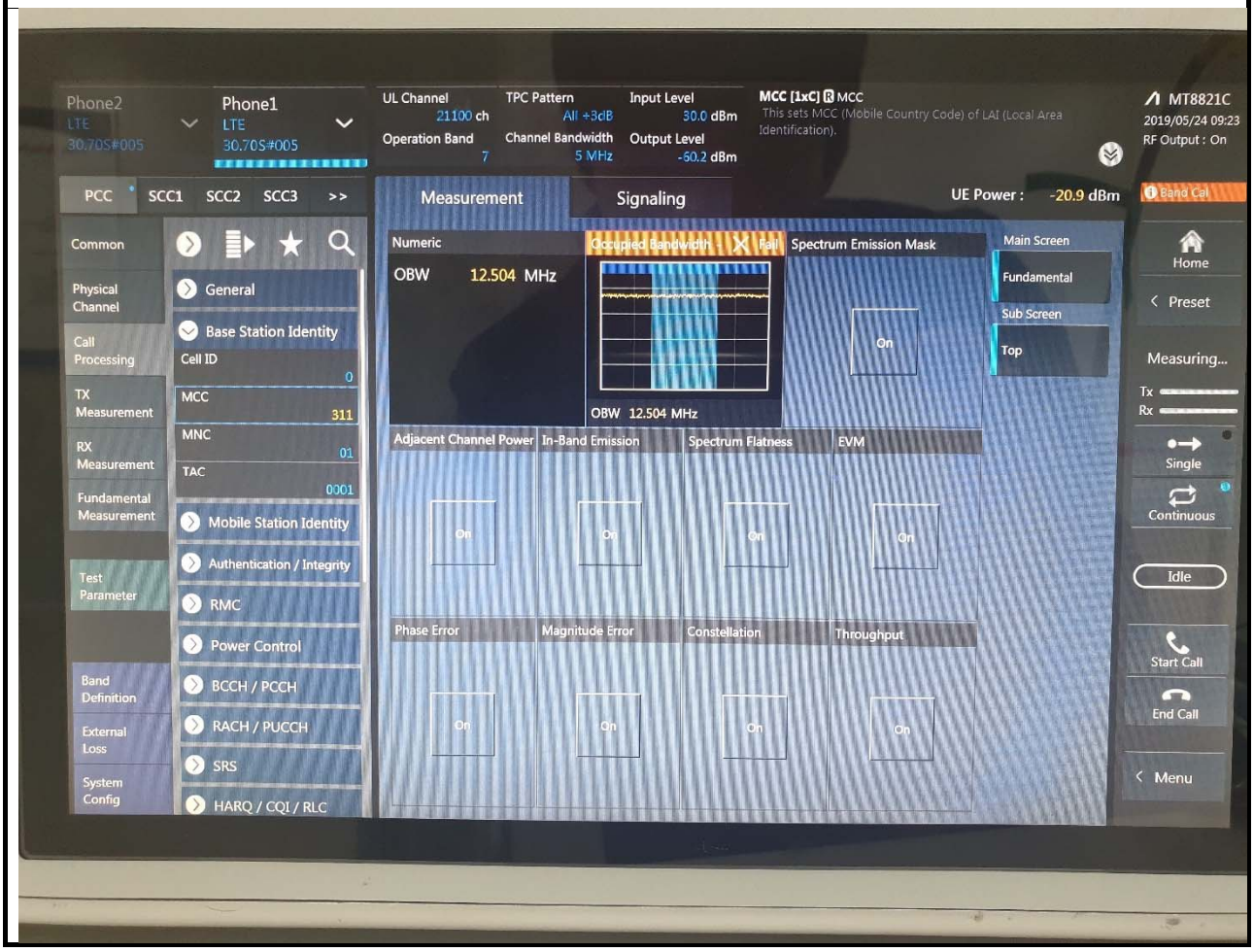
Connected(LTE B41)

(MCC = US)



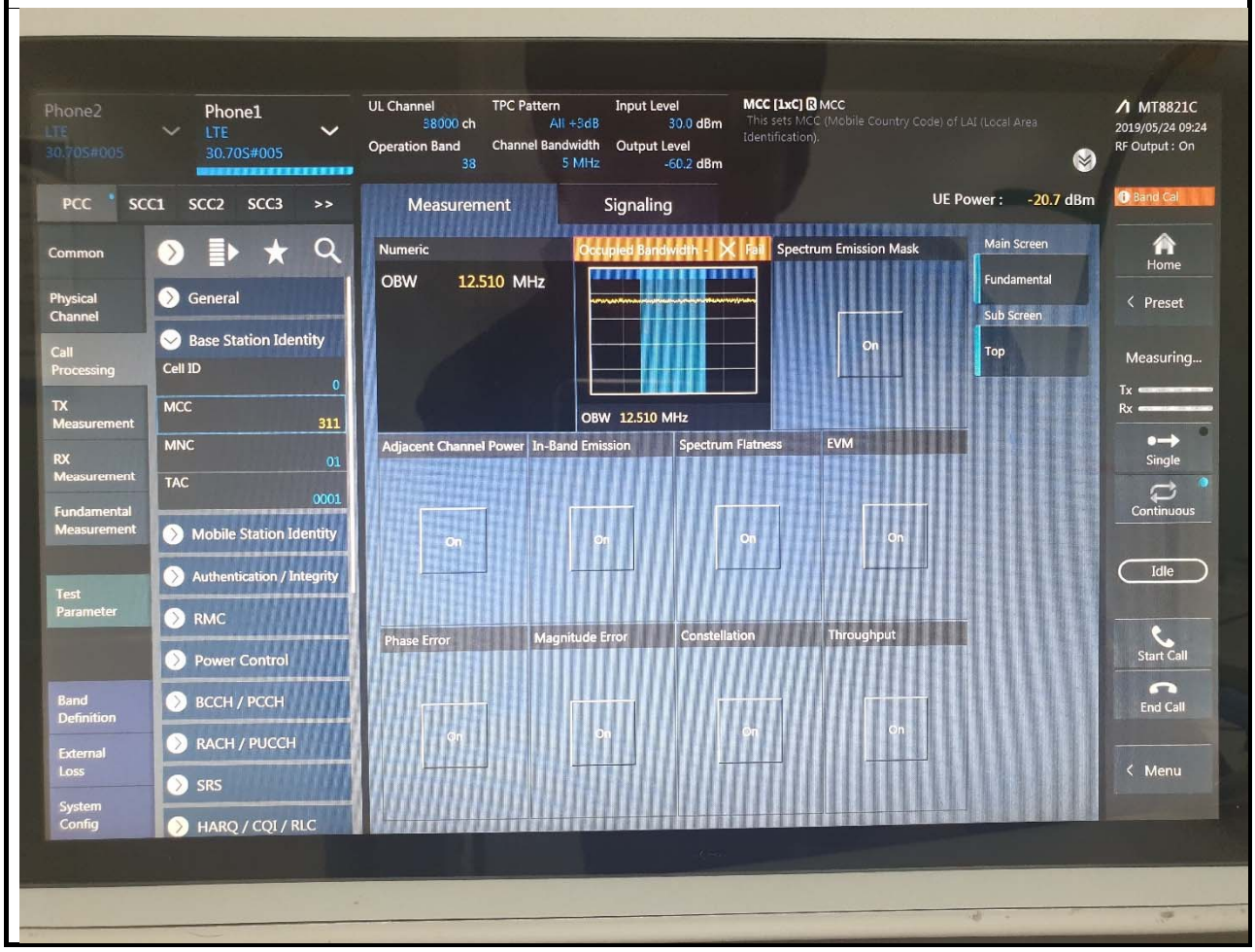
Did not connect (LTE B7)

(MCC = US)



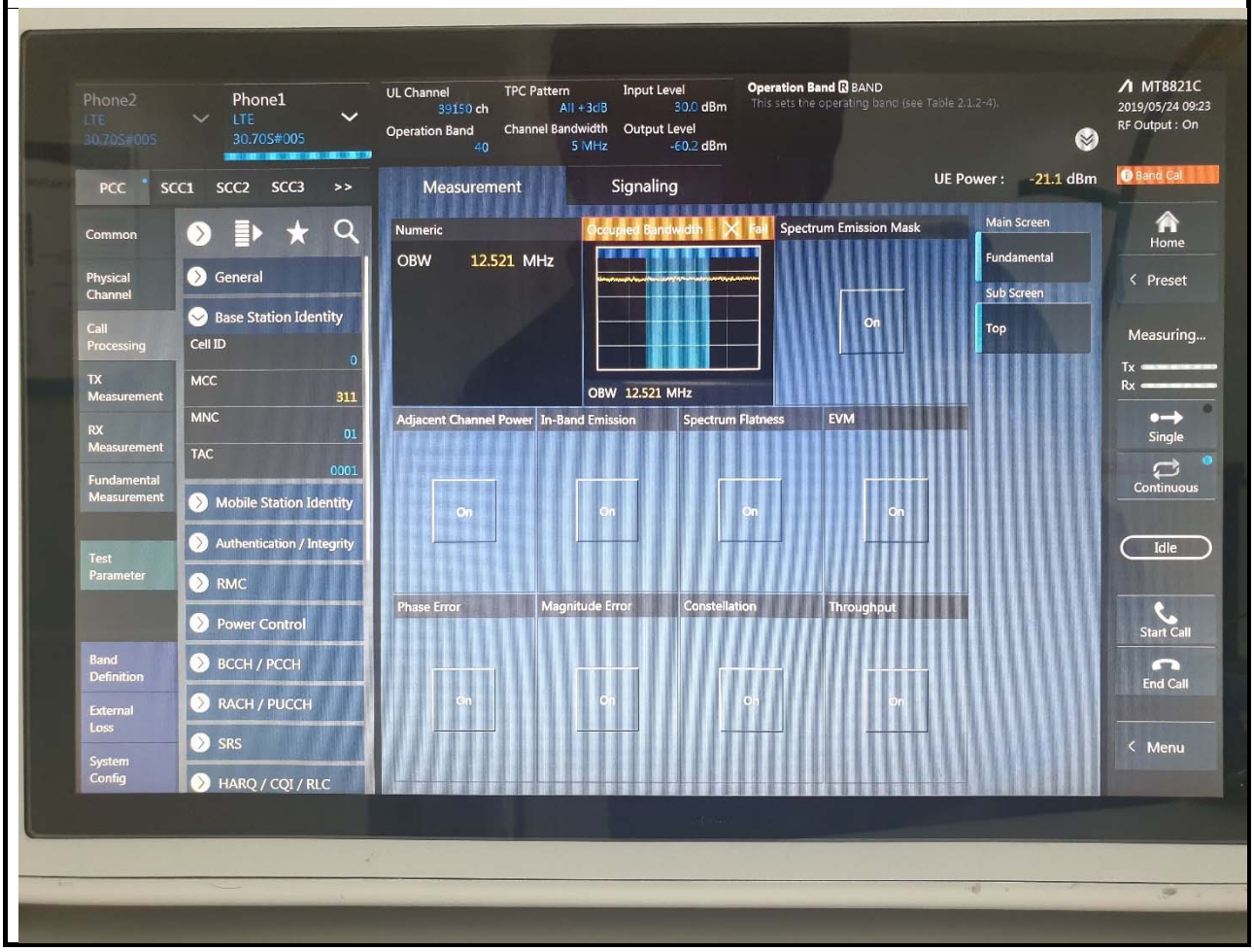
Did not connect (LTE B38)

(MCC = US)



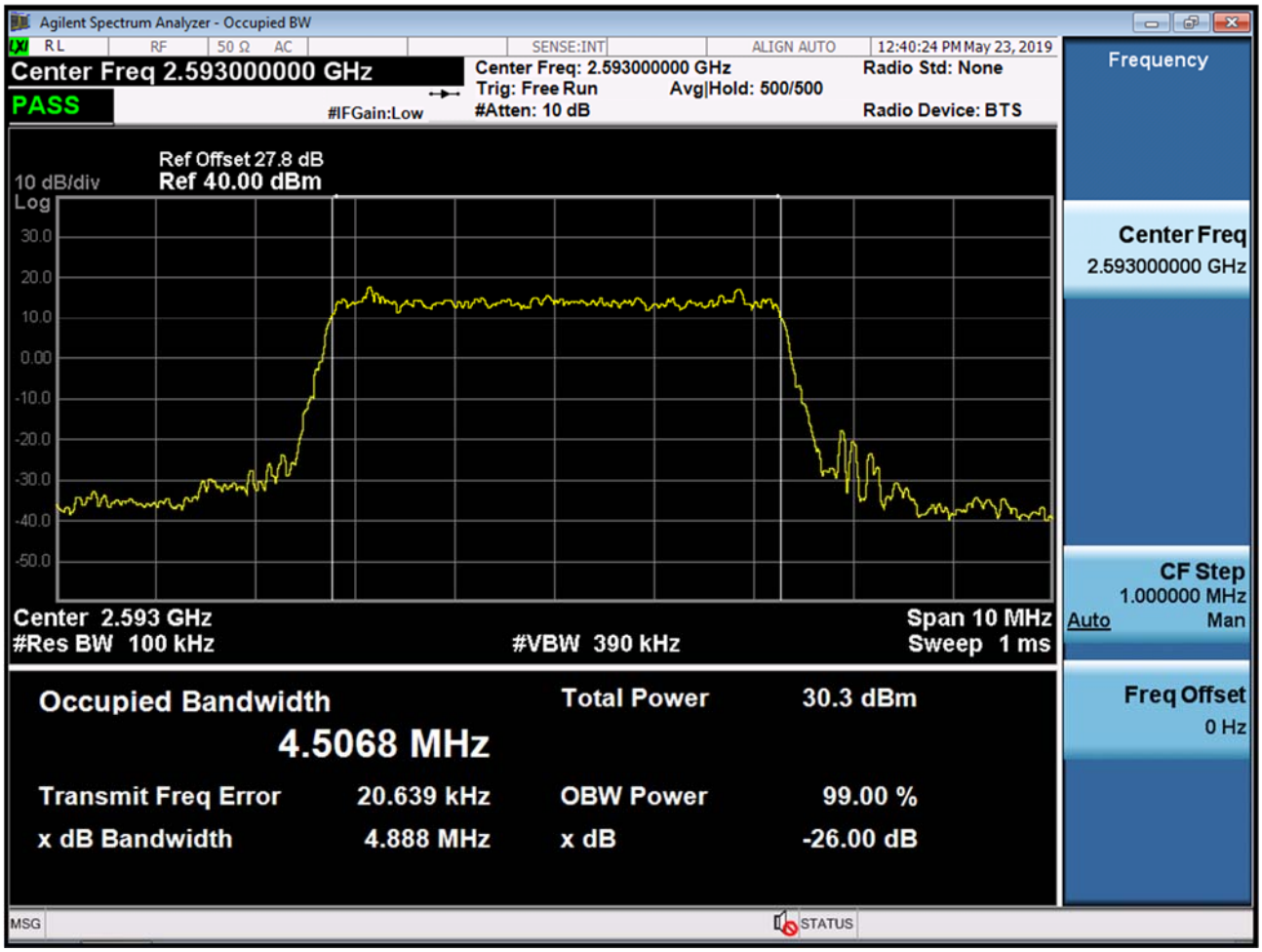
Did not connect (LTE B40)

(MCC = US)

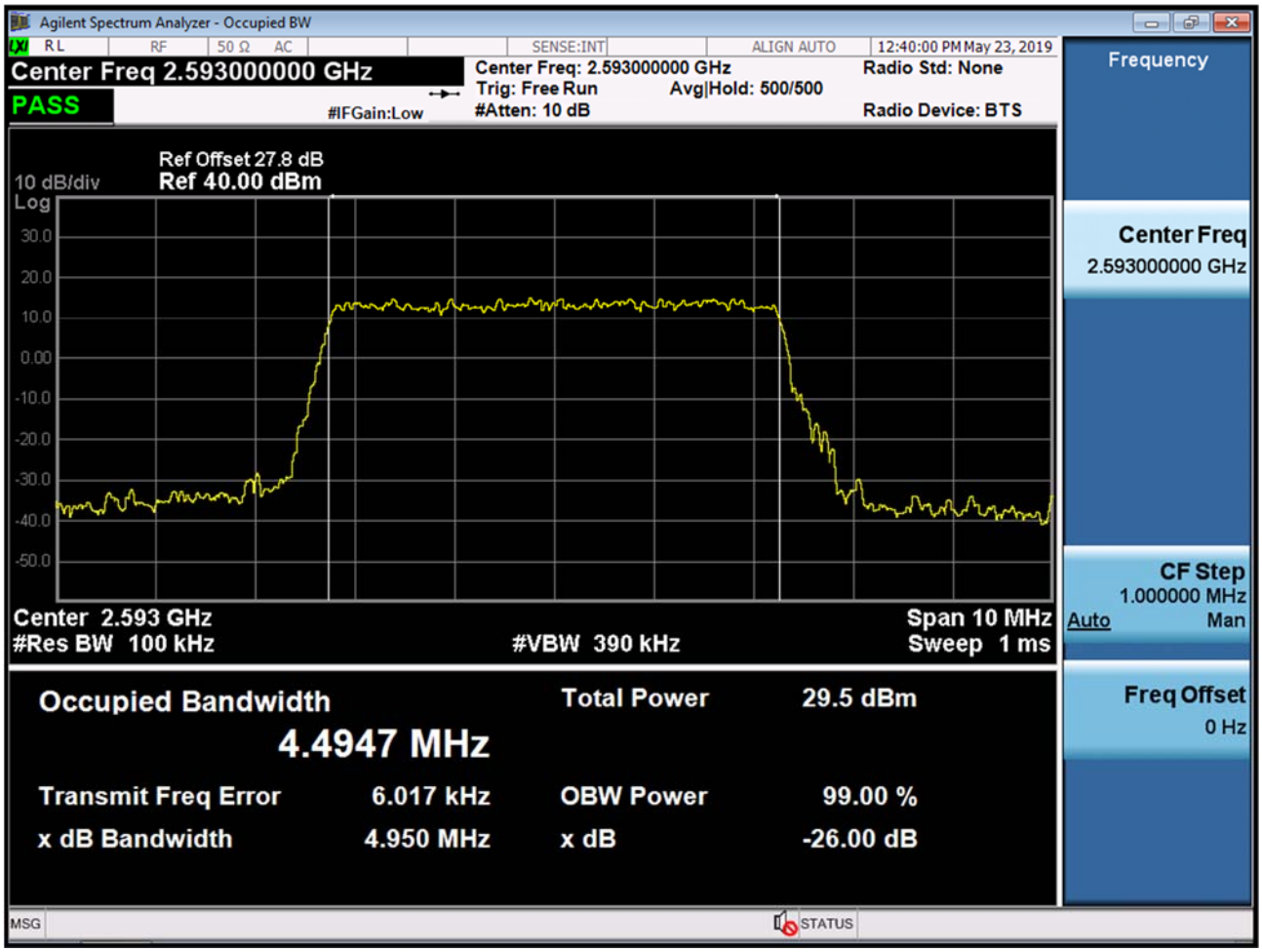


# 9. TEST PLOTS

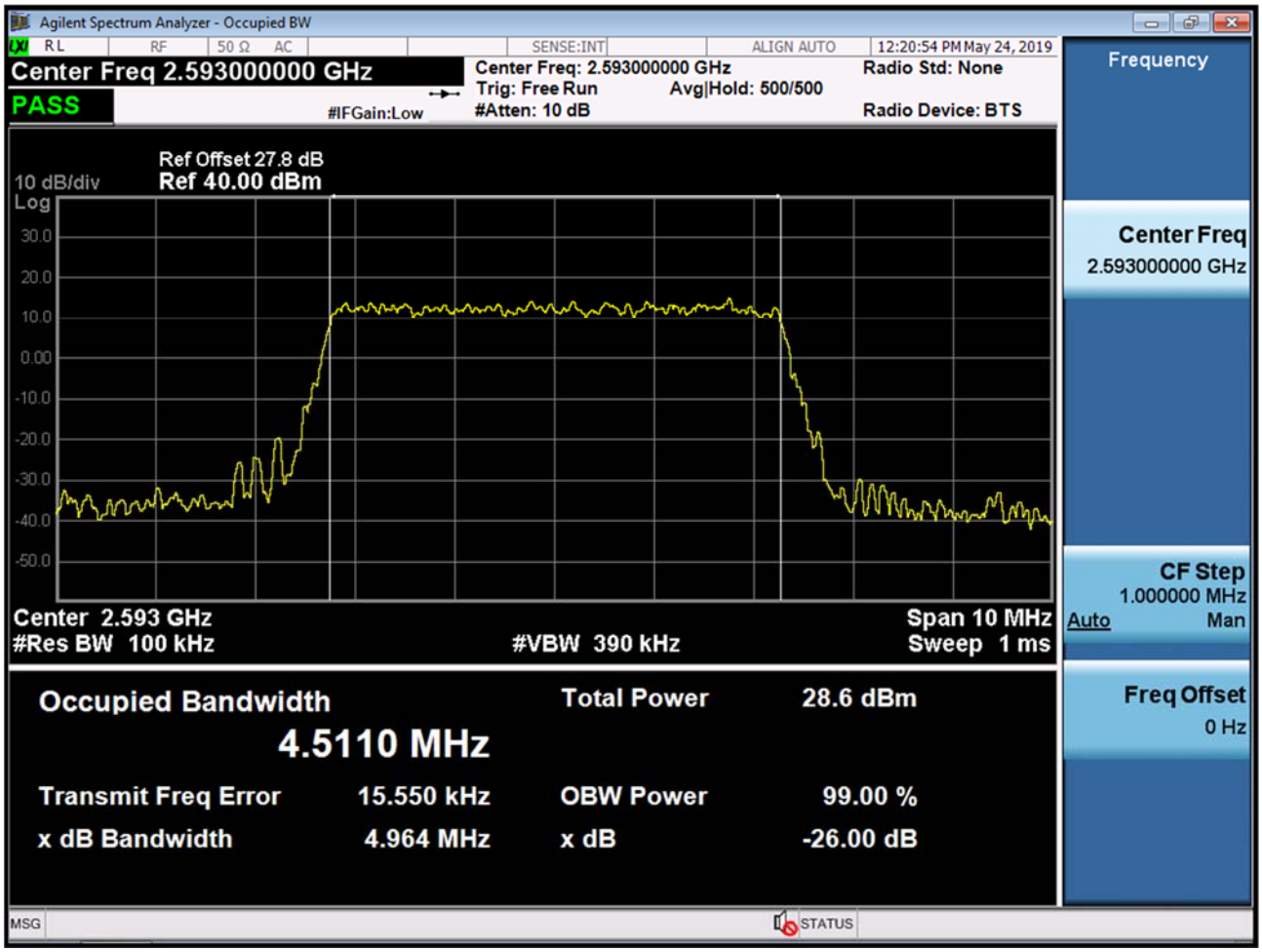
BAND 41. Occupied Bandwidth Plot (5 MHz Ch.40620 QPSK RB 25)



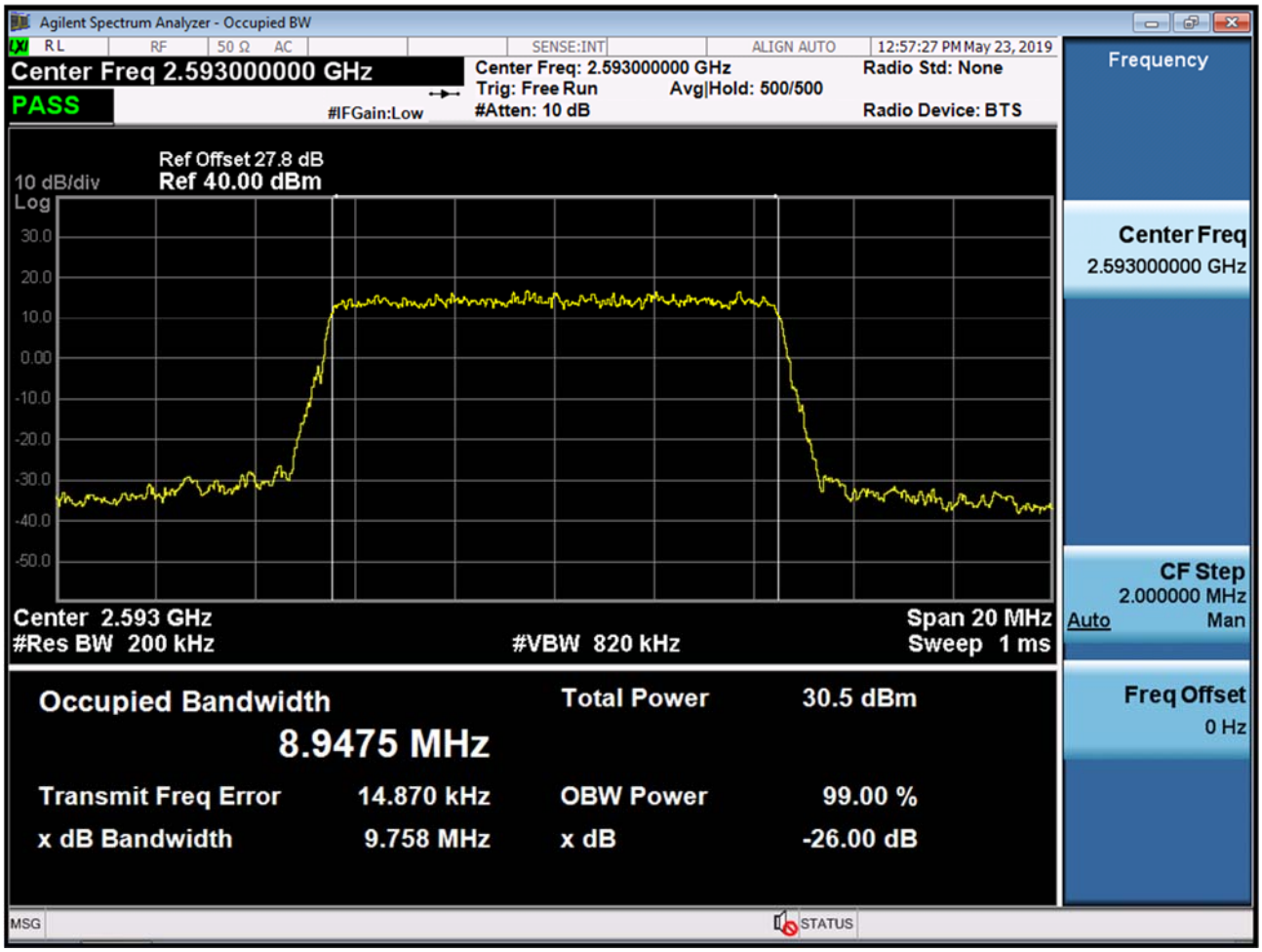
BAND 41. Occupied Bandwidth Plot (5 MHz Ch.40620 16-QAM RB 25)



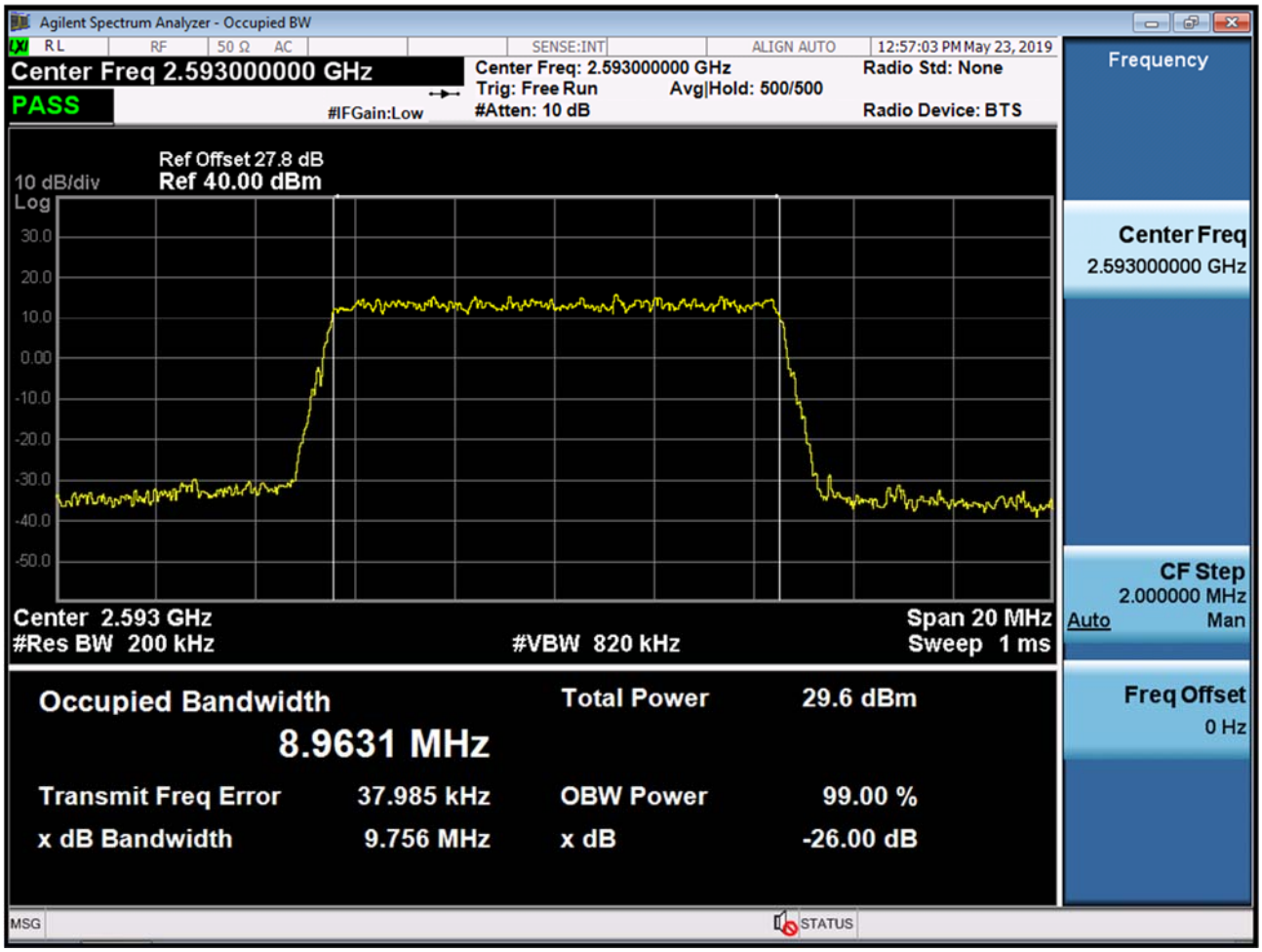
BAND 41. Occupied Bandwidth Plot (5 MHz Ch.40620 64-QAM RB 25)



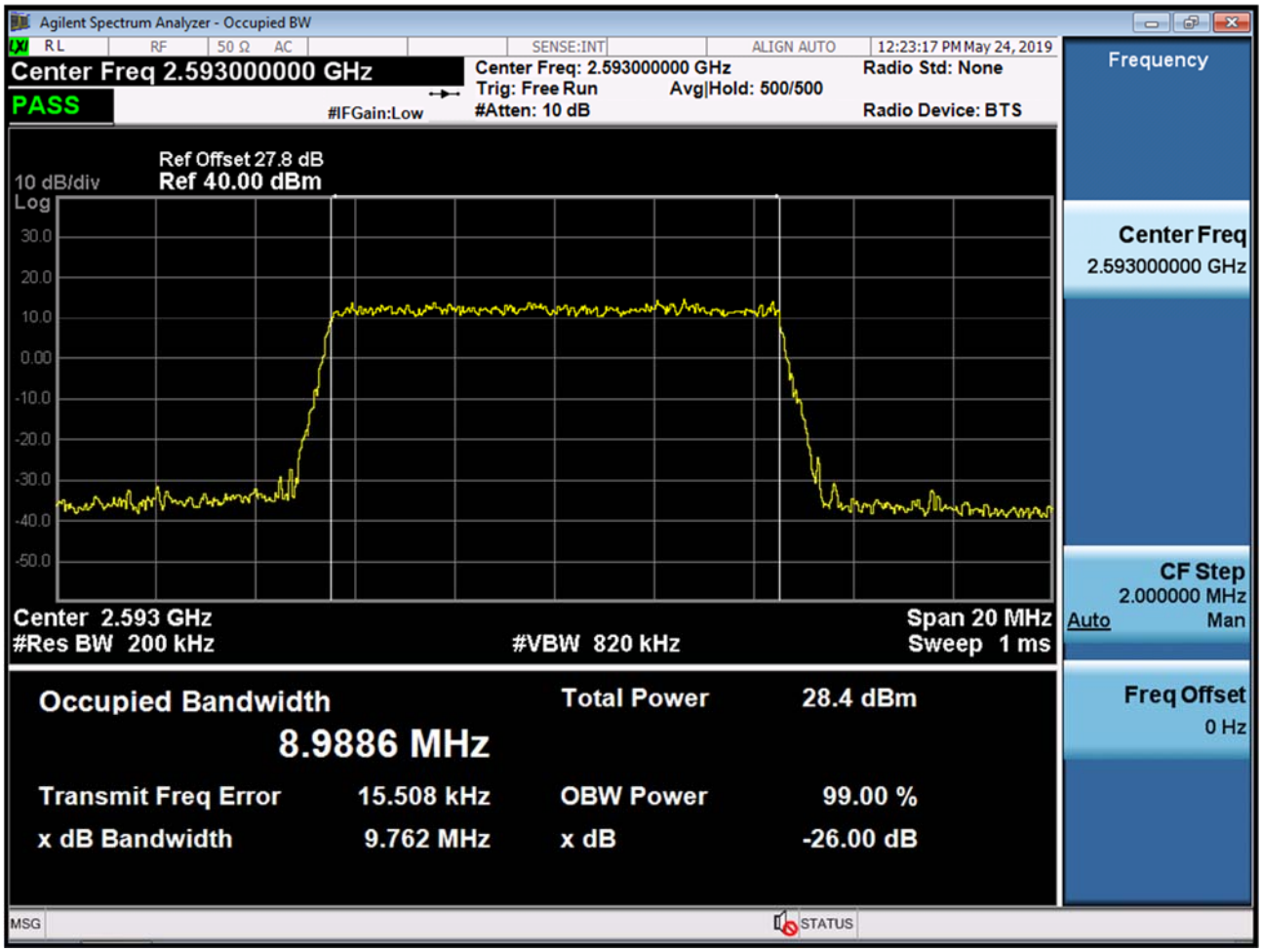
BAND 41. Occupied Bandwidth Plot (10 MHz Ch.40620 QPSK RB 50)



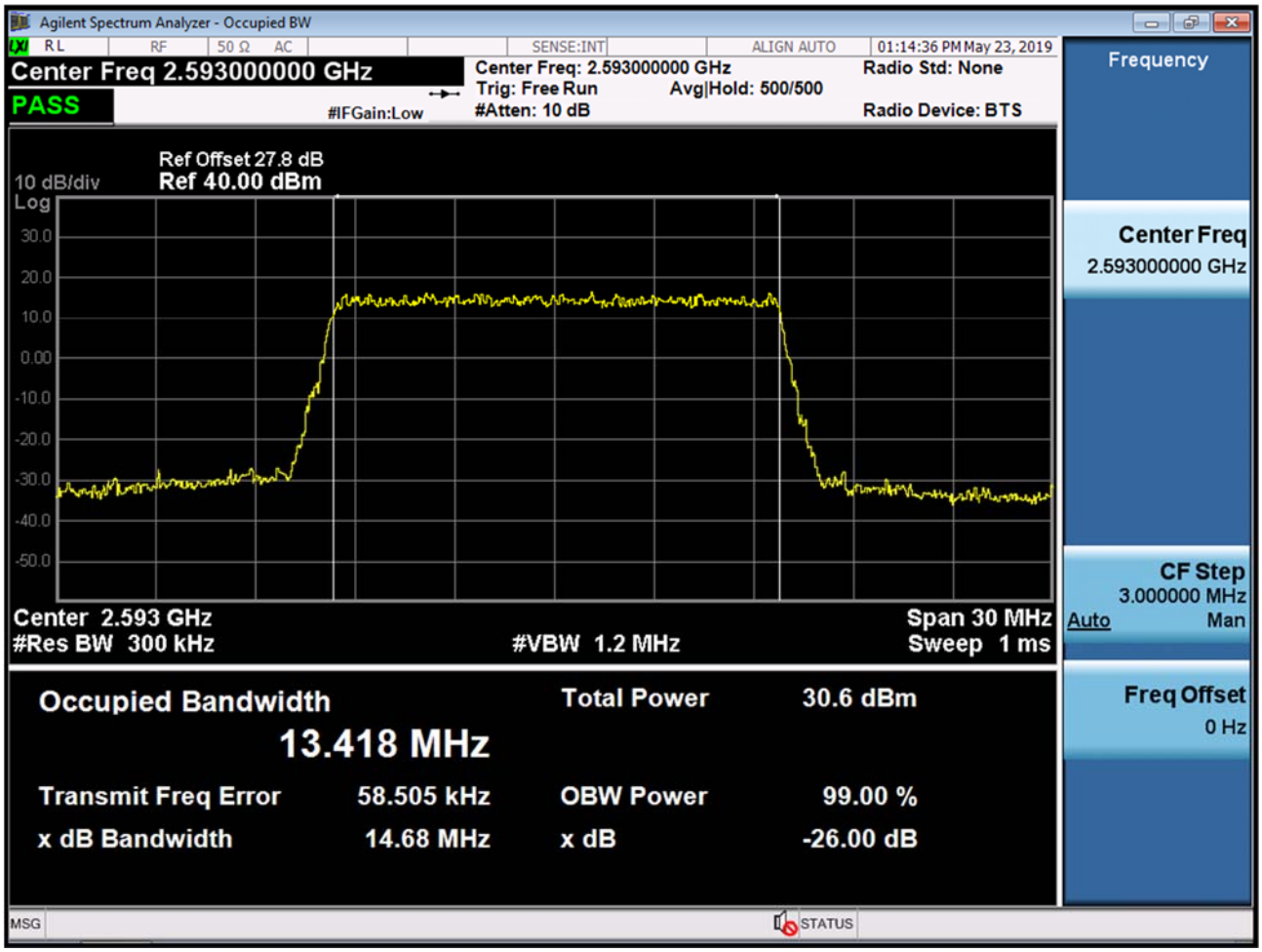
BAND 41. Occupied Bandwidth Plot (10 MHz Ch.40620 16-QAM RB 50)



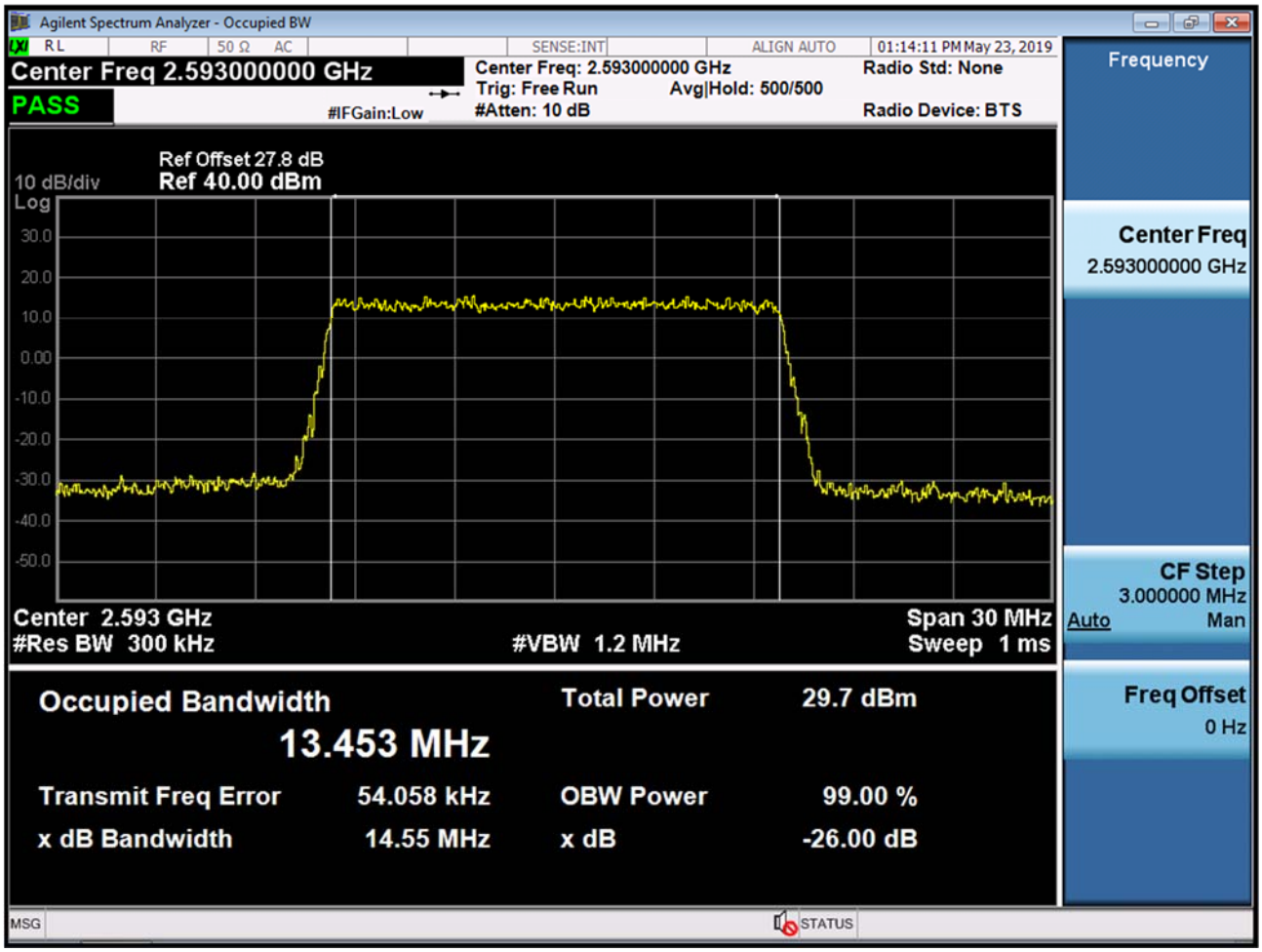
BAND 41. Occupied Bandwidth Plot (10 MHz Ch.40620 64-QAM RB 50)



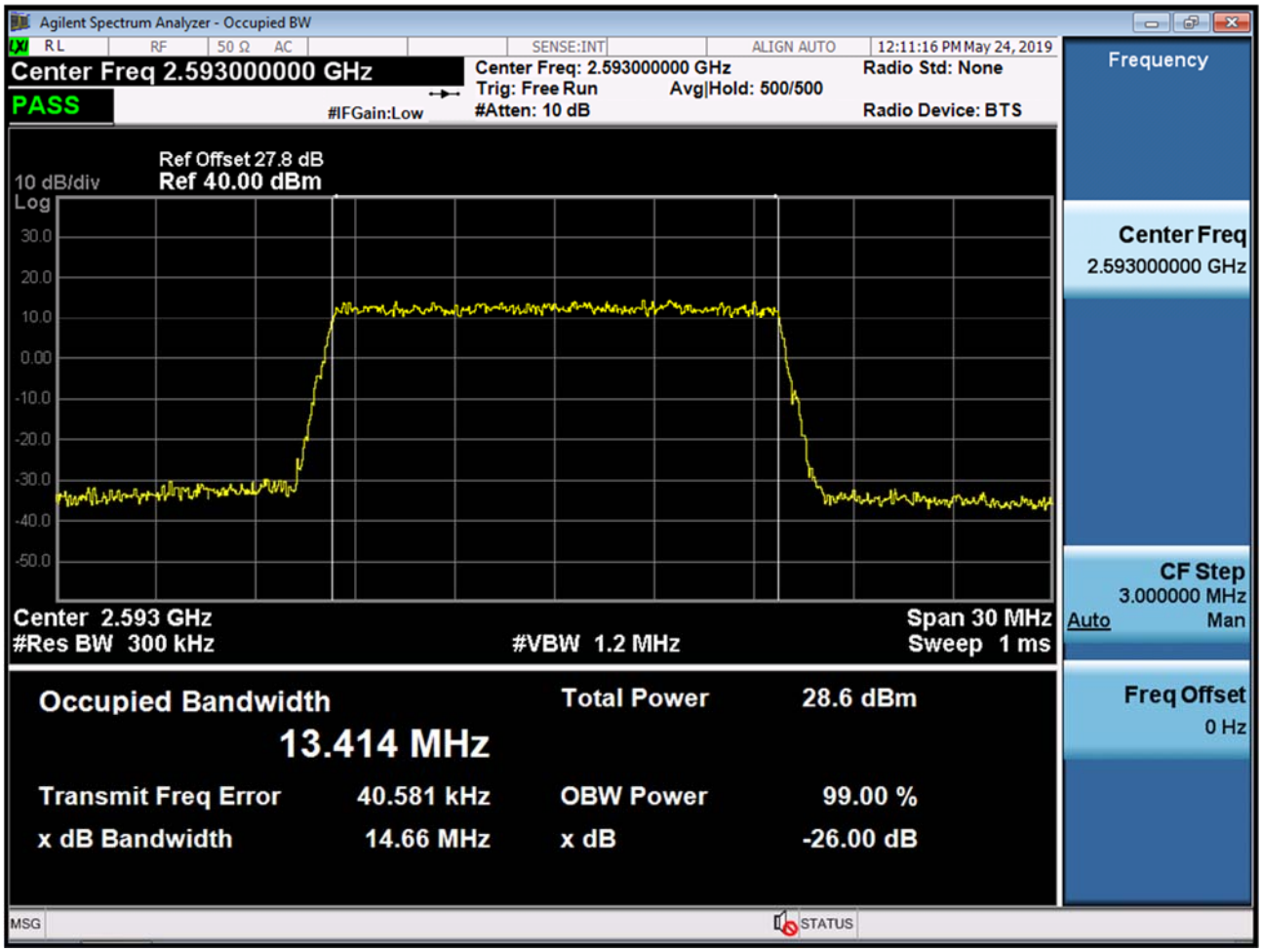
BAND 41. Occupied Bandwidth Plot (15 MHz Ch.40620 QPSK RB 75)



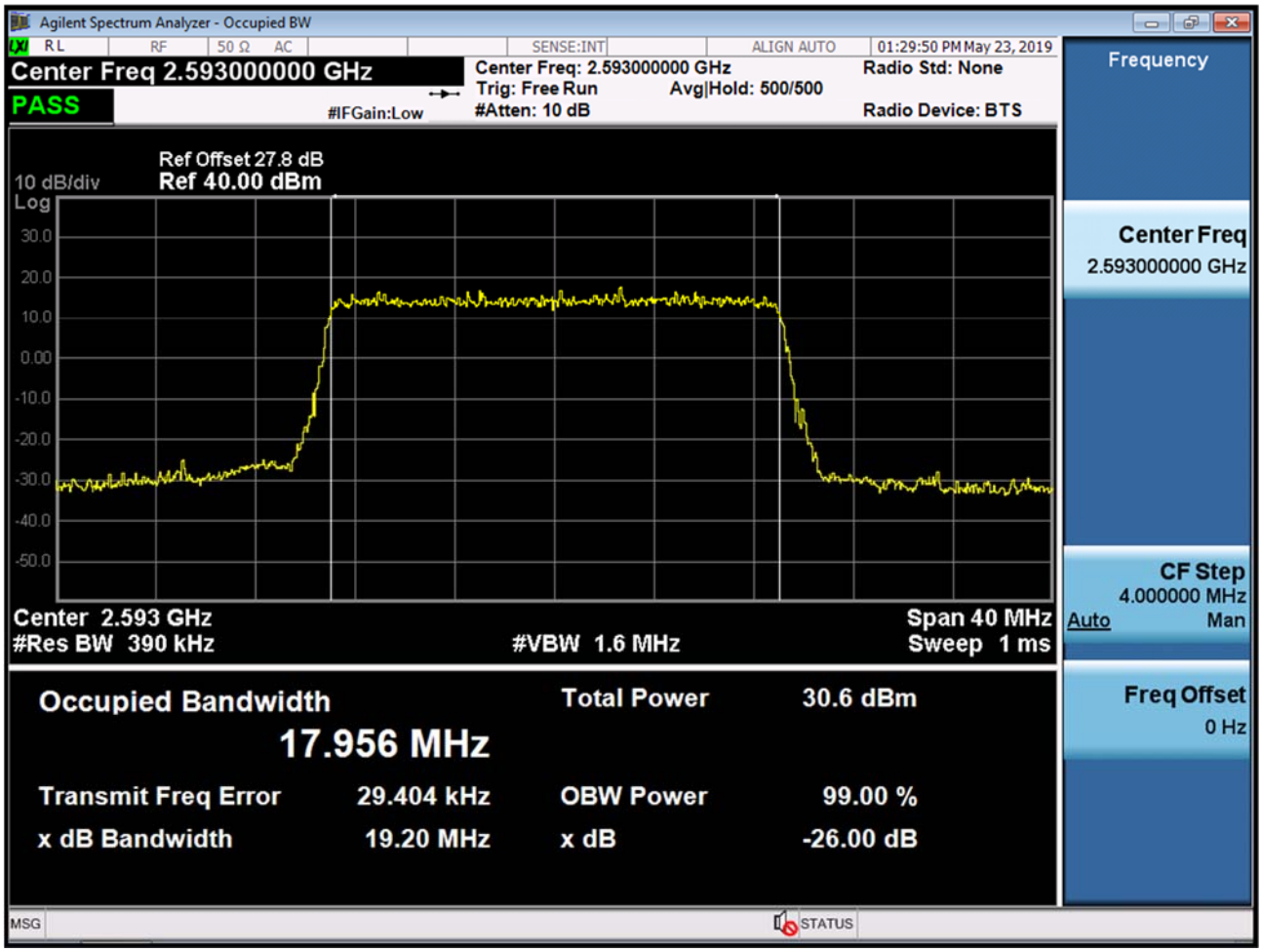
BAND 41. Occupied Bandwidth Plot (15 MHz Ch.40620 16-QAM RB 75)



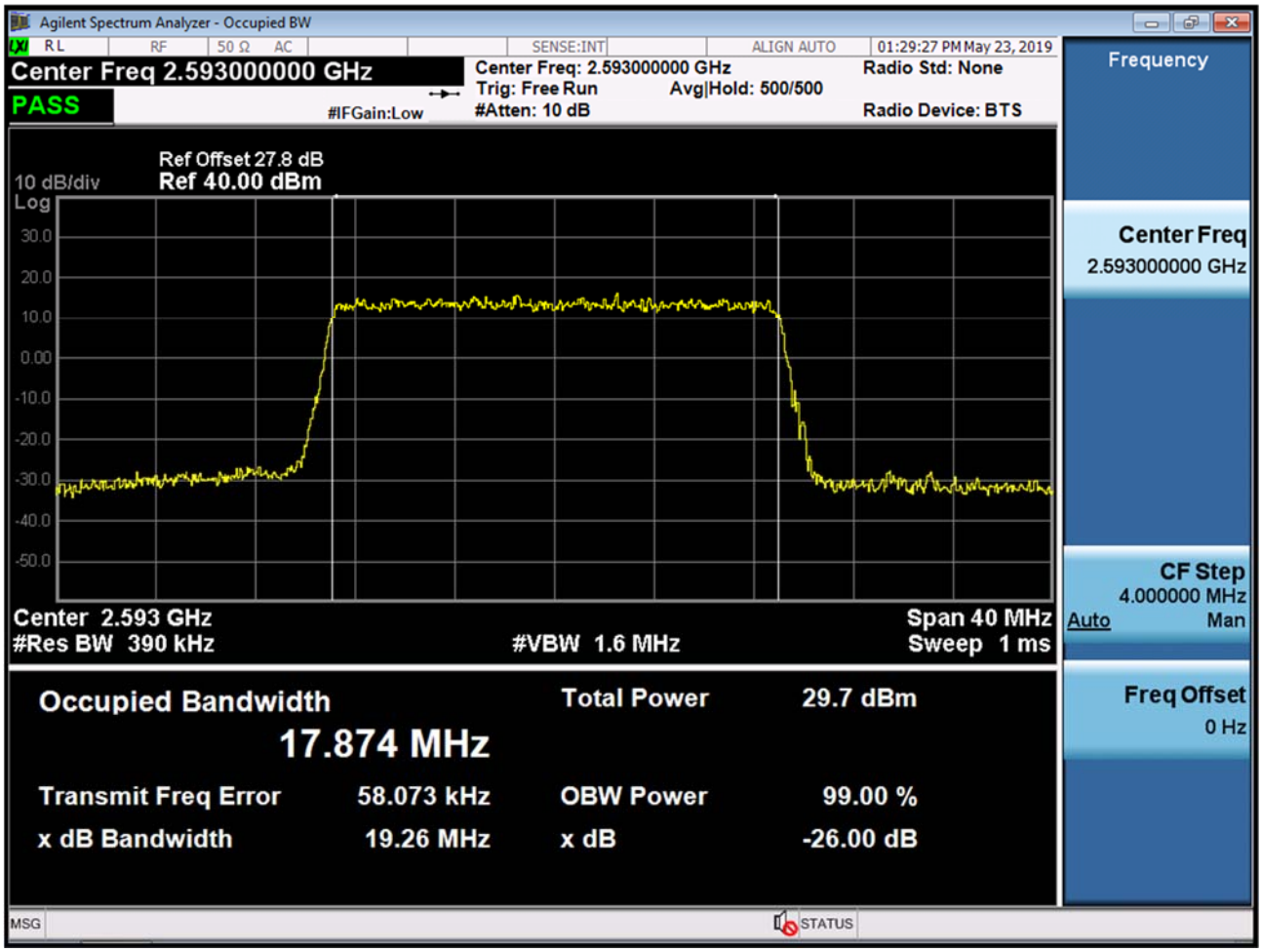
BAND 41. Occupied Bandwidth Plot (15 MHz Ch.40620 64-QAM RB 75)



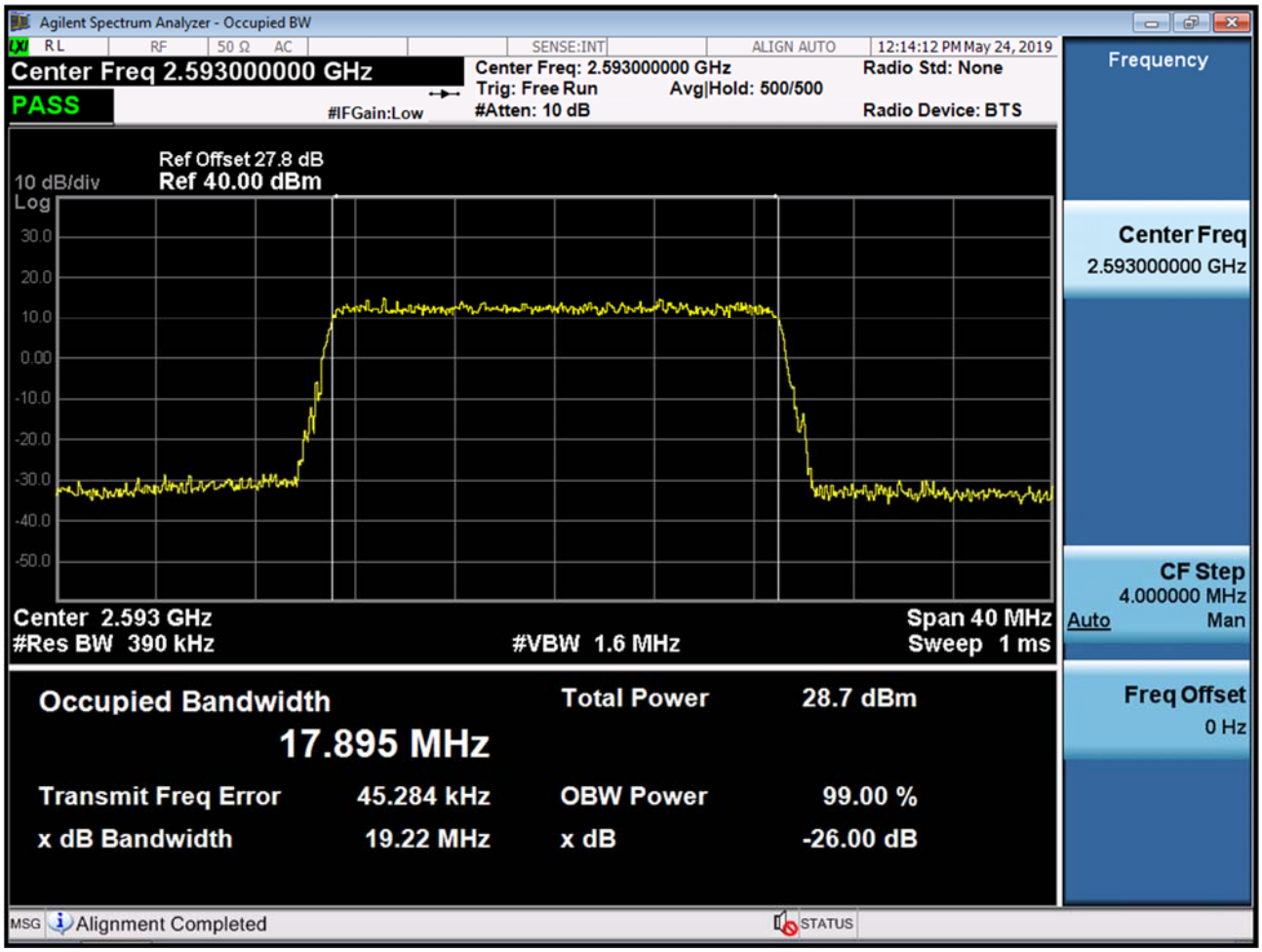
BAND 41. Occupied Bandwidth Plot (20 MHz Ch.40620 QPSK RB 100)



BAND 41. Occupied Bandwidth Plot (20 MHz Ch.40620 16-QAM RB 100)

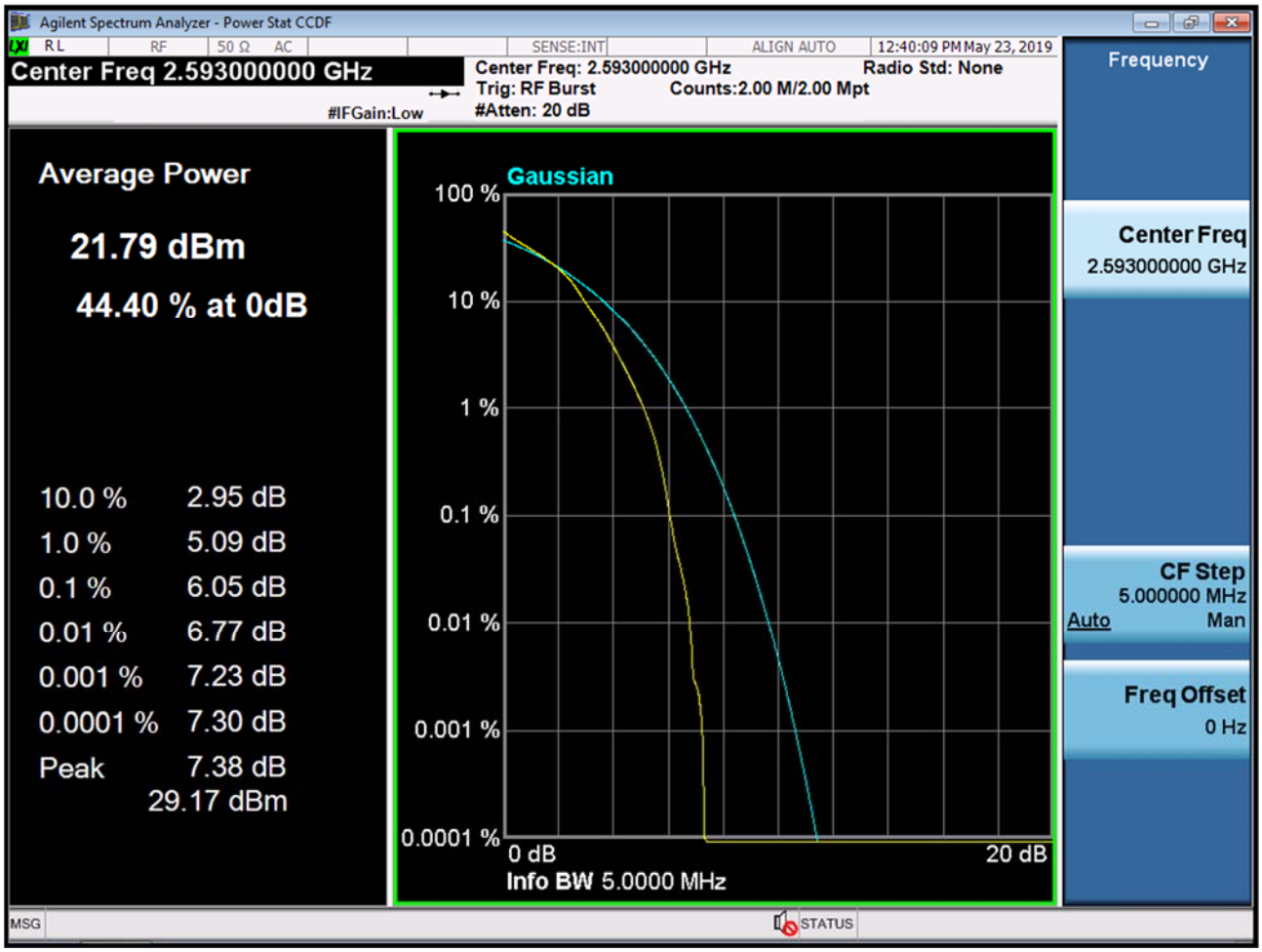


BAND 41. Occupied Bandwidth Plot (20 MHz Ch.40620 64-QAM RB 100)

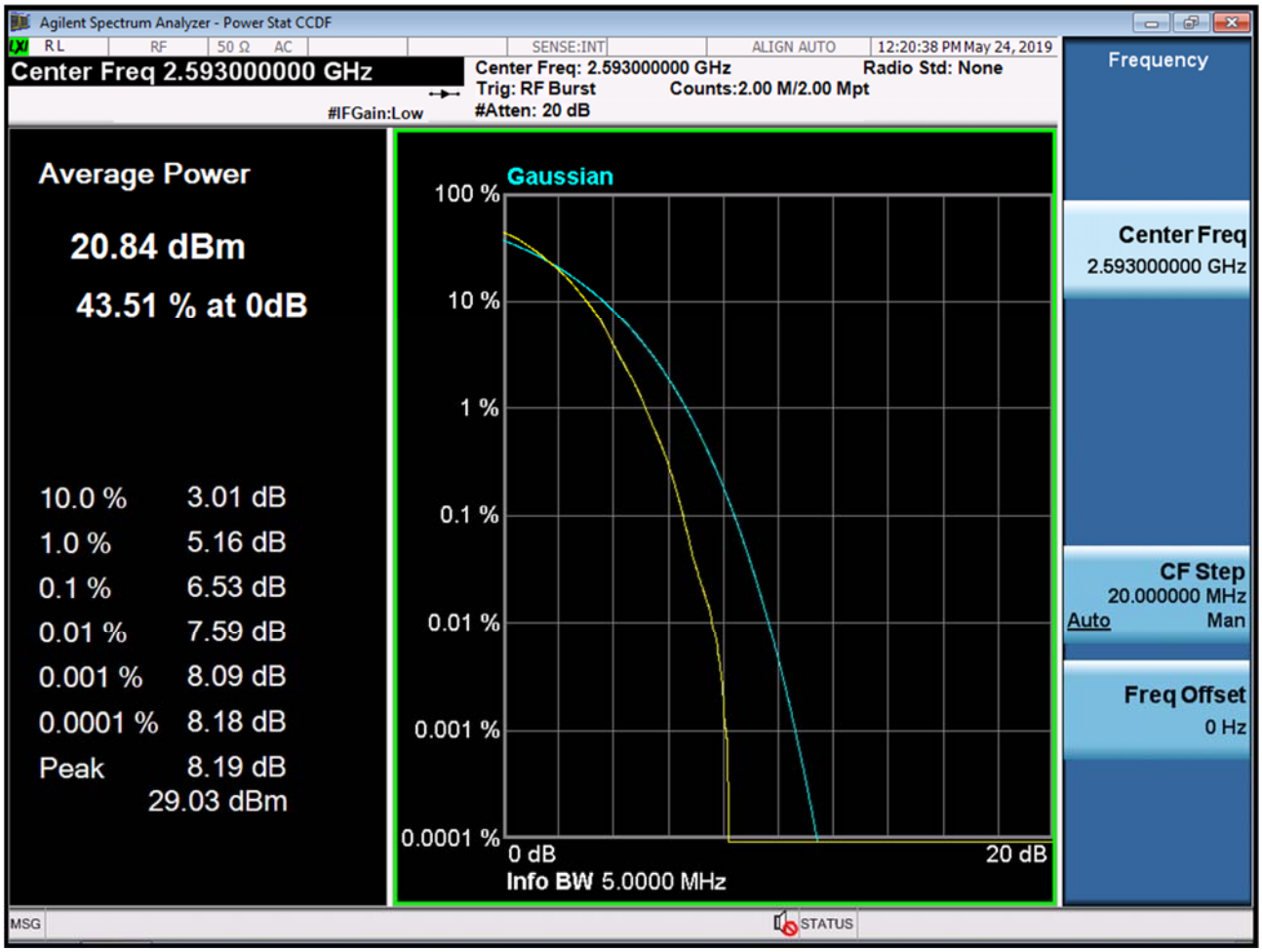


BAND 41. PAR Plot (5M BW_Ch.40620_QPSK_RB25_0)

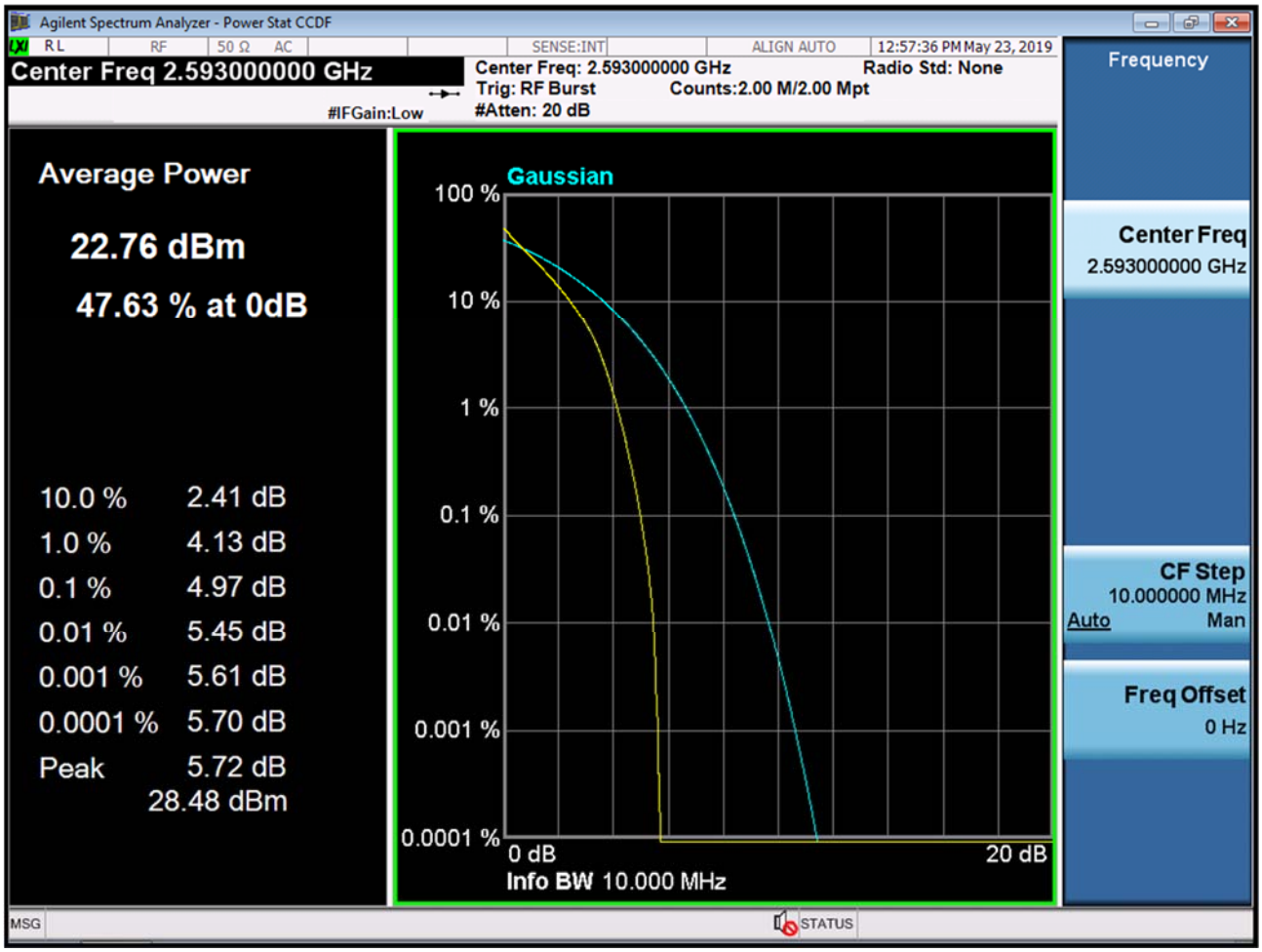
BAND 41. PAR Plot (5M BW_Ch.40620_16QAM_RB25_0)



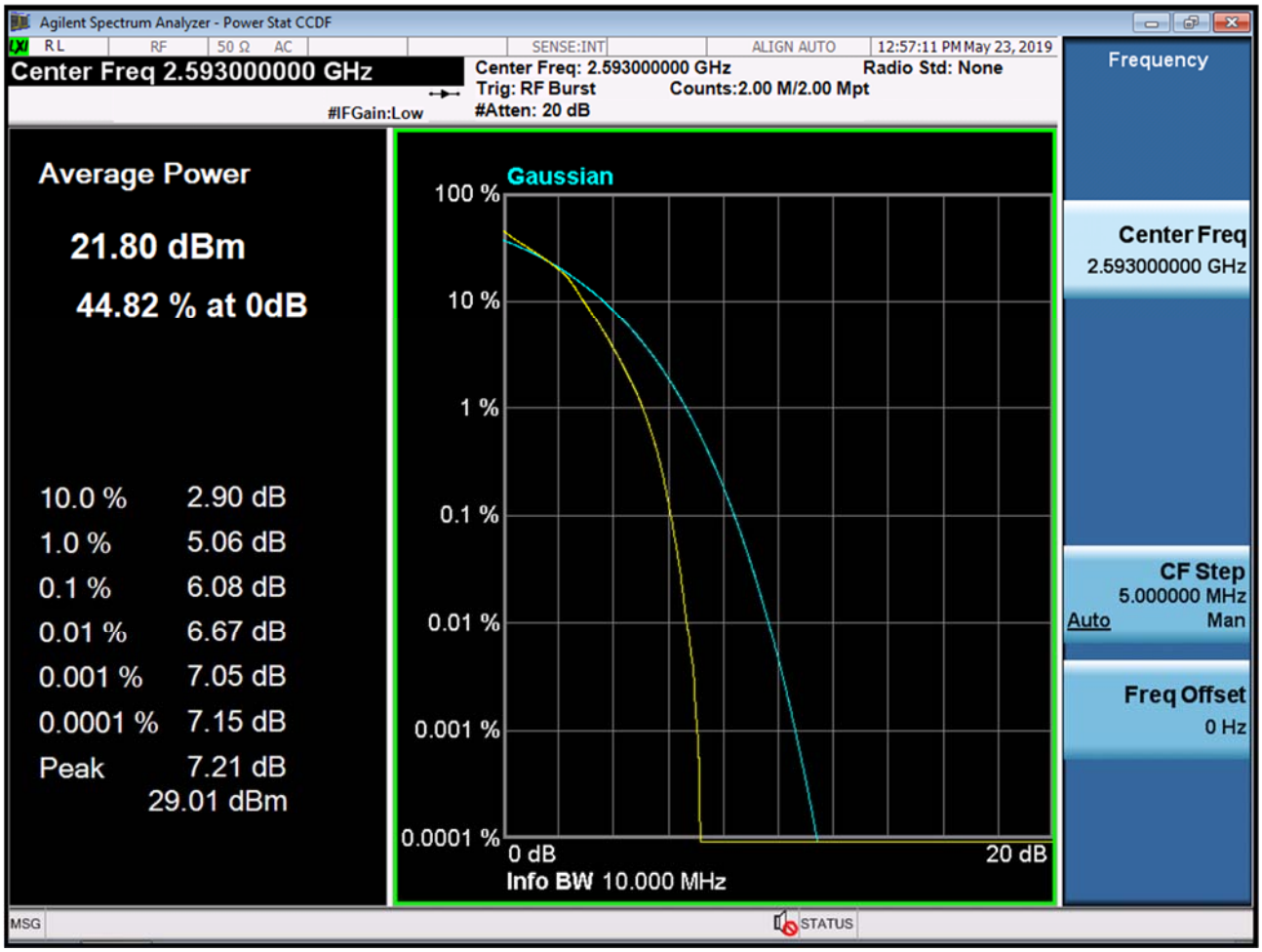
BAND 41. PAR Plot (5M BW_Ch.40620_64QAM_RB25_0)



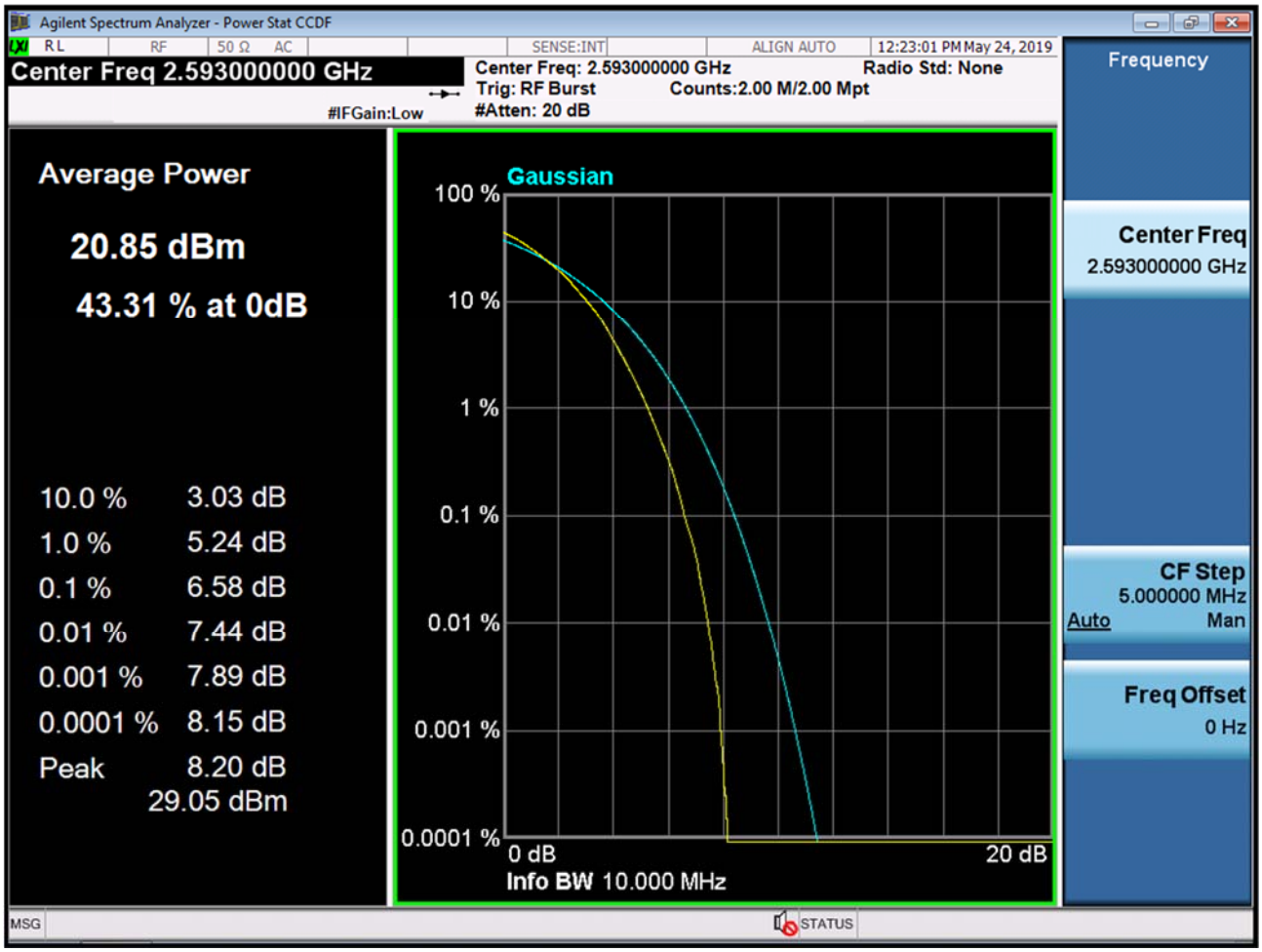
BAND 41. PAR Plot (10M BW_Ch.40620_QPSK_RB50_0)



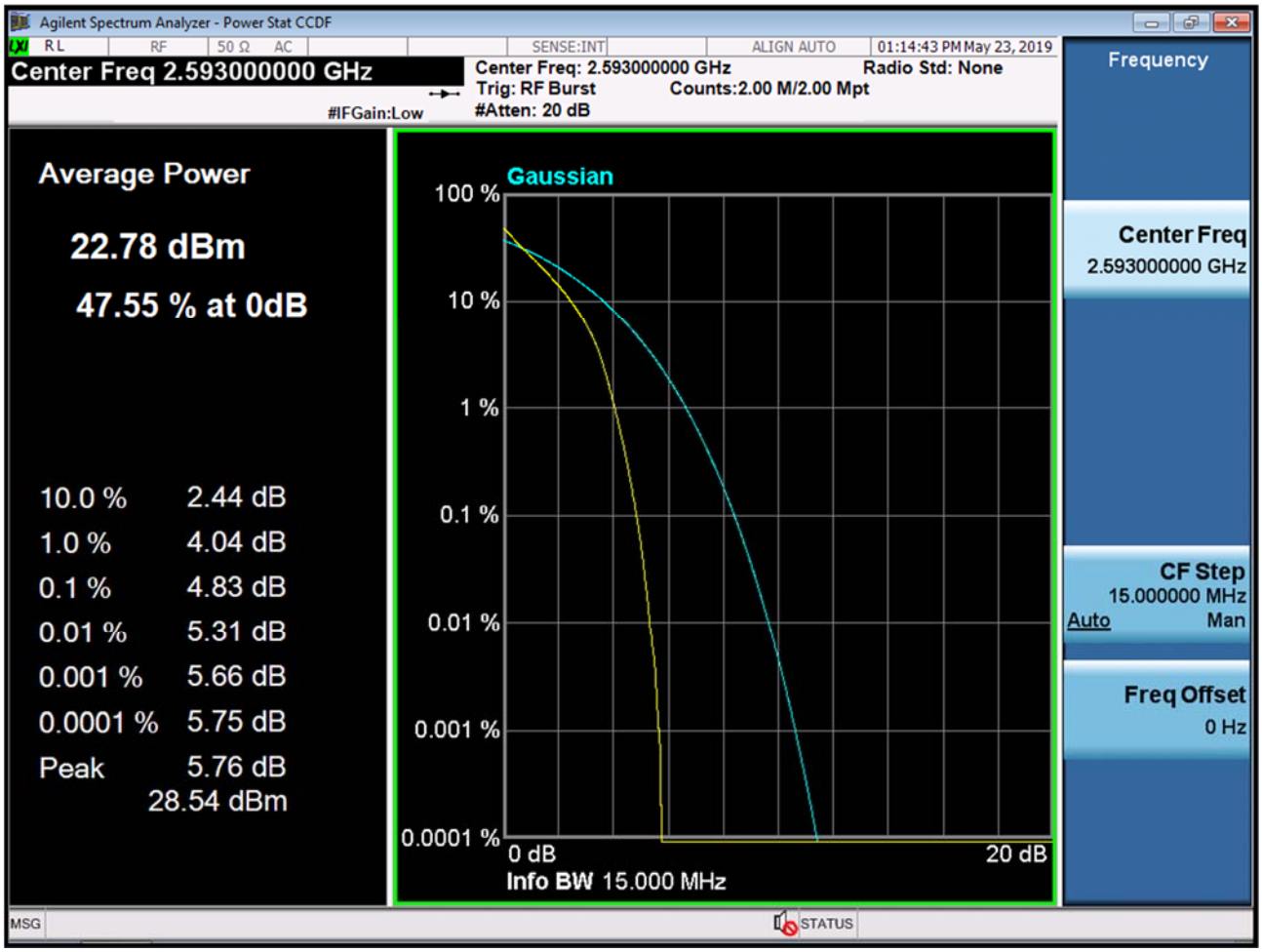
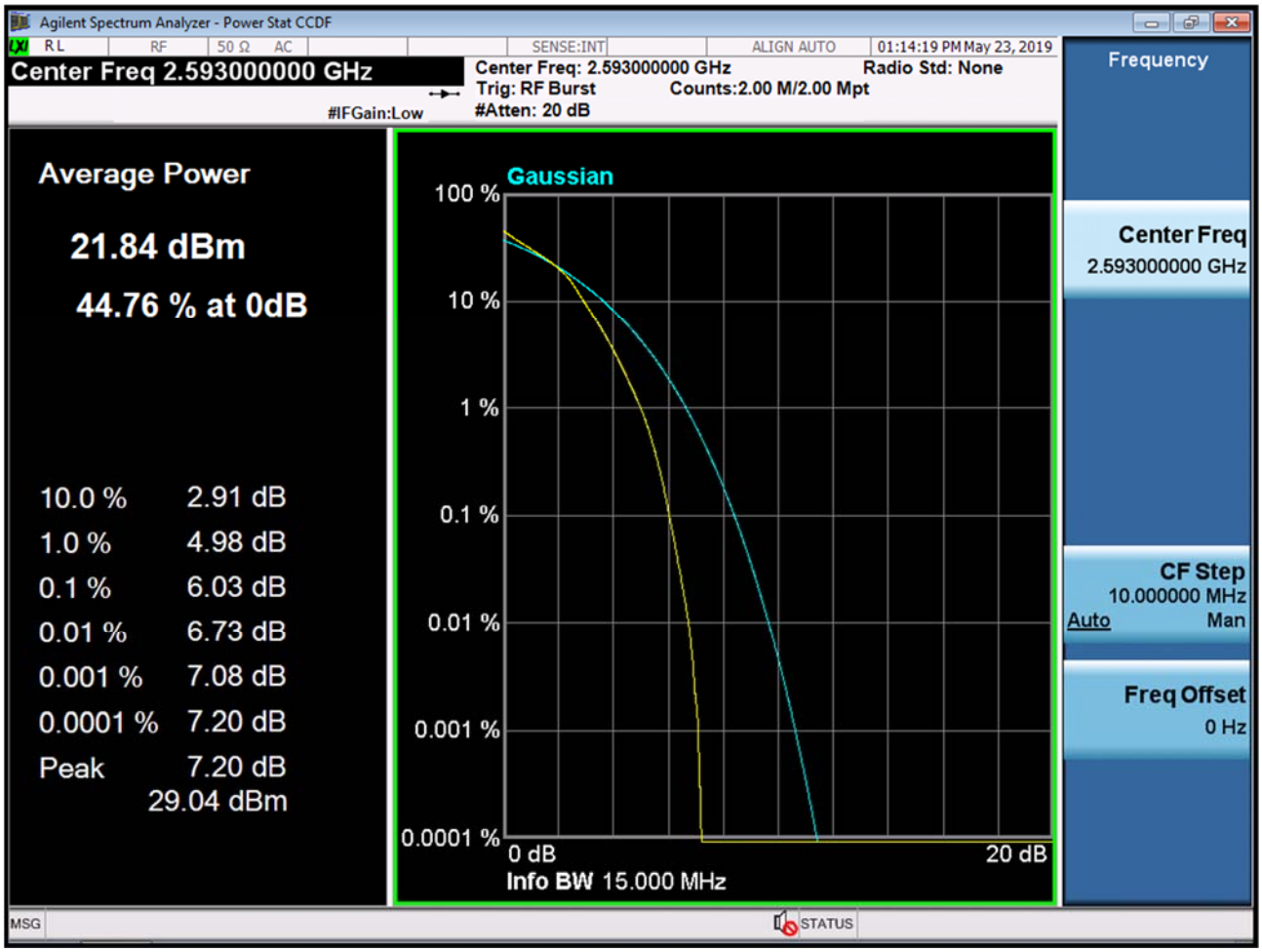
BAND 41. PAR Plot (10M BW_Ch.40620_16QAM_RB50_0)



BAND 41. PAR Plot (10M BW_Ch.40620_64QAM_RB50_0)



BAND 41. PAR Plot (15M BW_Ch.40620_QPSK_RB75_0)



BAND 41. PAR Plot (15M BW_Ch.40620_16QAM_RB75_0)