TCT 通测检测 TESTING CENTRE TECHNOLOGY

TEST REPORT

FCC ID. ..... :	2ALZEL50VA-01
Test Report No..... :	TCT230213E011
Date of issue..... :	Feb. 24, 2023
Testing laboratory ..... :	SHENZHEN TONGCE TESTING LAB
Testing location/ address:	2101 & 2201, Zhenchang Factory Renshan Industrial Zone, Fuhai Subdistrict, Bao'an District, Shenzhen, Guangdong, 518103, People's Republic of China
Applicant's name..... :	Shen Zhen ANNTLENT Communication Technology co., Ltd.
Address..... :	Room 601, Unit 1 Building 10, Haoyue Garden, Minzhi Sub-district, Longhua District, Shenzhen, China
Manufacturer's name ... :	Shen Zhen ANNTLENT Communication Technology co., Ltd.
Address..... :	Room 601, Unit 1 Building 10, Haoyue Garden, Minzhi Sub-district, Longhua District, Shenzhen, China
Standard(s) ..... :	FCC CFR Title 47 Part 20.21 KDB935210 D03 Signal Booster Measurements v04r04
Product Name..... :	Cell Phone Signal Booster
Trade Mark ..... :	Phonetone anntlent ANNTLENT PHONETONE
Model/Type reference..... :	AN-L50VA-01
Rating(s)..... :	Input: DC 12-24V Output: DC 5V, 2A
Date of receipt of test item ..... :	Feb. 13, 2023
Date (s) of performance of test..... :	Feb. 13, 2023 ~ Feb. 24, 2023
Tested by (+signature) ... :	Rleo LIU
Check by (+signature).... :	Beryl ZHAO
Approved by (+signature):	Tomsin

General disclaimer:

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Hotline: 400-6611-140 Tel: 86-755-27673339 Fax: 86-755-27673332 http://www.tct-lab.com

1. General Product Information

1.1. EUT description

Product Name.....:	Cell Phone Signal Booster
Model/Type reference.....:	AN-L50VA-01
Sample Number.....:	TCT230213E011-0101
Operation Frequency.....:	Lower700MHz Uplink: 698MHz - 716MHz, Downlink: 728MHz - 746MHz Upper700MHz Uplink: 776MHz - 787MHz, Downlink: 746MHz - 757MHz
Signal Booster Type.....:	Mobile Consumer Signal Booster
Emission Designator .....:	G7D, W7D
FCC Classification .....:	B2W/Wideband Consumer Booster(CMRS)
Rating(s).....:	Input: DC 12-24V Output: DC 5V, 2A

Note: The antenna gain listed in this report is provided by applicant, and the test laboratory is not responsible for this parameter.

1.2. Model(s) list

None.

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2. Test Result Summary

Requirement	CFR 47 Section	Result
Authorized Frequency Band Verification Test	§20.21(e)(3)	PASS
Maximum Power Measurement Procedure	§2.1046/20.21(e)(8)(i)(D)	PASS
Maximum Booster Gain Computation	§20.21(e)(8)(i)(B)	PASS
Intermodulation Product	§20.21(e)(8)(i)(F)	PASS
Out of Band Emissions	§20.21(e)(8)(i)(E)	PASS
Conducted Spurious Emission	§2.1051/§27	PASS
Noise Limit Procedure Variable Noise Variable Noise Timing	§20.21(e)(8)(i)(A)(2)(i) §20.21(e)(8)(i)(A)(1) §20.21(e)(8)(i)(H)	PASS
Uplink inactivity	§20.21(e)(8)(i)(I)	PASS
Variable Booster Gain Variable Uplink Gain Timing	§20.21(e)(8)(i)(C) (1), (2)(i) §20.21(e)(8)(i)(H)	PASS
Occupied Band Width	§2.1049/§27	PASS
Anti-Oscillation	§20.21(e)(8)(ii)(A)	PASS
Radiated Spurious Emission	§2.1053/§27	PASS
Spectrum Block Filter	N/A	N/A

Note:

1. PASS: Test item meets the requirement.

2. Fail: Test item does not meet the requirement.

3. N/A: Test case does not apply to the test object.

4. The test result judgment is decided by the limit of test standard.

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3. General Information

3.1. Test environment

Operating Environment:	
Temperature:	25.0 °C
Humidity:	56 % RH
Atmospheric Pressure:	1010 mbar

3.2. Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Equipment	Model No.	Serial No.	FCC ID	Trade Name
/	/	/	/	/

4. Facilities and Accreditations

4.1. Facilities

The test facility is recognized, certified, or accredited by the following organizations:

- FCC - Registration No.: 645098

  SHENZHEN TONGCE TESTING LAB

  Designation Number: CN1205

  The testing lab has been registered and fully described in a report with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files.

- IC - Registration No.: 10668A-1

  SHENZHEN TONGCE TESTING LAB

  CAB identifier: CN0031

  The testing lab has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing.

4.2. Location

SHENZHEN TONGCE TESTING LAB

Address: 2101 & 2201, Zhenchang Factory Renshan Industrial Zone, Fuhai Subdistrict, Bao'an District, Shenzhen, Guangdong, 518103, People's Republic of China

TEL: +86-755-27673339

4.3. Measurement Uncertainty

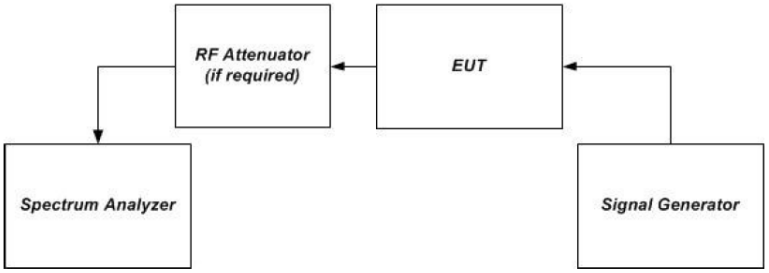
The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 %.

No.	Item	MU
1	Conducted Emission	± 3.10 dB
2	RF power, conducted	± 0.12 dB
3	Spurious emissions, conducted	± 0.11 dB
4	All emissions, radiated(<1 GHz)	± 4.56 dB
5	All emissions, radiated(1 GHz - 18 GHz)	± 4.22 dB
6	All emissions, radiated(18 GHz- 40 GHz)	± 4.36 dB

5. Test Results and Measurement Data

5.1. Authorized Frequency Band Verification

5.1.1. Test Specification

Test Requirement:	FCC Part20 Section 20.21(e)(3)
Test Method:	KDB935210 D03 Signal Booster Measurements v04r04
Limit	Lower700MHz Uplink: 698MHz - 716MHz, Downlink: 728MHz - 746MHz Upper700MHz Uplink: 776MHz - 787MHz, Downlink: 746MHz - 757MHz
Test Setup:	
Test Procedure:	935210 D03 Signal Booster Measurement v04r04 a) Connect the EUT to the test equipment as shown in Figure 1. Begin with the uplink output (donor) port connected to the spectrum analyzer. b) Set the spectrum analyzer resolution bandwidth (RBW) for 100 kHz with the video bandwidth (VBW) ≥ 3 x the RBW, using a PEAK detector with the MAX HOLD function. c) Set the center frequency of the spectrum analyzer to the center of the operational band under test with a span of 1 MHz. d) Set the signal generator for CW mode and tune to the center frequency of the operational band under test. e) Set the initial signal generator power to a level that is at least 6 dB below the AGC level specified by the manufacturer. f) Slowly increase the signal generator power level until the output signal reaches the AGC operational level. g) Reduce the signal generator power to a level that is 3 dB below the level noted above, then manually reset the EUT (e.g., cycle ac/dc power). h) Reset the spectrum analyzer span to 2xthe width of the CMRS band under test. Adjust the tuned frequency of the signal generator to sweep 2xthe width of the CMRS band using the sweep function. The AGC must be deactivated throughout the entire sweep. i) Using three markers, identify the CMRS band edges and the frequency with the highest power. Affirm that the values of all markers are visible on the display of the spectrum analyzer (e.g., marker table set to on). j) Capture the spectrum analyzer trace for inclusion in the test report. k) Repeat 7.1c) to 7.1j) for all operational uplink and downlink bands.
Test Result:	PASS

5.1.2. Test Instruments

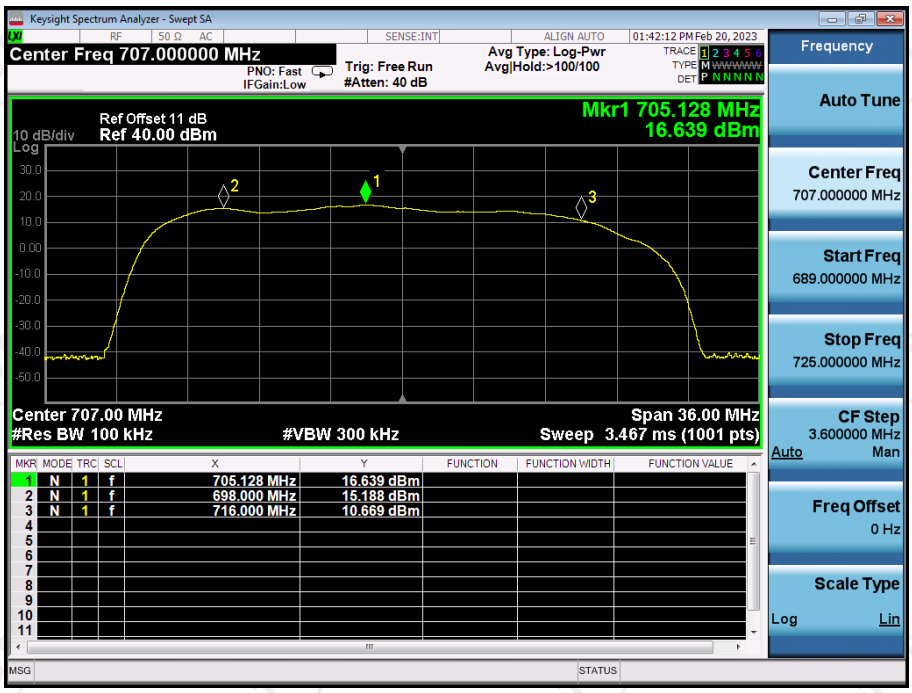
Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Generator	Agilent	N5182A	MY47070282	Jul. 04, 2022	Jul. 03, 2023
Spectrum Analyzer	Agilent	N9020A	MY49100619	Jul. 05, 2022	Jul. 04, 2023
Attenuator	50FP-006-H3	JFW	907763	/	/

5.1.3. Test data

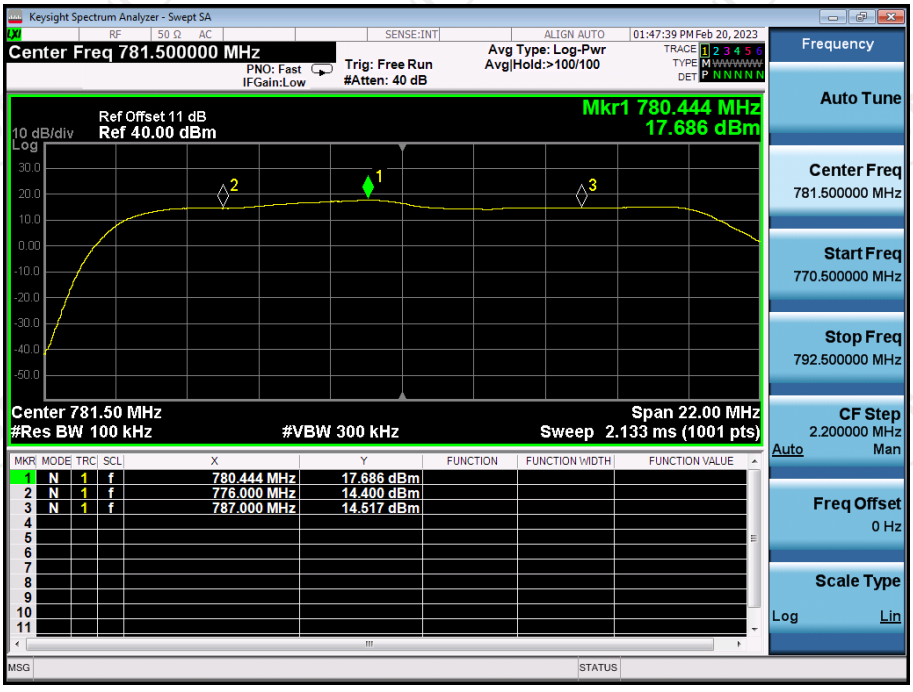
Test Plots

Uplink

Lower700MHz

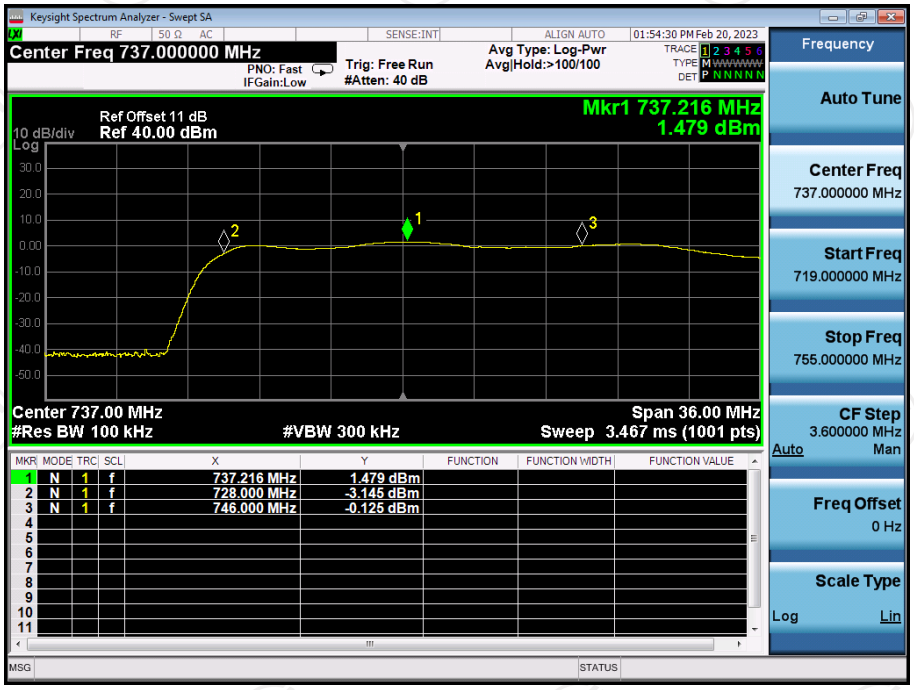


Upper700MHz

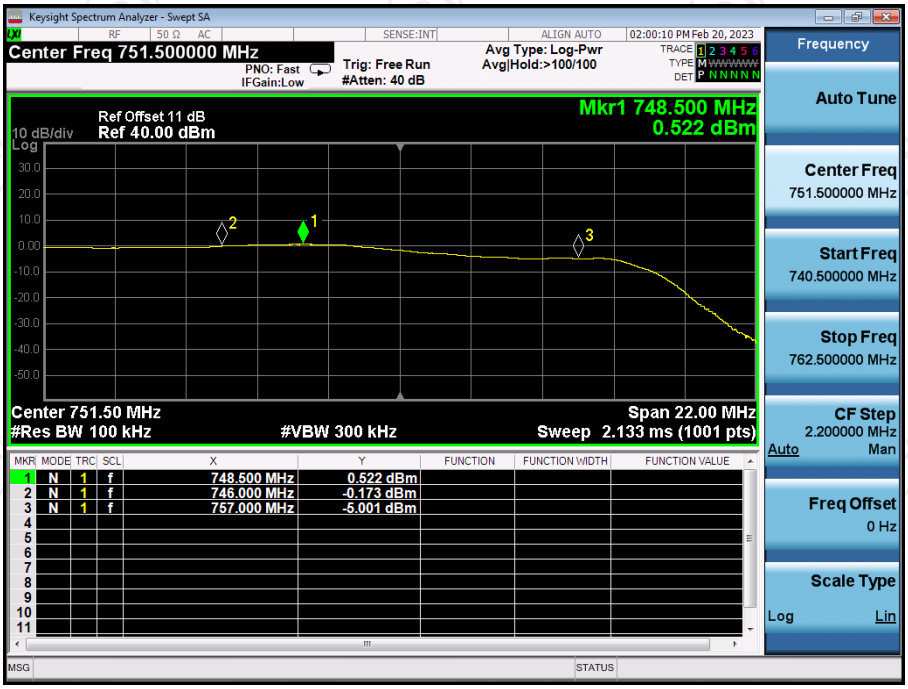


Downlink

Lower700MHz

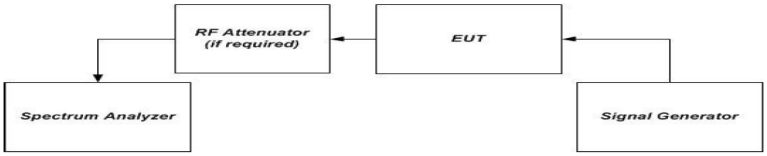


Upper700MHz



5.2. Maximum Power

5.2.1. Test Specification

Test Requirement:	FCC Part 20.21 (e)(8)(i)(B); FCC Part 20.21 (e)(8)(i)(D)
Test Method:	KDB935210 D03 Signal Booster Measurements v04r04
Limit:	Gain: 50 dB. *Where, Frequency is the uplink mid-band frequency of the supported spectrum bands in MHz.* Conducted Output Power: 17dBm<P_{uplink} <30dBm, $P_{donwlink}$<17dBm. EIRP: Uplink<30dBm, Donwlink<17dBm.
Test Setup:	
Test Procedure:	a) Connect the EUT to the test equipment as shown in Set-Up. Begin with the uplink output (donor port) connected to the spectrum analyzer. b) Configure the signal generator and spectrum analyzer for operation on the frequency determined in Frequency Band with the highest power level, but with the center frequency of the signal no closer than 2.5 MHz from the band edge. The spectrum analyzer span shall be set to at least 10 MHz. c) Set the initial signal generator power to a level well below that which causes AGC control. d) Slowly increase the signal generator power level until the output signal reaches the AGC operational limit (from observation of signal behavior on the spectrum analyzer; e.g., no further increase in output power as input power is increased). e) Reduce power sufficiently on the signal generator to ensure that the AGC is not controlling the power output. f) Slowly increase the signal generator power to a level just below (within 0.5 dB of) the AGC limit without triggering the AGC. Note the signal generator power level as (P_{in}). g) Measure the output power (P_{out}) with the spectrum analyzer as follows. h) Set RBW = 100 kHz for AWGN signal type and 300 kHz for CW or GSM signal type i) Set VBW ≥ 3X RBW j) Select either the BURST POWER or CHANNEL POWER measurement tool, as required for each signal type. The channel power integration bandwidth shall be 99% occupied bandwidth (4.1 MHz). k) Select the RMS (power averaging) detector. l) Ensure that the number of measurement points per sweep ≥ (2 x span)/RBW (Note: This requirement does not apply for BURST power measurement mode). m) Set sweep time = auto couple, or as necessary (but no less than auto couple value). n) Trace average at least 100 traces in power averaging (i.e., RMS) mode. o) Record the measured power level as P_{out} with one set of results for the GSM or CW input stimulus and another set of results for the AWGN input stimulus. p) Repeat the procedure for each operational uplink and downlink frequency band supported by the booster.

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Test Result:	PASS

5.2.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Generator	Agilent	N5182A	MY47070282	Jul. 04, 2022	Jul. 03, 2023
Spectrum Analyzer	Agilent	N9020A	MY49100619	Jul. 05, 2022	Jul. 04, 2023
Attenuator	50FP-006-H3	JFW	907763	/	/

5.2.3. Test Data

Max. Gain

Frequency Band	Signal Type	Pre AGC Input Level (dBm)	Conducted Output Level (dBm)	Gain (dB)	Gain Limit (dB)
Lower700M Hz Uplink	CW	-24	19.76	43.76	50
	AWGN	-24	18.02	42.02	
Upper700M Hz Uplink	CW	-22	19.89	41.89	
	AWGN	-21	18.61	39.61	
Lower700M Hz Downlink	CW	-42	-0.41	41.59	50
	AWGN	-43	-1.67	41.33	
Upper700M Hz Downlink	CW	-41	-0.36	40.64	
	AWGN	-42	-1.65	40.35	

Note: Mobile Booster maximum gain shall not exceed 50 dB when using an inside antenna.

Conducted output power at Max. input test level

Frequency Band	Signal Type	Input Level (dBm)	Conducted Output Level (dBm)	Lower Limit(dBm)	Upper Limit(dBm)
Lower700M Hz Uplink	CW	-9	18.28	17	30
	AWGN	-9	18.01		
Upper700M Hz Uplink	CW	-6	18.79		
	AWGN	-6	18.73		
Lower700M Hz Downlink	CW	-29	-0.47	N/A	17
	AWGN	-29	-1.65		
Upper700M Hz Downlink	CW	-28	-0.40		
	AWGN	-28	-1.85		

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Max. EIRP

Frequency Band	Signal Type	Max Conducted Output Level (dBm)	Max. Antenna Gain (dBi)	Min. Cable Loss (dB)	EIRP (dBm)	EIRP Limit (dBm)
Lower700MHz Uplink	CW	19.76	3	5.21	17.55	<30
	AWGN	18.02	3	5.21	15.81	
Upper700MHz Uplink	CW	19.89	3	5.21	17.68	
	AWGN	18.73	3	5.21	16.52	
Lower700MHz Downlink	CW	-0.41	7	2.19	4.40	<17
	AWGN	-1.65	7	2.19	3.16	
Upper700MHz Downlink	CW	-0.36	7	2.19	4.45	
	AWGN	-1.65	7	2.19	3.16	

Uplink Gain VS Downlink Gain

Band	Signal Type	Uplink Gain (dB)	Downlink Gain (dB)	D-value	Limit (dB)
Lower700MHz	CW	43.76	41.59	2.17	<9
	AWGN	42.02	41.33	0.69	
Upper700MHz	CW	41.89	40.64	1.25	
	AWGN	39.61	40.35	0.74	

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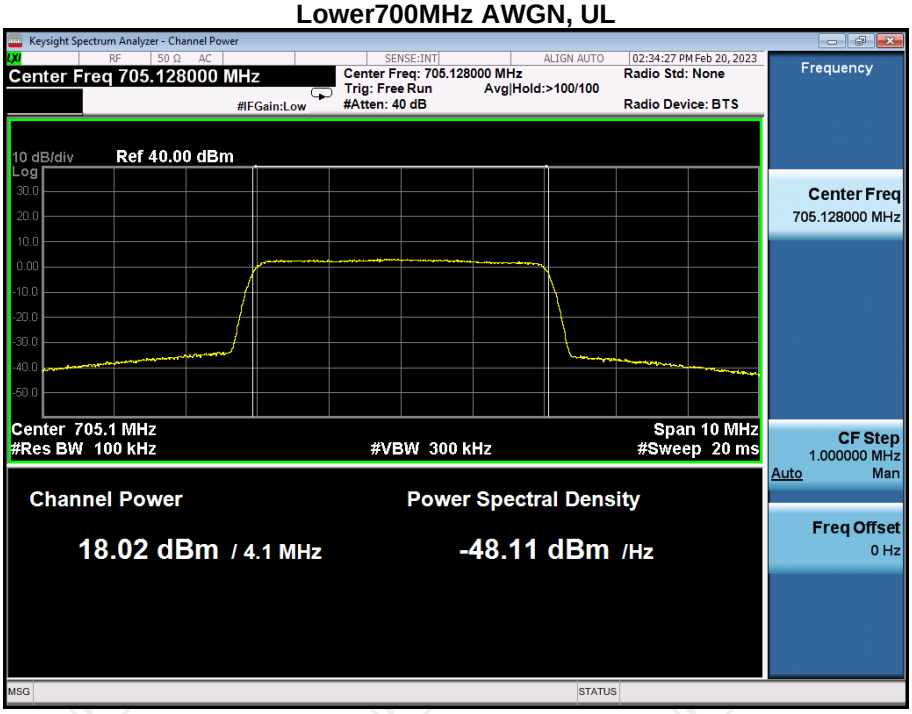
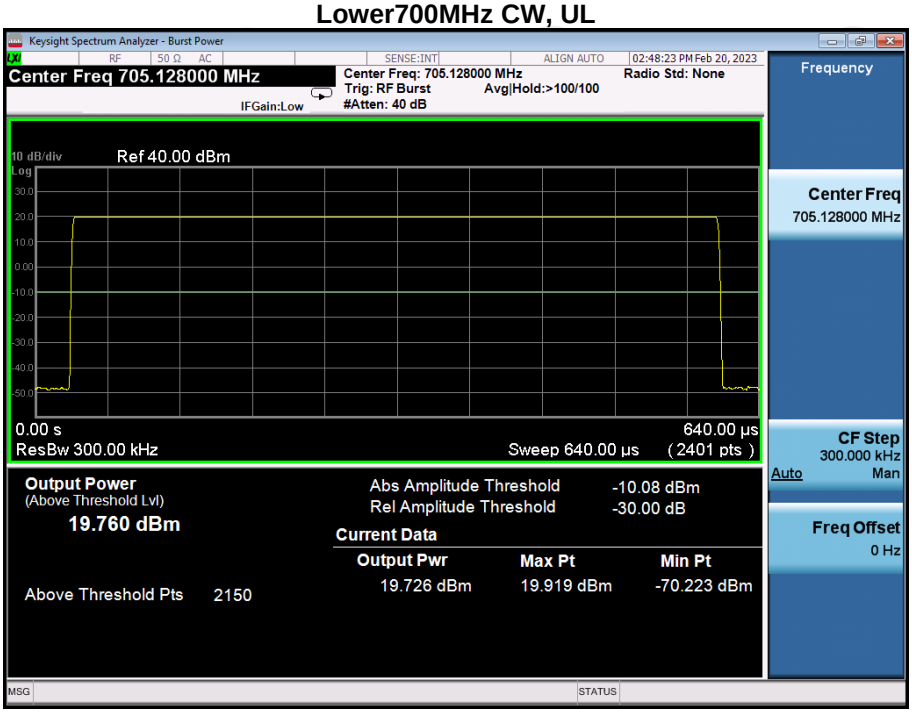
Test Plots

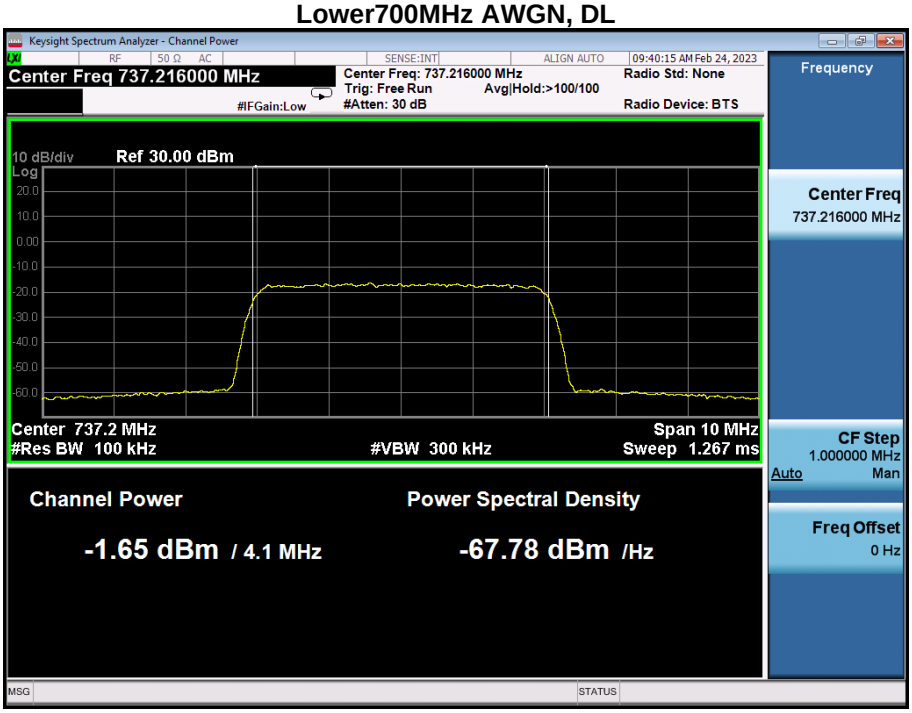
Lower700MHz AWGN, UL



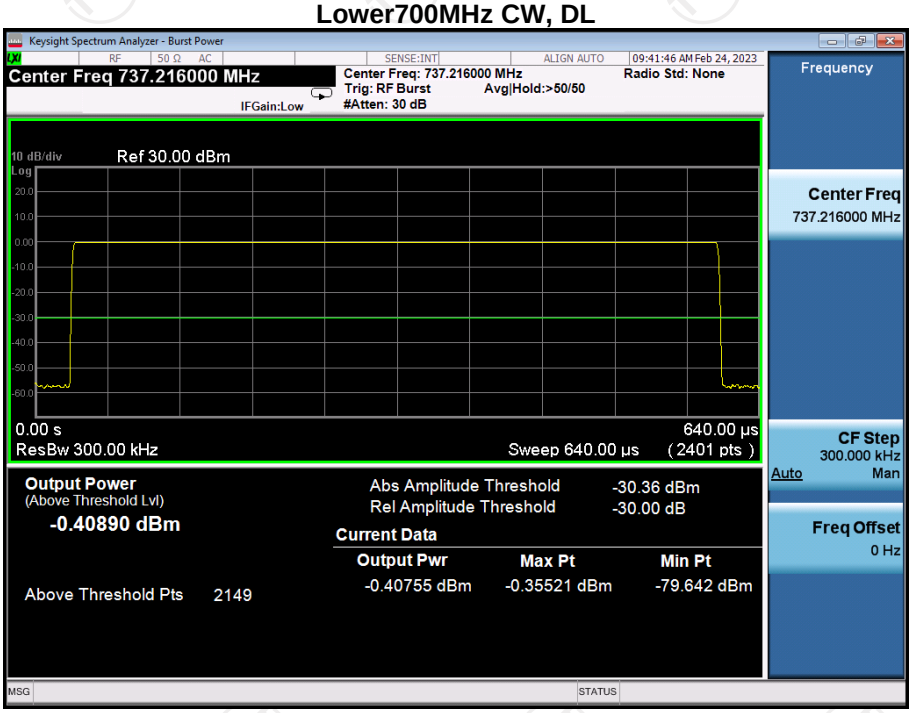
Lower700MHz CW, UL



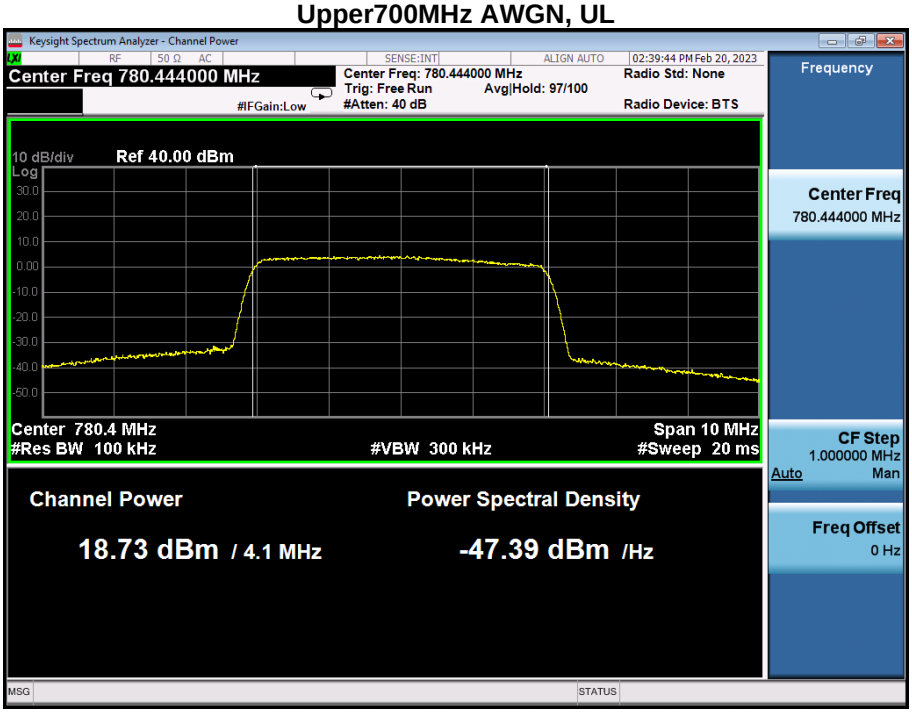
Lower700MHz AWGN, DL



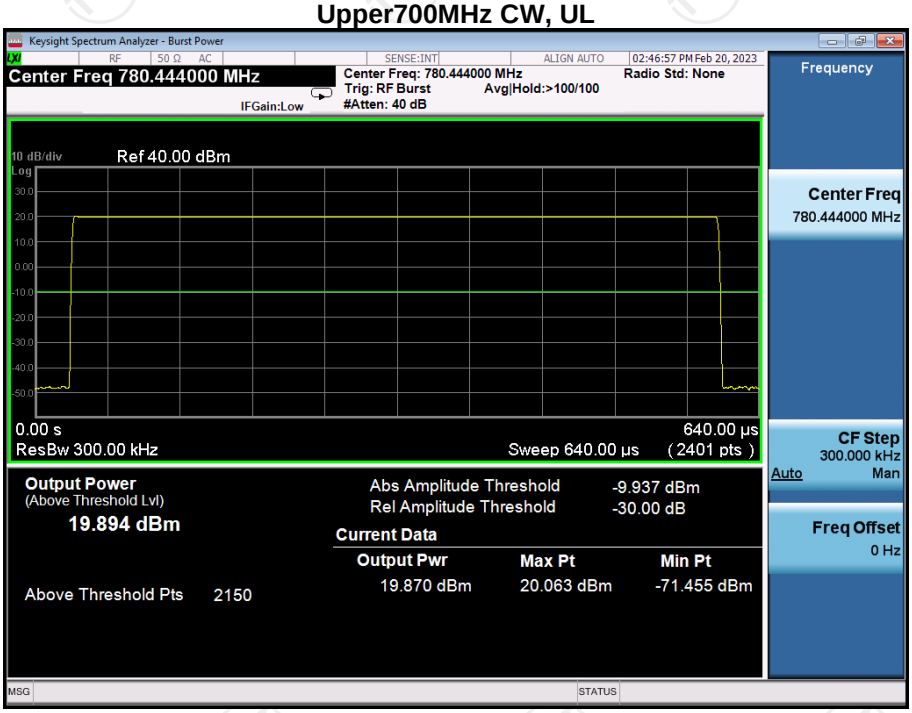
Lower700MHz CW, DL



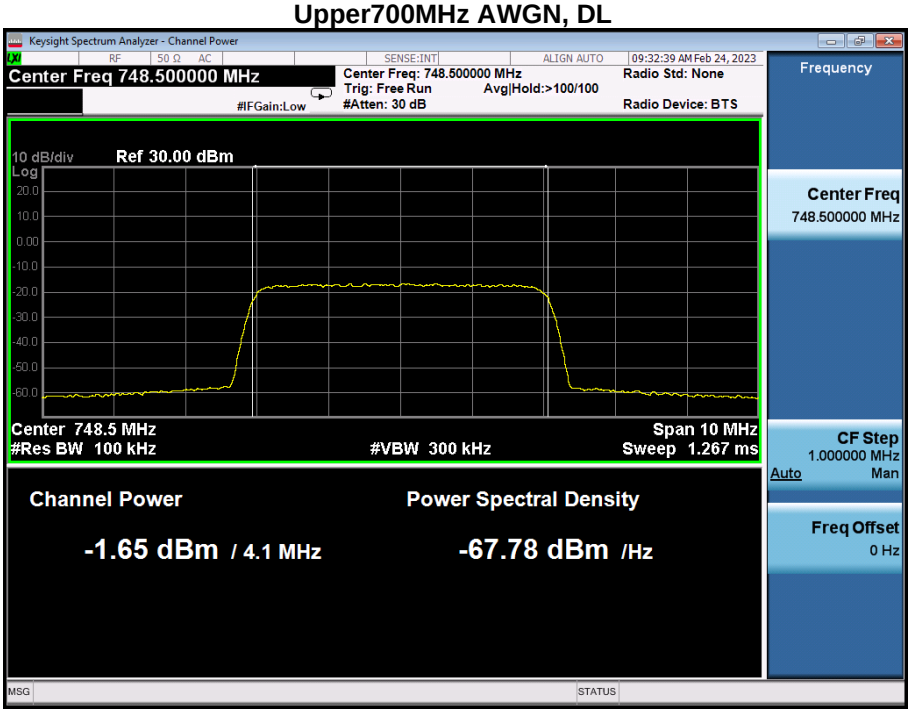
Upper700MHz AWGN, UL



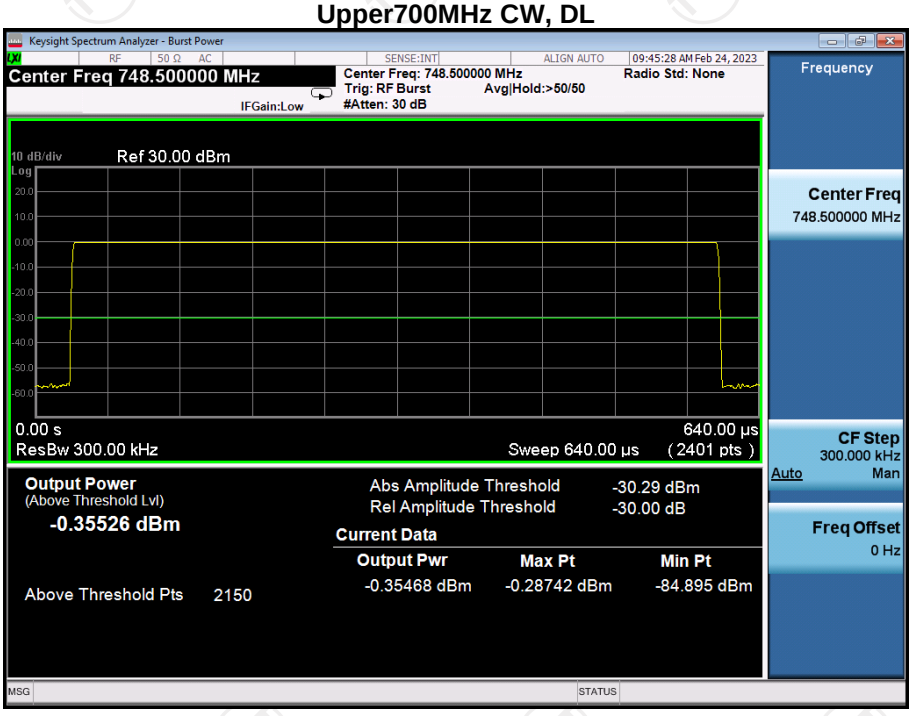
Upper700MHz CW, UL



Upper700MHz AWGN, DL

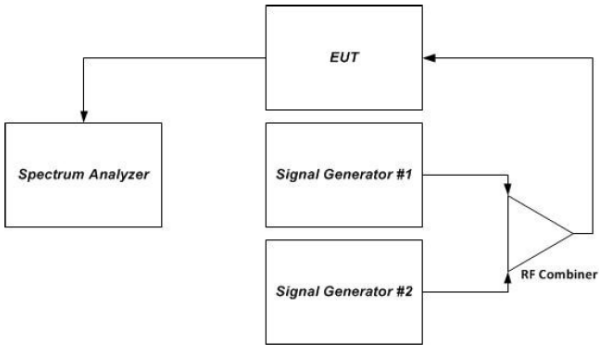


Upper700MHz CW, DL



5.3. Intermodulation Product

5.3.1. Test Specification

Test Requirement:	FCC Part20 Section 20.21(e)(8)(i)(F)
Test Method:	KDB935210 D03 Signal Booster Measurements v04r04
Limit:	-19dBm
Test Setup:	 Figure 2 – Intermodulation product instrumentation test setup
Test Procedure:	a) Connect the signal booster to the test equipment as shown in Set-Up. Begin with the uplink output connected to the spectrum analyzer. b) Set the spectrum analyzer RBW = 3 kHz. c) Set the VBW ≥ 3 X the RBW. d) Select the RMS detector. e) Set the spectrum analyzer center frequency to the center of the supported operational band under test. f) Set the span to 5 MHz. g) Configure the two signal generators for CW operation with generator 1 tuned 300 kHz below the operational band center frequency and generator 2 tuned 300 kHz above the operational band center frequency. h) Set the signal generator amplitudes so that the power from each into the RF combiner is equivalent and turn on the RF output. i) Increase the signal generators' amplitudes equally until just before the EUT begins AGC and ensure that all intermodulation products (if any exist), are below the specified limit of −19 dBm. j) Utilize the trace averaging function of the spectrum analyzer and wait for the trace to stabilize. Place a marker at the highest amplitude intermodulation product. k) Record the maximum intermodulation product amplitude level that is observed. l) Capture the spectrum analyzer trace for inclusion in the test report. m) Repeat steps e) to l) for all uplink and downlink operational bands. **Note:** If using a single signal generator with dual outputs, ensure that intermodulation products are not the result of the generator. n) Increase the signal generator amplitude in 2 dB steps to 10 dB above the AGC threshold determined in i) to ensure that the EUT maintains compliance with the intermodulation
Test Result:	PASS

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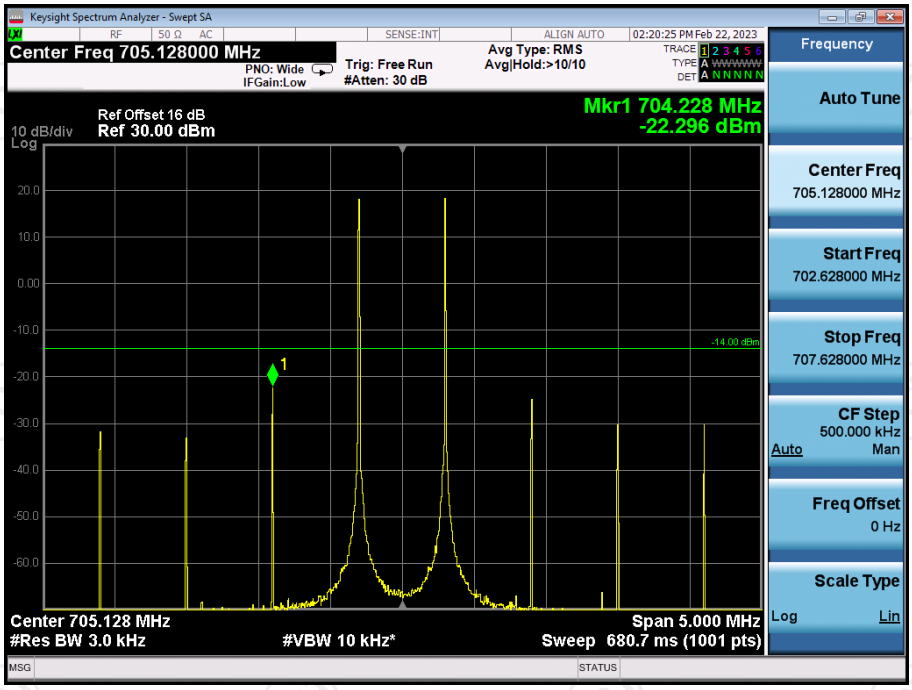
5.3.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Generator	Agilent	E4421B	GB39340839	Jul. 05, 2022	Jul. 04, 2023
Signal Generator	Agilent	N5182A	MY47070282	Jul. 04, 2022	Jul. 03, 2023
Spectrum Analyzer	Agilent	N9020A	MY49100619	Jul. 05, 2022	Jul. 04, 2023
RF Combiner	SUNVNDN	SUD-CS 0800	16230009	/	/
Attenuator	50FP-006-H3	JFW	907763	/	/

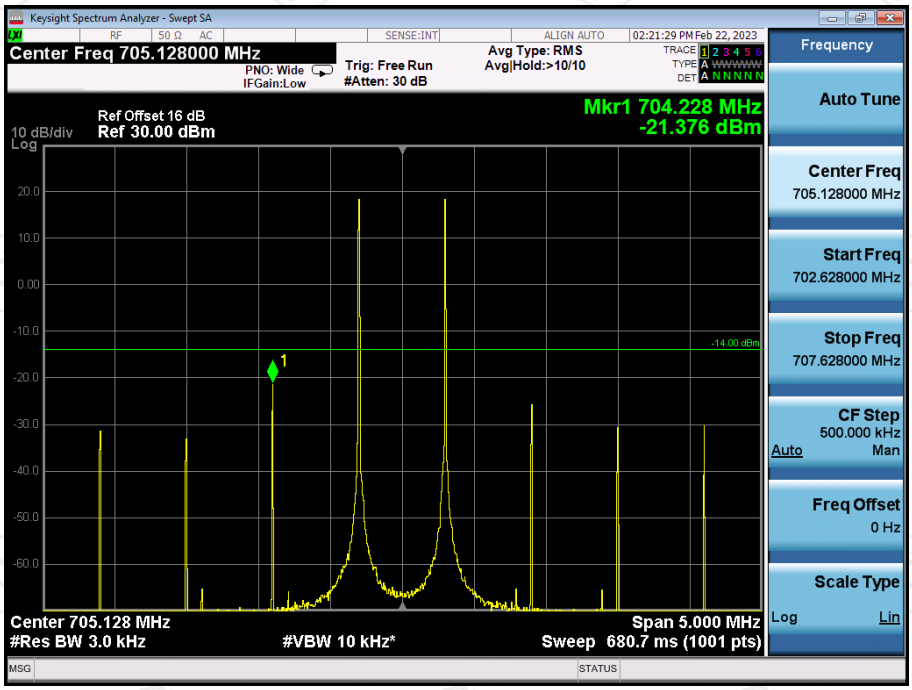
5.3.3. Test data

Test Plots

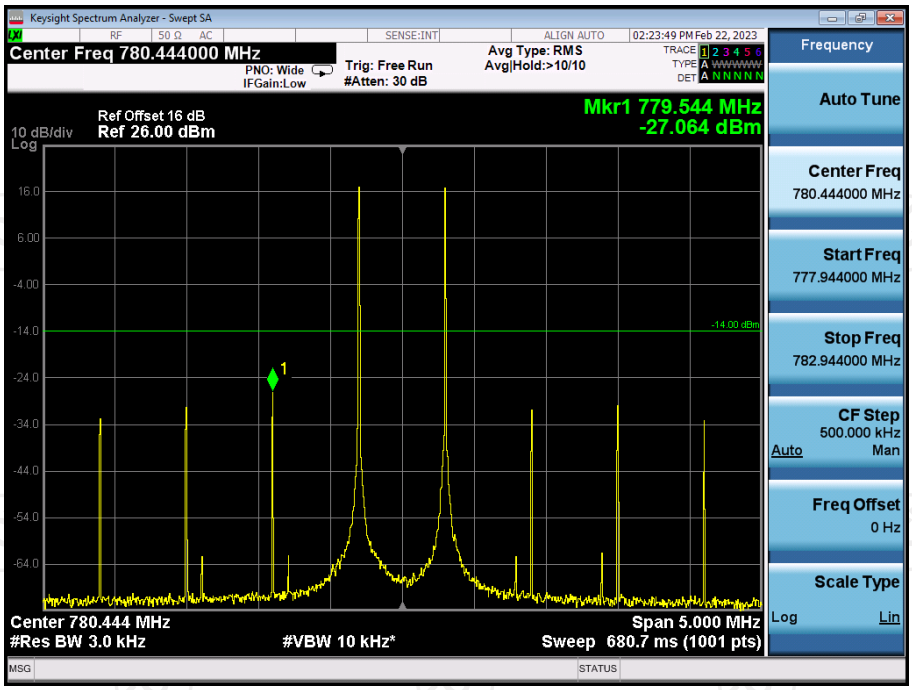
Lower700MHz Pre AGC, UL



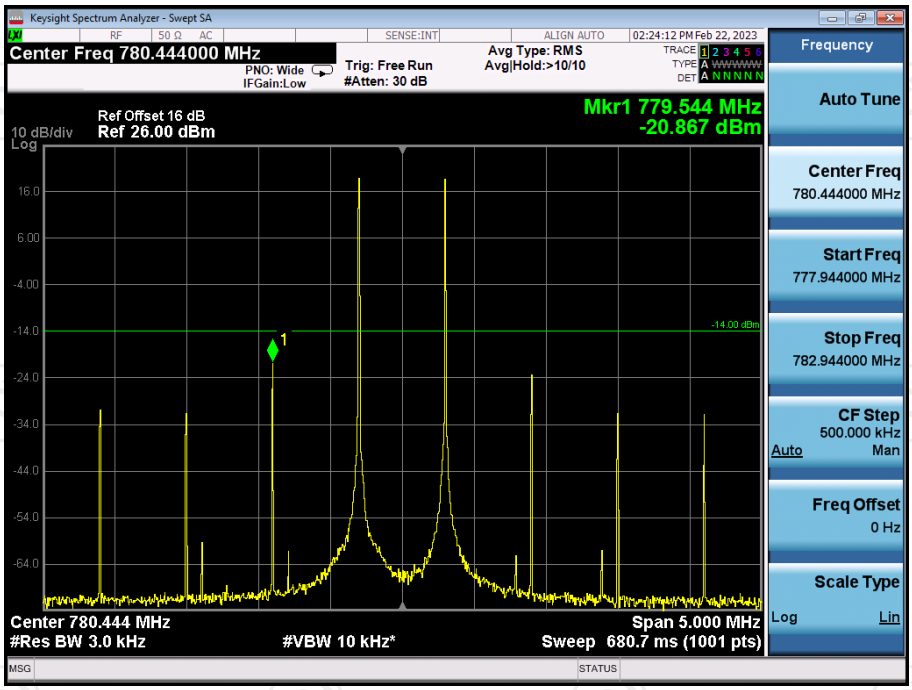
Lower700MHz Pre AGC + 10dB , UL



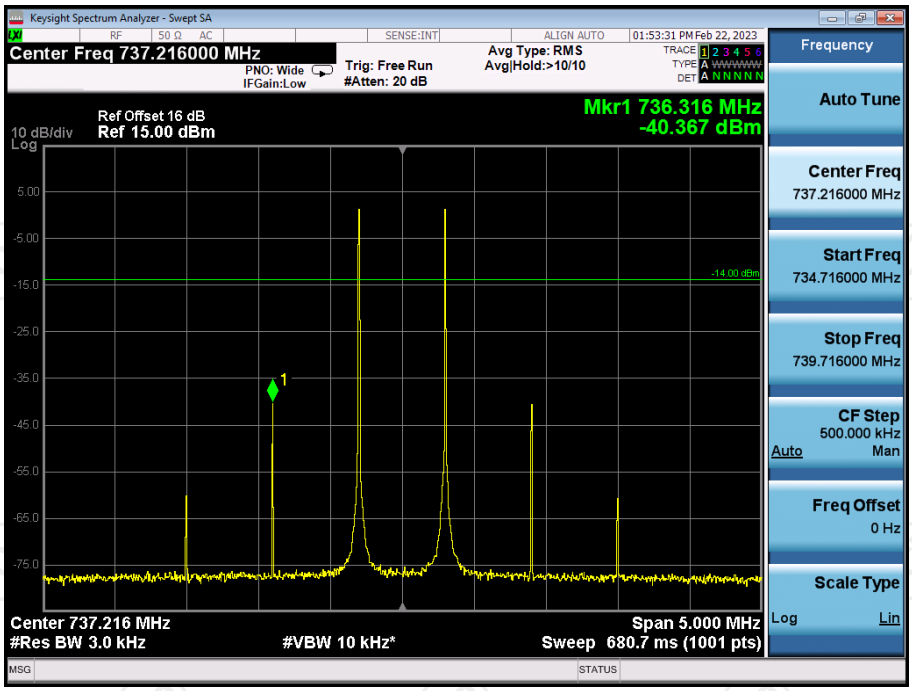
Upper700MHz Pre AGC, UL



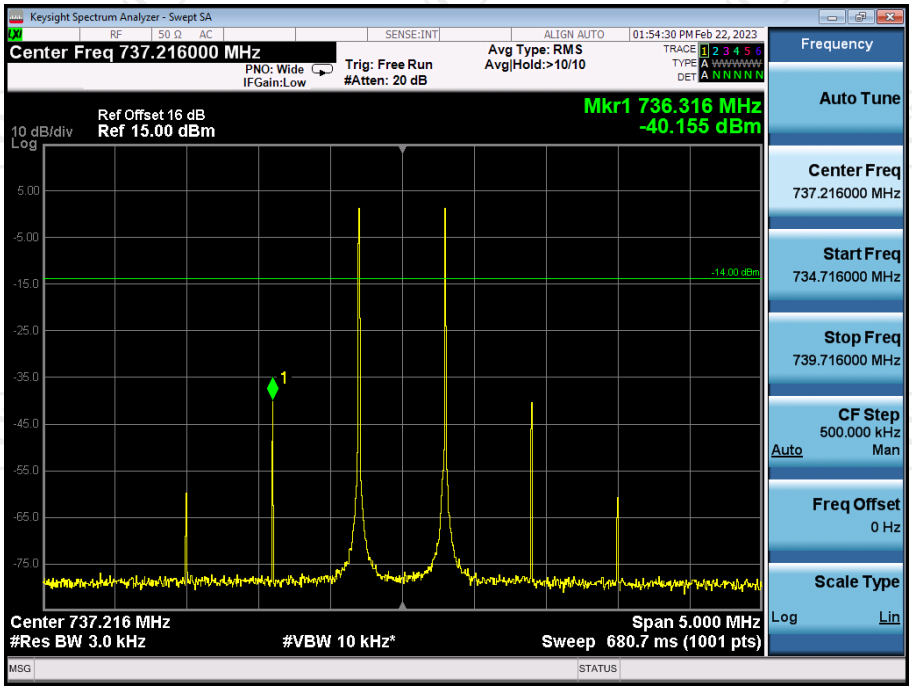
Upper700MHz Pre AGC + 10dB , UL



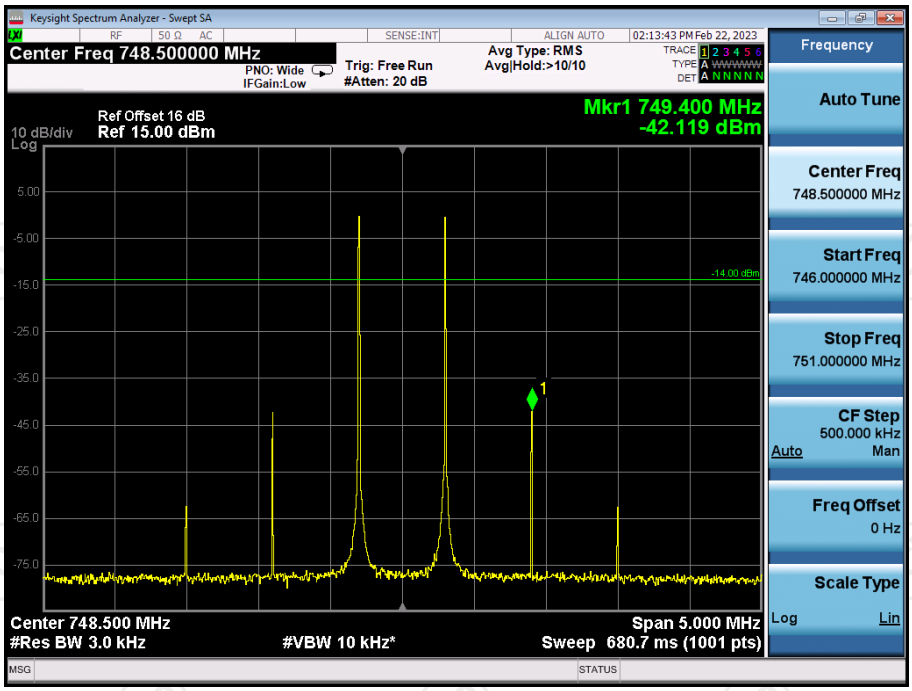
Lower700MHz Pre AGC, DL



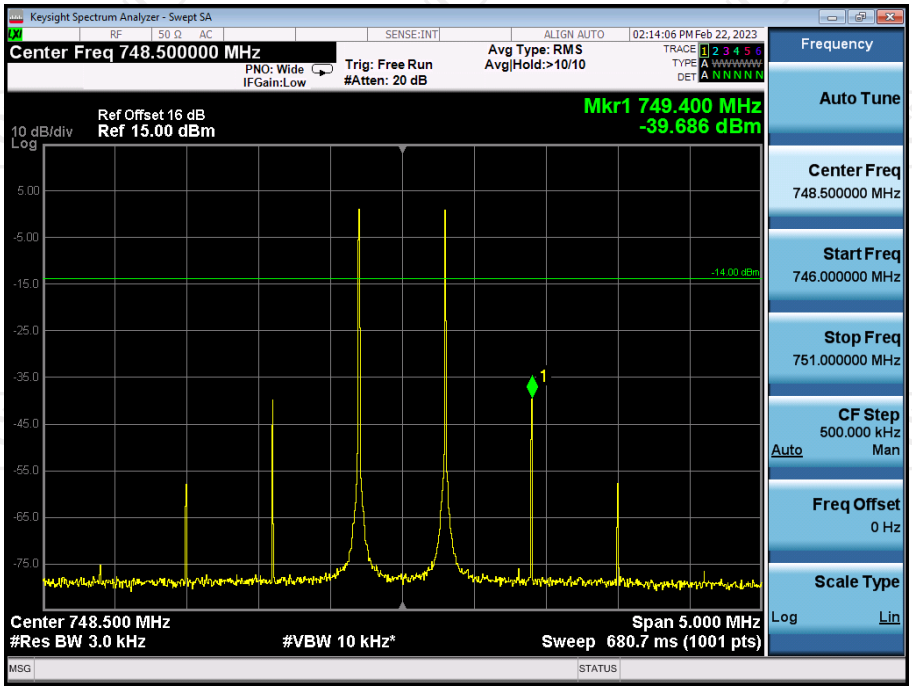
Lower700MHz Pre AGC + 10dB, DL



Upper700MHz Pre AGC, DL

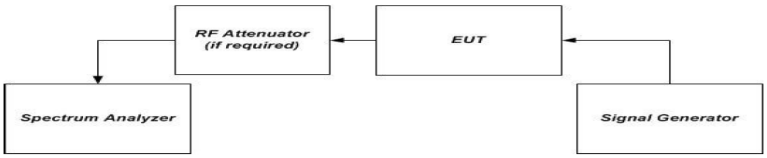


Upper700MHz Pre AGC + 10dB, DL



5.4. Out of Band Emission

5.4.1. Test Specification

Test Requirement:	FCC Part20 Section 20.21(e)(8)(i)(E)
Test Method:	KDB935210 D03 Signal Booster Measurements v04r04
Limit:	-19dBm
Test Setup:	
Test Procedure:	a) Connect the EUT to the test equipment as shown in Set-Up. Begin with the uplink output connected to the spectrum analyzer. b) Configure the signal generator for the appropriate operation for all uplink and downlink bands: i) GSM: 0.2 MHz from upper and lower band edge ii) LTE (5 MHz): 2.5 MHz from upper and lower band edge iii) CDMA: 1.25 MHz from upper and lower band edge, except for cellular as follows (only the upper and lower frequencies need to be tested): 824.88 MHz, 845.73 MHz, 836.52 MHz, 848.10 MHz, 869.88 MHz, 890.73 MHz, 881.52 MHz, 893.10 MHz. Note 1: Alternative test modulation types: • CDMA (alternative 1.25 MHz AWGN) • LTE 5 MHz (alternative W-CDMA or 4.1 MHz AWGN) Note 2: For LTE, the signal generator should utilize the uplink and downlink signal types for these modulations in uplink and downlink tests, respectively. LTE shall us e 5 MHz signal 25 resource blocks transmitting. Note 3: AWGN is the measured 99% occupied bandwidth. c) Set the signal generator amplitude to the maximum power level prior to AGC similar to the procedures in method of Maximum power d) to f) of power measurement procedure for appropriate modulations. d) Set RBW = measurement bandwidth specified in the applicable rule section for the supported frequency band. e) Set VBW = 3 x RBW. f) Select the RMS (power averaging) detector. g) Sweep time = auto-couple. h) Set the analyzer start frequency to the upper band/block edge frequency and the stop frequency to the upper band/block edge frequency plus 300 kHz (when operational frequency is < 1 GHz) or 3 MHz (when operational frequency is ≥ 1 GHz). i) Trace average at least 100 traces in power averaging (i.e., RMS) mode. j) Use peak marker function to find the maximum power level. k) Capture the spectrum analyzer trace of the power level for inclusion in the test report. l) Increase the signal generator amplitude in 2 dB steps until the maximum input level indicated in 5.4 is reached. Ensure that the EUT maintains compliance with the OOBE limits. m) Reset the analyzer start frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as per applicable rule part, and the stop frequency to the lower band/block edge frequency and repeat steps j) to l).

	n) Repeat steps b) through m) for each uplink and downlink operational band.
Test Result:	PASS

5.4.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Generator	Agilent	N5182A	MY47070282	Jul. 04, 2022	Jul. 03, 2023
Spectrum Analyzer	Agilent	N9020A	MY49100619	Jul. 05, 2022	Jul. 04, 2023
Attenuator	50FP-006-H3	JFW	907763	/	/

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5.4.3. Test data

Test Plots

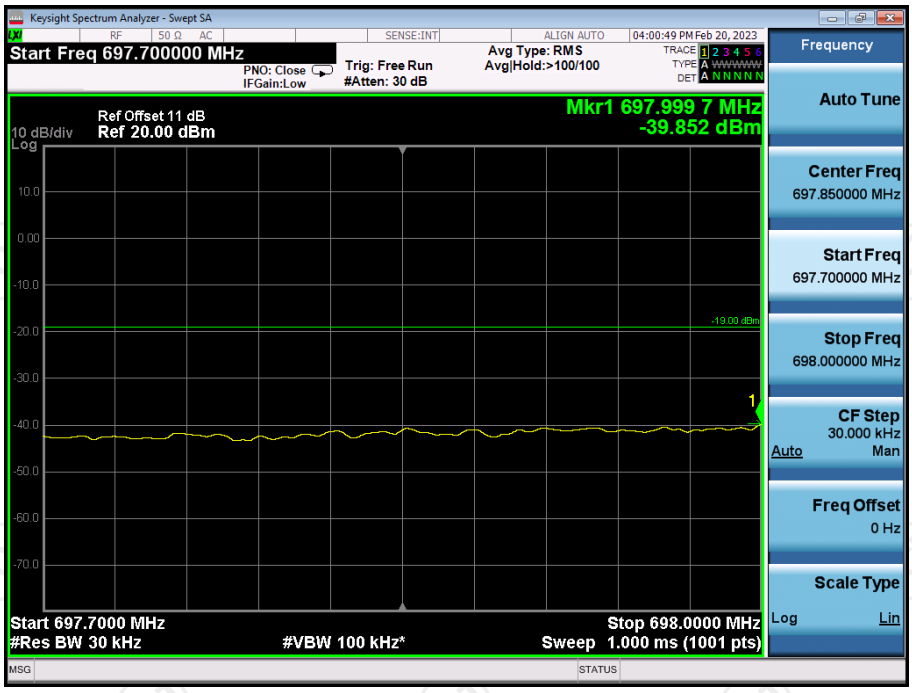
Lower700MHz GSM UL Left Side Pre AGC

Lower700MHz GSM UL Left Side Pre AGC + 10dB

Lower700MHz GSM UL Right Side Pre AGC

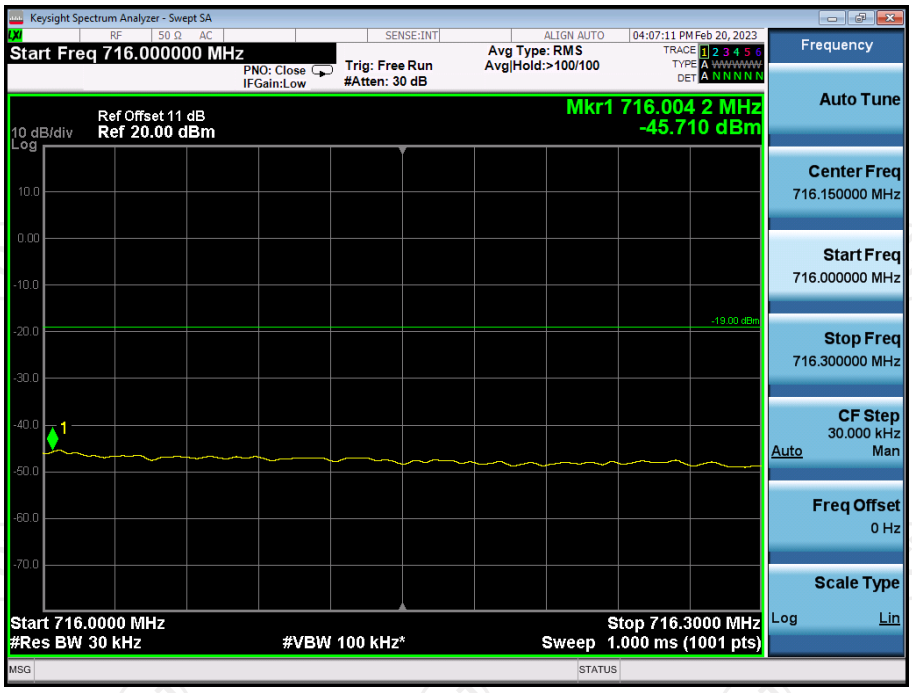
Lower700MHz GSM UL Right Side Pre AGC + 10dB

Lower700MHz CDMA UL Left Side Pre AGC



Lower700MHz CDMA UL Left Side Pre AGC + 10dB

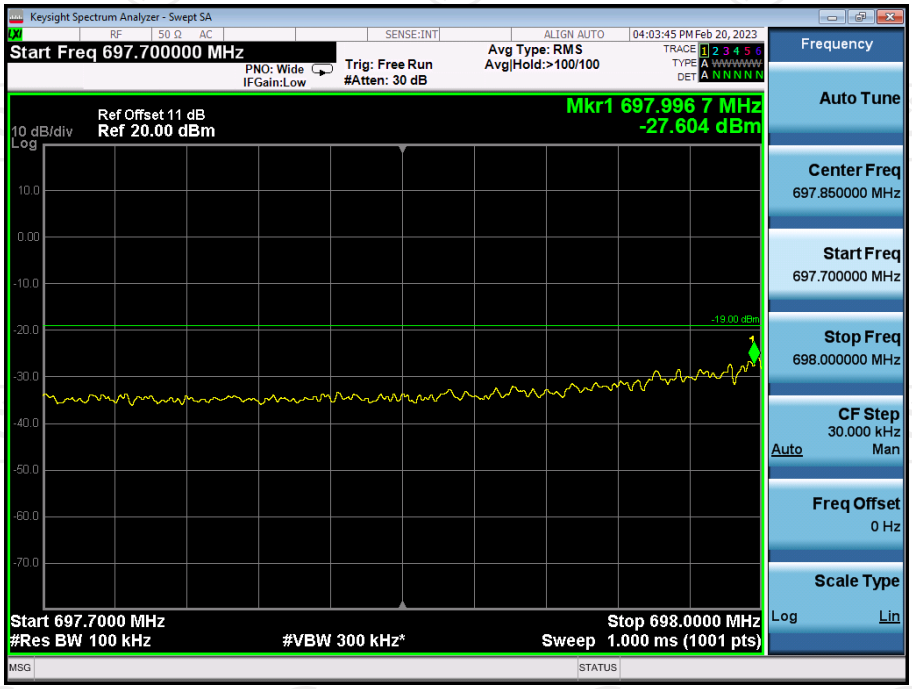
Lower700MHz CDMA UL Right Side Pre AGC



Lower700MHz CDMA UL Right Side Pre AGC + 10dB

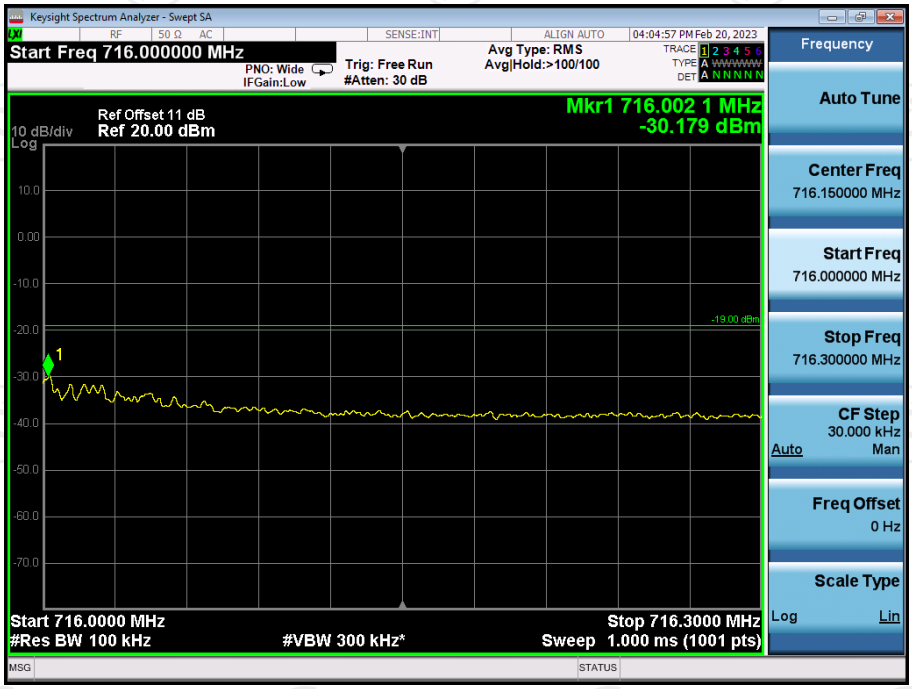
Lower700MHz LTE UL Left Side Pre AGC

Lower700MHz LTE UL Left Side Pre AGC + 10dB



Lower700MHz LTE UL Right Side Pre AGC

Lower700MHz LTE UL Right Side Pre AGC + 10dB



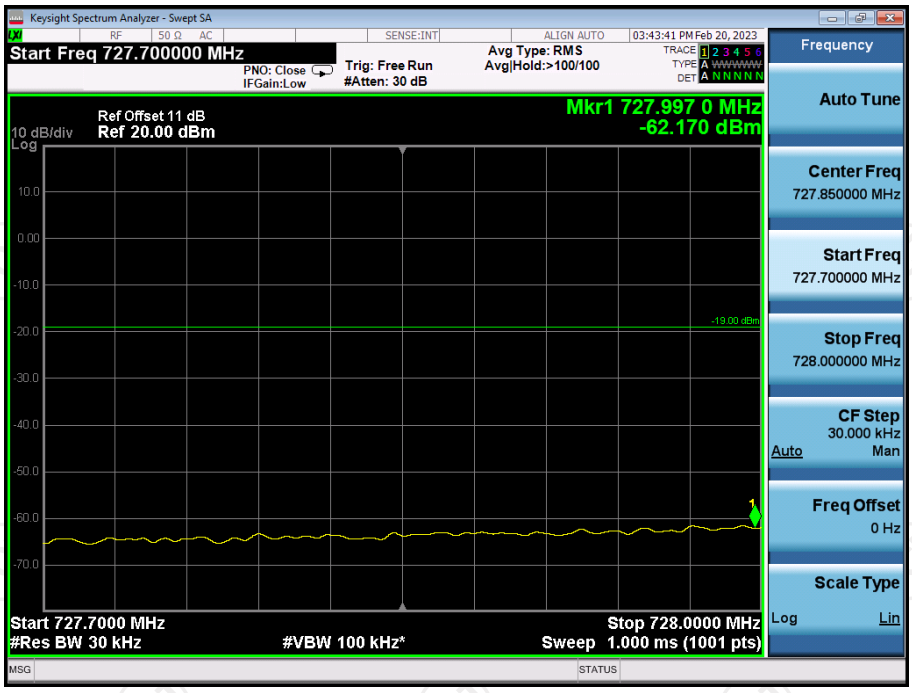
Lower700MHz GSM DL Left Side Pre AGC

Lower700MHz GSM DL Left Side Pre AGC + 10dB

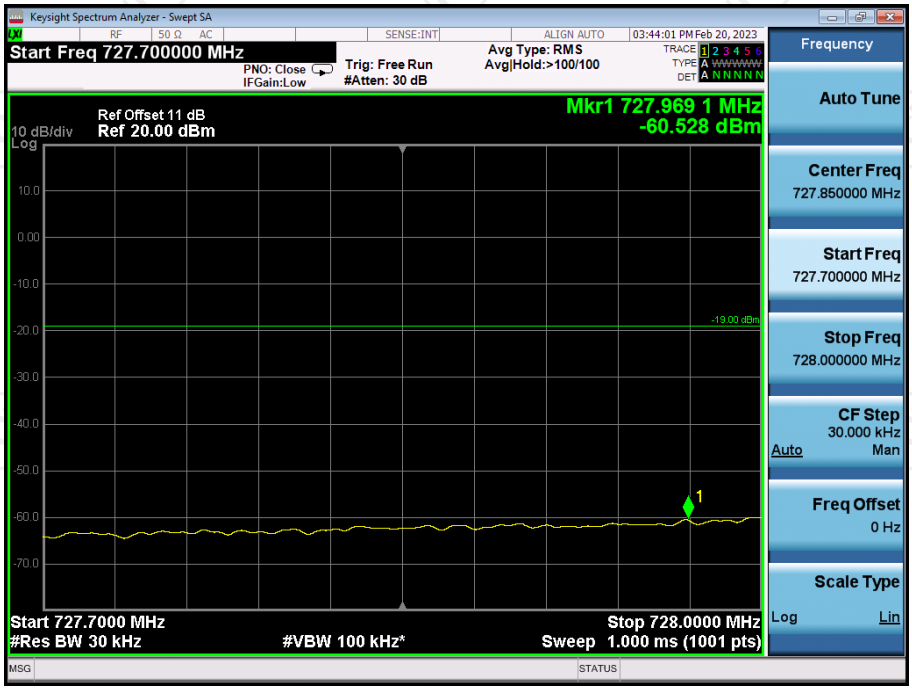
Lower700MHz GSM DL Right Side Pre AGC

Lower700MHz GSM DL Right Side Pre AGC + 10dB

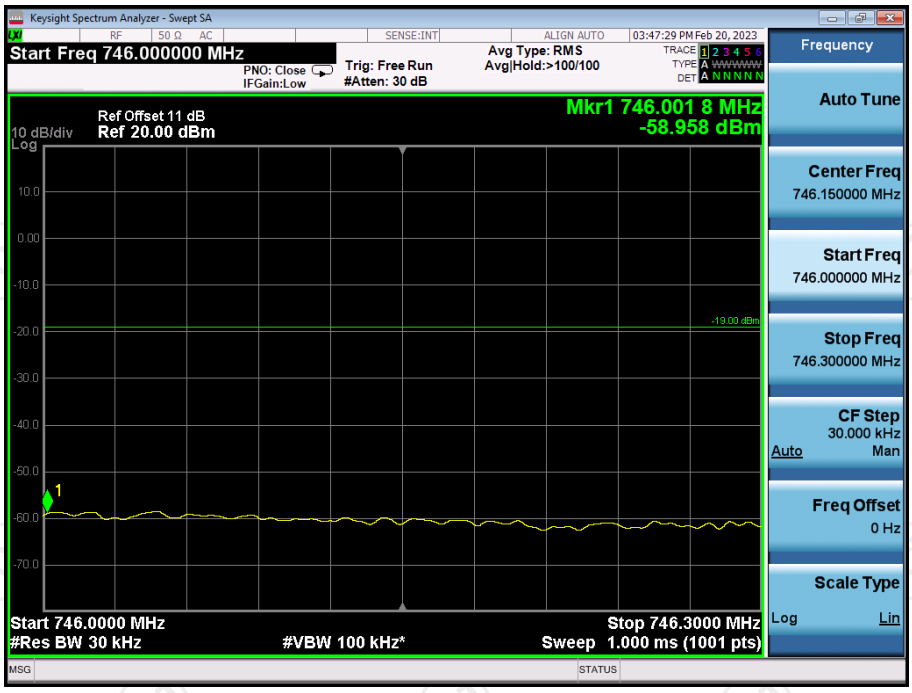
Lower700MHz CDMA DL Left Side Pre AGC



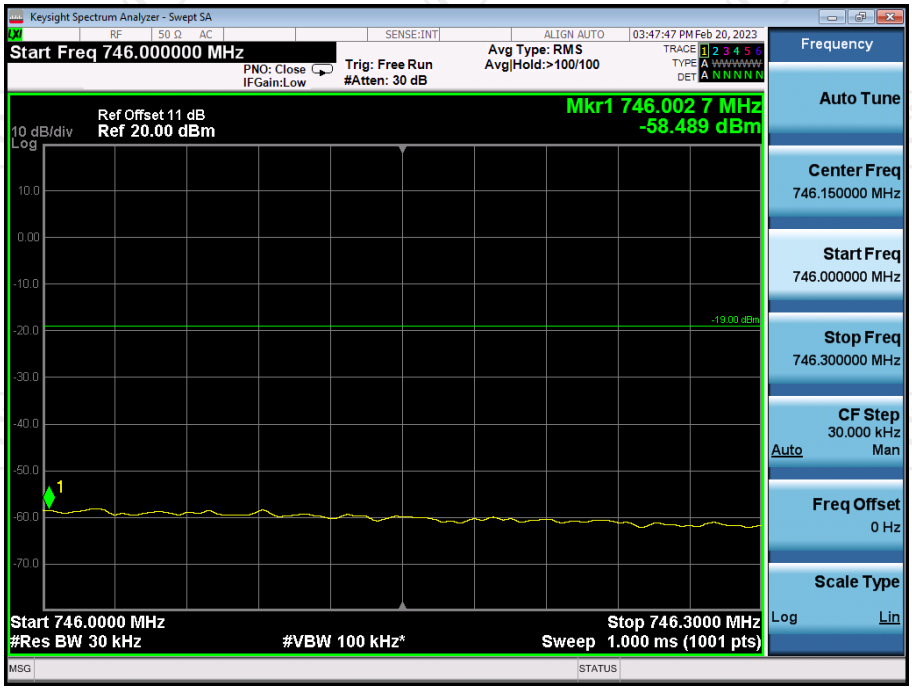
Lower700MHz CDMA DL Left Side Pre AGC + 10dB



Lower700MHz CDMA DL Right Side Pre AGC

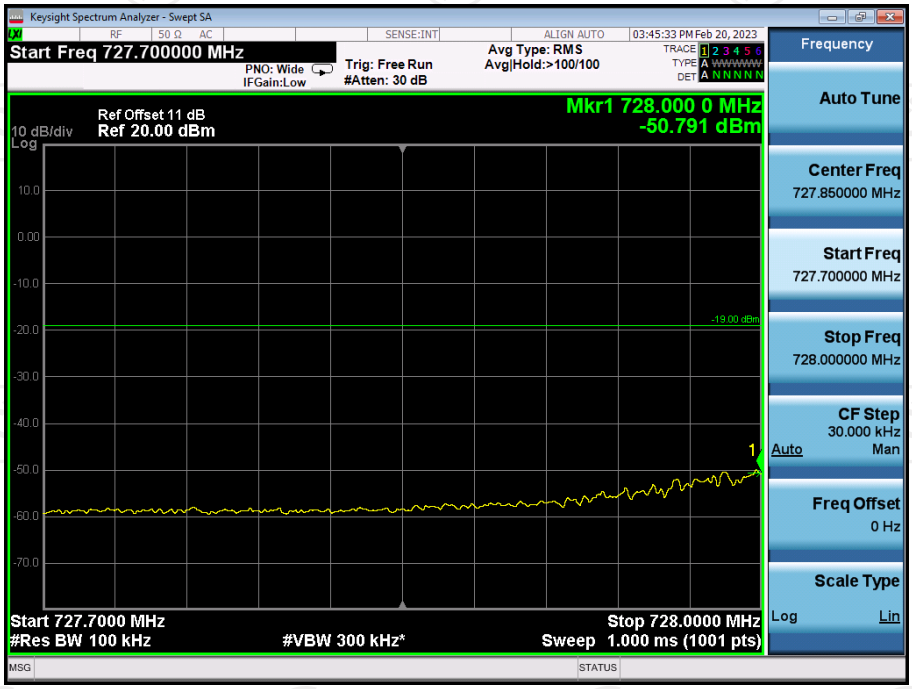


Lower700MHz CDMA DL Right Side Pre AGC + 10dB



Lower700MHz LTE DL Left Side Pre AGC

Lower700MHz LTE DL Left Side Pre AGC + 10dB



Lower700MHz LTE DL Right Side Pre AGC

Lower700MHz LTE DL Right Side Pre AGC + 10dB

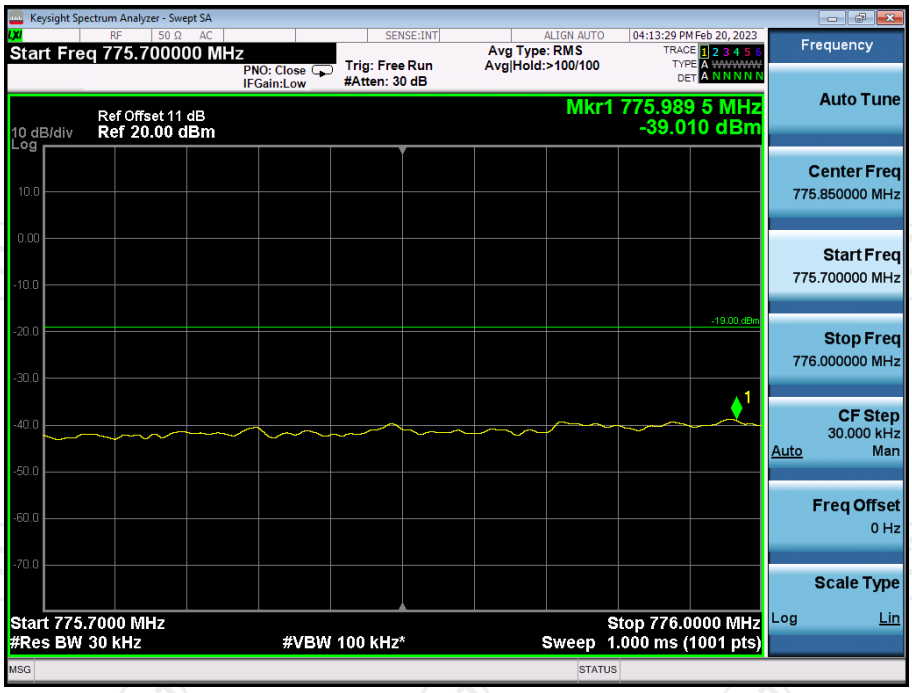
Upper700MHz GSM UL Left Side Pre AGC

Upper700MHz GSM UL Left Side Pre AGC + 10dB

Upper700MHz GSM UL Right Side Pre AGC

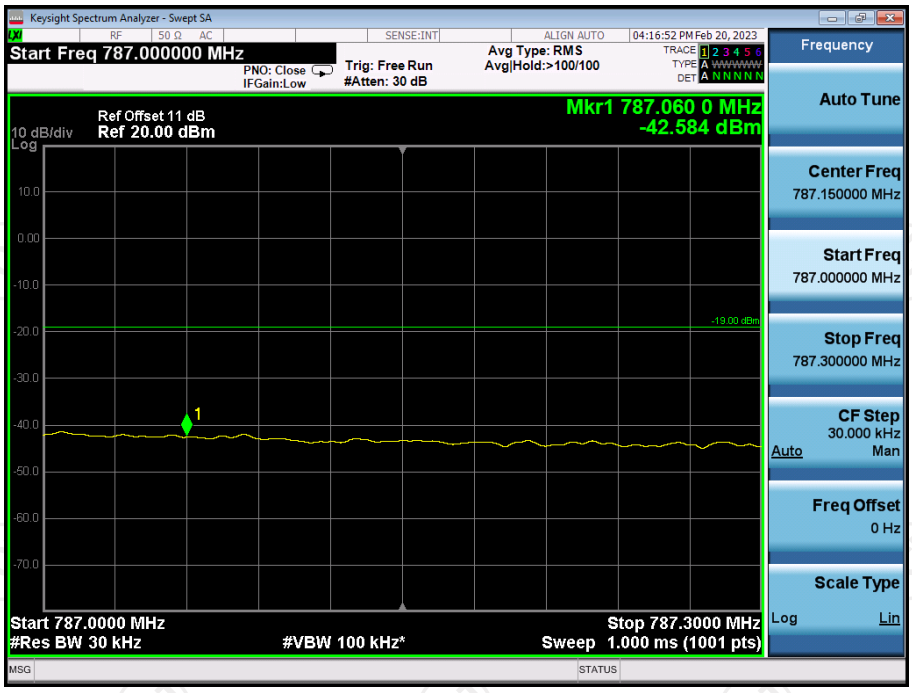
Upper700MHz GSM UL Right Side Pre AGC + 10dB

Upper700MHz CDMA UL Left Side Pre AGC

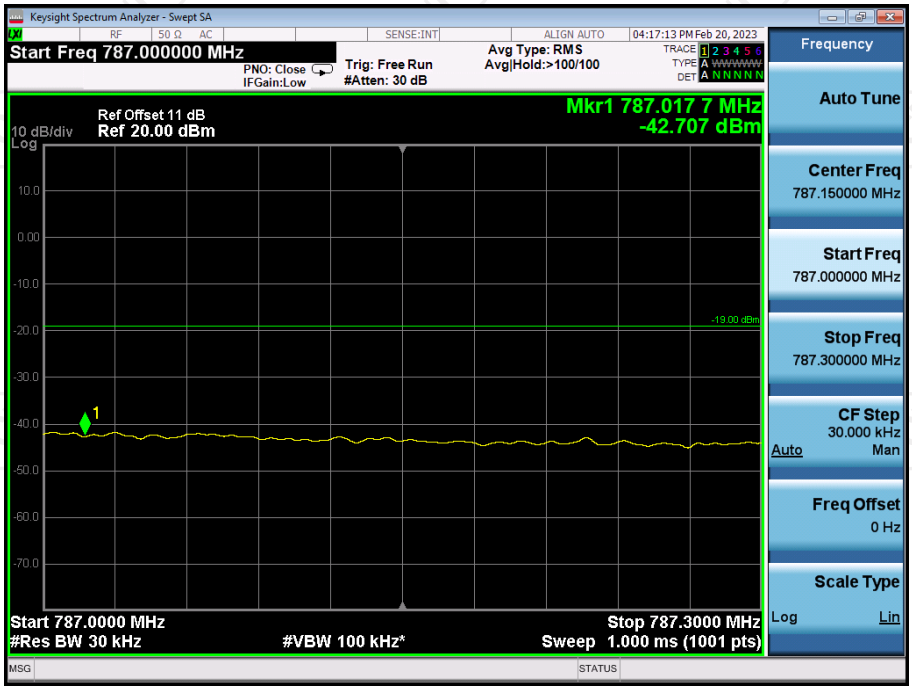


Upper700MHz CDMA UL Left Side Pre AGC + 10dB

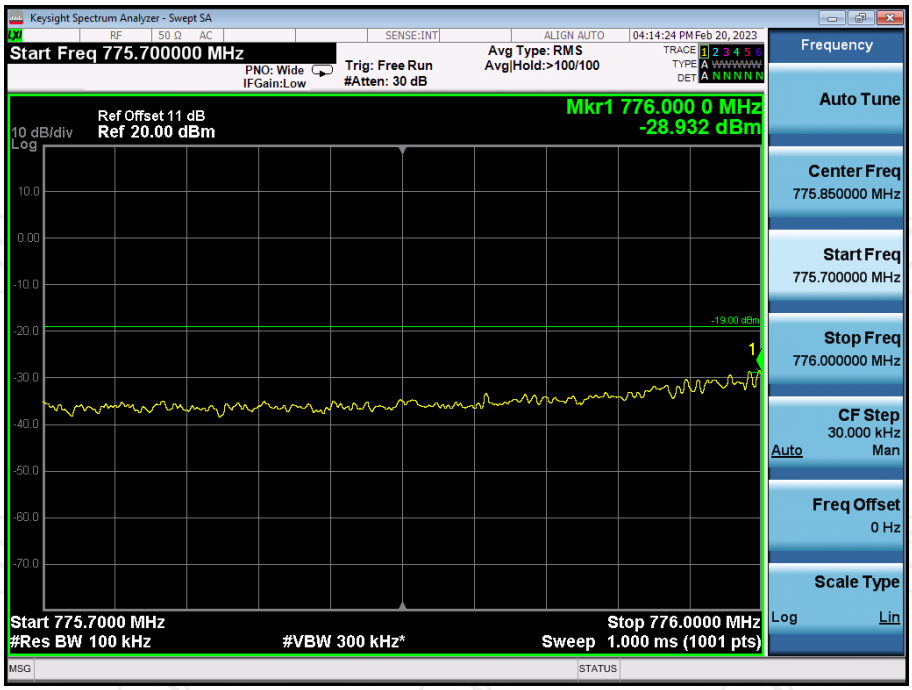
Upper700MHz CDMA UL Right Side Pre AGC



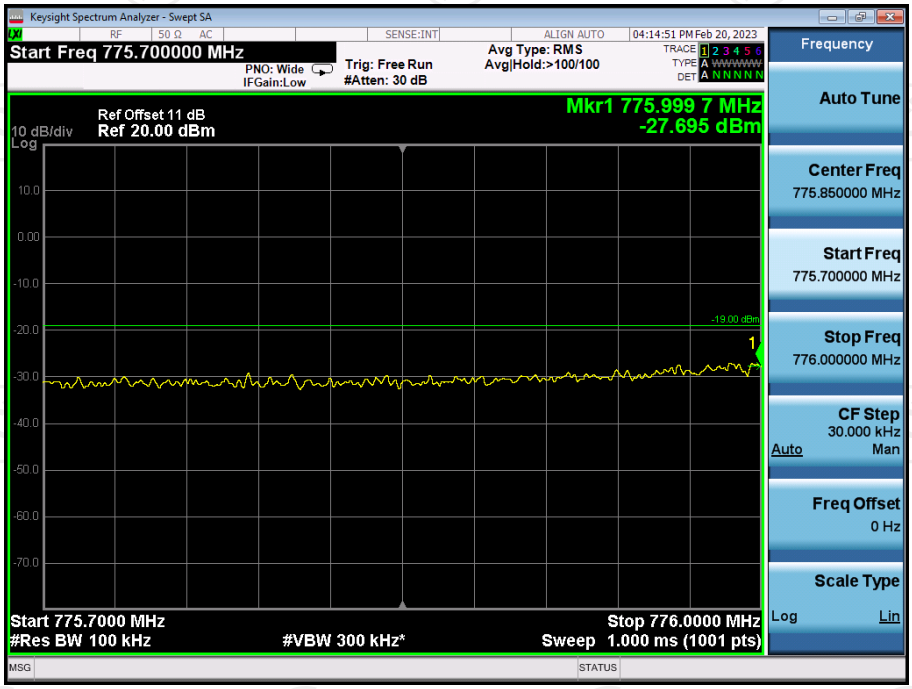
Upper700MHz CDMA UL Right Side Pre AGC + 10dB



Upper700MHz LTE UL Left Side Pre AGC

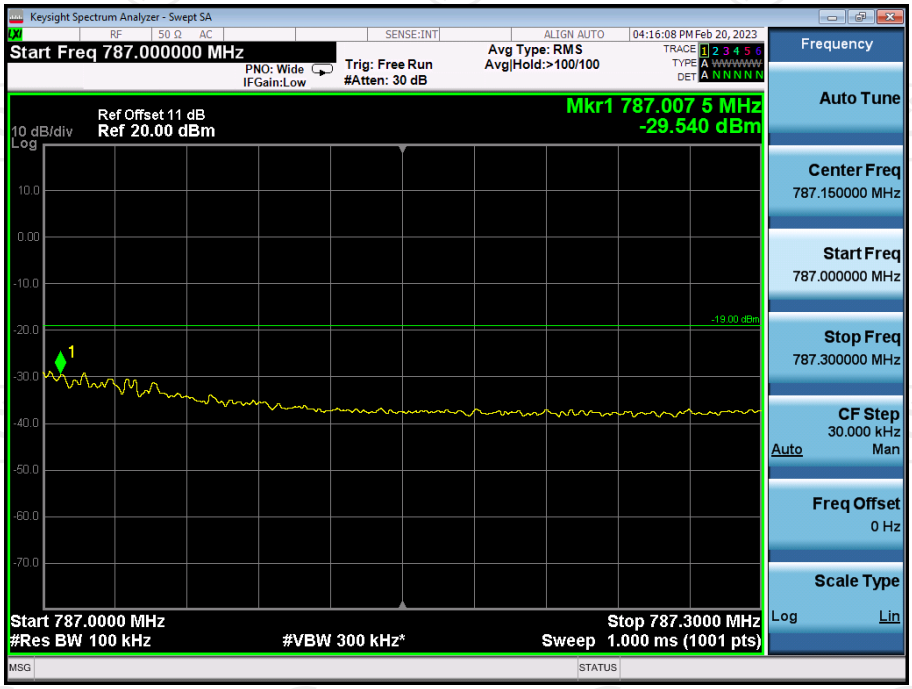


Upper700MHz LTE UL Left Side Pre AGC + 10dB



Upper700MHz LTE UL Right Side Pre AGC

Upper700MHz LTE UL Right Side Pre AGC + 10dB



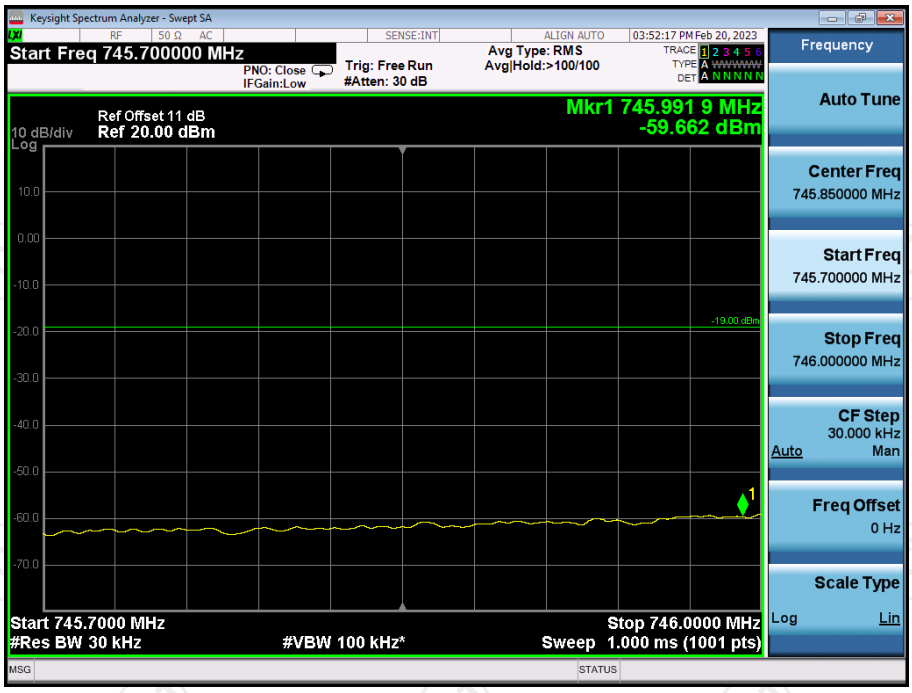
Upper700MHz GSM DL Left Side Pre AGC

Upper700MHz GSM DL Left Side Pre AGC + 10dB

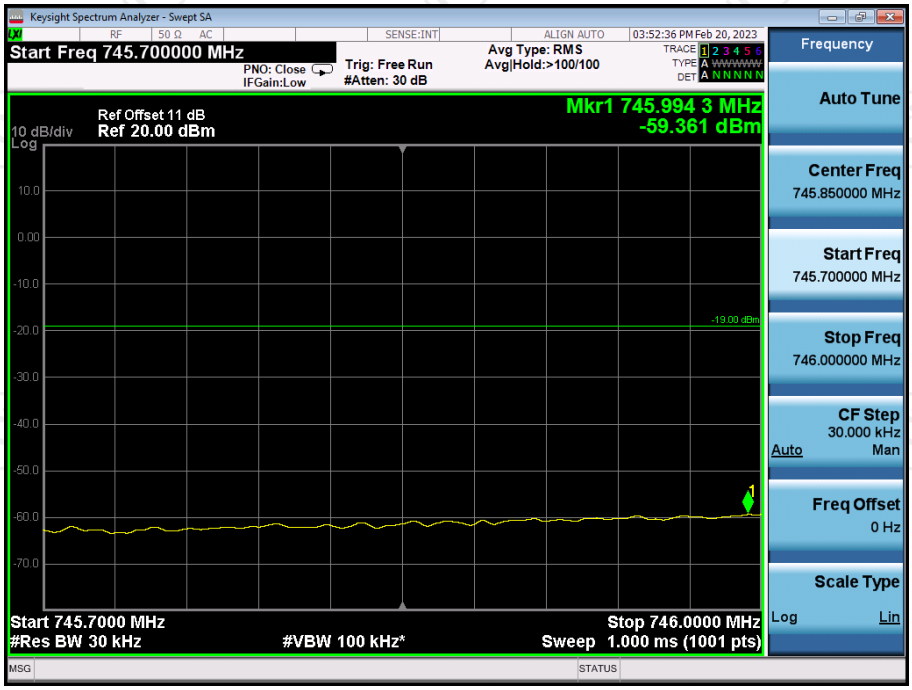
Upper700MHz GSM DL Right Side Pre AGC

Upper700MHz GSM DL Right Side Pre AGC + 10dB

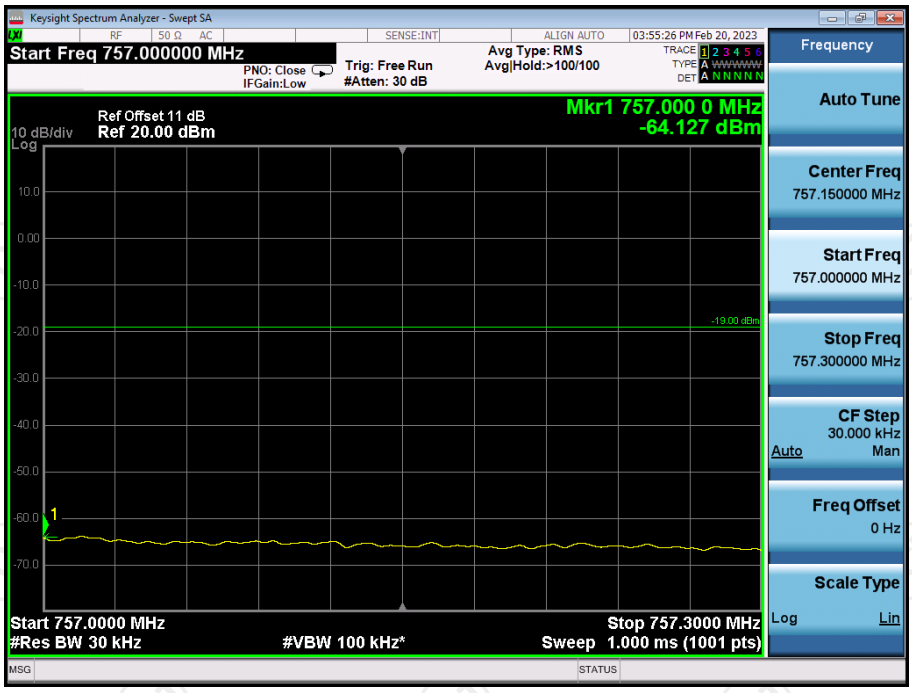
Upper700MHz CDMA DL Left Side Pre AGC



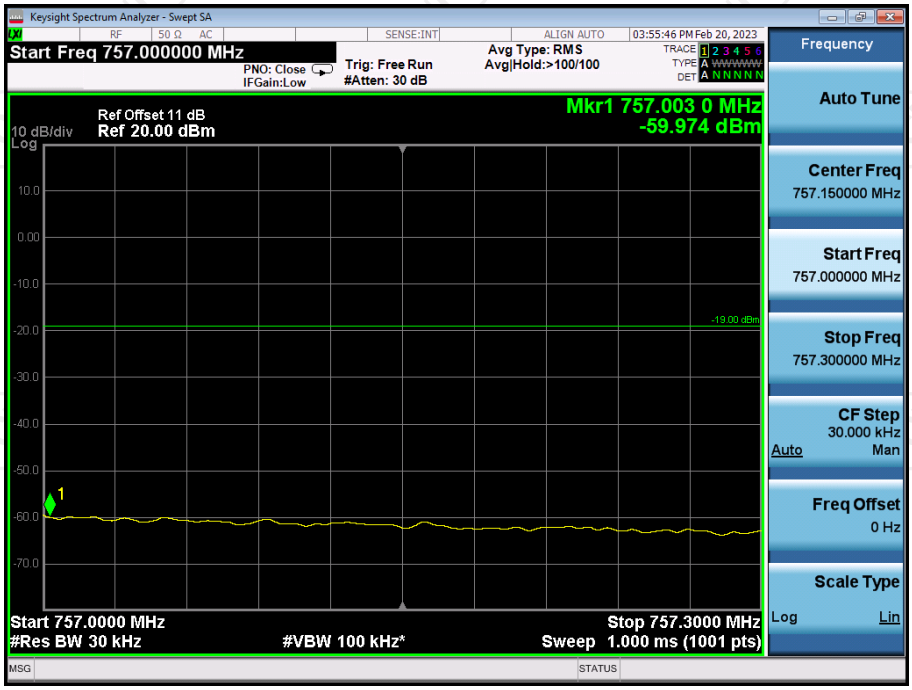
Upper700MHz CDMA DL Left Side Pre AGC + 10dB



Upper700MHz CDMA DL Right Side Pre AGC



Upper700MHz CDMA DL Right Side Pre AGC + 10dB



Upper700MHz LTE DL Left Side Pre AGC

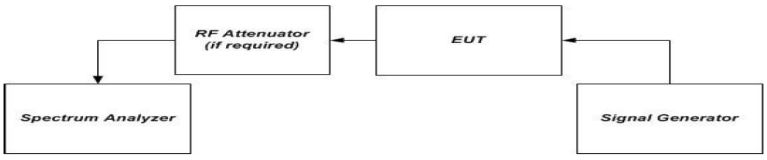
Upper700MHz LTE DL Left Side Pre AGC + 10dB

Upper700MHz LTE DL Right Side Pre AGC

Upper700MHz LTE DL Right Side Pre AGC + 10dB

5.5. Conducted Spurious Emission

5.5.1. Test Specification

Test Requirement:	FCC Part2 Section 1051; FCC Rules Part 27 Subpart C, Section 27.53
Test Method:	KDB 935210 D03 Signal Booster Measurements v04r04
Limit:	-13 dBm； For equipment operating in the frequency bands 746-756 MHz and 777-787 MHz, The power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least: (i) 76 + 10 log10 p (watts), dB, for base and fixed equipment, and (ii) 65 + 10 log10 p (watts), dB, for mobile and portable equipment.
Test Setup:	
Test Procedure:	a) Connect the EUT to the test equipment as shown in Set-Up. Begin with the uplink output connected to the spectrum analyzer. b) Configure the signal generator for AWGN with a 99% occupied bandwidth of 4.1 MHz operation with a center frequency corresponding to the center of the CMRS band under test. c) Set the signal generator amplitude to the level determined in the power measurement procedure in Maximum power. d) Turn on the signal generator RF output and measure the spurious emission power levels with an appropriate measurement instrument as follows. e) Set RBW = measurement bandwidth specified in the applicable rule section for the operational frequency band under consideration (see Annex A for relevant cross-references). Note that many of the individual rule sections permit the use of a narrower RBW (typically ≥ 1% of the emission bandwidth) to enhance measurement accuracy, but the result must then be integrated over the specified measurement bandwidth. f) Set VBW = 3 X RBW. g) Select the power averaging (RMS) detector. (See above note regarding the use of a peak detector for preliminary measurements.) h) Sweep time = auto-couple. i) Set the analyzer start frequency to the lowest radio frequency 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. Note that the number of measurement points in each sweep must be ≥ (2 X span/RBW) which may require that the measurement range defined by the start and stop frequencies above be subdivided, depending on the available number of measurement points provided by the spectrum analyzer. Trace average at least 10 traces in power averaging (i.e., RMS) mode.

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	j) Use the peak marker function to identify the highest amplitude level over each measured frequency range Record the frequency and amplitude and capture a Test Plots for inclusion in the test report. k) Reset the 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 analyzer stop frequency to 10 times the highest frequency of the fundamental emission. Note that the number of measurement points in each sweep must be ≥ (2 X span/RBW) which may require that the measurement range defined by the start and stop frequencies above be subdivided, depending on the available number of measurement points provided by the spectrum analyzer. l) 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 Test Plots for inclusion in the test report. m) Repeat steps b) through l) for each supported frequency band of operation.
Test Result:	PASS

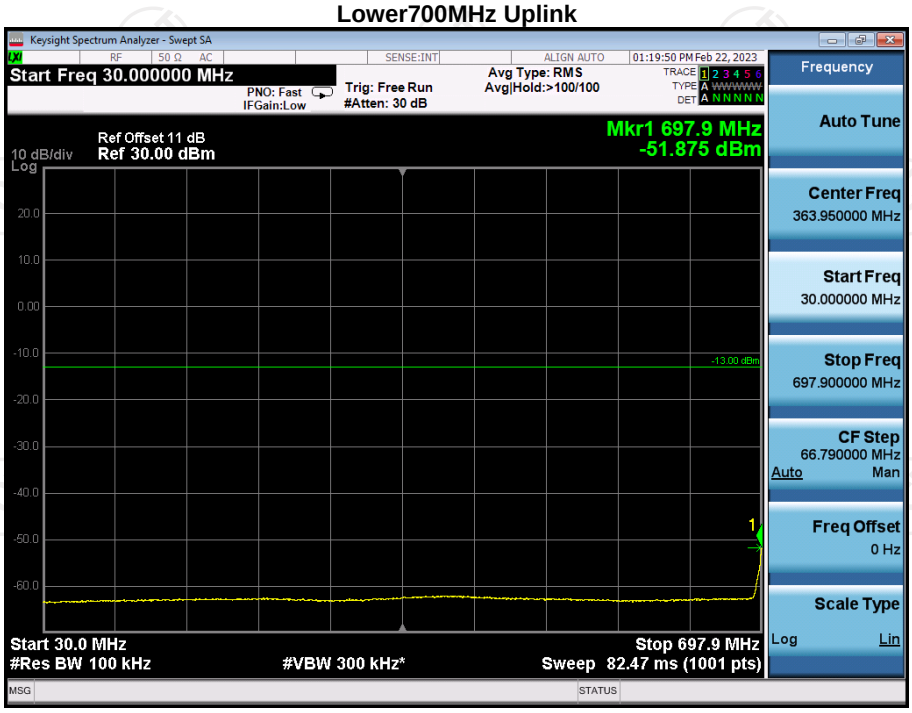
5.5.2. Test Instruments

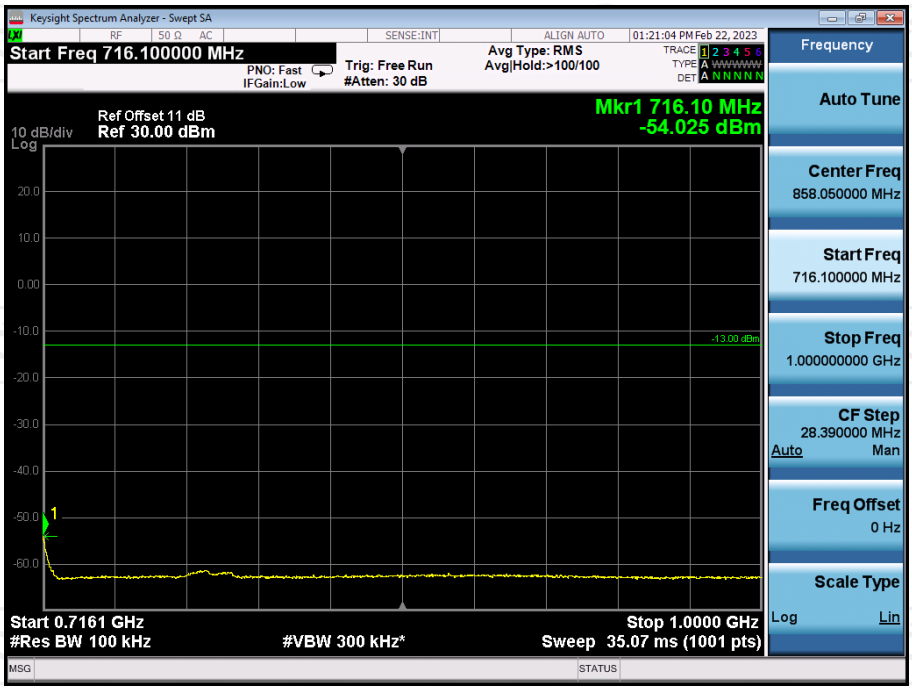
Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Generator	Agilent	N5182A	MY47070282	Jul. 04, 2022	Jul. 03, 2023
Spectrum Analyzer	Agilent	N9020A	MY49100619	Jul. 05, 2022	Jul. 04, 2023
Attenuator	50FP-006-H3	JFW	907763	/	/

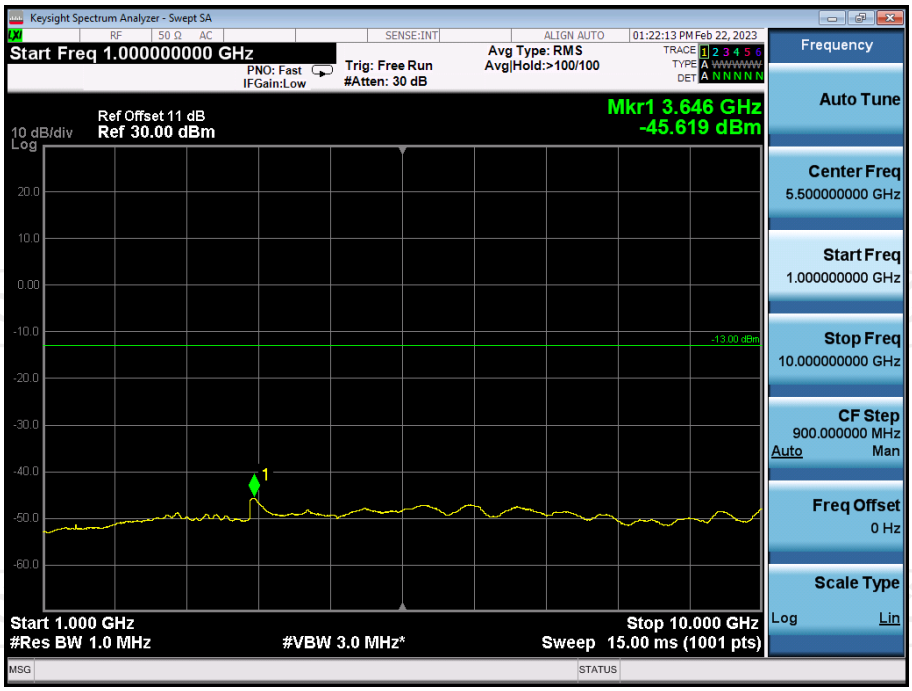
5.5.3. Test data

Test Plots

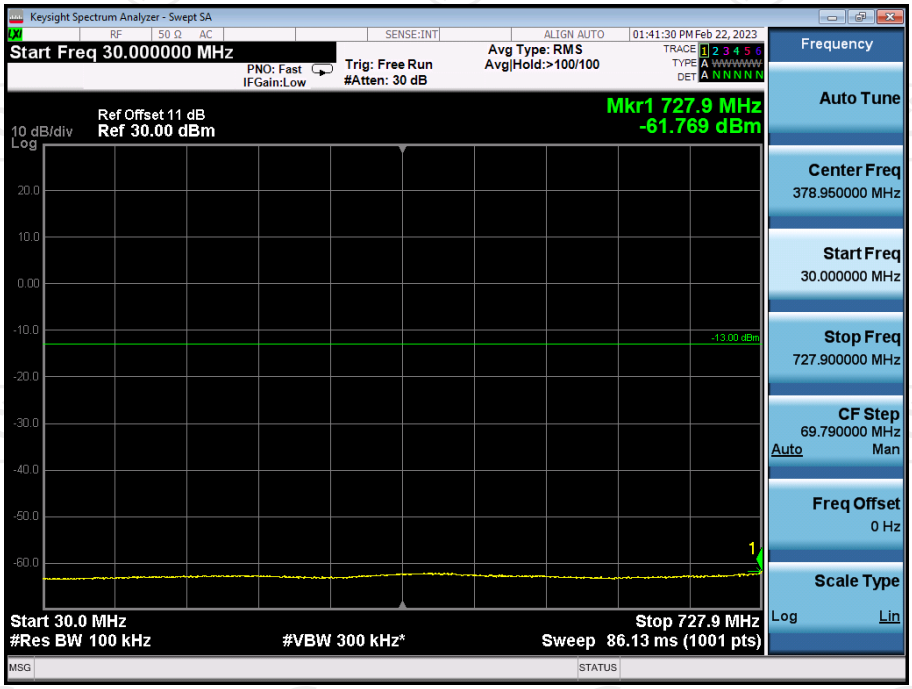
Lower700MHz Uplink

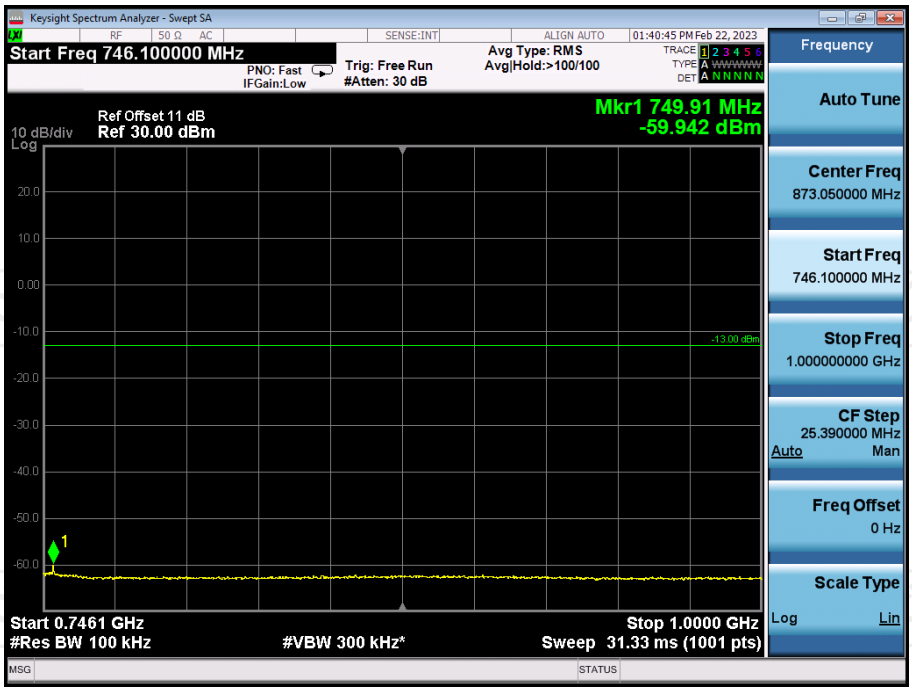


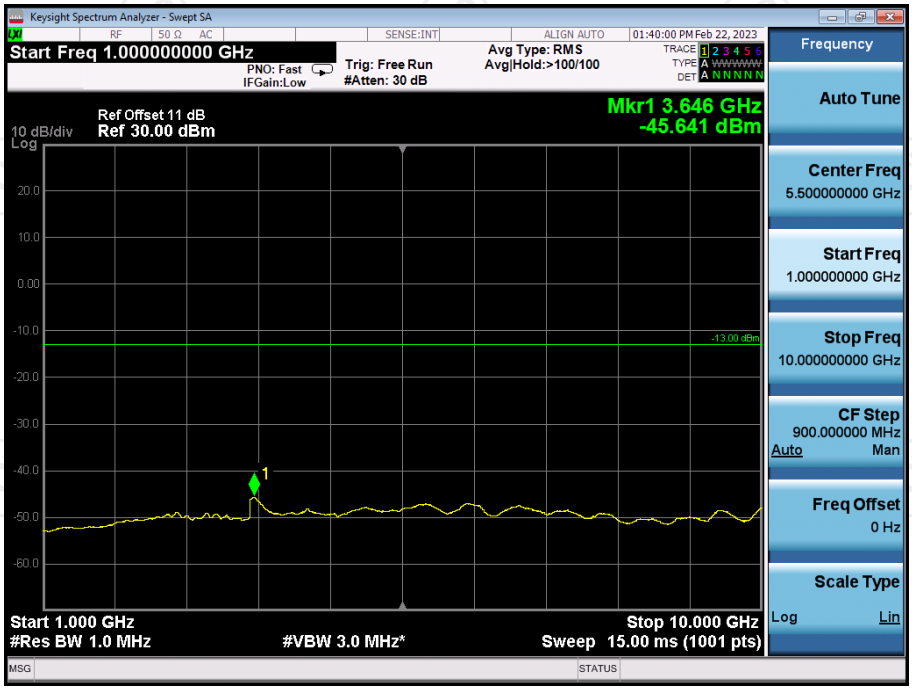




Lower700MHz Downlink

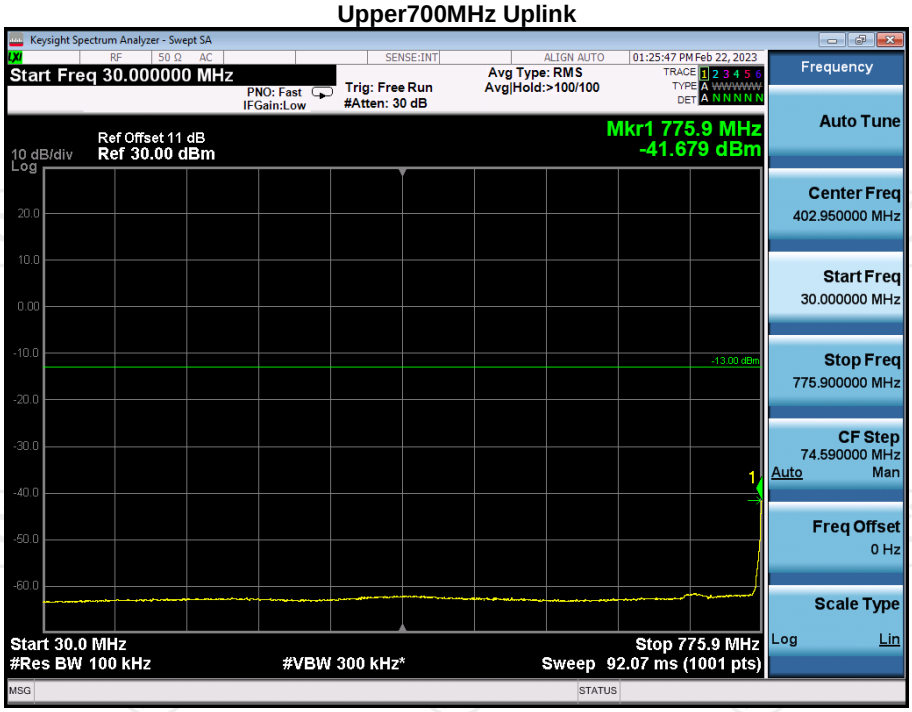


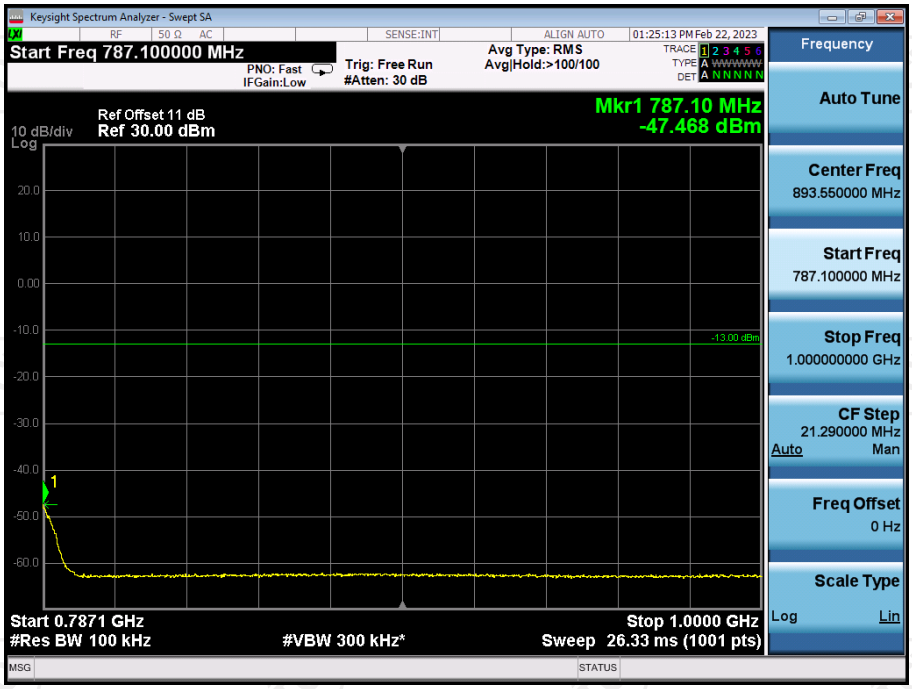

Keysight Spectrum Analyzer - Swept SA
Start Freq 746.100000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: RMS
Avg|Hold:>100/100
01:40:45 PM Feb 22, 2023
Frequency
Auto Tune
Ref Offset 11 dB
10 dB/div
Log
Ref 30.00 dBm
Mkr1 749.91 MHz
-59.942 dBm
-13.00 dBm
Center Freq
873.050000 MHz
Start Freq
746.100000 MHz
Stop Freq
1.000000000 GHz
CF Step
25.390000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin
Start 0.7461 GHz
#Res BW 100 kHz
#VBW 300 kHz*
Stop 1.0000 GHz
Sweep 31.33 ms (1001 pts)
MSG
STATUS

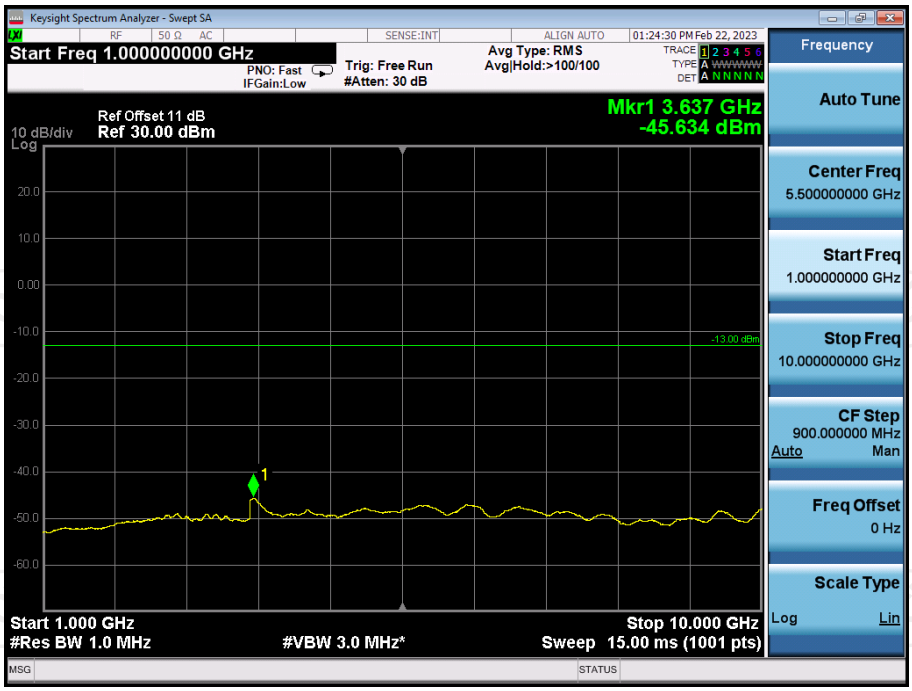

Keysight Spectrum Analyzer - Swept SA
Start Freq 1.000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: RMS
Avg|Hold:>100/100
01:40:00 PM Feb 22, 2023
Frequency
Auto Tune
Ref Offset 11 dB
10 dB/div
Log
Ref 30.00 dBm
Mkr1 3.646 GHz
-45.641 dBm
-13.00 dBm
Center Freq
5.500000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
10.000000000 GHz
CF Step
900.000000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin
Start 1.000 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz*
Stop 10.000 GHz
Sweep 15.00 ms (1001 pts)
MSG
STATUS

Test Plots

Upper700MHz Uplink

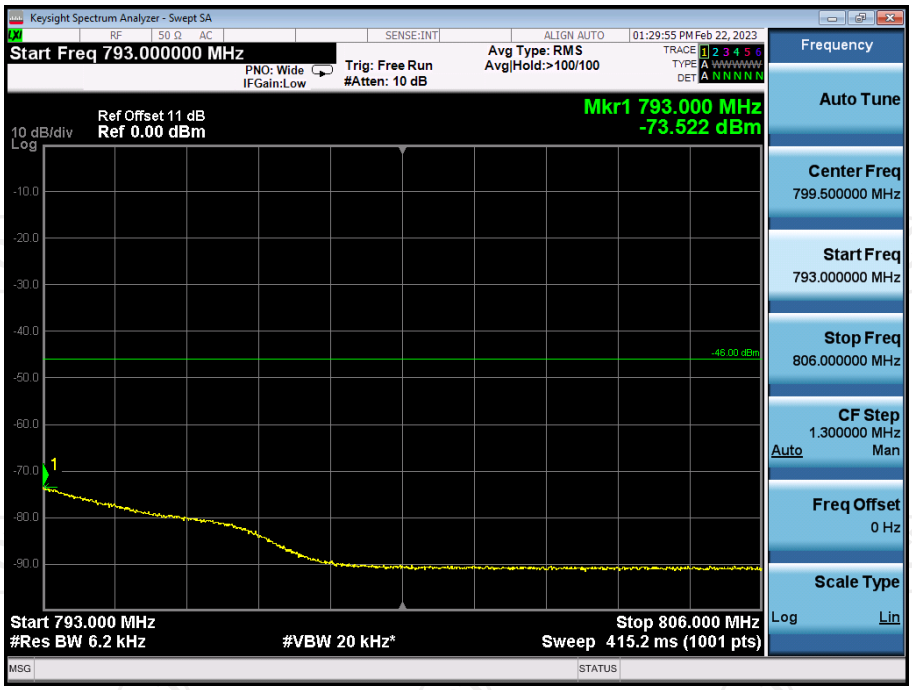




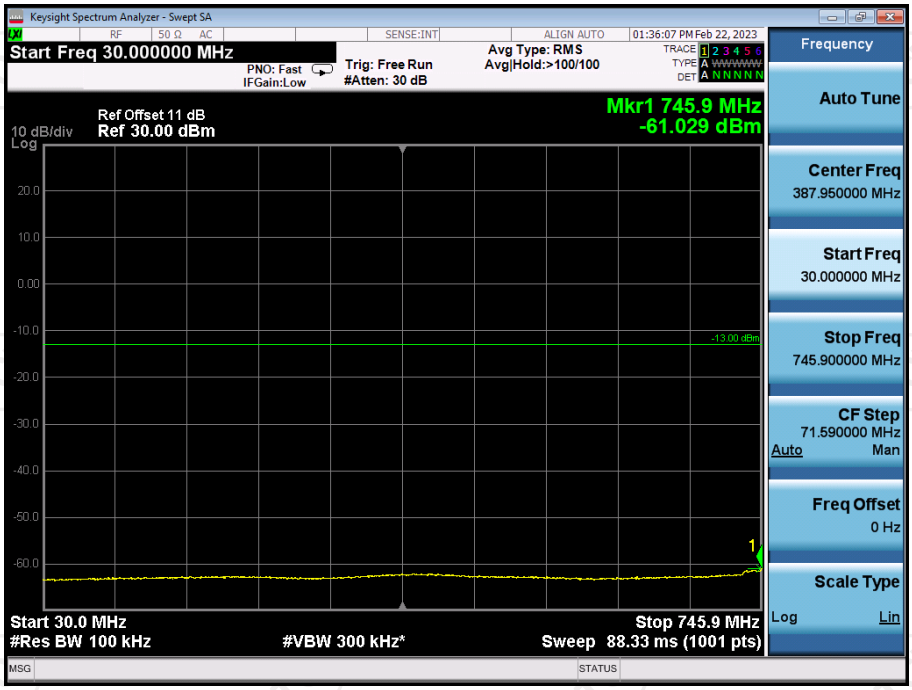


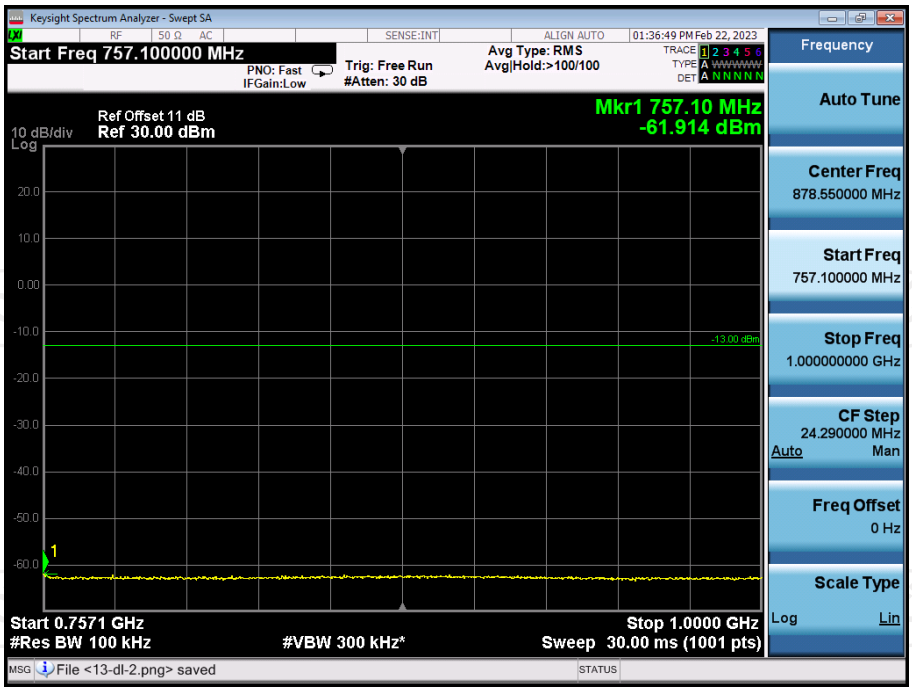
763 MHz - 775 MHz

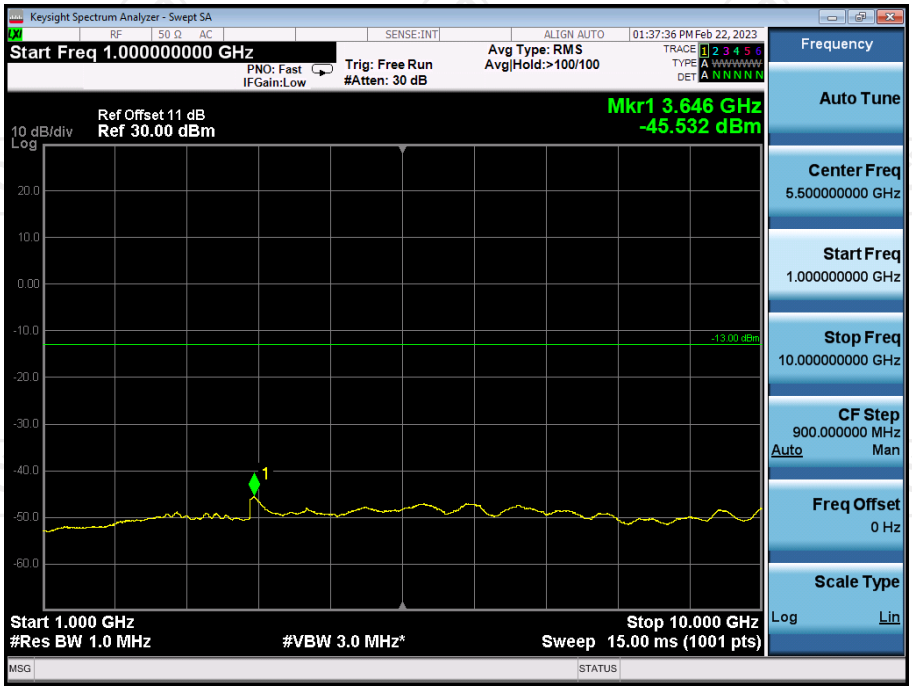
793 MHz - 806 MHz



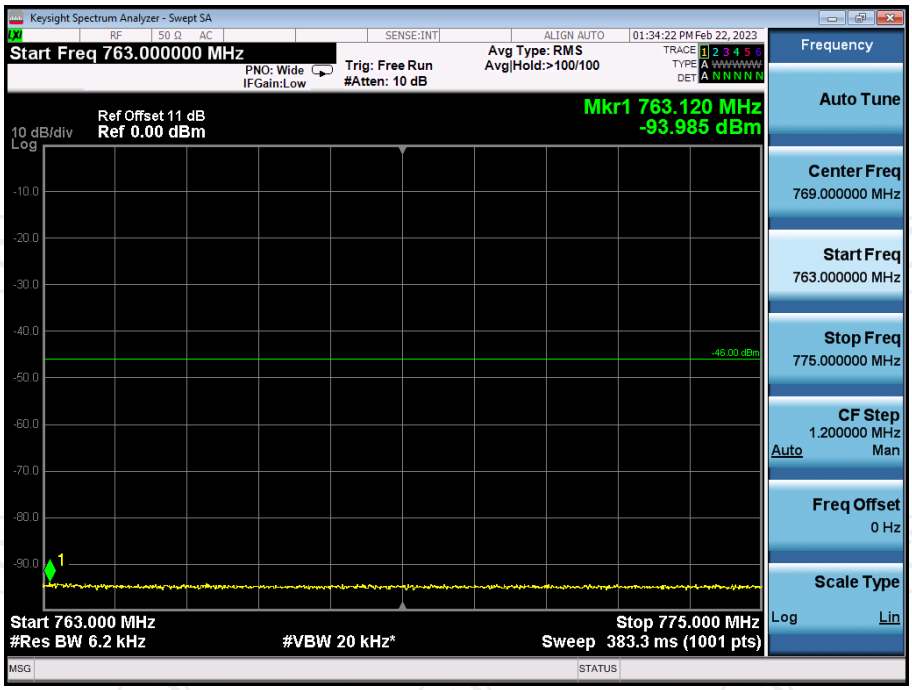
Upper700MHz Downlink



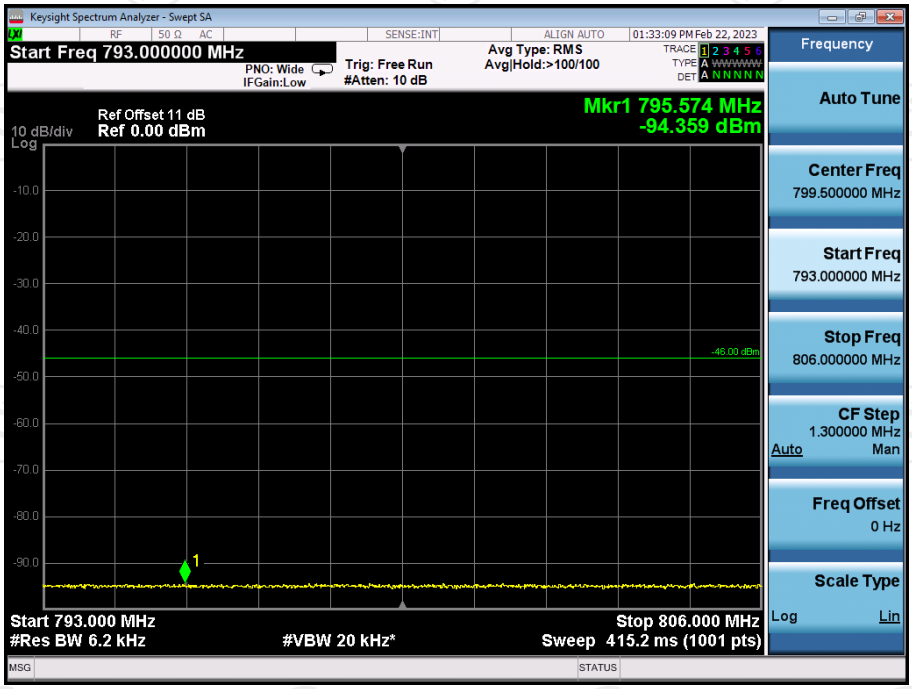

Keysight Spectrum Analyzer - Swept SA
Start Freq 757.100000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: RMS
Avg|Hold:>100/100
01:36:49 PM Feb 22, 2023
Frequency
Auto Tune
Ref Offset 11 dB
10 dB/div
Log
Ref 30.00 dBm
Mkr1 757.10 MHz
-61.914 dBm
-13.00 dBm
Center Freq
878.550000 MHz
Start Freq
757.100000 MHz
Stop Freq
1.000000000 GHz
CF Step
24.290000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin
Start 0.7571 GHz
#Res BW 100 kHz
#VBW 300 kHz*
Stop 1.0000 GHz
Sweep 30.00 ms (1001 pts)
File <13-dl-2.png> saved


Keysight Spectrum Analyzer - Swept SA
Start Freq 1.000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: RMS
Avg|Hold:>100/100
01:37:36 PM Feb 22, 2023
Frequency
Auto Tune
Ref Offset 11 dB
10 dB/div
Log
Ref 30.00 dBm
Mkr1 3.646 GHz
-45.532 dBm
-13.00 dBm
Center Freq
5.500000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
10.000000000 GHz
CF Step
900.000000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin
Start 1.000 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz*
Stop 10.000 GHz
Sweep 15.00 ms (1001 pts)

763 MHz - 775 MHz

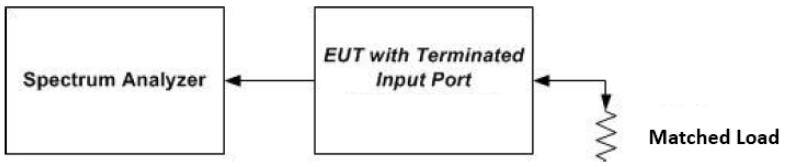
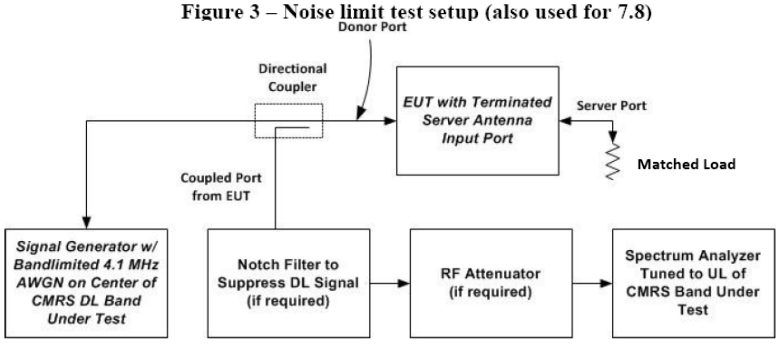


793 MHz - 806 MHz



5.6. Noise Limits

5.6.1. Test Specification

Test Requirement:	FCC Part20 Section 20.21(e)(8)(i)(A); 20.21(e)(8)(i)(H)
Test Method:	KDB935210 D03 Signal Booster Measurements v04r04
Limit:	−59 dBm/MHz or −103 dBm/MHz—RSSI which is less.
Test Setup:	 Figure 3 – Noise limit test setup (also used for 7.8)  Figure 4 – Test setup for uplink noise power measurement in the presence of a downlink signal
Test Procedure:	a) Connect the EUT to the test equipment as shown in Figure 3. Begin with the uplink output (donor) port connected to the spectrum analyzer. When measuring downlink noise, connect the downlink output (server) port to the spectrum analyzer. b) Set the spectrum analyzer RBW to 1 MHz with the VBW ≥ 3 . RBW. c) Select the power averaging (rms) detector and trace average over at least 100 traces. d) Set the center frequency of the spectrum analyzer to the center of the CMRS band under test with the span ≥ 2 . the CMRS band. e) Measure the maximum transmitter noise power level. f) Save the spectrum analyzer Test Plots as necessary for inclusion in the final test report. g) Repeat 7.7b) to 7.7f) for all operational uplink and downlink bands. h) Connect the EUT to the test equipment as shown in Figure 4 for uplink noise power measurement in the presence a downlink signal. Affirm the coupled path of the RF coupler is connected to the spectrum analyzer. i) Configure the signal generator for AWGN operation with a 99% OBW of 4.1 MHz. j) Set the spectrum analyzer RBW for 1 MHz, VBW ≥ 3 . RBW, with a power averaging (rms) detector with at least 100 trace averages. k) Set the center frequency of the spectrum analyzer to the center of the CMRS band under test, with the span ≥ 2 the CMRS band. This shall include all spectrum blocks in the particular CMRS band under test (see Appendix A).

	l) For uplink noise measurements, set the spectrum analyzer center frequency for the uplink band under test, and tune the signal generator to the center of the paired downlink band. m) Measure the maximum transmitter noise power level while varying the downlink signal generator output level from −90 dBm to −20 dBm, as measured at the input port (i.e., downlink signal level at the booster donor port node of Figure 4), in 1 dB steps inside the RSSI-dependent region, and in 10 dB steps outside the RSSI-dependent region. Report the six values closest to the limit, with at least two points within the RSSI-dependent region of the limit. See Appendix D for noise limits graphs. n) Repeat 7.7.1h) through 7.7.1m) for all operational uplink bands. **Variable uplink noise timing** Variable uplink noise timing is to be measured as follows, using the test setup shown in Figure 4. a) Set the spectrum analyzer to the uplink frequency to be measured. b) Set the span to 0 Hz, with a sweep time of 10 seconds. c) Set the power level of signal generator to the lowest level of the RSSI-dependent noise [see 7.7.1m)]. d) Select MAX HOLD and increase the power level of signal generator by 10 dB for mobile boosters, and 20 dB for fixed boosters. e) Confirm that the uplink noise decreases to the specified level within 1 second for mobile devices, and within 3 seconds for fixed devices.12 f) Repeat 7.7.2a) to 7.7.2e) for all operational uplink bands. g) Include Test Plotss and summary table in test report.
Test Result:	PASS

5.6.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Generator	Agilent	N5182A	MY47070282	Jul. 04, 2022	Jul. 03, 2023
Spectrum Analyzer	Agilent	N9020A	MY49100619	Jul. 05, 2022	Jul. 04, 2023
RF Combiner	SUNVNDN	SUD-CS 0800	16230009	/	/
Attenuator	50FP-006-H3	JFW	907763	/	/

5.6.3. Test Data

Max Noise Power			
Frequency Band (MHz)	Measured dBm/MHz	Limit dBm/MHz	Result (dB)
Lower700MHz Uplink	-63.17	-59	PASS
Upper700MHz Uplink	-60.30	-59	PASS
Lower700MHz Downlink	-59.45	-59	PASS
Upper700MHz Downlink	-59.53	-59	PASS

Variable Uplink Noise				
Operation Bands	RSSI dBm	Measured dBm/MHz	Limit dBm/MHz	Results
Lower700MHz	-62	-61.82	-59	PASS
	-59	-61.73	-59	PASS
	-55	-62.28	-59	PASS
	-52	-62.81	-59	PASS
	-48	-64.56	-59	PASS
	-47	-69.72	-59	PASS
Upper700MHz	-64	-60.01	-59	PASS
	-60	-59.92	-59	PASS
	-56	-59.80	-59	PASS
	-53	-60.85	-59	PASS
	-51	-61.07	-59	PASS
	-49	-62.58	-59	PASS

Variable Uplink Noise Timing

Operation Bands	Measured Sec	Limit Sec	Results
Lower700MHz	0.010	1	PASS
Upper700MHz	0.015	1	PASS

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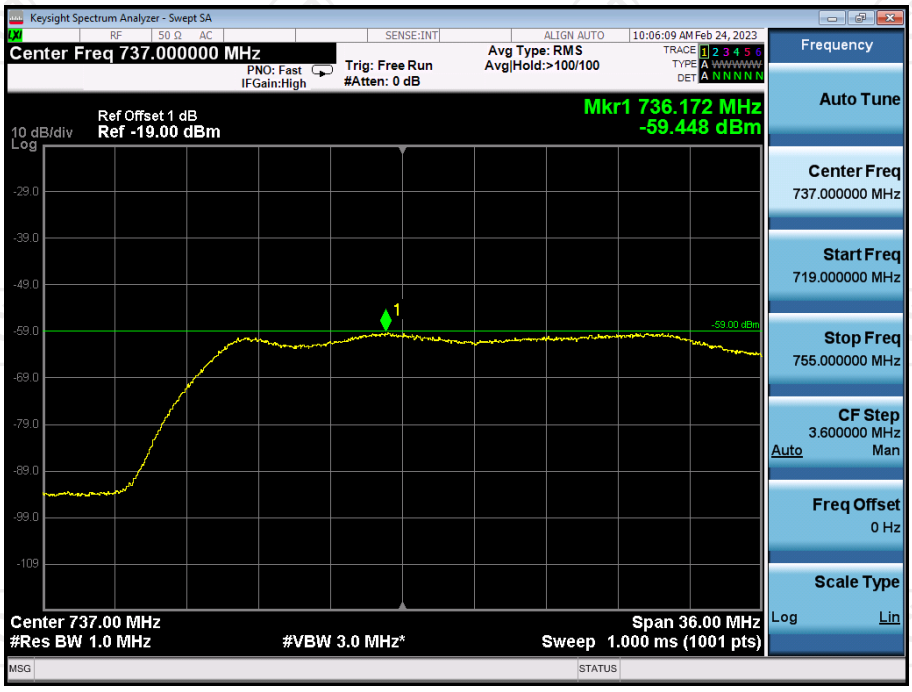
Test Plots

Lower700MHz

Uplink Noise



Downlink Noise

Upper700MHz

Uplink Noise

Downlink Noise

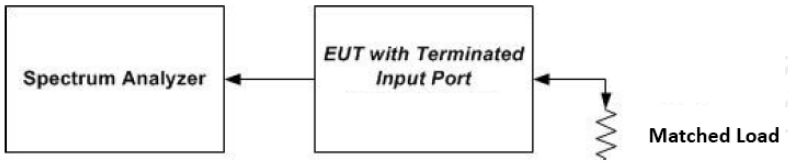
Variable Noise Timing Test Plots

Lower700MHz

Upper700MHz

5.7. Uplink Inactivity

5.7.1. Test Specification

Test Requirement:	FCC Part20 Section 20.21(e)(8)(i)(l)
Test Method:	KDB935210 D03 Signal Booster Measurements v04r04
Limit:	20.21(e), When a consumer booster is not serving an active device connection after 5 minutes the uplink noise power shall not exceed -70 dBm/MHz.
Test Setup:	 Figure 3 – Noise limit test setup (also used for 7.8)
Test Procedure:	a) Connect the EUT to the test equipment as shown in Set-Up with the uplink output connected to the spectrum analyzer. b) Select the RMS power averaging detector. c) Set the spectrum analyzer RBW for 1 MHz with the VBW ≥ 3X RBW. d) Set the center frequency of the spectrum analyzer to the center of the uplink operational band. e) Set the span for 0 Hz with a single sweep time for a minimum of 330 seconds. f) Start to capture a new trace using MAX HOLD. g) After approximately 15 seconds turn on the EUT power. h) Once the full spectrum analyzer trace is complete place a MARKER on the leading edge of the pulse and use the DELTA MARKER METHOD to measure the time until the uplink was squelched. i) Ensure the noise level for the squelched signal is below the uplink inactivity noise power limit, as specified by the rules. j) Capture the Test Plots for inclusion in the test report. k) Measure noise using procedures in a) to e). l) Repeat steps c) to k) for all operational uplink bands.
Test Result:	PASS

5.7.2. Test Instruments

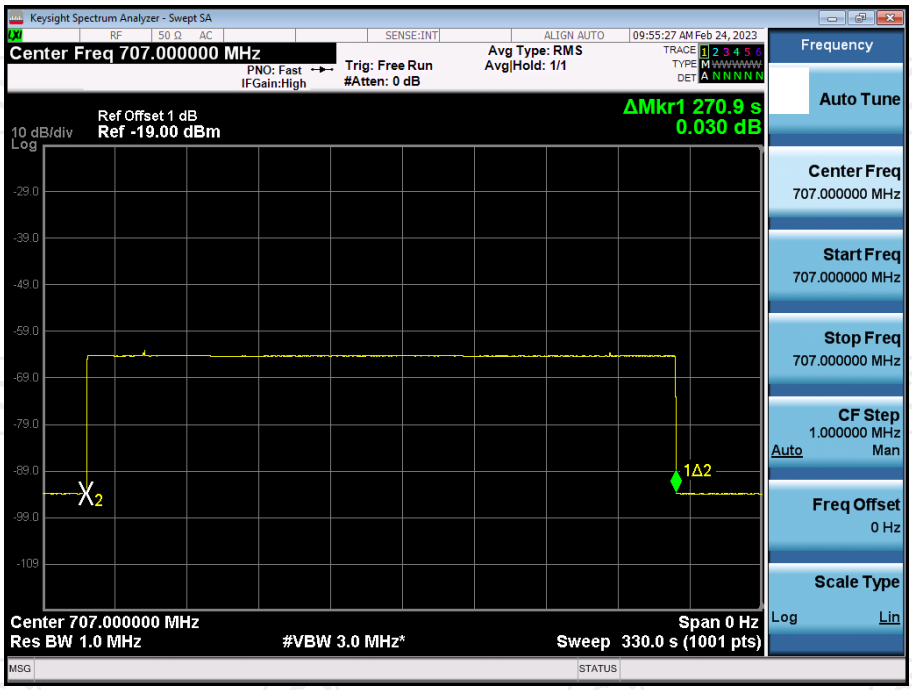
Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Spectrum Analyzer	Agilent	N9020A	MY49100619	Jul. 05, 2022	Jul. 04, 2023

5.7.3. Test Data

Uplink Inactivity			
Operation Bands	Measured (s)	Limit (s)	Result
Lower700MHz	270.9	300.0	PASS
Upper700MHz	270.6	300.0	PASS

Test Plots

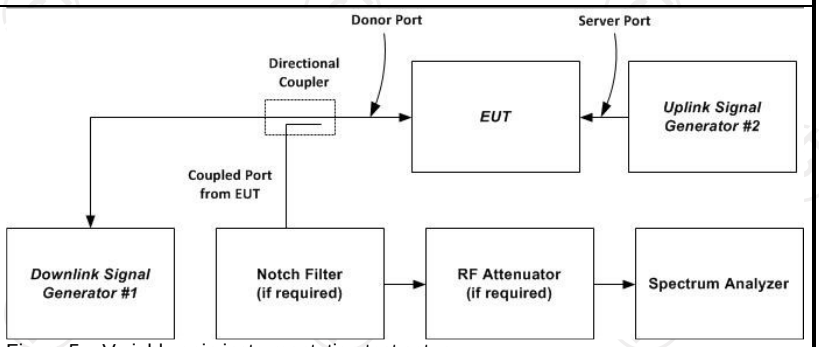
Lower700MHz



Upper700MHz

5.8. Variable Booster Gain

5.8.1. Test Specification

Test Requirement:	FCC Part20 Section 120.21(e)(8)(i)(C)(1) FCC Part20 Section 120.21(e)(8)(i)(H)
Test Method:	KDB935210 D03 Signal booster Measurements v04r04
Limit:	-34 dB - RSSI + MSCL
Test Setup:	 Figure 5 – Variable gain instrumentation test setup
Test Procedure:	**Variable gain:** a) Connect the EUT to the test equipment as shown in Figure 5 with the uplink output (donor) port connected to signal generator #1. Affirm that the coupled path of the RF coupler is connected to the spectrum analyzer. b) Configure downlink signal generator #1 for AWGN operation with a 99% OBW of 4.1 MHz, tuned to the center of the operational band. c) Set the power level and frequency of signal generator #2 to a value that is 5 dB below the AGC level determined from 7.2. The signal type is AWGN with a 99% OBW of 4.1 MHz. d) Set RBW = 100 kHz. e) Set VBW ≥ 300 kHz. f) Select the CHANNEL POWER measurement mode. g) Select the power averaging (rms) detector. h) Affirm that the number of measurement points per sweep ≥ (2 . span)/RBW. i) Sweep time = auto couple or as necessary (but no less than auto couple value). j) Trace average at least 10 traces in power averaging (i.e., rms) mode. k) Measure the maximum channel power and compute maximum gain when varying the signal generator #1 output to a level from .90 dBm to .20 dBm, as measured at the input port (i.e., downlink signal level at the booster donor port node of Figure 5), in 1 dB steps inside the RSSI-dependent region, and 10 dB steps outside the RSSI-dependent region. Report the six values closest to the limit, including at least two points from within the RSSI-dependent region of operation. See gain limit in charts in Appendix D for uplink gain requirements. Additionally, document that the EUT provides equivalent uplink and downlink gain, and when operating in shutoff mode that the uplink and downlink gain is within the transmit power off mode gain limits. l) Repeat 7.9.1b) to 7.9.1k) for all operational uplink bands. **Variable uplink gain timing:** Variable uplink gain timing is to be measured as follows, using the test setup shown in Figure 5. a) Set the spectrum analyzer to the uplink frequency to be

	measured. b) Set the span to 0 Hz with a sweep time of 10 seconds. c) Set the power level of signal generator #1 to the lowest level of the RSSI-dependent gain [see 7.9.1k)]. d) Select MAX HOLD and increase the power level of signal generator #1 by 10 dB for mobile boosters, and by 20 dB for fixed indoor boosters. Signal generator #2 remains same, as described in 7.9.1c). e) Confirm that the uplink gain decreases to the specified levels, within 1 second for mobile devices, and within 3 seconds for fixed devices.13 f) Repeat 7.9.2a) to 7.9.2e) for all operational uplink bands.
Test Result:	PASS

5.8.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Generator	Agilent	E4421B	GB39340839	Jul. 05, 2022	Jul. 04, 2023
Signal Generator	Agilent	N5182A	MY47070282	Jul. 04, 2022	Jul. 03, 2023
Spectrum Analyzer	Agilent	N9020A	MY49100619	Jul. 05, 2022	Jul. 04, 2023
RF Combiner	SUNVNDN	SUD-CS 0800	16230009	/	/
Attenuator	50FP-006-H3	JFW	907763	/	/

5.8.3. Test Data

Mobile station coupling loss (MSCL): *the minimum coupling loss (in dB) between the wireless device and the input (server) port of the consumer booster. MSCL must be calculated or measured for each band of operation and provided in compliance test reports. MSCL includes the path loss from the wireless device, and the booster's server antenna gain and cable loss. The wireless device is assumed to be an isotropic (0 dBi) antenna reference. Minimum standoff distances from inside wireless devices to the booster's server antenna must be reasonable and specified by the manufacturer in customer provided installation manuals.*

MSCL Calculation							
Operation Bands	Frequency (MHz)	Distance (m)	Path loss (dB)	Indoor Antenna Gain(dBi)	Indoor Cable Loss(dB)	Polarity Loss(dB)	MSCL (dB)
Lower700 MHz	698	0.2	15.40	7	2.19	3.01	**13.60**
Upper700 MHz	776	0.2	16.32	7	2.19	3.01	**14.52**

Note : Path loss = 20logf + 20logd – 27.5

Polarity loss = 20Log (1/Sin (45deg)) dB = 3.01dB

Variable booster gain							
Operation Band	RSSI (dBm)	Input Power (dBm)	Output Power (dBm)	Measured Gain (dB)	MSCL	Limit	Results
Lower700MHz	-61	-29	9.74	38.74	13.60	40.60	PASS
	-56	-29	6.52	35.52	13.60	35.60	PASS
	-54	-29	4.20	33.20	13.60	33.60	PASS
	-51	-29	2.86	31.86	13.60	30.60	PASS
	-49	-29	-1.14	27.86	13.60	28.60	PASS
	-47	-29	-2.72	26.28	13.60	26.60	PASS
Upper700MHz	-63	-26	11.15	37.15	14.52	43.52	PASS
	-58	-26	9.13	35.13	14.52	38.52	PASS
	-54	-26	5.08	31.08	14.52	34.52	PASS
	-49	-26	2.17	28.17	14.52	29.52	PASS
	-46	-26	0.43	26.43	14.52	26.52	PASS
	-43	-26	-1.86	24.14	14.52	25.52	PASS

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Variable Uplink Gain Timing

Operation Band	Measured Sec	Limit Sec	Result
Lower700MHz	0.015	1	PASS
Upper700MHz	0.010	1	PASS

Variable Uplink Gain Timing Test Plots

Lower700MHz

Upper700MHz