PCTEST
7185 Oakland Mills Road, Columbia, MD 21046 USA
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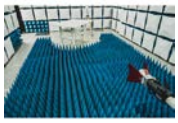

PART 24 MEASUREMENT REPORT

Applicant Name:
Samsung Electronics Co., Ltd.
129, Samsung-ro,
Yeongtong-gu, Suwon-si
Gyeonggi-do, 16677, Korea

Date of Testing:
02/07/2022 - 02/21/2022
Test Report Issue Date:
2/28/2022
Test Site/Location:
PCTEST Lab. Columbia, MD, USA
Test Report Serial No.:
1M2202030012-04.A3L

FCC ID:	**A3LSMS901E**
Applicant Name:	**Samsung Electronics Co., Ltd.**

Application Type:	Class II Permissive Change
Model:	SM-S901E/DS
Additional Model(s):	SM-S901E
EUT Type:	Portable Handset
FCC Classification:	PCS Licensed Transmitter Held to Ear (PCE)
FCC Rule Part:	24
Test Procedure(s):	ANSI C63.26-2015, ANSI/TIA-603-E-2016, KDB 971168 D01 v03r01, KDB 648474 D03 v01r04
Class II Permissive Change:	Please see FCC change document
Original Grant Date:	01/10/2022

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

ACCREDITED
CERT #2041.01

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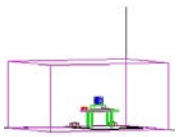
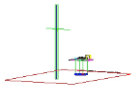


PART 24 MEASUREMENT REPORT



Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	EIRP		Emission Designator
				Max. Power [W]	Max. Power [dBm]	
NR Band n25/2	20 MHz	π/2 BPSK	1860 - 1905	0.251	24.00	18M0G7D
		QPSK	1860 - 1905	0.214	23.31	19M1G7D
		16QAM	1860 - 1905	0.195	22.90	19M0W7D
	15 MHz	π/2 BPSK	1857.5 - 1907.5	0.264	24.22	13M5G7D
		QPSK	1857.5 - 1907.5	0.251	24.00	14M2G7D
		16QAM	1857.5 - 1907.5	0.208	23.18	14M2W7D
	10 MHz	π/2 BPSK	1855 - 1910	0.258	24.12	8M99G7D
		QPSK	1855 - 1910	0.245	23.88	9M35G7D
		16QAM	1855 - 1910	0.211	23.25	9M36W7D
	5 MHz	π/2 BPSK	1852.5 - 1912.5	0.257	24.10	4M58G7D
		QPSK	1852.5 - 1912.5	0.249	23.97	4M50G7D
		16QAM	1852.5 - 1912.5	0.198	22.96	4M54W7D

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 Engineering Laboratory, Inc. facility located at 7185 Oakland Mills Road, Columbia, MD 21046. 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 PCTEST Engineering Lab located in Columbia, MD 21046, U.S.A.

- PCTEST is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.01 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 (2451B) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Samsung Portable Handset FCC ID: A3LSMS901E**. 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 24.

Test Device Serial No.: 1755M, 2226V, 2346V, 1863M

2.2 Device Capabilities

This device contains the following capabilities:

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

2.3 Test Configuration

The EUT was tested per the guidance of ANSI/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.

This device supports wireless charging capability and, thus, is subject to the test requirements of KDB 648474 D03 v01r04. Additional radiated spurious emission measurements were performed with the EUT lying flat on an authorized wireless charging pad (WCP) Model: EP-N5100 while operating under normal conditions in a simulated call or data transmission configuration. The worst case radiated emissions data is shown in this report.

2.4 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 "Land Mobile FM or PM – Communications Equipment – Measurements and Performance Standards" (ANSI/TIA-603-E-2016) and "Measurement Guidance for Certification of Licensed Digital Transmitters" (KDB 971168 D01 v03r01) 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/TIA-603-E-2016. 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 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

$$EIRP_{[dBm]} = E_{[dB\mu V/m]} + 20\log D - 104.8;$$ 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/TIA-603-E-2016.

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	1.13
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

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
-	AP1	EMC Cable and Switch System	3/9/2021	Annual	3/9/2022	AP1
-	ETS	EMC Cable and Switch System	3/4/2021	Annual	3/4/2022	ETS
-	LTx2	Licensed Transmitter Cable Set	3/12/2021	Annual	3/12/2022	LTx2
-	LTx3	LIcensed Transmitter Cable Set	2/26/2021	Annual	2/26/2022	LTx3
Agilent	E5515C	Wireless Communications Test Set	N/A			GB45360985
Anritsu	MT8821C	Radio Communication Analyzer	N/A			6200901190
Espec	ESX-2CA	Environmental Chamber	8/27/2020	Annual	8/27/2022	17620
ETS Lindgren	3117	1-18 GHz DRG Horn (Medium)	4/20/2021	Biennial	4/20/2023	00125518
ETS Lindgren	3164-08	Quad Ridge Horn Antenna	3/12/2020	Biennial	3/12/2022	128337
Mini-Circuits	SSG-4000HP	Synthesized Signal Generator	N/A			11208010032
Rohde & Schwarz	CMW500	Radio Communication Tester	N/A			112347
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	7/27/2020	Biennial	7/27/2022	A051107

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.

6.0 SAMPLE CALCULATIONS

GSM Emission Designator

Emission Designator = 250KGXW
GSM BW = 250 kHz
G = Phase Modulation
X = Cases not otherwise covered
W = Combination (Audio/Data)

EDGE Emission Designator

Emission Designator = 250KG7W
EDGE BW = 250 kHz
G = Phase Modulation
7 = Quantized/Digital Info
W = Combination (Audio/Data)

CDMA Emission Designator

Emission Designator = 1M25F9W
CDMA BW = 1.25 MHz
F = Frequency Modulation
9 = Composite Digital Info
W = Combination (Audio/Data)

WCDMA Emission Designator

Emission Designator = 4M16F9W
WCDMA BW = 4.16 MHz
F = Frequency Modulation
9 = Composite Digital Info
W = Combination (Audio/Data)

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

Example: Spurious emission at 3700.40 MHz

The receive 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 3700.40 MHz. So 6.1 dB is added to the signal generator reading of –30.9 dBm yielding –24.80 dBm. The fundamental EIRP was 25.50 dBm so this harmonic was 25.50 dBm – (-24.80) = 50.3 dBc.

7.0 TEST RESULTS

7.1 Summary

Company Name: Samsung Electronics Co., Ltd.

FCC ID: A3LSMS901E

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

Mode(s): NR

Test Condition	Test Description	FCC Part Section(s)	RSS Section(s)	Test Limit	Test Result	Reference
CONDUCTED	Transmitter Conducted Output Power	2.1046(a), 2.1046(c)	RSS-Gen(6.12)	N/A	PASS	See RF Exposure Report
	Occupied Bandwidth	2.1049(h)	RSS-Gen(6.7)	N/A	PASS	Section 7.2
	Conducted Band Edge / Spurious Emissions	2.1051, 24.238(a)	RSS-Gen(6.13), RSS-133(6.5)	> 43 + 10log10(P[Watts]) at Band Edge and for all out-of-band emissions	PASS	Sections 7.3, 7.4
	Peak-to-Average Ratio	24.232(d)	RSS-133(6.4)	≤ 13 dB	PASS	Section 7.5
	Frequency Stability	2.1055, 24.235	RSS-Gen(6.11), RSS-133(6.3)	Fundamental emissions stay within authorized frequency block **Carrier frequency shall not depart from the reference frequency in excess of ±2.5 ppm	PASS	Section 7.8
RADIATED	Equivalent Isotropic Radiated Power	24.232(c)	RSS-Gen(6.12), RSS-133(6.4)	< 2 Watts max. EIRP	PASS	Section 7.6
	Radiated Spurious Emissions	2.1053, 24.238(a)	RSS-Gen(6.13), RSS-133(6.5)	≥ 43 + 10 log (P[Watts]) dB of attenuation below transmitter power **Spurious emissions from receivers shall not exceed the limits detailed in RSS-Gen(7.3)	PASS	Section 7.7

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 were all 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) All conducted emissions measurements are performed with automated test software to capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST EMC Software Tool v1.0.

7.2 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

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 ≥ 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.

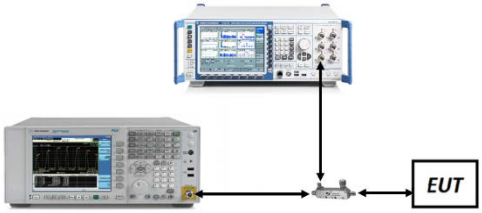
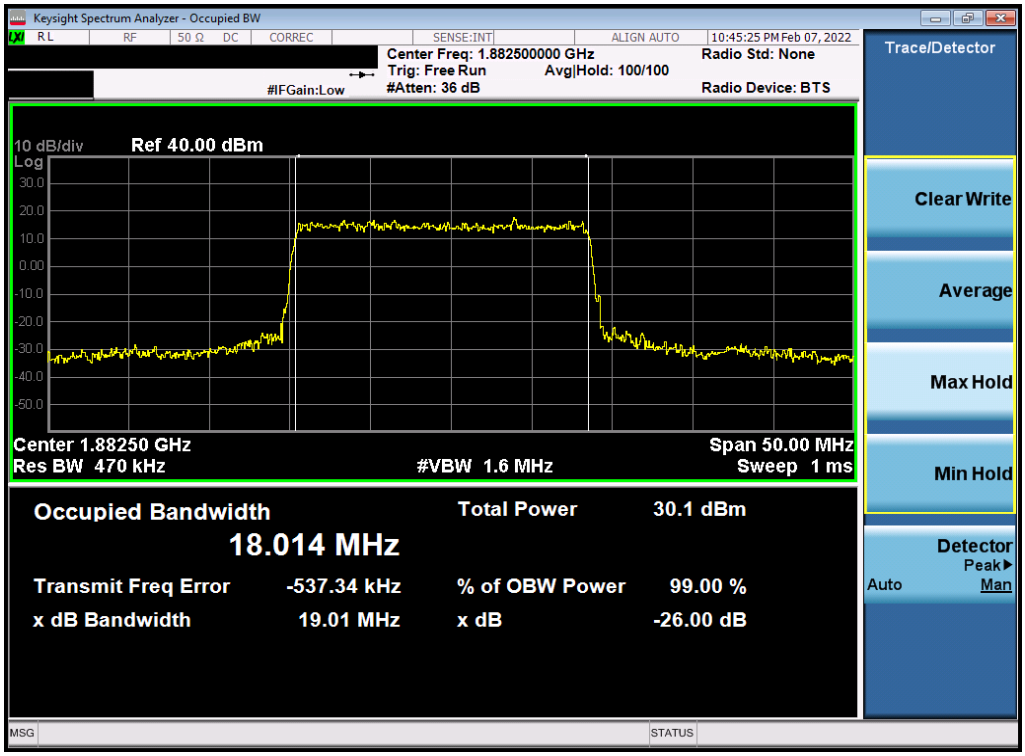


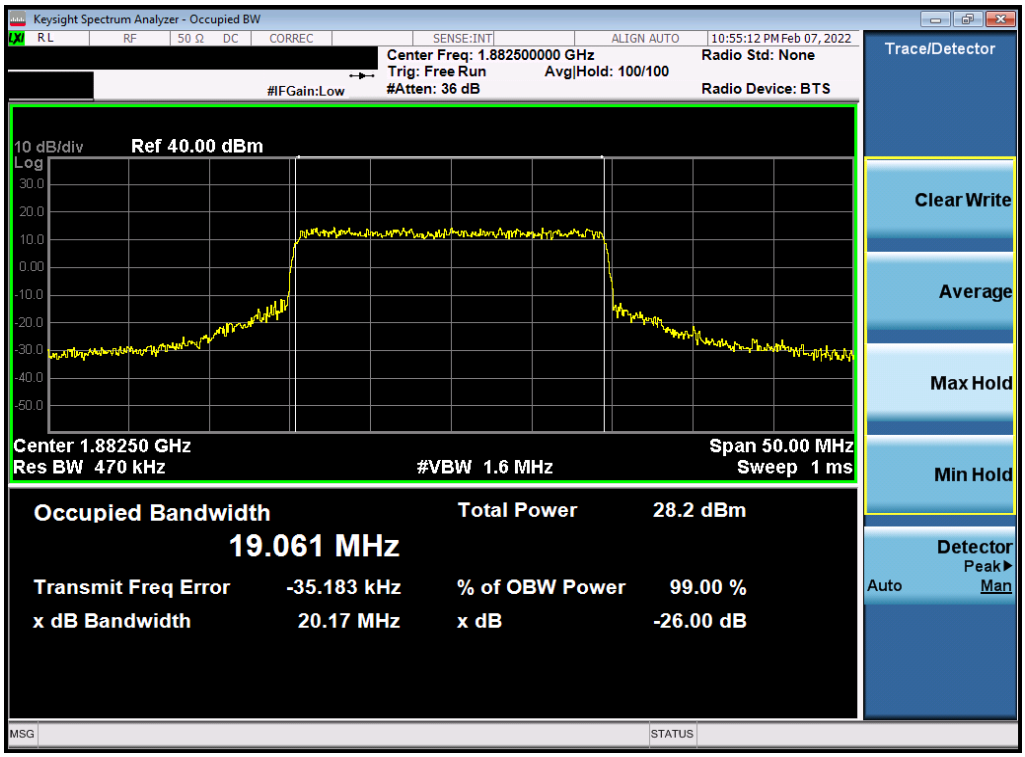
Figure 7-1. Test Instrument & Measurement Setup

Test Notes

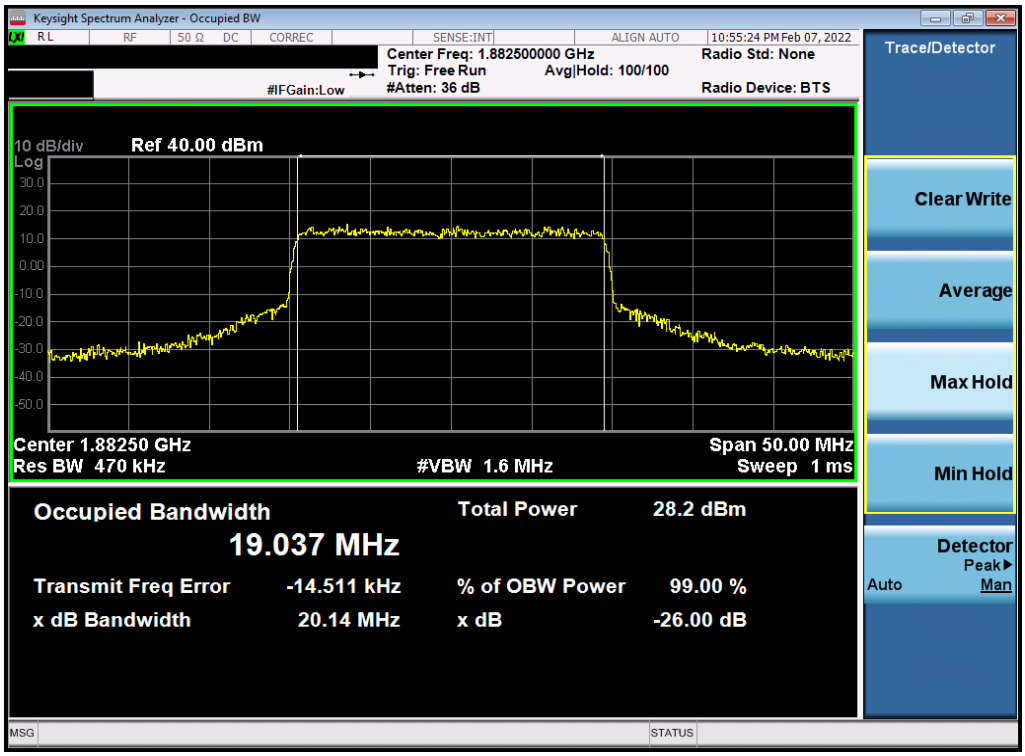
None.



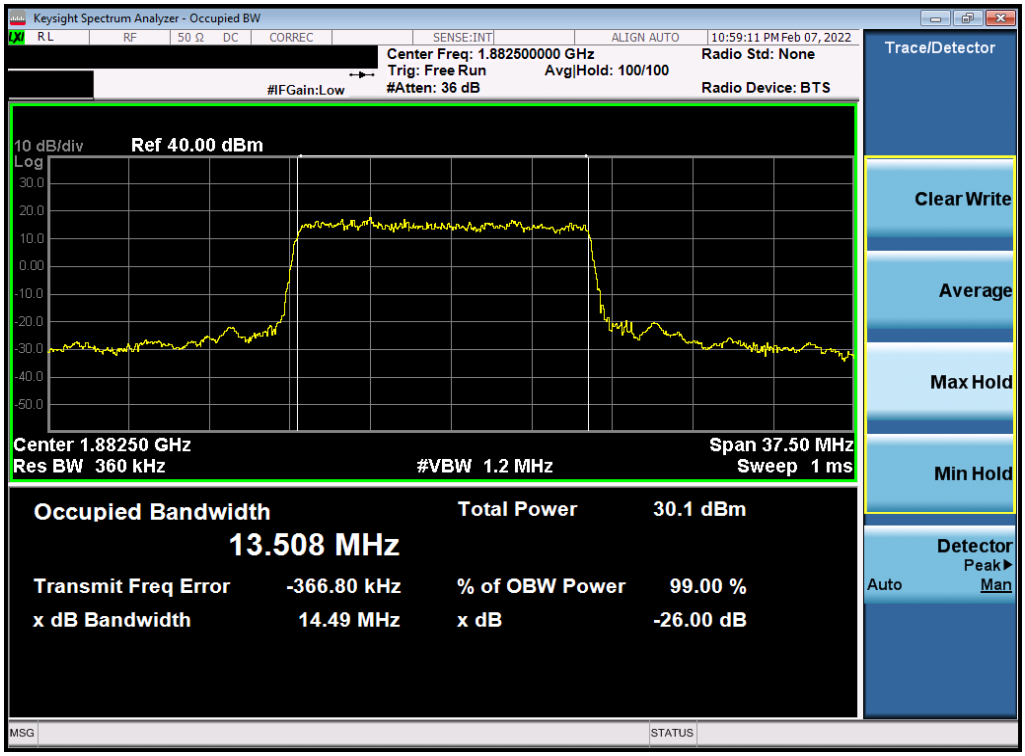
Plot 7-1. Occupied Bandwidth Plot (NR Band n25/2 - 20.0MHz DFT-s-OFDM BPSK - Full RB)



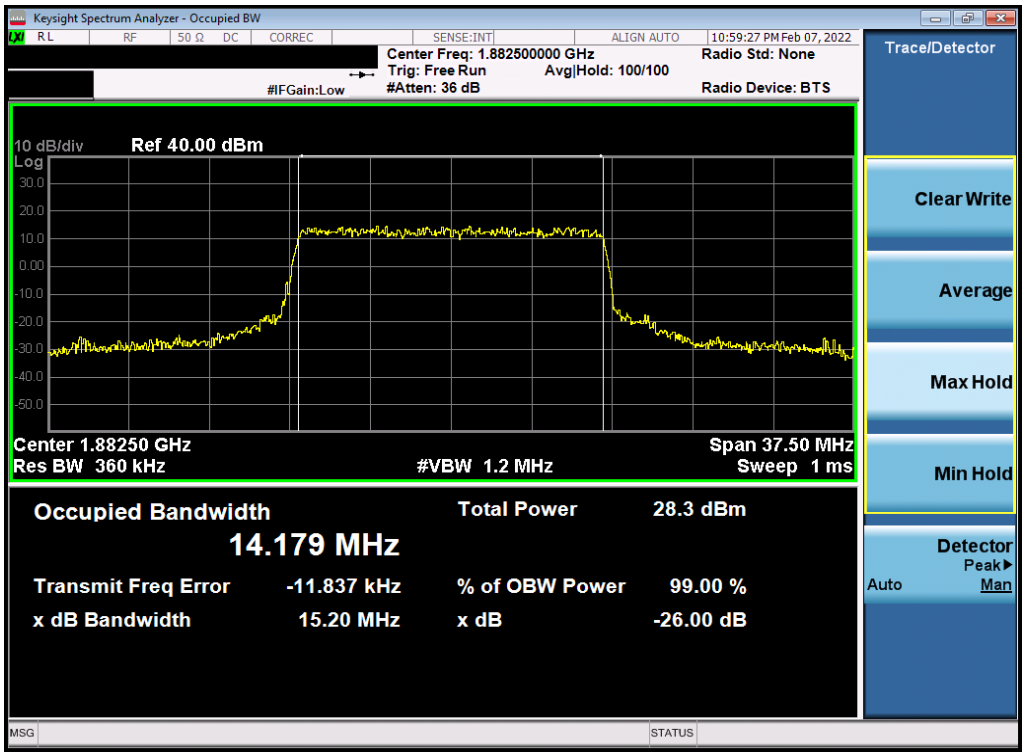
Plot 7-2. Occupied Bandwidth Plot (NR Band n25/2 - 20.0MHz CP-OFDM QPSK - Full RB)



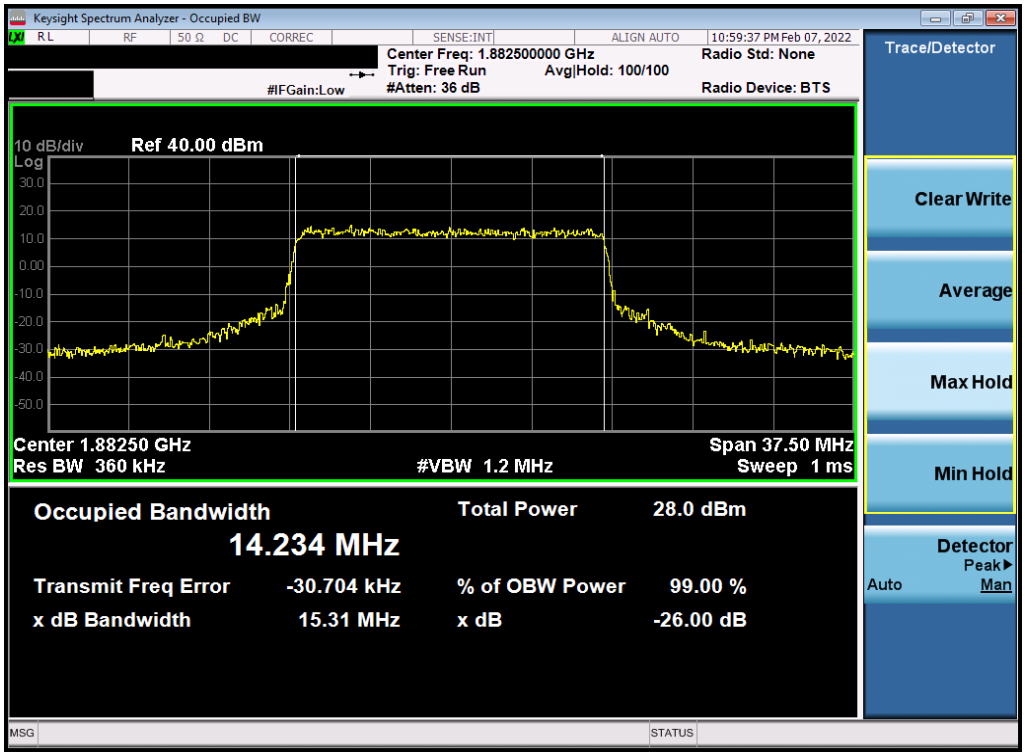
Plot 7-3. Occupied Bandwidth Plot (NR Band n25/2 - 20.0MHz CP-OFDM 16QAM - Full RB)



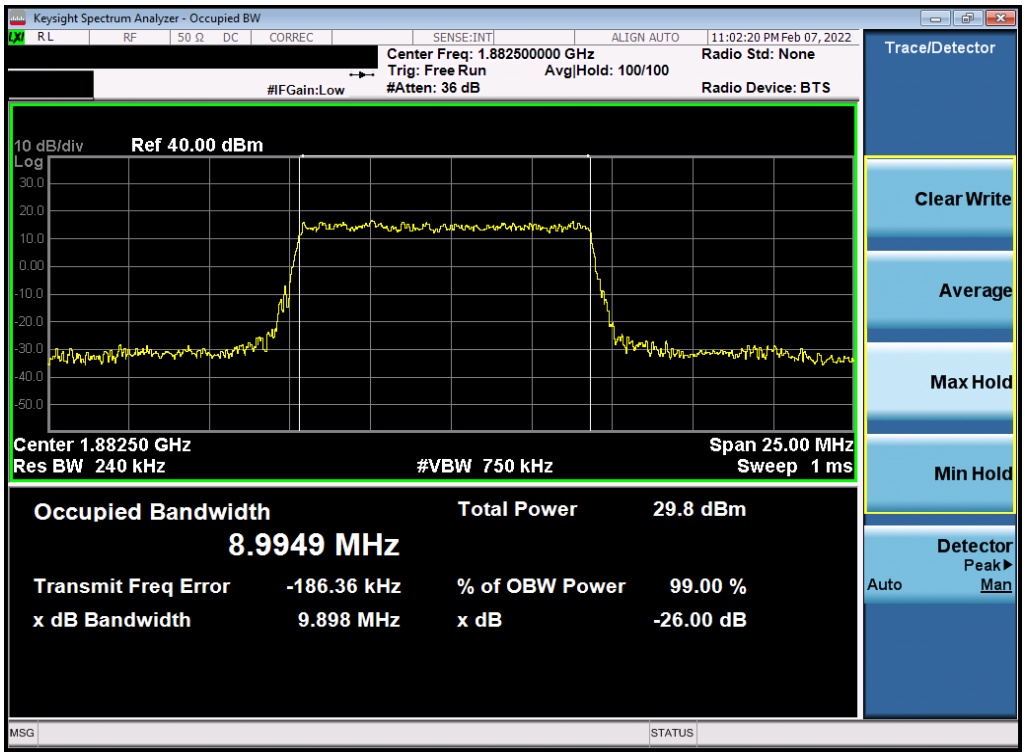
Plot 7-4. Occupied Bandwidth Plot (NR Band n25/2 - 15.0MHz DFT-s-OFDM BPSK - Full RB)



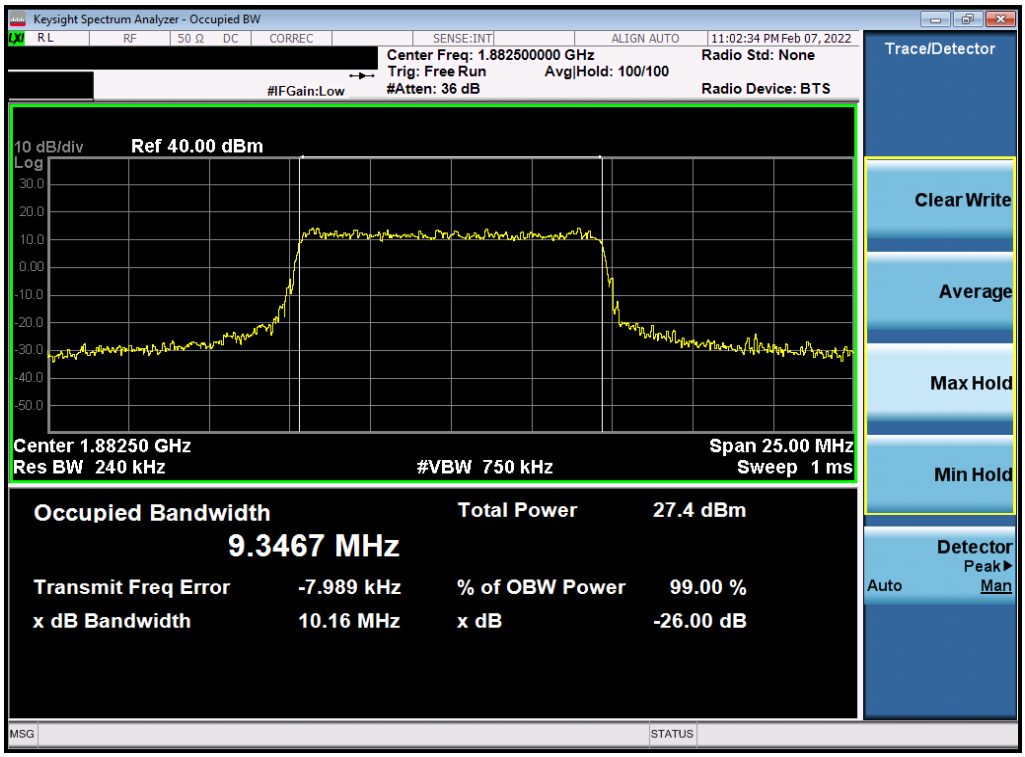
Plot 7-5. Occupied Bandwidth Plot (NR Band n25/2 - 15.0MHz CP-OFDM QPSK - Full RB)



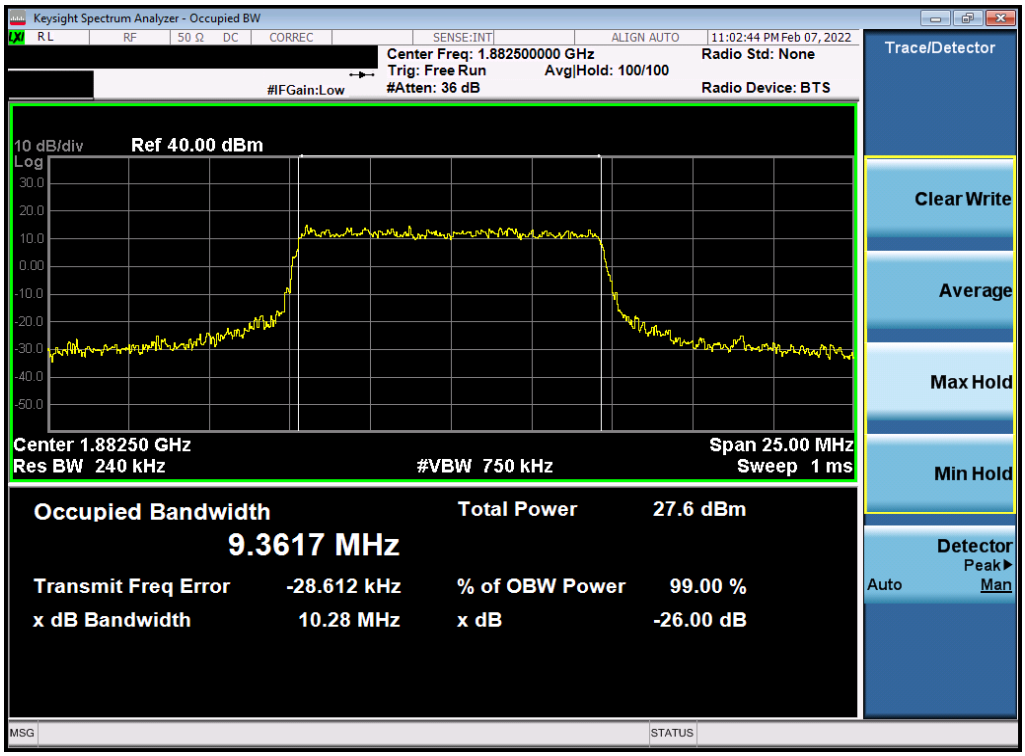
Plot 7-6. Occupied Bandwidth Plot (NR Band n25/2 - 15.0MHz CP-OFDM 16QAM - Full RB)



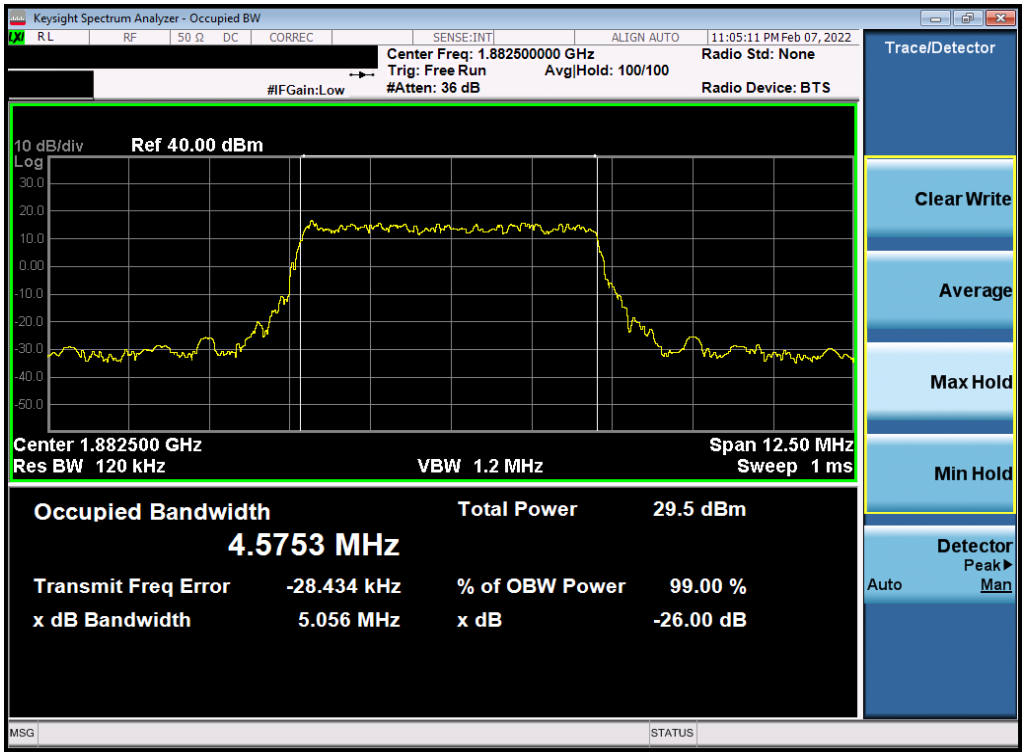
Plot 7-7. Occupied Bandwidth Plot (NR Band n25/2 - 10.0MHz DFT-s-OFDM BPSK - Full RB)



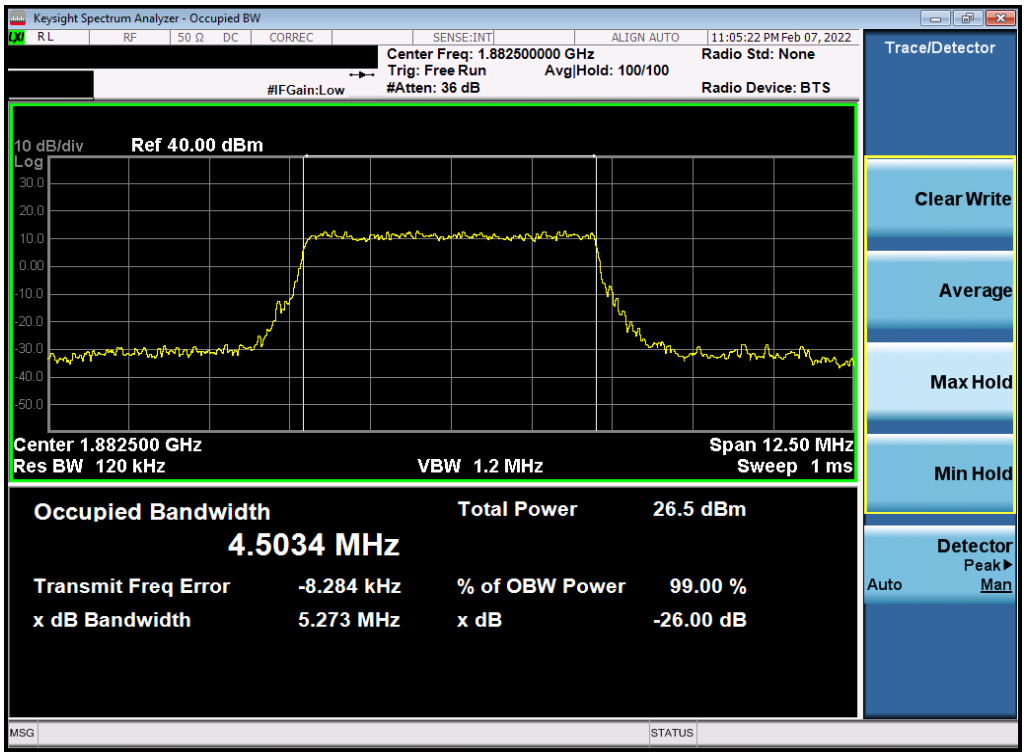
Plot 7-8. Occupied Bandwidth Plot (NR Band n25/2 - 10.0MHz CP-OFDM QPSK - Full RB)



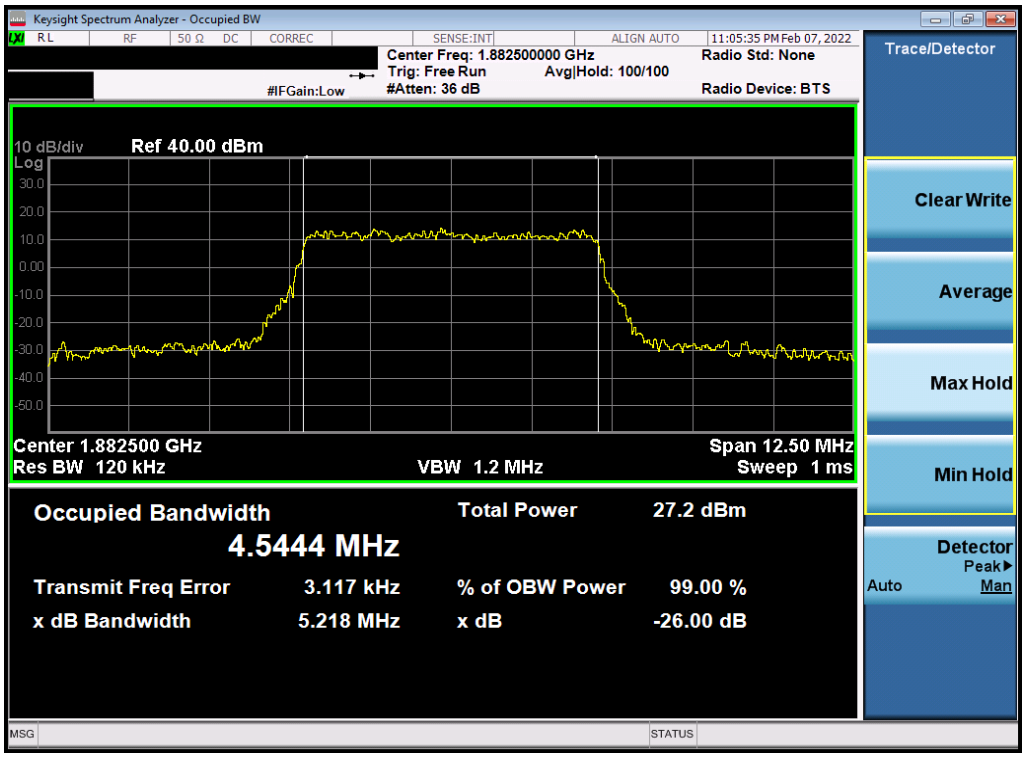
Plot 7-9. Occupied Bandwidth Plot (NR Band n25/2 - 10.0MHz CP-OFDM 16QAM - Full RB)



Plot 7-10. Occupied Bandwidth Plot (NR Band n25/2 - 5.0MHz DFT-s-OFDM BPSK - Full RB)



Plot 7-11. Occupied Bandwidth Plot (NR Band n25/2 - 5.0MHz CP-OFDM QPSK - Full RB)



Plot 7-12. Occupied Bandwidth Plot (NR Band n25/2 - 5.0MHz CP-OFDM 16QAM - Full RB)

7.3 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

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 20GHz (separated into at least two plots per channel)
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.

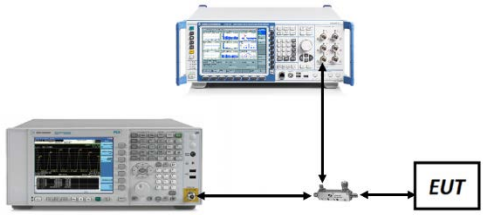
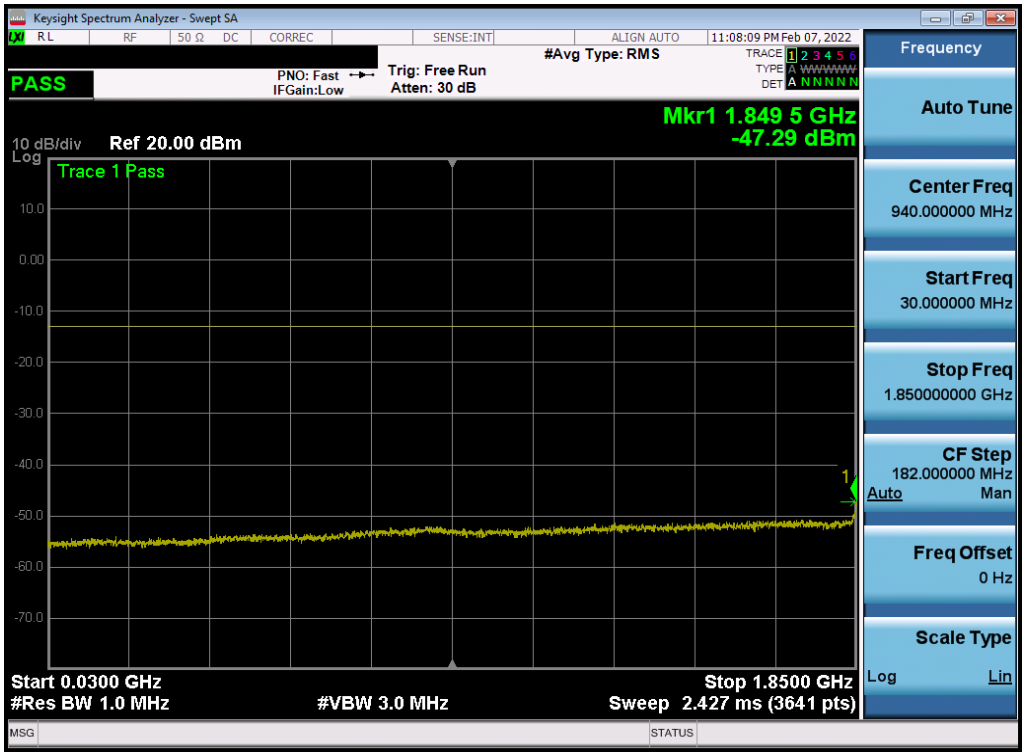


Figure 7-2. Test Instrument & Measurement Setup

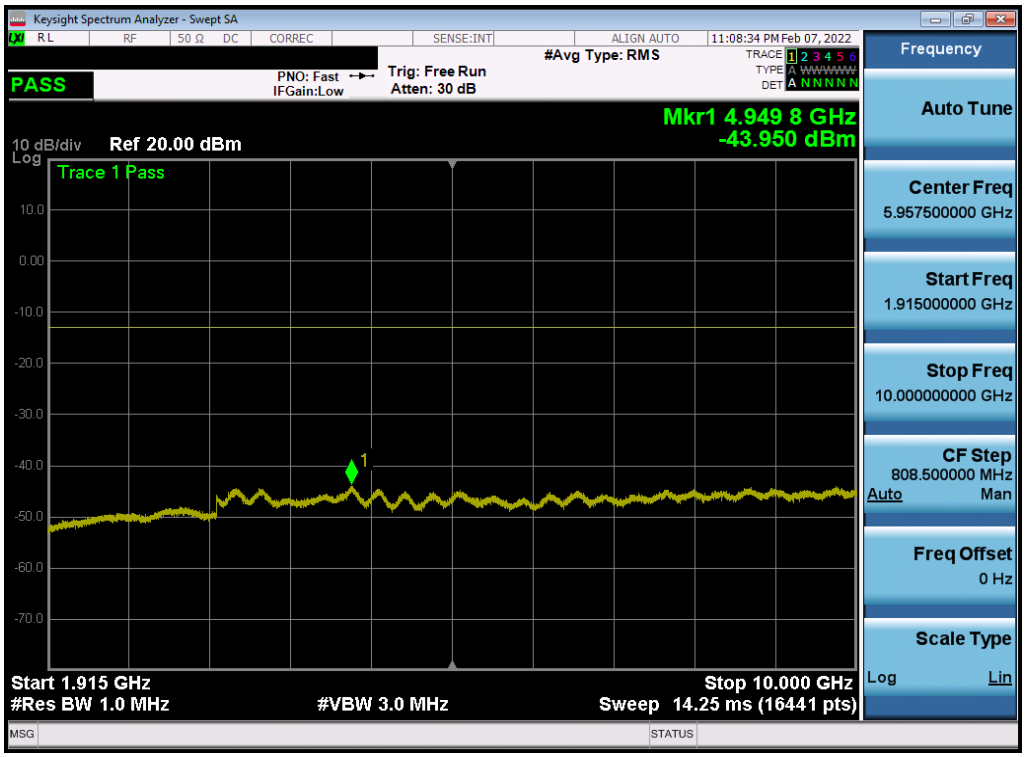
Test Notes

1. Per Part 24 and RSS-133, compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth 100 kHz or greater for measurements below 1GHz. 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.

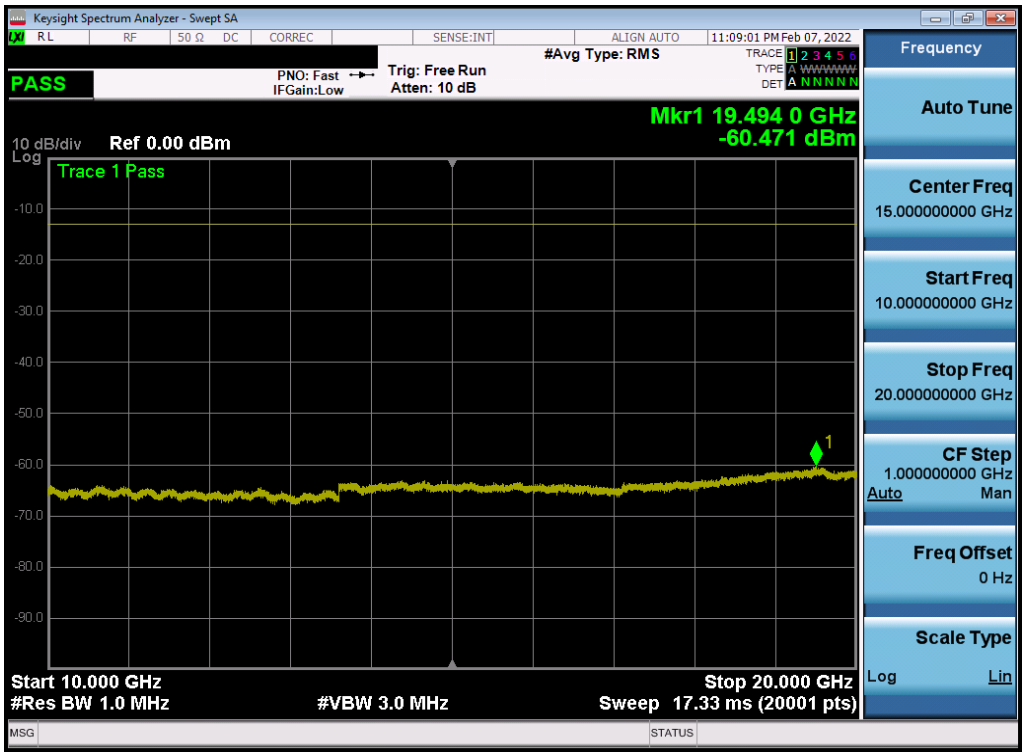
2. For NR operation, all subcarrier spacings (SCS) and transmission schemes (e.g. CP-OFDM and DFT-s-OFDM) were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.



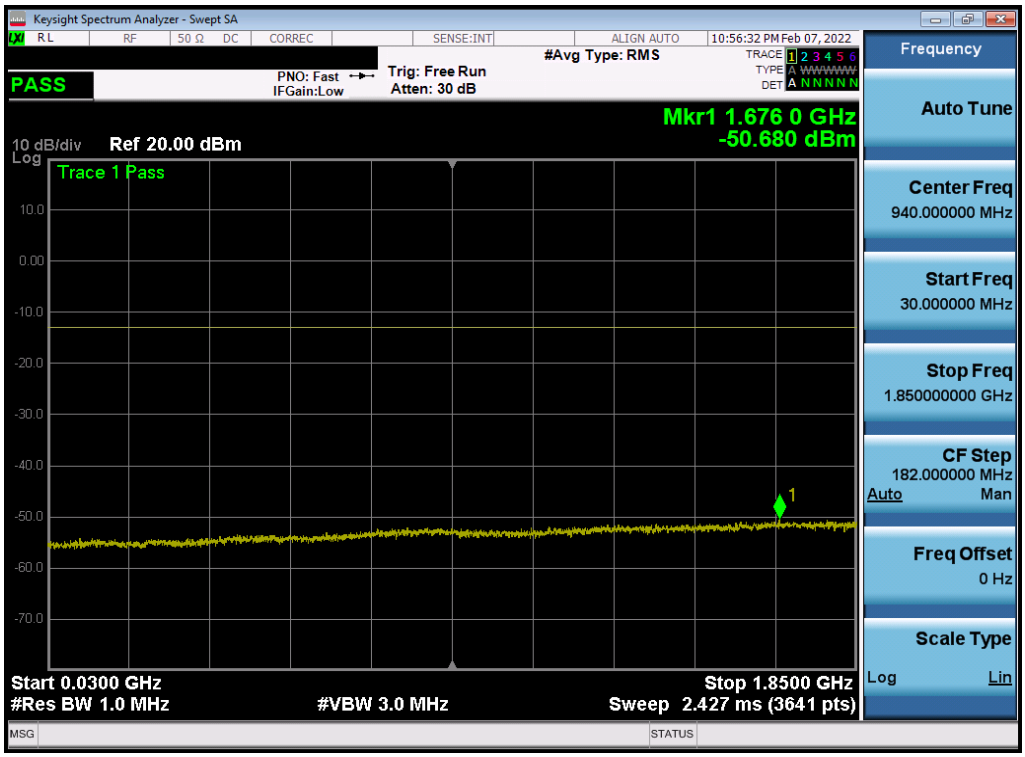
Plot 7-13. Conducted Spurious Plot (NR Band n25/2 -20.0MHz - 1RB - Low Channel)



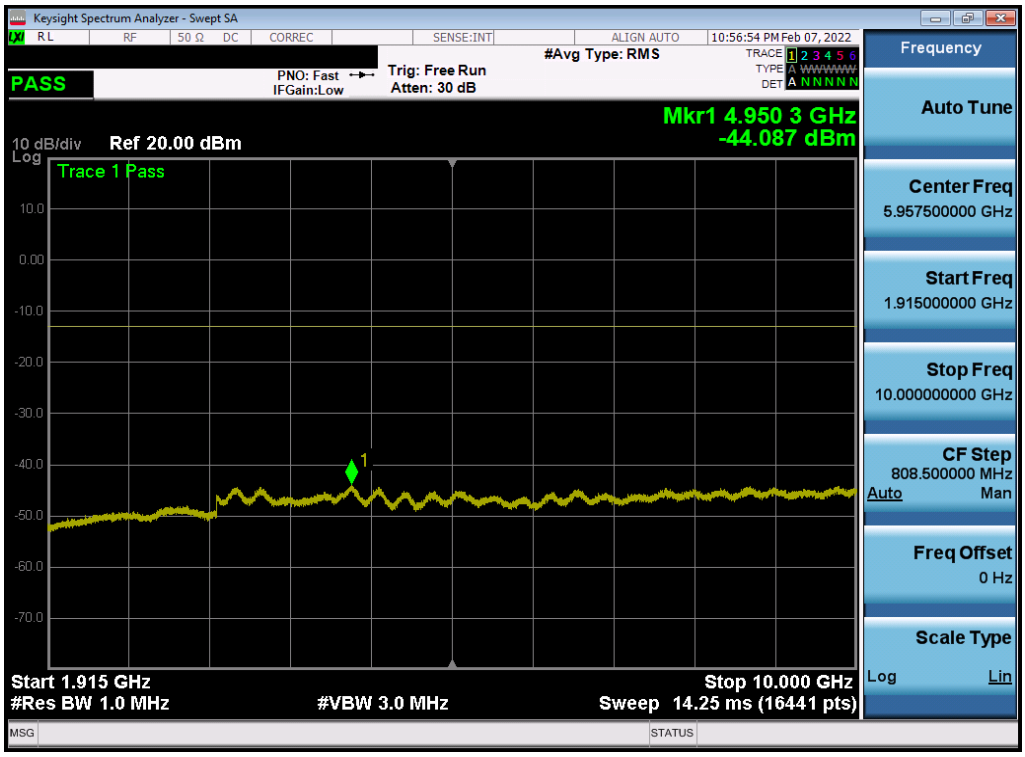
Plot 7-14. Conducted Spurious Plot (NR Band n25/2 - 20.0MHz - 1RB - Low Channel)



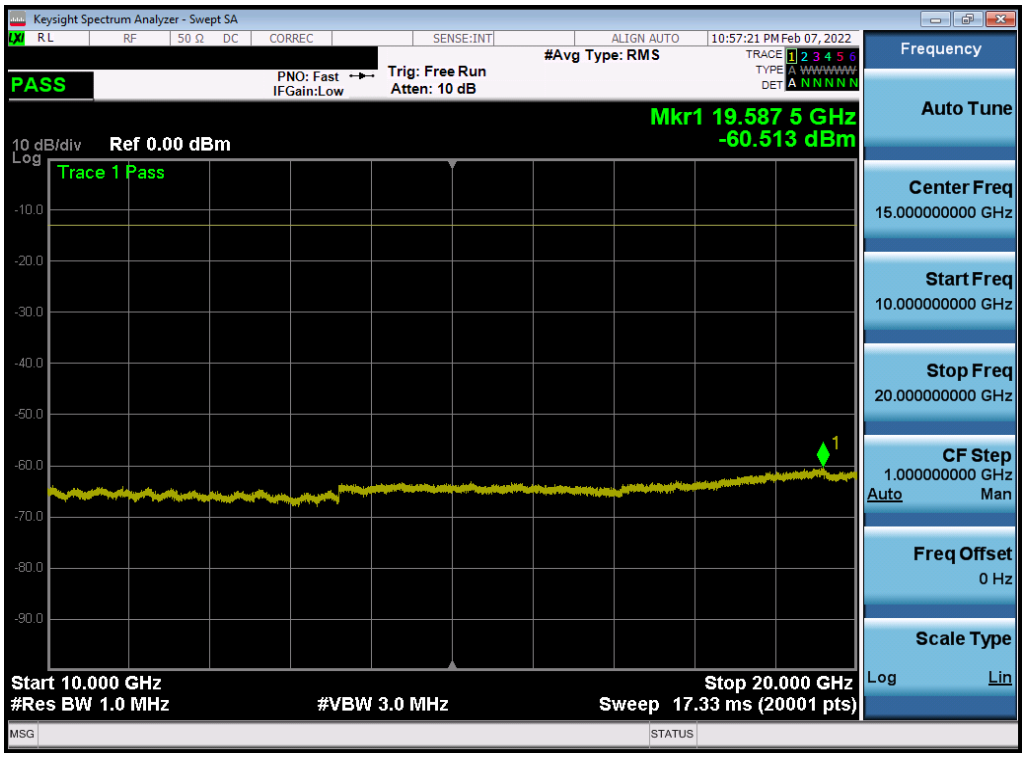
Plot 7-15. Conducted Spurious Plot (NR Band n25/2 - 20.0MHz - 1RB - Low Channel)



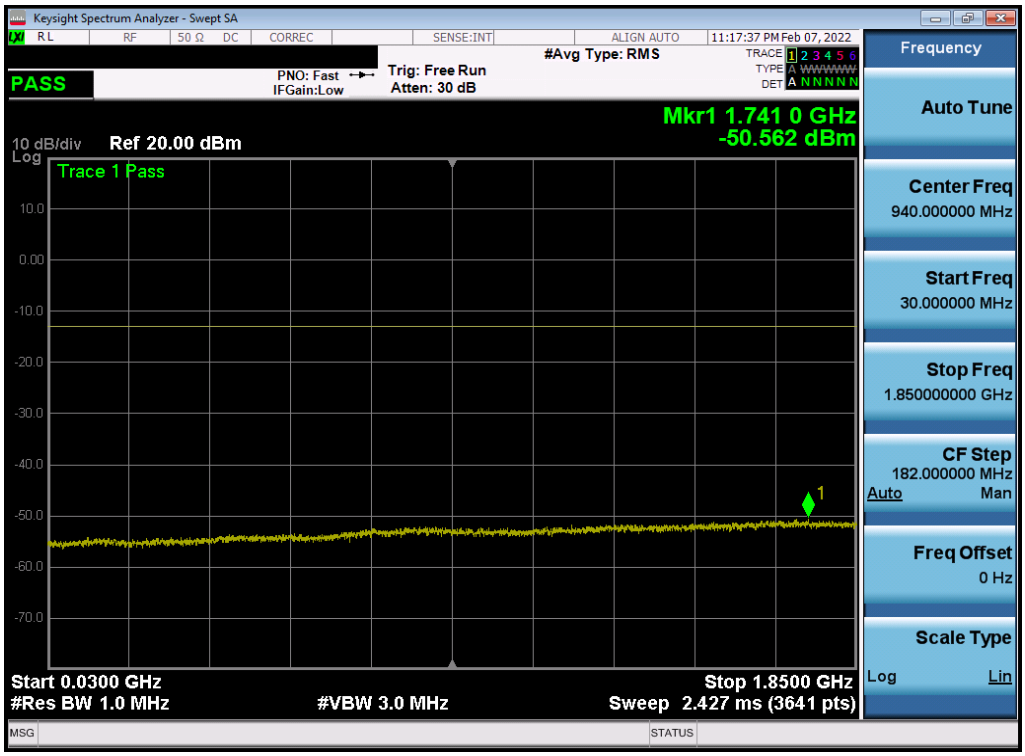
Plot 7-16. Conducted Spurious Plot (NR Band n25/2 - 20.0MHz - 1RB - Mid Channel)



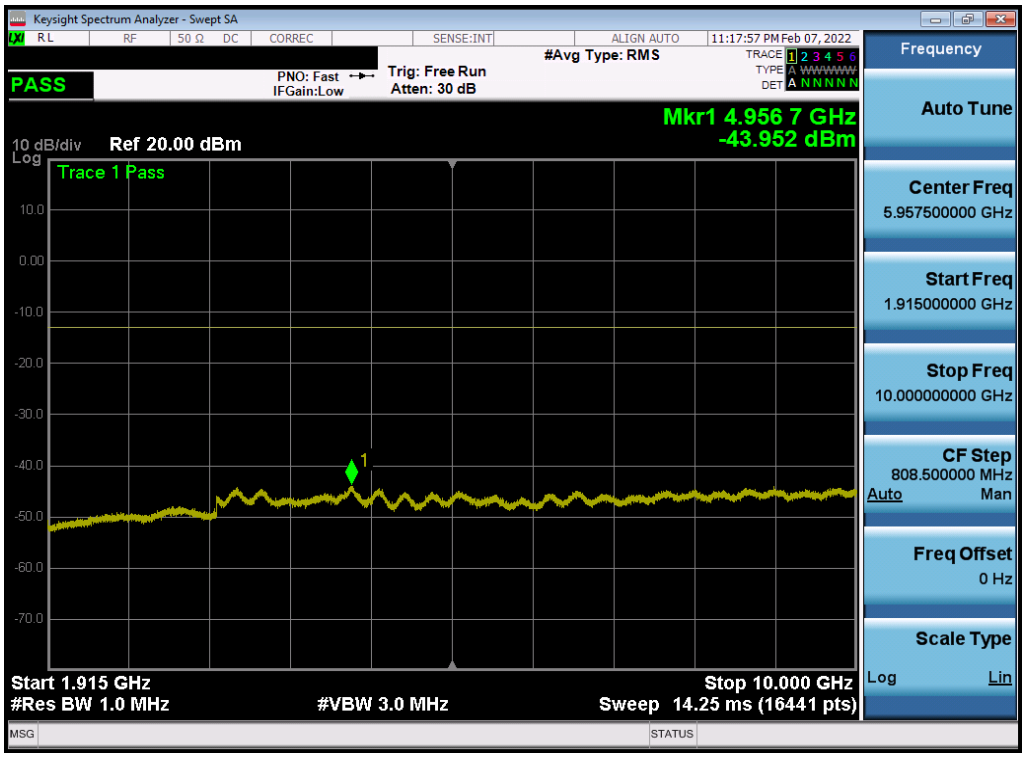
Plot 7-17. Conducted Spurious Plot (NR Band n25/2 - 20.0MHz - 1RB - Mid Channel)



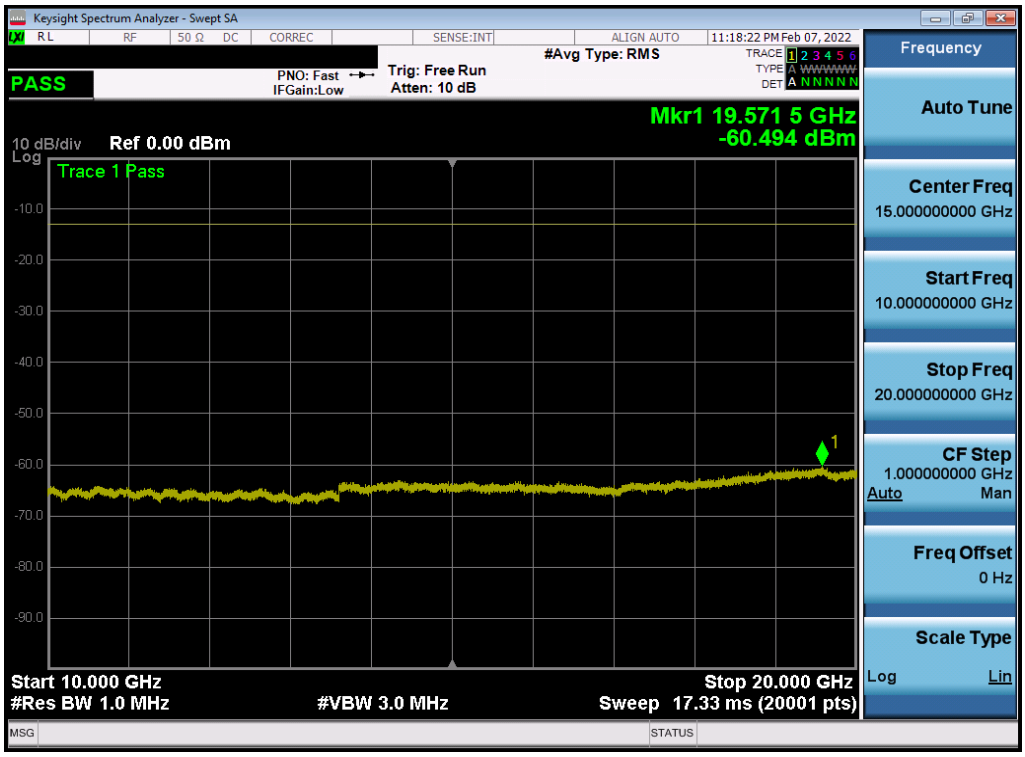
Plot 7-18. Conducted Spurious Plot (NR Band n25/2 - 20.0MHz - 1RB - Mid Channel)



Plot 7-19. Conducted Spurious Plot (NR Band n25/2 - 20.0MHz - 1RB - High Channel)



Plot 7-20. Conducted Spurious Plot (NR Band n25/2 - 20.0MHz - 1RB - High Channel)



Plot 7-21. Conducted Spurious Plot (NR Band n25/2 - 20.0MHz - 1RB - High Channel)

7.4 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.

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

Test Setup

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

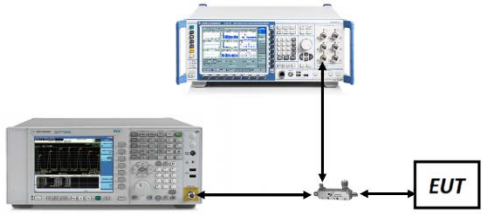


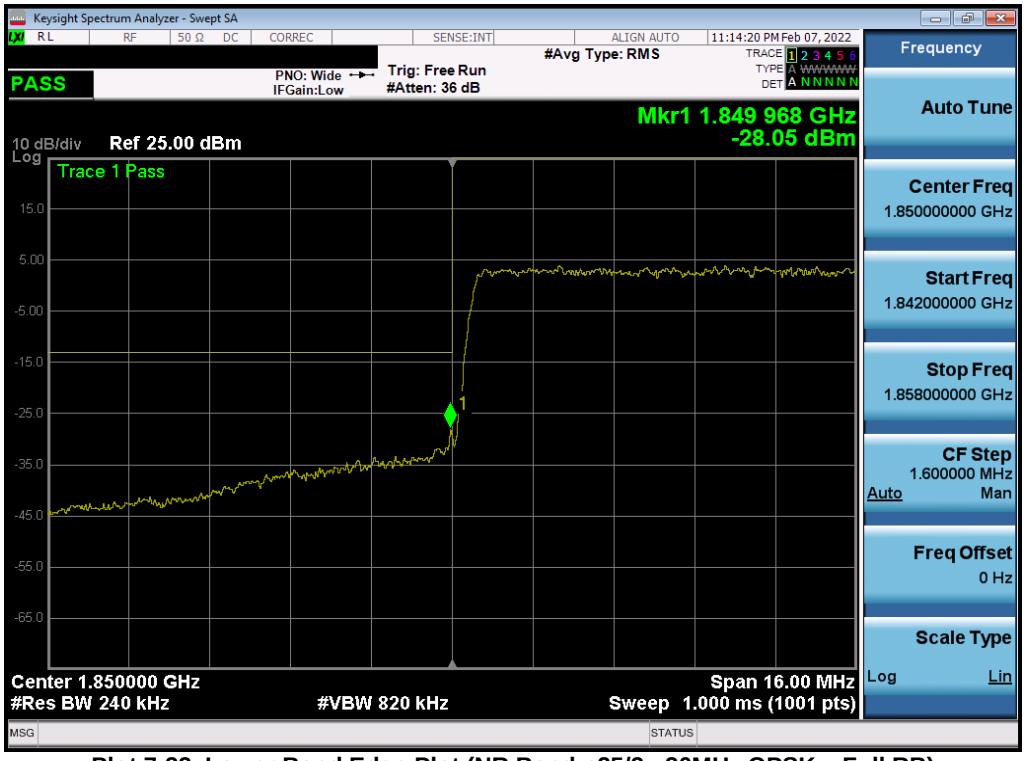
Figure 7-3. Test Instrument & Measurement Setup

Test Notes

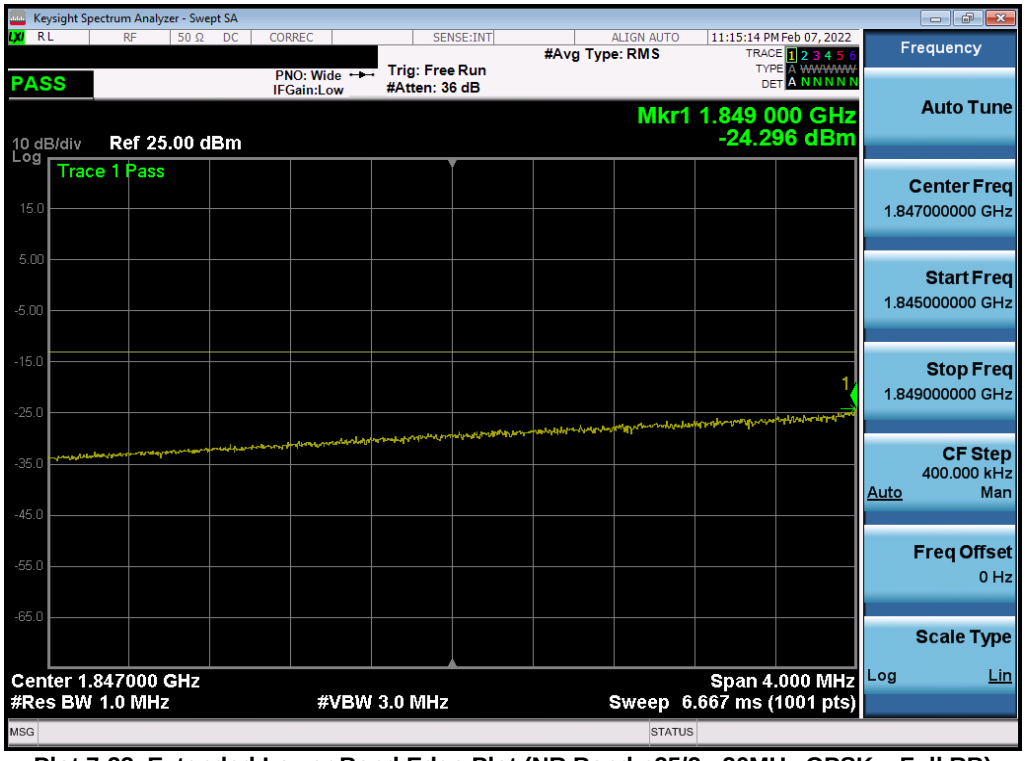
1. Per 24.238(b) and RSS-133(6.5), in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed to demonstrate compliance with the out-of-band emissions 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.

2. For NR operation, all subcarrier spacings (SCS) and transmission schemes (e.g. CP-OFDM and DFT-s-OFDM) 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.

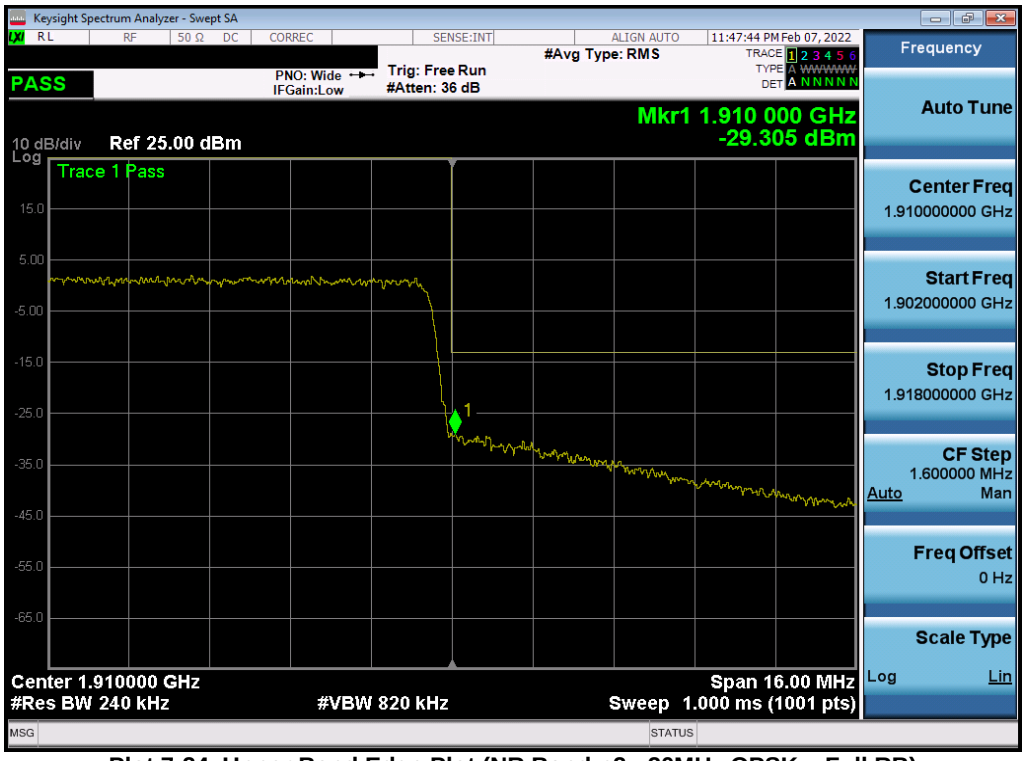
NR Band n25/2



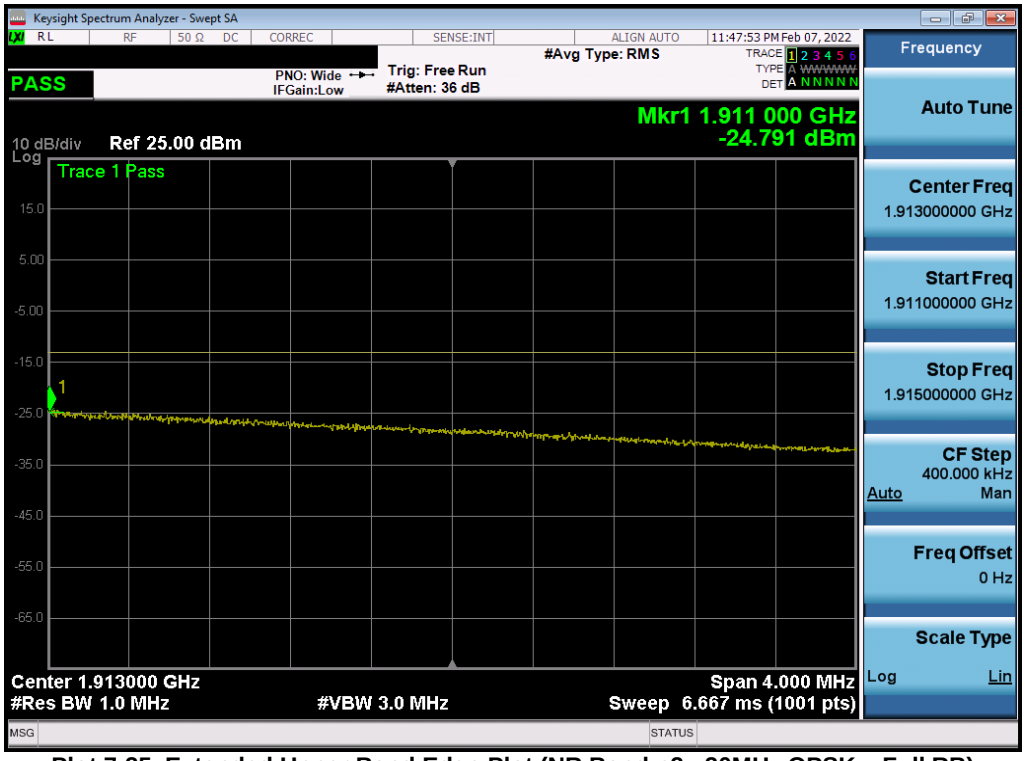
Plot 7-22. Lower Band Edge Plot (NR Band n25/2 - 20MHz QPSK – Full RB)



Plot 7-23. Extended Lower Band Edge Plot (NR Band n25/2 - 20MHz QPSK – Full RB)

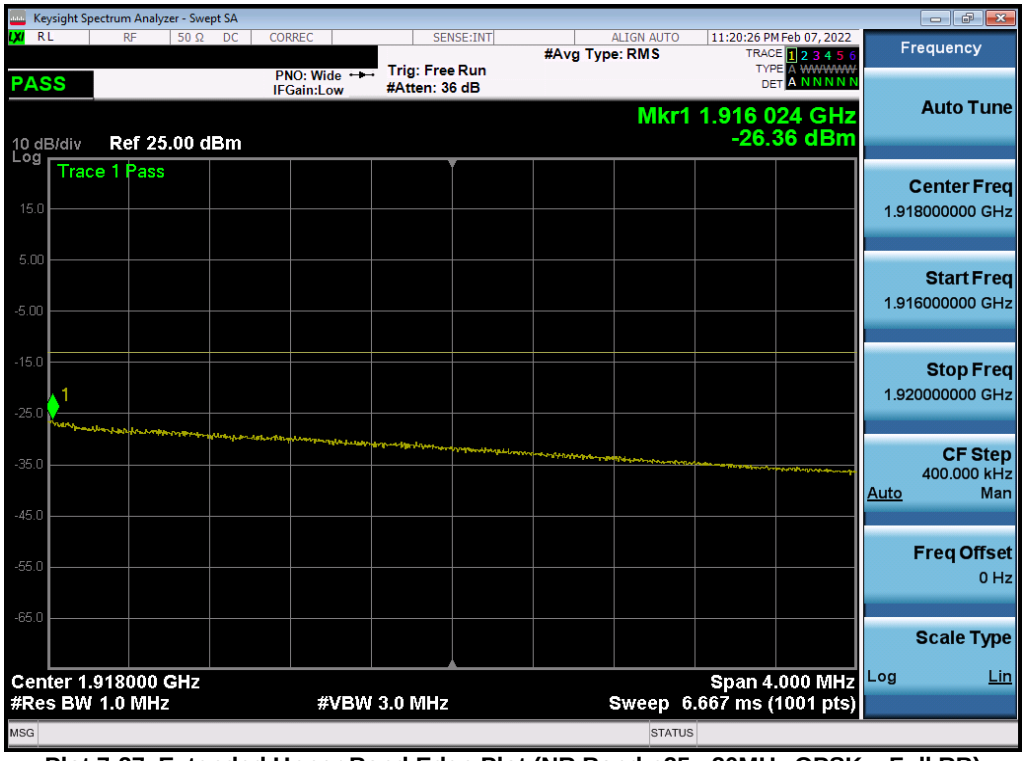


Plot 7-24. Upper Band Edge Plot (NR Band n2 - 20MHz QPSK – Full RB)

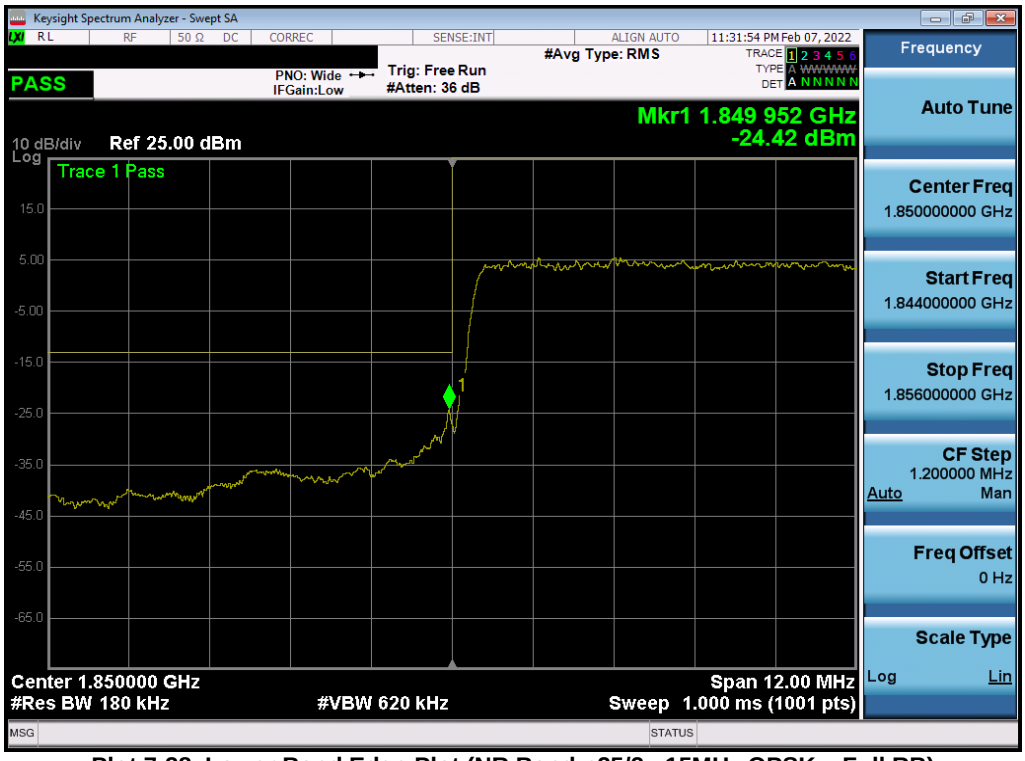


Plot 7-25. Extended Upper Band Edge Plot (NR Band n2 - 20MHz QPSK – Full RB)

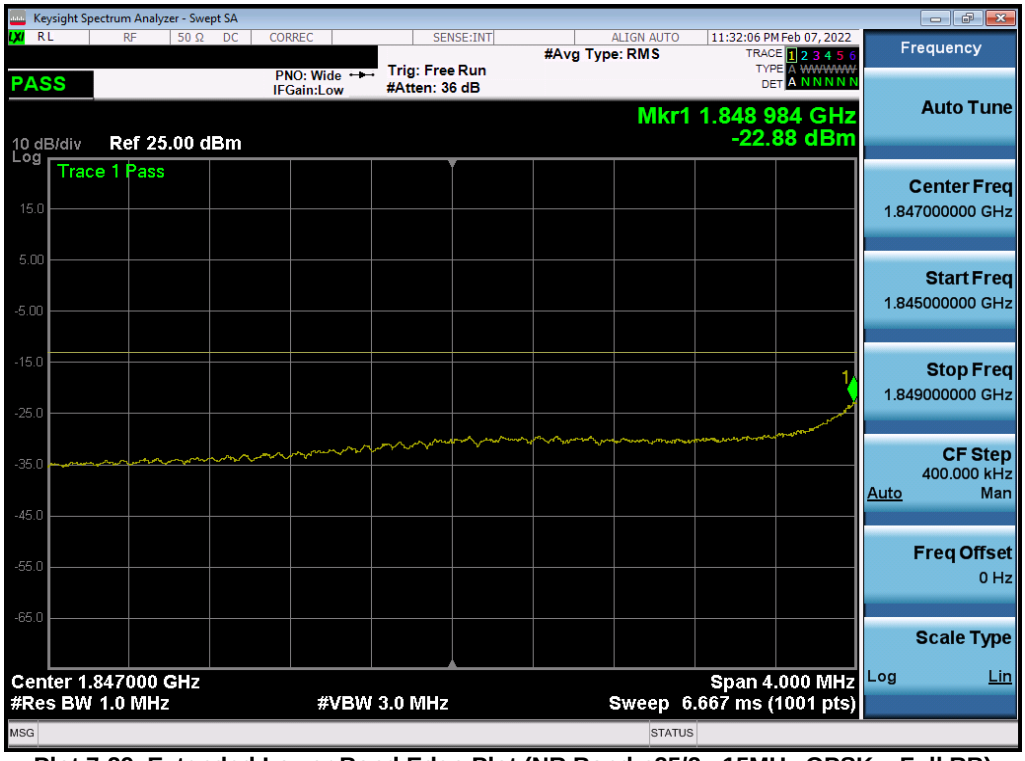
Plot 7-26. Upper Band Edge Plot (NR Band n25 - 20MHz QPSK – Full RB)



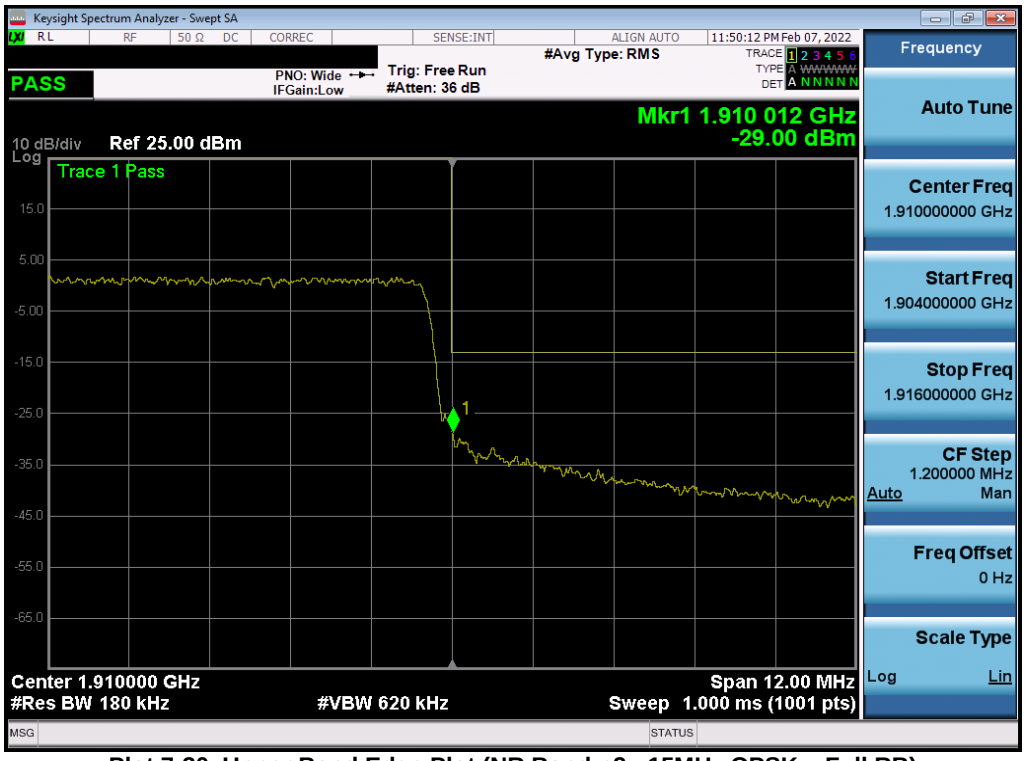
Plot 7-27. Extended Upper Band Edge Plot (NR Band n25 - 20MHz QPSK – Full RB)



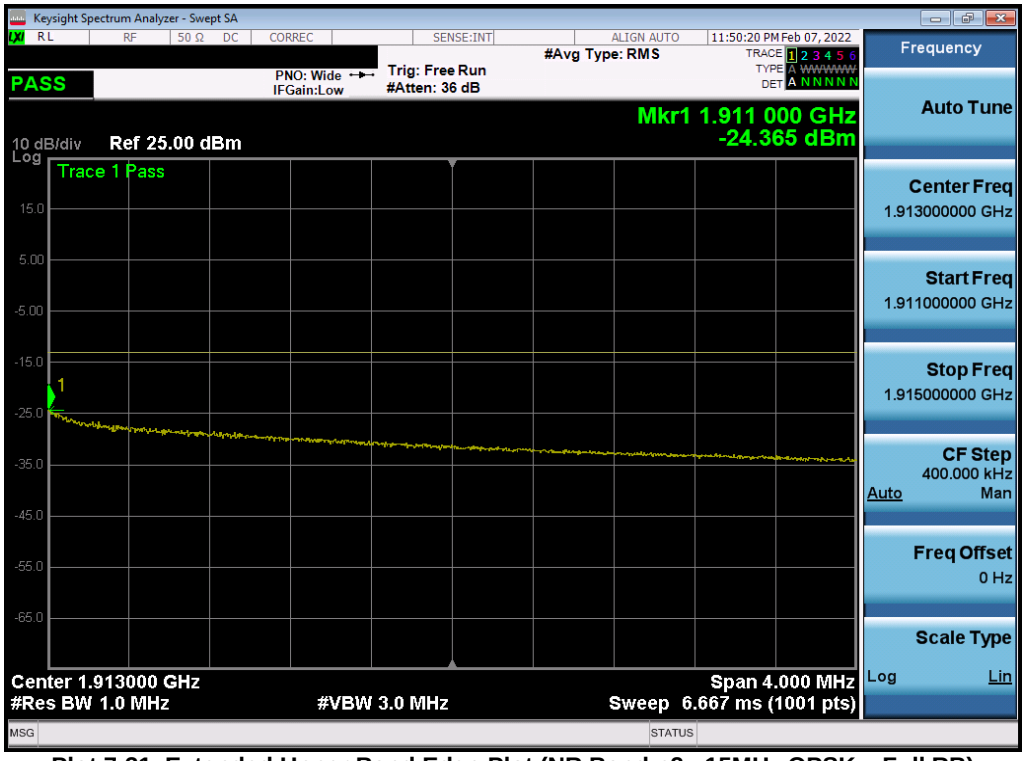
Plot 7-28. Lower Band Edge Plot (NR Band n25/2 - 15MHz QPSK – Full RB)



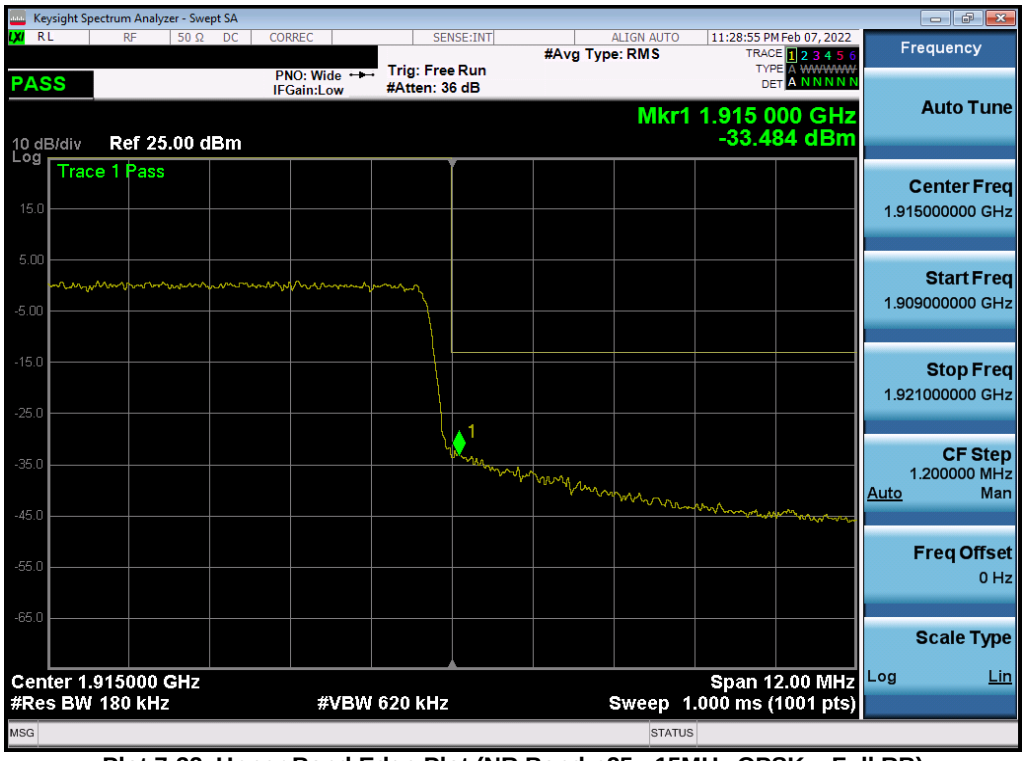
Plot 7-29. Extended Lower Band Edge Plot (NR Band n25/2 - 15MHz QPSK – Full RB)



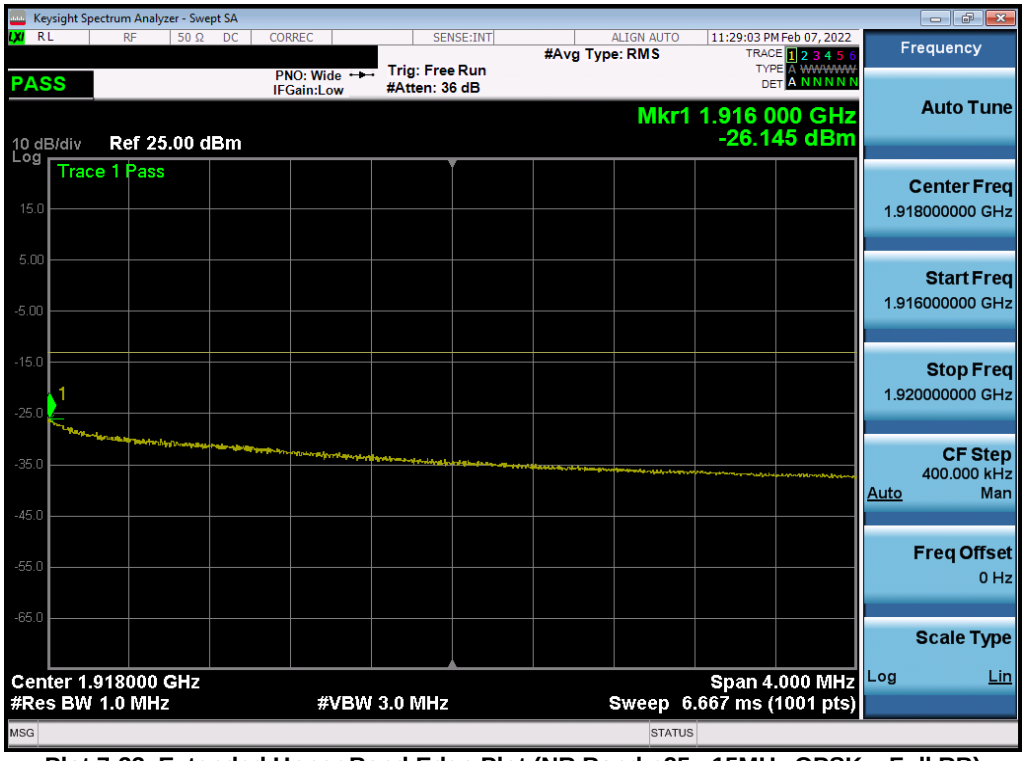
Plot 7-30. Upper Band Edge Plot (NR Band n2 - 15MHz QPSK – Full RB)



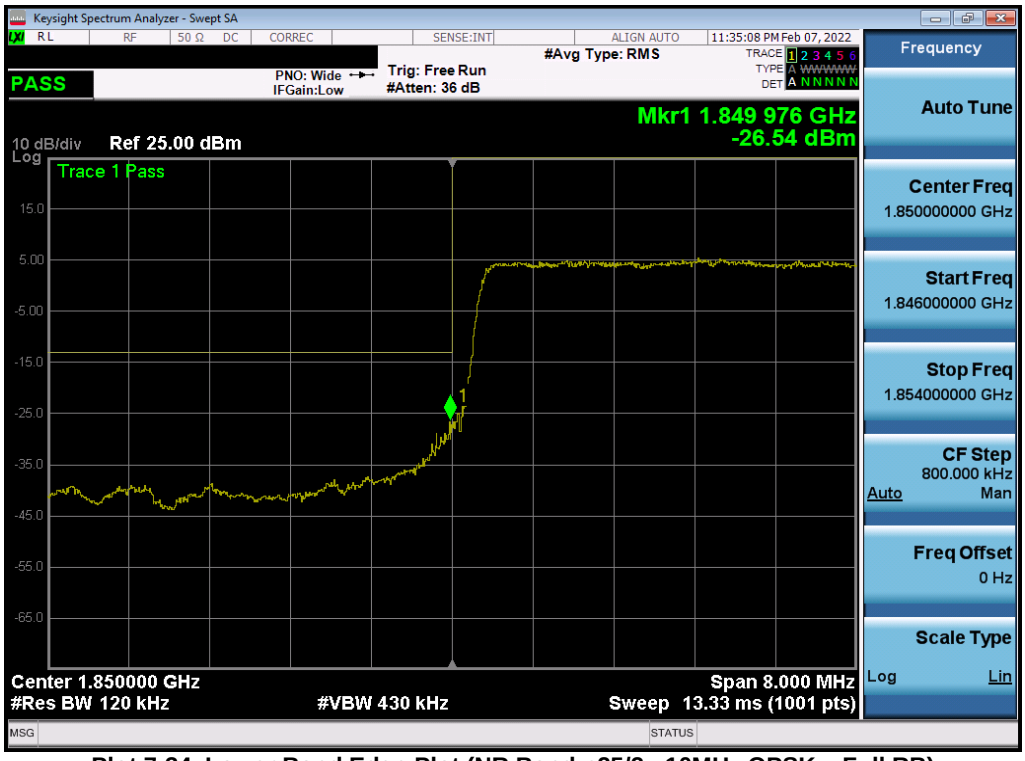
Plot 7-31. Extended Upper Band Edge Plot (NR Band n2 - 15MHz QPSK – Full RB)



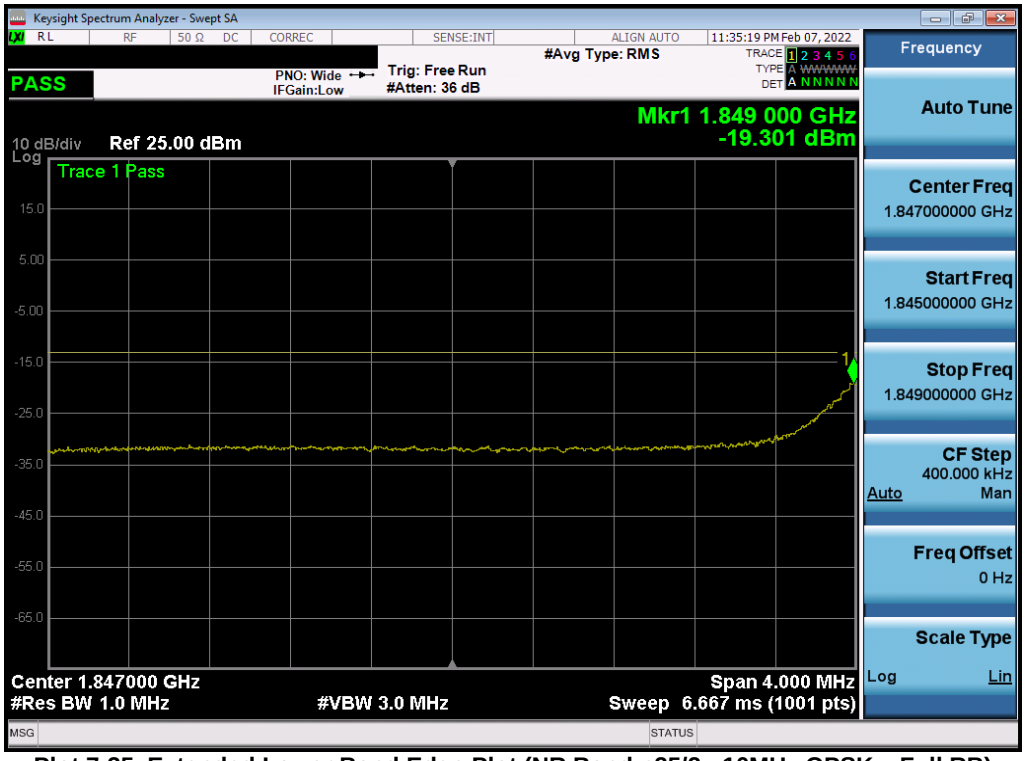
Plot 7-32. Upper Band Edge Plot (NR Band n25 - 15MHz QPSK – Full RB)



Plot 7-33. Extended Upper Band Edge Plot (NR Band n25 - 15MHz QPSK – Full RB)

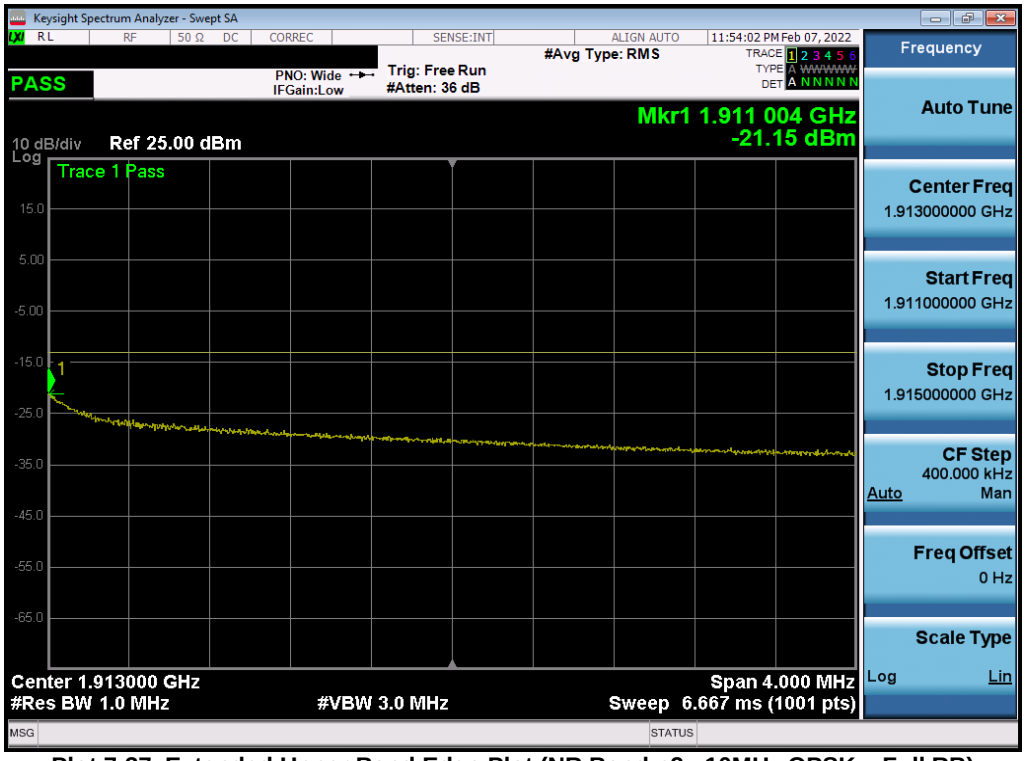


Plot 7-34. Lower Band Edge Plot (NR Band n25/2 - 10MHz QPSK – Full RB)



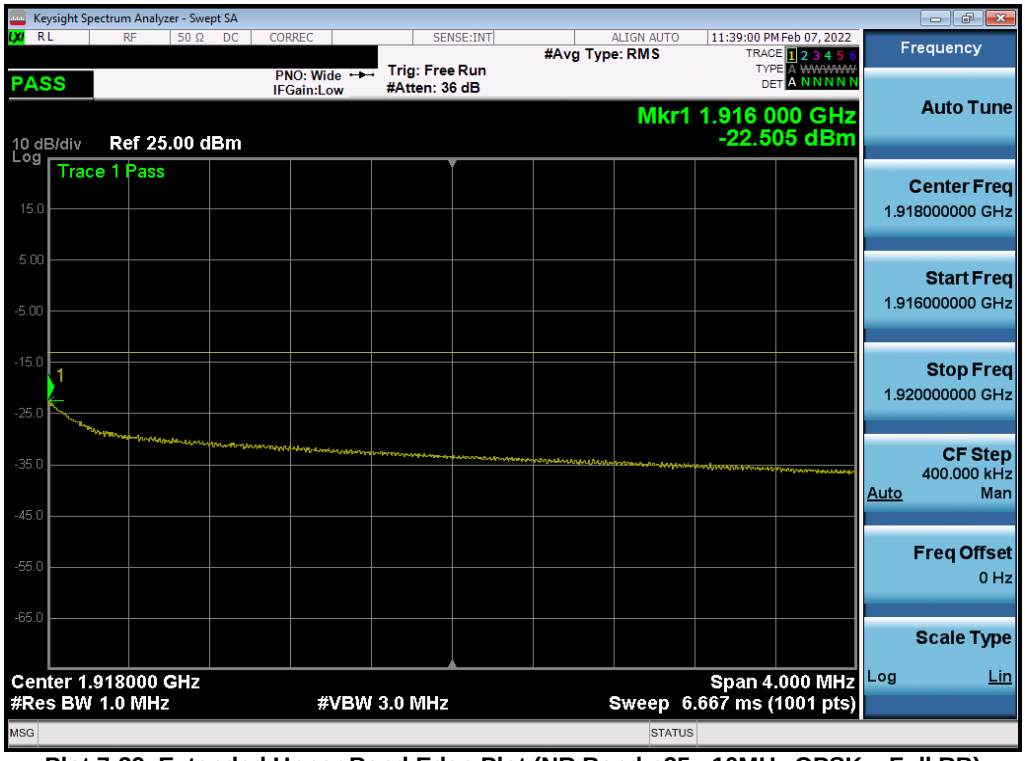
Plot 7-35. Extended Lower Band Edge Plot (NR Band n25/2 - 10MHz QPSK – Full RB)

Plot 7-36. Upper Band Edge Plot (NR Band n2 - 10MHz QPSK – Full RB)

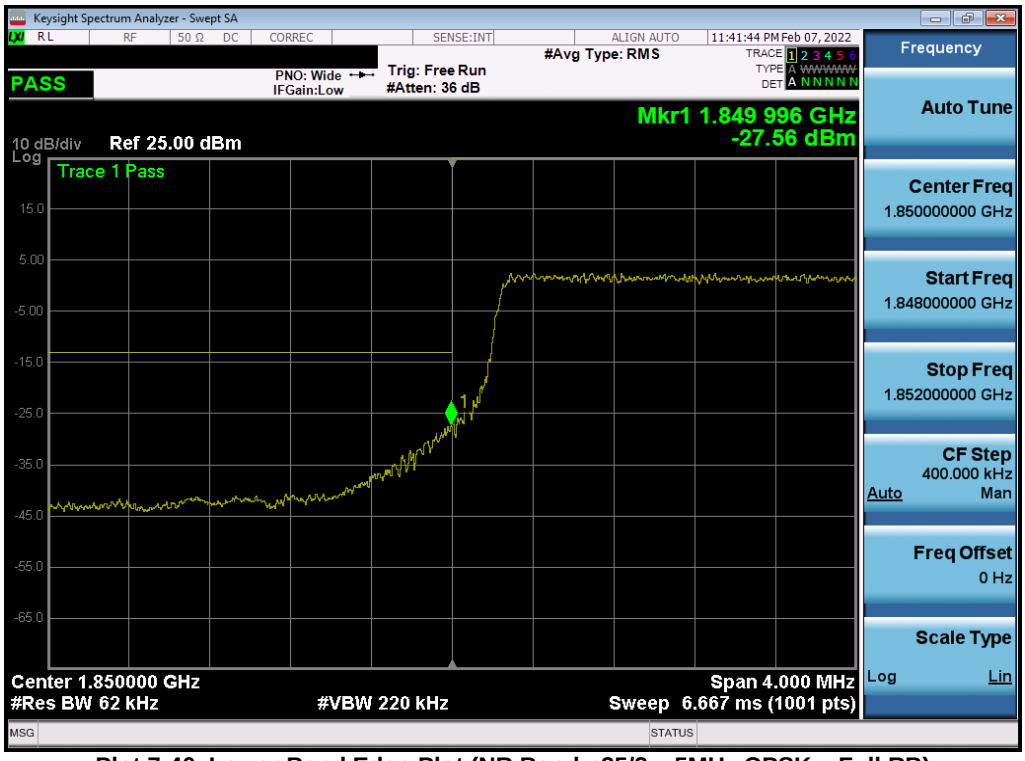


Plot 7-37. Extended Upper Band Edge Plot (NR Band n2 - 10MHz QPSK – Full RB)

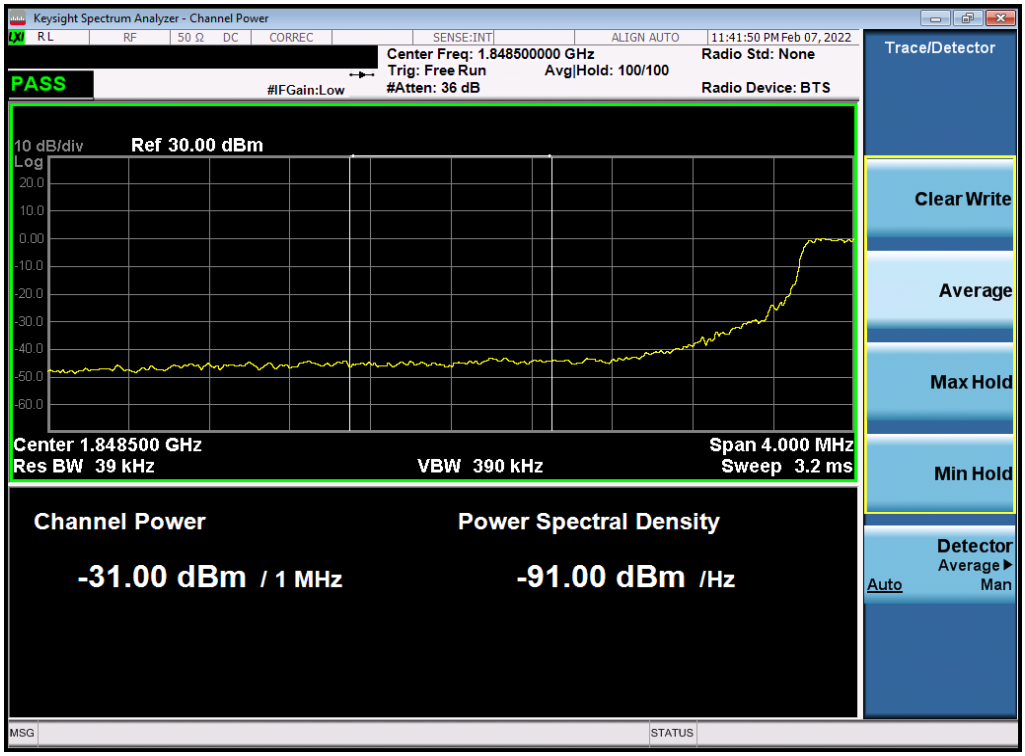
Plot 7-38. Upper Band Edge Plot (NR Band n25 - 10MHz QPSK – Full RB)



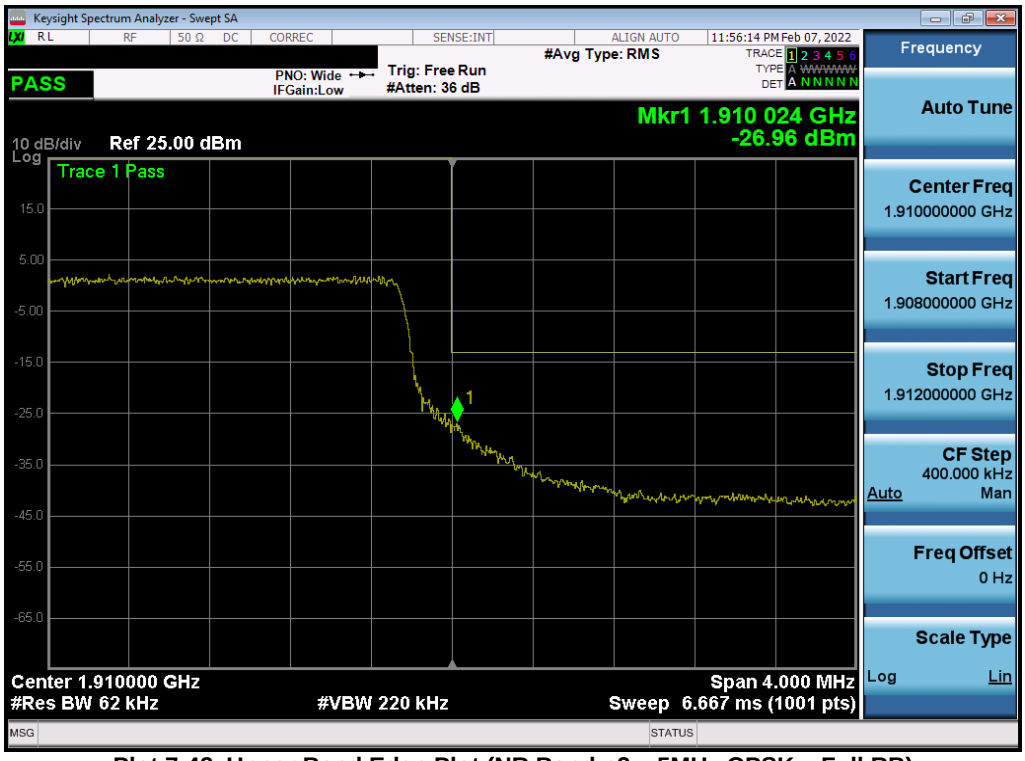
Plot 7-39. Extended Upper Band Edge Plot (NR Band n25 - 10MHz QPSK – Full RB)



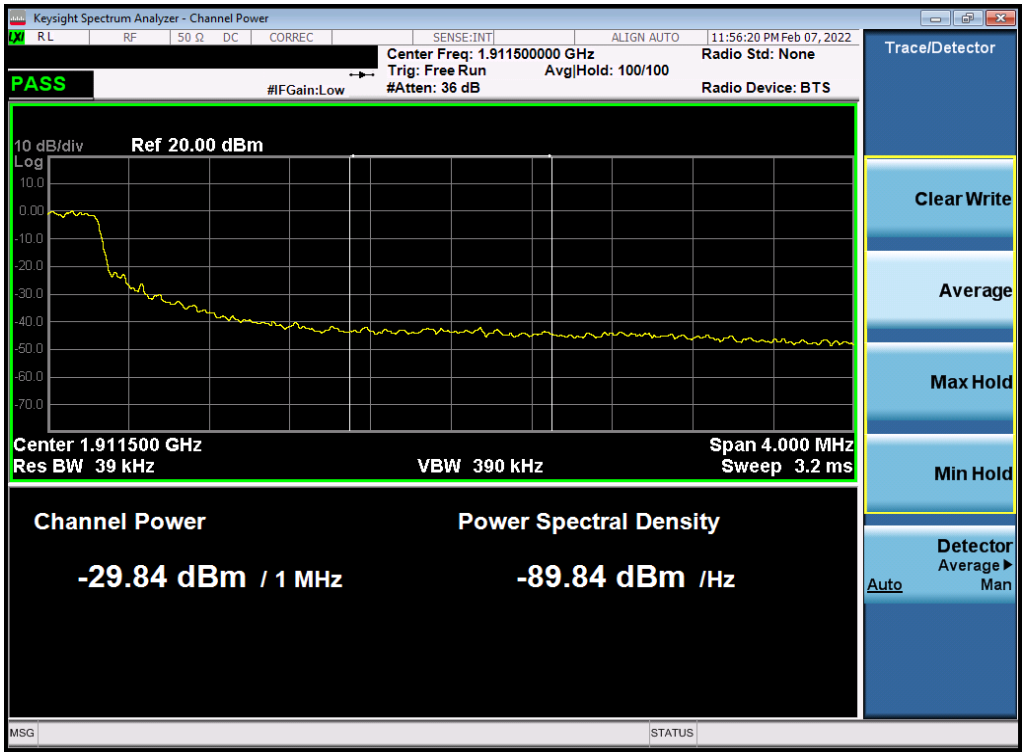
Plot 7-40. Lower Band Edge Plot (NR Band n25/2 – 5MHz QPSK – Full RB)



Plot 7-41. Extended Lower Band Edge Plot (NR Band n25/2 – 5MHz QPSK – Full RB)

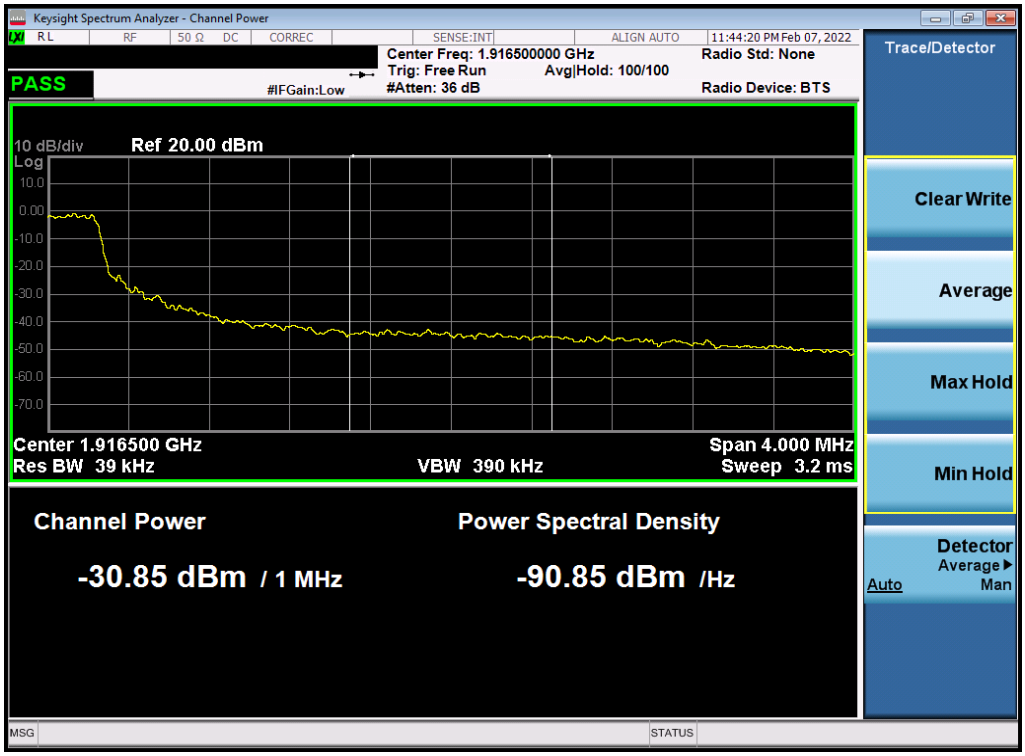


Plot 7-42. Upper Band Edge Plot (NR Band n2 – 5MHz QPSK – Full RB)



Plot 7-43. Extended Upper Band Edge Plot (NR Band n2 – 5MHz QPSK – Full RB)

Plot 7-44. Upper Band Edge Plot (NR Band n25 – 5MHz QPSK – Full RB)



Plot 7-45. Extended Upper Band Edge Plot (NR Band n25 – 5MHz QPSK – Full RB)

7.5 Peak-Average Ratio

Test Overview

A peak to average ratio measurement is performed at the conducted port of the EUT. The spectrum analyzers Complementary Cumulative Distribution Function (CCDF) measurement profile is used to determine the largest deviation between the average and the peak power of the EUT in a given bandwidth. The CCDF curve shows how much time the peak waveform spends at or above a given average power level. The percent of time the signal spends at or above the level defines the probability for that particular power level.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 5.7.1

Test Settings

1. The signal analyzer's CCDF measurement profile is enabled
2. Frequency = carrier center frequency
3. Measurement BW ≥ OBW or specified reference bandwidth
4. The signal analyzer was set to collect one million samples to generate the CCDF curve
5. The measurement interval was set depending on the type of signal analyzed. For continuous signals (>98% duty cycle), the measurement interval was set to 1ms. For burst transmissions, the spectrum analyzer is set to use an internal "RF Burst" trigger that is synced with an incoming pulse and the measurement interval is set to less than the duration of the "on time" of one burst to ensure that energy is only captured during a time in which the transmitter is operating at maximum power

Test Setup

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

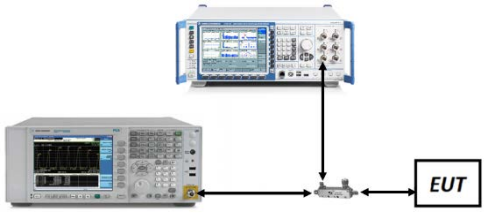
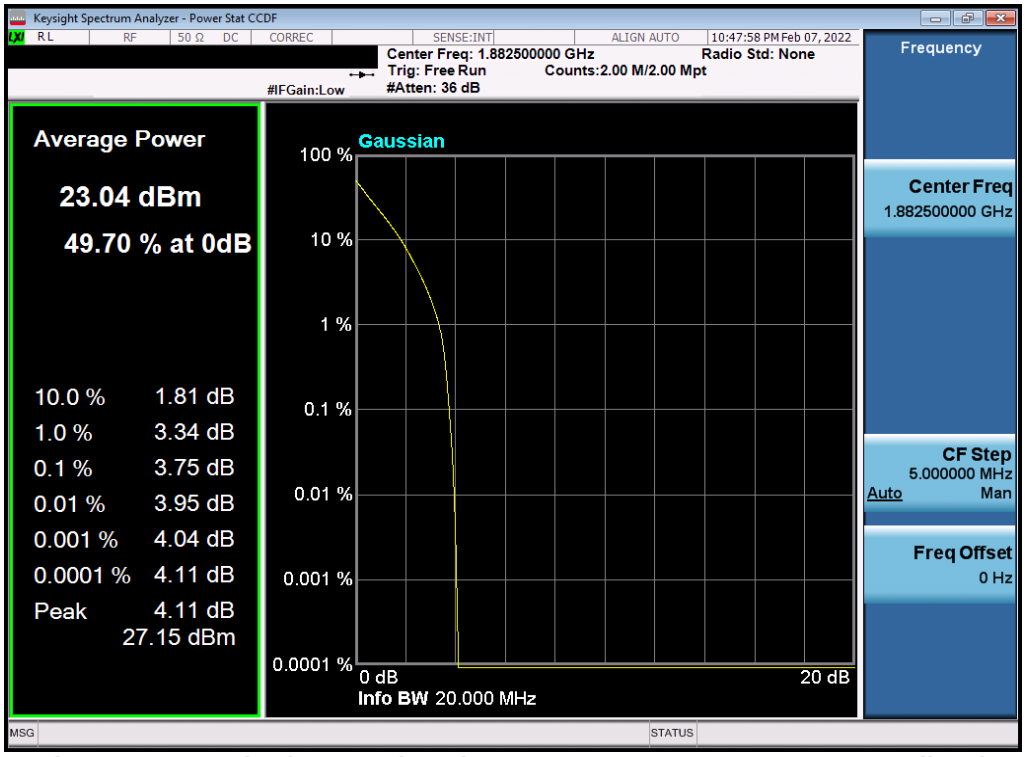


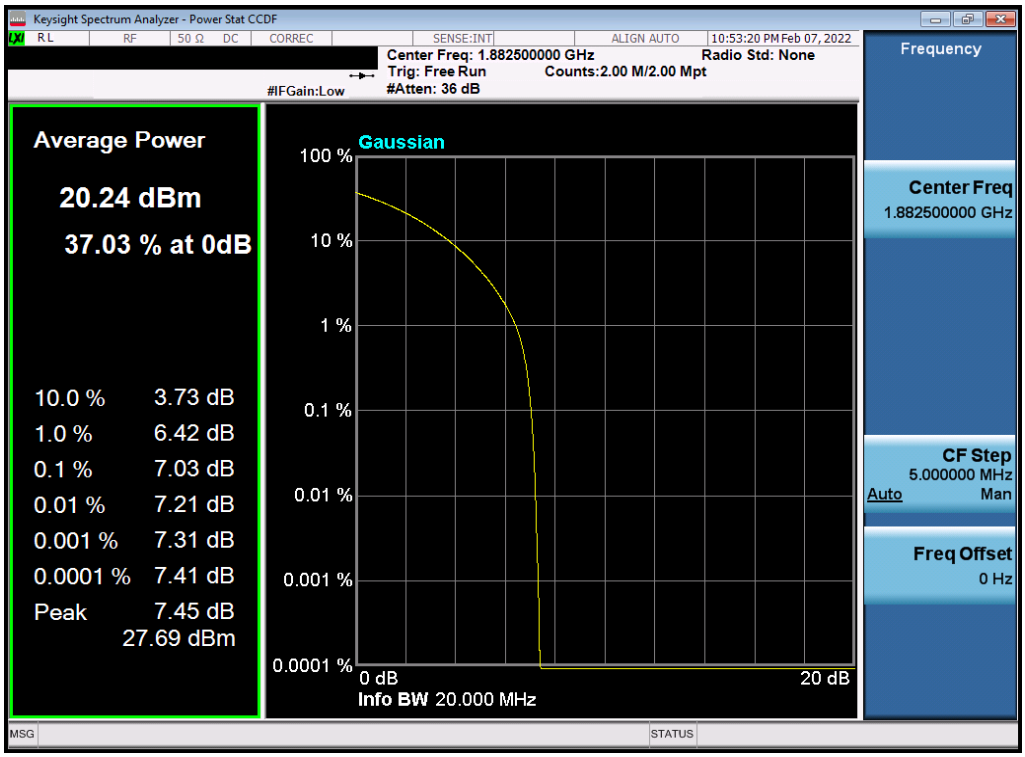
Figure 7-4. Test Instrument & Measurement Setup

Test Notes

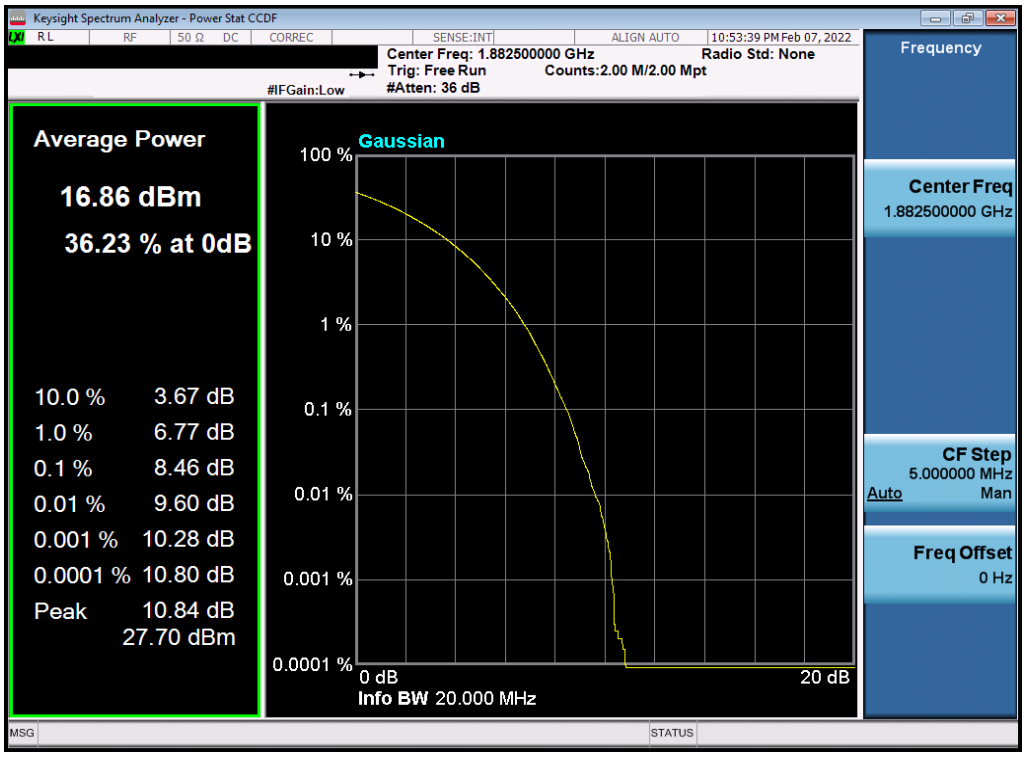
None.



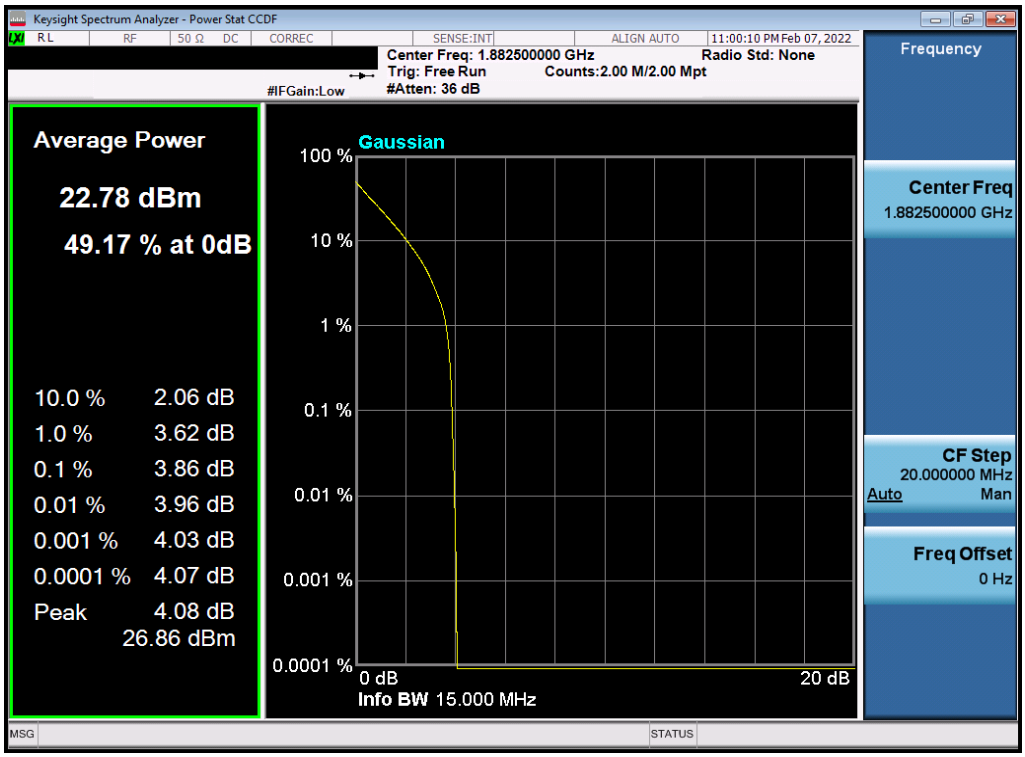
Plot 7-46. PAR Plot (NR Band n25/2 - 20.0MHz DFT-s-OFDM BPSK - Full RB)



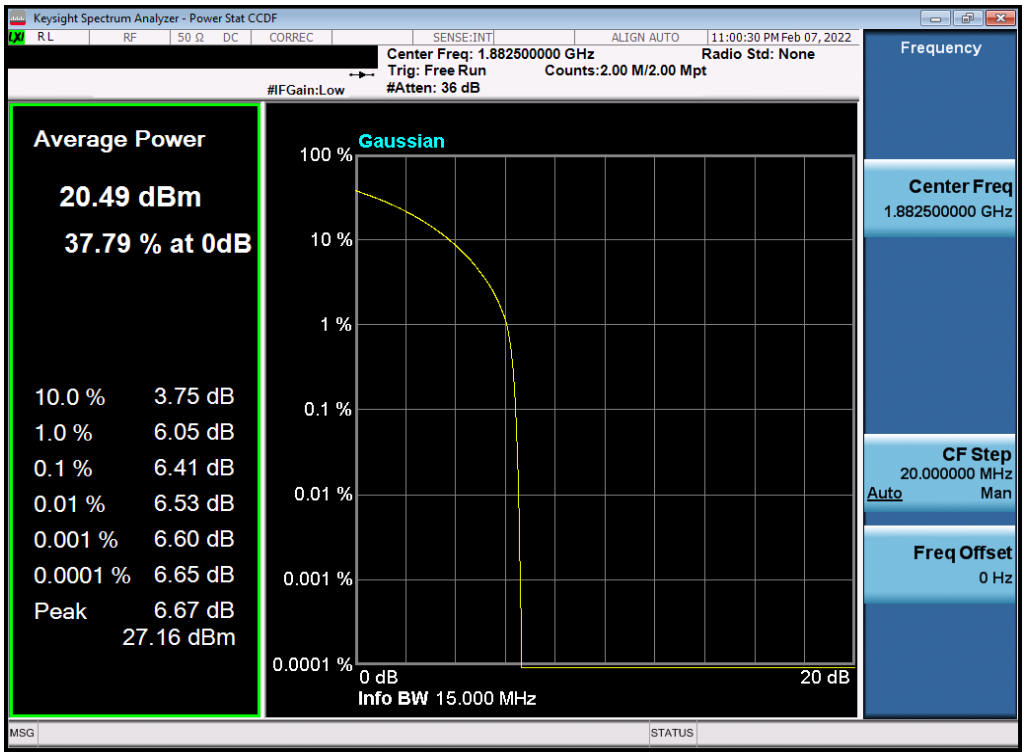
Plot 7-47. PAR Plot (NR Band n25/2 - 20.0MHz CP-OFDM QPSK - Full RB)



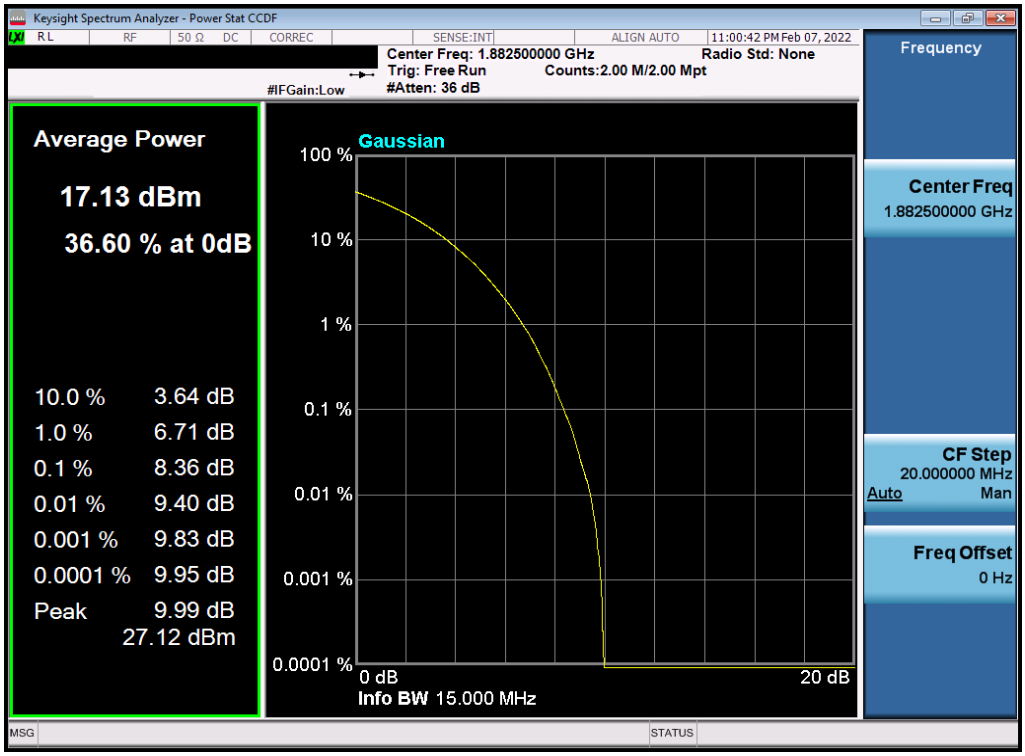
Plot 7-48. PAR Plot (NR Band n25/2 - 20.0MHz CP-OFDM 256-QAM - Full RB)



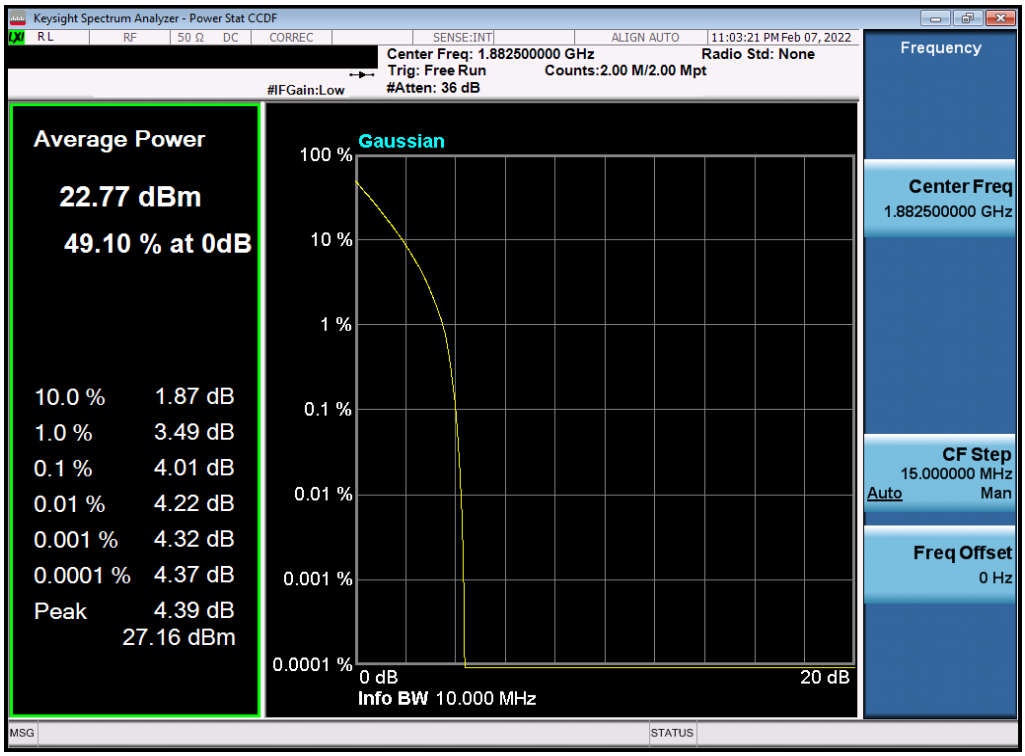
Plot 7-49. PAR Plot (NR Band n25/2 - 15.0MHz DFT-s-OFDM BPSK - Full RB)



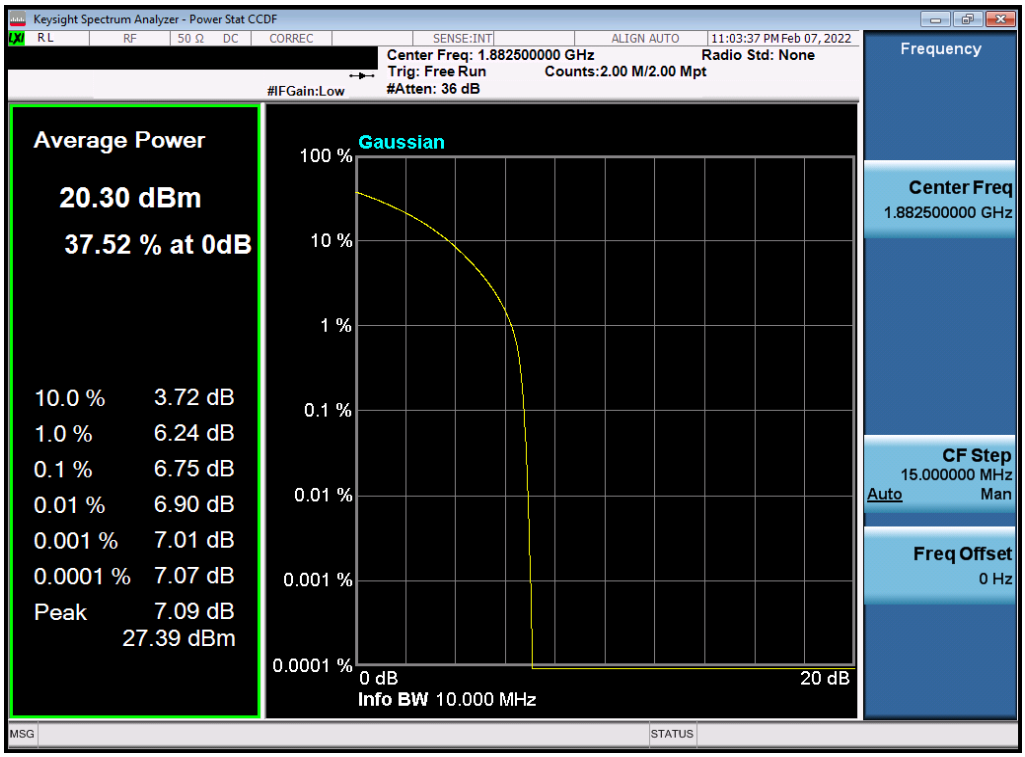
Plot 7-50. PAR Plot (NR Band n25/2 - 15.0MHz CP-OFDM QPSK - Full RB)



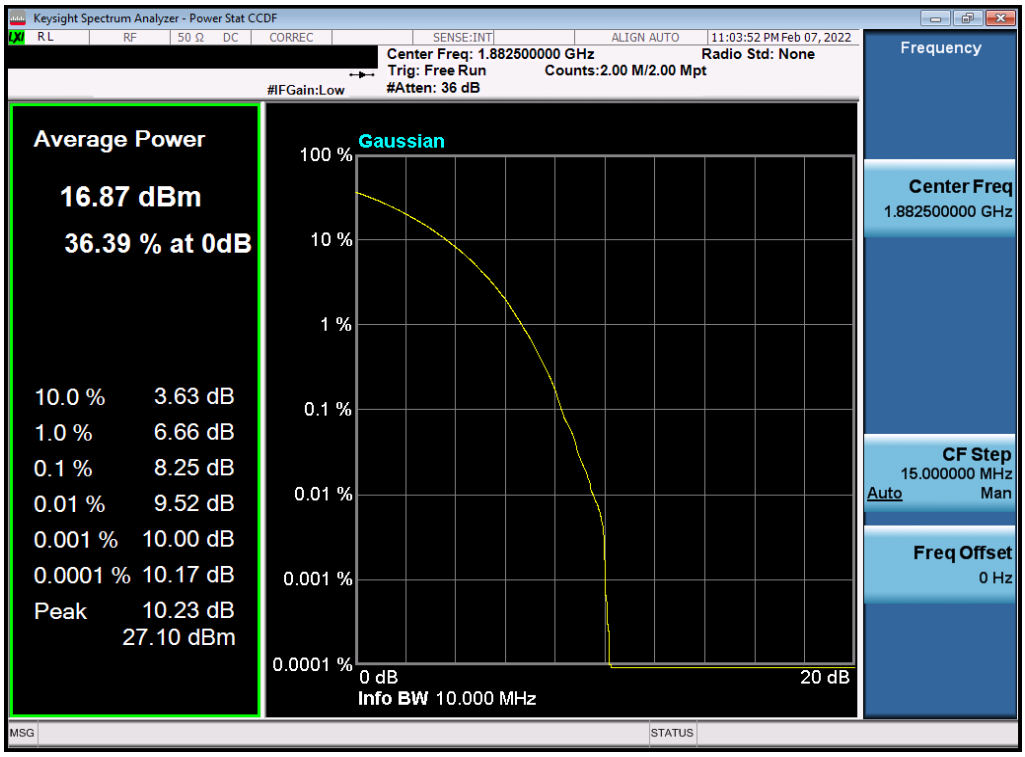
Plot 7-51. PAR Plot (NR Band n25/2 - 15.0MHz CP-OFDM 256-QAM - Full RB)



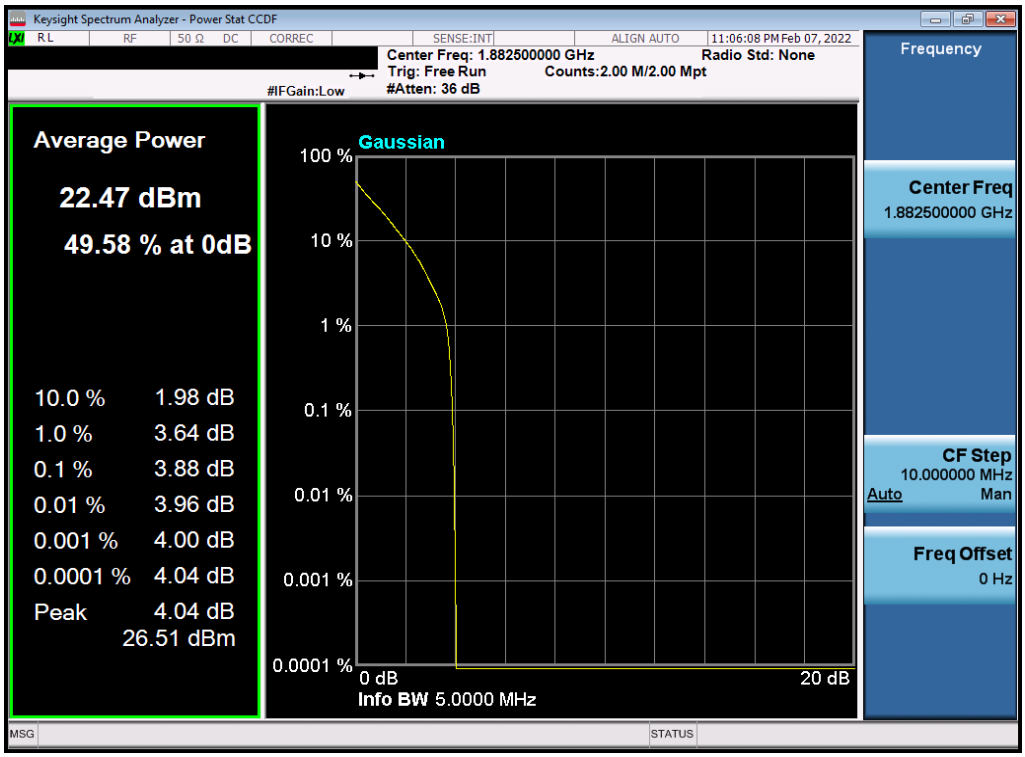
Plot 7-52. PAR Plot (NR Band n25/2 - 10.0MHz DFT-s-OFDM BPSK - Full RB)



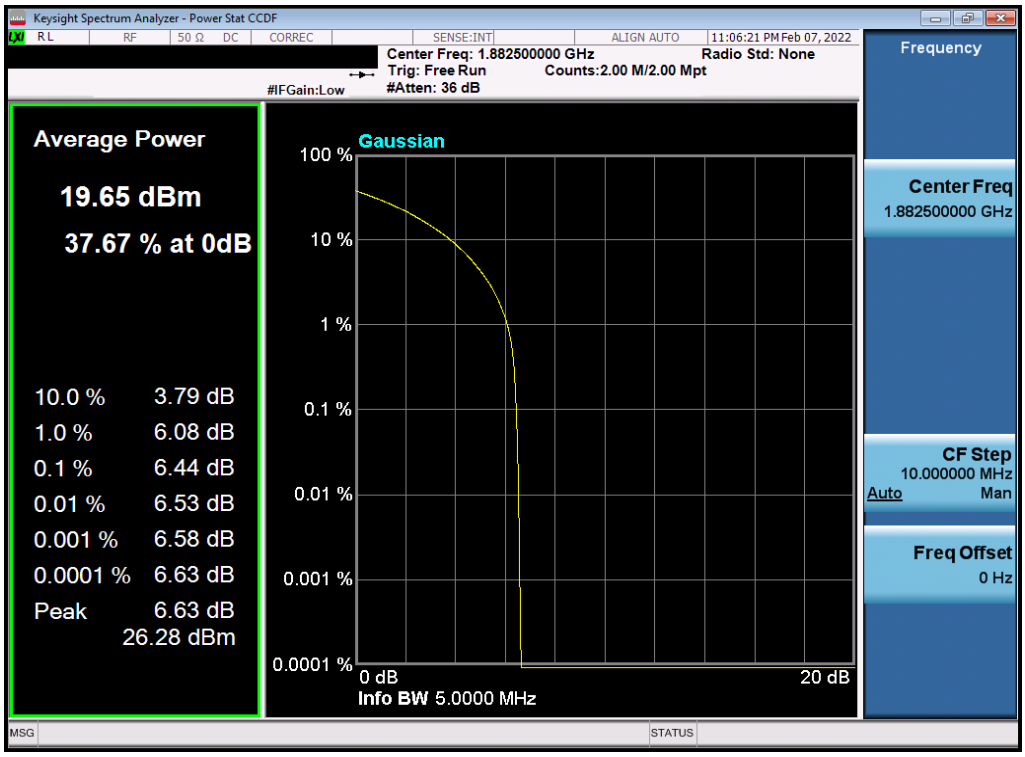
Plot 7-53. PAR Plot (NR Band n25/2 - 10.0MHz CP-OFDM QPSK - Full RB)



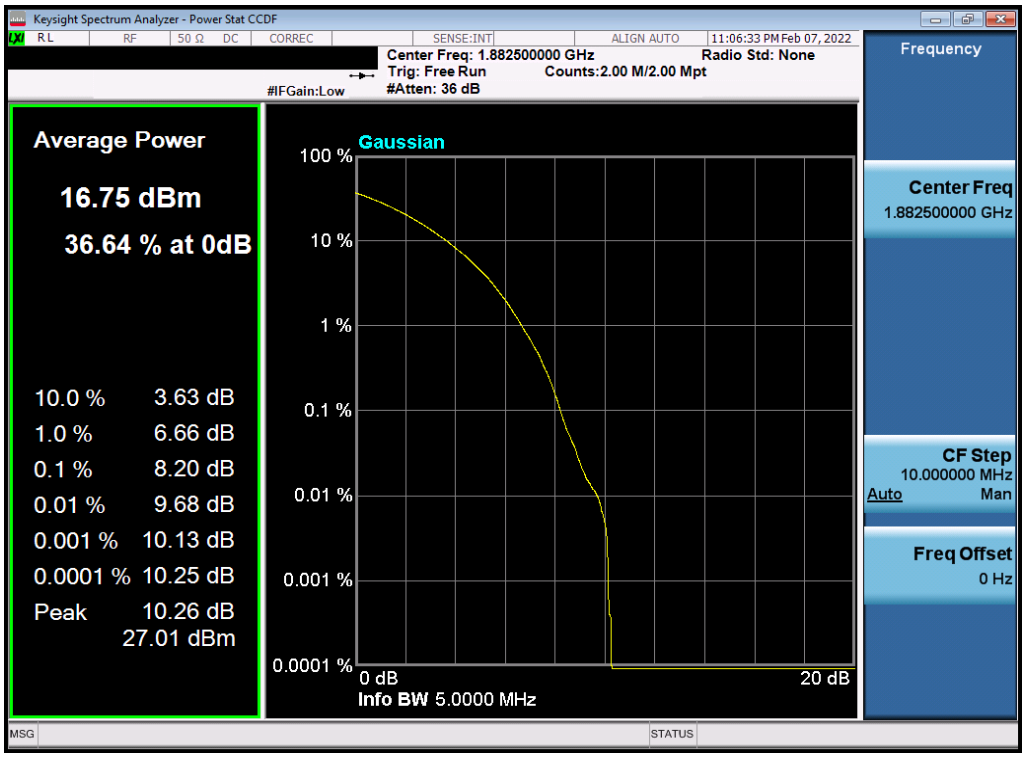
Plot 7-54. PAR Plot (NR Band n25/2 - 10.0MHz CP-OFDM 256-QAM - Full RB)



Plot 7-55. PAR Plot (NR Band n25/2 - 5.0MHz DFT-s-OFDM BPSK - Full RB)



Plot 7-56. PAR Plot (NR Band n25/2 - 5.0MHz CP-OFDM QPSK - Full RB)



Plot 7-57. PAR Plot (NR Band n25/2 - 5.0MHz CP-OFDM 256-QAM - Full RB)

7.6 Radiated Power (ERP/EIRP)

Test Overview

Effective Radiated Power (ERP) and Equivalent Isotropic Radiated Power (EIRP) measurements are performed using the substitution method described in ANSI/TIA-603-E-2016 with the EUT transmitting into an integral antenna. Measurements on signals operating below 1GHz are performed using vertically and horizontally polarized tuned dipole antennas. Measurements on signals operating above 1GHz 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

KDB 971168 D01 v03r01 – Section 5.2.1

ANSI/TIA-603-E-2016 – Section 2.2.17

Test Settings

1. Radiated power measurements are performed using the signal analyzer's "channel power" measurement capability for signals with continuous operation. For signals with burst transmission, the signal analyzer's "time domain power" measurement capability is used
2. RBW = 1 – 5% of the expected OBW, not to exceed 1MHz
3. VBW ≥ 3 x RBW
4. Span = 1.5 times the OBW
5. No. of sweep points ≥ 2 x span / RBW
6. Detector = RMS
7. Trigger is set to "free run" for signals with continuous operation with the sweep times set to "auto". Trigger is set to enable triggering only on full power bursts with the sweep time set less than or equal to the transmission burst duration
8. The integration bandwidth was roughly set equal to the measured OBW of the signal for signals with continuous operation. For signals with burst transmission, the "gating" function was enabled to ensure that measurements are performed during times in which the transmitter is operating at its maximum power
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.

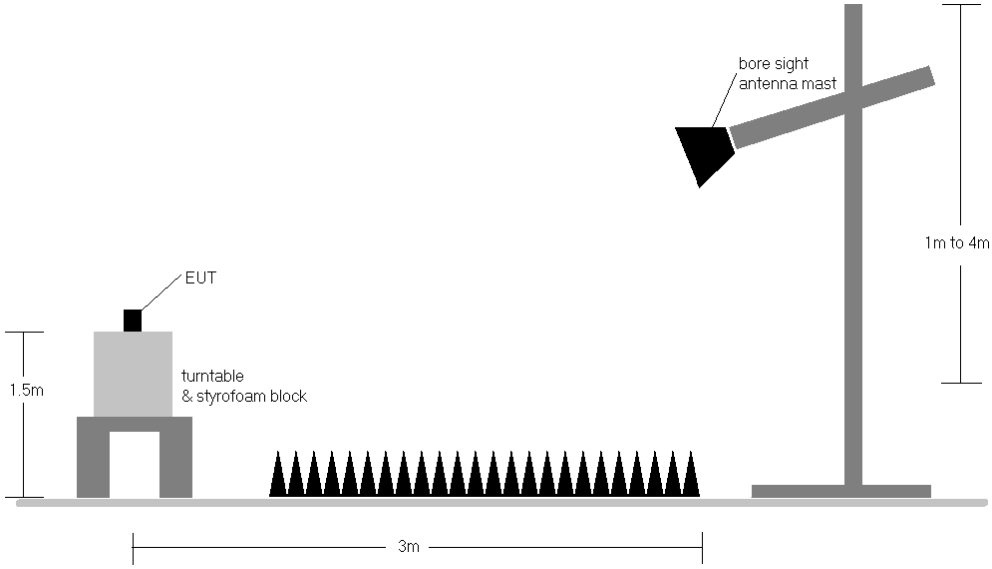


Figure 7-5. Radiated Test Setup >1GHz

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.

3) For NR operation, all subcarrier spacings (SCS) and transmission schemes (e.g. CP-OFDM and DFT-s-OFDM) 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.

Bandwidth	Mod.	Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Ant. Gain [dBi]	RB Size/Offset	Substitute Level [dBm]	EIRP [dBm]	EIRP [Watts]	EIRP Limit [dBm]	Margin [dB]
20 MHz	π/2 BPSK	1860.0	H	100	199	9.55	1 / 79	13.72	23.27	0.212	33.01	-9.74
	π/2 BPSK	1882.5	H	100	199	9.83	1 / 26	13.78	23.61	0.230	33.01	-9.40
	π/2 BPSK	1905.0	H	143	203	10.16	1 / 26	13.84	**24.00**	0.251	33.01	-9.01
	QPSK	1860.0	H	100	199	9.55	1 / 79	13.66	23.21	0.209	33.01	-9.80
	QPSK	1882.5	H	100	199	9.83	1 / 26	13.48	23.31	0.214	33.01	-9.70
	QPSK	1905.0	H	143	203	10.16	1 / 53	13.13	23.29	0.213	33.01	-9.72
	16-QAM	1882.5	H	100	199	9.83	1 / 26	13.07	22.90	0.195	33.01	-10.11
15 MHz	π/2 BPSK	1857.5	H	100	199	9.51	1 / 20	13.89	23.40	0.219	33.01	-9.61
	π/2 BPSK	1882.5	H	100	199	9.83	1 / 58	13.88	23.71	0.235	33.01	-9.30
	π/2 BPSK	1907.5	H	143	203	10.21	1 / 39	14.02	**24.22**	0.264	33.01	-8.79
	QPSK	1857.5	H	100	199	9.51	1 / 20	14.48	24.00	0.251	33.01	-9.01
	QPSK	1882.5	H	100	199	9.83	1 / 58	13.42	23.26	0.212	33.01	-9.75
	QPSK	1907.5	H	143	203	10.21	1 / 20	12.96	23.17	0.207	33.01	-9.84
	16-QAM	1882.5	H	100	199	9.83	1 / 58	13.35	23.18	0.208	33.01	-9.83
10 MHz	π/2 BPSK	1855.0	H	100	199	9.48	1 / 13	14.31	23.78	0.239	33.01	-9.23
	π/2 BPSK	1882.5	H	100	199	9.83	1 / 13	13.79	23.63	0.230	33.01	-9.38
	π/2 BPSK	1910.0	H	143	203	10.25	1 / 38	13.87	**24.12**	0.258	33.01	-8.89
	QPSK	1855.0	H	100	199	9.48	1 / 38	14.41	23.88	0.245	33.01	-9.13
	QPSK	1882.5	H	100	199	9.83	1 / 13	13.16	22.99	0.199	33.01	-10.02
	QPSK	1910.0	H	143	203	10.25	1 / 26	12.85	23.10	0.204	33.01	-9.91
	16-QAM	1882.5	H	100	199	9.83	1 / 13	13.41	23.25	0.211	33.01	-9.76
5 MHz	π/2 BPSK	1852.5	H	100	199	9.44	1 / 6	14.45	23.89	0.245	33.01	-9.12
	π/2 BPSK	1882.5	H	100	199	9.83	1 / 18	13.82	23.65	0.232	33.01	-9.36
	π/2 BPSK	1912.5	H	143	203	10.28	1 / 12	13.83	**24.10**	0.257	33.01	-8.91
	QPSK	1852.5	H	100	199	9.44	1 / 6	14.53	23.97	0.249	33.01	-9.04
	QPSK	1882.5	H	100	199	9.83	1 / 12	13.16	22.99	0.199	33.01	-10.02
	QPSK	1912.5	H	143	203	10.28	1 / 18	12.76	23.03	0.201	33.01	-9.98
	16-QAM	1882.5	H	100	199	9.83	1 / 6	13.13	22.96	0.198	33.01	-10.05
20 MHz	QPSK (CP-OFDM)	1905.0	H	145	226	9.83	1 / 26	12.09	21.92	0.156	33.01	-11.09
	QPSK (Opposite Pol.)	1905.0	V	114	225	10.18	1 / 26	12.25	22.43	0.175	33.01	-10.58
	QPSK (WCP)	1905.0	H	140	218	9.83	1 / 26	13.38	23.21	0.210	33.01	-9.80

Table 7-2. EIRP Data (NR Band n25/2)

7.7 Radiated Spurious Emissions Measurements

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 tuned dipole 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

KDB 971168 D01 v03r01 – Section 5.8

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.

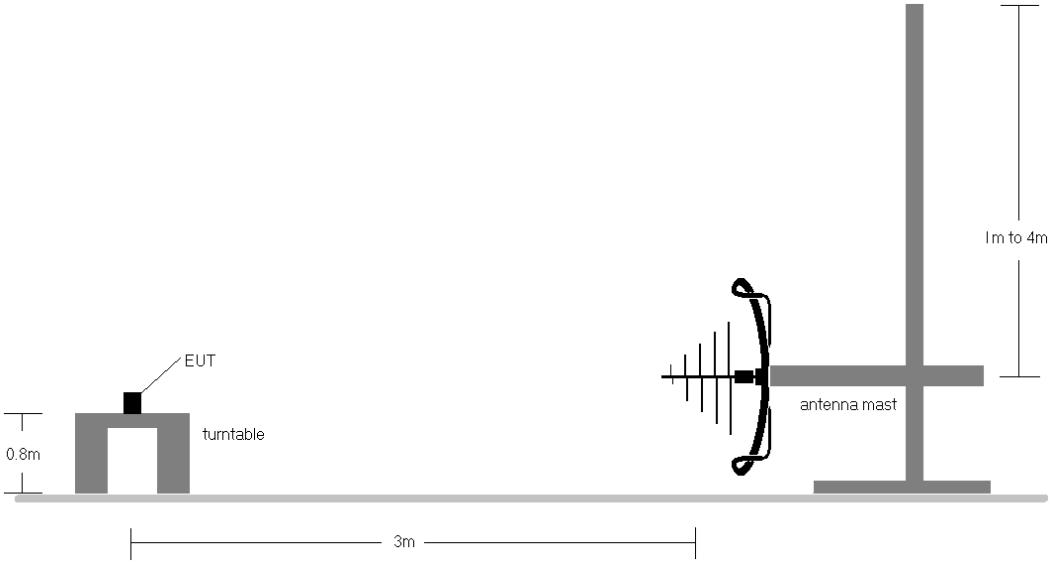


Figure 7-6. Test Instrument & Measurement Setup < 1GHz

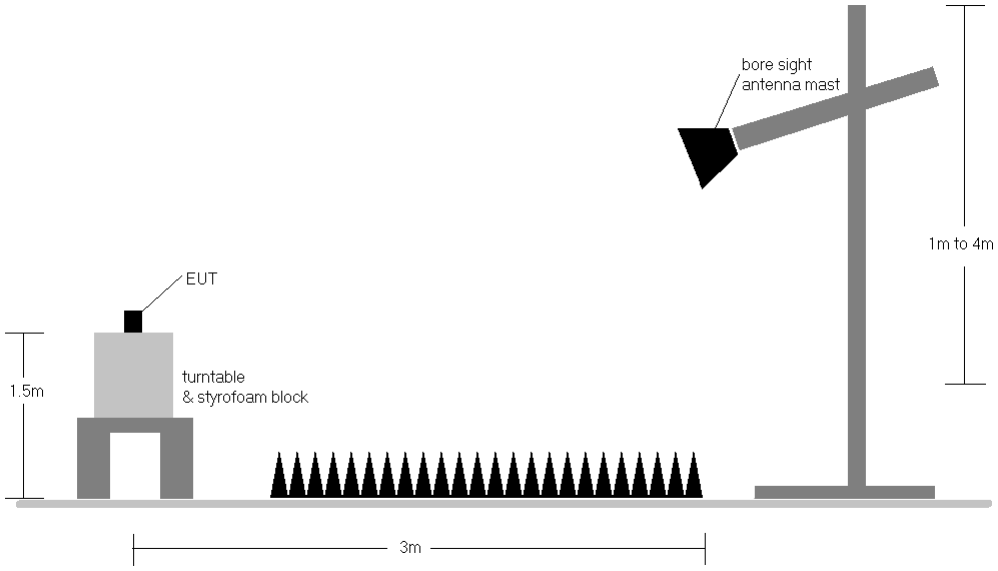


Figure 7-7. Test Instrument & Measurement Setup >1 GHz

Test Notes

1) Field strengths are calculated using the Measurement quantity conversions in KDB 971168 Section 5.8.4.
   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.

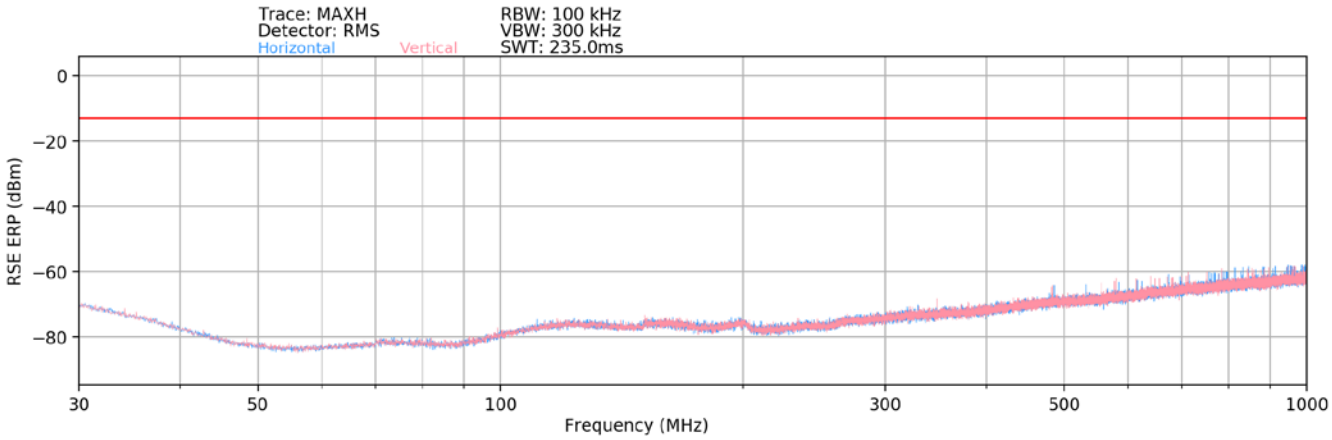
5) Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.

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

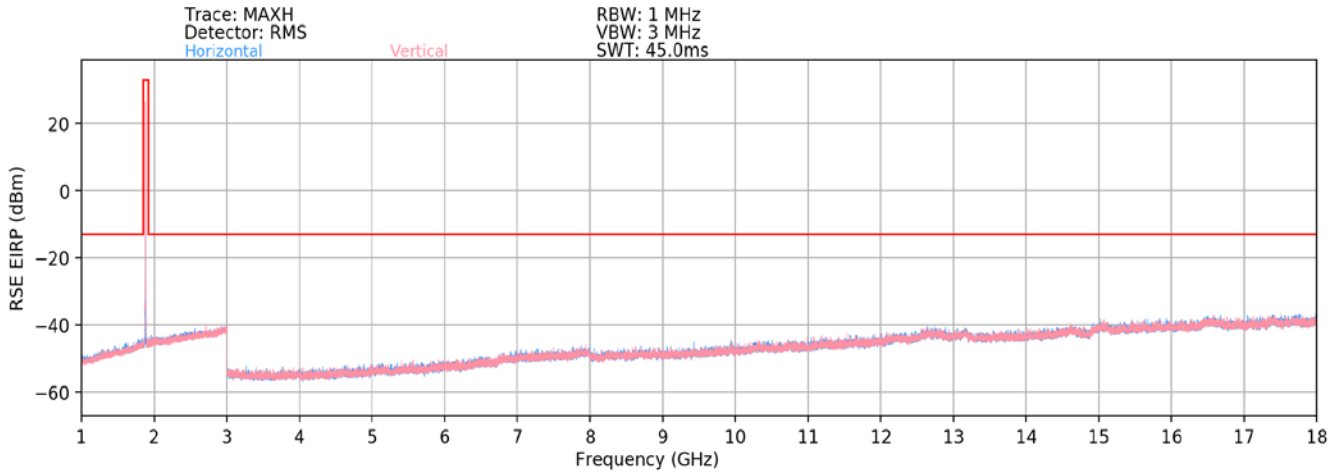
7) For NR operation, all subcarrier spacings (SCS) and transmission schemes (e.g. CP-OFDM and DFT-s-OFDM) were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.

8) Spurious emissions shown in this section are measured while operating in EN-DC mode with Sub 6GHz NR carrier as well as an LTE carrier (anchor). Spurious emissions from the NR carrier device, is subject to the rules under which the NR carrier operates. Spurious emission caused by the LTE carrier must meet the requirements of the rules under which the LTE carrier operates.

NR Band n25/2



Plot 7-58. Radiated Spurious Plot Below 1GHz (NR Band n25/2)



Plot 7-59. Radiated Spurious Plot (NR Band n25/2)

Bandwidth (MHz):	20
Frequency (MHz):	1860
RB / Offset:	1 / 53
Mode:	Stand Alone

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]
3720.00	H	108.00	41.00	-76.51	5.92	36.41	-58.84	-13.00	-45.84
5580.00	H	-	-	-79.24	8.79	36.55	-58.70	-13.00	-45.70
7440.00	H	-	-	-80.37	12.94	39.57	-55.68	-13.00	-42.68
9300.00	H	-	-	-81.50	14.74	40.24	-55.02	-13.00	-42.02

Table 7-3. Radiated Spurious Data (NR Band n25/2 – Low Channel)

Bandwidth (MHz):	20
Frequency (MHz):	1882.5
RB / Offset:	1 / 53
Mode:	Stand Alone

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]
3765.00	H	123.00	48.00	-77.40	6.15	35.75	-59.51	-13.00	-46.51
5647.50	H	-	-	-79.23	8.63	36.40	-58.86	-13.00	-45.86
7530.00	H	-	-	-80.28	13.15	39.87	-55.38	-13.00	-42.38
9412.50	H	-	-	-81.60	15.41	40.81	-54.45	-13.00	-41.45

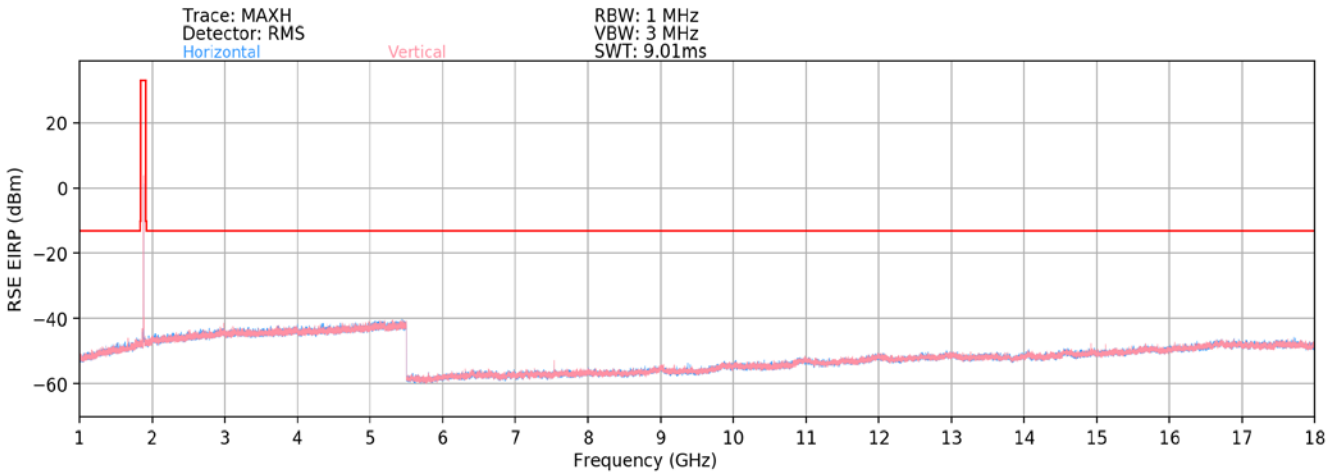
Table 7-4. Radiated Spurious Data (NR Band n25/2 – Mid Channel)

Bandwidth (MHz):	20
Frequency (MHz):	1905
RB / Offset:	1 / 53
Mode:	Stand Alone

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]
3810.00	H	167.00	45.00	-77.51	6.05	35.54	-59.72	-13.00	-46.72
5715.00	H	-	-	-79.50	8.88	36.38	-58.87	-13.00	-45.87
7620.00	H	-	-	-80.20	12.96	39.76	-55.50	-13.00	-42.50
9525.00	H	-	-	-81.12	14.97	40.85	-54.40	-13.00	-41.40

Table 7-5. Radiated Spurious Data (NR Band n25/2 – High Channel)

NR Band n25/2+B13



Plot 7-60. Radiated Spurious Plot (NR Band n25/2 +LTE Band 13)

Bandwidth (MHz):	20 / 10
Frequency (MHz):	1882.5 / 782
RB / Offset:	1/53 / 1/25
Mode:	EN-DC
Anchor Band:	Band 13

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]
1419.00	V	-	-	-66.81	-3.92	36.27	-58.99	-13.00	-45.99
2519.00	V	-	-	-67.59	0.95	40.36	-54.90	-13.00	-41.90
2983.00	V	140	68	-70.71	3.68	39.97	-55.29	-13.00	-42.29
3620.00	V	-	-	-68.39	2.76	41.37	-53.88	-13.00	-40.88
4083.00	V	-	-	-67.59	3.17	42.58	-52.67	-13.00	-39.67
5184.00	V	-	-	-69.07	4.91	42.84	-52.42	-13.00	-39.42
6284.00	V	-	-	-68.20	6.24	45.04	-50.22	-13.00	-37.22

Table 7-6. Radiated Spurious Data (NR Band n25/2 + LTE B13)

7.8 Frequency Stability / Temperature Variation

Test Overview and Limit

Frequency stability testing is performed in accordance with the guidelines of ANSI/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.

Test Procedure Used

ANSI/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

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

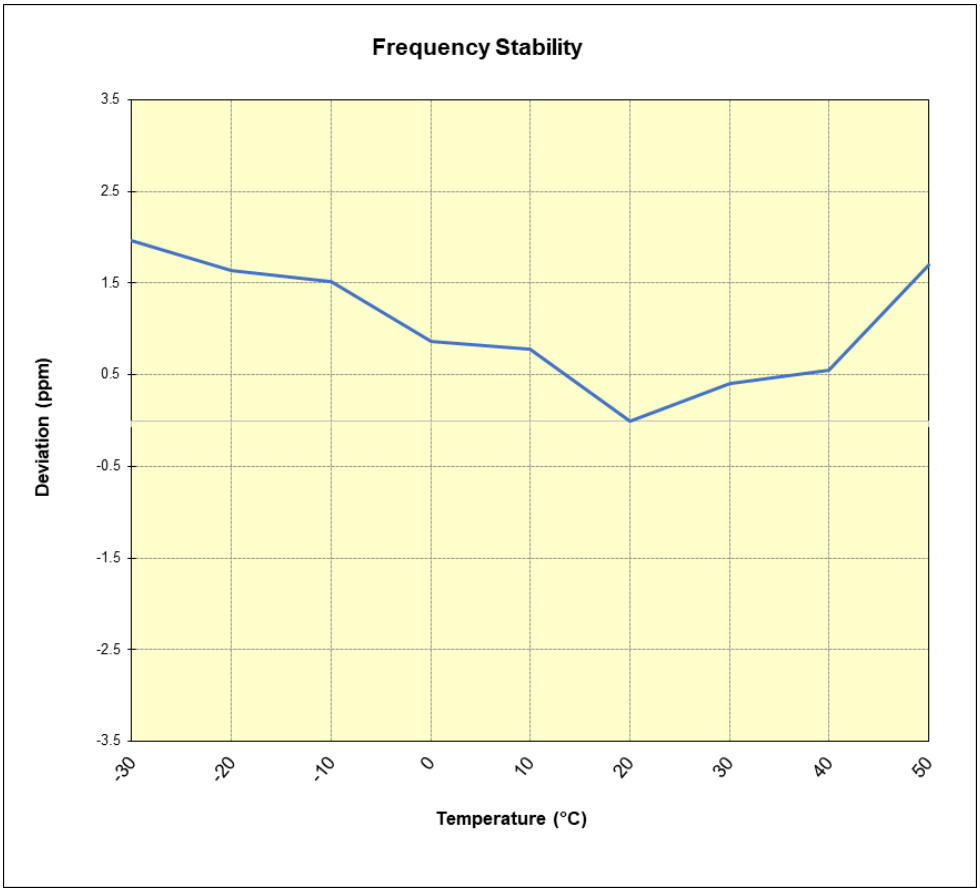
Test Notes

None

NR Band n25/2

Operating Frequency (Hz):	1,882,500,000
Ref. Voltage (VDC):	4.40

Voltage (%)	Power (VDC)	Temp (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	4.40	- 30	1,882,582,310	3,695	0.0001963
		- 20	1,882,581,693	3,078	0.0001635
		- 10	1,882,581,465	2,850	0.0001514
		0	1,882,580,235	1,620	0.0000861
		+ 10	1,882,580,080	1,465	0.0000778
		+ 20 (Ref)	1,882,578,615	0	0.0000000
		+ 30	1,882,579,388	773	0.0000410
		+ 40	1,882,579,643	1,028	0.0000546
		+ 50	1,882,581,823	3,208	0.0001704
Battery Endpoint	3.85	+ 20	1,882,578,327	-288	-0.0000153



8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the Samsung **Portable Handset FCC ID: A3LSMS901E** complies with all the requirements of Part 24 of the FCC rules.