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PART 22 & 90 MEASUREMENT REPORT

Applicant Name:
Samsung Electronics Co., Ltd.
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Gyeonggi-do, 16677, Korea

Date of Testing:
09/14/2023 - 10/23/2023
Test Report Issue Date:
10/30/2023
Test Site/Location:
Element lab., Gyeonggi-do, South Korea
Test Report Serial No.:
1M2309070100-06.A3L

FCC ID:	**A3LSMA156U**
APPLICANT:	**Samsung Electronics Co., Ltd.**

Application Type:	Certification
Model:	SM-A156U
Additional Model(s):	SM-A156U1/DS, SM-S156V
EUT Type:	Portable Handset
FCC Classification:	PCS Licensed Transmitter Held to Ear (PCE)
FCC Rule Part:	§22(H), §90(S), §90(R)
Test Procedure(s):	ANSI C63.26-2015

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.

Prepared by

Reviewed by

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Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	Measurement	Max. Power [W]	Max. Power [dBm]	Emission Designator
LTE Band 14	10 MHz	QPSK	793.0	ERP	0.178	22.51	9M02G7D
		16QAM	793.0	ERP	0.142	21.53	9M02W7D
	5 MHz	QPSK	790.5 - 795.5	ERP	0.179	22.53	4M51G7D
		16QAM	790.5 - 795.5	ERP	0.150	21.76	4M50W7D
LTE Band 26	15 MHz	QPSK	821.5	ERP	0.114	20.57	13M5G7D
		16QAM	821.5	ERP	0.094	19.75	13M5W7D
	15 MHz	QPSK	821.5	Conducted	0.342	25.33	13M5G7D
		16QAM	821.5	Conducted	0.266	24.26	13M5W7D
	10 MHz	QPSK	819.0	Conducted	0.340	25.32	9M05G7D
		16QAM	819.0	Conducted	0.284	24.54	9M00W7D
	5 MHz	QPSK	816.5 - 821.5	Conducted	0.353	25.48	4M53G7D
		16QAM	816.5 - 821.5	Conducted	0.281	24.49	4M52W7D
	3 MHz	QPSK	815.5 - 822.5	Conducted	0.346	25.39	2M71G7D
		16QAM	815.5 - 822.5	Conducted	0.275	24.39	2M70W7D
	1.4 MHz	QPSK	814.7 - 823.3	Conducted	0.338	25.29	1M10G7D
		16QAM	814.7 - 823.3	Conducted	0.274	24.38	1M10W7D

EUT Overview

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 Element Test Location

These measurement tests were conducted at the Element Suwon Laboratory located at 13, Heungdeok 1-ro, Giheung-gu, Yongin-si, Gyeonggi-do, 16954, South Korea. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014.

1.3 Test Facility / Accreditations

Measurements were performed at Element Materials Technology Suwon, Ltd. located in Yongin-si, Gyeonggi-do, 16954, South Korea.

- Element Materials Technology Suwon, Ltd. is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation(A2LA) with Certificate number 2041.04 for Specific Absorption Rate (SAR), and Electromagnetic Compatibility (EMC) & Telecommunications testing for FCC and Innovation, Science, and Economic Development Canada rules.

- Element Materials Technology Suwon, Ltd. facility is accredited, designated, and recognized in accordance with the provision of Radio Wave Act and International Standard ISO/IEC 17025:2017 under the National Radio Research Agency.

  - Designation Number / CABID: KR0169
  - Test Firm Registration Number of FCC: 417945
  - Test Firm Registration Number of ISED: 26168

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Samsung Portable Handset FCC ID: A3LSMA156U**. 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 and 22H.

Test Device Serial No.: 0515M, 0528M, 0534M, 0712M, 0736M

2.2 Device Capabilities

This device contains the following capabilities:

850/1900 GSM/GPRS/EDGE, 850/1700/1900 WCDMA/HSPA, Multi-band LTE, Multi-band 5G NR (FR1), 802.11b/g/n WLAN, 802.11a/n/ac UNII (5GHz), Bluetooth (1x, EDR, LE), NFC

2.3 Test Configuration

The EUT was tested per the guidance of ANSI C63.26-2015. See Section 7.0 of this test report for a description of the radiated and antenna port conducted emissions tests.

2.4 Software and Firmware

Testing was performed on device(s) using software/firmware version A156USQU0AWIB installed on the EUT.

2.5 EMI Suppression Device(s)/Modifications

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

3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the "American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services" (ANSI C63.26-2015) were used in the measurement of the EUT.

Deviation from Measurement Procedure……..None

3.2 Radiated Power and 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 power measurements, substitution method is used per the guidance of ANSI C63.26-2015. For emissions below 1GHz, a half-wave dipole is 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 with the level of the signal generator being adjusted to obtain the same receive spectrum analyzer level previously recorded from the spurious emission from the EUT. The power of the emission is calculated using the following formula:

$$P_{d\ [dBm]} = P_{g\ [dBm]} - \text{cable loss}_{\ [dB]} + \text{antenna gain}_{\ [dBd/dBi]};$$

where P_d is the dipole equivalent power, P_g is the generator output into the substitution antenna, and the antenna gain is the gain of the substitute antenna used relative to either a half-wave dipole (dBd) or an isotropic source (dBi). The substitute level is equal to $P_{g\ [dBm]}$ – cable loss $_{[dB]}$.

For radiated spurious emissions measurements, the field strength conversion method is used per the formulas in Section 5.2.7 of ANSI C63.26-2015. 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

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

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 414788 D01 v01r01.

Radiated power and radiated spurious emission levels are investigated with the receive antenna horizontally and vertically polarized per ANSI C63.26-2015.

4.0 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 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 (±dB)
Conducted Bench Top Measurements	1.95
Radiated Disturbance (<1GHz)	4.10
Radiated Disturbance (>1GHz)	4.82
Radiated Disturbance (>18GHz)	4.96

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	N9030A	PXA Signal Analyzer	2023-07-04	Annual	2024-07-03	MY49432391
Anritsu	S820E	Cable and Antenna Analyzer	2023-07-05	Annual	2024-07-04	1839097
Anritsu	MA24106A	USB Power Sensor	2023-07-05	Annual	2024-07-04	1244512
Com-Power	AL-130	9kHz - 30MHz Loop Antenna	2022-10-21	Biennial	2024-10-20	10160045
Com-Power	PAM-118A	Preamplifier	2023-07-05	Annual	2024-07-04	551042
Espec	SH-242	Environmental Chamber	2023-07-05	Annual	2024-07-04	93011064
Fairview Microwave	FM2CP1122-10	2.92mm Directional Coupler	2023-07-04	Annual	2024-07-03	1946
Keysight Technologies	N9030B	MXA Signal Analyzer	2023-07-04	Annual	2024-07-03	MY57143276
Mini-Circuits	BW-N10W5+	Attenuator	2023-07-04	Annual	2024-07-03	1607
Mini-Circuits	BW-N10W5+	Attenuator	2023-07-04	Annual	2024-07-03	1607
Rohde & Schwarz	TS-PR18	Preamplifier	2023-07-05	Annual	2024-07-04	102141
Rohde & Schwarz	SMB100A03	Signal Generator	2023-01-17	Annual	2024-01-16	182487
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	2023-02-17	Annual	2024-02-16	131453
Rohde & Schwarz	FSW43	Signal and Spectrum Analyzer	2023-01-13	Annual	2024-01-12	101955
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	2023-02-17	Annual	2024-02-16	102131
Rohde & Schwarz	TC-TA18	VIVALDI-ANT	2021-10-22	Biennial	2023-10-21	101097
Rohde & Schwarz	TC-TA18	VIVALDI-ANT	2021-10-22	Biennial	2023-10-21	101098
Schwarzbeck	VULB9162	Broadband TRILOG Antenna	2023-06-01	Biennial	2025-05-31	9162-217
Schwarzbeck	UHA9105	Dipole Antenna	2022-07-19	Biennial	2024-07-18	91052522
Sunol	DRH-118	Horn Antenna	2023-01-26	Biennial	2025-01-25	A060215

Table 5-1. Test Equipment

Notes:

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.

6.0 SAMPLE CALCULATIONS

Emission Designator

QPSK Modulation

Emission Designator = 8M62G7D

LTE BW = 8.62 MHz
G = Phase Modulation
7 = Quantized/Digital Info
D = Data transmission, telemetry, telecommand

QAM Modulation

Emission Designator = 8M45W7D

LTE BW = 8.45 MHz
W = Amplitude/Angle Modulated
7 = Quantized/Digital Info
D = Data transmission, telemetry, telecommand

Spurious Radiated Emission – LTE Band

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 analzyer. 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) = 50.3 dBc.

7.0 TEST RESULTS

7.1 Summary

Company Name: Samsung Electronics Co., Ltd.

FCC ID: A3LSMA156U

FCC Classification: PCS Licensed Transmitter Held to Ear (PCE)

Mode(s): LTE

Test Condition	Test Description	FCC Part Section(s)	RSS Section(s)	Test Limit	Test Result	Reference
CONDUCTED	Transmitter Conducted Output Power*	2.1046(a), 90.635(b)	RSS-Gen(6.12)	< 100 Watts	PASS	Section 7.2
	Occupied Bandwidth	2.1049(h)	RSS-Gen(6.7)	N/A	PASS	Section 7.3
	Conducted Band Edge / Spurious Emissions (LTE Band 14)	2.1051, 90.543(c)(e)	RSS-Gen(6.13), RSS-140(4.4)	On all frequencies between 769-775 MHz and 799-805 MHz, attenuation by a factor not less than 65 + 10 log(P) dB in a 6.25 kHz band segment, for mobile and portable stations. On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, attenuation by at least 43 + 10 log(P) dB > 43 + 10log10(P[Watts]) for all out-of-band emissions outside of those specified in 90.543(e)	PASS	Sections 7.4, 7.5
	Conducted Band Edge / Spurious Emissions (LTE Band 26)	2.1051, 90.691(a)	N/A	> 43 + 10 log10(P[Watts]) for all out-of-band emissions except emissions beyond 37.5kHz from the block edge > 50 + 10 log10(P[Watts]) at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	PASS	Sections 7.4, 7.5
	Frequency Stability	2.1055, 90.213	RSS-Gen(6.11), RSS-140(4.2)	< 2.5 ppm **Fundamental emissions stay within authorized frequency block	PASS	Section 7.8
RADIATED	Effective Radiated Power (LTE Band 14)	90.542(a)(7)	RSS-Gen(6.12), RSS-140(4.3)	< 3 Watts max. ERP	PASS	Section 7.6
	Effective Radiated Power (LTE Band 26)	22.913(a)(2)	N/A	< 7 Watts max. ERP	PASS	Section 7.6
	Radiated Spurious Emissions (LTE Band 14)	2.1053, 90.543(e)(f)	RSS-Gen(7.3), RSS-140(4.4)	> 43 + 10 log10 (P[Watts]) for all out-of-band emissions except emissions in the 1559 - 1610MHz band are subject to a limit of -40dBm/MHz for wideband signals	PASS	Section 7.7
	Radiated Spurious Emissions (LTE Band 26)	2.1053, 90.691(a)	N/A	> 43 + 10 log10(P[Watts]) for all out-of-band emissions except emissions beyond 37.5kHz from the block edge > 50 + 10 log10(P[Watts]) at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	PASS	Section 7.7

* The only transmitter output conducted powers included in this report are those where the Pmax value, per the tune-up document, is higher than any of the DSI power levels. For the remaining conducted power measurements, see the **RF Exposure Report**.

Table 7-1. Summary of Test Results

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 EMC Software Tool v1.1.

7.2 Conducted Output Power Data

Test Overview

All 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 Procedure Used

ANSI C63.26-2015 – Section 5.2

Test Settings

1. Span = 2 x OBW to 3 x OBW
2. Detector = RMS
3. Trace mode = trace average for continuous emissions, max hold for pulse emissions
4. Sweep time = auto couple
5. The trace was allowed to stabilize
6. Please see test notes below for RBW and VBW settings

Test Setup

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

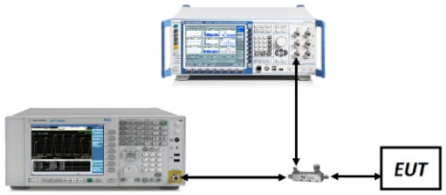


Figure 7-1. Test Instrument & Measurement Setup

Test Notes

1. 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.

2. Conducted power measurements were evaluated using various combinations of RB size, RB offset, modulation, and channel bandwidth. Channel bandwidth data is shown in the tables below based only on the channel bandwidths that were supported in this device.

3. All other conducted power measurements are contained in the RF exposure report for this filing.

4. Conducted power was found to reduce for the higher order QAM modulations when compared to 16QAM. Due to this trend, only the worst-case QAM (16QAM) powers are included in this section.

Bandwidth	Modulation	Channel	Frequency [MHz]	RB Size/Offset	Conducted Power [dBm]	Conducted Power [Watts]	Conducted Power Limit [dBm]	Margin [dB]
15 MHz	QPSK	26765	821.5	1 / 0	25.33	0.342	50.00	-24.67
	16-QAM	26765	821.5	1 / 0	24.26	0.266	50.00	-25.74
10 MHz	QPSK	26740	819.0	1 / 25	25.32	0.340	50.00	-24.68
	16-QAM	26740	819.0	1 / 25	24.54	0.284	50.00	-25.46
5 MHz	QPSK	26715	816.5	1 / 12	25.35	0.343	50.00	-24.65
		26765	821.5	1 / 0	25.48	0.353	50.00	-24.52
	16-QAM	26715	816.5	1 / 12	24.49	0.281	50.00	-25.51
		26765	821.5	1 / 0	24.35	0.272	50.00	-25.65
3 MHz	QPSK	26705	815.5	1 / 14	25.39	0.346	50.00	-24.61
		26775	822.5	1 / 7	25.23	0.334	50.00	-24.77
	16-QAM	26705	815.5	1 / 14	24.39	0.275	50.00	-25.61
		26775	822.5	1 / 7	24.25	0.266	50.00	-25.75
1.4 MHz	QPSK	26697	814.7	1 / 0	24.93	0.311	50.00	-25.07
		26783	823.3	1 / 5	25.29	0.338	50.00	-24.71
	16-QAM	26697	814.7	1 / 0	24.38	0.274	50.00	-25.62
		26783	823.3	1 / 5	24.29	0.268	50.00	-25.71

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

Bandwidth	Modulation	Channel	Frequency [MHz]	RB Size/Offset	Conducted Power [dBm]	Conducted Power [Watts]	Conducted Power Limit [dBm]	Margin [dB]
10 MHz	QPSK	23330	793.0	1 / 49	23.78	0.239	50.00	-26.22
	16-QAM	23330	793.0	1 / 49	22.82	0.192	50.00	-27.18
5 MHz	QPSK	23305	790.5	1 / 24	23.56	0.227	50.00	-26.44
		23330	793.0	1 / 0	23.77	0.238	50.00	-26.23
		23355	795.5	1 / 24	23.80	0.240	50.00	-26.20
	16-QAM	23305	790.5	1 / 24	22.60	0.182	50.00	-27.40
		23330	793.0	1 / 0	22.62	0.183	50.00	-27.38
		23355	795.5	1 / 24	23.06	0.202	50.00	-26.94

Table 7-3. Conducted Power Output Data (LTE Band 14)

7.3 Occupied Bandwidth

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

ANSI C63.26-2015 – Section 5.4.4

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

Test Setup

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

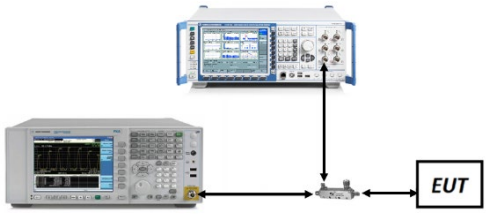


Figure 7-2. Test Instrument & Measurement Setup

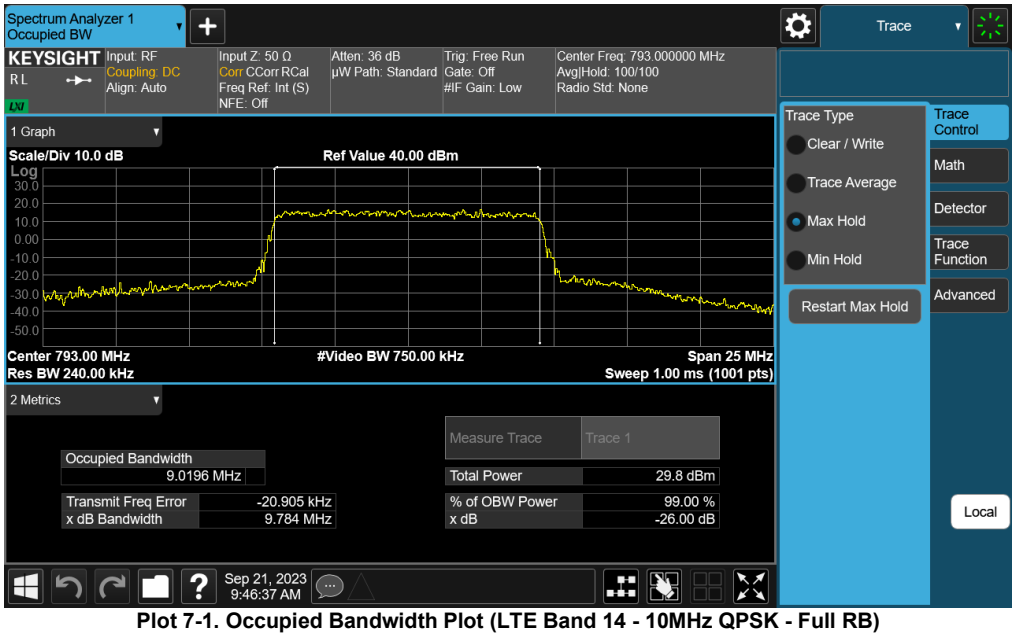
Test Notes

None

Mode	Bandwidth	Modulation	OBW [MHz]
LTE-B26	15 MHz	QPSK	13.46
		16QAM	13.49
	10 MHz	QPSK	9.05
		16QAM	9.00
	5 MHz	QPSK	4.53
		16QAM	4.52
	3 MHz	QPSK	2.71
		16QAM	2.70
	1.4 MHz	QPSK	1.10
		16QAM	1.10
LTE-B14	10 MHz	QPSK	9.02
		16QAM	9.02
	5 MHz	QPSK	4.51
		16QAM	4.50

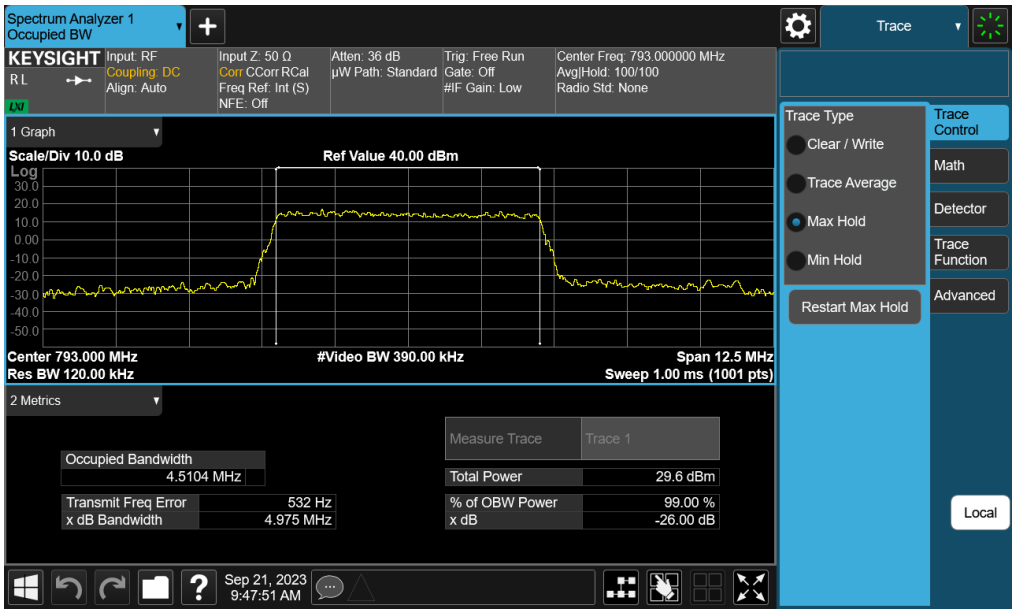
Table 7-4. Occupied Bandwidth Test Results

LTE Band 14

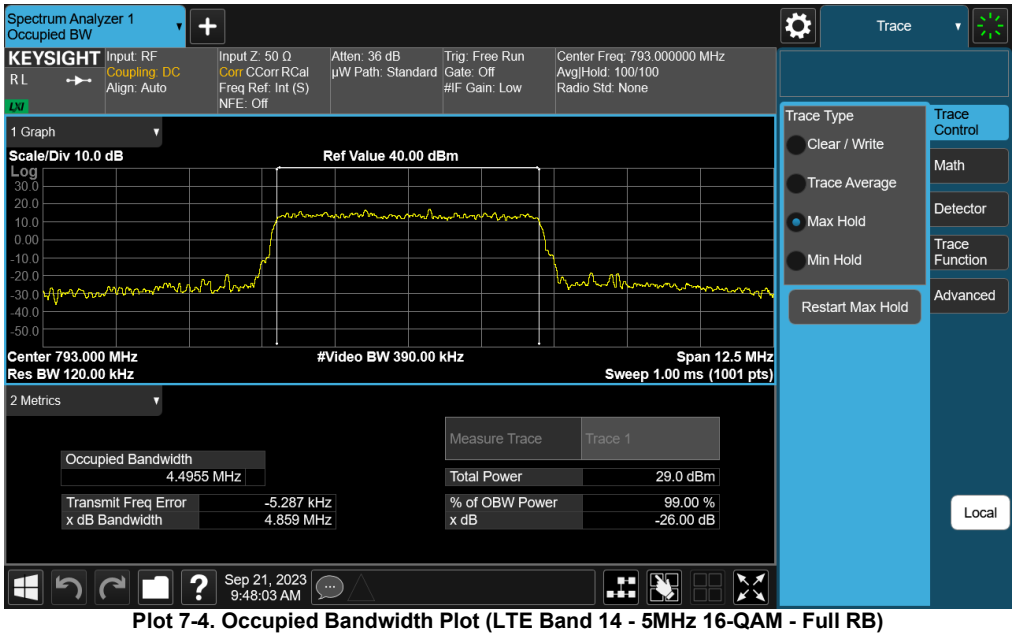


Plot 7-1. Occupied Bandwidth Plot (LTE Band 14 - 10MHz QPSK - Full RB)

Plot 7-2. Occupied Bandwidth Plot (LTE Band 14 - 10MHz 16-QAM - Full RB)

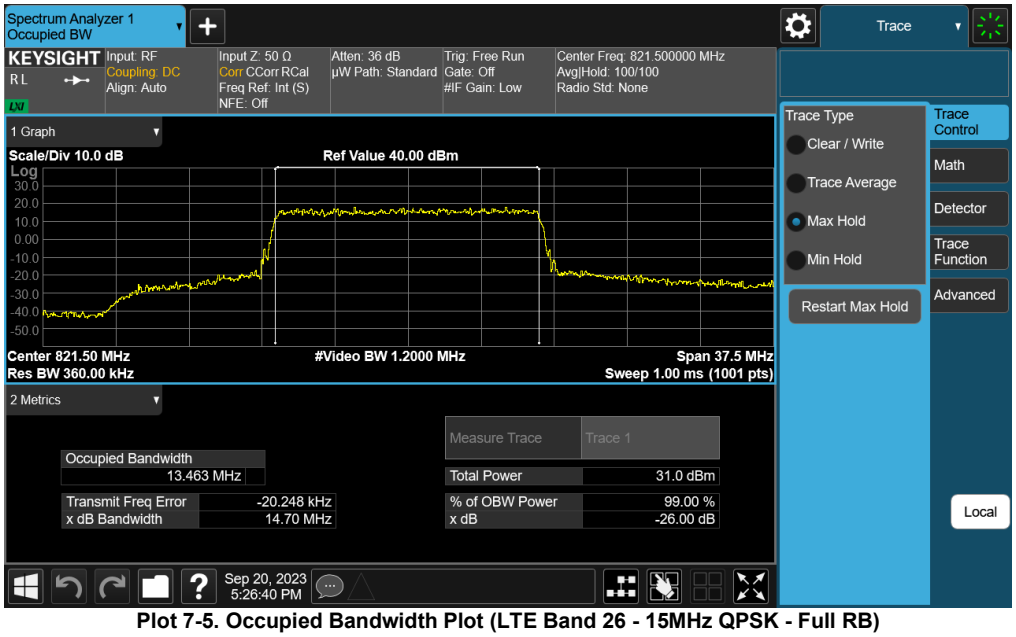


Plot 7-3. Occupied Bandwidth Plot (LTE Band 14 - 5MHz QPSK - Full RB)



Plot 7-4. Occupied Bandwidth Plot (LTE Band 14 - 5MHz 16-QAM - Full RB)

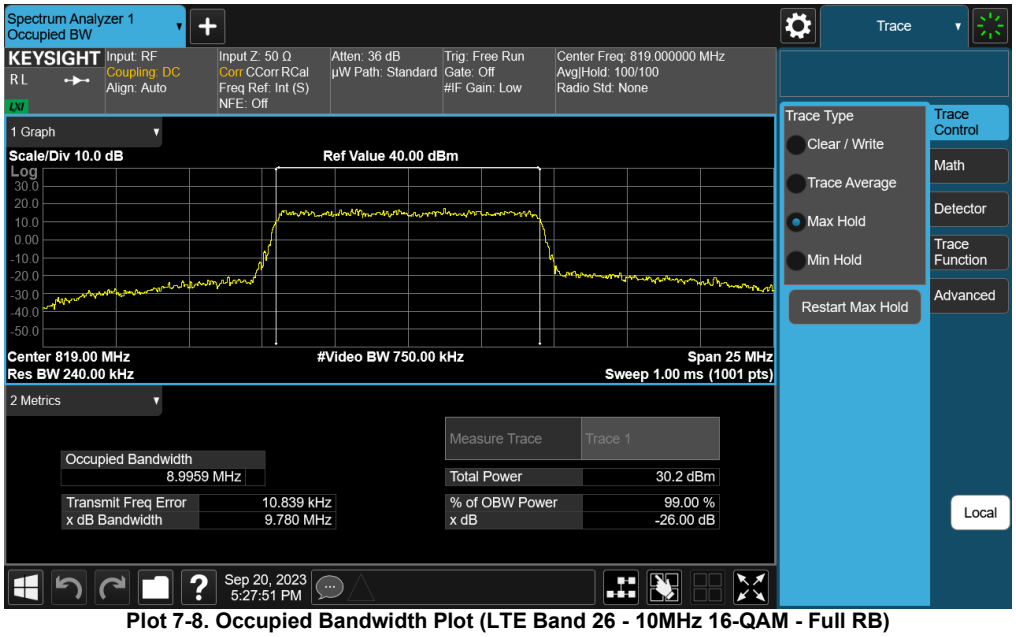
LTE Band 26



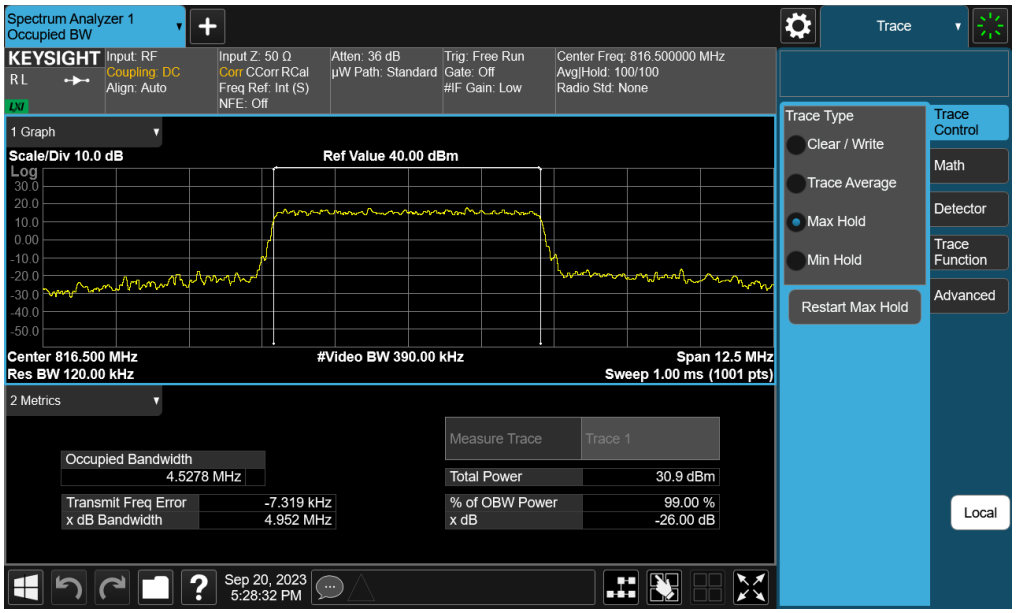
Plot 7-5. Occupied Bandwidth Plot (LTE Band 26 - 15MHz QPSK - Full RB)

Plot 7-6. Occupied Bandwidth Plot (LTE Band 26 - 15MHz 16-QAM - Full RB)

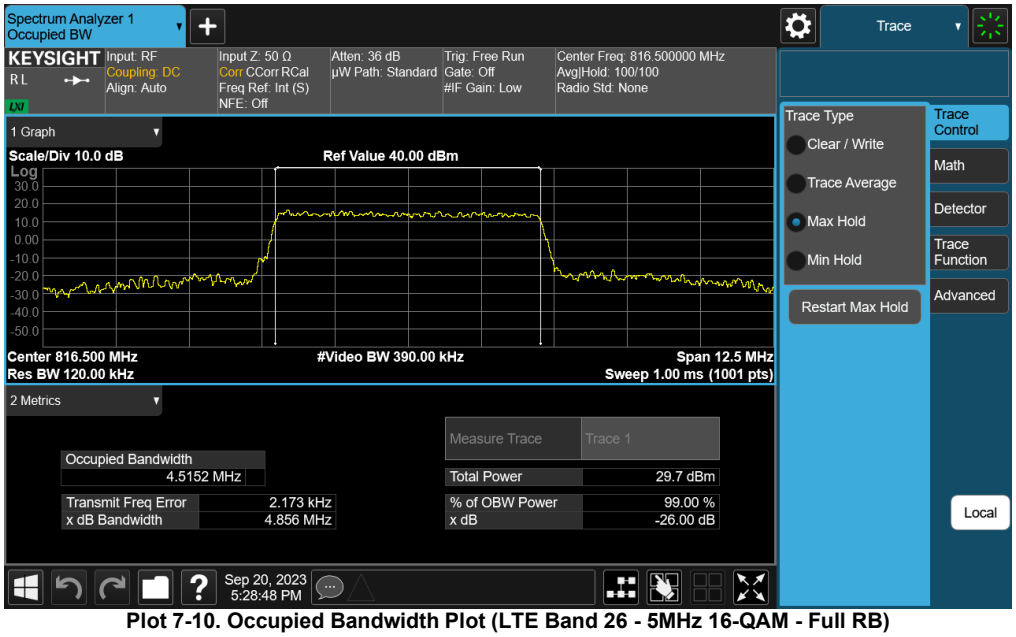
Plot 7-7. Occupied Bandwidth Plot (LTE Band 26 - 10MHz QPSK - Full RB)



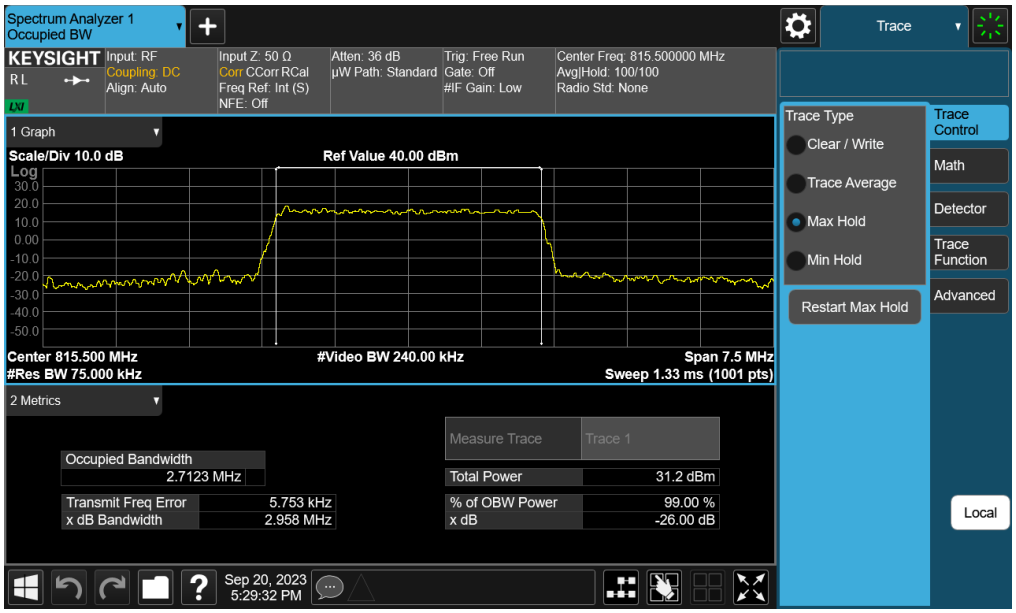
Plot 7-8. Occupied Bandwidth Plot (LTE Band 26 - 10MHz 16-QAM - Full RB)



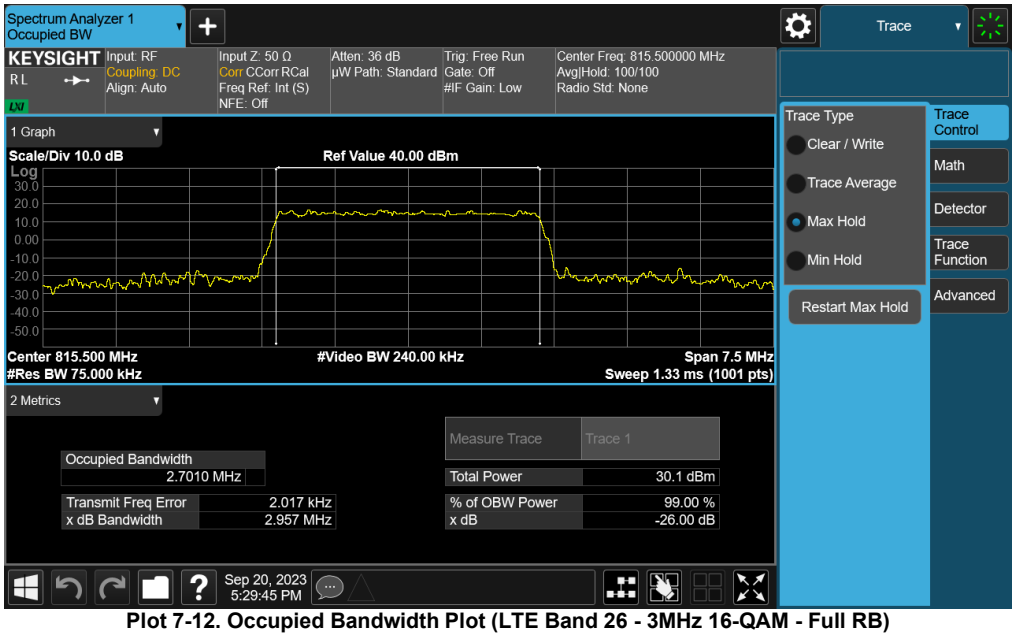
Plot 7-9. Occupied Bandwidth Plot (LTE Band 26 - 5MHz QPSK - Full RB)



Plot 7-10. Occupied Bandwidth Plot (LTE Band 26 - 5MHz 16-QAM - Full RB)

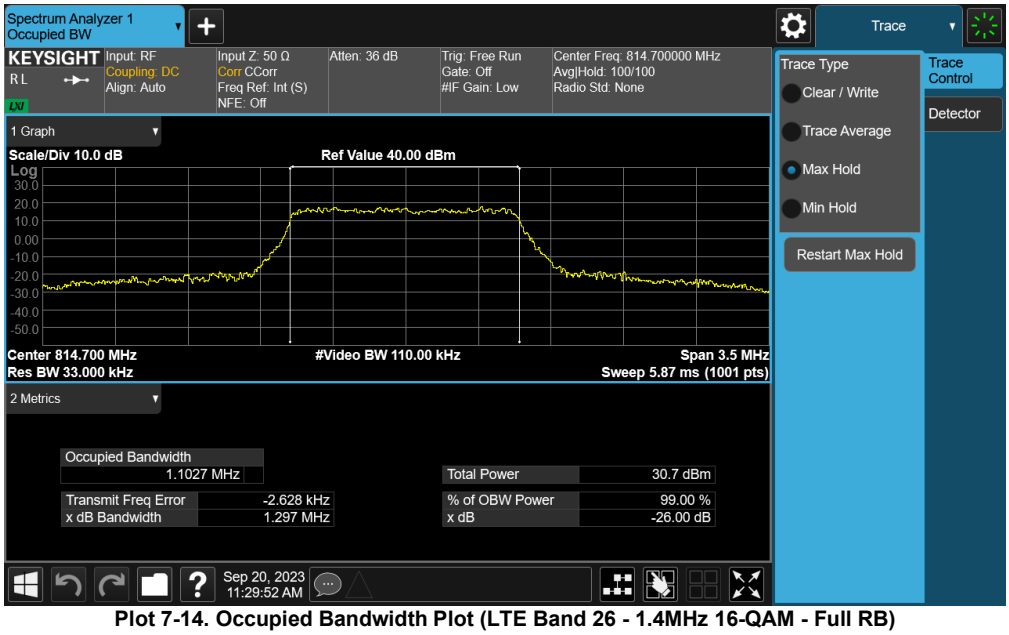


Plot 7-11. Occupied Bandwidth Plot (LTE Band 26 - 3MHz QPSK - Full RB)



Plot 7-12. Occupied Bandwidth Plot (LTE Band 26 - 3MHz 16-QAM - Full RB)

Plot 7-13. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz QPSK - Full RB)



Plot 7-14. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz 16-QAM - Full RB)

7.4 Spurious and Harmonic Emissions at Antenna Terminal

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

ANSI C63.26-2015 – Section 5.7.4

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 ≥ 100kHz
3. VBW ≥ 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.

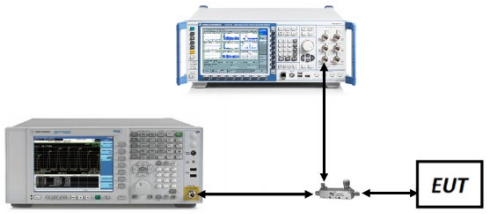


Figure 7-3. Test Instrument & Measurement Setup

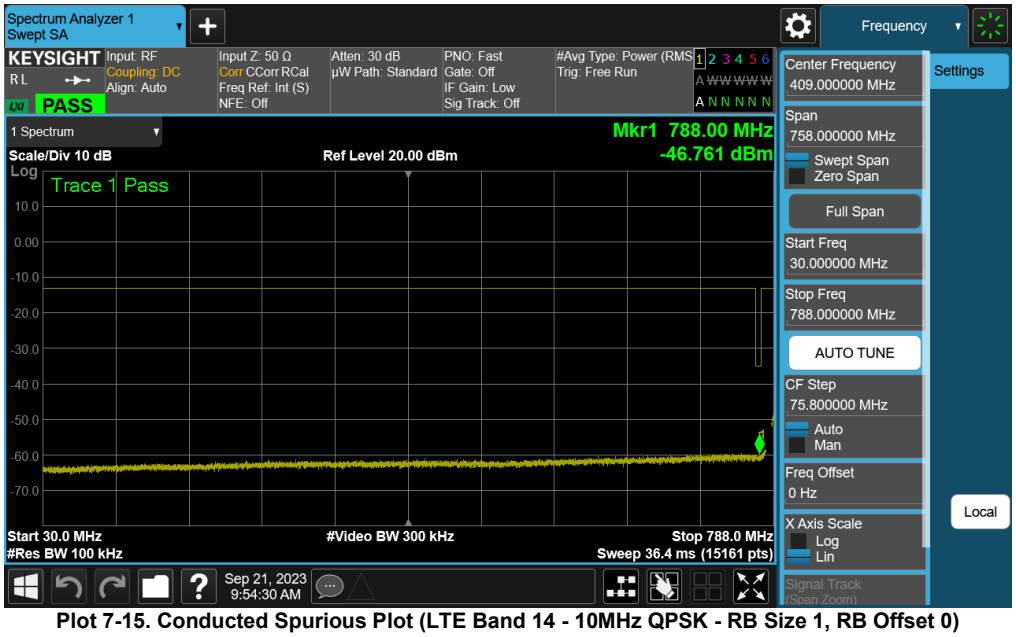
Test Notes

Per Part 22H and 90, compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

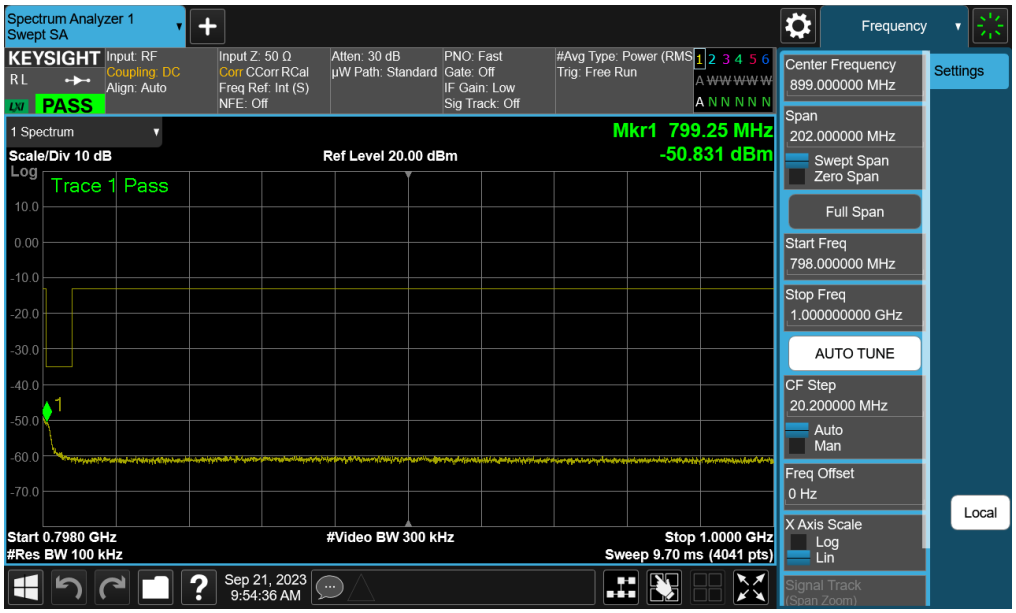
Mode	Bandwidth	Channel	Range [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]
LTE-B26	15 MHz	Mid	30.0 - 814.0	-44.45	-13	-31.45
		Mid	824.0 - 1000.0	-29.92	-13	-16.92
		Mid	1000.0 - 10000.0	-39.39	-13	-26.39
LTE-B14	10 MHz	Mid	30.0 - 788.0	-46.76	-35	-11.76
		Mid	798.0 - 1000.0	-50.83	-35	-15.83
		Mid	1000.0 - 10000.0	-39.42	-13	-26.42

Table 7-5. Conducted Spurious Emission Results

LTE Band 14



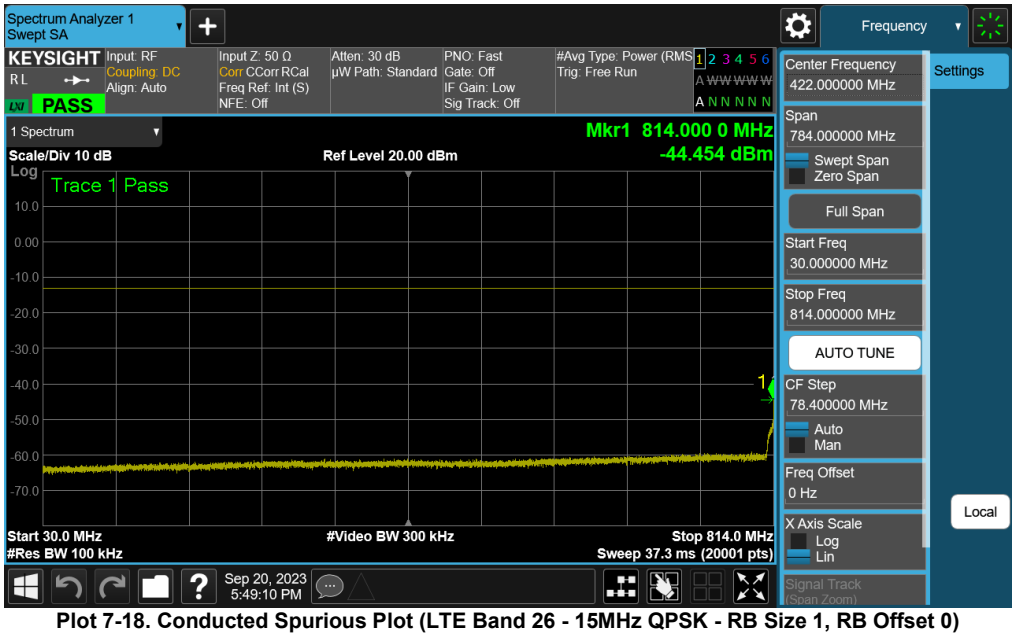
Plot 7-15. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0)



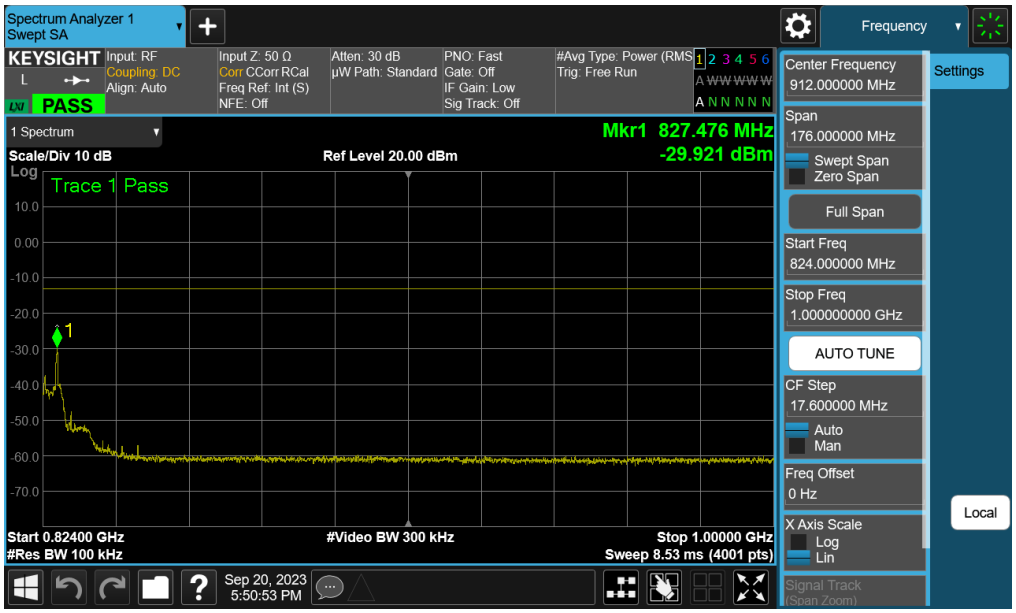
Plot 7-16. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0)

Plot 7-17. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0)

LTE Band 26



Plot 7-18. Conducted Spurious Plot (LTE Band 26 - 15MHz QPSK - RB Size 1, RB Offset 0)



Plot 7-19. Conducted Spurious Plot (LTE Band 26 - 15MHz QPSK - RB Size 1, RB Offset 0)

Plot 7-20. Conducted Spurious Plot (LTE Band 26 - 15MHz QPSK - RB Size 1, RB Offset 0)

7.5 Band Edge Emissions at Antenna Terminal

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 + 10log$_{10}$(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 + 10log$_{10}$(P$_{[Watts]}$), where P is the transmitter power in Watts.

For LTE Band 14 operation under Part 90.543, the power of any emission must be reduced below the mean output power (P) by at least 43 + 10log (P) dB measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

Additionally, for LTE Band 14 operation, on all frequencies between 769-775 MHz and 799-805 MHz, the power of any emission shall be attenuated by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.

Test Procedure Used

ANSI C63.26-2015 – Section 5.7.3

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.

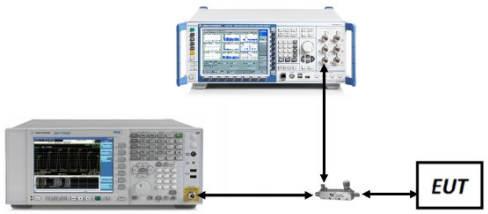


Figure 7-4. Test Instrument & Measurement Setup

Test Notes

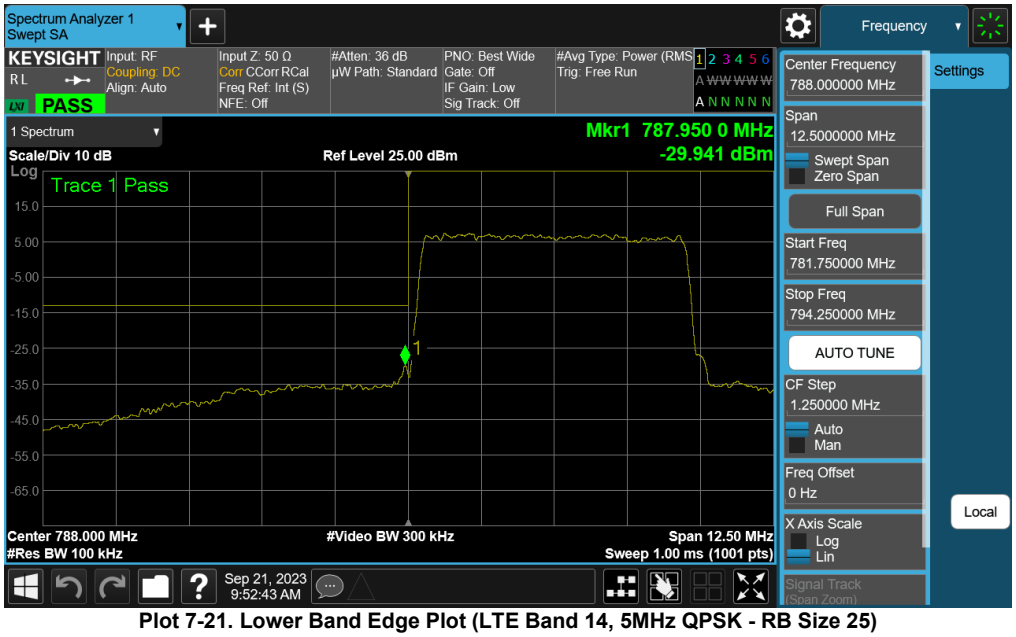
1. For channel edge emission, the signal analyzer's "ACP" measurement capability is used.

2. Per 22.917(b) 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 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 frequency, outside of which all emission are attenuated at least 26 dB below the transmitter power.

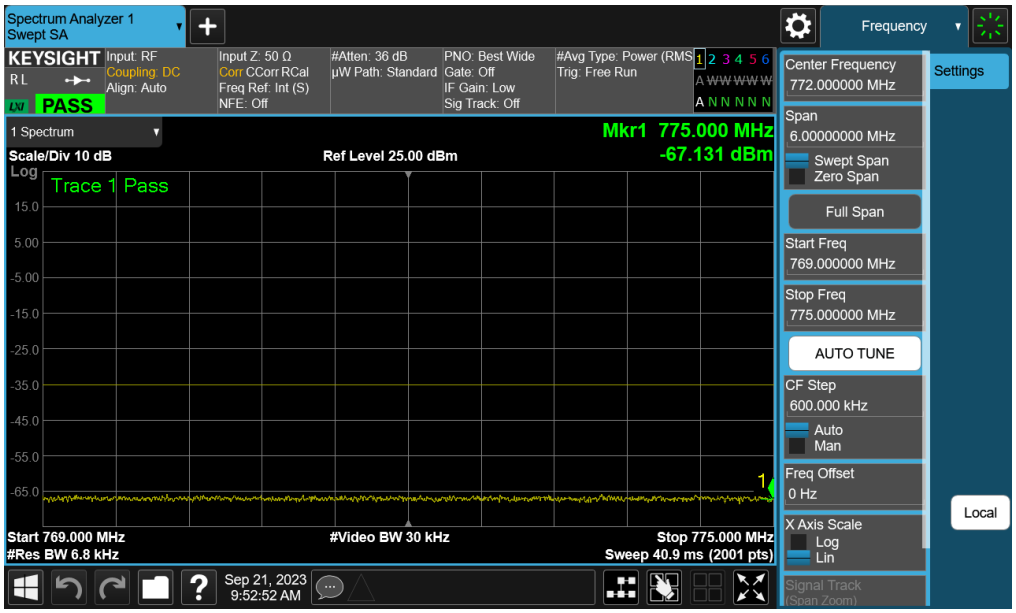
Mode	Bandwidth	Channel	Test Case	Level [dBm]	Limit [dBm]	Margin [dB]
LTE-B26	15 MHz	Mid	Band Edge	-36.86	-20	-16.86
	10 MHz	Mid	Band Edge	-33.50	-20	-13.50
	5 MHz	Low	Band Edge	-29.91	-20	-9.91
		High	Band Edge	-30.30	-20	-10.30
	3 MHz	Low	Band Edge	-29.37	-20	-9.37
		High	Band Edge	-29.43	-20	-9.43
	1.4 MHz	Low	Band Edge	-25.22	-20	-5.22
		High	Band Edge	-25.39	-20	-5.39
LTE-B14	10 MHz	Low	Band Edge	-32.56	-13	-19.56
		Low EmMask	Band Edge	-67.38	-35	-32.38
		High	Band Edge	-31.54	-13	-18.54
		High EmMask	Band Edge	-45.18	-35	-10.18
	5 MHz	Low	Band Edge	-29.94	-13	-16.94
		Low EmMask	Band Edge	-67.13	-35	-32.13
		High	Band Edge	-24.32	-13	-11.32
		High EmMask	Band Edge	-42.40	-35	-7.40

Table 7-6. Band Edge Test Results

LTE Band 14



Plot 7-21. Lower Band Edge Plot (LTE Band 14, 5MHz QPSK - RB Size 25)

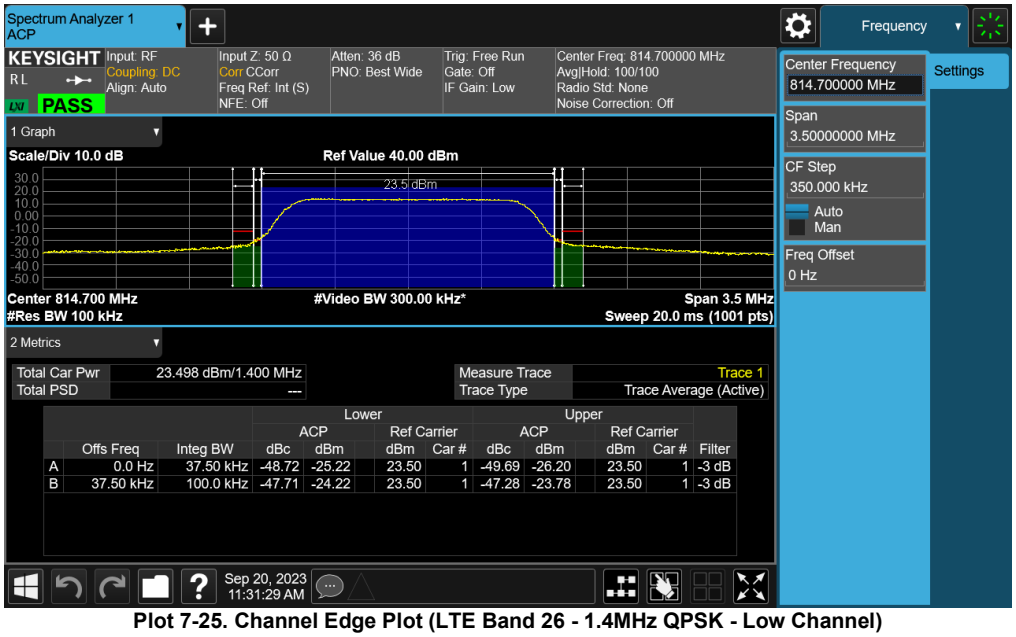


Plot 7-22. Lower Emission Mask Plot (LTE Band 14, 5MHz QPSK - RB Size 25)

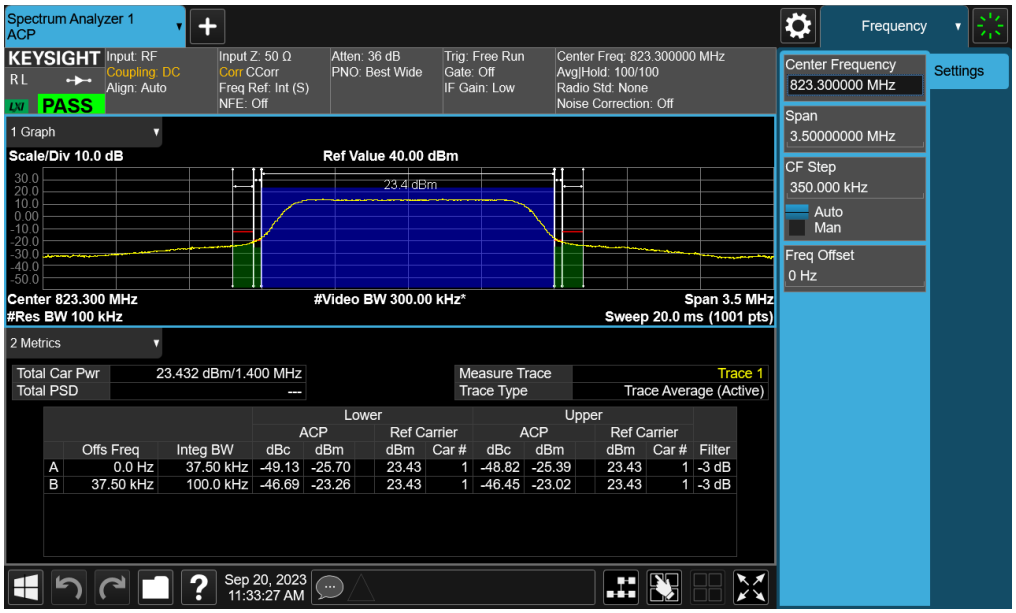
Plot 7-23. Upper Band Edge Plot (LTE Band 14, 5MHz QPSK - RB Size 25)

Plot 7-24. Upper Emission Mask Plot (LTE Band 14, 5MHz QPSK - RB Size 25)

LTE Band 26



Plot 7-25. Channel Edge Plot (LTE Band 26 - 1.4MHz QPSK - Low Channel)



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

7.6 Radiated Power (ERP)

Test Overview

Effective Radiated Power (ERP) measurements are performed using the substitution method described in ANSI C63.26-2015 with the EUT transmitting into an integral antenna. Measurements are performed using vertically and horizontally polarized broadband horn antennas. All measurements are performed as RMS average measurements while the EUT is operating at maximum power, and at the appropriate frequencies.

Test Procedures Used

ANSI C63.26-2015 – Section 5.2.4.4

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
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 Setup

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

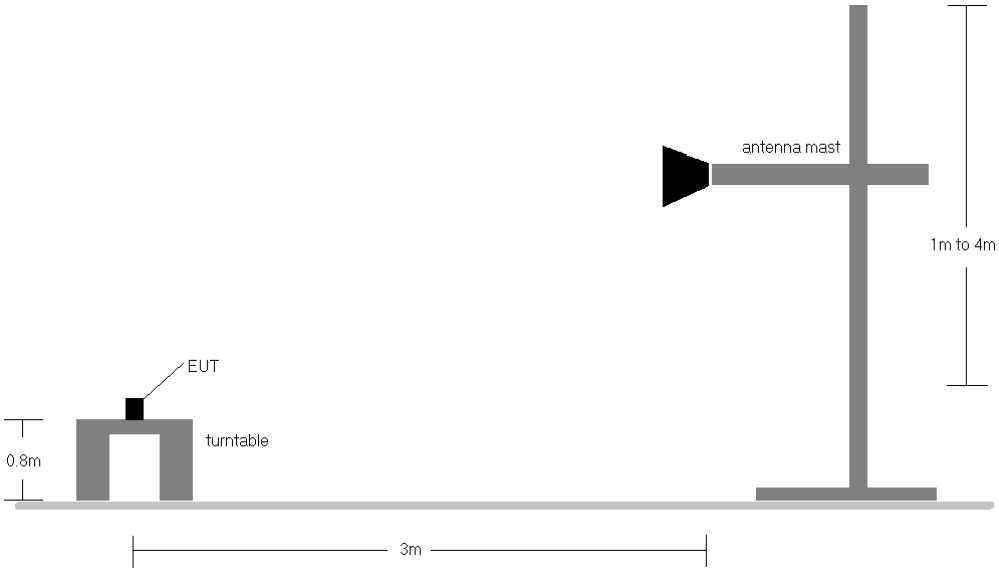


Figure 7-5. Radiated Test Setup <1GHz

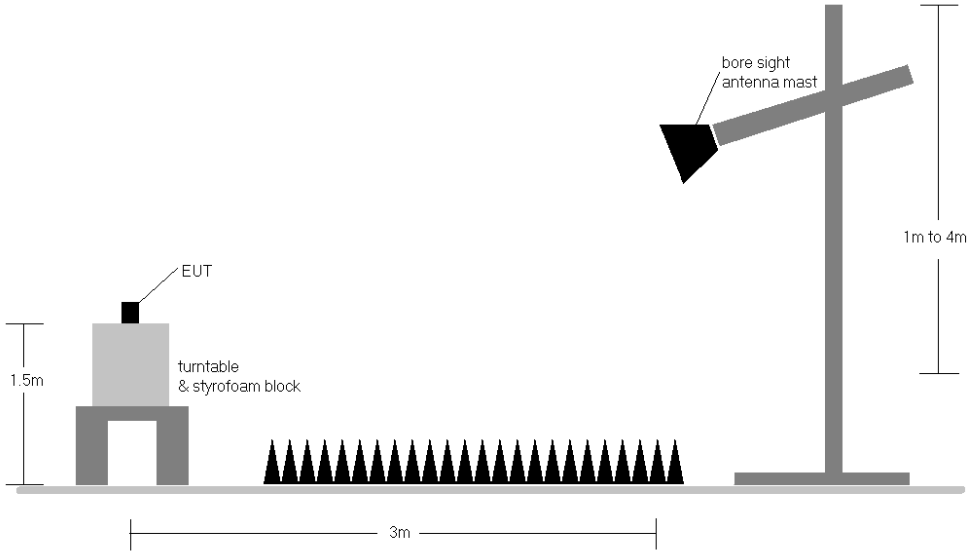


Figure 7-6. Radiated Test Setup > 1GHz

Test Notes

1) The EUT was tested in three orthogonal planes 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 tables below.

2) This unit was tested with its standard battery.

Bandwidth	Mod.	Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Ant. Gain [dBi]	RB Size/Offset	Substitute Level [dBm]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]
10 MHz	QPSK	793.00	V	137	0	1.15	1 / 0	23.51	**22.51**	0.178	34.77	-12.27	24.66	0.292	36.92	-12.27
	16-QAM	793.00	V	137	0	1.15	1 / 0	22.53	21.53	0.142	34.77	-13.25	23.68	0.233	36.92	-13.25
5 MHz	QPSK	790.50	V	137	0	1.15	1 / 24	23.29	22.29	0.169	34.77	-12.48	24.44	0.278	36.92	-12.48
	QPSK	793.00	V	137	0	1.15	1 / 0	23.50	22.50	0.178	34.77	-12.27	24.65	0.292	36.92	-12.27
	QPSK	795.50	V	137	0	1.14	1 / 24	23.54	**22.53**	0.179	34.77	-12.25	24.68	0.293	36.92	-12.25
	16-QAM	790.50	V	137	0	1.15	1 / 24	22.30	21.30	0.135	34.77	-13.47	23.45	0.221	36.92	-13.47
	16-QAM	793.00	V	137	0	1.15	1 / 0	22.33	21.33	0.136	34.77	-13.45	23.48	0.223	36.92	-13.45
	16-QAM	795.50	V	137	0	1.14	1 / 24	22.77	21.76	0.150	34.77	-13.01	23.91	0.246	36.92	-13.01
10 MHz	QPSK (Opposite Pol.)	793.00	H	115	287	1.15	1 / 0	18.24	17.24	0.053	34.77	-17.53	19.39	0.087	36.92	-17.53

Table 7-7. ERP Data (LTE Band 14)

Bandwidth	Mod.	Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Ant. Gain [dBi]	RB Size/Offset	Substitute Level [dBm]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]
15 MHz	QPSK	821.50	V	140	240	1.24	1 / 74	21.48	**20.57**	0.114	38.45	-17.88	22.72	0.187	40.61	-17.89
	16-QAM	821.50	V	140	240	1.24	1 / 74	20.66	19.75	0.094	38.45	-18.70	21.90	0.155	40.61	-18.71
10 MHz	QPSK	819.00	V	140	240	1.23	1 / 25	21.48	**20.55**	0.114	38.45	-17.90	22.70	0.186	40.61	-17.91
	16-QAM	819.00	V	140	240	1.23	1 / 25	20.96	20.03	0.101	38.45	-18.42	22.18	0.165	40.61	-18.43
5 MHz	QPSK	816.50	V	140	240	1.21	1 / 12	21.52	20.58	0.114	38.45	-17.87	22.73	0.188	40.61	-17.88
	QPSK	821.50	V	140	240	1.24	1 / 0	21.62	**20.71**	0.118	38.45	-17.74	22.86	0.193	40.61	-17.75
	16-QAM	816.50	V	140	240	1.21	1 / 12	20.92	19.99	0.100	38.45	-18.46	22.14	0.164	40.61	-18.47
	16-QAM	821.50	V	140	240	1.24	1 / 0	20.76	19.84	0.096	38.45	-18.61	21.99	0.158	40.61	-18.61
3 MHz	QPSK	815.50	V	140	240	1.21	1 / 14	21.57	**20.62**	0.115	38.45	-17.83	22.77	0.189	40.61	-17.83
	QPSK	822.50	V	140	240	1.24	1 / 7	21.37	20.46	0.111	38.45	-17.99	22.61	0.183	40.61	-17.99
	16-QAM	815.50	V	140	240	1.21	1 / 14	20.82	19.88	0.097	38.45	-18.57	22.03	0.160	40.61	-18.58
	16-QAM	822.50	V	140	240	1.24	1 / 7	20.65	19.74	0.094	38.45	-18.71	21.89	0.155	40.61	-18.72
1.4 MHz	QPSK	814.70	V	140	240	1.20	1 / 0	21.11	20.16	0.104	38.45	-18.29	22.31	0.170	40.61	-18.30
	QPSK	823.30	V	140	240	1.25	1 / 5	21.42	**20.52**	0.113	38.45	-17.93	22.67	0.185	40.61	-17.94
	16-QAM	814.70	V	140	240	1.20	1 / 0	20.81	19.87	0.097	38.45	-18.58	22.02	0.159	40.61	-18.59
	16-QAM	823.30	V	140	240	1.25	1 / 5	20.68	19.78	0.095	38.45	-18.67	21.93	0.156	40.61	-18.68
15 MHz	QPSK (Opposite Pol.)	821.50	H	124	296	1.24	1 / 74	21.71	20.80	0.114	38.45	-17.65	22.95	0.197	40.61	-17.66

Table 7-8. ERP Data (LTE Band 26)

7.7 Radiated Spurious Emissions Measurements

Test Overview

Radiated spurious emissions measurements are performed using the field strength conversion method described in ANSI C63.26-2015 with the EUT transmitting into an integral antenna. Measurements on signals operating below 1GHz are performed using hybrid (biconical/log) antennas. Measurements on signals operating above 1GHz are performed using vertically and horizontally polarized broadband horn antennas. All measurements are performed as RMS measurements while the EUT is operating at maximum power, and at the appropriate frequencies.

Test Procedures Used

ANSI C63.26-2015 – Section 5.5.4

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 = RMS
6. Trace mode = Average (Max Hold for pulsed emissions)
7. The trace was allowed to stabilize

Test Setup

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

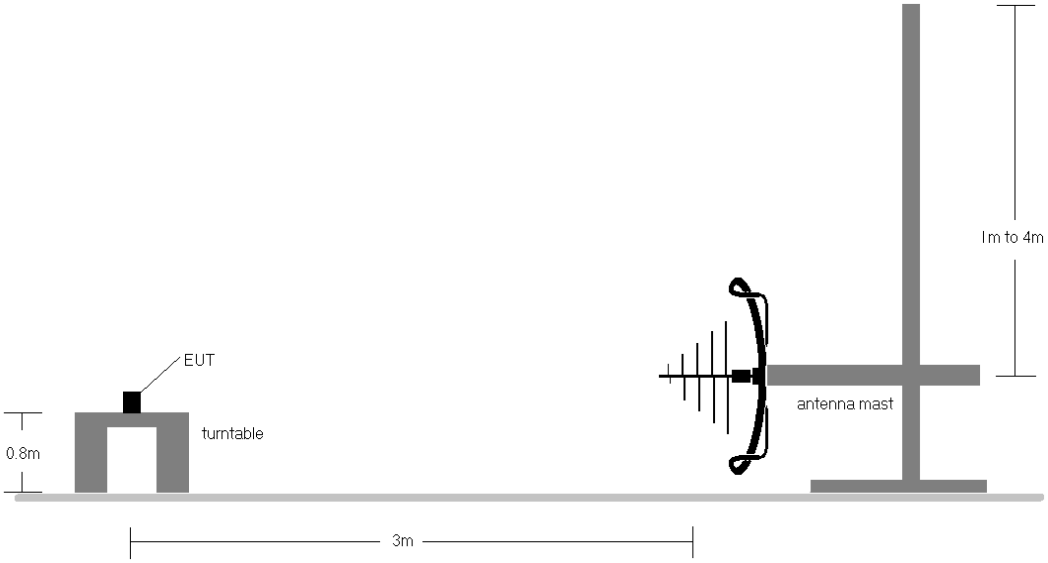


Figure 7-7. Test Instrument & Measurement Setup < 1GHz

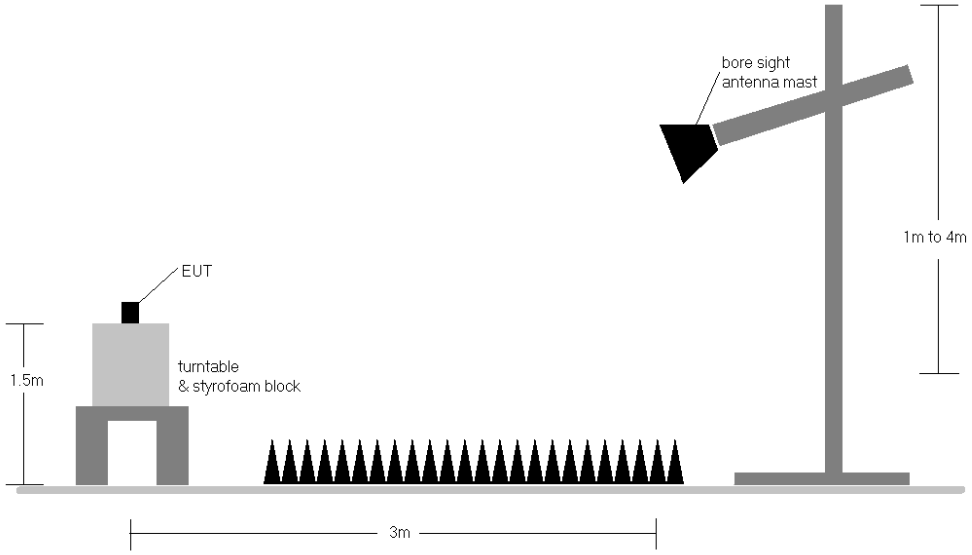


Figure 7-8. Test Instrument & Measurement Setup >1 GHz

Test Notes

1) Field strengths are calculated using the Measurement quantity conversions in ANSI C63.26-2015 Section 5.2.7:
   a) E(dBµV/m) = Measured amplitude level (dBm) + 107 + Cable Loss (dB) + Antenna Factor (dB/m)
   b) EIRP (dBm) = E(dBµV/m) + 20logD – 104.8; where D is the measurement distance in meters.

2) The EUT was tested in three orthogonal planes 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 tables below.

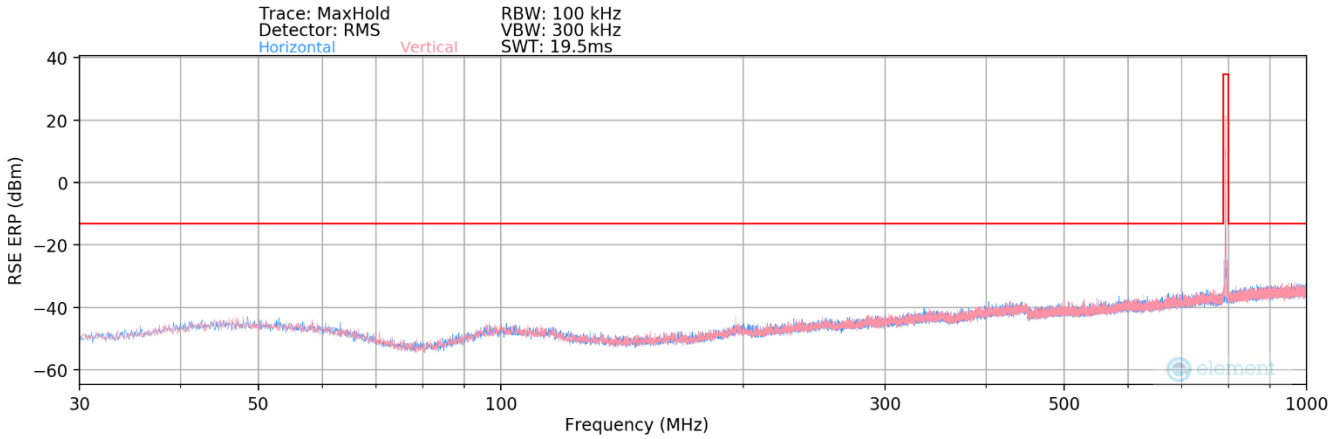
3) This unit was tested with its standard battery.

4) The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter. The worst-case emissions are reported.

5) Emissions below 18GHz were measured at a 3-meter test distance while emissions above 18GHz were measured at a 1-meter test distance with the application of a distance correction factor.

6) The "-" shown in the following RSE tables are used to denote a noise floor measurement.

LTE Band 14

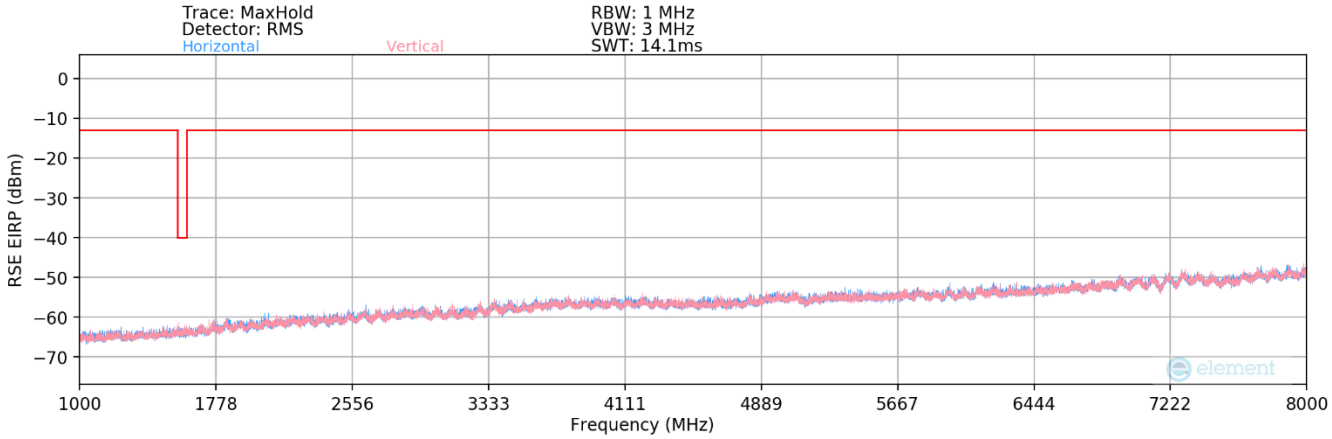


Plot 7-27. Radiated Spurious Plot Below 1GHz (LTE Band 14)

Bandwidth (MHz):	10
Frequency (MHz):	793
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]	ERP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
987.24	H	-	-	-82.33	31.03	55.70	-41.70	-13.00	-28.70

Table 7-9. Radiated Spurious Data Below 1GHz (LTE Band 14)



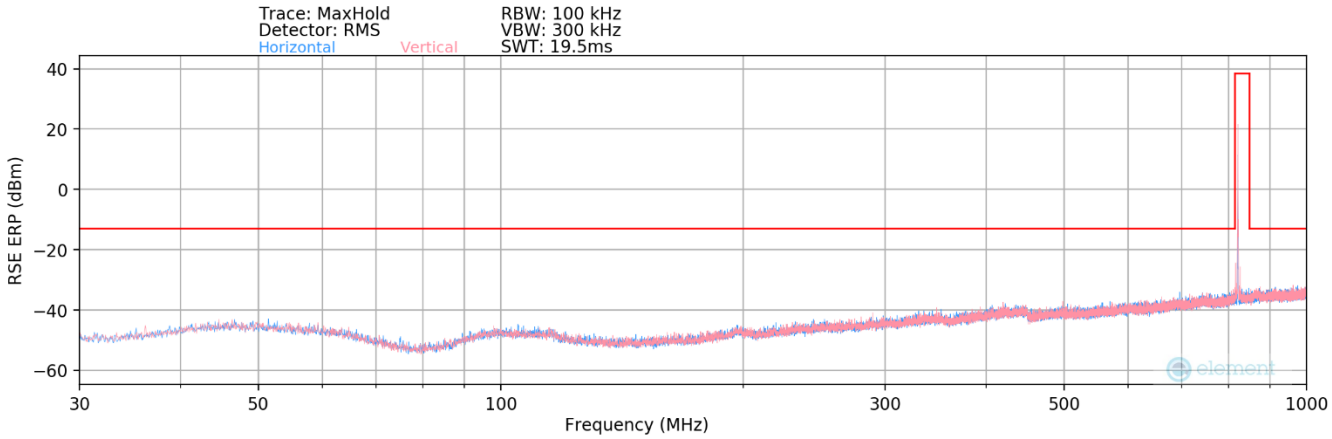
Plot 7-28. Radiated Spurious Plot Above 1GHz (LTE Band 14)

Bandwidth (MHz):	10
Frequency (MHz):	793
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]
1586.00	H	-	-	-73.75	-9.14	24.11	-71.15	-40.00	-31.15
2379.00	H	-	-	-73.59	-5.72	27.69	-67.56	-13.00	-54.56
3172.00	H	-	-	-74.55	-3.59	28.86	-66.39	-13.00	-53.39

Table 7-10. Radiated Spurious Data (LTE Band 14)

LTE Band 26

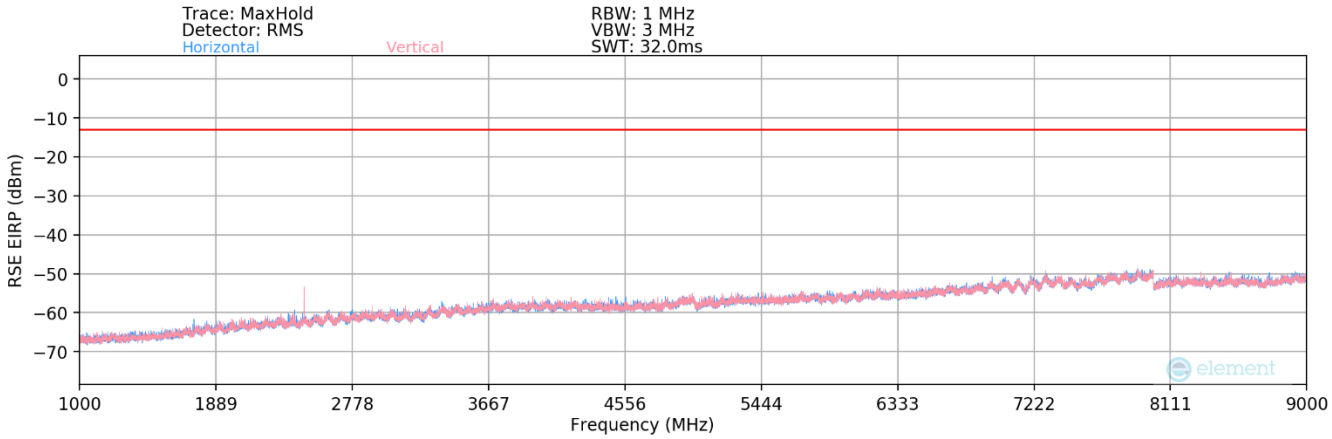


Plot 7-29. Radiated Spurious Plot Below 1GHz (LTE Band 26)

Bandwidth (MHz):	15
Frequency (MHz):	821.5
RB Config (Size / Offset):	1 / 37

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	ERP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
994.65	H	-	-	-82.39	31.19	55.80	-41.61	-13.00	-28.61

Table 7-11. Radiated Spurious Data Below 1GHz(LTE Band 26)



Plot 7-30. Radiated Spurious Plot Above 1GHz (LTE Band 26)

Bandwidth (MHz):	15
Frequency (MHz):	821.5
RB Config (Size / Offset):	1 / 37

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]
1643.00	H	-	-	-73.58	-9.11	24.31	-70.95	-13.00	-57.95
2464.50	H	142	244	-66.37	-5.74	34.89	-60.37	-13.00	-47.37
3286.00	H	-	-	-73.32	-2.66	31.02	-64.24	-13.00	-51.24
4107.50	H	-	-	-75.63	0.12	31.49	-63.76	-13.00	-50.76
4929.00	H	-	-	-75.22	1.12	32.90	-62.36	-13.00	-49.36

Table 7-12. Radiated Spurious Data Above 1GHz (LTE Band 26)

7.8 Frequency Stability / Temperature Variation

Test Overview and Limit

Frequency stability testing is performed in accordance with the guidelines of ANSI C63.26-2015. 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.

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 – Section 5.6

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

The EUT was connected via an RF cable to a spectrum analyzer with the EUT placed inside an environmental chamber.

Test Notes

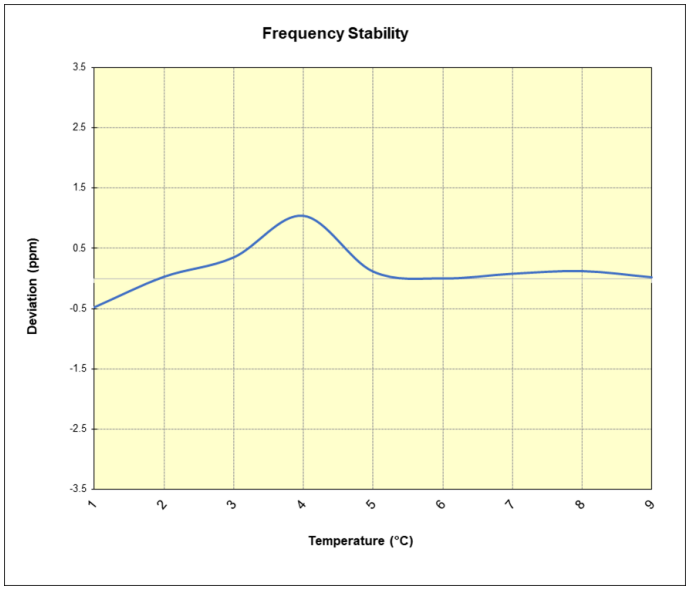
None

LTE Band 14

LTE Band 14	
Operating Frequency (Hz):	793,000,000
Ref. Voltage (VDC):	4.358

Voltage (%)	Power (VDC)	Temp (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	4.358	- 30	792,998,764	-383	-0.0000483
		- 20	792,999,168	21	0.0000026
		- 10	792,999,424	277	0.0000349
		0	792,999,977	830	0.0001047
		+ 10	792,999,240	93	0.0000117
		+ 20 (Ref)	792,999,147	0	0.0000000
		+ 30	792,999,210	62	0.0000078
		+ 40	792,999,245	97	0.0000123
		+ 50	792,999,163	16	0.0000020
Battery Endpoint	3.372	+ 20	792,999,844	697	0.0000879

Table 7-13. LTE Band 14 Frequency Stability Data



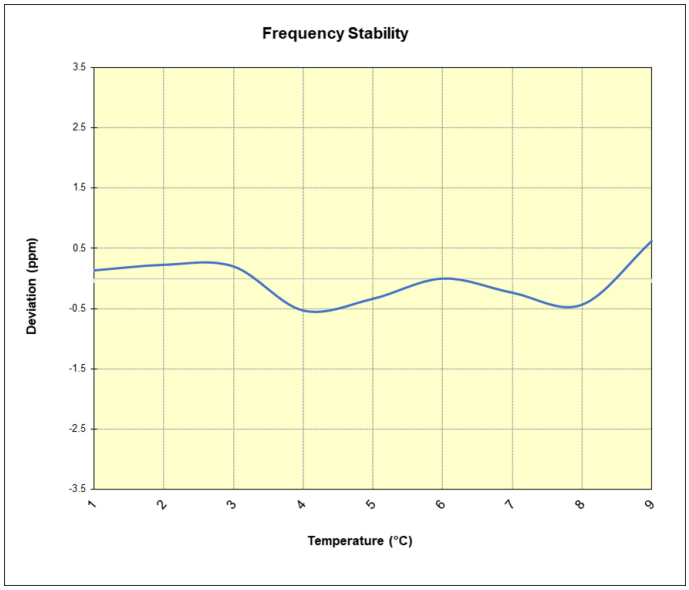
Plot 7-31. LTE Band 14 Frequency Stability Chart

LTE Band 26

LTE Band 26	
Operating Frequency (Hz):	819,000,000
Ref. Voltage (VDC):	4.358
Deviation Limit:	± 0.00025% or 2.5 ppm

Voltage (%)	Power (VDC)	Temp (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	4.358	- 30	821,499,822	112	0.0000136
		- 20	821,499,896	187	0.0000227
		- 10	821,499,875	165	0.0000201
		0	821,499,275	-435	-0.0000529
		+ 10	821,499,435	-275	-0.0000335
		+ 20 (Ref)	821,499,710	0	0.0000000
		+ 30	821,499,518	-192	-0.0000233
		+ 40	821,499,354	-355	-0.0000433
		+ 50	821,500,219	509	0.0000620
Battery Endpoint	3.372	+ 20	821,499,392	-318	-0.0000387

Table 7-14. LTE Band 26 Frequency Stability Data



Plot 7-32. LTE Band 26 Frequency Stability Chart

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Samsung Portable Handset FCC ID: A3LSMA156U** complies with all the requirements of Parts 22(H) and 90 of the FCC rules.