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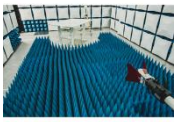

MEASUREMENT REPORT
PART 90

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

Date of Testing:
10/1/2023 - 03/20/2024
Test Report Issue Date:
4/3/2024
Test Site/Location:
Element Materials Technology Morgan Hill, CA, USA
Test Report Serial No.:
1C2311270070-12.BCG

FCC ID:	**BCGA2926**
Applicant Name:	**Apple Inc.**

Application Type:	Certification
Model:	A2926, A3007
EUT Type:	Tablet Device
FCC Classification:	PCS Licensed Transmitter (PCB)
FCC Rule Part:	§2.1049, §90(S), §90(R)
Test Procedure(s):	ANSI C63.26-2015, TIA-603-E-2016, KDB 971168 D01 v03r01

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

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

RJ Ortanez
Executive Vice President

Prepared by: WKR0000006184

Reviewed by: WKR0000005805

ACCREDITED
CERT #2041.02

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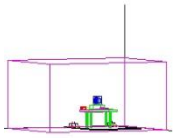
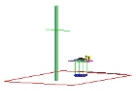


PART 90 MEASUREMENT REPORT



Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	Measurement	OBW [MHz]	Max. Power [W]	Max. Power [dBm]	Emission Designator
LTE Band 26	1.4 MHz	QPSK	814.7 - 823.3	Conducted	1.1029	0.370	25.68	1M10G7W
		16QAM	814.7 - 823.3	Conducted	1.1049	0.294	24.68	1M10D7W
		64QAM	814.7 - 823.3	Conducted	1.1057	0.230	23.61	1M11D7W
		256QAM	814.7 - 823.3	Conducted	1.1016	0.119	20.77	1M10D7W
	3 MHz	QPSK	815.5 - 822.5	Conducted	2.7107	0.362	25.59	2M71G7W
		16QAM	815.5 - 822.5	Conducted	2.7173	0.294	24.69	2M72D7W
		64QAM	815.5 - 822.5	Conducted	2.7167	0.229	23.59	2M72D7W
		256QAM	815.5 - 822.5	Conducted	2.7287	0.119	20.77	2M73D7W
	5 MHz	QPSK	816.5 - 821.5	Conducted	4.5254	0.372	25.70	4M53G7W
		16QAM	816.5 - 821.5	Conducted	4.5350	0.293	24.67	4M54D7W
		64QAM	816.5 - 821.5	Conducted	4.5237	0.238	23.77	4M52D7W
		256QAM	816.5 - 821.5	Conducted	4.5215	0.122	20.86	4M52D7W
	10 MHz	QPSK	819.0	Conducted	9.0269	0.359	25.55	9M03G7W
		16QAM	819.0	Conducted	9.0188	0.234	23.69	9M02D7W
		64QAM	819.0	Conducted	9.0211	0.359	25.55	9M02D7W
		256QAM	819.0	Conducted	9.0145	0.234	23.69	9M01D7W
LTE Band 14	5 MHz	QPSK	790.5 - 795.5	ERP	4.5393	0.130	21.15	4M54G7W
		16QAM	790.5 - 795.5	ERP	4.5303	0.103	20.14	4M53D7W
		64QAM	790.5 - 795.5	ERP	4.5266	0.082	19.15	4M53D7W
		256QAM	790.5 - 795.5	ERP	4.5395	0.042	16.24	4M54D7W
	10 MHz	QPSK	793.0	ERP	9.0459	0.125	20.97	9M05G7W
		16QAM	793.0	ERP	9.0272	0.099	19.96	9M03D7W
		64QAM	793.0	ERP	9.0076	0.080	19.05	9M01D7W
		256QAM	793.0	ERP	9.0195	0.042	16.21	9M02D7W
NR Band n14	5 MHz	π/2 BPSK	790.5 - 795.5	ERP	4.4710	0.128	21.07	4M47G7W
		QPSK	790.5 - 795.5	ERP	4.4763	0.130	21.15	4M48G7W
		16QAM	790.5 - 795.5	ERP	4.4807	0.102	20.10	4M48D7W
		64QAM	790.5 - 795.5	ERP	4.4816	0.083	19.19	4M48D7W
		256QAM	790.5 - 795.5	ERP	4.4956	0.042	16.26	4M50D7W
	10 MHz	π/2 BPSK	793.0	ERP	8.9710	0.129	21.09	8M97G7W
		QPSK	793.0	ERP	9.2951	0.130	21.15	9M30G7W
		16QAM	793.0	ERP	9.2843	0.095	19.80	9M28D7W
		64QAM	793.0	ERP	9.3120	0.081	19.06	9M31D7W
		256QAM	793.0	ERP	9.2598	0.042	16.25	9M26D7W
NR Band n26	5 MHz	π/2 BPSK	816.5 - 821.5	Conducted	4.4944	0.364	25.61	4M49G7W
		QPSK	816.5 - 821.5	Conducted	4.4842	0.372	25.70	4M48G7W
		16QAM	816.5 - 821.5	Conducted	4.4757	0.293	24.67	4M48D7W
		64QAM	816.5 - 821.5	Conducted	4.5035	0.232	23.65	4M50D7W
		256QAM	816.5 - 821.5	Conducted	4.4814	0.121	20.82	4M48D7W
	10 MHz	π/2 BPSK	819.0	Conducted	8.9584	0.366	25.63	8M96G7W
		QPSK	819.0	Conducted	9.2870	0.362	25.59	9M29G7W
		16QAM	819.0	Conducted	9.3364	0.296	24.71	9M34D7W
		64QAM	819.0	Conducted	9.2945	0.235	23.71	9M29D7W
		256QAM	819.0	Conducted	9.2892	0.121	20.82	9M29D7W

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 Materials Technology Test Location

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

1.3 Test Facility / Accreditations

Measurements were performed at Element Materials Technology

- Element Materials Technology is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- Element Washington DC LLC 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).

- Element Materials Technology facility is a registered (22831) test laboratory with the site description on file with ISED.

- Element Washington DC LLC is a Recognized U.S. Certification Assessment Body (CAB # US0110) for ISED Canada as designated by NIST under the U.S. and Canada Mutual Agreements (MRAs).

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID: BCGA2926**. 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.

Test Device Serial No.: H440XJV4X5, W2G6PFDHG7, P7TX0QQKCQ, DLXH190002M000063A

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, 5G NR (FR1), 802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, 802.11a/ax WIFI 6E, 802.15.4, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8), NB UNII (1x, HDR4, HDR8), WPT

This device supports BT Beamforming

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

Antenna	Simultaneous Tx Config	Wifi 2GHz	Bluetooth	Thread	Wifi 5GHz	Wifi 6GHz	NB UNII	LTE/FR1 NR	
		802.11 b/g/n/ax	BDR, EDR, HDR4/8, LE1/2M	802.15.4	802.11 a/n/ac/ax	802.11 a/ax	BDR, HDR4/8	MB/HB	UHB
2a	Config 1	✗	✓	✗	✓	✗	✗	✗	✗
2a	Config 2	✗	✓	✗	✗	✓	✗	✗	✗
2a	Config 3	✓	✗	✗	✗	✗	✓	✗	✗
2a	Config 4	✗	✗	✓	✓	✗	✗	✗	✗
2a	Config 5	✗	✗	✓	✗	✓	✗	✗	✗
4a	Config 6	✗	✓	✗	✓	✗	✗	✗	✗
4a	Config 7	✗	✓	✗	✗	✓	✗	✗	✗
4a	Config 8	✓	✗	✗	✗	✗	✓	✗	✗
4a	Config 9	✗	✗	✓	✓	✗	✗	✗	✗
4a	Config 10	✗	✗	✓	✗	✓	✗	✗	✗

Table 2-1. Simultaneous Transmission Configurations

✓ = Support; × = Not Support

Note:

1. All the above simultaneous transmission configurations have been tested and the worst case configuration was found to be Config 1 and reported in RF UNII OFDM and RF Bluetooth reports.

2. Specific 2.4GHz Wi-Fi antenna that can only transmit simultaneously with 2.4GHz Bluetooth antenna is listed in the SAR test report. For BT (2.4GHz) in connected mode and Wi-Fi (2.4GHz) - Wi-Fi max power will not exceed minimum of (13.5dBm, SAR max cap, Reg max cap) power. For BT (2.4GHz) in disconnected mode and Wi-Fi (2.4GHz) - BT will be using iPA only and Wi-Fi max power will not exceed minimum of (SAR max cap, Reg max cap) power. Bluetooth can simultaneously transmit with IEEE 802.11a/n/ac/ax 5/6 GHz on separate antenna.

2.3 Antenna Description

Following antenna gains provided by manufacturer were used for testing.

Band	Antenna Gain [dBi]	
	Antenna 3	Antenna 1
LTE Band 14	-2.40	-2.60
NR Band n14		
LTE Band 26	-2.70	-3.00
NR Band n26		

Table 2-2. Highest Antenna Gain

2.4 Test Support Equipment

1	Apple MacBook Pro	Model:	A2141	S/N:	C02H604EQ05D
	w/AC/DC Adapter	Model:	A2166	S/N:	C4H042705ZNPM0WA6
2	Apple USB-C Cable	Model:	Spartan	S/N:	GXK1336018XKTR024
3	USB-C Cable	Model:	A246C	S/N:	DWH80115BK826GV19
	w/ AC Adapter	Model:	A2305	S/N:	C4H95160004PF4F4V
4	Apple Pencil	Model:	A2538	S/N:	KJ26TCFXJW
5	DC Power Supply	Model:	KPS3010D	S/N:	N/A

Table 2-3. Test Support Equipment

2.5 Test Configuration

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

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

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

2.6 Software and Firmware

The test was conducted with firmware version 21E8197 installed on the EUT.

2.7 EMI Suppression Device(s)/Modifications

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

3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the documents titled “American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services” (ANSI C63.26-2015 and TIA-603-E-2016) and “Procedures for Compliance Measurement of the Fundamental Emission Power of Licensed Wideband (> 1 MHz) Digital Transmission Systems” (KDB 971168 D01 v03r01) were used in the measurement of the EUT.

Deviation from Measurement Procedure……...None

3.2 Radiated Spurious Emissions

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

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

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

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

And

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

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

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

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

4.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.23-2012. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
Conducted Bench Top Measurements	2.07
Radiated Disturbance (<30MHz)	4.12
Radiated Disturbance (30MHz-1GHz)	4.85
Radiated Disturbance (1-18GHz)	5.08

5.0 TEST EQUIPMENT CALIBRATION DATA

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

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	6/21/2023	Annual	6/21/2024	MY49430244
ESPEC	SU-241	Tabletop Temperature Chamber	11/17/2023	Annual	11/17/2024	92009574
ETS-Lindgren	3117	Double Ridged Guide Antenna (1-18 GHz)	3/30/2023	Annual	3/30/2024	00218555
Keysight Technology	N9040B	UXA Signal Analyzer	11/5/2023	Annual	11/5/2024	MY57213068
Rohde & Schwarz	TS-PR18	Pre-Amplifier (1GHz - 18GHz)	8/31/2023	Annual	8/31/2024	100052
Rohde & Schwarz	FSV40	Signal Analyzer (10Hz-40GHz)	5/11/2023	Annual	5/11/2024	101619
Rohde & Schwarz	ESW44	EMI Test Receiver	6/6/2023	Annual	6/6/2024	101668
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz - 8GHz)	6/22/2023	Annual	6/22/2024	102356
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	11/30/2023	Annual	11/30/2024	161616
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	12/27/2023	Annual	12/27/2024	164715
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz - 40GHz)	6/2/2023	Annual	6/2/2024	100050
Rohde & Schwarz	HFH2-Z2	Loop Antenna	5/1/2023	Annual	5/1/2024	100519
Rohde & Schwarz	FSW43	Signal Analyzer (2Hz-43.5GHz)	7/13/2023	Annual	7/13/2024	101261
Schwarzbeck	VULB 9162	Bilog Antenna (30MHz - 6GHz)	4/17/2023	Annual	4/17/2024	00304

Table 5-1. Test Equipment List

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.

6.0 SAMPLE CALCULATIONS

Emission Designator

π/2 BPSK / QPSK Modulation

Emission Designator = 8M62G7W
BW = 8.62 MHz
G = Phase Modulation
7 = Quantized/Digital Info
W = Combination of Any

QAM Modulation

Emission Designator = 8M45D7W
BW = 8.45 MHz
D = Amplitude/Angle Modulated
7 = Quantized/Digital Info
W = Combination of Any

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: Apple Inc.

FCC ID: BCGA2926

FCC Classification: PCS Licensed Transmitter (PCB)

Mode(s): LTE/NR

Test Condition	Test Description	FCC Part Section(s)	Test Limit	Test Result	Reference
CONDUCTED	Occupied Bandwidth	2.1049	N/A	N/A	Section 7.2
	Conducted Band Edge / Spurious Emissions (LTE Band 14)	2.1051, 90.543(e)	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	PASS	Sections 7.3, 7.4
	Conducted Band Edge / Spurious Emissions (NR Band n14)				
	Conducted Band Edge / Spurious Emissions (LTE Band 26)	2.1051, 90.691(a)	-13 dBm for all out-of-band emissions except -30 dBm at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	PASS	Sections 7.3, 7.4
	Conducted Band Edge / Spurious Emissions (NR Band n26)			PASS	Sections 7.3, 7.4
	Frequency Stability (LTE Band 14)	2.1055	Fundamental emissions stay within authorized frequency block over the temperature and voltage range as tested.	PASS	Section 7.8
	Frequency Stability (NR Band n14)				
	Frequency Stability (LTE Band 26)	90.213	< 2.5 ppm	PASS	Section 7.8
	Frequency Stability (NR Band n26)				
	Conducted Power	2.1046, 90.635	< 100 Watts	PASS	Section 7.5
	Effective Radiated Power (LTE Band 14)	90.542(a)(7)	< 3 Watts max. ERP	PASS	Section 7.6
	Effective Radiated Power (NR Band n14)			PASS	Section 7.6
	Effective Radiated Power (LTE Band 26)	22.913(a)(5)	< 7 Watts max. ERP	PASS	Section 7.6
	Effective Radiated Power (NR Band n26)			PASS	Section 7.6
RADIATED	Radiated Spurious Emissions (LTE Band 14)	2.1053, 90.543(e)	> 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 (NR Band n14)			PASS	Section 7.7
	Radiated Spurious Emissions (LTE Band 26)	2.1053, 90.691(a)	-13 dBm for all out-of-band emissions except -30 dBm at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	PASS	Section 7.7
	Radiated Spurious Emissions (NR Band n26)			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 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 Element EMC Software Tool v1.2.

5. For radiated spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software's utilized are Element "Chamber Automation," Version 1.3.1.

6. All ports were investigated and for some test cases only the worst case data was reported.

7.2 Occupied Bandwidth

§2.1049

Test Overview

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. All modes of operation and all ports 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.

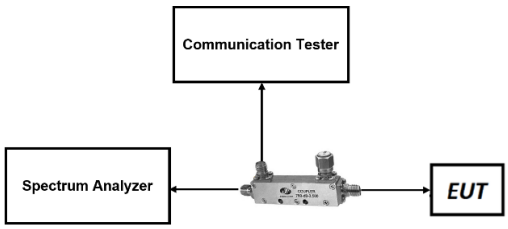
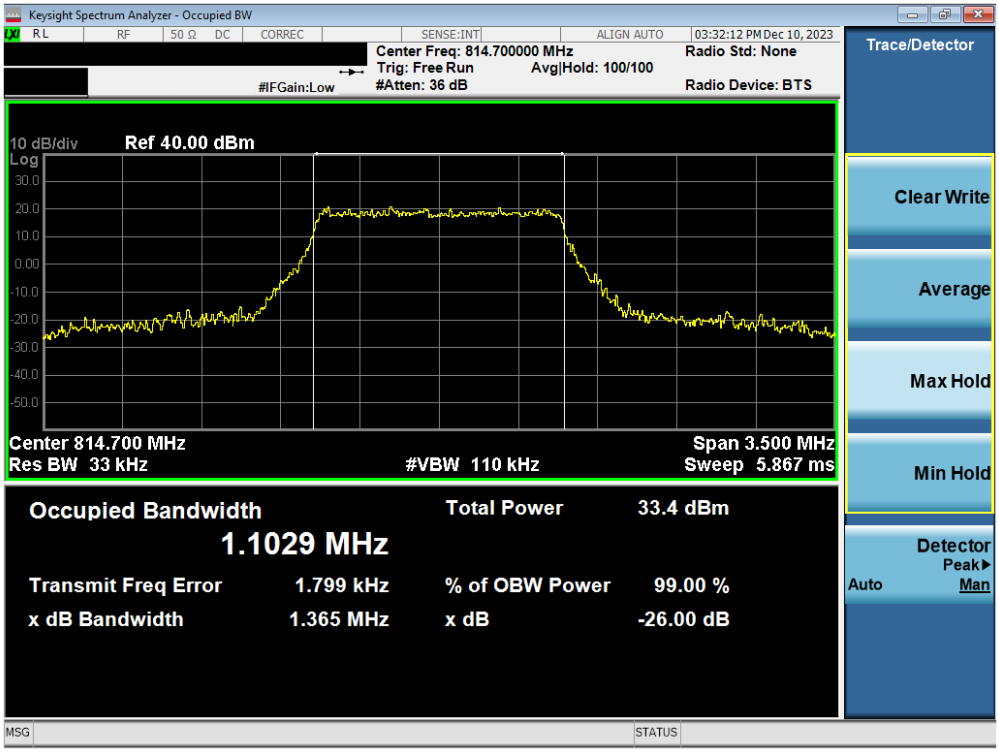


Figure 7-1. Test Instrument & Measurement Setup

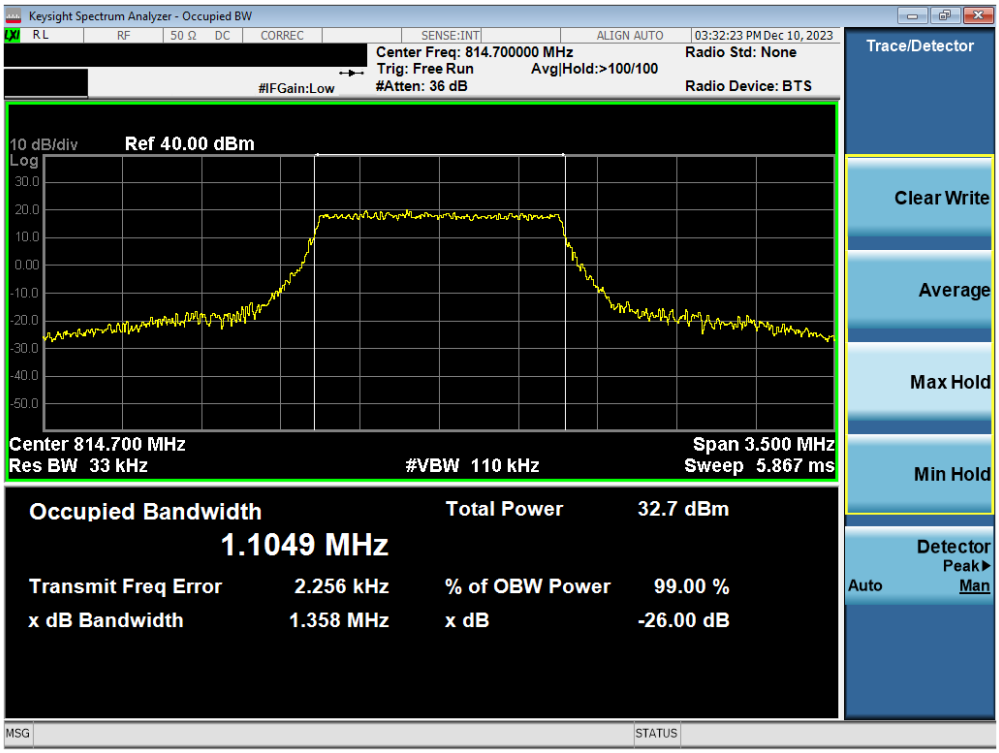
Test Notes

None.

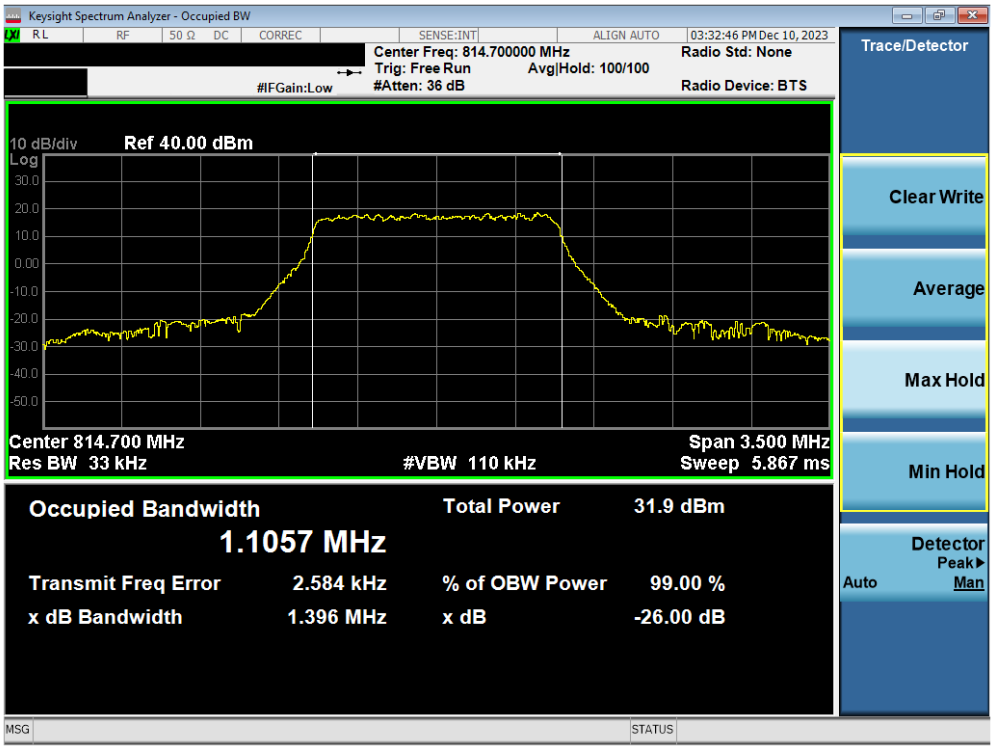
LTE Band 26



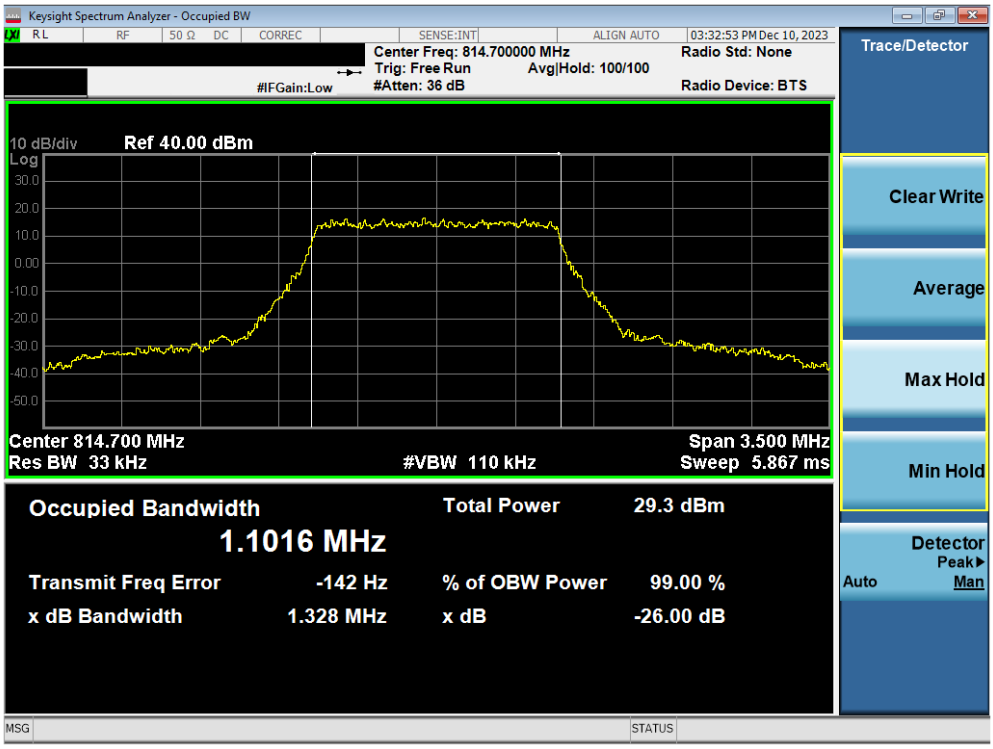
Plot 7-1. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz QPSK - Full RB)



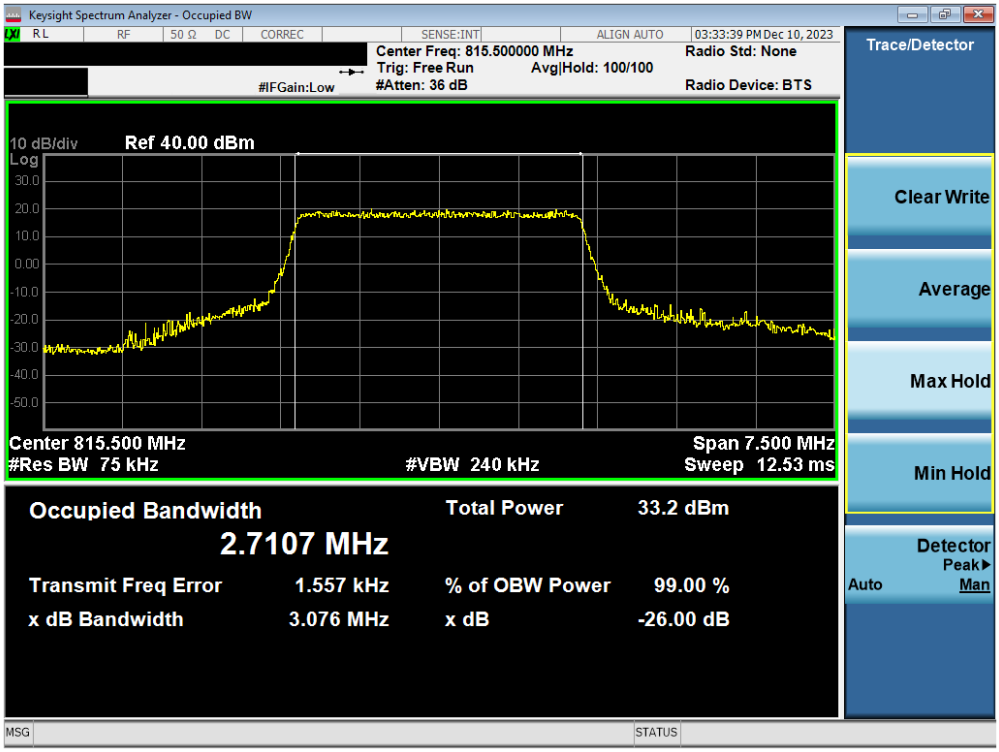
Plot 7-2. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz 16-QAM - Full RB)



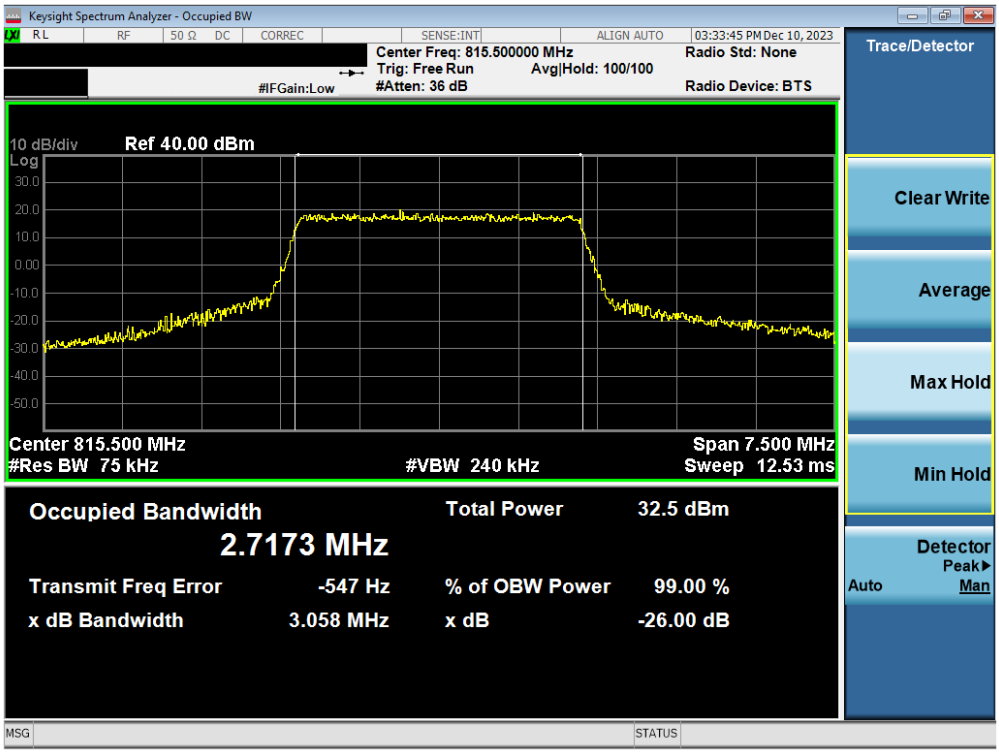
Plot 7-3. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz 64-QAM - Full RB)



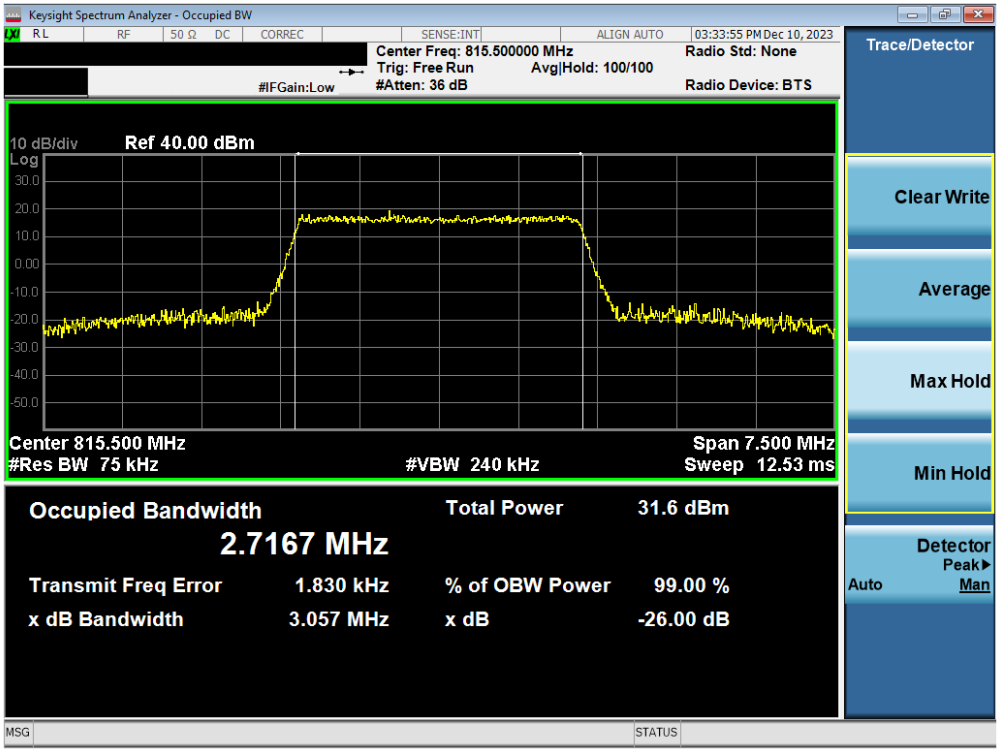
Plot 7-4. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz 256-QAM - Full RB)



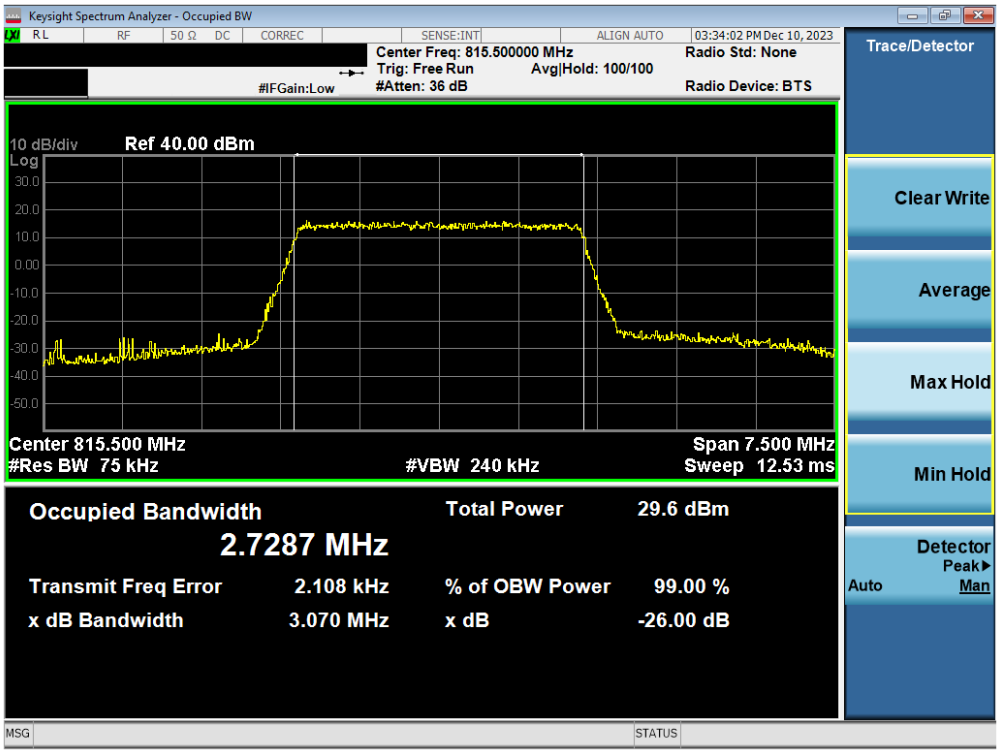
Plot 7-5. Occupied Bandwidth Plot (LTE Band 26 - 3MHz QPSK - Full RB)



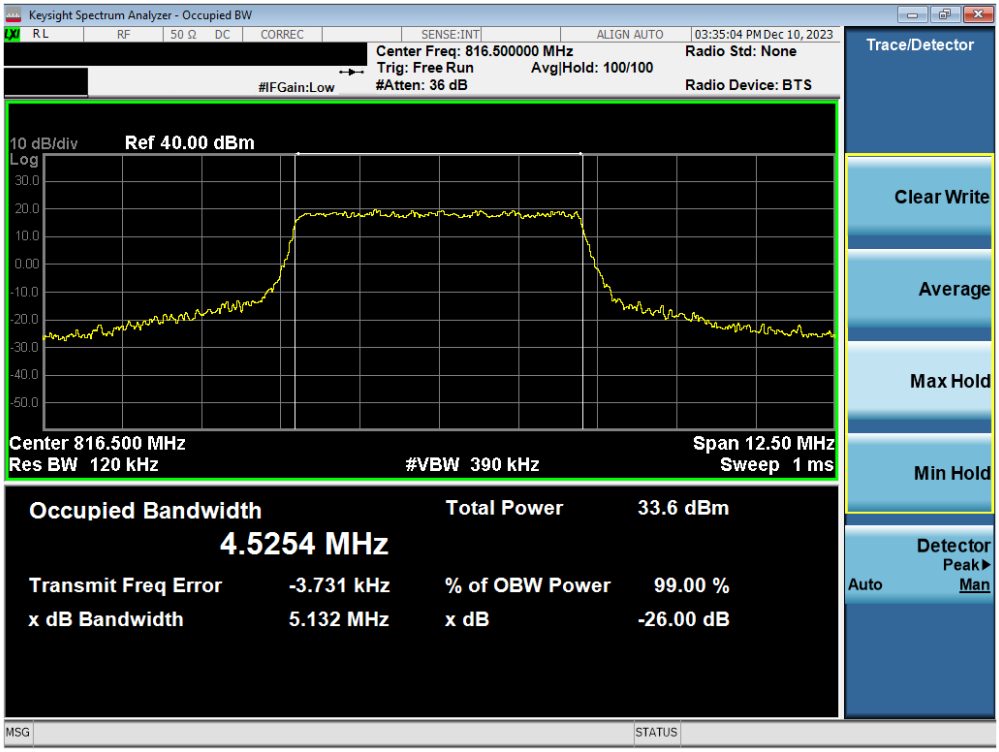
Plot 7-6. Occupied Bandwidth Plot (LTE Band 26 - 3MHz 16-QAM - Full RB)



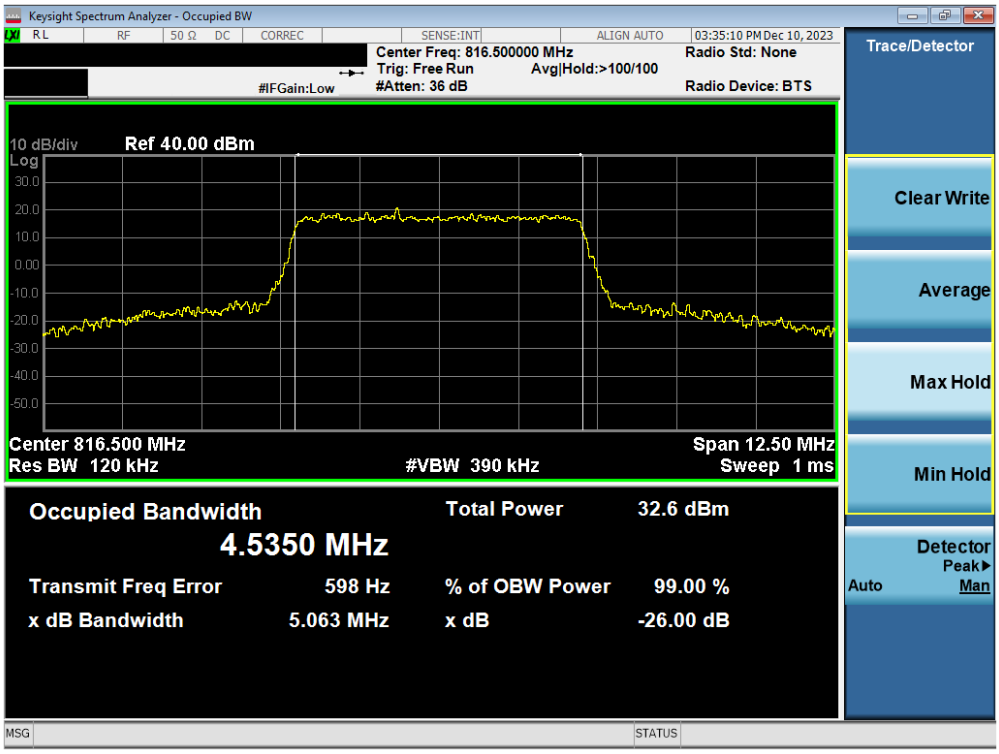
Plot 7-7. Occupied Bandwidth Plot (LTE Band 26 - 3MHz 64-QAM - Full RB)



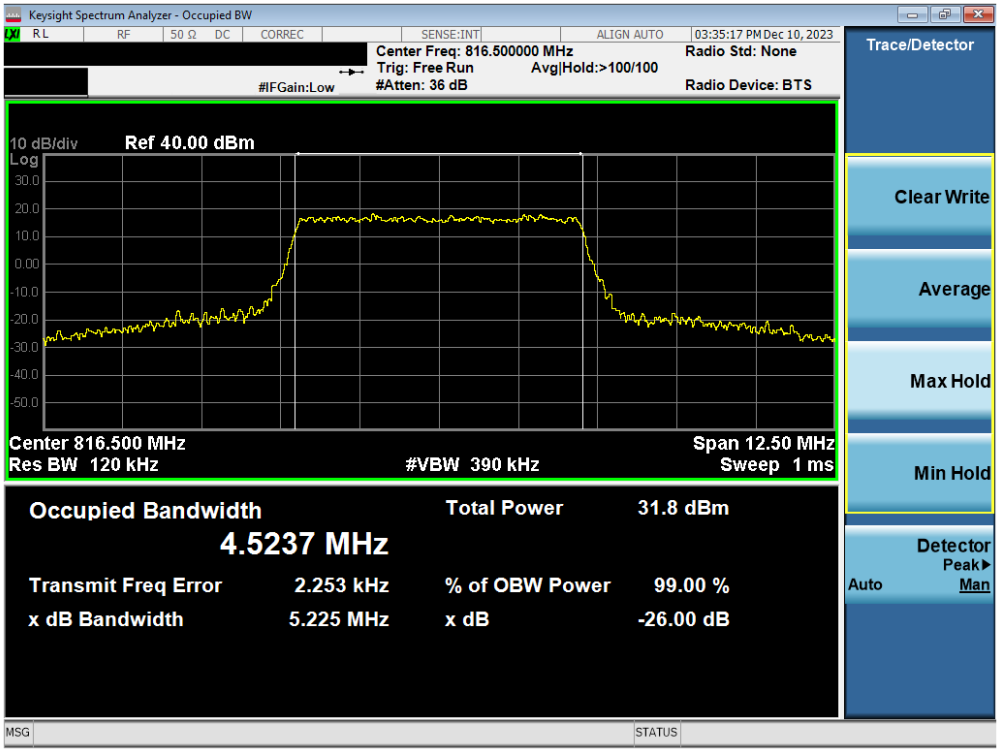
Plot 7-8. Occupied Bandwidth Plot (LTE Band 26 - 3MHz 256-QAM - Full RB)



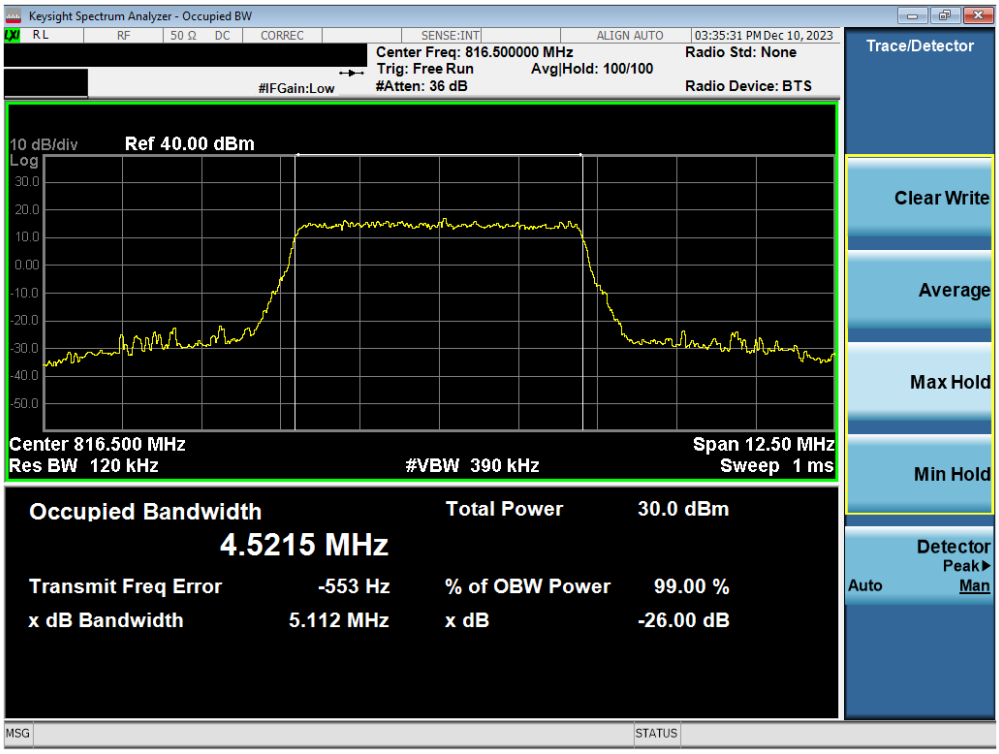
Plot 7-9. Occupied Bandwidth Plot (LTE Band 26 - 5MHz QPSK - Full RB)



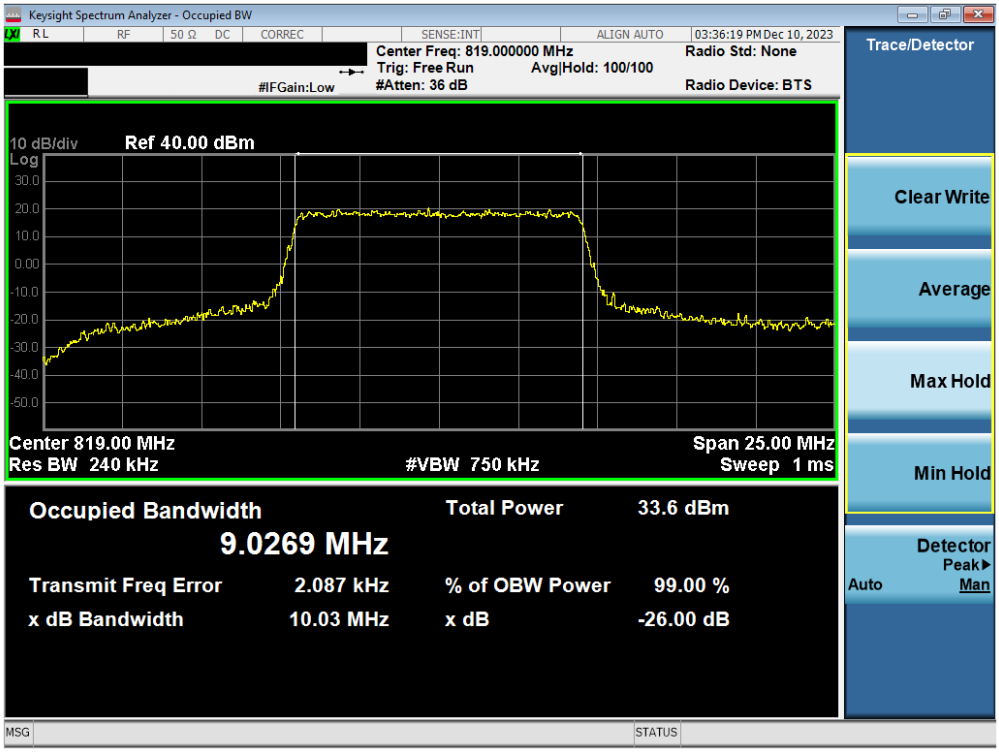
Plot 7-10. Occupied Bandwidth Plot (LTE Band 26 - 5MHz 16-QAM - Full RB)



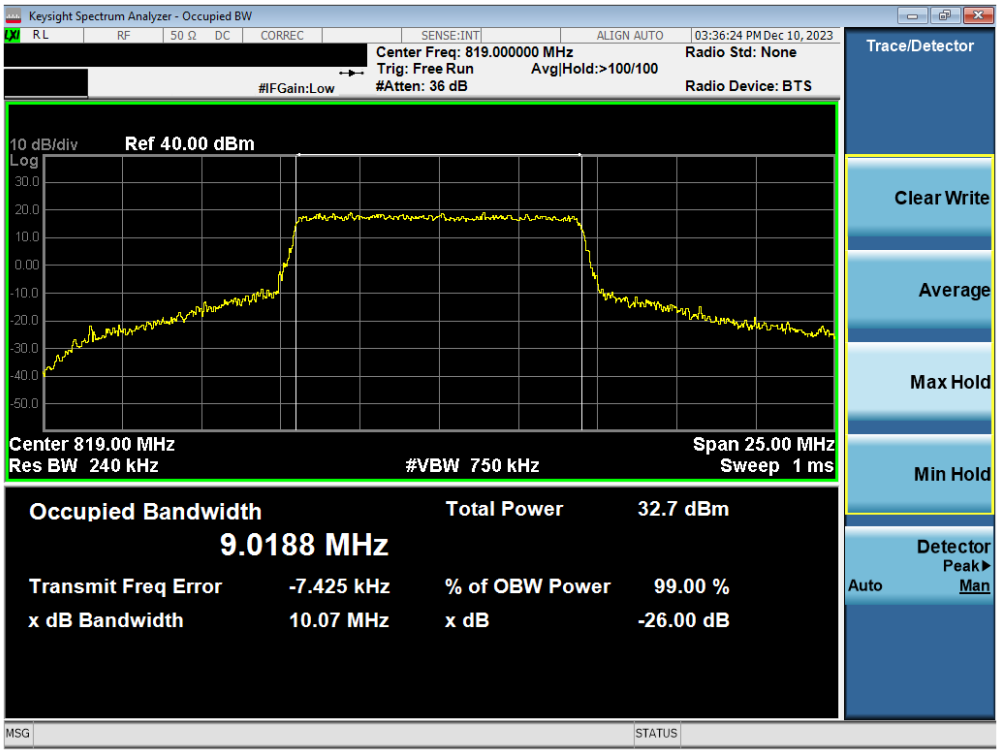
Plot 7-11. Occupied Bandwidth Plot (LTE Band 26 - 5MHz 64-QAM - Full RB)



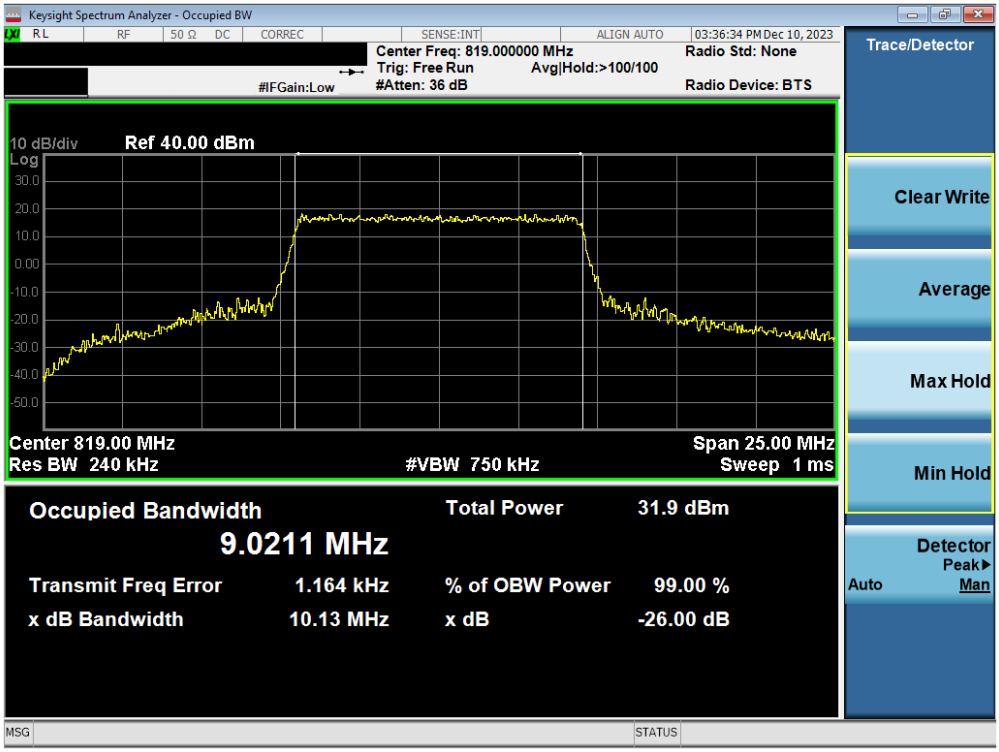
Plot 7-12. Occupied Bandwidth Plot (LTE Band 26 - 5MHz 256-QAM - Full RB)



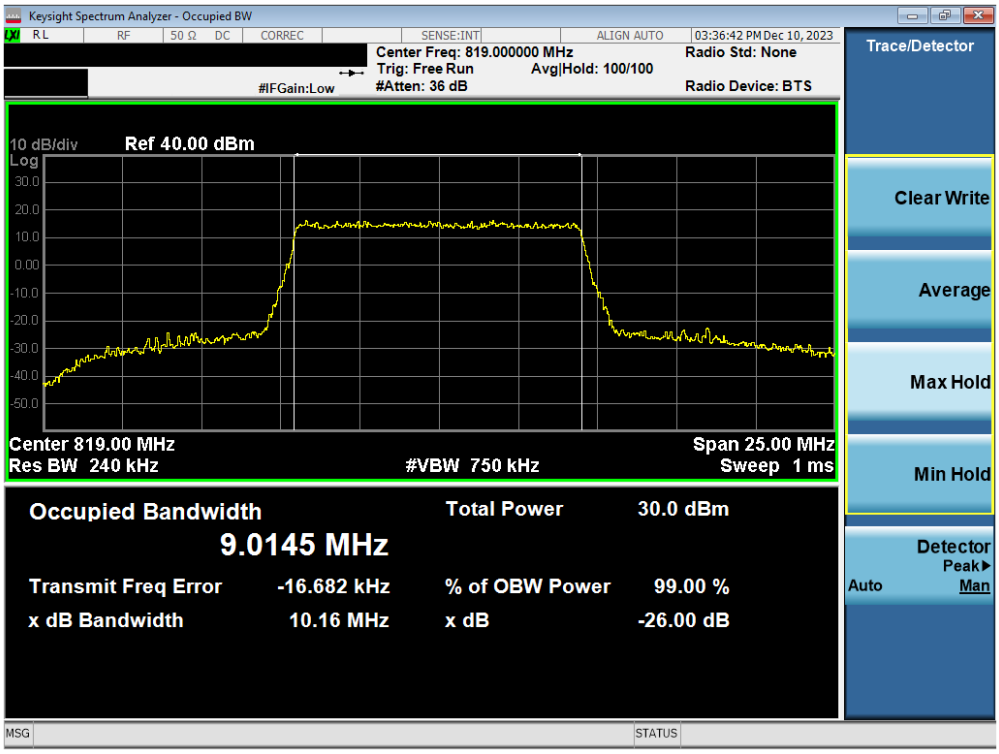
Plot 7-13. Occupied Bandwidth Plot (LTE Band 26 - 10MHz QPSK - Full RB)



Plot 7-14. Occupied Bandwidth Plot (LTE Band 26 - 10MHz 16-QAM - Full RB)

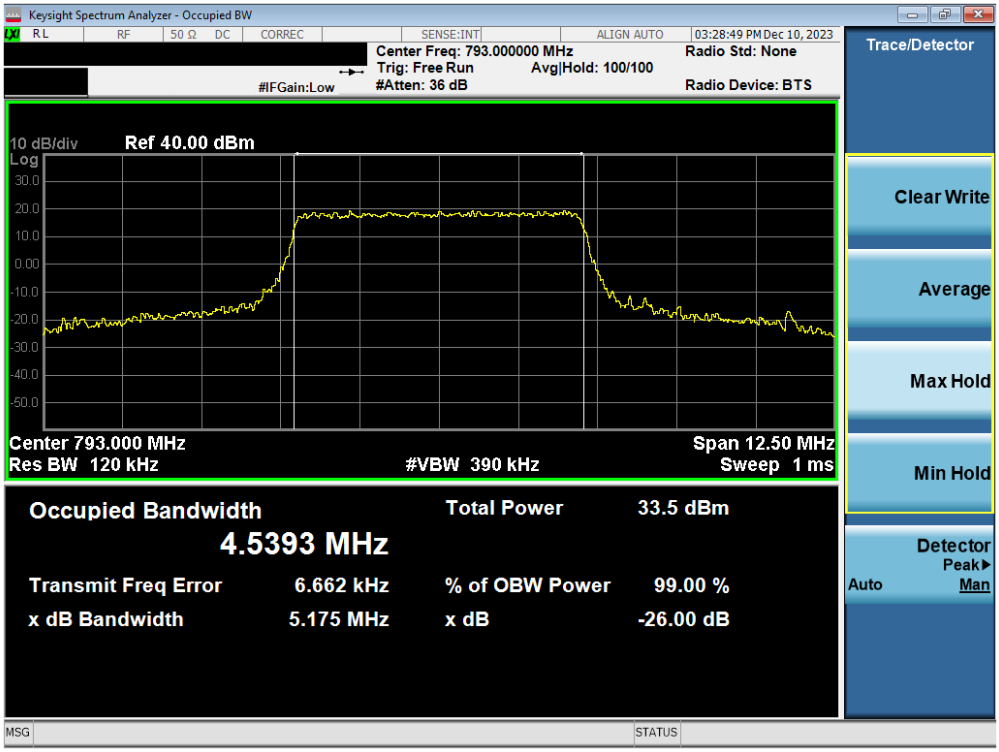


Plot 7-15. Occupied Bandwidth Plot (LTE Band 26 - 10MHz 64-QAM - Full RB)

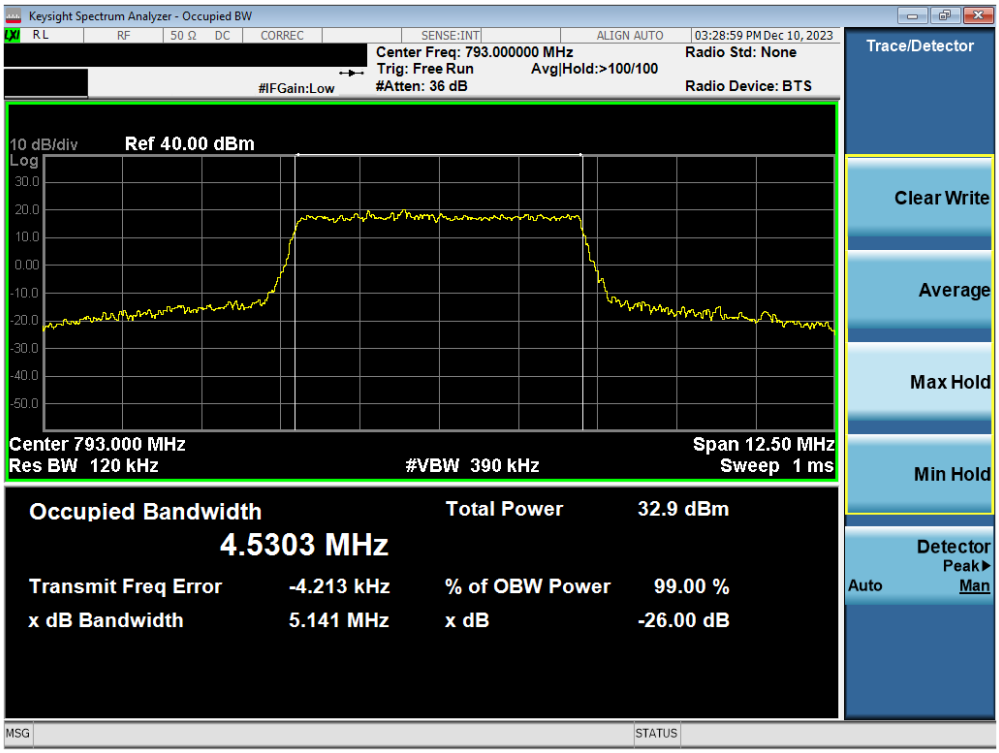


Plot 7-16. Occupied Bandwidth Plot (LTE Band 26 - 10MHz 256-QAM - Full RB)

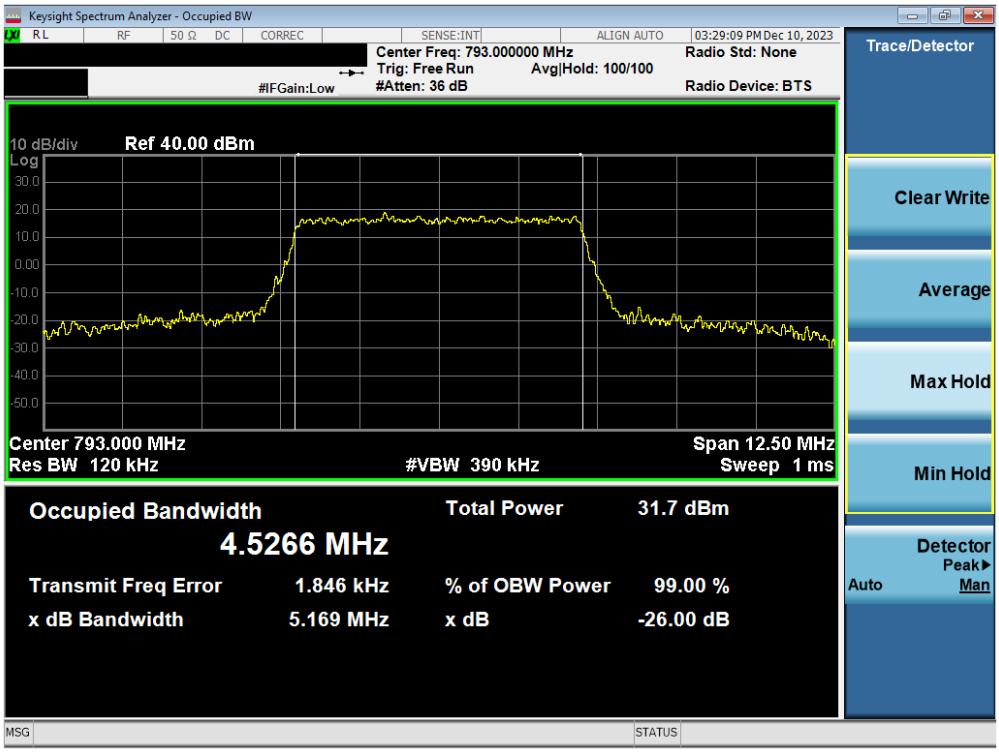
LTE Band 14



Plot 7-17. Occupied Bandwidth Plot (LTE Band 14 - 5MHz QPSK - Full RB)

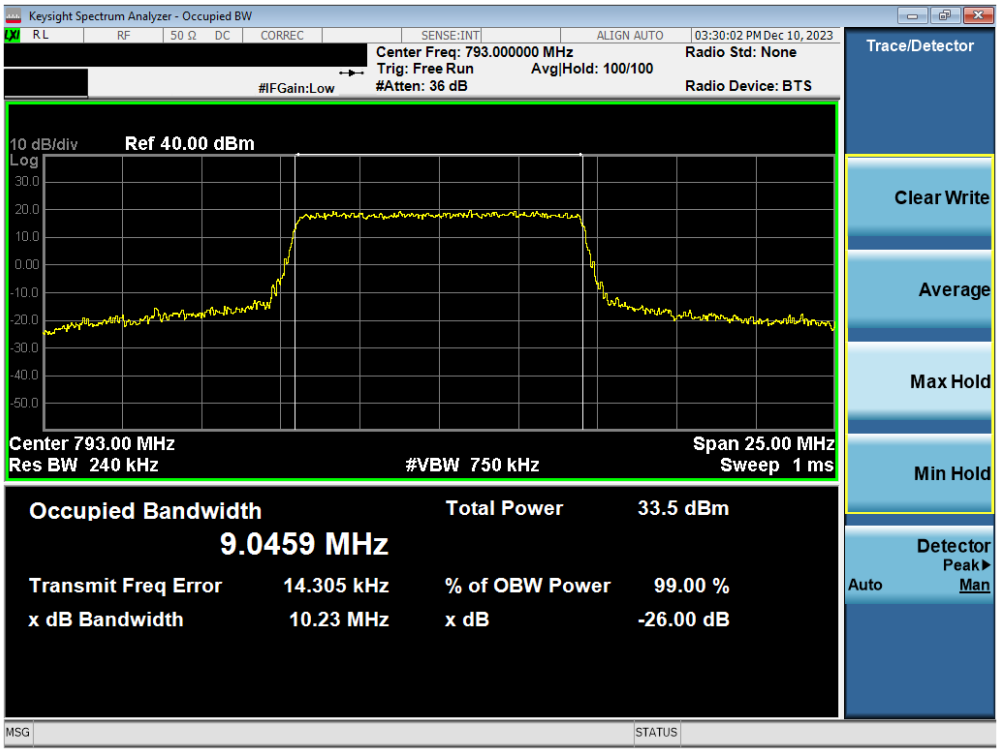


Plot 7-18. Occupied Bandwidth Plot (LTE Band 14 - 5MHz 16-QAM - Full RB)

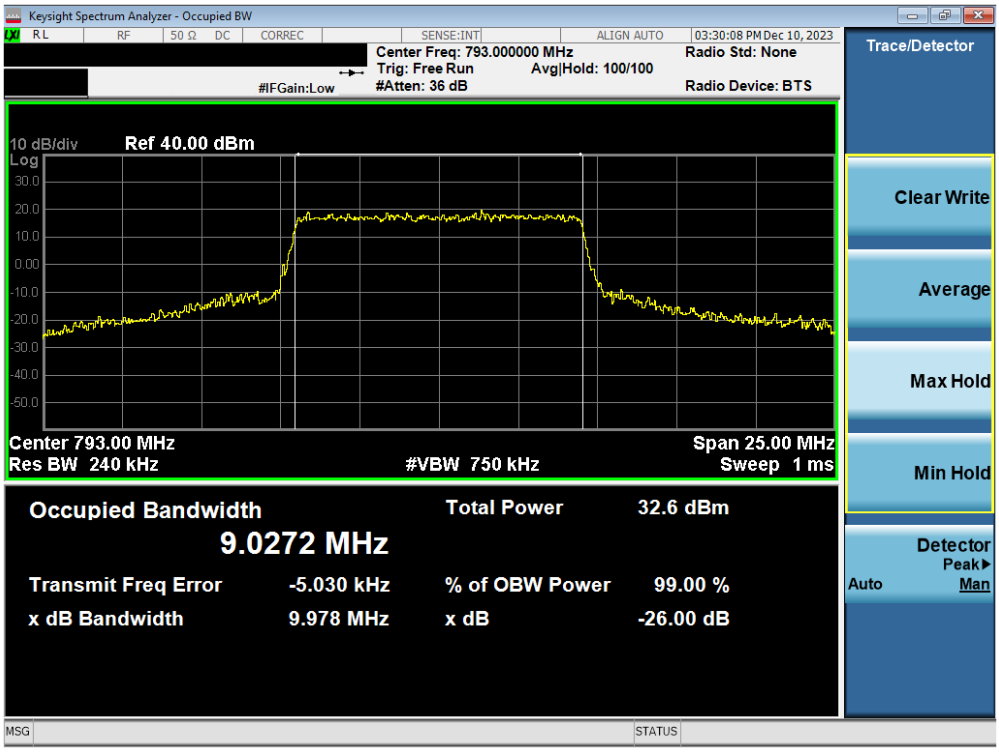


Plot 7-19. Occupied Bandwidth Plot (LTE Band 14 - 5MHz 64-QAM - Full RB)

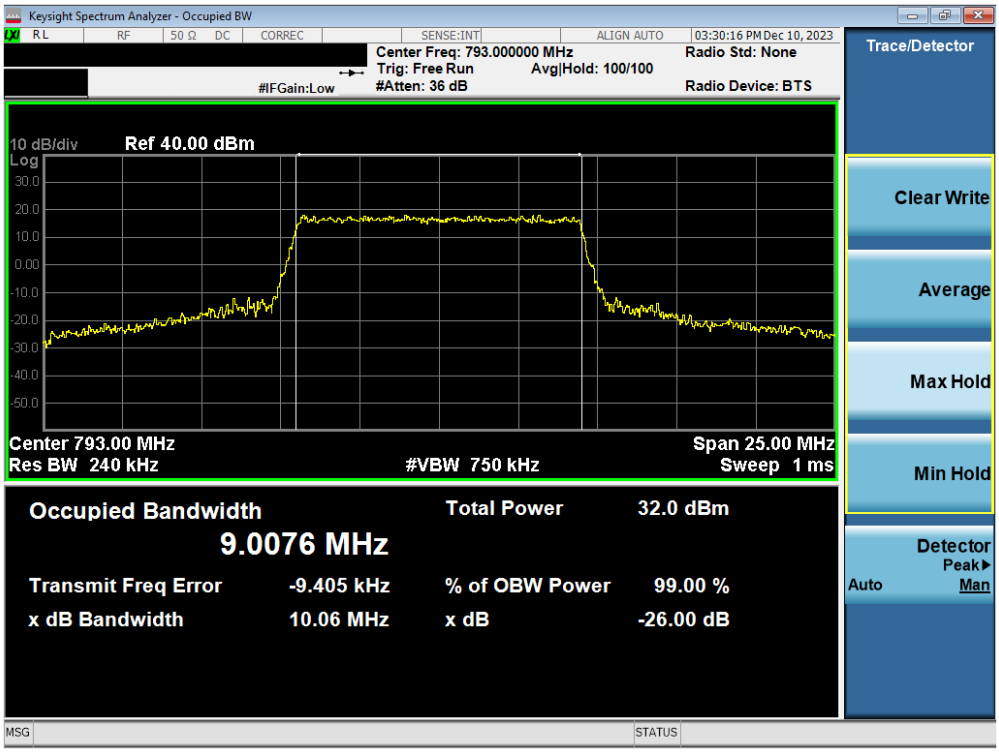
Plot 7-20. Occupied Bandwidth Plot (LTE Band 14 - 5MHz 256-QAM - Full RB)



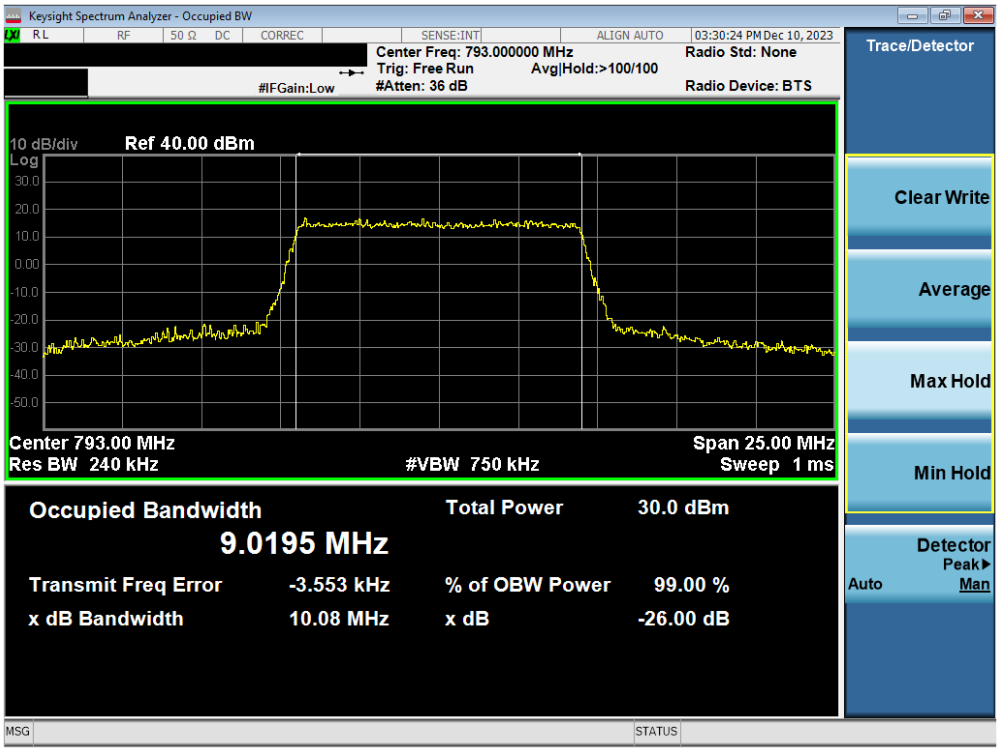
Plot 7-21. Occupied Bandwidth Plot (LTE Band 14 - 10MHz QPSK - Full RB)



Plot 7-22. Occupied Bandwidth Plot (LTE Band 14 - 10MHz 16-QAM - Full RB)

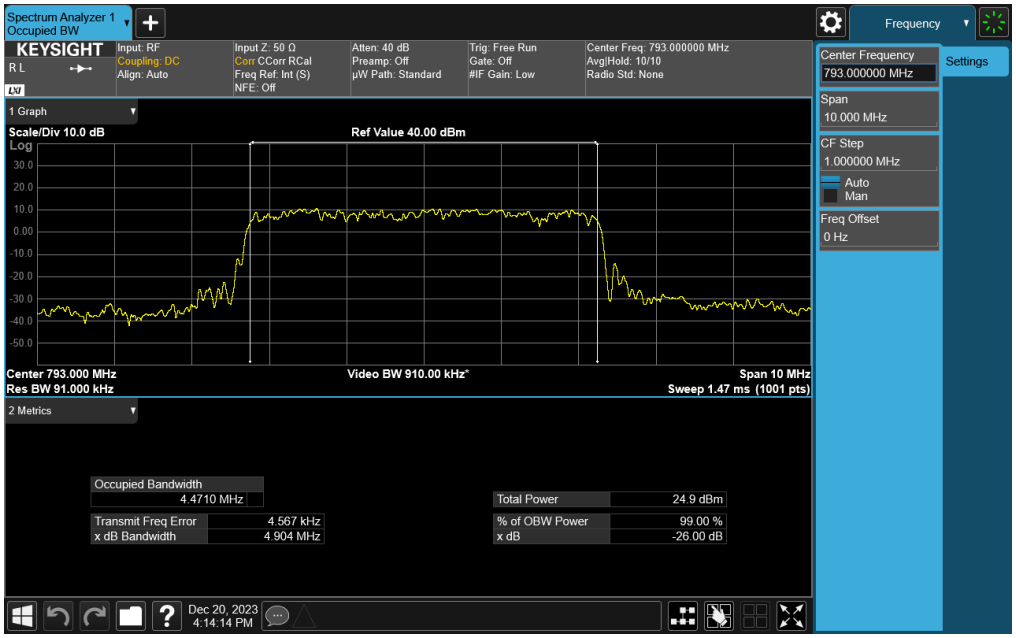


Plot 7-23. Occupied Bandwidth Plot (LTE Band 14 - 10MHz 64-QAM - Full RB)

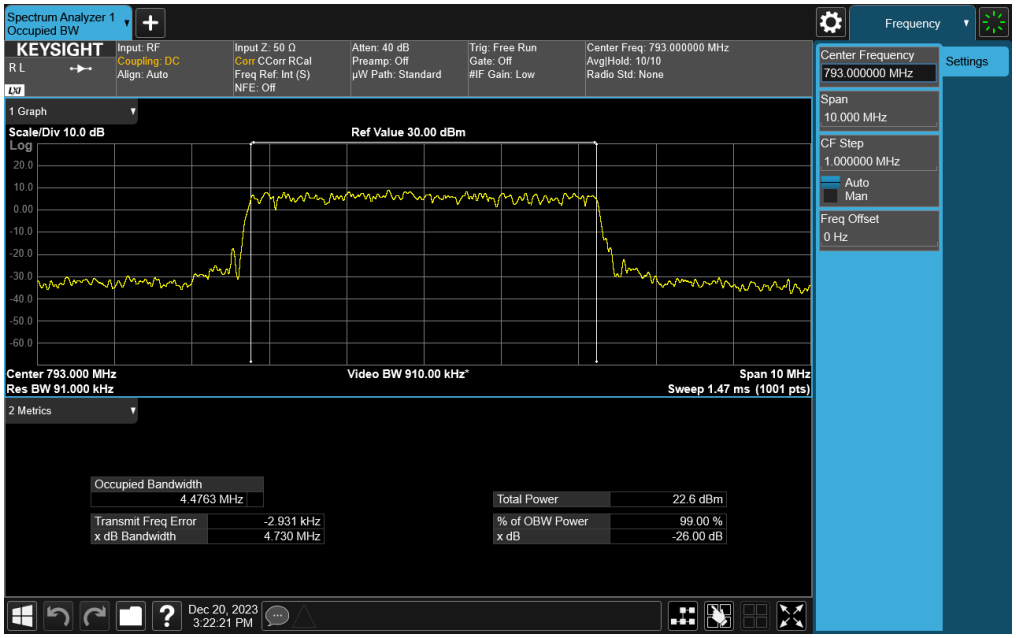


Plot 7-24. Occupied Bandwidth Plot (LTE Band 14 - 10MHz 256-QAM - Full RB)

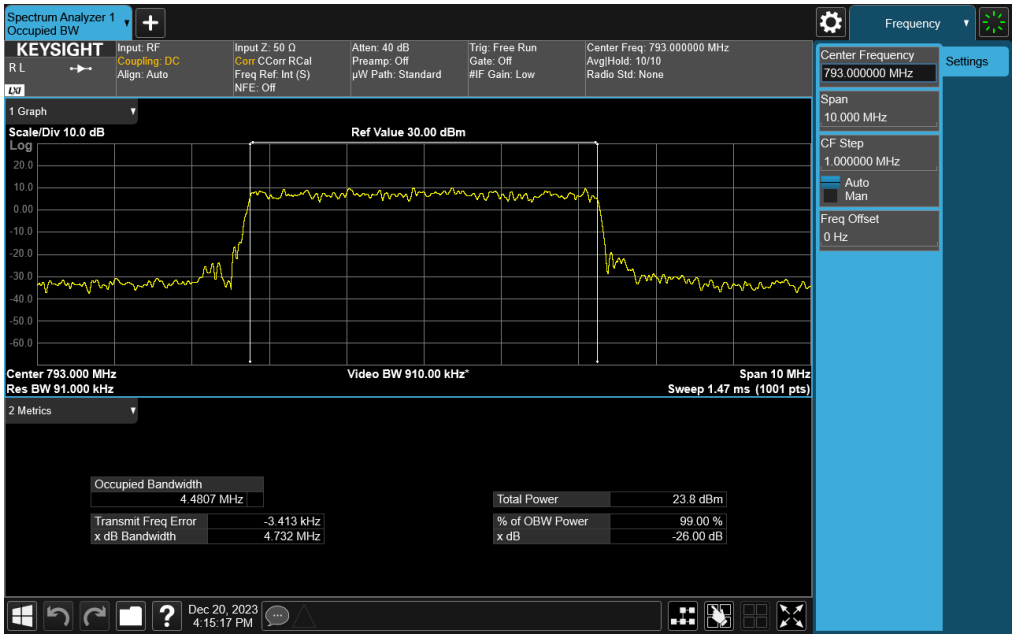
NR Band n14



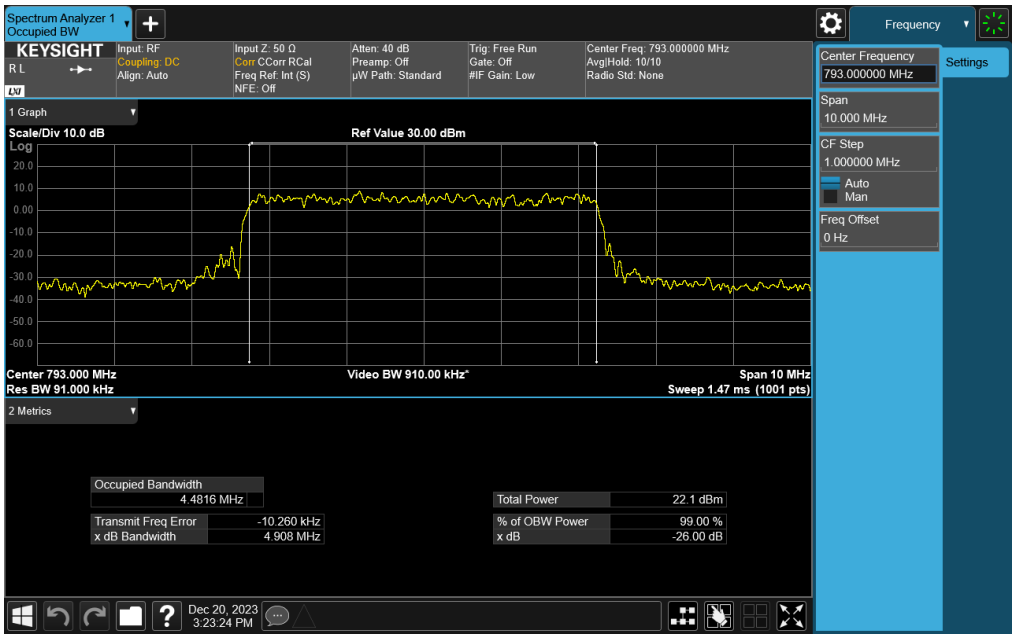
Plot 7-25. Occupied Bandwidth Plot (NR Band 14 - 5MHz DFT-s-OFDM π/2 BPSK - Full RB)



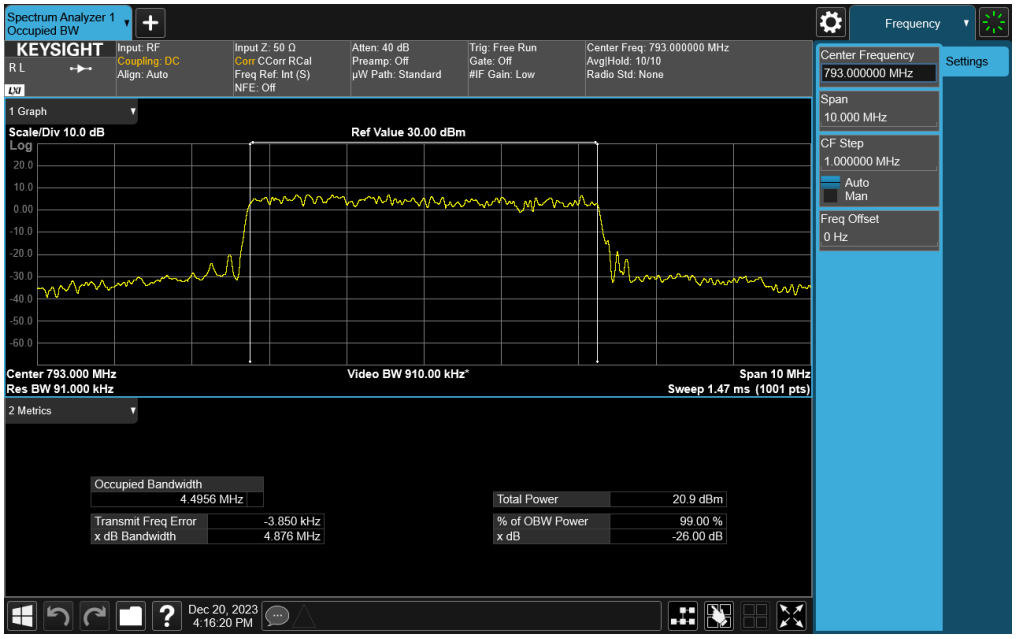
Plot 7-26. Occupied Bandwidth Plot (NR Band 14 - 5MHz CP-OFDM QPSK - Full RB)



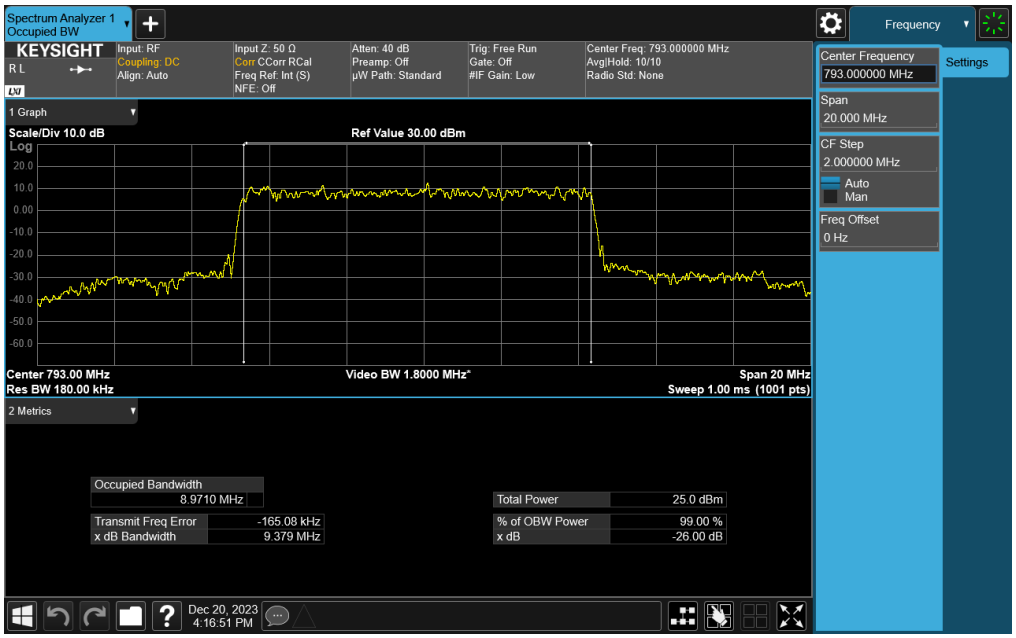
Plot 7-27. Occupied Bandwidth Plot (NR Band 14 - 5MHz DFT-s-OFDM 16-QAM - Full RB)



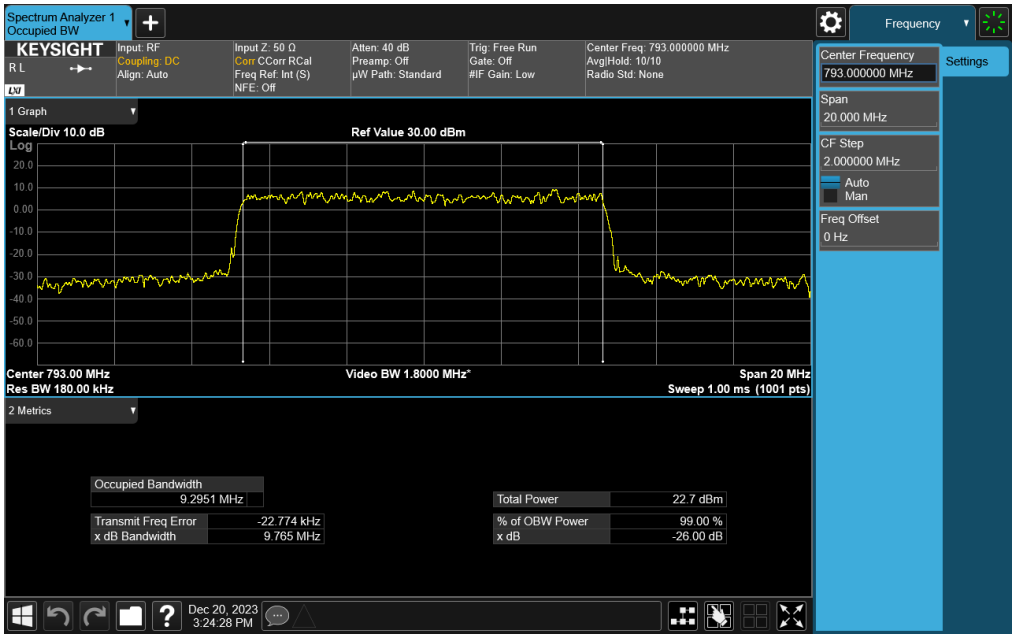
Plot 7-28. Occupied Bandwidth Plot (NR Band 14 - 5MHz CP-OFDM 64-QAM - Full RB)



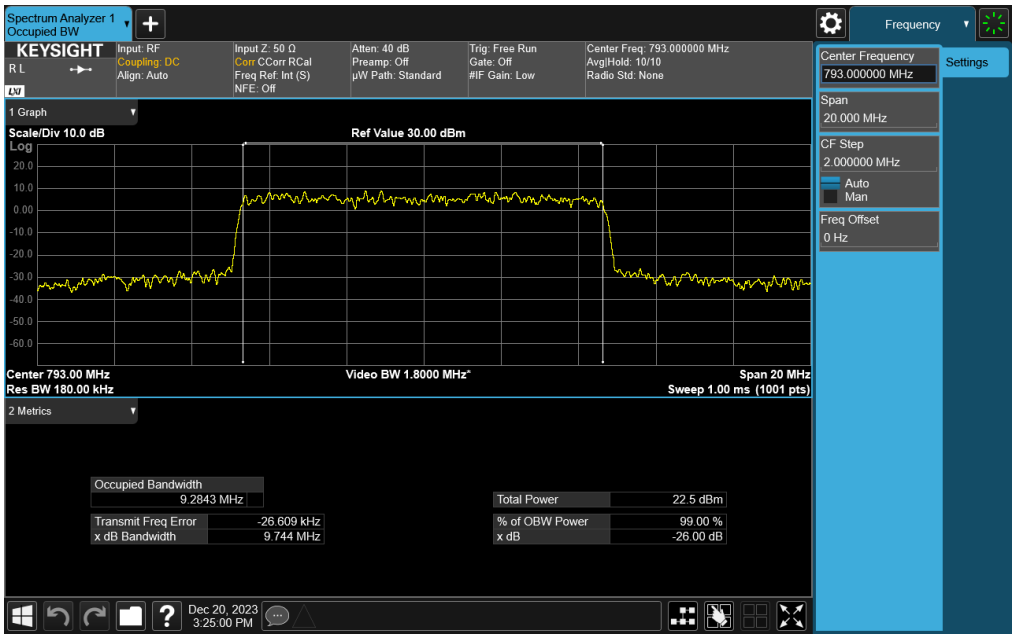
Plot 7-29. Occupied Bandwidth Plot (NR Band 14 - 5MHz DFT-s-OFDM 256-QAM - Full RB)



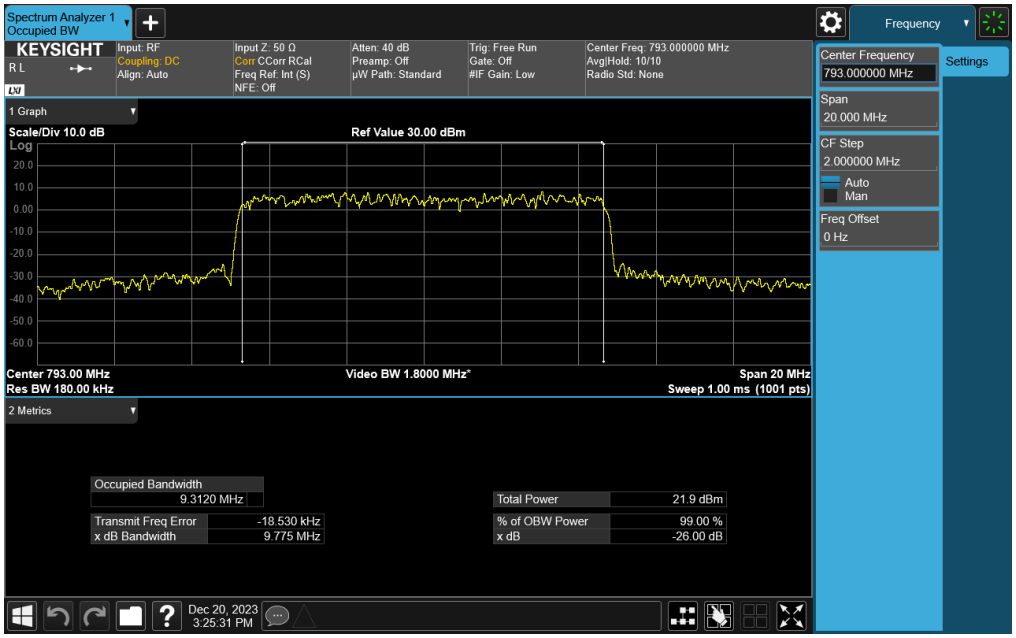
Plot 7-30. Occupied Bandwidth Plot (NR Band 14 - 10MHz DFT-s-OFDM π/2 BPSK - Full RB)



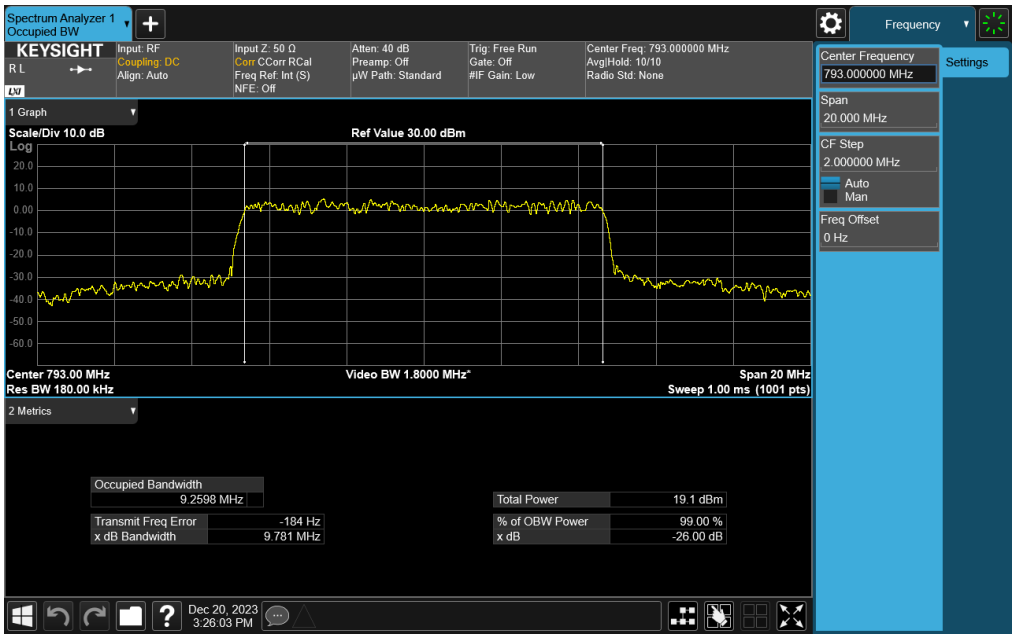
Plot 7-31. Occupied Bandwidth Plot (NR Band 14 - 10MHz CP-OFDM QPSK - Full RB)



Plot 7-32. Occupied Bandwidth Plot (NR Band 14 - 10MHz CP-OFDM 16-QAM - Full RB)

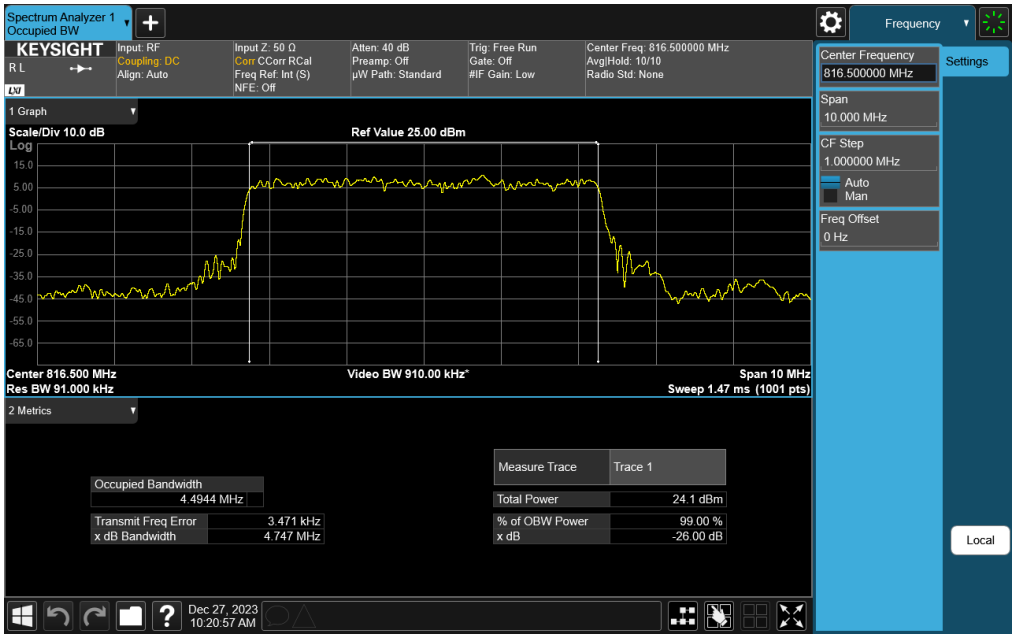


Plot 7-33. Occupied Bandwidth Plot (NR Band 14 - 10MHz CP-OFDM 64-QAM - Full RB)



Plot 7-34. Occupied Bandwidth Plot (NR Band 14 - 10MHz CP-OFDM 256-QAM - Full RB)

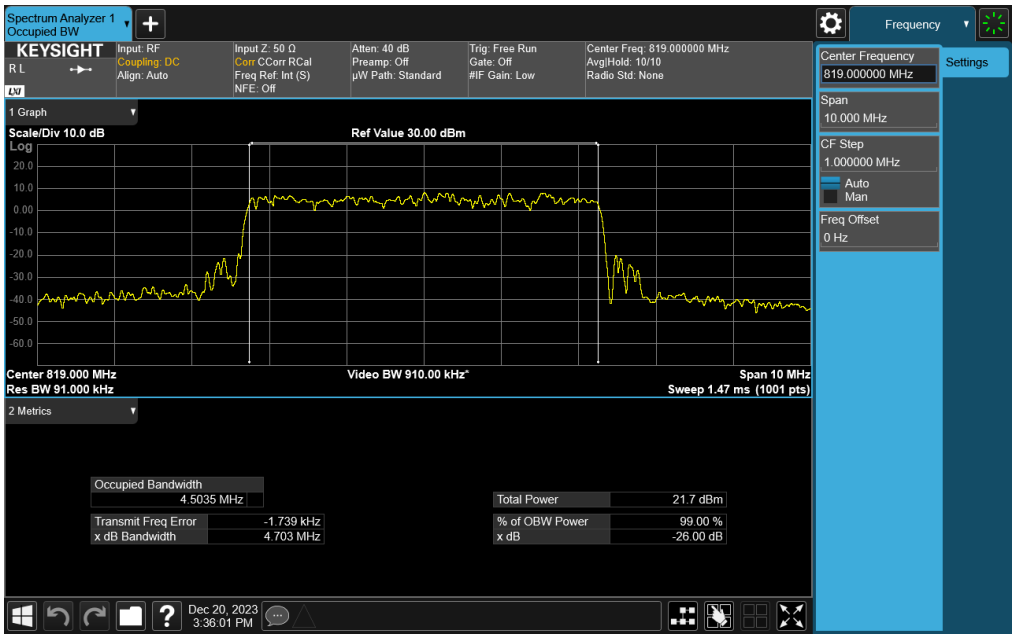
NR Band n26



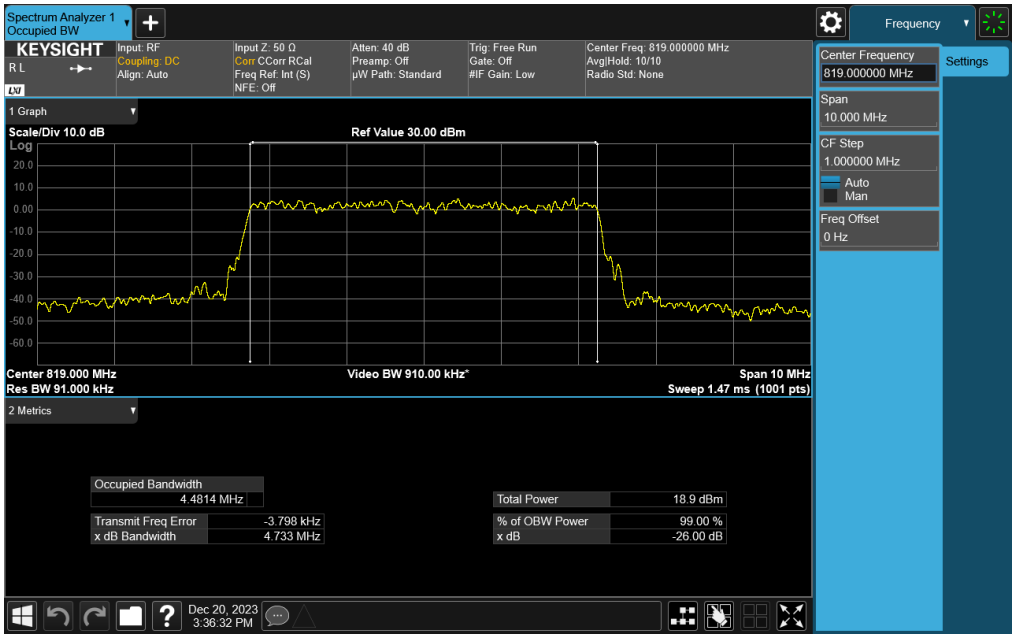
Plot 7-35. Occupied Bandwidth Plot (NR Band 26 - 5MHz DFT-s-OFDM π/2 BPSK - Full RB)

Plot 7-36. Occupied Bandwidth Plot (NR Band 26 - 5MHz DFT-s-OFDM QPSK - Full RB)

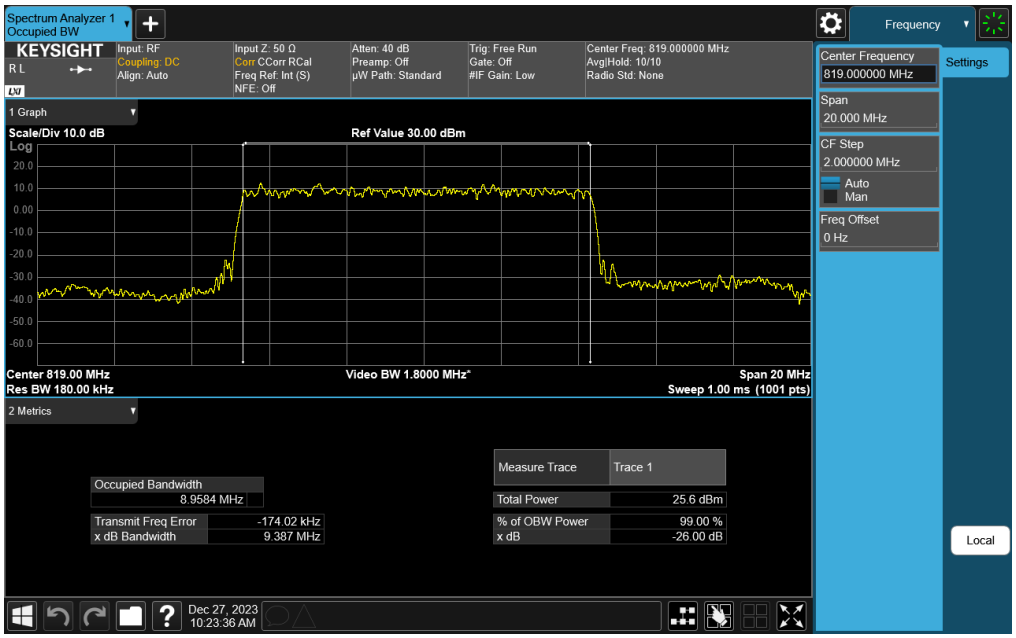
Plot 7-37. Occupied Bandwidth Plot (NR Band 26 - 5MHz CP-OFDM 16-QAM - Full RB)



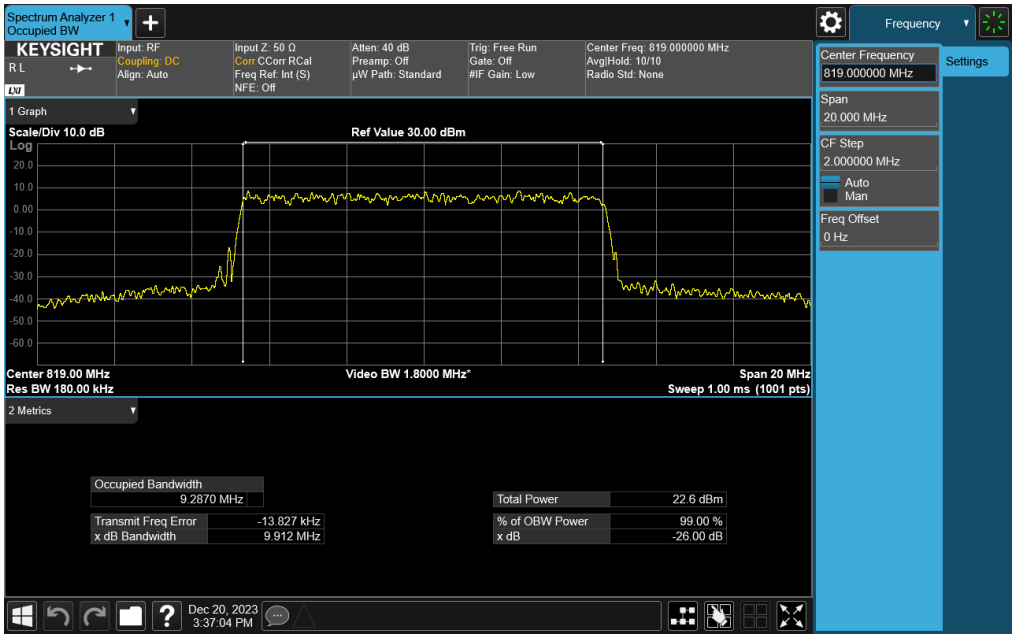
Plot 7-38. Occupied Bandwidth Plot (NR Band 26 - 5MHz CP-OFDM 64-QAM - Full RB)



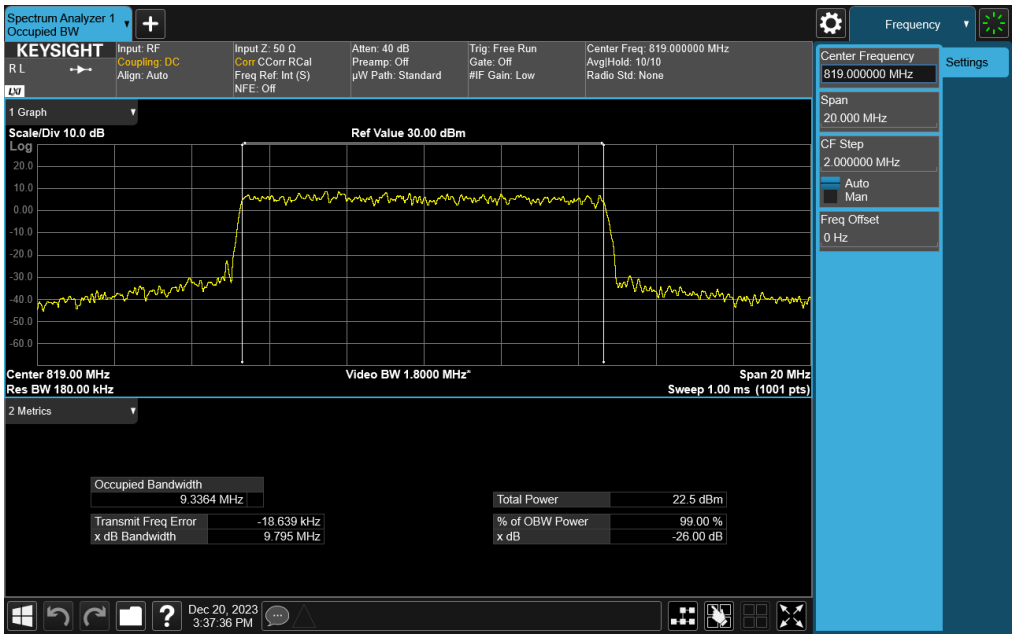
Plot 7-39. Occupied Bandwidth Plot (NR Band 26 - 5MHz CP-OFDM 256-QAM - Full RB)



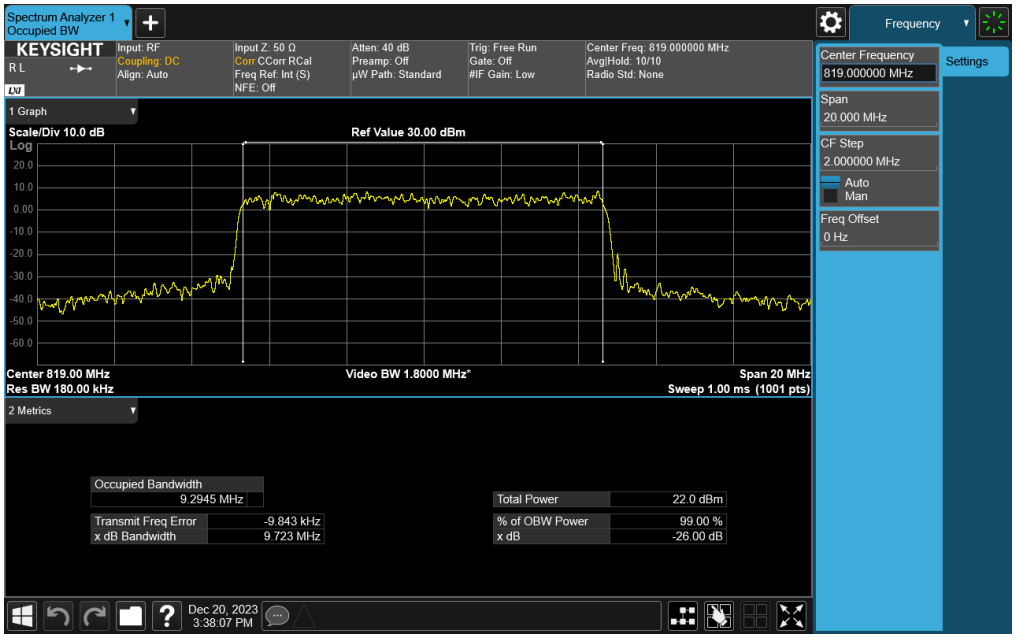
Plot 7-40. Occupied Bandwidth Plot (NR Band 26 - 10MHz DFT-s-OFDM π/2 BPSK - Full RB)



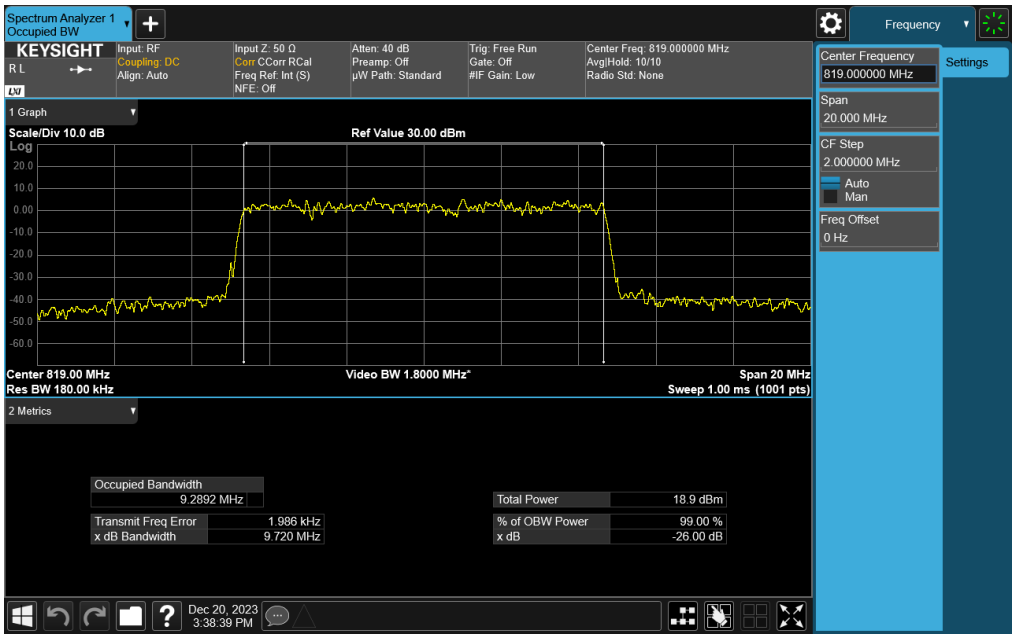
Plot 7-41. Occupied Bandwidth Plot (NR Band 26 - 10MHz CP-OFDM QPSK - Full RB)



Plot 7-42. Occupied Bandwidth Plot (NR Band 26 - 10MHz CP-OFDM 16-QAM - Full RB)



Plot 7-43. Occupied Bandwidth Plot (NR Band 26 - 10MHz CP-OFDM 64-QAM - Full RB)



Plot 7-44. Occupied Bandwidth Plot (NR Band 26 - 10MHz CP-OFDM 256-QAM - Full RB)

7.3 Spurious and Harmonic Emissions at Antenna Terminal

§2.1051 §90.691(a) §90.543(e)

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 and all ports were investigated and the worst case configuration results are reported in this section.

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

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 10GHz (separated into at least two plots per channel)
2. RBW ≥ 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.

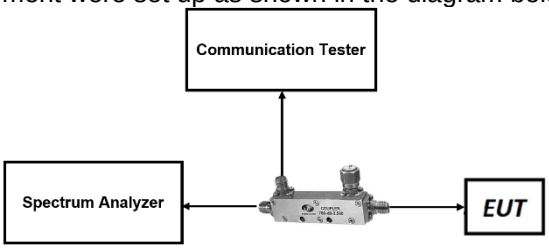
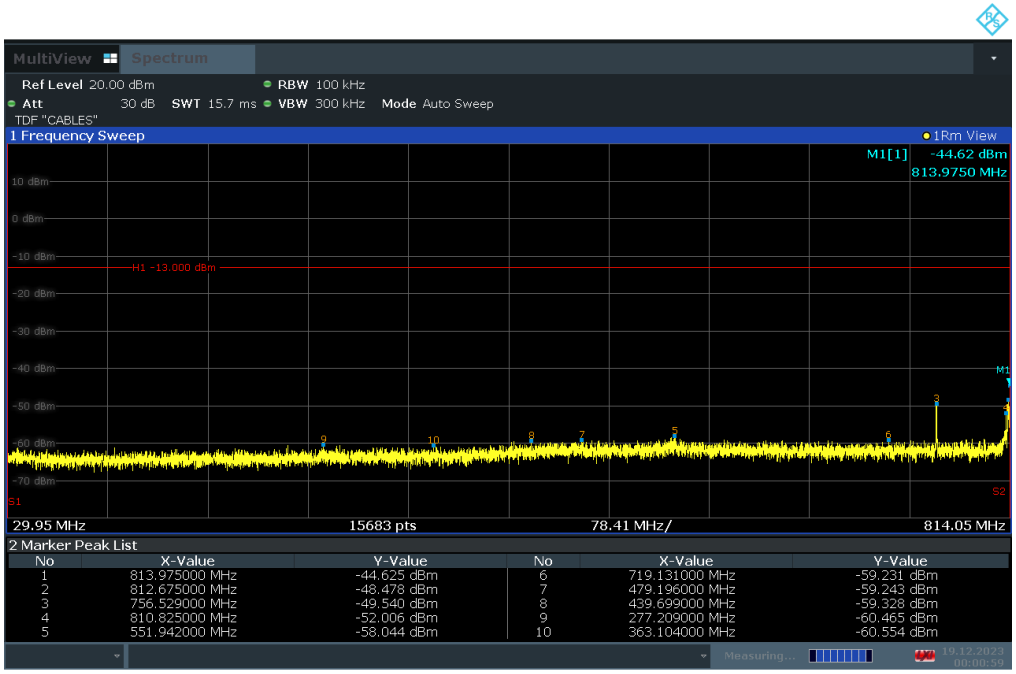


Figure 7-2. Test Instrument & Measurement Setup

Test Notes

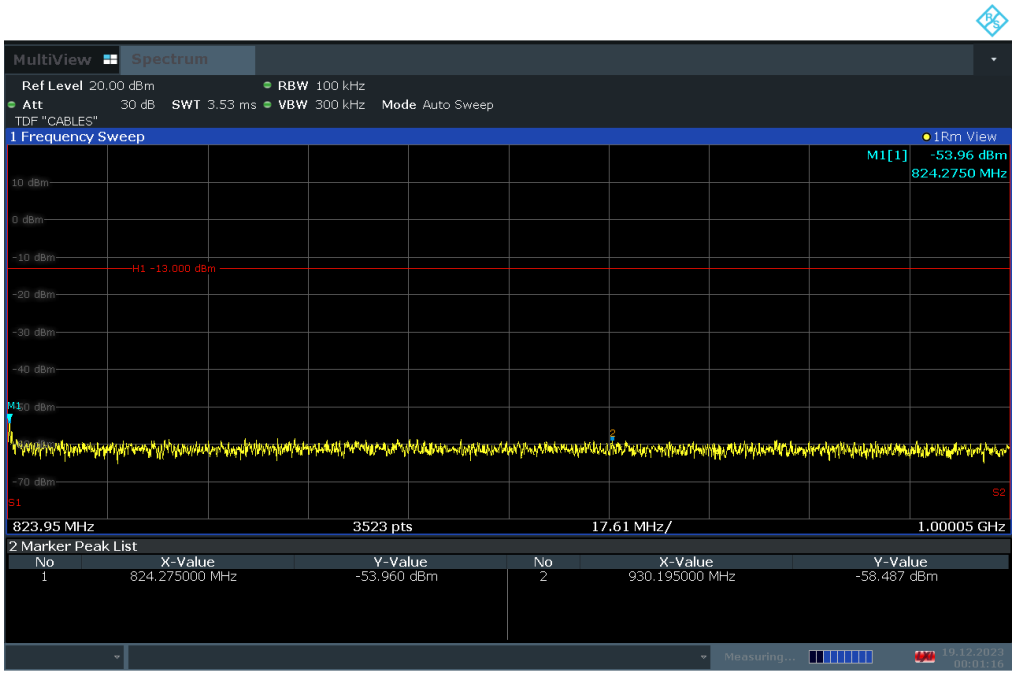
Compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater for Part 90. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission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

LTE Band 26



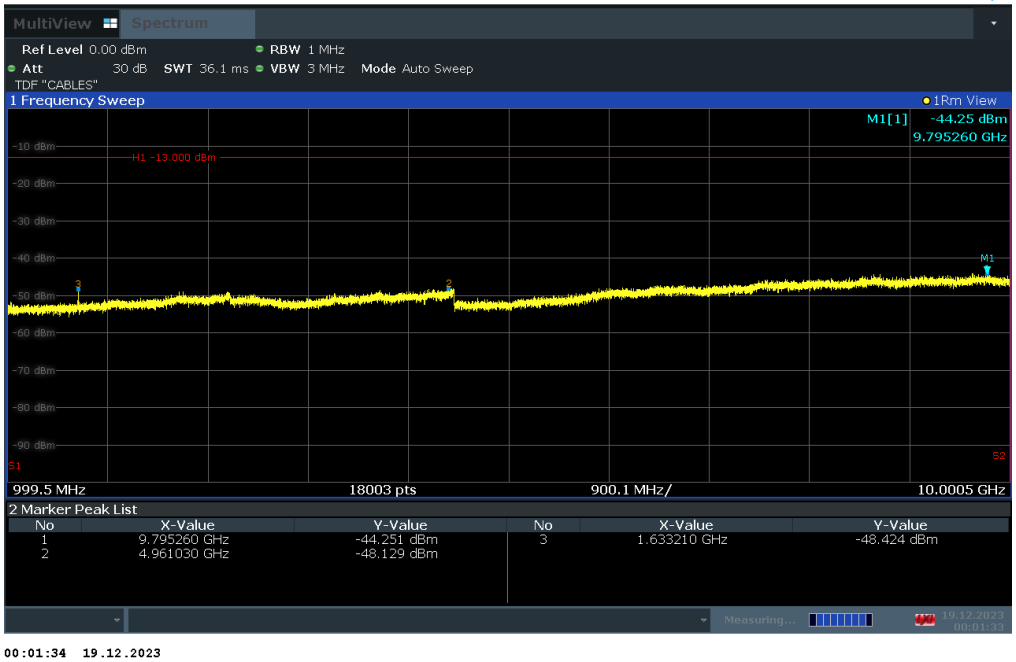
00:01:00 19.12.2023

Plot 7-45. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



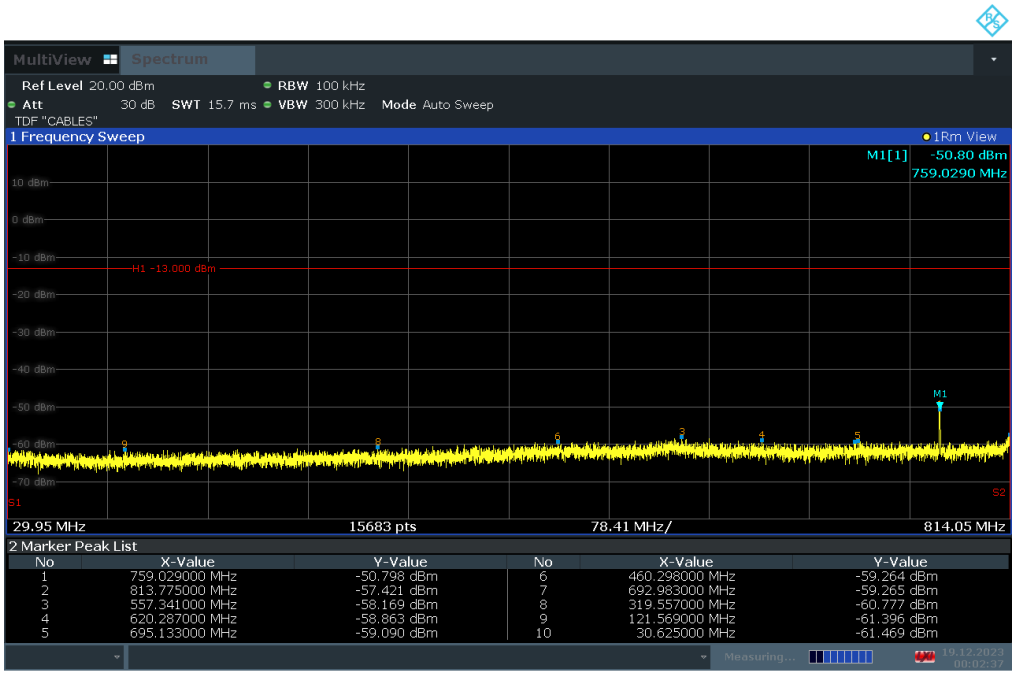
00:01:17 19.12.2023

Plot 7-46. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



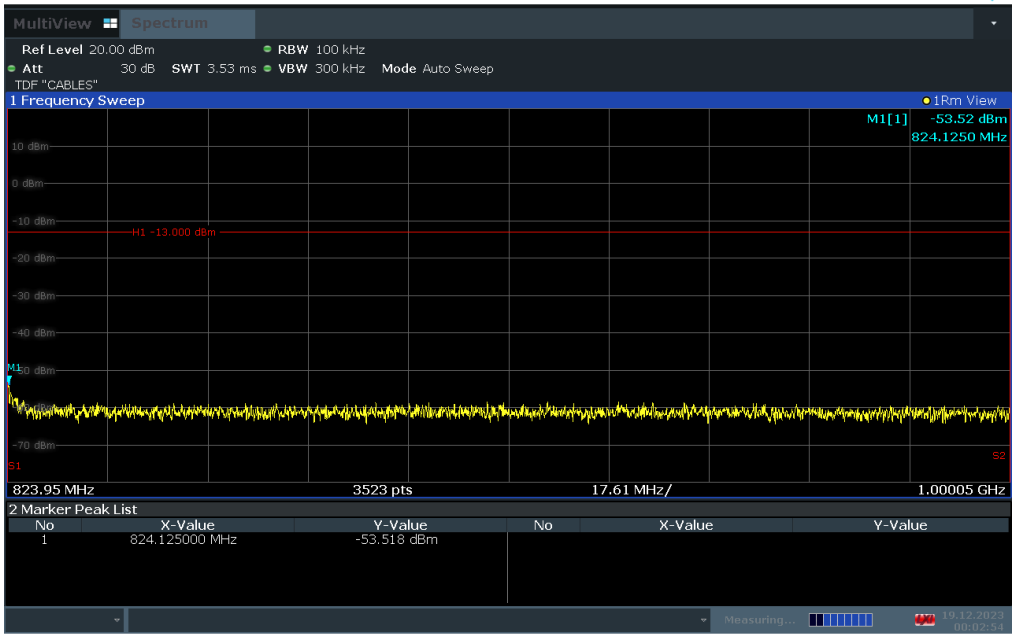
00:01:34 19.12.2023

Plot 7-47. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



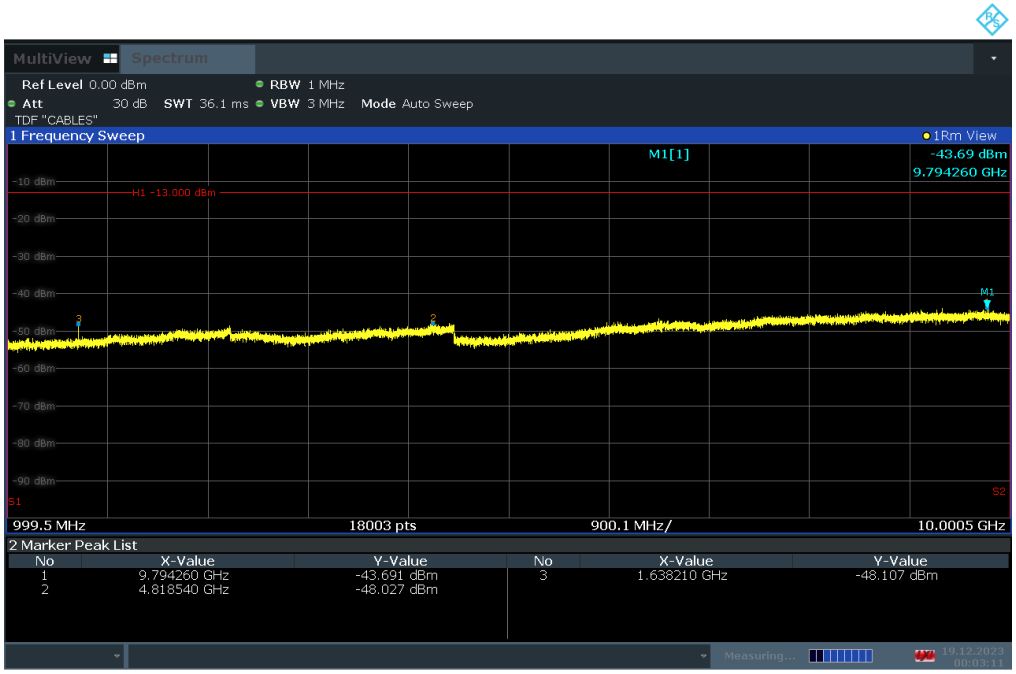
00:02:38 19.12.2023

Plot 7-48. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



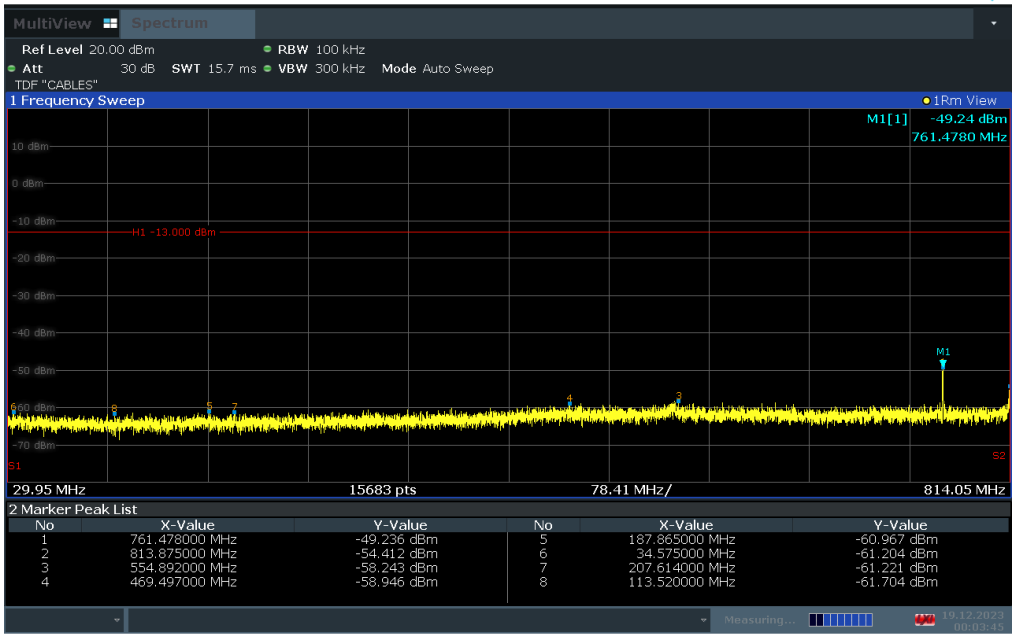
00:02:55 19.12.2023

Plot 7-49. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



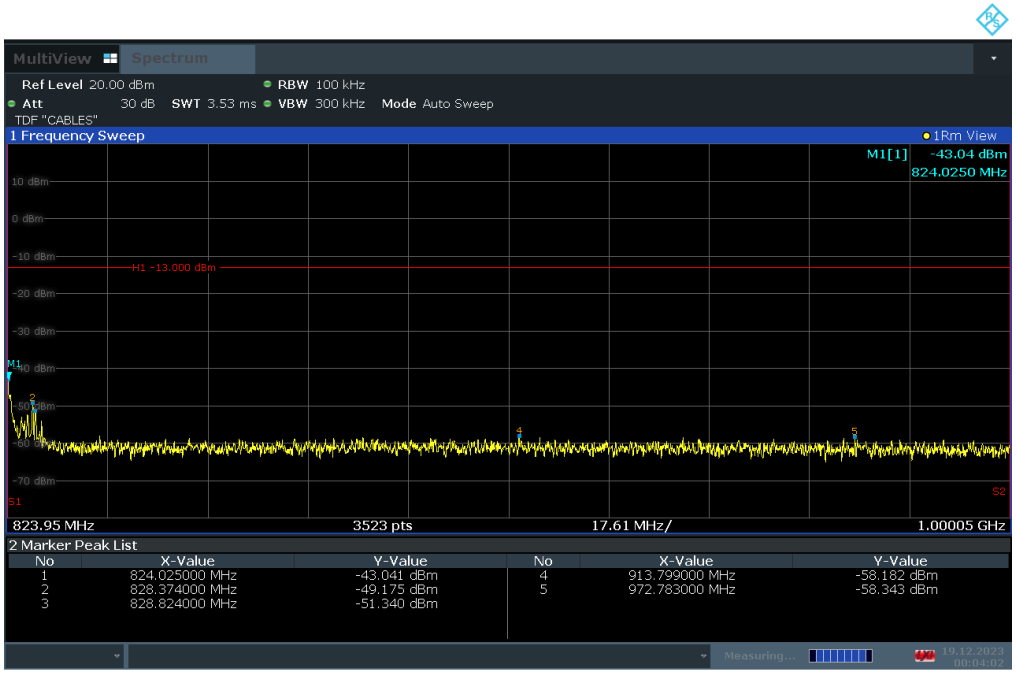
00:03:12 19.12.2023

Plot 7-50. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



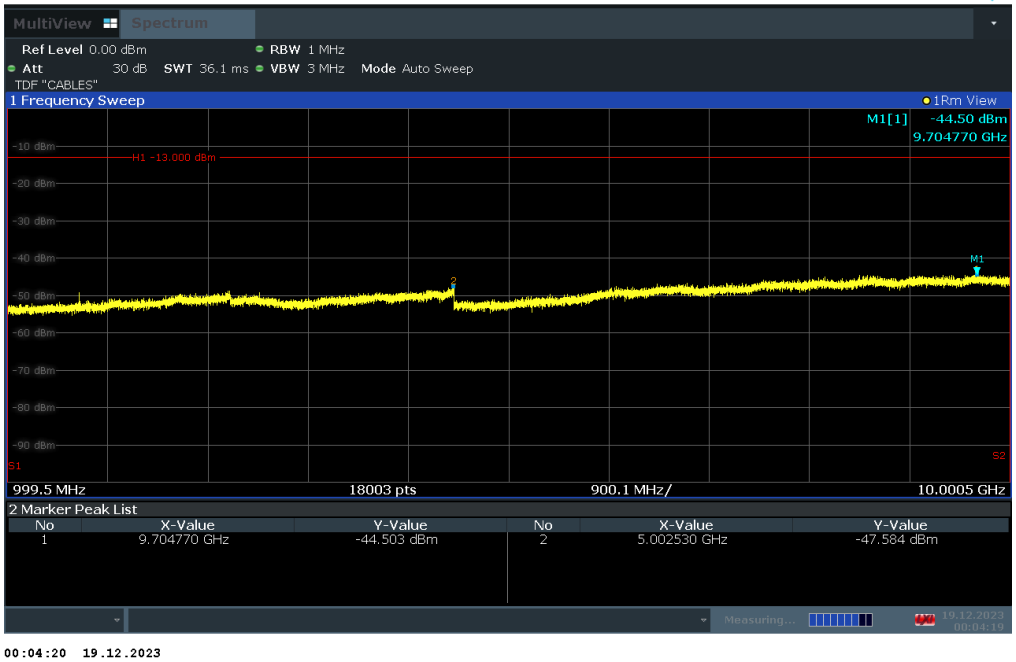
00:03:46 19.12.2023

Plot 7-51. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



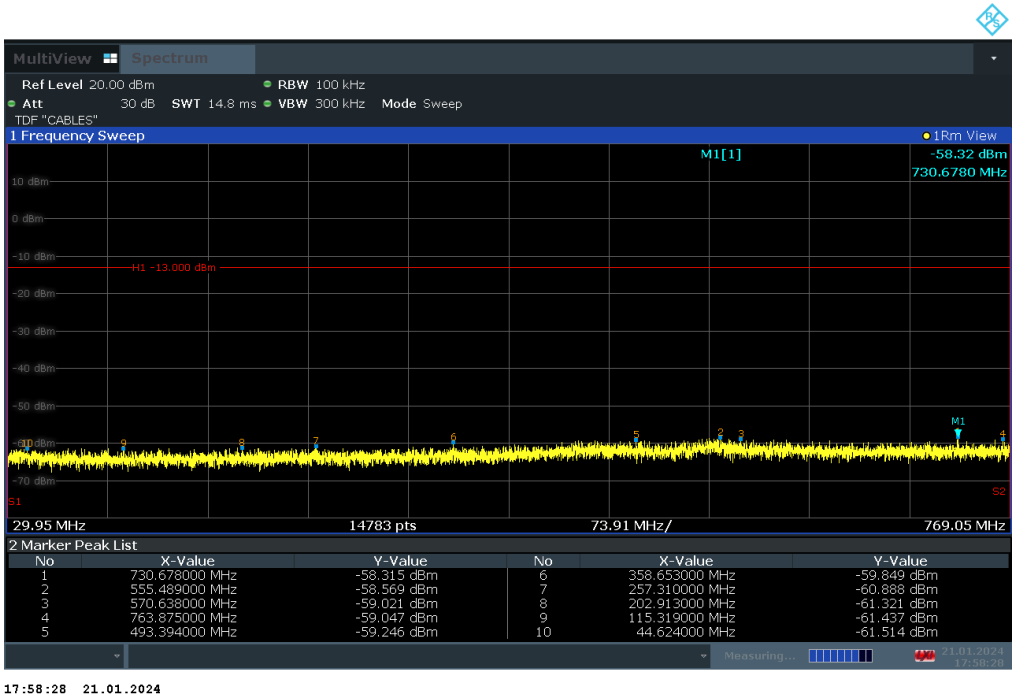
00:04:03 19.12.2023

Plot 7-52. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



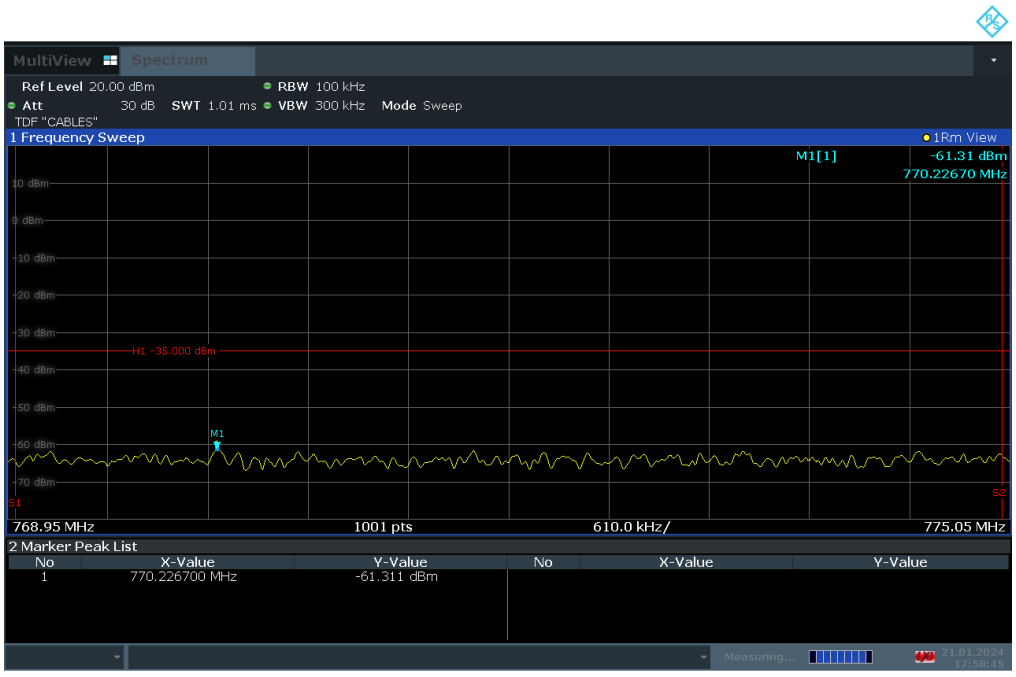
Plot 7-53. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

LTE Band 14



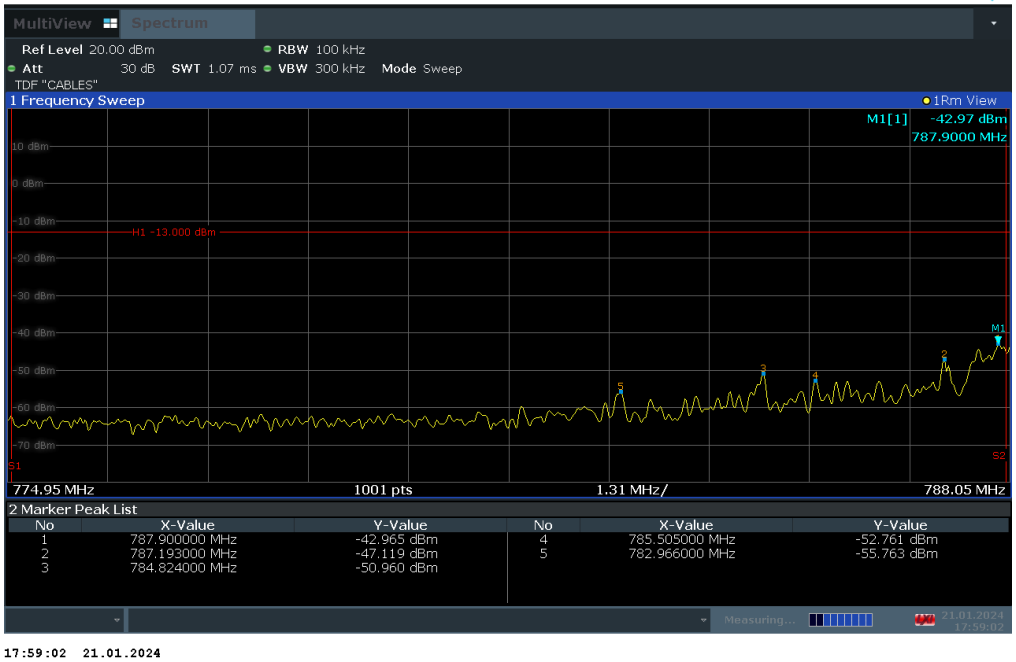
17:58:28 21.01.2024

Plot 7-54. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



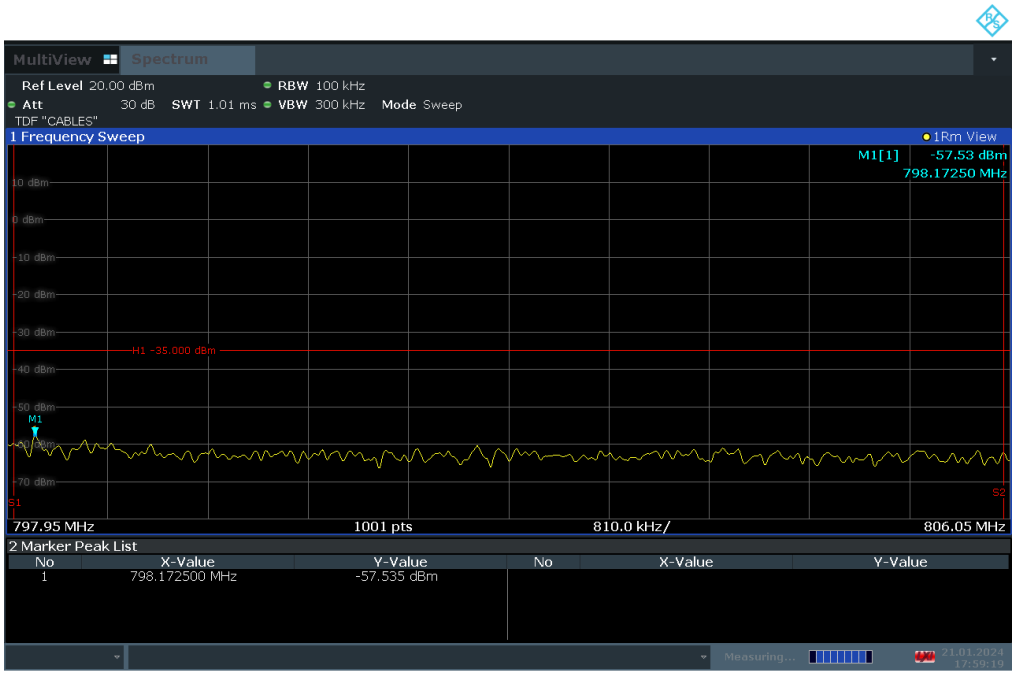
17:58:45 21.01.2024

Plot 7-55. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



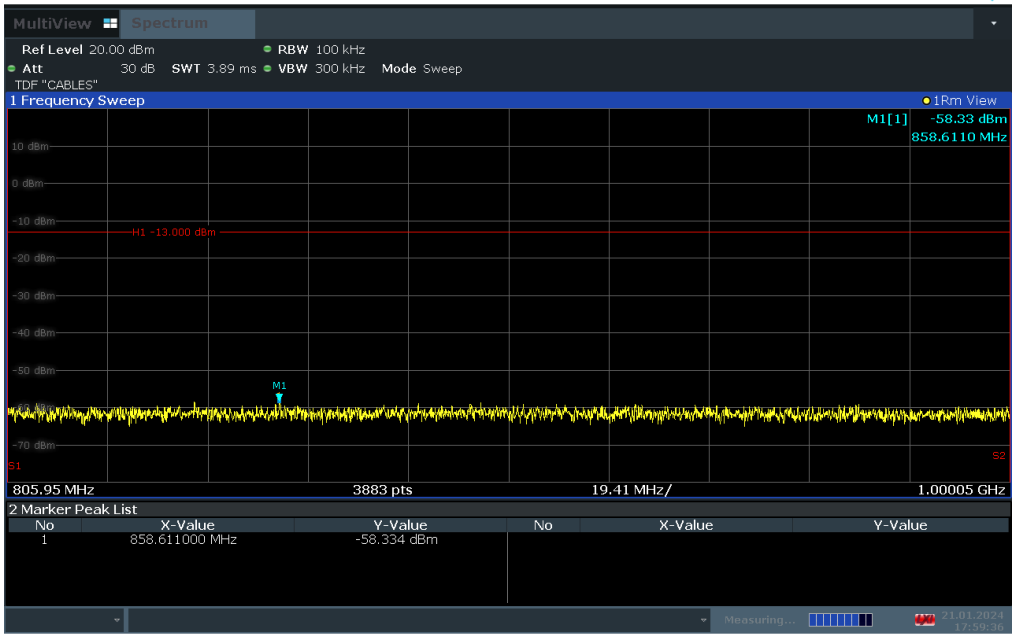
17:59:02 21.01.2024

Plot 7-56. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



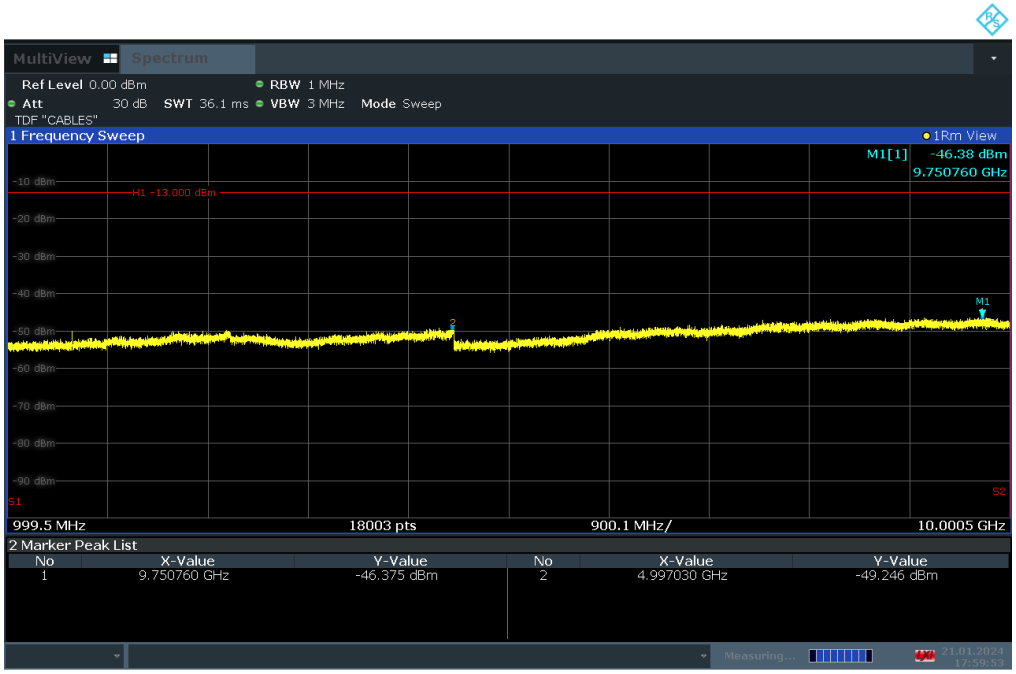
17:59:19 21.01.2024

Plot 7-57. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



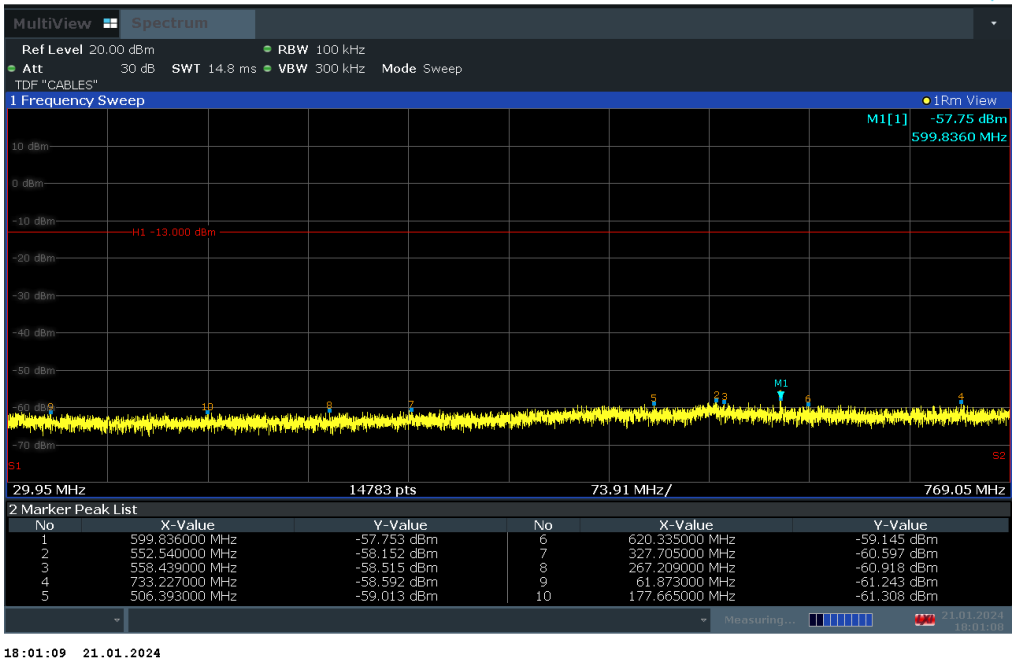
17:59:37 21.01.2024

Plot 7-58. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

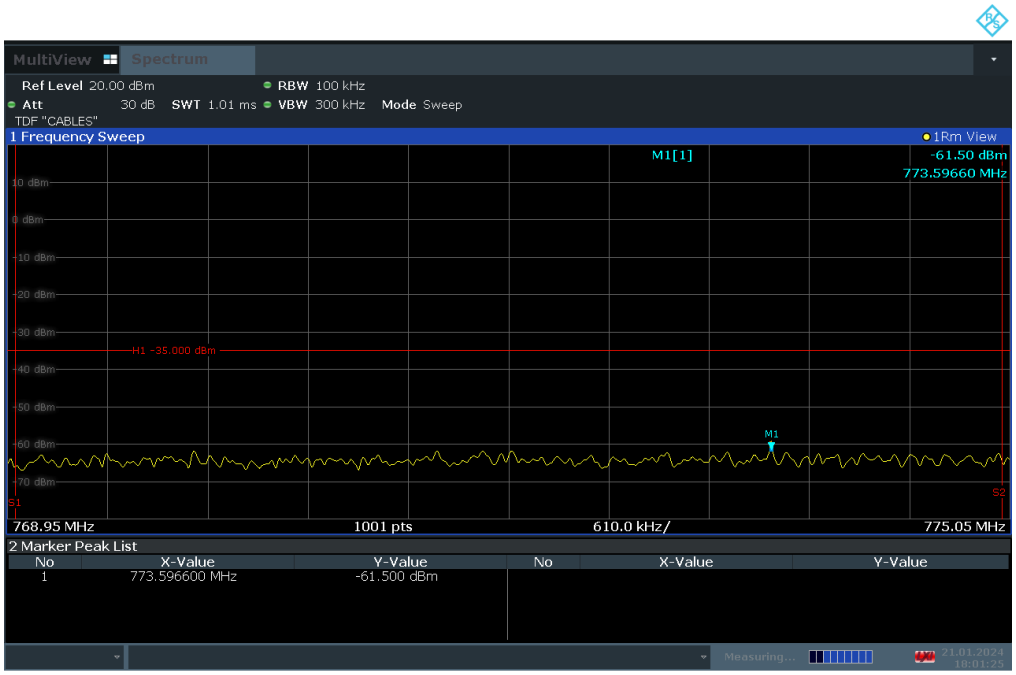


17:59:54 21.01.2024

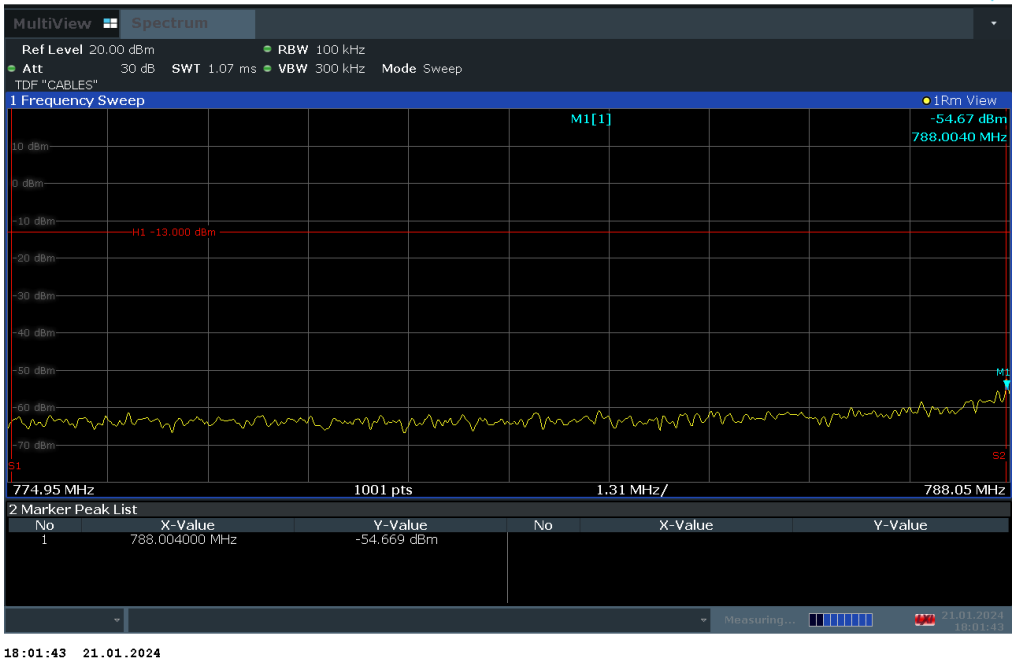
Plot 7-59. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



Plot 7-60. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

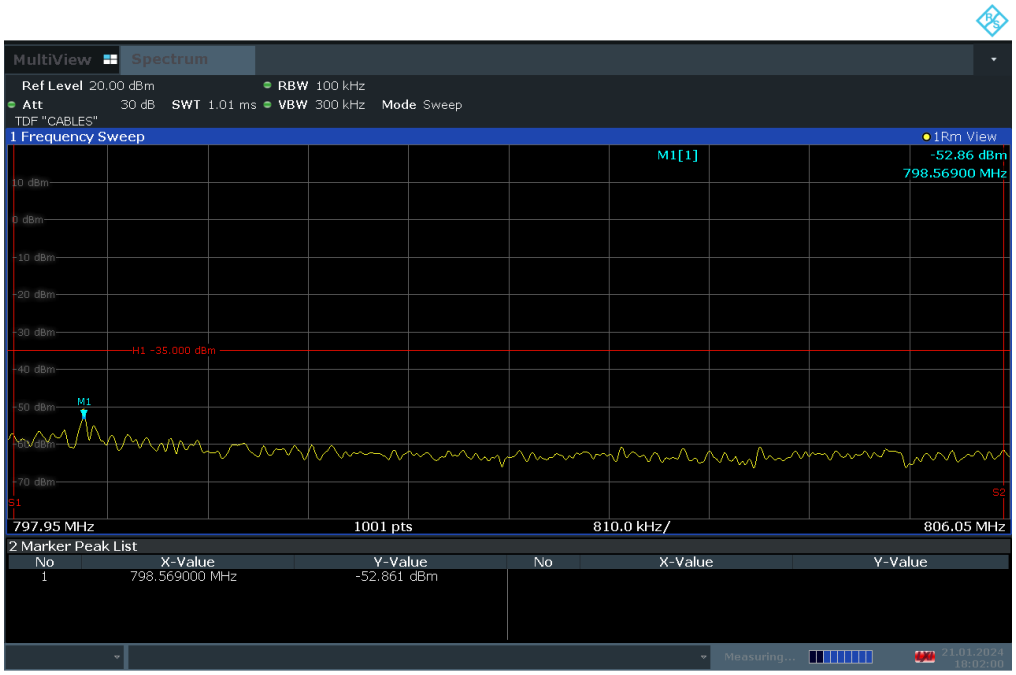


Plot 7-61. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



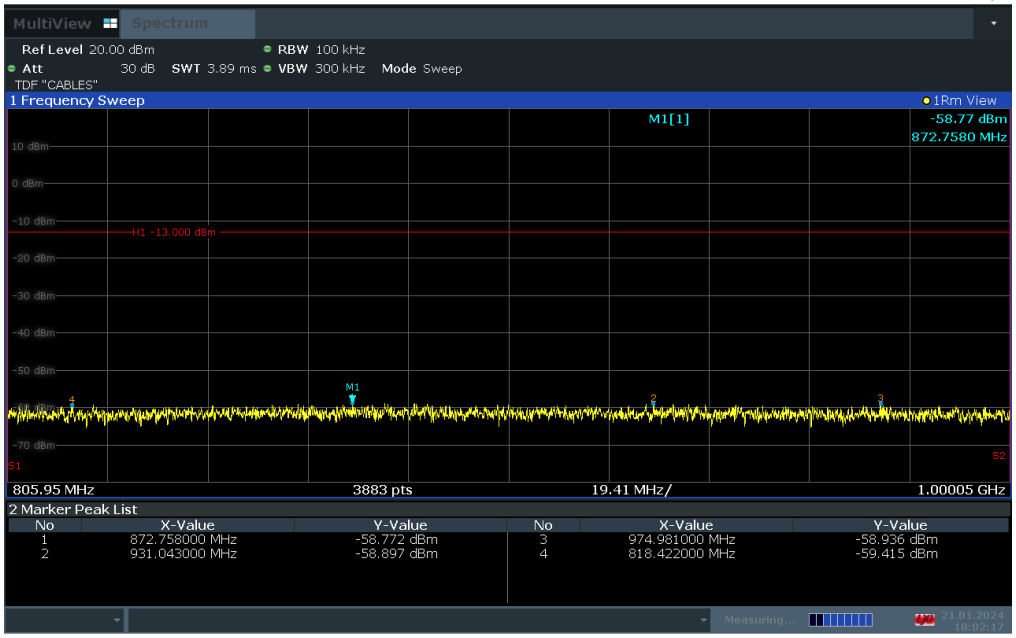
18:01:43 21.01.2024

Plot 7-62. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



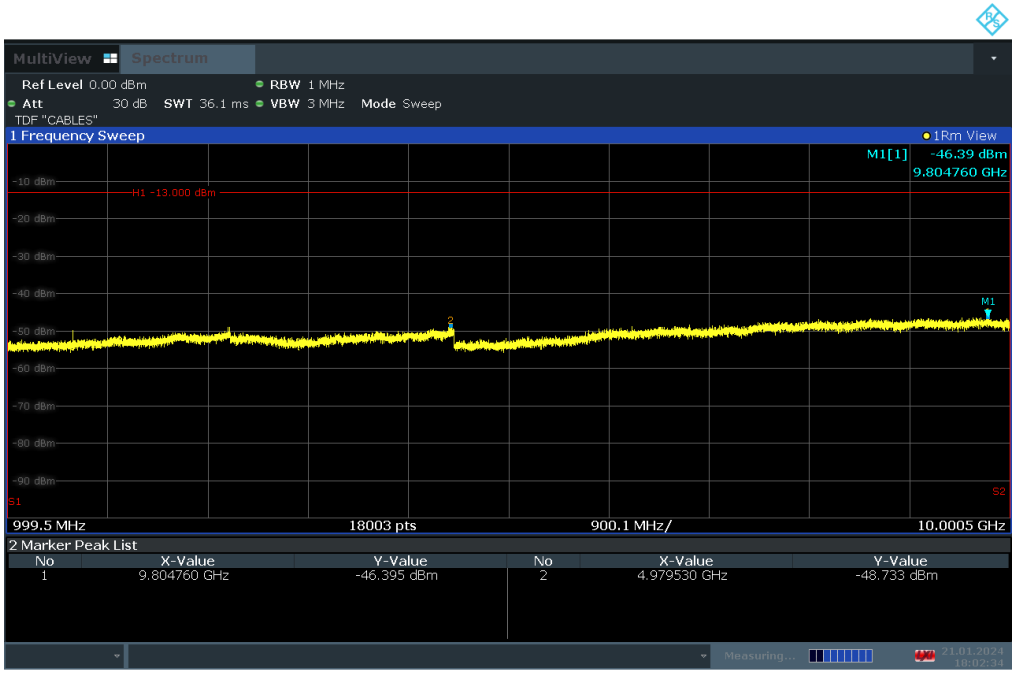
18:02:00 21.01.2024

Plot 7-63. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



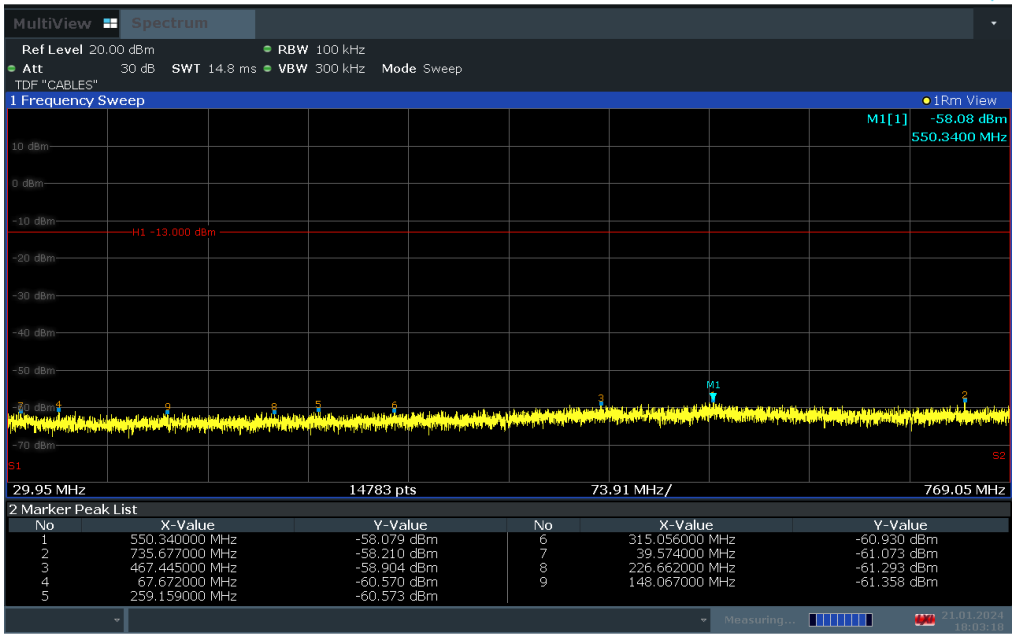
18:02:18 21.01.2024

Plot 7-64. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



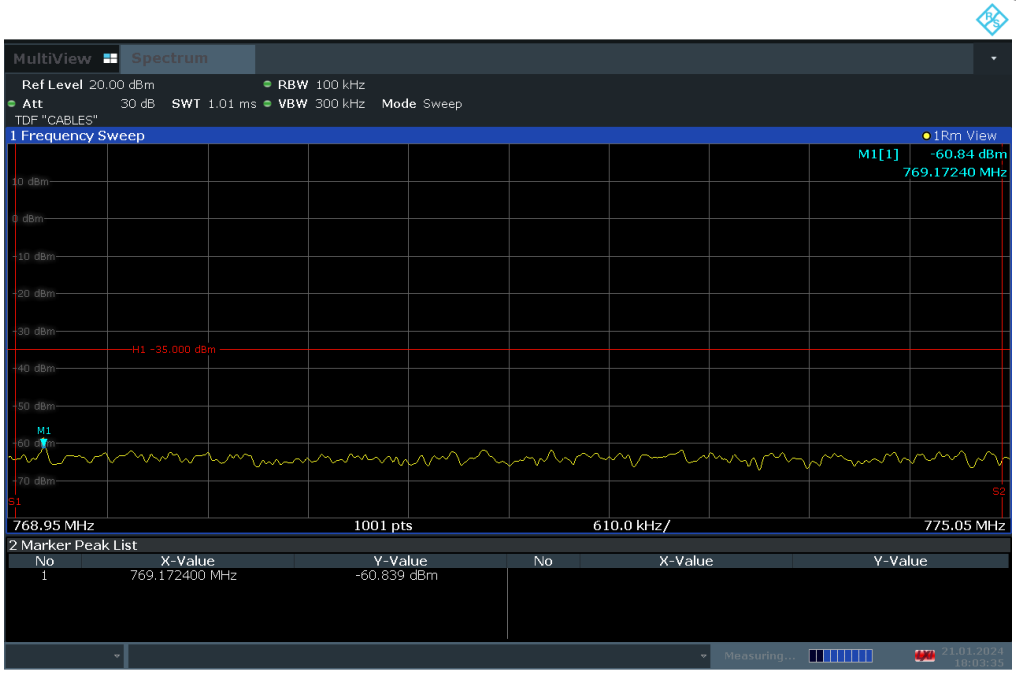
18:02:35 21.01.2024

Plot 7-65. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



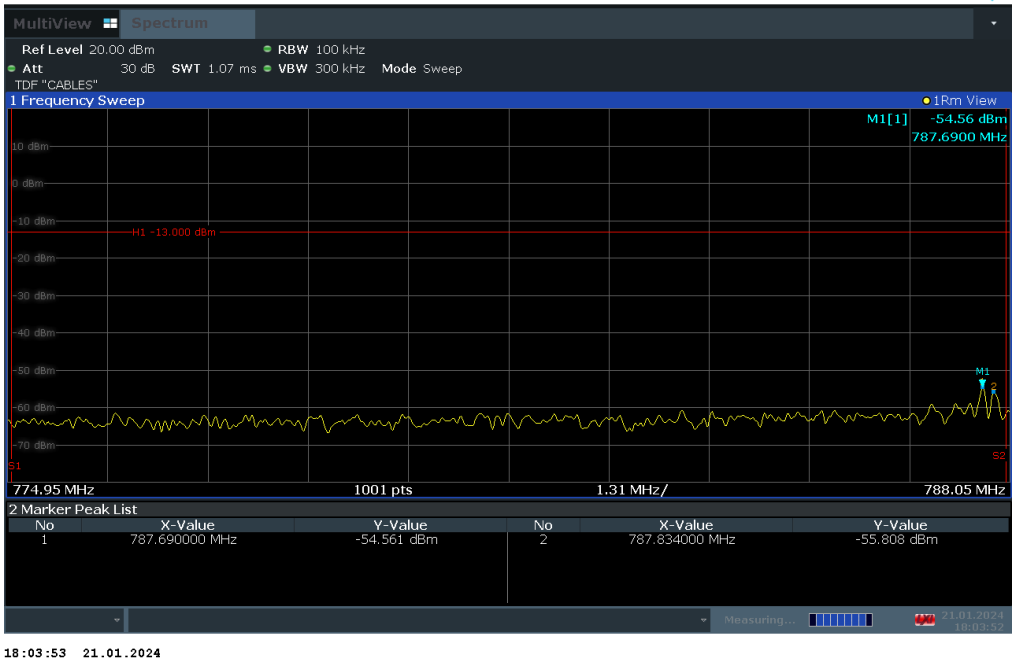
18:03:19 21.01.2024

Plot 7-66. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



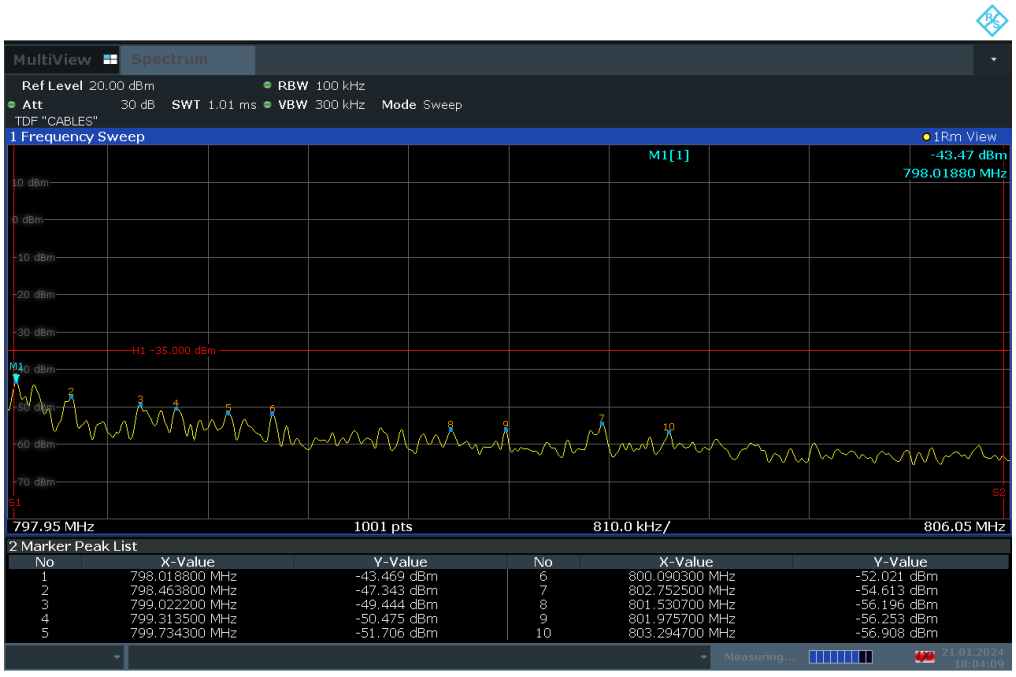
18:03:36 21.01.2024

Plot 7-67. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



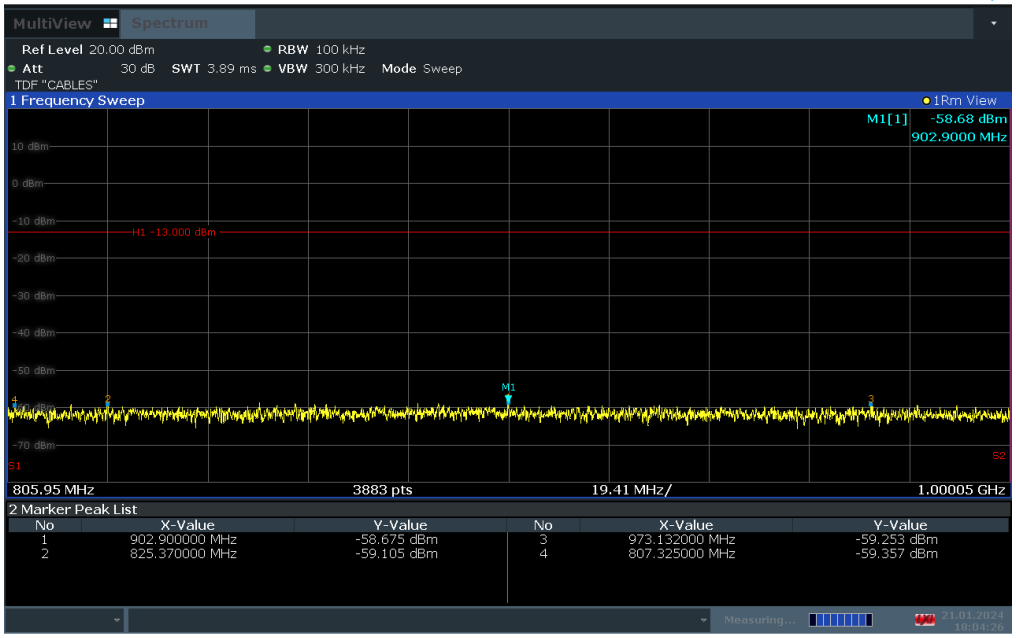
18:03:53 21.01.2024

Plot 7-68. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

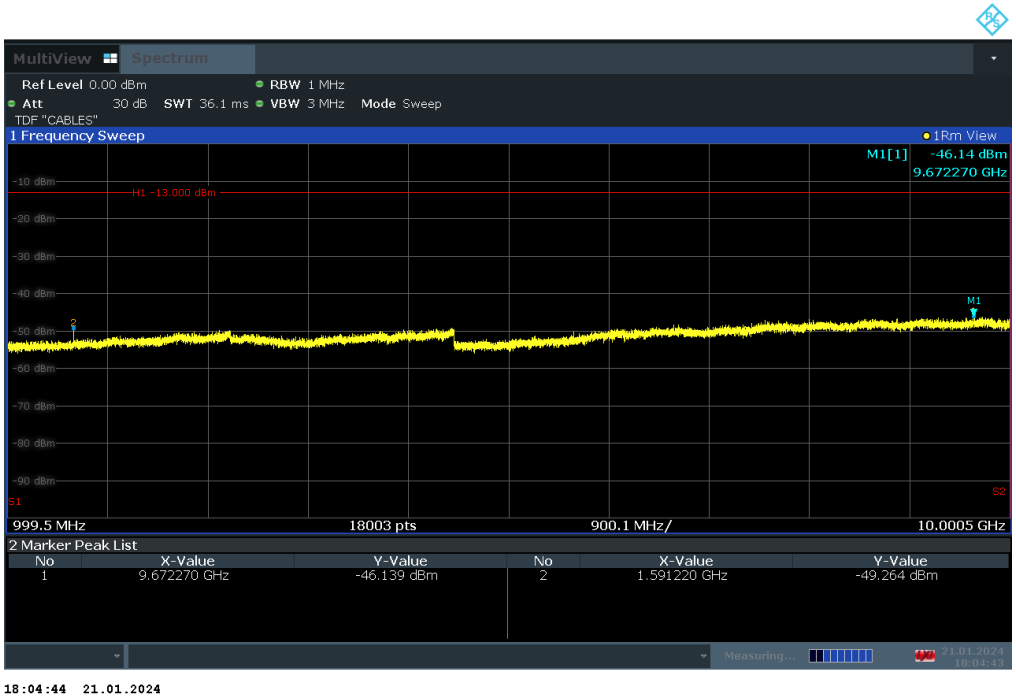


18:04:10 21.01.2024

Plot 7-69. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

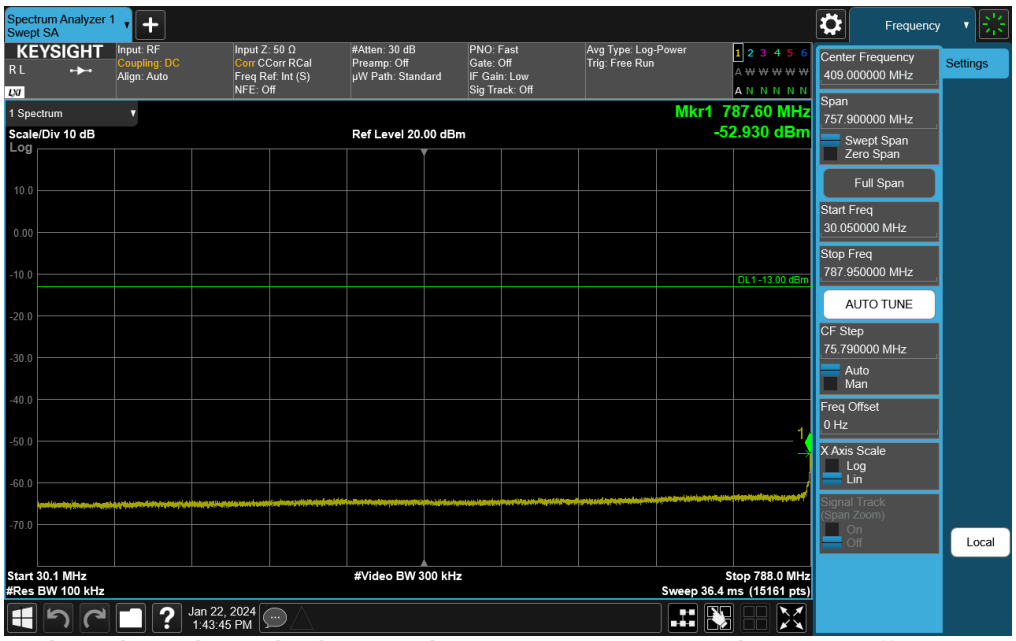


Plot 7-70. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

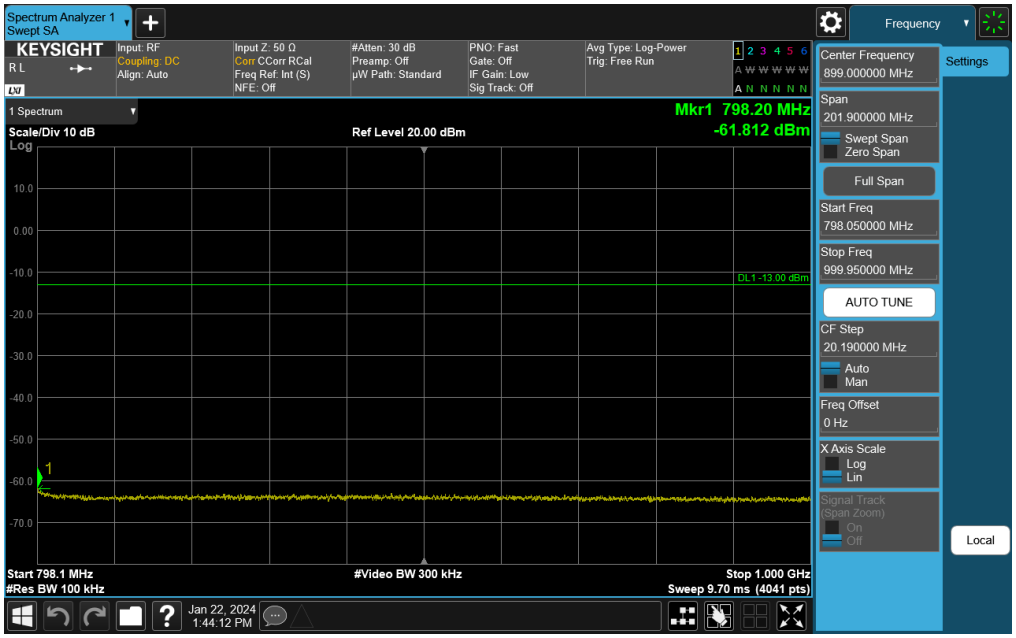


Plot 7-71. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

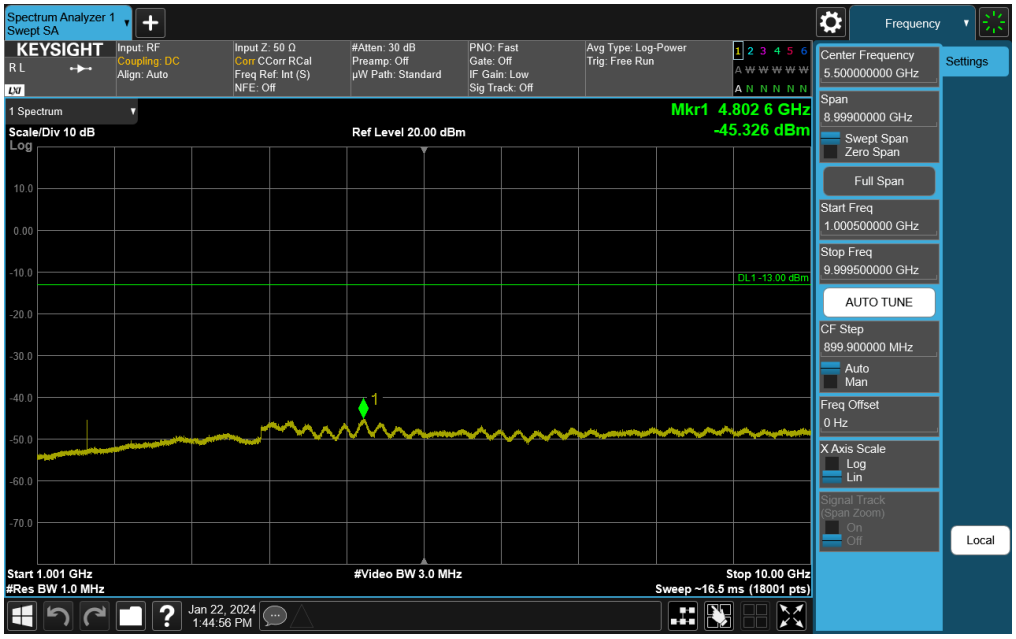
NR Band 14



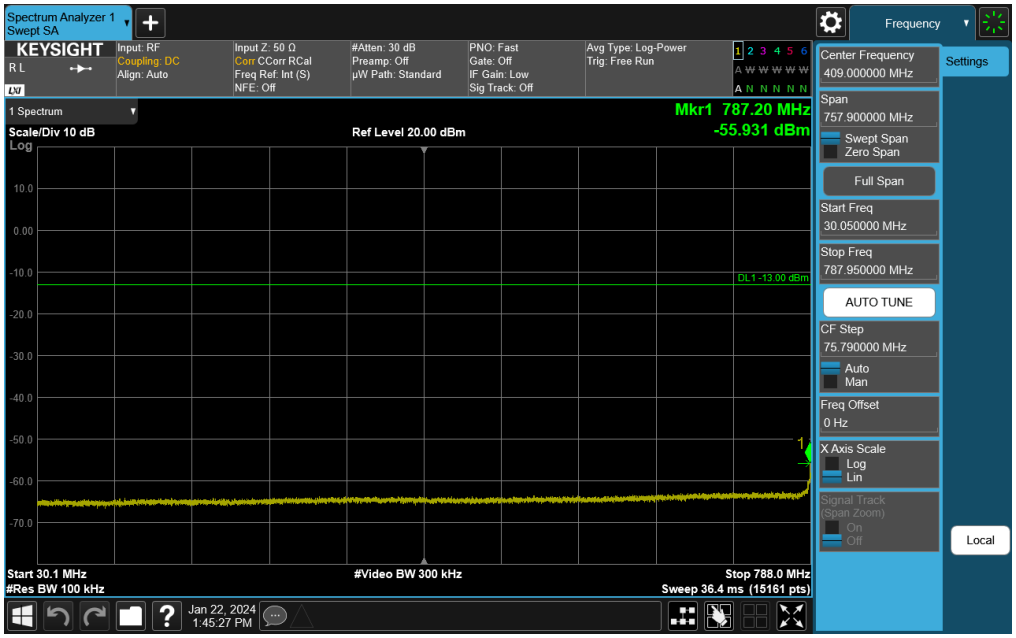
Plot 7-72. Conducted Spurious Plot (NR Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



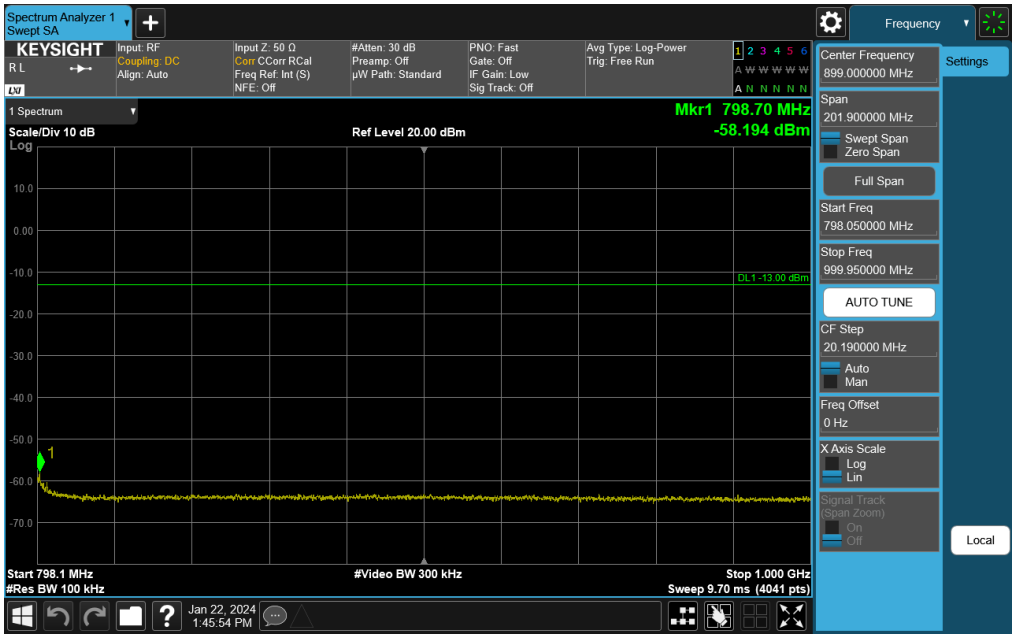
Plot 7-73. Conducted Spurious Plot (NR Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



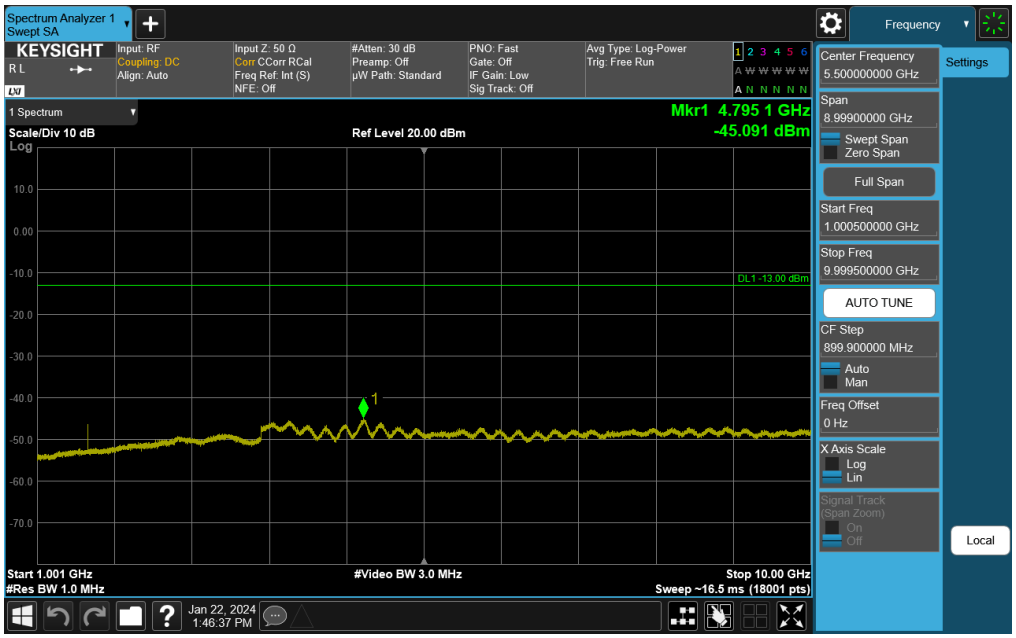
Plot 7-74. Conducted Spurious Plot (NR Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



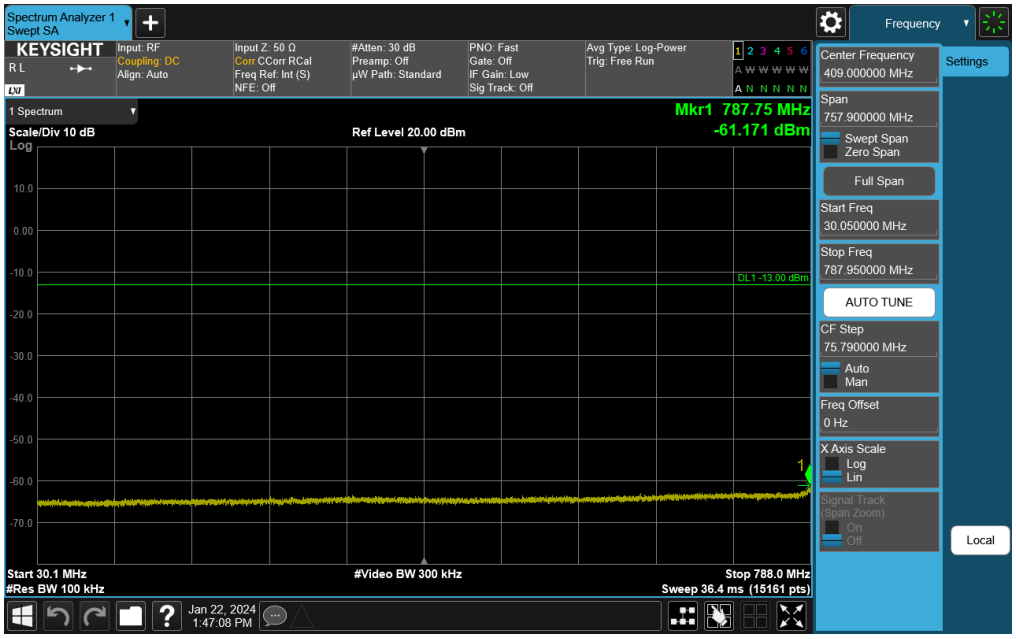
Plot 7-75. Conducted Spurious Plot (NR Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



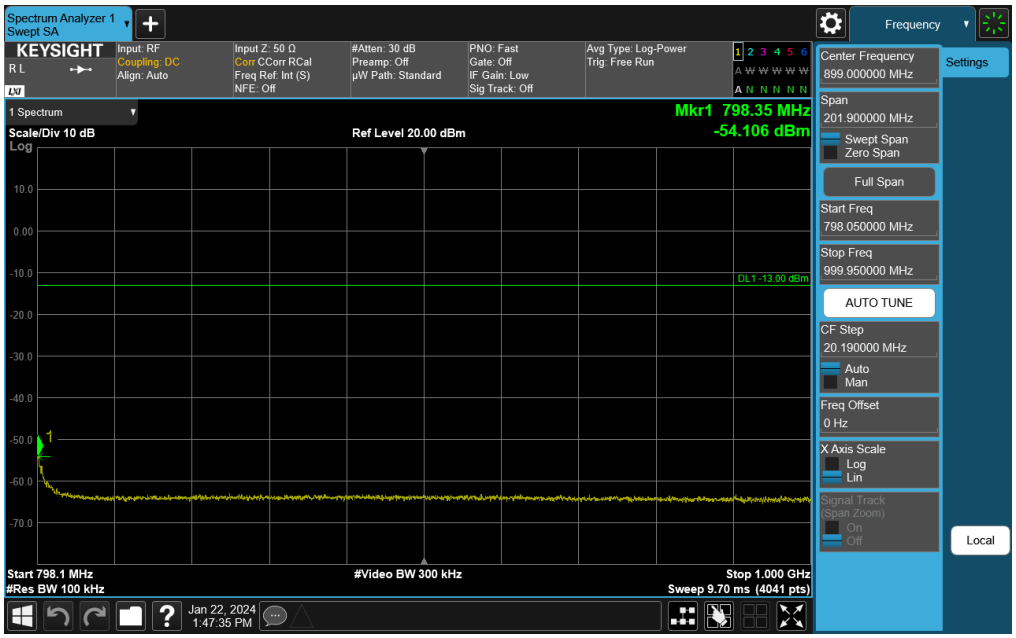
Plot 7-76. Conducted Spurious Plot (NR Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



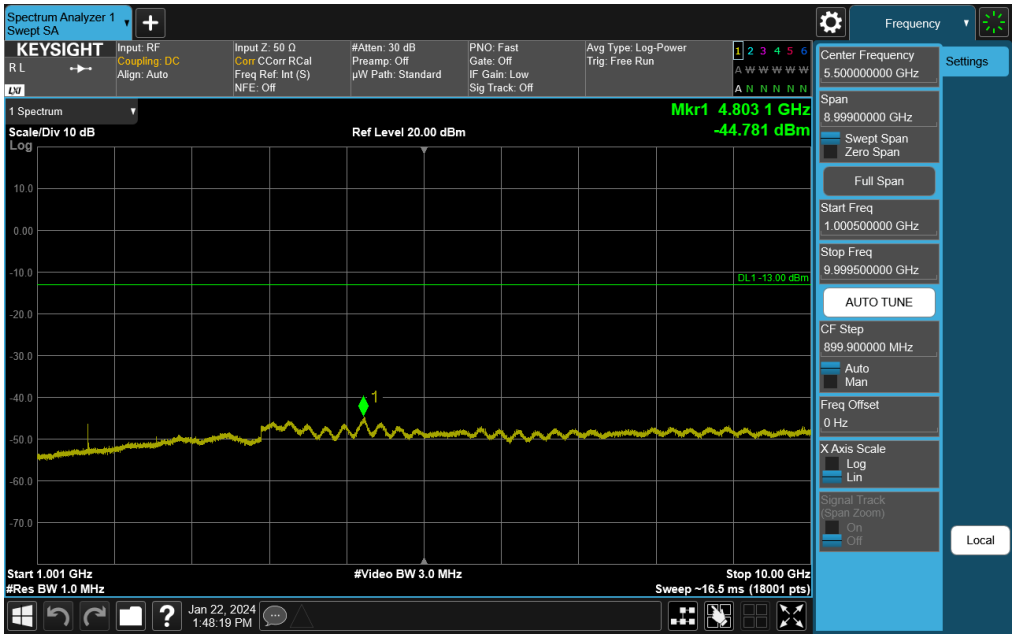
Plot 7-77. Conducted Spurious Plot (NR Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



Plot 7-78. Conducted Spurious Plot (NR Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

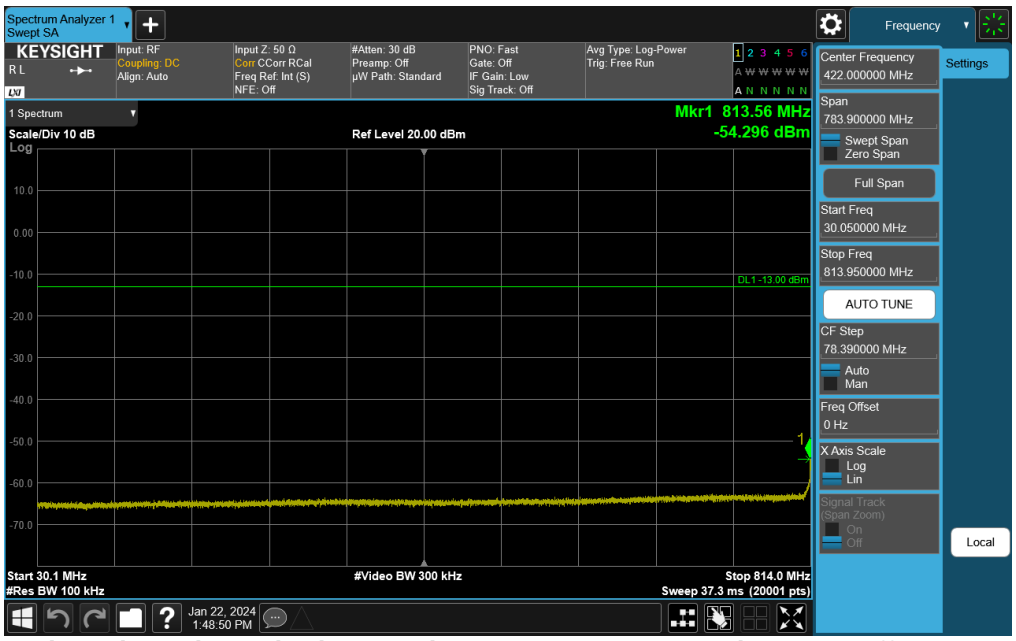


Plot 7-79. Conducted Spurious Plot (NR Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

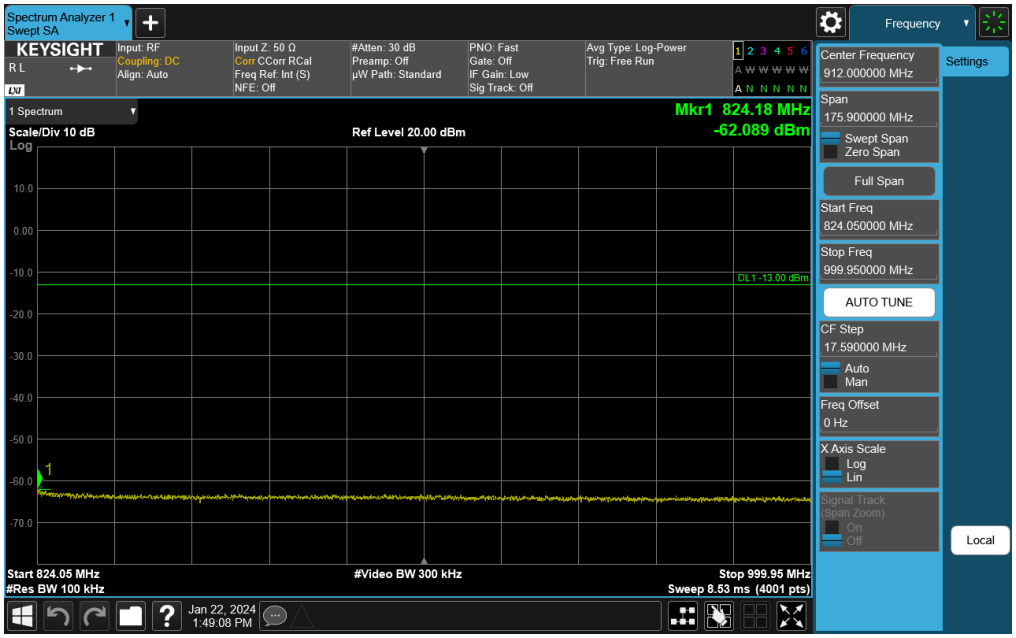


Plot 7-80. Conducted Spurious Plot (NR Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

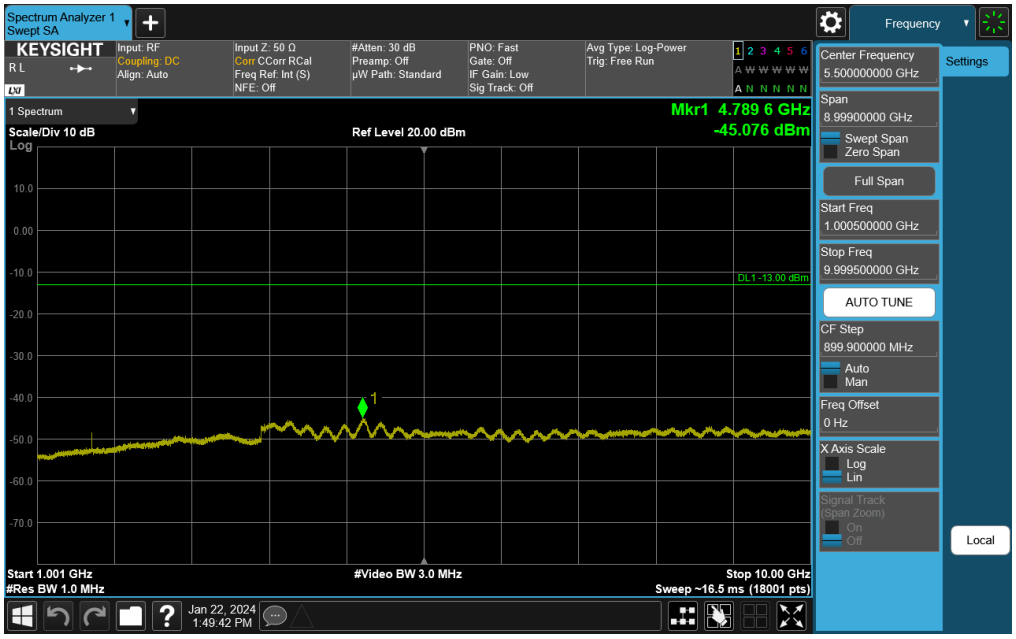
NR Band 26



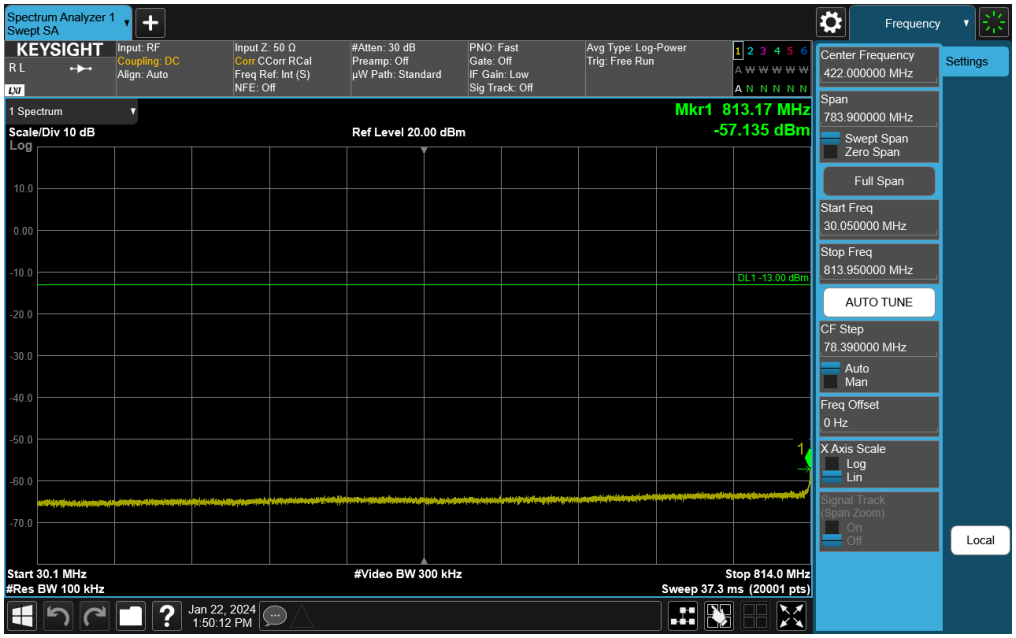
Plot 7-81. Conducted Spurious Plot (NR Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



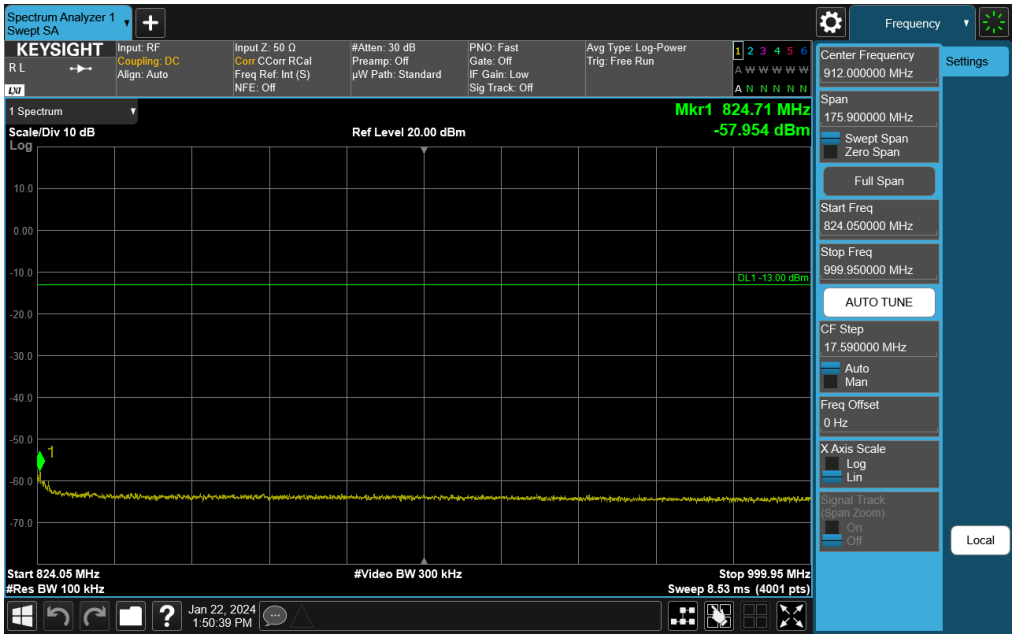
Plot 7-82. Conducted Spurious Plot (NR Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



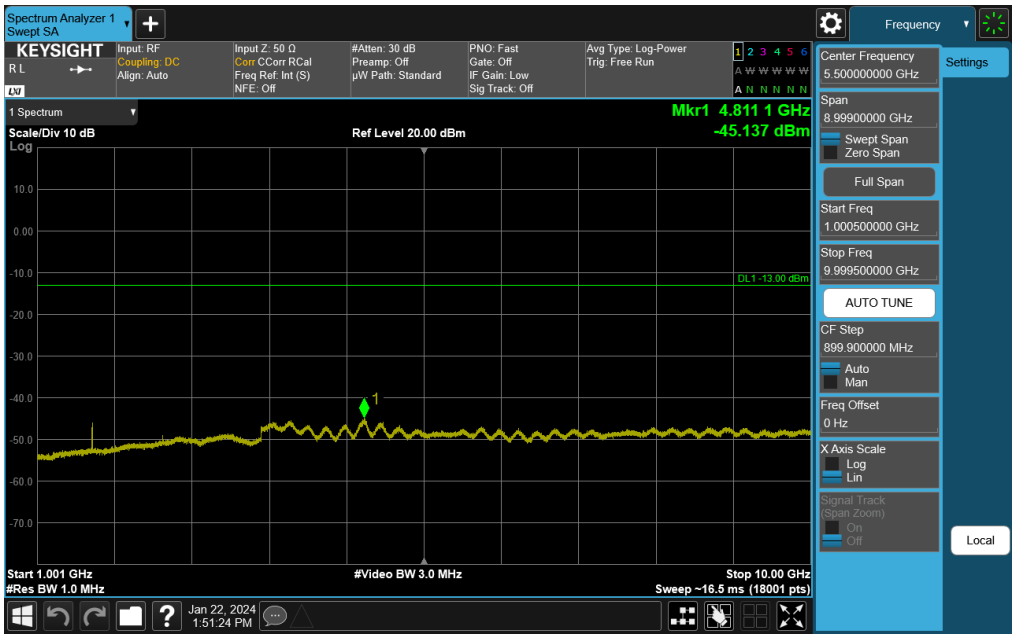
Plot 7-83. Conducted Spurious Plot (NR Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



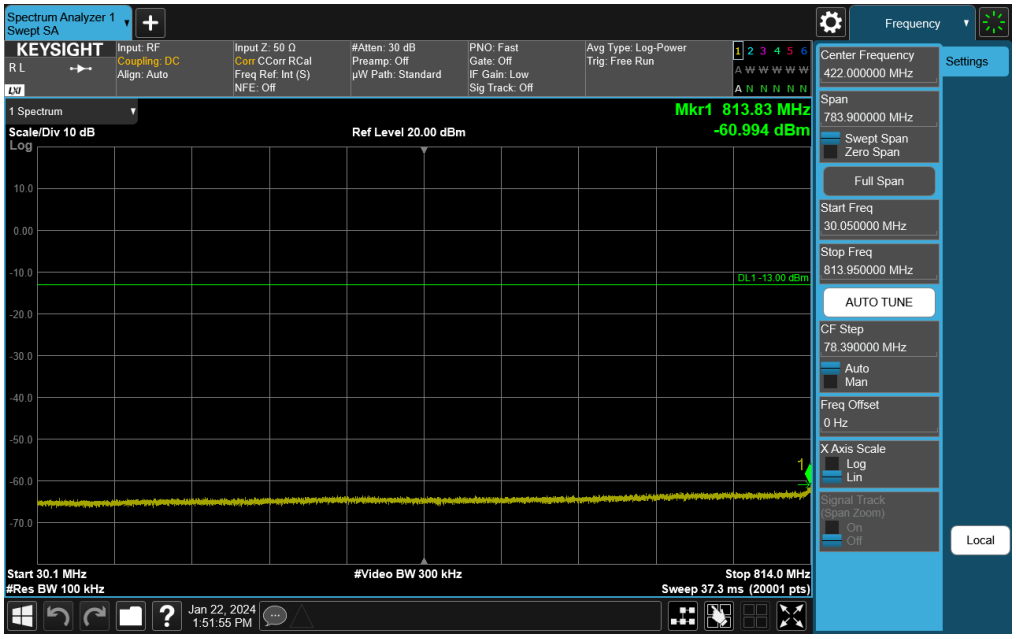
Plot 7-84. Conducted Spurious Plot (NR Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



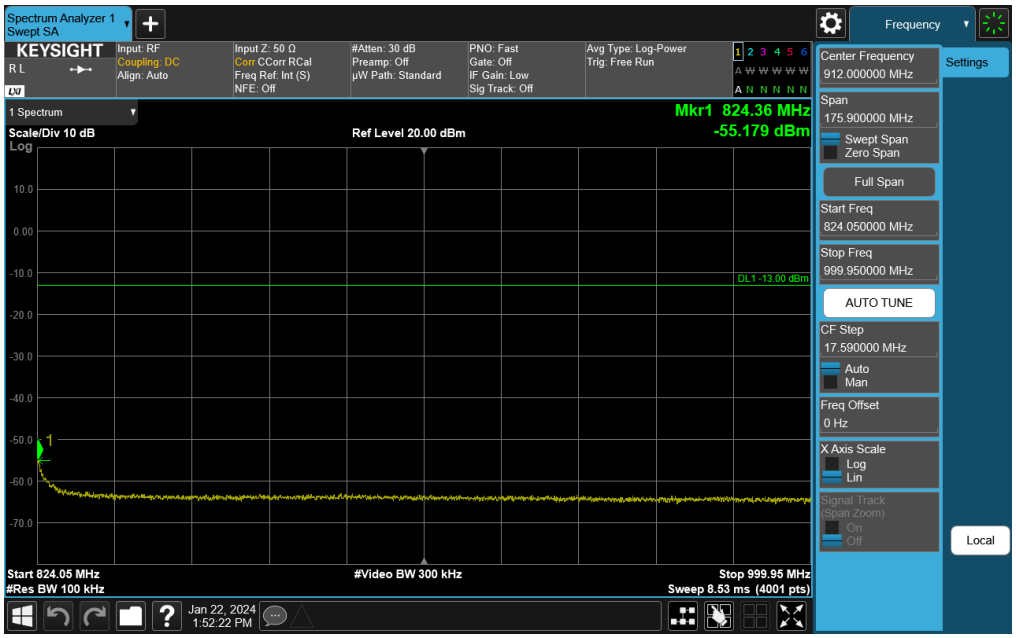
Plot 7-85. Conducted Spurious Plot (NR Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



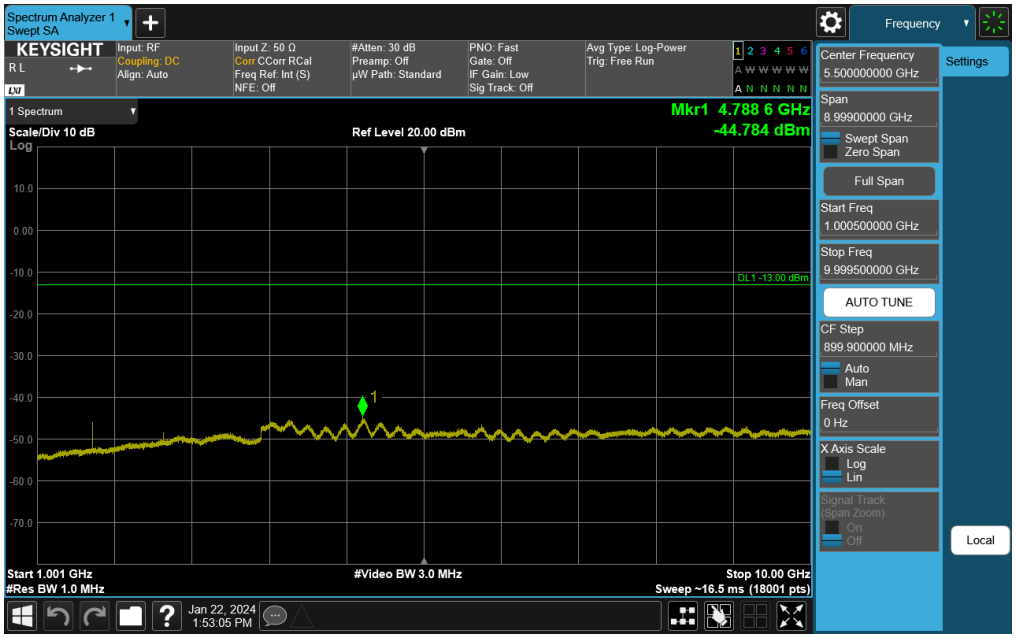
Plot 7-86. Conducted Spurious Plot (NR Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



Plot 7-87. Conducted Spurious Plot (NR Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



Plot 7-88. Conducted Spurious Plot (NR Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



Plot 7-89. Conducted Spurious Plot (NR Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

7.4 Band Edge Emissions at Antenna Terminal

§2.1051 §90.691(a) §90.543(e)

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. All ports were tested and only the worst case data were reported.

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.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

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

Test Setup

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

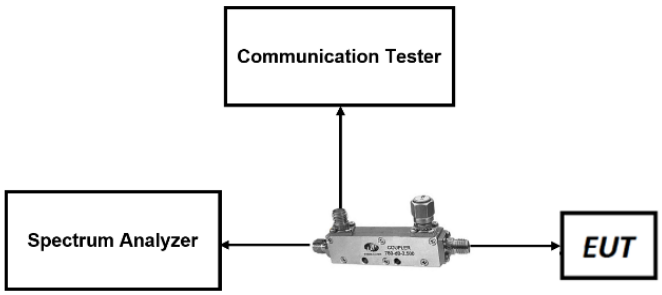


Figure 7-3. Test Instrument & Measurement Setup

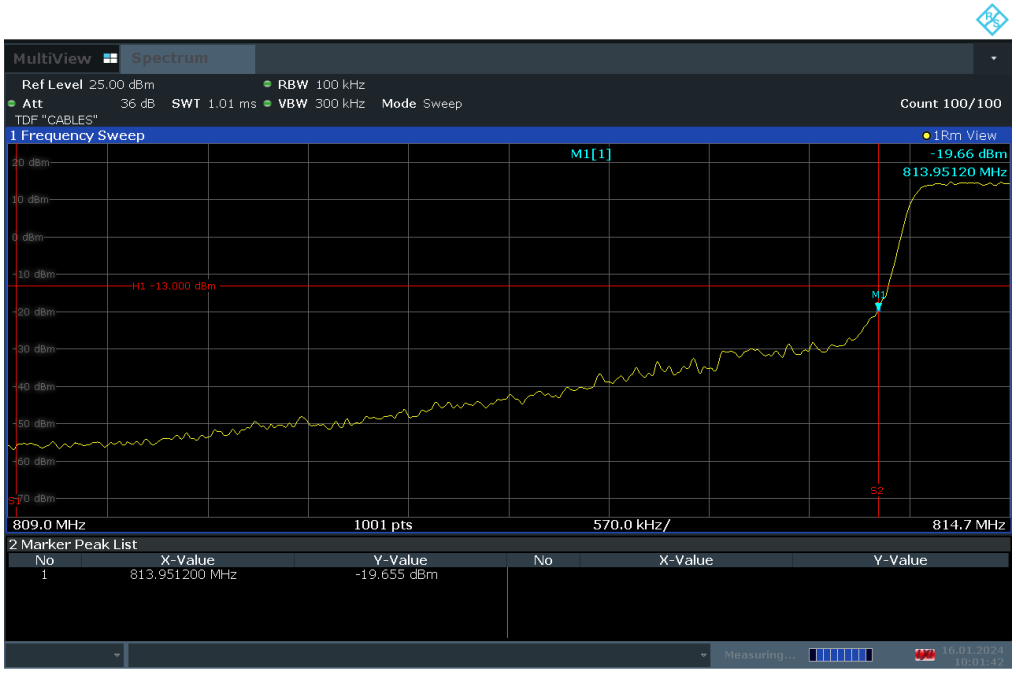
Test Notes

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

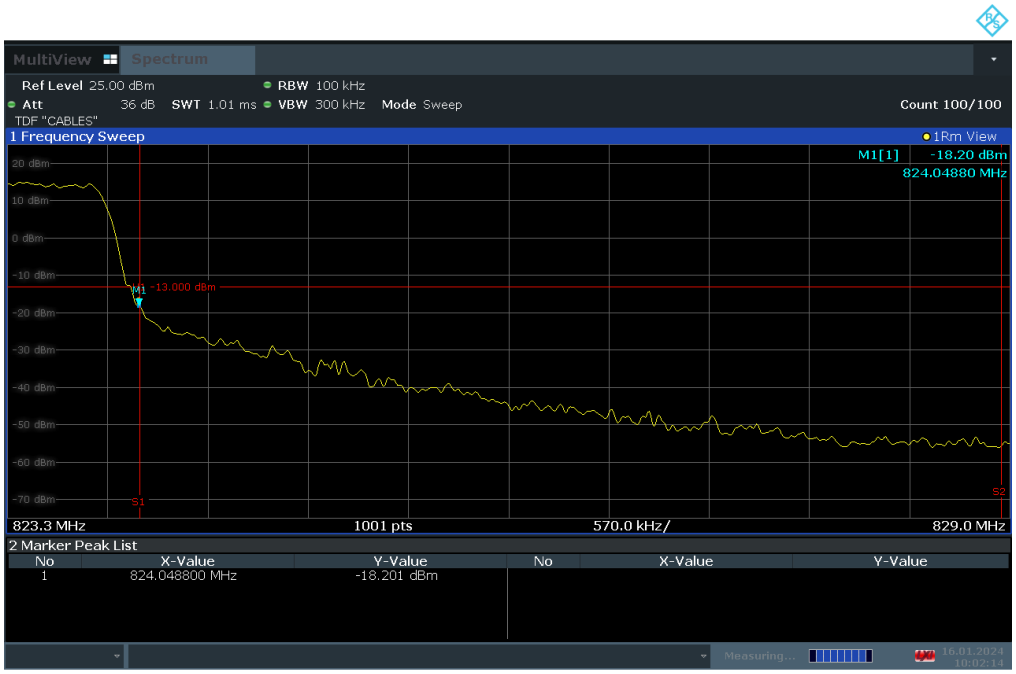
2. For LTE Band 14 and NR Band n14 operation under Part 90.543, the power of any emission must be reduced below the mean output power (P) by at least 43 + 10log (P) dB measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

3. Additionally, for LTE Band 14 and NR Band n14 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.

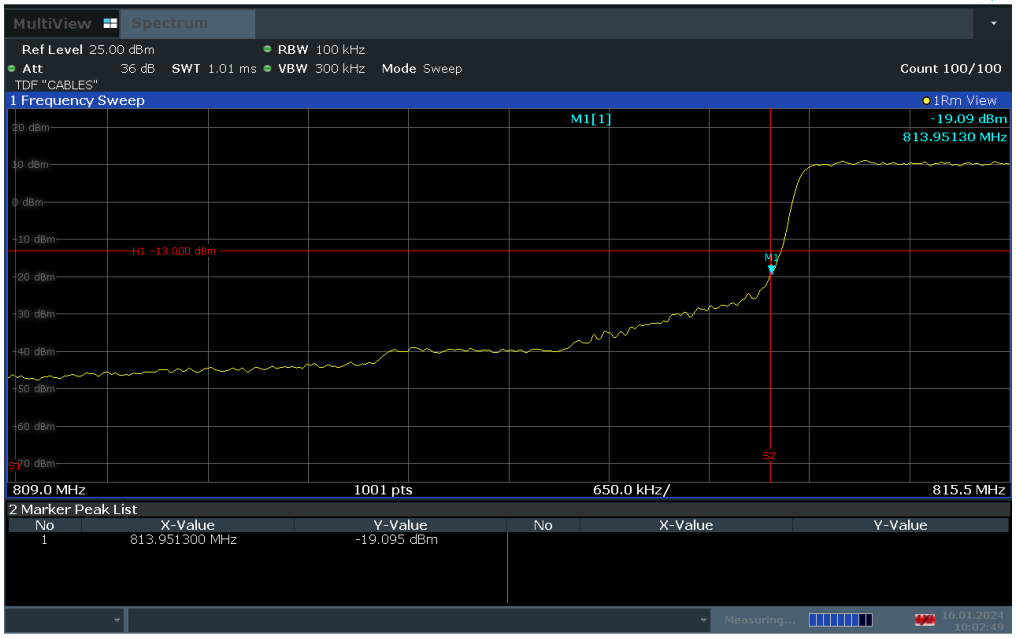
LTE Band 26



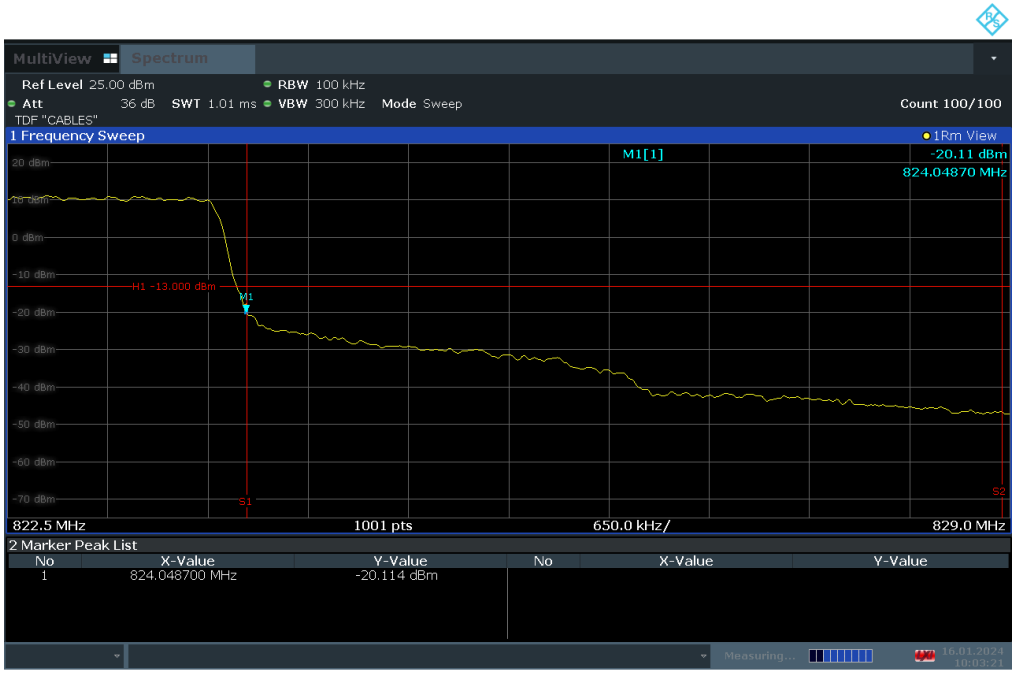
Plot 7-90. Channel Edge Plot (LTE Band 26 – 1.4MHz QPSK – Low Channel)



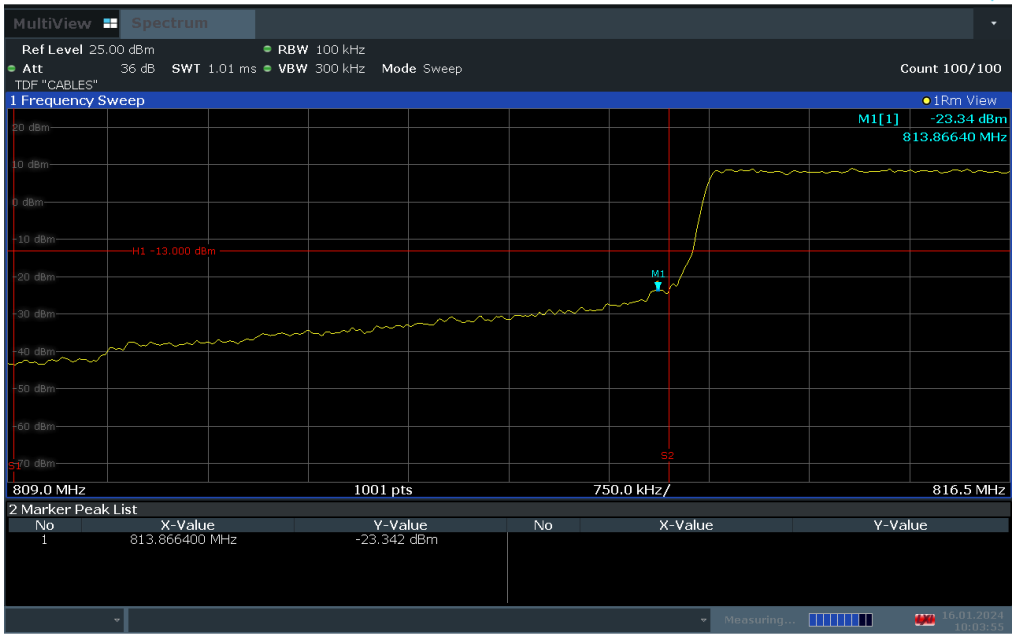
Plot 7-91. Channel Edge Plot (LTE Band 26 – 1.4MHz QPSK – High Channel)



Plot 7-92. Channel Edge Plot (LTE Band 26 - 3MHz QPSK – Low Channel)

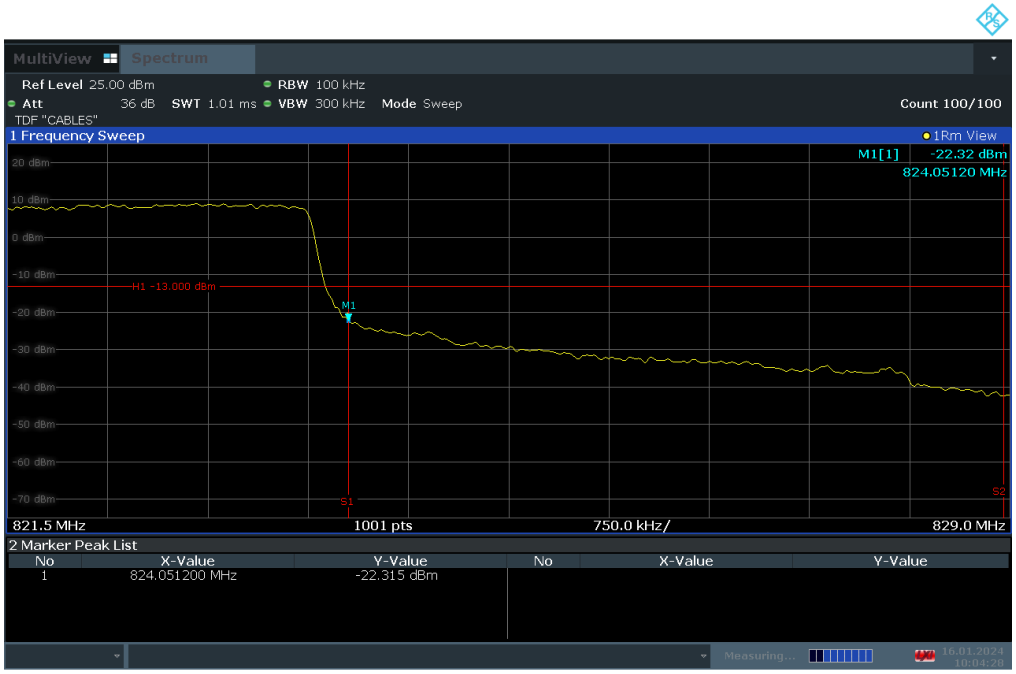


Plot 7-93. Channel Edge Plot (LTE Band 26 - 3MHz QPSK – High Channel)



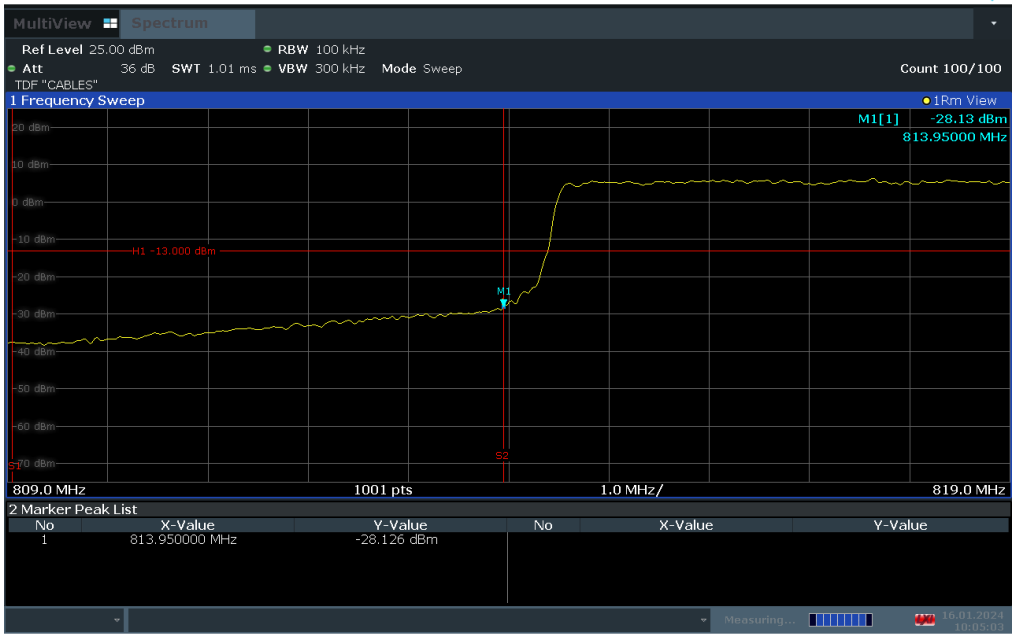
10:03:56 16.01.2024

Plot 7-94. Channel Edge Plot (LTE Band 26 - 5MHz QPSK – Low Channel)



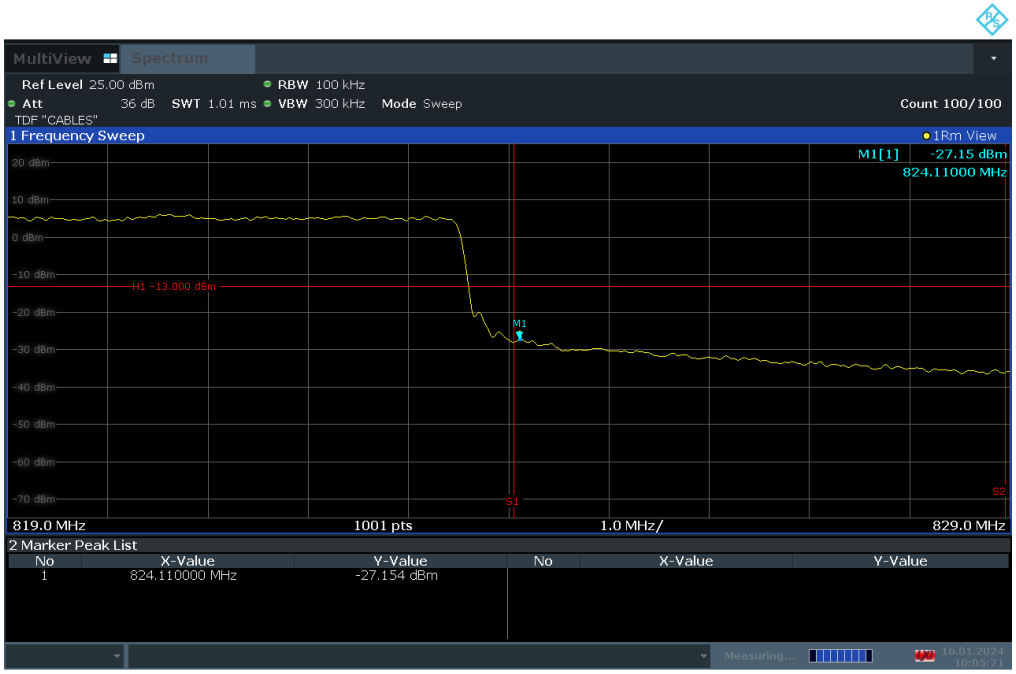
10:04:29 16.01.2024

Plot 7-95. Channel Edge Plot (LTE Band 26 - 5MHz QPSK – High Channel)



10:05:04 16.01.2024

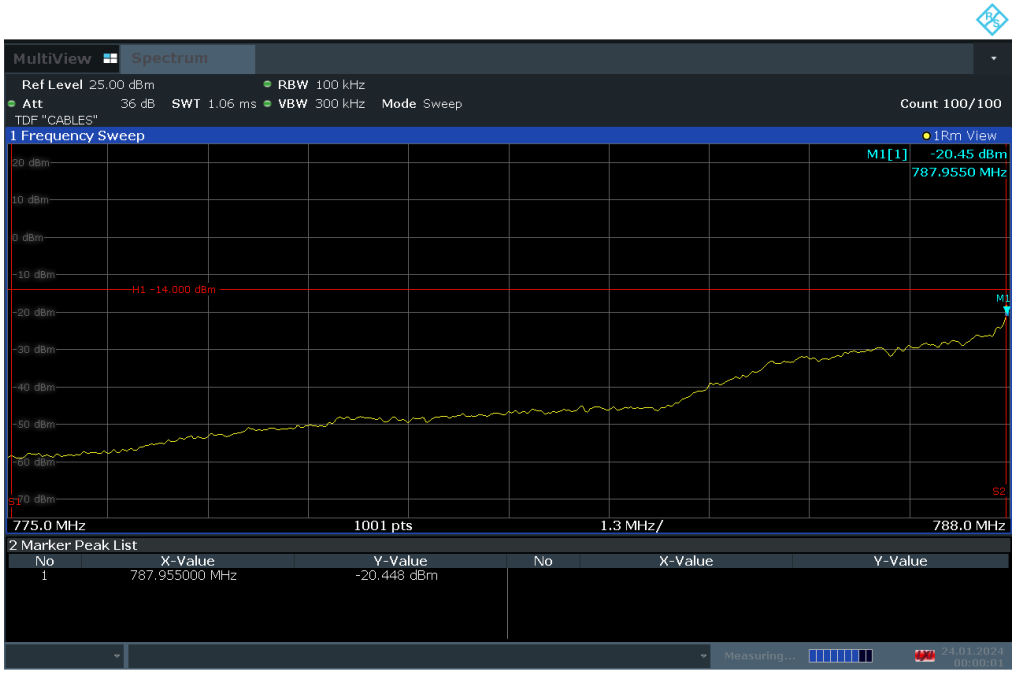
Plot 7-96. Channel Edge Plot (LTE Band 26 - 10MHz QPSK – Low Channel)



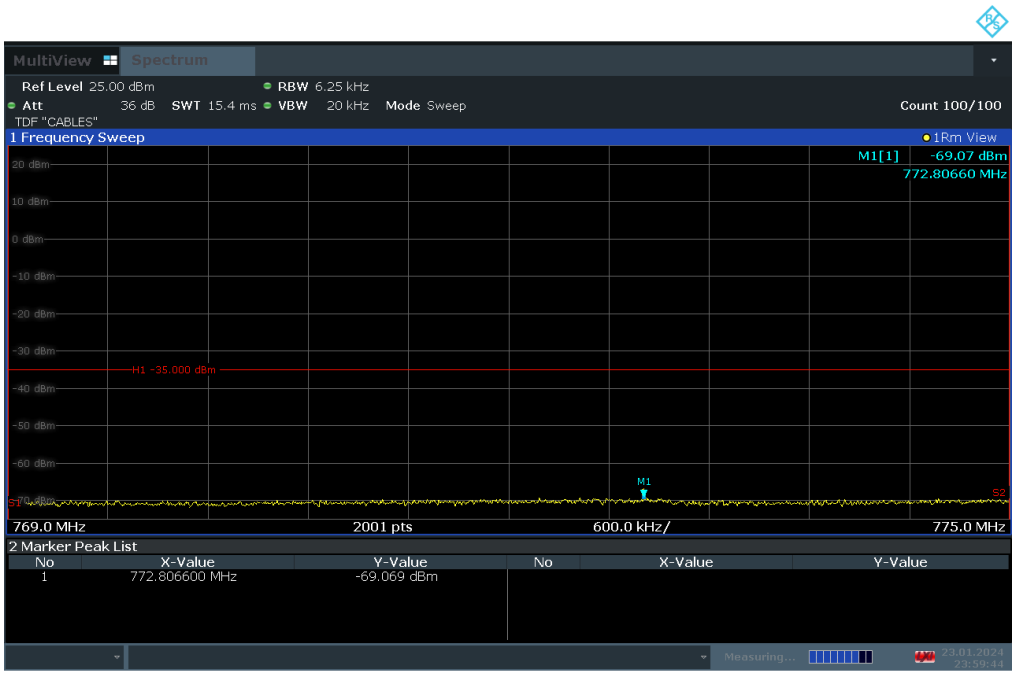
10:05:21 16.01.2024

Plot 7-97. Channel Edge Plot (LTE Band 26 - 10MHz QPSK – High Channel)

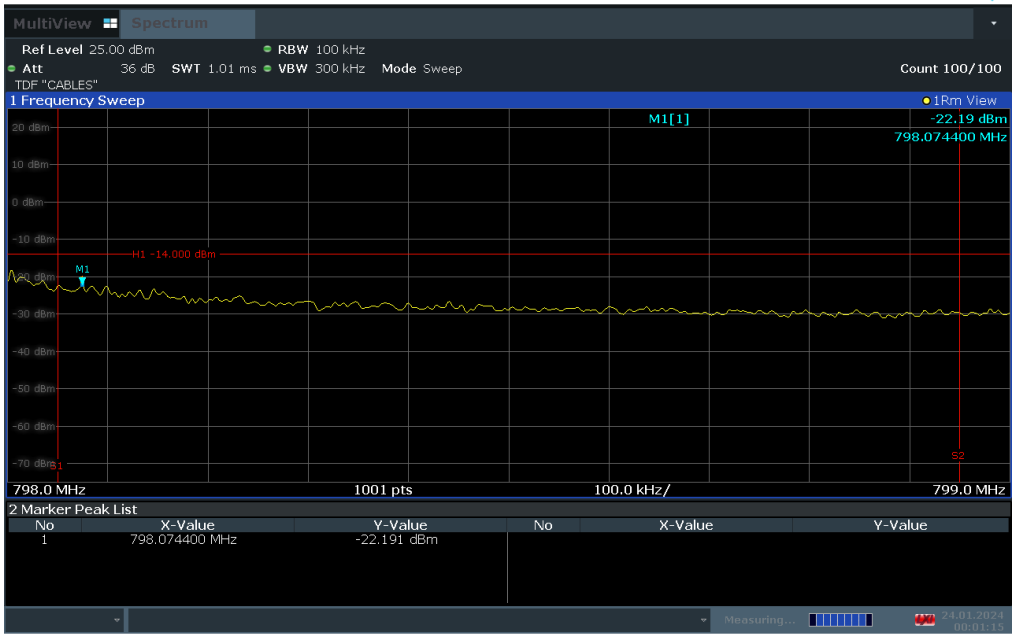
LTE Band 14



Plot 7-98. Lower Band Edge Plot (LTE Band 14 - 5MHz QPSK – RB Size 25)

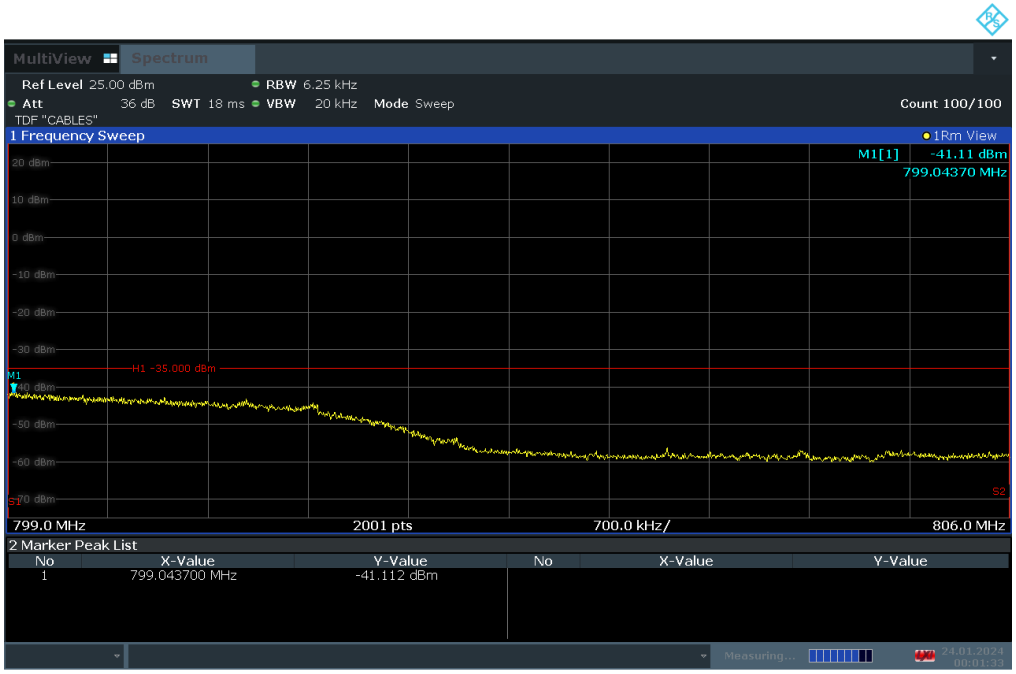


Plot 7-99. Lower Emission Mask Plot (LTE Band 14 - 5MHz QPSK – RB Size 25)



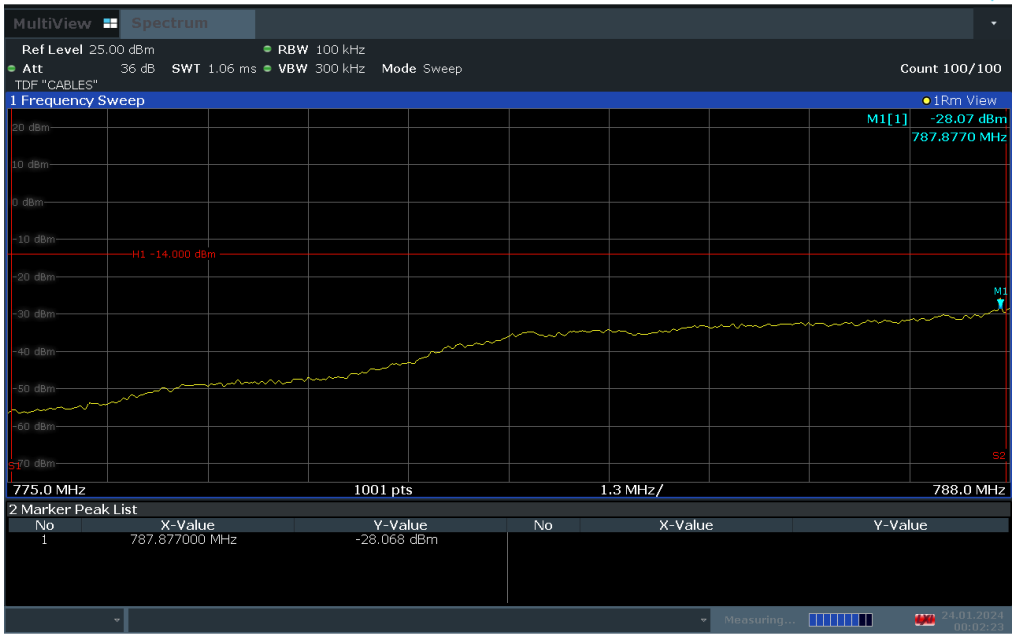
00:01:16 24.01.2024

Plot 7-100. Upper Band Edge Plot (LTE Band 14 - 5MHz QPSK – RB Size 25)

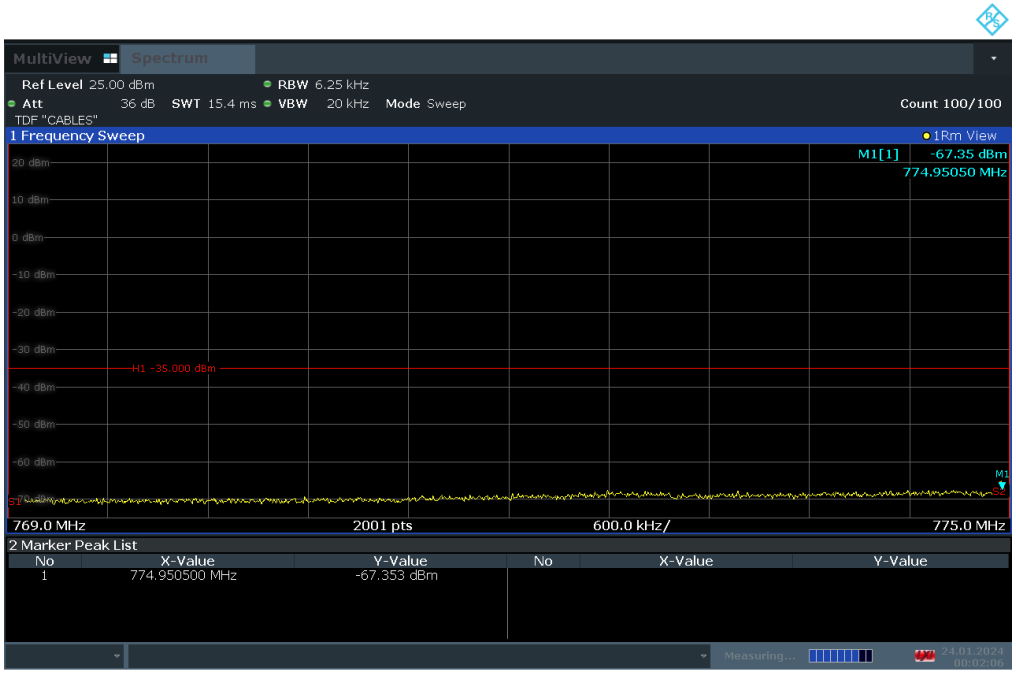


00:01:33 24.01.2024

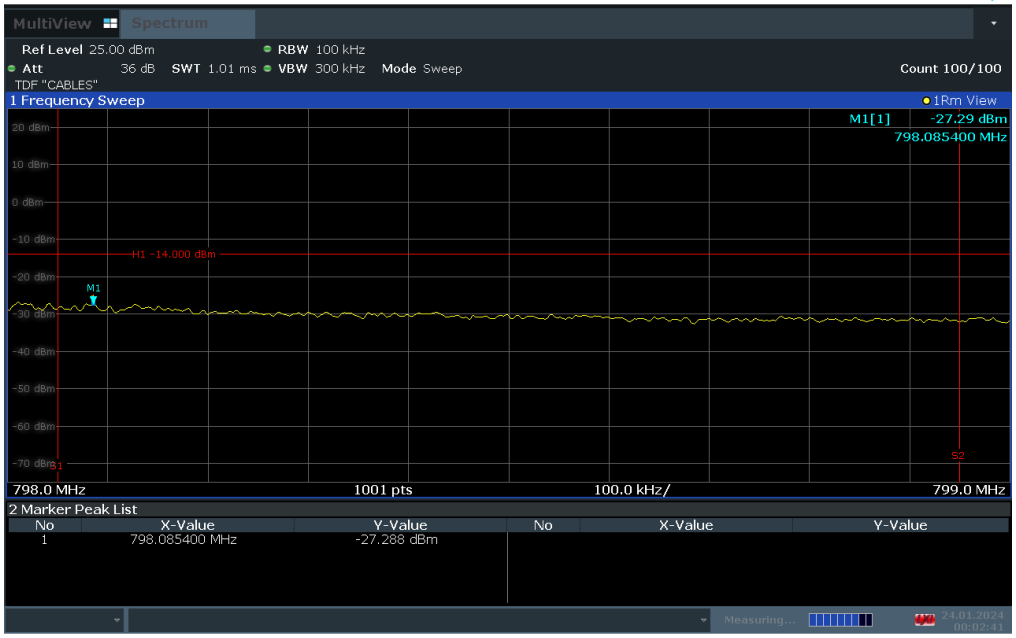
Plot 7-101. Upper Emission Mask Plot (LTE Band 14 - 5MHz QPSK – RB Size 25)



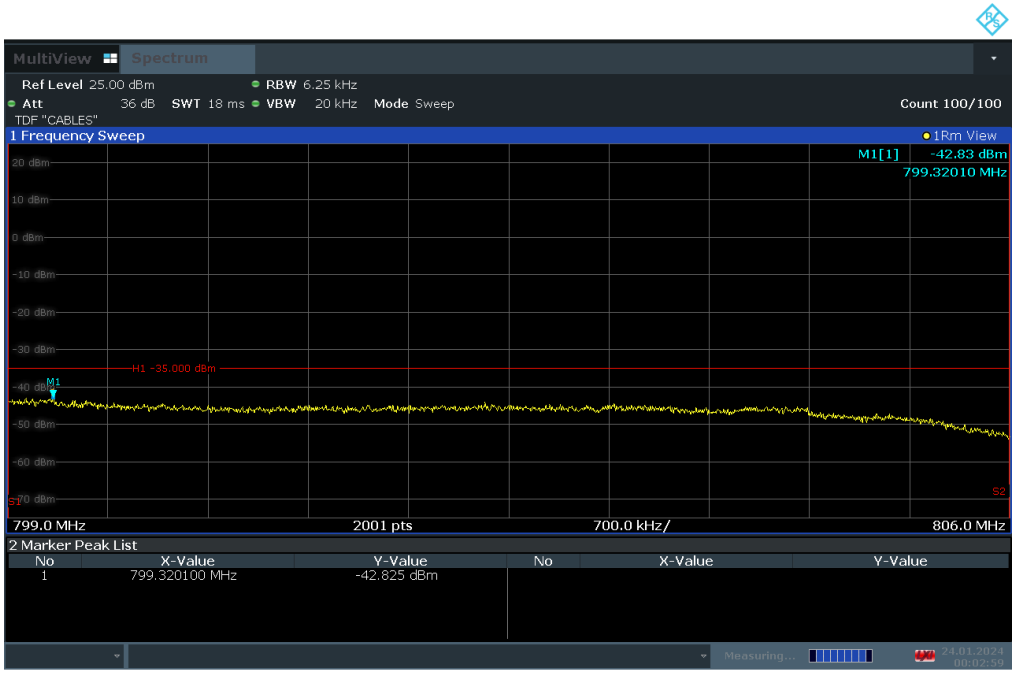
Plot 7-102. Lower Band Edge Plot (LTE Band 14 - 10MHz QPSK – RB Size 50)



Plot 7-103. Lower Emission Mask Plot (LTE Band 14 - 10MHz QPSK – RB Size 50)

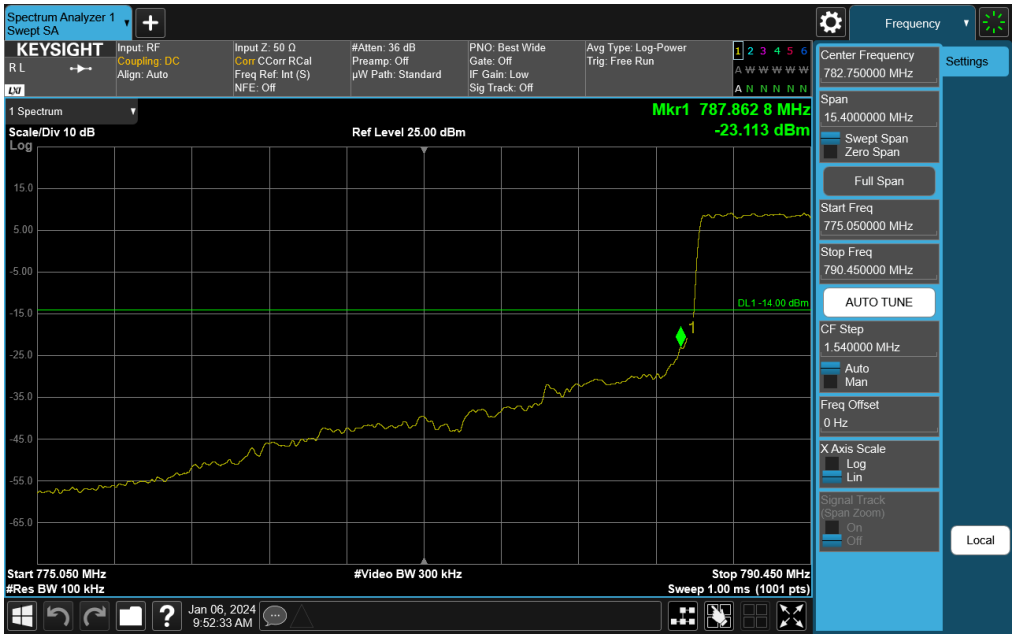


Plot 7-104. Upper Band Edge Plot (LTE Band 14 - 10MHz QPSK – RB Size 50)



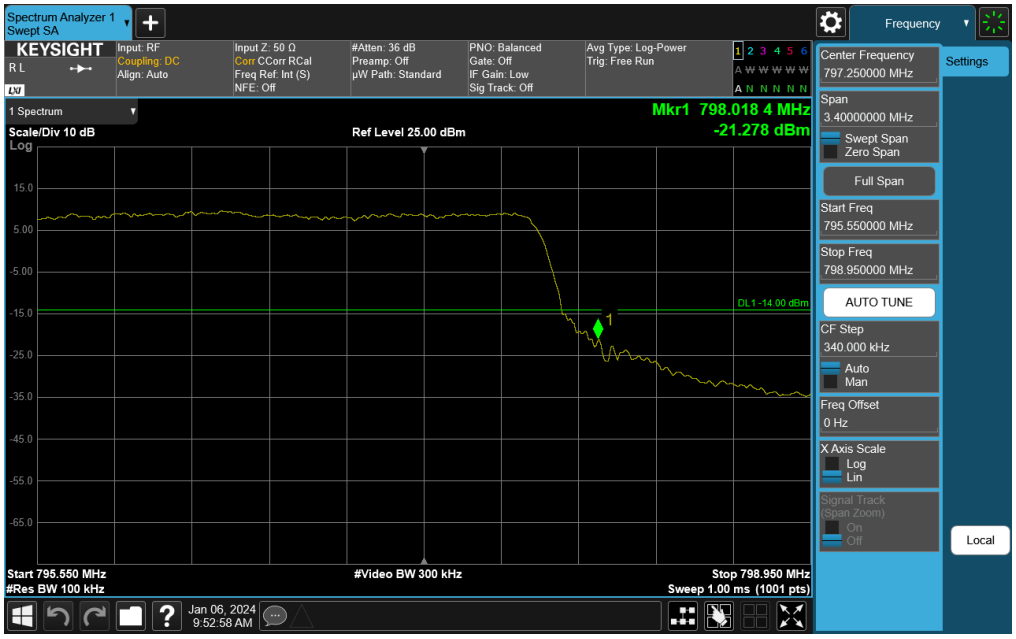
Plot 7-105. Upper Emission Mask Plot (LTE Band 14 - 10MHz QPSK – RB Size 50)

NR Band n14

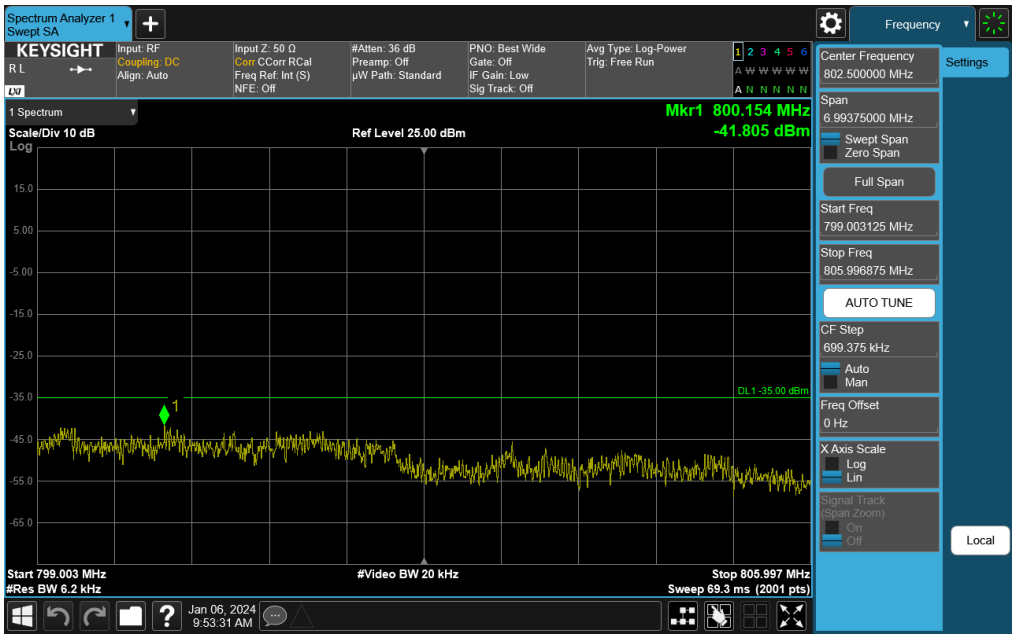


Plot 7-106. Lower Band Edge Plot (NR Band n14 - 5MHz DFT-s-OFDM π/2 BPSK – RB Size 25)

Plot 7-107. Lower Emission Mask Plot (NR Band n14 - 5MHz DFT-s-OFDM QPSK – RB Size 25)



Plot 7-108. Upper Band Edge Plot (NR Band n14 - 5MHz DFT-s-OFDM π/2 BPSK – RB Size 25)



Plot 7-109. Upper Emission Mask Plot (NR Band n14 - 5MHz DFT-s-OFDM π/2 BPSK – RB Size 25)