

TEST REPORT

FCC Test for N20-HRDU_A_850IC
Certification

APPLICANT
SOLiD, Inc.

REPORT NO.
HCT-RF-2005-FC007

DATE OF ISSUE
May 14, 2020

HCT Co., Ltd.

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N20-HRDU_A_850IC

REPORT NO.
HCT-RF-2005-FC007
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Additional Model
-

Applicant	SOLiD, Inc. 10, 9th Floor, SOLiD Space, Pangyoyeok-ro 220, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-400, South Korea
EUT Type	DAS
Model Name	N20-HRDU_A_850IC
FCC ID	W6UNHA850IC
Output Power	43 dBm
Date of Test	May 06, 2020 ~ May 13, 2020
FCC Rule Parts	CFR 47 Part 2, Part 22, Part 90

This test results were applied only to the test methods required by the standard.

Tested by
Kwang Il Yoon

(signature)

Technical Manager
Jong Seok Lee

(signature)

(signature)
HCT CO., LTD.
Soo Chan Lee
SooChan Lee / CEO

REVISION HISTORY

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

Revision No.	Date of Issue	Description
0	May 14, 2020	Initial Release

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules under normal use and maintenance.

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1. GENERAL INFORMATION

1.1. APPLICANT INFORMATION

Company Name	SOLiD, Inc.
Company Address	10, 9th Floor, SOLiD Space, Pangyoyeok-ro 220, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-400, South Korea

1.2. PRODUCT INFORMATION

EUT Type	DAS		
EUT Serial Number	20030001		
Power Supply	AC 100-240V, 50/60 Hz/ DC -48V		
Frequency Range	Band Name	Uplink (MHz)	Downlink (MHz)
	ESMR	817 ~824	862 ~ 869
	Cellular	824 ~ 849	869 ~ 894
Tx Output Power	43 dBm		
Antenna Peak Gain	16 dBi		

1.3. TEST INFORMATION

FCC Rule Parts	CFR 47 Part 2, Part 22, Part 90
Measurement Standards	ANSI C63.26-2015, KDB 971168 D01 v03r01, KDB 935210 D05 v01r04
Test Location	HCT CO., LTD. 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA

2. FACILITIES AND ACCREDITATIONS

2.1. FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA.

The site is constructed in conformance with the requirements of ANSI C63.4 (Version: 2014) and CISPR Publication 22.

Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: KR0032).

2.2. EQUIPMENT

Radiated emissions are measured with one or more of the following types of linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

3. TEST SPECIFICATIONS

3.1. STANDARDS

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 2, Part 22, Part 90.

Description	Reference	Results
Conducted RF Output Power	§ 2.1046, § 22.913 § 90.635	Compliant
Occupied Bandwidth	§ 2.1049	Compliant
Input-versus-output Spectrum	-	Compliant
Out of Band Rejection & Mean Output Power and Zone Enhancer Gain	KDB 935210 D05 v01r04	Compliant
Spurious Emissions at Antenna Terminals	§ 2.1051, § 22.917 § 90.691	Compliant
Radiated Spurious Emissions	§ 2.1053, § 22.917 § 90.691	Compliant

3.2. ADDITIONAL DESCRIPTIONS ABOUT TEST

Except for the following cases, EUT was tested under normal operating conditions.

: Out-of-band rejection test requires maximum gain condition without AGC

The test was generally based on the method of KDB 935210 D05 v01r04 and only followed ANSI C63.26-2015 if there was no test method in KDB standard.

EUT was tested with following modulated signals provide by applicant.

Band Name	Tested signals
ESMR	CDMA
	LTE 5 MHz
	WCDMA
Cellular	CDMA
	WCDMA
	LTE 5 MHz
	LTE 10 MHz

The frequency stability measurement has been omitted in accordance with section 3.7 of KDB 935210 D05 v01r04.

: It can be confirmed through input-versus-output signal comparison test that EUT does not alter the input signal.

The tests results included actual loss value for attenuator and cable combination as shown in the table below.

: Input Path

Correction factor table			
Frequency (MHz)	Factor (dB)	Frequency (MHz)	Factor (dB)
500	0.560	800	0.725
550	0.507	850	0.702
600	0.692	900	0.717
650	0.745	950	0.702
700	0.782	1000	0.643
750	0.728	1050	0.666

: Output Path

Correction factor table			
Frequency (MHz)	Factor (dB)	Frequency (MHz)	Factor (dB)
2	30.497	2000	31.603
10	29.846	2500	31.931
20	29.922	3000	32.272
30	29.772	3500	32.387
40	29.808	4000	32.685
50	29.780	4500	32.517
100	29.858	5000	32.662
200	30.053	5500	33.296
300	30.409	6000	33.361
400	30.536	6500	34.388
500	30.682	7000	33.551
600	30.773	7500	33.924
700	30.855	8000	33.681
800	30.878	8500	33.775
900	30.890	9000	34.452
1000	30.920	9500	33.954
1200	31.244	10000	36.689
1400	31.309	-	-
1600	31.515	-	-
1800	31.368	-	-

3.3. MEASUREMENT UNCERTAINTY

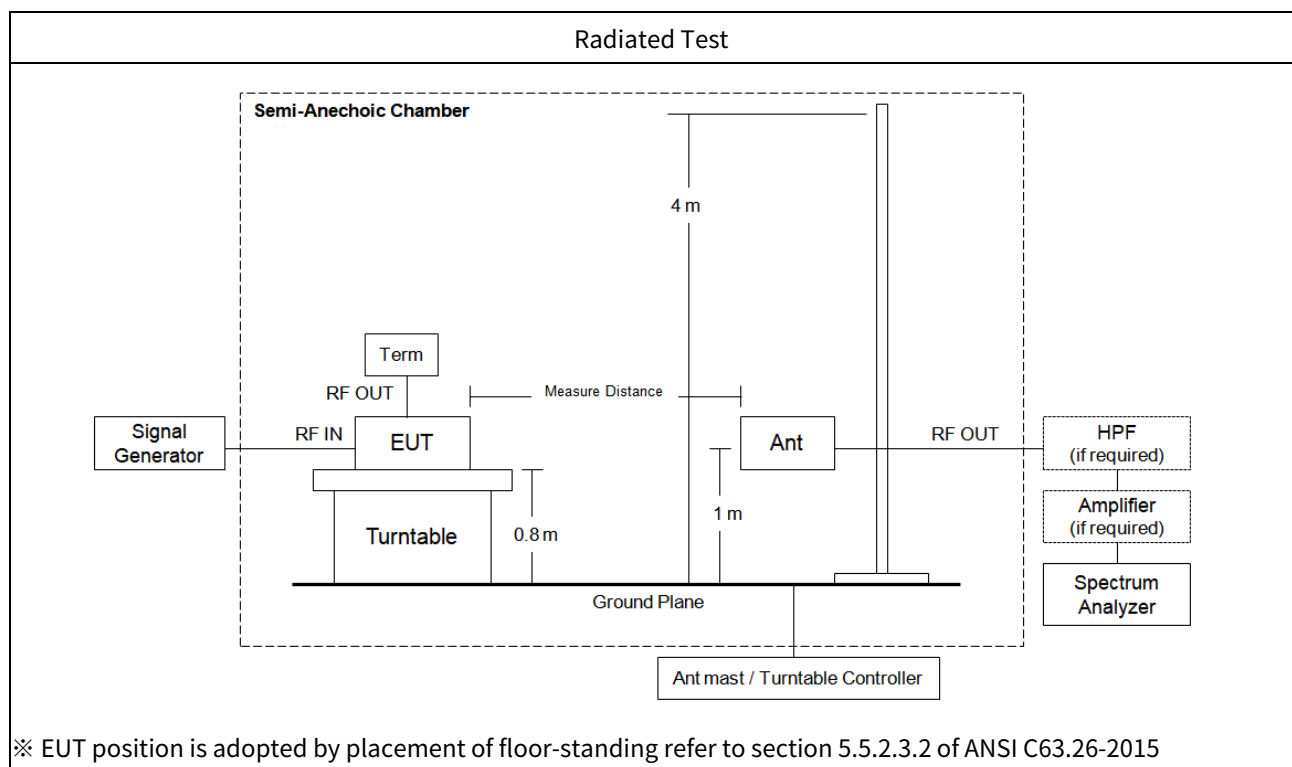
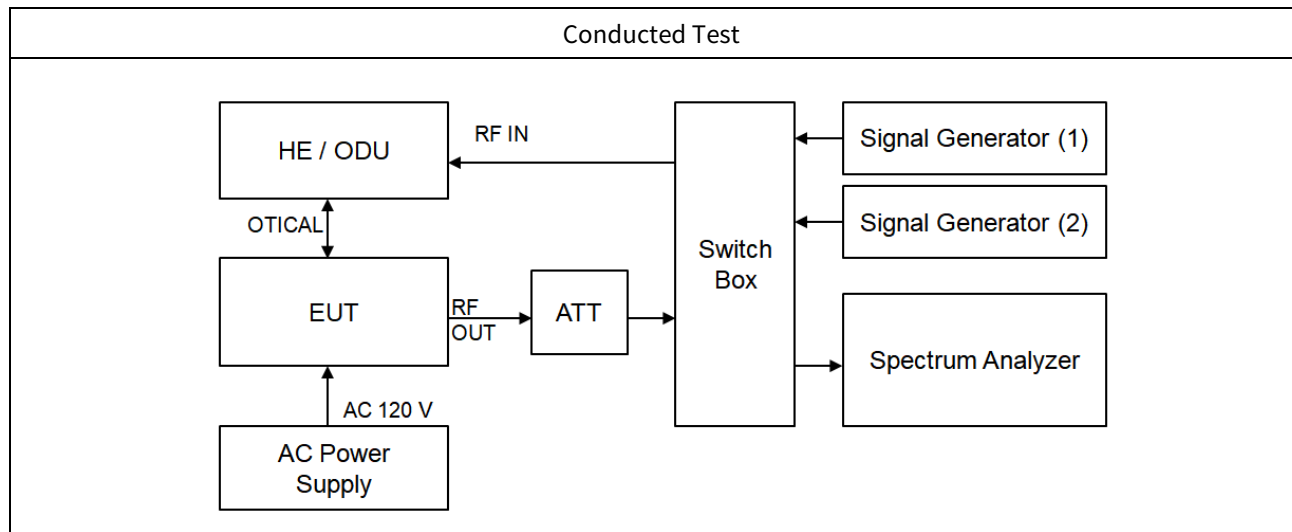
Description	Reference	Results
AGC threshold	-	± 0.87 dB
Out-of-band rejection	-	± 0.58 MHz
Input-versus-output signal comparison	OBW > 5 MHz	± 0.58 MHz
Input/output power and amplifier/booster gain	-	± 0.87 dB
Out-of-band/out-of-block emissions and spurious emissions	-	± 1.08 dB
Spurious emissions radiated	$f \leq 1$ GHz	± 4.80 dB
	$f > 1$ GHz	± 6.07 dB

* Coverage factor $k = 2$, Confidence levels of 95 %

3.4. STANDARDS ENVIRONMENTAL TEST CONDITIONS

Temperature	+15 °C to +35 °C
Relative humidity	30 % to 60 %
Air pressure	860 mbar to 1 060 mbar

3.5. TEST DIAGRAMS



4. TEST EQUIPMENTS

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Agilent	N9020A / MXA Signal Analyzer	04/27/2020	Annual	MY51110063
Agilent	N5182A / MXG Vector Signal Generator	12/23/2019	Annual	MY46240523
Agilent	N5182A / MXG Vector Signal Generator	01/17/2020	Annual	MY47070406
Agilent	8493C-030 / 30 dB Attenuator	07/08/2019	Annual	77640
KEITHLEY	S46 / Switch	N/A	N/A	1088024
Deayoung ENT	DFSS60 / AC Power Supply	04/07/2020	Annual	1003030-1
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
Innco system	MA4640/800-XP-EP / Antenna Position Tower	N/A	N/A	N/A
Audix	EM1000 / Controller	N/A	N/A	060520
Audix	- / Turn Table	N/A	N/A	N/A
Rohde&Schwarz	- / Loop Antenna	04/26/2019	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	08/31/2018	Biennial	0895
Schwarzbeck	BBHA 9120D / Horn Antenna	06/28/2019	Biennial	9120D-1300
Schwarzbeck	BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz)	11/29/2019	Biennial	BBHA9170541
Rohde&Schwarz	FSP (9 kHz ~ 40 GHz) / Spectrum Analyzer	07/16/2019	Annual	100843
CERNEX	CBLU1183540B-01 / Power Amplifier	01/21/2020	Annual	25540
CERNEX	CBL06185030 / Power Amplifier	07/01/2019	Annual	22965
CERNEX	CBL18265035 / Power Amplifier	12/26/2019	Annual	22966
CERNEX	CBL26405040 / Power Amplifier	03/23/2020	Annual	25956

5. TEST RESULT

5.1. AGC THRESHOLD

Test Requirement:

KDB 935210 D05 v01r04

Testing at and above the AGC threshold is required.

Test Procedures:

Measurements were in accordance with the test methods section 3.2 of KDB 935210 D05 v01r04.

In the case of fiber-optic distribution systems, the RF input port of the equipment under test (EUT) refers to the RF input of the supporting equipment RF to optical convertor; see also descriptions and diagrams for typical DAS booster systems in KDB Publication 935210 D02.

Devices intended to be directly connected to an RF source (donor port) only need to be evaluated for any over-the-air transmit paths.

- a) Connect a signal generator to the input of the EUT.
- b) Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation as necessary.
- c) The signal generator should initially be configured to produce either of the required test signals.
- d) Set the signal generator frequency to the center frequency of the EUT operating band.
- e) While monitoring the output power of the EUT, measured using the methods of ANSI C63.26-2015 subclause 5.2.4.4.1, increase the input level until a 1 dB increase in the input signal power no longer causes a 1 dB increase in the output signal power.
- f) Record this level as the AGC threshold level.
- g) Repeat the procedure with the remaining test signal.

Output power measurement in subclause 5.2.4.4.1 of ANSI C63.26

- a) Set span to $2 \times$ to $3 \times$ the OBW.
- b) Set RBW = 1% to 5% of the OBW.
- c) Set VBW $\geq 3 \times$ RBW.
- d) Set number of measurement points in sweep $\geq 2 \times$ span / RBW.
- e) Sweep time: auto-couple
- f) Detector = power averaging (rms).
- g) If the EUT can be configured to transmit continuously, then set the trigger to free run.
- h) Omit

- i) Trace average at least 100 traces in power averaging (rms) mode if sweep is set to auto-couple. To accurately determine the average power over multiple symbols, it can be necessary to increase the number of traces to be averaged above 100 or, if using a manually configured sweep time, increase the sweep time.

Compute the power by integrating the spectrum across the OBW of the signal using the instrument's band or channel power measurement function, with the band/channel limits set equal to the OBW band edges. If the instrument does not have a band or channel power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

Test Results:

Test Band	Link	Signal	Center Frequency (MHz)	AGC Threshold Level (dBm)	Output Level (dBm)
ESMR	Downlink	CDMA	865.50	-20	43.20
		LTE 5 MHz	865.50	-20	43.16
		WCDMA	865.50	-20	42.83
Cellular		CDMA	881.50	-20	43.01
		WCDMA	881.50	-20	43.17
		LTE 5 MHz	881.50	-20	43.15
		LTE 10 MHz	881.50	-20	43.26

5.2. OUT-OF-BAND REJECTION

Test Requirement:

KDB 935210 D05 v01r04

Out-of-band rejection required.

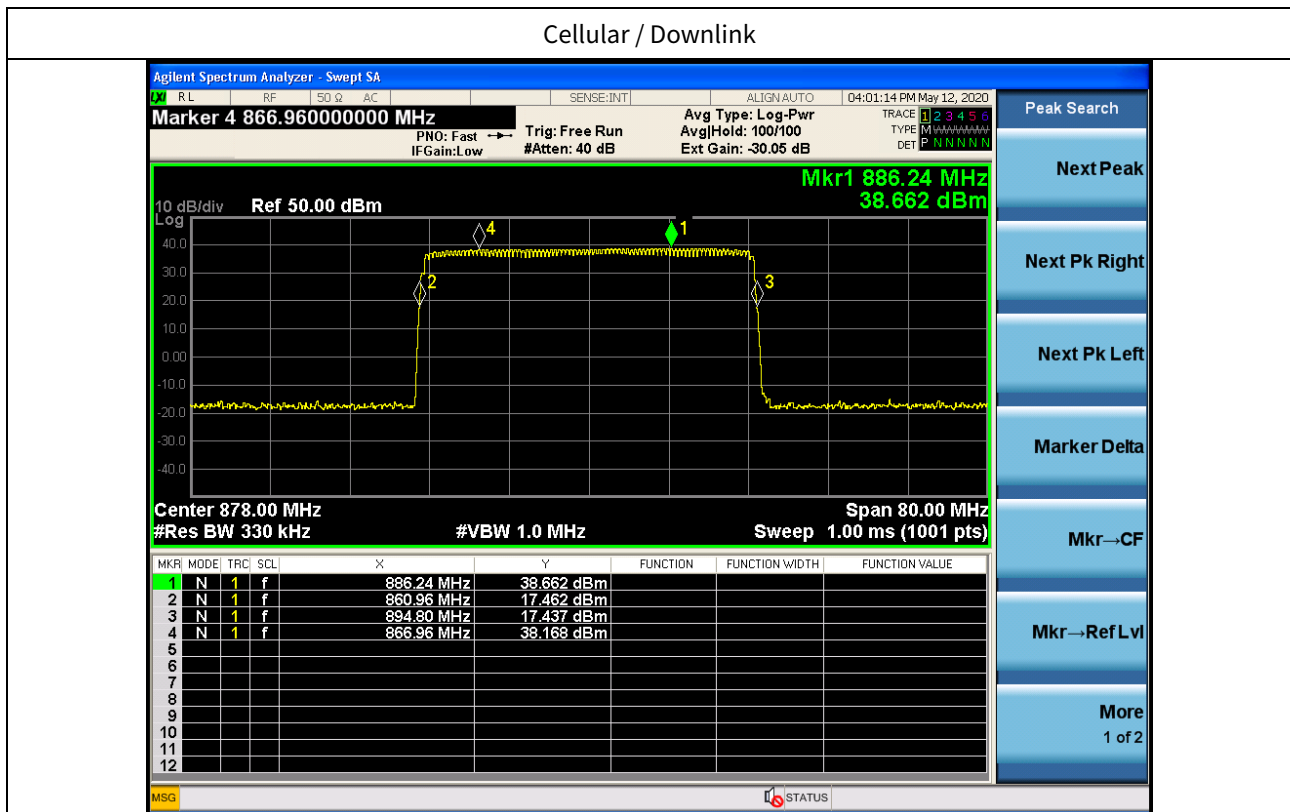
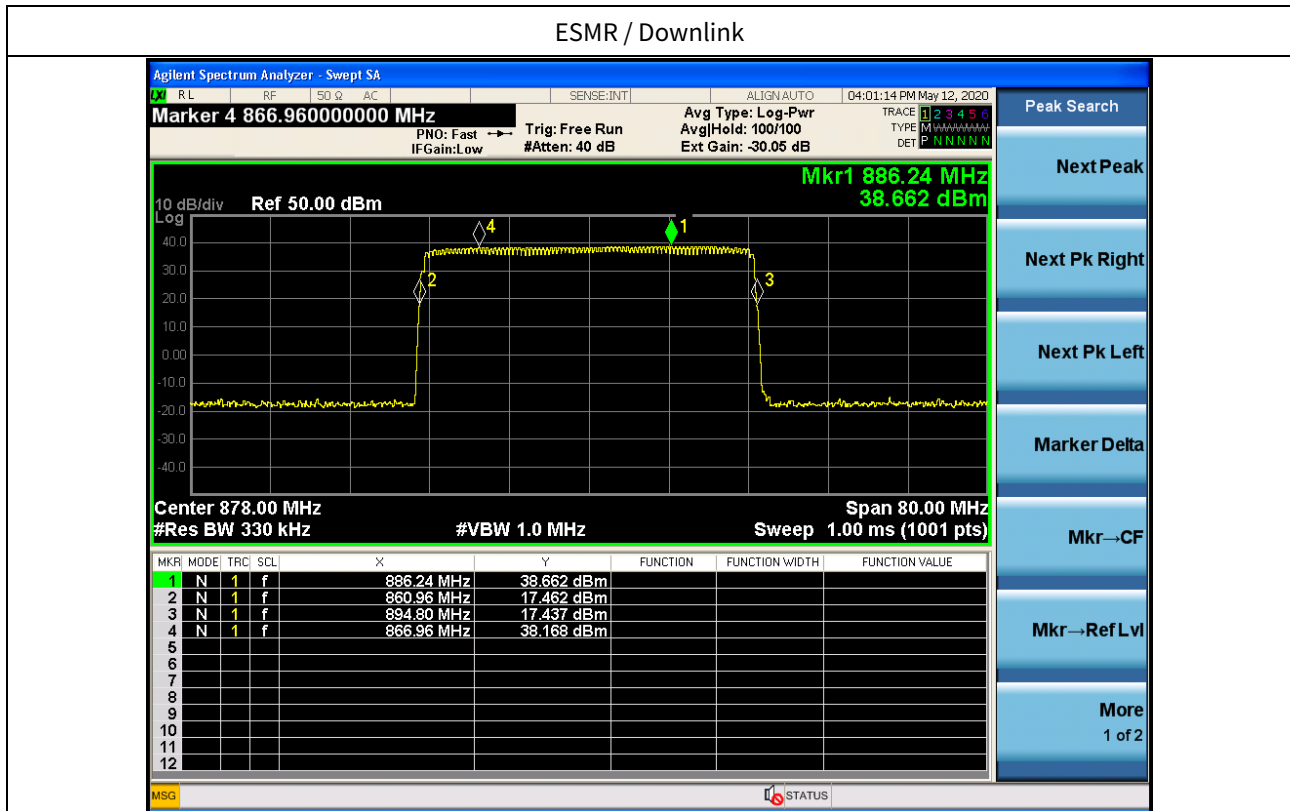
Test Procedures:

Measurements were in accordance with the test methods section 3.3 of KDB 935210 D05 v01r04.

Adjust the internal gain control of the EUT to the maximum gain for which equipment certification is sought.

- a) Connect a signal generator to the input of the EUT.
- b) Configure a swept CW signal with the following parameters:
 - 1) Frequency range = $\pm 250\%$ of the passband, for each applicable CMRS band.
 - 2) Level = a sufficient level to affirm that the out-of-band rejection is > 20 dB above the noise floor and will not engage the AGC during the entire sweep.
 - 3) Dwell time = approximately 10 ms.
 - 4) Number of points = $\text{SPAN}/(\text{RBW}/2)$.
- c) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
- d) Set the span of the spectrum analyzer to the same as the frequency range of the signal generator.
- e) Set the resolution bandwidth (RBW) of the spectrum analyzer to be 1 % to 5 % of the EUT passband, and the video bandwidth (VBW) shall be set to $\geq 3 \times \text{RBW}$.
- f) Set the detector to Peak Max-Hold and wait for the spectrum analyzer's spectral display to fill.
- g) Place a marker to the peak of the frequency response and record this frequency as f_0 .
- h) Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the -20 dB down amplitude, to determine the 20 dB bandwidth.
- i) Capture the frequency response of the EUT.
- j) Repeat for all frequency bands applicable for use by the EUT.

Test Results:



5.3. INPUT-VERSUS-OUTPUT SIGNAL COMPARISON

Test Requirement:

§ 2.1049 Measurements required: Occupied bandwidth.

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 under the specified conditions of § 2.1049 (a) through (i) as applicable.

Test Procedures:

Measurements were in accordance with the test methods section 3.4 of KDB 935210 D05 v01r04.

- a) Connect a signal generator to the input of the EUT.
- b) Configure the signal generator to transmit the AWGN signal.
- c) Configure the signal amplitude to be just below the AGC threshold level (see 3.2), but not more than 0.5 dB below.
- d) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
- e) Set the spectrum analyzer center frequency to the center frequency of the operational band under test. The span range of the spectrum analyzer shall be between 2 times to 5 times the emission bandwidth (EBW) or alternatively, the OBW.
- f) The nominal RBW shall be in the range of 1 % to 5 % of the anticipated OBW, and the VBW shall be $\geq 3 \times \text{RBW}$.
- g) Set the reference level of the instrument as required to preclude the signal from exceeding the maximum spectrum analyzer input mixer level for linear operation. In general, the peak of the spectral envelope must be more than $[10 \log (\text{OBW} / \text{RBW})]$ below the reference level.
Steps f) and g) may require iteration to enable adjustments within the specified tolerances.
- h) The noise floor of the spectrum analyzer at the selected RBW shall be at least 36 dB below the reference level.
- i) Set spectrum analyzer detection function to positive peak.
- j) Set the trace mode to max hold.
- k) Determine the reference value: Allow the trace to stabilize. Set the spectrum analyzer marker to the highest amplitude level of the displayed trace (this is the reference value) and record the associated frequency.
- l) Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the -26 dB down amplitude. The 26 dB EBW (alternatively OBW) is the positive frequency difference between the two markers. If the spectral envelope crosses the -26 dB down amplitude at multiple points, the lowest or highest frequency shall be selected as the frequencies that are the furthest removed from the center frequency at which the spectral envelope crosses the -26 dB down amplitude point.
- m) Repeat steps e) to l) with the input signal connected directly to the spectrum analyzer (i.e., input signal measurement).
- n) Compare the spectral plot of the input signal (determined from step m) to the output signal (determined from step l) to affirm that they are similar (in passband and rolloff characteristic features and relative spectral locations), and include plot(s) and descriptions in test report.
- o) Repeat the procedure [steps e) to n)] with the input signal amplitude set to 3 dB above the AGC threshold.
- p) Repeat steps e) to o) with the signal generator set to the narrowband signal.
- q) Repeat steps e) to p) for all frequency bands authorized for use by the EUT.

Test Results:

Tabular data of Output Occupied Bandwidth

Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
ESMR	Downlink	CDMA	865.50	1.2646	1.396
		LTE 5 MHz	865.50	4.5269	5.007
		WCDMA	865.50	4.1922	4.723
Cellular		CDMA	881.50	1.2602	1.394
		WCDMA	881.50	4.1862	4.708
		LTE 5 MHz	881.50	4.5236	4.944
		LTE 10 MHz	881.50	9.0165	9.941

Tabular data of Input Occupied Bandwidth

Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
ESMR	Downlink	CDMA	865.50	1.2616	1.398
		LTE 5 MHz	865.50	4.5106	5.003
		WCDMA	865.50	4.1869	4.725
Cellular		CDMA	881.50	1.2664	1.404
		WCDMA	881.50	4.1954	4.691
		LTE 5 MHz	881.50	4.5131	4.988
		LTE 10 MHz	881.50	8.9901	9.952

Tabular data of 3 dB above the AGC threshold Output Occupied Bandwidth

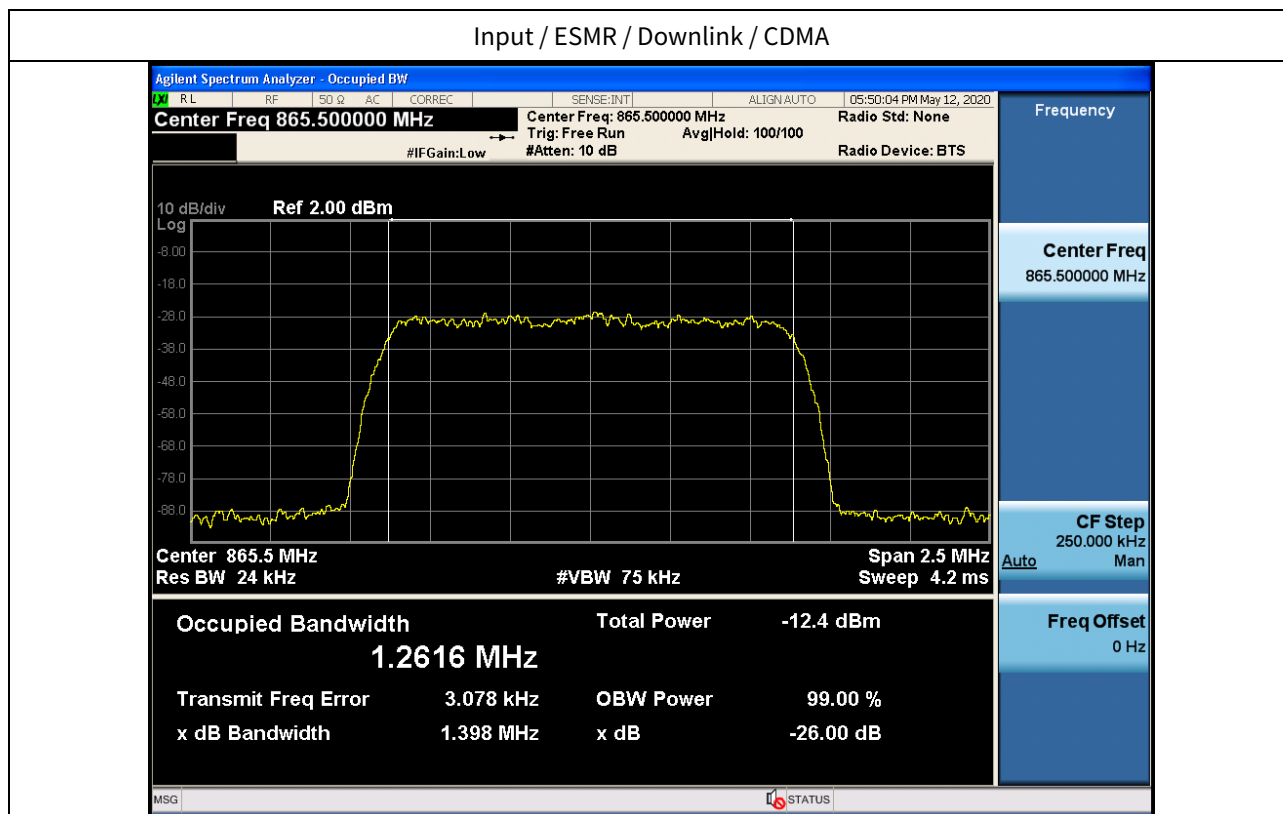
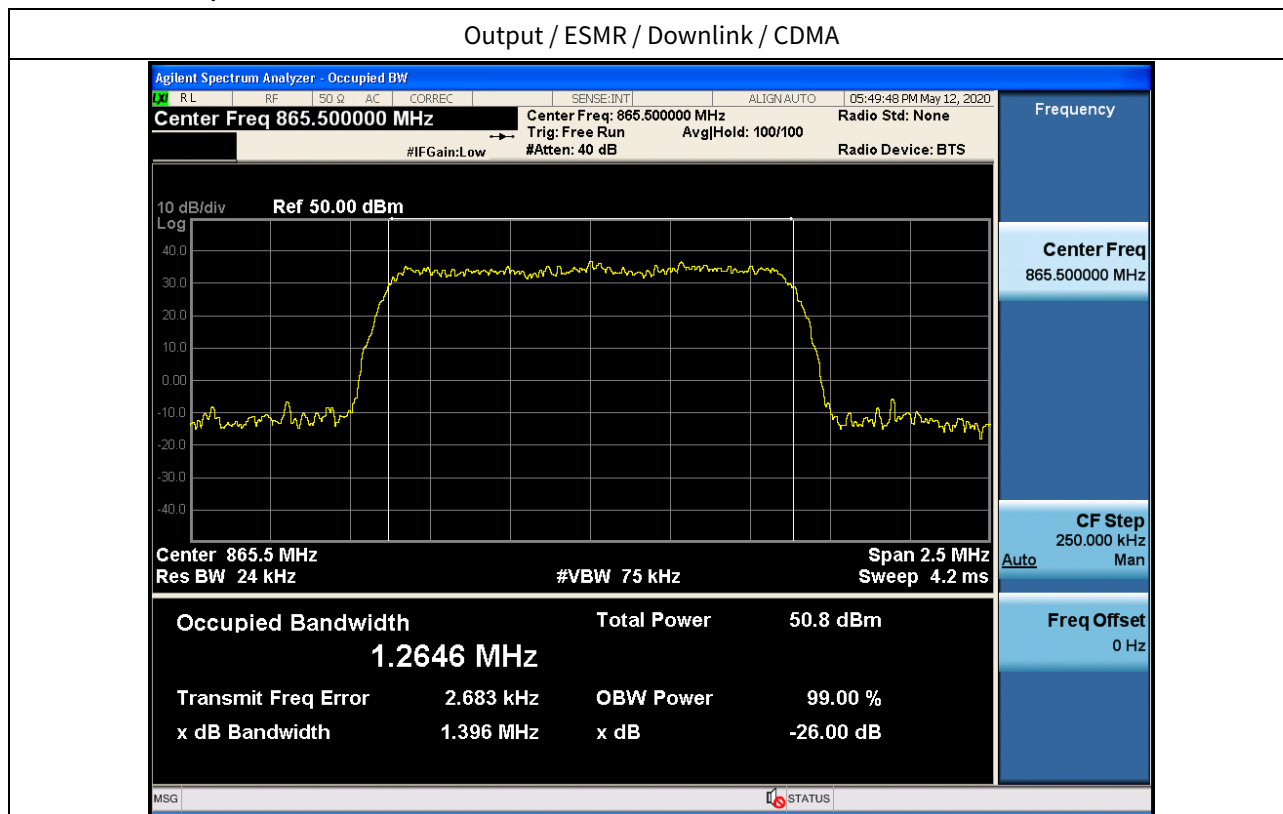
Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
ESMR	Downlink	CDMA	865.50	1.2619	1.398
		LTE 5 MHz	865.50	4.5132	4.953
		WCDMA	865.50	4.1862	4.713
Cellular		CDMA	881.50	1.2609	1.398
		WCDMA	881.50	4.1926	4.738
		LTE 5 MHz	881.50	4.5147	5.007
		LTE 10 MHz	881.50	9.0019	10.029

Measured Occupied Bandwidth Comparison

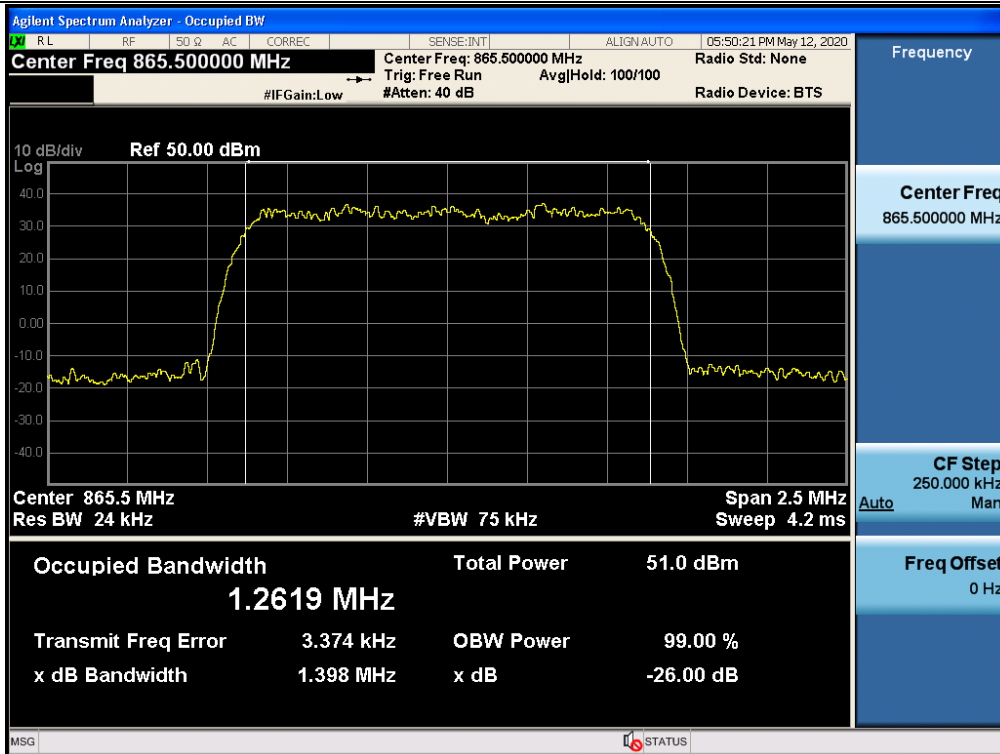
Test Band	Link	Signal	Variant of Input and output Occupied Bandwidth (%)	Variant of Input and 3 dB above the AGC threshold output Occupied Bandwidth (%)
ESMR	Downlink	CDMA	-0.143	0.000
		LTE 5 MHz	0.080	-0.999
		WCDMA	-0.042	-0.254
Cellular		CDMA	-0.712	-0.427
		WCDMA	0.362	1.002
		LTE 5 MHz	-0.882	0.381
		LTE 10 MHz	-0.111	0.774

** Change in input-output OBW is less than ± 5 %.*

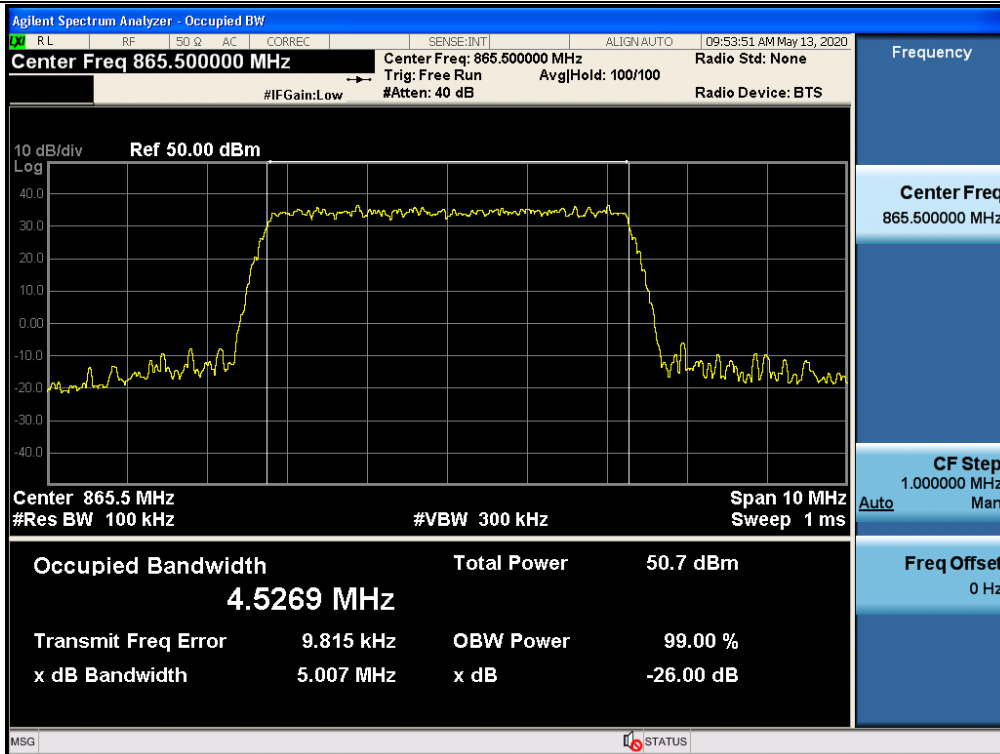
Plot data of Occupied Bandwidth



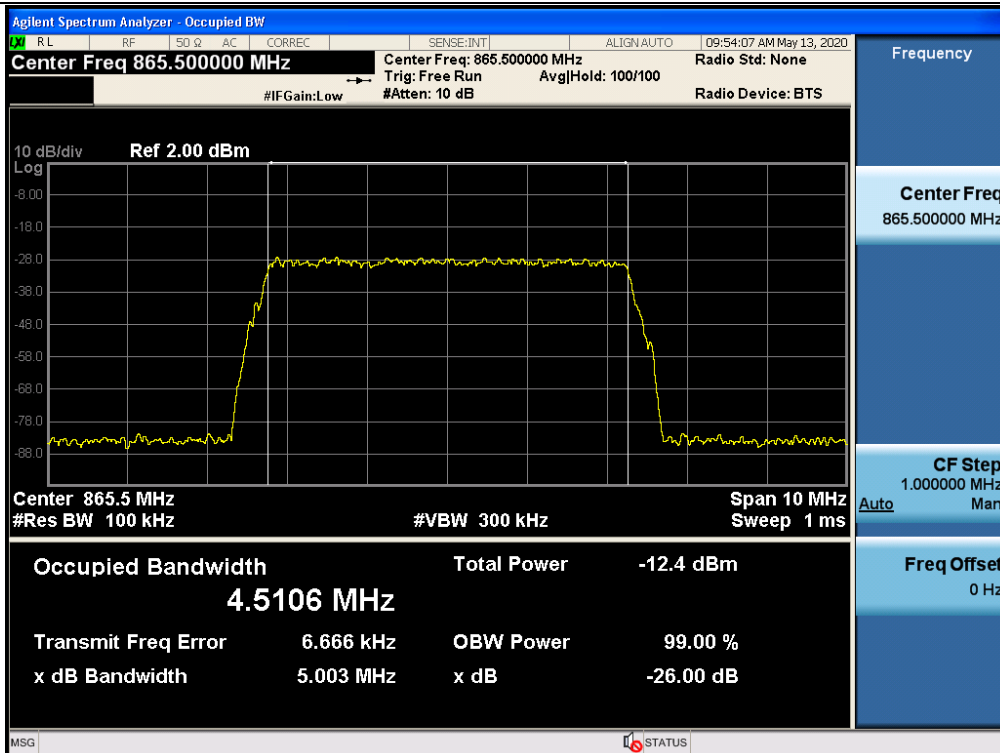
3 dB above the AGC threshold output / ESMR / Downlink / CDMA



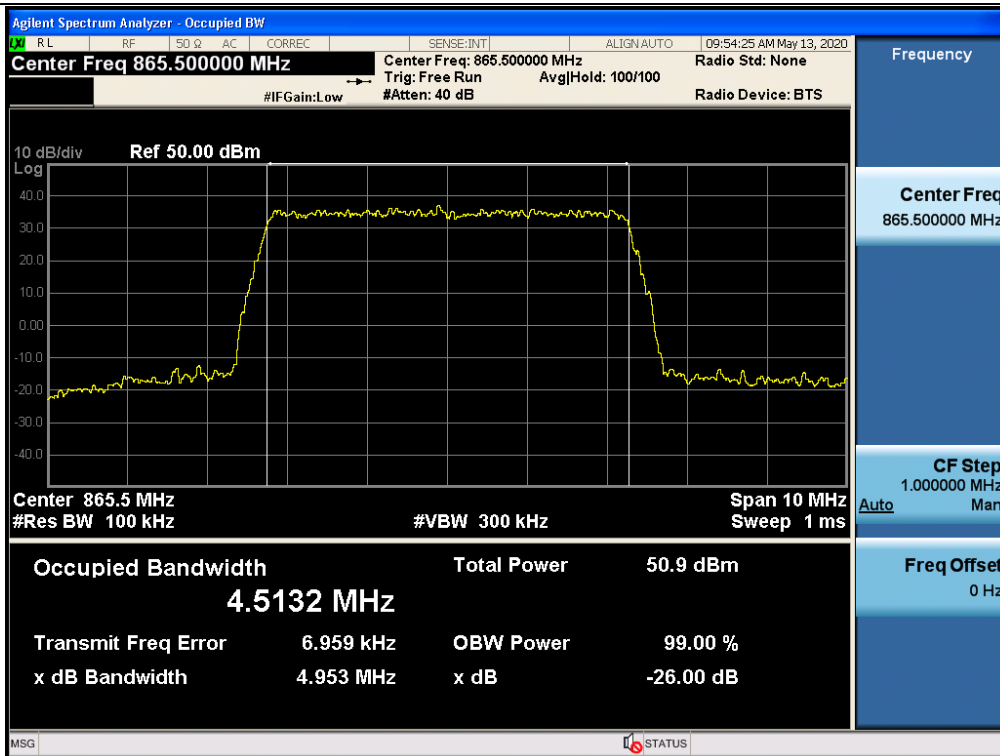
Output / ESMR / Downlink / LTE 5 MHz



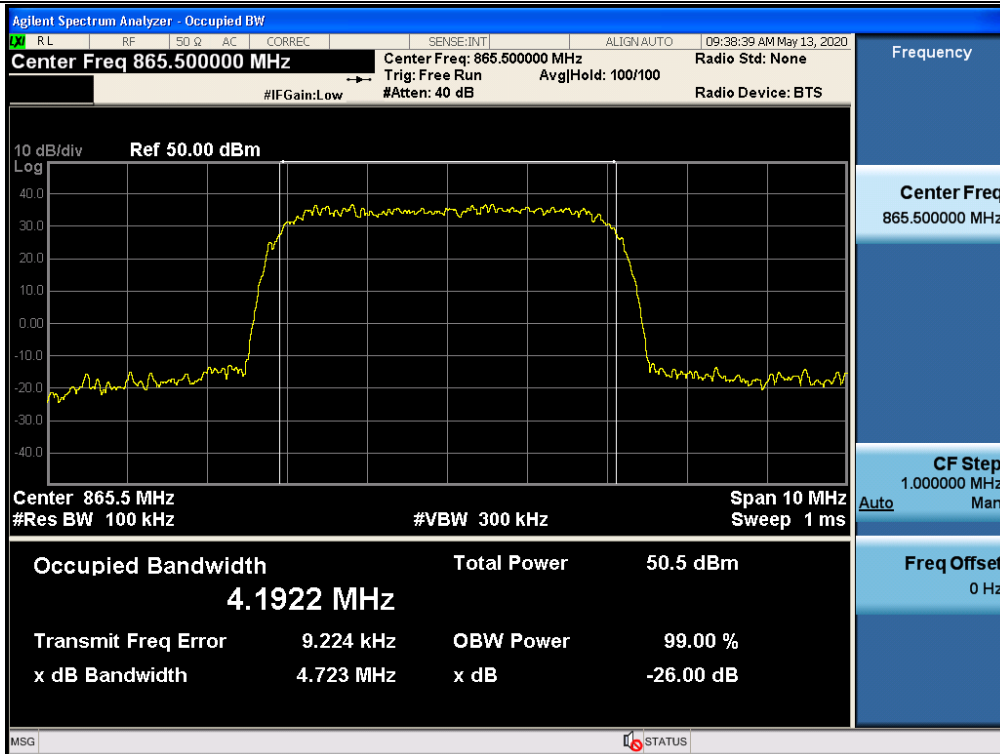
Input / ESMR / Downlink / LTE 5 MHz



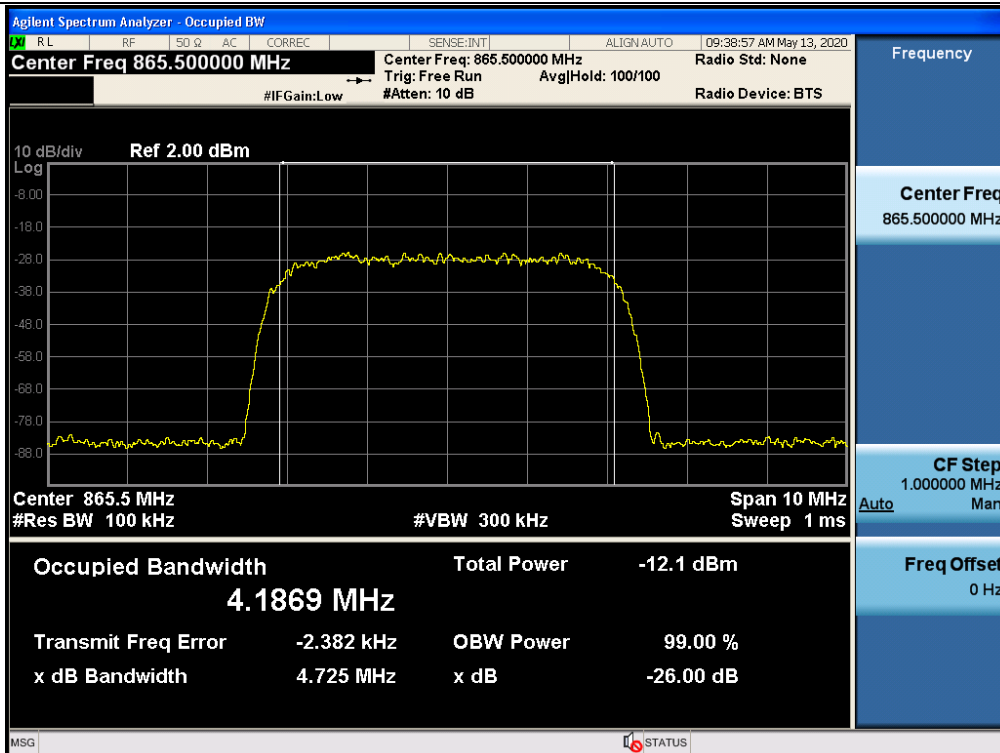
3 dB above the AGC threshold output / ESMR / Downlink / LTE 5 MHz



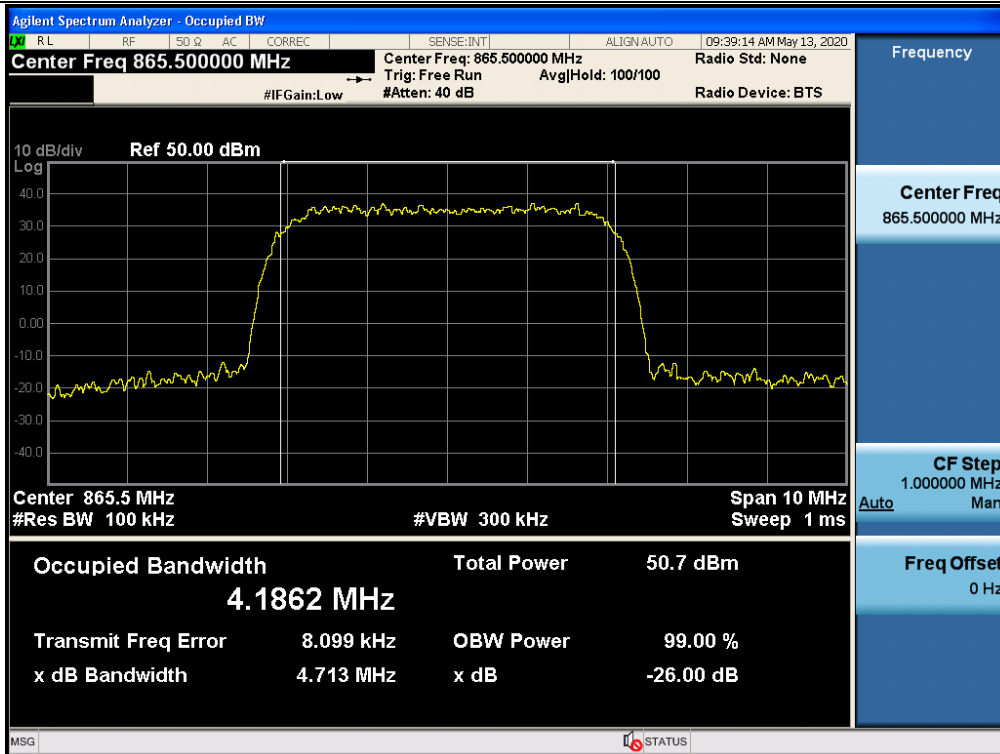
Output / ESMR / Downlink / WCDMA



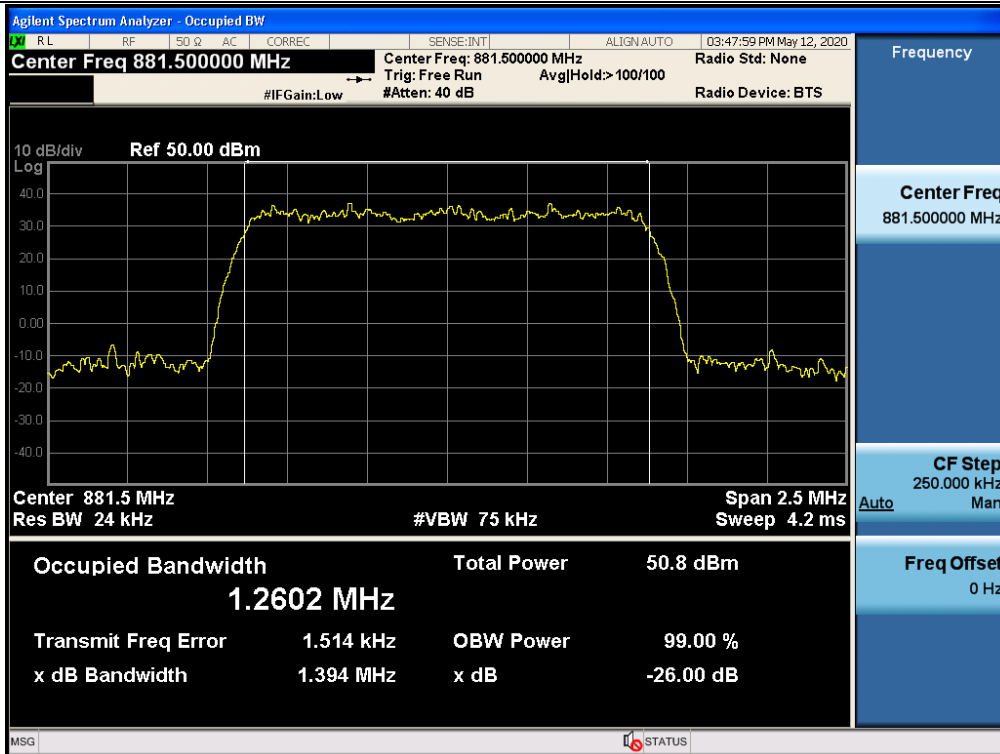
Input / ESMR / Downlink / WCDMA



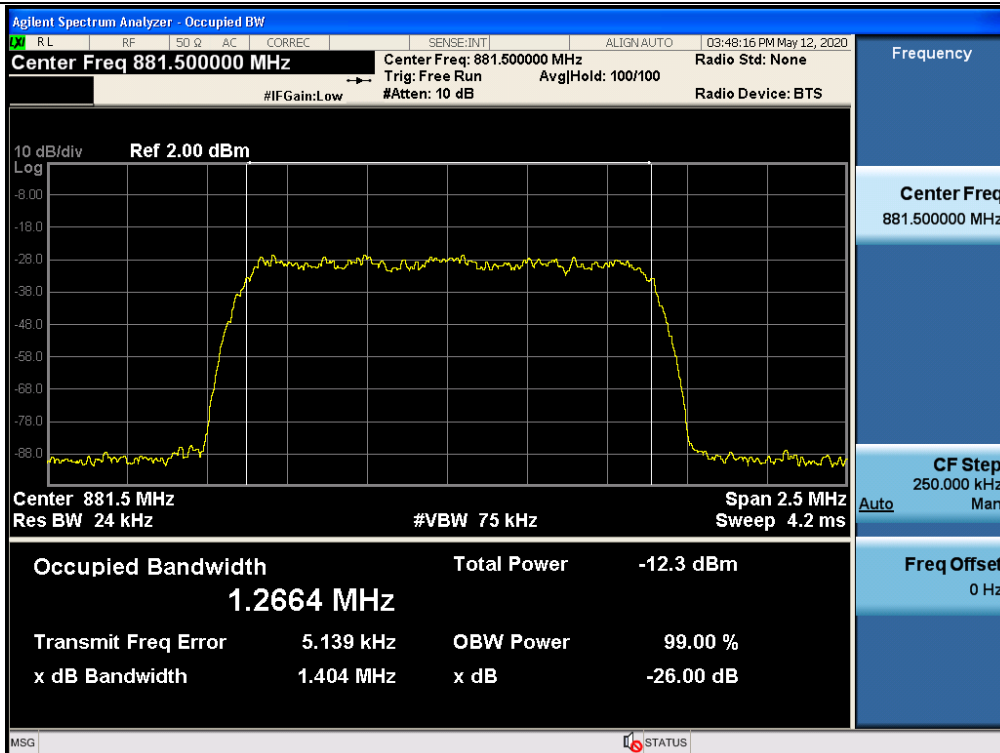
3 dB above the AGC threshold output / ESMR / Downlink / WCDMA



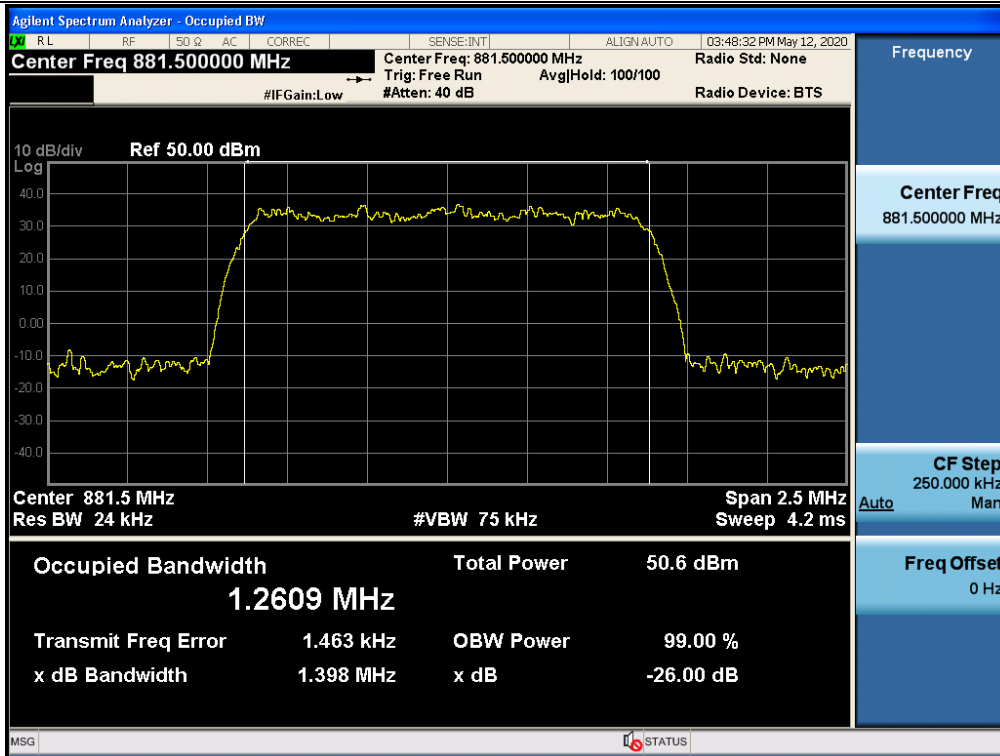
Output / Cellular / Downlink / CDMA



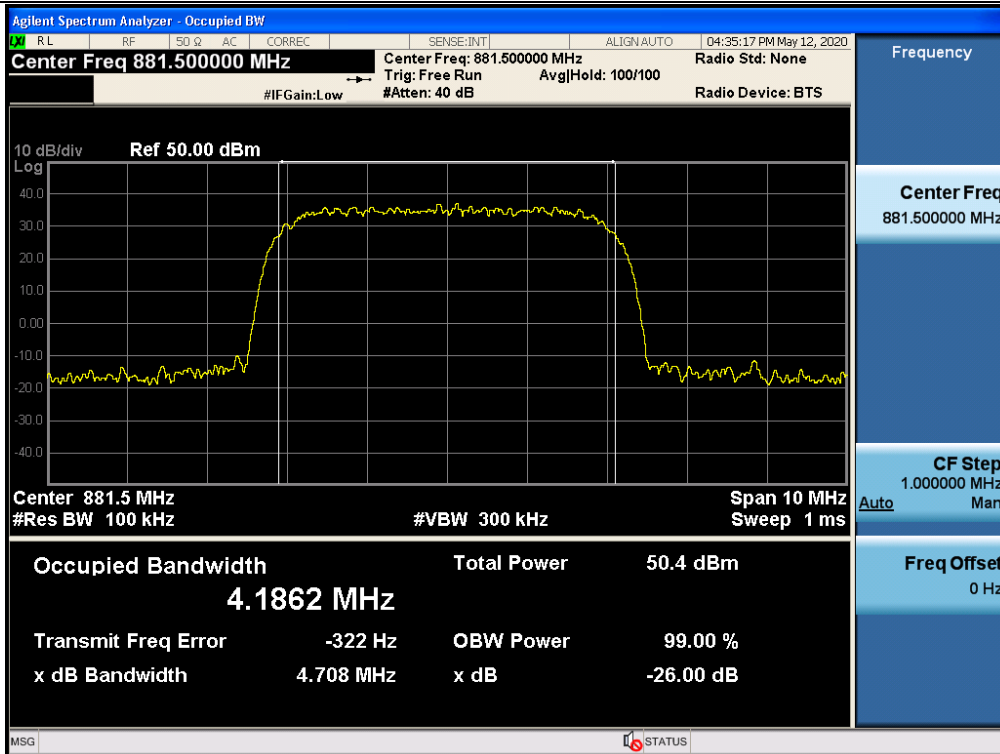
Input / Cellular / Downlink / CDMA



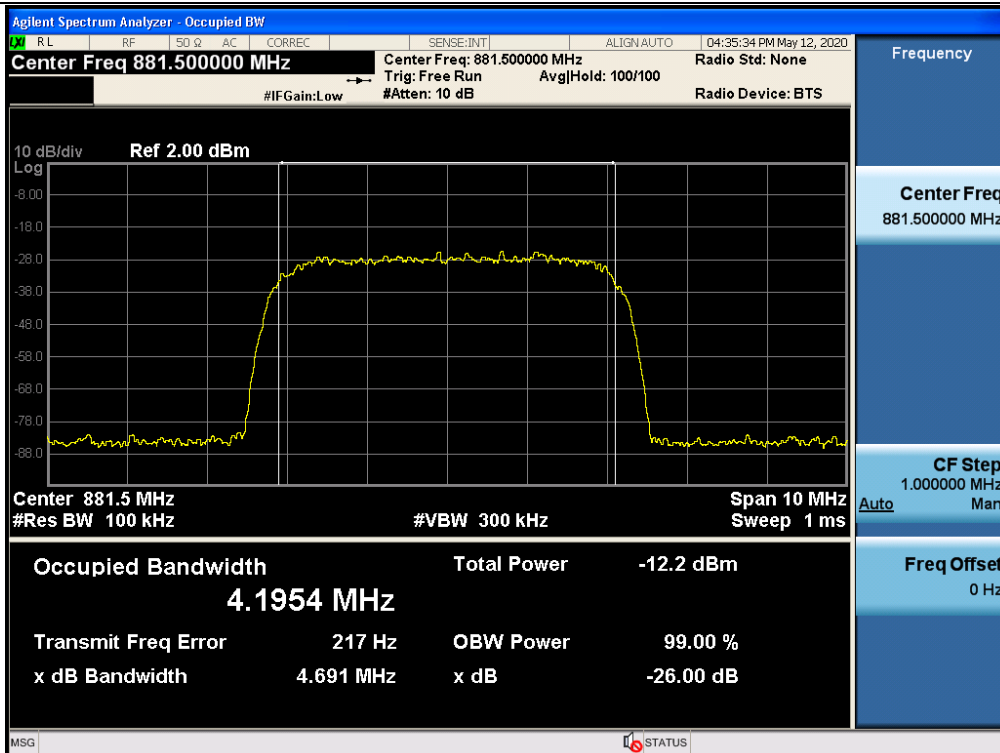
3 dB above the AGC threshold output / Cellular / Downlink / CDMA



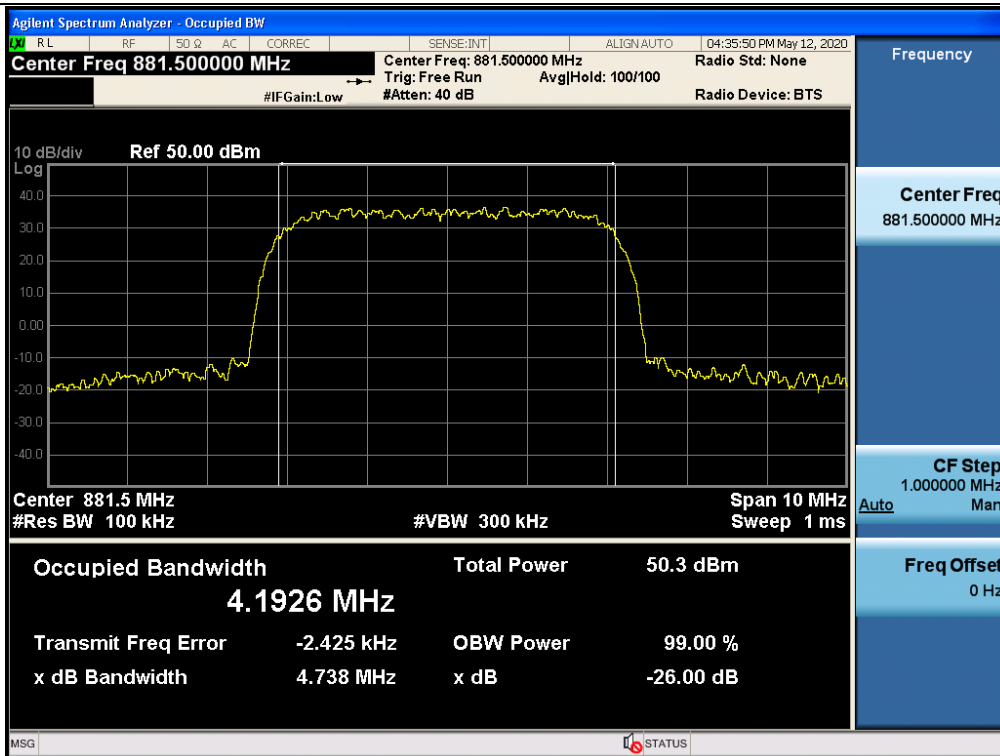
Output / Cellular / Downlink / WCDMA



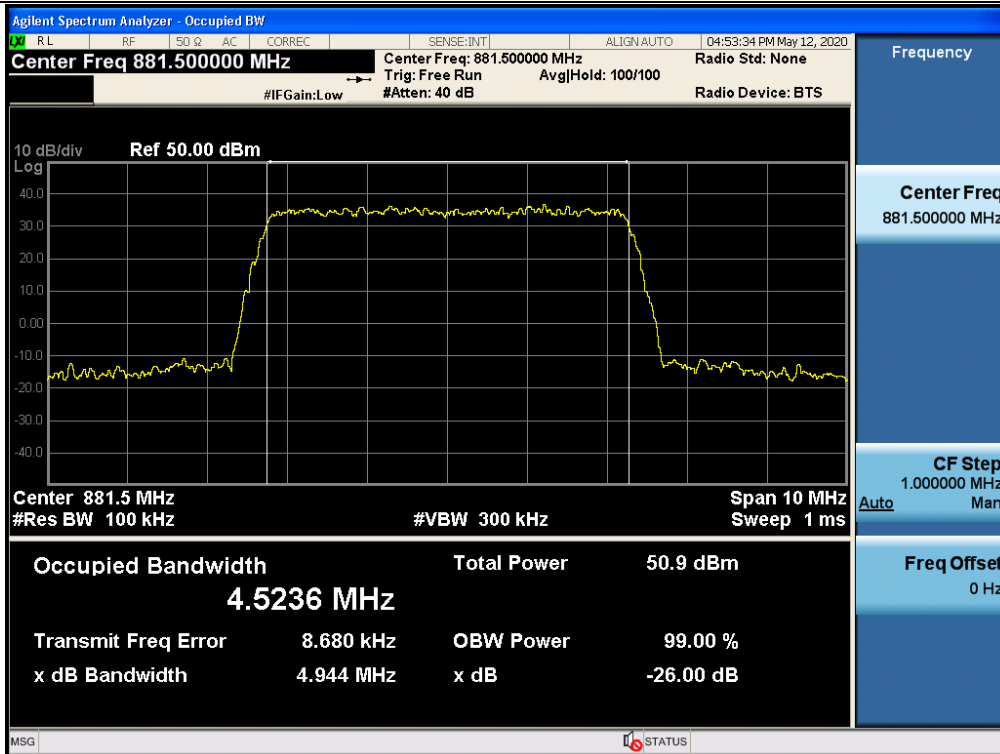
Input / Cellular / Downlink / WCDMA



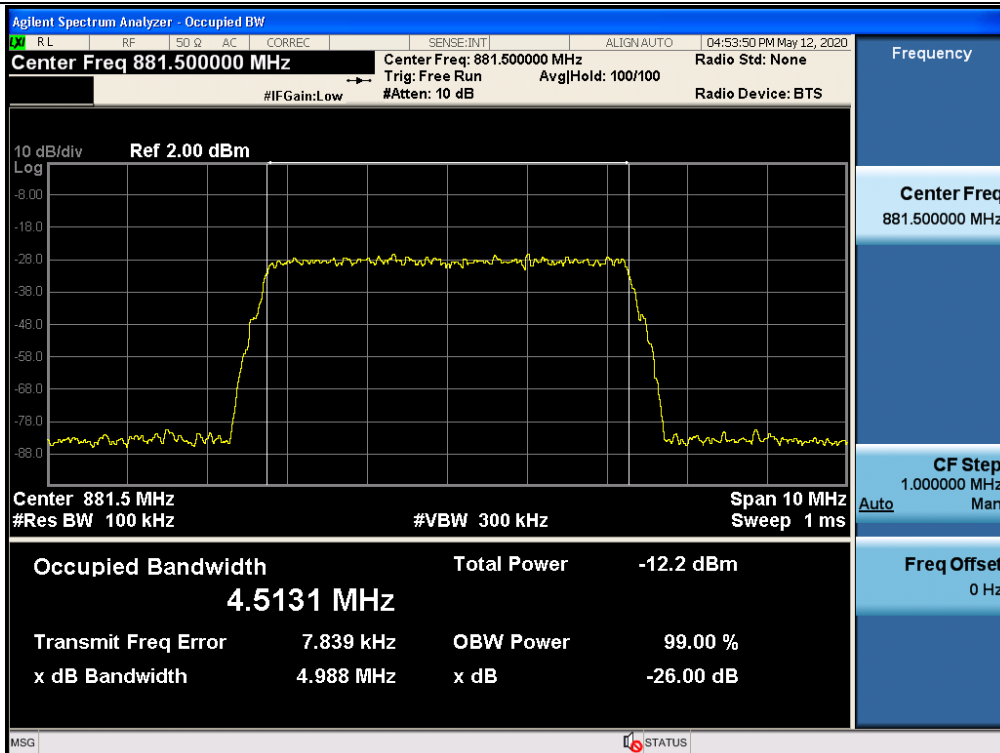
3 dB above the AGC threshold output / Cellular / Downlink / WCDMA



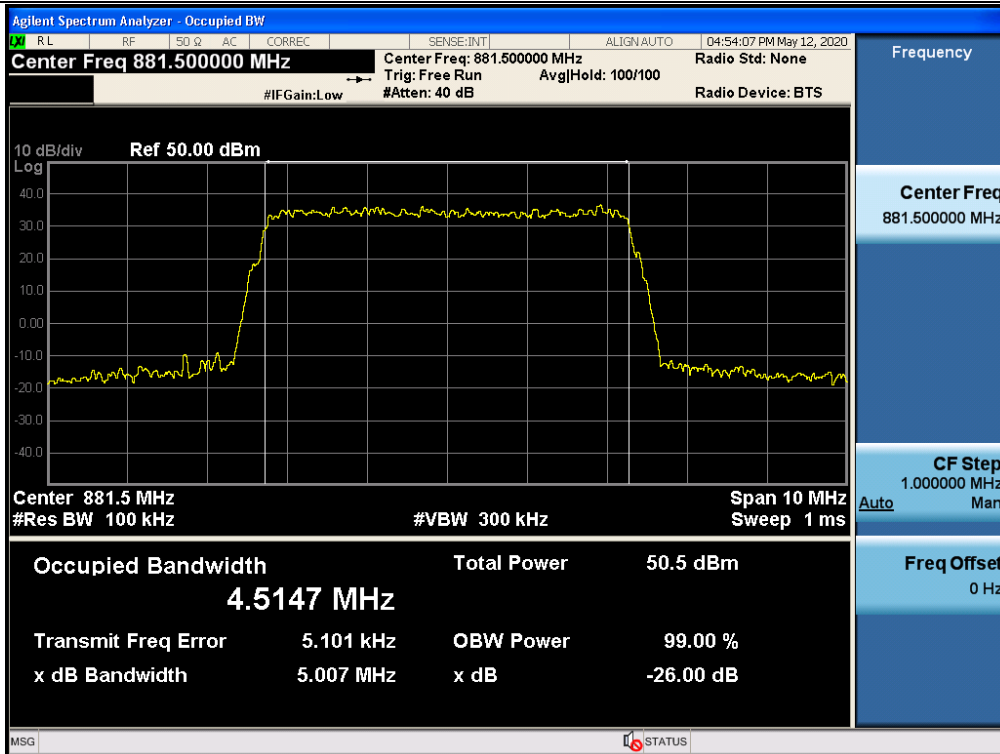
Output / Cellular / Downlink / LTE 5 MHz



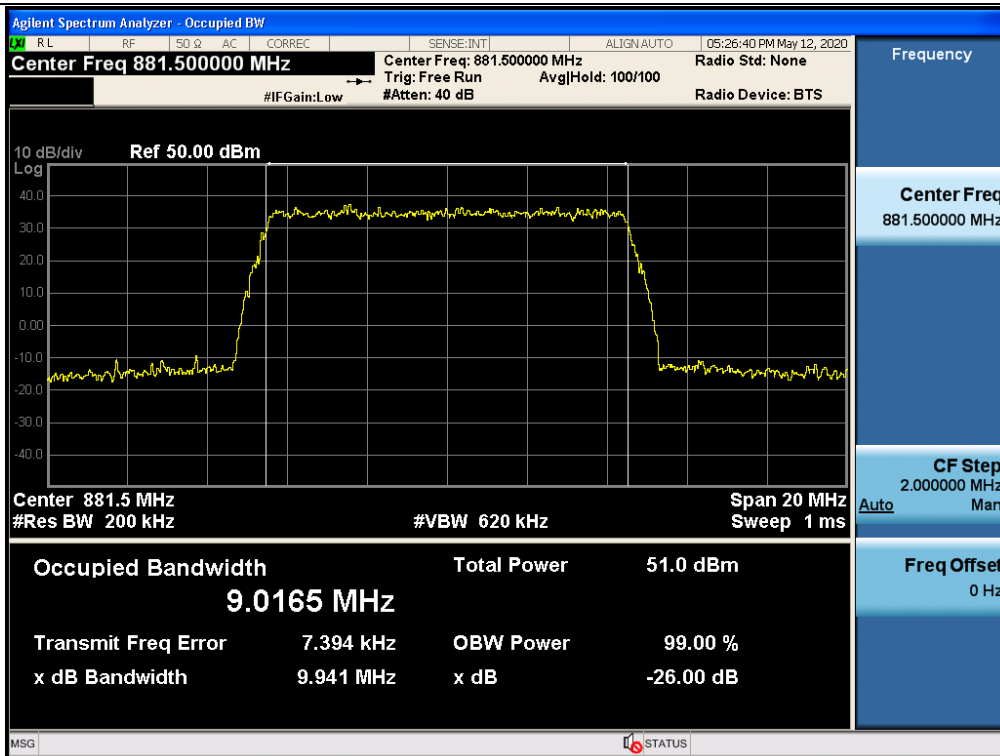
Input / Cellular / Downlink / LTE 5 MHz



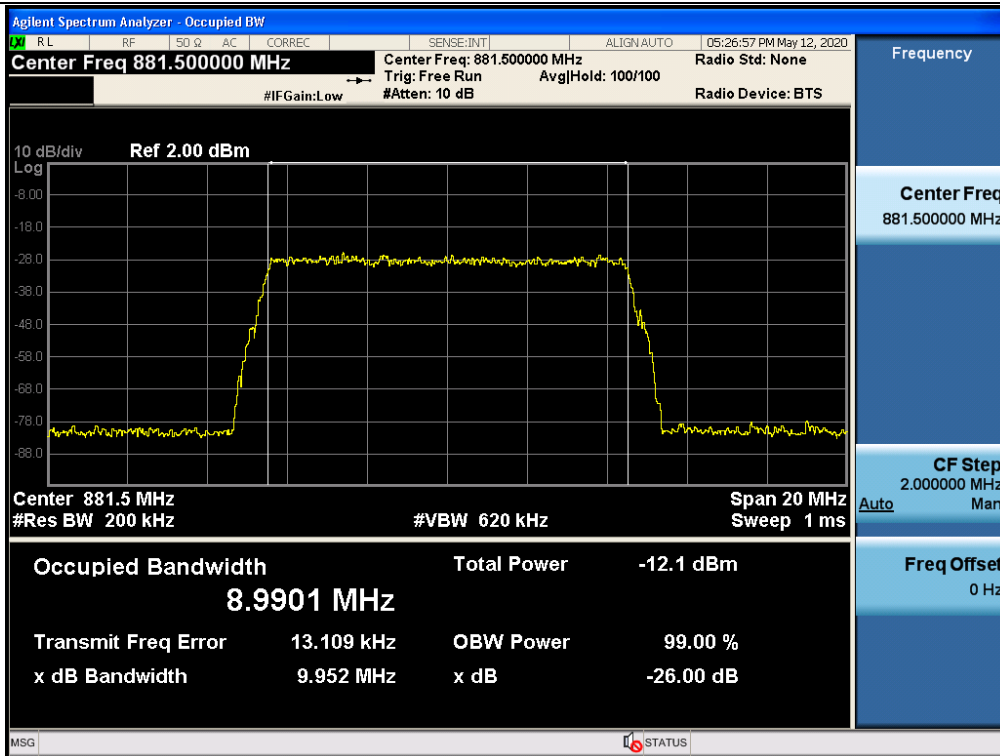
3 dB above the AGC threshold output / Cellular / Downlink / LTE 5 MHz



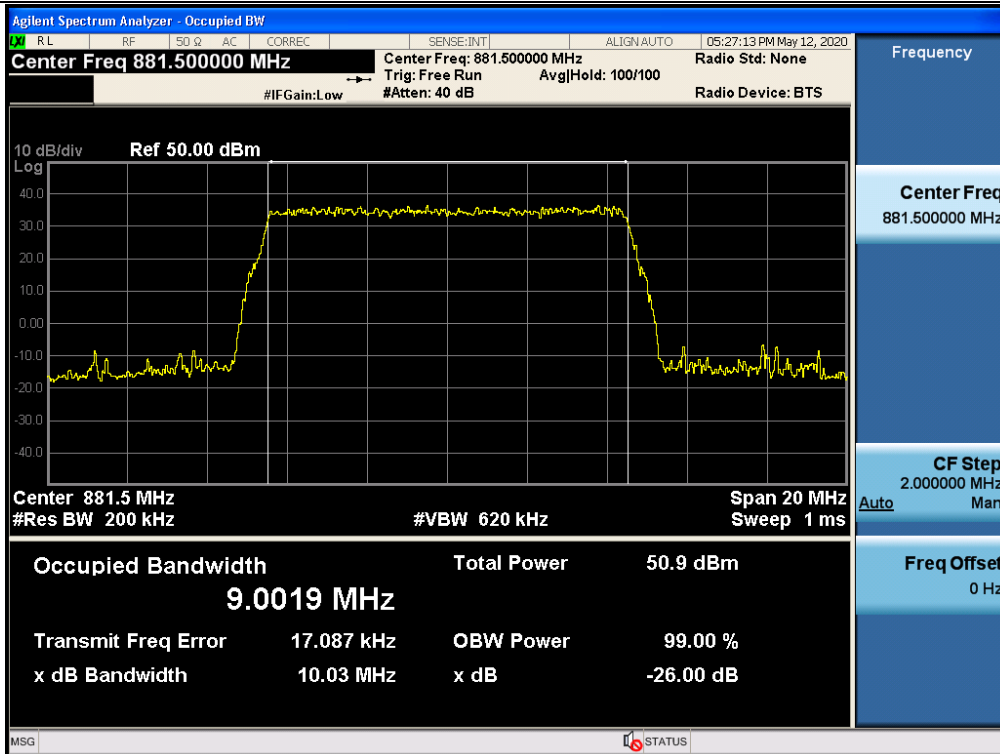
Output / Cellular / Downlink / LTE 10 MHz



Input / Cellular / Downlink / LTE 10 MHz



3 dB above the AGC threshold output / Cellular / Downlink / LTE 10 MHz



5.4. INPUT/OUTPUT POWER AND AMPLIFIER/BOOSTER GAIN

Test Requirements:

§ 2.1046 Measurements required: RF power output:

- (a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.
- (b) For single sideband, independent sideband, and single channel, controlled carrier radio telephone transmitters, the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as specified and as applicable in § 2.1046 (b) (1-5). In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.
- (c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

§ 22.913 Effective radiated power limits.

Licensees in the Cellular Radiotelephone Service are subject to the effective radiated power (ERP) limits and other requirements in this Section. See also § 22.169.

- (a) *Maximum ERP.* The ERP of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.
 - (1) Except as described in paragraphs (a)(2), (3), and (4) of this section, the ERP of base stations and repeaters must not exceed—
 - (i) 500 watts per emission; or
 - (ii) 400 watts/MHz (PSD) per sector.
 - (d) Power measurement. Measurement of the ERP of Cellular base transmitters and repeaters must be made using an average power measurement technique. The peak-to-average ratio (PAR) of the transmission must not exceed 13 dB. Power measurements for base transmitters and repeaters must be made in accordance with either of the following:
 - (1) A Commission-approved average power technique (see FCC Laboratory's Knowledge Database); or
 - (2) For purposes of this section, peak transmit power must be measured over an interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

§ 90.635 Limitations on power and antenna height

(a) The effective radiated power and antenna height for base stations may not exceed 1 kilowatt (30 dBw) and 304 m. (1,000 ft.) above average terrain (AAT), respectively, or the equivalent thereof as determined from the Table.

These are maximum values, and applicants will be required to justify power levels and antenna heights requested.

(b) The maximum output power of the transmitter for mobile stations is 100 watts (20 dBw).

Table—Equivalent Power and Antenna Heights for Base Stations in the 851-869 MHz and 935-940 MHz Bands Which Have a Requirement for a 32 km (20 mi) Service Area Radius

Antenna height (ATT) meters (feet)	Effective radiated power (watts)
Above 1,372 (4,500)	65
Above 1,220 (4,000) to 1,372 (4,500)	70
Above 1,067 (3,500) to 1,220 (4,000)	75
Above 915 (3,000) to 1,067 (3,500)	100
Above 763 (2,500) to 915 (3,000)	140
Above 610 (2,000) to 763 (2,500)	200
Above 458 (1,500) to 610 (2,000)	350
Above 305 (1,000) to 458 (1,500)	600
Up to 305 (1,000)	1,000

Test Procedures:

Measurements were in accordance with the test methods section 3.5 of KDB 935210 D05 v01r04.

Adjust the internal gain control of the EUT to the maximum gain for which the equipment certification is being sought. Any EUT attenuation settings shall be set to their minimum value.

Input power levels (uplink and downlink) should be set to maximum input ratings while confirming that the device is not capable of operating in saturation (non-linear mode) at the rated input levels, including during the performance of the input/output power measurements.

3.5.2 Measuring the EUT mean input and output power

- a) Connect a signal generator to the input of the EUT.
- b) Configure to generate the test signal.
- c) The frequency of the signal generator shall be set to the frequency f_0 as determined from out-of-band rejection test.
- d) Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation as necessary.
- e) Set the signal generator output power to a level that produces an EUT output level that is just below the AGC threshold, but not more than 0.5 dB below.
- f) Measure and record the output power of the EUT; use ANSI C63.26-2015 subclause 5.2.4.4.1, for power measurement.
- g) Remove the EUT from the measurement setup. Using the same signal generator settings, repeat the power measurement at the signal generator port, which was used as the input signal to the EUT, and record as the input power. EUT gain may be calculated as described in 3.5.5.
- h) Repeat steps f) and g) with input signal amplitude set to 3 dB above the AGC threshold level.
- i) Repeat steps e) to h) with the narrowband test signal.
- j) Repeat steps e) to i) for all frequency bands authorized for use by the EUT.

3.5.5 Calculating amplifier, repeater, or industrial booster gain

After the input and output power levels have been measured as described in the preceding subclauses, the gain of the EUT can be determined from:

$$\text{Gain (dB)} = \text{output power (dBm)} - \text{input power (dBm)}.$$

Report the gain for each authorized operating frequency band, and each test signal stimulus.

Note1. *If f_0 that determined from out-of-band test is smaller or greater than difference of test signal's center frequency and operation band block, test is performed at the lowest or the highest frequency that test signals can be passed.*

Tabular data of Input / Output Power and Gain

Test Band	Link	Signal	f ₀ Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
ESMR	Downlink	CDMA	866.96	-20.14	43.29	63.43
		LTE 5 MHz	866.50	-20.17	42.74	62.91
		WCDMA	866.50	-20.15	43.18	63.33
Cellular		CDMA	886.24	-20.01	43.02	63.03
		WCDMA	886.24	-19.92	43.18	63.10
		LTE 5 MHz	886.24	-19.92	42.66	62.58
		LTE 10 MHz	886.24	-19.98	43.29	63.27

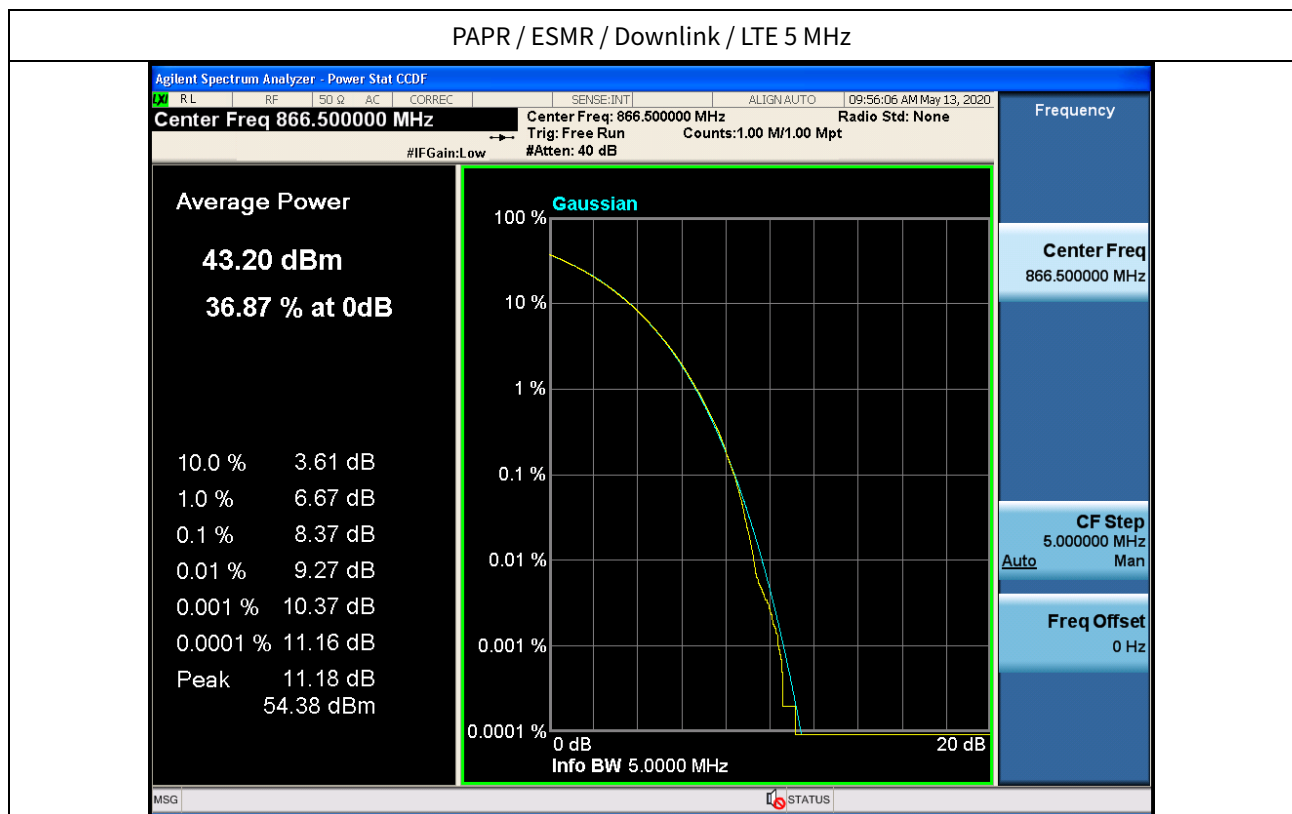
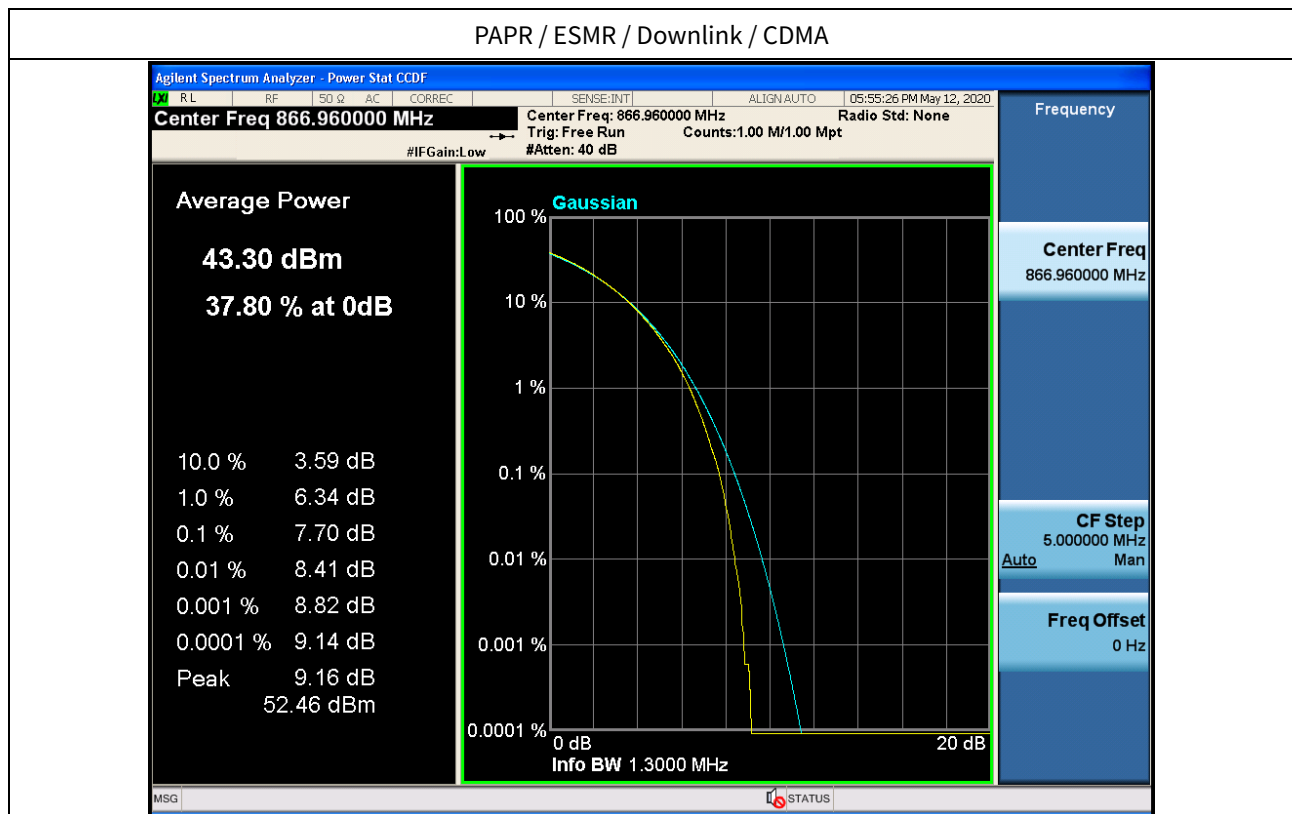
Tabular data of Input / 3 dB above AGC threshold Output Power and Gain

Test Band	Link	Signal	f ₀ Frequency (MHz)	Input Power (dBm)	+3 dB Output Power (dBm)	Gain (dB)
ESMR	Downlink	CDMA	866.96	-20.14	43.46	63.60
		LTE 5 MHz	866.50	-20.17	43.20	63.37
		WCDMA	866.50	-20.15	42.98	63.13
CDMA		886.24	-20.01	43.14	63.15	
WCDMA		886.24	-19.92	43.18	63.10	
LTE 5 MHz		886.24	-19.92	43.24	63.16	
LTE 10 MHz		886.24	-19.98	42.77	62.75	

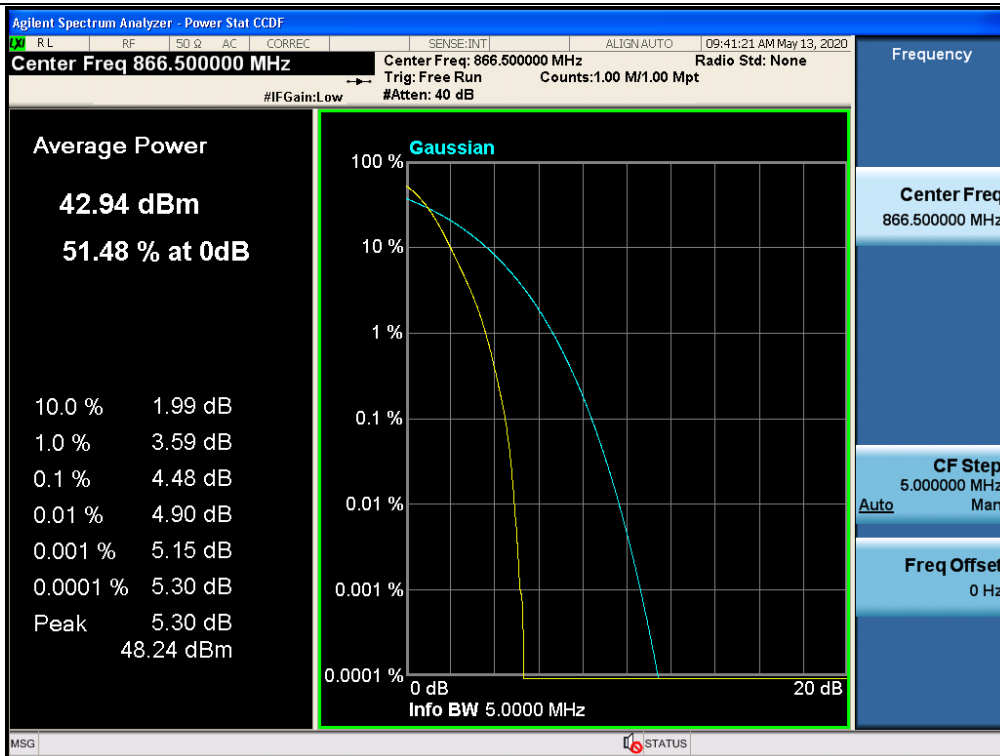
Tabular data of PAPR

Test Band	Link	Signal	f ₀ Frequency (MHz)	0.1 % PAPR (dB)
ESMR	Downlink	CDMA	866.96	7.70
		LTE 5 MHz	866.50	8.37
		WCDMA	866.50	4.48
Cellular		CDMA	886.24	7.67
		WCDMA	886.24	4.47
		LTE 5 MHz	886.24	8.34
		LTE 10 MHz	886.24	8.31

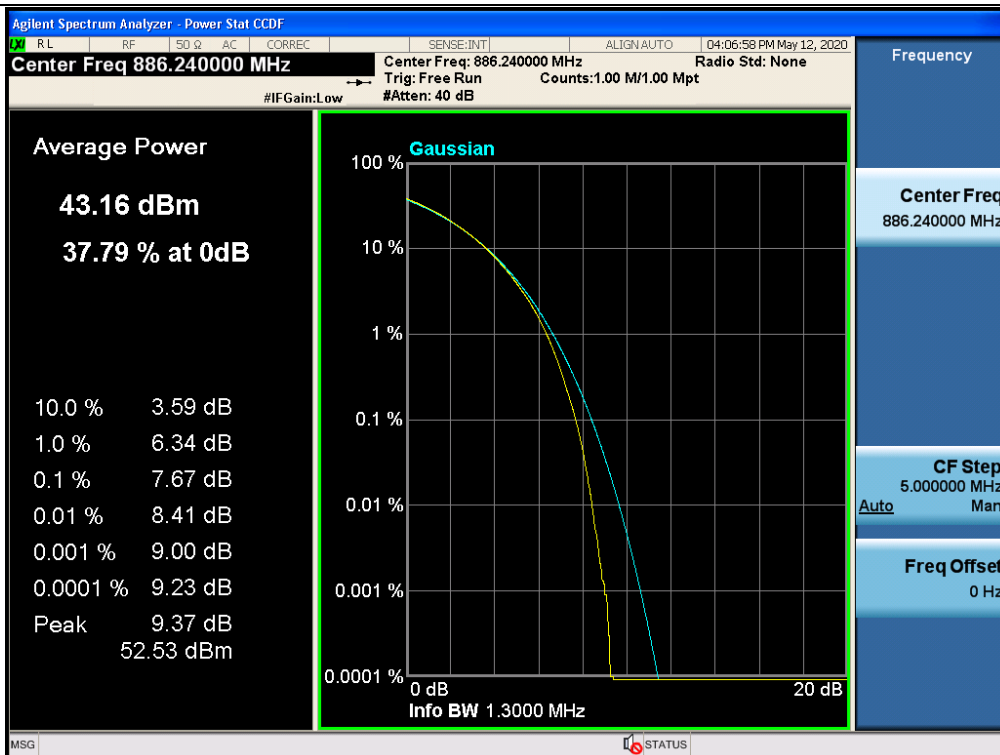
Plot data of PAPR



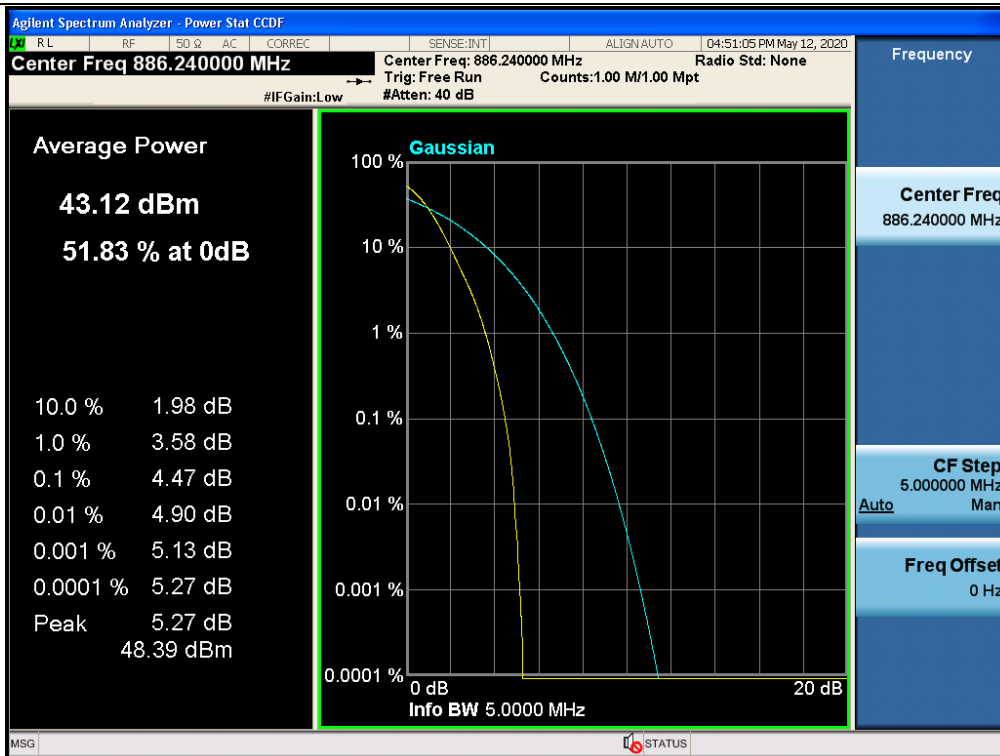
PAPR / ESMR / Downlink / WCDMA



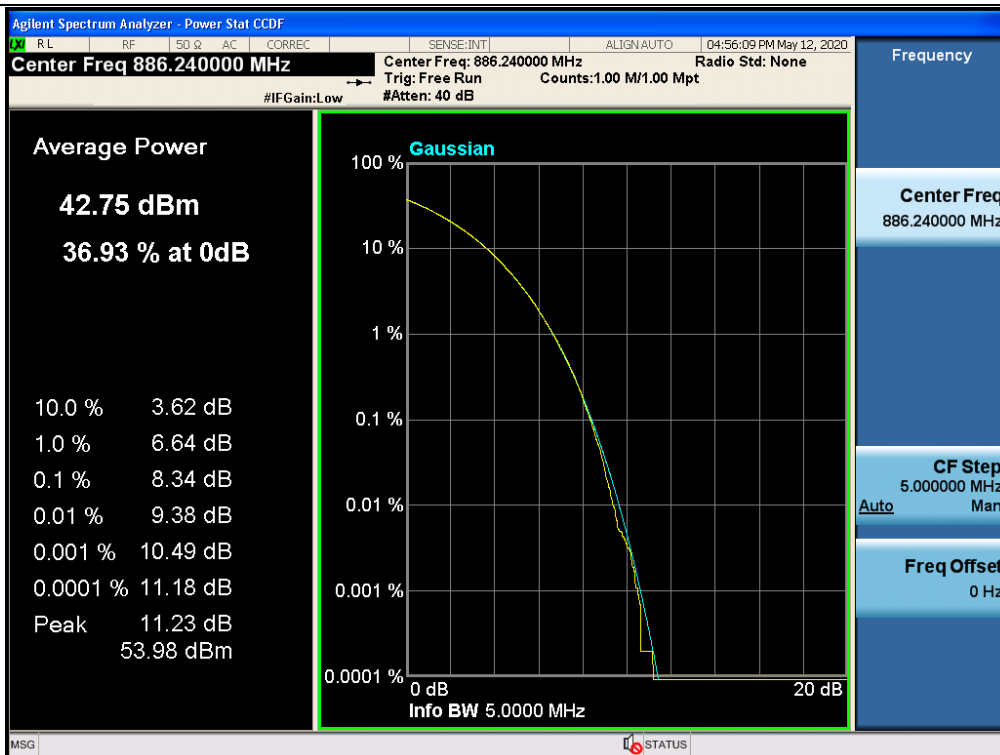
PAPR / Cellular / Downlink / CDMA



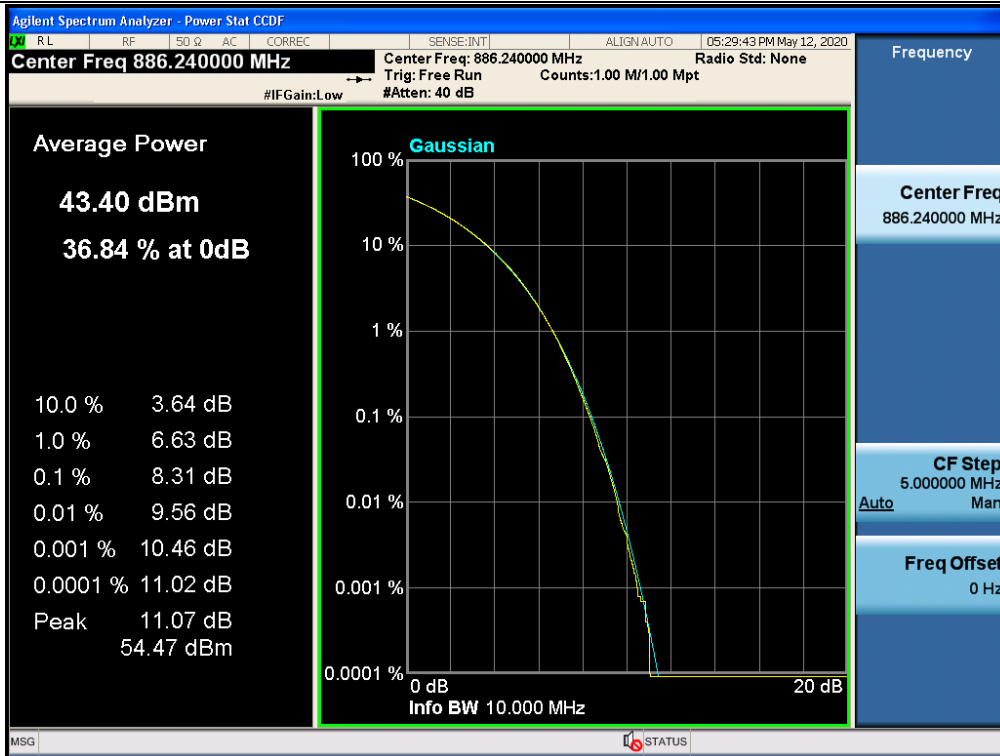
PAPR / Cellular / Downlink / WCDMA



PAPR / Cellular / Downlink / LTE 5 MHz



PAPR / Cellular / Downlink / LTE 10 MHz



5.5. OUT-OF-BAND/OUT-OF-BLOCK EMISSIONS AND SPURIOUS EMISSIONS

Test Requirements:

§ 2.1051 Measurements required: Spurious emissions at antenna terminals:

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 22.917 Emission limitations for cellular equipment.

The rules in this section govern the spectral characteristics of emissions in the Cellular Radiotelephone Service.

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a reference bandwidth as follows:

(1) In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater.

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. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy, provided that the measured power is integrated over the full required reference bandwidth (i.e., 100 kHz or 1 percent of emission bandwidth, as specified). 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 emissions are attenuated at least 26 dB below the transmitter power.

(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz.

(c) Alternative out of band emission limit. Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.

(d) Interference caused by out of band emissions. If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

§ 90.691 Emission mask requirements for EA-based systems

(a) Out-of-band emission requirement shall apply only to the “outer” channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

(1) For any frequency removed from the EA licensee's frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $116 \log_{10}(f/6.1)$ decibels or $50 + 10 \log_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz.

(2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

(b) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

Test Procedures:

Measurements were in accordance with the test methods section 3.6 of KDB 935210 D05 v01r04.

Spurious emissions shall be measured using a single test signal sequentially tuned to the low, middle, and high channels or frequencies within each authorized frequency band of operation.

Out-of-band/out-of-block emissions (including intermodulation products) shall be measured under each of the following two stimulus conditions:

- a) two adjacent test signals sequentially tuned to the lower and upper frequency band/block edges;*
- b) a single test signal, sequentially tuned to the lowest and highest frequencies or channels within the frequency band/block under examination.*

NOTE—Single-channel boosters that cannot accommodate two simultaneous signals within the passband may be excluded from the test stipulated in step a).

3.6.2 Out-of-band/out-of-block emissions conducted measurements

- a) Connect a signal generator to the input of the EUT.

If the signal generator is not capable of generating two modulated carriers simultaneously, then two discrete signal generators can be connected with an appropriate combining network to support this two-signal test.

- b) Set the signal generator to produce two AWGN signals as previously described.
- c) Set the center frequencies such that the AWGN signals occupy adjacent channels, as defined by industry standards such as 3GPP or 3GPP2, at the upper edge of the frequency band or block under test.
- d) Set the composite power levels such that the input signal is just below the AGC threshold, but not more than 0.5 dB below. The composite power can be measured using the procedures provided in KDB Publication 971168, but it will be necessary to expand the power integration bandwidth so as to include both of the transmit channels.
- e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.
- f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band.
- g) Set the VBW = $3 \times \text{RBW}$.
- h) Set the detector to power averaging (rms) detector.
- i) Set the Sweep time = auto-couple.
- j) Set the spectrum analyzer start frequency to the upper block edge frequency, and the stop frequency to the upper block edge frequency plus 300 kHz or 3 MHz, for frequencies below and above 1 GHz, respectively.
- k) Trace average at least 100 traces in power averaging (rms) mode.
- l) Use the marker function to find the maximum power level.
- m) Capture the spectrum analyzer trace of the power level for inclusion in the test report.
- n) Repeat steps k) to m) with the composite input power level set to 3 dB above the AGC threshold.

- o) Reset the frequencies of the input signals to the lower edge of the frequency block or band under test.
- p) Reset the spectrum analyzer start frequency to the lower block edge frequency minus 300 kHz or 3 MHz, for frequencies below and above 1 GHz, respectively, and the stop frequency to the lower band or block edge frequency.
- q) Repeat steps k) to n).
- r) Repeat steps a) to q) with the signal generator configured for a single test signal tuned as close as possible to the

block edges.

- s) Repeat steps a) to r) with the narrowband test signal.
- t) Repeat steps a) to s) for all authorized frequency bands or blocks used by the EUT.

3.6.3 Spurious emissions conducted measurements

- a) Connect a signal generator to the input of the EUT.
- b) Set the signal generator to produce the broadband test signal as previously described.
- c) Set the center frequency of the test signal to the lowest available channel within the frequency band or block.
- d) Set the EUT input power to a level that is just below the AGC threshold, but not more than 0.5 dB below.
- e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.
- f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band of operation.
- g) Set the VBW $\geq 3 \times$ RBW.
- h) Set the Sweep time = auto-couple.
- i) Set the spectrum analyzer start frequency to the lowest RF signal generated in the equipment, without going below 9 kHz, and the stop frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as specified in the applicable rule part.

The number of measurement points in each sweep must be $\geq (2 \times \text{span}/\text{RBW})$, which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.

- j) Select the power averaging (rms) detector function.
- k) Trace average at least 10 traces in power averaging (rms) mode.
- l) Use the peak marker function to identify the highest amplitude level over each measured frequency range.

Record the frequency and amplitude and capture a plot for inclusion in the test report.

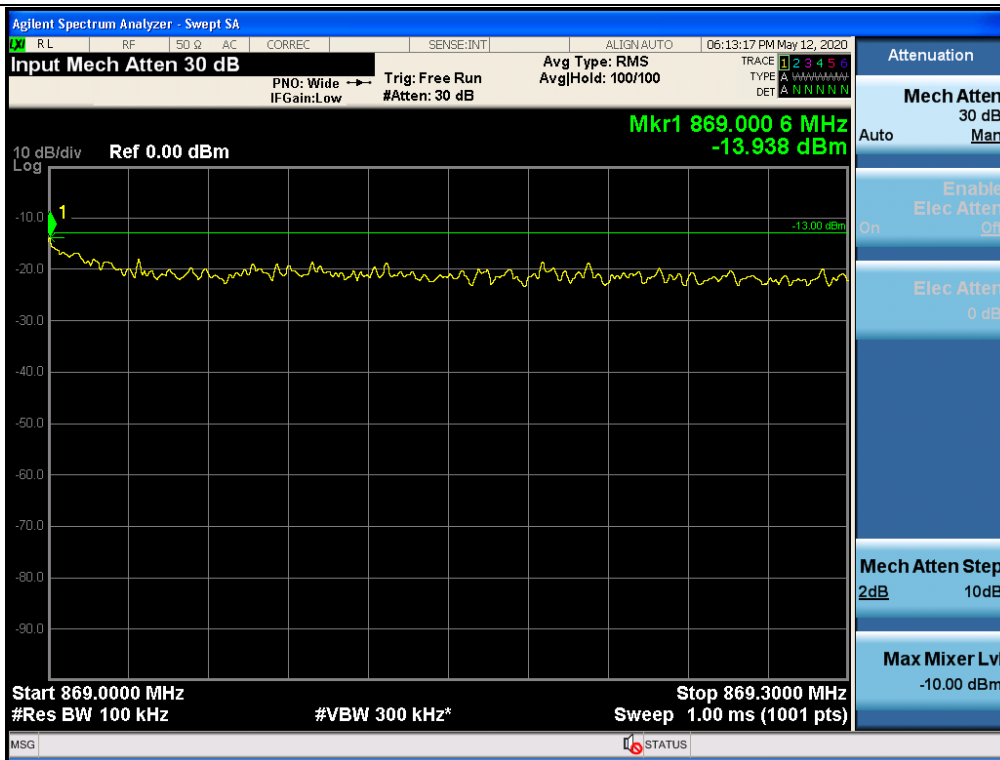
- m) Reset the spectrum analyzer start frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, as specified in the applicable rule part, and the spectrum analyzer stop frequency to 10 times the highest frequency of the fundamental emission. The number of measurement points in each sweep must be $\geq (2 \times \text{span}/\text{RBW})$, which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.

- n) Trace average at least 10 traces in power averaging (rms) mode.
- o) Use the peak marker function to identify the highest amplitude level over each of the measured frequency ranges. Record the frequency and amplitude and capture a plot for inclusion in the test report; also provide tabular data, if required.
- p) Repeat steps i) to o) with the input test signals firstly tuned to a middle band/block frequency/channel, and then tuned to a high band/block frequency/channel.
- q) Repeat steps b) to p) with the narrowband test signal.
- r) Repeat steps b) to q) for all authorized frequency bands/blocks used by the EUT.

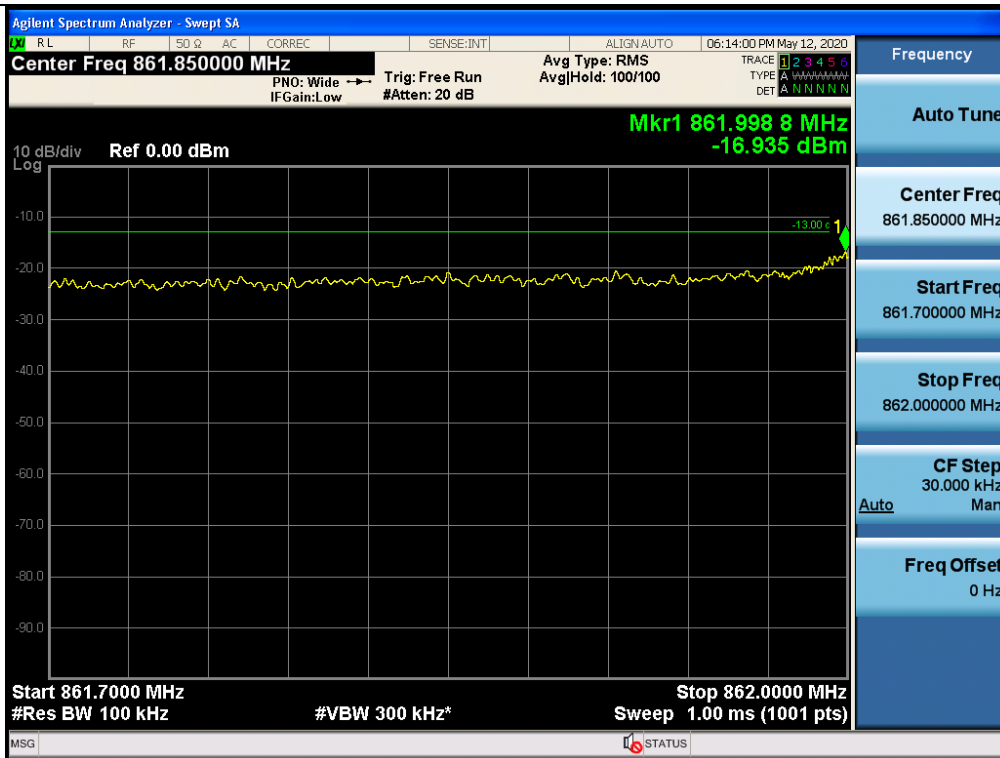
Note: In 9 kHz-150 kHz and 150 kHz-30 MHz bands, RBW was reduced to 0.1 % and 1 % of the reference bandwidth for measuring unwanted emission level (typically, 1 MHz if the authorized frequency band is above 1 GHz) and power was integrated. (1% = +30 dB, 10% = +20 dB)

Test Results: Plot data of Out-of-band/out-of-block emissions

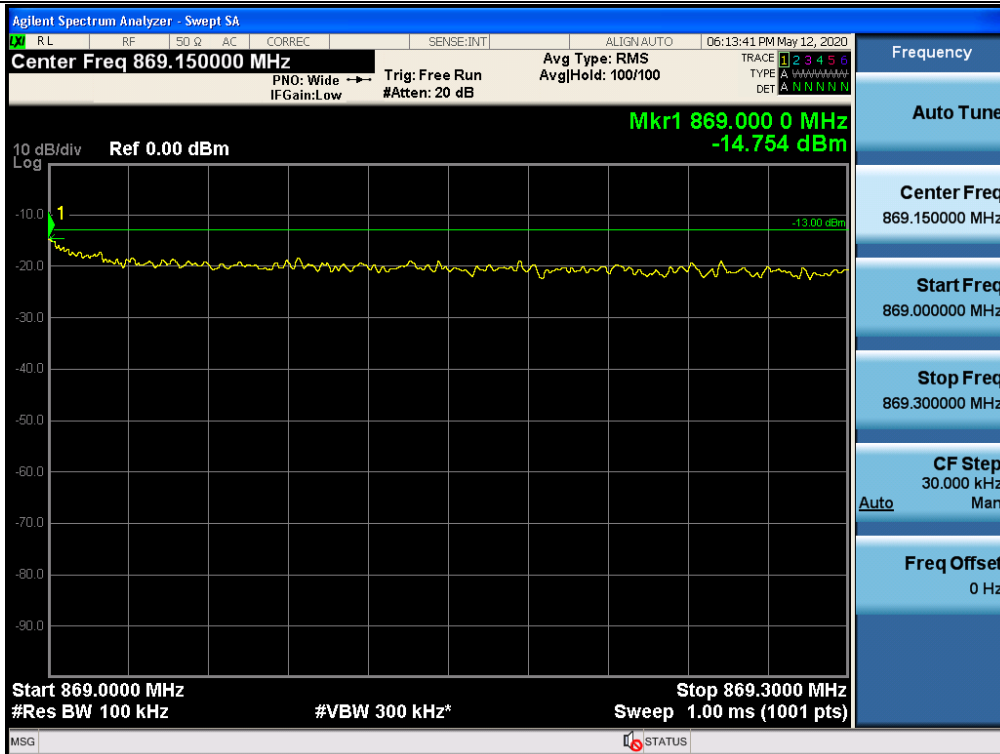
Out-of-band (two adjacent test signals) / ESMR / Downlink / CDMA / Upper



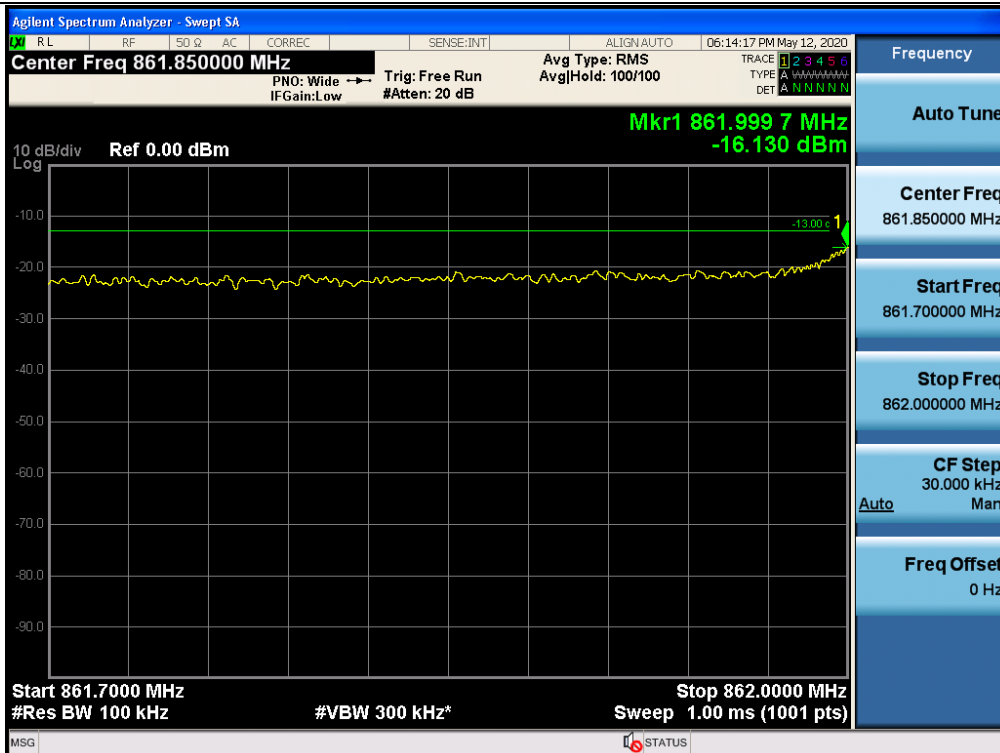
Out-of-band (two adjacent test signals) / ESMR / Downlink / CDMA / Lower



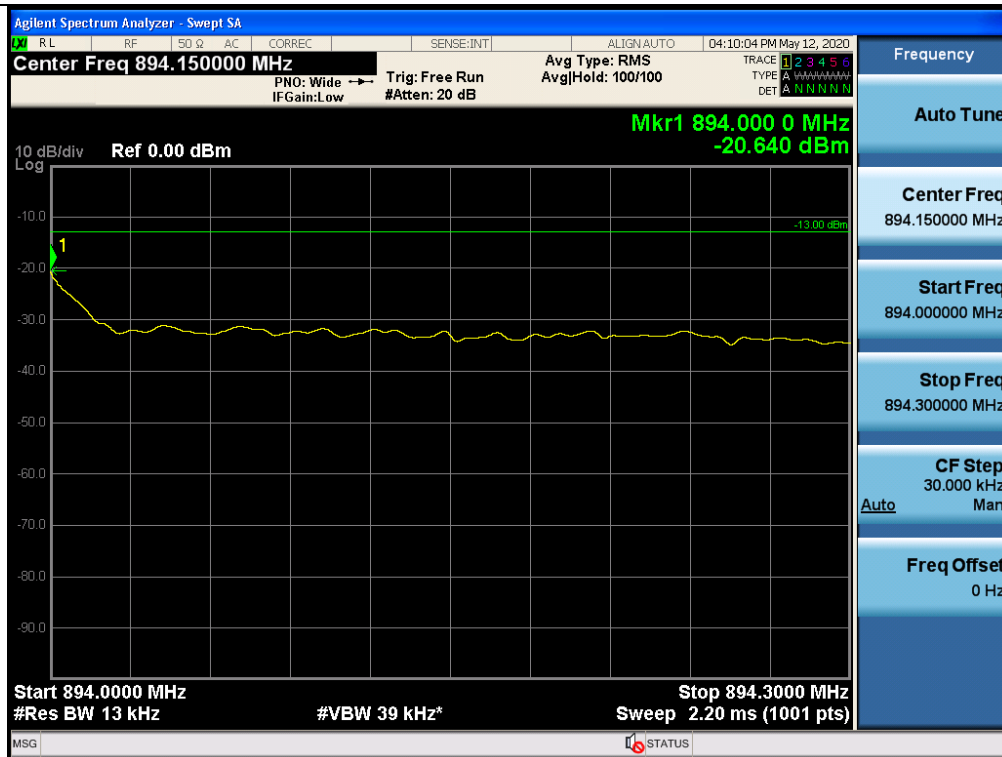
+3 dB above Out-of-band (two adjacent test signals) / ESMR / Downlink / CDMA / Upper



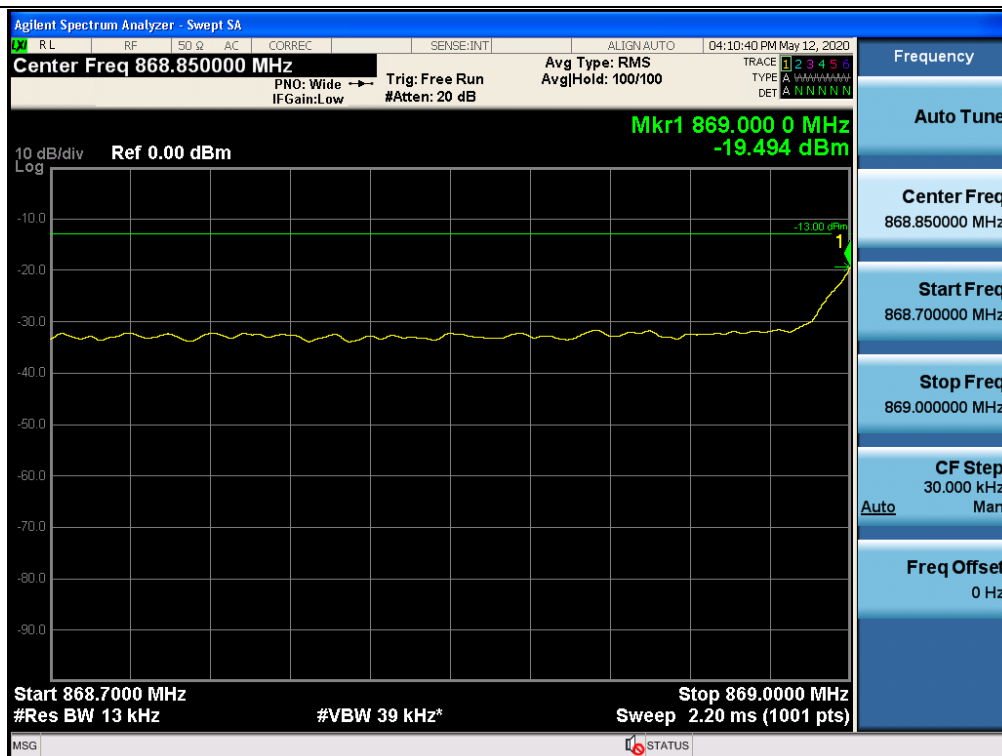
+3 dB above Out-of-band (two adjacent test signals) / ESMR / Downlink / CDMA / Lower



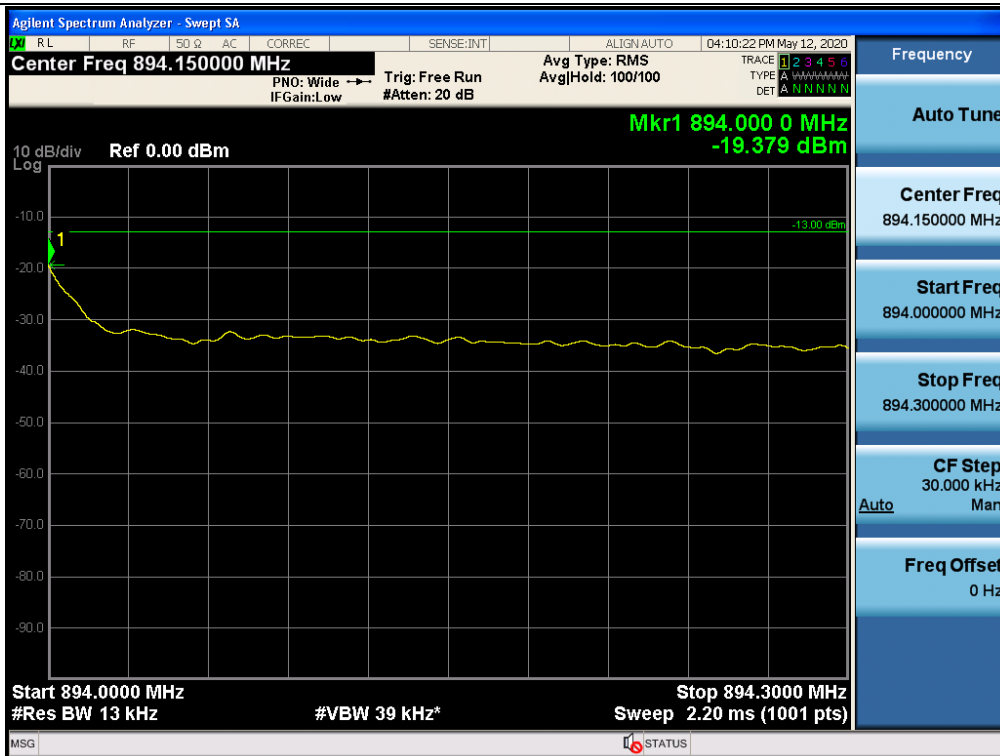
Out-of-band (two adjacent test signals) / Cellular / Downlink / CDMA / Upper



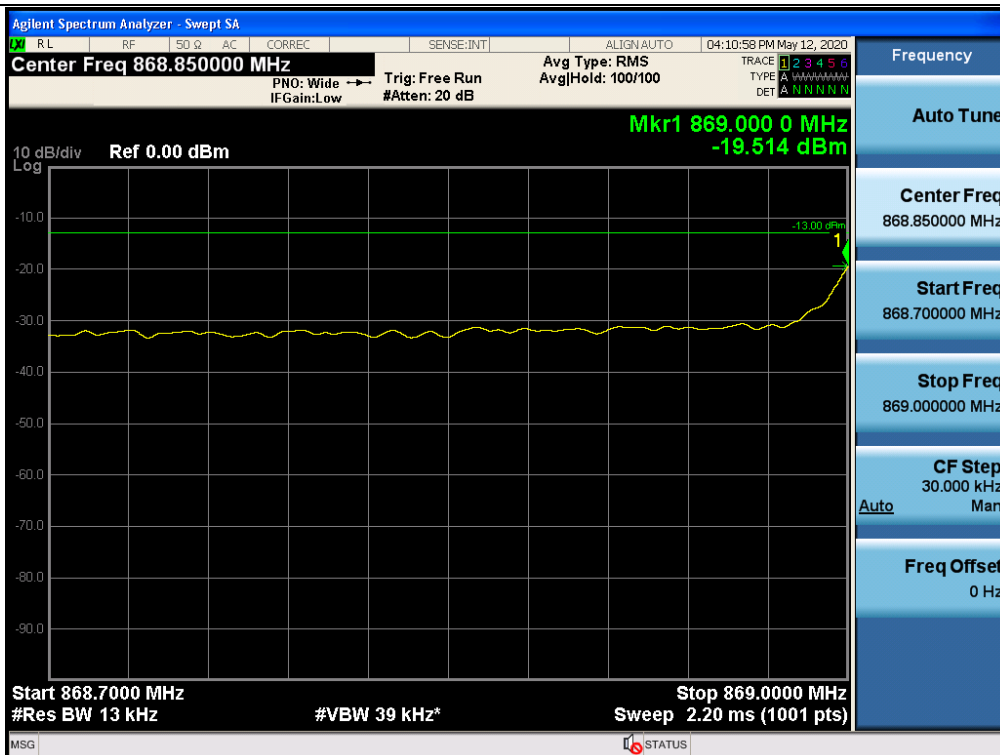
Out-of-band (two adjacent test signals) / Cellular / Downlink / CDMA / Lower



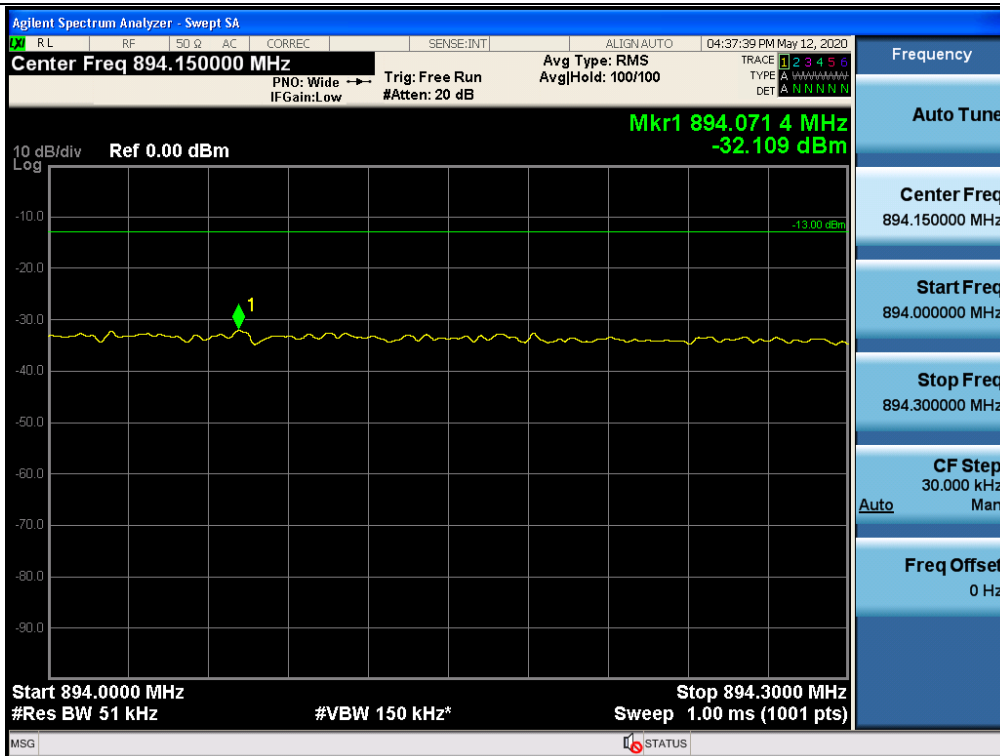
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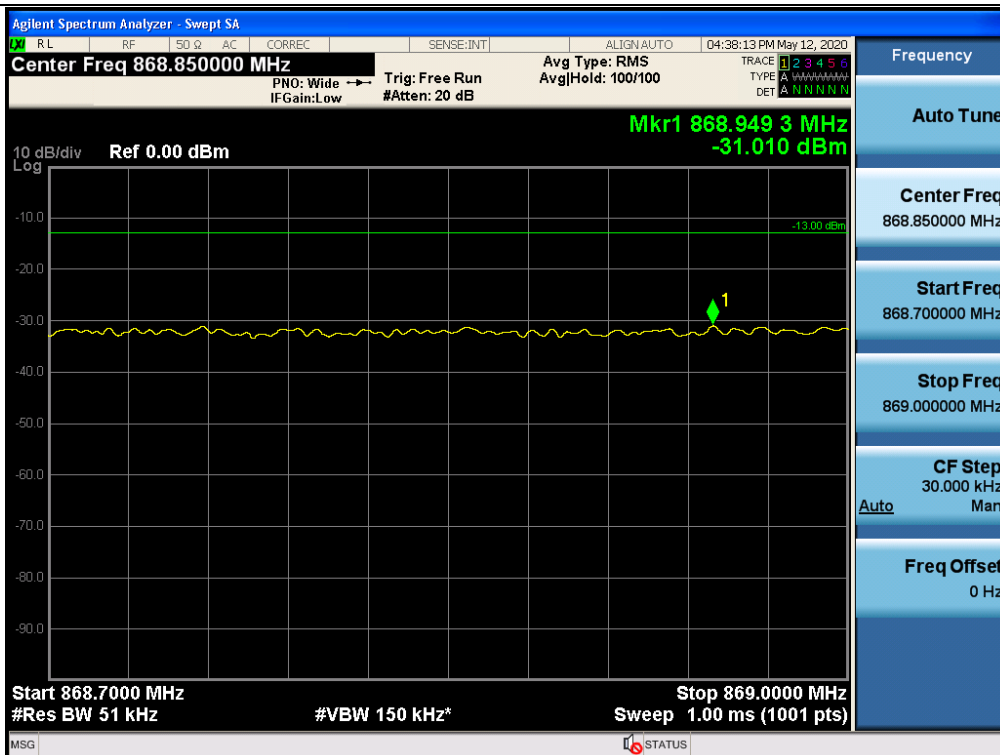
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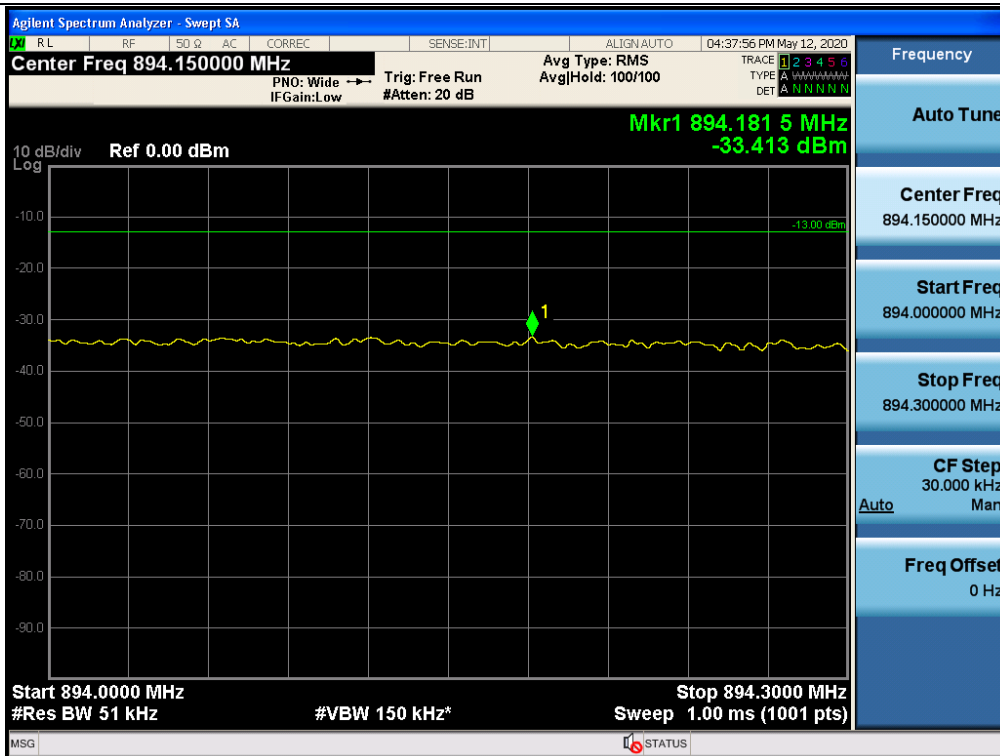
Out-of-band (two adjacent test signals) / Cellular / Downlink / WCDMA / Upper



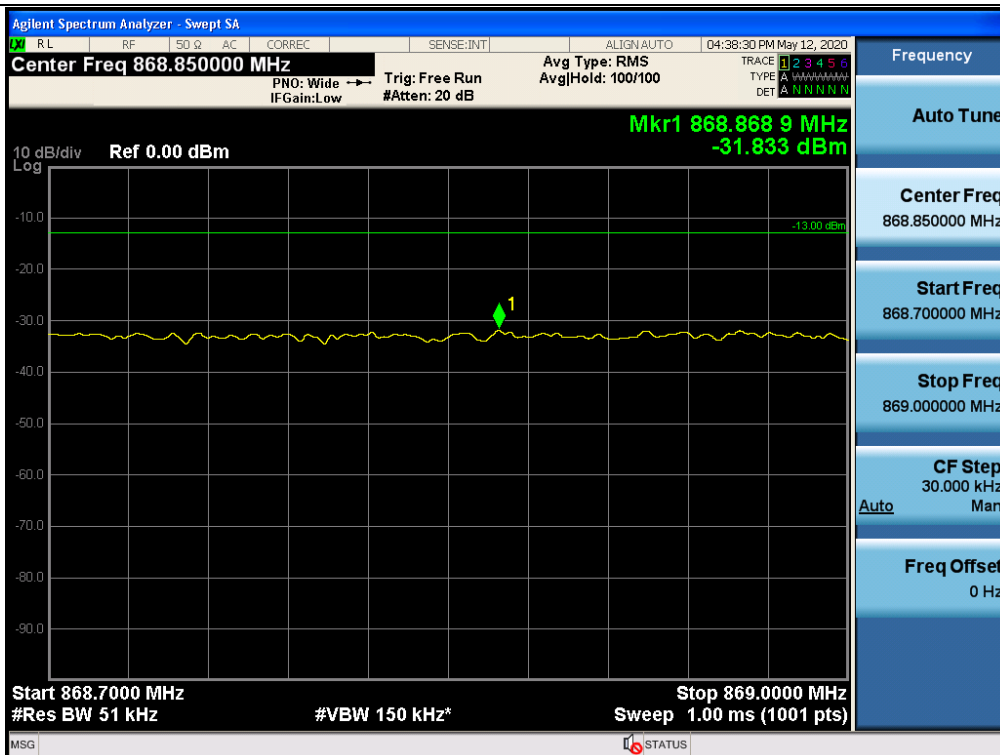
Out-of-band (two adjacent test signals) / Cellular / Downlink / WCDMA / Lower



+3 dB above Out-of-band (two adjacent test signals) / Cellular / Downlink / WCDMA / Upper



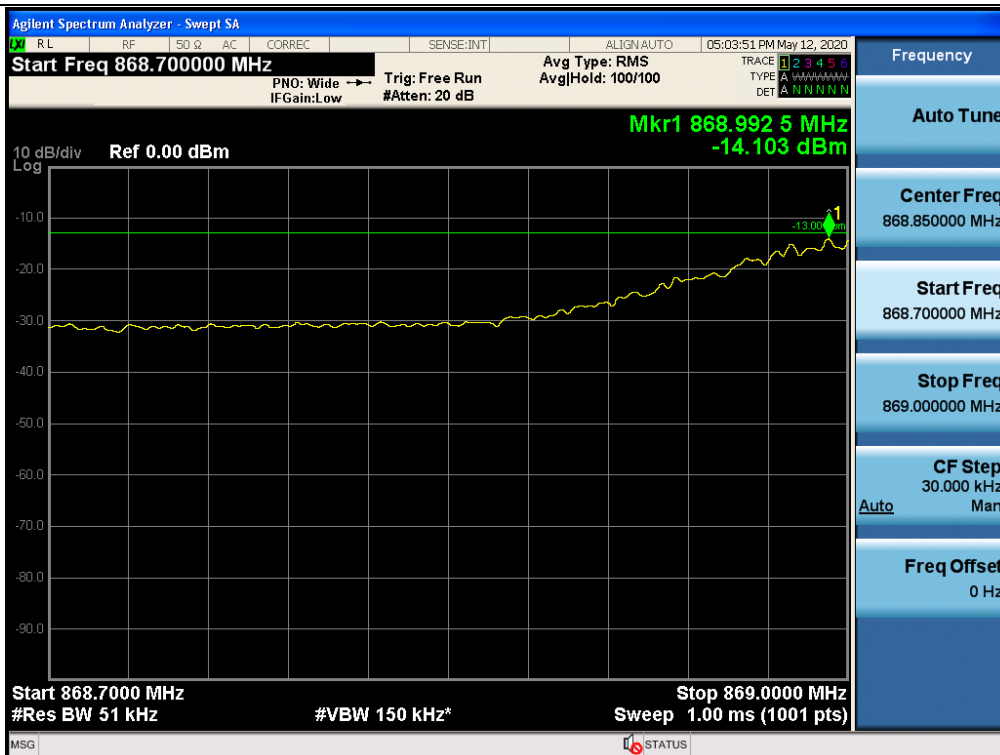
+3 dB above Out-of-band (two adjacent test signals) / Cellular / Downlink / WCDMA / Lower



Out-of-band (two adjacent test signals) / Cellular / Downlink / LTE 5 MHz / Upper



Out-of-band (two adjacent test signals) / Cellular / Downlink / LTE 5 MHz / Lower



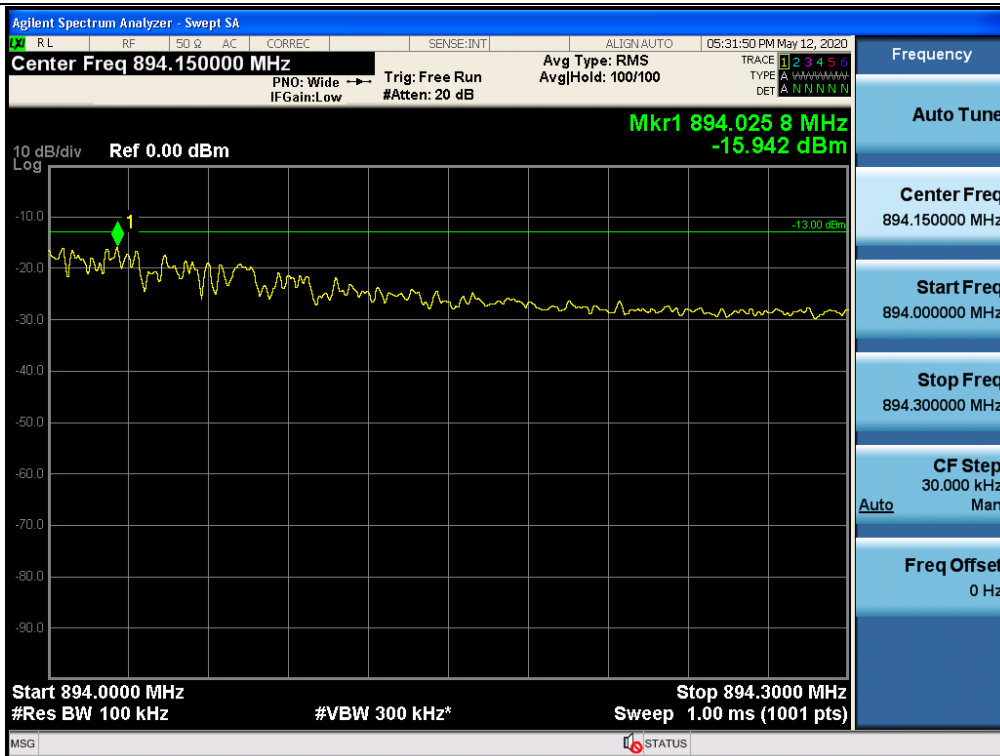
+3 dB above Out-of-band (two adjacent test signals) / Cellular / Downlink / LTE 5 MHz / Upper



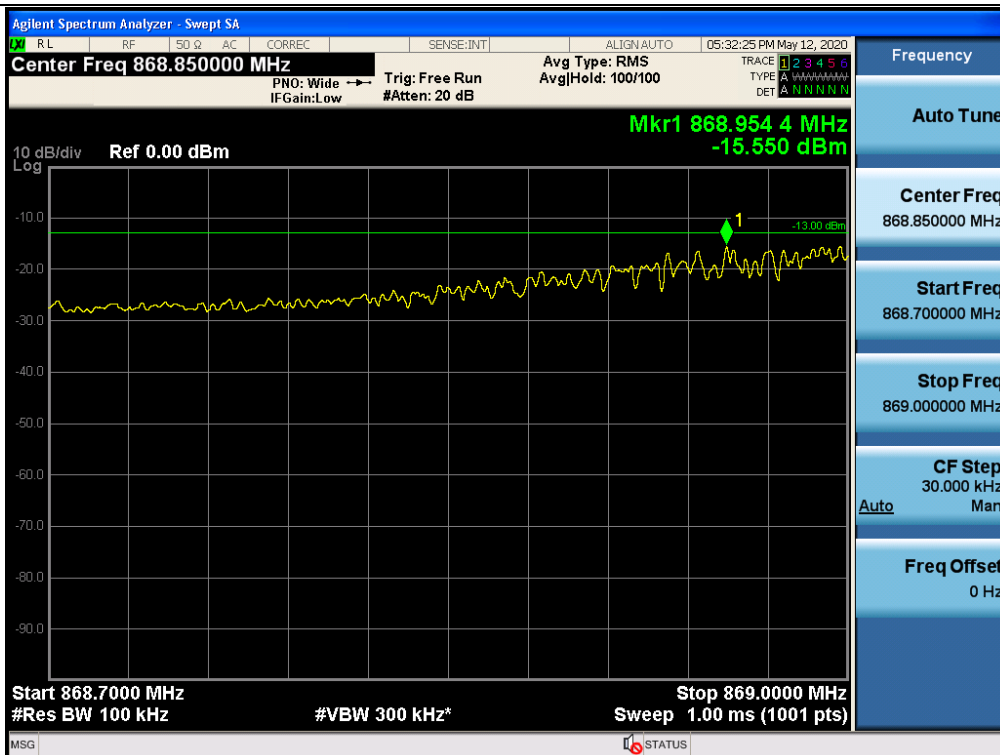
+3 dB above Out-of-band (two adjacent test signals) / Cellular / Downlink / LTE 5 MHz / Lower



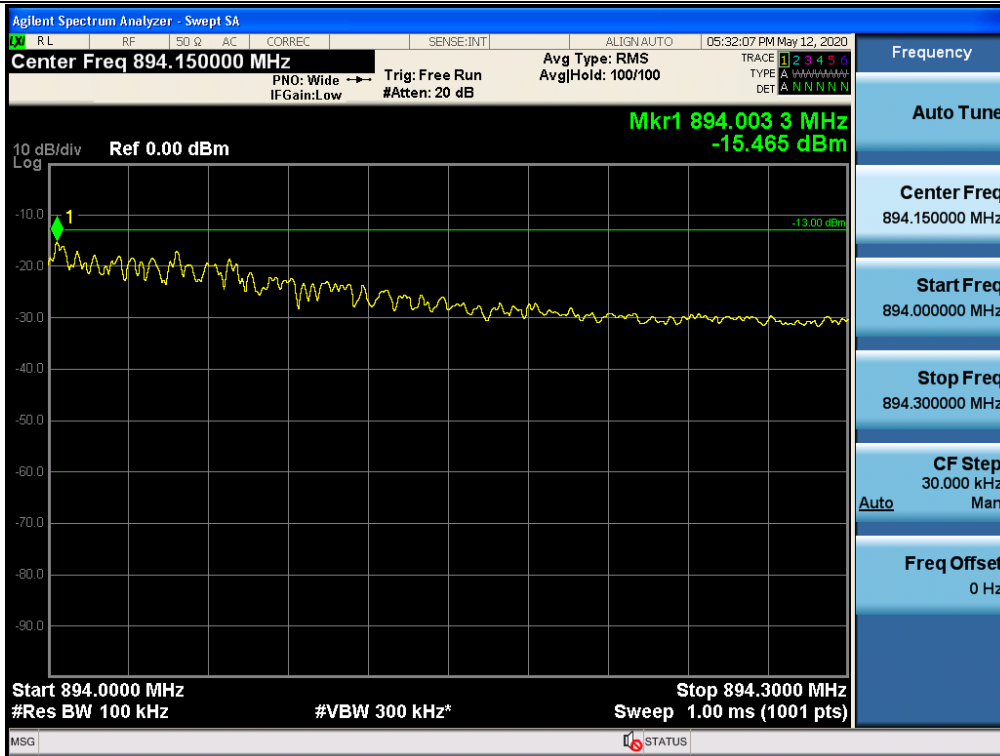
Out-of-band (two adjacent test signals) / Cellular / Downlink / LTE 10 MHz / Upper



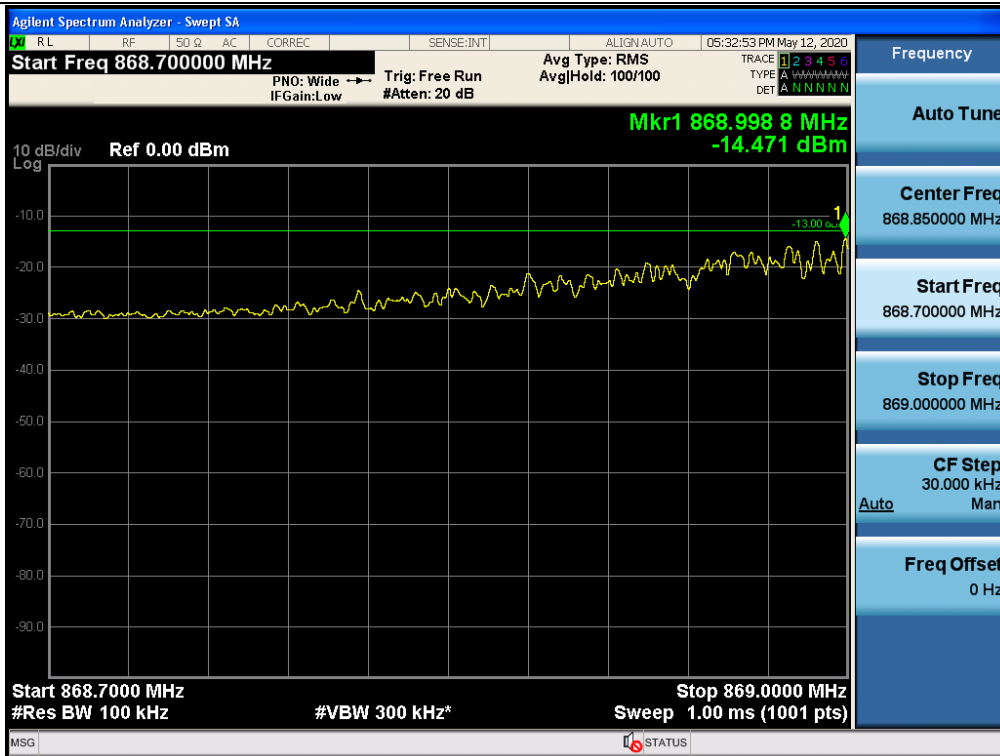
Out-of-band (two adjacent test signals) / Cellular / Downlink / LTE 10 MHz / Lower



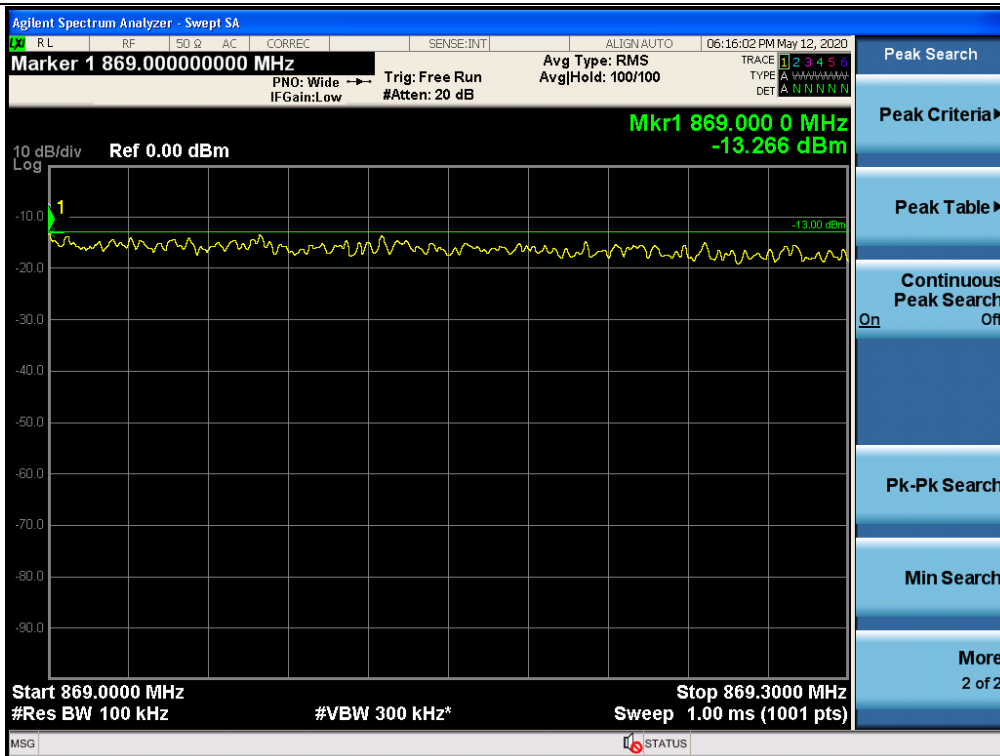
+3 dB above Out-of-band (two adjacent test signals) / Cellular / Downlink / LTE 10 MHz / Upper



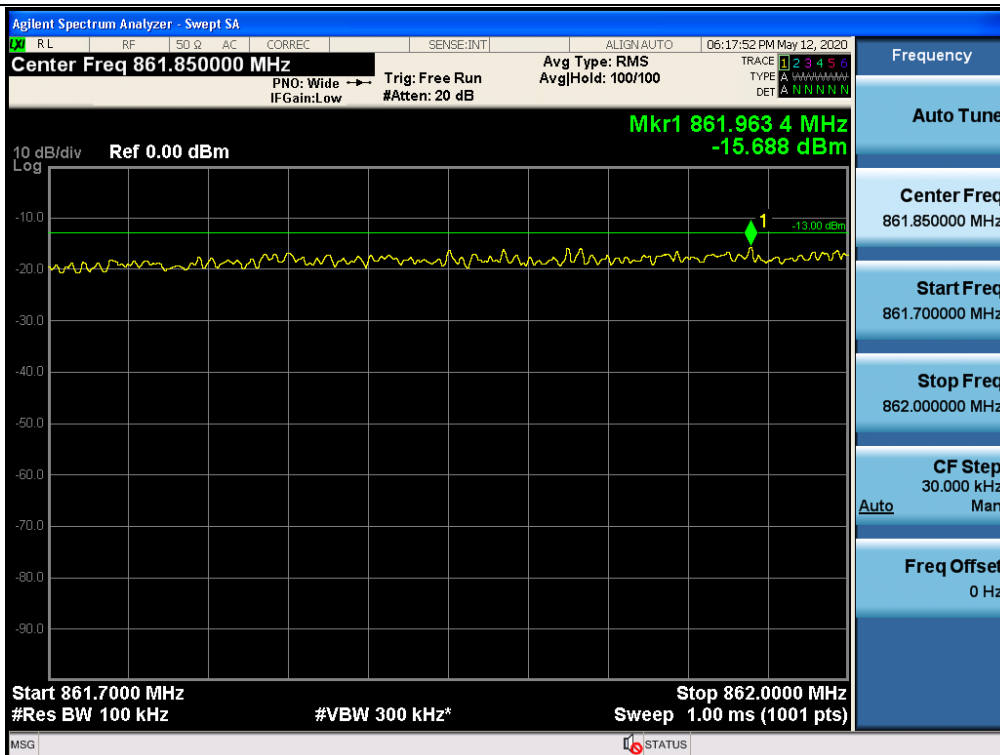
+3 dB above Out-of-band (two adjacent test signals) / Cellular / Downlink / LTE 10 MHz / Lower



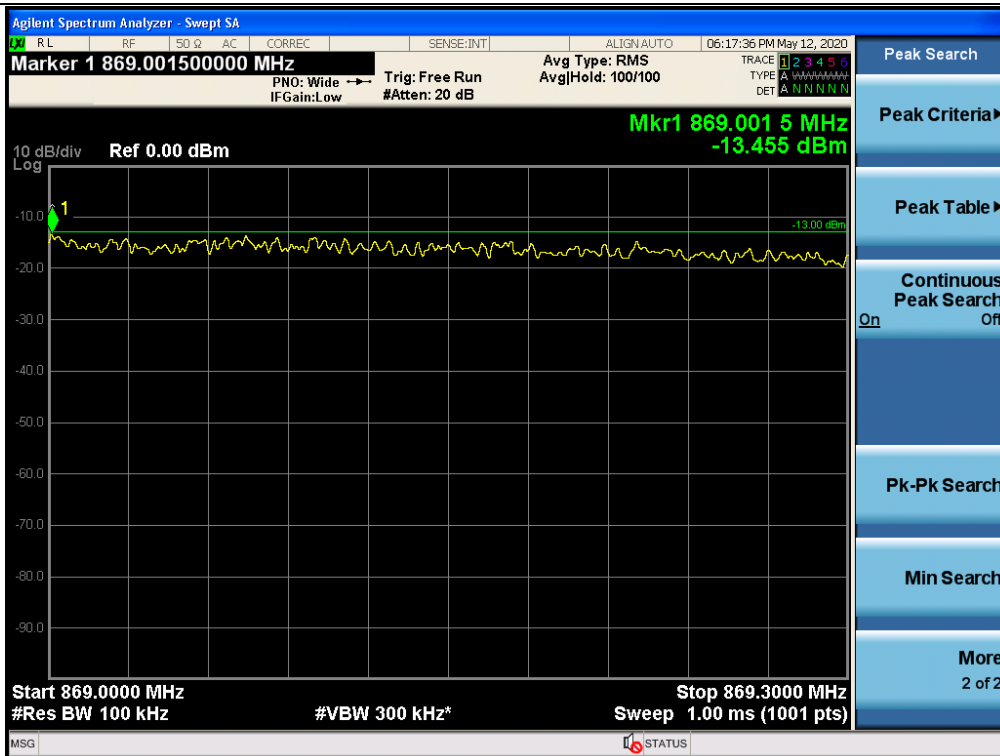
Out-of-band (single test signals) / ESMR / Downlink / CDMA / Upper



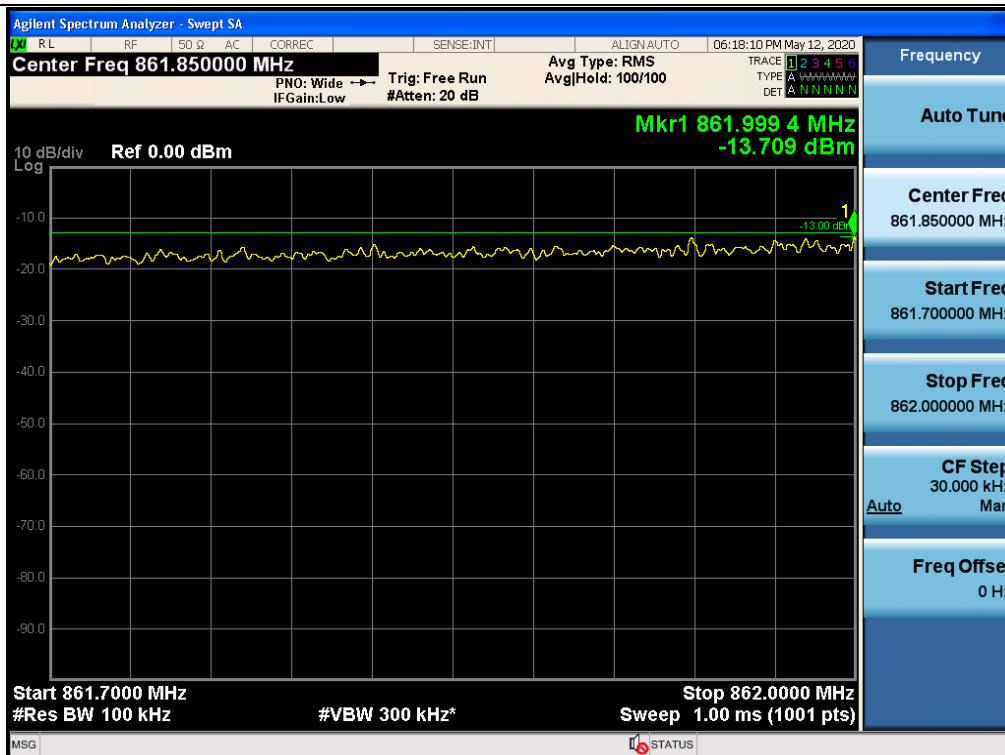
Out-of-band (single test signals) / ESMR / Downlink / CDMA / Lower



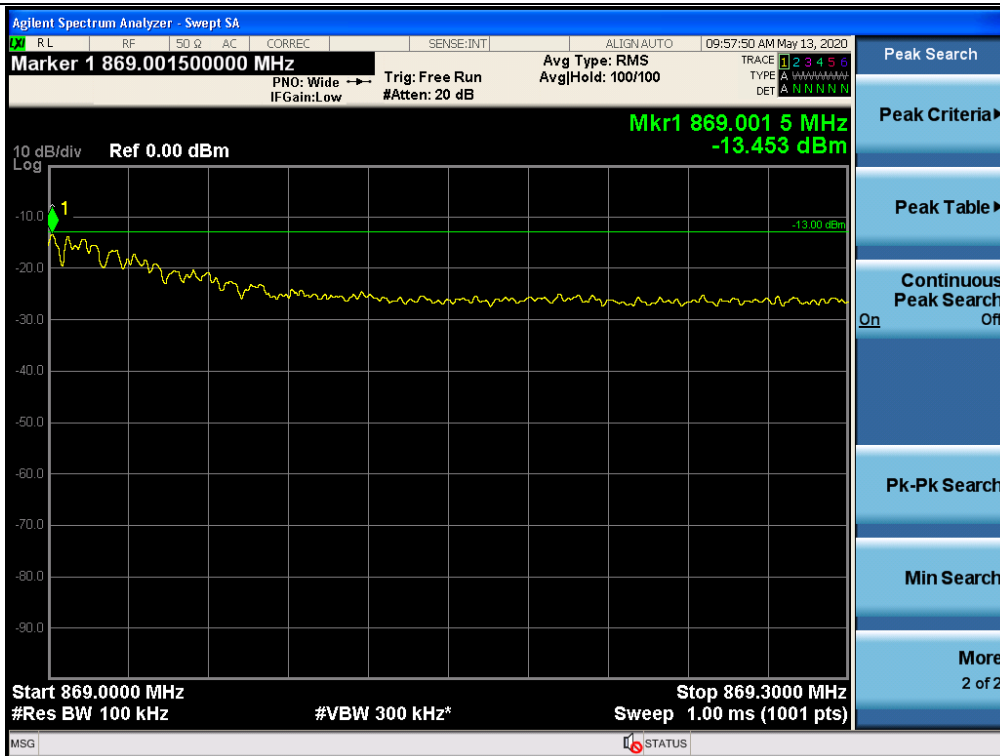
+3 dB above Out-of-band (single test signals) / ESMR / Downlink / CDMA / Upper



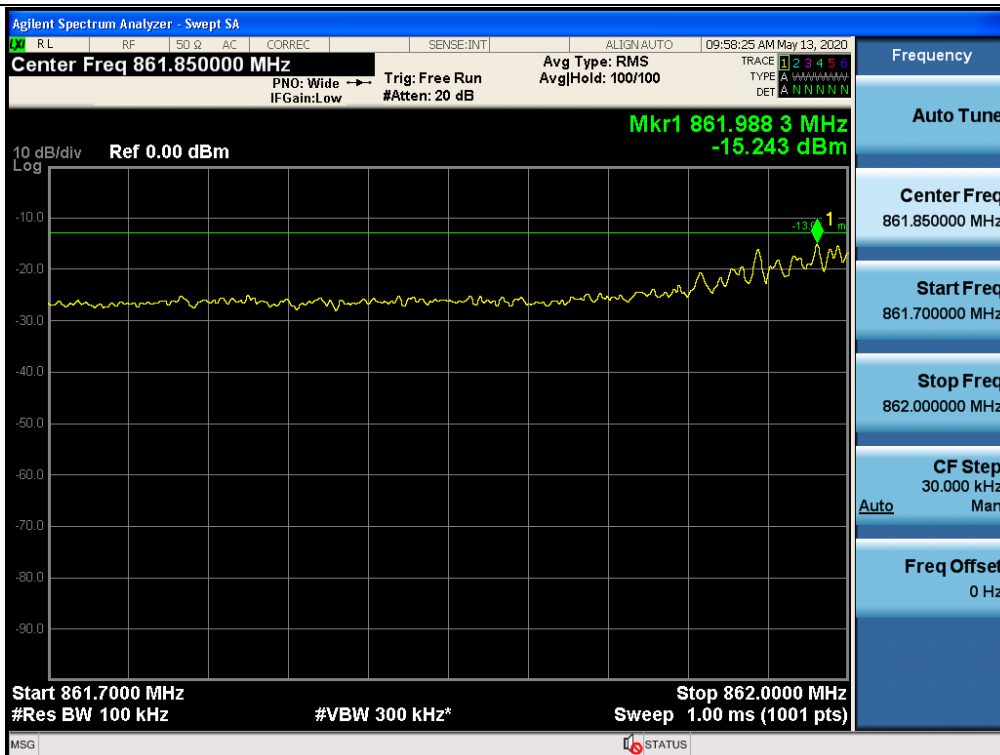
+3 dB above Out-of-band (single test signals) / ESMR / Downlink / CDMA / Lower



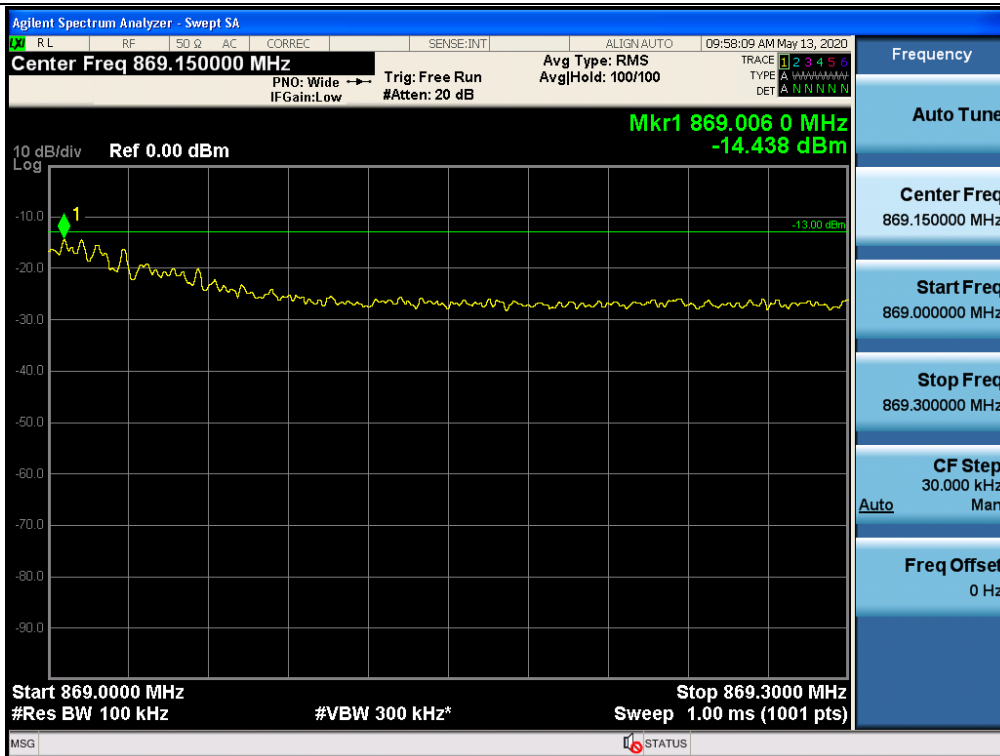
Out-of-band (single test signals) / ESMR / Downlink / LTE 5 MHz / Upper



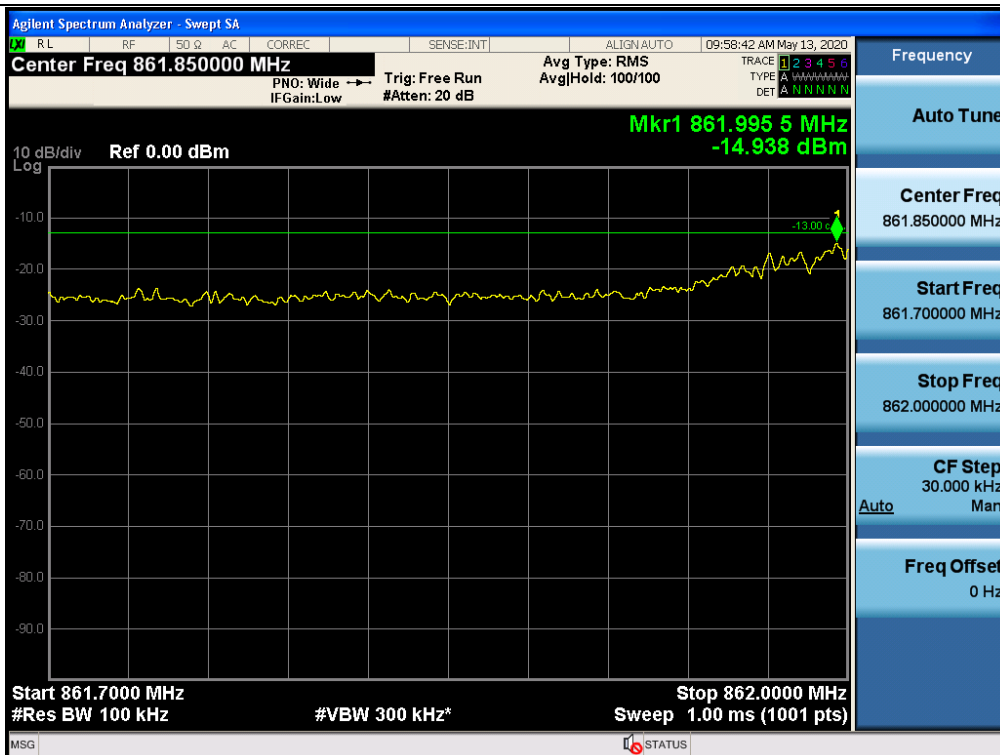
Out-of-band (single test signals) / ESMR / Downlink / LTE 5 MHz / Lower



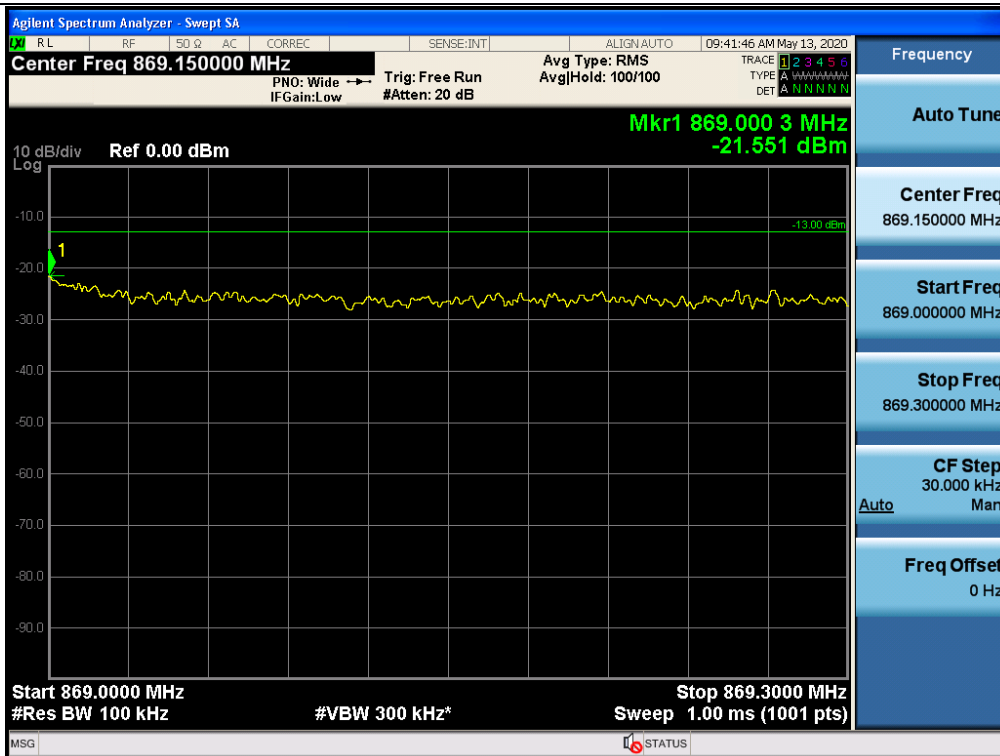
+3 dB above Out-of-band (single test signals) / ESMR / Downlink / LTE 5 MHz / Upper



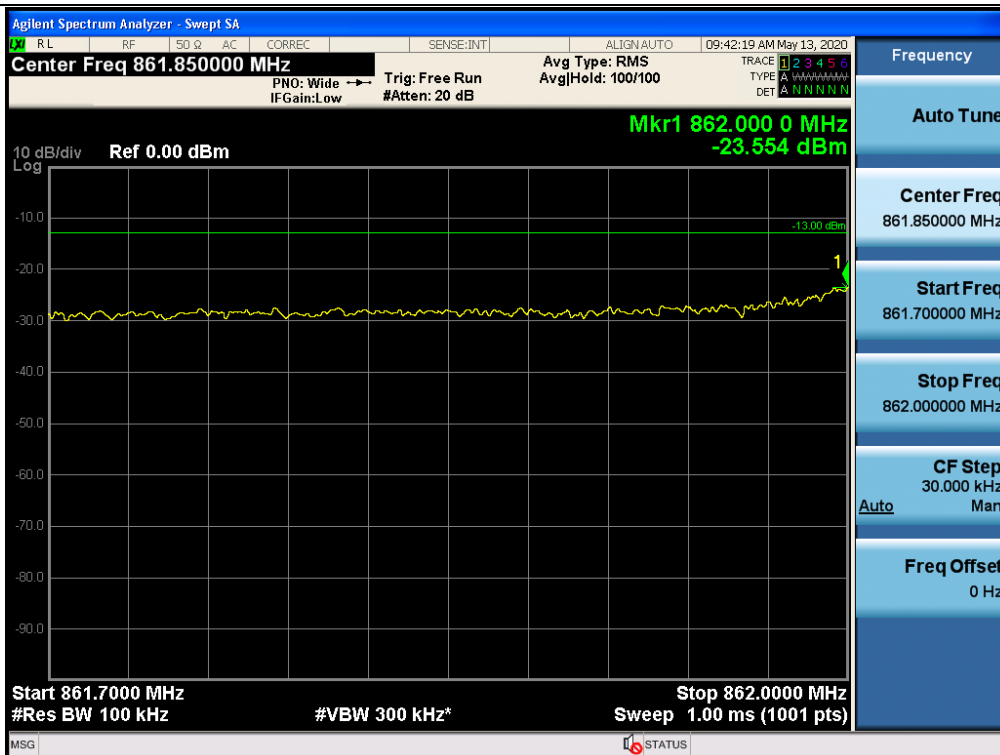
+3 dB above Out-of-band (single test signals) / ESMR / Downlink / LTE 5 MHz / Lower



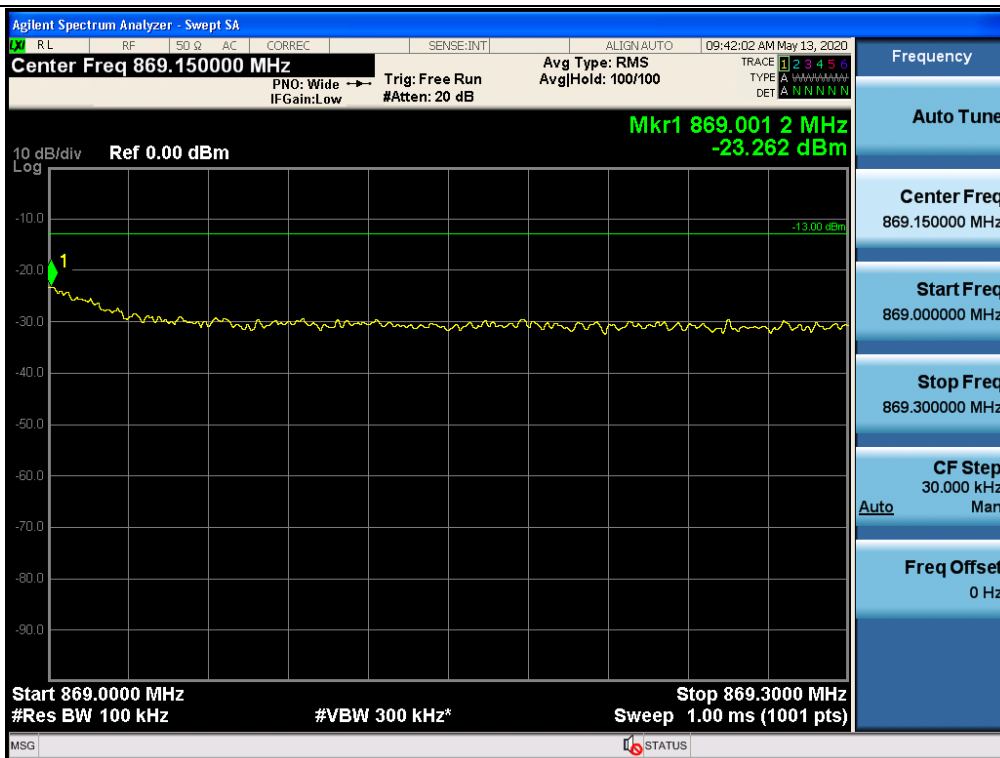
Out-of-band (single test signals) / ESMR / Downlink / WCDMA / Upper



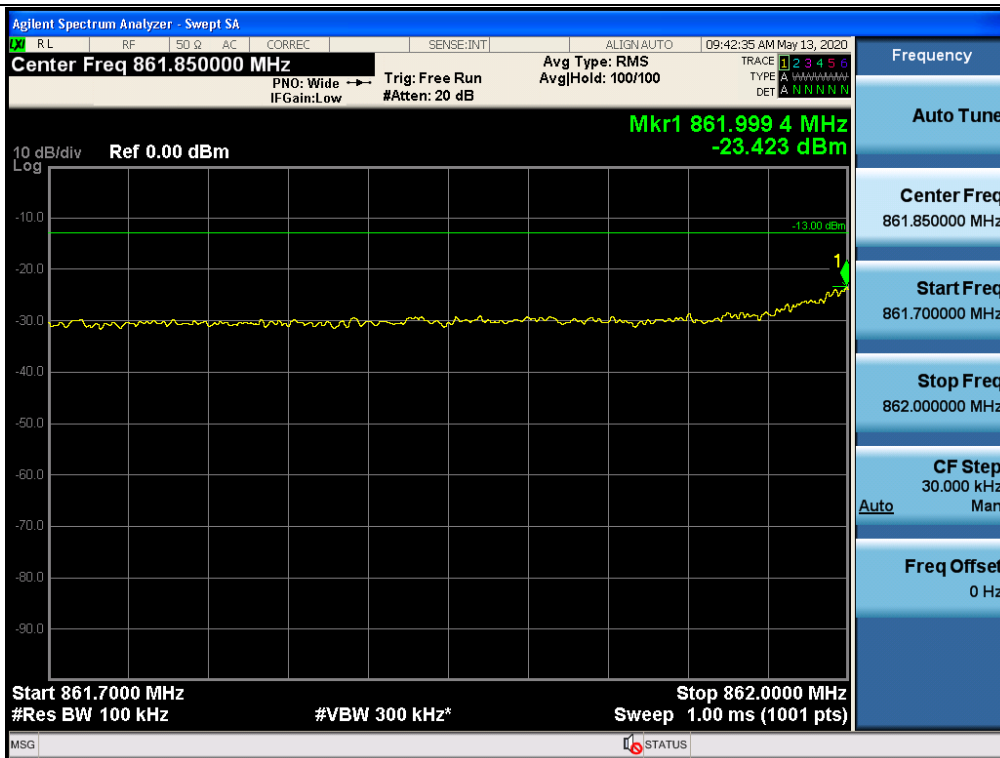
Out-of-band (single test signals) / ESMR / Downlink / WCDMA / Lower



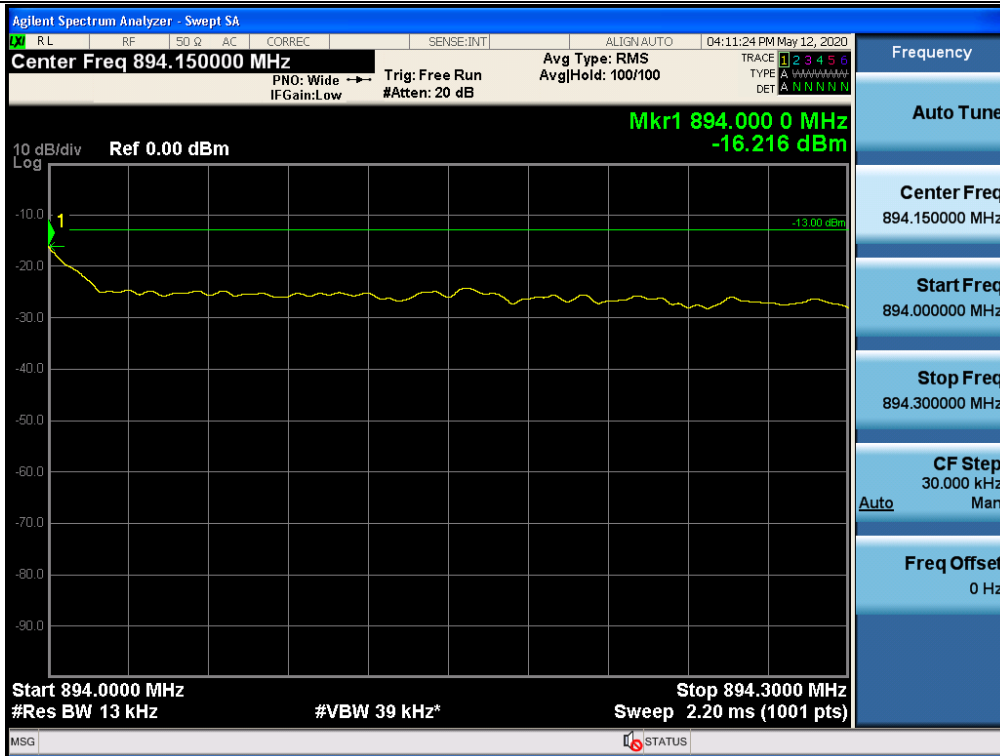
+3 dB above Out-of-band (single test signals) / ESMR / Downlink / WCDMA / Upper



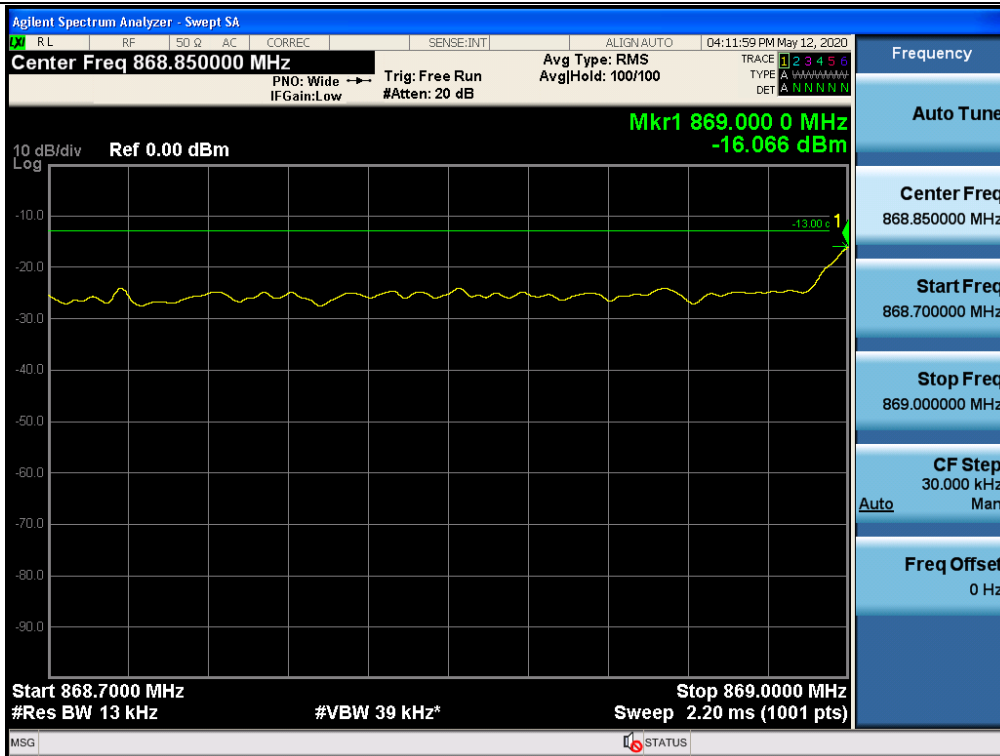
+3 dB above Out-of-band (single test signals) / ESMR / Downlink / WCDMA / Lower



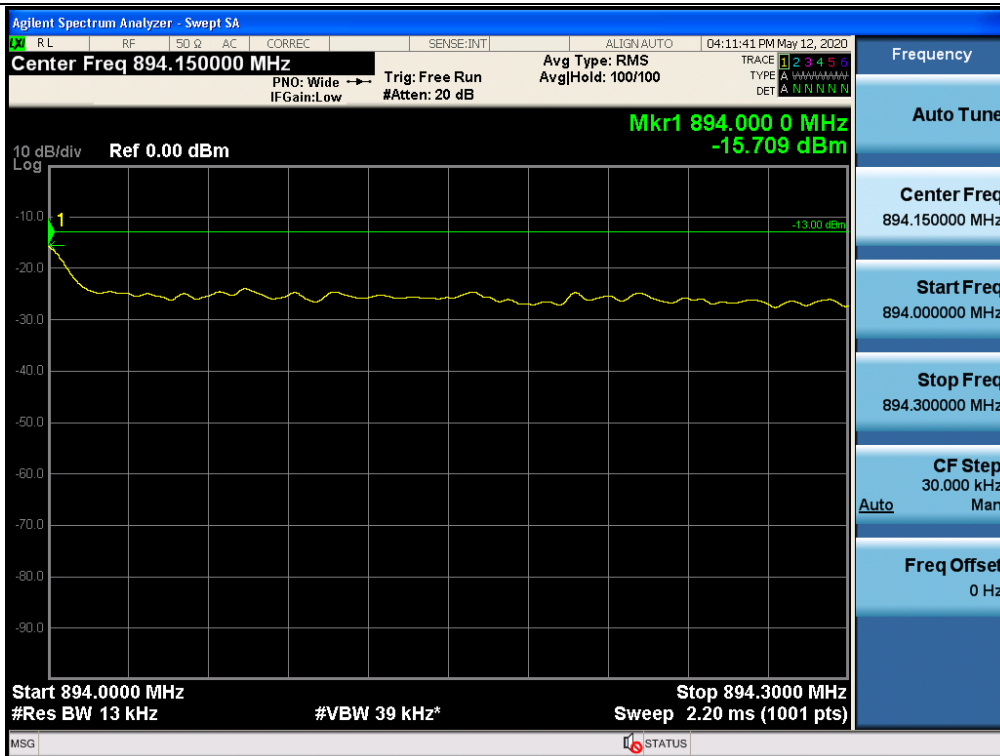
Out-of-band (single test signals) / Cellular / Downlink / CDMA / Upper



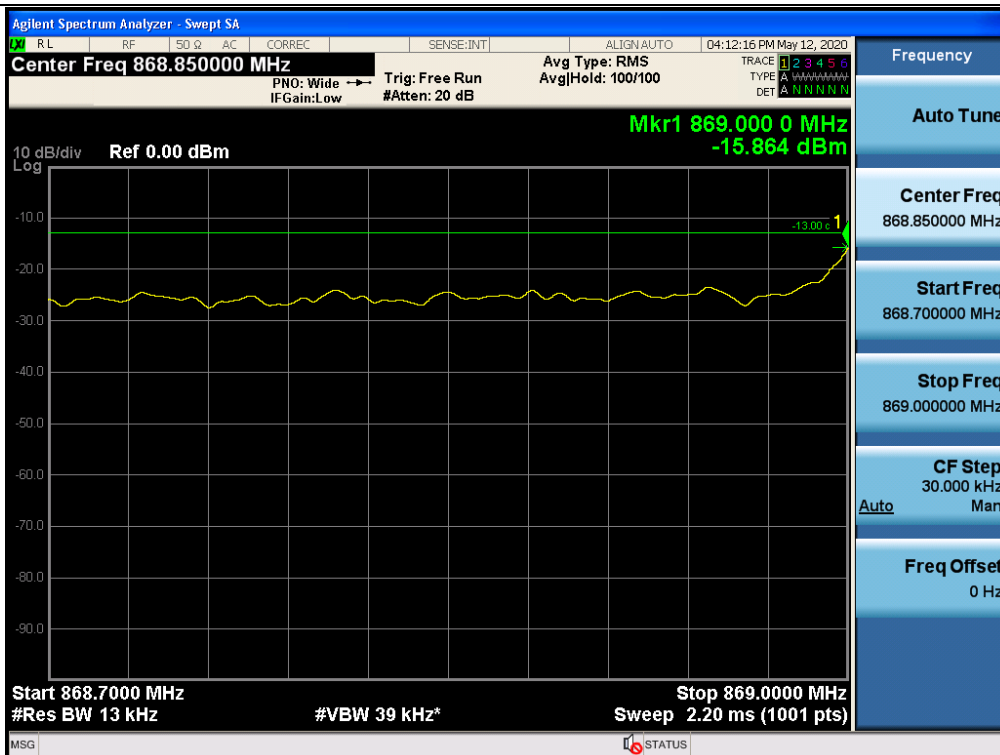
Out-of-band (single test signals) / Cellular / Downlink / CDMA / Lower



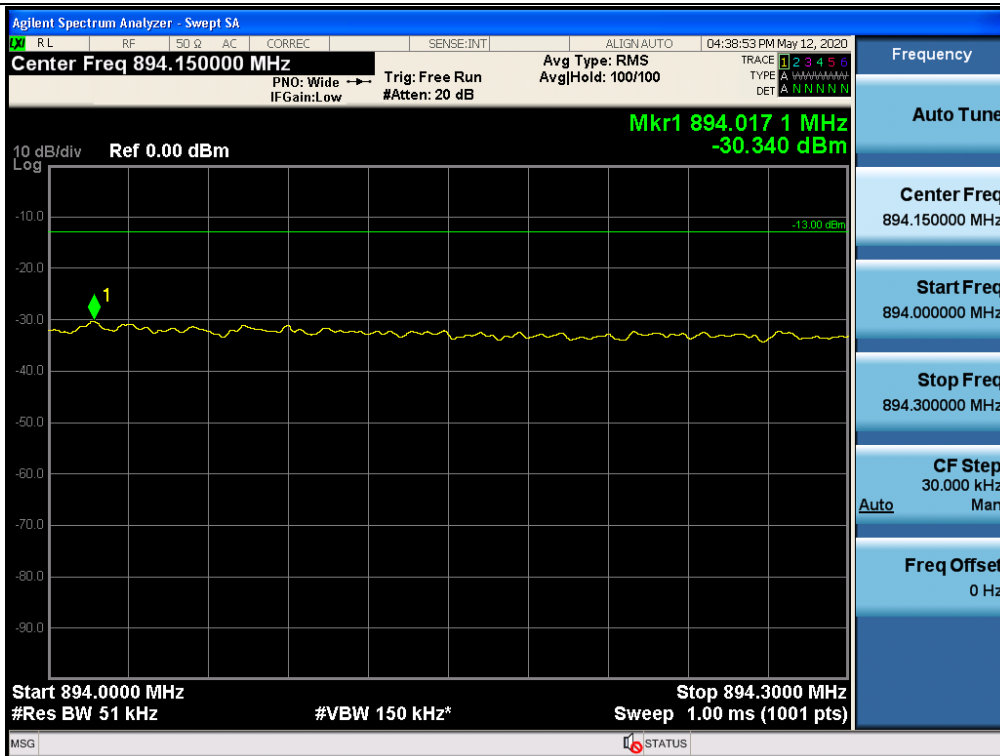
+3 dB above Out-of-band (single test signals) / Cellular / Downlink / CDMA / Upper



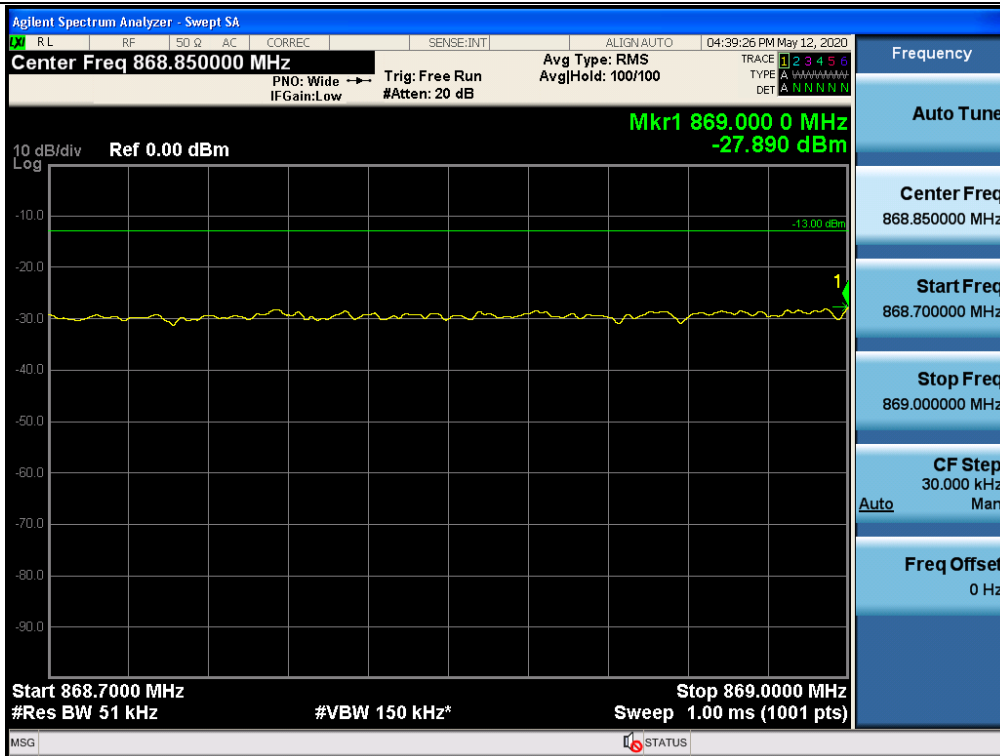
+3 dB above Out-of-band (single test signals) / Cellular / Downlink / CDMA / Lower



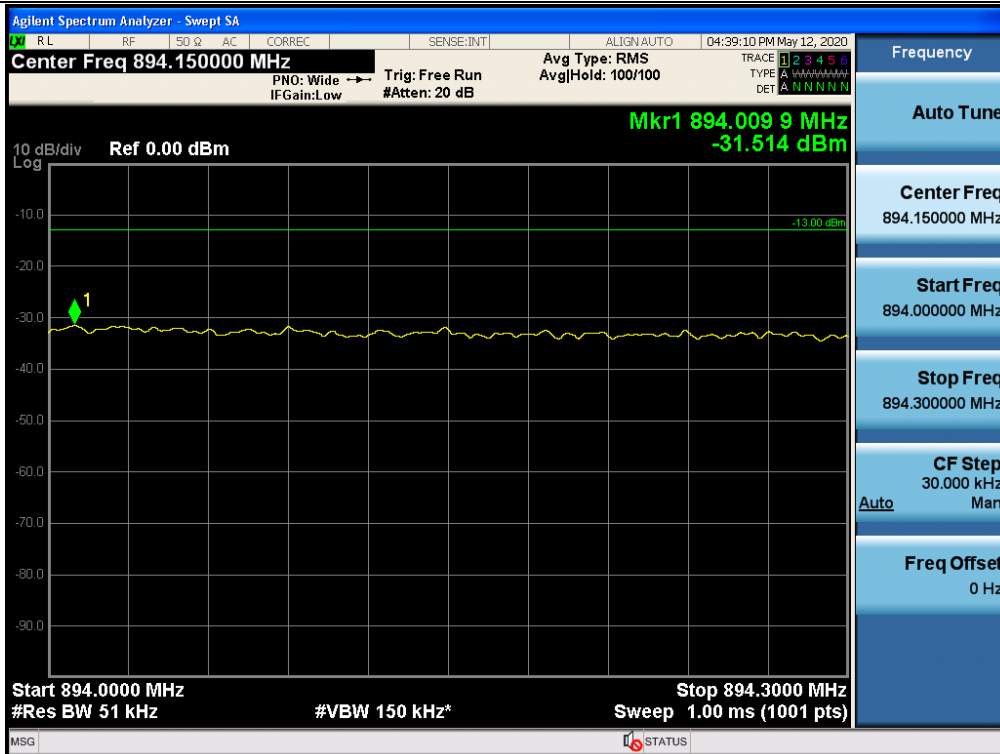
Out-of-band (single test signals) / Cellular / Downlink / WCDMA / Upper



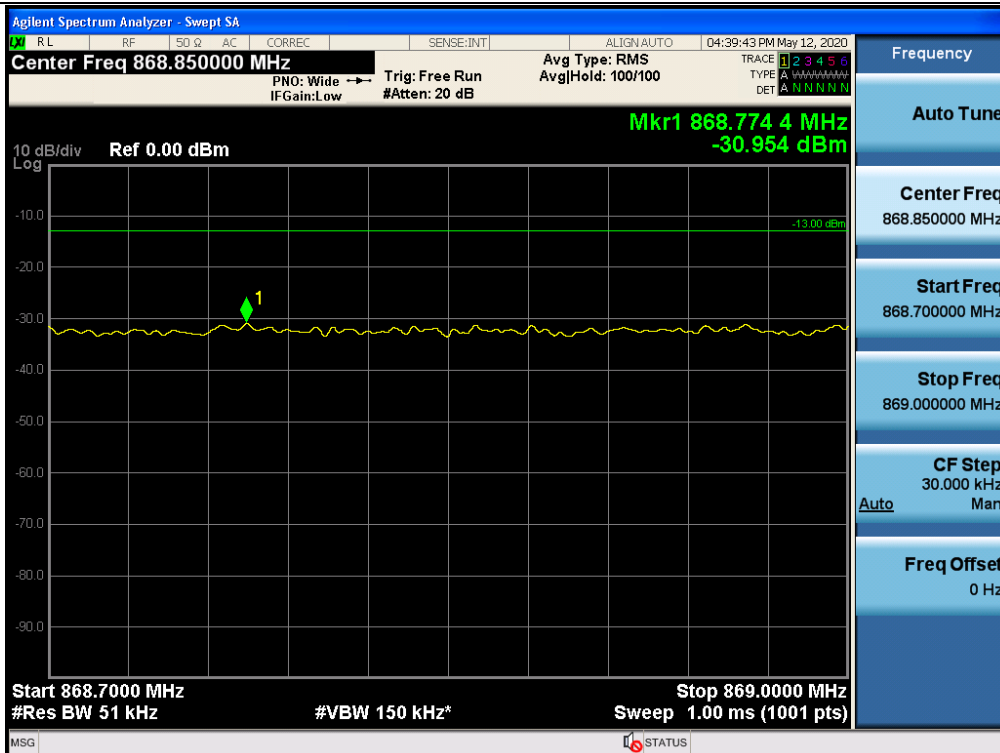
Out-of-band (single test signals) / Cellular / Downlink / WCDMA / Lower



+3 dB above Out-of-band (single test signals) / Cellular / Downlink / WCDMA / Upper



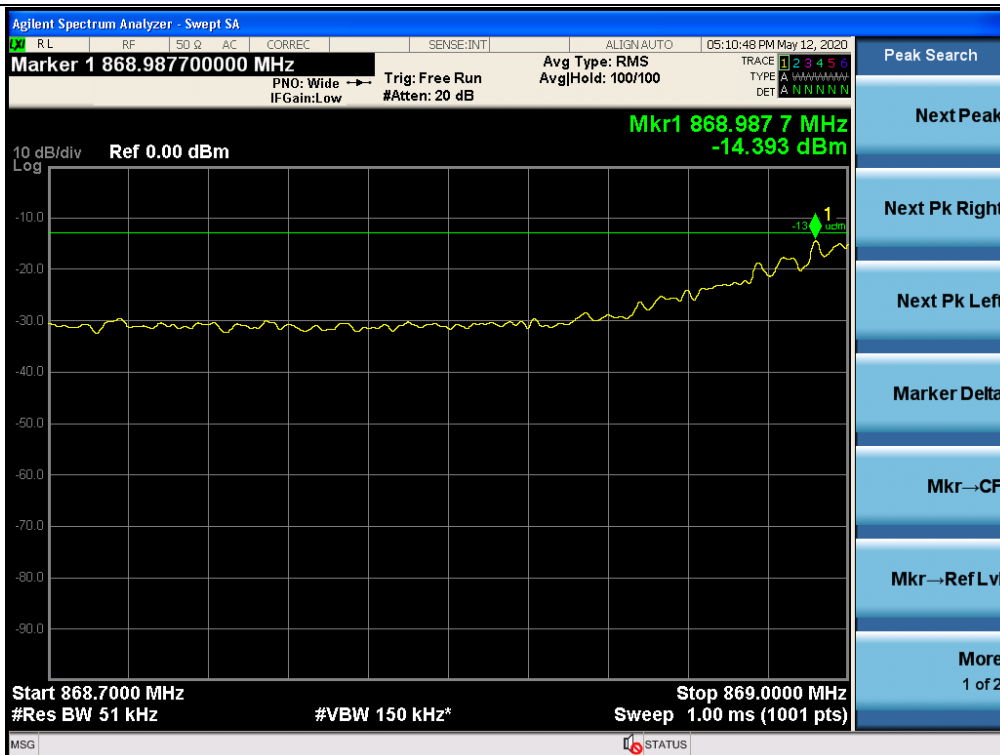
+3 dB above Out-of-band (single test signals) / Cellular / Downlink / WCDMA / Lower



Out-of-band (single test signals) / Cellular / Downlink / LTE 5 MHz / Upper



Out-of-band (single test signals) / Cellular / Downlink / LTE 5 MHz / Lower



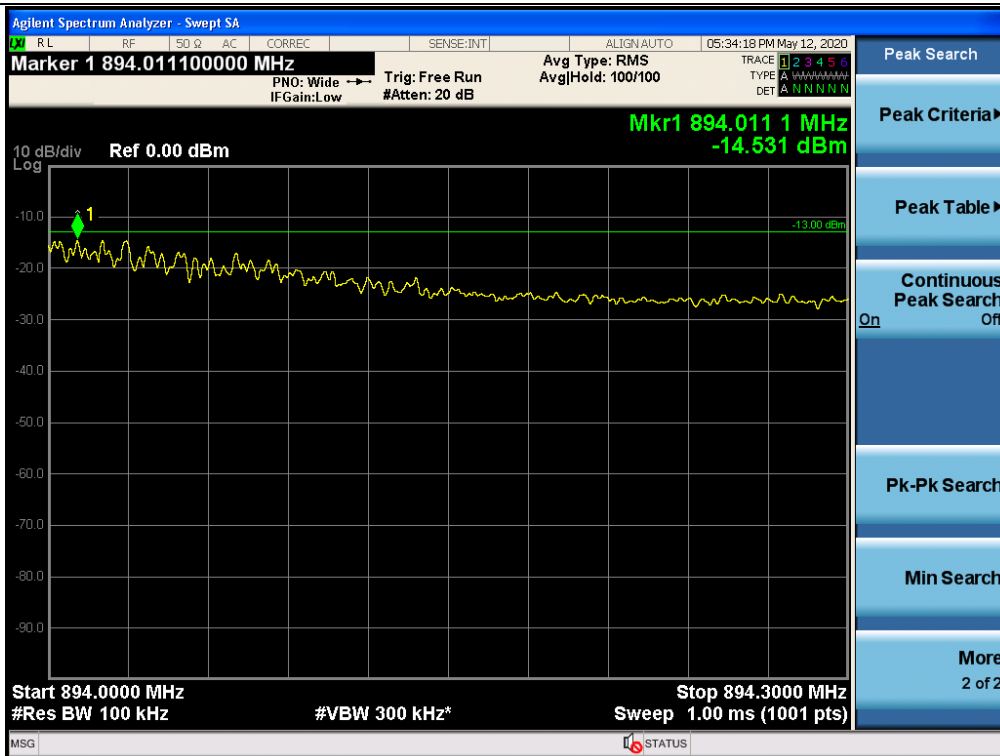
+3 dB above Out-of-band (single test signals) / Cellular / Downlink / LTE 5 MHz / Upper



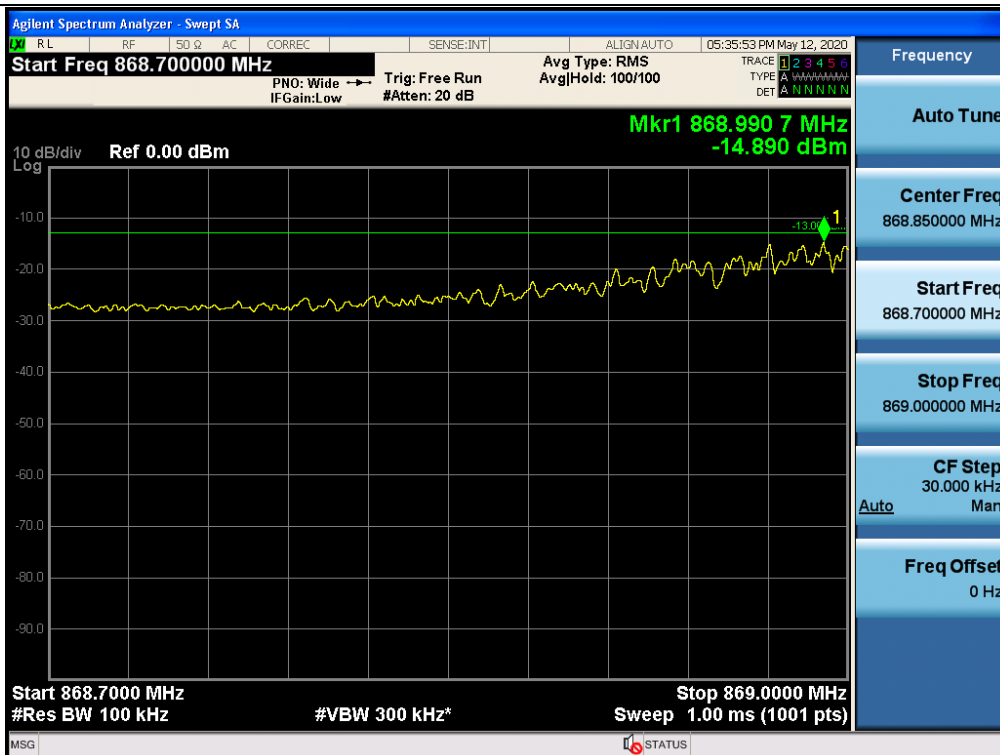
+3 dB above Out-of-band (single test signals) / Cellular / Downlink / LTE 5 MHz / Lower



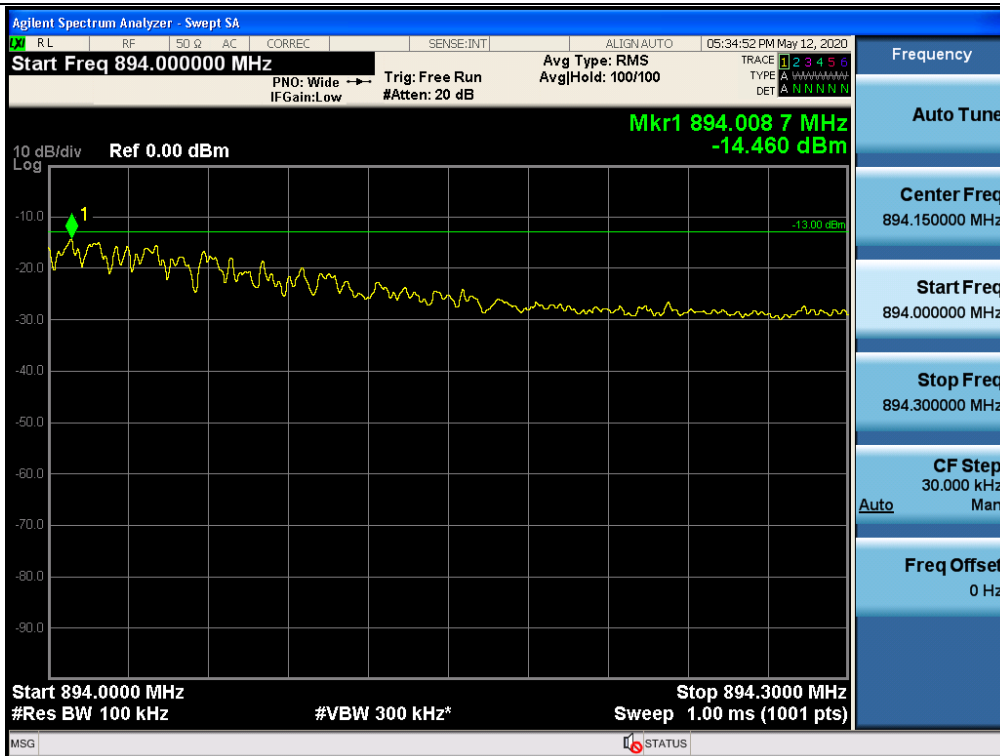
Out-of-band (single test signals) / Cellular / Downlink / LTE 10 MHz / Upper



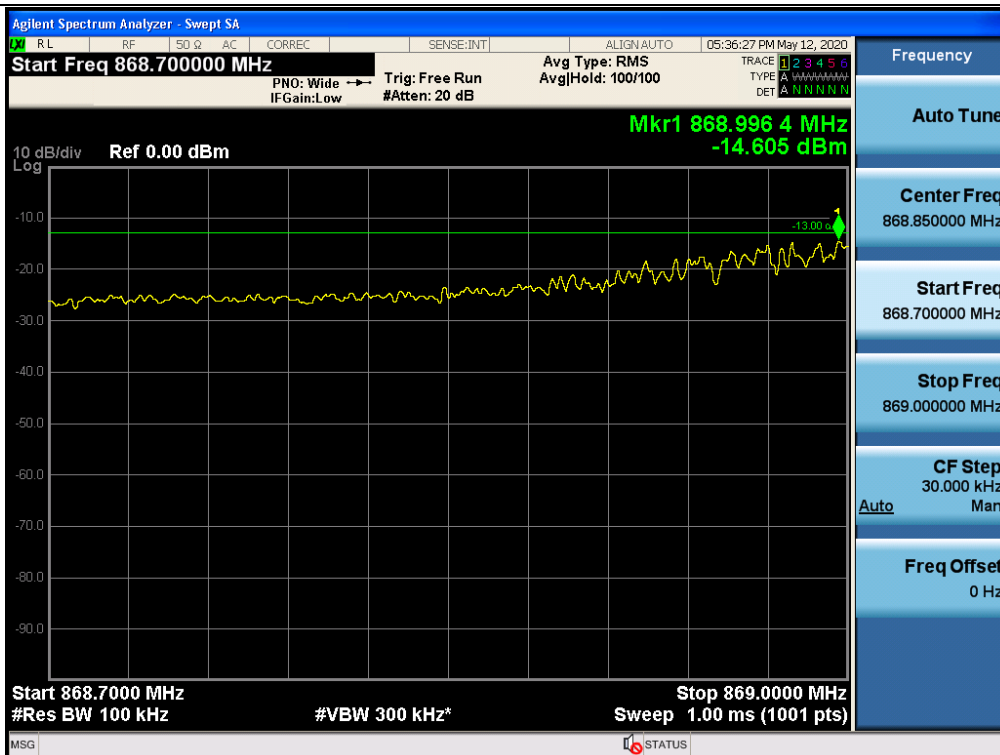
Out-of-band (single test signals) / Cellular / Downlink / LTE 10 MHz / Lower



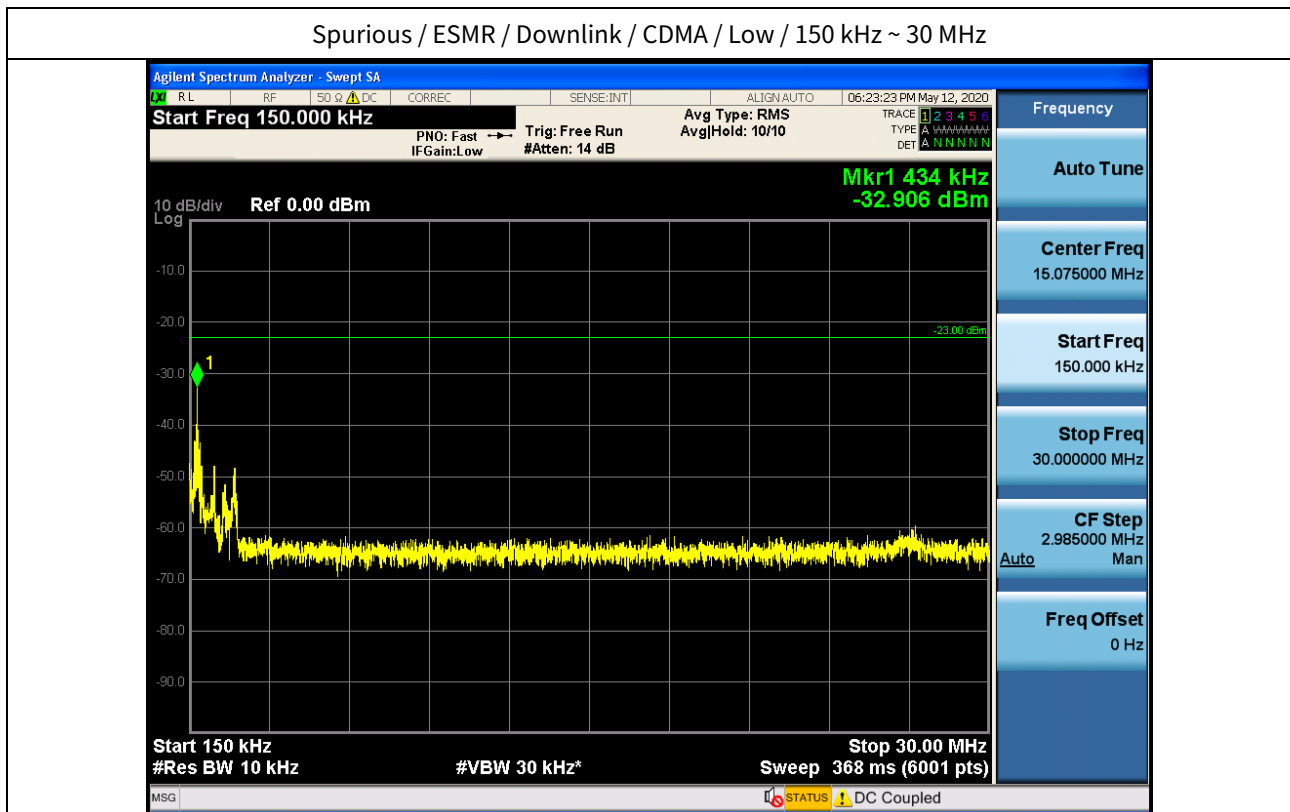
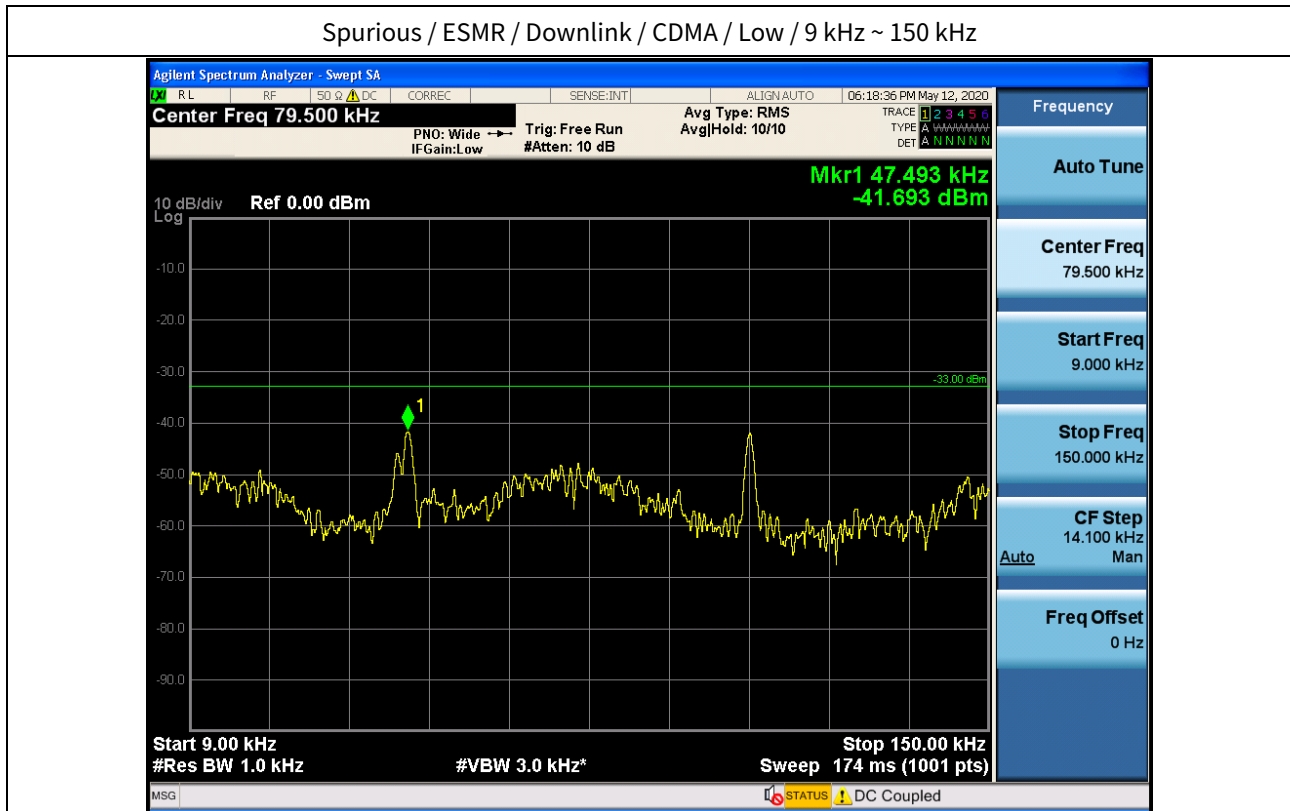
+3 dB above Out-of-band (single test signals) / Cellular / Downlink / LTE 10 MHz / Upper



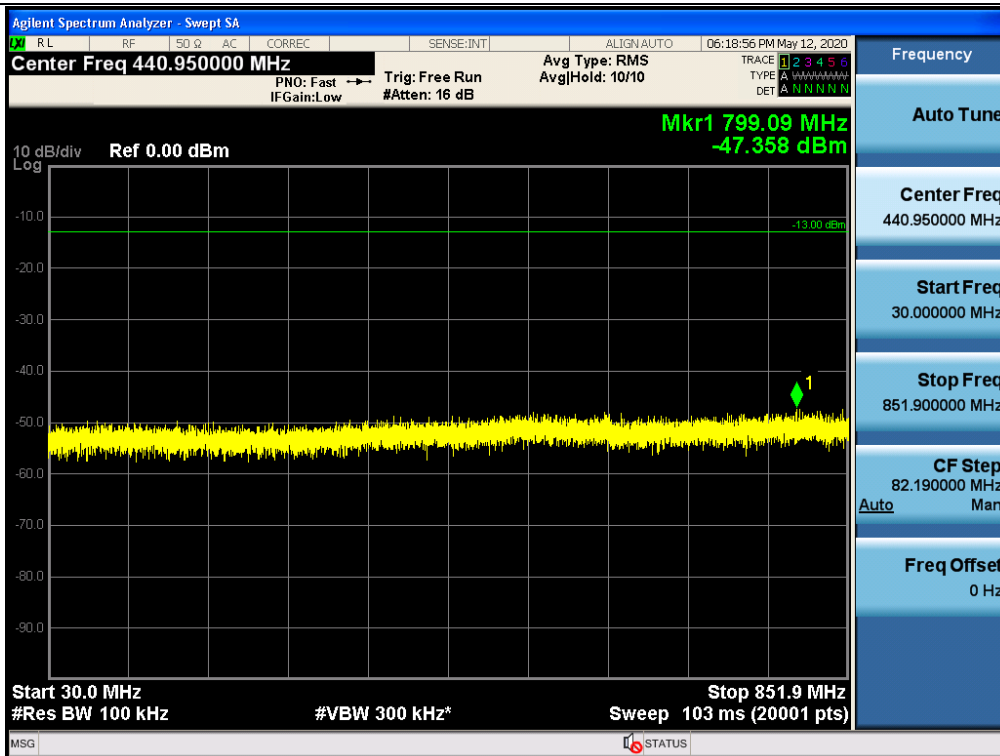
+3 dB above Out-of-band (single test signals) / Cellular / Downlink / LTE 10 MHz / Lower



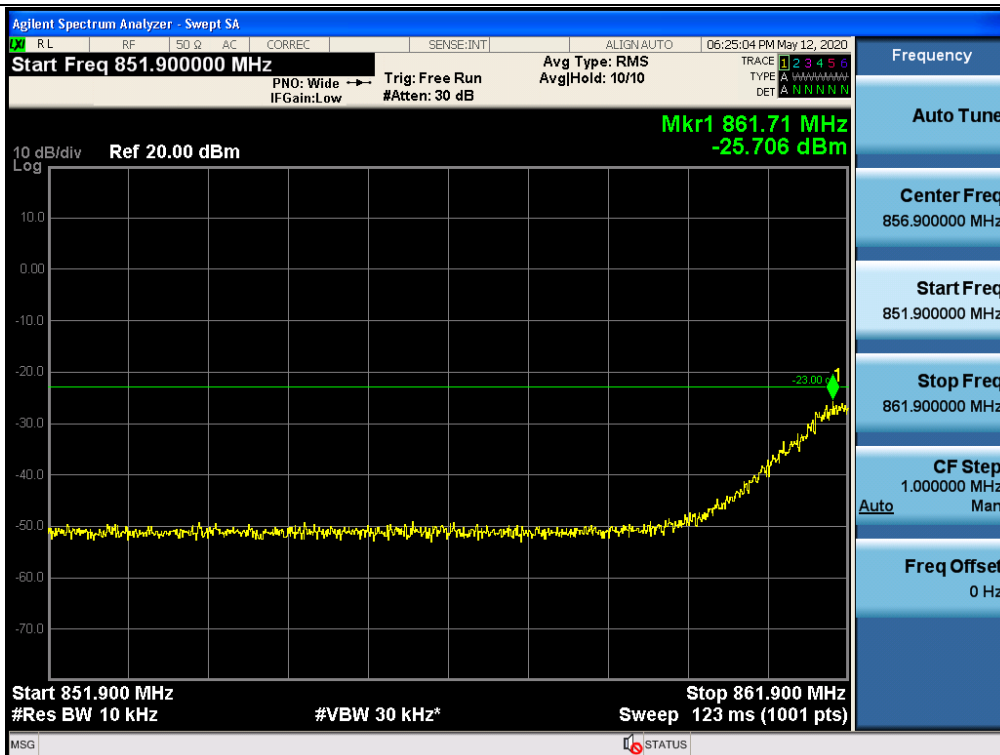
Plot data of Spurious Emissions



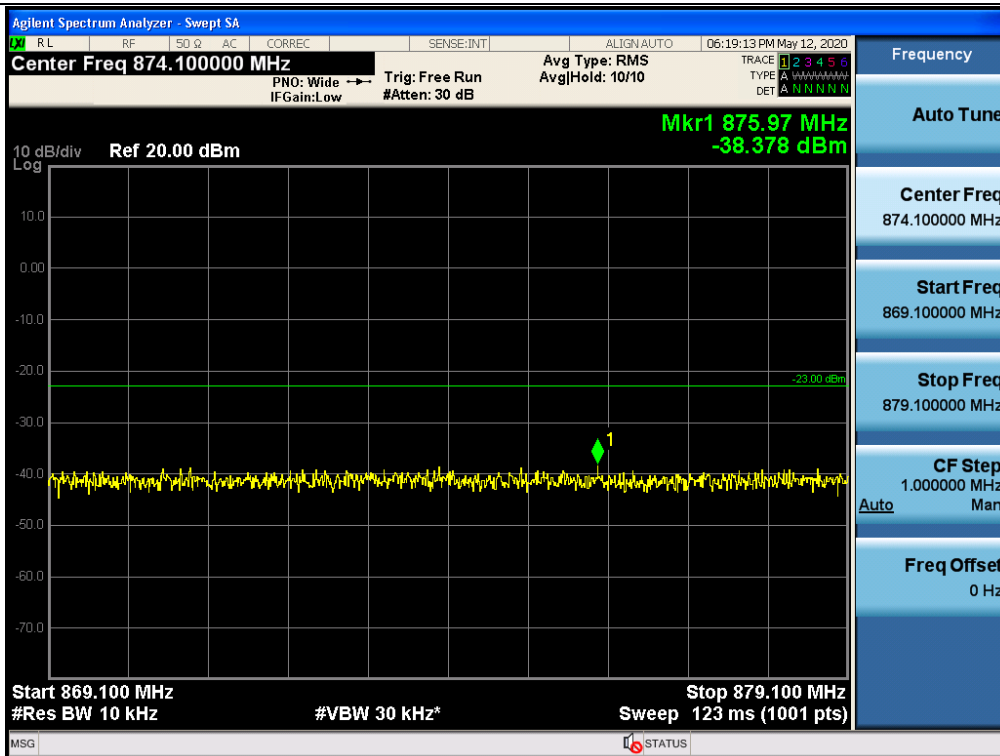
Spurious / ESMR / Downlink / CDMA / Low / 30 MHz ~ Low Edge-10



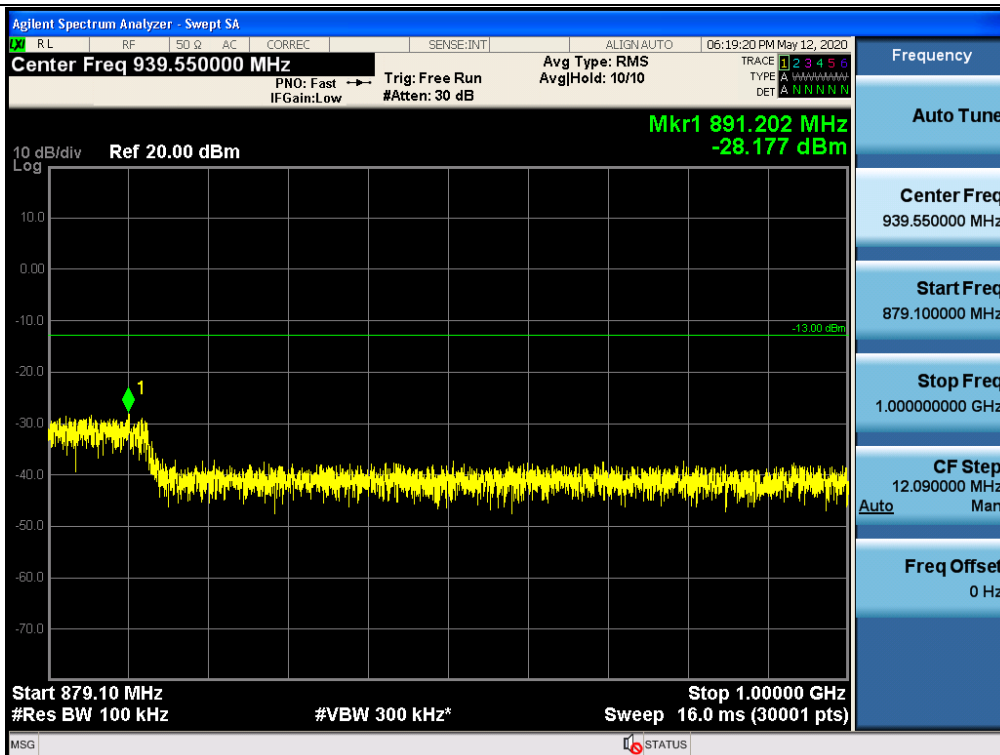
Spurious / ESMR / Downlink / CDMA / Low / Low Edge-10 ~ Low Edge



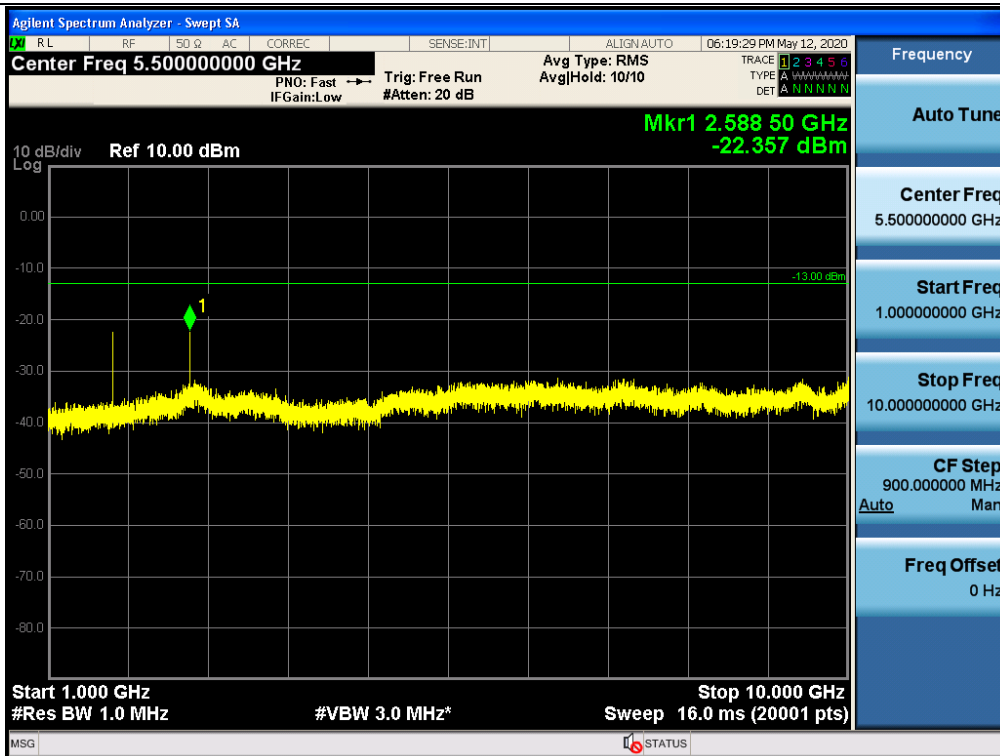
Spurious / ESMR / Downlink / CDMA / Low / High Edge ~ High Edge+10



Spurious / ESMR / Downlink / CDMA / Low / High Edge+10 ~ 1 GHz



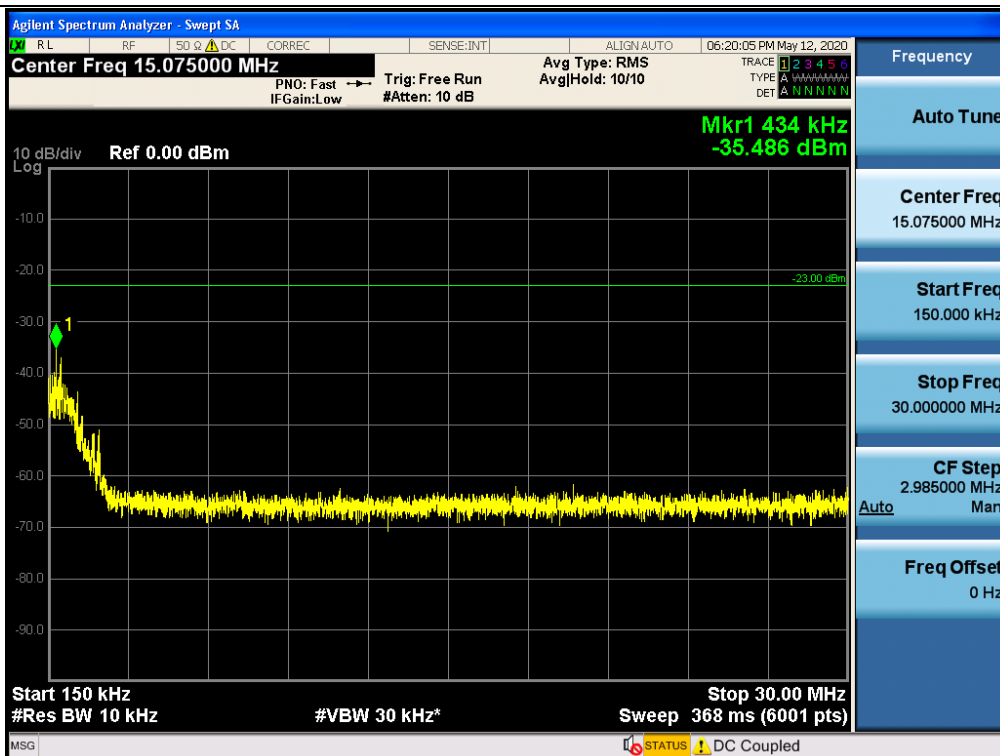
Spurious / ESMR / Downlink / CDMA / Low / 1 GHz ~ 10 GHz



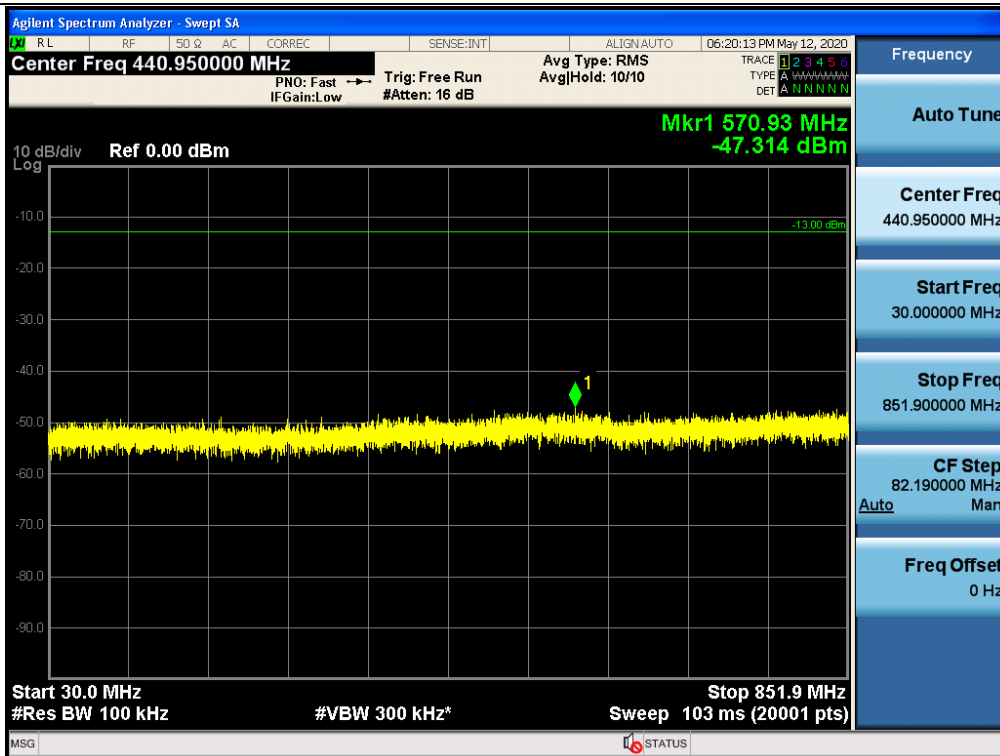
Spurious / ESMR / Downlink / CDMA / Middle / 9 kHz ~ 150 kHz



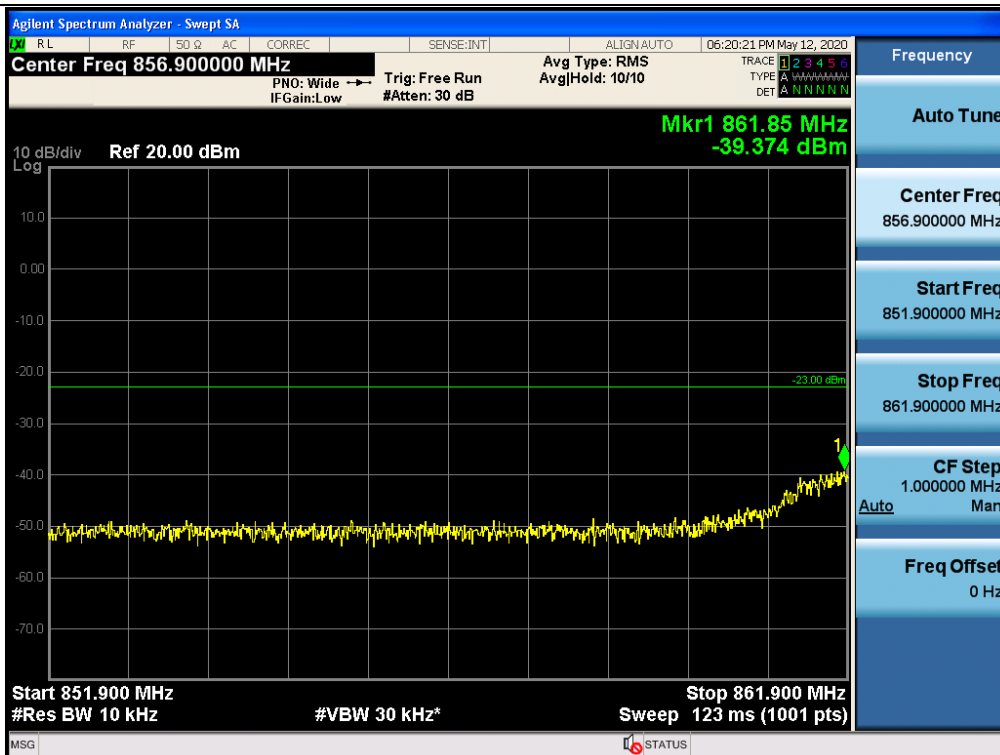
Spurious / ESMR / Downlink / CDMA / Middle / 150 kHz ~ 30 MHz



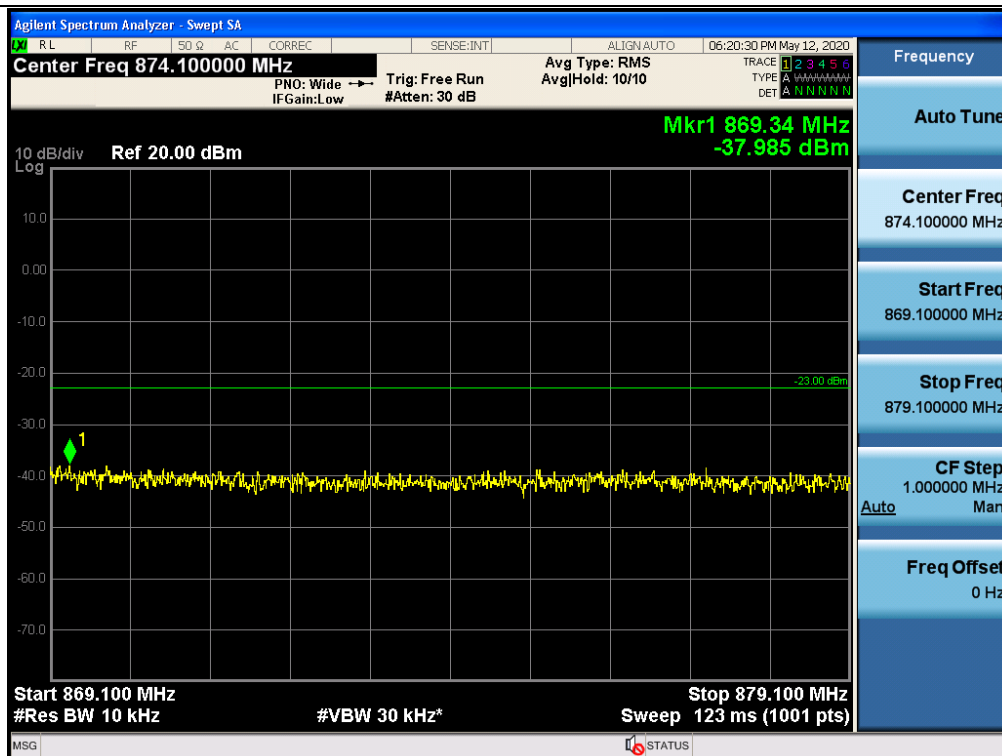
Spurious / ESMR / Downlink / CDMA / Middle / 30 MHz ~ Low Edge-10



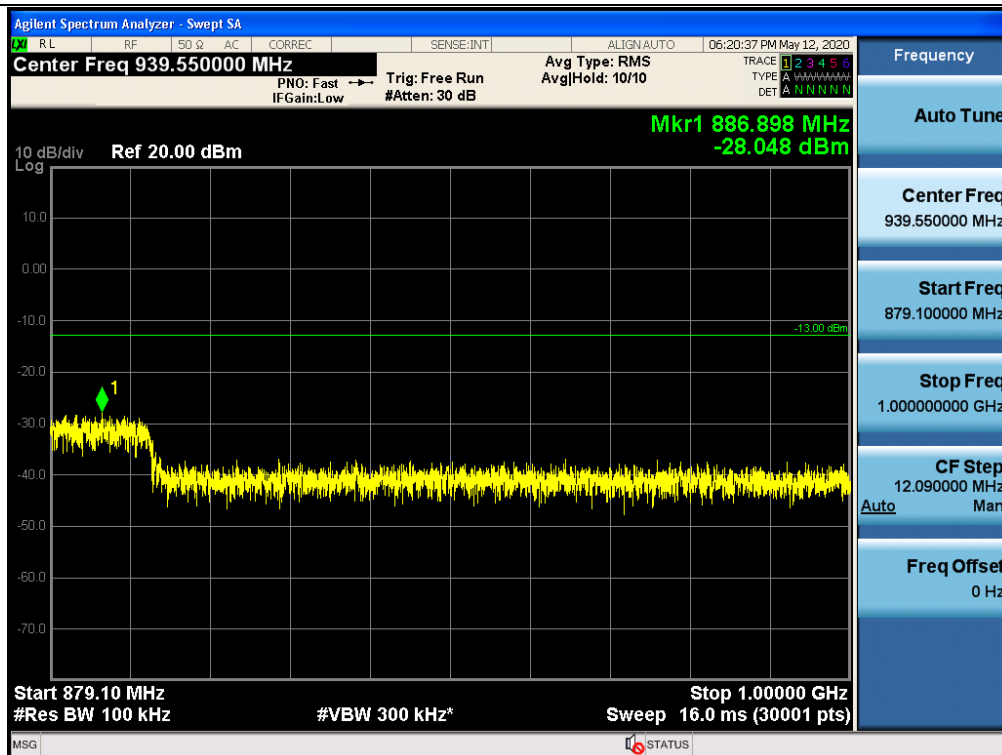
Spurious / ESMR / Downlink / CDMA / Middle / Low Edge-10 ~ Low Edge



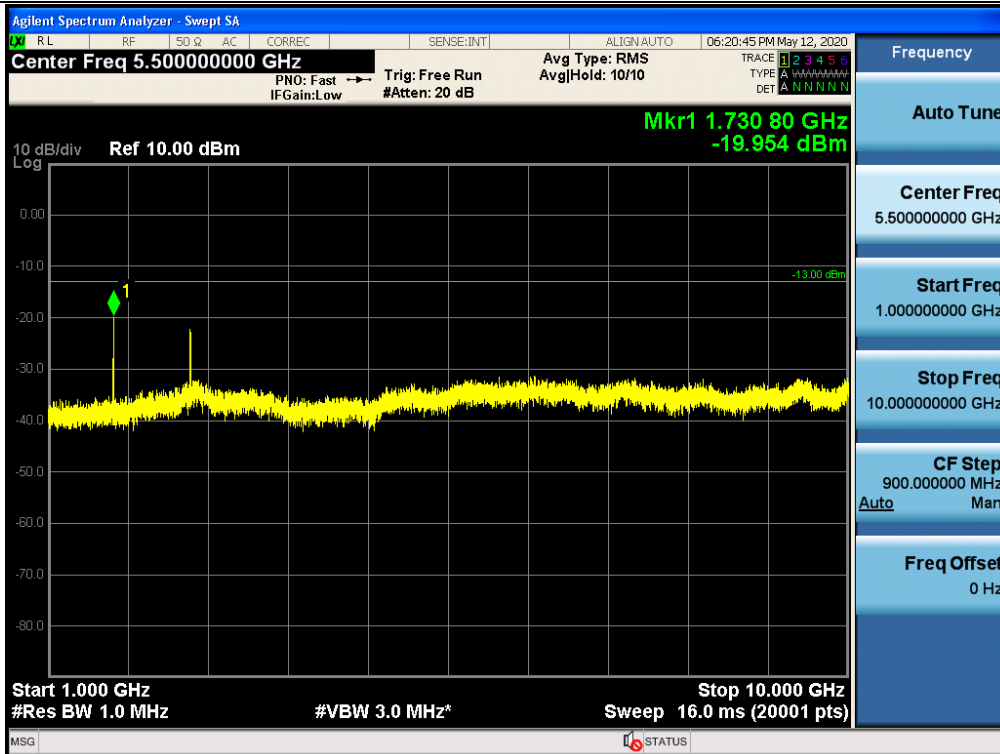
Spurious / ESMR / Downlink / CDMA / Middle / High Edge ~ High Edge+10



Spurious / ESMR / Downlink / CDMA / Middle / High Edge+10 ~ 1 GHz



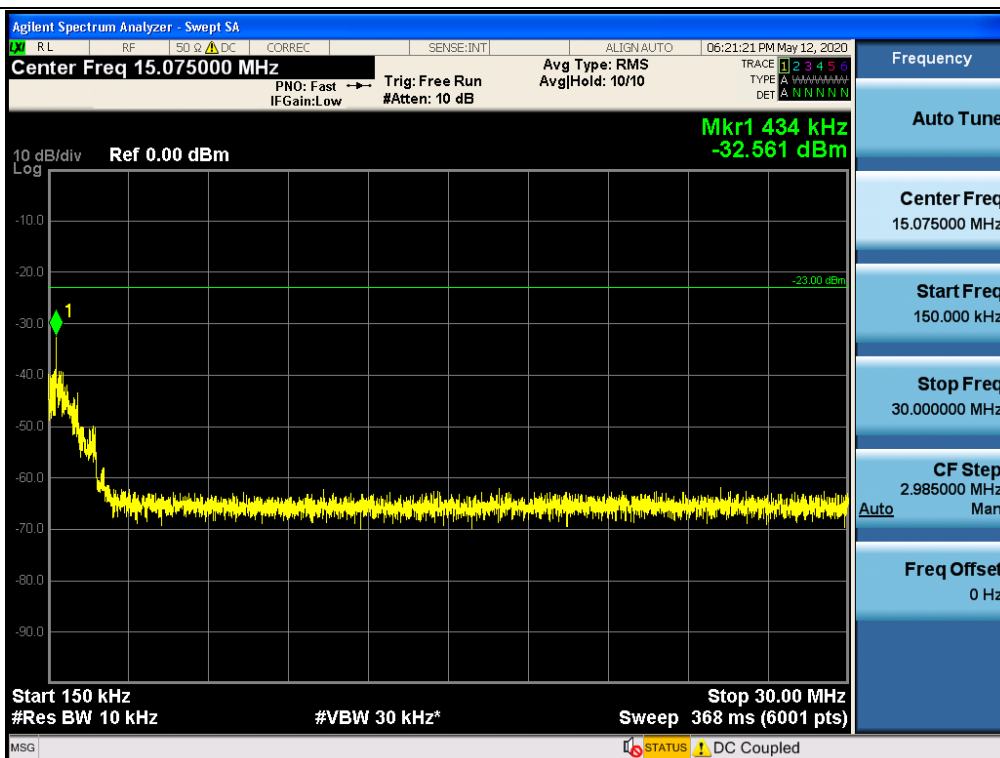
Spurious / ESMR / Downlink / CDMA / Middle / 1 GHz ~ 10 GHz



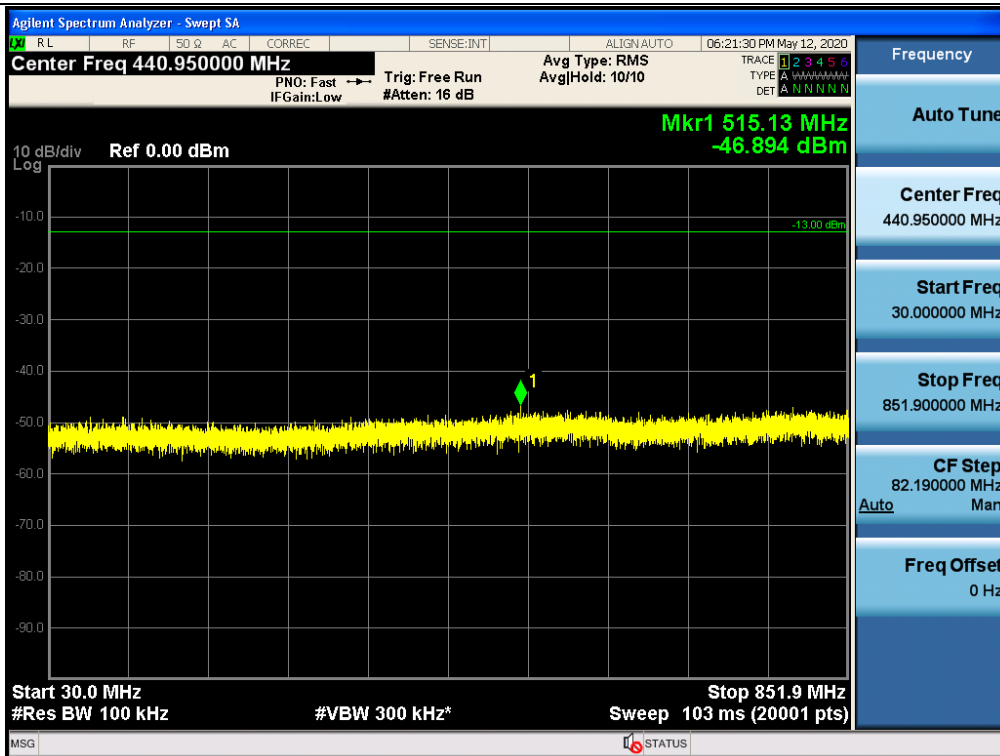
Spurious / ESMR / Downlink / CDMA / High / 9 kHz ~ 150 kHz



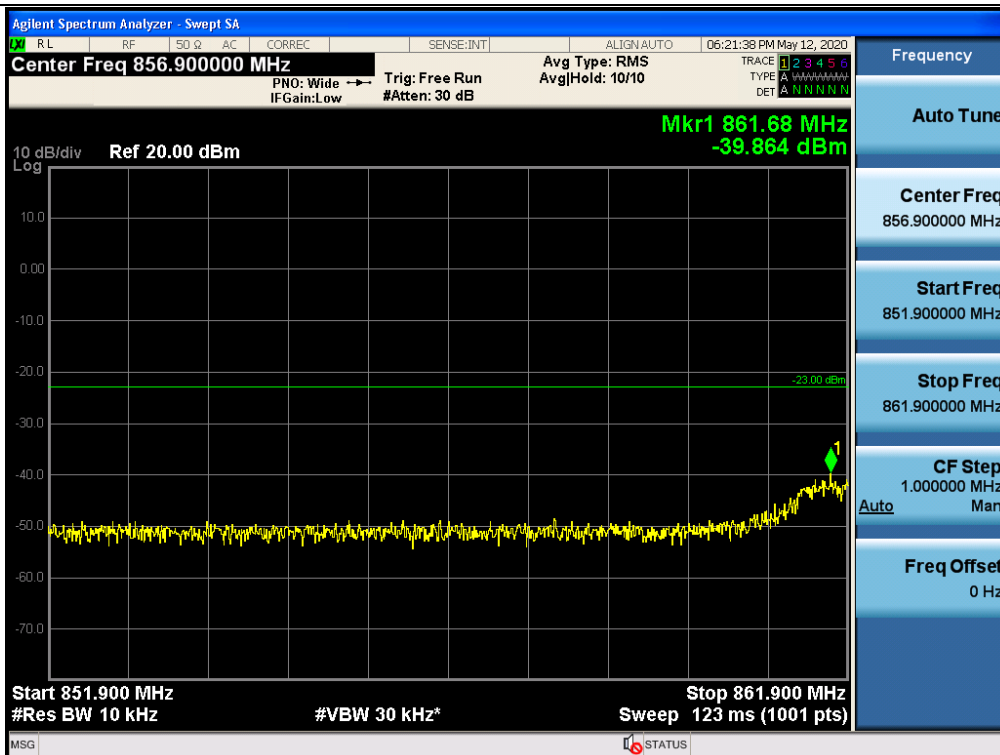
Spurious / ESMR / Downlink / CDMA / High / 150 kHz ~ 30 MHz



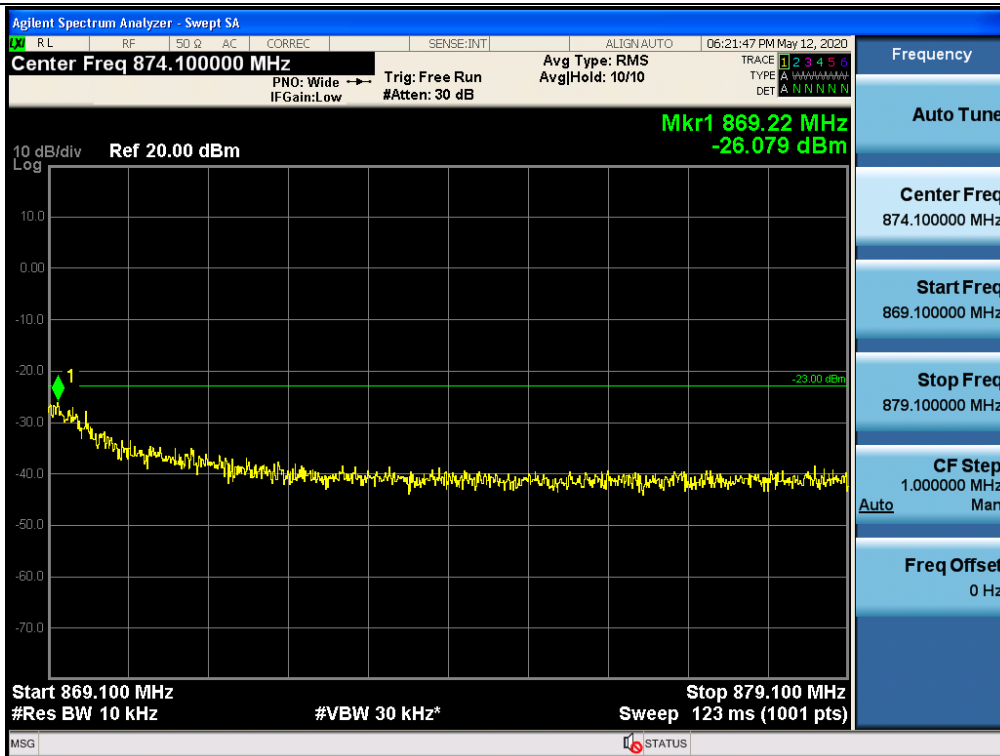
Spurious / ESMR / Downlink / CDMA / High / 30 MHz ~ Low Edge-10



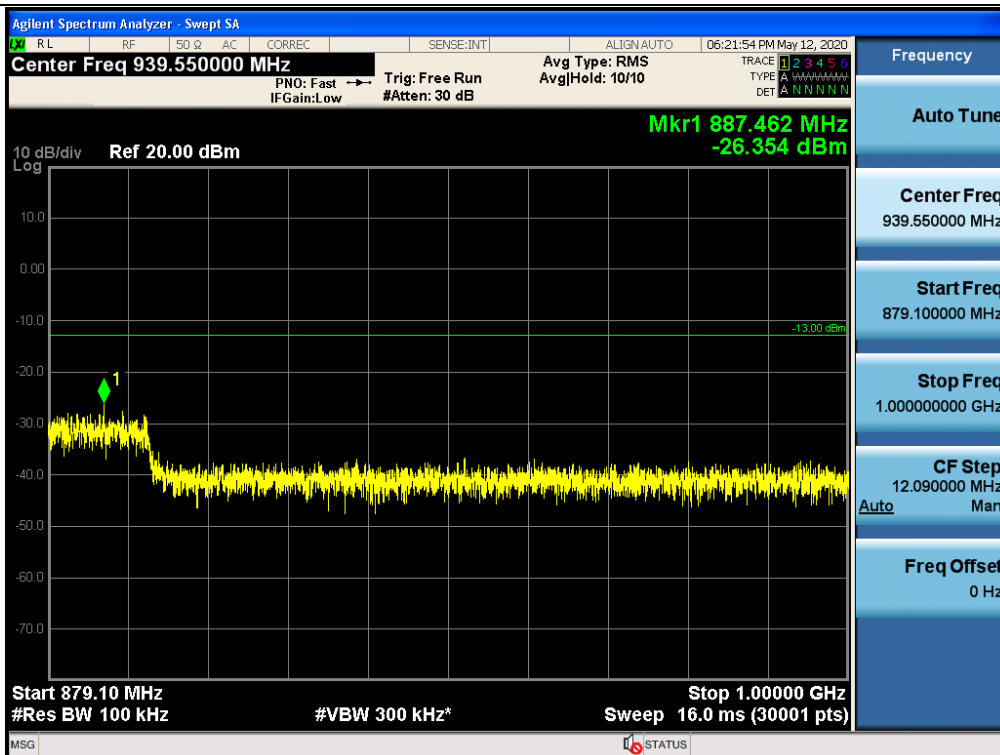
Spurious / ESMR / Downlink / CDMA / High / Low Edge-10 ~ Low Edge



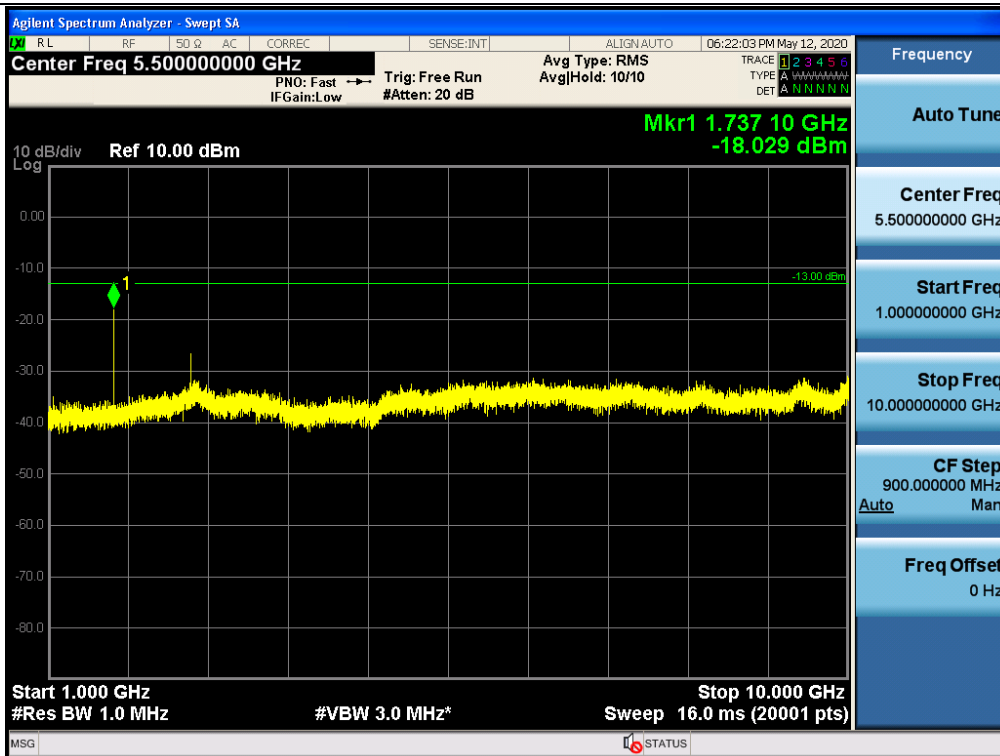
Spurious / ESMR / Downlink / CDMA / High / High Edge ~ High Edge+10



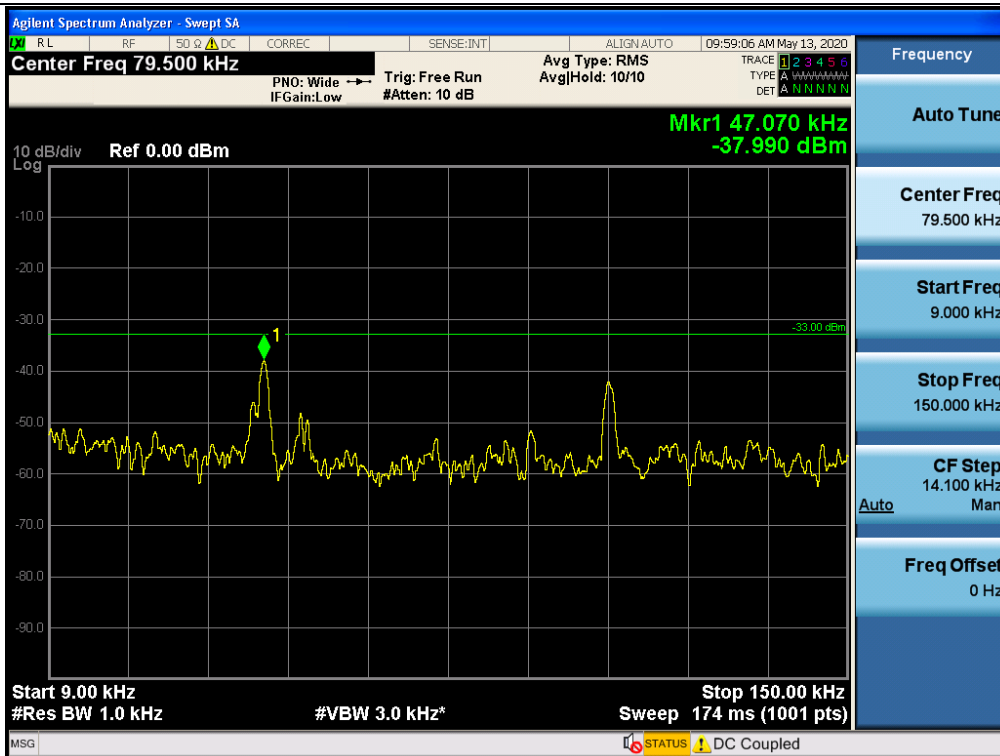
Spurious / ESMR / Downlink / CDMA / High / High Edge+10 ~ 1 GHz



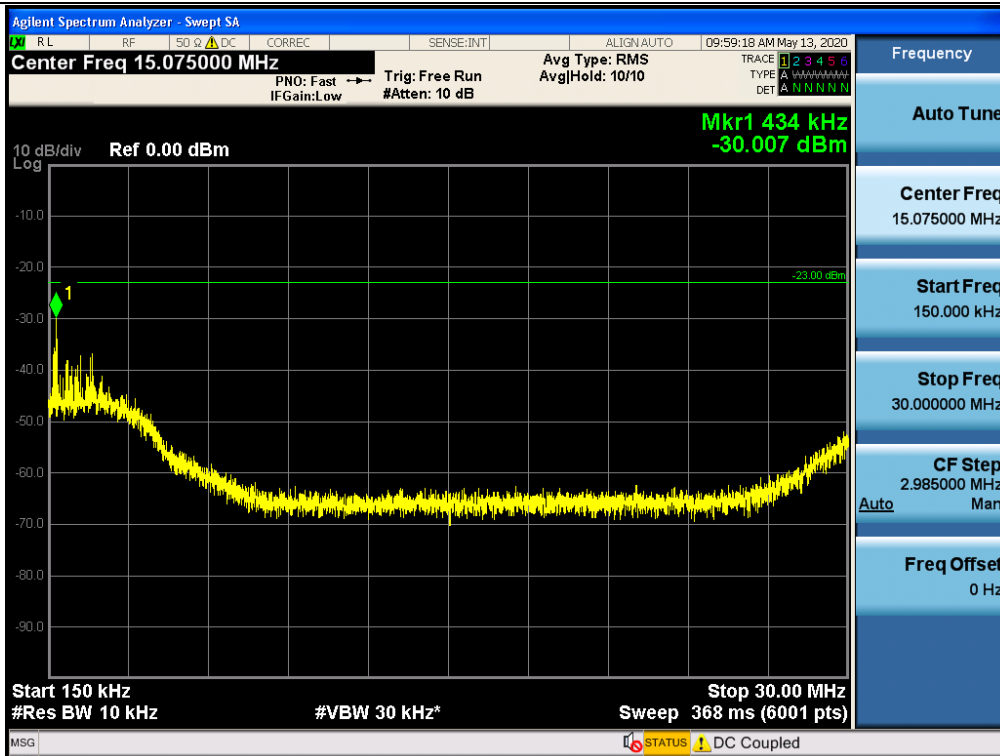
Spurious / ESMR / Downlink / CDMA / High / 1 GHz ~ 10 GHz



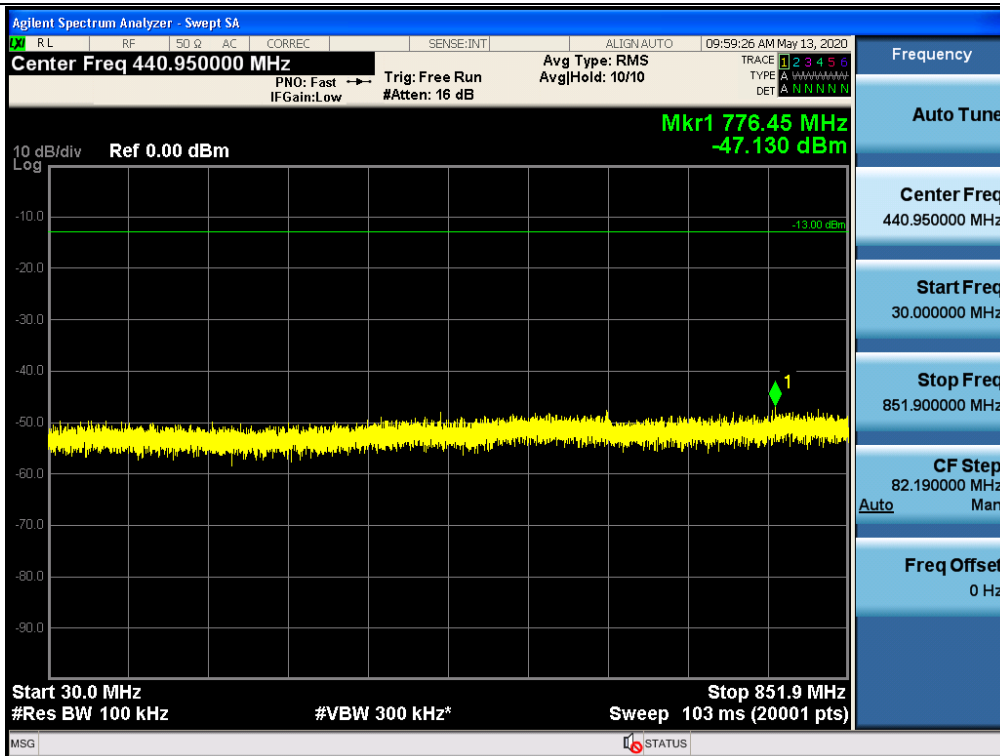
Spurious / ESMR / Downlink / LTE 5 MHz / Low / 9 kHz ~ 150 kHz



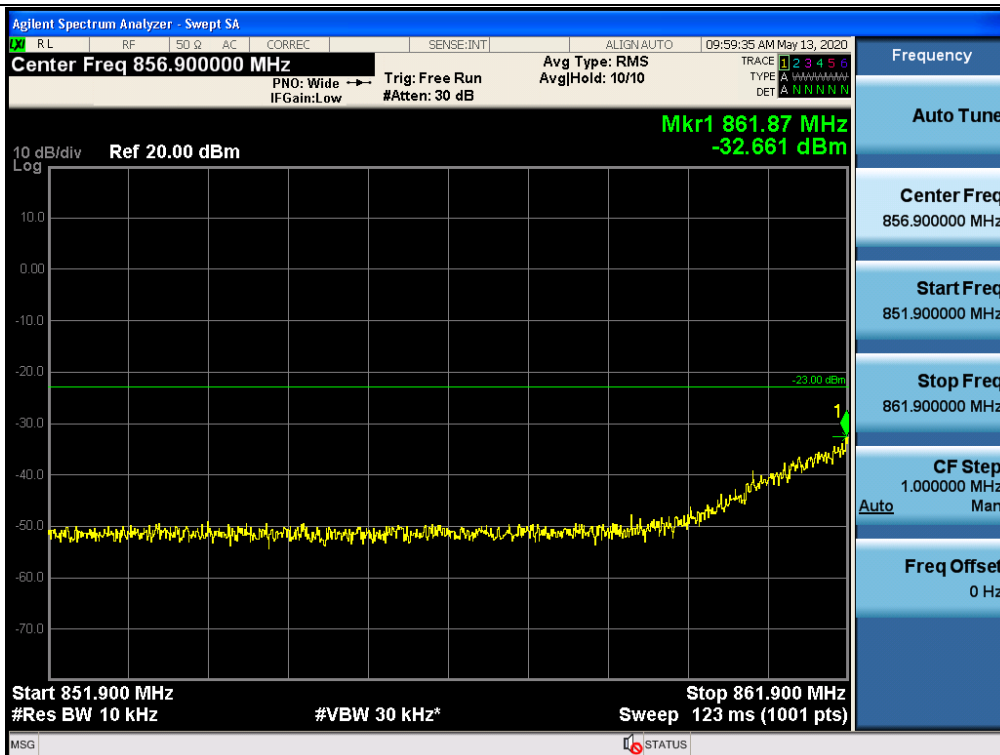
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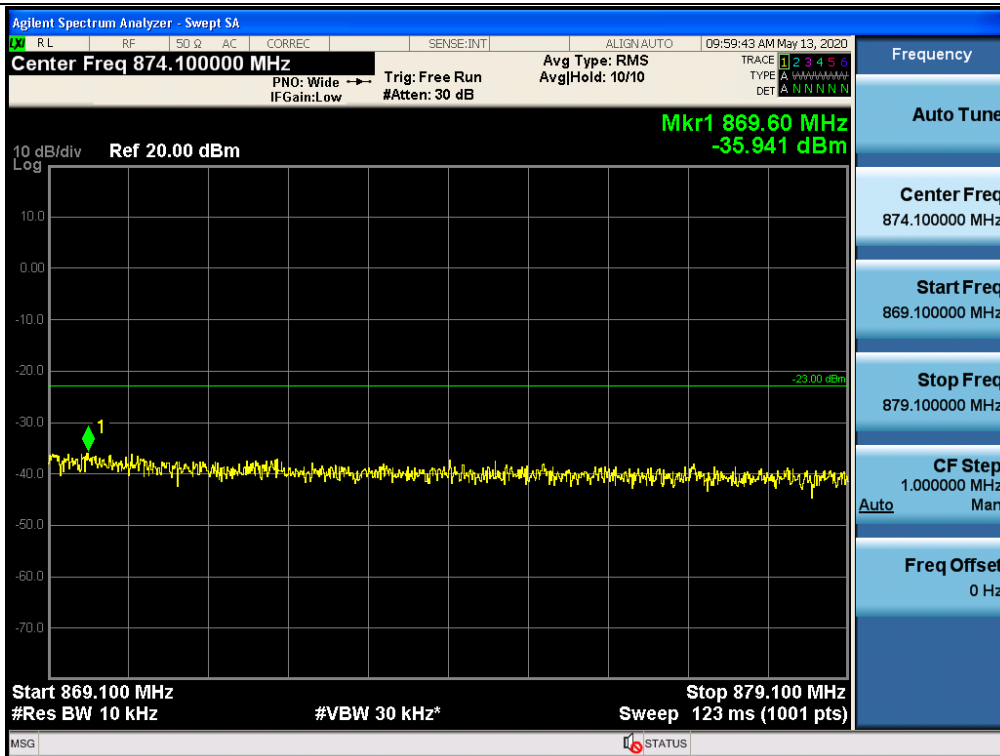
Spurious / ESMR / Downlink / LTE 5 MHz / Low / 30 MHz ~ Low Edge-10



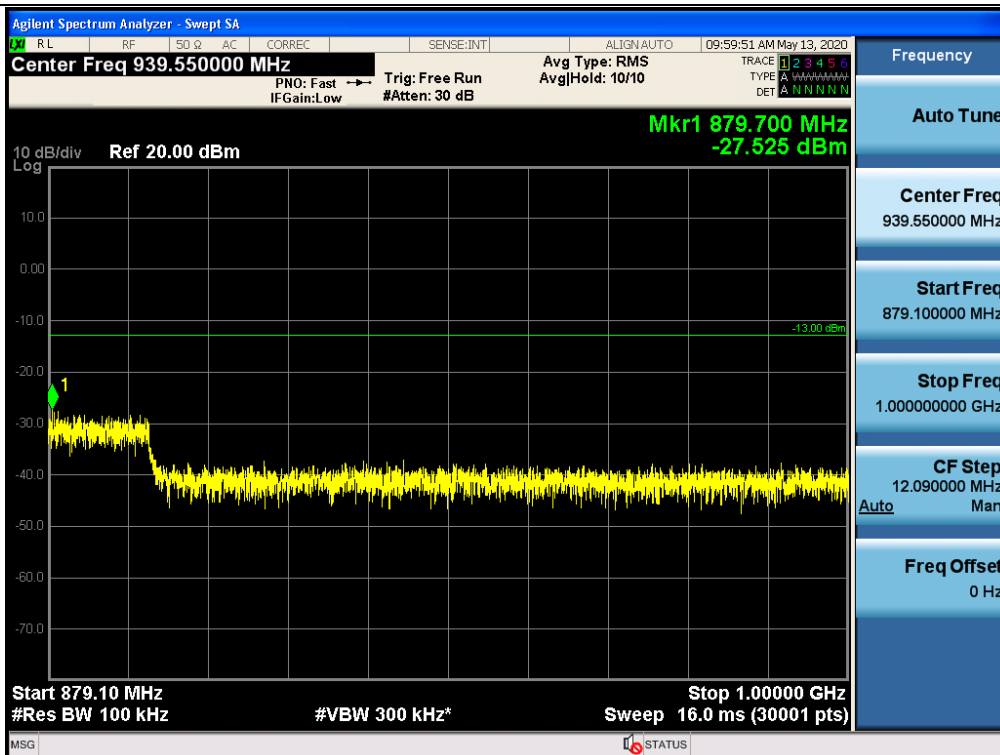
Spurious / ESMR / Downlink / LTE 5 MHz / Low / Low Edge-10 ~ Low Edge



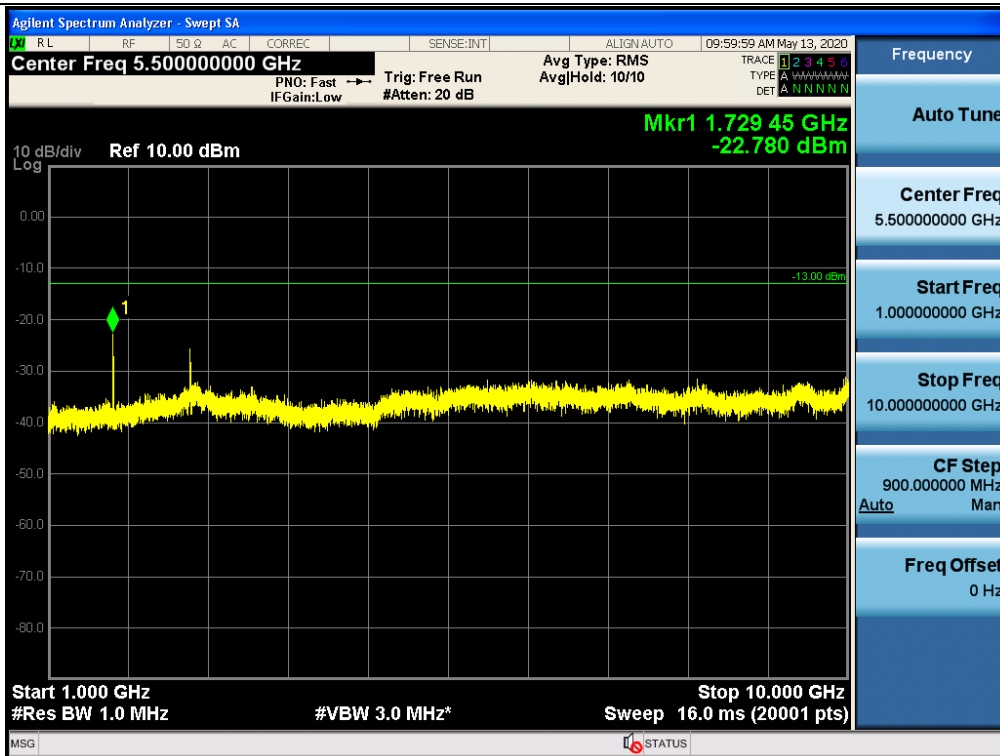
Spurious / ESMR / Downlink / LTE 5 MHz / Low / High Edge ~ High Edge+10



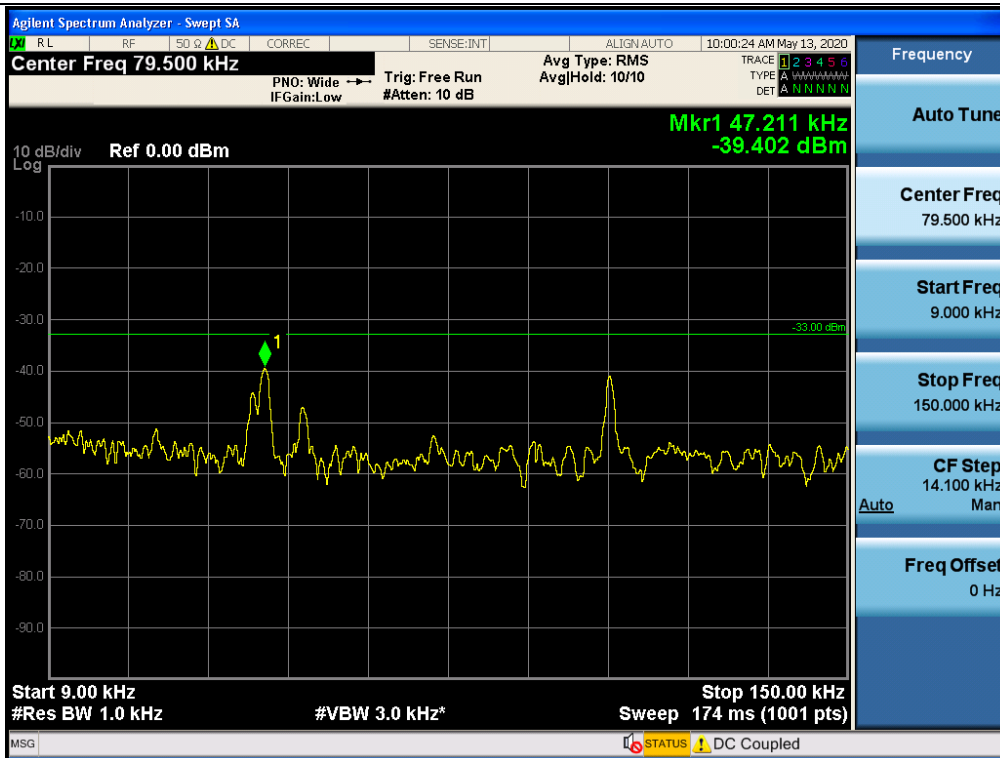
Spurious / ESMR / Downlink / LTE 5 MHz / Low / High Edge+10 ~ 1 GHz



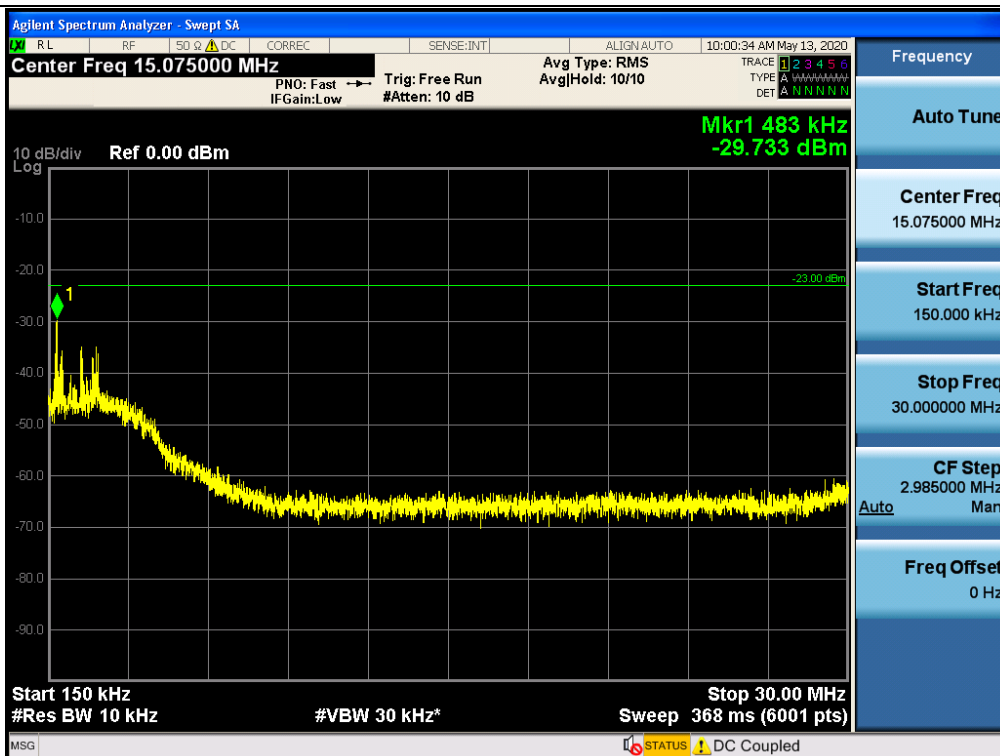
Spurious / ESMR / Downlink / LTE 5 MHz / Low / 1 GHz ~ 10 GHz



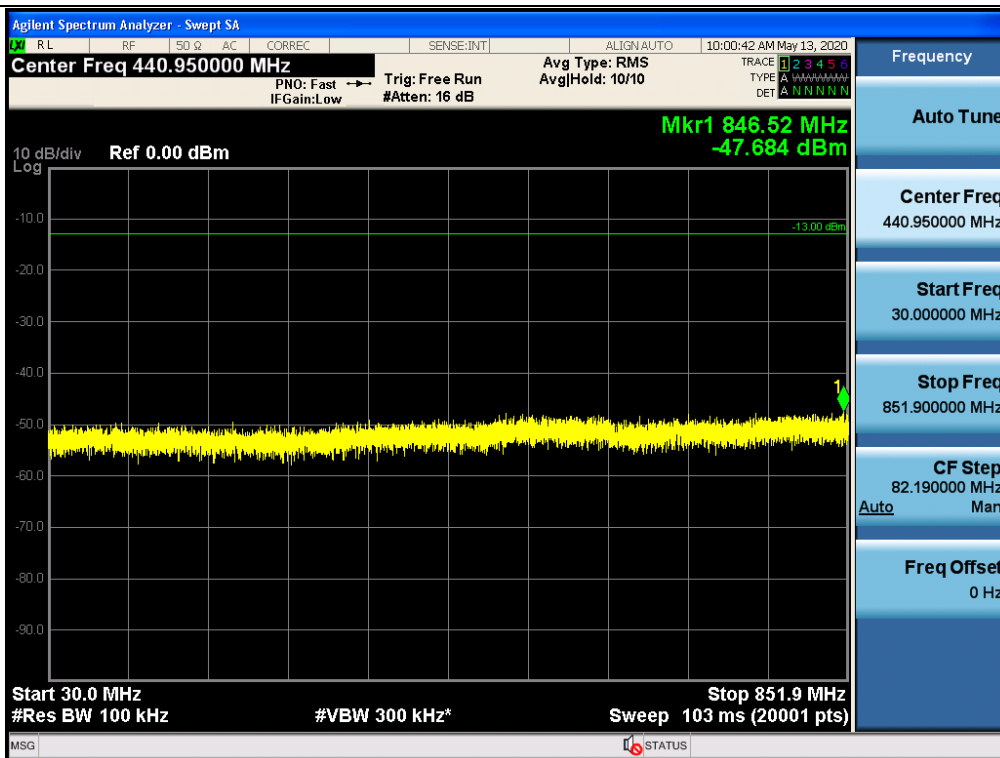
Spurious / ESMR / Downlink / LTE 5 MHz / Middle / 9 kHz ~ 150 kHz



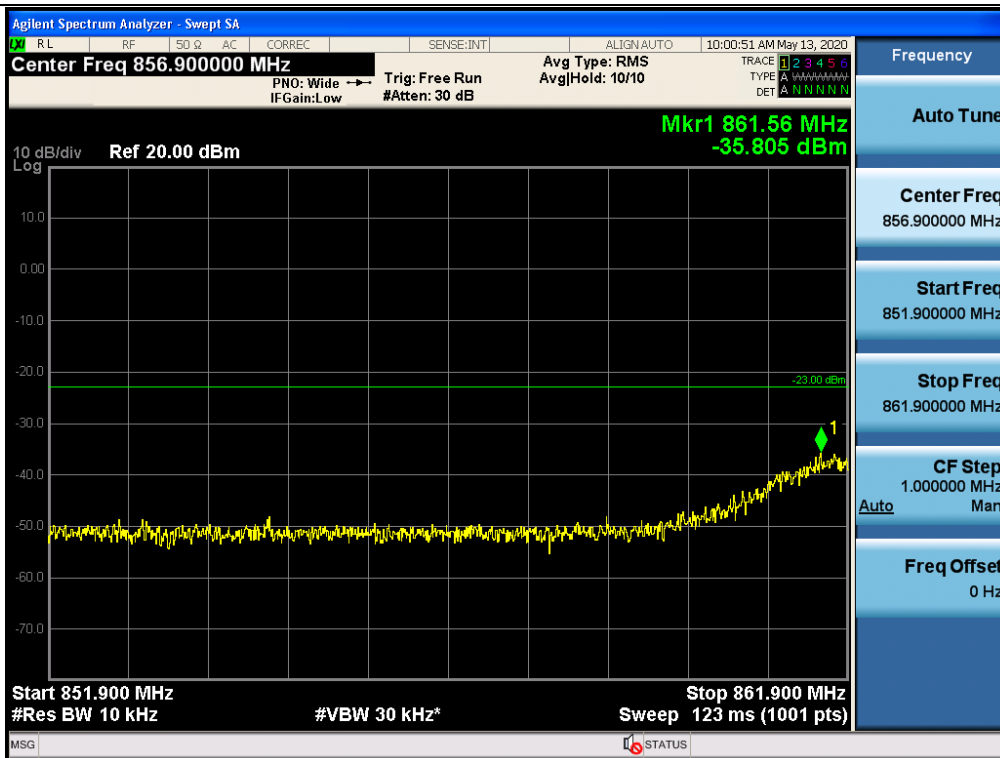
Spurious / ESMR / Downlink / LTE 5 MHz / Middle / 150 kHz ~ 30 MHz



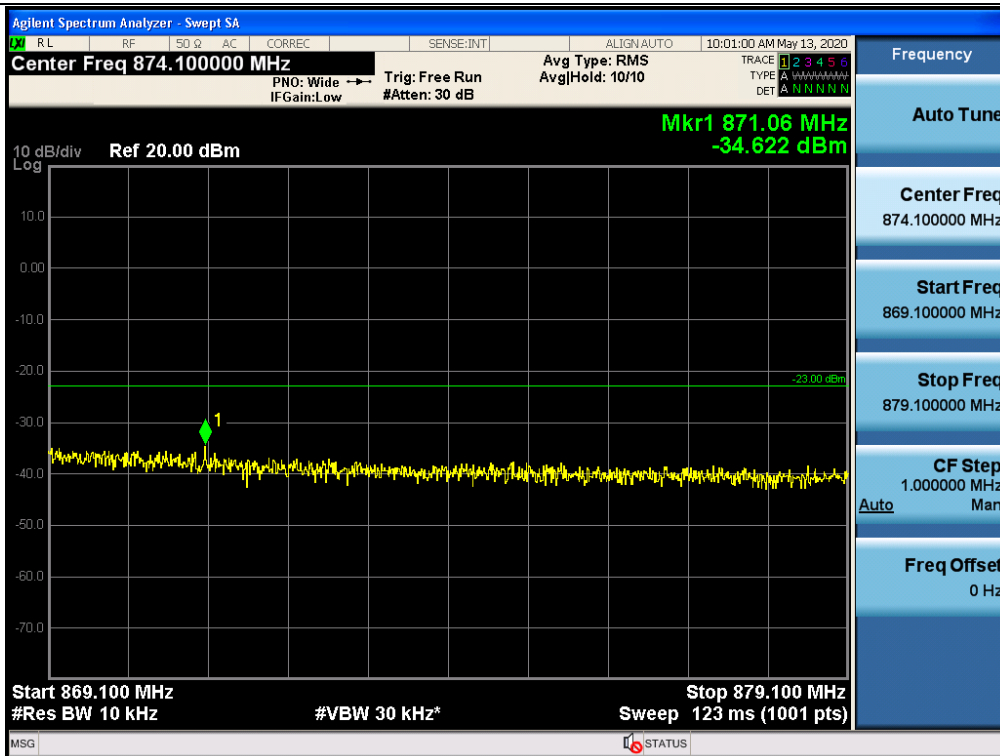
Spurious / ESMR / Downlink / LTE 5 MHz / Middle / 30 MHz ~ Low Edge-10



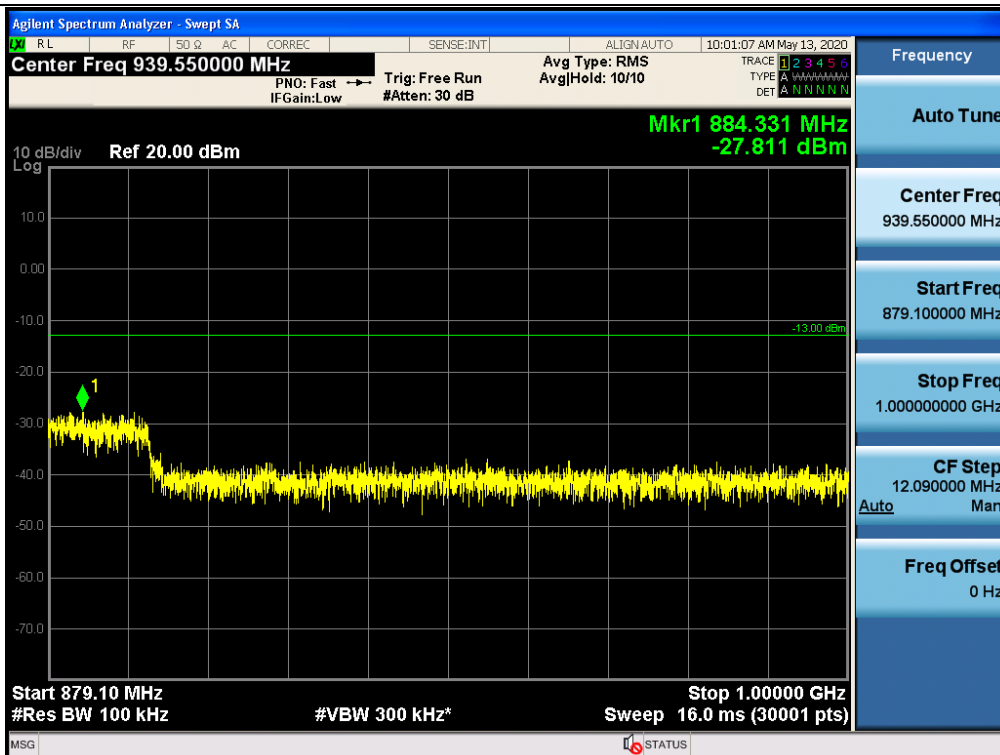
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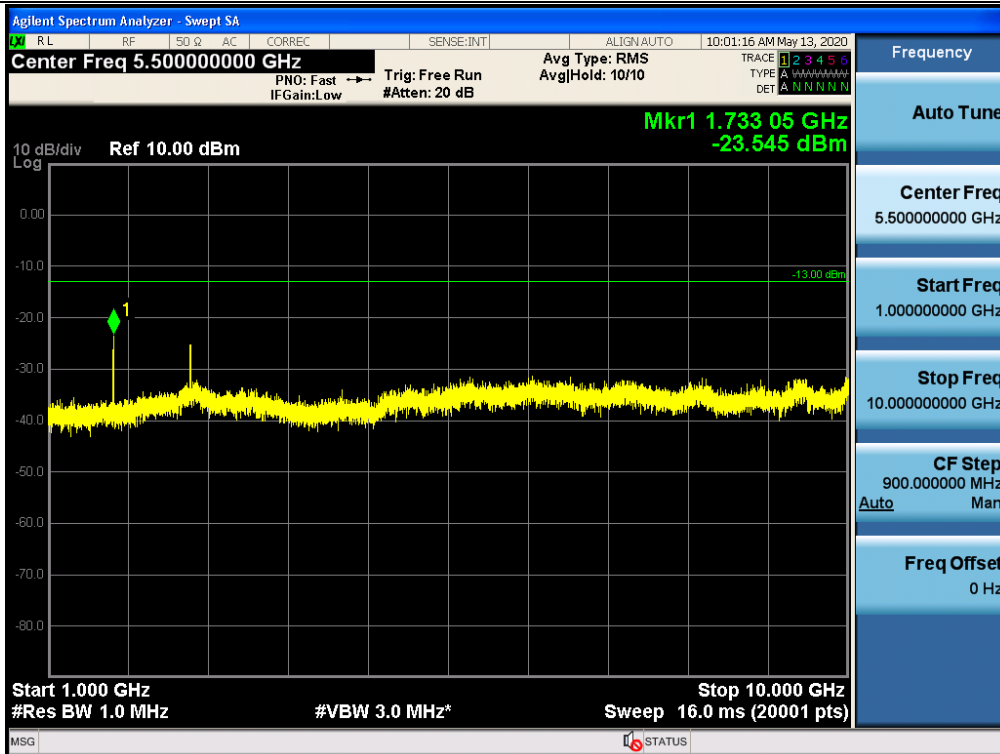
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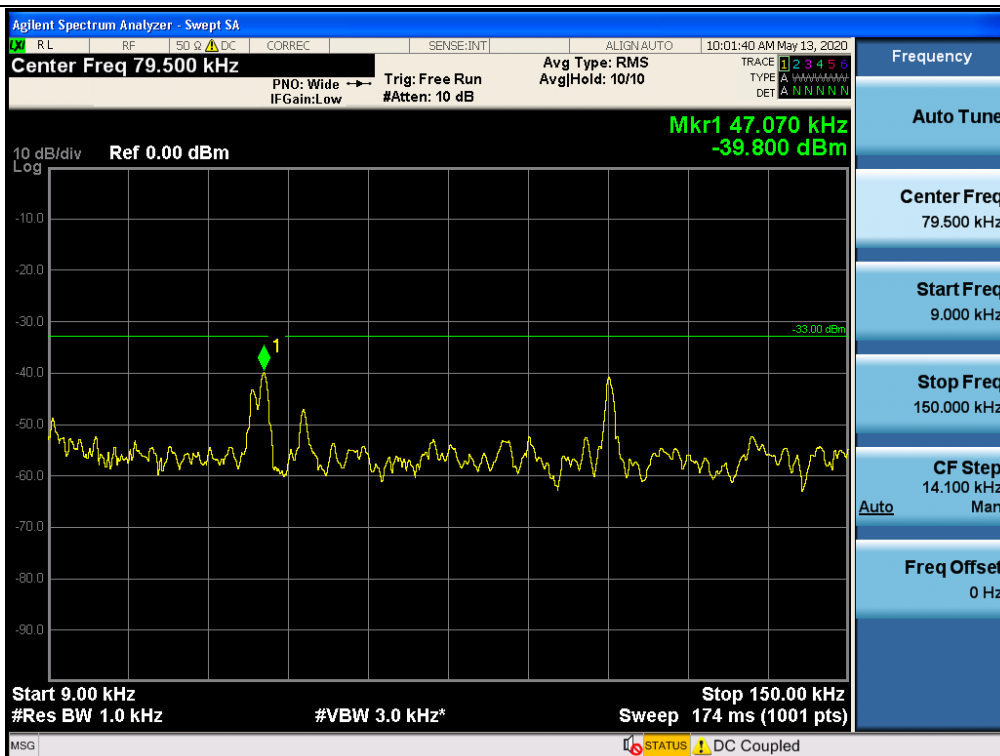
Spurious / ESMR / Downlink / LTE 5 MHz / Middle / High Edge+10 ~ 1 GHz



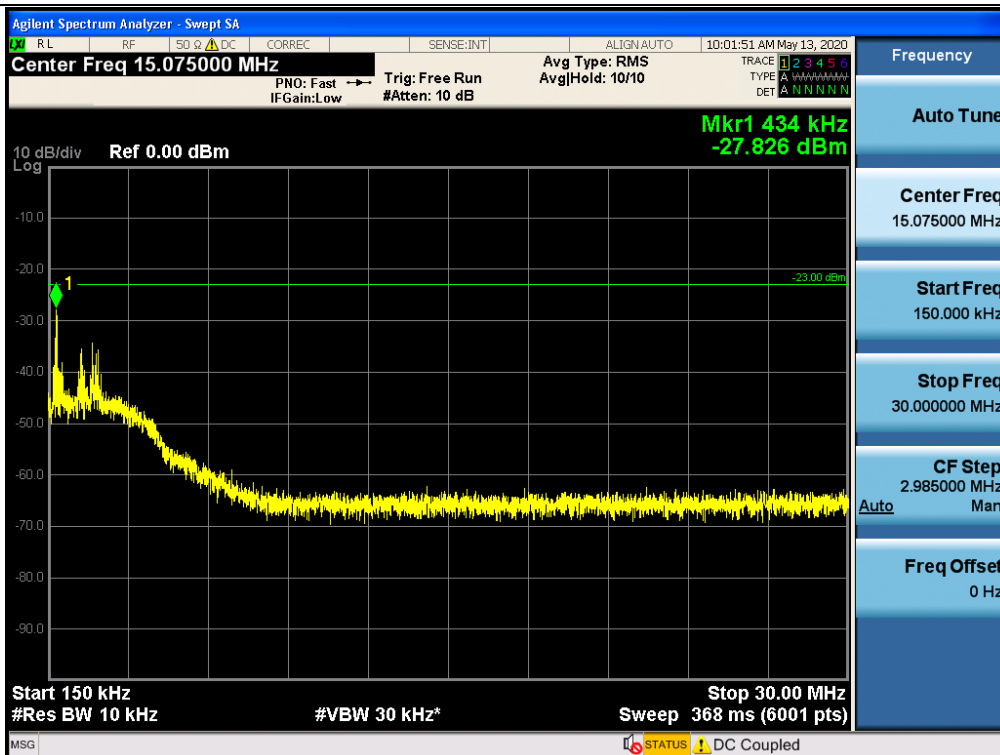
Spurious / ESMR / Downlink / LTE 5 MHz / Middle / 1 GHz ~ 10 GHz



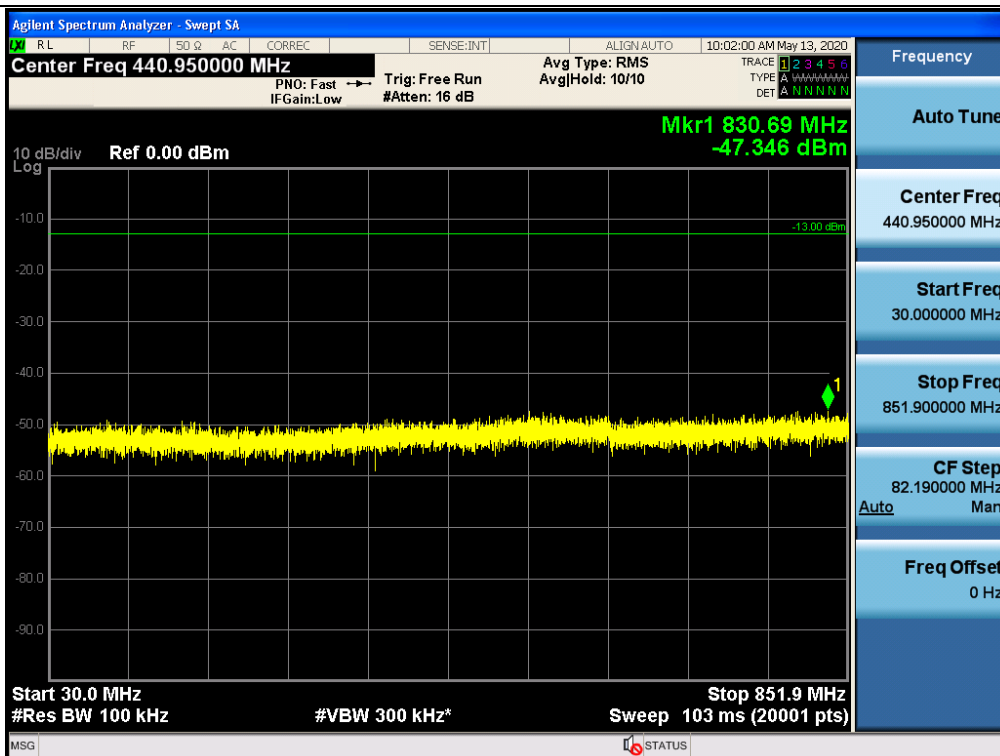
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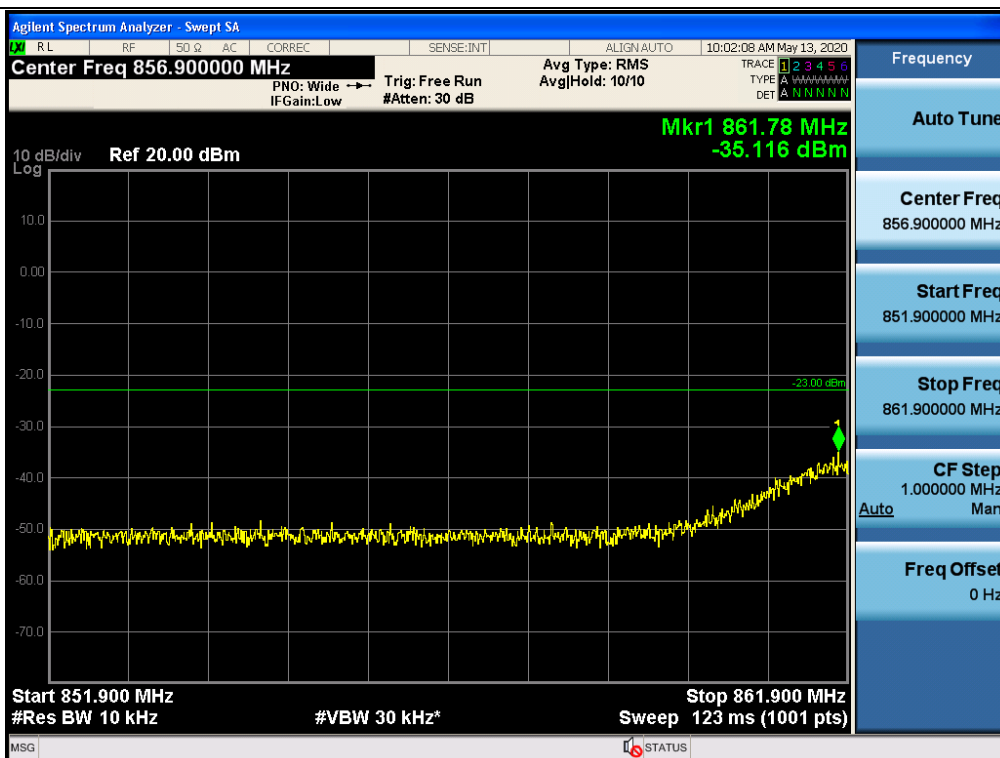
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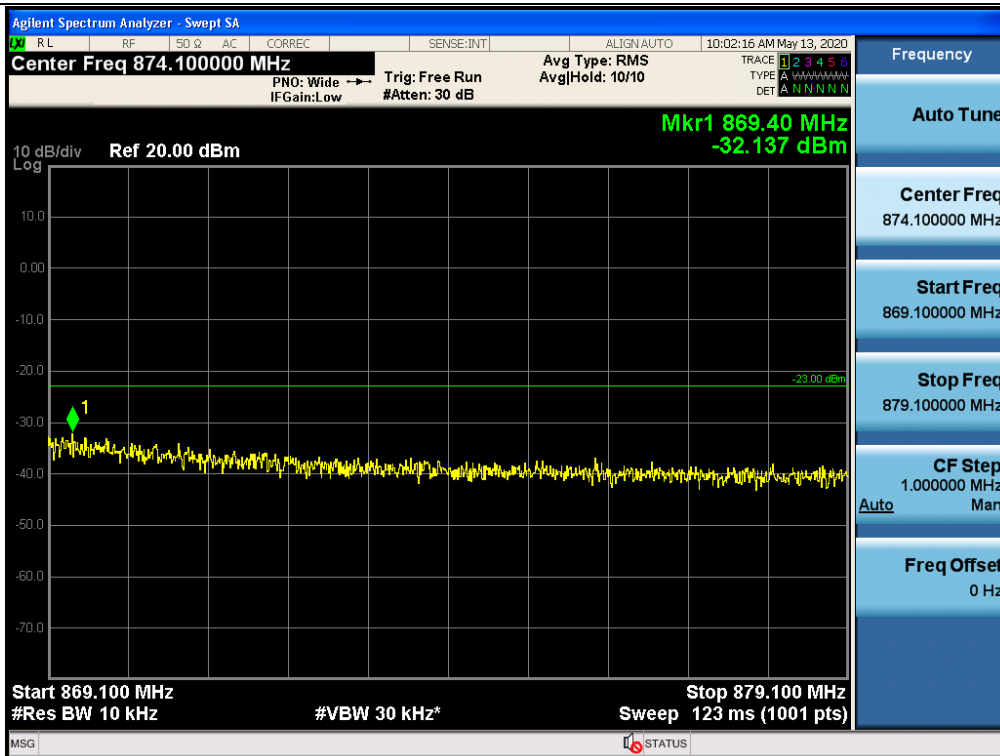
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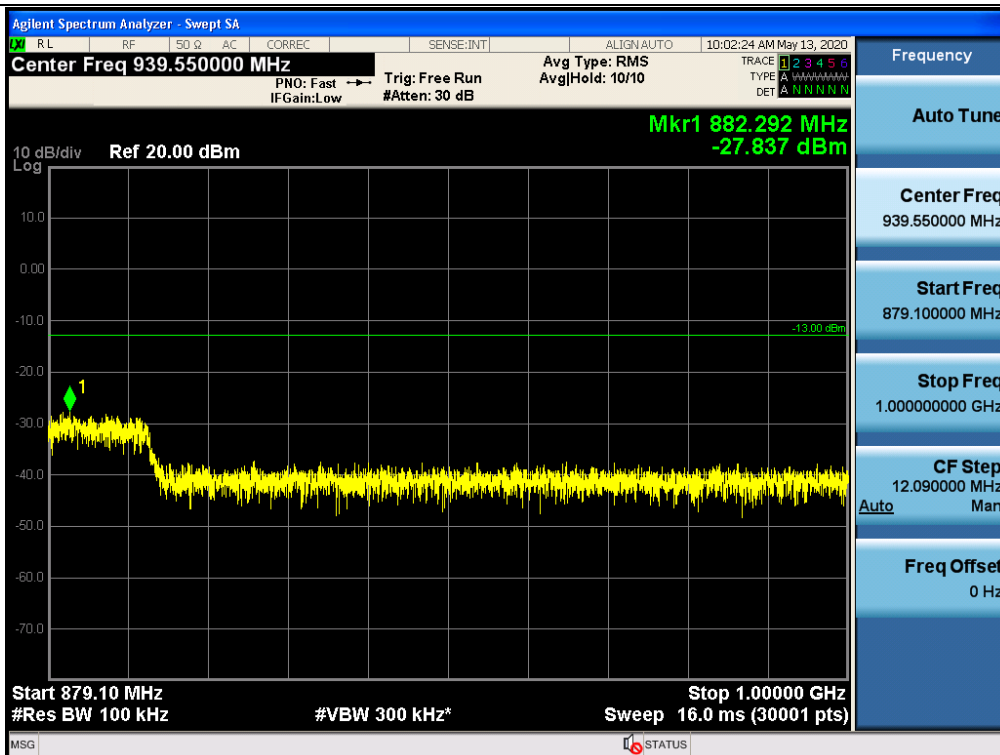
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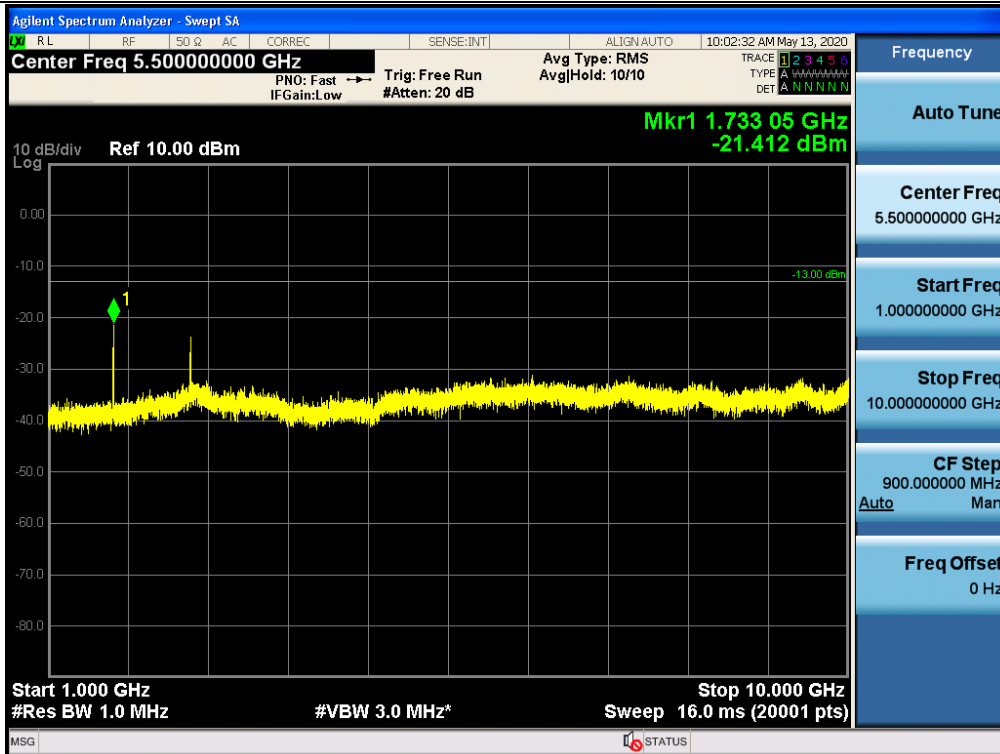
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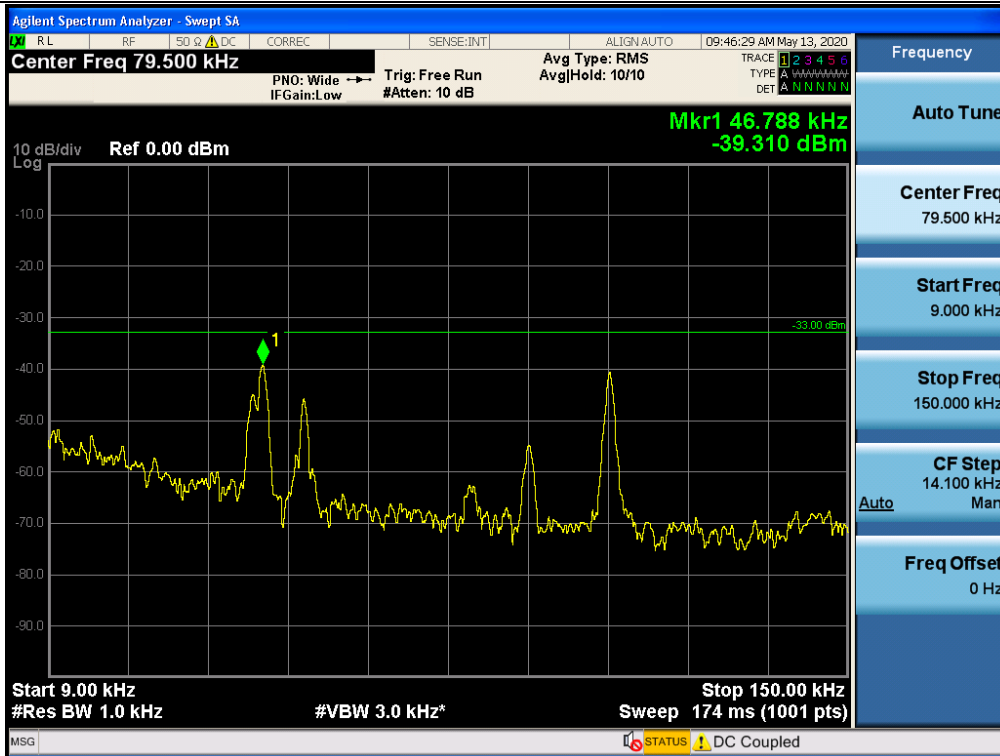
Spurious / ESMR / Downlink / LTE 5 MHz / High / High Edge+10 ~ 1 GHz



Spurious / ESMR / Downlink / LTE 5 MHz / High / 1 GHz ~ 10 GHz



Spurious / ESMR / Downlink / WCDMA / Low / 9 kHz ~ 150 kHz



Spurious / ESMR / Downlink / WCDMA / Low / 150 kHz ~ 30 MHz

