



MEASUREMENT REPORT FCC Part 90

Applicant Name:

Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:

06/08/2021- 08/16/2021

Test Site/Location:

PCTEST Morgan Hill, CA, USA

Test Report Serial No.:

1C2106070046-05.BCG

FCC ID:	BCG-A2478
APPLICANT:	Apple Inc.

Application Type:

Certification

Model:

A2478

EUT Type:

Watch

FCC Classification:

PCS Licensed Transmitter Worn on Body (PCT)

FCC Rule Part:

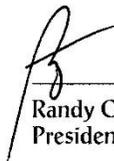
§2.1049, §90(S)

Test Procedure(s):

ANSI C63.26-2015, TIA-603-E-2016, KDB 971168 D01 v03r01

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in §2.947. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.



Randy Ortanez
President

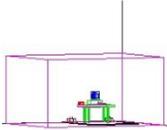


FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021 EUT Type: Watch	Page 1 of 40

TABLE OF CONTENTS

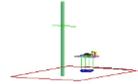
1.0	INTRODUCTION	4
1.1	Scope	4
1.2	PCTEST Test Location.....	4
1.3	Test Facility / Accreditations.....	4
2.0	PRODUCT INFORMATION.....	5
2.1	Equipment Description	5
2.2	Device Capabilities.....	5
2.3	Antenna Description	6
2.4	Test Support Equipment.....	6
2.5	Test Configuration	7
2.6	Software and Firmware	7
2.7	EMI Suppression Device(s)/Modifications	7
3.0	DESCRIPTION OF TESTS	8
3.1	Evaluation Procedure	8
3.2	Radiated Spurious Emissions	8
4.0	MEASUREMENT UNCERTAINTY	9
5.0	TEST EQUIPMENT CALIBRATION DATA	10
6.0	SAMPLE CALCULATIONS	11
7.0	TEST RESULTS.....	12
7.1	Summary.....	12
7.2	Occupied Bandwidth	14
7.3	Spurious and Harmonic Emissions at Antenna Terminal	19
7.4	Band Edge Emissions at Antenna Terminal	25
7.5	Conducted Power Output Data	31
7.6	Radiated Spurious Emissions	33
7.7	Frequency Stability / Temperature Variation	38
8.0	CONCLUSION.....	40

FCC ID: BCG-A2478	 Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 2 of 40



MEASUREMENT REPORT

FCC Part 90



Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	Measurement	OBW [MHz]	Max. Power [mW]	Max. Power [dBm]	Emission Designator
LTE Band 26	1.4 MHz	QPSK	814.7 - 823.3	Conducted	1.1068	354.813	25.50	1M11G7W
		16QAM	814.7 - 823.3	Conducted	1.1135	325.087	25.12	1M11D7W
	3 MHz	QPSK	815.5 - 822.5	Conducted	2.7283	354.813	25.50	2M73G7W
		16QAM	815.5 - 822.5	Conducted	2.7371	299.226	24.76	2M74D7W
	5 MHz	QPSK	816.5 - 821.5	Conducted	4.5526	354.813	25.50	4M55G7W
		16QAM	816.5 - 821.5	Conducted	4.5748	295.121	24.70	4M57D7W
	10 MHz	QPSK	819.0	Conducted	9.1005	354.813	25.50	9M10G7W
		16QAM	819.0	Conducted	5.4506	294.442	24.69	5M45D7W

EUT Overview

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 3 of 40

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 PCTEST Test Location

These measurement tests were conducted at the PCTEST facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at PCTEST located in Morgan Hill, CA 95037, U.S.A.

- PCTEST is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).
- PCTEST facility is a registered (22831) test laboratory with the site description on file with ISED.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 4 of 40

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Watch FCC ID: BCG-A2478**. The test data contained in this report pertains only to the emissions due to the EUT's licensed transmitters that operate under the provisions of Part 90.

Test Device Serial No.: J3DH93TR29, K6GG26L469, H3695YHQYW

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, 802.11b/g/n WLAN, 802.11a/n UNII, Bluetooth (1x, EDR, HDR4, HDR8, LE1M, LE2M), NFC, UWB, 60.5GHz Transmitter

This device supports simultaneous transmission operations, which allows for multiple transmitters to transmit simultaneously on the same antenna. The table below shows all configurations possible.

Simultaneous Tx Config	Antenna FCM				
	WLAN	Bluetooth	LTE/WCDMA	UNII	UWB
	802.11 b/g/n	BDR, EDR, HDR4/8, LE	Mid band/ High band	802.11 a/n	Ch.5, Ch.9
Config 1	✓	✗	✗	✗	✓
Config 2	✗	✓	✗	✗	✓
Config 3	✗	✗	✓	✗	✓
Config 4	✗	✓	✓	✗	✗
Config 5	✓	✗	✓	✗	✗
Config 6	✗	✗	✓	✓	✗
Config 7	✗	✓	✗	✓	✗
Config 8	✓	✗	✓	✗	✓
Config 9	✗	✓	✓	✗	✓
Config 10	✗	✓	✓	✓	✗

Table 2-1. Simultaneous Transmission Configurations

✓ = Support ; ✗ = NOT Support

All the above simultaneous transmission configurations have been tested and the worst case configuration was found to be config 10 and reported in RF UNII, RF Bluetooth and RF Part 27b test reports.

FCC ID: BCG-A2478		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 5 of 40

2.3 Antenna Description

Following antenna gain provided by manufacturer was used for testing.

Band	Antenna Gain (dBi)
LTE B26	-28.4

Table 2-2. Highest Antenna Gain

2.4 Test Support Equipment

1	Apple Macbook	Model: A1398	S/N:	C2QKP008F6F3
	w/AC/DC Adapter	Model: A1435	S/N:	N/A
2	Apple USB-C cable	Model: N/A	S/N:	N/A
	w/ Charging Dock	Model: A2687	S/N:	FV411420544MW6M4H
	w/Dock	Model: X241	S/N:	N/A
3	Apple Magnetic Charger	Model: A2515	S/N:	DLC035200UJMFR0AJ
	Apple Magnetic Charger	Model: A2515	S/N:	DLC035202KRMFR0A2
4	Pathfinder Falcon	Model: 920-098626-01	S/N:	DLC034200APQ6PM1E
	SiP Socket	Model: P2 X2011B PF 150	S/N:	DLC0485009D0KPG24
5	DC Power Supply	Model: KPS3010D	S/N:	N/A
6	Store Bracelet Assy1	Model: N/A	S/N:	DLC1197001R19G21N

Table 2-3. Test Support Equipment

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 6 of 40

2.5 Test Configuration

The EUT was tested per the guidance of ANSI C63.26 2015, TIA-603-E-2016 and KDB 971168 D01 v03r01. See Section 7.0 of this test report for a description of the radiated and antenna port conducted emissions tests.

The worst case configuration was investigated for all combinations of the three materials, aluminum, stainless steel, and Titanium and various types of wristbands, metal and non-metal wristbands. The EUT was also investigated with and without wireless charger. The worst case configuration found was used for all testing.

For emissions from 1GHz – 18GHz, low, mid, and high channels were tested with highest power and worst case configuration. The emissions below 1GHz were tested with the highest transmitting power and the worst case channel.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst case emissions were reported in this test report.

This device only supports 27RBs or less for 16-QAM uplink.

2.6 Software and Firmware

The test was conducted with firmware version watchOS 8.0 installed on the EUT.

2.7 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and no modifications were made during testing.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 7 of 40

3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the document titled "Land Mobile FM or PM – Communications Equipment – Measurements and Performance Standards" (ANSI C63.26-2015 and TIA-603-E-2016) and "Procedures for Compliance Measurement of the Fundamental Emission Power of Licensed Wideband (> 1 MHz) Digital Transmission Systems" (KDB 971168 D01 v03r01) were used in the measurement of the EUT.

Deviation from Measurement Procedure.....None

3.2 Radiated Spurious Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. For measurements below 1GHz, the absorbers are removed. A raised turntable is used for radiated measurement. The turn table is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm tall test table made of Styrodur is placed on top of the turn table. A Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

The equipment under test was transmitting while connected to its integral antenna and is placed on a turntable 3 meters from the receive antenna. The receive antenna height is adjusted between 1 and 4 meter height, the turntable is rotated through 360 degrees, and the EUT is manipulated through all orthogonal planes representative of its typical use to achieve the highest reading on the receive spectrum analyzer.

For radiated spurious emissions measurements and calculations, conversion method is used per the formulas in KDB 971168 Section 5.8.4. Field Strength (EIRP) is calculated using the following formulas:

$$E_{[dB\mu V/m]} = \text{Measured amplitude level}_{[dBm]} + 107 + \text{Cable Loss}_{[dB]} + \text{Antenna Factor}_{[dB/m]}$$

And

$$\text{EIRP}_{[dBm]} = E_{[dB\mu V/m]} + 20\log D - 104.8; \text{ where } D \text{ is the measurement distance in meters.}$$

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014.

Per KDB 414788 D01 v01r01, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30MHz if characterized so that the measurements correspond to those obtained at an open-field test site. To determine test site equivalency, a reference sample transmitting at 149kHz was measured on an open field test site (asphalt with no ground plane) and then measured in the 3m semi-anechoic chamber. A calibrated 60cm loop antenna was used while the reference device was rotated through the X, Y and Z axis in order to capture the worst case level. A maximum deviation of 2.77dB at 149kHz was measured when comparing the 3 meter semi-anechoic chamber to the open field site.

Radiated spurious emission levels are investigated with the receive antenna horizontally and vertically polarized per ANSI C63.26-2015 and TIA-603-E-2016.

FCC ID: BCG-A2478	 Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 8 of 40

4.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.23-2012. All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95% level of confidence. The measurement uncertainty shown below 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.

Contribution	Expanded Uncertainty (\pm dB)
Conducted Bench Top Measurements	1.65
Radiated Disturbance (<30MHz)	4.06
Radiated Disturbance (30MHz-1GHz)	4.30
Radiated Disturbance (1-18GHz)	4.78
Radiated Disturbance (>18GHz)	4.79

FCC ID: BCG-A2478	 PCTEST [®] Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 9 of 40

5.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	3/31/2021	Annual	3/31/2022	MY49430244
Keysight Technology	N9040B	UXA Signal Analyzer	12/19/2020	Annual	12/19/2021	MY57212015
ATM	180-442A-KF	20dB Nominal Gain Horn Antenna	8/11/2020	Annual	8/11/2021	T058701-01
ESPEC	SU-241	Tabletop Temperature Chamber	9/28/2020	Annual	9/28/2021	92009574
ETS-Lindgren	3142E	BiConiLog Antenna (30MHz - 6GHz)	9/15/2020	Annual	9/15/2021	208204
ETS-Lindgren	3117	Double Ridged Guide Antenna (1-18 GHz)	5/3/2021	Annual	5/3/2022	205956
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz - 8GHz)	12/3/2020	Annual	12/3/2021	102327
Rohde & Schwarz	TS-PR18	Pre-Amplifier (1GHz - 18GHz)	12/3/2020	Annual	12/3/2021	101648
Rohde & Schwarz	FSV40	Signal Analyzer (10Hz-40GHz)	3/16/2021	Annual	3/16/2022	101619
Rohde & Schwarz	ESW26	EMI Test Receiver	6/11/2021	Annual	6/11/2022	101299
Rohde & Schwarz	ESW44	EMI Test Receiver	11/9/2020	Annual	11/9/2021	101570
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	10/13/2020	Annual	10/13/2021	161616
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	9/24/2020	Annual	9/24/2021	151888
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz - 40GHz)	4/29/2021	Annual	4/29/2022	100051
Rohde & Schwarz	TC-TA18	Cross Polarized Vivaldi Antenna (400MHz-18GHz)	10/2/2020	Annual	10/2/2021	101063
Rohde & Schwarz	HFH2-Z2	Loop Antenna	4/5/2021	Annual	4/5/2022	100519

Table 5-1. Test Equipment

Notes:

1. For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.
2. Equipment with a calibration date of "N/A" shown in this list was not used to make direct calibrated measurements.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 10 of 40

6.0 SAMPLE CALCULATIONS

Emission Designator

QPSK Modulation

Emission Designator = 8M62G7W

LTE BW = 8.62 MHz

G = Phase Modulation

7 = Quantized/Digital Info

W = Combination of Any

16QAM Modulation

Emission Designator = 8M45D7W

LTE BW = 8.45 MHz

D = Amplitude/Angle Modulated

7 = Quantized/Digital Info

W = Combination of Any

Spurious Radiated Emission

Example: Middle Channel LTE Mode 2nd Harmonic (1564 MHz)

The average spectrum analyzer reading at 3 meters with the EUT on the turntable was -81.0 dBm. The gain of the substituted antenna is 8.1 dBi. The signal generator connected to the substituted antenna terminals is adjusted to produce a reading of -81.0 dBm on the spectrum analyzer. The loss of the cable between the signal generator and the terminals of the substituted antenna is 2.0 dB at 1564 MHz. So 6.1 dB is added to the signal generator reading of -30.9 dBm yielding -24.80 dBm. The fundamental EIRP was 25.501 dBm so this harmonic was 25.501 dBm - (-24.80).

FCC ID: BCG-A2478		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 11 of 40

7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.
 FCC ID: BCG-A2478
 FCC Classification: PCS Licensed Transmitter Worn on Body (PCT)
 Mode(s): LTE

Test Condition	Test Description	FCC Part Section(s)	Test Limit	Test Result	Reference
CONDUCTED	Occupied Bandwidth	2.1049	N/A	PASS	Section 7.2
	Conducted Band Edge / Spurious Emissions (LTE Band 26)	2.1051, 90.543(a)	-13 dBm for all out-of-band emissions except > 50 + 10 log ₁₀ (P[Watts]) at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	PASS	Sections 7.3, 7.4
	Frequency Stability	2.1055, 90.213	< 2.5 ppm	PASS	Section 7.7
	Conducted Power	2.1046, 90.635	< 100 Watts	PASS	Section 7.5
RADIATED	Radiated Spurious Emissions (LTE Band 26)	2.1053, 90.543(e)	-13 dBm for all out-of-band emissions except -20 dBm at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	PASS	Section 7.6

Table 7-1. Summary of Test Results

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 12 of 40

Notes:

1. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2. The analyzer plots shown in Section 7.0 were taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables, directional couplers, and attenuators used as part of the system to maintain a link between the call box and the EUT at all frequencies of interest.
3. All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables, attenuators, and couplers.
4. For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST EMC Software Tool 1.0.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 13 of 40

7.2 Occupied Bandwidth

\$2.1049

Test Overview

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. All modes of operation were investigated and the worst case configuration results are reported in this section.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 4.2

Test Settings

1. The signal analyzer’s automatic bandwidth measurement capability was used to perform the 99% occupied bandwidth and the 26dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 1 – 5% of the expected OBW
3. VBW $\geq 3 \times$ 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

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

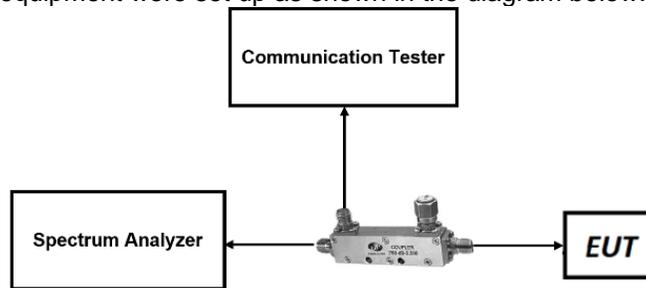


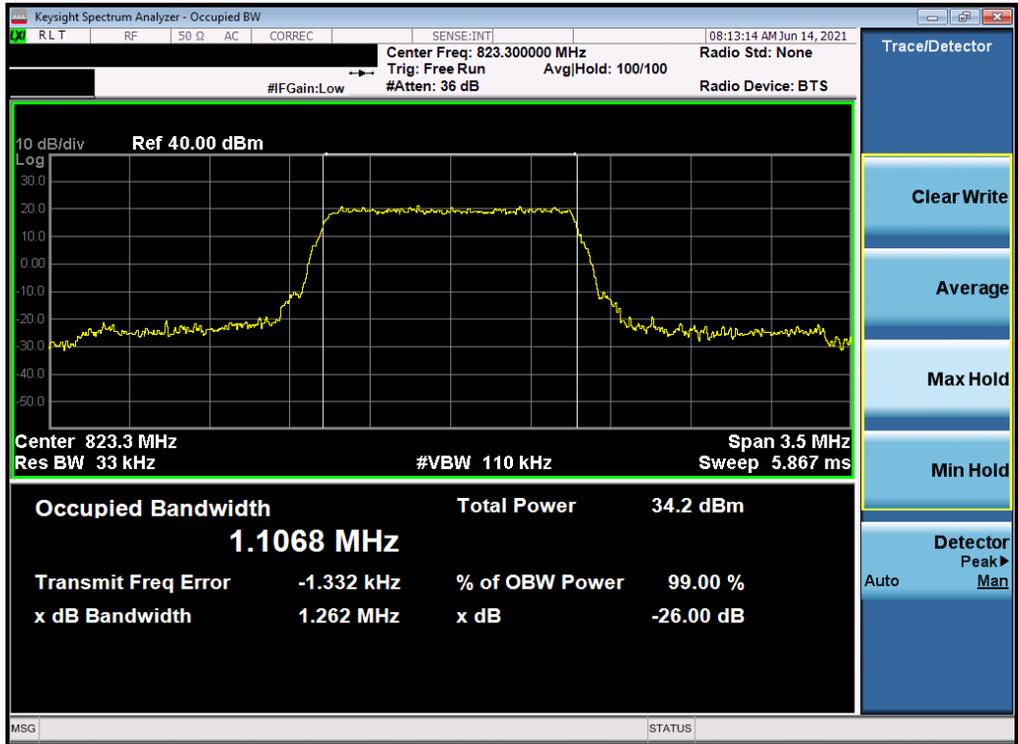
Figure 7-1. Test Instrument & Measurement Setup

Test Notes

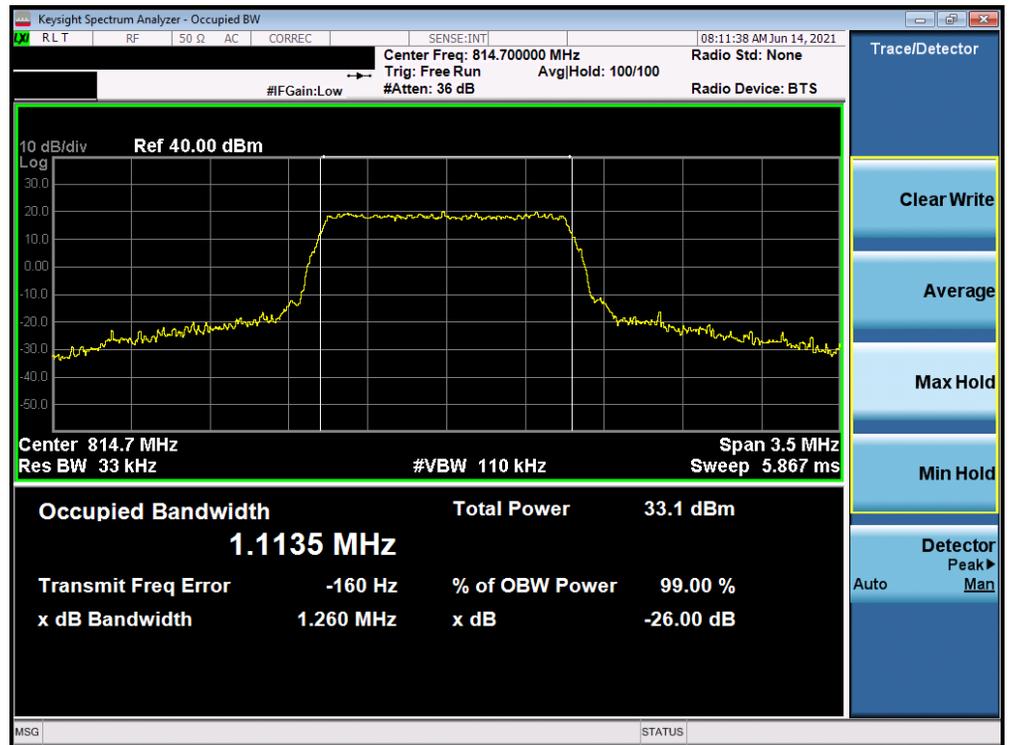
None.

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch		Page 14 of 40

LTE Band 26

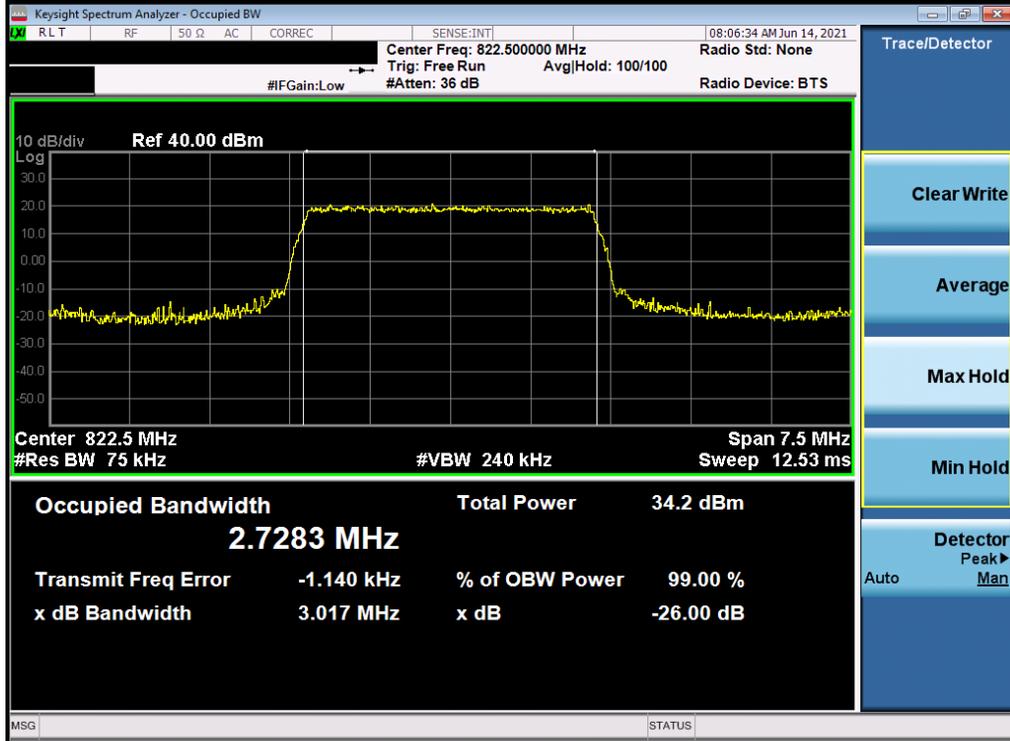


Plot 7-1. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz QPSK - Full RB Configuration)

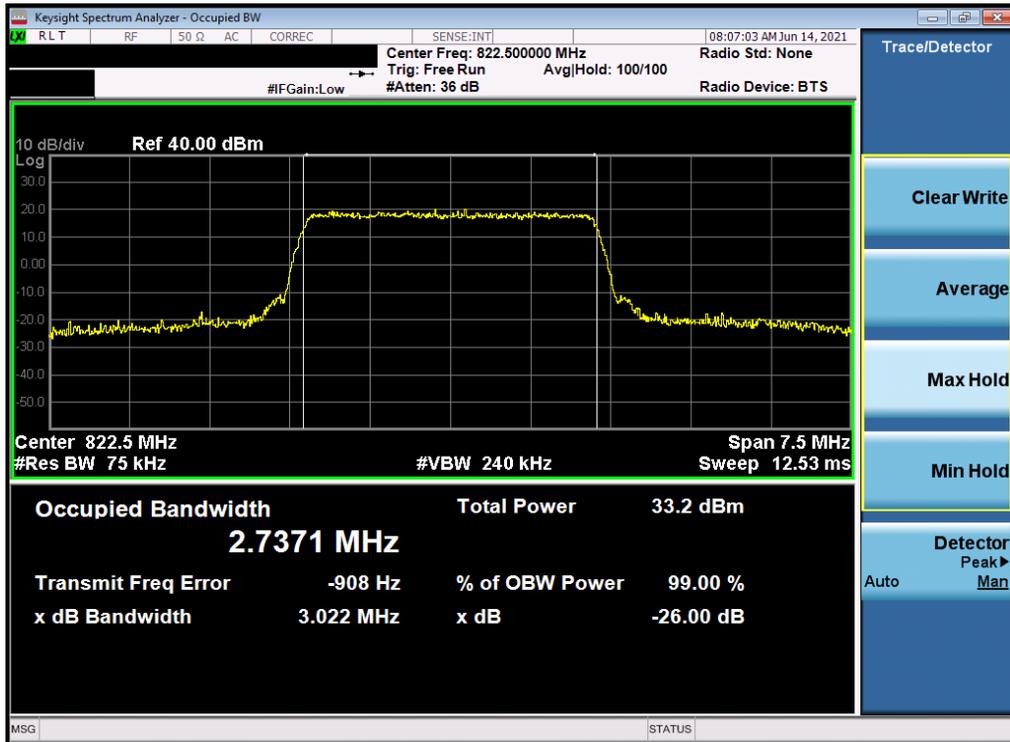


Plot 7-2. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz 16-QAM - Full RB Configuration)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 15 of 40



Plot 7-3. Occupied Bandwidth Plot (LTE Band 26 - 3MHz QPSK - Full RB Configuration)

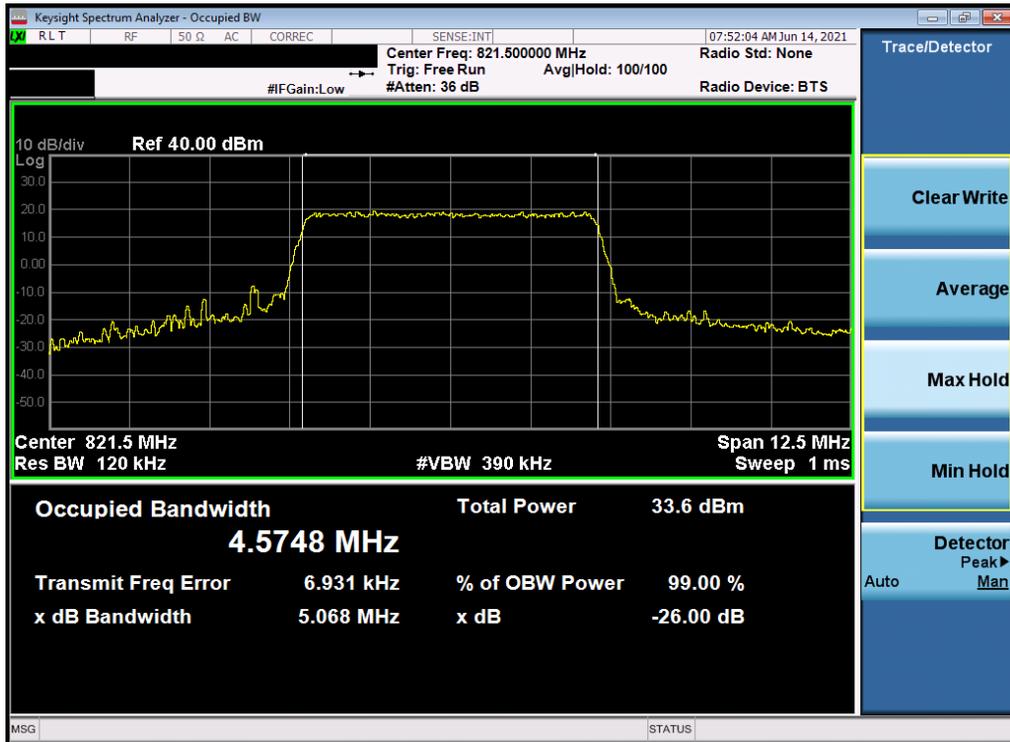


Plot 7-4. Occupied Bandwidth Plot (LTE Band 26 - 3MHz 16-QAM - Full RB Configuration)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 16 of 40

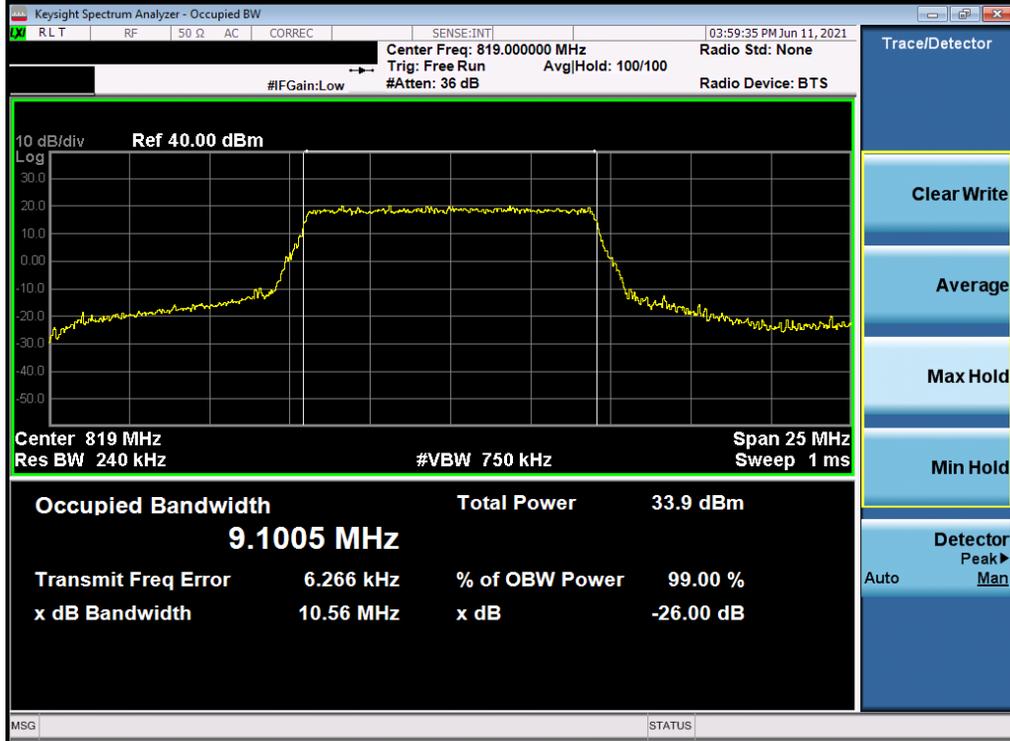


Plot 7-5. Occupied Bandwidth Plot (LTE Band 26 - 5MHz QPSK - Full RB Configuration)

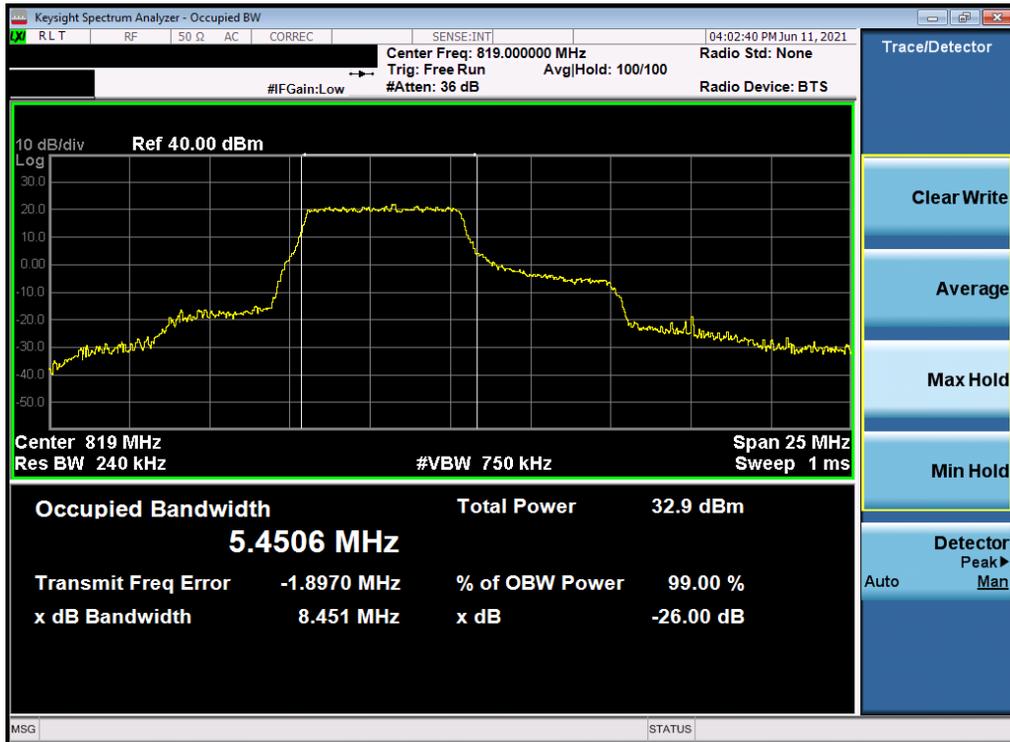


Plot 7-6. Occupied Bandwidth Plot (LTE Band 26 - 5MHz 16-QAM - Full RB Configuration)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 17 of 40



Plot 7-7. Occupied Bandwidth Plot (LTE Band 26 - 10MHz QPSK - Full RB Configuration)



Plot 7-8. Occupied Bandwidth Plot (LTE Band 26 - 10MHz 16-QAM - Full RB Configuration)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 18 of 40

7.3 Spurious and Harmonic Emissions at Antenna Terminal

§2.1051 §90(S).691(a)

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 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.

The minimum permissible attenuation level of any spurious emission is $43 + 10 \log_{10}(P_{[Watts]})$, where P is the transmitter power in Watts.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 10GHz (separated into at least two plots per channel)
2. RBW \geq 100kHz
3. VBW \geq 3 x RBW
4. Detector = RMS
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

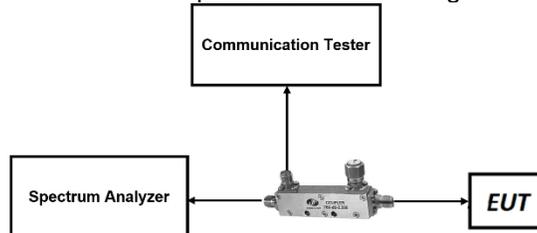


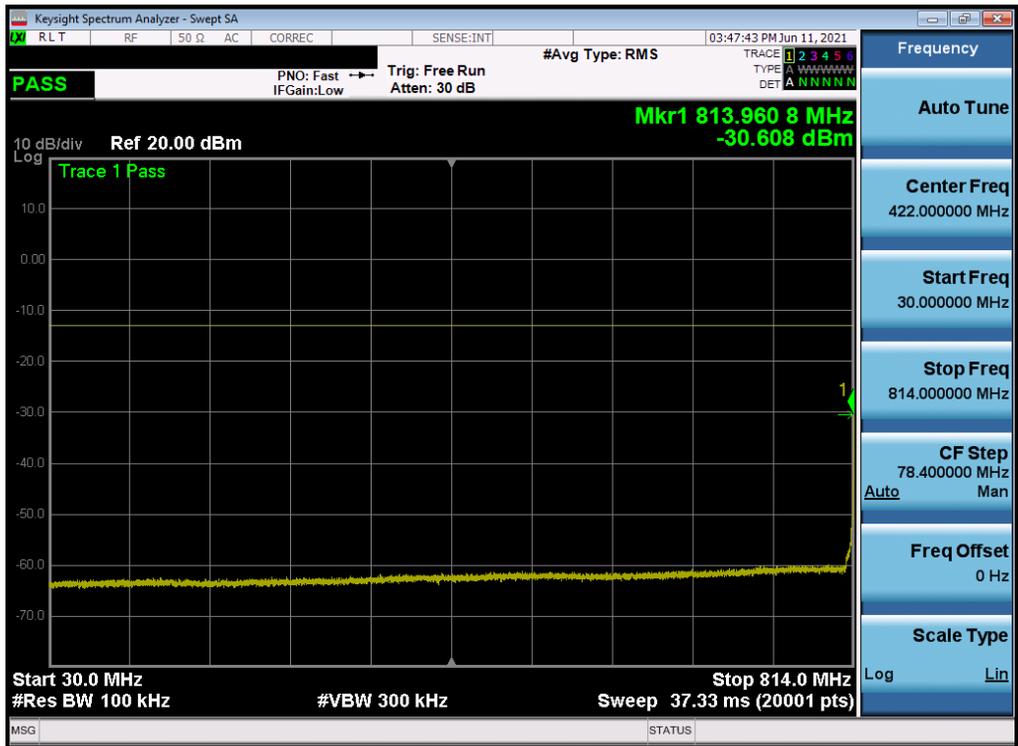
Figure 7-2. Test Instrument & Measurement Setup

Test Notes

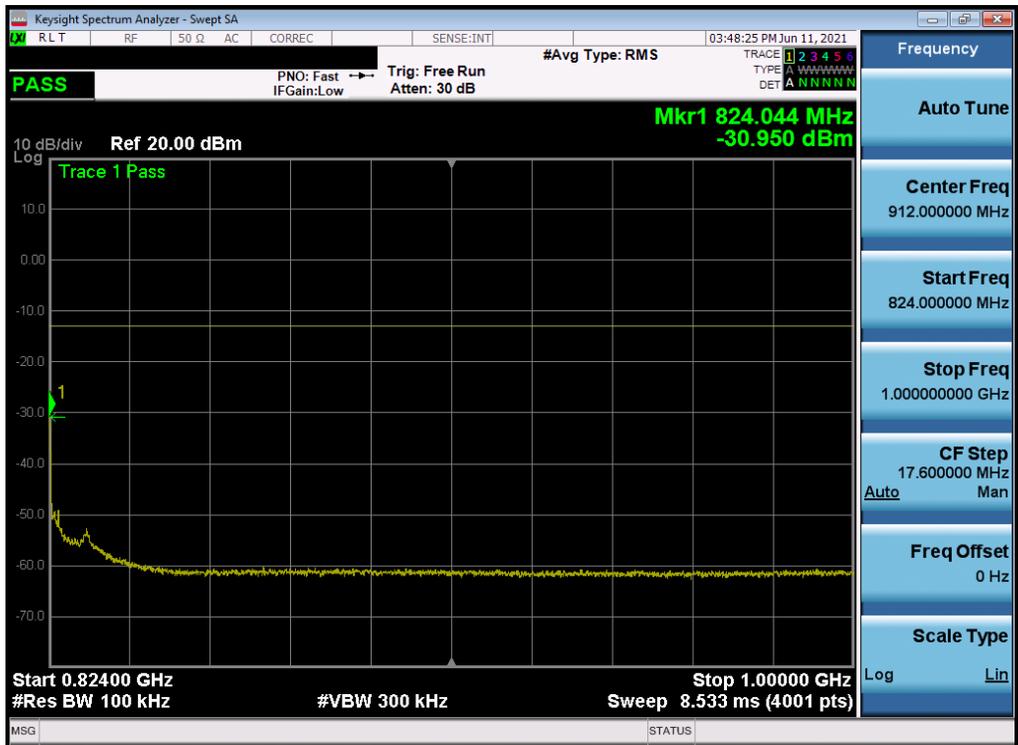
Compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater for Part 90. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emission are attenuated at least 26 dB below the transmitter power.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 19 of 40

LTE Band 26

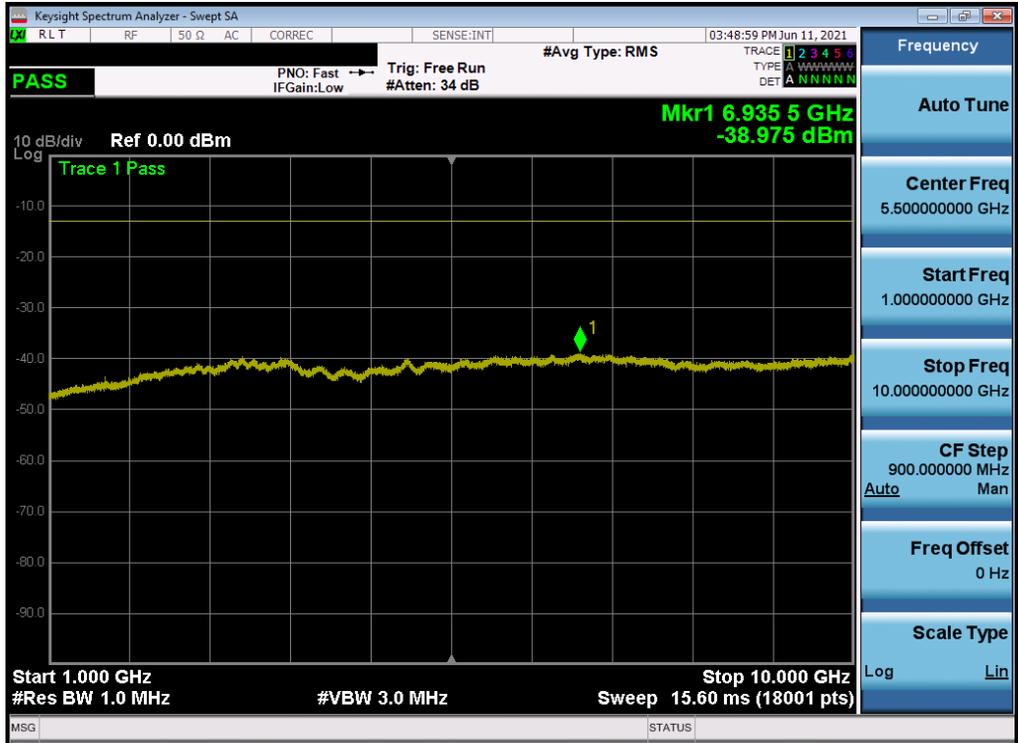


Plot 7-9. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0)

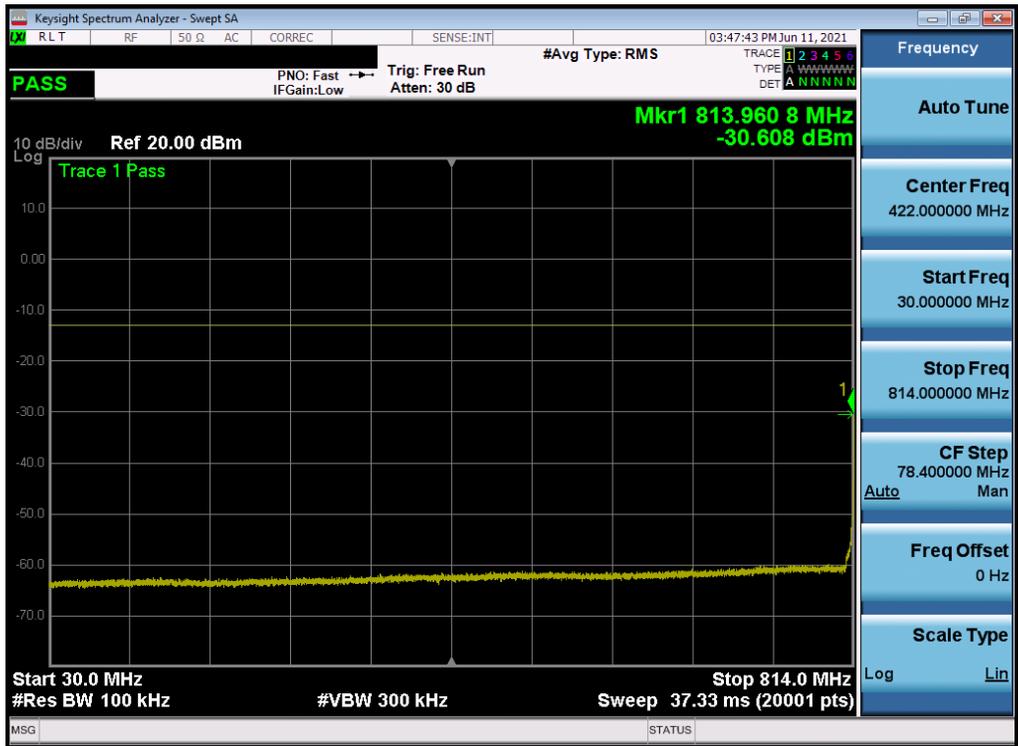


Plot 7-10. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 20 of 40

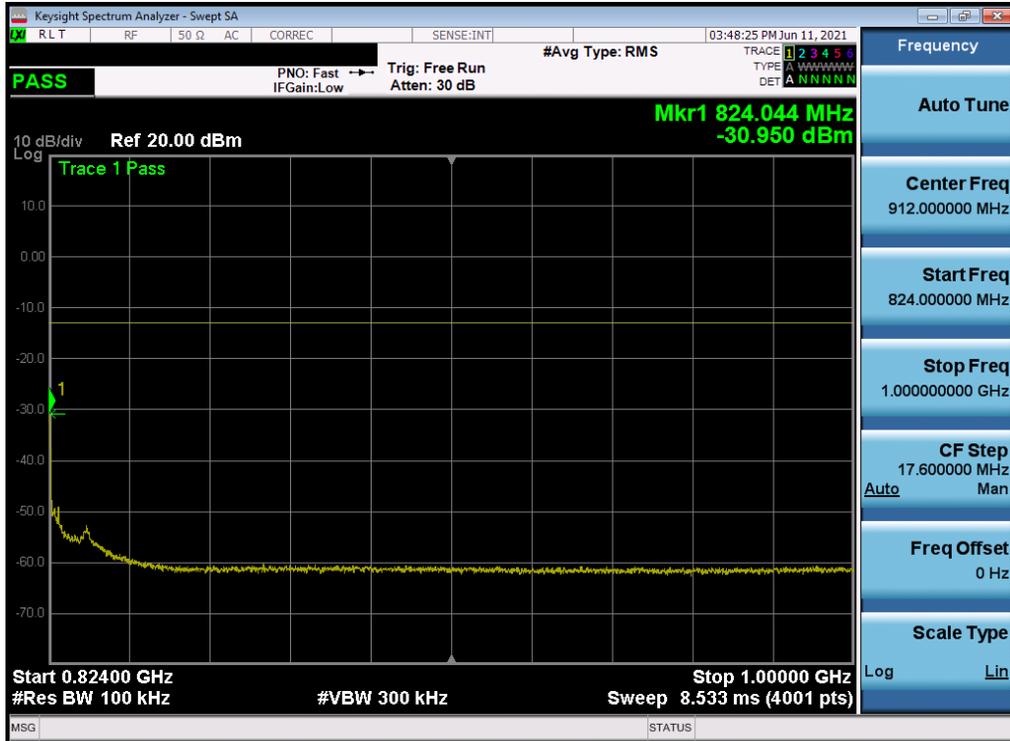


Plot 7-11. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0)

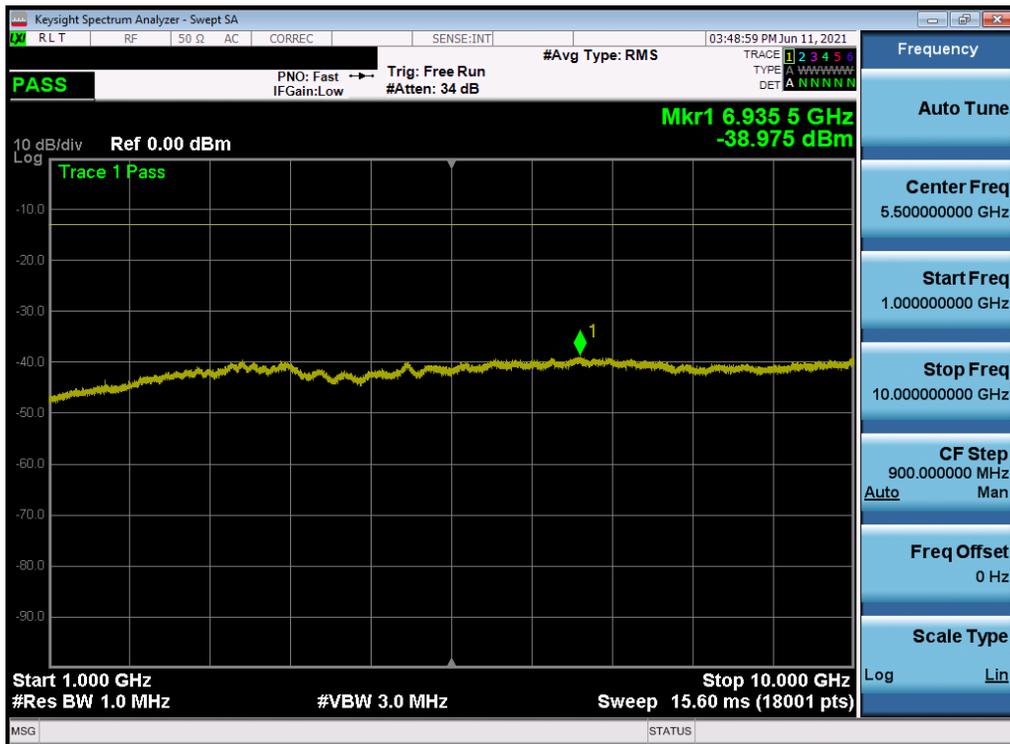


Plot 7-12. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 – Mid Channel)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 21 of 40

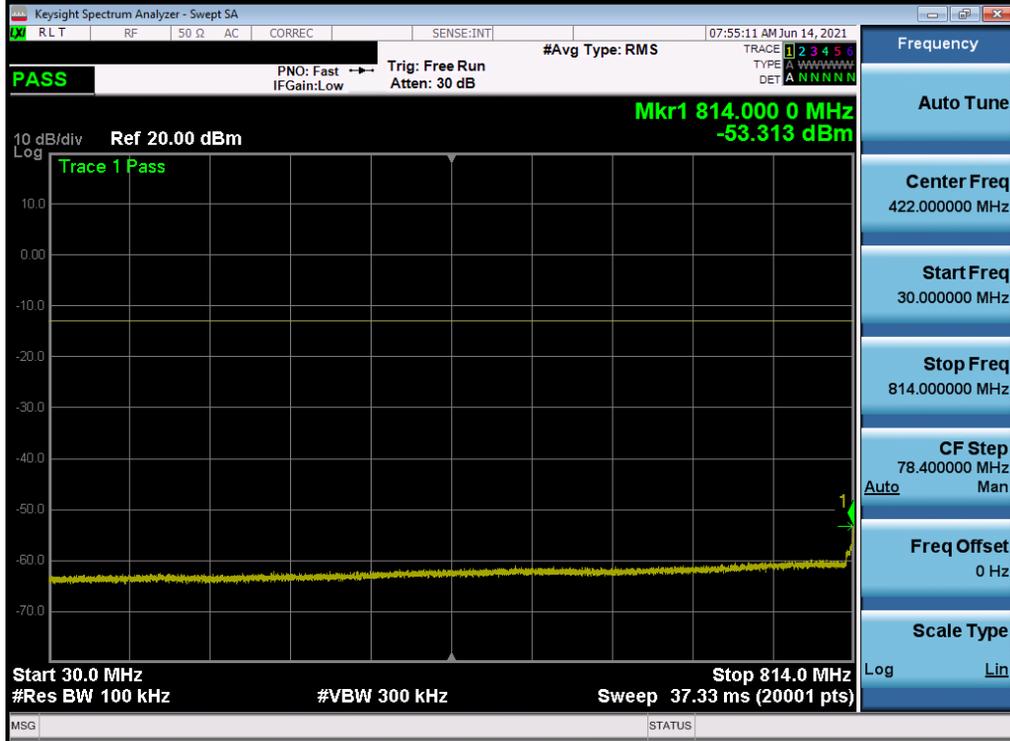


Plot 7-13. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 – Mid Channel)

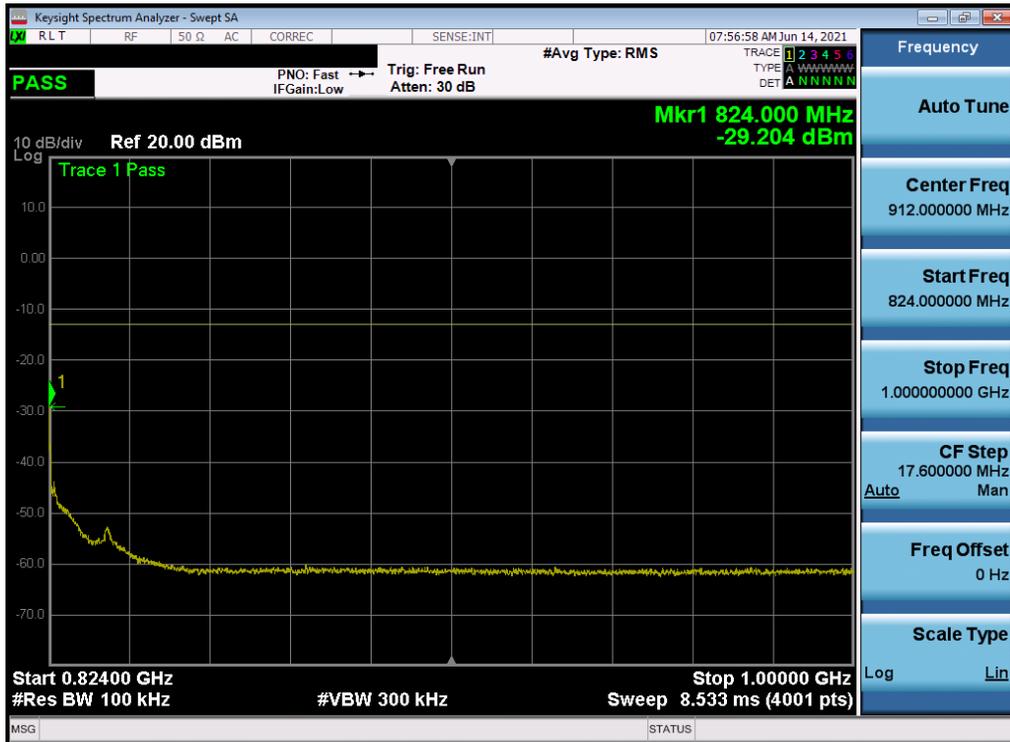


Plot 7-14. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 – Mid Channel)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 22 of 40

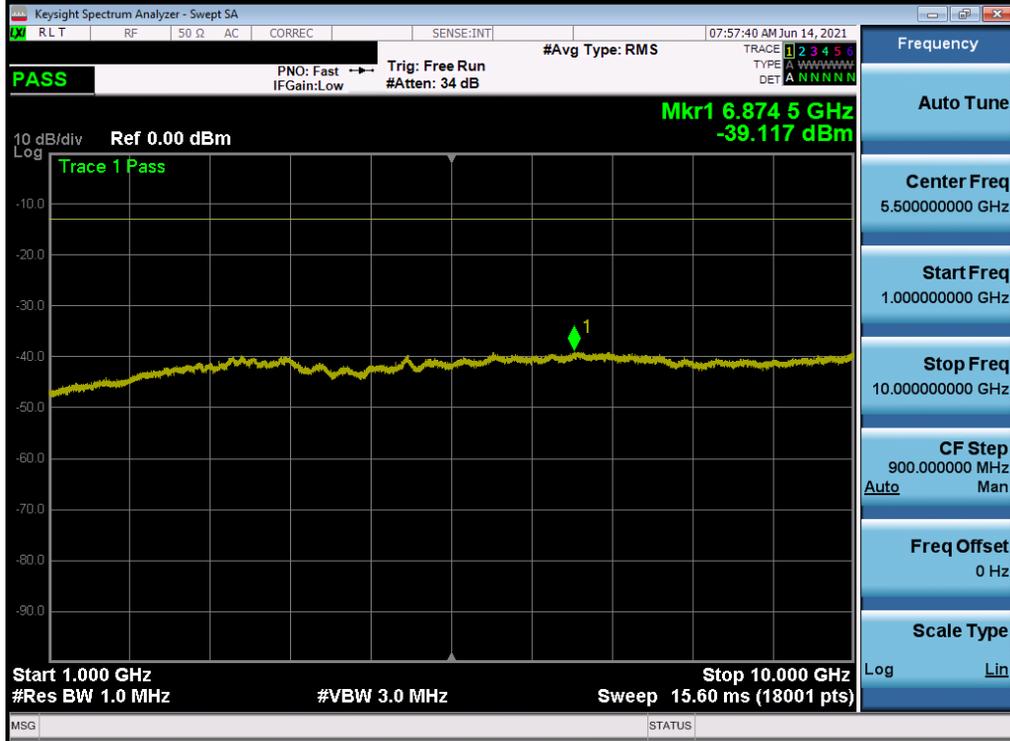


Plot 7-15. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 – High Channel)



Plot 7-16. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 – High Channel)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 23 of 40



Plot 7-17. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 – High Channel)

FCC ID: BCG-A2478	PCTEST Proud to be part of element		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch		Page 24 of 40

7.4 Band Edge Emissions at Antenna Terminal §2.1051 §90(S).691(a)

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 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.

For LTE B26 operation under Part 90.691, the minimum permissible attenuation level of any spurious emission removed from the EA licensee's frequency block by greater than 37.5 kHz is $43 + 10\log_{10}(P_{[Watts]})$, where P is the transmitter power in Watts. The minimum permissible attenuation level of any spurious emission removed from the EA licensee's frequency block by up to and including 37.5 kHz is $50 + 10\log_{10}(P_{[Watts]})$, where P is the transmitter power in Watts.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Span was set large enough so as to capture all out of band emissions near the band edge
2. RBW = 100 kHz
3. VBW = 300 kHz
4. Detector = RMS
5. Trace mode = trace average
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

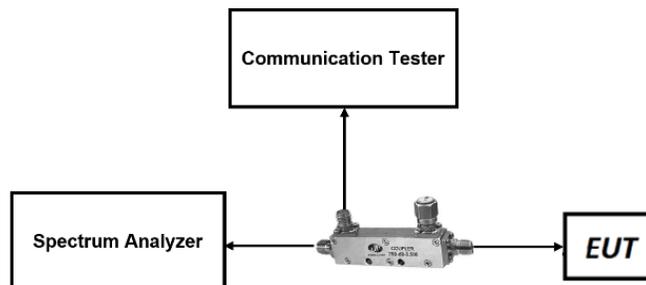


Figure 7-3. Test Instrument & Measurement Setup

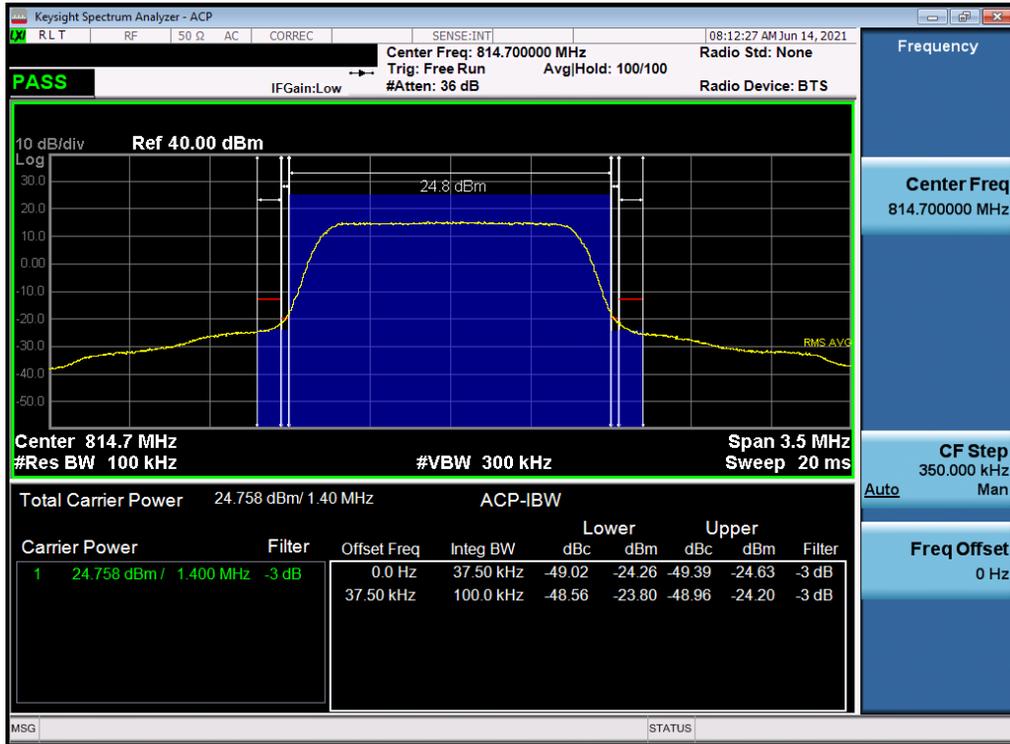
FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch		Page 25 of 40

Test Notes

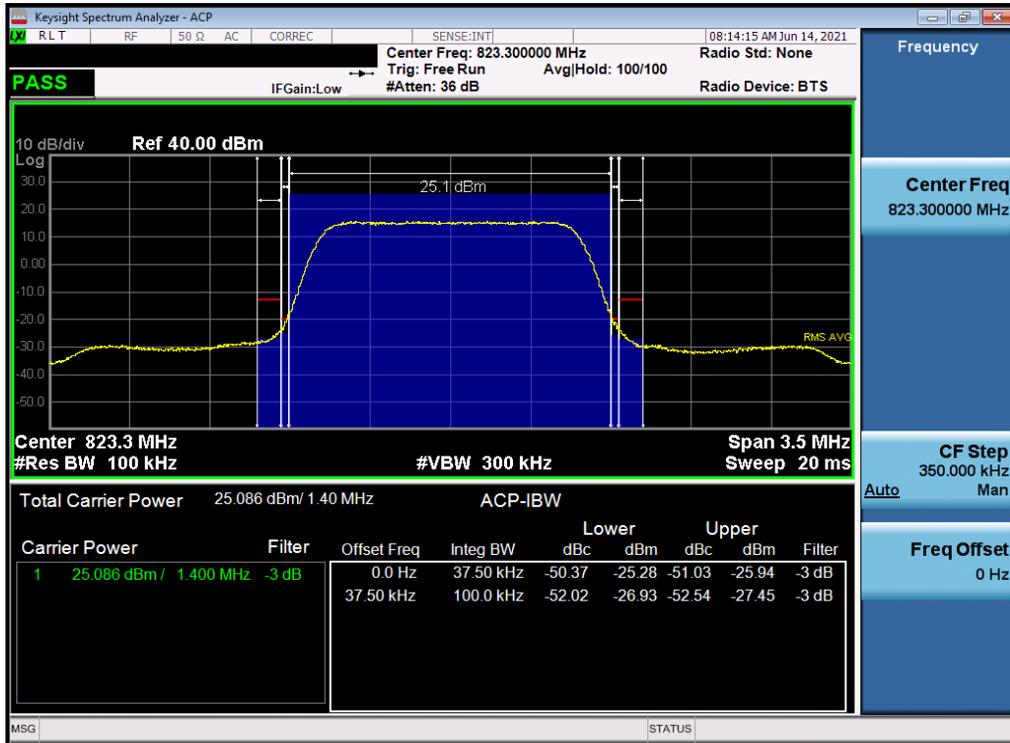
1. For channel edge emission, the signal analyzer's "ACP" measurement capability is used.
2. Per Part 90, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed to demonstrate compliance with the out-of-band emissions limit. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 26 of 40

LTE Band 26

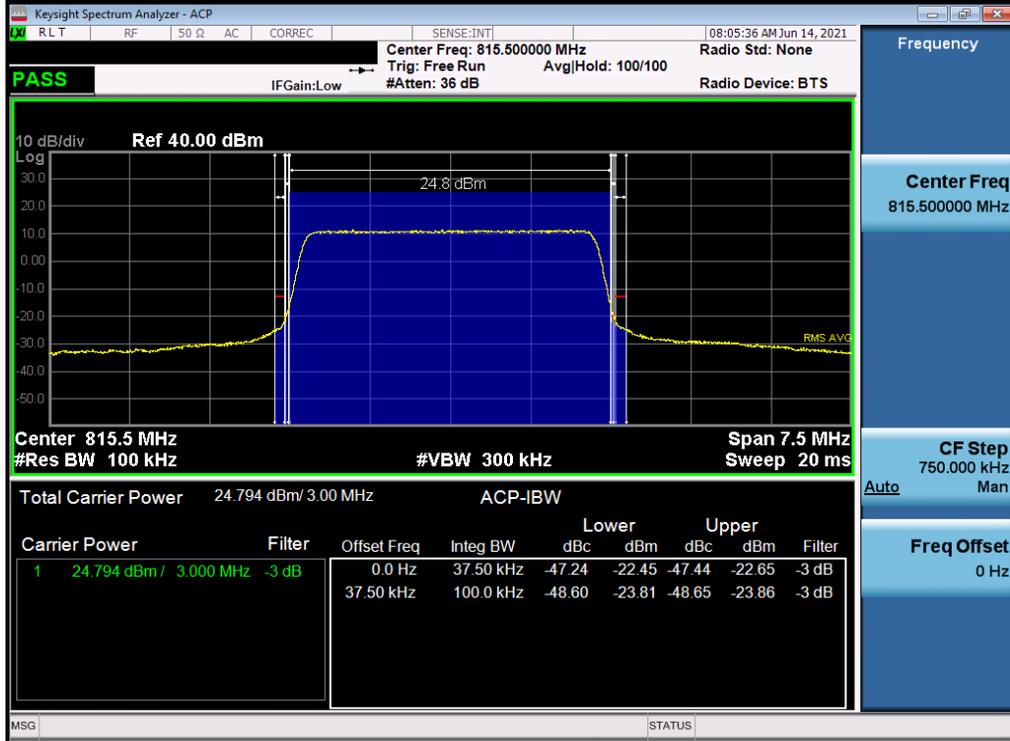


Plot 7-18. Channel Edge Plot (LTE Band 26 - 1.4MHz QPSK - Low Channel)

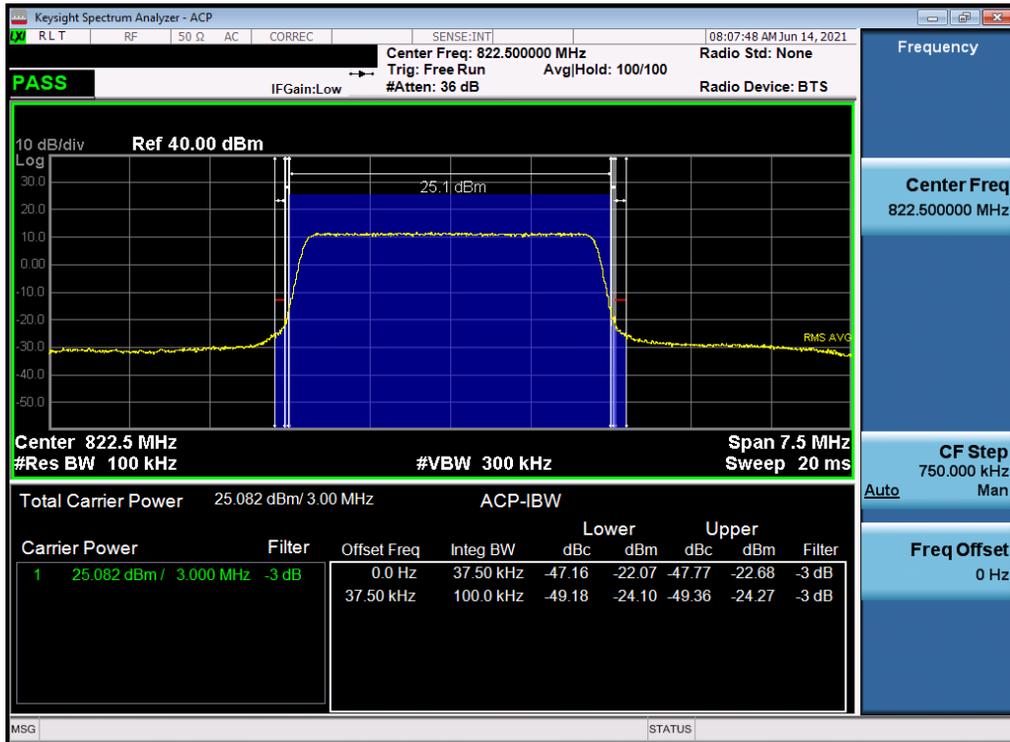


Plot 7-19. Channel Edge Plot (LTE Band 26 - 1.4MHz QPSK - High Channel)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 27 of 40

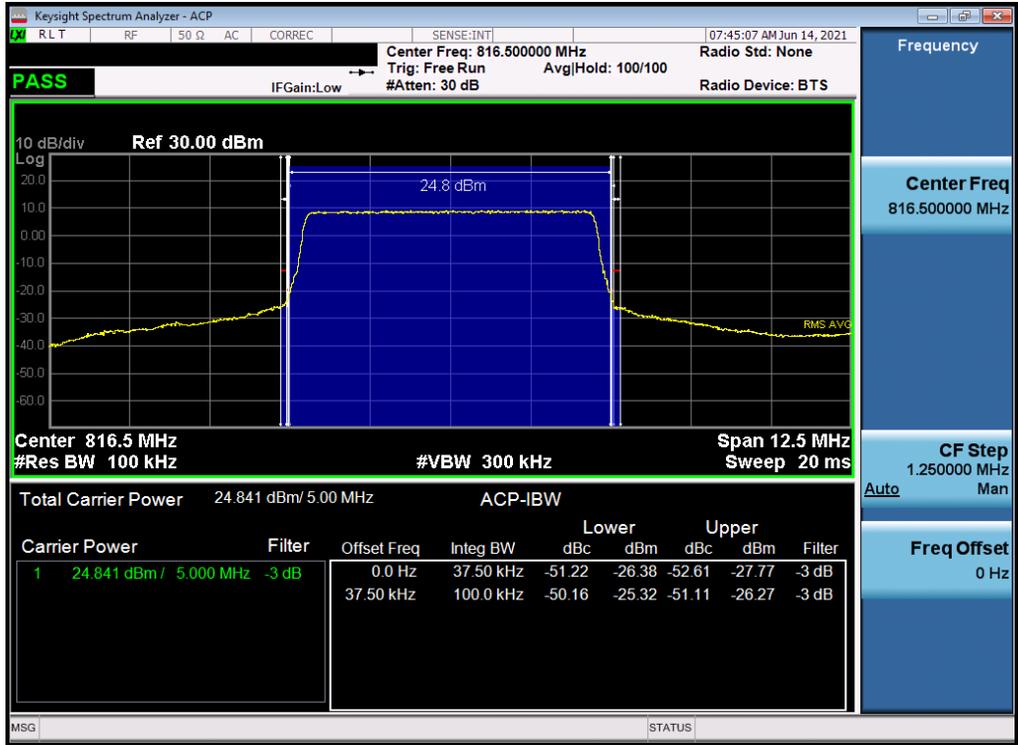


Plot 7-20. Channel Edge Plot (LTE Band 26 - 3MHz QPSK - Low Channel)

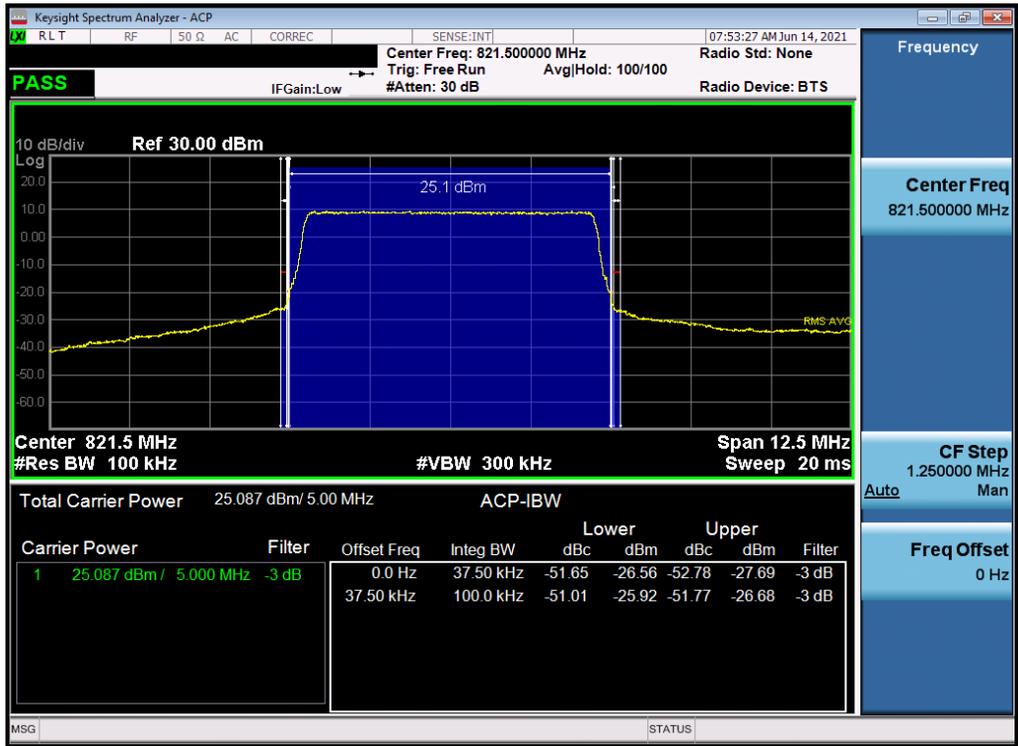


Plot 7-21. Channel Edge Plot (LTE Band 26 - 3MHz QPSK - High Channel)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 28 of 40

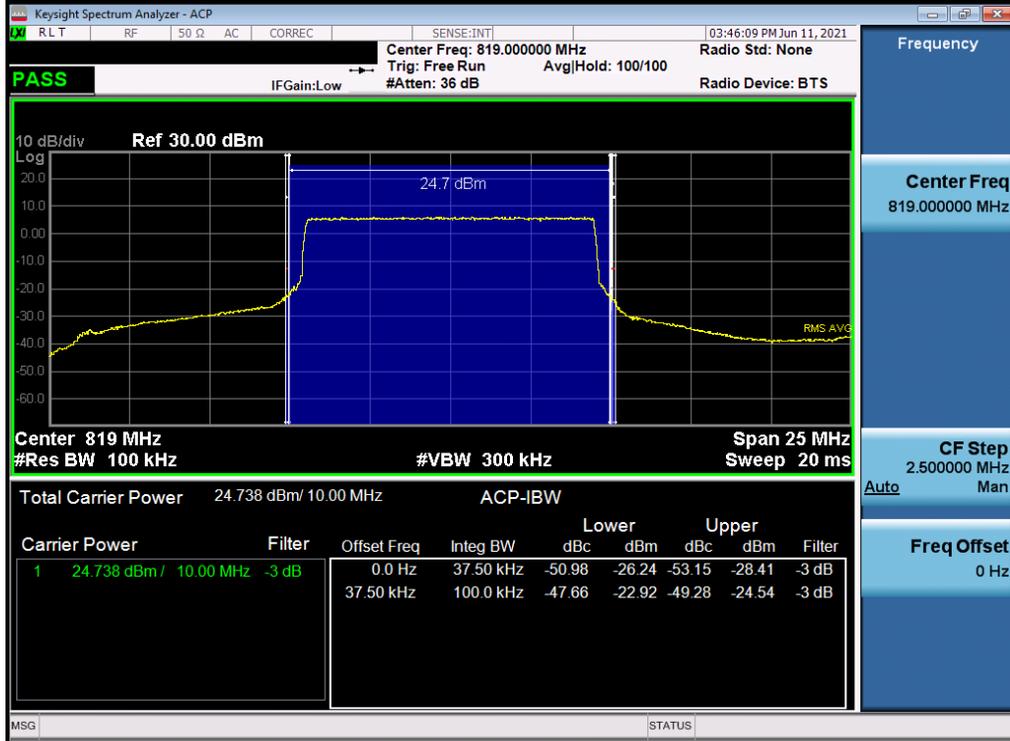


Plot 7-22. Channel Edge Plot (LTE Band 26 - 5MHz QPSK - Low Channel)



Plot 7-23. Channel Edge Plot (LTE Band 26 - 5MHz QPSK - High Channel)

FCC ID: BCG-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 29 of 40



Plot 7-24. Channel Edge Plot (LTE Band 26 - 10MHz QPSK - Mid Channel)

FCC ID: BCG-A2478	PCTEST Proud to be part of element		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch		Page 30 of 40

7.5 Conducted Power Output Data

§2.1046 §90.635

Test Overview

Conducted power measurements are performed to measure the average output power of the EUT. The averaging is to be performed only over duration of active transmissions at maximum output power level. The average measurements do not include averaging over periods when the transmitter is quiescent or when operating at reduced power level.

Test Procedures Used

KDB 971168 D01 v03r01

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

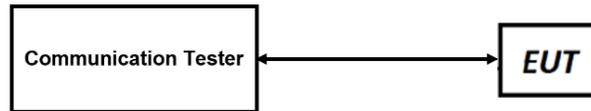


Figure 7-4. Conducted Power Measurement Setup

Test Notes

1. The EUT was tested in all possible test configurations. The worst case emissions are reported with the EUT modulations and channel bandwidth configurations shown in the tables below.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 31 of 40

Antenna BCM

Bandwidth	Modulation	Channel	Frequency [MHz]	RB Size/Offset	Conducted Power [dBm]	Conducted Power [mW]	Conducted Power Limit [dBm]	Margin [dB]
1.4 MHz	QPSK	26697	814.7	1 / 3	25.47	352.371	50.00	-24.53
		26783	823.3	1 / 0	25.50	354.813	50.00	-24.50
	16-QAM	26697	814.7	1 / 5	25.12	325.087	50.00	-24.88
3 MHz	QPSK	26705	815.5	1 / 14	25.49	353.997	50.00	-24.51
		26775	822.5	1 / 7	25.50	354.813	50.00	-24.50
	16-QAM	26775	822.5	1 / 0	24.76	299.226	50.00	-25.24
5 MHz	QPSK	26715	816.5	1 / 0	25.47	352.371	50.00	-24.53
		26765	821.5	1 / 24	25.50	354.813	50.00	-24.50
	16-QAM	26765	821.5	1 / 12	24.70	295.121	50.00	-25.30
10 MHz	QPSK	26740	819.0	1 / 49	25.50	354.813	50.00	-24.50
	16-QAM	26740	819.0	1 / 25	24.69	294.442	50.00	-25.31

Table 7-2. Conducted Power Output Data (LTE Band 26)

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 32 of 40

7.6 Radiated Spurious Emissions

§2.1053 §90(S).691(a)

Test Overview

Radiated spurious emissions measurements are performed using the field strength conversion method described in KDB 971168 with the EUT transmitting into an integral antenna. Measurements on signals operating below 1GHz are performed using horizontally and vertically polarized broadband hybrid antennas. Measurements on signals operating above 1GHz are performed using vertically and horizontally polarized broadband horn antennas. All measurements are performed while the EUT is operating at maximum power and at the appropriate frequencies.

Test Procedures Used

KDB 971168 D01 v03r01 – Section 5.8

ANSI C63.26-2015

TIA-603-E-2016 – Section 2.2.12

Test Settings

1. RBW = 100kHz for emissions below 1GHz and 1MHz for emissions above 1GHz
2. VBW \geq 3 x RBW
3. Span = 1.5 times the OBW
4. No. of sweep points \geq 2 x span / RBW
5. Detector = RMS
6. Trace mode = Average (Max Hold for pulsed emissions)
7. The trace was allowed to stabilize

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 33 of 40

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

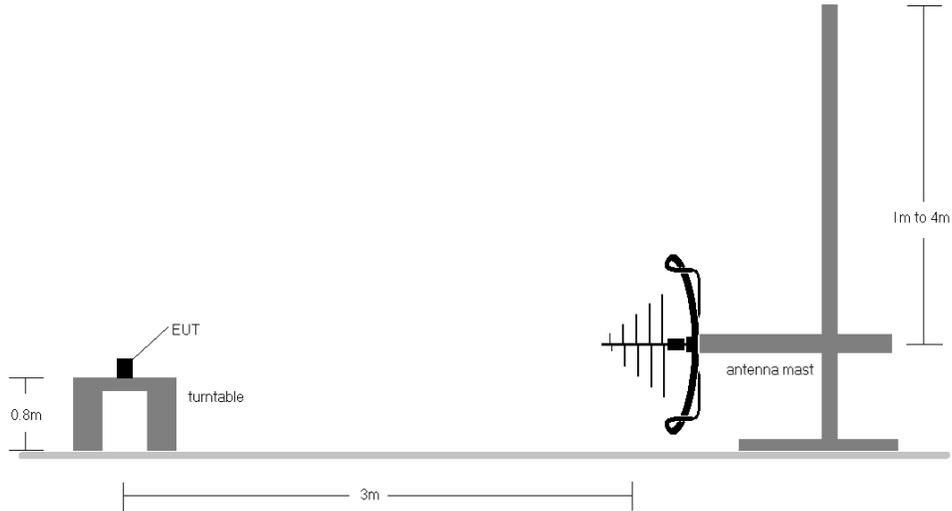


Figure 7-5. Test Instrument & Measurement Setup < 1GHz

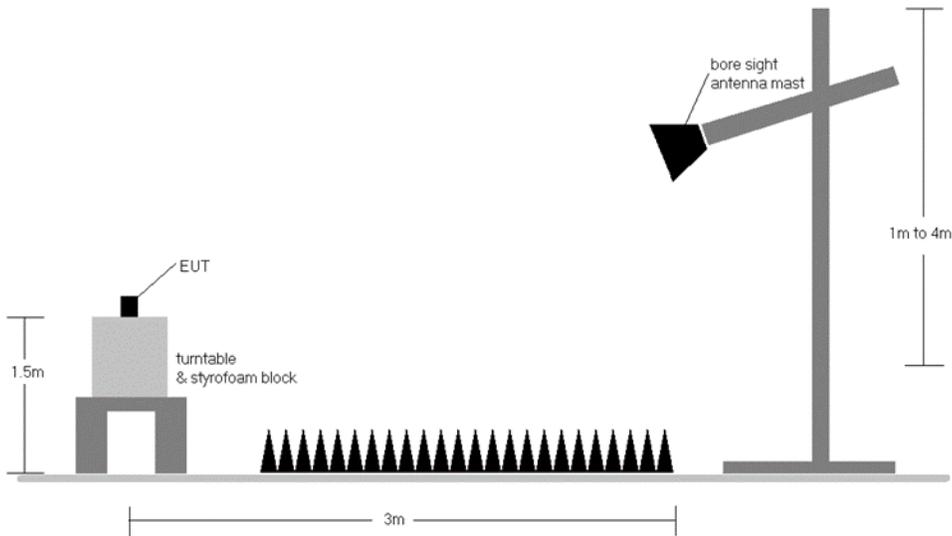


Figure 7-6. Test Instrument & Measurement Setup >1 GHz

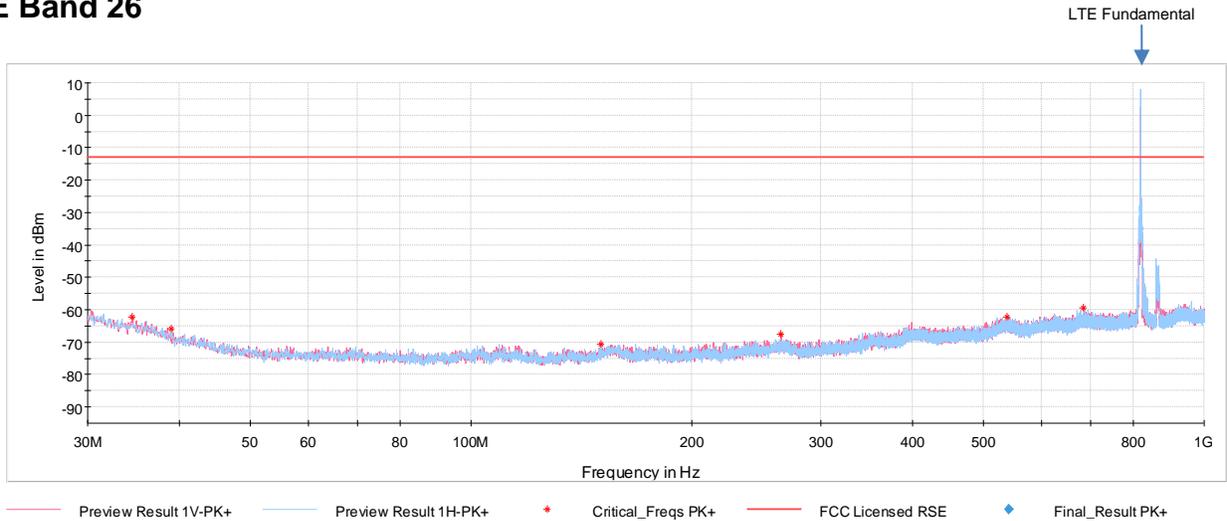
<p>FCC ID: BCG-A2478</p>		<p>MEASUREMENT REPORT (CERTIFICATION)</p>	<p>Approved by: Quality Manager</p>
<p>Test Report S/N: 1C2106070046-05.BCG</p>	<p>Test Dates: 06-08-2021 - 08-16-2021</p>		<p>EUT Type: Watch</p>

Test Notes

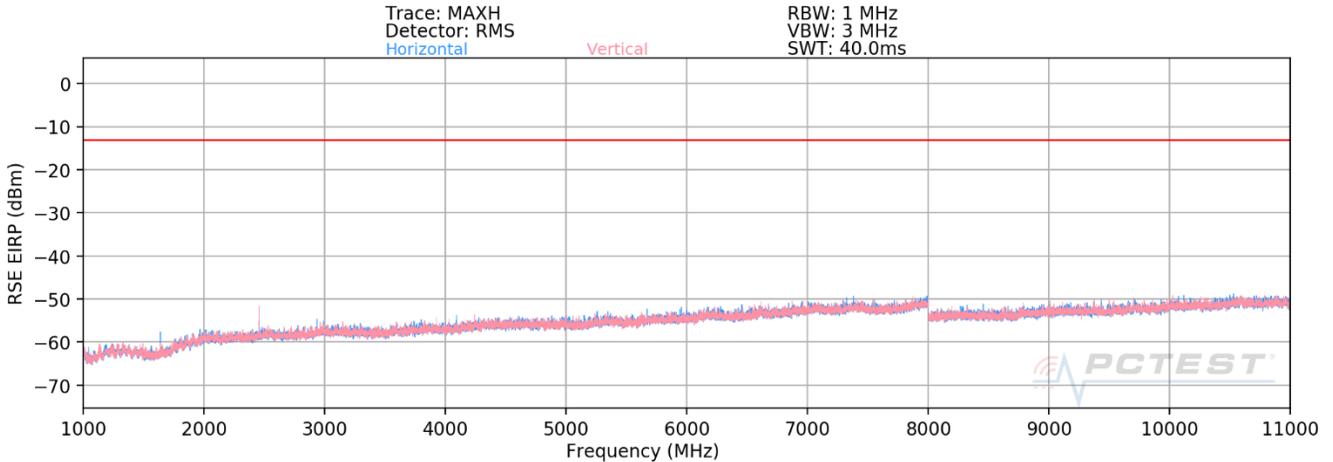
1. Field strengths are calculated using the Measurement quantity conversions in KDB 971168 Section 5.8.4.
 - a. $E(\text{dB}\mu\text{V}/\text{m}) = \text{Measured amplitude level (dBm)} + 107 + \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$
 - b. $\text{EIRP (dBm)} = E(\text{dB}\mu\text{V}/\text{m}) + 20\log D - 104.8$; where D is the measurement distance in meters.
2. For LTE mode, the device was tested under all modulations, RB sizes and offsets, and channel bandwidth configurations and the worst case emissions are reported with 1 RB.
3. This unit was tested with its standard battery.
4. The EUT was tested in three orthogonal planes and in all possible test configurations and positioning. The worst case setup is reported in the tables below.
5. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 35 of 40

7.6.1 Antenna BCM – Radiated Spurious Emission Measurements LTE Band 26



Plot 7-25. Antenna BCM Radiated Spurious Plot below 1GHz (LTE Band 26)



Plot 7-26. Antenna BCM Radiated Spurious Plot above 1GHz (LTE Band 26)

FCC ID: BCG-A2478	PCTEST Proud to be part of element		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch		Page 36 of 40

Bandwidth (MHz):	5
Frequency (MHz):	816.5
Modulation Signal:	QPSK
RB Config (Size / Offset):	1 / 12

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
1633.0	V	126	198	-72.98	-4.10	29.92	-65.34	-13.00	-52.34
2449.5	V	148	12	-67.22	0.34	40.12	-55.14	-13.00	-42.14
3266.0	V	-	-	-77.23	2.07	31.84	-63.41	-13.00	-50.41
4082.5	V	-	-	-77.60	3.55	32.95	-62.30	-13.00	-49.30
4899.0	V	-	-	-78.42	5.09	33.67	-61.58	-13.00	-48.58

Table 7-3. Antenna BCM Radiated Spurious Data (LTE Band 26 – Low Channel)

Bandwidth (MHz):	10
Frequency (MHz):	819.0
Modulation Signal:	QPSK
RB Config (Size / Offset):	1 / 25

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
1638.0	V	174	15	-65.96	-4.05	36.99	-58.27	-13.00	-45.27
2457.0	V	107	22	-57.75	0.40	49.65	-45.61	-13.00	-32.61
3276.0	V	-	-	-76.29	2.10	32.81	-62.44	-13.00	-49.44
4095.0	V	-	-	-77.58	3.81	33.23	-62.03	-13.00	-49.03
4914.0	V	-	-	-78.30	4.68	33.38	-61.88	-13.00	-48.88

Table 7-4. Antenna BCM Radiated Spurious Data (LTE Band 26 – Mid Channel)

Bandwidth (MHz):	5
Frequency (MHz):	821.5
Modulation Signal:	QPSK
RB Config (Size / Offset):	1 / 12

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
1643.0	V	294	350	-71.12	-4.00	31.88	-63.37	-13.00	-50.37
2464.5	V	234	186	-66.15	0.51	41.36	-53.90	-13.00	-40.90
3286.0	V	-	-	-77.51	2.12	31.61	-63.65	-13.00	-50.65
4107.5	V	-	-	-77.78	3.57	32.79	-62.47	-13.00	-49.47
4929.0	V	-	-	-78.03	4.74	33.71	-61.55	-13.00	-48.55

Table 7-5. Antenna BCM Radiated Spurious Data (LTE Band 26 – High Channel)

FCC ID: BCG-A2478			MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 37 of 40	

7.7 Frequency Stability / Temperature Variation

§2.1055 §90.213

Test Overview and Limit

Frequency stability testing is performed in accordance with the guidelines of ANSI C63.26-2015 and TIA-603-E-2016. The frequency stability of the transmitter is measured by:

- a.) **Temperature:** The temperature is varied from -30°C to +50°C in 10°C increments using an environmental chamber.
- b.) **Primary Supply Voltage:** The primary supply voltage is varied from 85% to 115% of the nominal value for non hand-carried battery and AC powered equipment. For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

For Band 26, the frequency stability of the transmitter shall be maintained within ±0.00025% (±2.5 ppm) of the center frequency.

Test Procedure Used

ANSI C63.26 2015

TIA-603-E-2016

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.

Test Setup

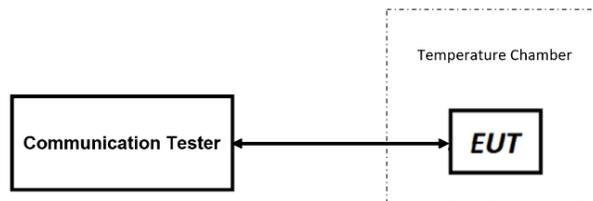


Figure 7-7. Test Instrument & Measurement Setup

Test Notes

None.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch	Page 38 of 40

Frequency Stability / Temperature Variation

LTE Band 26					
		Operating Frequency (Hz):		819,000,000	
		Ref. Voltage (VDC):		3.80	
		Deviation Limit:		± 0.00025% or 2.5 ppm	
Voltage (%)	Power (VDC)	Temp (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 30	818,999,997	-3.49	-0.0000004
		- 20	818,999,998	-2.09	-0.0000003
		- 10	818,999,998	-2.45	-0.0000003
		0	819,000,001	0.94	0.0000001
		+ 10	819,000,001	0.96	0.0000001
		+ 20 (Ref)	819,000,000	0.66	0.0000001
		+ 30	819,000,001	1.06	0.0000001
		+ 40	819,000,001	1.16	0.0000001
Battery Endpoint	3.40	+ 20	819,000,001	0.50	0.0000001

Table 7-6. LTE Band 26 Frequency Stability Data

FCC ID: BCG-A2478		MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch		Page 39 of 40

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Watch FCC ID: BCG-A2478** complies with all the requirements of Part 90 of the FCC rules.

FCC ID: BCG-A2478	 MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-05.BCG	Test Dates: 06-08-2021 - 08-16-2021	EUT Type: Watch
		Page 40 of 40