H.B. Compliance Solutions

Intentional Radiator Test Report

For the

Wilson Electronics.

Quint Band Bi-Directional Amplifier

Tested under

FCC Part 20

For Fixed Consumer Signal Booster

Prepared for:

Wilson Electronics

3301 E. Deseret Drive,

St. George, UT 8479085224

Prepared By:

H.B. Compliance Solutions

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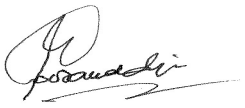
Reviewed By:



Hoosamuddin Bandukwala

Cert # ATL-0062-E

Engineering Statement: The measurements shown in this report were made in accordance with the procedure indicated, 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 measurement made, the equipment tested is capable of operation in accordance with the requirements of Part 20 of the FCC Rules under normal use and maintenance. All results contained herein relate only to the sample tested.

Report Status Sheet

Revision #	Report Date	Reason for Revision
Ø	December 27, 2018	Initial Issue
1	January 28, 2019	Added Plot for Radiated Emissions

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EXECUTIVE SUMMARY

1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 20. All tests were conducted using measurement procedure from FCC Signal Booster Measurement KDB 935210 D03 v04r02 Jun 19, 2018 as appropriate.

Test Name	Test Method/Standard	Result	Comments
Authorized Frequency Band	20.21(e)(3)	Pass	
Maximum Power & Booster Gain	20.21(e)(8)(i)(B) 20.21(e)(8)(i)(C) 20.21(e)(8)(i)(D)	Pass	
Intermodulation	20.21(e)(8)(i)(F)	Pass	
Out-of-Band Emissions	20.21(e)(8)(i)(E)	Pass	
Conducted Spurious Emissions	2.1051	Pass	
Noise Limits	20.21(e)(8)(i)(A) 20.21(e)(9)(i)(l)	Pass	
Uplink Inactivity	20.21(e)(8)(i)(l) 20.21(e)(9)(i)(J)	Pass	
Variable Booster Gain	20.21(e)(8)(i)(C)	Pass	
Occupied Bandwidth	2.1049	Pass	
Oscillation Detection	20.21(e)(8)(ii)(A)	Pass	
Radiated Spurious Emissions	2.1053	Pass	
Spectrum Block Filtering	20.21(e)(8)(i)(B)	N/A	Applies to devices utilizing spectrum block filtering, In this case this is not applicable

EQUIPMENT CONFIGURATION

1. Overview

H.B. Compliance Solutions was contracted by Wilson Electronics to perform testing on the Bi-Directional Amplifier under the purchase order number 0037052.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Wilson Electronics, Bi-Directional Amplifier.

The tests were based on FCC Part 20 Rules. The tests described in this document were formal tests as described with the objective of the testing was to evaluate compliance of the Equipment Under Test (EUT) to the requirements of the aforementioned specifications. Wilson Electronics should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been permanently discontinued. The results obtained relate only to the item(s) tested.

Product Name:	Quint Band Bi-Directional Amplifier
Model(s) Tested:	460047
FCC ID:	None
Supply Voltage Input:	Primary Power : 12.0 Vdc
Frequency Range:	Uplink 698-716, 776-787MHz, 824-849MHz, 1710-1755 & 1850-1915MHz, Downlink 728-746MHz, 746-757MHz, 869-894MHz, 1930-1995MHz & 2110-2155MHz
No. of Channels:	N/A
Type(s) of Modulation:	CDMA, GSM, EDGE, HSPA, EVDO, LTE
Range of Operation Power:	0.029 – 0.32W
Emission Designator:	F9W, GXW, G7W & G7D
Channel Spacing(s)	N/A
Test Item:	Pre-Production
Type of Equipment :	Fixed Booster
Antenna Requirement	External
Environmental Test Conditions:	Temperature: 15-35°C Humidity: 30-60% Barometric Pressure: 860-1060 mbar
Modification to the EUT:	None
Evaluated By:	Staff at H.B. Compliance Solutions
Test Date(s):	11/14/2018 till 12/07/2018

2. Test Facility

All testing was performed at H.B. Compliance Solutions. This facility is located at 5005 S. Ash Avenue, Suite # A-10, Tempe AZ-85282. All equipment used in making physical determination is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements from 30MHz to 1GHz were performed in a GTEM chamber (equivalent to an Open Area Test Site). Radiated Emission above 1GHz were performed on an Open Area Test Site (OATS). In accordance with §2.948(a)(3), a complete site description is contained at H.B. Compliance Solutions.

Test facility H.B. Compliance Solutions is an ANAB accredited test site. The ANAB certificate number is L2458. The scope of accreditation can be found on ANAB website www.anab.org

3. Description of Test Sample

The Wilson Electronics, is a quint-band bi-directional amplifier for enhancing the range of cell phones and data communication devices (computer, PDAs, etc.) in both mobile and in-building applications. The components are contained in a plastic enclosure.

4. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number
# 1	Quint Band Bi-Directional Amplifier	460047	N/A

Table 1. Equipment Configuration

5. Support Equipment

All support equipment supplied is listed in the following Support Equipment List.

Ref ID	Name / Description	Manufacturer	Model #	Serial #
N/A	-	-	-	-

Table 2. Support Equipment

6. Ports and Cabling Information

Ref ID	Port name on the EUT	Cable Description	Qty.	Length (m)	Shielded? (Y/N)	Termination Box ID & Port ID
#2	Power	2 wire	1	1	N	DC Power Supply

Table 3. Ports and Cabling Information

7. Method of Monitoring EUT Operation

A test receiver will be used to monitor the data transmission from the EUT.

8. Mode of Operation

The EUT will be configured as defined in each section of this document. These settings were created for testing purpose only.

9. Modifications

9.1 Modifications to EUT

No modifications were made to the EUT

9.2 Modifications to Test Standard

No Modifications were made to the test standard.

10. Disposition of EUT

The test sample including all support equipment submitted to H.B Compliance Solutions for testing will be returned to Wilson Electronics upon completion of testing & certification

1. Authorized Frequency Band

Test Requirement(s):	§20.21(e)(3)	Test Engineer(s):	Hoosam B.
Test Results:	Pass	Test Date(s):	Nov/14/2018

Test Procedures: As required by 47 CFR §20.21(e)(3), Authorized frequency band measurements were made at the RF output terminals of the EUT.

The EUT was connected through an attenuator to a Spectrum Analyzer. A signal generator was used for the input to the EUT to provide a CW signal tuned to the center channel of each uplink and downlink operational band. Measurements were made at the low and high channels of each uplink and downlink frequency band.

Test Setup:

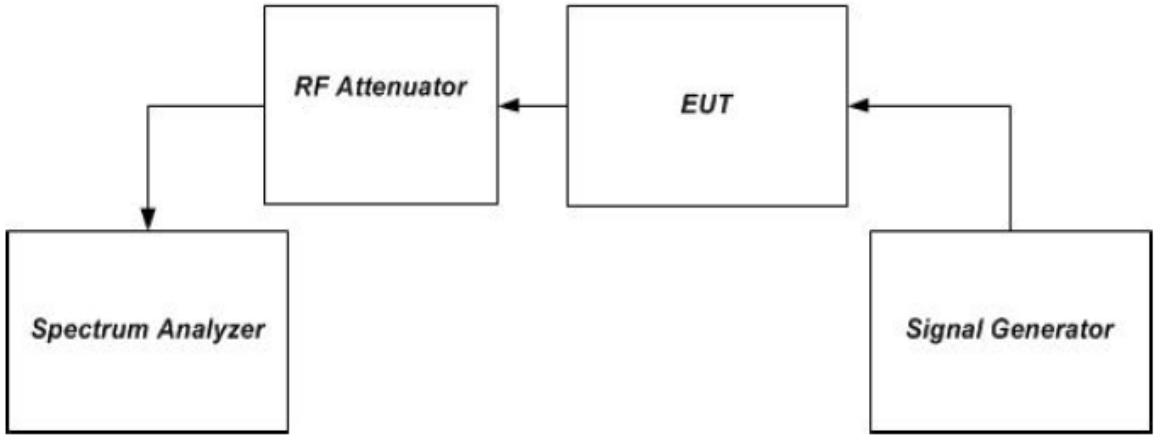
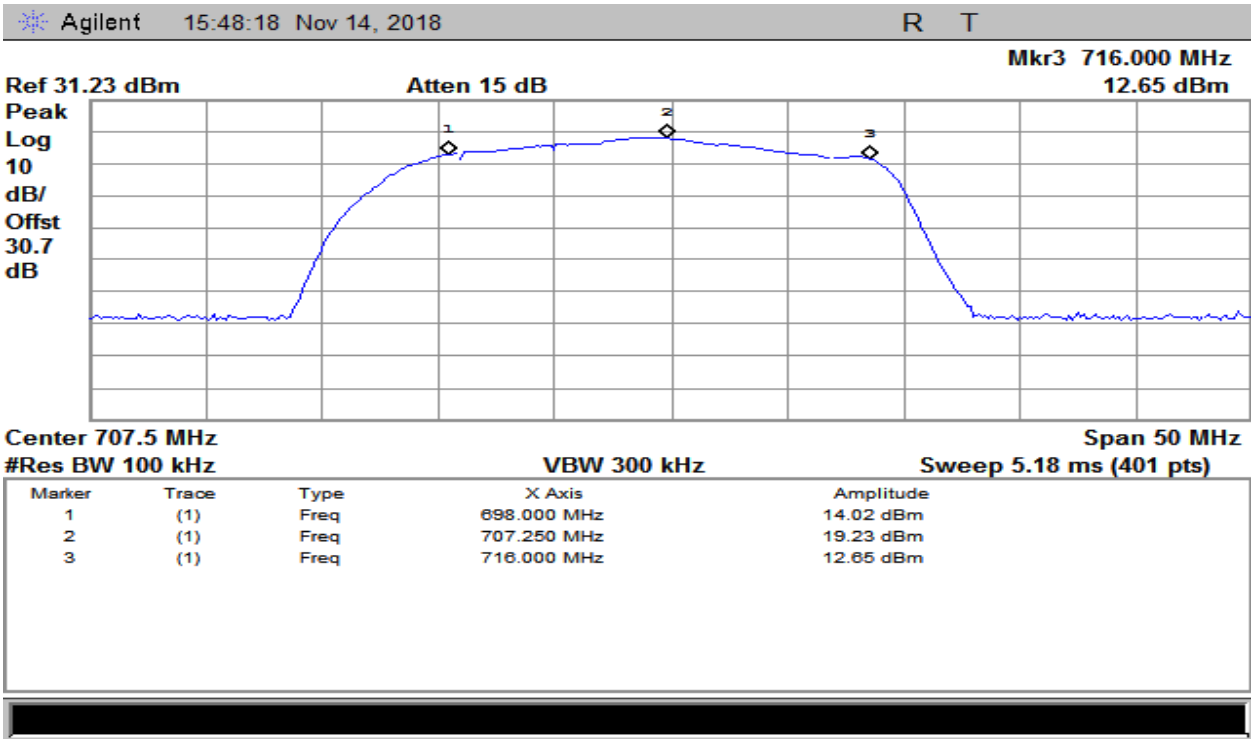
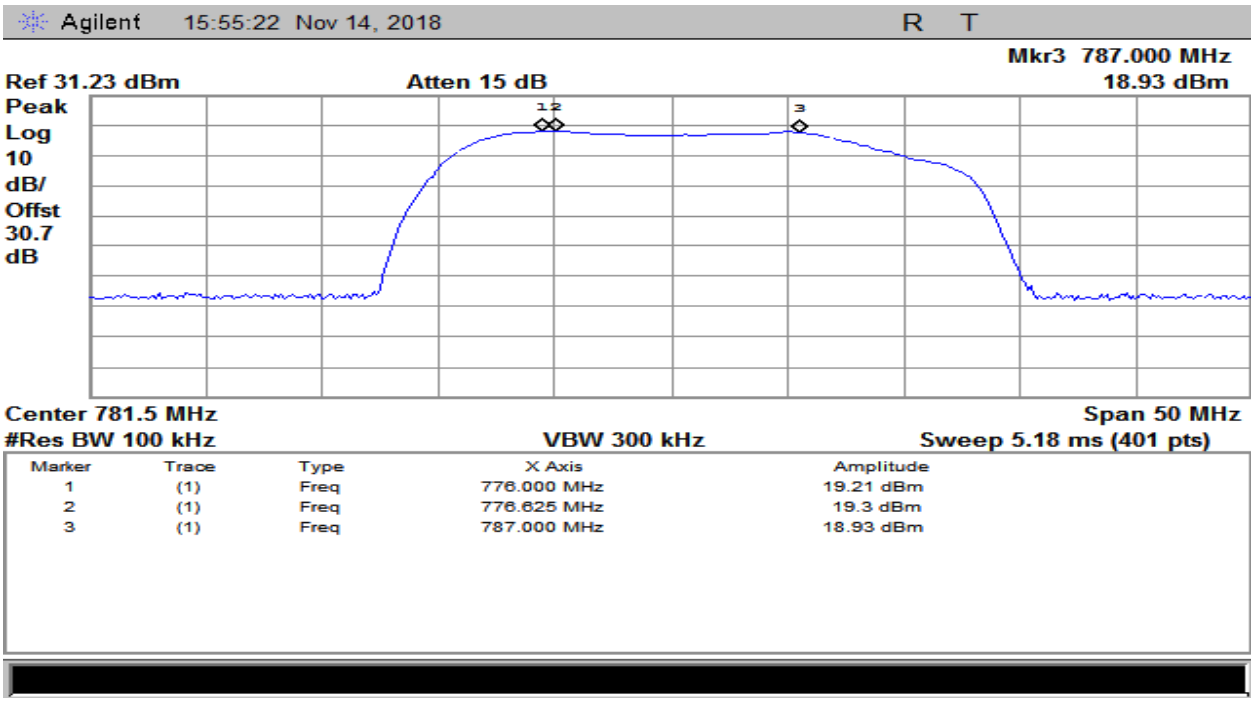


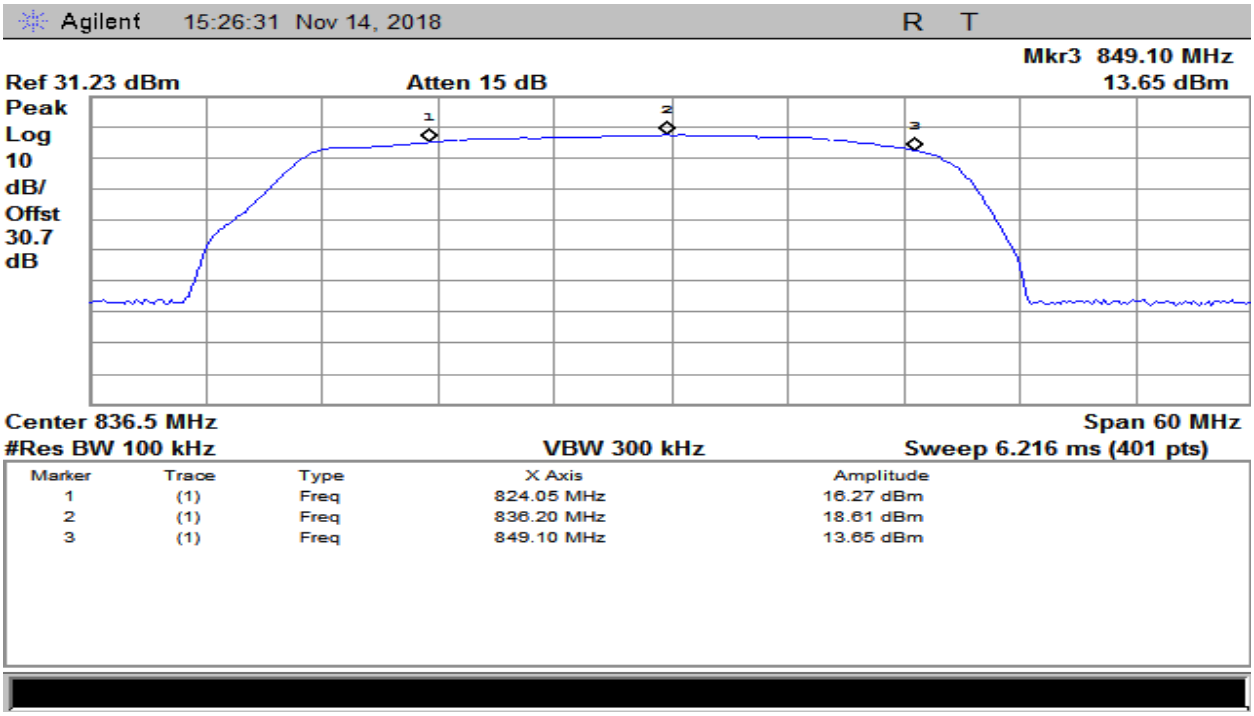
Figure 1 – Band Verification



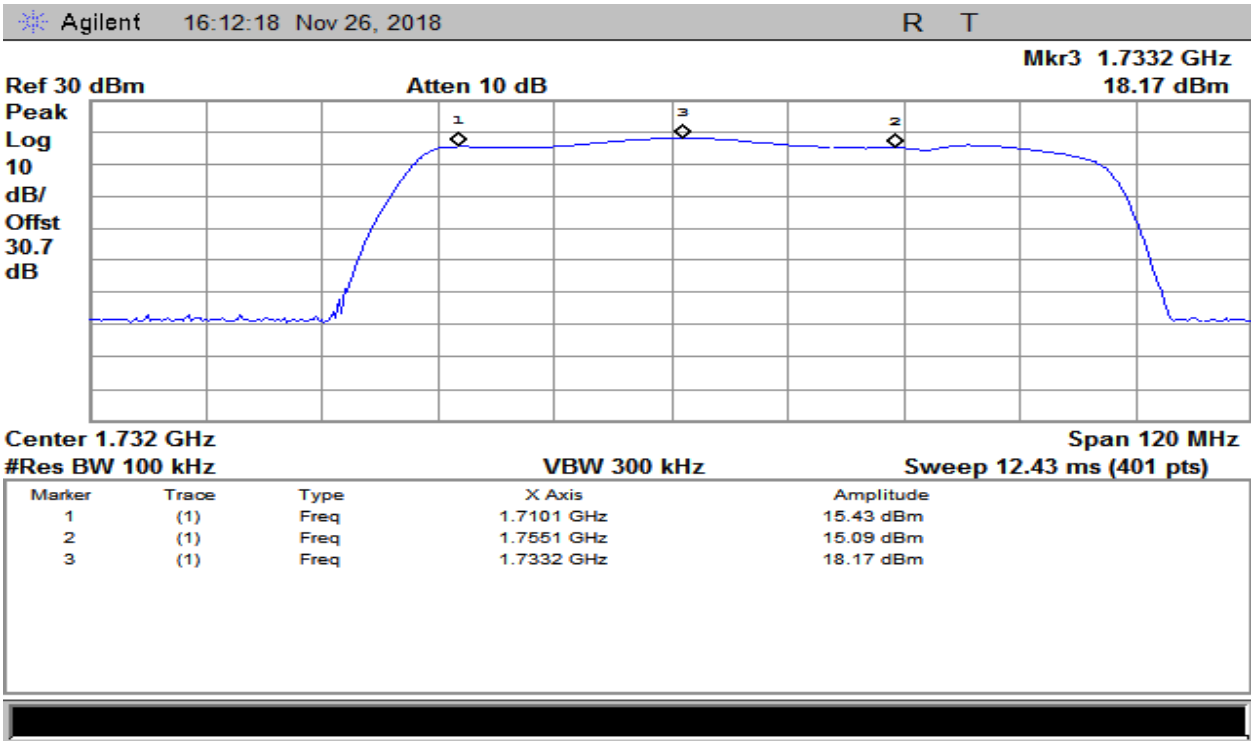
Plot 1 – 698-716MHz Band – Uplink



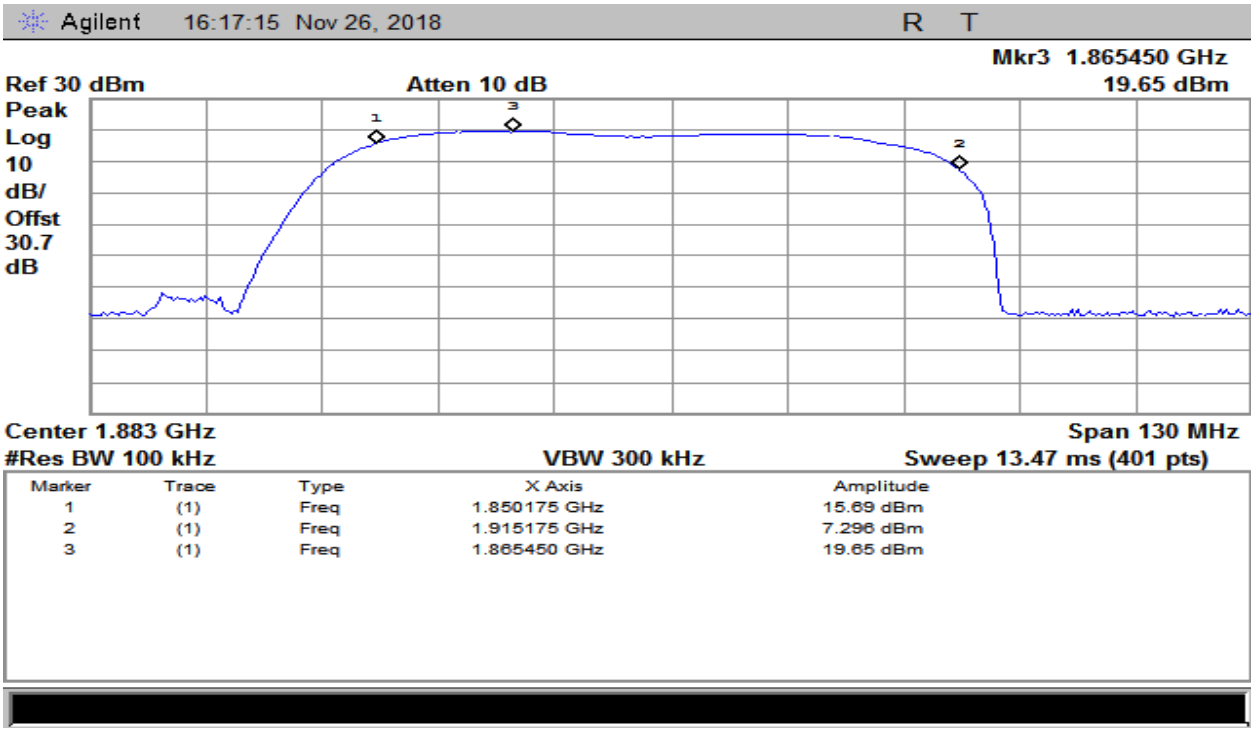
Plot 2 – 776-787MHz Band – Uplink



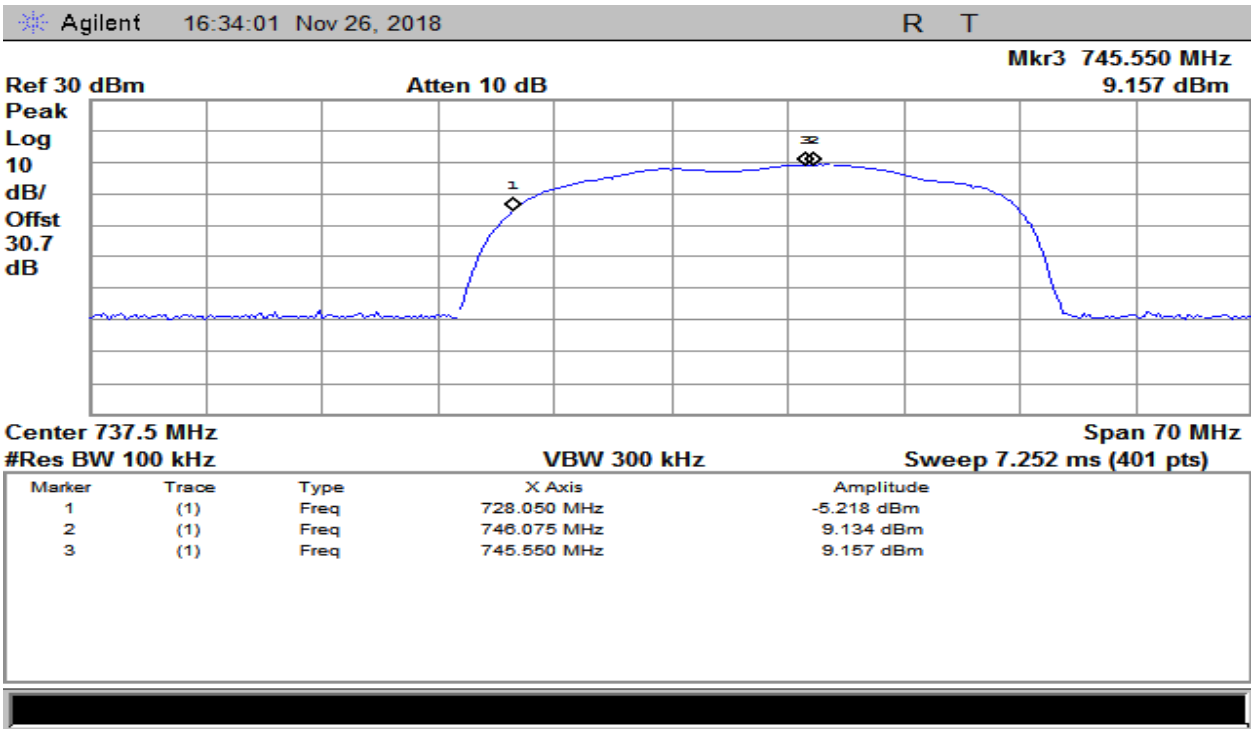
Plot 3 – 824-849MHz Band – Uplink



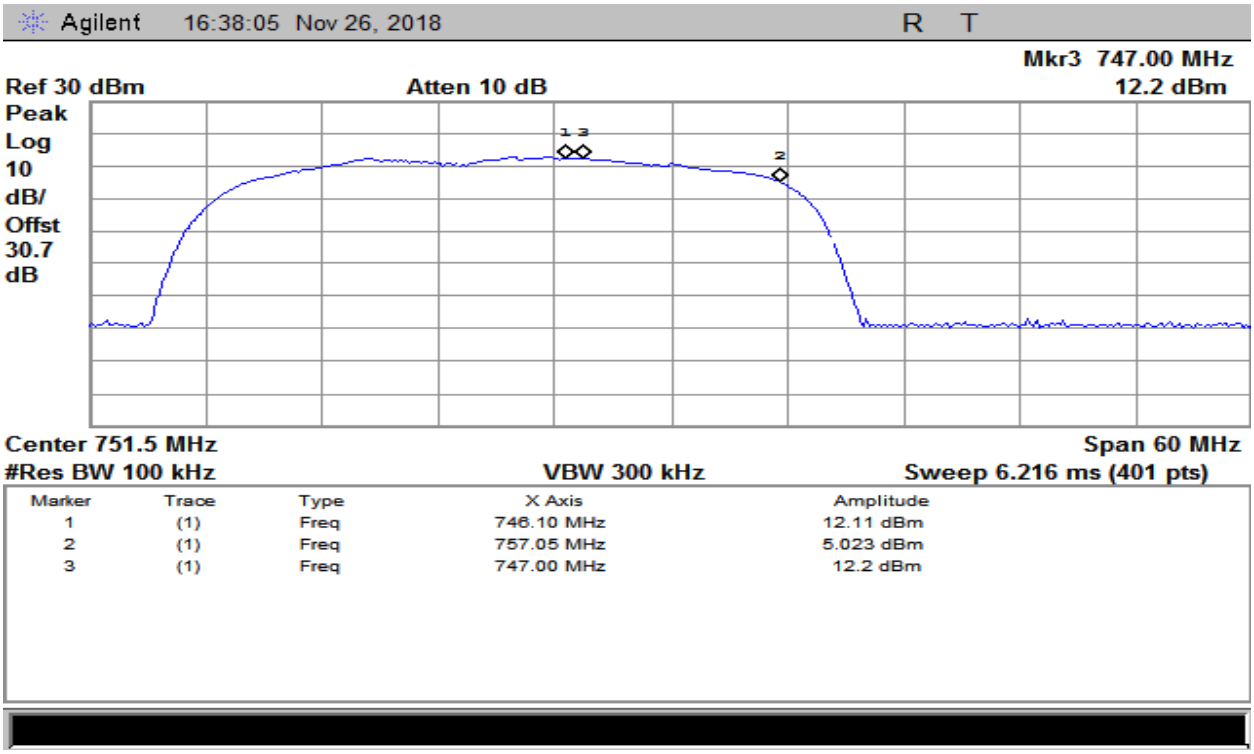
Plot 4 – 1710-1755MHz Band – Uplink



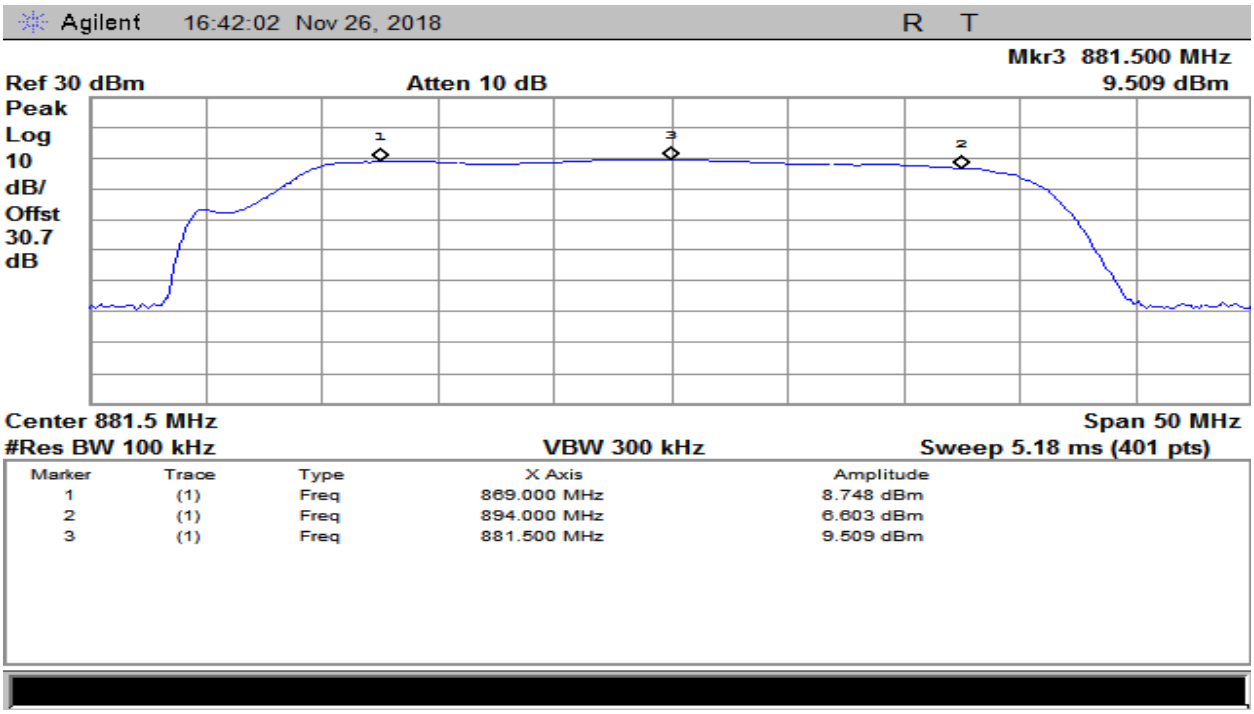
Plot 5 – 1850-1915MHz Band – Uplink



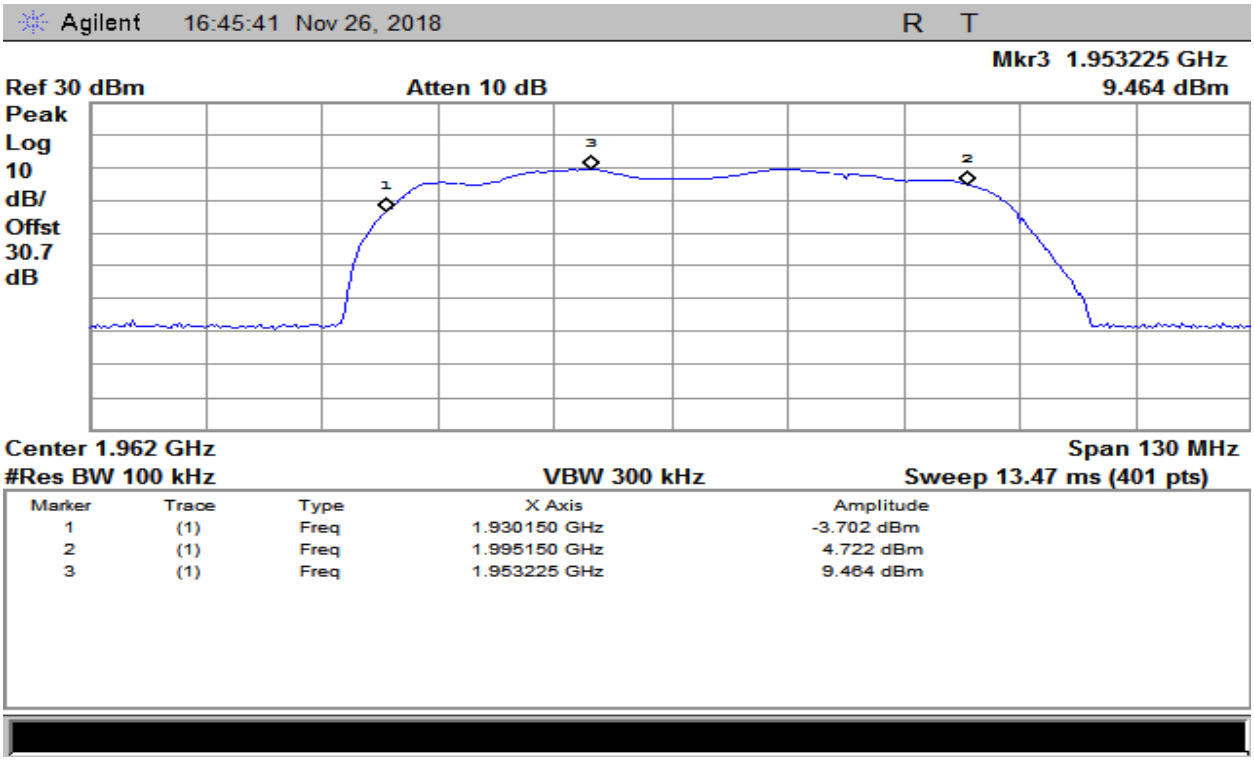
Plot 6 – 728-746MHz Band – Downlink



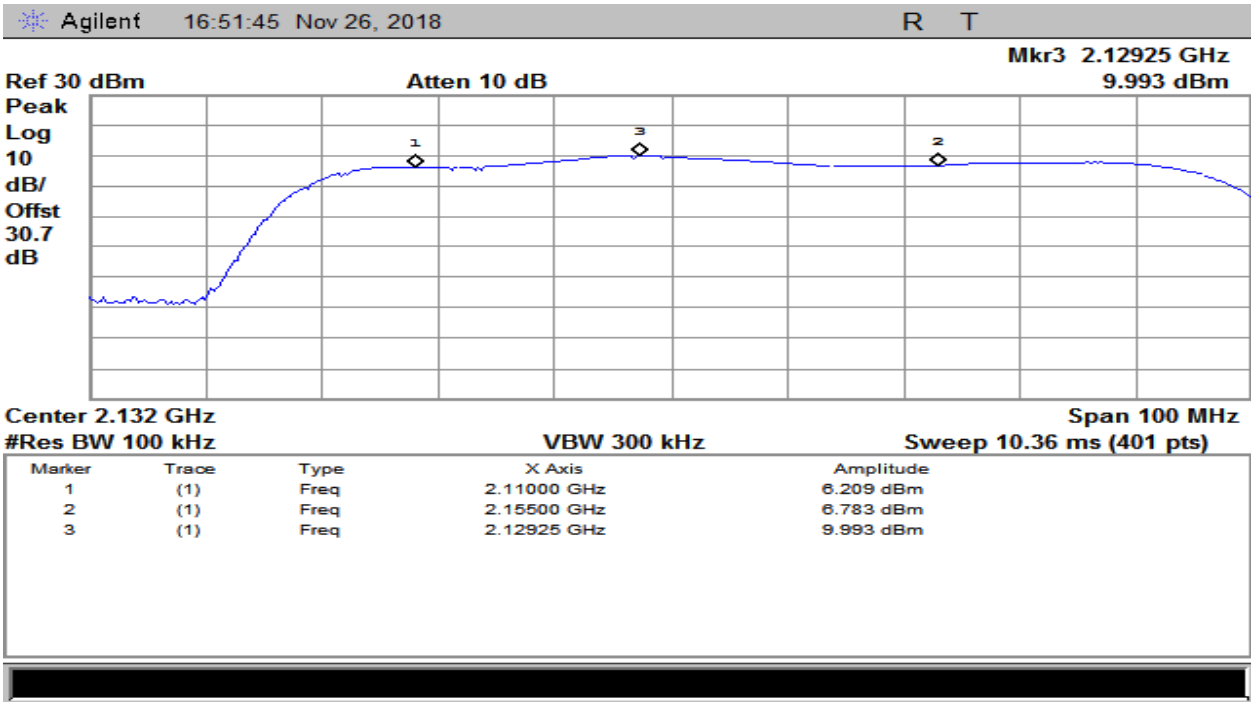
Plot 7 – 746-757MHz Band – Downlink



Plot 8 – 869-894MHz Band – Downlink



Plot 9 – 1930-1995MHz Band – Downlink



Plot 10 – 2110-2155MHz Band – Downlink

2. Maximum Power and Gain

Test Requirement(s):	§20.21(e)(8)(i)(D)	Test Engineer(s):	Hoosam B.
Test Results:	Pass	Test Date(s):	Nov/14/2018

Test Procedure: As required by 47 CFR 20.21(e)(8)(i)(D): Maximum power measurements were made at the RF output terminals of the EUT.

The EUT was connected as per Figure 1 through an attenuator to a Spectrum Analyzer. A signal generator was used for the input to the EUT to provide a GSM & AWGN with 99% of 4.1MHz bandwidth signal tuned to the highest frequency measured in Authorized frequency band test of each uplink and downlink operational band.

KDB Procedure 935210 D03 §7.2.2 and §7.3 was used to measure the maximum power of Fixed Booster and to calculate the maximum gain.

Test Results:

Frequency (MHz)	Input Level (dBm)	Output Power (dBm)	Lower Limit (dBm)	Upper Limit (dBm)
698-716 GSM	-38.4	25.14	17	30
698-716 AWGN	-38.94	24.04	17	30
776-787 GSM	-37.1	24.69	17	30
776-787 AWGN	-37.94	23.54	17	30
824-849 GSM	-36.8	25.06	17	30
824-849 AWGN	-38.14	23.48	17	30
1710-1755 GSM	-46.0	25.15	17	30
1710-1755 AWGN	-46.9	23.47	17	30
1850-1915 GSM	-44.7	25.16	17	30
1850-1915 AWGN	-47.0	23.97	17	30

Table 1. Uplink Max Power Test Results

Frequency (MHz)	Input Level (dBm)	Output Power (dBm)	Upper Limit (dBm)
728-746 GSM	-45.9	14.82	17
728-746 AWGN	-45.7	15.09	17
746-757 GSM	-46.1	14.65	17
746-757 AWGN	-45.7	15.06	17
869-894 GSM	-47.8	14.88	17
869-894 AWGN	-47.1	15.25	17
1930-1995 GSM	-50.9	14.95	17
1930-1995 AWGN	-51	15.17	17
2110-2155 GSM	-50.2	15.1	17
2110-2155 AWGN	-50.2	15.17	17

Table 2. Downlink Max Power Test Results

Modulation	Uplink Frequency (MHz	Downlink Frequency (MHz)	Uplink Gain (dB)	Uplink Limit (dB)	Downlink Gain (dB)	Downlink Limit (dB)	UL Gain - DL Gain (Delta in dB	Limit (dB)	Margin (dB)
GSM	707.25	743.5	63.45	63.49	60.72	63.8	2.73	9	6.27
AWGN	707.25	743.5	62.98	63.49	60.79	63.8	2.19	9	6.81
GSM	776.62	748.5	61.79	64.35	60.75	64.0	1.04	9	7.96
AWGN	776.62	748.5	61.48	64.35	60.76	64.0	0.72	9	8.28
GSM	836.20	881.5	61.86	64.94	62.68	65.4	-0.82	9	8.18
AWGN	836.20	881.5	61.62	64.94	62.35	65.4	-0.73	9	8.27
GSM	1733.20	1953.2	71.15	71.27	65.85	72.35	5.3	9	3.7
AWGN	1733.20	1953.2	70.37	71.27	66.17	72.35	4.2	9	4.8
GSM	1865.45	2129.25	69.86	71.99	65.3	73.07	4.56	9	4.44
AWGN	1865.45	2129.25`	70.97	71.99	65.37	73.07	5.6	9	3.4

Table 3. Maximum Booster Gain Test Results

3. Intermodulation

Test Requirement(s):	CFR §20.21(e)(8)(i)(F)	Test Engineer(s):	Hoosam B.
Test Results:	Pass	Test Date(s):	Nov/15/2018

Test Procedures: As required by 47 CFR §20.21(e)(8)(i)(F), Intermodulation measurements were made at the RF output terminals of the EUT.

The EUT was connected through an attenuator to a Spectrum Analyzer. Signal generator was setup for a two-tone CW signal with 300kHz offset below and above the operational band frequency. Measurements were made as per KDB 935210 D03 §7.4 procedure.

Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
RMS	3kHz	≥3 x RBW	5MHz

Table 4 – Analyzer Settings

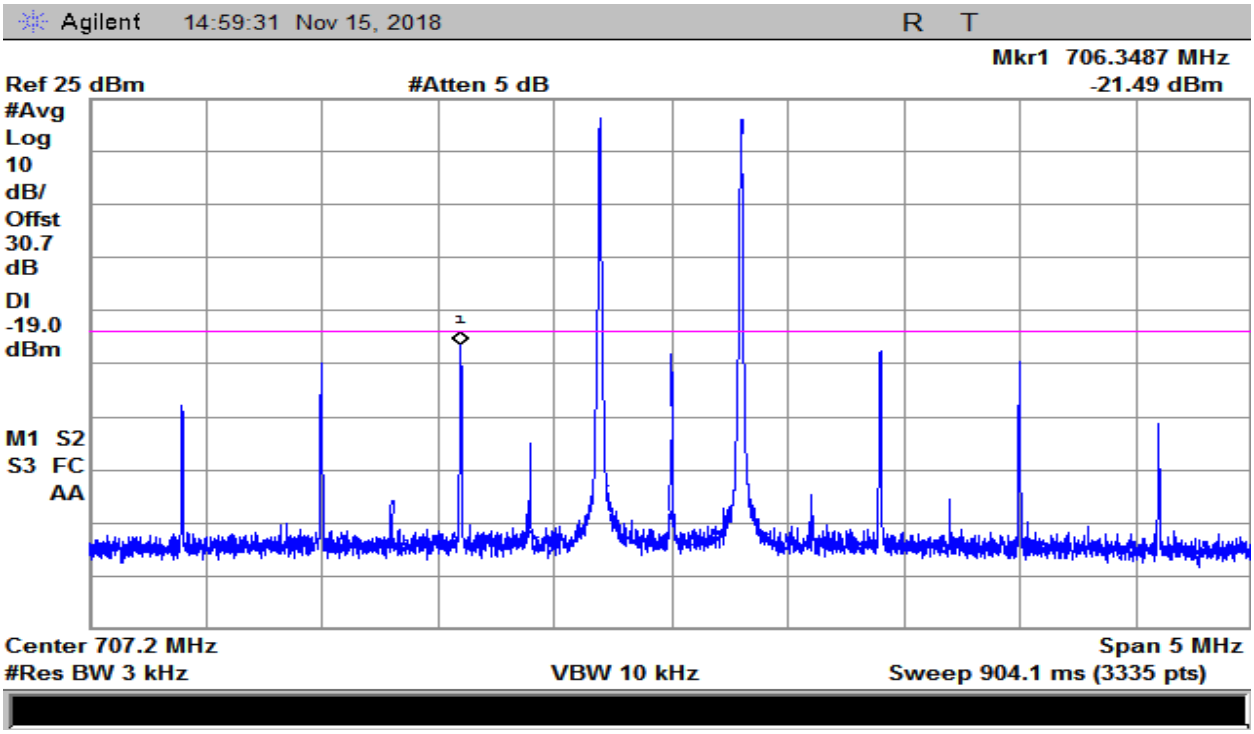
Frequency Band (MHz)	Intermodulation Level (dBm)	Limit (dBm)	Margin (dB)
698-716	-21.29	-19	-2.99
776-787	-19.8	-19	-0.8
824-849	-19.93	-19	-0.93
1710-1755	-20.95	-19	-1.95
1850-1915	-22.22	-19	-3.22

Table 5. Summary Uplink Intermodulation, Test Results

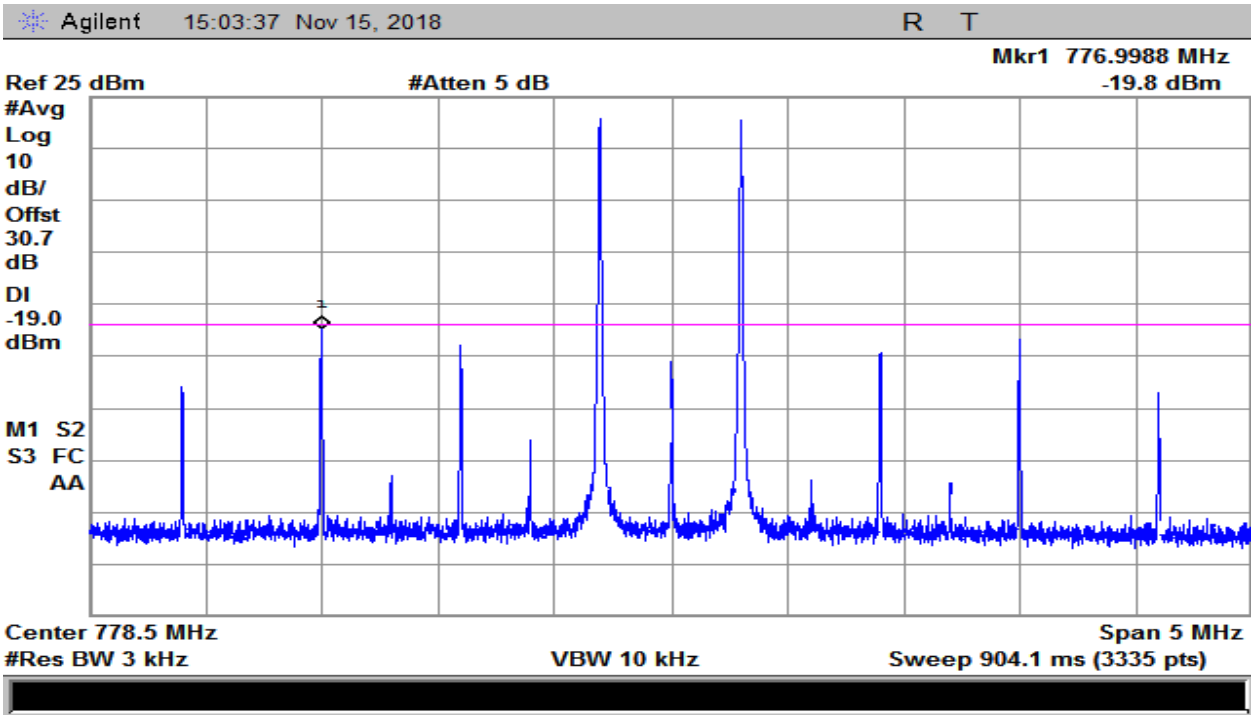
Frequency (MHz)	Intermodulation Level (dBm)	Limit (dBm)	Margin (dB)
728-746	-35.69	-19	-16.69
746-757	-35.19	-19	-16.19
869-894	-46.13	-19	-27.13
1930-1995	-36.14	-19	-17.14
2110-2155	-40.87	-19	-21.87

Table 6. Summary Downlink Intermodulation Test Results

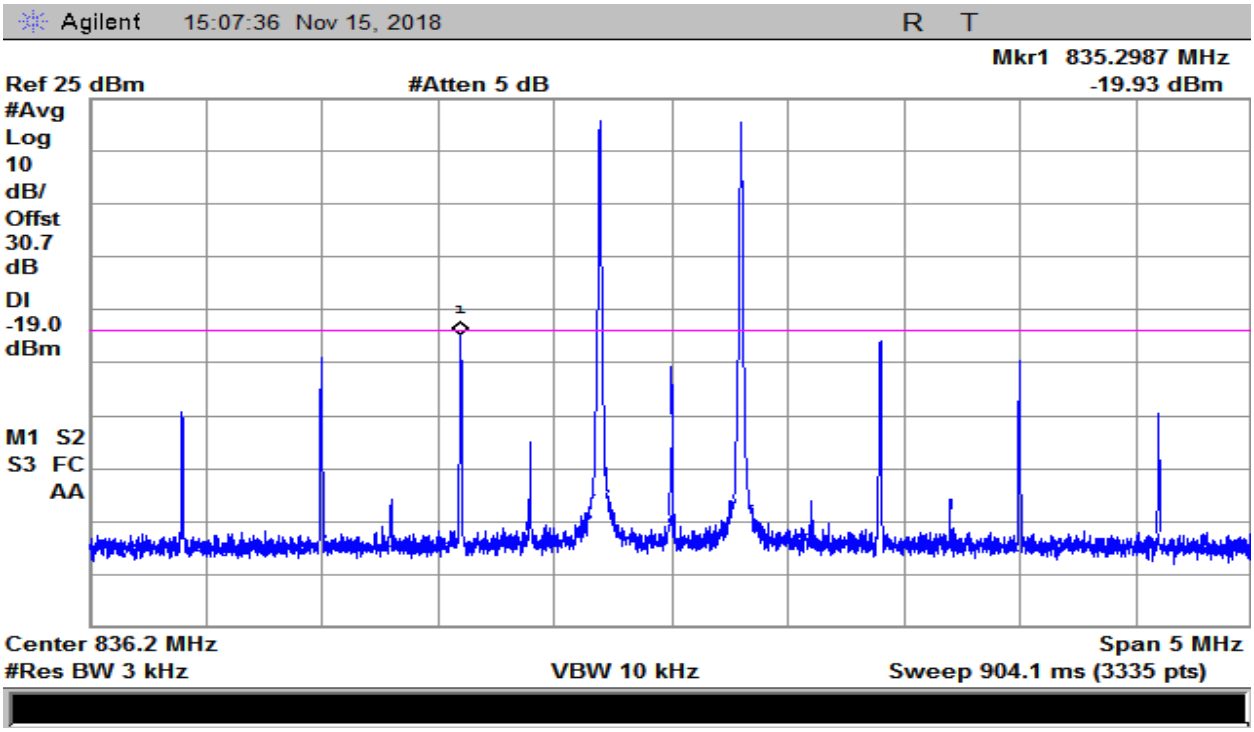
Statement: Device complies with 10dB above AGC power level for both uplink and downlink bands



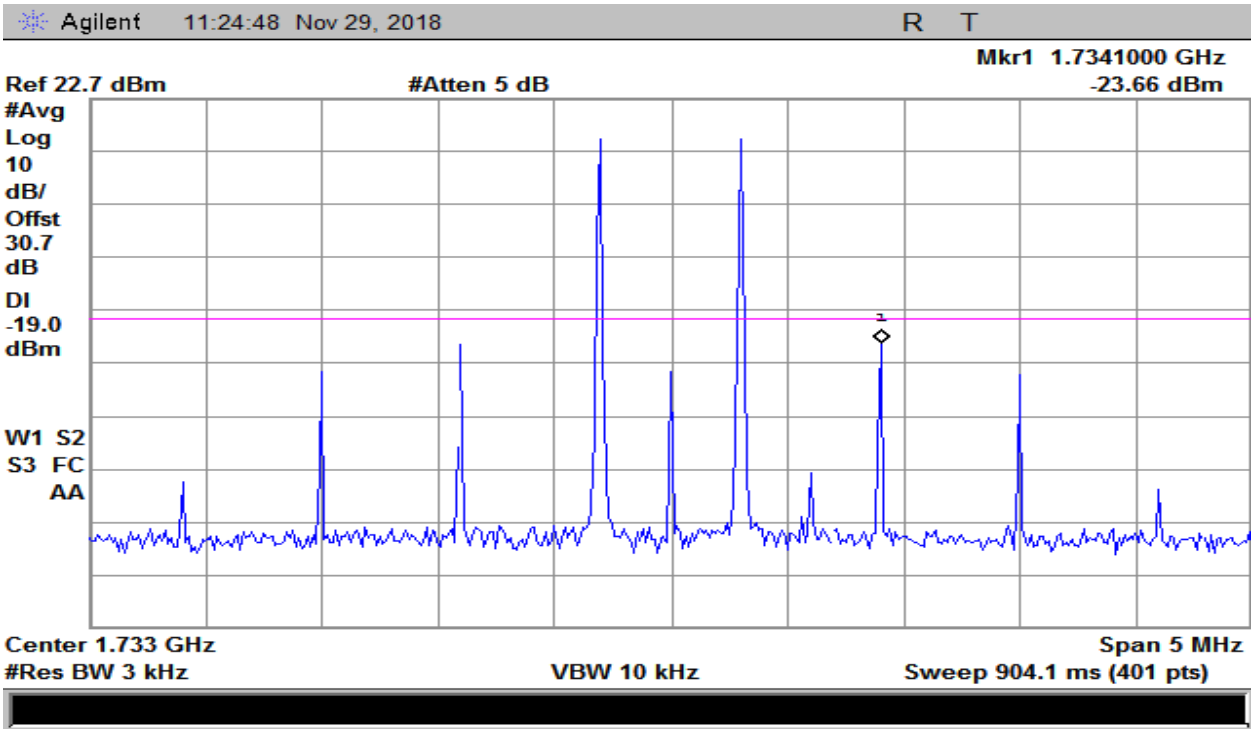
Plot 11 698-716MHz Band – Uplink



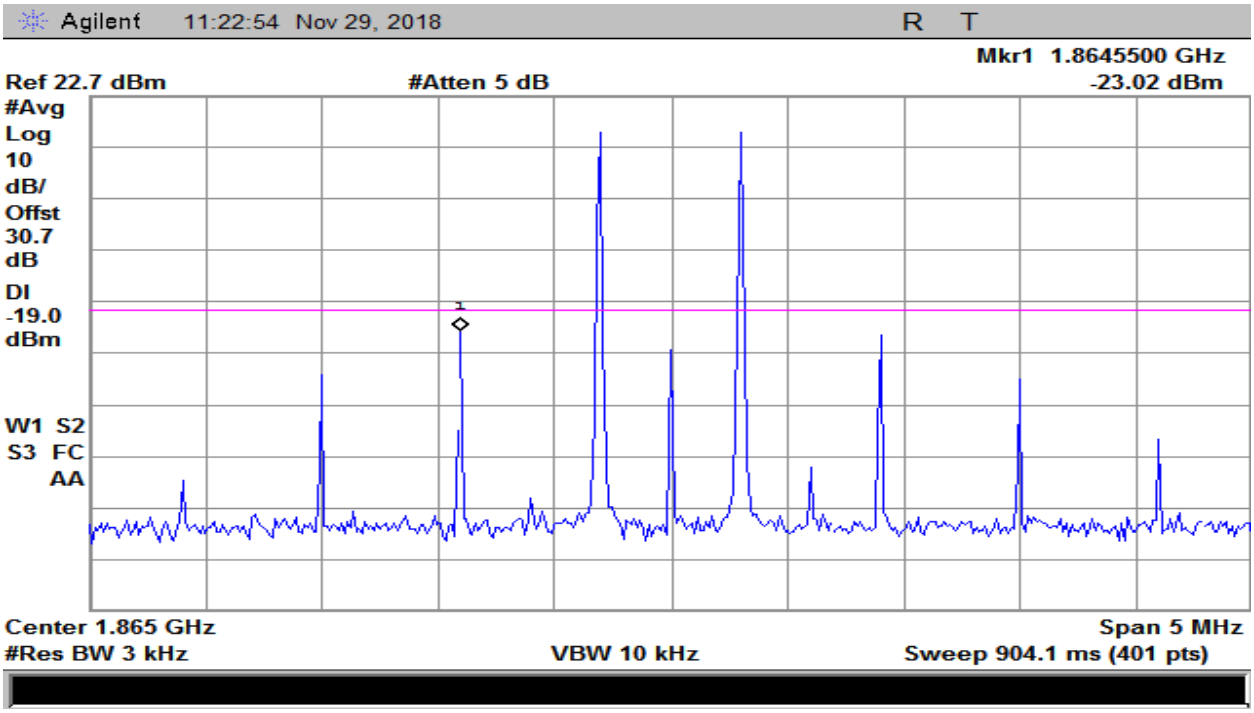
Plot 12 – 776-787MHz Band – Uplink



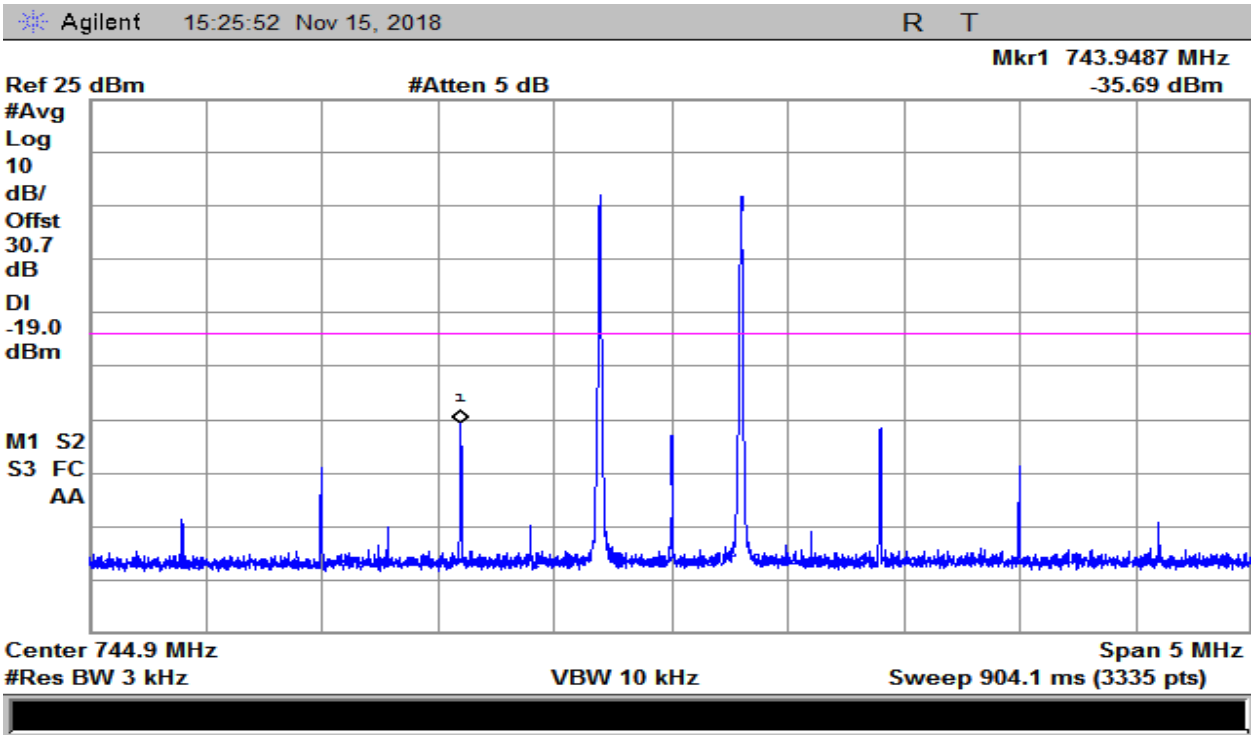
Plot 13 – 824-849MHz Band – Uplink



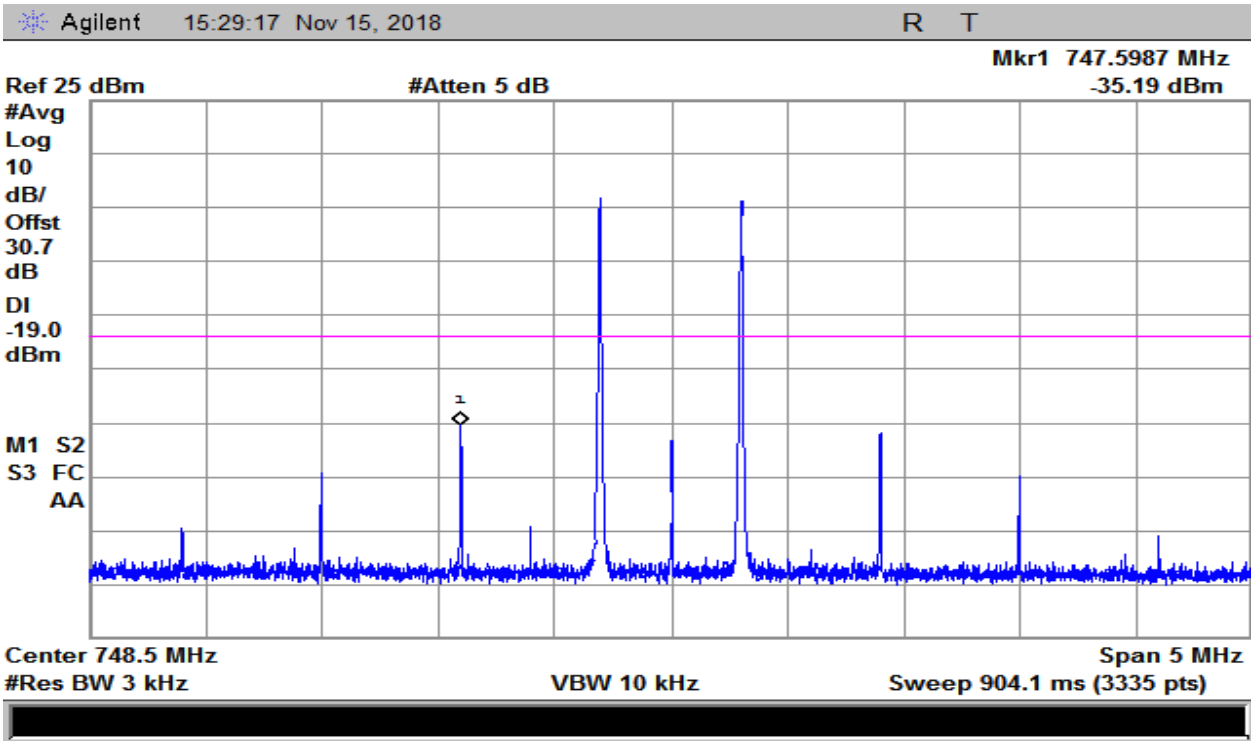
Plot 14 – 1710-1755MHz Band – Uplink



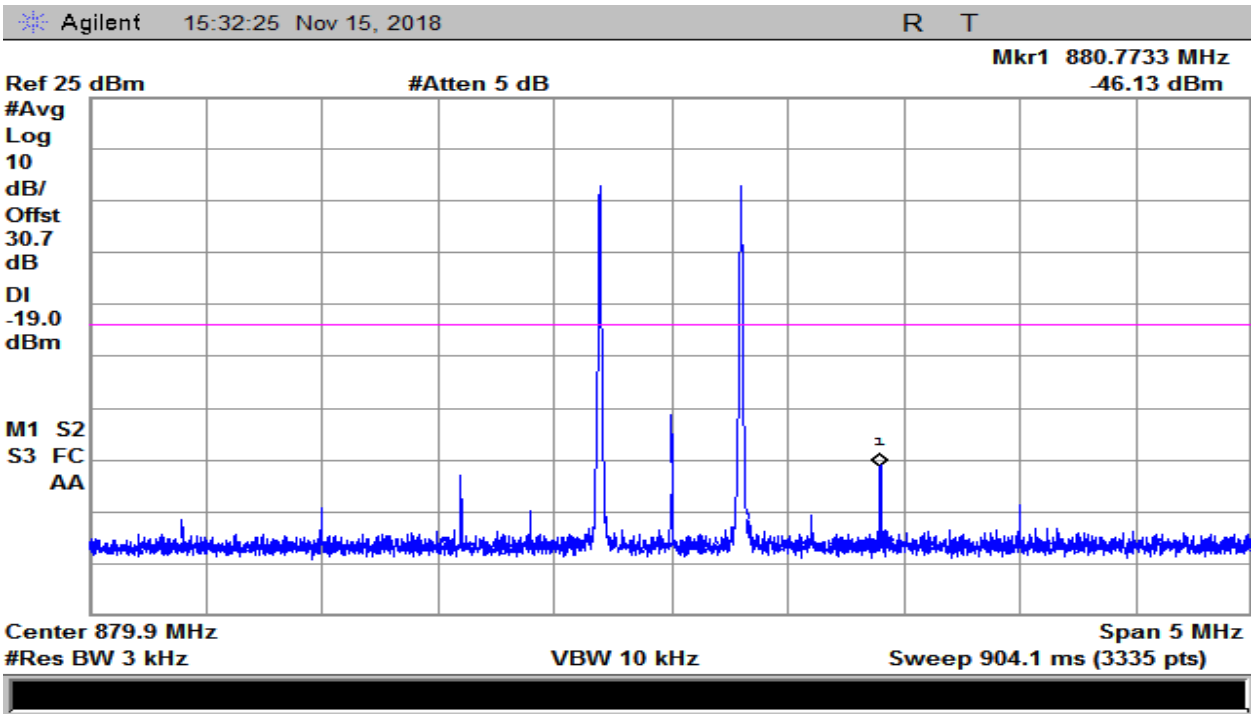
Plot 15 – 1850-1915MHz Band – Uplink



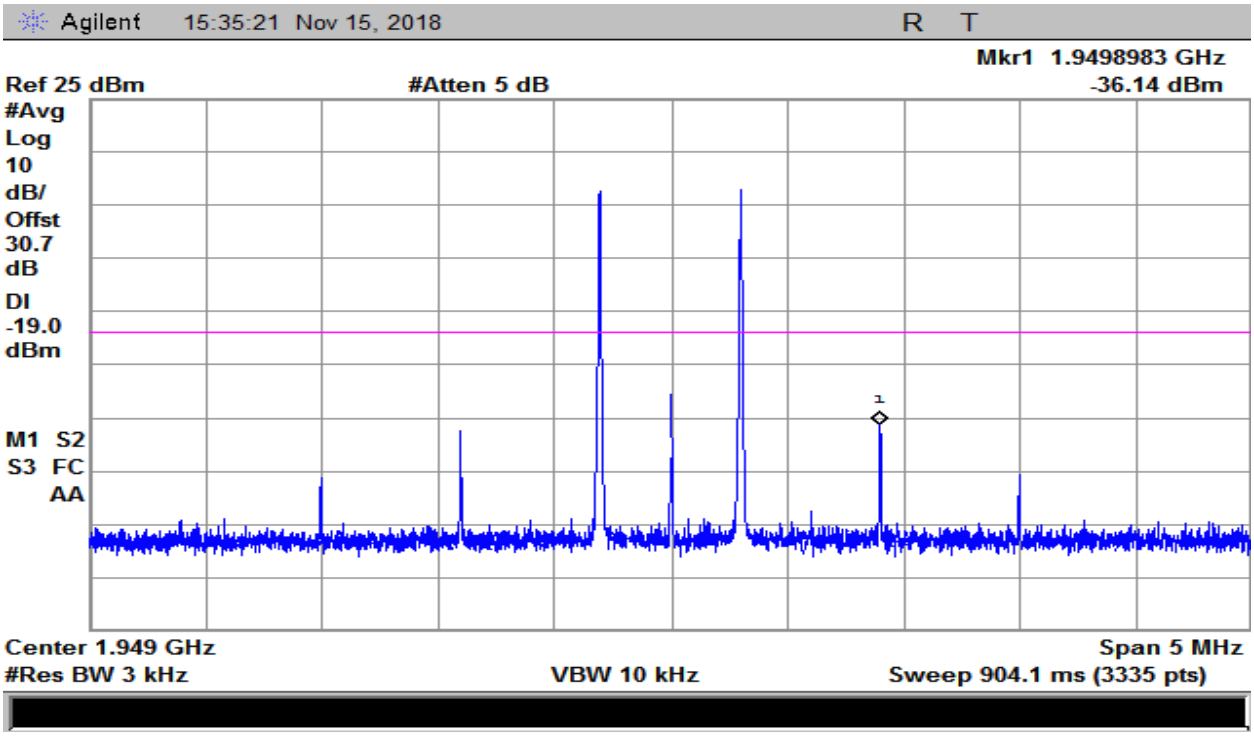
Plot 16 – 728-746MHz Band – Downlink



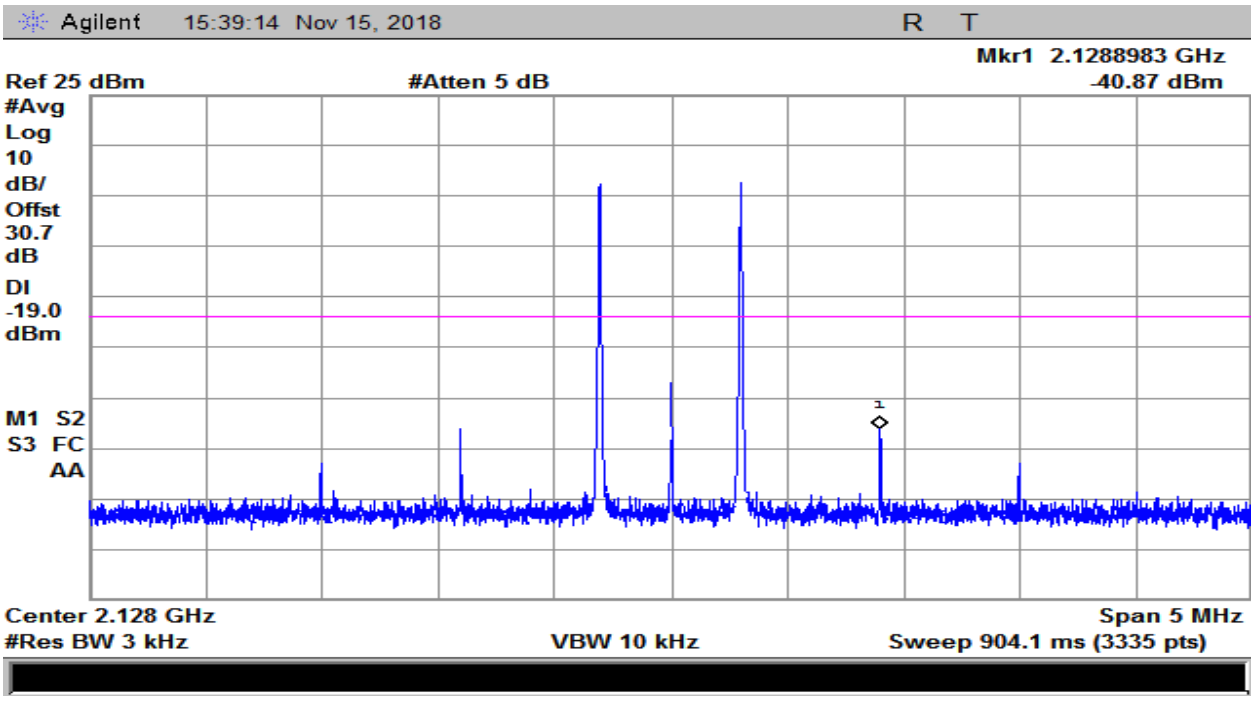
Plot 17 – 746-757MHz Band – Downlink



Plot 18 – 869-894MHz Band – Downlink



Plot 19 – 1930-1995MHz Band – Downlink



Plot 20 – 2110-2155MHz Band – Downlink

4. Out-of-band emissions

Test Requirement(s):	§20.21§(8)(i)(E)	**Test Engineer(s):**	Keith T.
Test Results:	Pass	**Test Date(s):**	Nov/21/2018

Test Procedures:

As required by 47 CFR §20.21(8)(i)(E), Out-of-band emissions measurements were made at the RF output terminals of the EUT.

The EUT was connected through an attenuator to a Spectrum Analyzer as per figure 1. Signal generator was setup to produce GSM, LTE & CDMA signals for all uplink and downlink bands. Measurements were made as per procedure defined in KDB 935210 D03 §7.5.

Out of Band Emission Limits = P1 - 6 – (43 _ 10log (P2) = -19dBm

Where P1 = Power in dBm and P2 = Power in Watts

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)
698-716	Lower	-30.88	-19
698-716	Upper	-30.2	-19
776-787	Lower	-25.53	-19
776-787	Upper	-24.99	-19
824-849	Lower	-47.87	-19
824-849	Upper	-38.88	-19
1710-1755	Lower	-38.17	-19
1710-1755	Upper	-37.9	-19
1850-1915	Lower	-38.17	-19
1850-1915	Upper	-50.2	-19

Table 7. GSM Uplink – Out-of band Emissions, Test Results

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)
698-716	Lower	-52.32	-19
698-716	Upper	-43.61	-19
776-787	Lower	-33.59	-19
776-787	Upper	-29.0	-19
824-849	Lower	-28.38	-19
824-849	Upper	-31.22	-19
1710-1755	Lower	-35.1	-19
1710-1755	Upper	-32.88	-19
1850-1915	Lower	-40.47	-19
1850-1915	Upper	-52.85	-19

Table 8. CDMA Uplink – Out-of band Emissions, Test Results

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)
698-716	Lower	-37.14	-19
698-716	Upper	-39.94	-19
776-787	Lower	-25.76	-19
776-787	Upper	-25.49	-19
824-849	Lower	-26.15	-19
824-849	Upper	-29.14	-19
1710-1755	Lower	-47.29	-19
1710-1755	Upper	-31.43	-19
1850-1915	Lower	-34.54	-19
1850-1915	Upper	-46.08	-19

Table 9. LTE Uplink – Out-of band Emissions, Test Results

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)
728-746	Lower	-67.41	-19
728-746	Upper	-61.36	-19
746-757	Lower	-59.79	-19
746-757	Upper	-64.81	-19
869-894	Lower	-60.66	-19
869-894	Upper	-60.85	-19
1930-1995	Lower	-63.39	-19
1930-1995	Upper	-58.09	-19
2110-2155	Lower	-59.54	-19
2110-2155	Upper	-58.35	-19

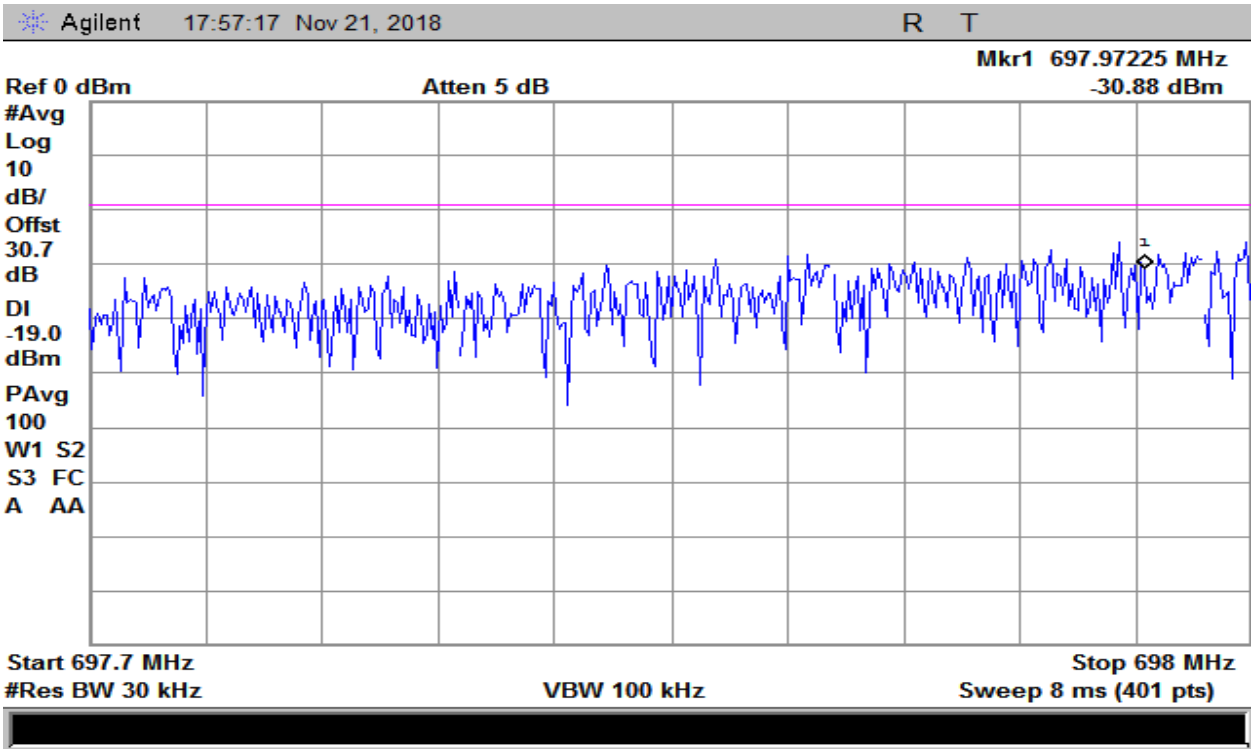
Table 10. GSM Downlink – Out-of band Emissions, Test Results

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)
728-746	Lower	-67.31	-19
728-746	Upper	-60.87	-19
746-757	Lower	-59.82	-19
746-757	Upper	-64.95	-19
869-894	Lower	-59.85	-19
869-894	Upper	-60.57	-19
1930-1995	Lower	-65.67	-19
1930-1995	Upper	-61.52	-19
2110-2155	Lower	-59.45	-19
2110-2155	Upper	-58.88	-19

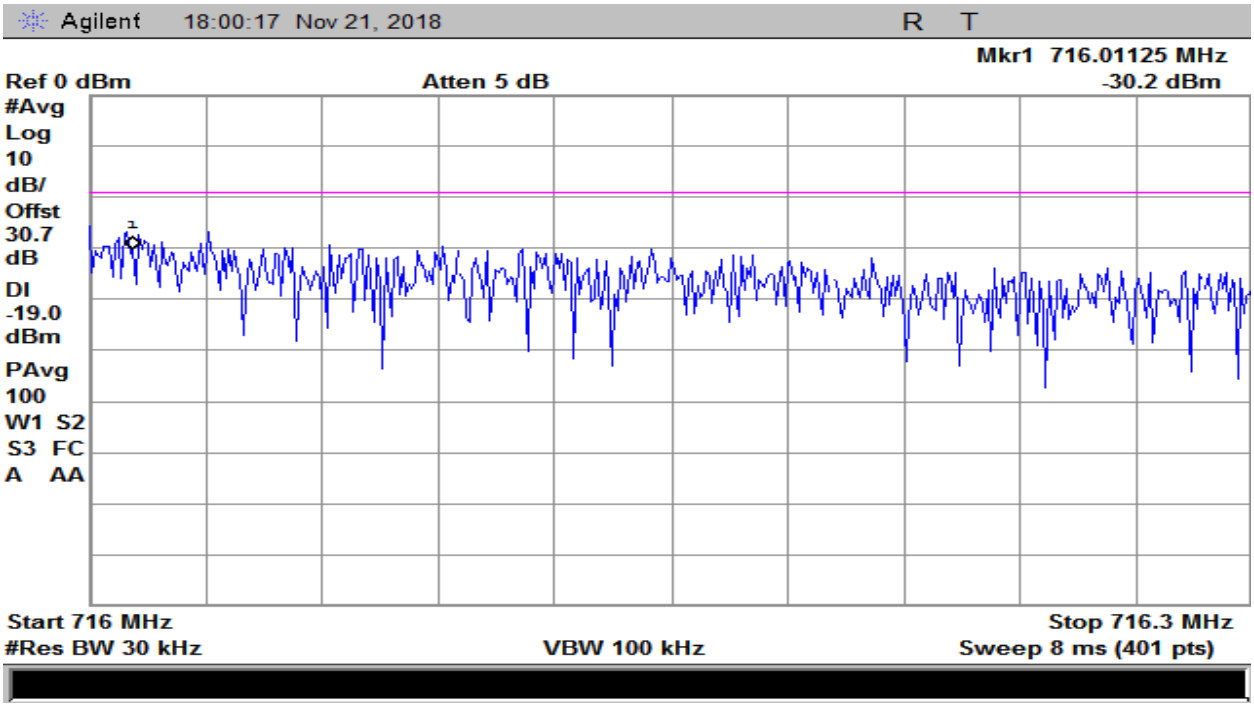
Table 11. CDMA Downlink – Out-of band Emissions, Test Results

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)
728-746	Lower	-65.41	-19
728-746	Upper	-60.45	-19
746-757	Lower	-57.97	-19
746-757	Upper	-61.54	-19
869-894	Lower	-60.60	-19
869-894	Upper	-60.35	-19
1930-1995	Lower	-63.63	-19
1930-1995	Upper	-58.33	-19
2110-2155	Lower	-53.96	-19
2110-2155	Upper	-53.02	-19

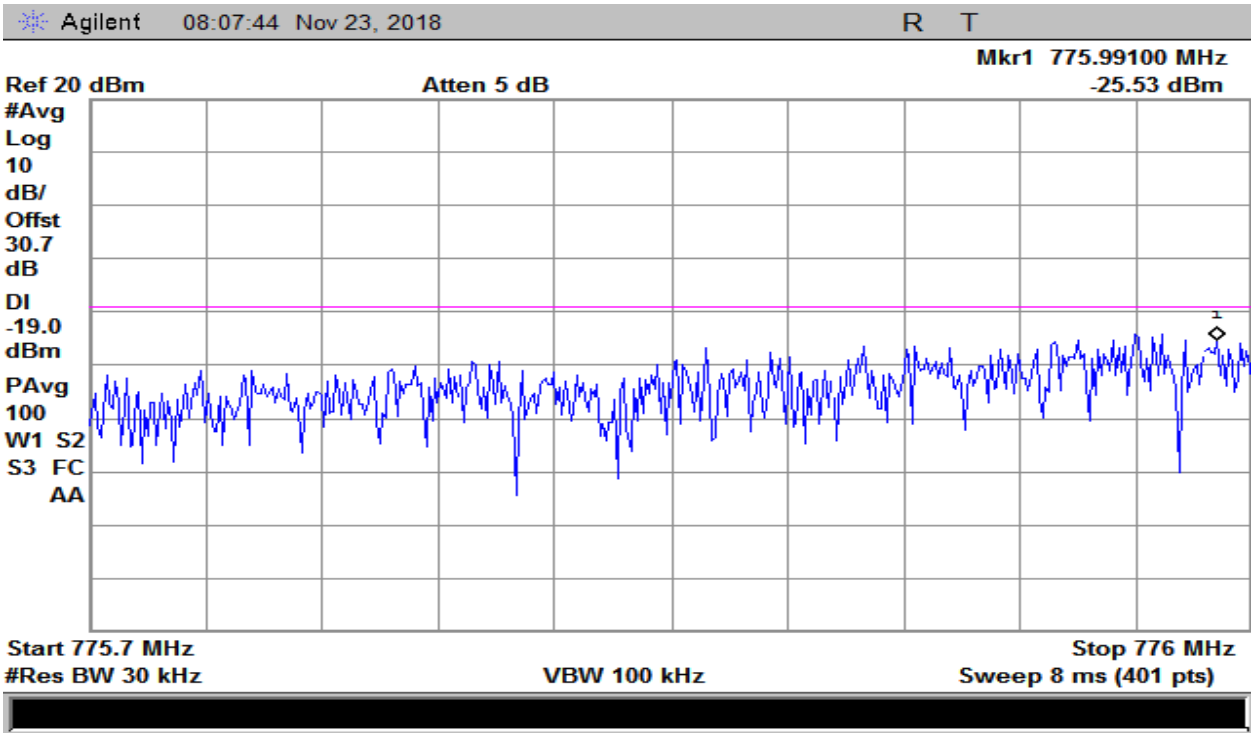
Table 12. LTE Downlink – Out-of band Emissions, Test Results



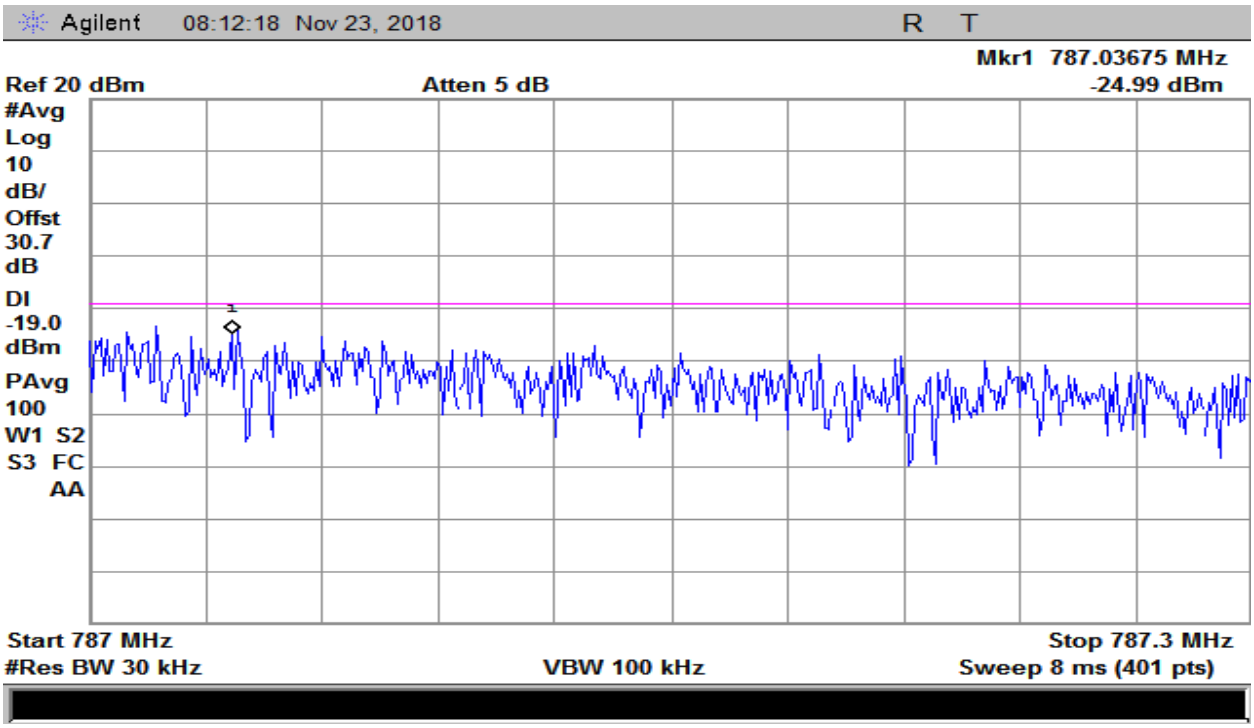
Plot 21 – 698-716MHz Band – GSM Uplink Lower Band Edge



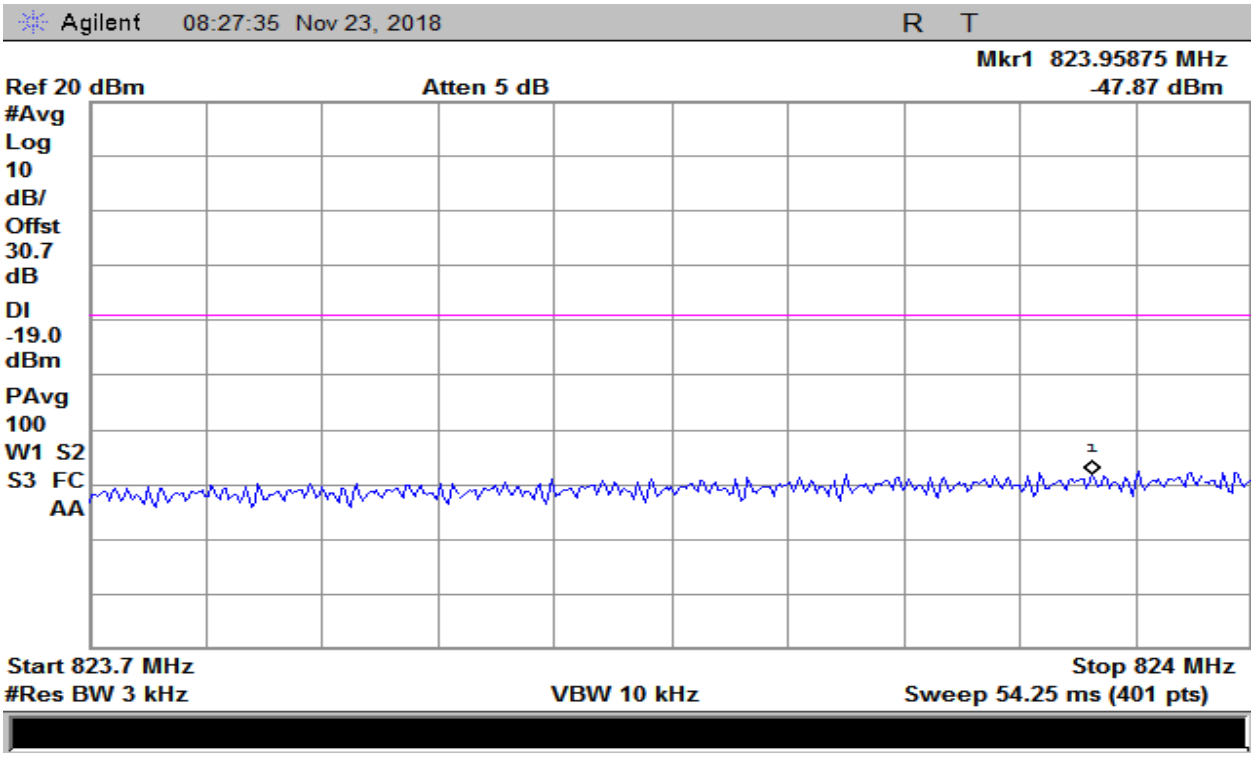
Plot 22 - 698-716MHz Band – GSM Uplink Upper Band Edge



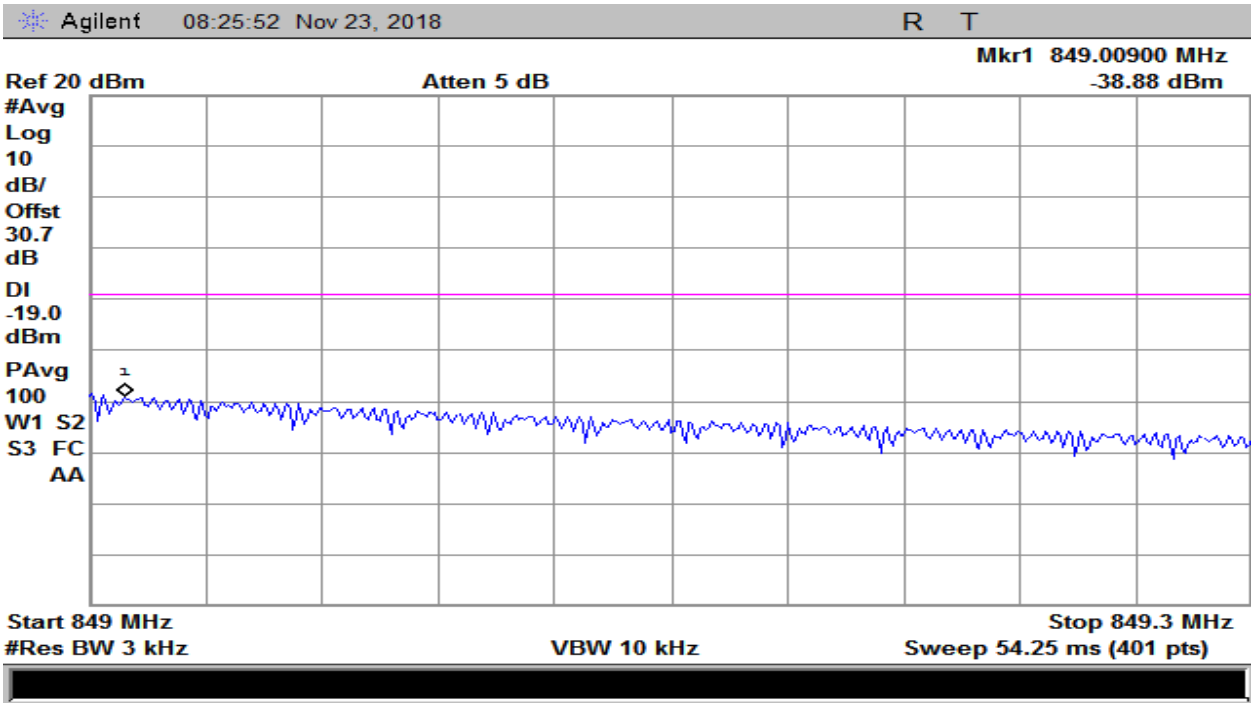
Plot 23 – 776-787MHz Band – GSM Uplink Lower Band Edge



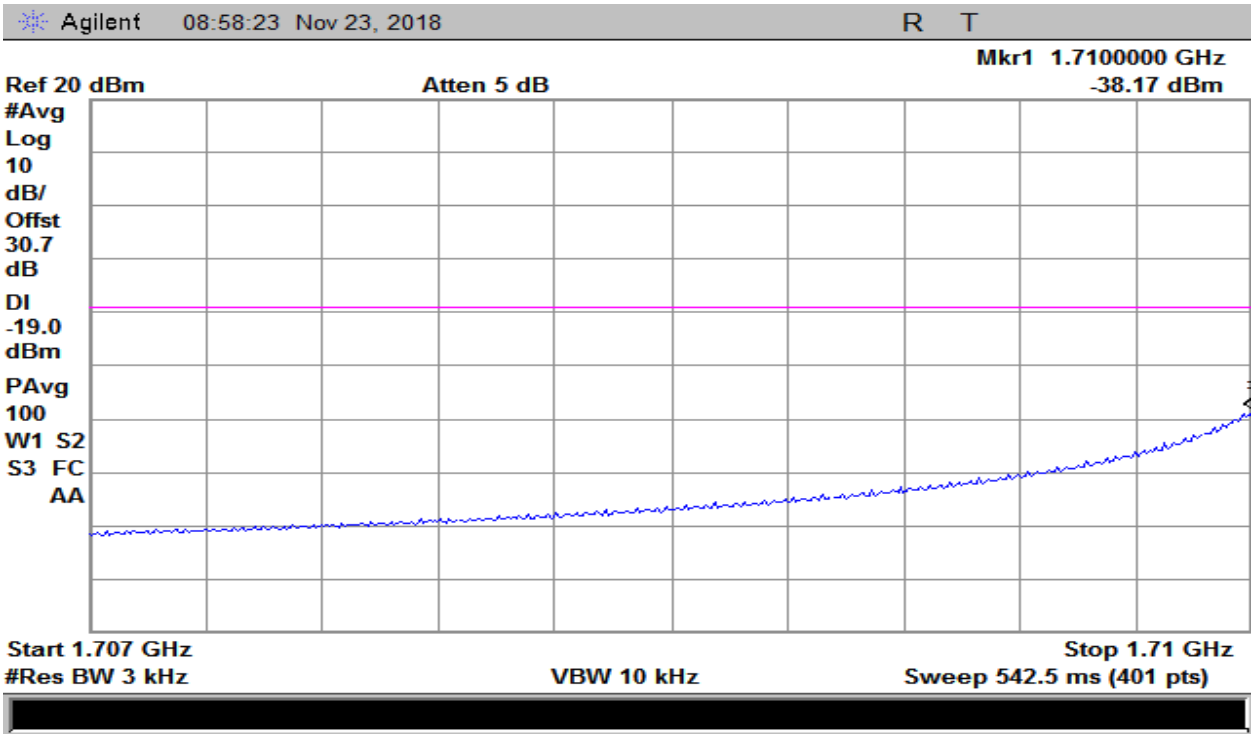
Plot 24 – 776-787MHz Band – GSM Uplink Upper Band Edge



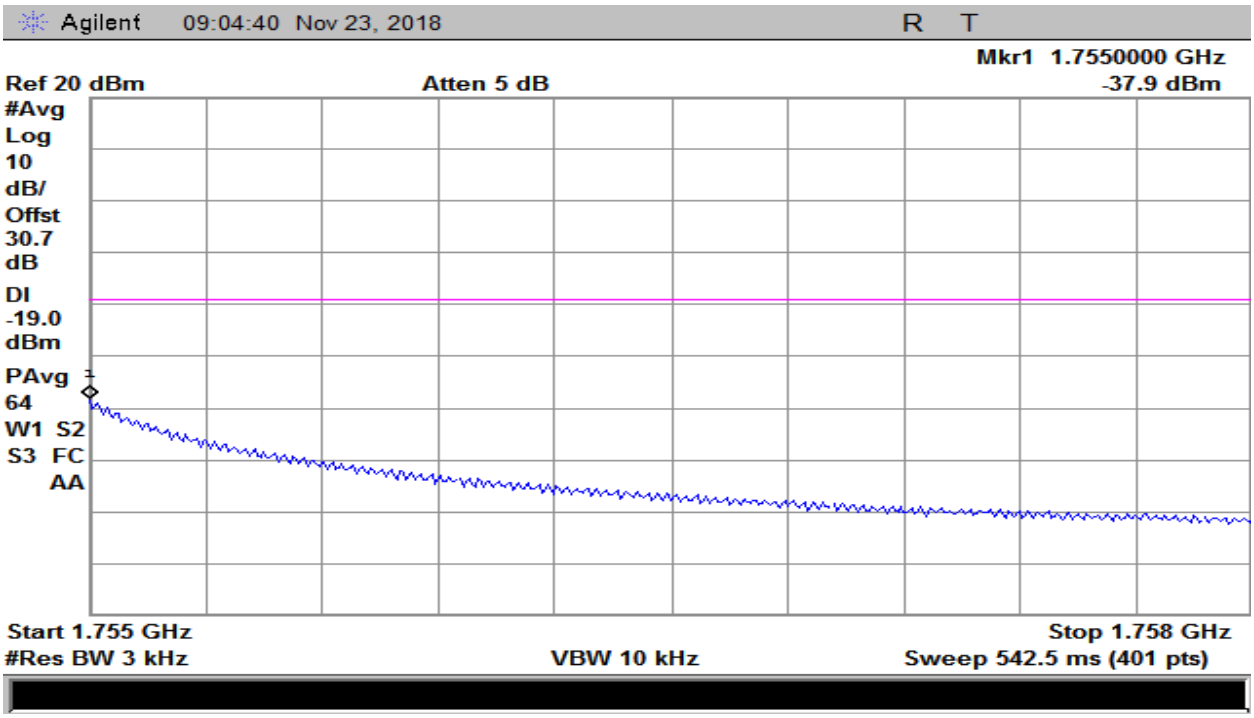
Plot 25 – 824-849MHz Band – GSM Uplink Lower Band Edge



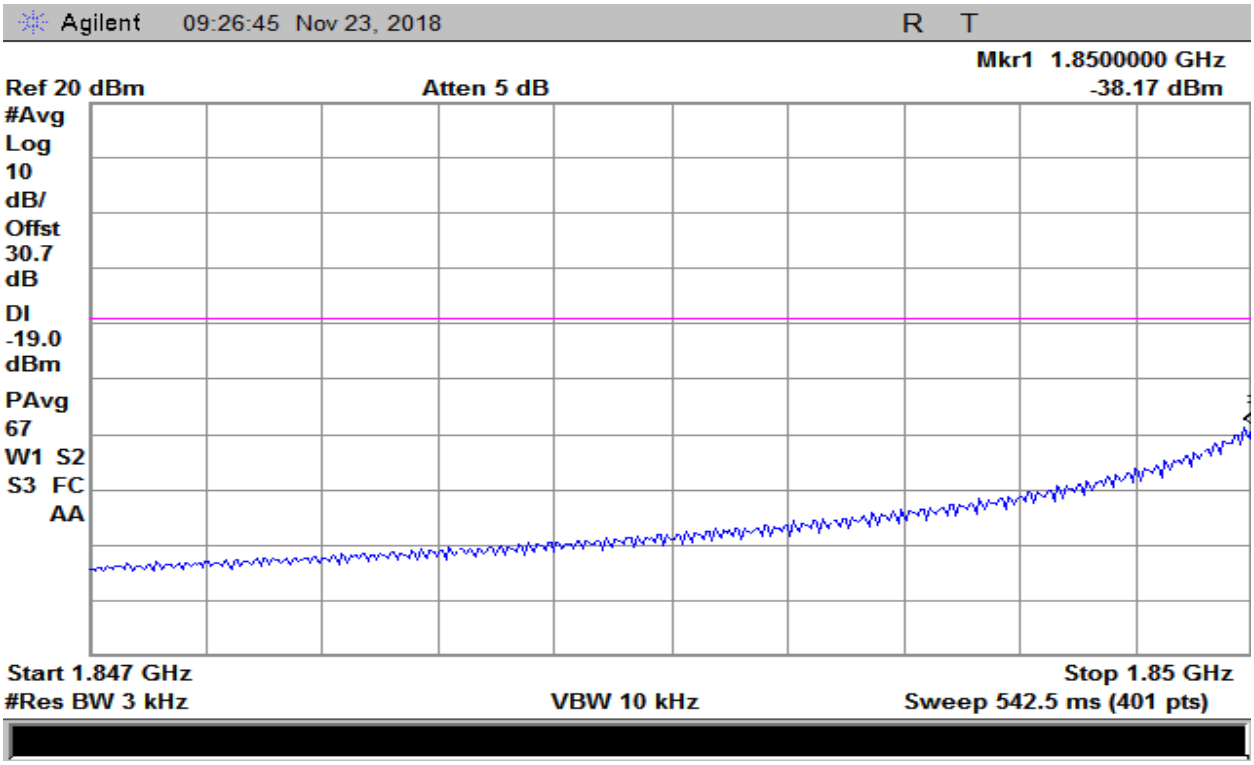
Plot 26 – 824-849MHz Band – GSM Uplink Upper Band Edge



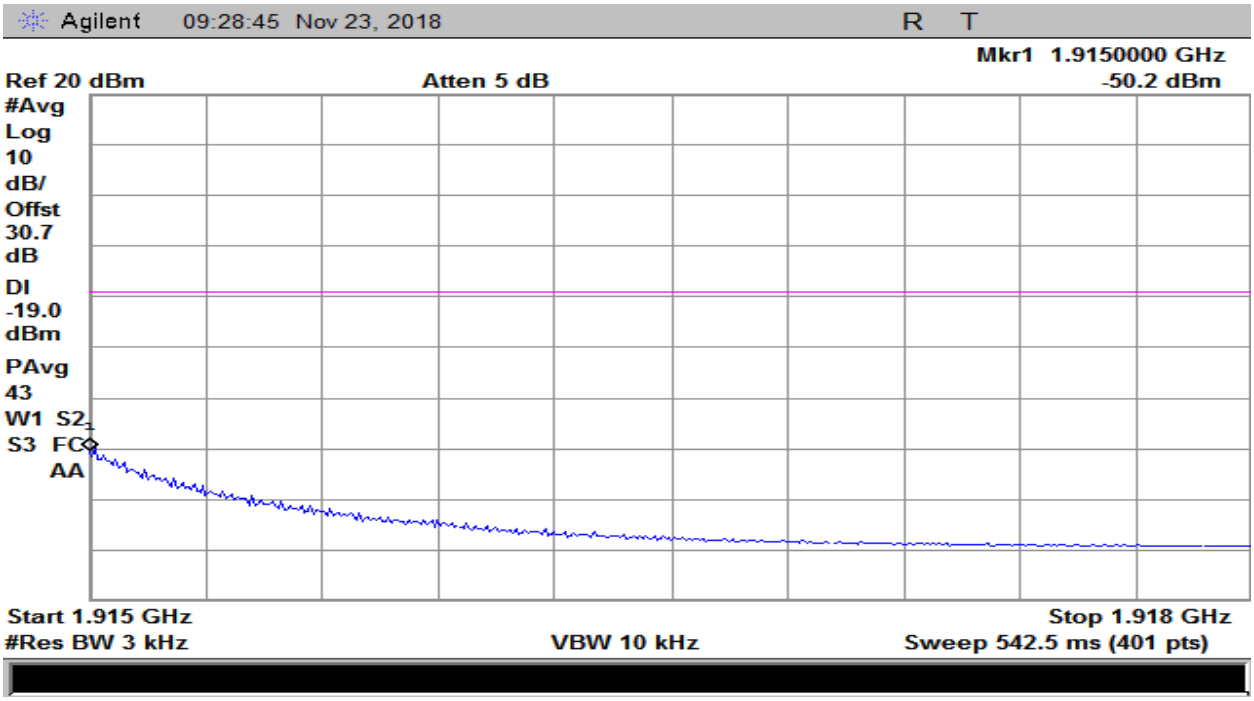
Plot 26 – 1710-1755MHz Band – GSM Uplink Lower Band Edge



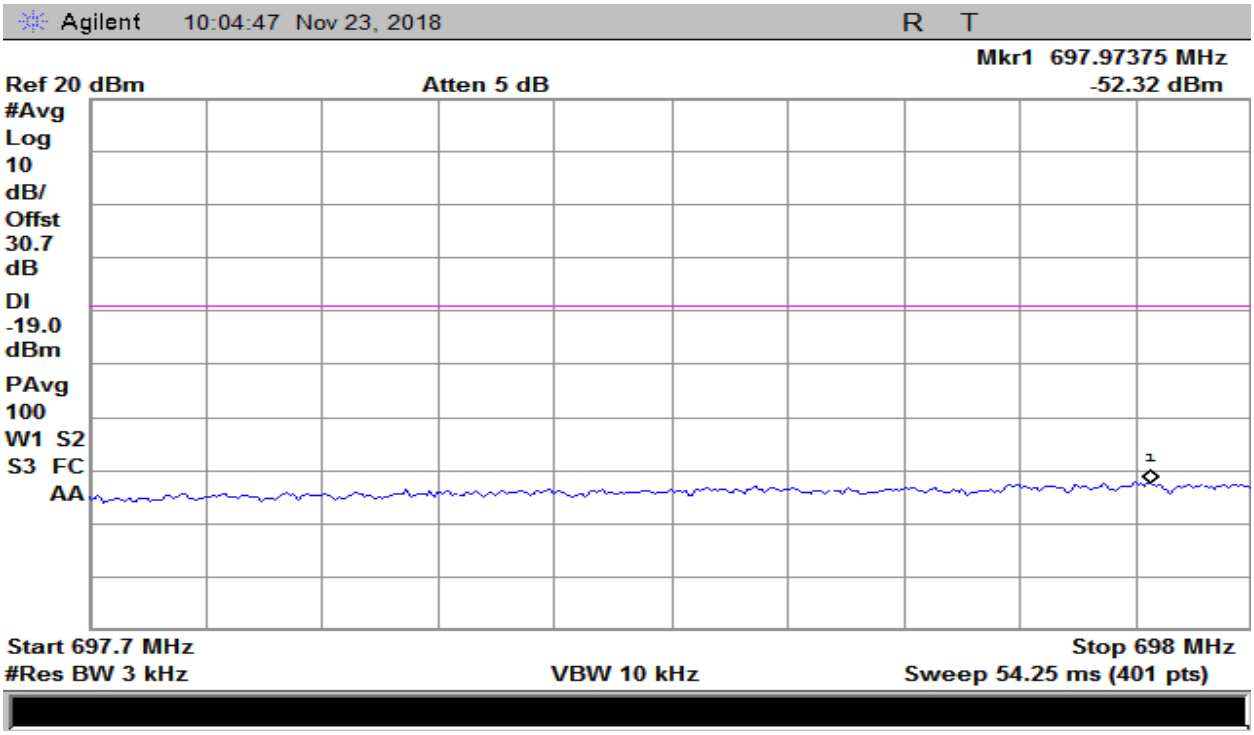
Plot 27 – 1710-1755MHz Band – GSM Uplink Upper Band Edge



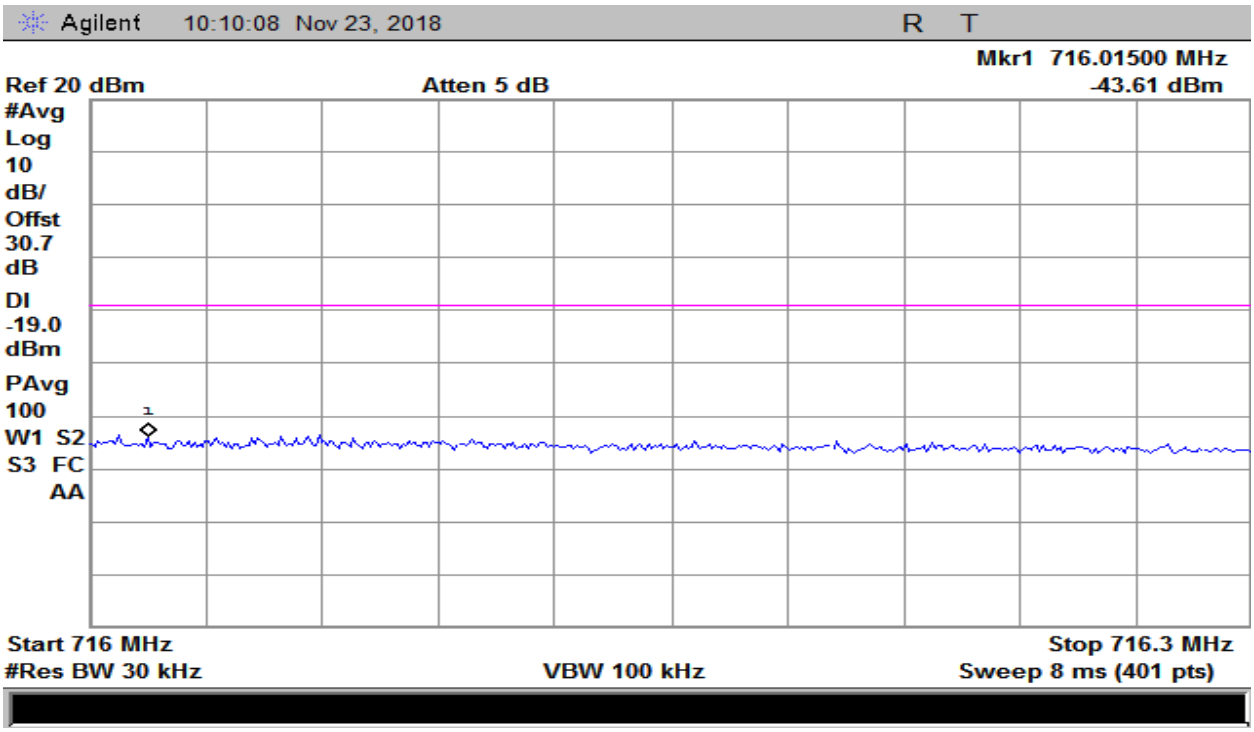
Plot 28 – 1850-1915MHz Band – GSM Uplink Lower Band Edge



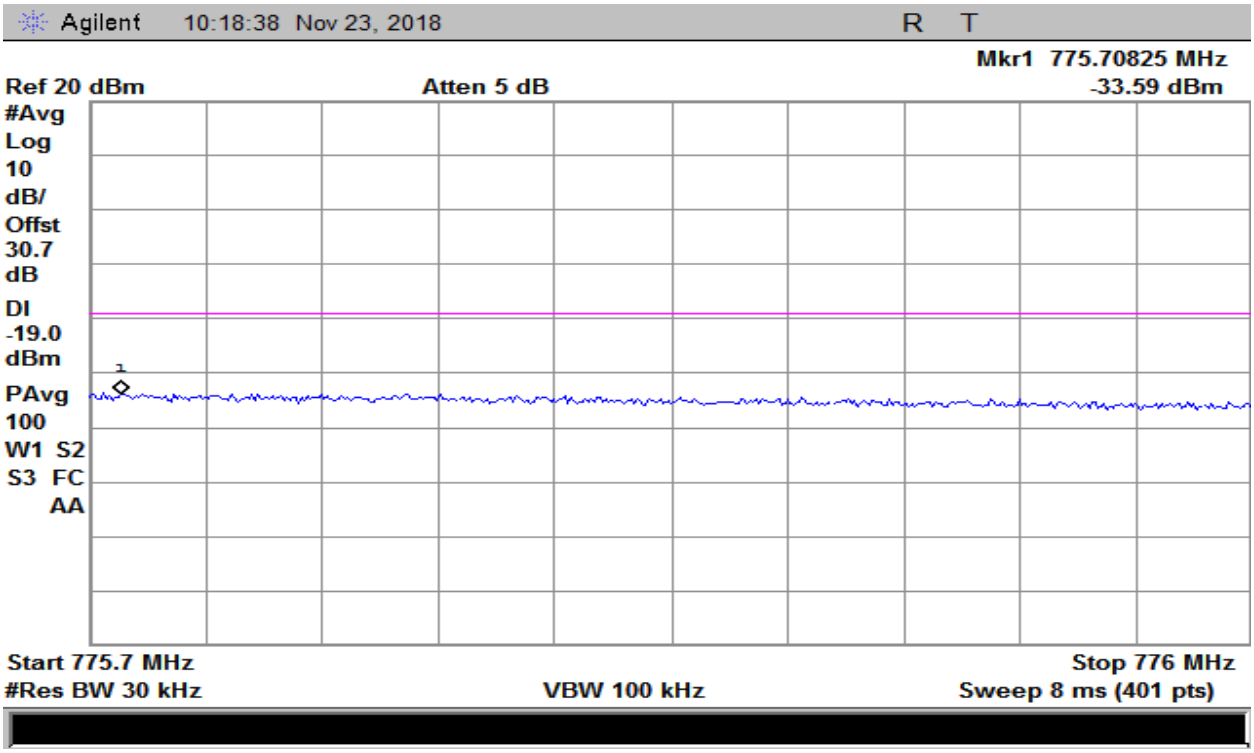
Plot 29 – 1850-1915MHz Band – GSM Uplink Upper Band Edge



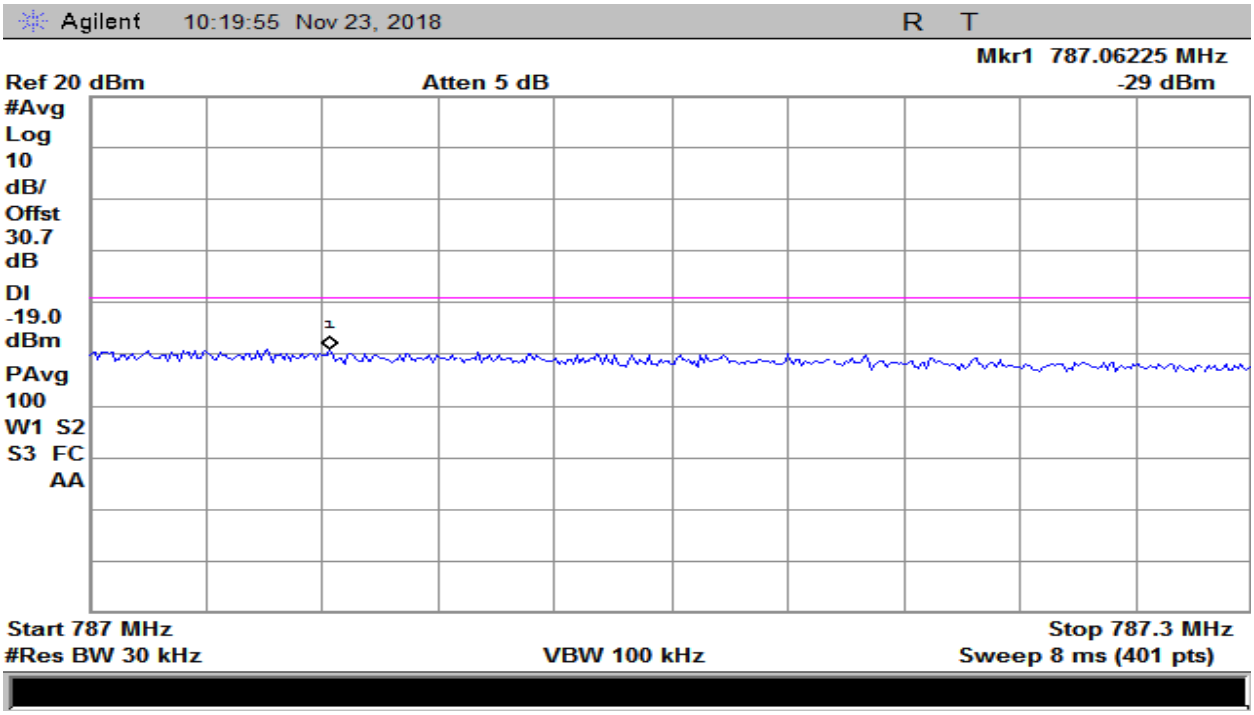
Plot 30 – 698-716MHz Band – CDMA Uplink Lower Band Edge



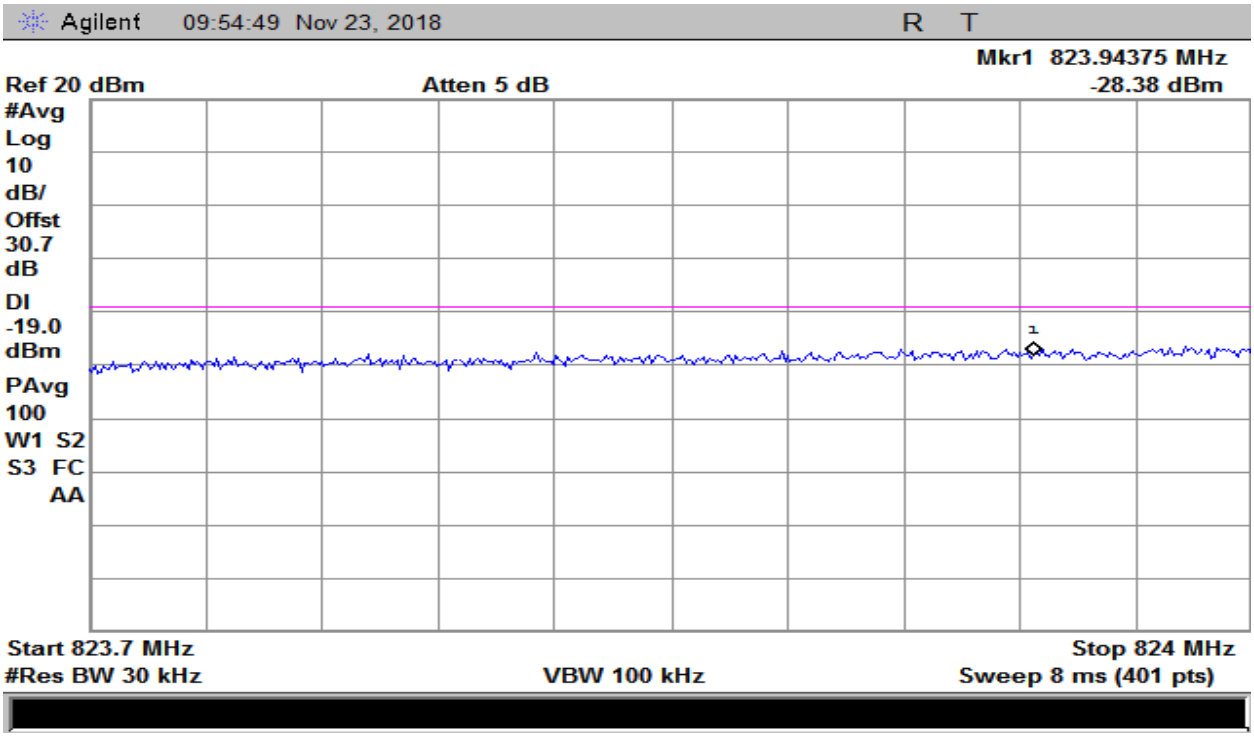
Plot 31 – 698-716MHZ Band – CDMA Uplink Upper Band Edge



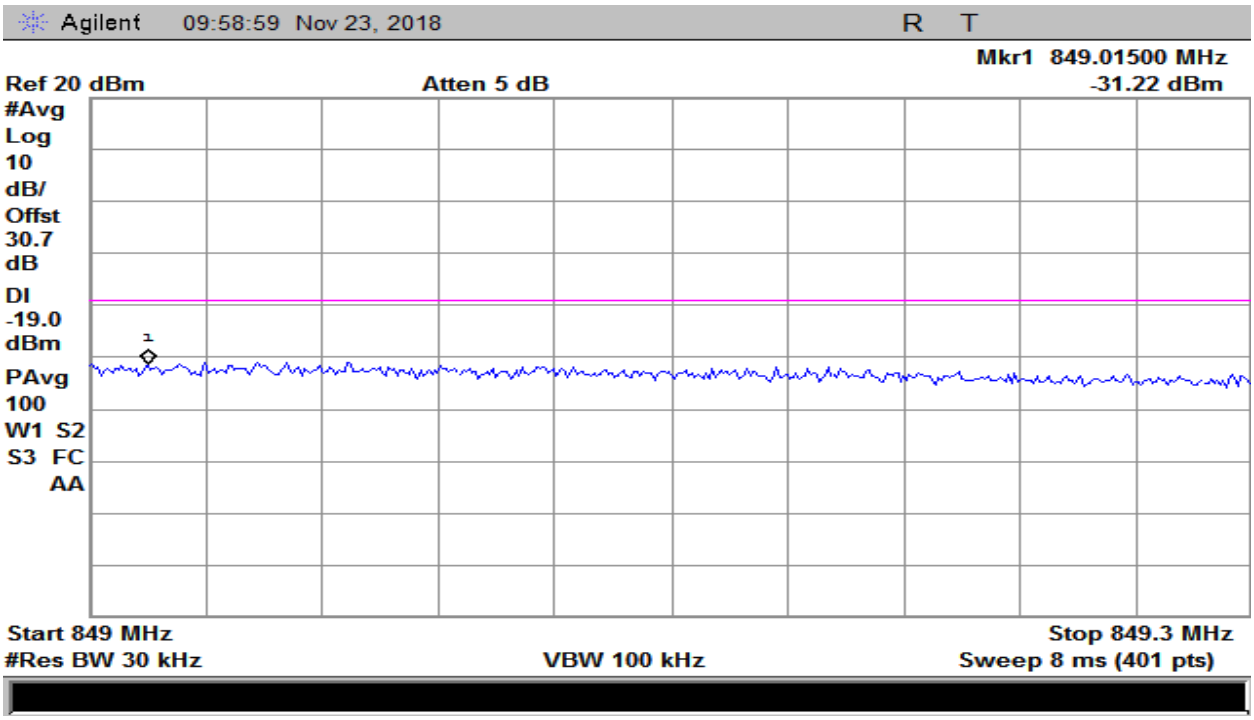
Plot 32 – 776-787MHz Band – CDMA Uplink Lower Band Edge



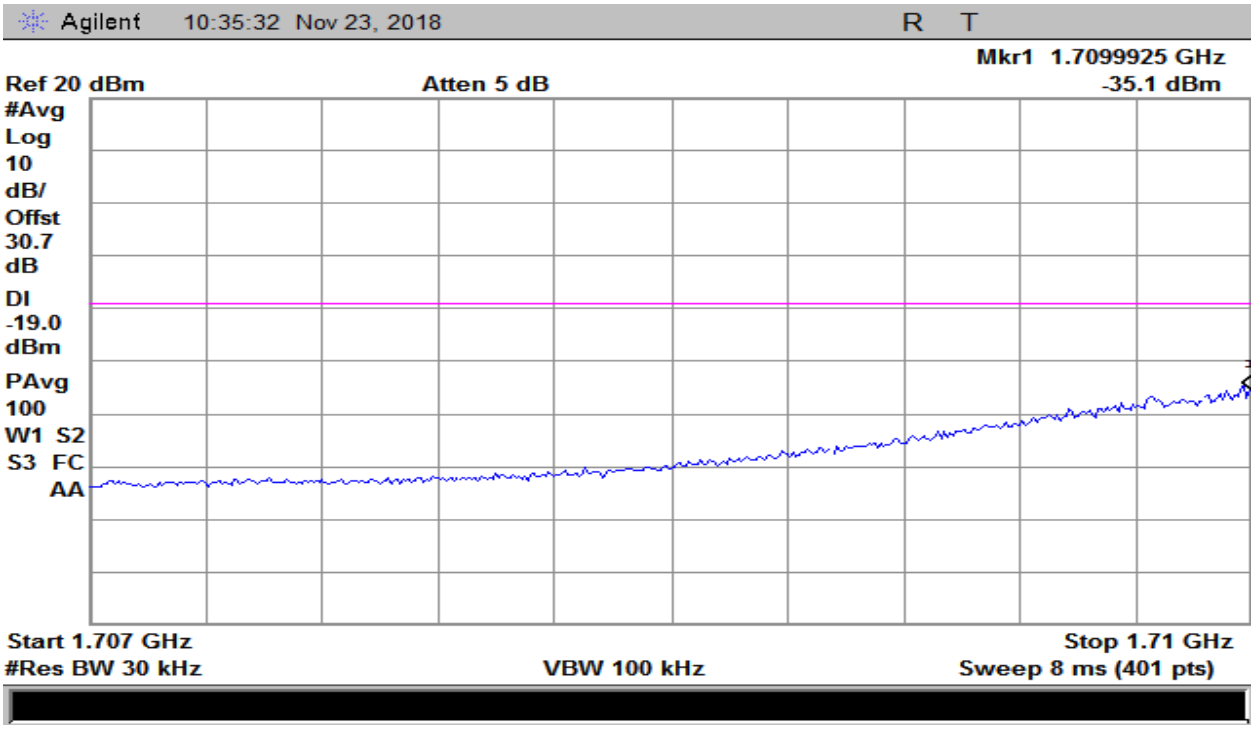
Plot 33 – 776-787MHz Band – CDMA Uplink Upper Band Edge



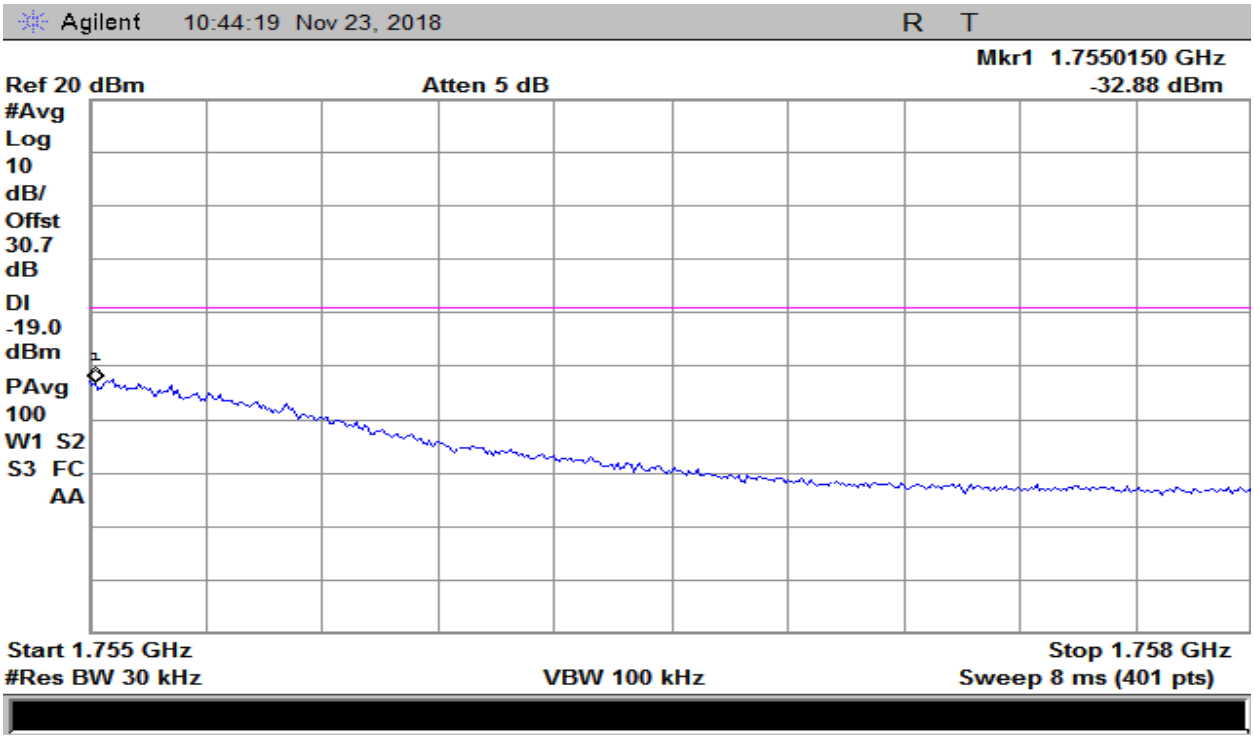
Plot 34 – 824-849MHz Band – CDMA Uplink Lower Band Edge



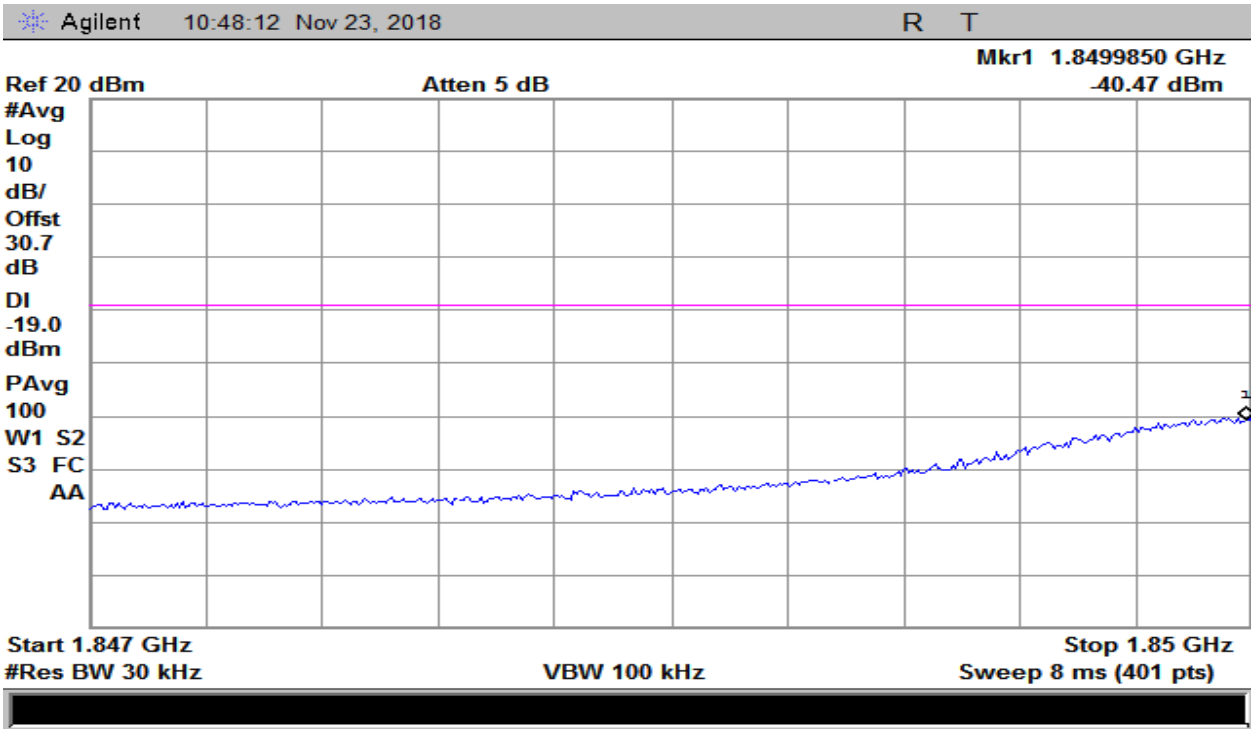
Plot 35 – 824-849MHz Band – CDMA Uplink Upper Band Edge



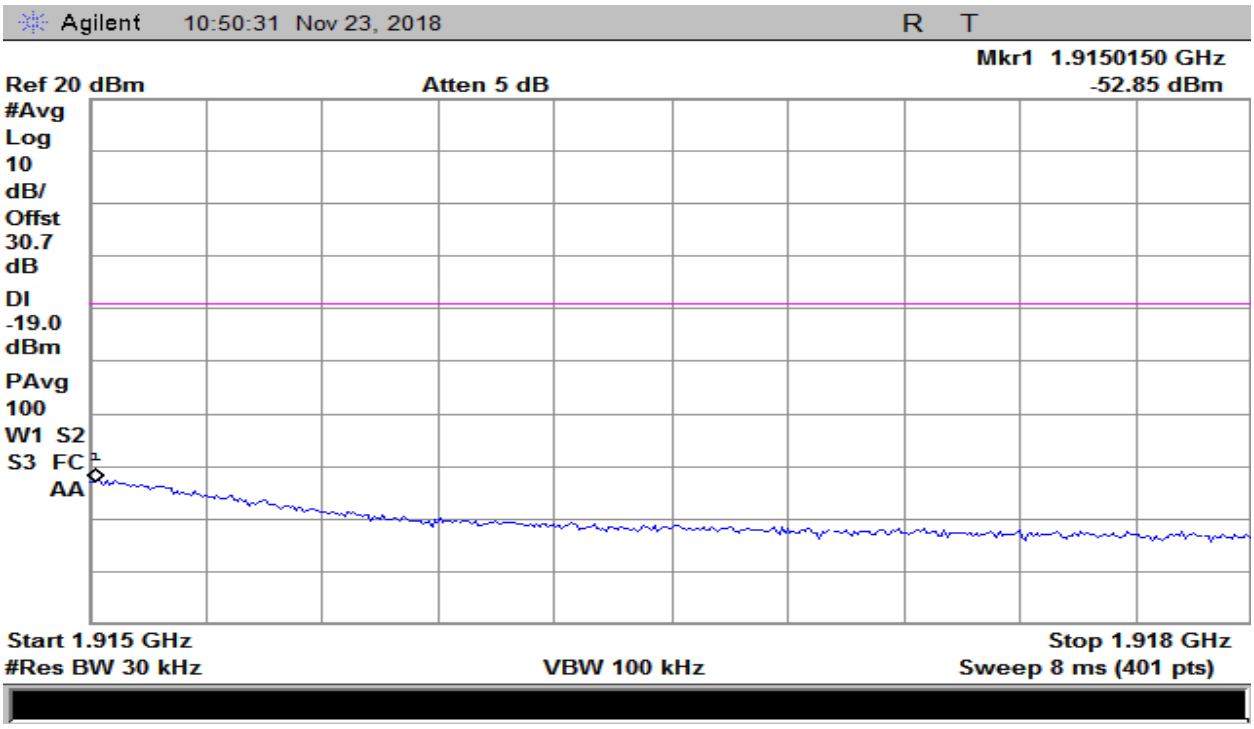
Plot 36 – 1710-1755MHz Band – CDMA Uplink Lower Band Edge



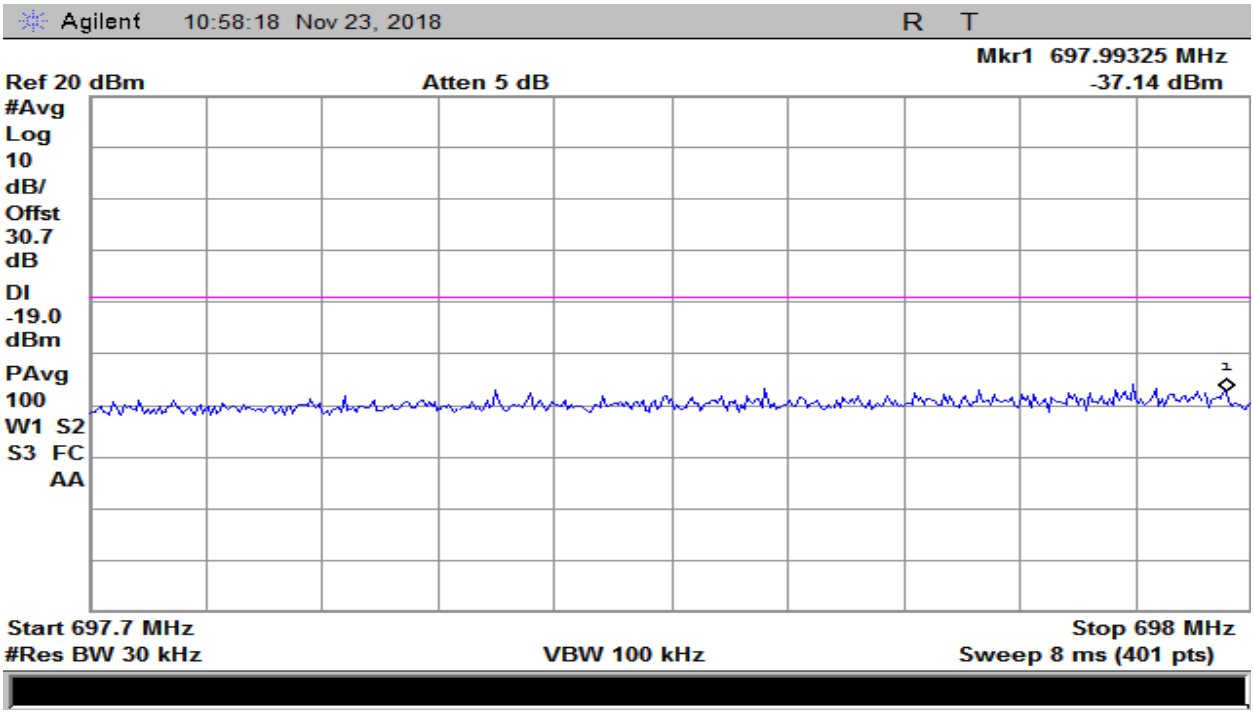
Plot 37 – 1710-1755MHz Band – CDMA Uplink Upper Band Edge



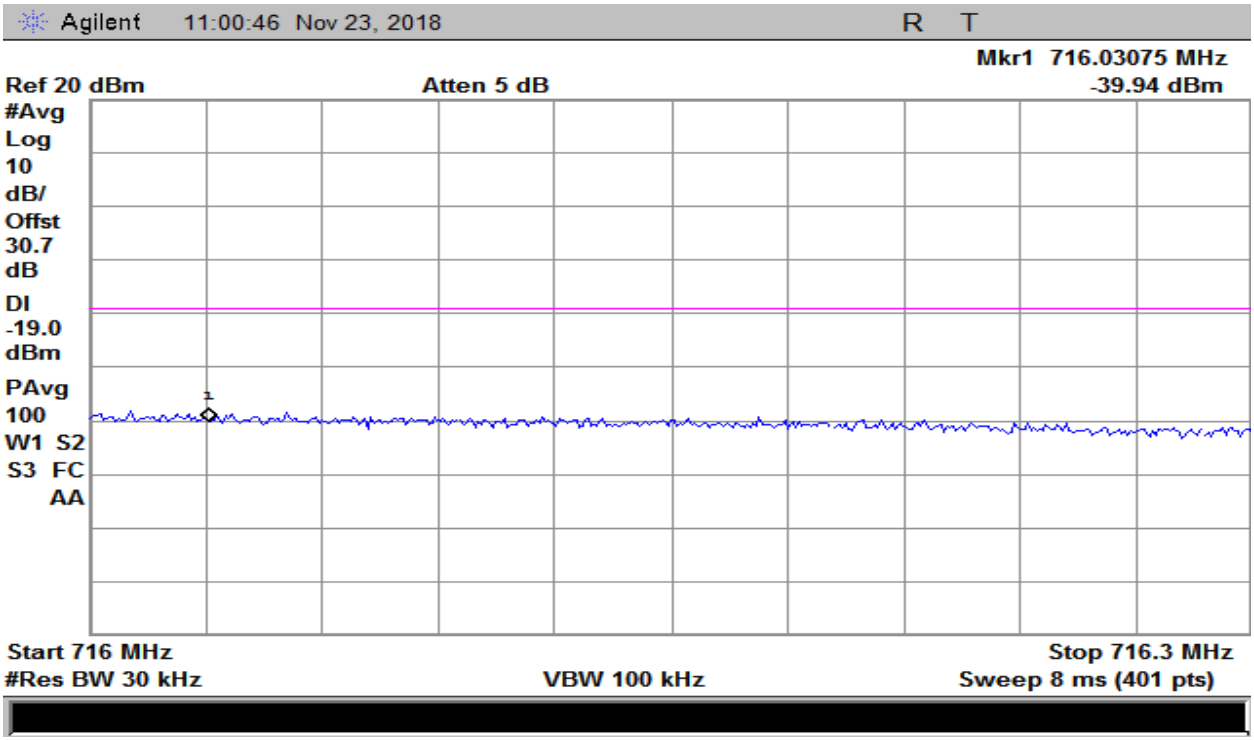
Plot 38 – 1850-1915MHz Band – CDMA Uplink Lower Band Edge



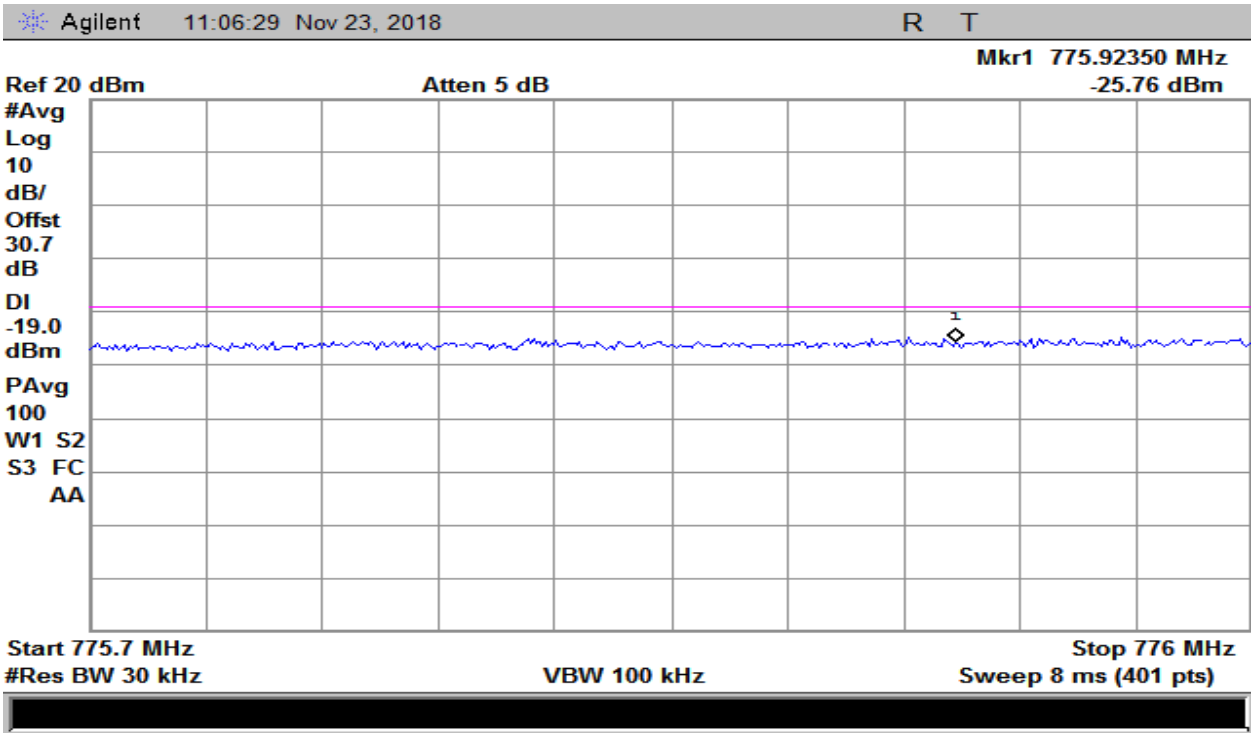
Plot 39 – 1850-1915MHz Band – CDMA Uplink Upper Band Edge



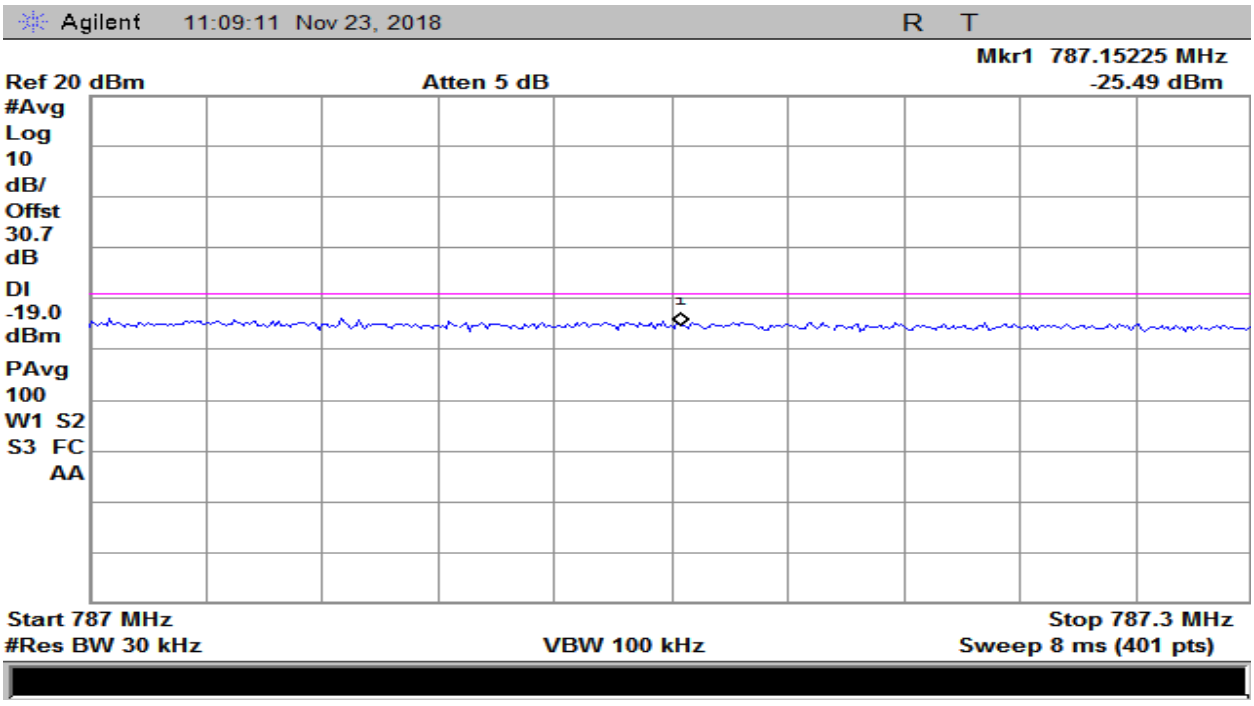
Plot 40 – 698-716MHz Band – LTE Uplink Lower Band Edge



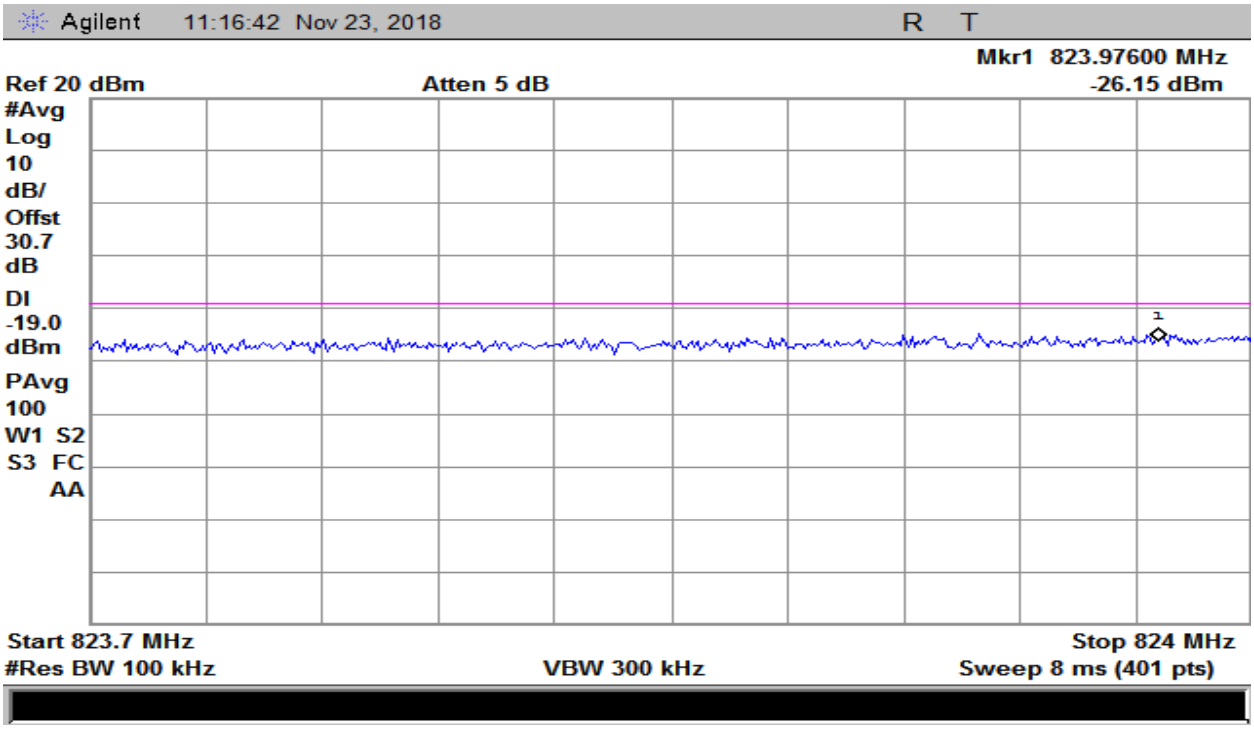
Plot 41 – 698-716MHz Band – LTE Uplink Upper Band Edge



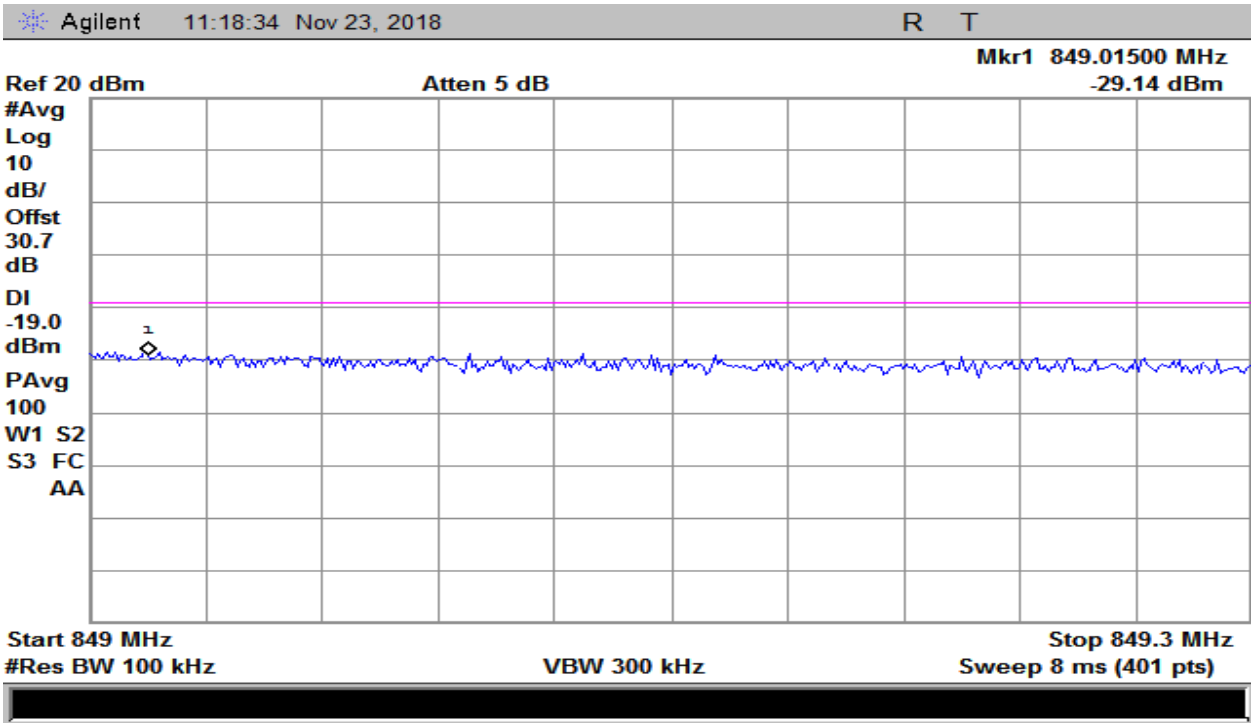
Plot 42 – 776-787MHz Band – LTE Uplink Lower Band Edge



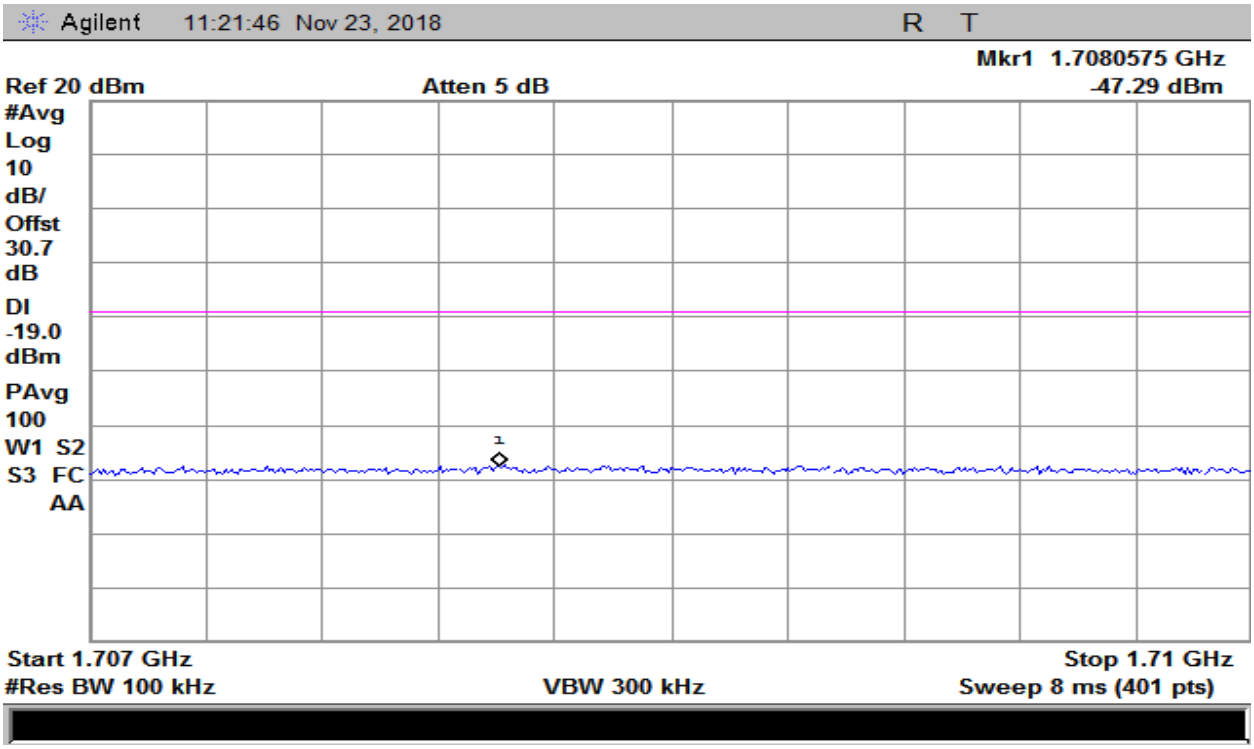
Plot 43 – 776-787MHz Band – LTE Uplink Upper Band Edge



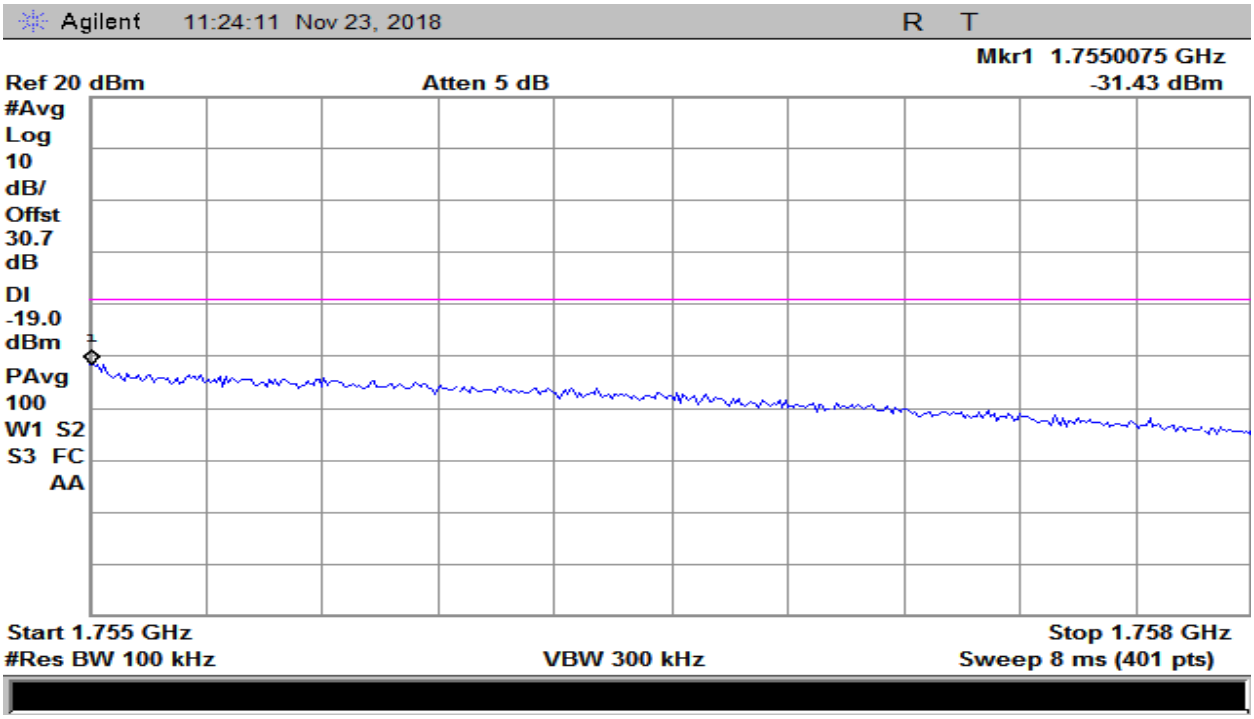
Plot 44 – 824-849MHz Band – LTE Uplink Lower Band Edge



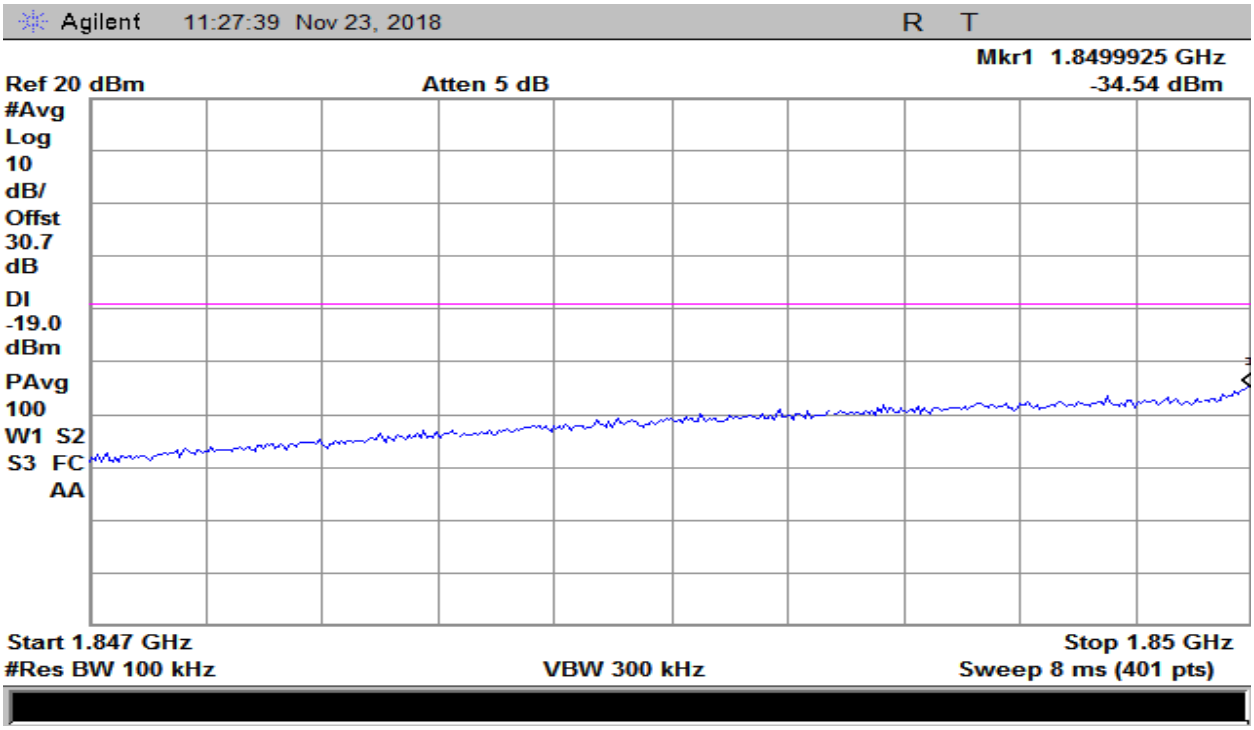
Plot 45 – 824-849MHz Band – LTE Uplink Upper Band Edge



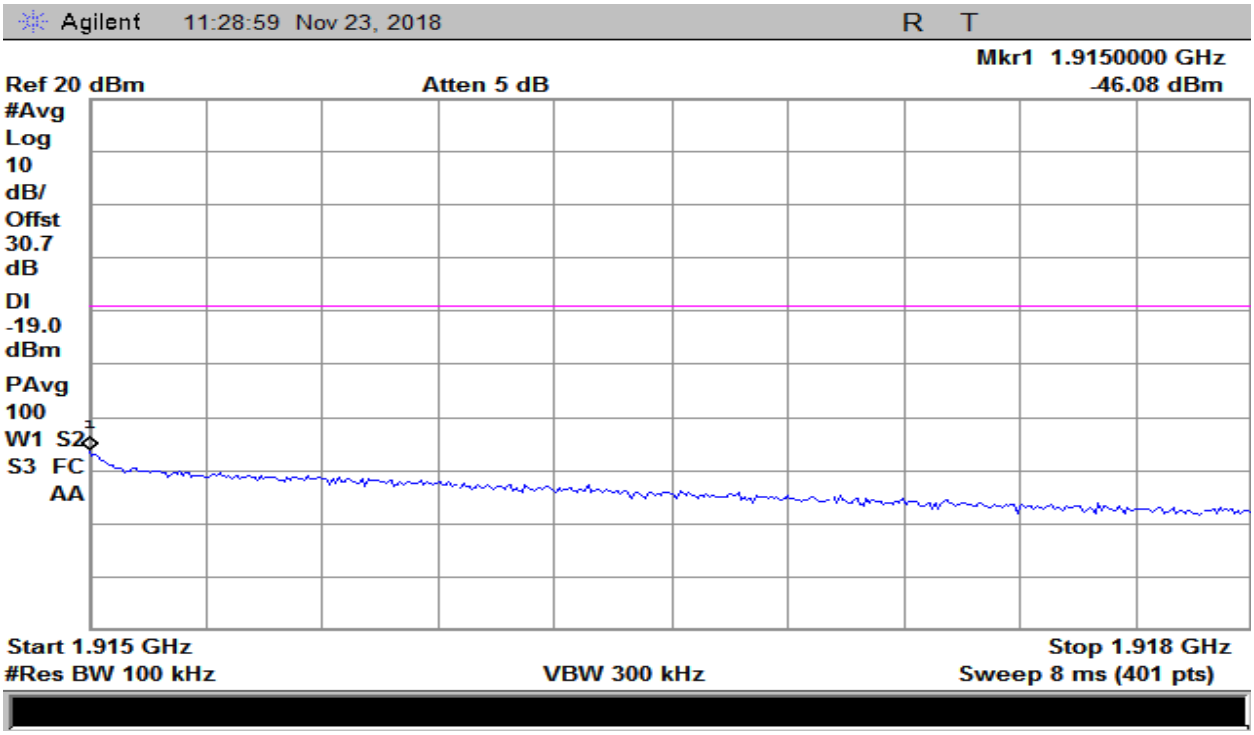
Plot 46 – 1710-1755MHz Band – LTE Uplink Lower Band Edge



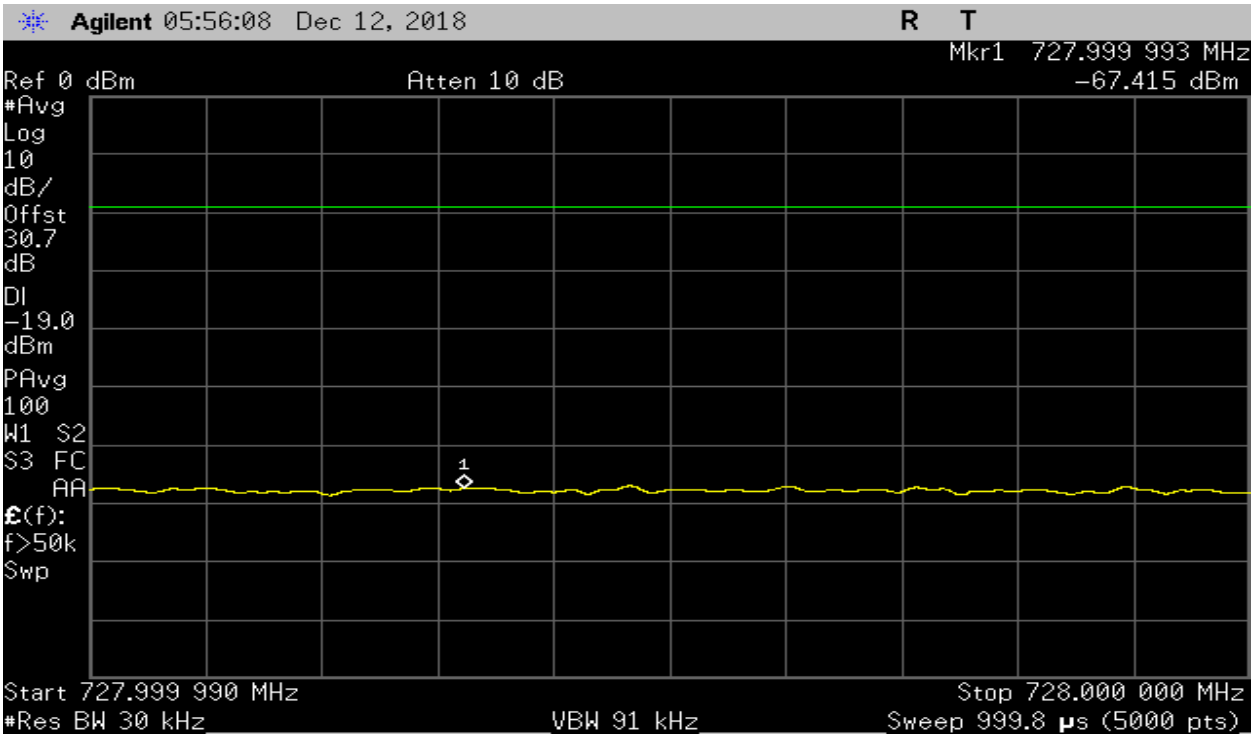
Plot 47 – 1710-1755MHz Band – LTE Uplink Upper Band Edge



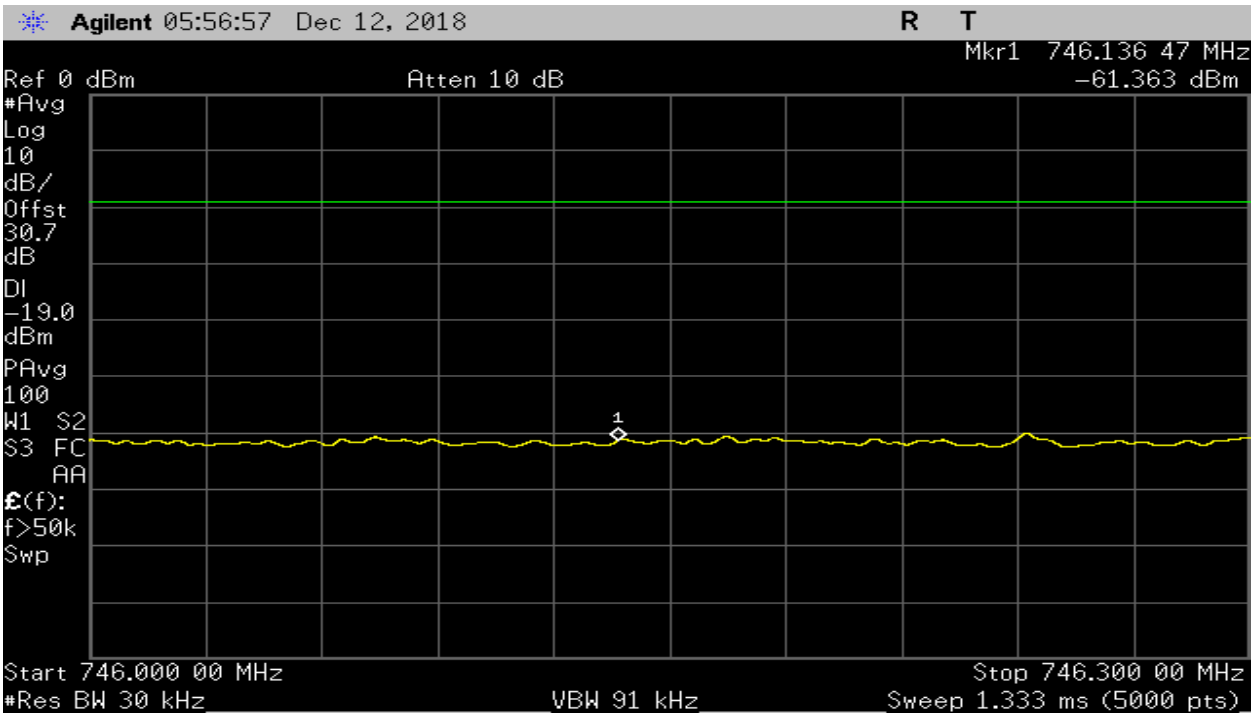
Plot 48 – 1850-1915MHz Band – LTE Uplink Lower Band Edge



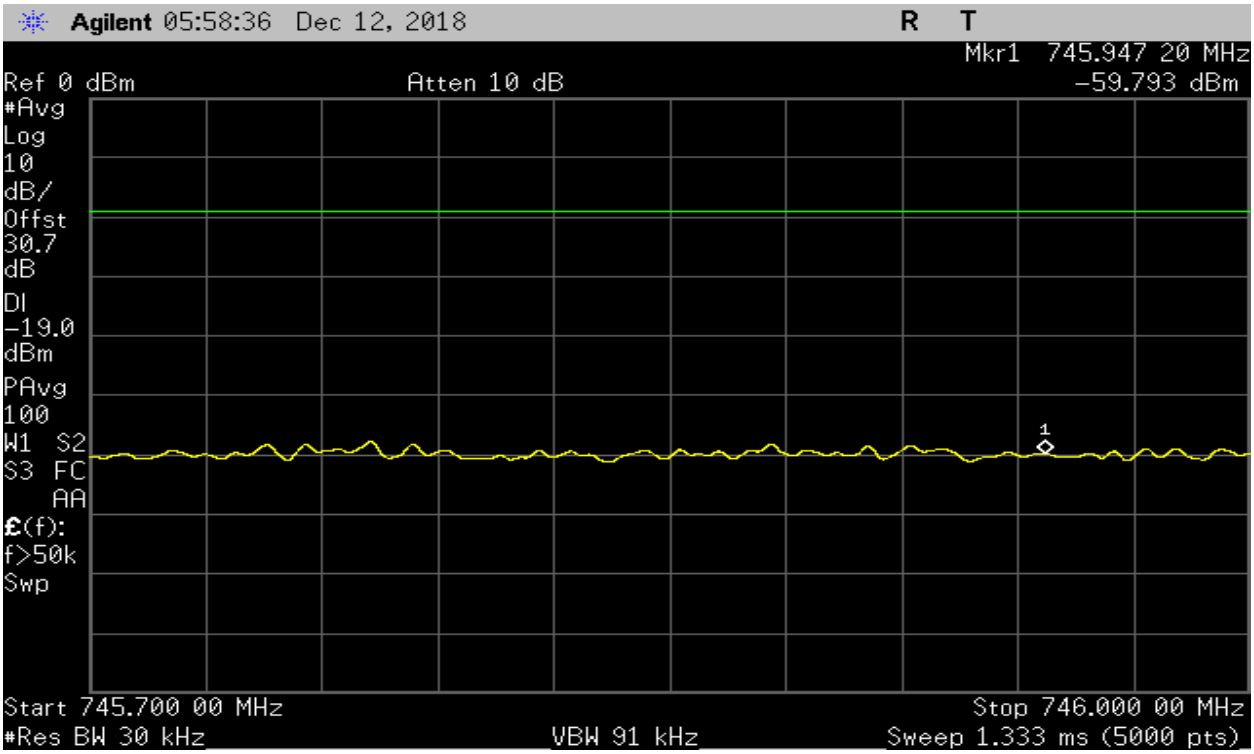
Plot 49 – 1850-1915MHz Band – LTE Uplink Upper Band Edge



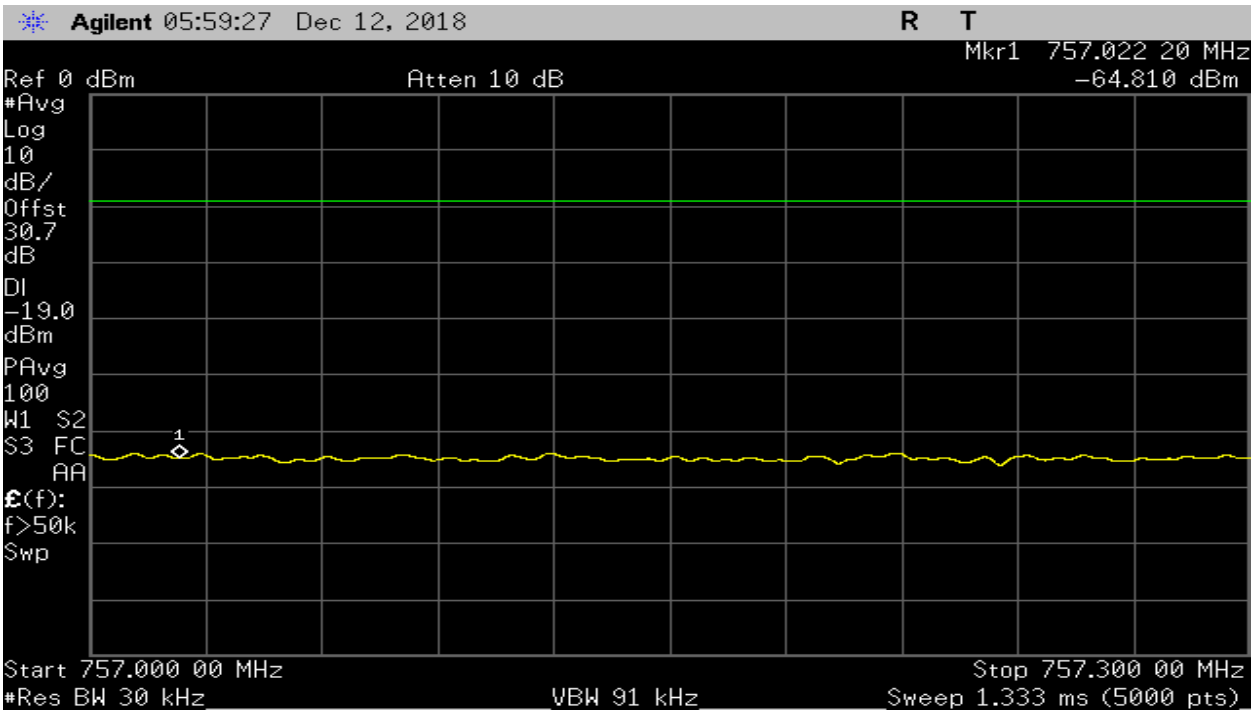
Plot 50 – 728-746MHz Band – GSM Downlink Lower Band Edge



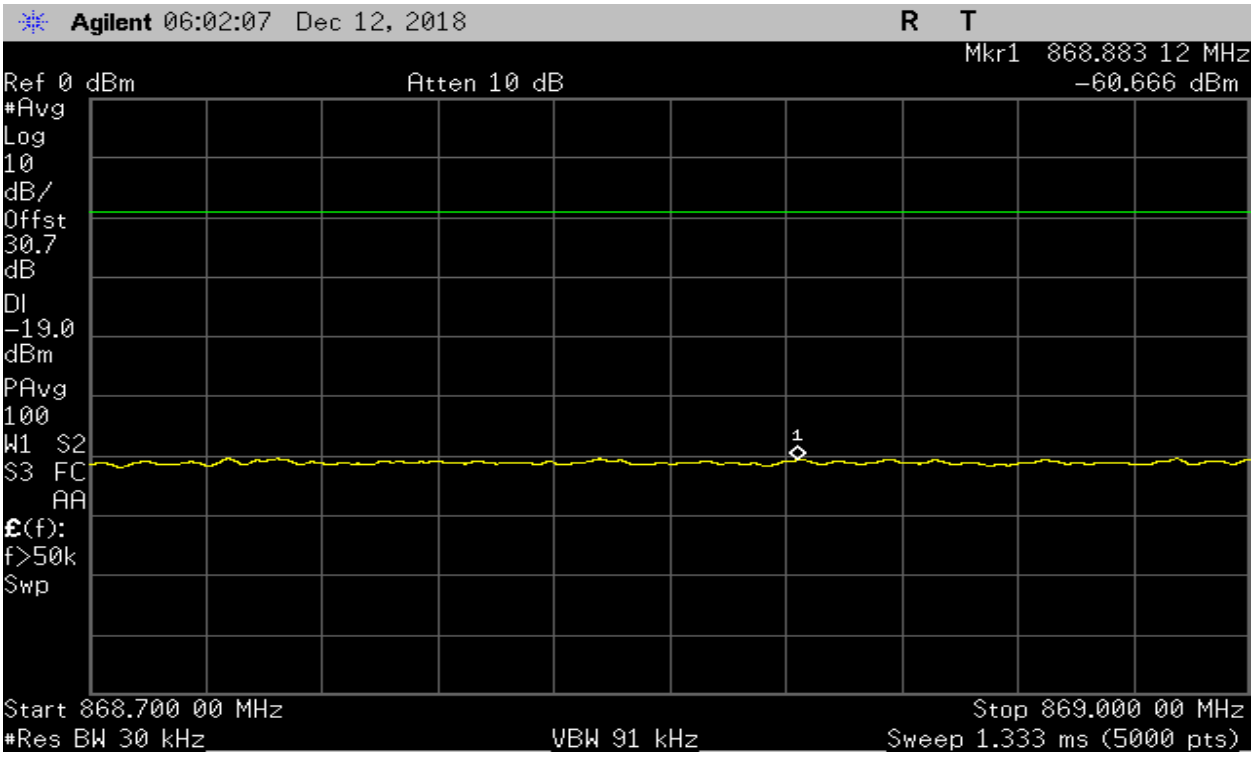
Plot 51 – 728-746MHz Band – GSM Downlink Upper Band Edge



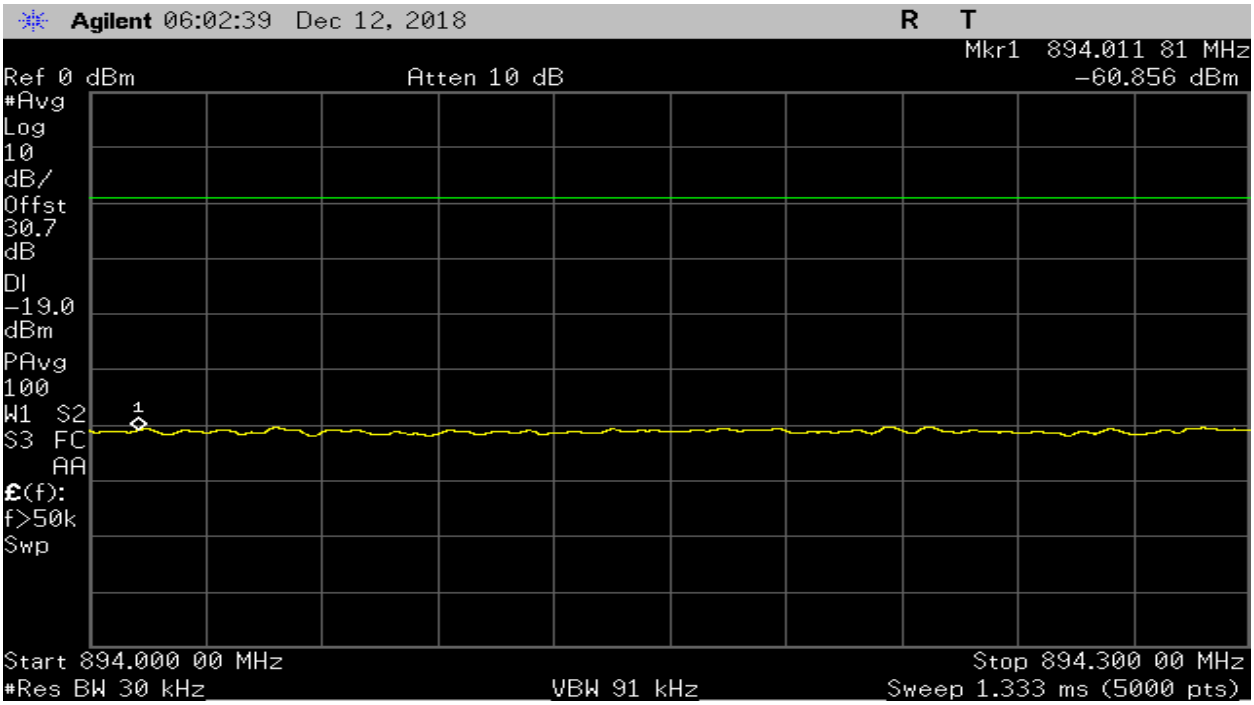
Plot 52 – 746-757MHz Band – GSM Downlink Lower Band Edge



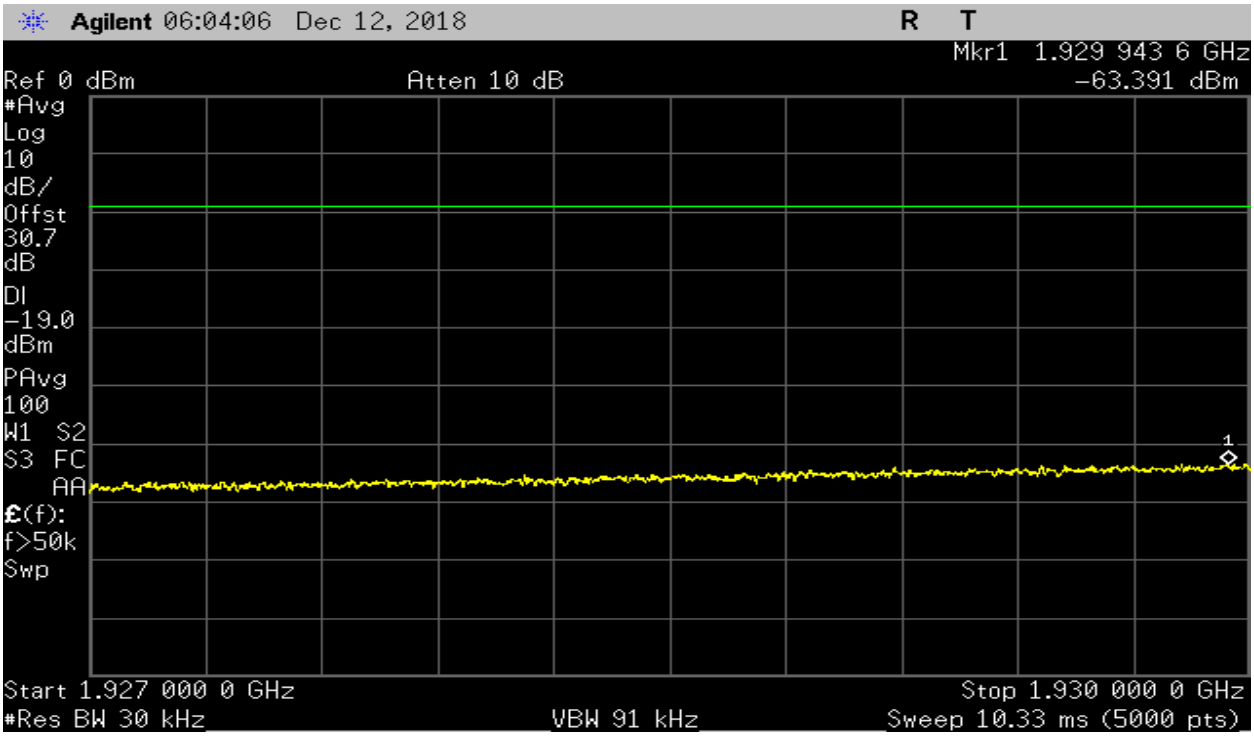
Plot 53 – 746-757MHz Band – GSM Downlink Upper Band Edge



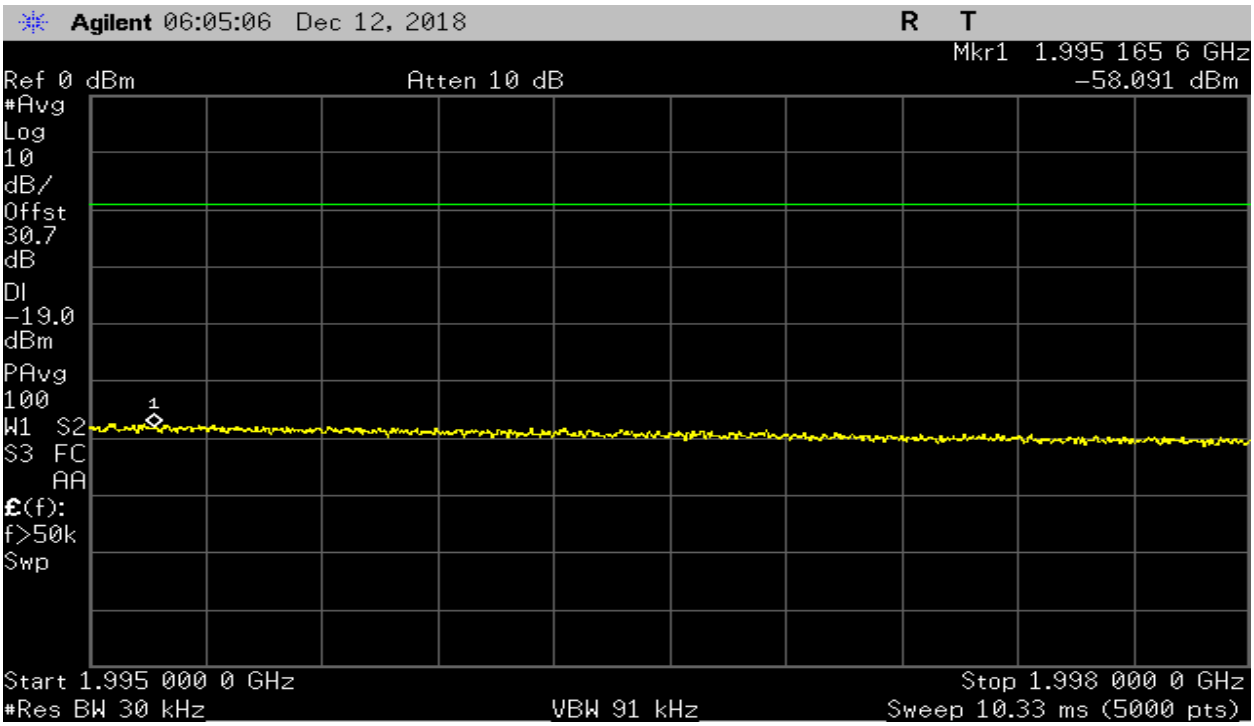
Plot 54 – 869-894MHz Band – GSM Downlink Lower Band Edge



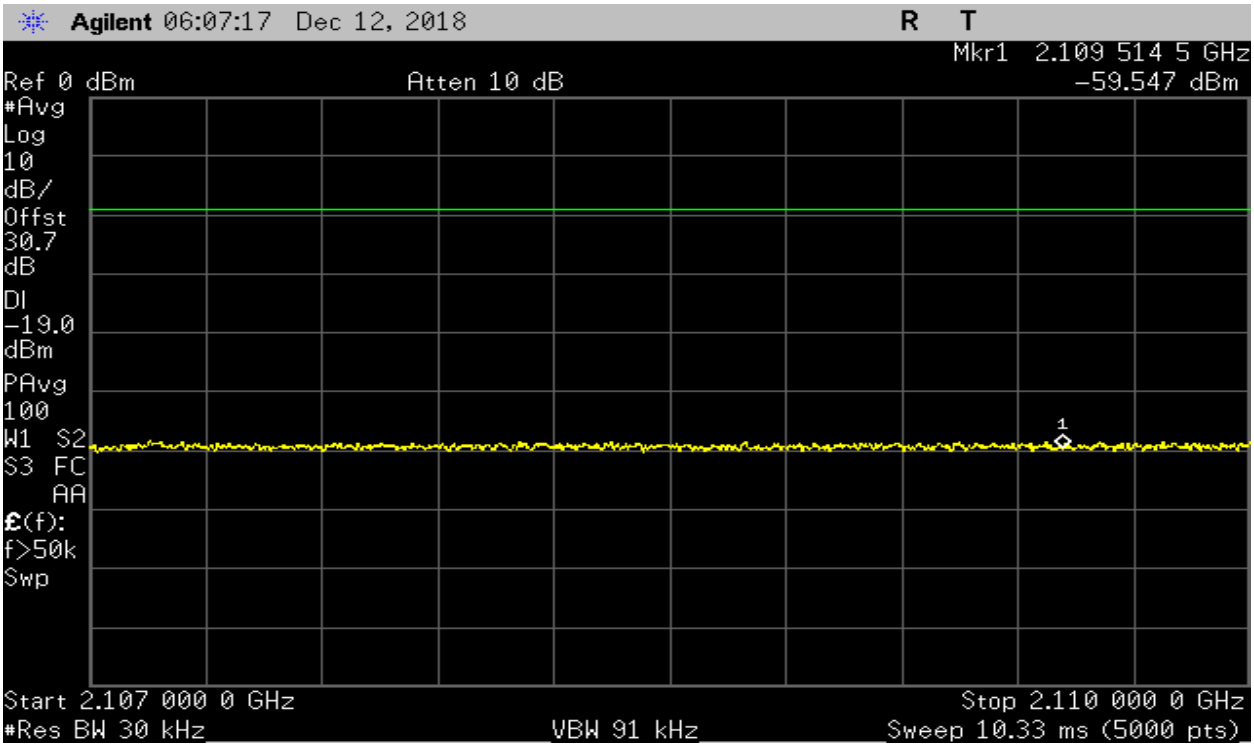
Plot 55 – 869-894MHz Band – GSM Downlink Upper Band Edge



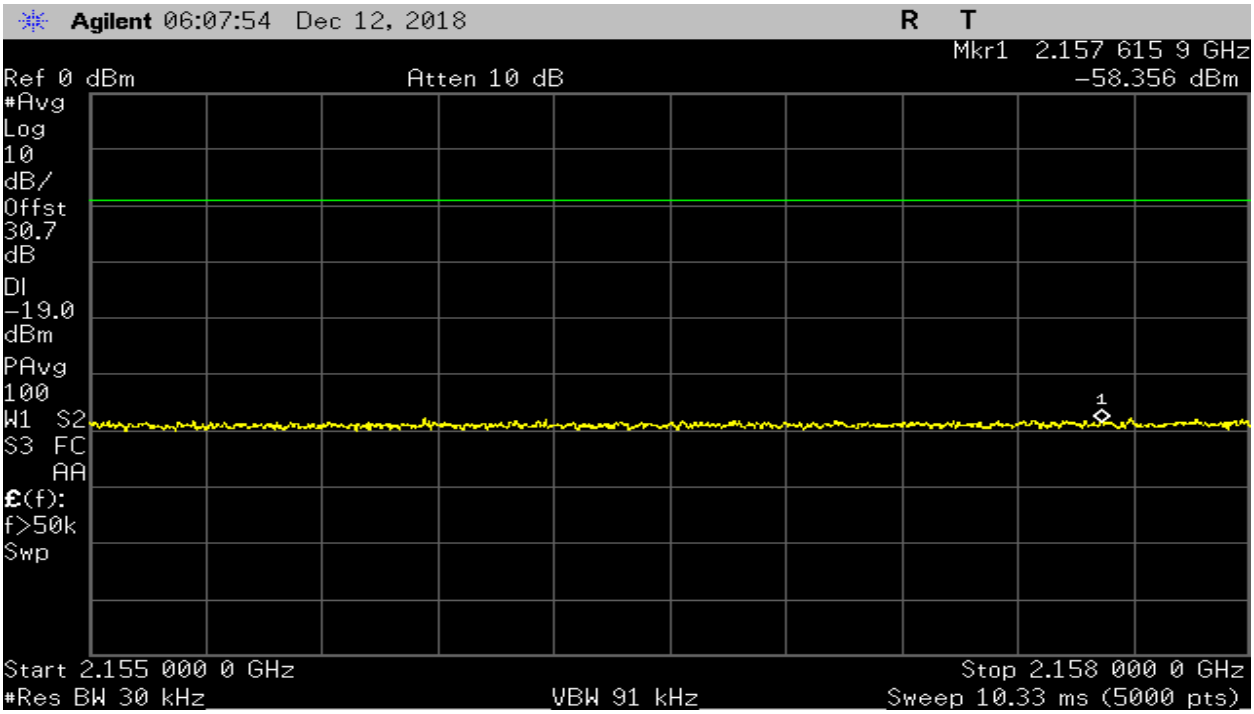
Plot 56 – 1930-1995MHz Band – GSM Downlink Lower Band Edge



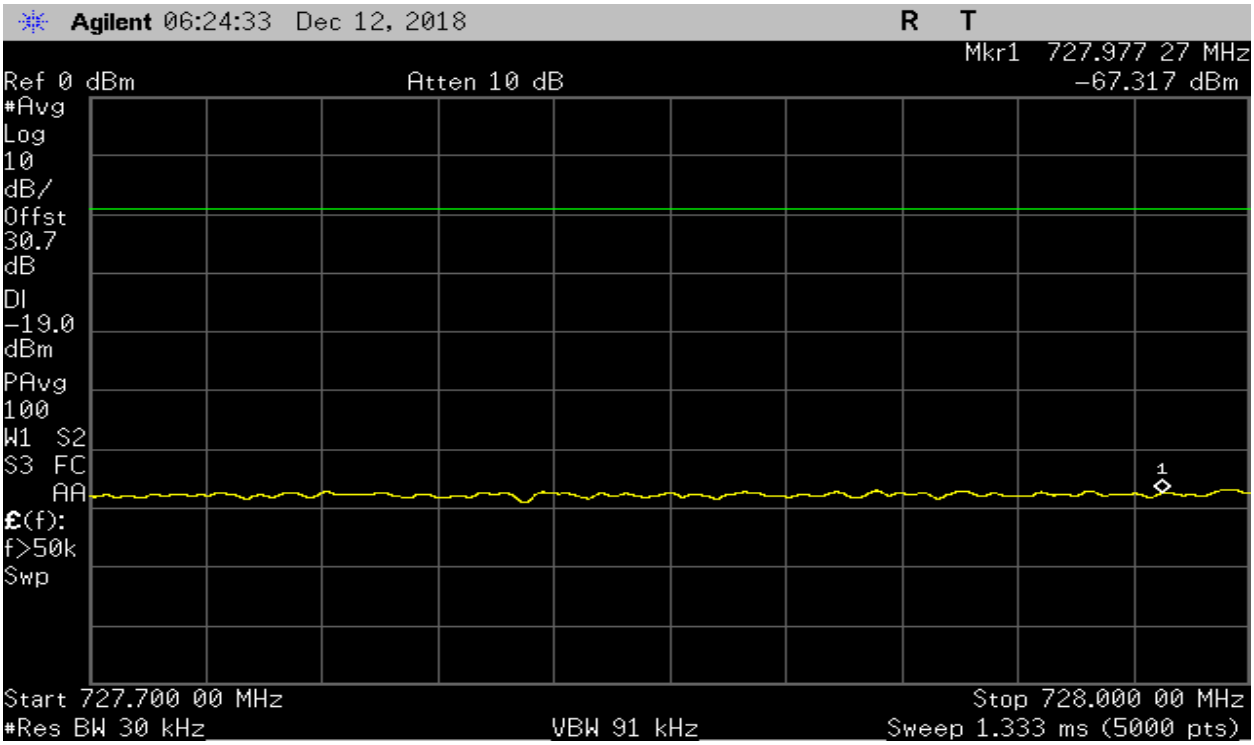
Plot 57 – 1930-1995MHz Band – GSM Downlink Upper Band Edge



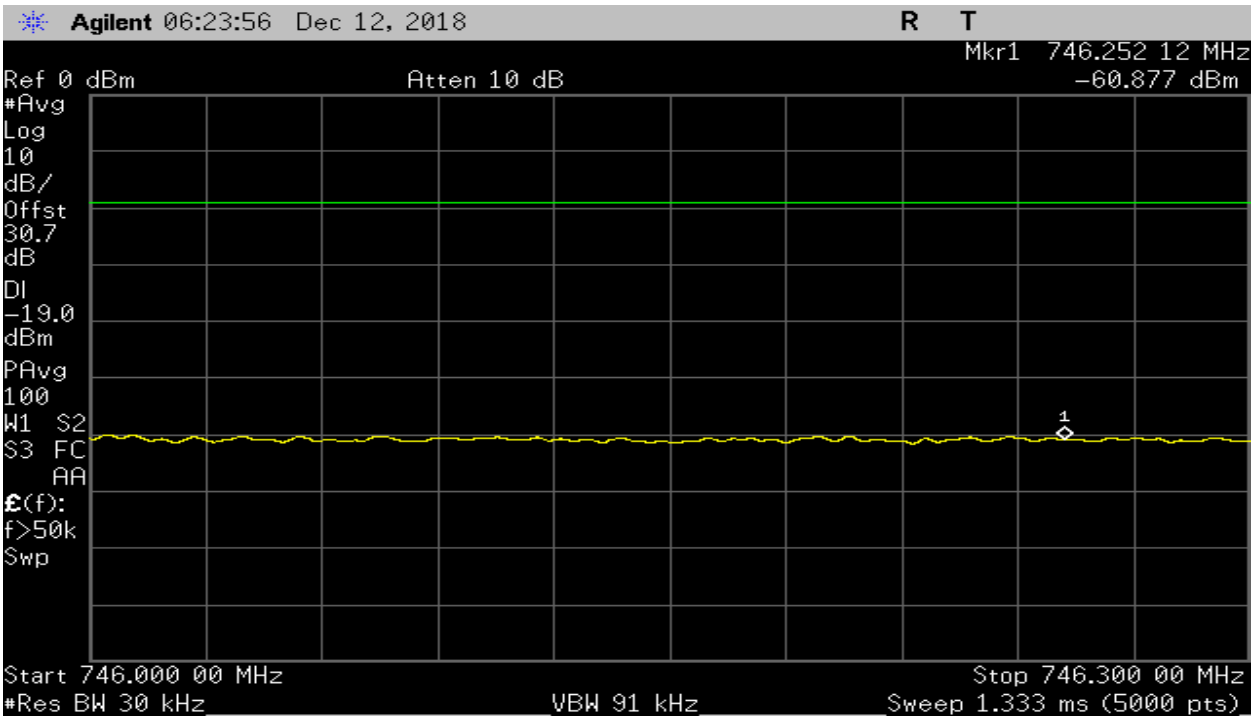
Plot 58 – 2110-2155MHz Band – GSM Downlink Lower Band Edge



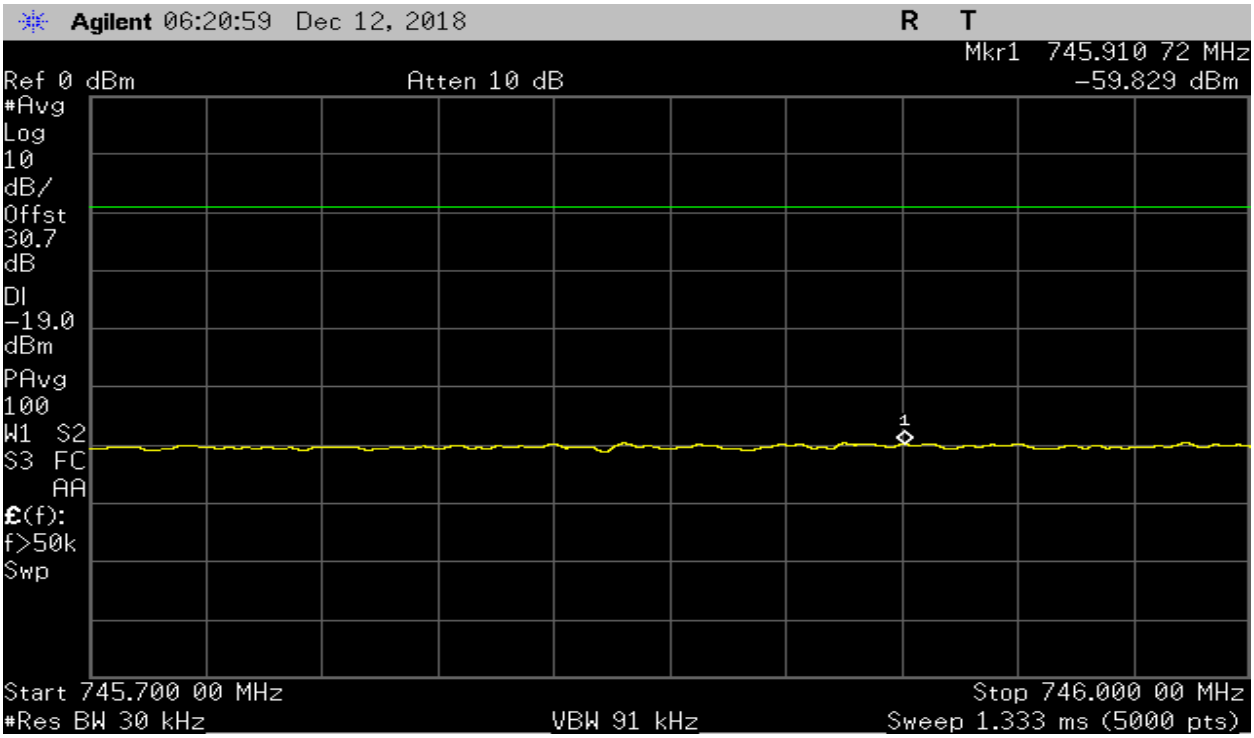
Plot 59 – 2110-2155MHz Band – GSM Downlink Upper Band Edge



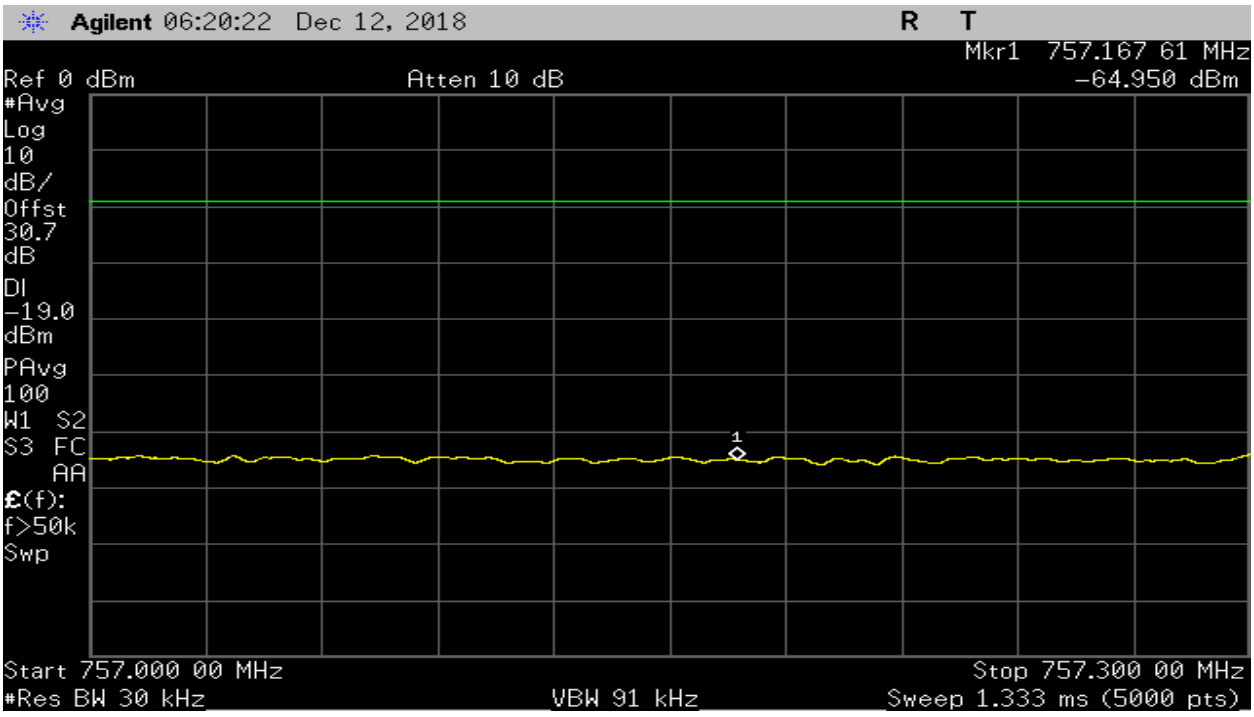
Plot 60 – 728-746MHz Band – CDMA Downlink Lower Band Edge



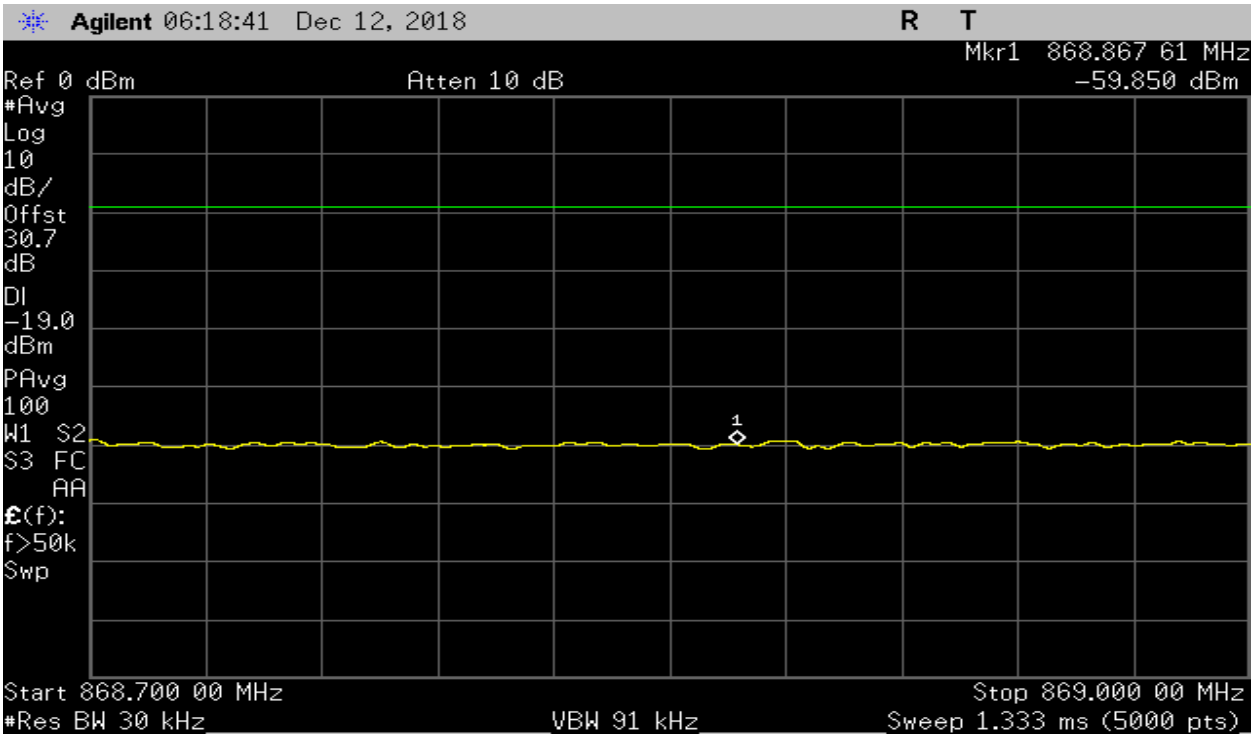
Plot 61 – 728-746MHz Band – CDMA Downlink Upper Band Edge



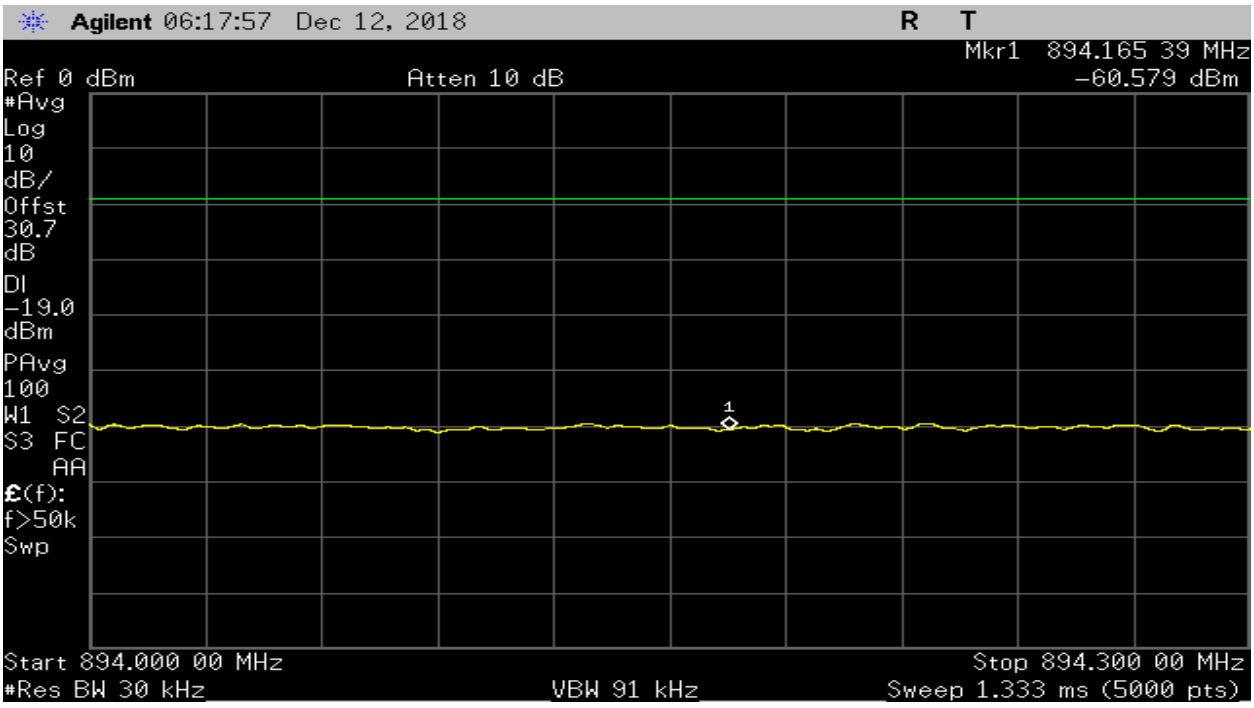
Plot 62 –746-757MHz Band – CDMA Downlink Lower Band Edge



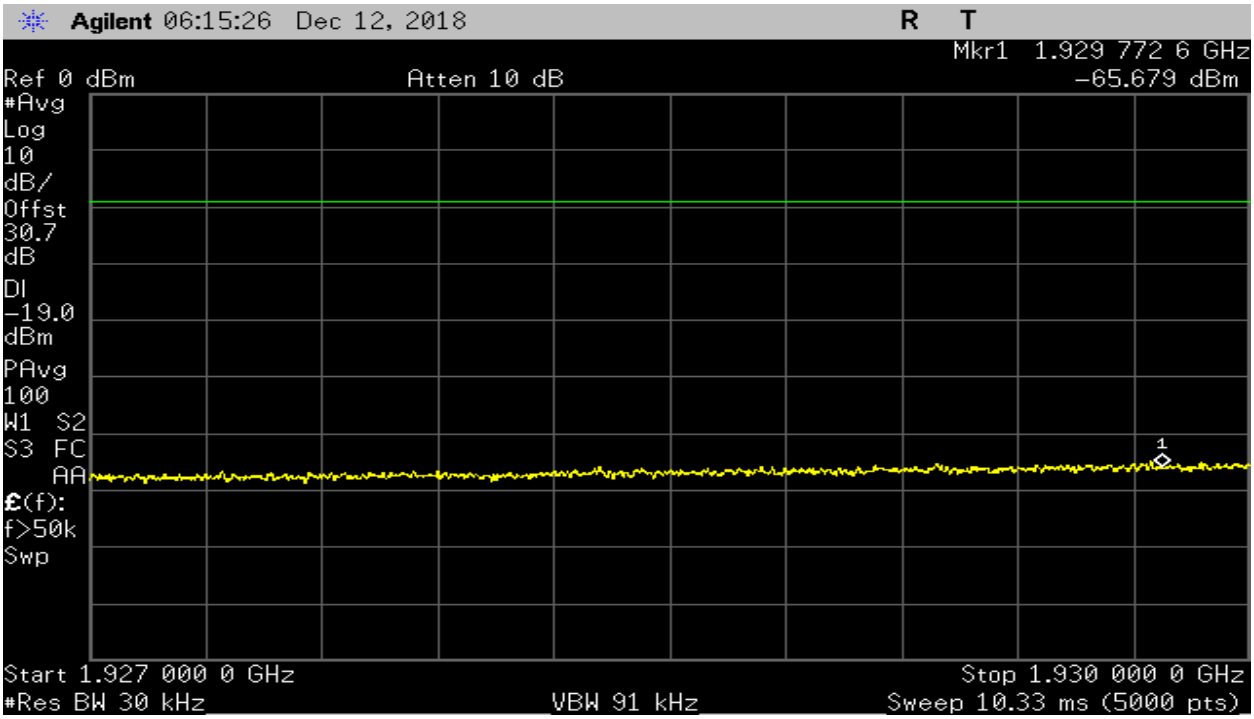
Plot 63 – 746-757MHz Band – CDMA Downlink Upper Band Edge



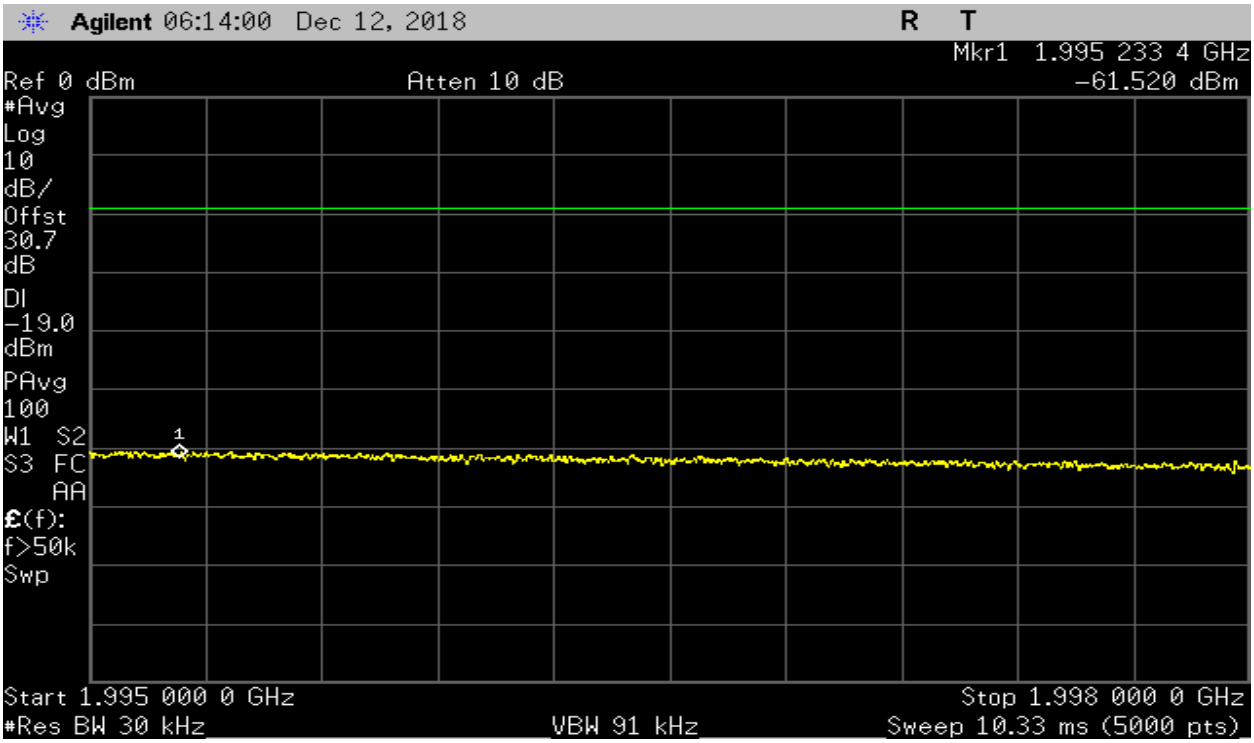
Plot 64 – 869-894MHz Band – CDMA Downlink Lower Band Edge



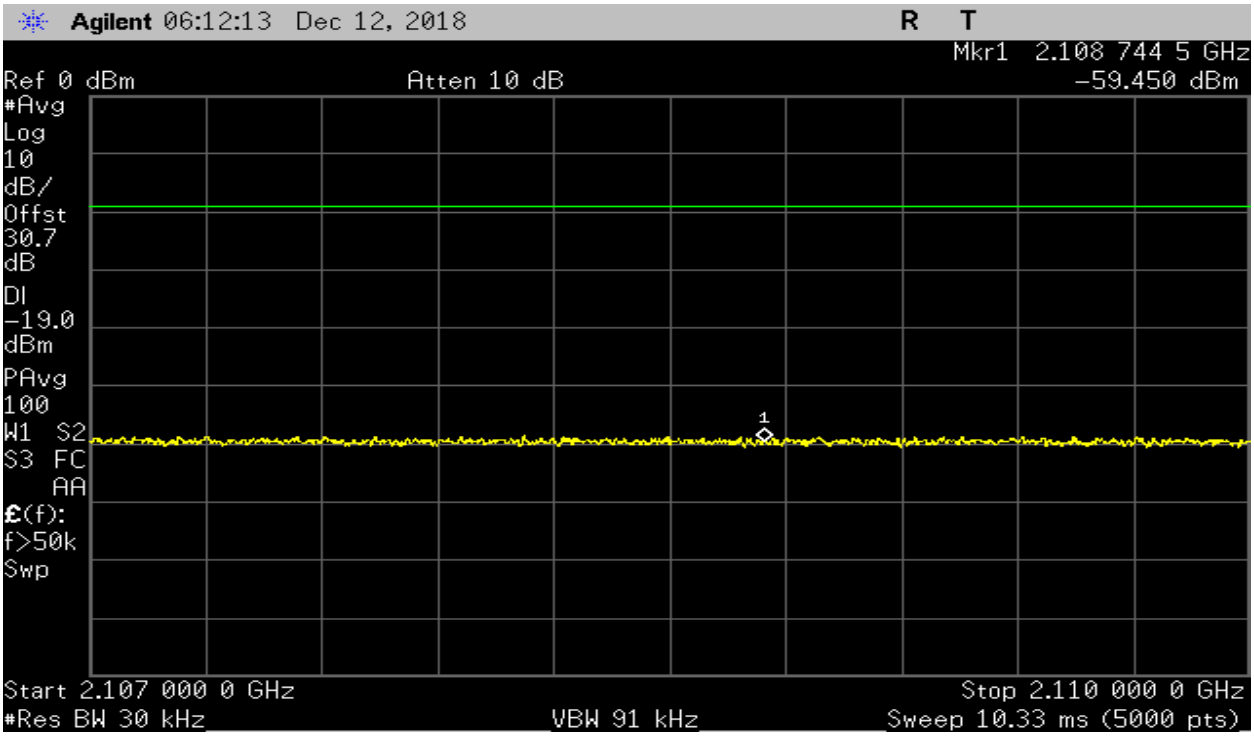
Plot 65 – 869-894MHz Band – CDMA Downlink Upper Band Edge



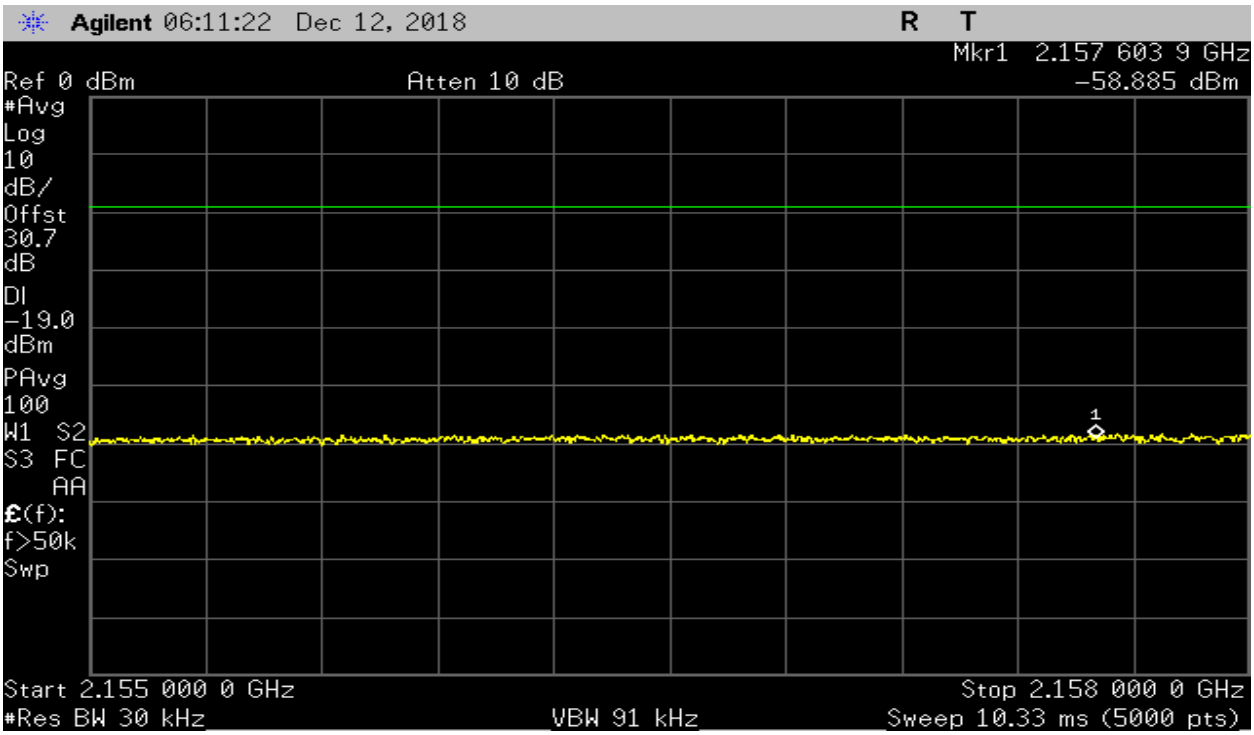
Plot 66 – 1930-1955MHz Band – CDMA Downlink Lower Band Edge



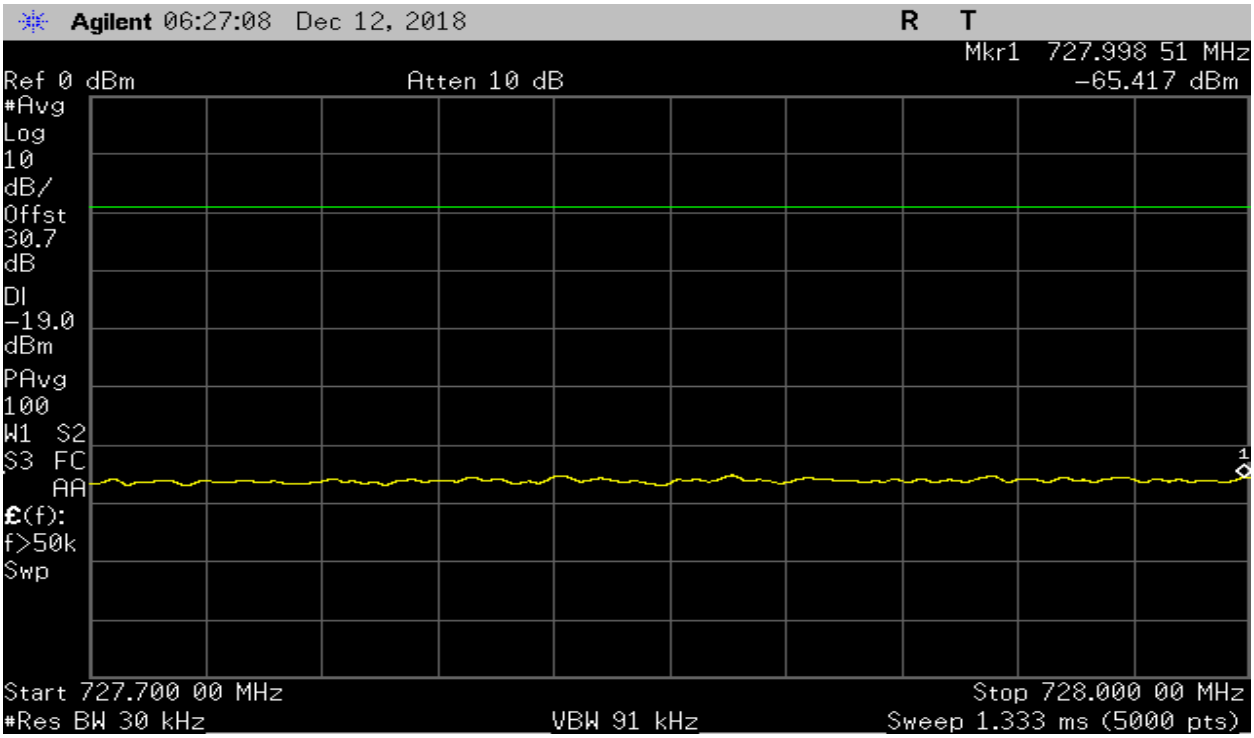
Plot 67 – 1930-1955MHz Band – CDMA Downlink Upper Band Edge



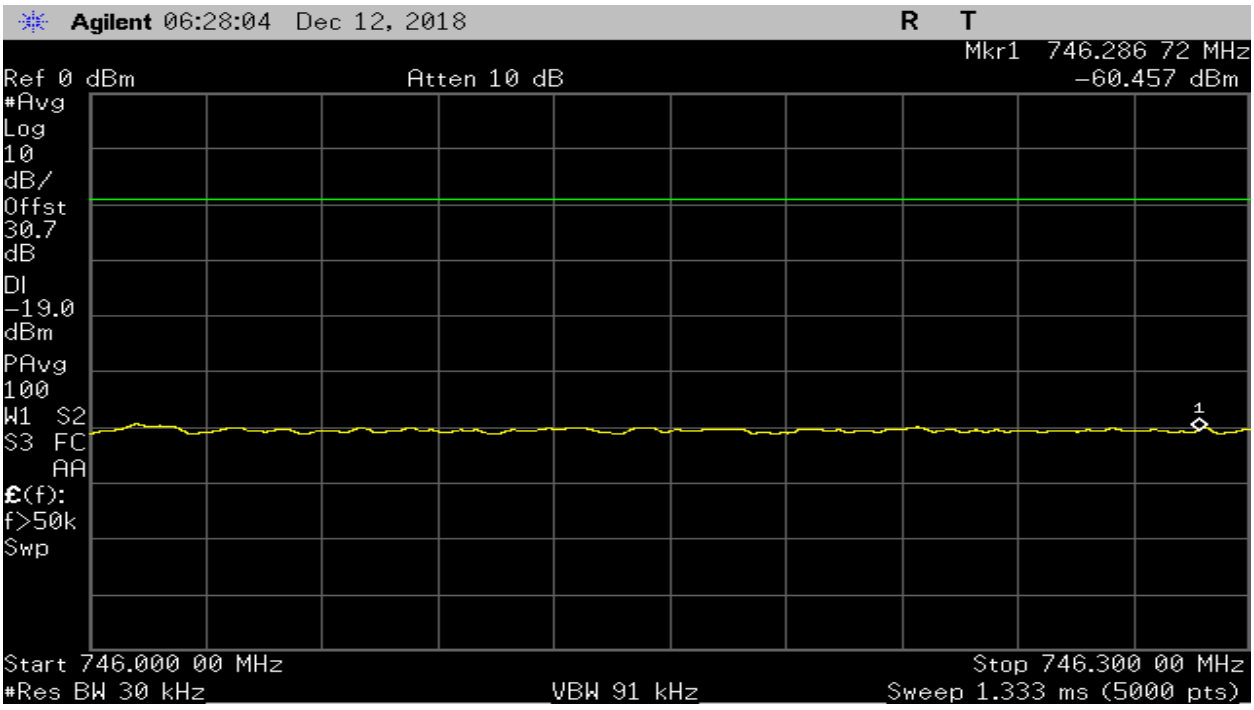
Plot 68 – 2110-2155MHz Band – CDMA Downlink Lower Band Edge



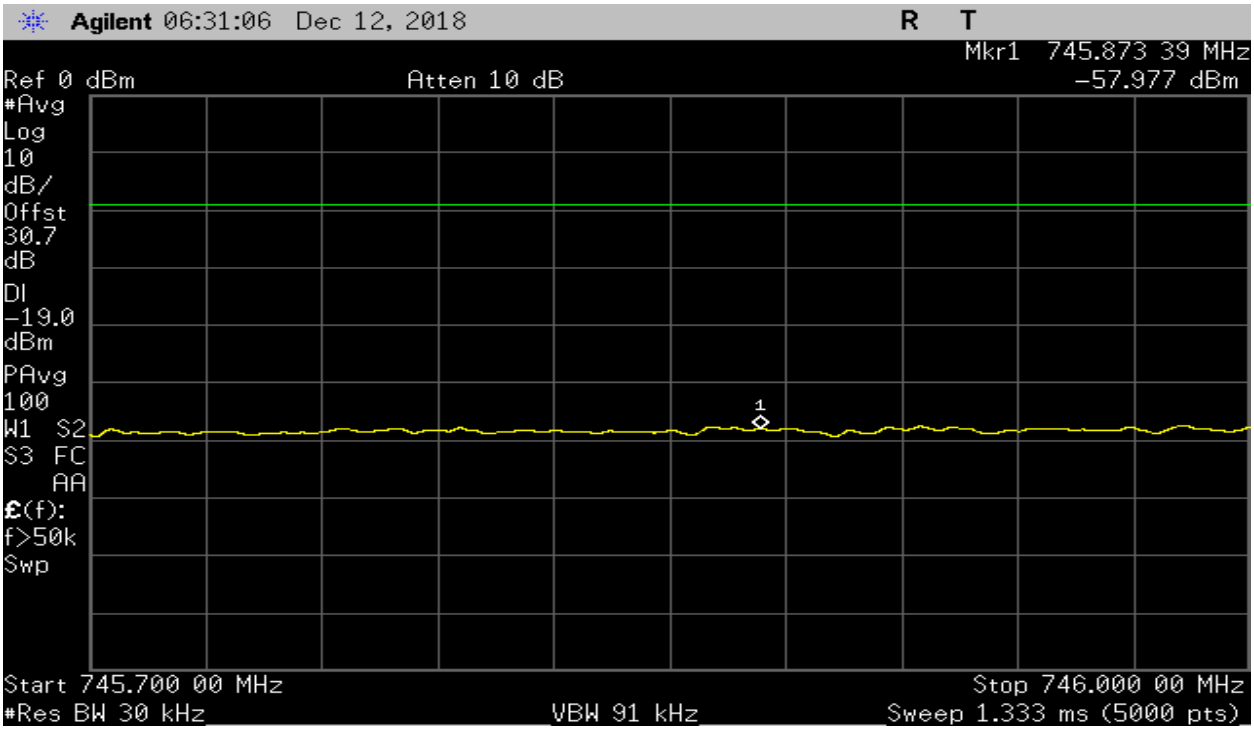
Plot 69 – 2110-2155MHz Band – CDMA Downlink Upper Band Edge



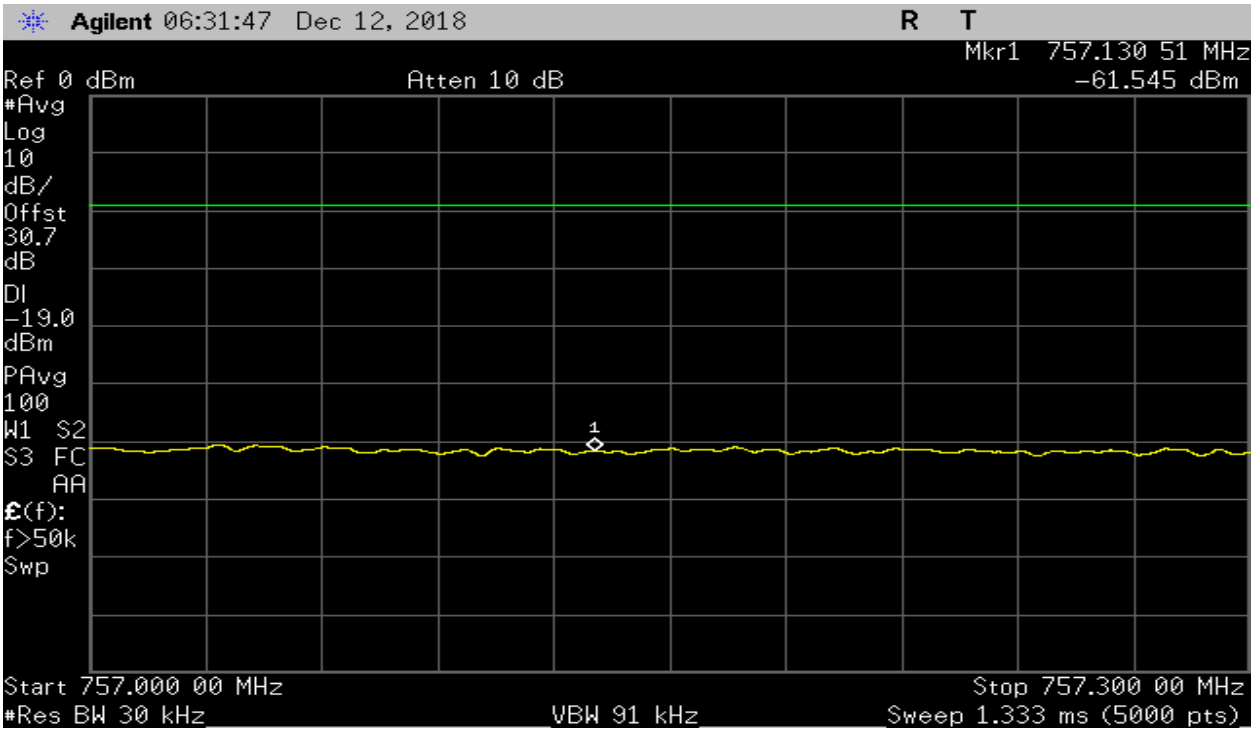
Plot 70 – 728-746MHz Band – LTE Downlink Lower Band Edge



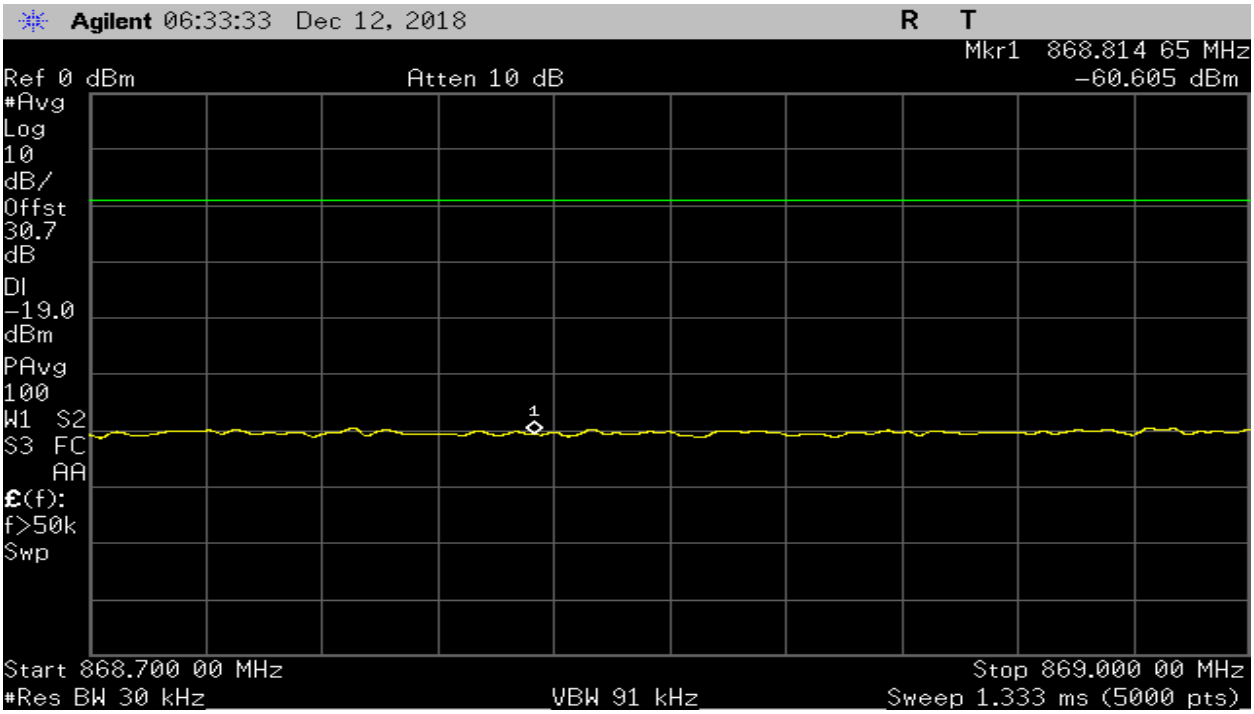
Plot 71 – 728-746MHz Band – LTE Downlink Upper Band Edge



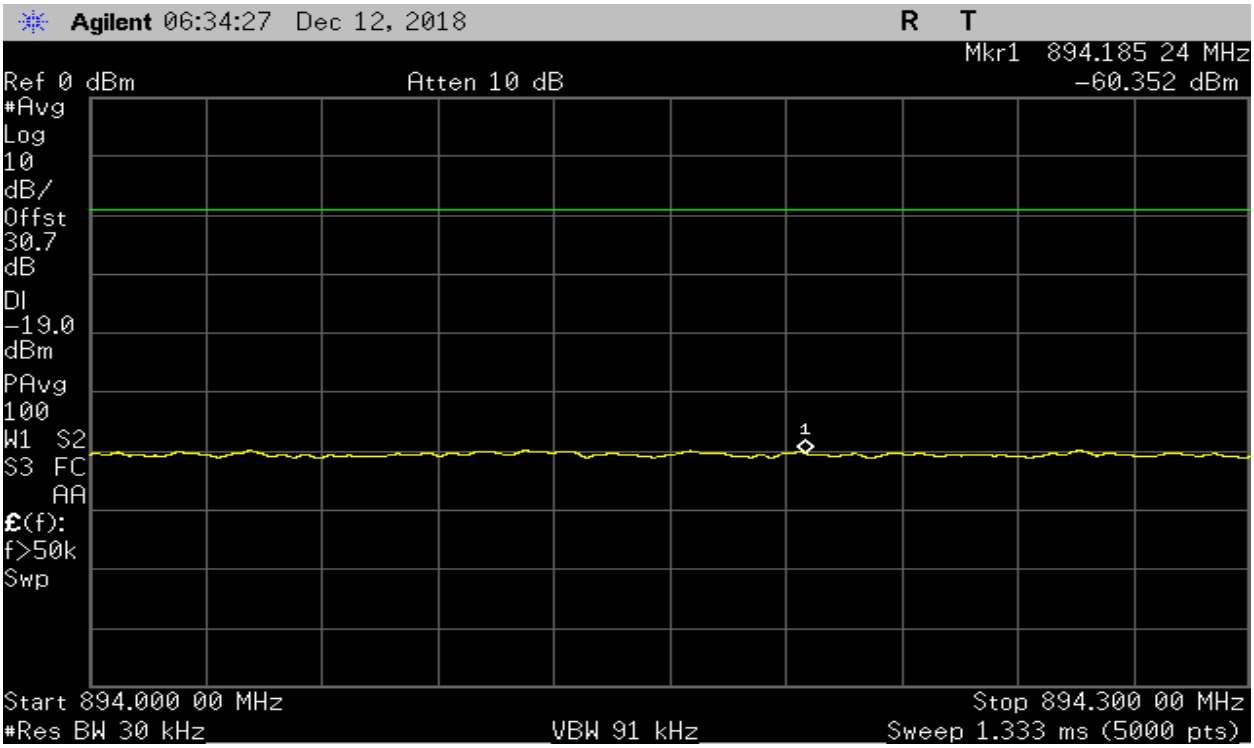
Plot 72 – 746-757MHz Band – LTE Downlink Lower Band Edge



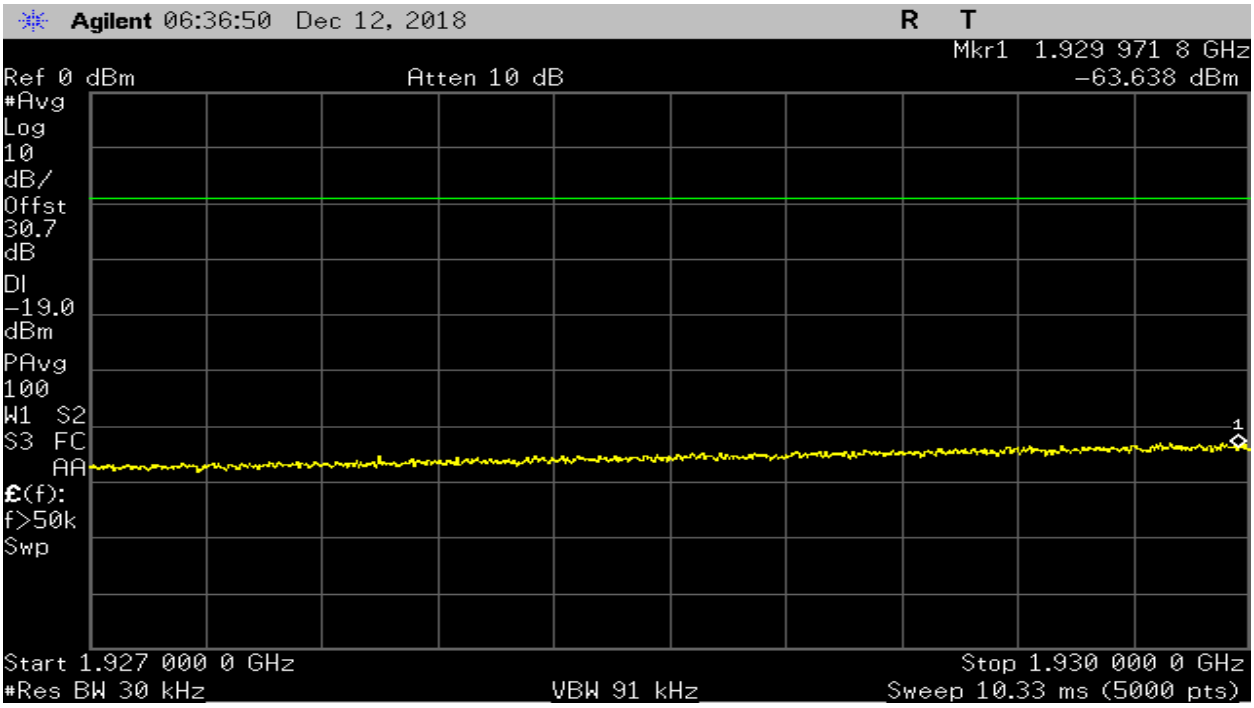
Plot 73 – 746-757MHz Band – LTE Downlink Upper Band Edge



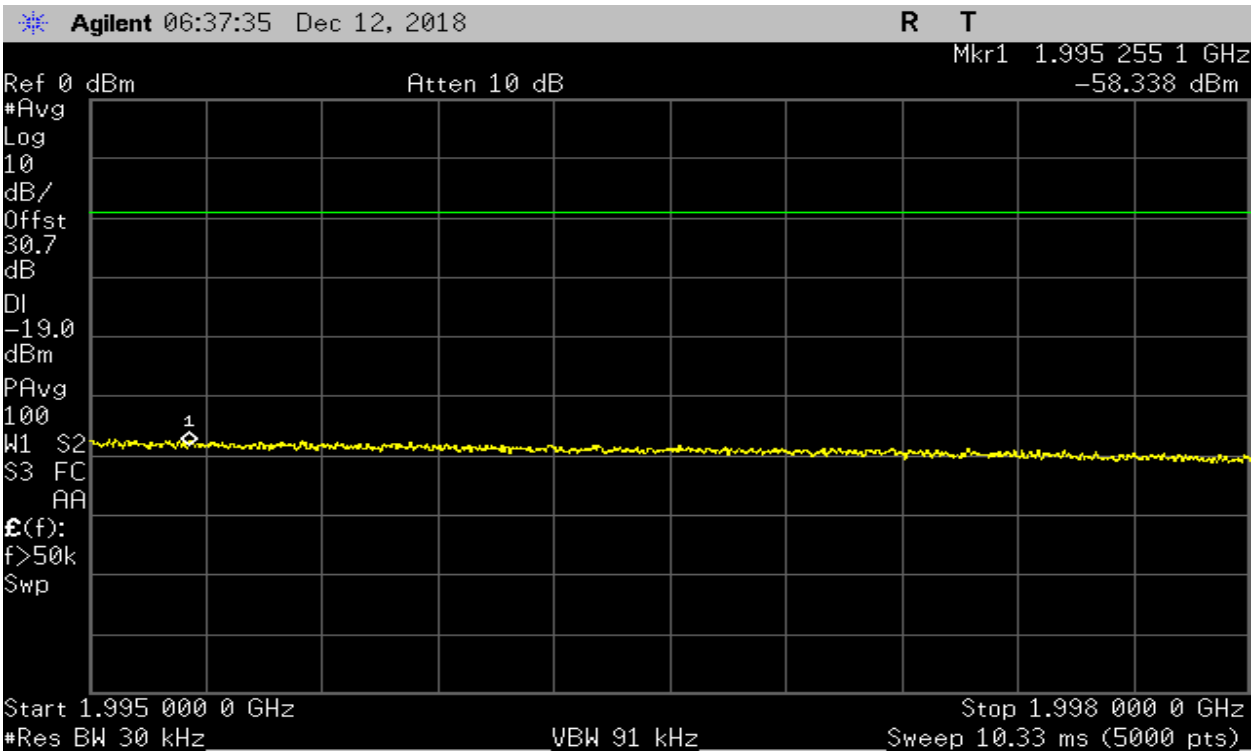
Plot 74 – 869-894MHz Band – LTE Downlink Lower Band Edge



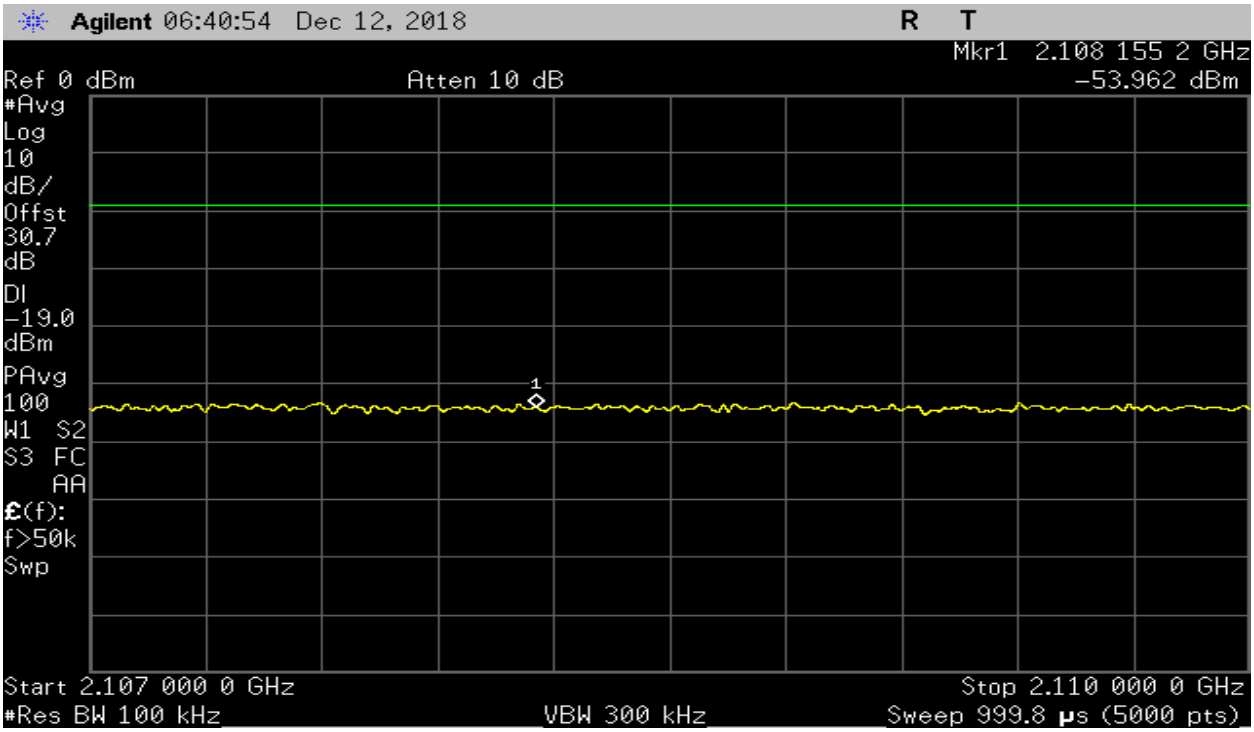
Plot 75 – 869-894MHz Band – LTE Downlink Upper Band Edge



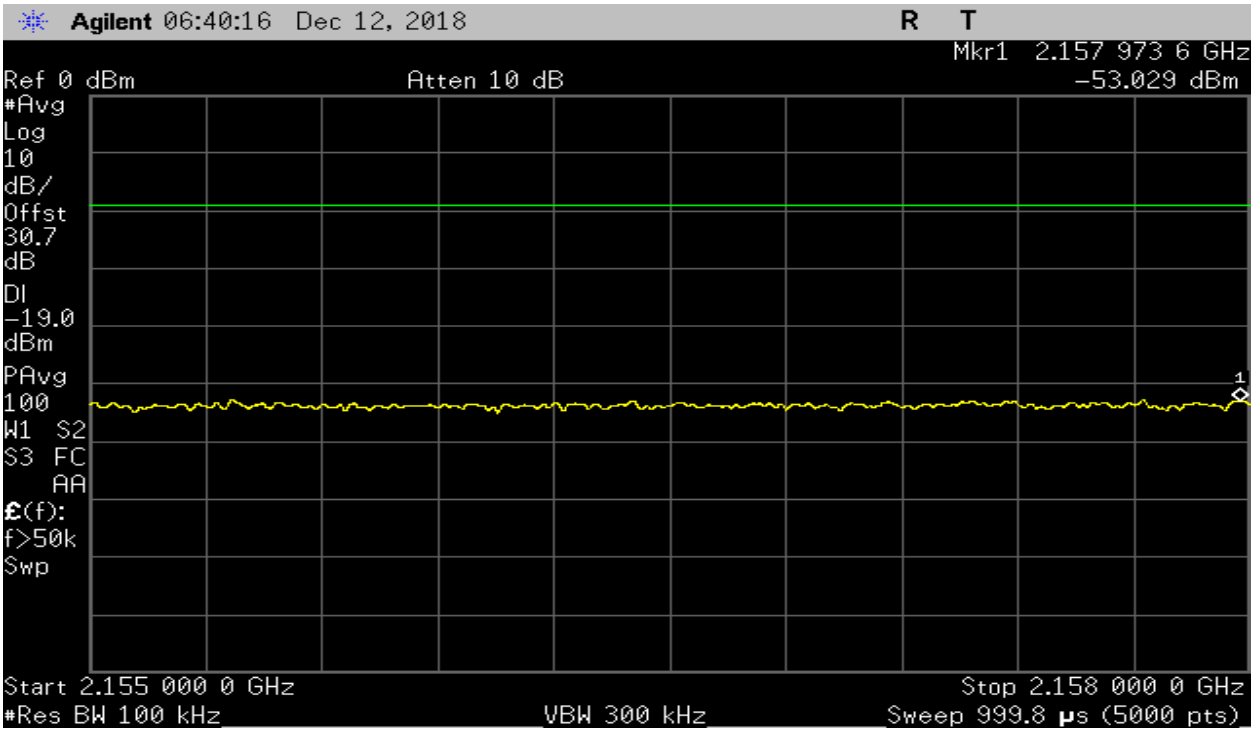
Plot 76 – 1930-1995MHz Band – LTE Downlink Lower Band Edge



Plot 77 – 1930-1995MHz Band – LTE Downlink Upper Band Edge



Plot 78 – 2110-2155MHz Band – LTE Downlink Lower Band Edge



Plot 79 – 2110-2155MHz Band – LTE Downlink Upper Band Edge

5. Conducted Spurious Emissions

Test Requirement(s):	§2.1051	Test Engineer(s):	Keith T.
Test Results:	Pass	Test Date(s):	Nov/26/2018

Test Procedures: As required by 47 CFR §2.1051, Spurious emissions measurements were made at antenna terminals in accordance with the procedures of the KDB 935210 D03.

The EUT was connected through an attenuator to a spectrum analyzer. A signal generator was used at the input of the EUT to produce a 4.1MHz AWGN signal at the center of each CMRS operating band. Measurements were made at the low and high frequency of the uplink and downlink operational band. The required minimum resolution bandwidth was used as stated by different rule part (i.e. Part 22, 27, 24, etc.)

Frequency Band (MHz)	Measured Frequency (MHz)	Measured Level (dBm)	Limit (dBm)	Margin
698-716	6935	-36.33	-13	-23.33
776-787	775	-33.11	-13	-20.11
824-849	1726	-31.09	-13	-18.09
1710-1755	14540	-35.83	-13	-22.83
1850-1915	1731	-33.49	-13	-20.49

Table 13 – Conducted Spurious Emission Data – Uplink Summary

Frequency Band (MHz)	Measured Frequency (MHz)	Measured Level (dBm)	Limit (dBm)	Margin
728-746	1975	-36.05	-13	-23.05
746-757	1972	-36.30	-13	-23.3
869-894	1951	-36.24	-13	-23.2
1930-1995	2129.9	-38.13	-13	-25.1
2110-2155	1974	-38.28	-13	-25.28

Table 14 – Conducted Spurious Emission Data – Downlink Summary

Per FCC § 27.53 (C) for frequency operating in 746 – 758MHz and 776-788MHz band following additional requirements apply

As per § 27.53 (C)(4) On all frequencies between 763-775MHz and 793-895MHz, by a factor not less than 65 + 10log (P) dB in a 6.25kHz band segment, for mobile and portable stations.

BW correction for 6.25kHz to 10kHz RBW is following

BW correction factor = 10log B1/B2

Therefore BW correction factor = 10log 6.25/10 = -2.04

Frequency Range (MHz)	Measured Frequency (MHz)	Measured Level (dBm)	RBW correction Factor (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
763-775	774.94	-51.55	-2.04	-53.59	-35	-18.59
793-805	793.0	-66.43	-2.04	-68.47	-35	-33.47

Table 15 – Conducted Spurious Emission Data – 776-787MHz Uplink Band Summary

Frequency Range (MHz)	Measured Frequency (MHz)	Measured Level (dBm)	RBW correction Factor (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
763-775	767.68	-71.89	-2.04	-73.93	-35	-38.93
793-805	794.53	-71.96	-2.04	-74.0	-35	-39.0

Table 16 – Conducted Spurious Emission Data – 746-757MHz Downlink Band Summary

Per FCC § 27.53 (f) for frequency operating in 746 – 763MHz and 775-793MHz emissions in the band 1559-1610MHz shall be limited to -70dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80dBW EIRP for discrete emissions of less than 700Hz bandwidth.

Since the limit is in EIRP, the MSCL (Cable Loss) information supplied by manufacturer is added along with the bandwidth correction factor.

BW correction for 700Hz to 10kHz RBW is following

BW correction factor = 10log B1/B2

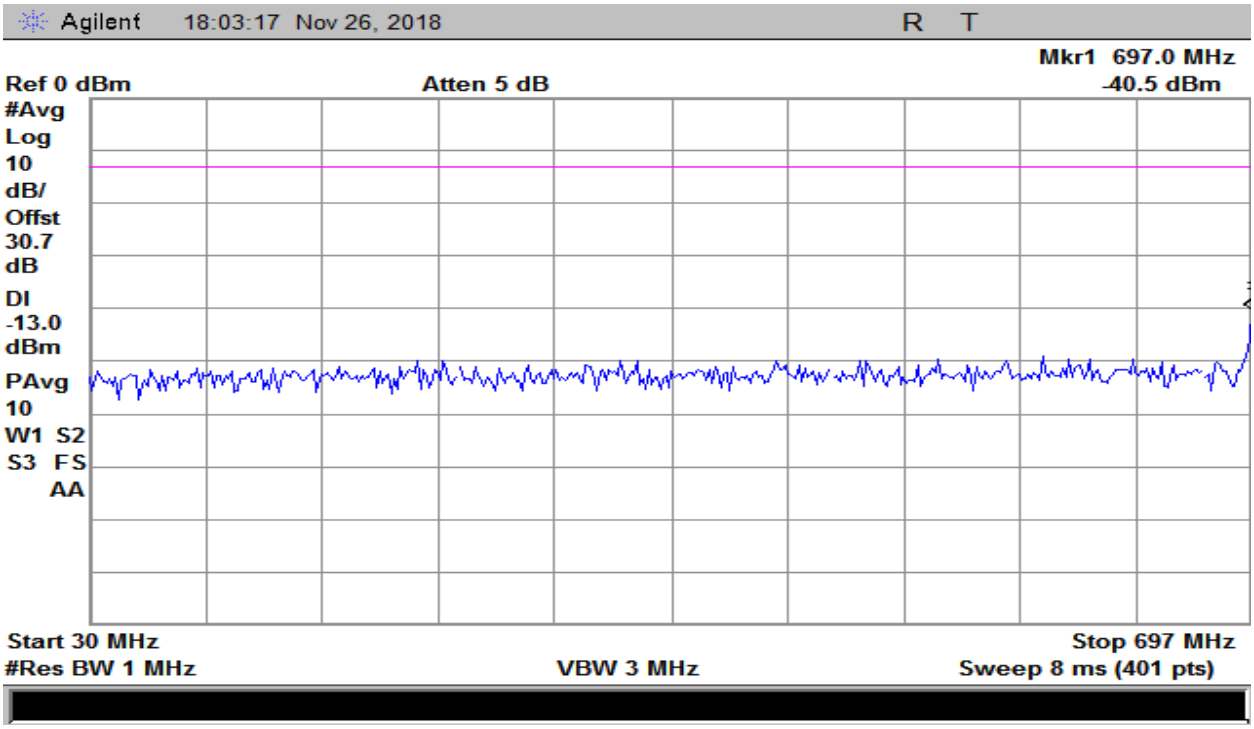
Therefore BW correction factor = 10log 700/1000 = -11.55

Frequency Range (MHz)	Measured Frequency (MHz)	Measured Level (dBm)	RBW correction Factor (dB)	Gain/Loss (dB) from Antenna Kitting Info (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1559-1610 (Wideband)	1562.99	-51.18	0	-0.15	-51.33	-40	-11.3
1559-1610 (Narrowband)	1562.95	-57.86	-11.55	-0.15	-69.56	-50	-19.5

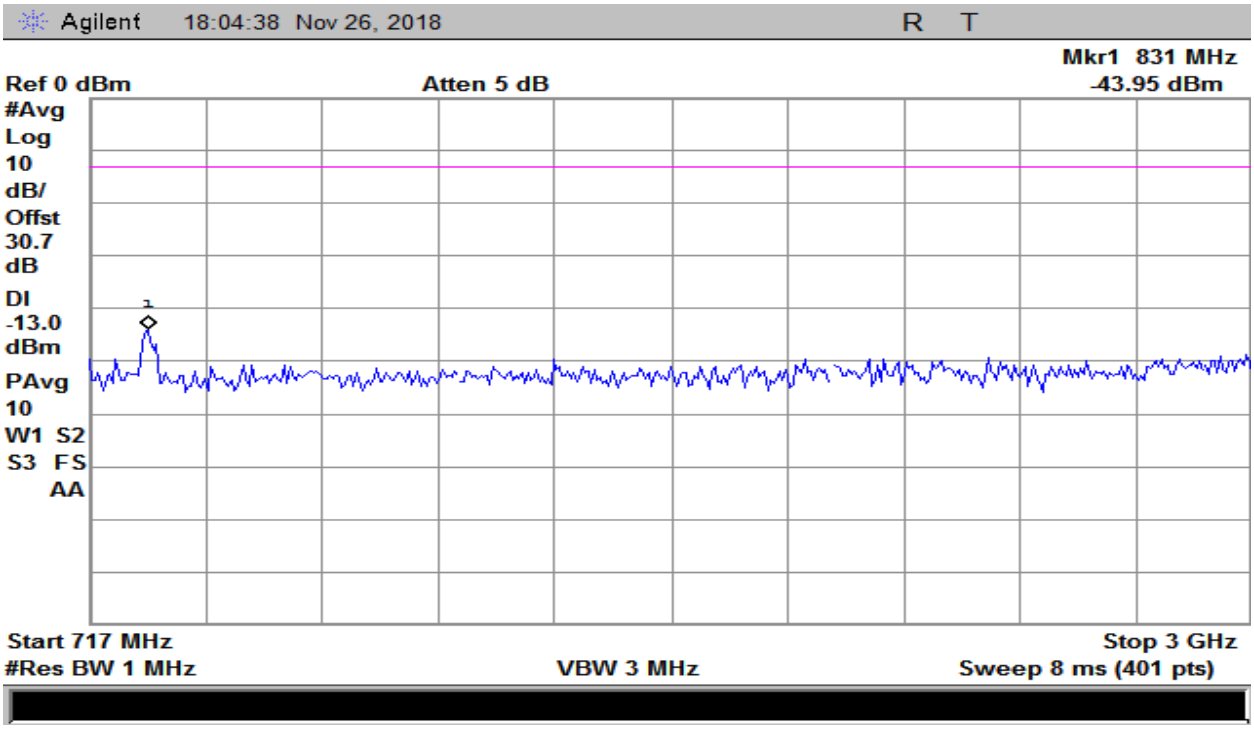
Table 17 – Conducted Spurious Emission Data – 776-787MHz Uplink Band Summary

Frequency Range (MHz)	Measured Frequency (MHz)	Measured Level (dBm)	RBW correction Factor (dB)	MSCL (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1559-1610 (Wideband)	1560.79	-50.47	0	-0.15	-50.6	-40	-10.6
1559-1610 (Narrowband)	1586.92	-73.15	-11.55	-0.15	-84.85	-50	-34.85

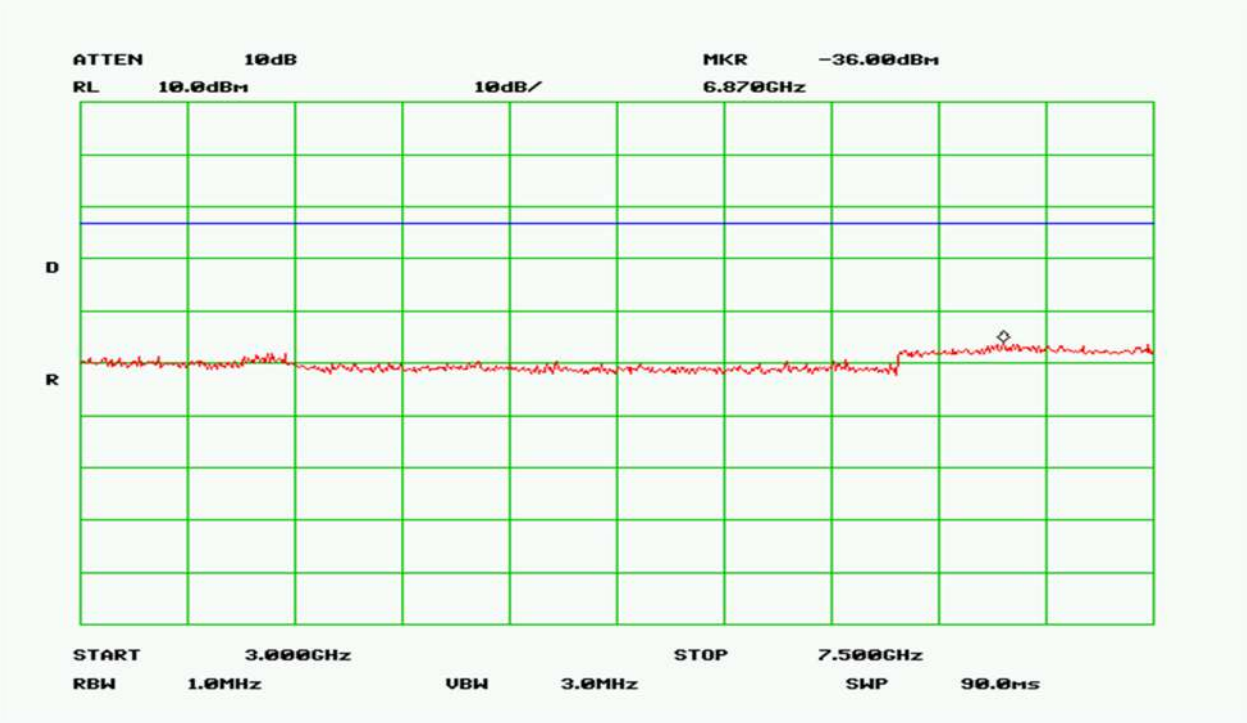
Table 18 – Conducted Spurious Emission Data – 746-757MHz Downlink Band Summary



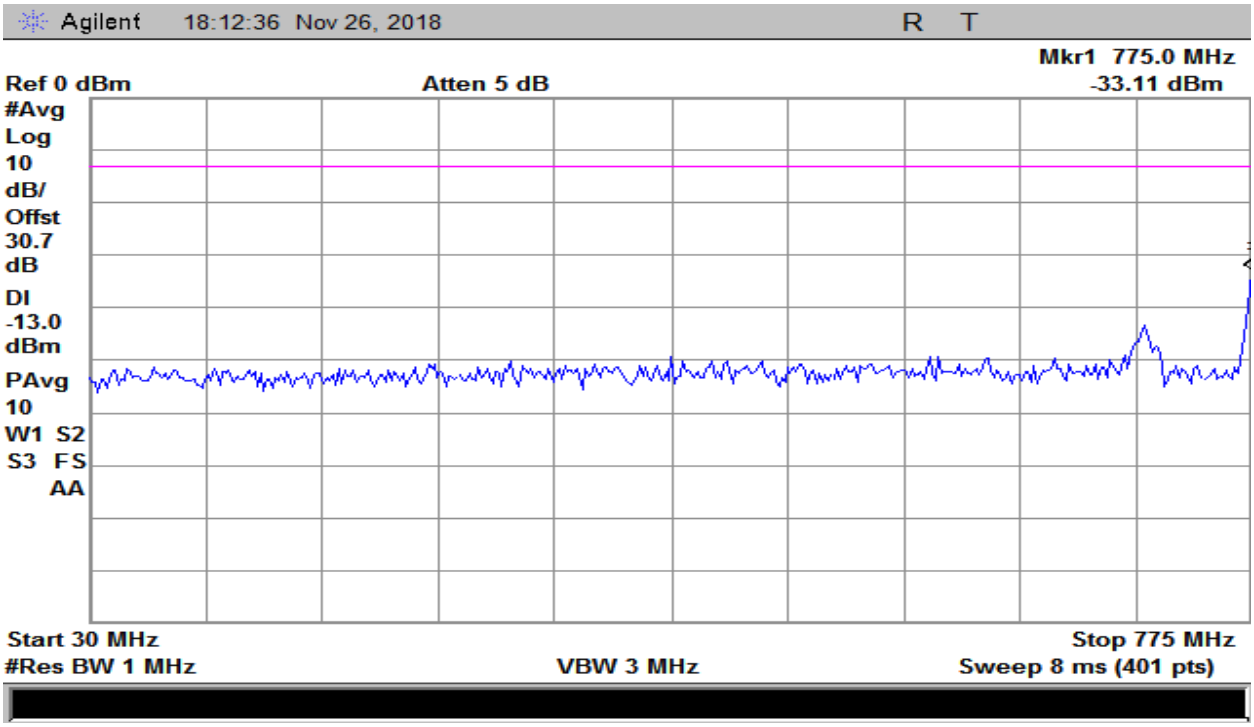
Plot 80 – 698-716MHz Band – Uplink



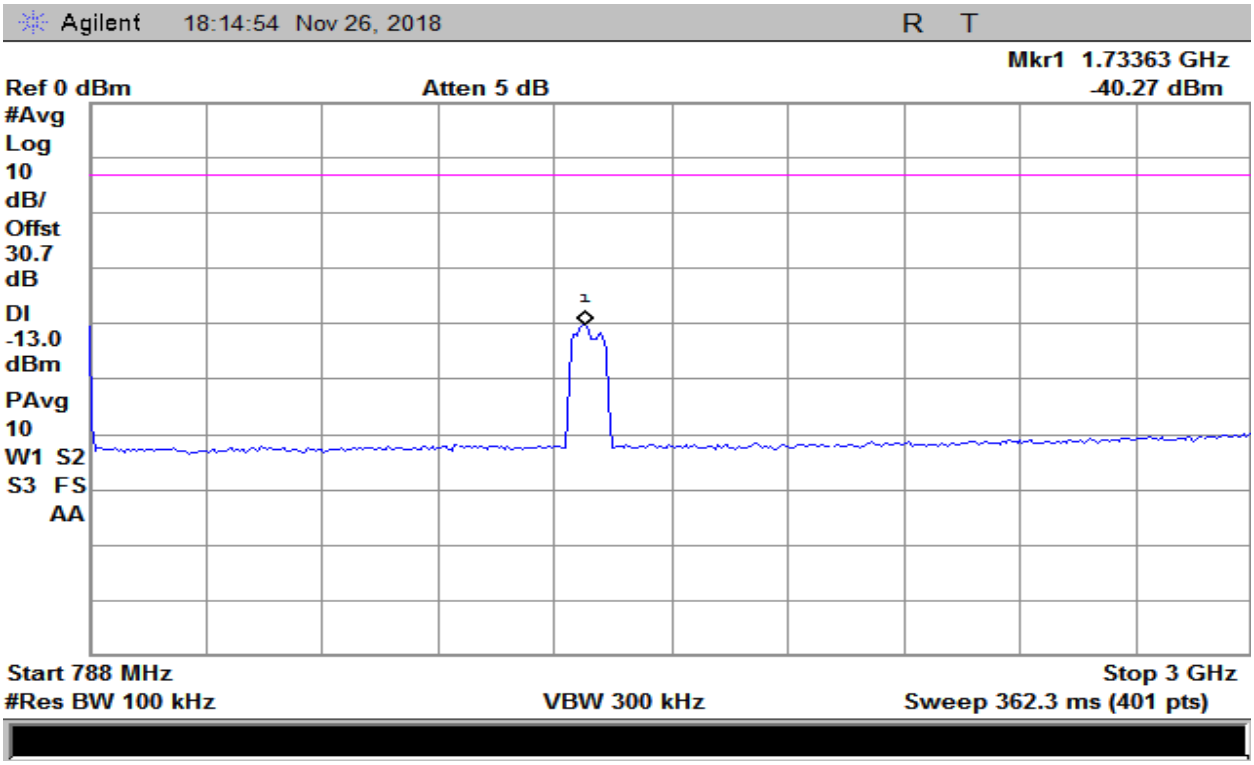
Plot 81 - 698-716MHz Band – Uplink



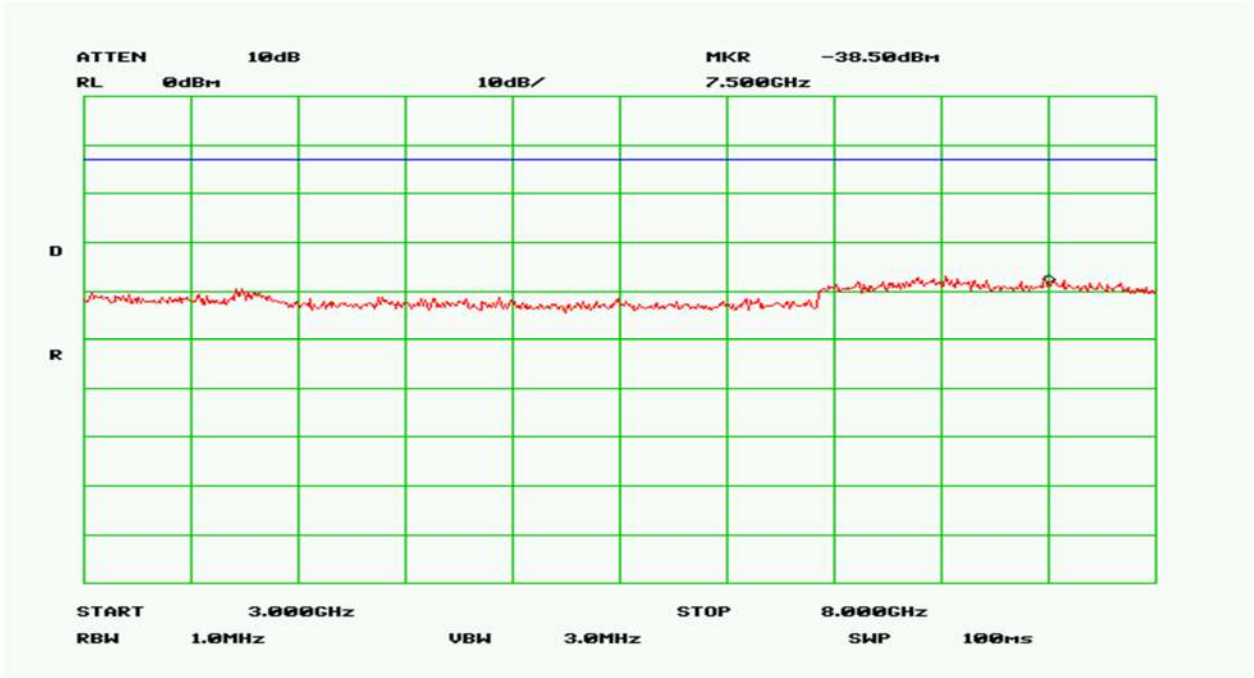
Plot 82 – 698-716MHz Band – Uplink



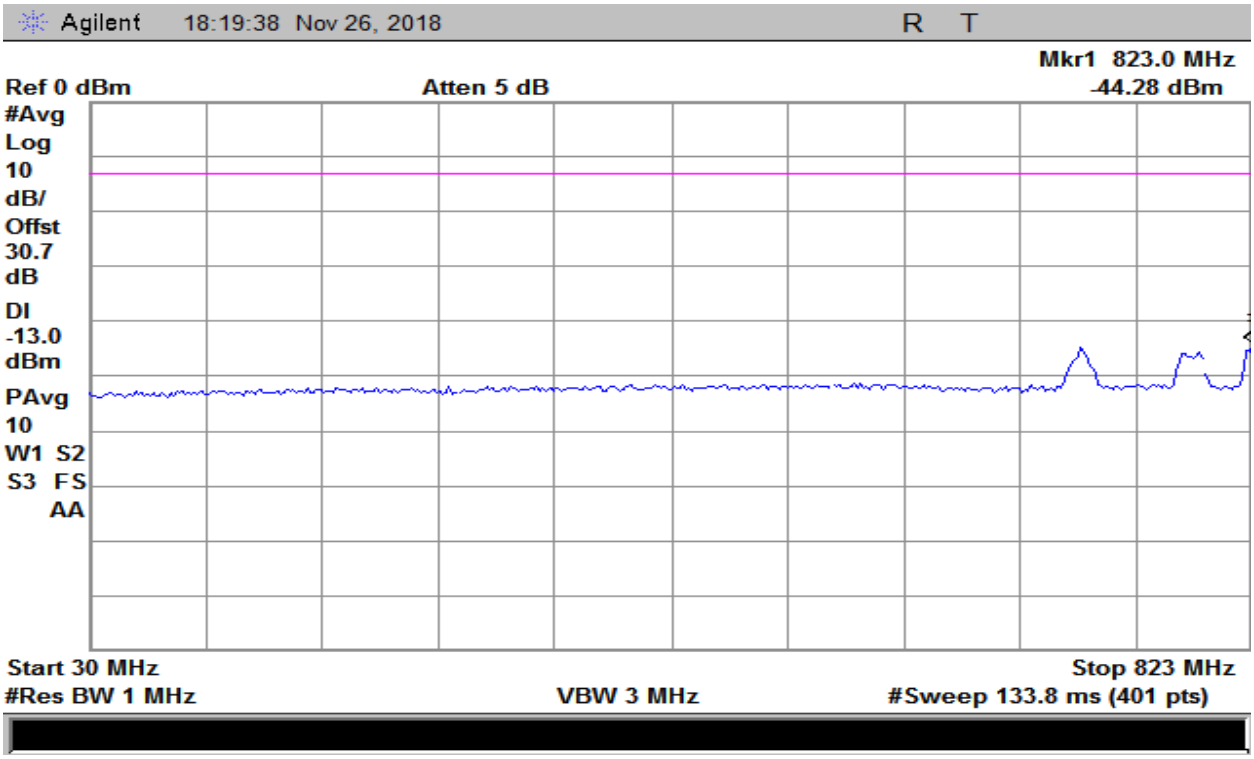
Plot 83 – 776-787MHz Band – Uplink



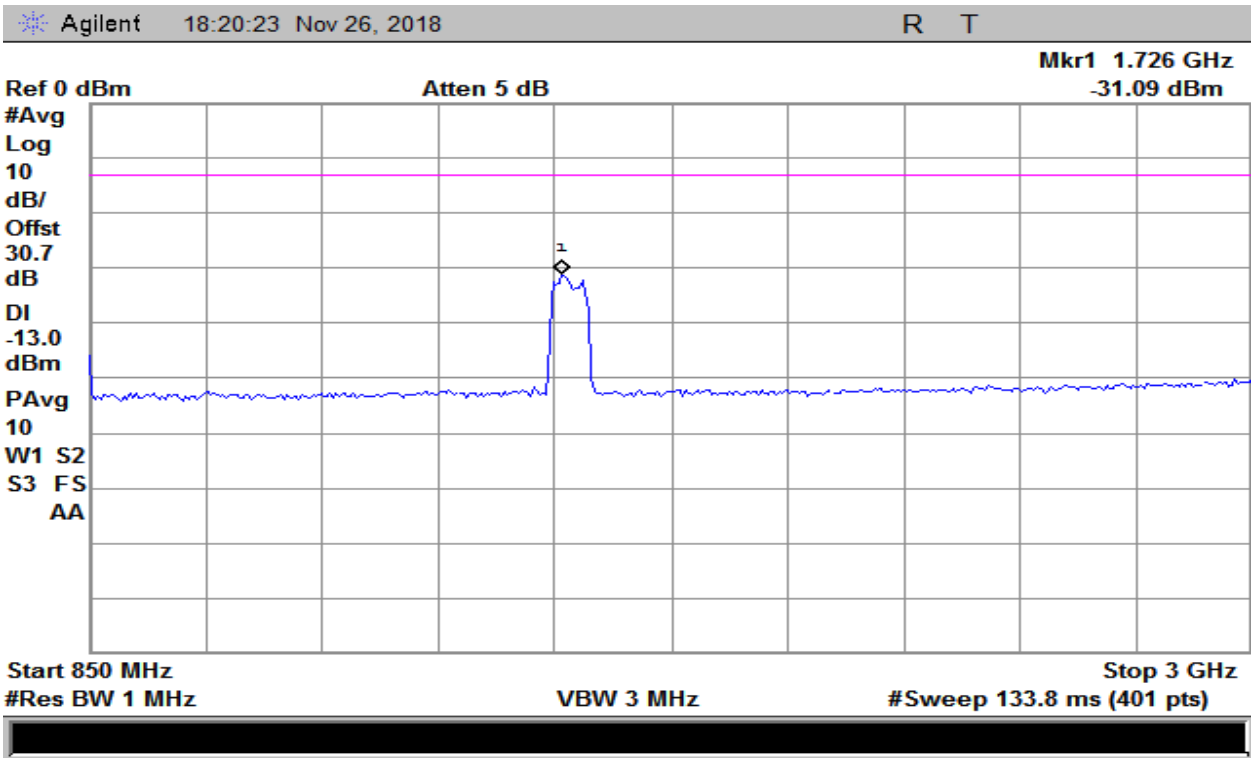
Plot 84 – 776-787MHz Band – Uplink



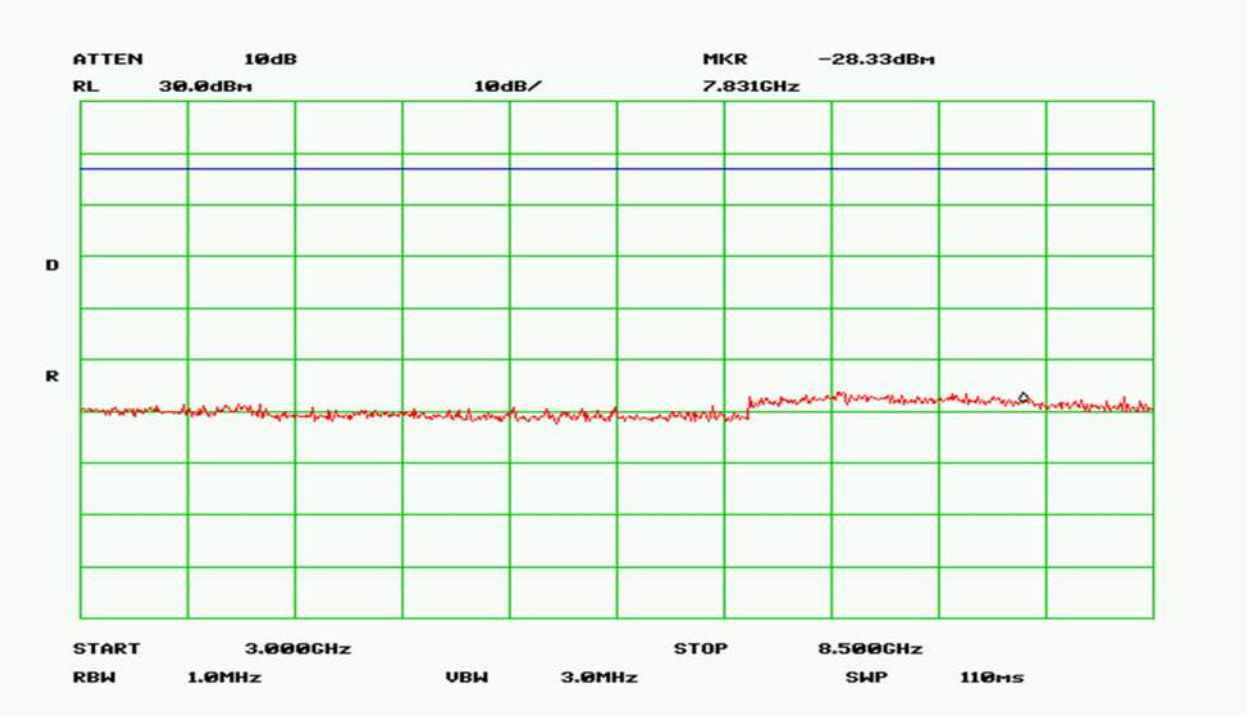
Plot 85 – 776-787MHz Band – Uplink



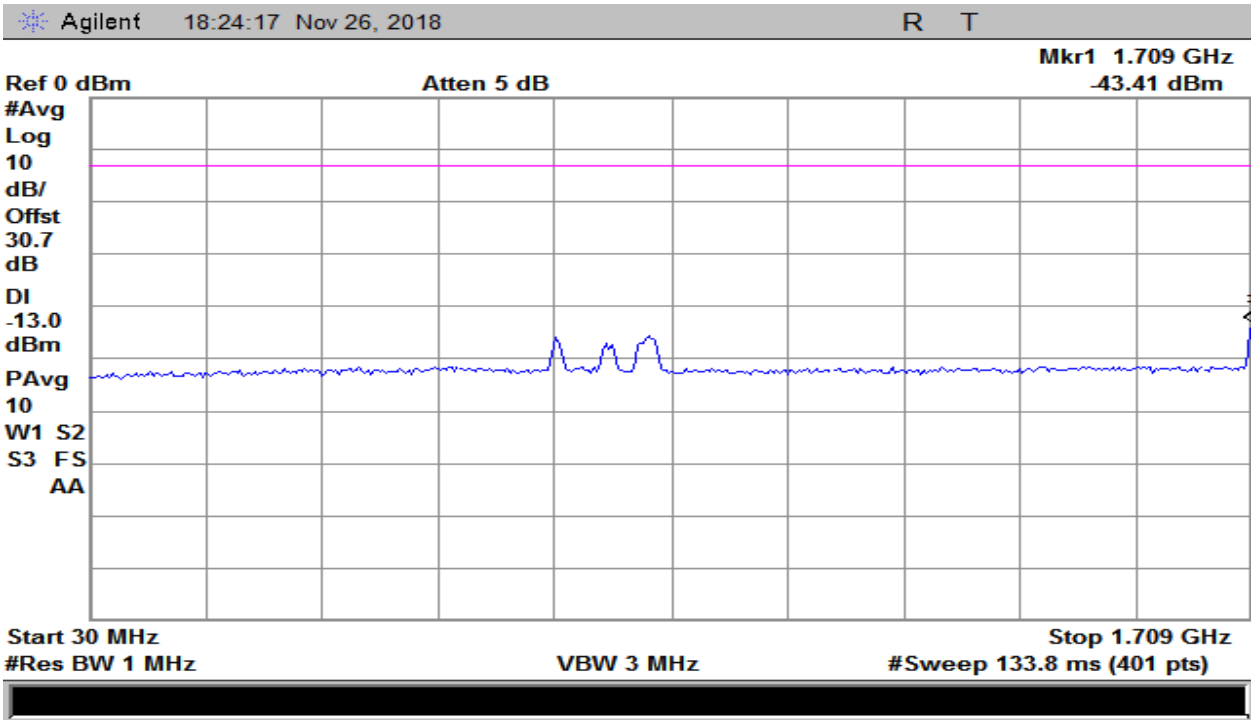
Plot 86 – 824-849MHz Band – Uplink



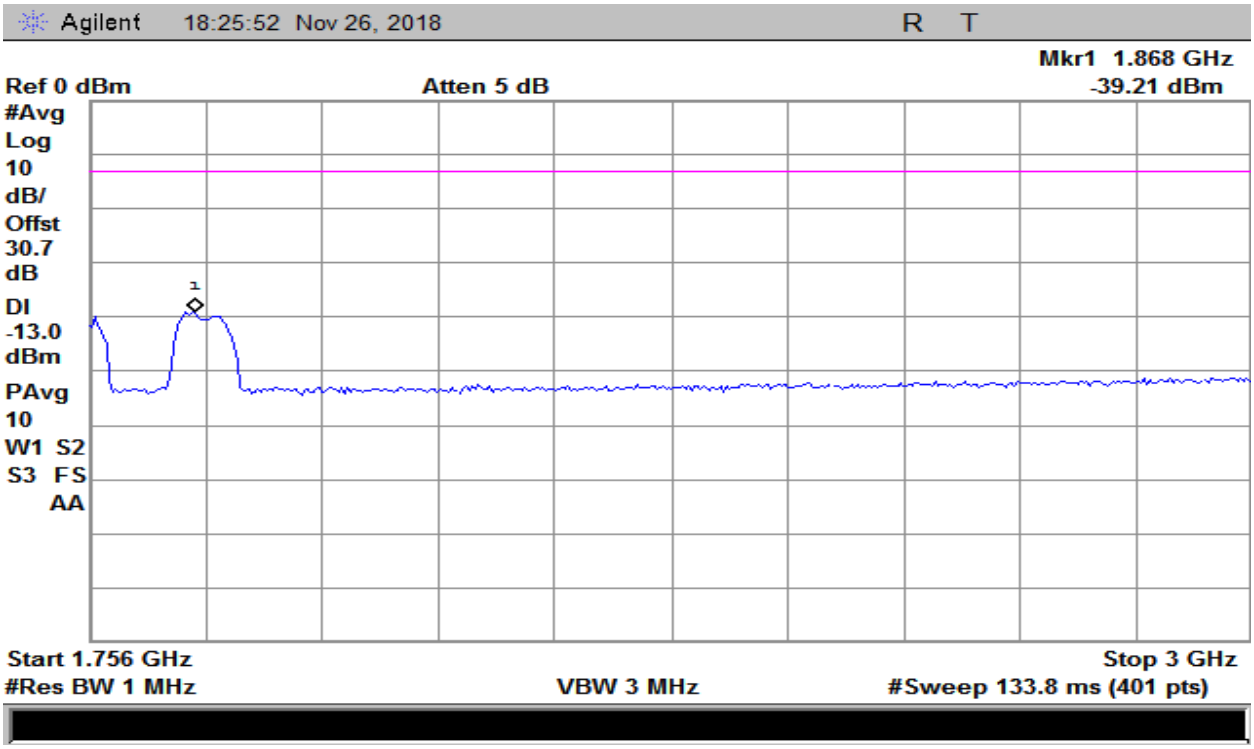
Plot 87 – 824-849MHz Band –Uplink



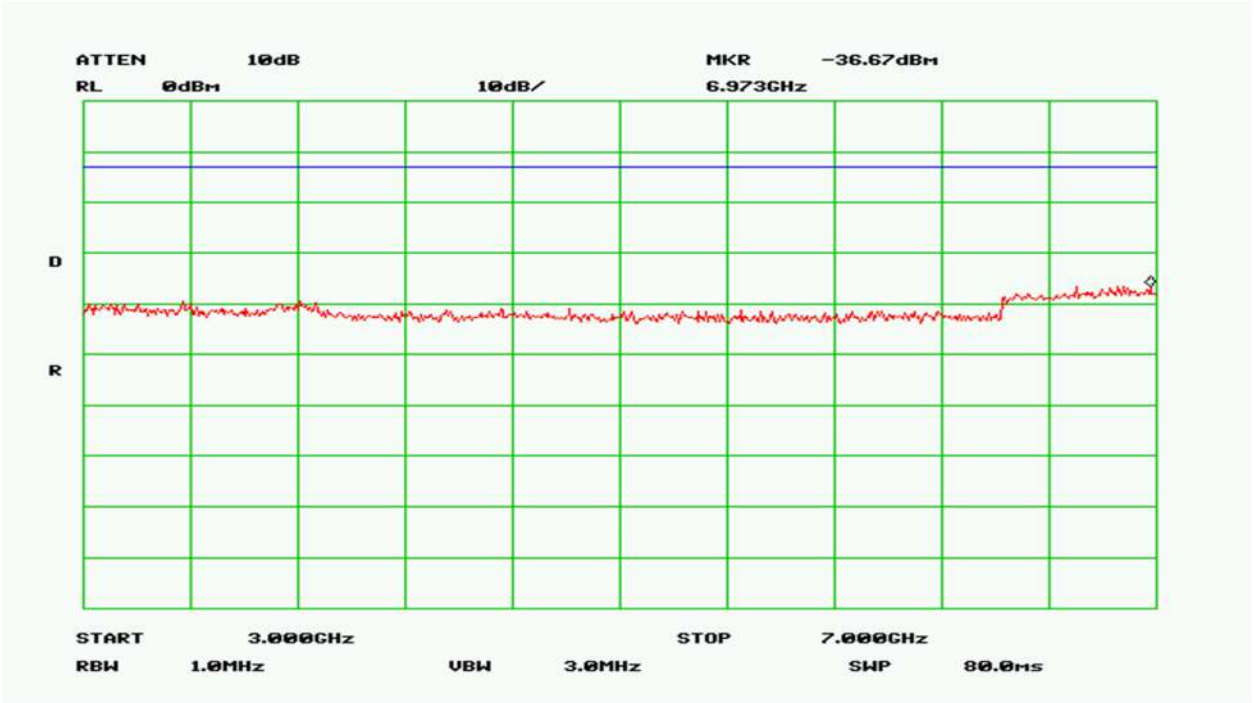
Plot 88 - 824-849MHz Band – Uplink



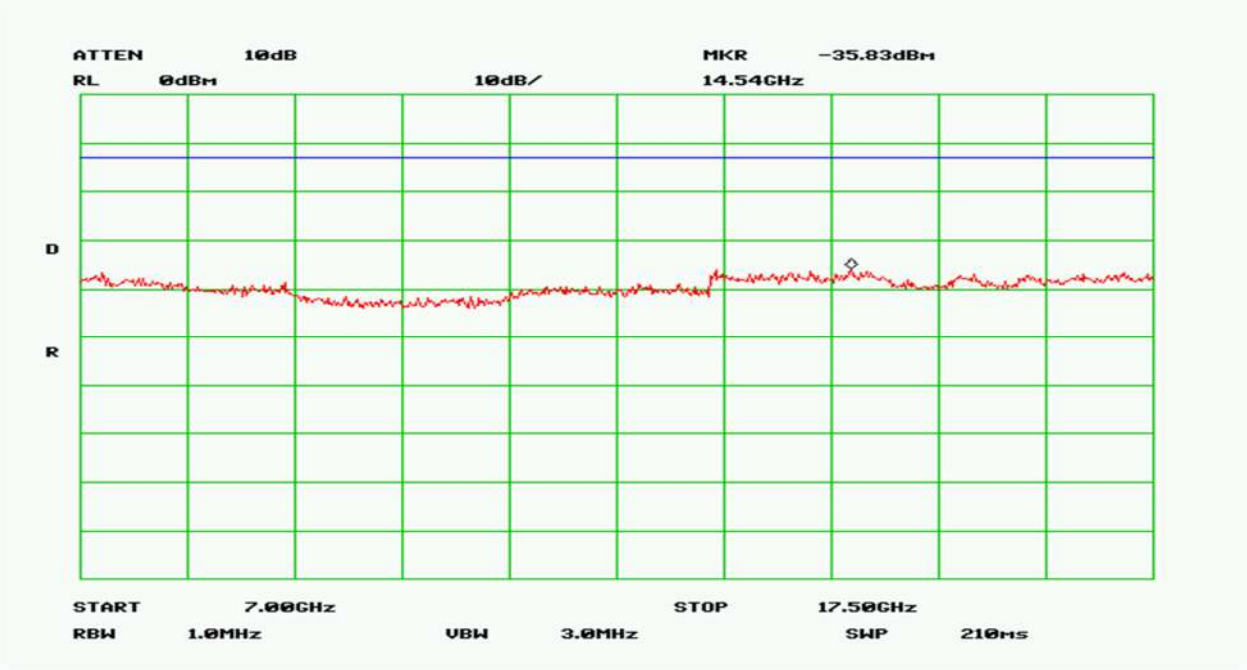
Plot 89 – 1710-1755MHz Band – Uplink



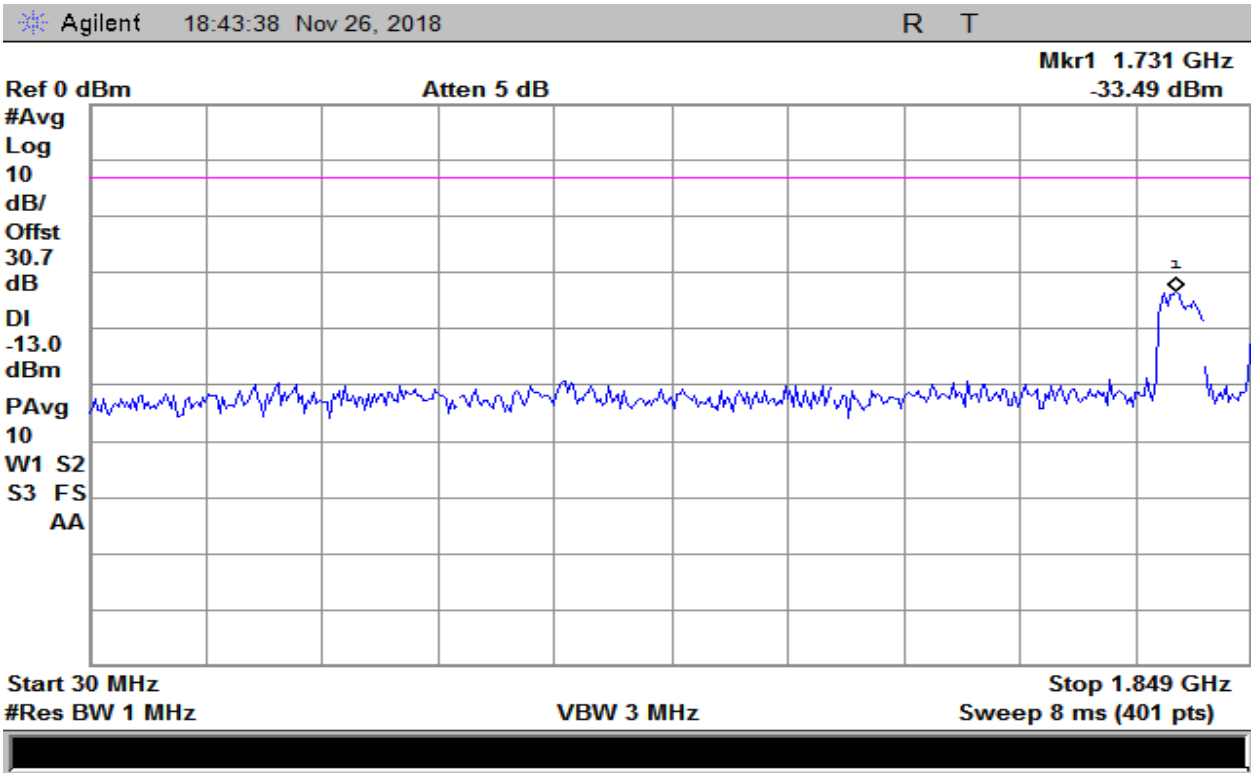
Plot 90 – 1710-1755MHz Band – Uplink



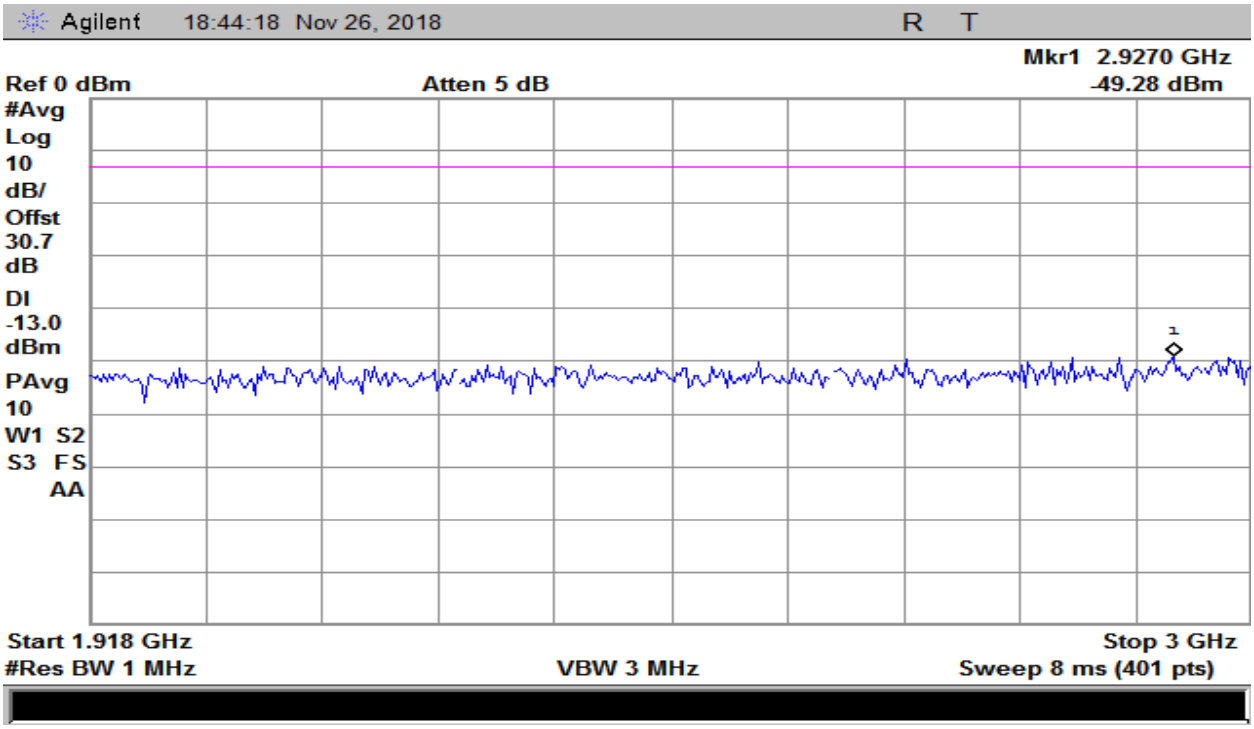
Plot 91 - 1710-1755MHz Band – Uplink



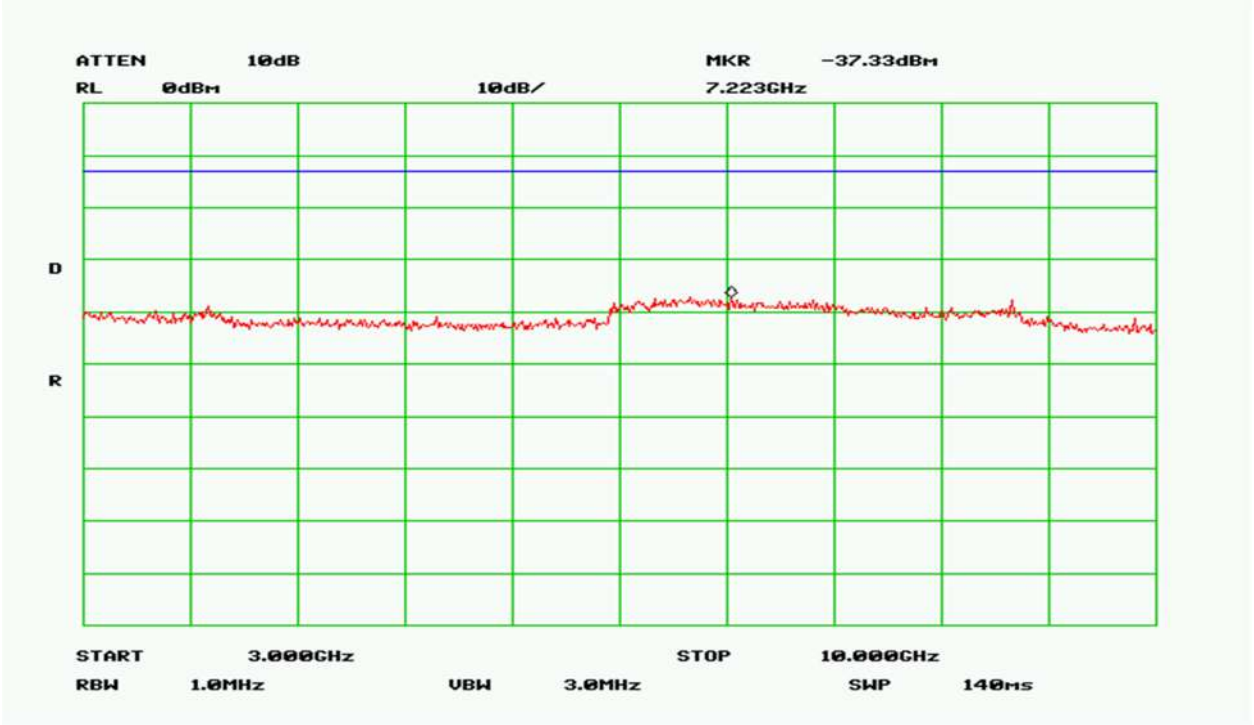
Plot 92 - 1710-1755MHz Band – Uplink



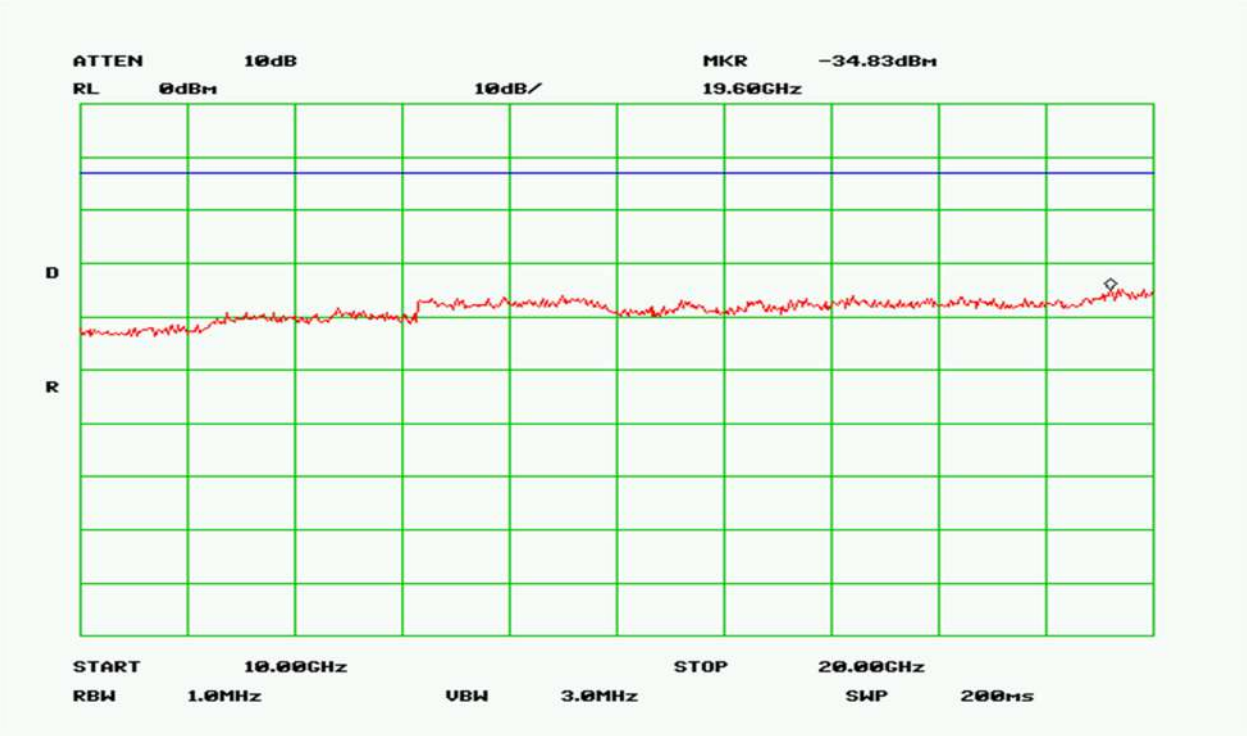
Plot 93 – 1850-1915MHz Band – Uplink



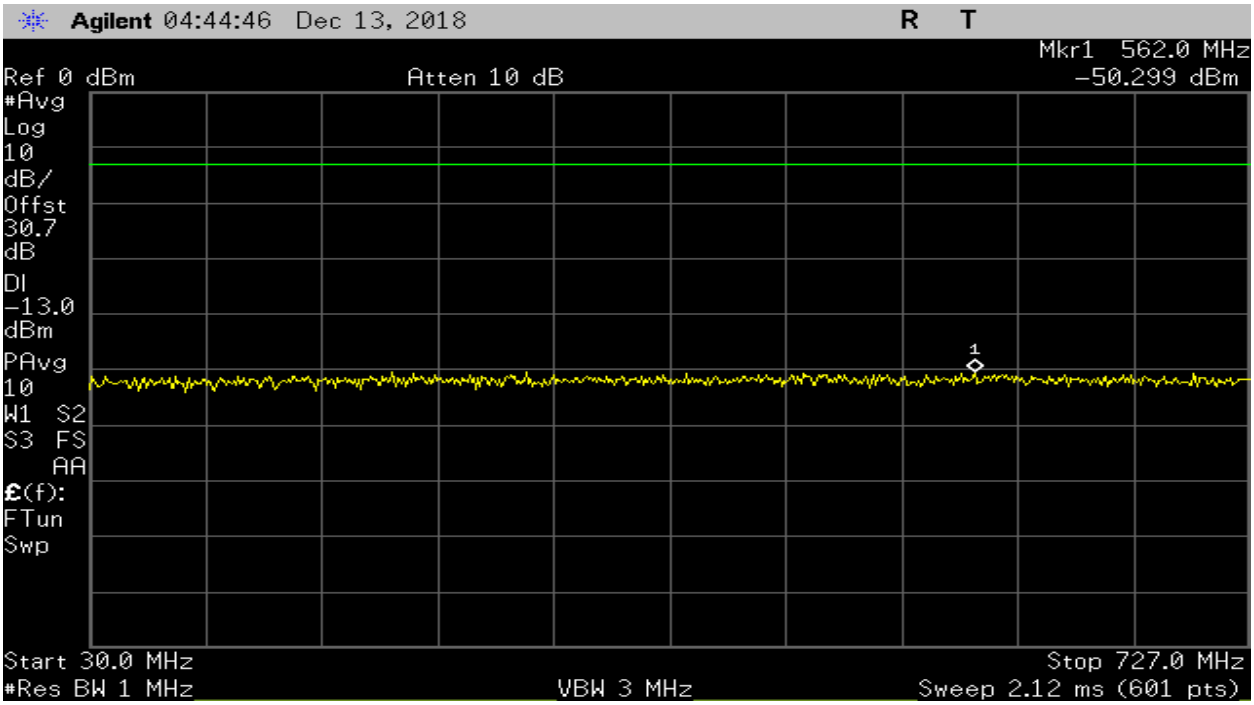
Plot 94 – 1850-1915MHz Band – Uplink



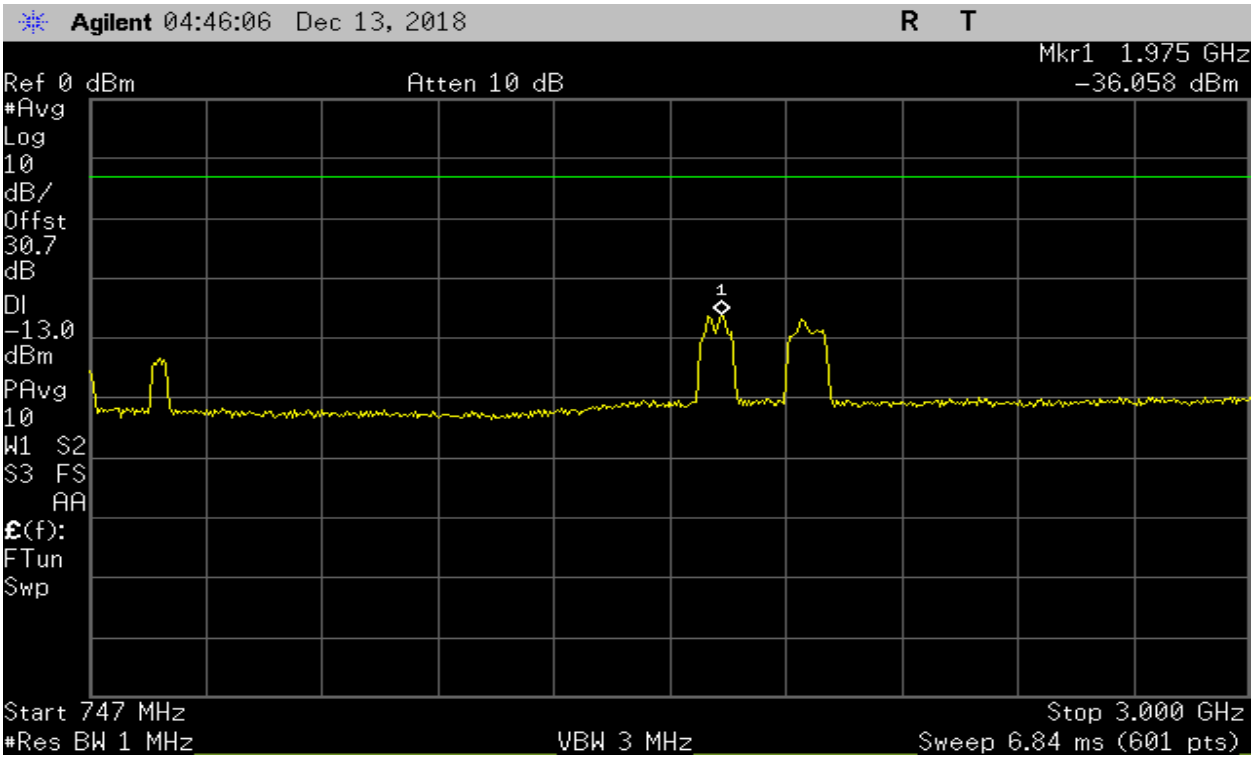
Plot 95 – 1850-1915MHz Band – Uplink



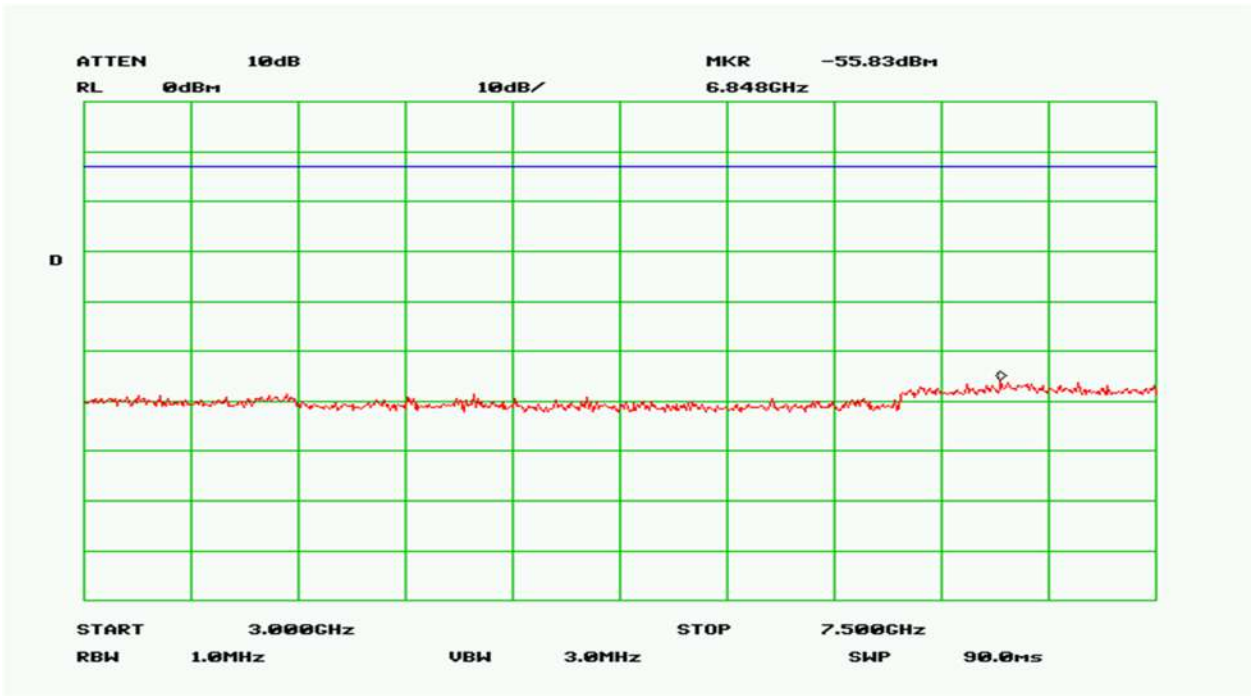
Plot 96 – 1850-1915MHz Band – Uplink



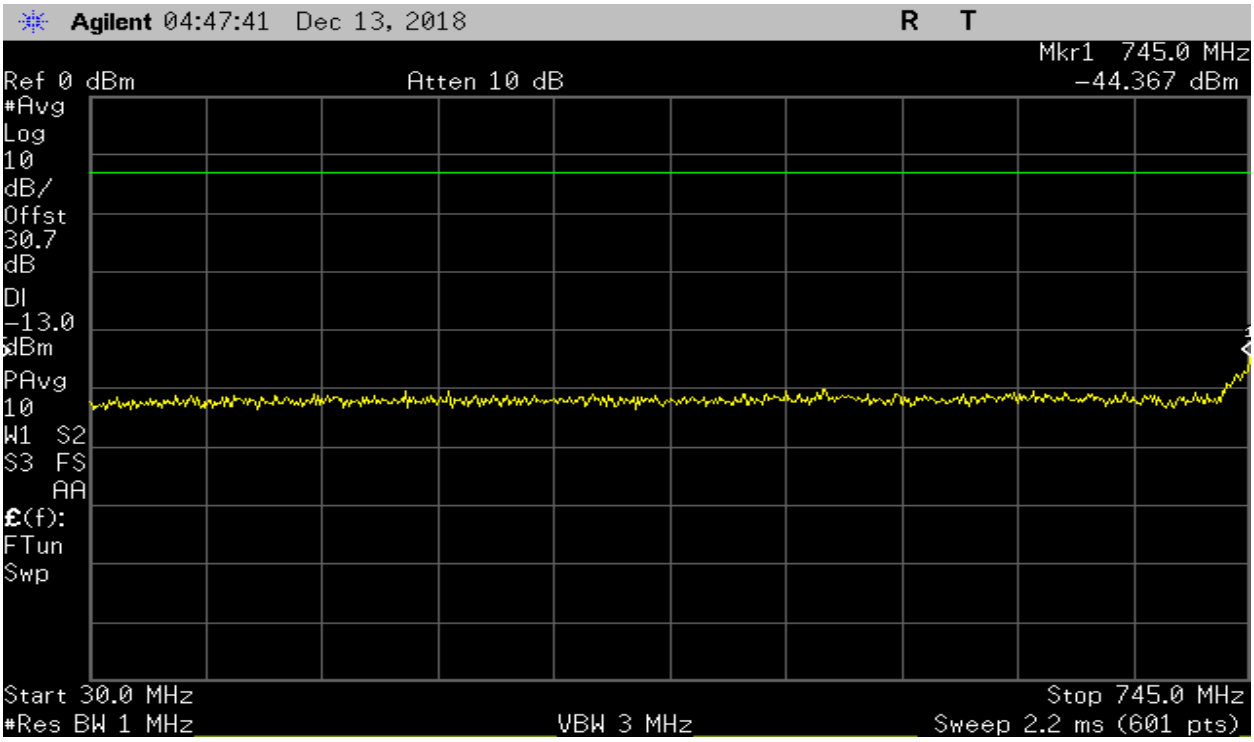
Plot 97 – 728-746MHz Band – Downlink



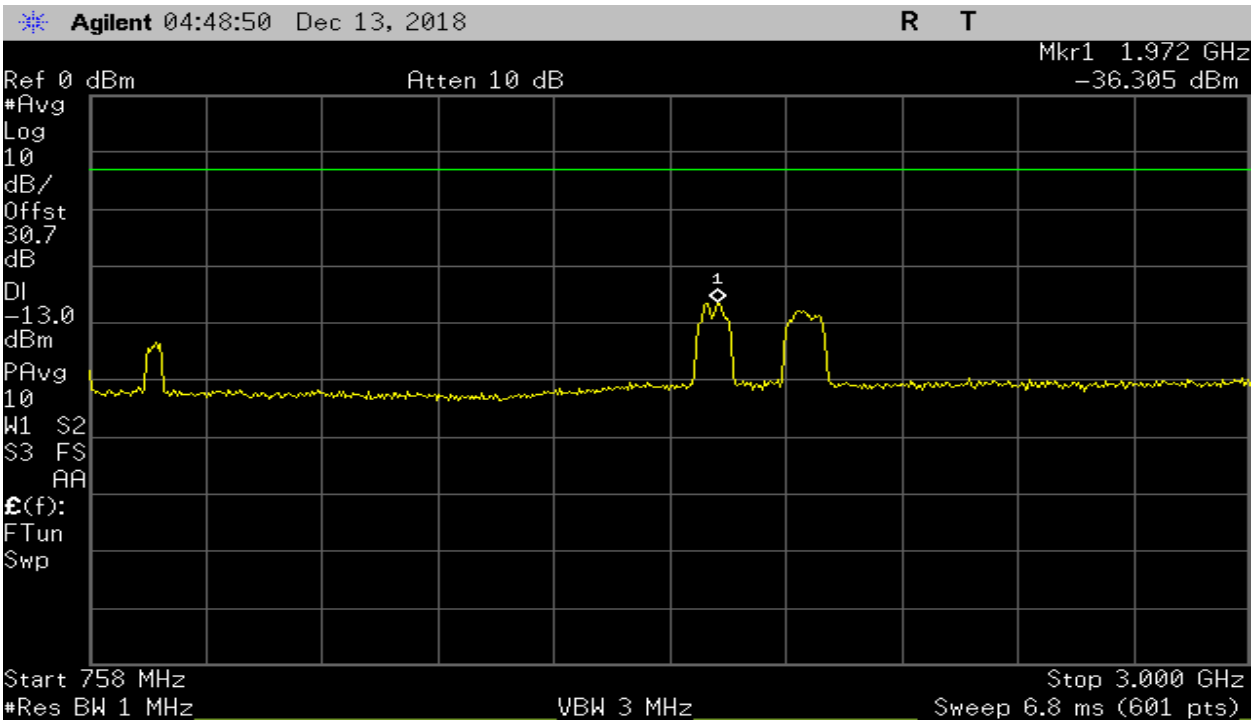
Plot 98 – 728-746MHz Band – Downlink



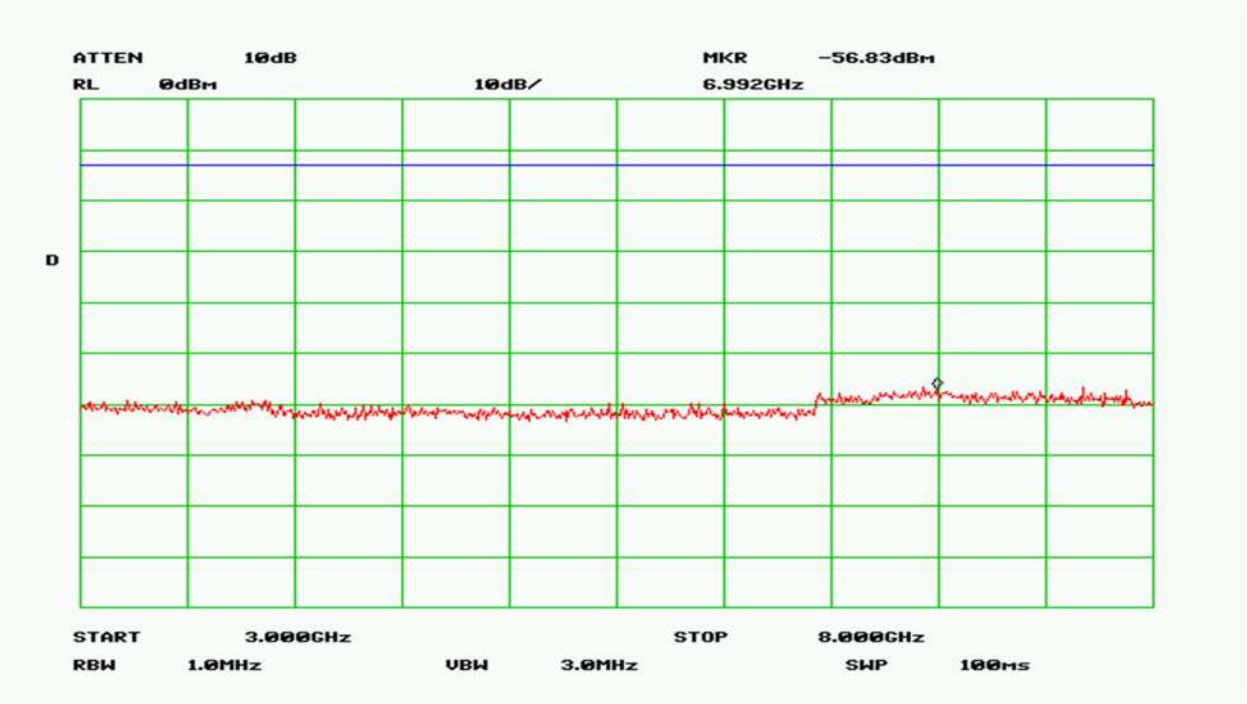
Plot 99 – 728-746MHz Band – Downlink



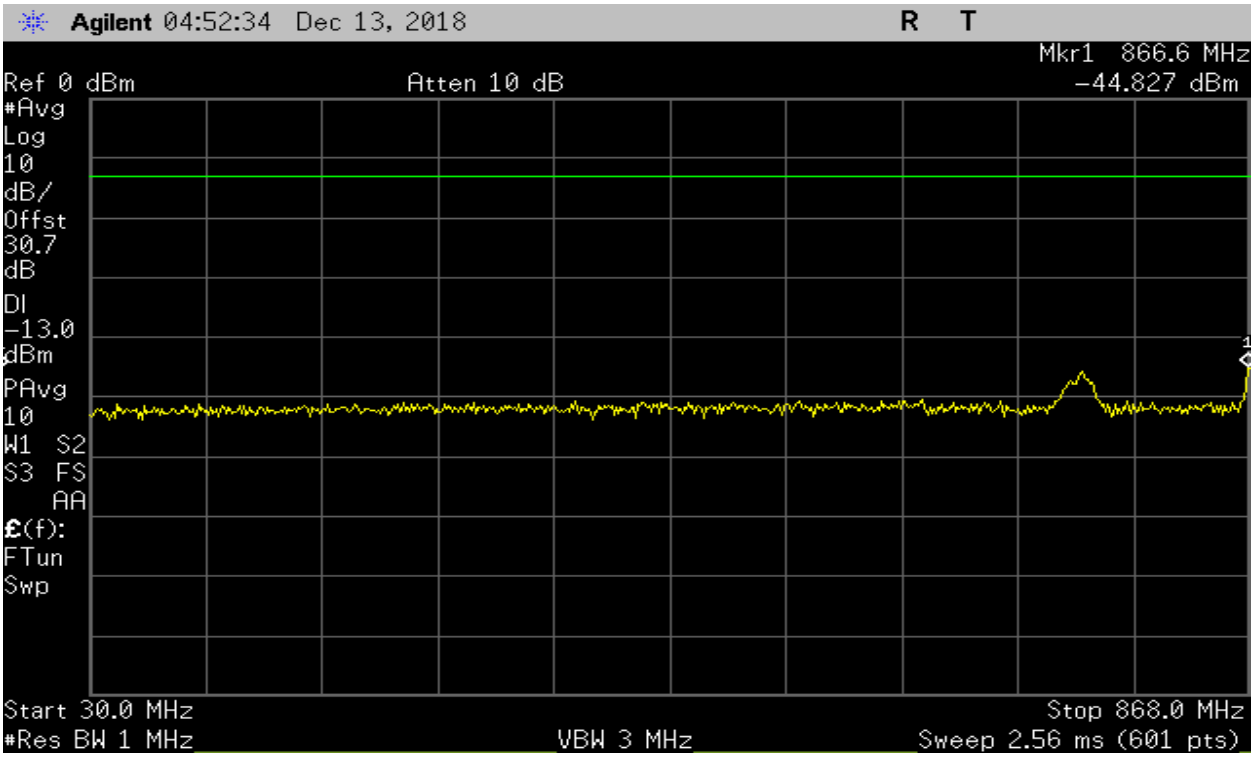
Plot 100 – 746-757MHz Band – Downlink



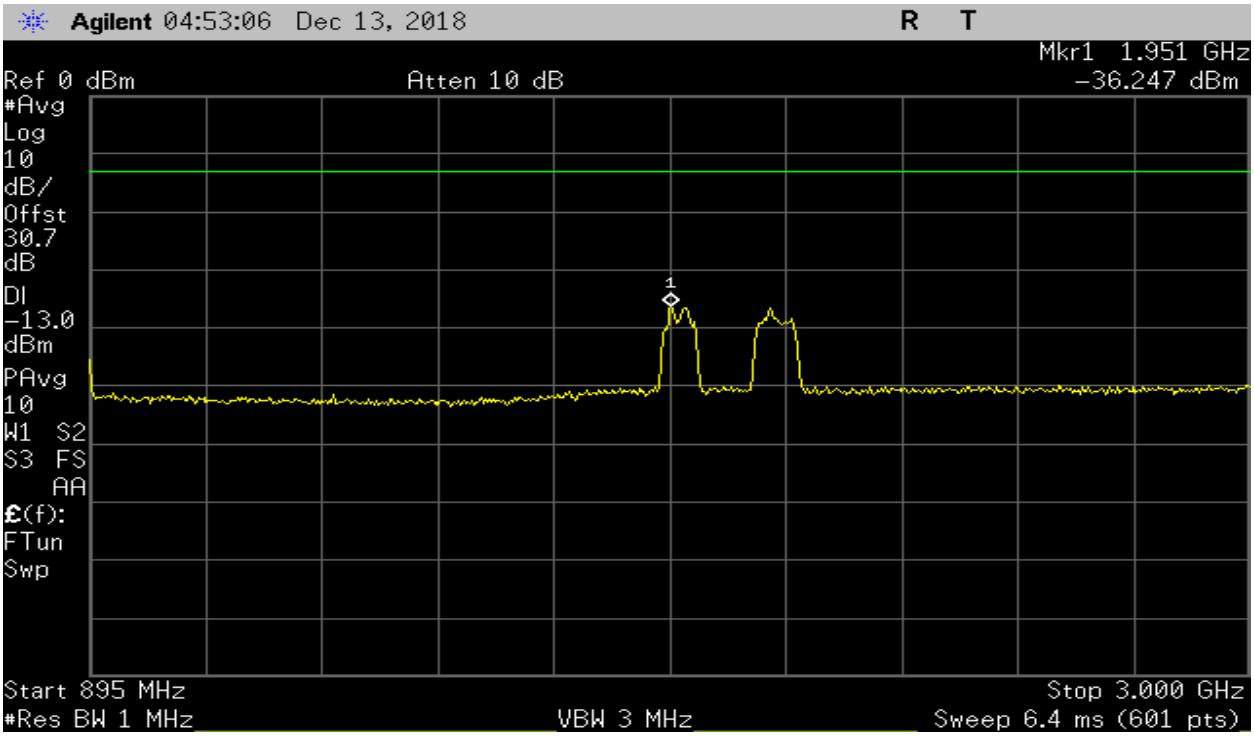
Plot 101 – 746-757MHz Band – Downlink



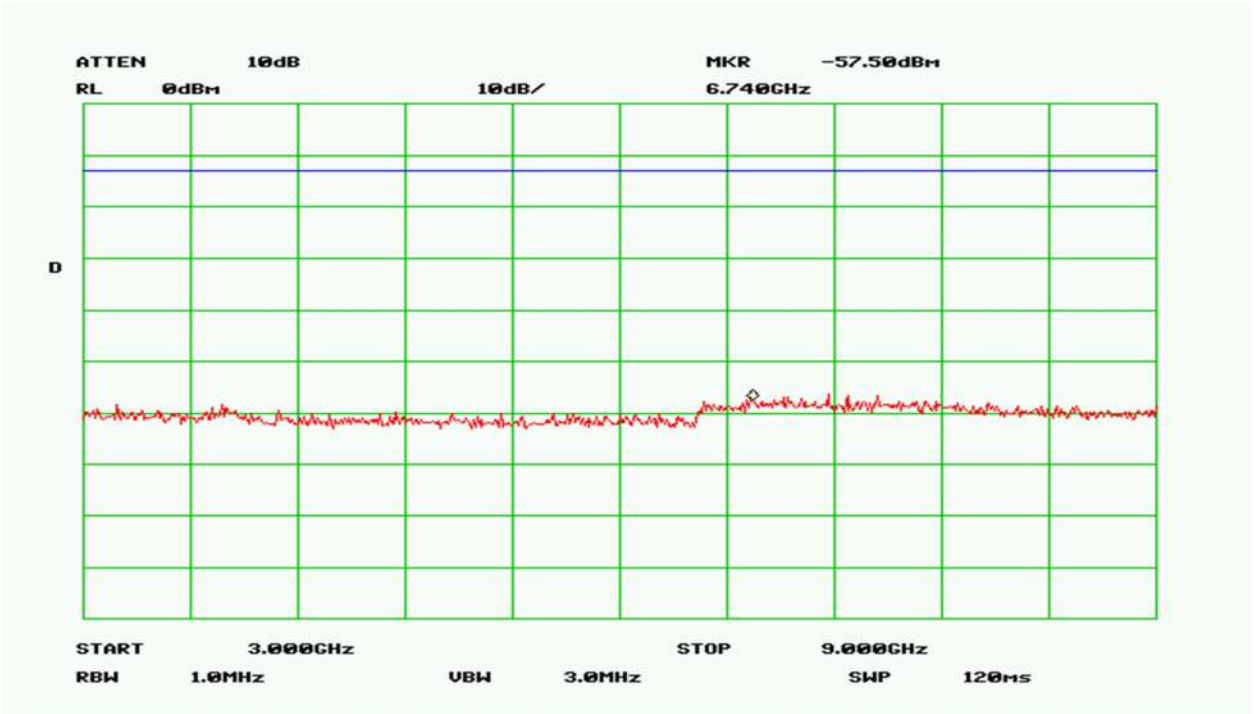
Plot 102 – 746-757MHz Band – Downlink



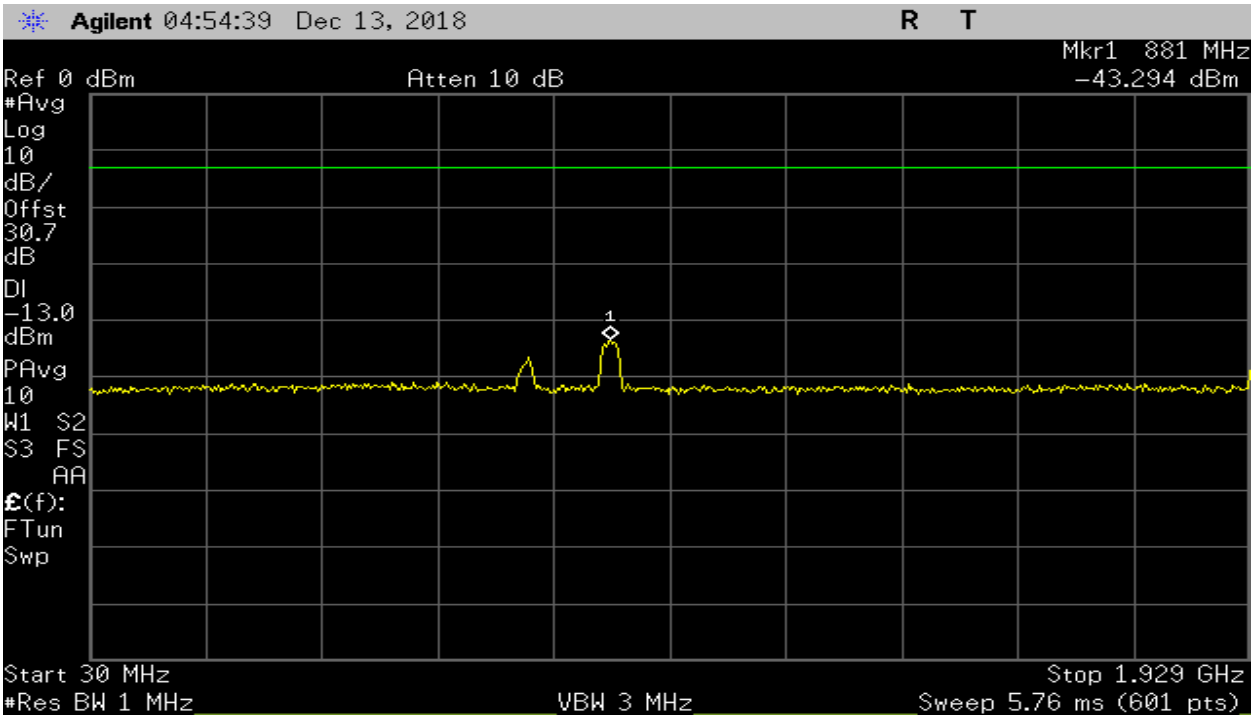
Plot 103 – 869-894MHz Band – Downlink



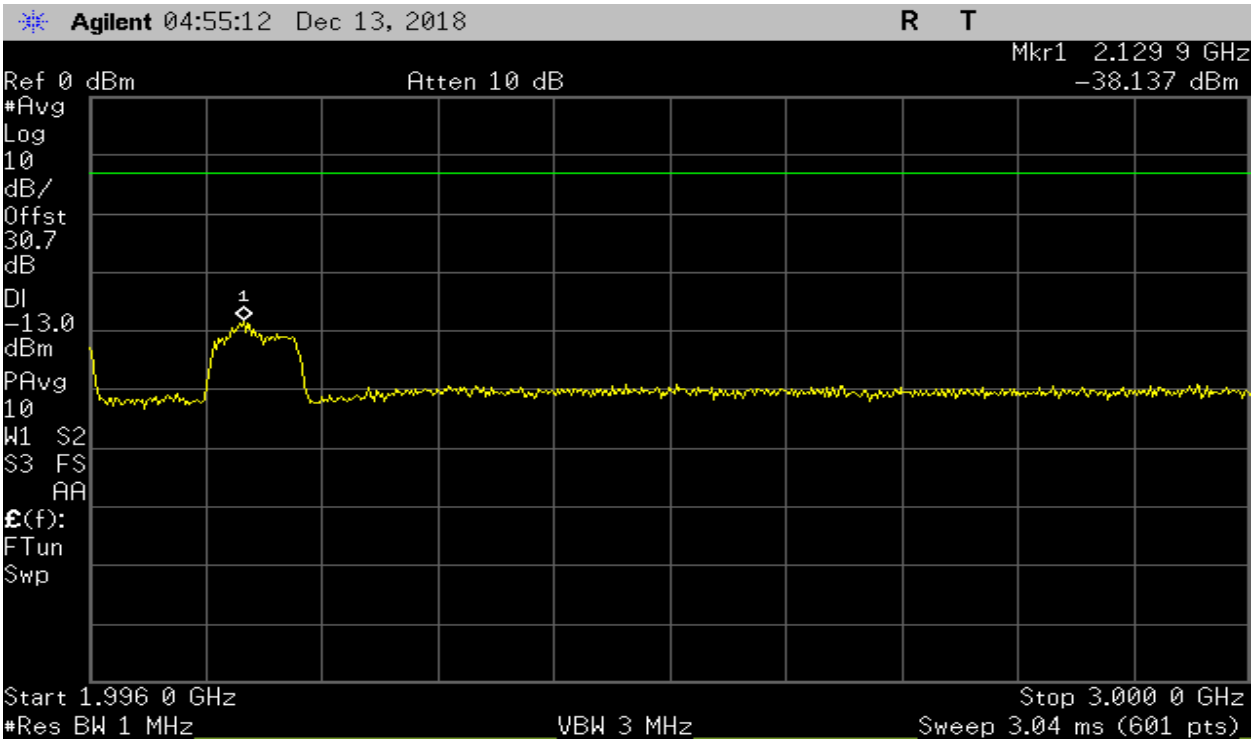
Plot 104 – 869-894MHz Band – Downlink



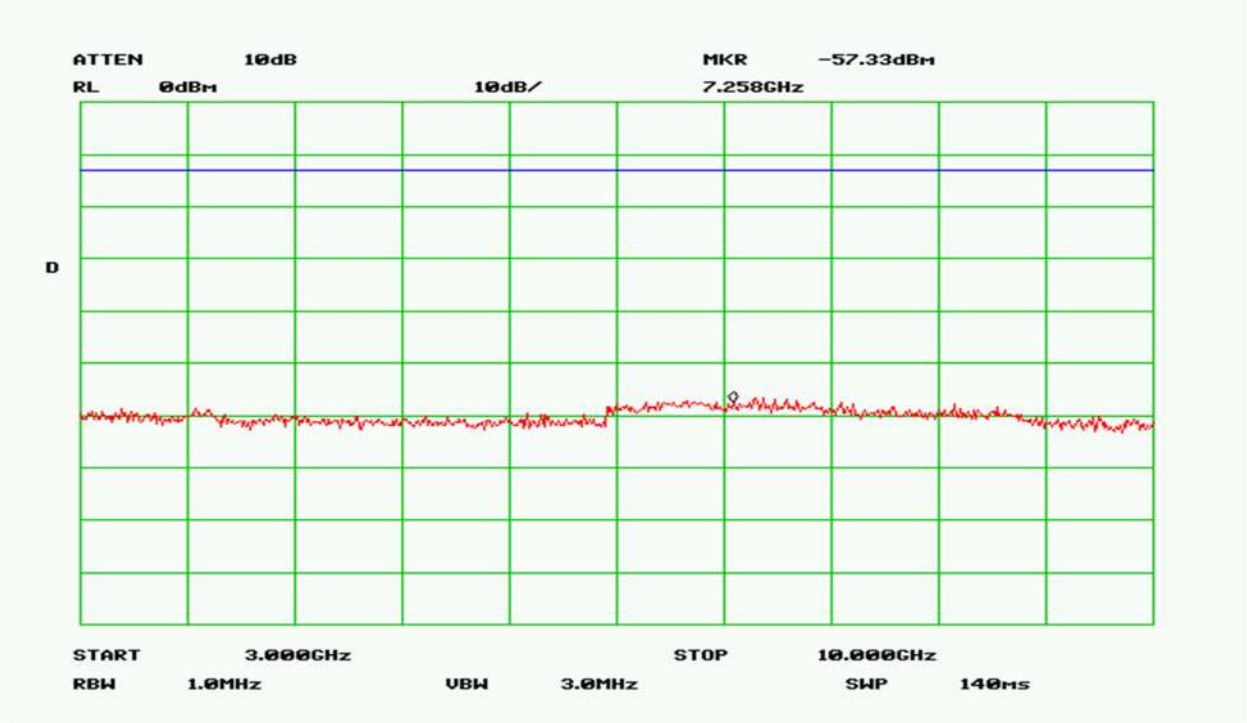
Plot 105 – 869-894MHz Band – Downlink



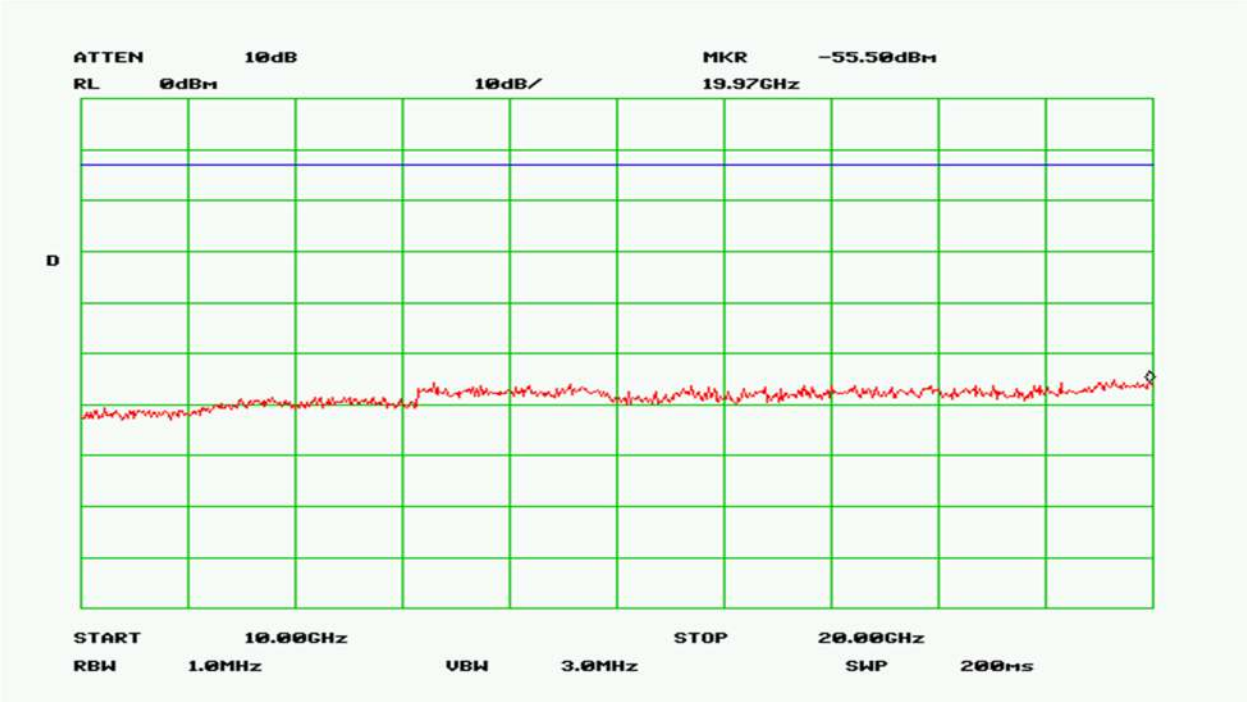
Plot 106 – 1930-1995MHz Band – Downlink



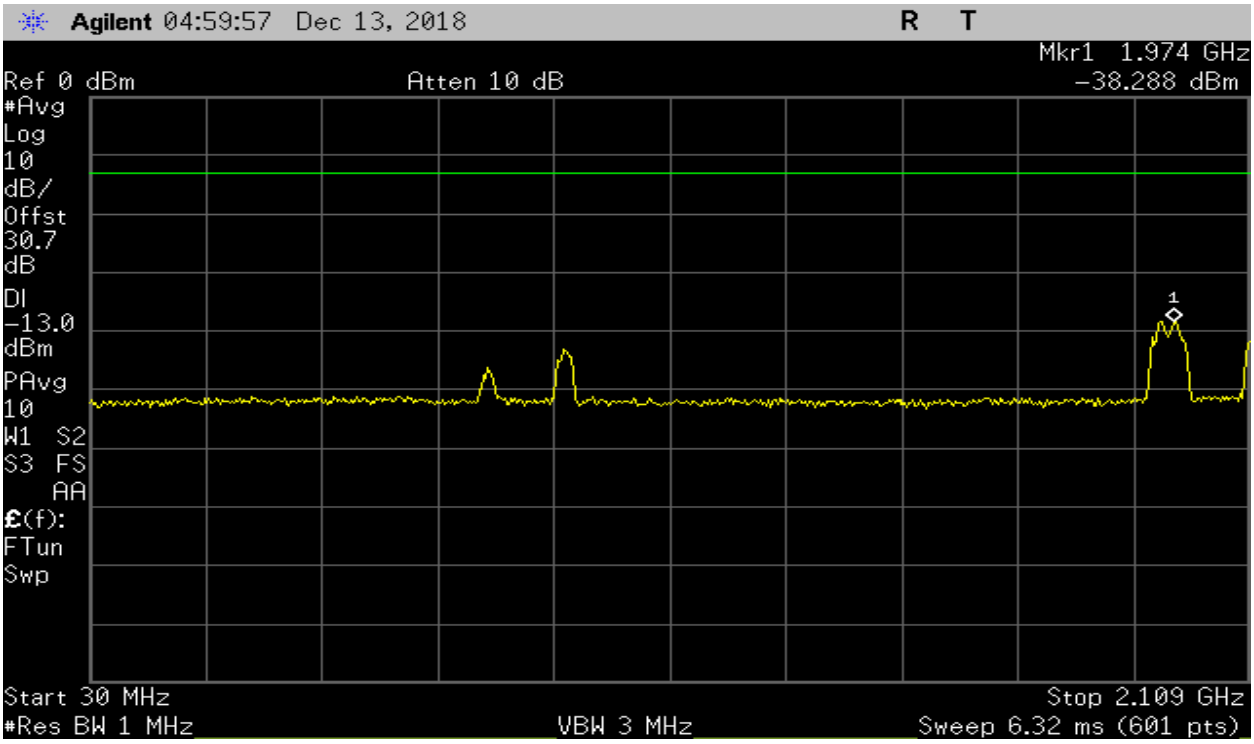
Plot 107 – 1930-1995MHz Band – Downlink



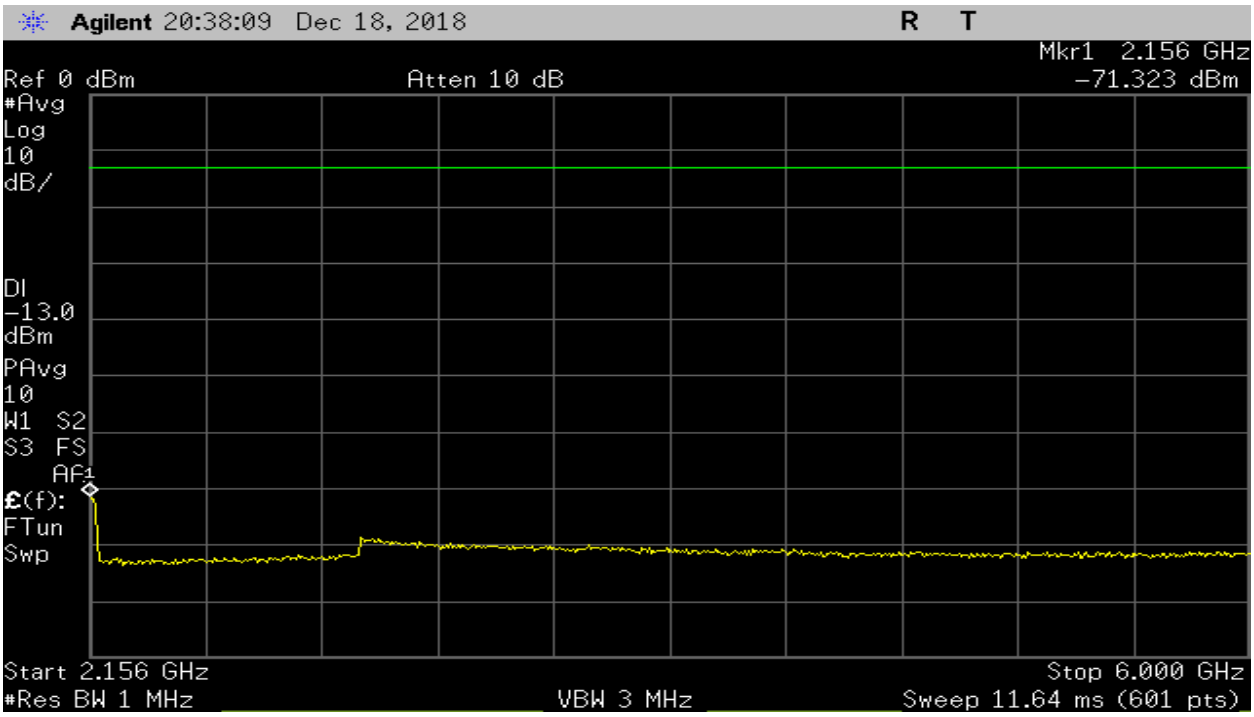
Plot 108 – 1930-1995MHz Band – Downlink



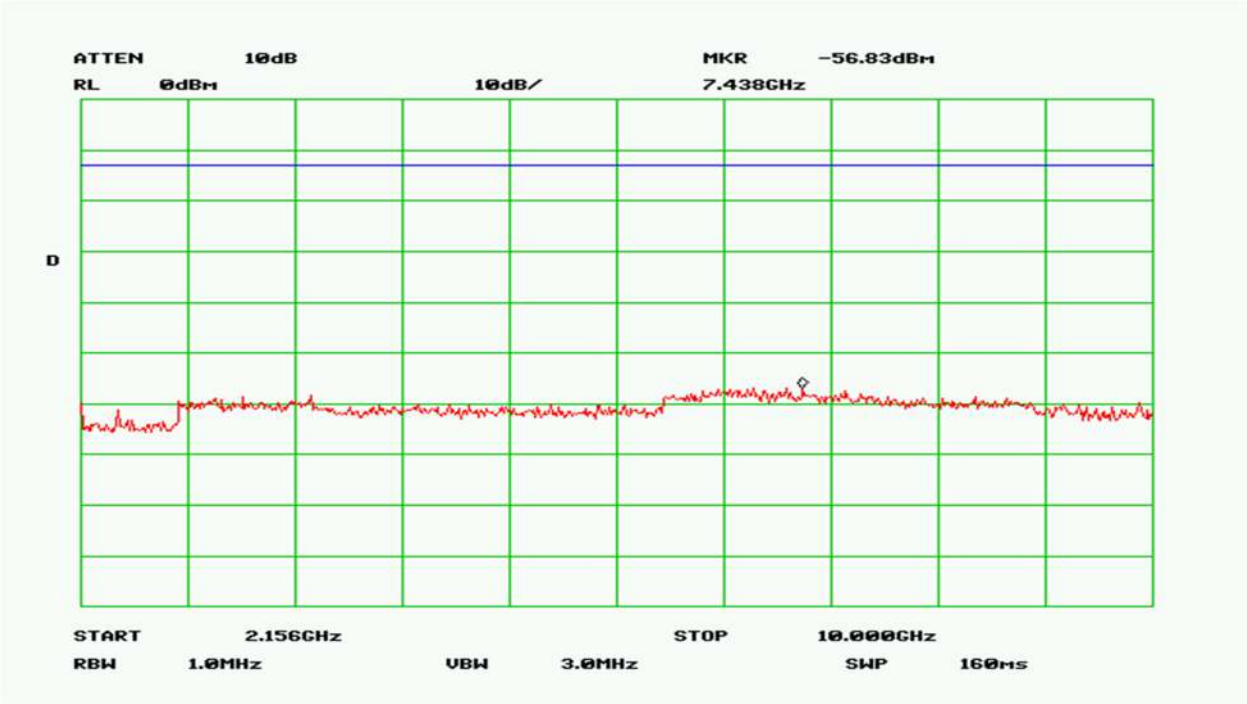
Plot 109 – 1930-1995MHz Band – Downlink



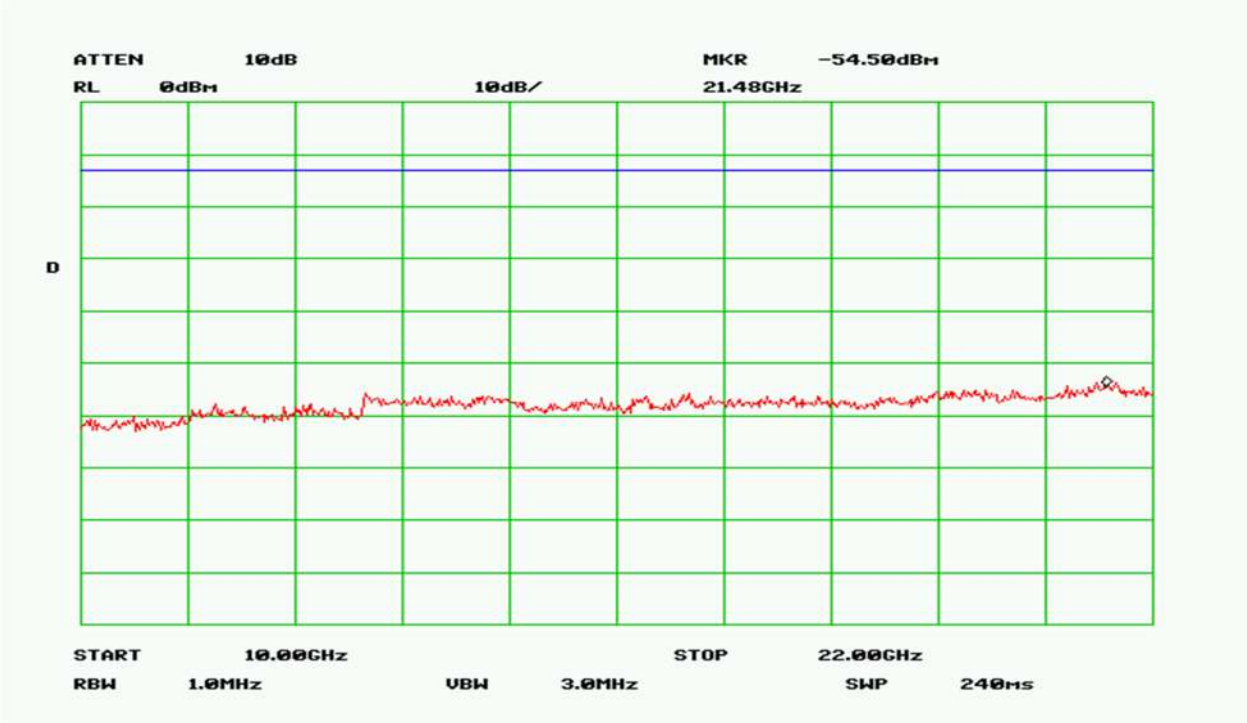
Plot 110 – 2110-2155MHz Band – Downlink



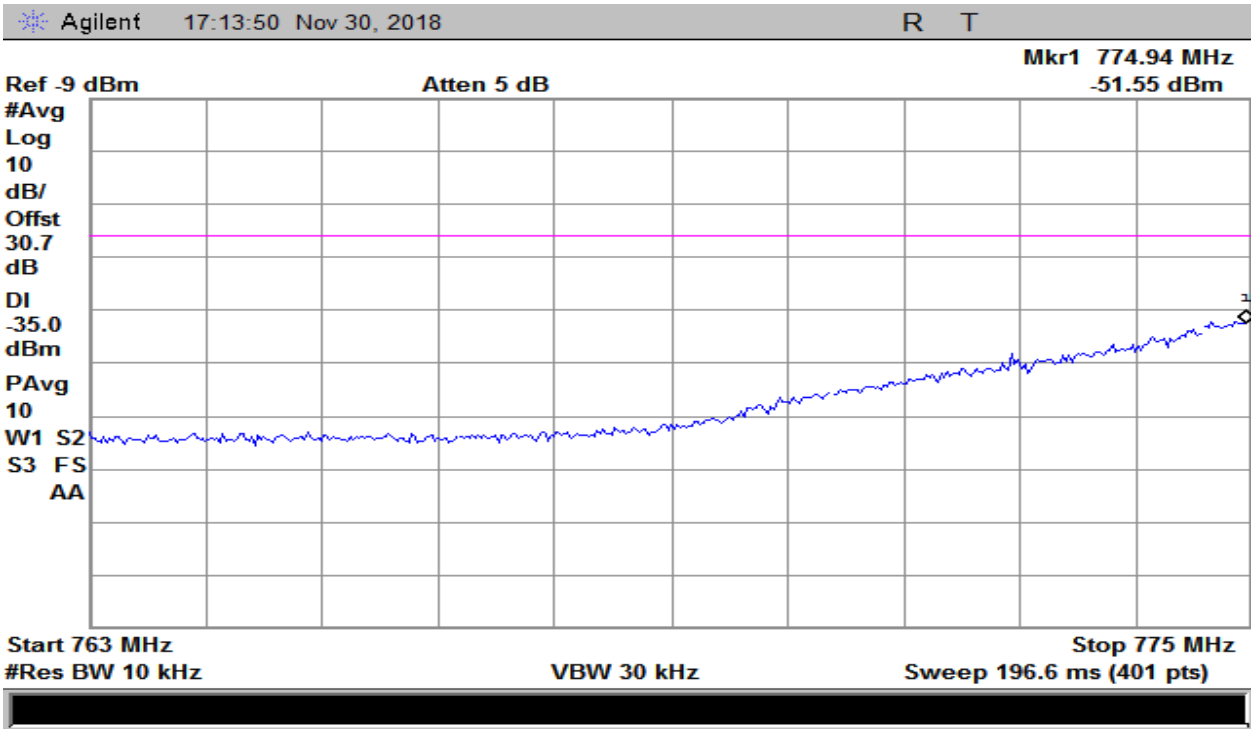
Plot 111 – 2110-2155MHz Band – Downlink



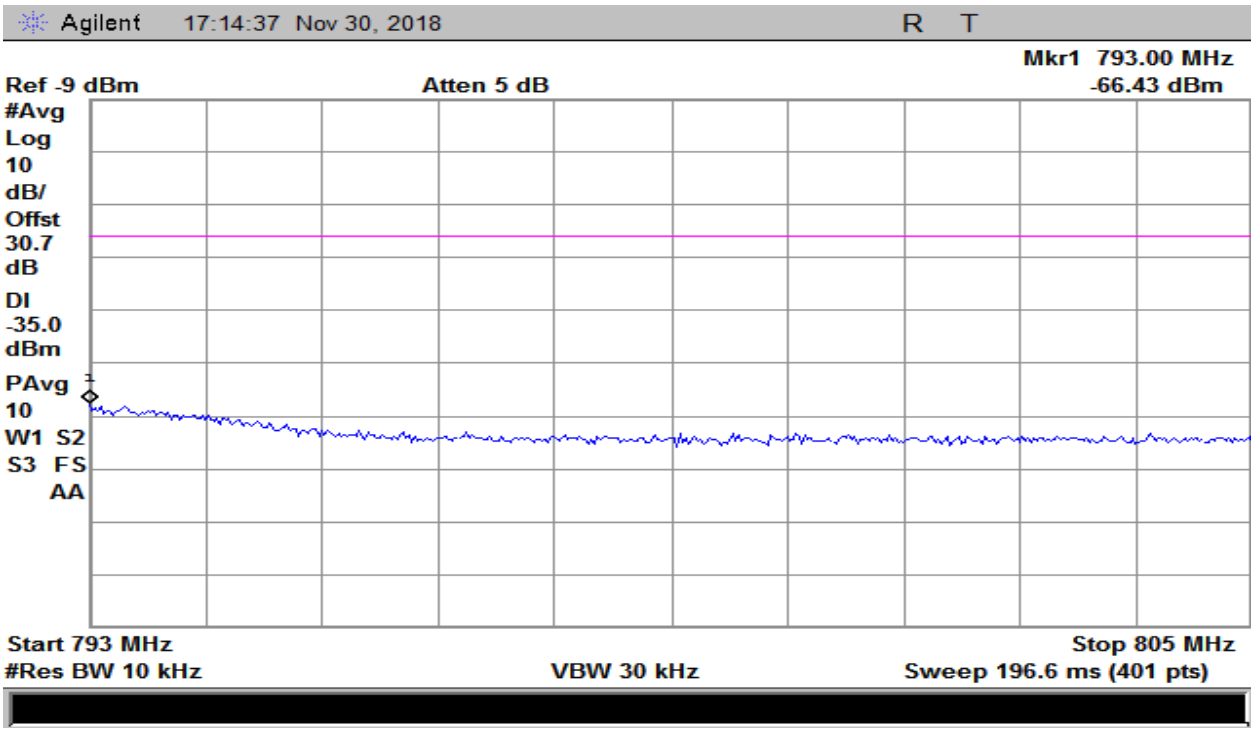
Plot 112 –2110-2155MHz Band – Downlink



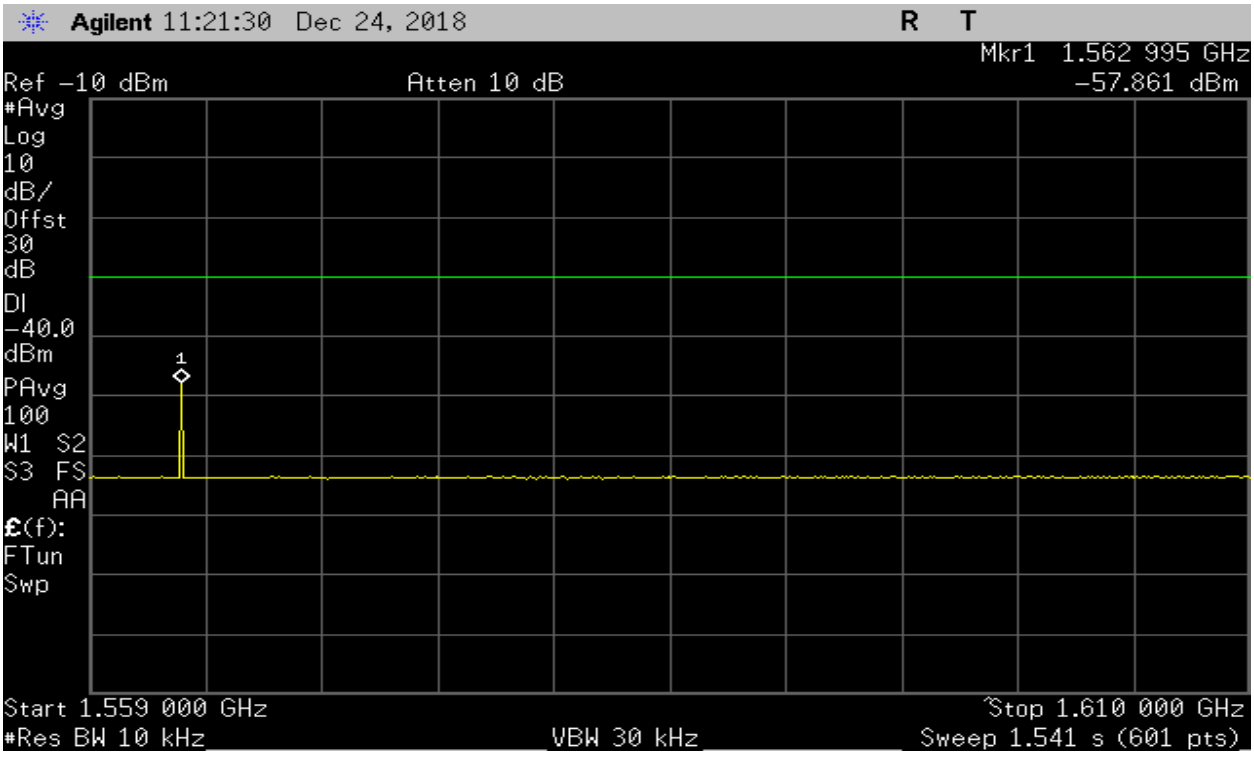
Plot 113 –2110-2155MHz Band – Downlink



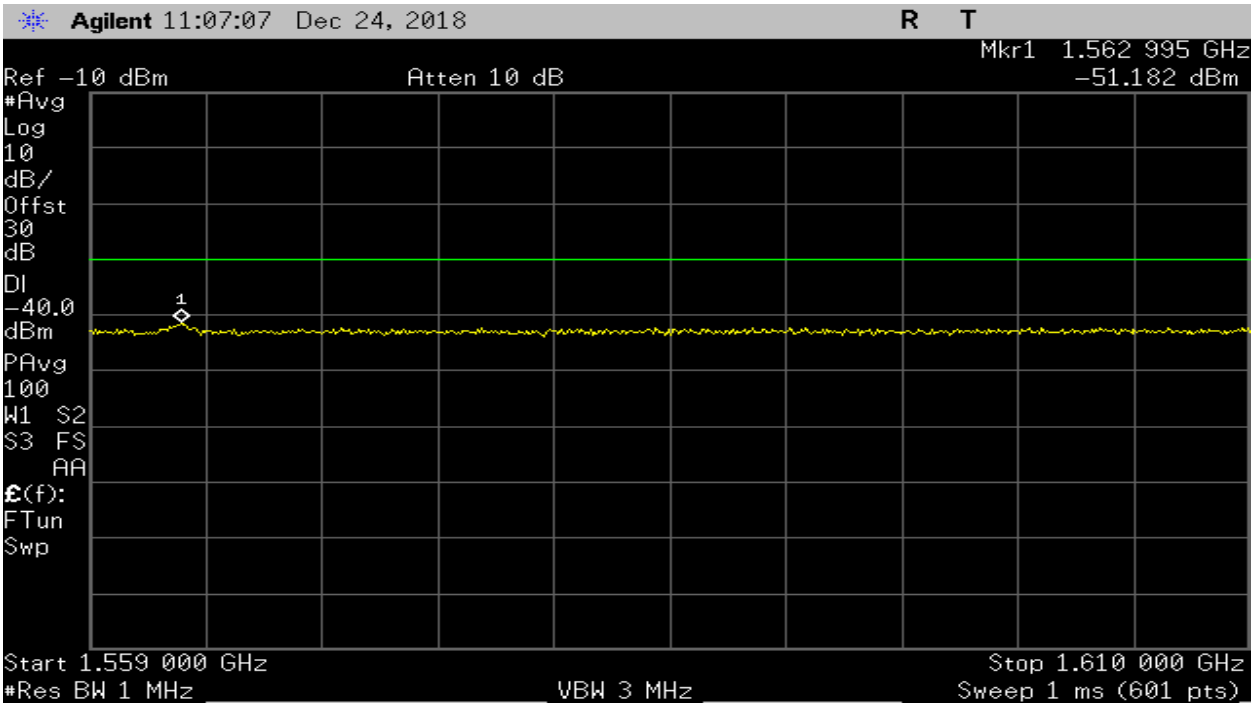
Plot 114 –27.53c4 – Uplink



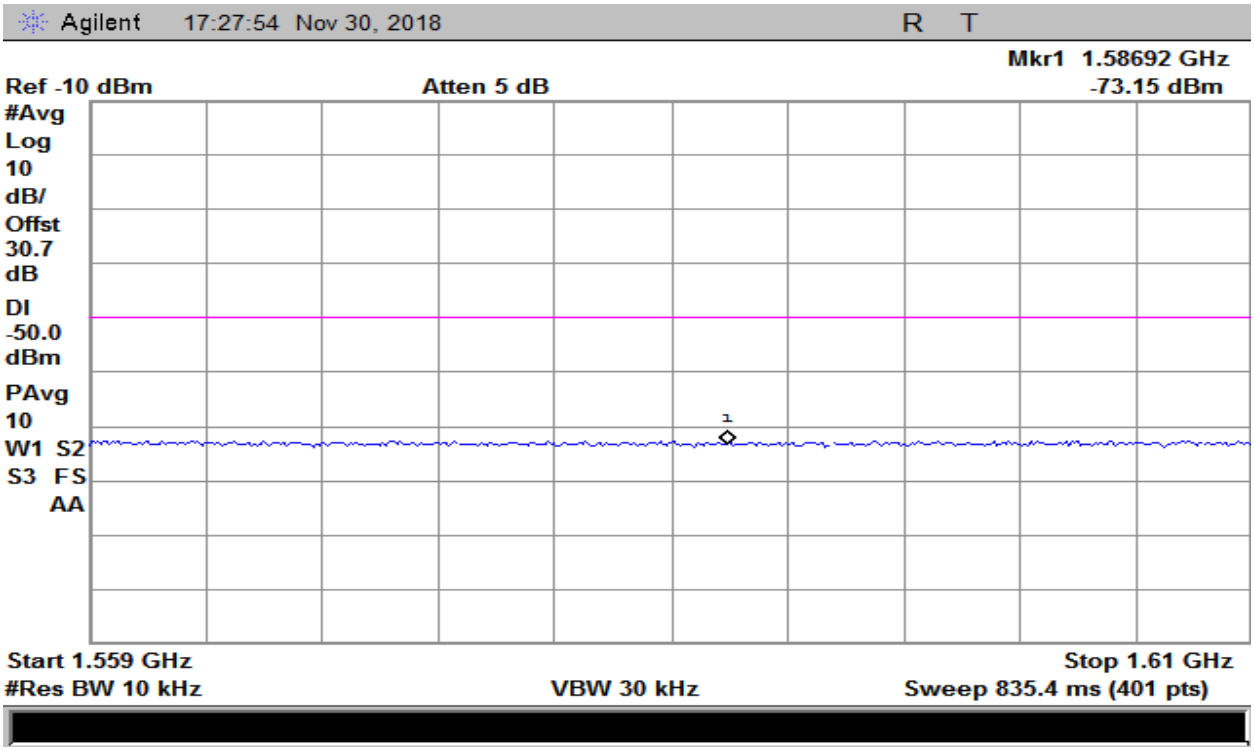
Plot 115 –27.53c4 – Uplink



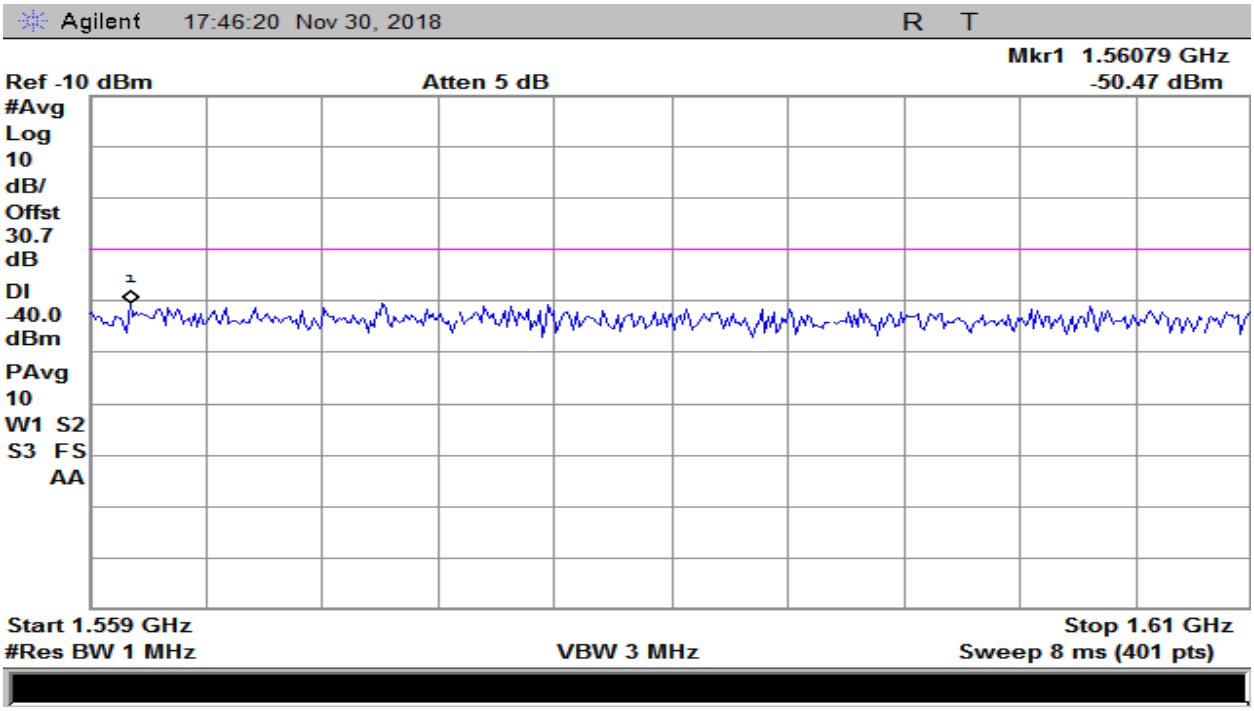
Plot 116 –27.53f – Uplink Narrowband



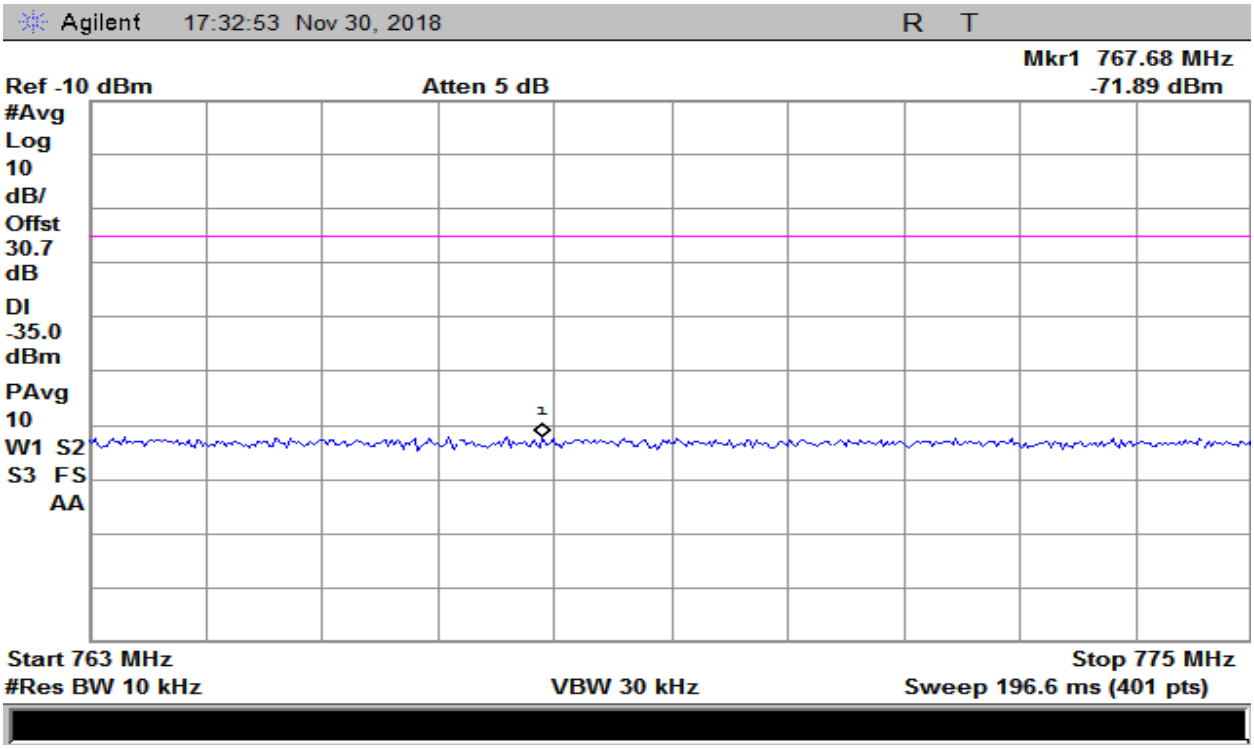
Plot 117 –27.53f – Uplink Wideband



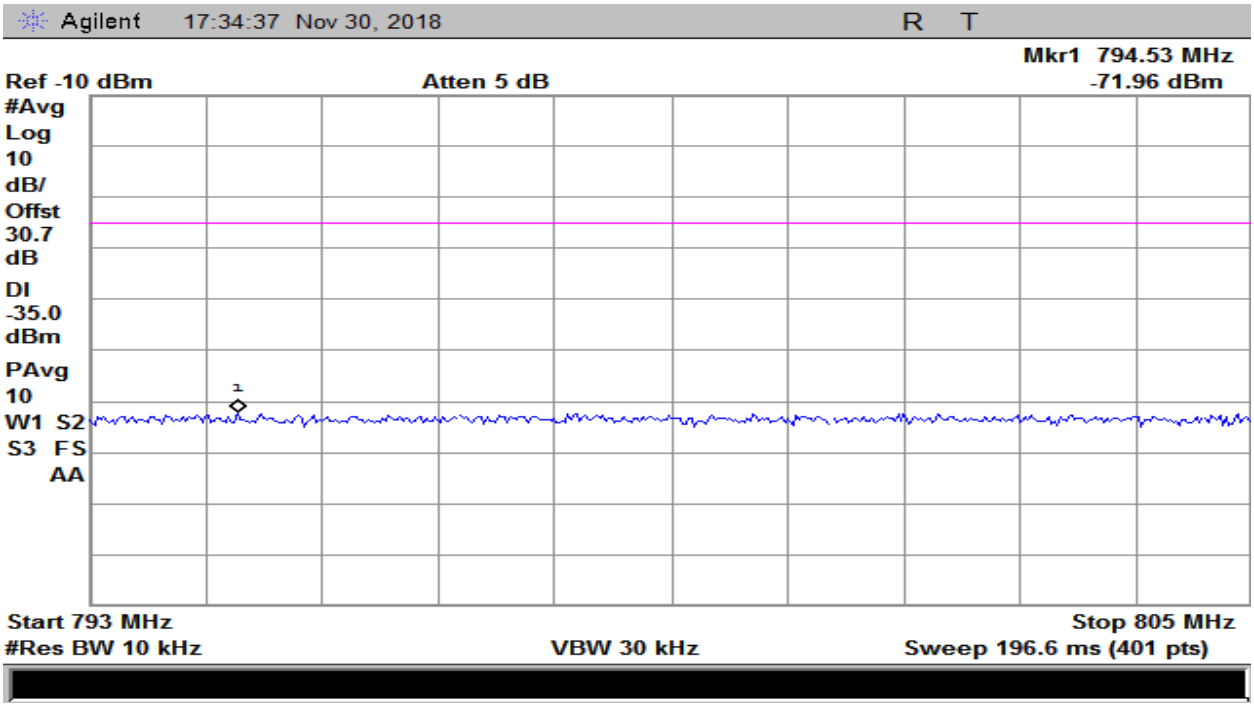
Plot 118 –27.53f – Downlink Narrowband



Plot 119 –27.53f – Downlink Wideband



Plot 120 –27.53c4 – Downlink



Plot 121 –27.53c4 – Downlink

6. Noise Limits

Test Requirement(s):	§20.21(e)(8)(i)(A)	**Test Engineer(s):**	Hoosam B.
Test Results:	Pass	**Test Date(s):**	Nov/15/2018

Test Procedures: As required by 47 CFR §20.21(e)(8)(i)(A), Noise limits measurements were made as per the FCC KDB 935210 D03 procedures defined in §7.7.

The EUT was set up as per Figure 2 and 3.

Test Setup:

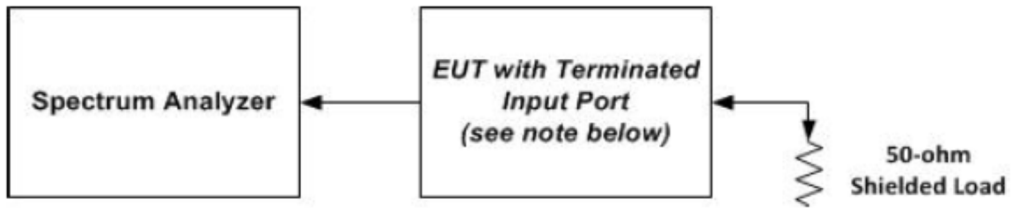


Figure 2 – Noise Limit

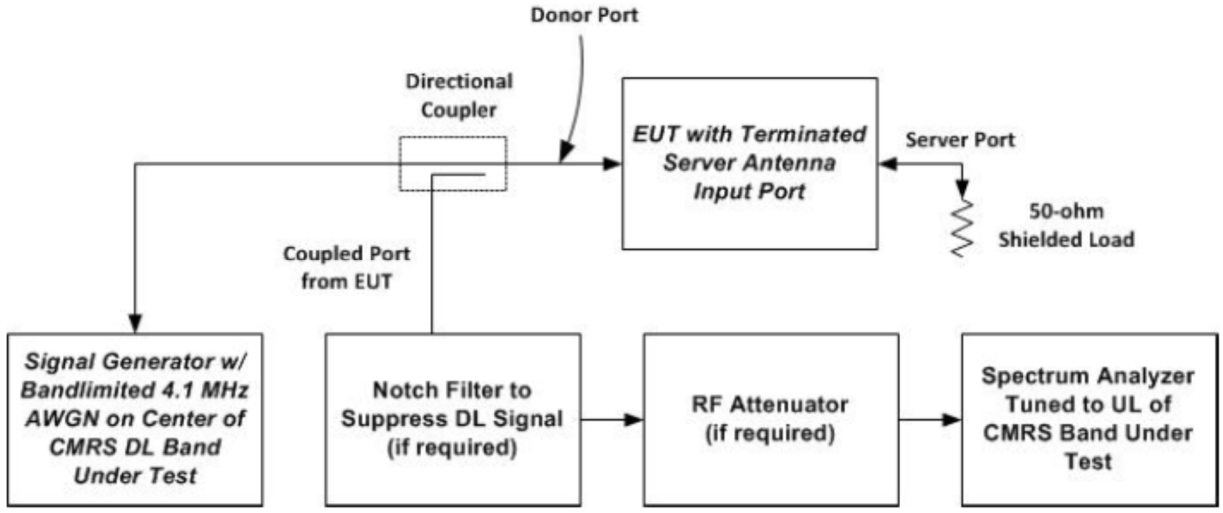


Figure 3 – Uplink Noise power in presence of a downlink signal

Limit: -103dBm/MHz - RSSI

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dB)
698-716	-47.09	-45.5	-1.59
776-787	-45.78	-44.7	-1.08
824-849	-46.6	-44.1	-2.50
1710-1755	-38.75	-37.7	-1.05
1850-1915	-40.07	-37.0	-3.07

Table 19 – Maximum Uplink Noise Summary

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dB)
728-746	-47.16	-45.5	-1.66
746-757	-47.43	-44.7	-2.73
869-894	-44.83	-44.1	-0.73
1930-1995	-38.71	-37.7	-1.01
2110-2155	38.85	-37.0	-1.85

Table 20 – Maximum Downlink Noise Summary

Frequency Band (MHz)	Measured Time (Sec)	Limit (Seconds)	Margin (Seconds)
698-716	0.0975	3.0	-2.90
776-787	0.112	3.0	-2.88
824-849	0.375	3.0	-2.62
1710-1755	0.3075	3.0	-2.69
1850-1915	0.0909	3.0	-2.90

Table 21 – Variable Uplink Noise Timing Summary

RSSI Input (dBm)	Measured Noise Power Tx dBm/MHz	Limit (dBm)	Margin (dB)
-90	-46.4	-46	-0.4
-50	-63.2	-53	-10.2
-40	-71.6	-63	-8.6
-35	-72.8	-68	-4.8
-30	Shutdown	-70	-
-25	Shutdown	-70	-

Table 22 – 698-716MHz Band – Uplink Noise Power Summary

RSSI Input (dBm)	Measured Noise Power Tx dBm/MHz	Limit (dBm)	Margin (dB)
-90	-45.2	-45	-0.2
-50	-57.8	-53	-4.8
-40	-67.9	-63	-4.9
-35	-70.4	-68	-2.4
-30	Shutdown	-70	-
-20	Shutdown	-70	-

Table 23 – 776-787MHz Band – Uplink Noise Power Summary

RSSI Input (dBm)	Measured Noise Power Tx dBm/MHz	Limit (dBm)	Margin (dB)
-90	-46.9	-44	-2.9
-50	-60.6	-53	-7.6
-40	-67.5	-63	-4.5
-35	-70.2	-68	-2.2
-30	-71.8	-70	-1.8
-20	-72.6	-70	-2.6

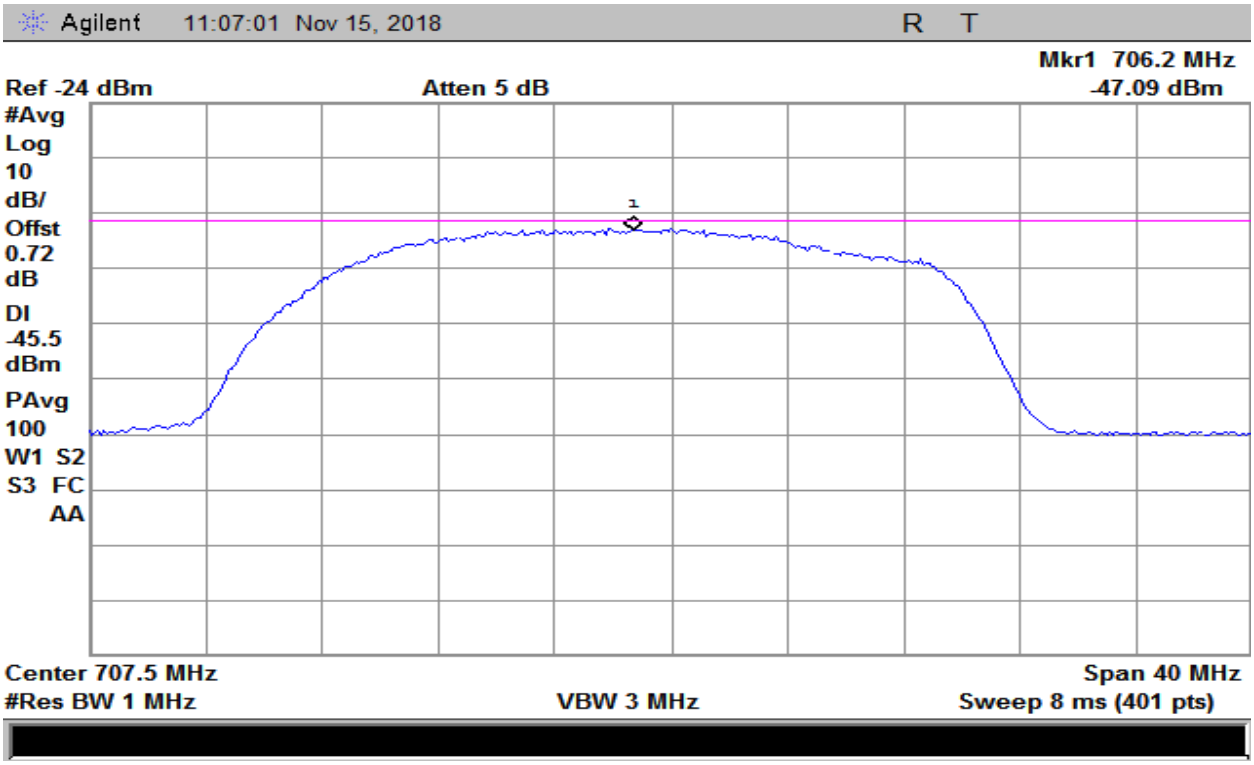
Table 24 – 824-849MHz Band – Uplink Noise Power Summary

RSSI Input (dBm)	Measured Noise Power Tx dBm/MHz	Limit (dBm)	Margin (dB)
-90	-38.4	-46	-0.4
-50	-63.3	-53	-10.3
-40	-69.8	-63	-6.8
-35	Shutdown	-68	-
-30	Shutdown	-70	-
-20	Shutdown	-70	-

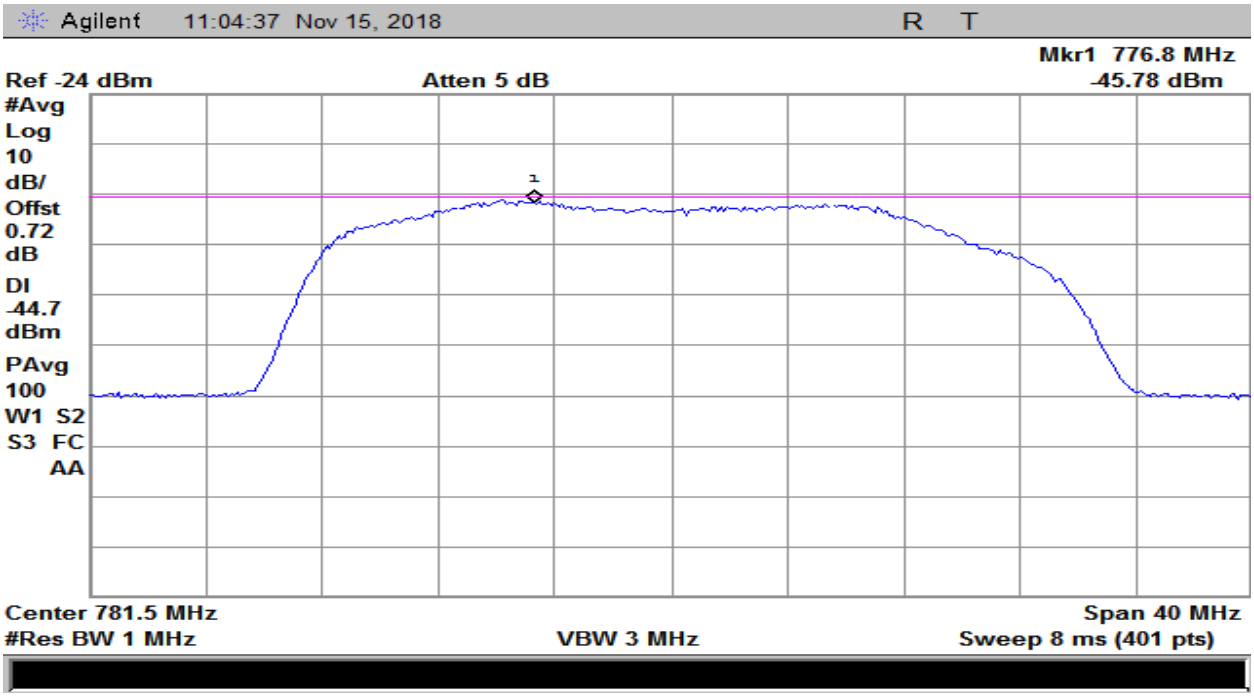
Table 25 – 1710-1755MHz Band – Uplink Noise Power Summary

RSSI Input (dBm)	Measured Noise Power Tx dBm/MHz	Limit (dBm)	Margin (dB)
-90	-38.2	-37	-1.2
-60	-53.5	-43	-10.5
-40	-69.8	-63	-6.8
-35	-72.7	-68	-4.7
-30	Shutdown	-70	-
-20	Shutdown	-70	-

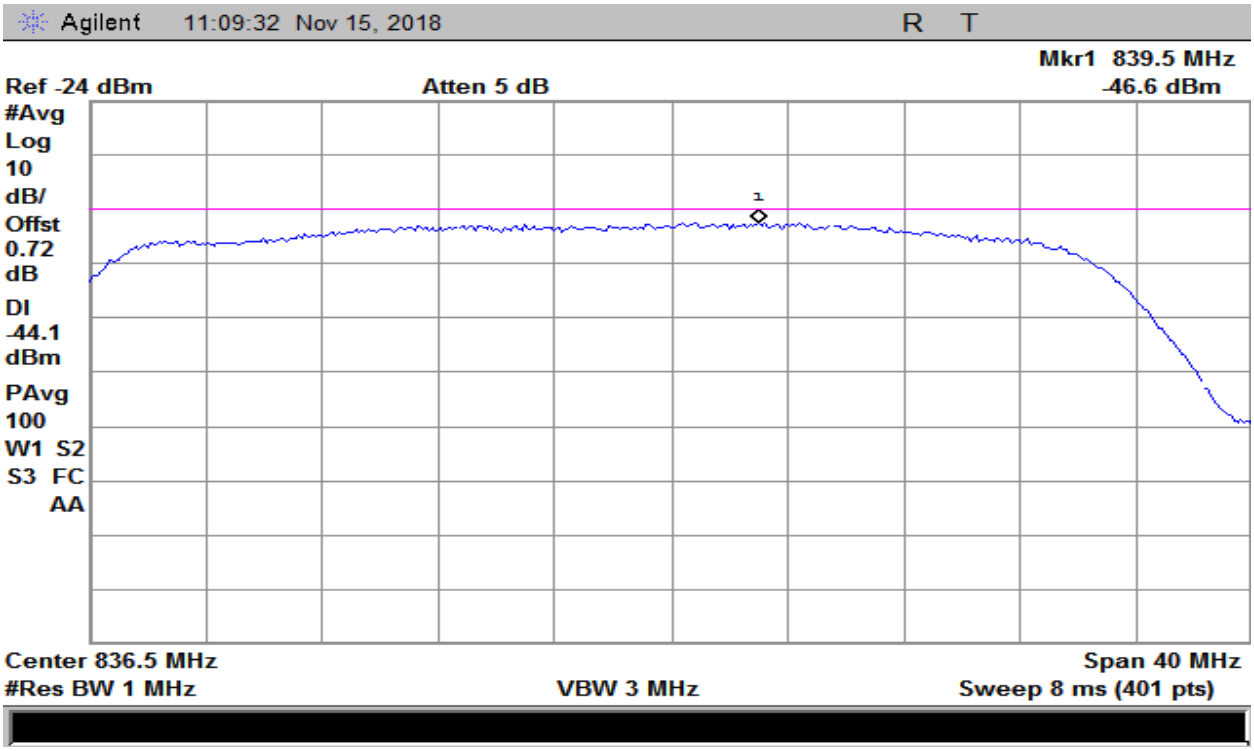
Table 26 – 1850-1915MHz Band – Uplink Noise Power Summary



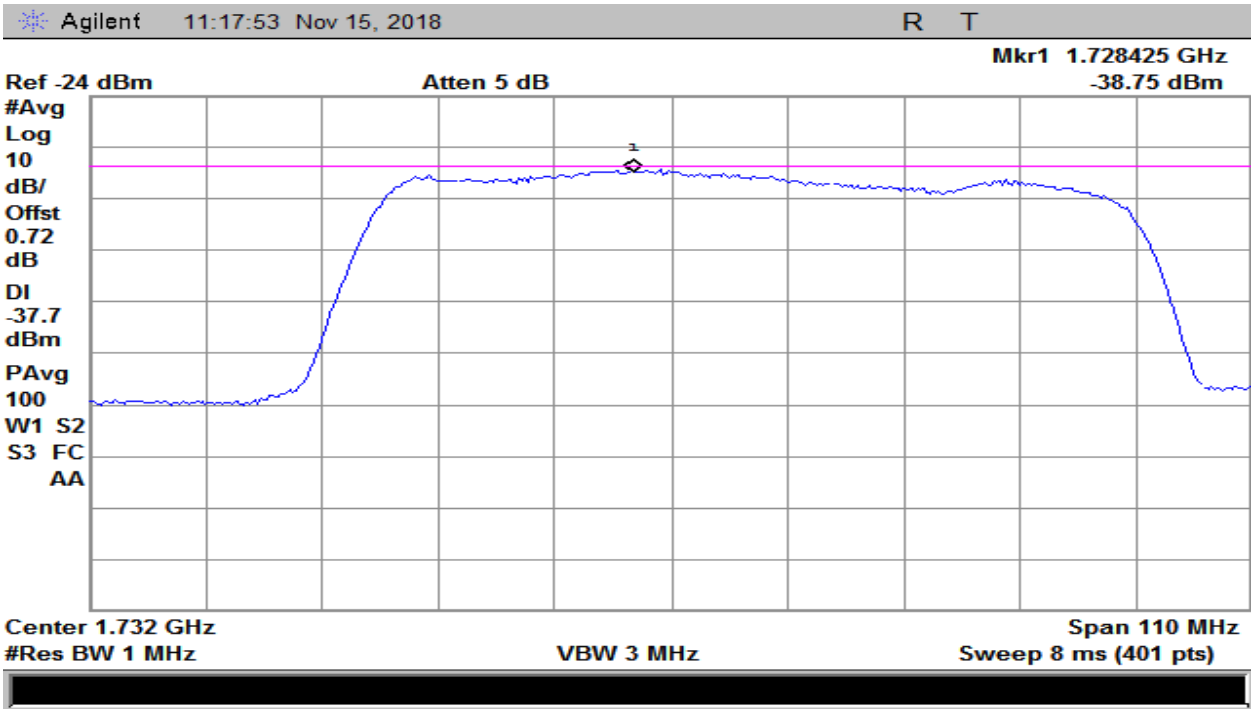
Plot 121 – 698-716MHz Band – Maximum Uplink Noise



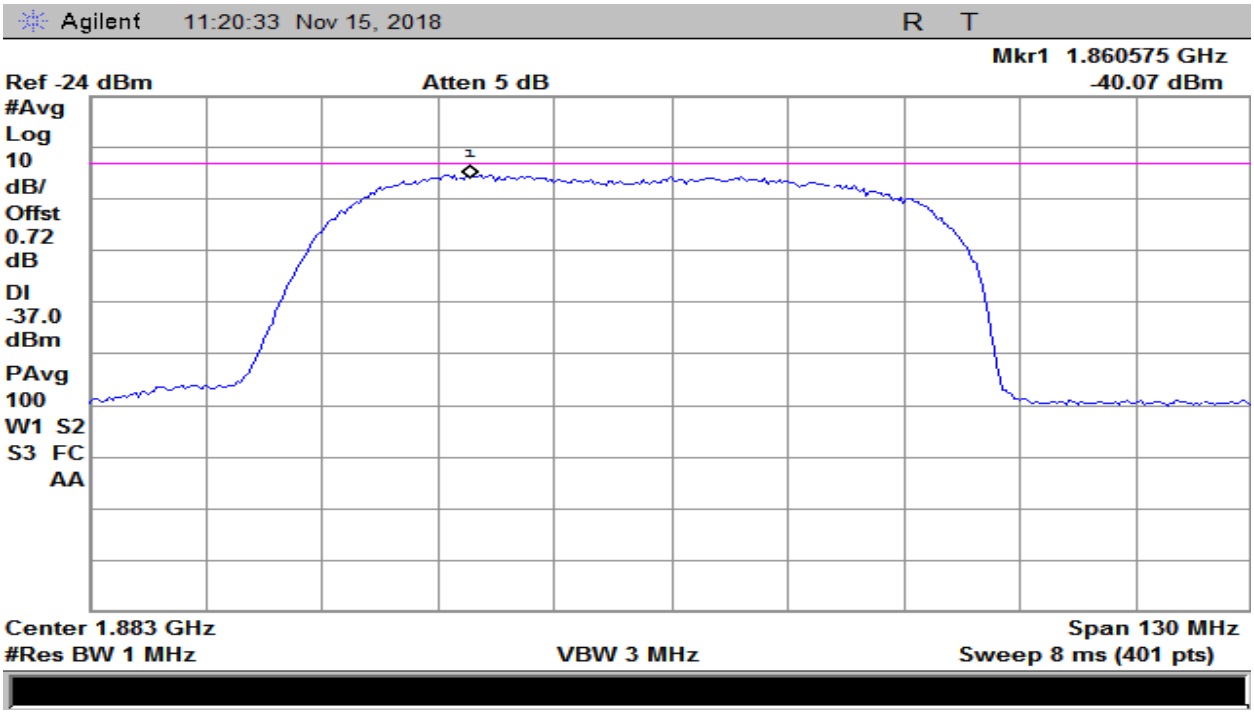
Plot 122 – 776-787MHz Band – Maximum Uplink Noise



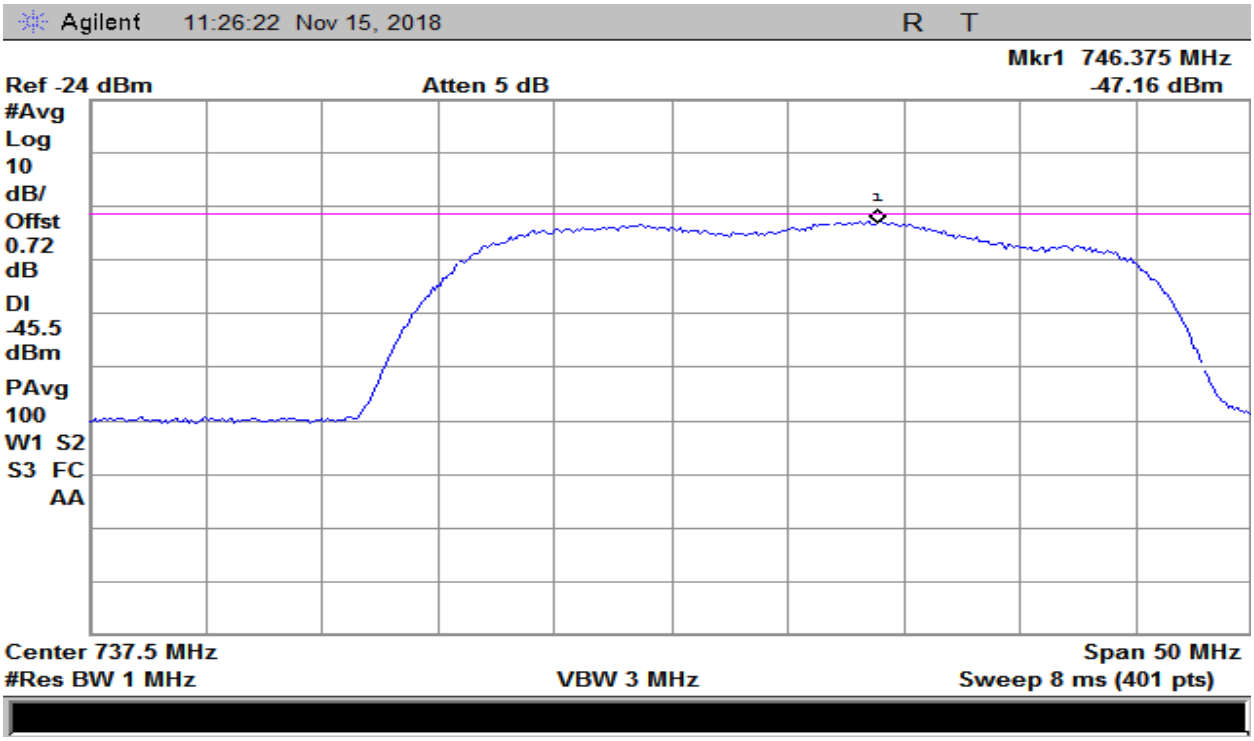
Plot 123 – 824-849MHz Band – Maximum Uplink Noise



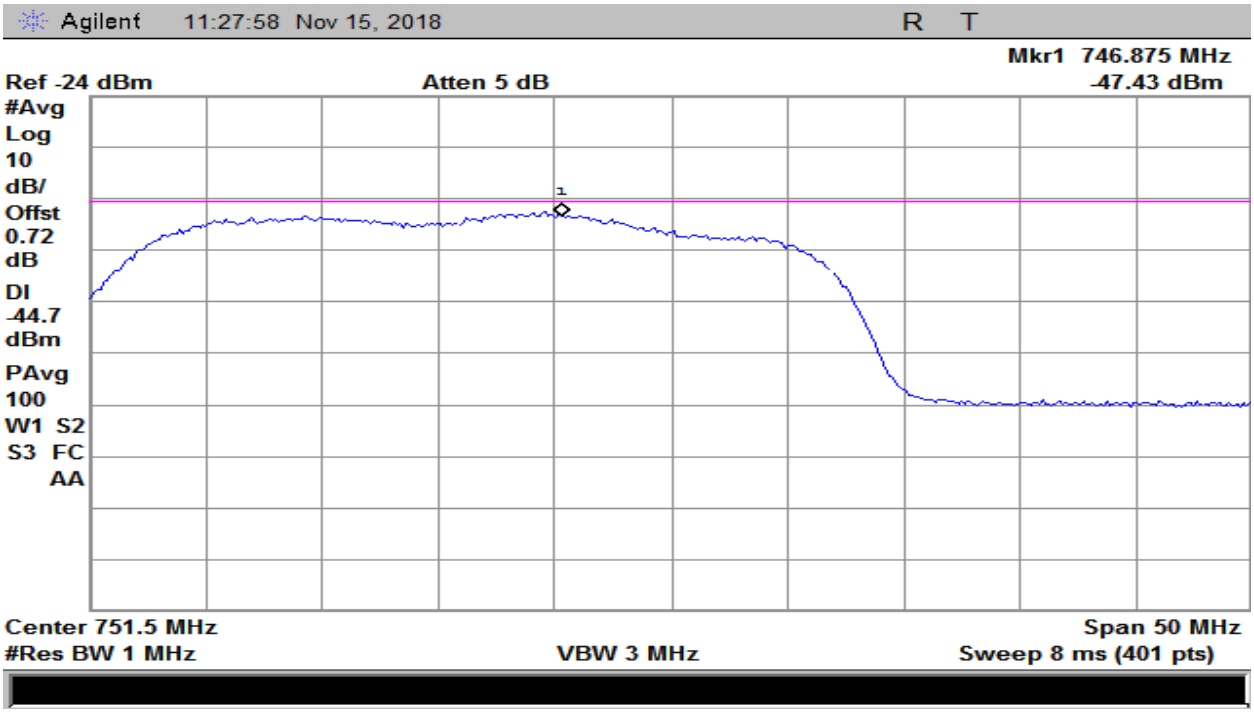
Plot 124 – 1710-1755MHz Band – Maximum Uplink Noise



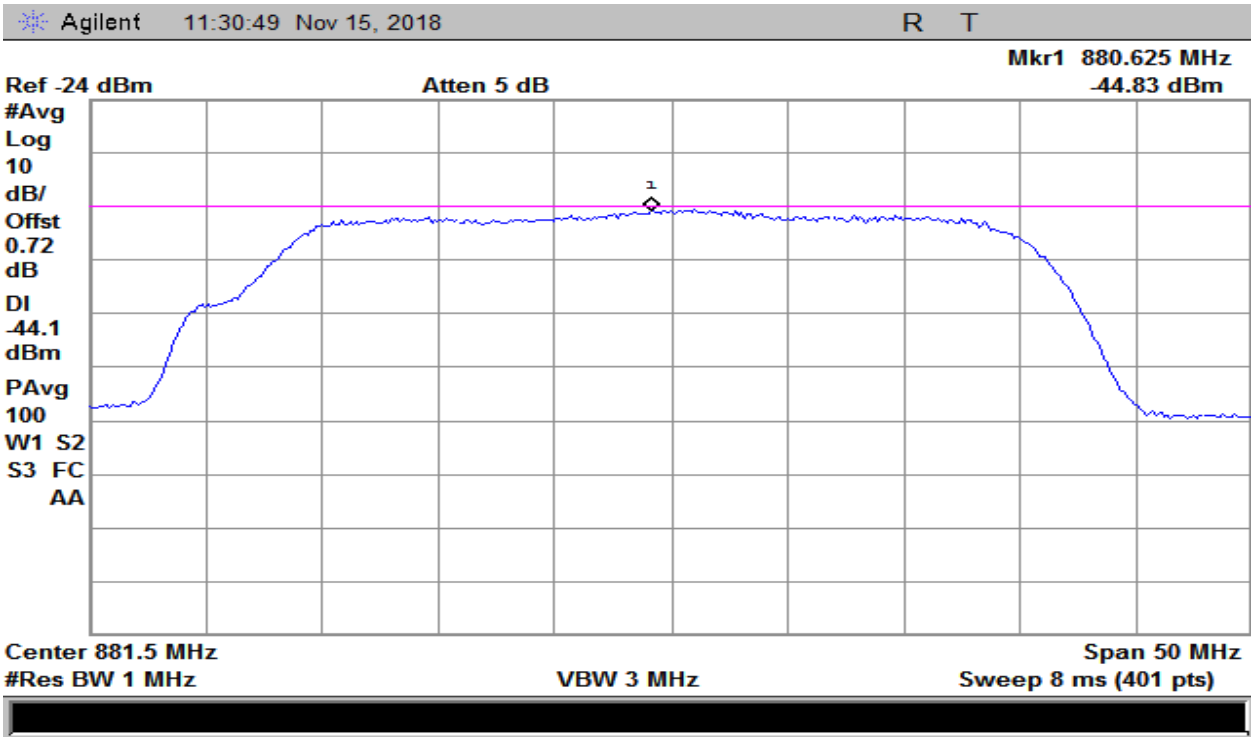
Plot 125 – 1850-1915MHz Band – Maximum Uplink Noise



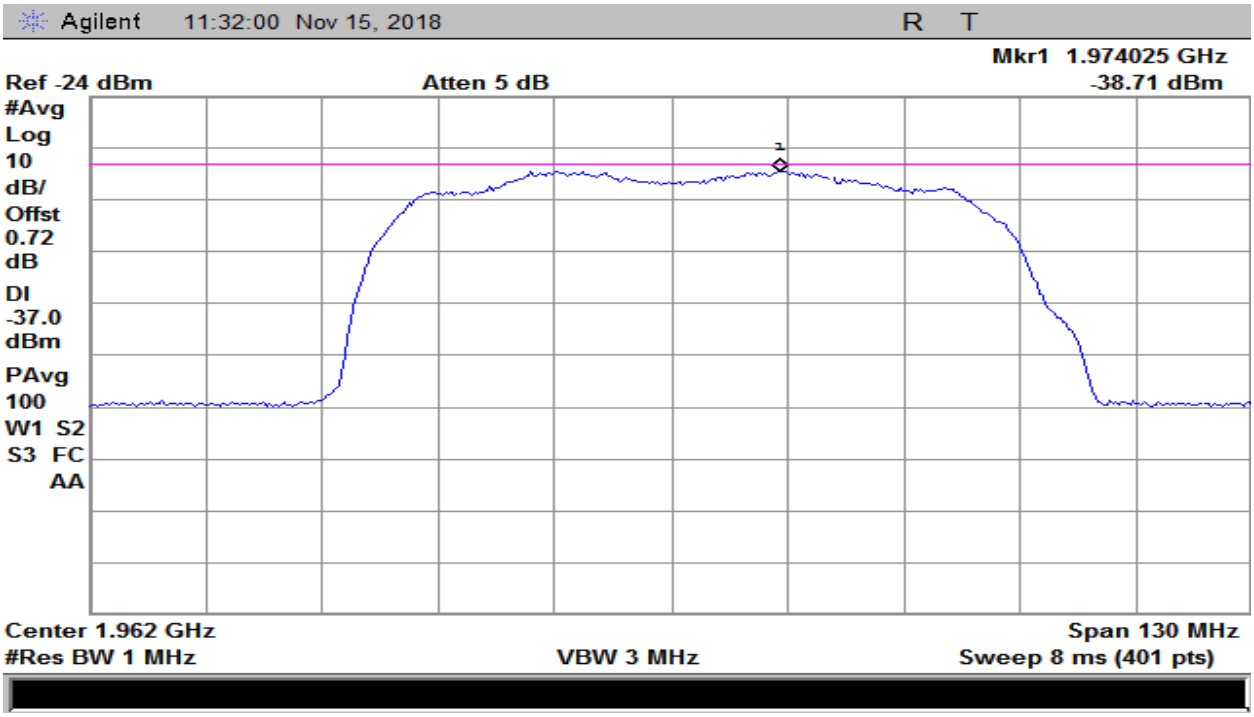
Plot 126 – 728-746MHz Band – Maximum Downlink Noise



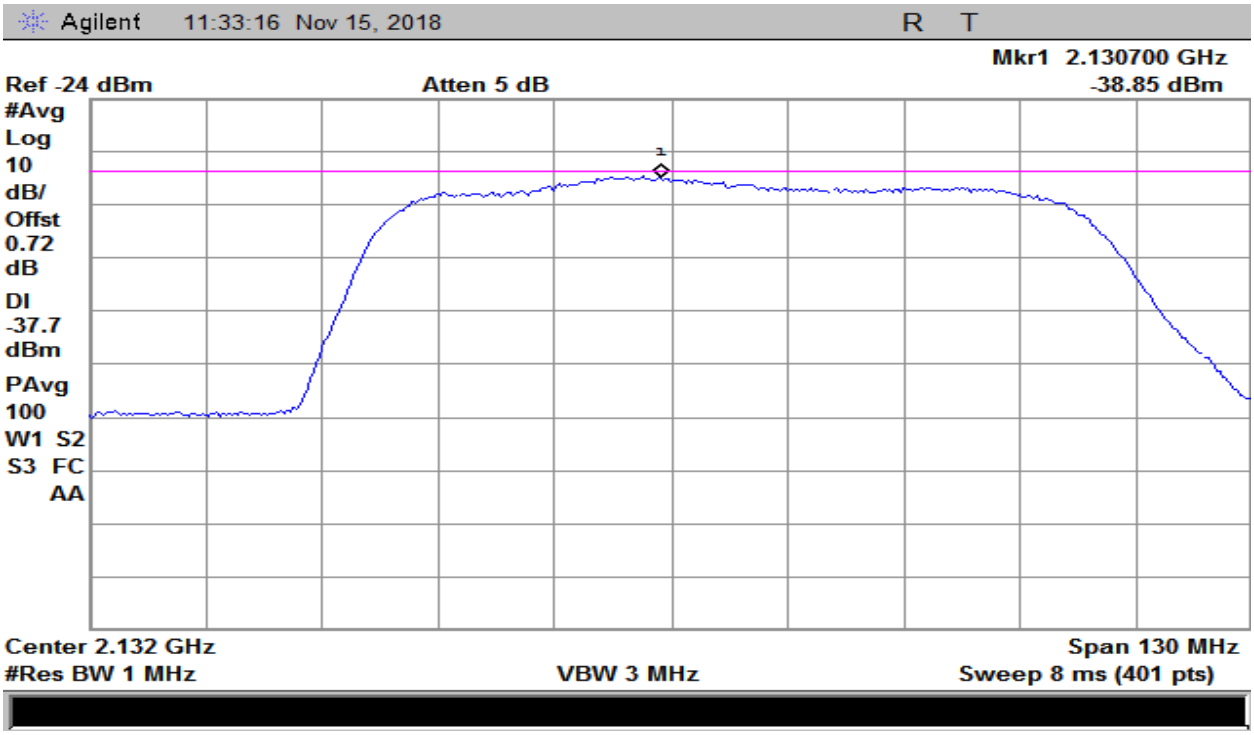
Plot 127 – 746-757MHz Band – Maximum Downlink Noise



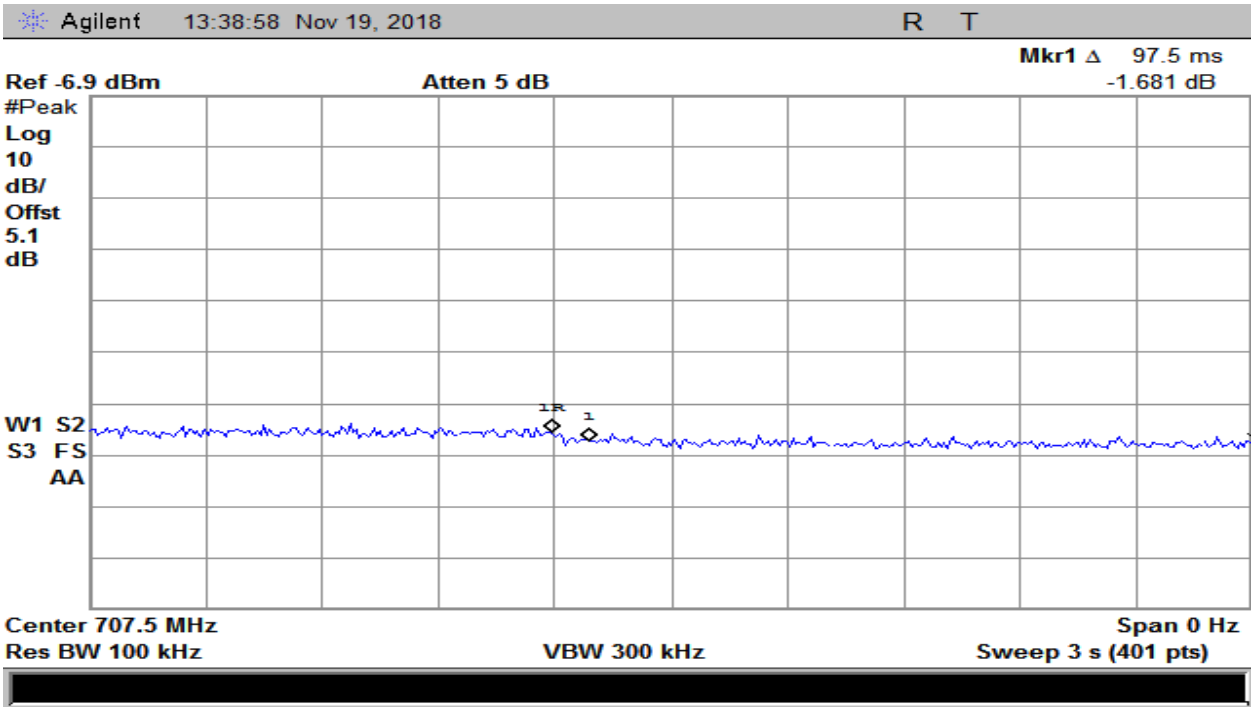
Plot 128 – 869-894MHz Band – Maximum Downlink Noise



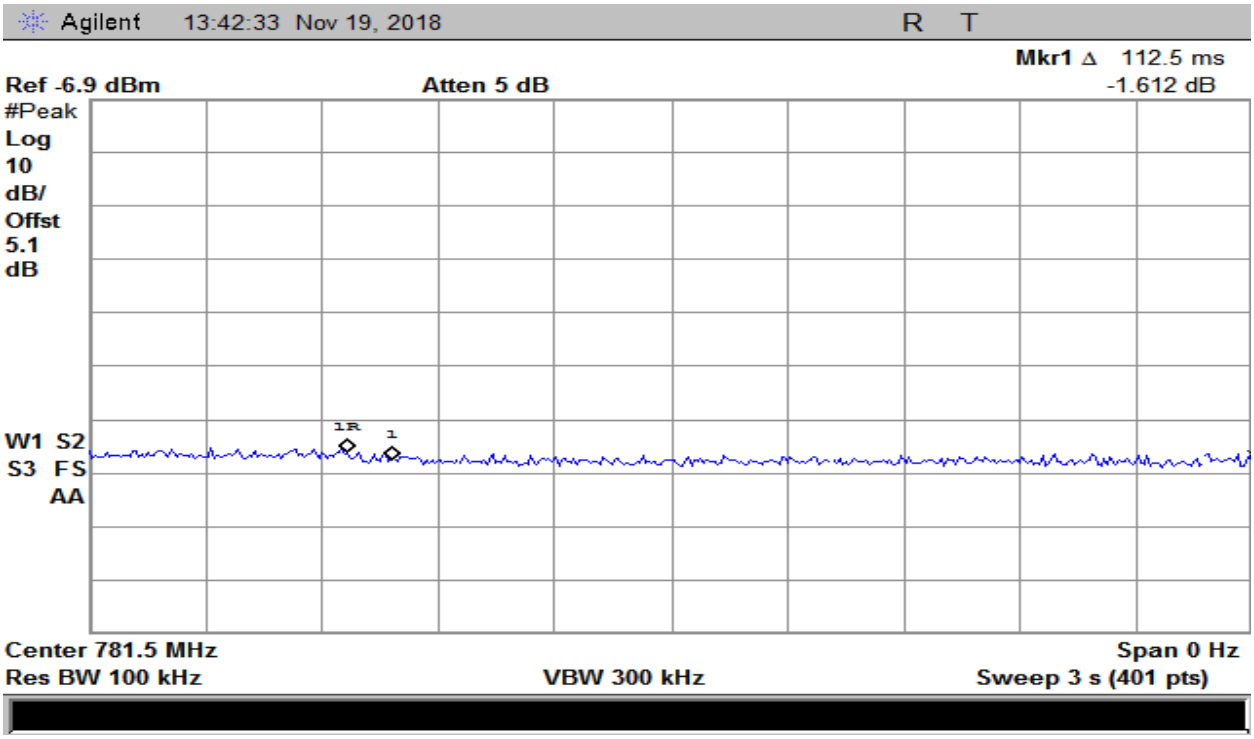
Plot 129 – 1930-1995MHz Band – Maximum Downlink Noise



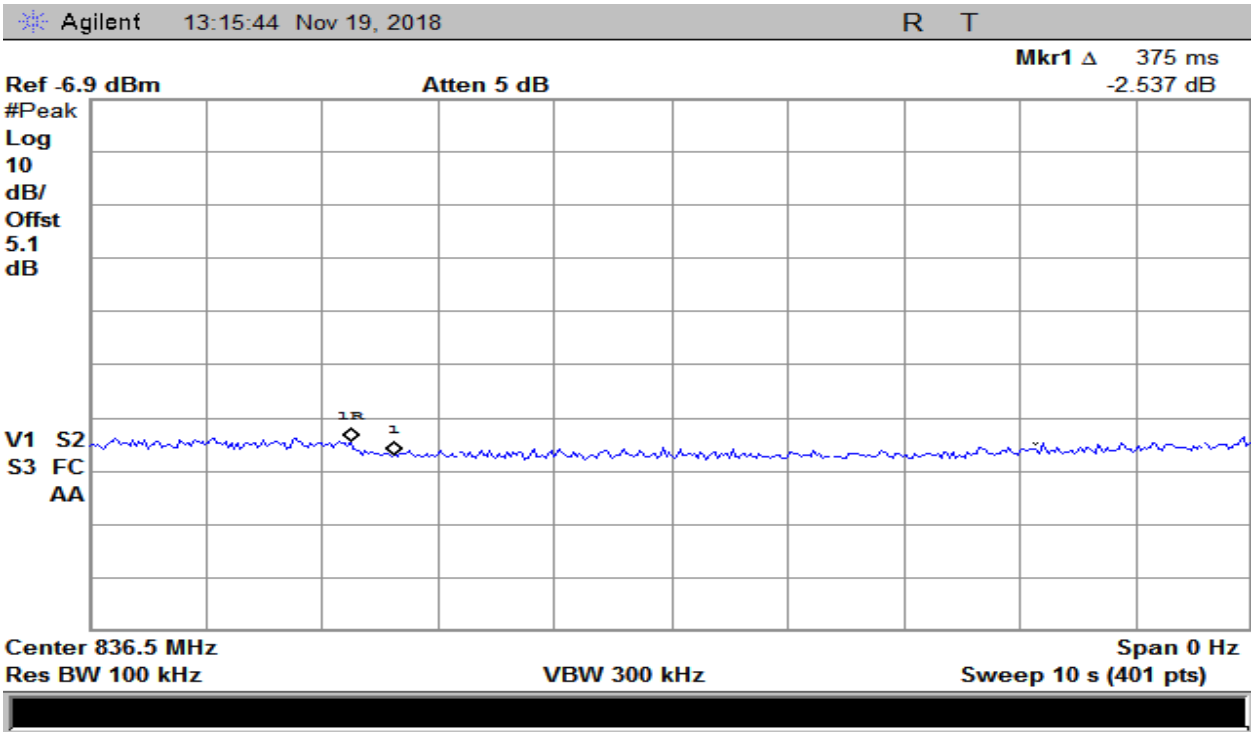
Plot 130 – 2110-2155MHz Band – Maximum Downlink Noise



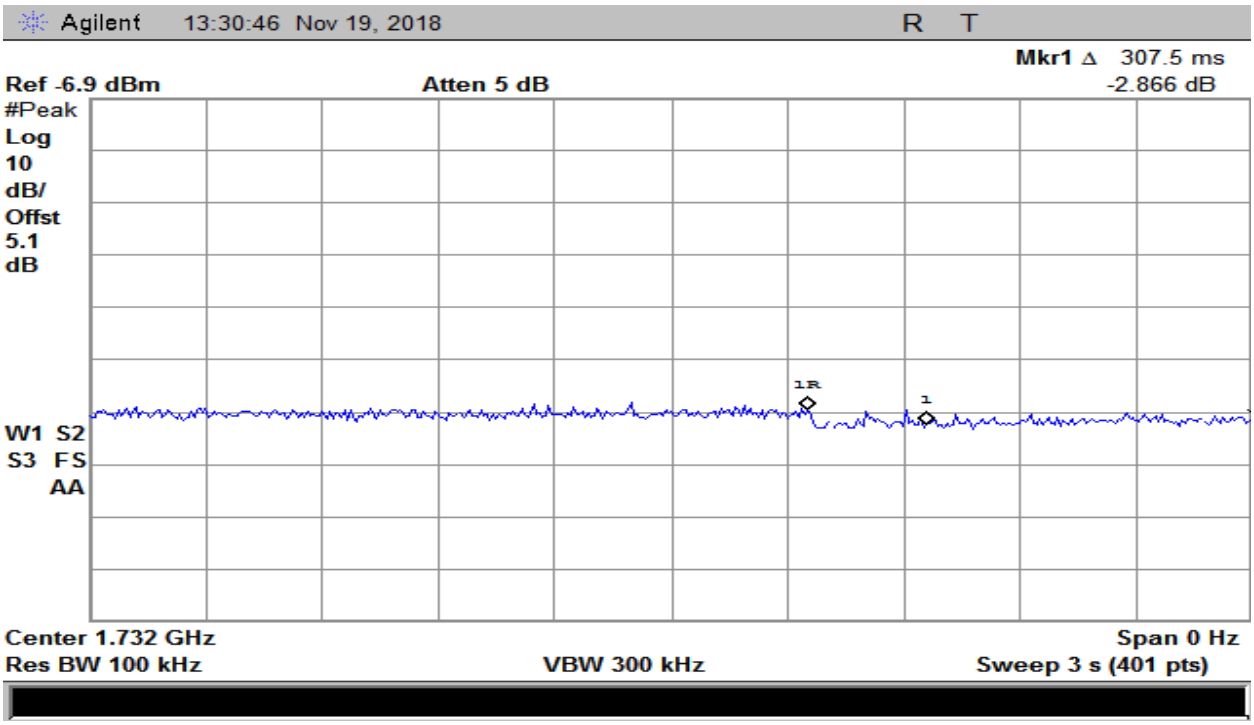
Plot 131 – 698-716MHz Band – Variable Uplink Noise Timing



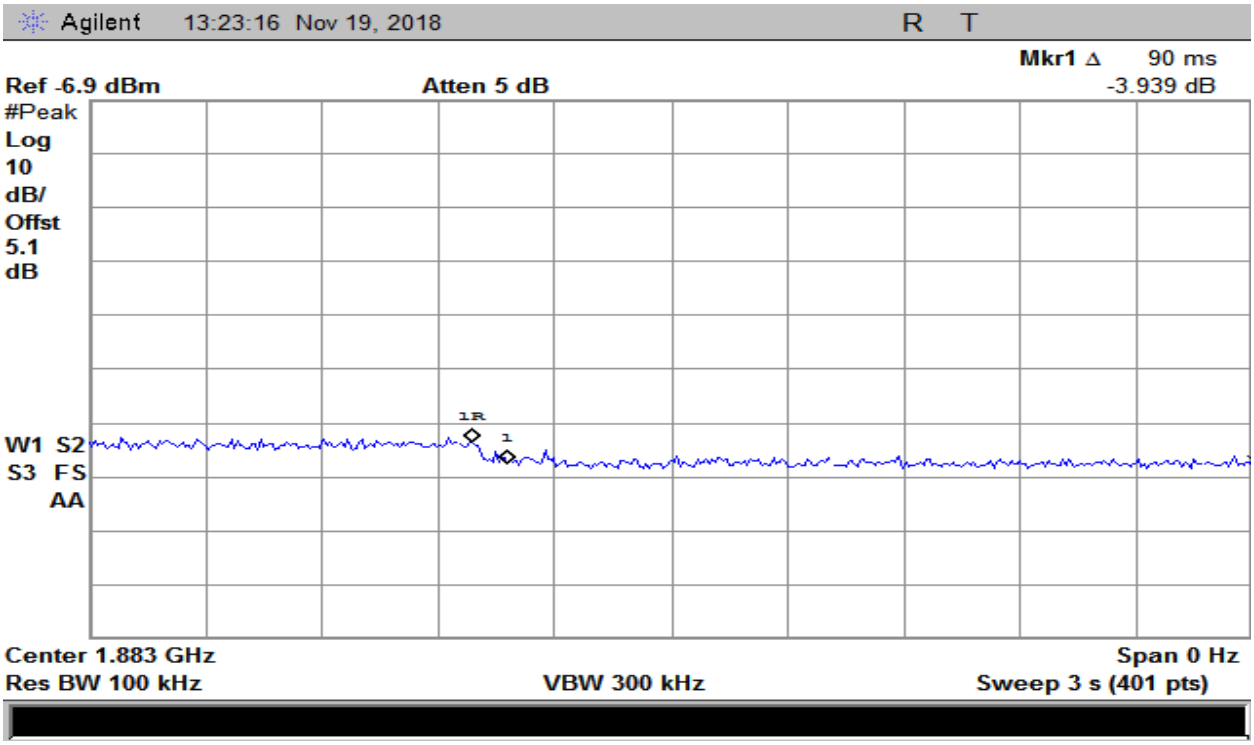
Plot 132 – 776-787MHz Band – Variable Uplink Noise Timing



Plot 133 – 824-849MHz Band – Variable Uplink Noise Timing



Plot 134 – 1710-1755MHz Band – Variable Uplink Noise Timing



Plot 135 – 1850-1915MHz Band – Variable Uplink Noise Timing

7. Variable Booster Gain

Test Requirement(s):	§20.21(e)(8)(i)(c)(1)	Test Engineer(s):	Hoosam B.
Test Results:	Pass	Test Date(s):	Nov/20/2018

Test Procedures: As required by 47 §20.21(e)(8)(i)(c)(1), Variable Booster Gain measurements were made as per FCC KDB procedures 935210 D03 defined in §7.9.

The EUT was set up as per Figure 4.

Gain limits are based on §20.21(e)(8)(i)(C) for consumer booster Fixed devices shall not exceed -34dB – RSSI + MSCL.

Test Setup:

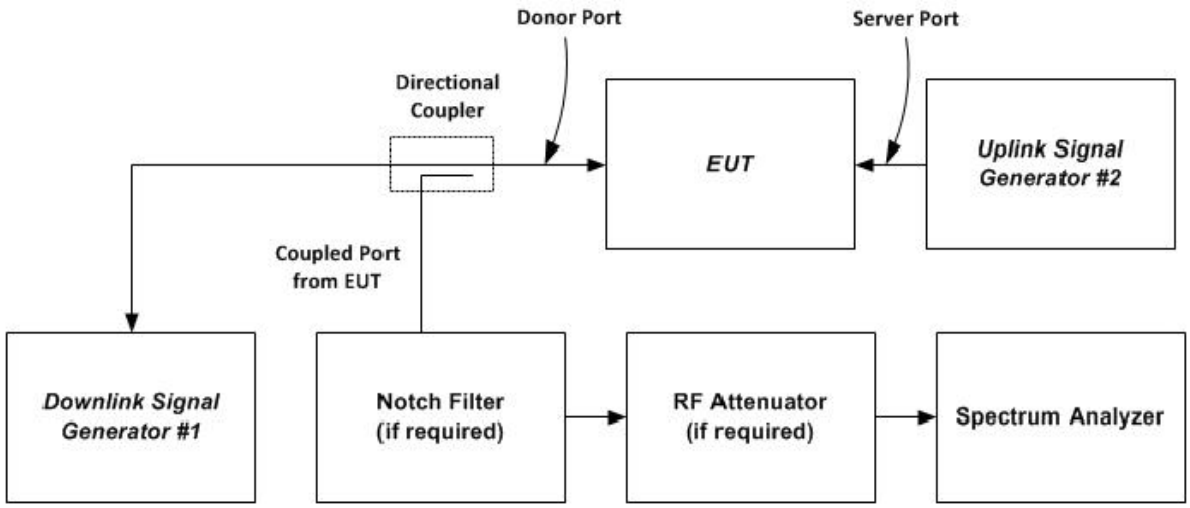


Figure 4 – Variable Gain

Detector Setting	Resolution Bandwidth	Video Bandwidth	Sweep Time
RMS	100 kHz	300 kHz	Auto

Table 20 – Analyzer Settings

RSSI (dBm)	Gain Limit (dBm)	P(in) (dBm)	P(out) dBm	Gain (dB)	Margin (dB)
-20	24.63	-43	-51.5	-8.5	-33.13
-35	39.63	-43	-11.63	31.37	-8.26
-40	44.63	-43	-6.8	36.2	-8.43
-45	49.63	-43	-1.75	41.25	-8.38
-50	54.63	-43	3.48	46.48	-8.15
-55	59.63	-43	9.1	52.1	-7.53

Table 27 – 698-716MHz Band – Uplink Data

RSSI (dBm)	Gain Limit (dBm)	P(in) (dBm)	P(out) dBm	Gain (dB)	Margin (dB)
-20	24.72	-43	-25.98	17.02	-7.7
-35	39.72	-43	-11.6	31.4	-8.32
-40	44.72	-43	-7.1	35.9	-8.82
-45	49.72	-43	-2.19	40.81	-8.91
-50	54.72	-43	4.02	47.02	-7.7
-55	59.72	-43	8.7	51.7	-8.02

Table 28 – 776-787MHz Band – Uplink Data

RSSI (dBm)	Gain Limit (dBm)	P(in) (dBm)	P(out) dBm	Gain (dB)	Margin (dB)
-20	25.92	-43	-51.5	-8.5	-34.42
-35	40.92	-43	-16.58	26.42	-14.5
-40	45.92	-43	-11.63	31.37	-14.55
-45	50.92	-43	-7.2	35.8	-15.12
-50	55.92	-43	-2.21	40.79	-15.13
-55	60.92	-43	4.2	47.2	-13.72

Table 29 – 824-849MHz Band – Uplink Data

RSSI (dBm)	Gain Limit (dBm)	P(in) (dBm)	P(out) dBm	Gain (dB)	Margin (dB)
-20	29.82	-53	-51.6	1.4	-28.42
-35	44.82	-53	-25.9	27.1	-17.72
-40	49.82	-53	-21.1	31.9	-17.92
-45	54.82	-53	-15.6	37.4	-17.42
-50	59.82	-53	-10.5	42.5	-17.32
-55	64.82	-53	-5.6	47.4	-17.42

` **Table 30 – 1710-1755MHz Band – Uplink Data**

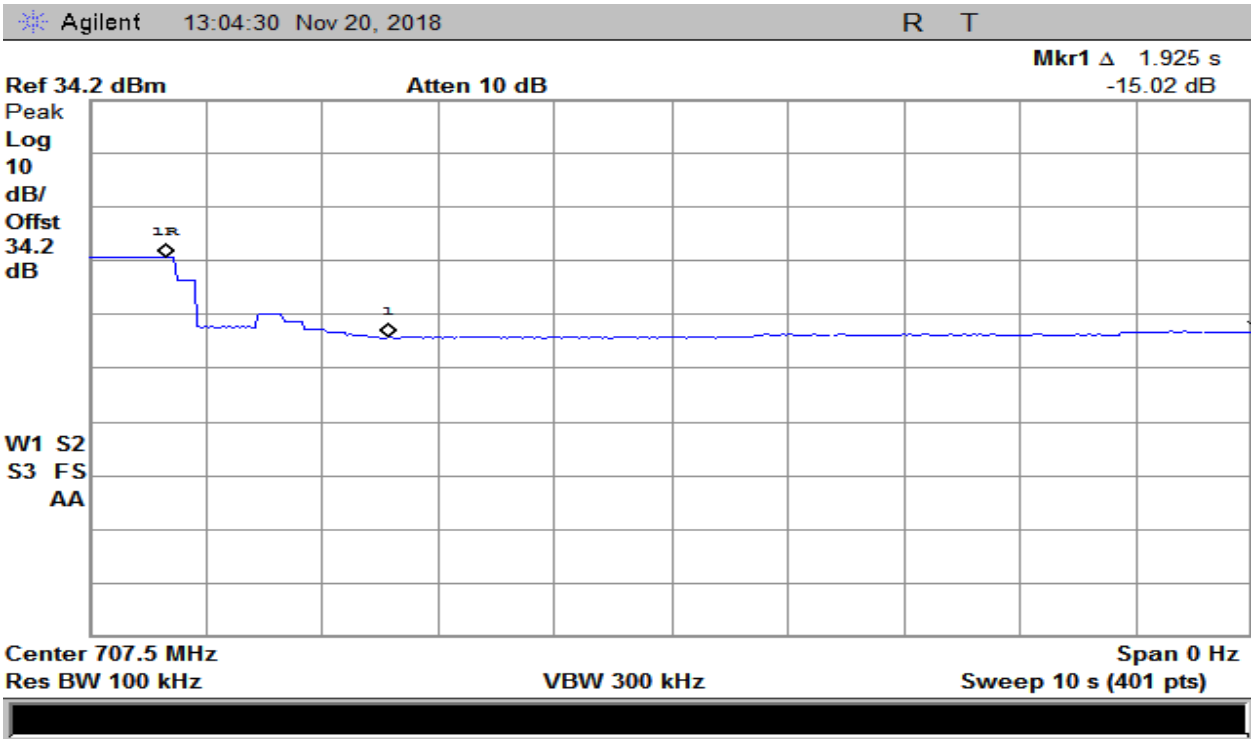
RSSI (dBm)	Gain Limit (dBm)	P(in) (dBm)	P(out) dBm	Gain (dB)	Margin (dB)
-20	30.38	-52	-51.5	0.5	-29.88
-35	45.38	-52	-20.8	31.2	-14.18
-40	50.38	-52	-15.4	36.6	-13.78
-45	55.38	-52	-10.75	41.25	-14.13
-50	60.38	-52	-5.47	46.53	-13.85
-55	65.38	-52	-0.45	51.55	-13.83

Table 31 – 1850-1915MHz Band – Uplink Data

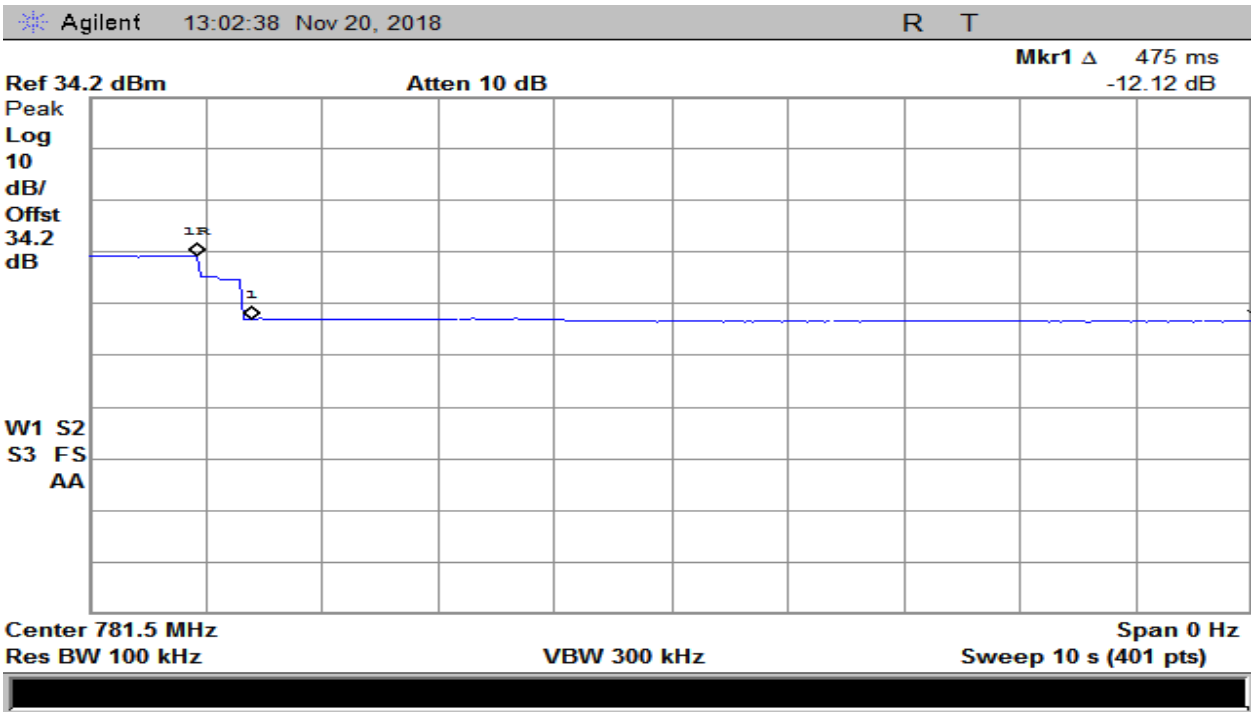
Frequency Band (MHz)	Measured Timing (Seconds)	Limit (Seconds)	Margin (Seconds)
698-716	1.925	3.0	-1.07
776-787	0.475	3.0	-2.52
824-849	2.325	3.0	-0.675
1710-1755	1.775	3.0	-1.225
1850-1915	1.85	3.0	-1.15

Table 32 – Variable Uplink Gain Timing - Summary Table

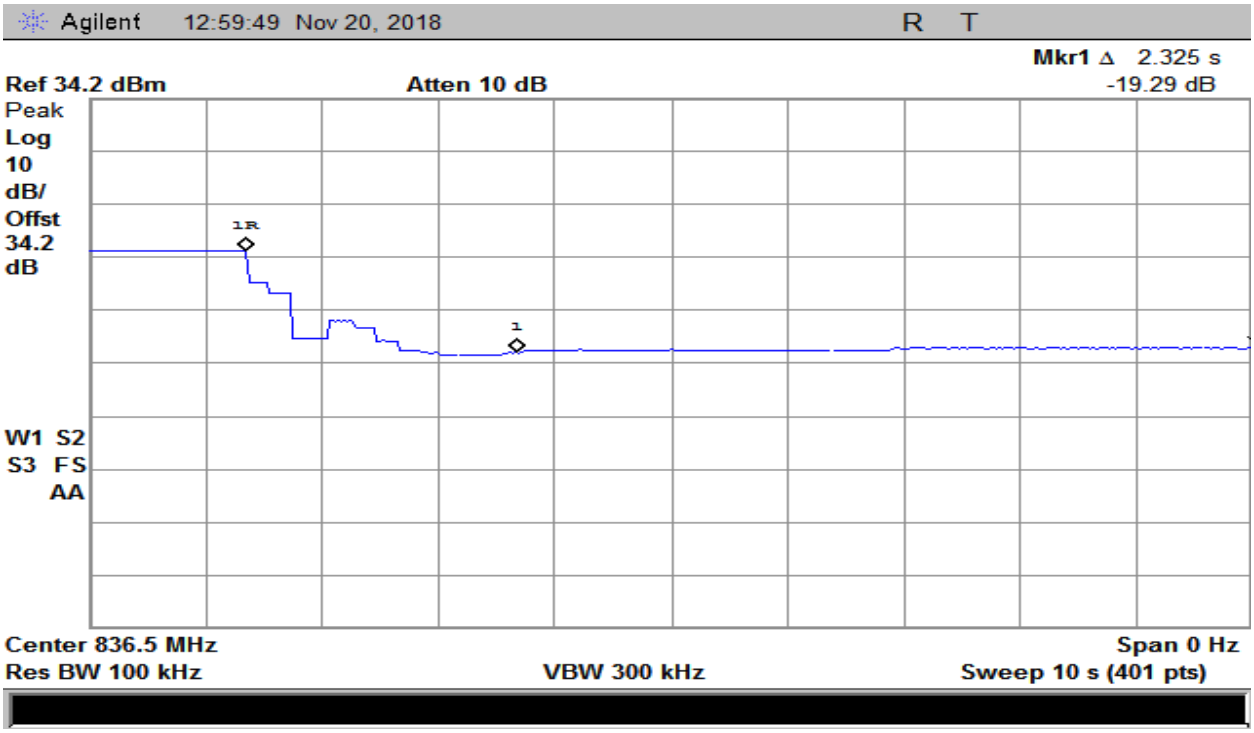
The following pages show measurements of Variable Booster Gain Timing plots:



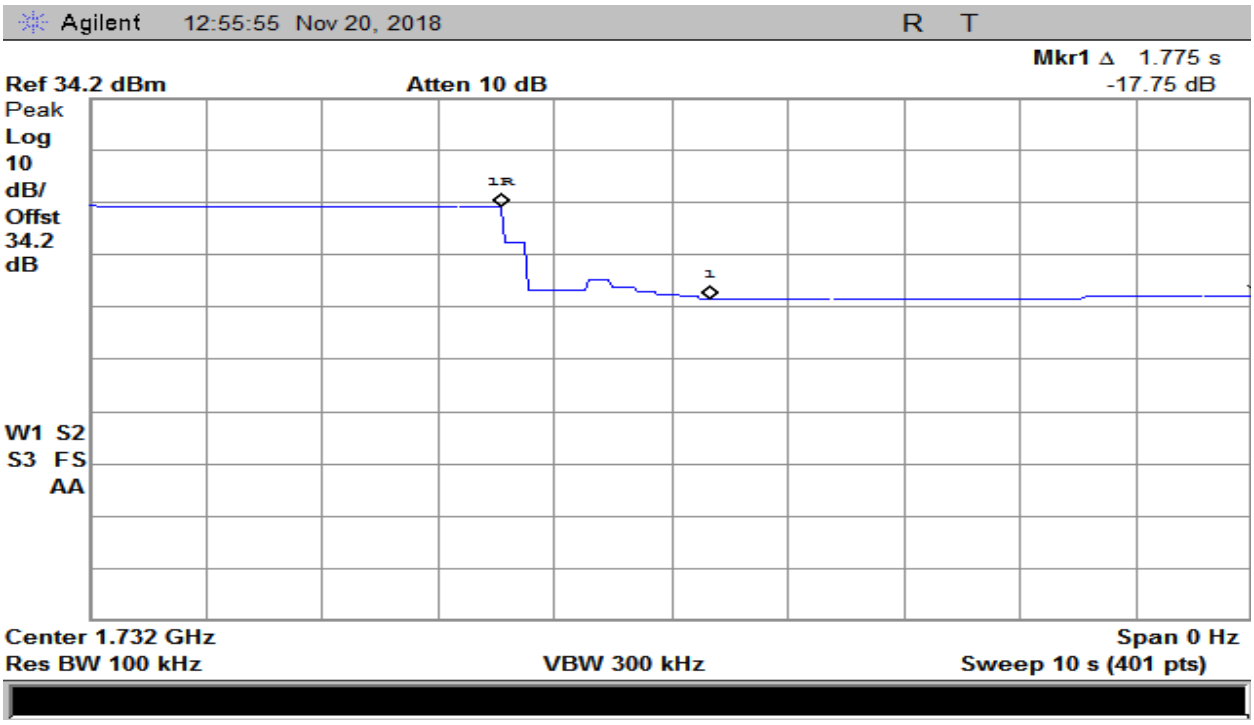
Plot 136 – 698-716MHz Band – Uplink Gain Timing



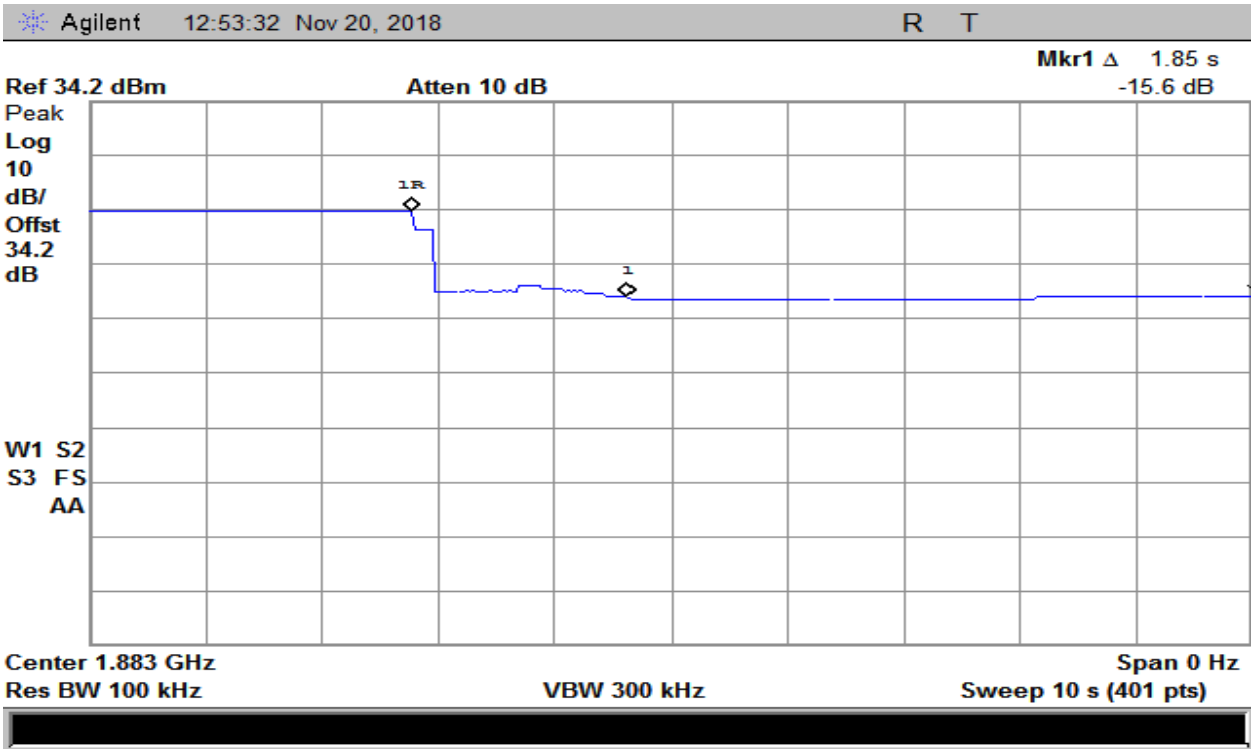
Plot 137 – 776-787MHz Band – Uplink Gain Timing



Plot 138 – 824-849MHz Band – Uplink Gain Timing



Plot 139 – 1710-1755MHz Band – Uplink Gain Timing



Plot 140 – 1850-1915MHz Band – Uplink Gain Timing

8. Occupied Bandwidth

Test Requirement(s):	§2.1049	Test Engineer(s):	Keith T.
Test Results:	Pass	Test Date(s):	Nov/28/2018

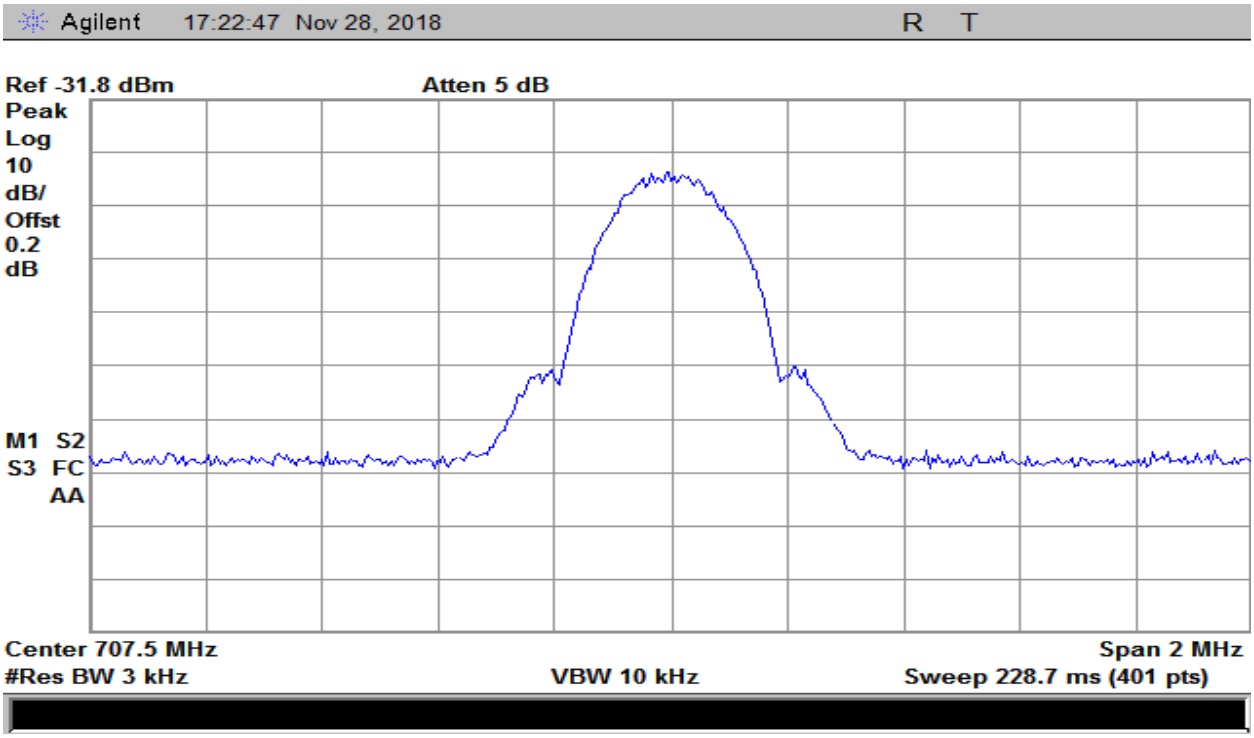
Test Procedures: As required by CFR47 §2.1049, Occupied Bandwidth were made at the RF antenna output terminals of the EUT. Measurements were made as per the FCC KDB 935210 D03 procedures defined in §7.10

The EUT output was connected directly to a spectrum analyzer through an attenuator. A signal generator was connected to the EUT to produce GSM, CDMA & LTE signals to show the input and output signals were similar.

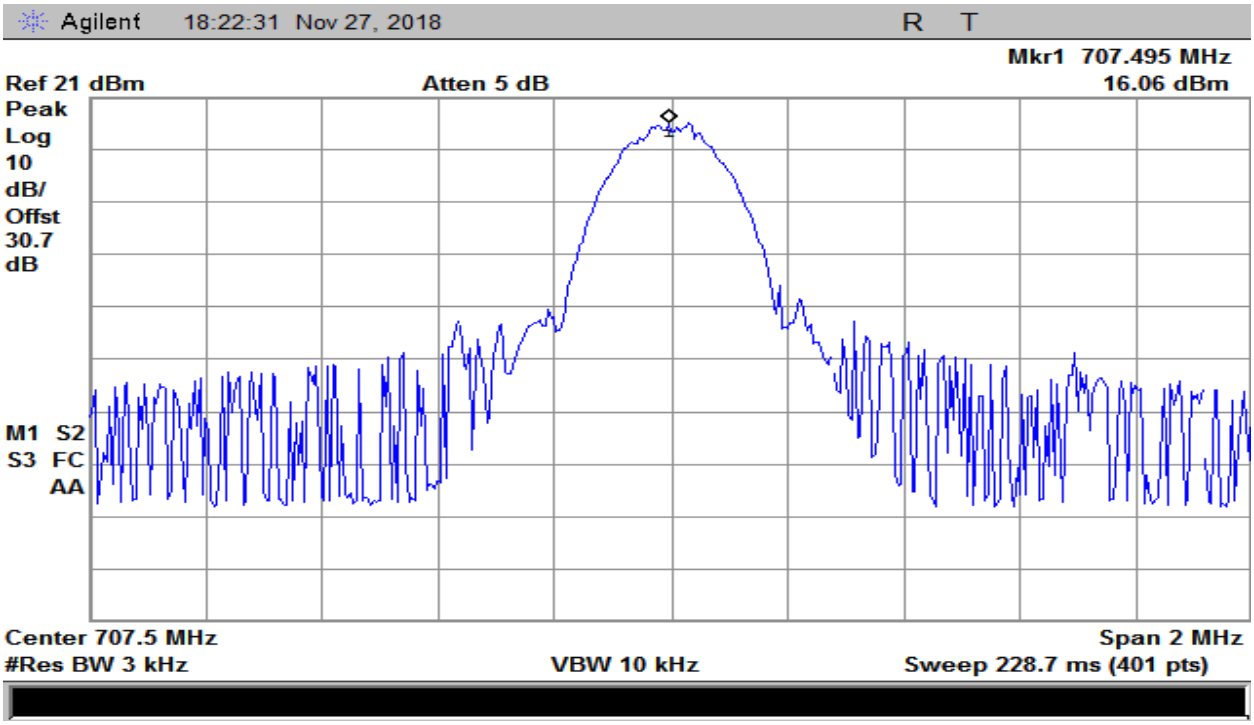
The following pages show measurements of Occupied Bandwidth plots:

Detector Setting	Resolution Bandwidth	Video Bandwidth	Sweep Time	Span
Peak	1% - 5%	≥3 x RBW	Auto	As per Modulation Type

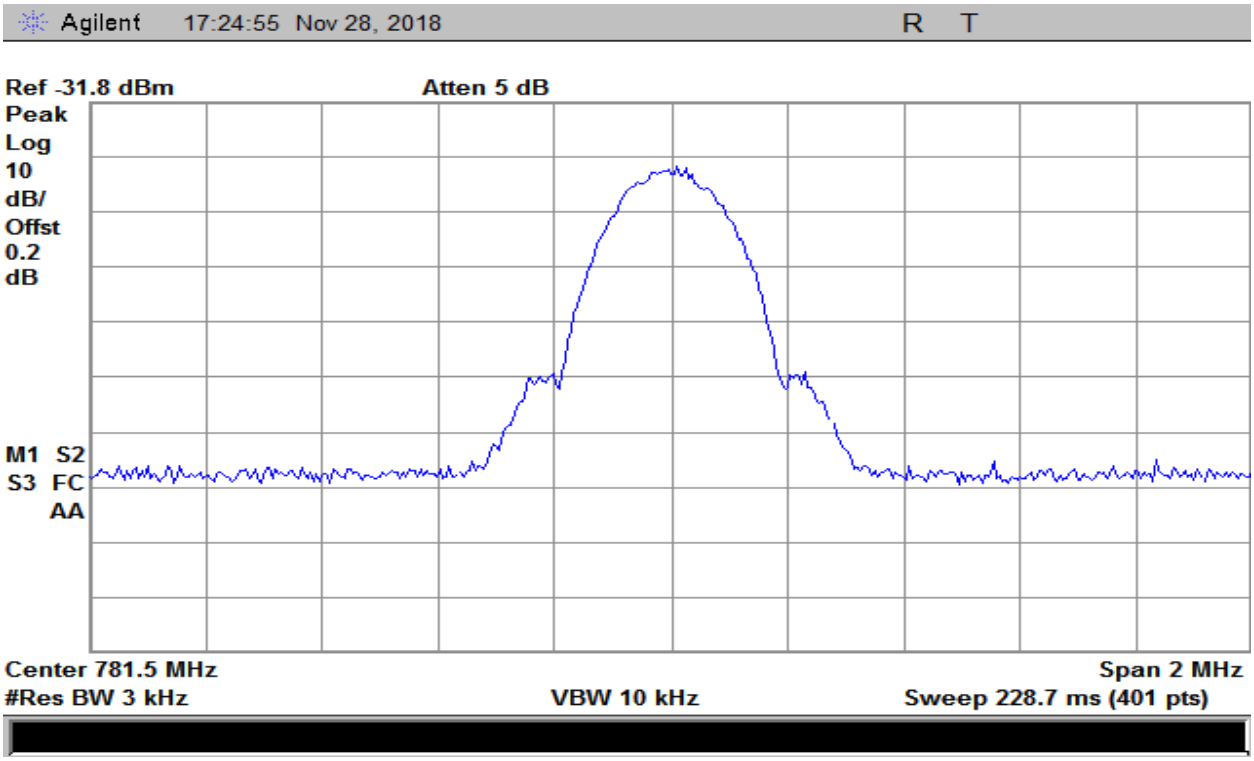
Table 33 – Analyzer Settings



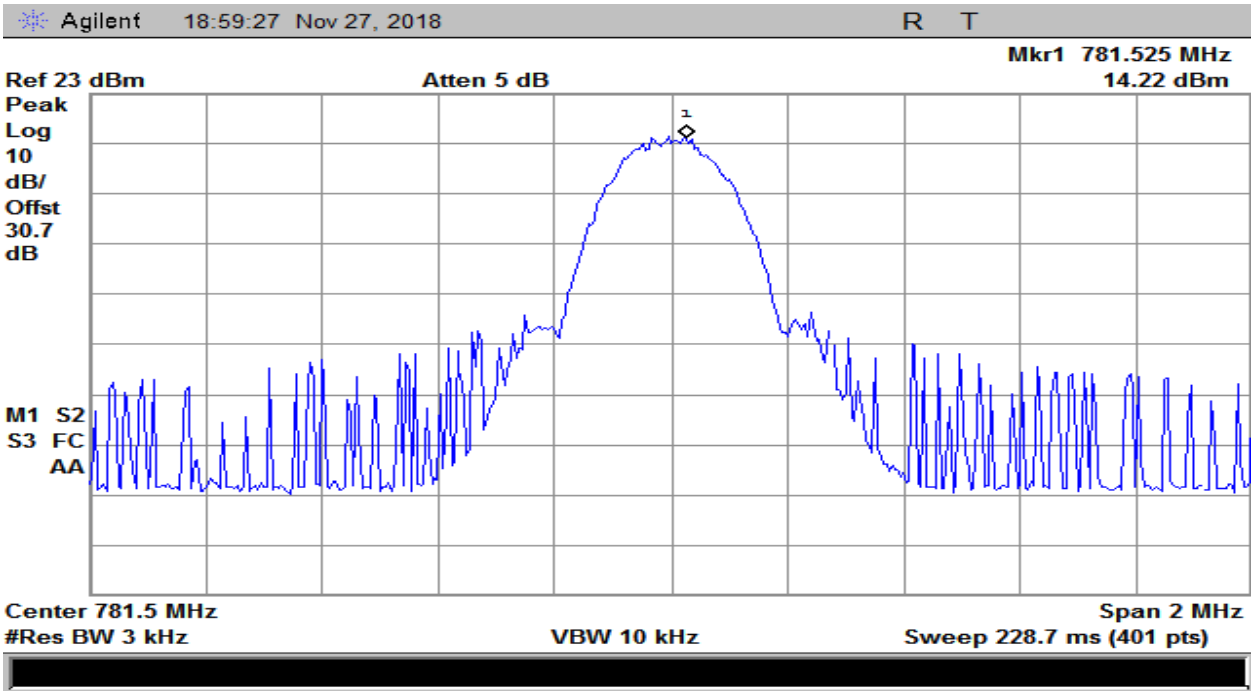
Plot 141 – 698-716MHz Band – Uplink Input – GSM



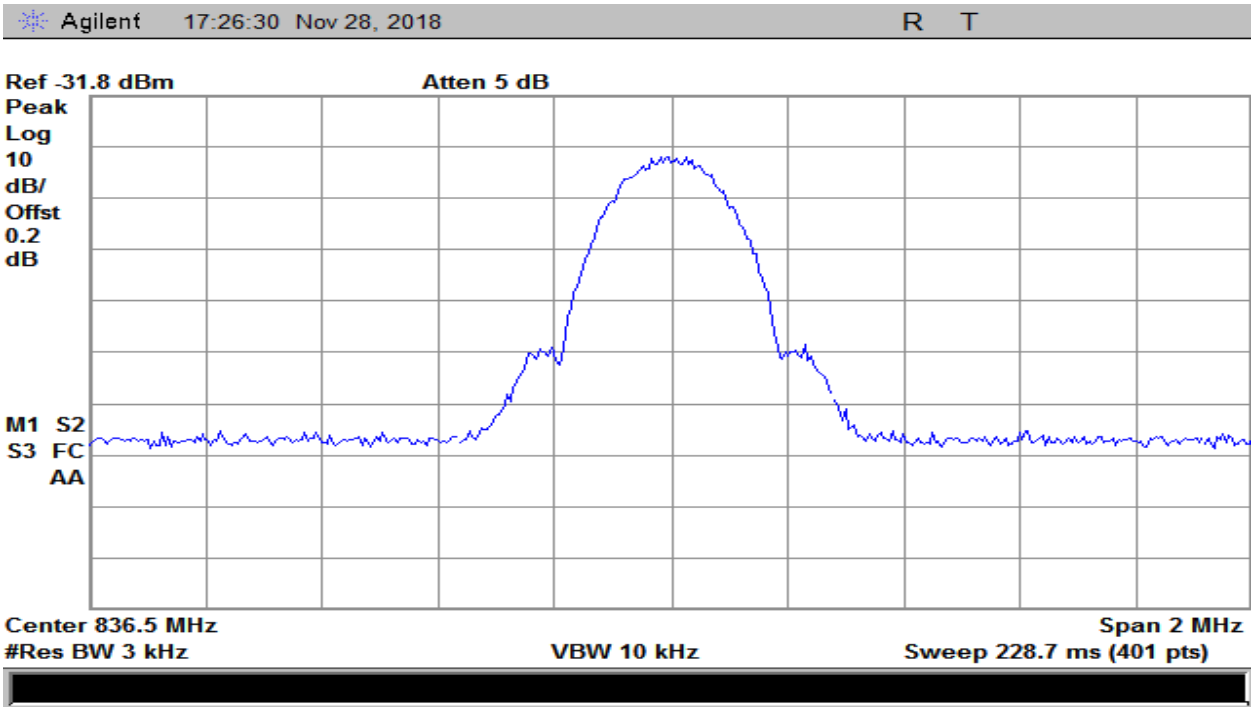
Plot 142 – 698-716MHz Band – Uplink Output – GSM



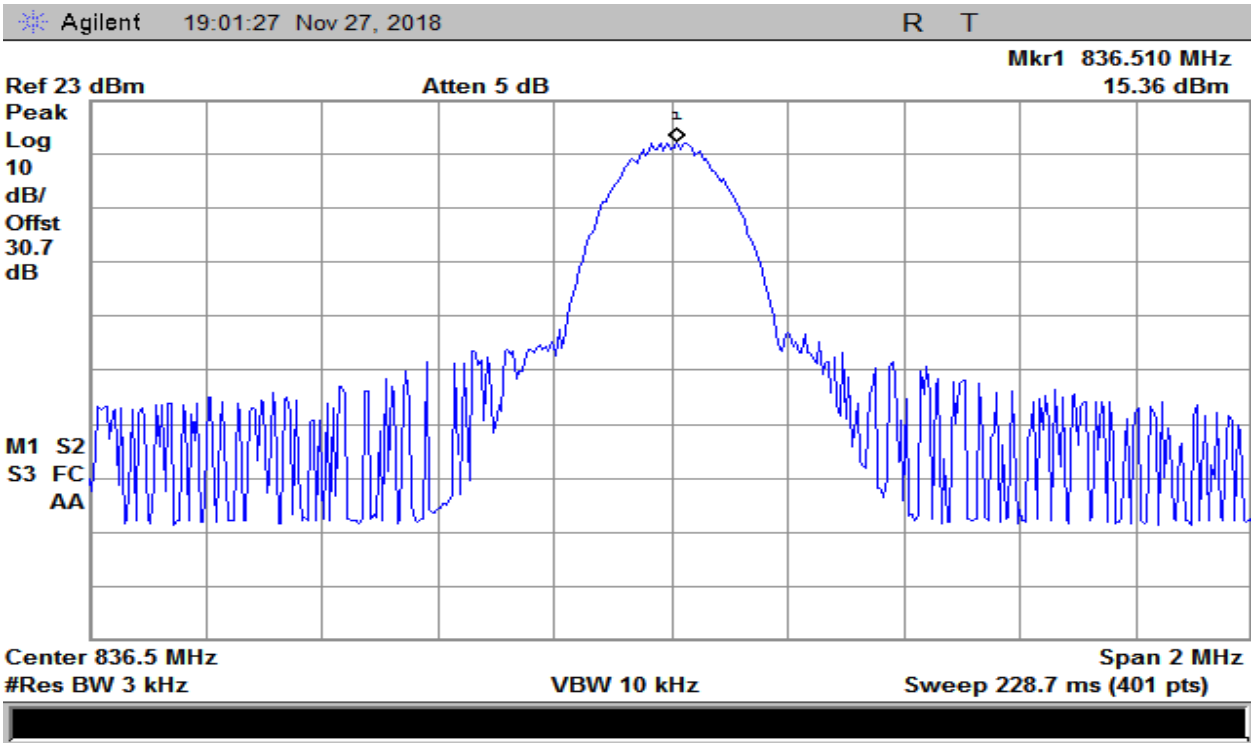
Plot 143 – 776-787MHz Band – Uplink Input – GSM



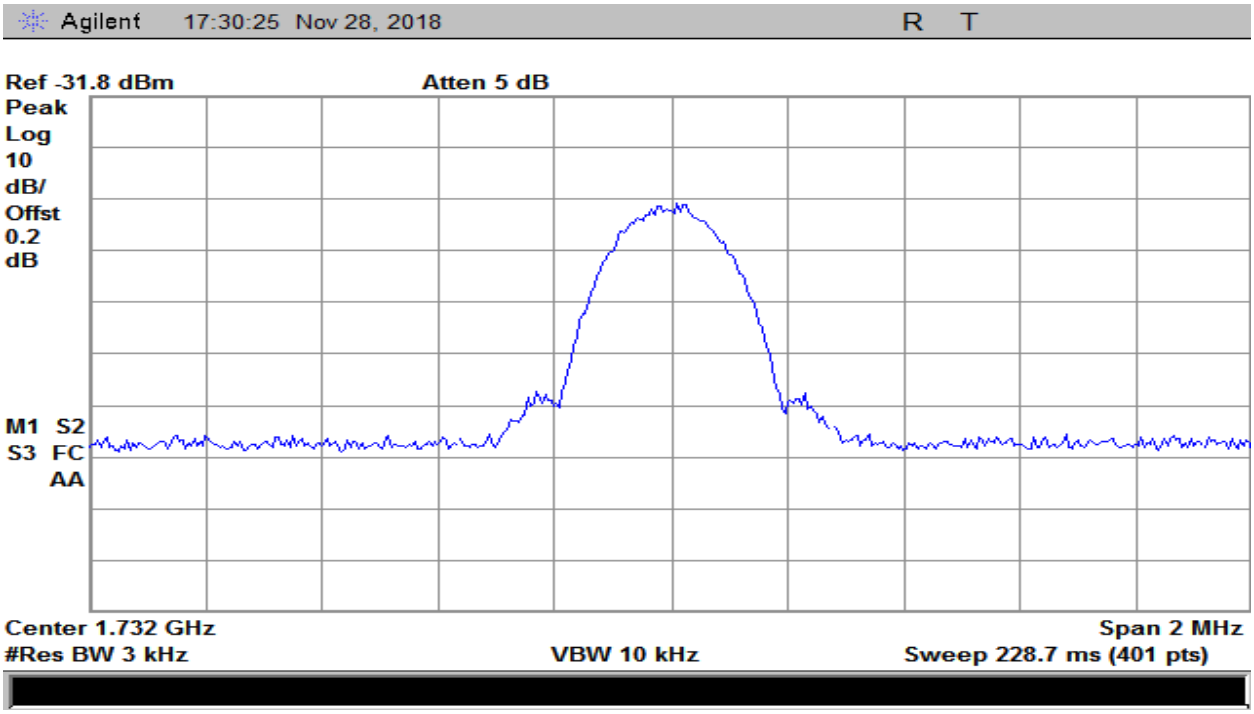
Plot 144 – 776-787MHz Band – Uplink Output – GSM



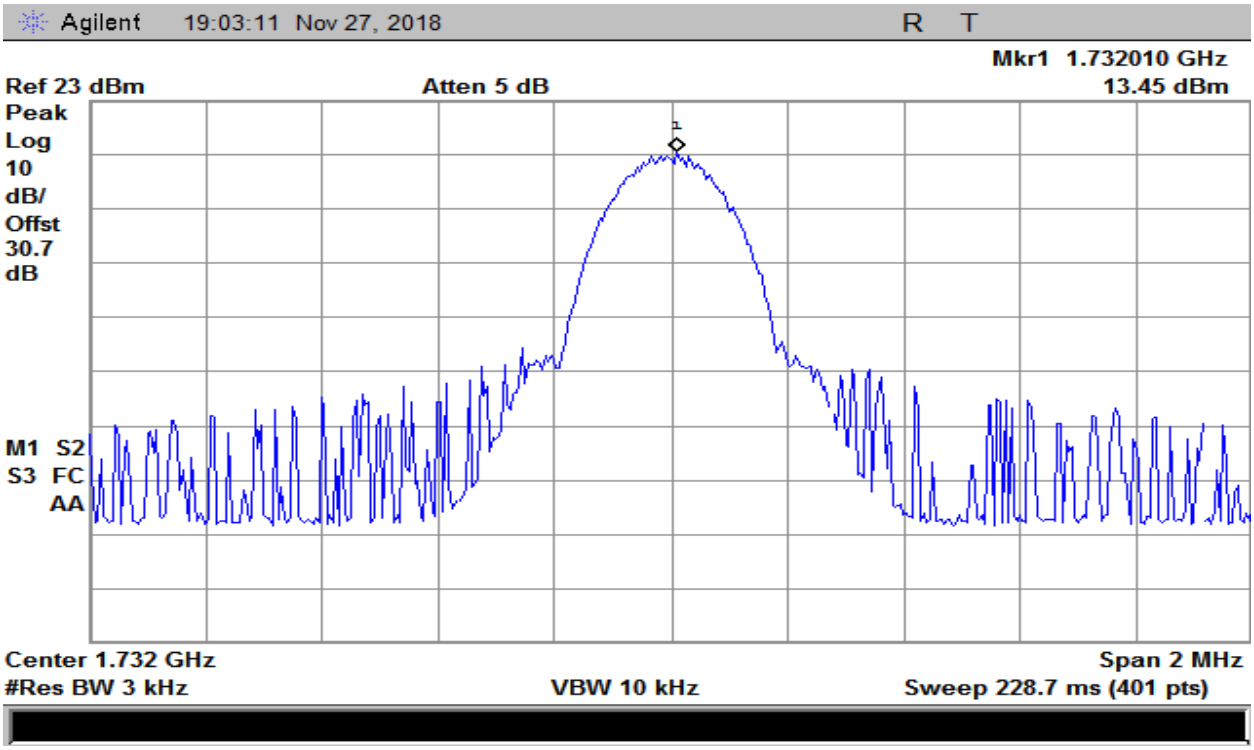
Plot 145 – 824-849MHz Band – Uplink Input – GSM



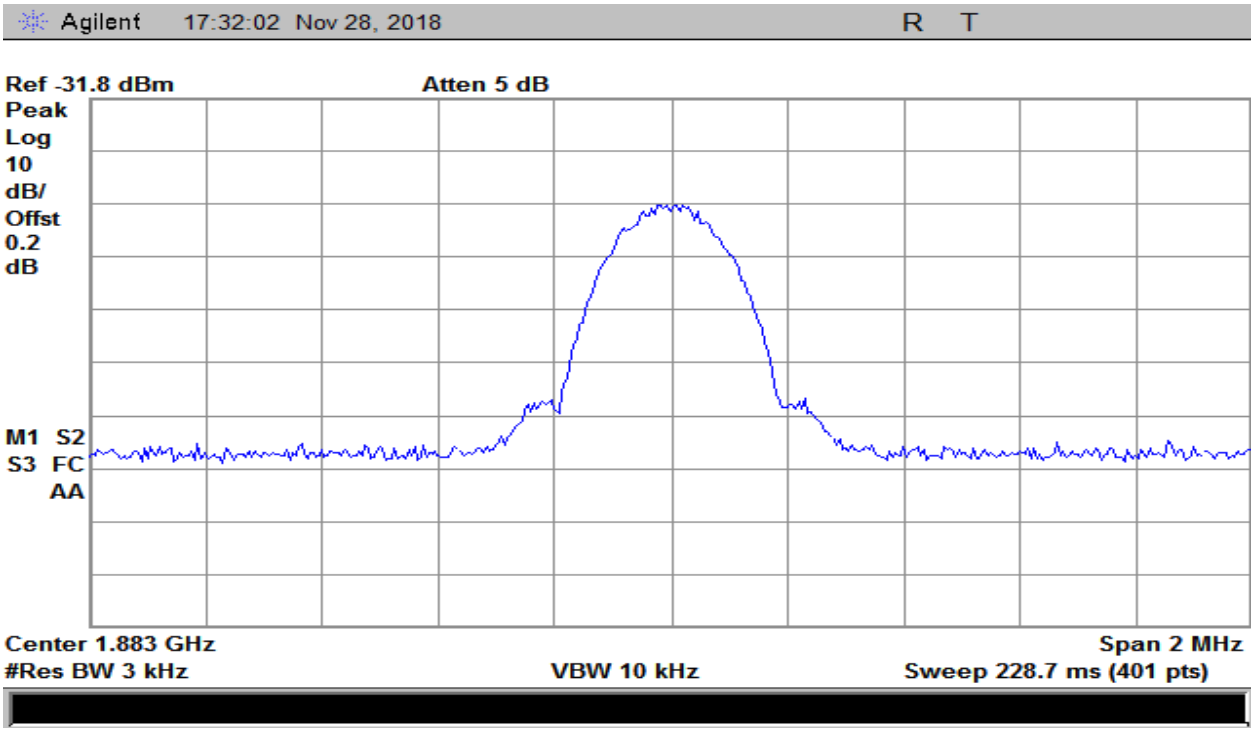
Plot 146 – 824-849MHz Band – Uplink Output – GSM



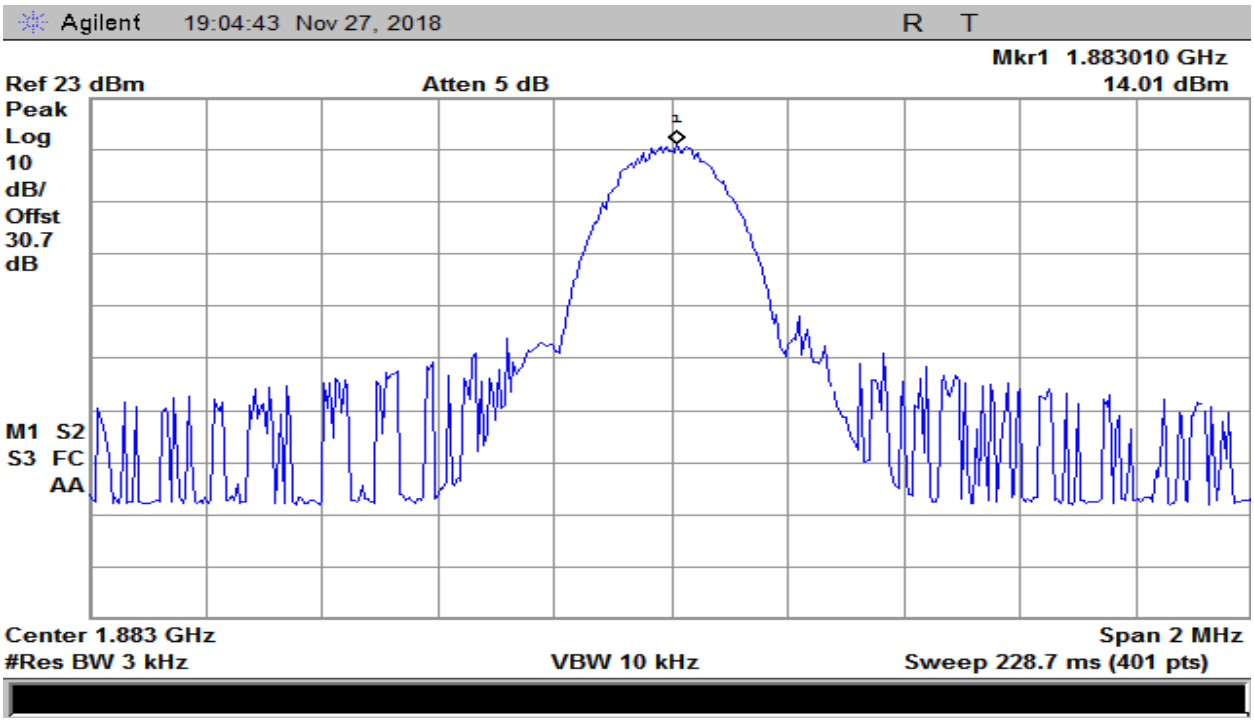
Plot 147 – 1710-1755MHz Band – Uplink Input – GSM



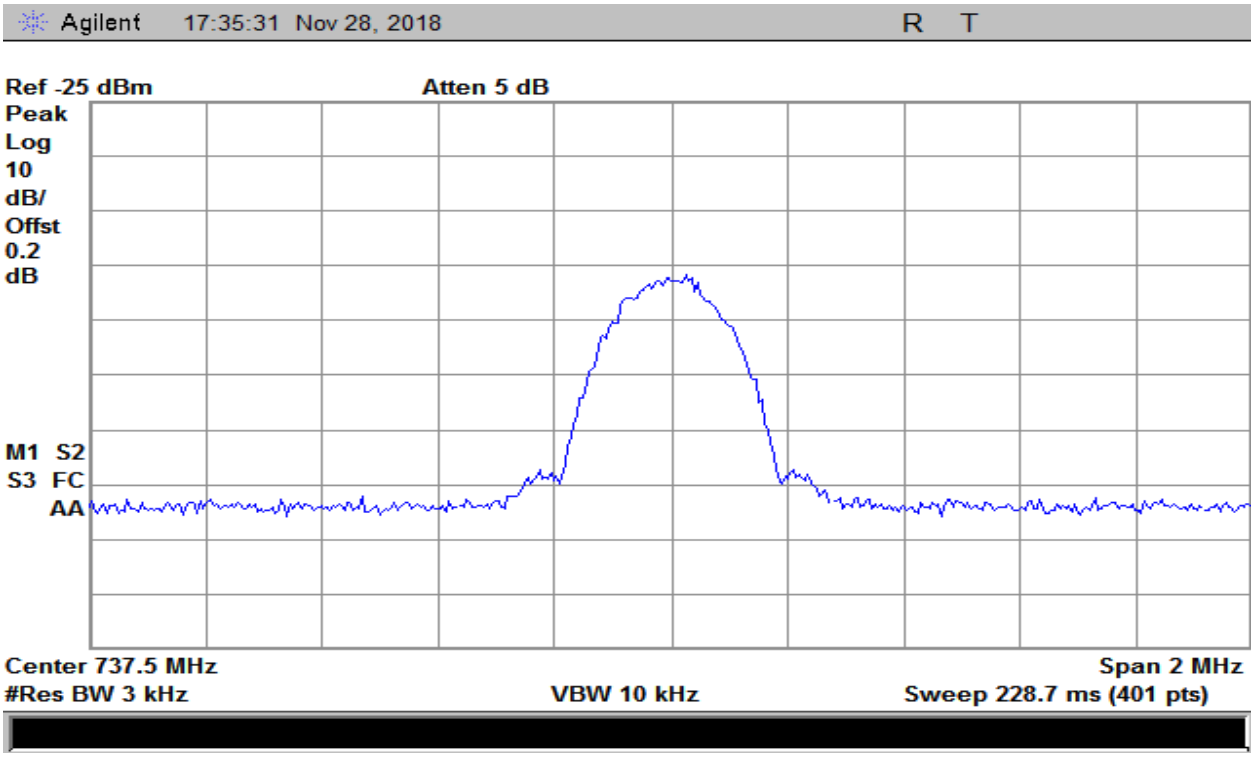
Plot 148 – 1710-1755MHz Band – Uplink Output – GSM



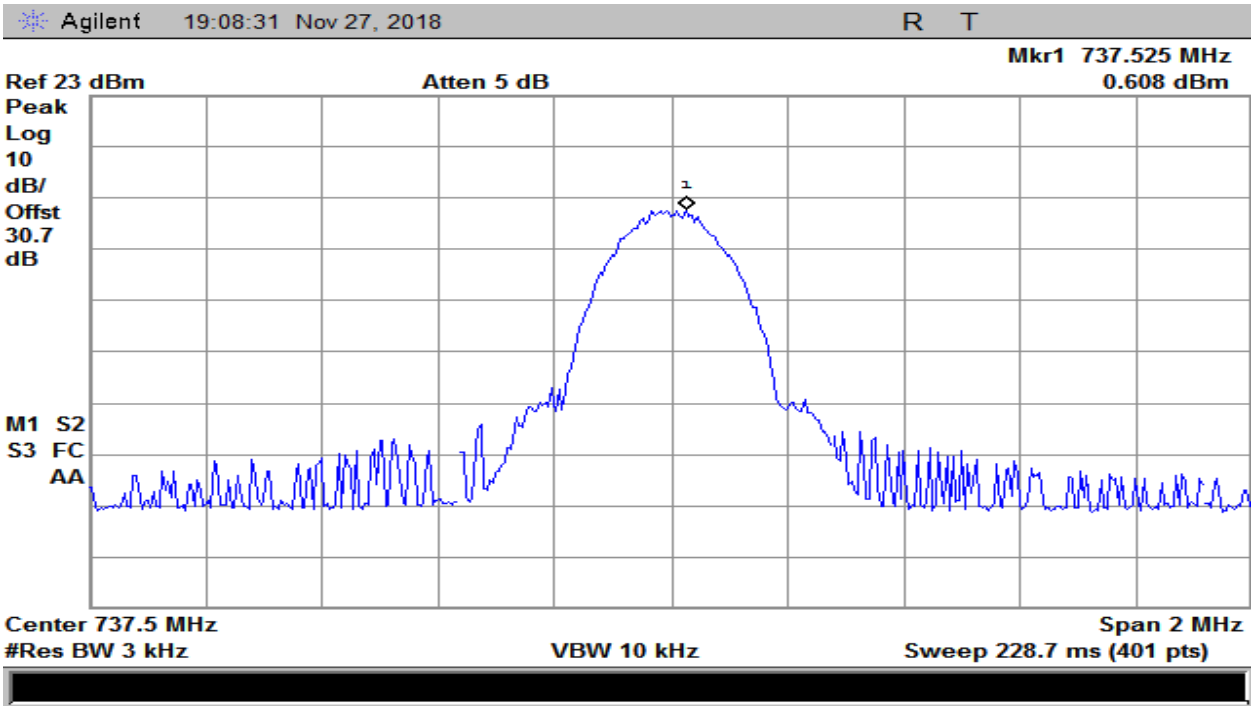
Plot 149 – 1850-1915MHz Band – Uplink Input – GSM



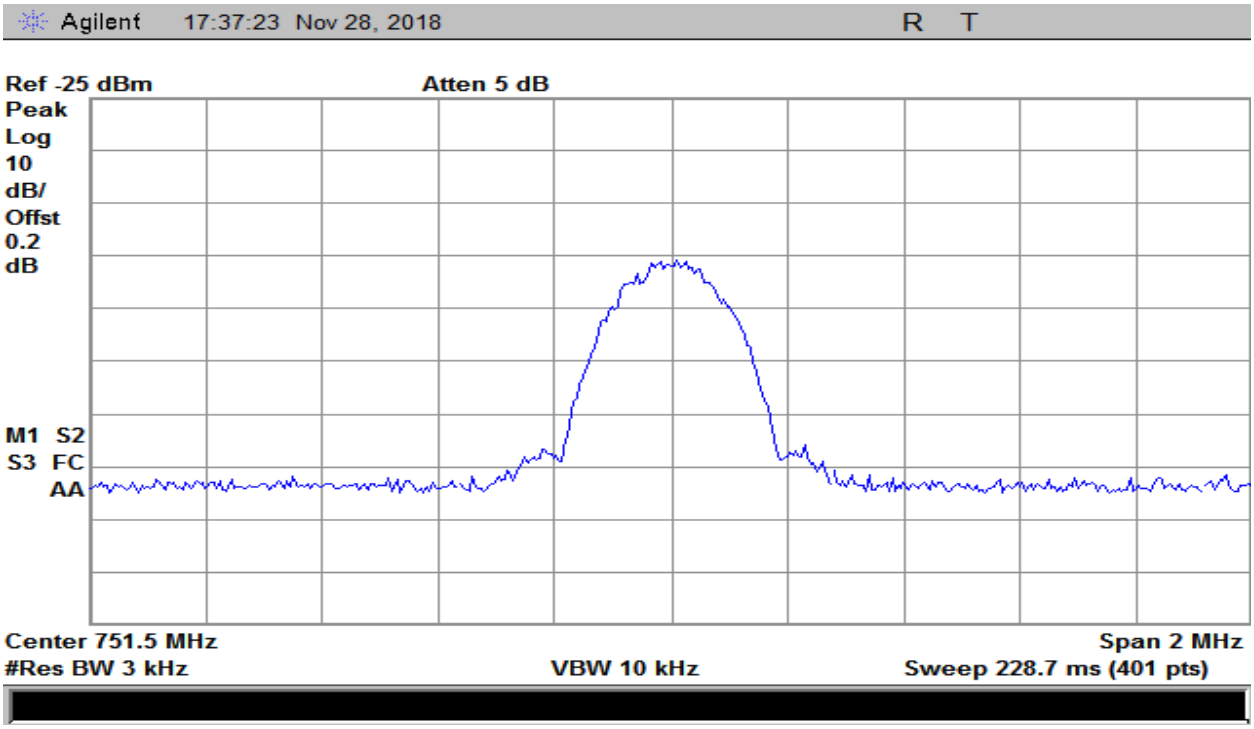
Plot 150 – 1850-1915MHz Band – Uplink Output – GSM



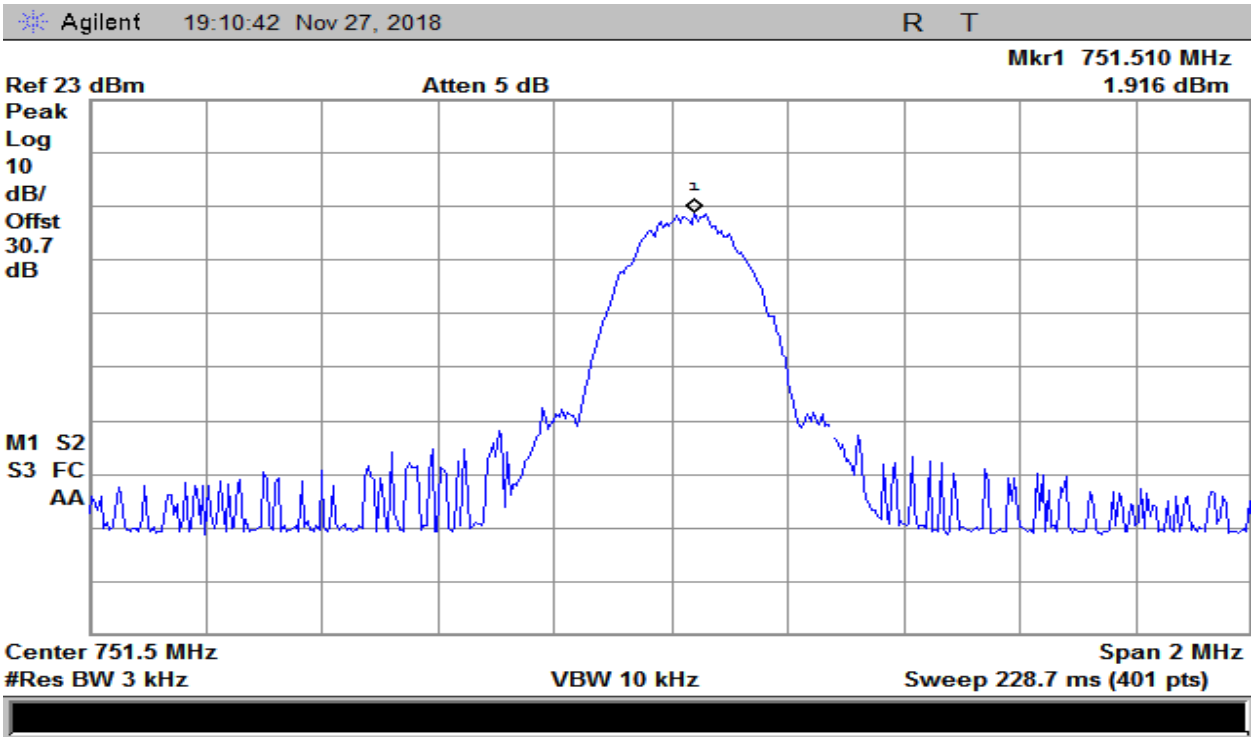
Plot 151 – 728-746MHz Band – Downlink Input – GSM



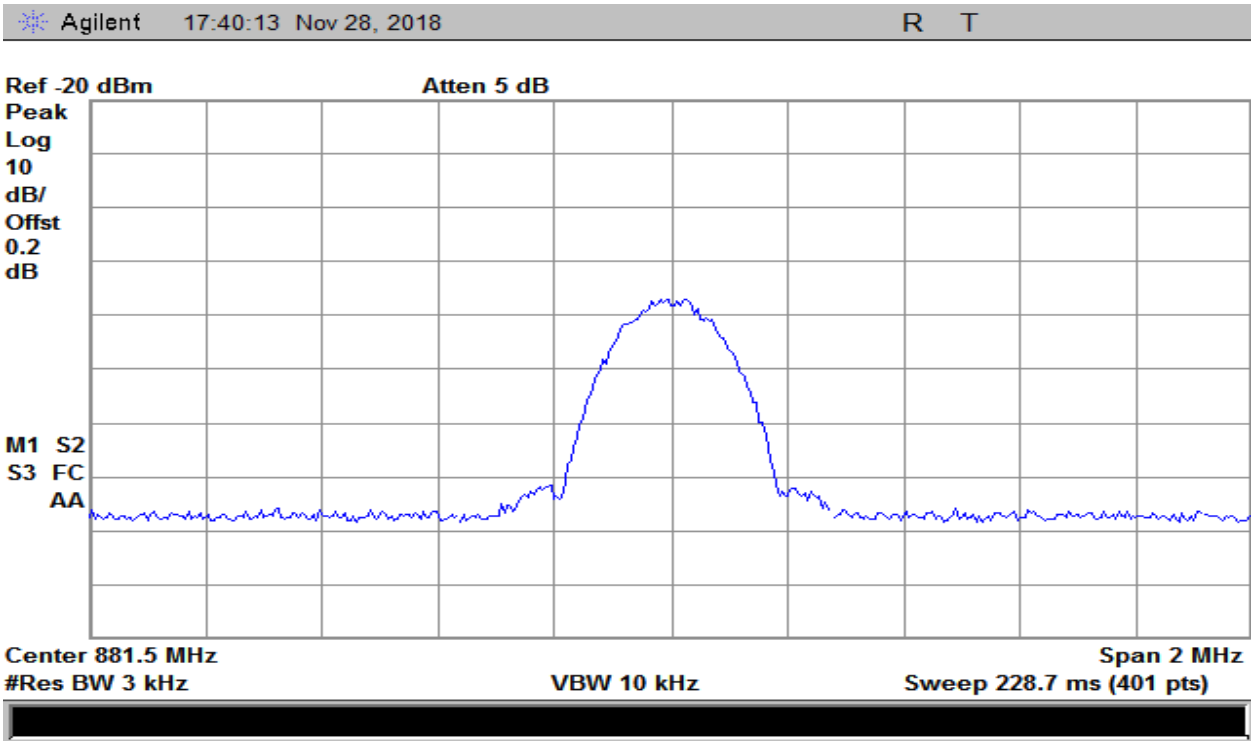
Plot 152 – 728-746MHz Band – Downlink Output – GSM



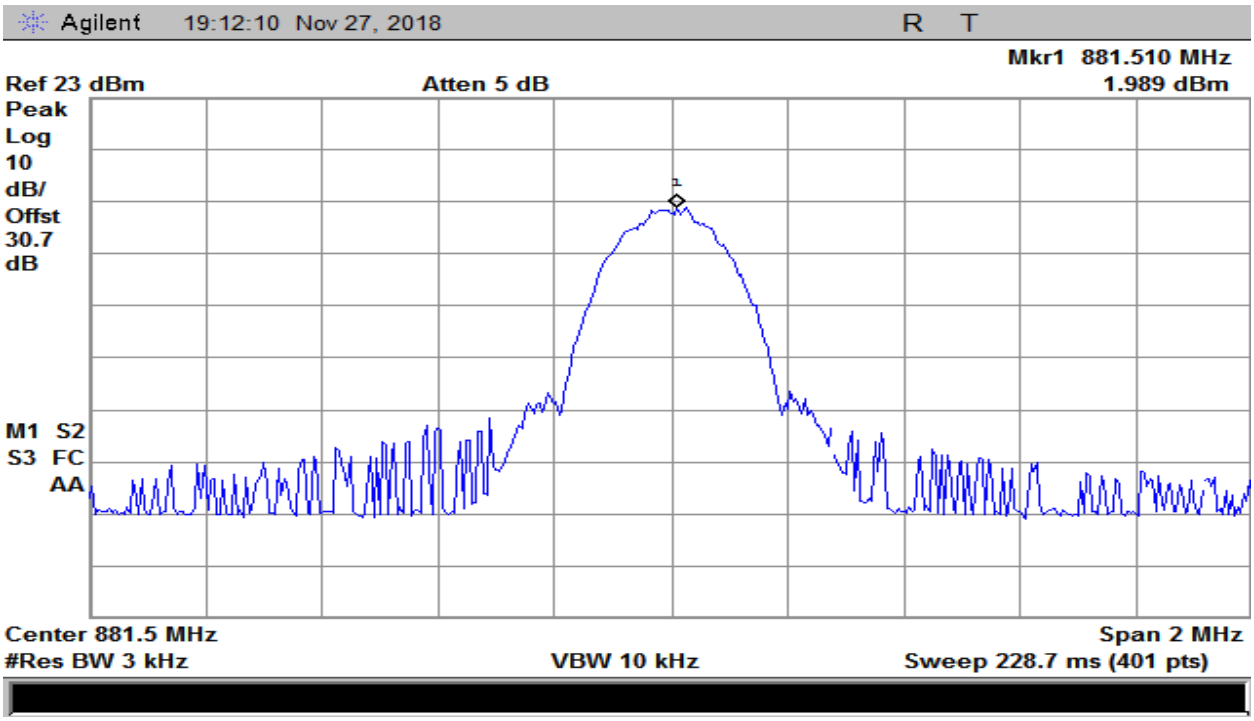
Plot 153 – 746-757MHz Band – Downlink Input – GSM



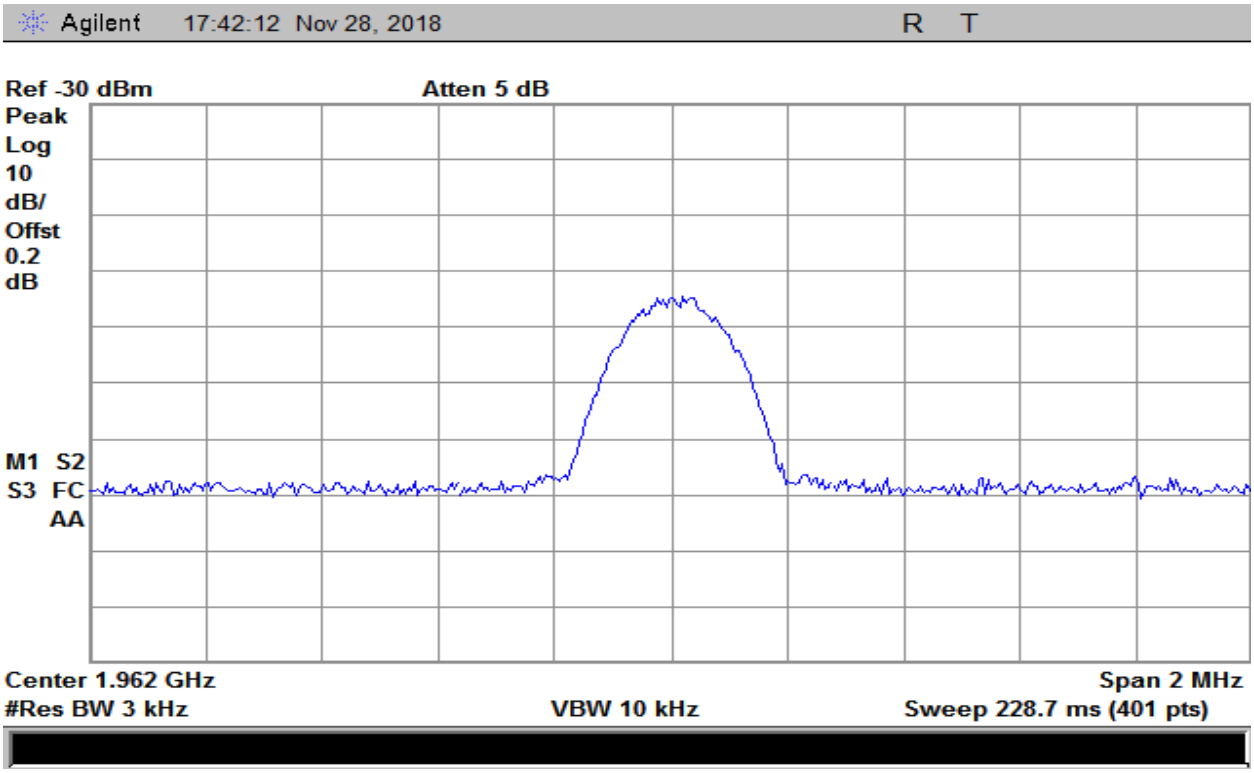
Plot 154 – 746-757MHz Band – Downlink Output – GSM



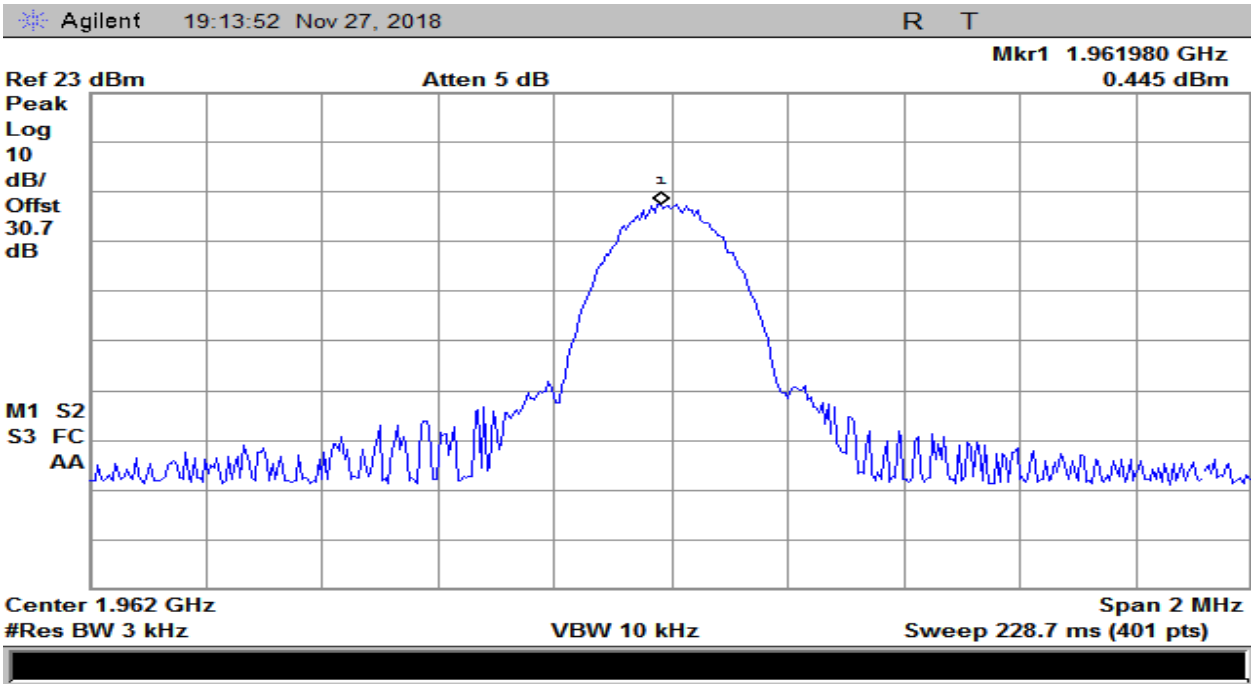
Plot 155 – 869-894MHz Band – Downlink Input – GSM



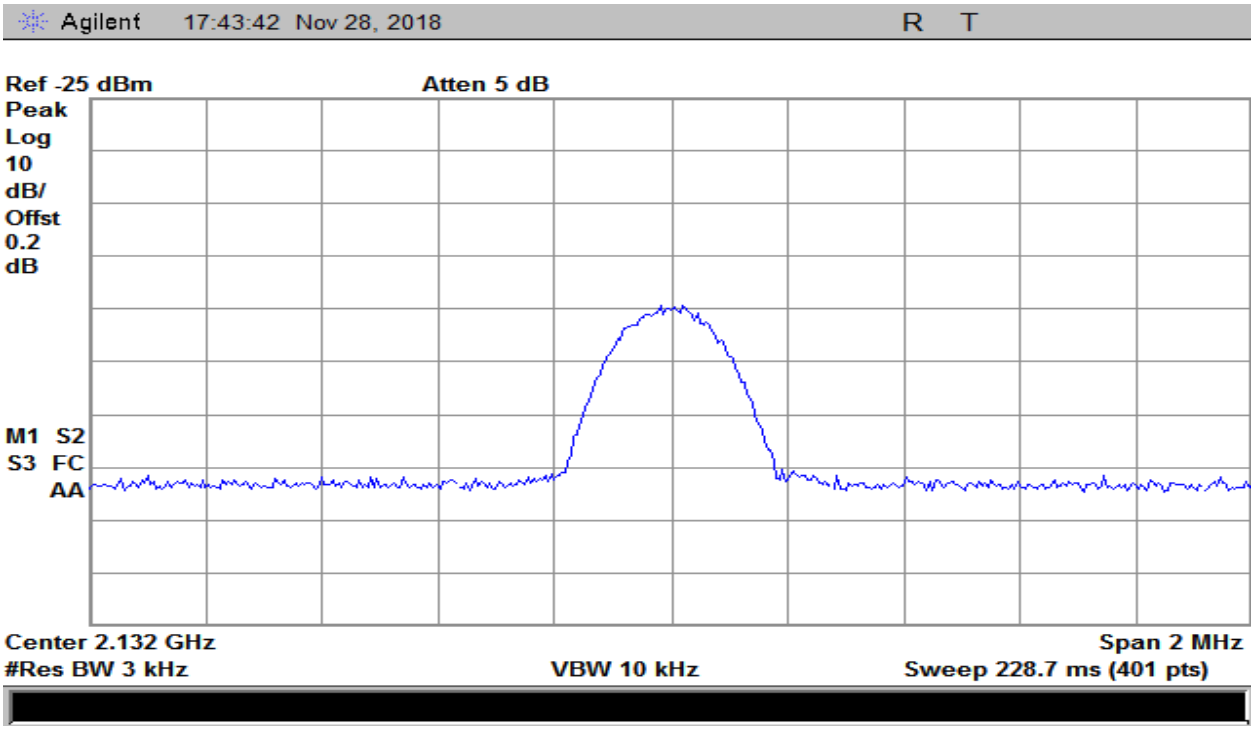
Plot 156 – 869-894MHz Band – Uplink Output – GSM



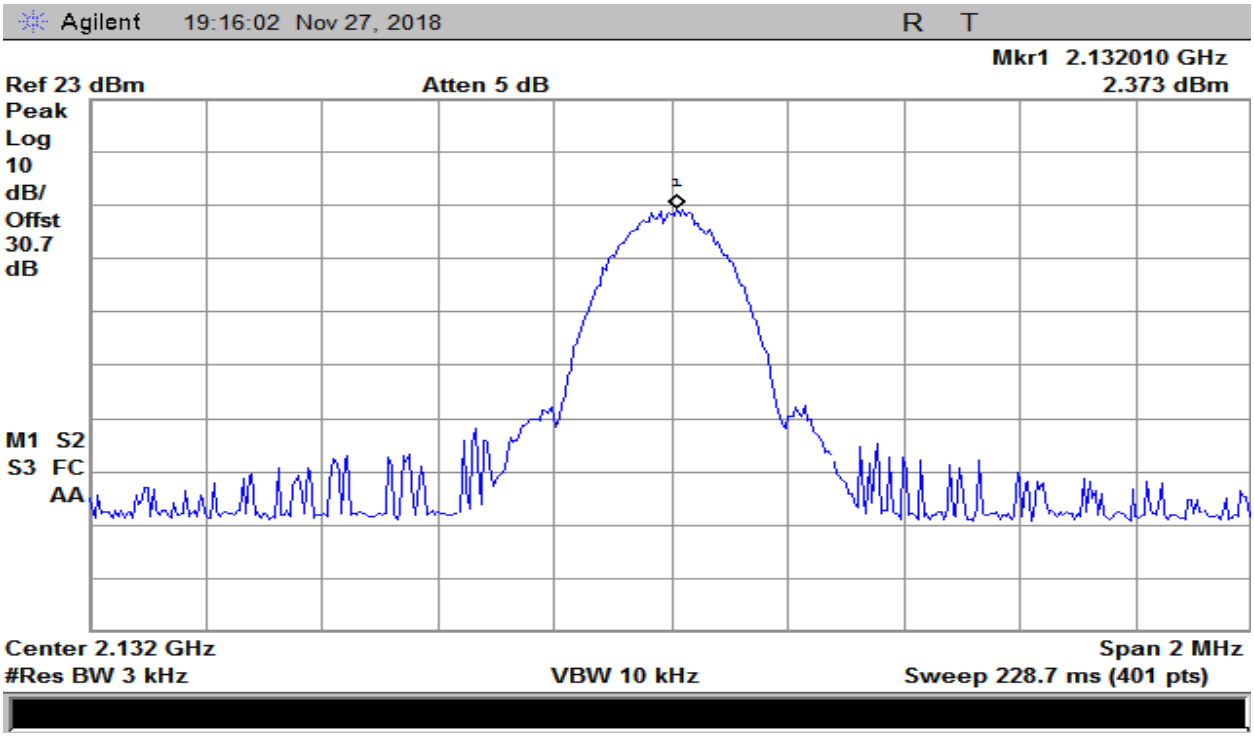
Plot 157 – 1930-1995MHz Band – Downlink Input – GSM



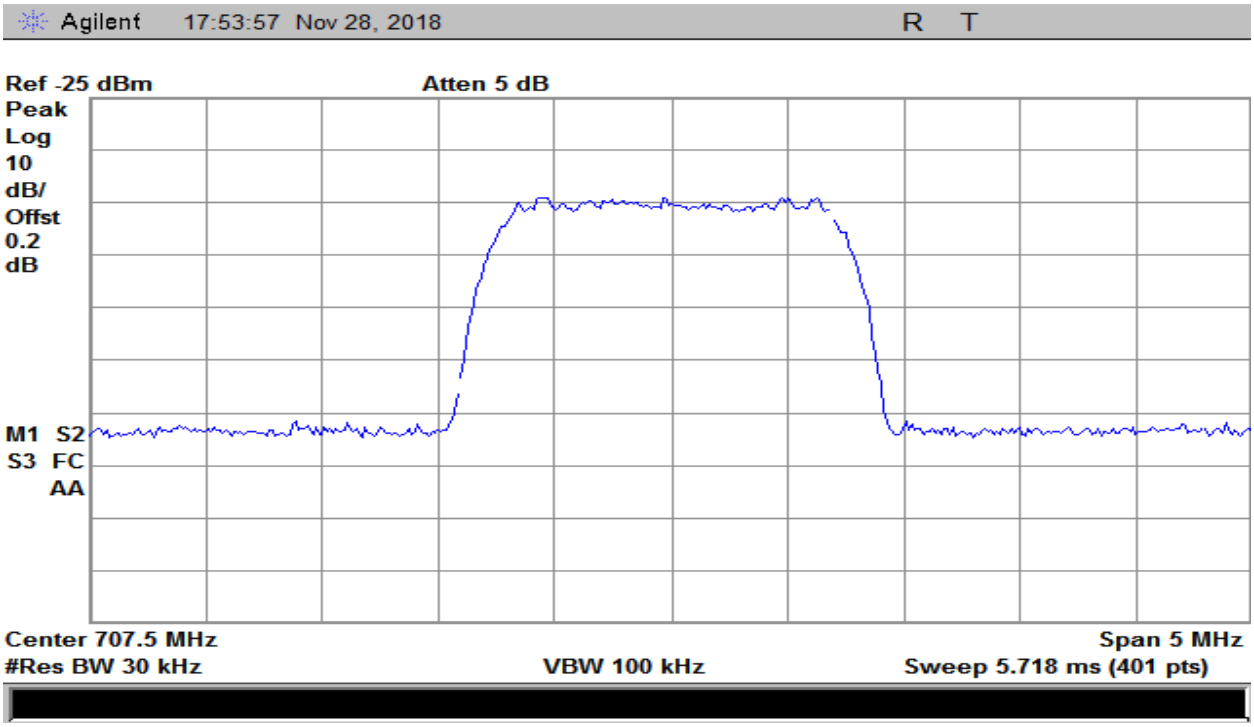
Plot 158 – 1930-1995MHz Band – Downlink Output – GSM



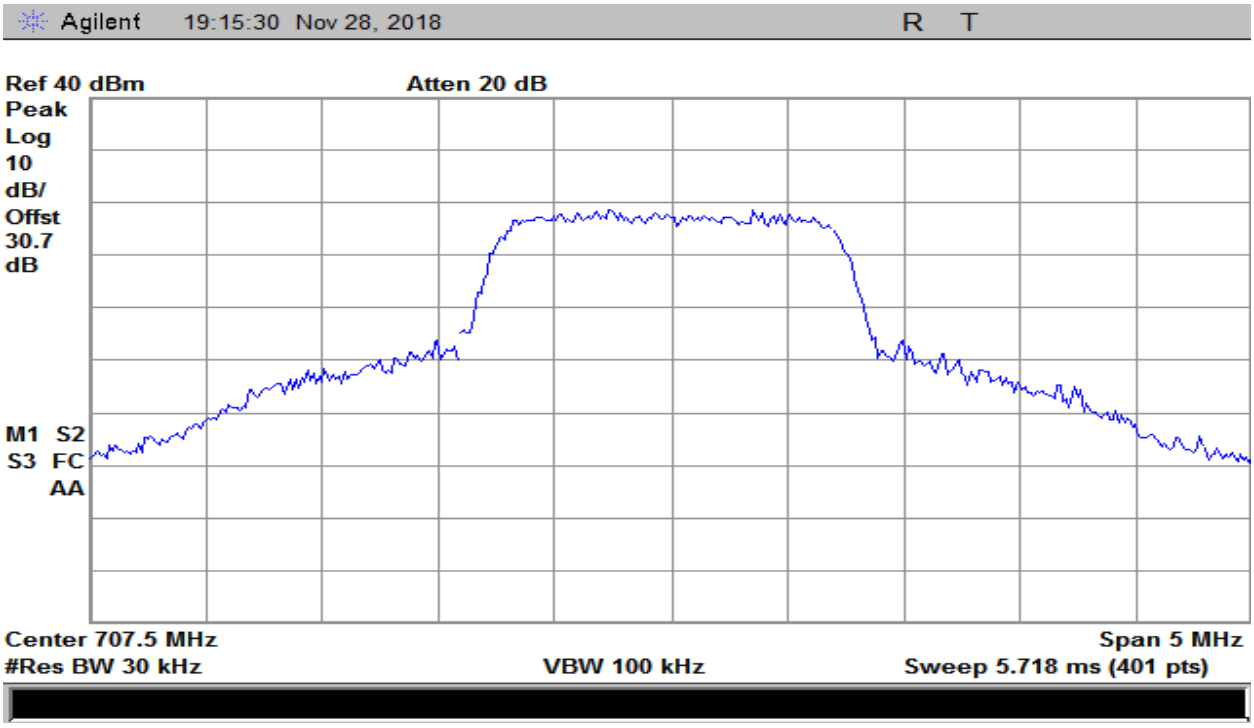
Plot 159 – 2110-2155MHz Band – Downlink Input – GSM



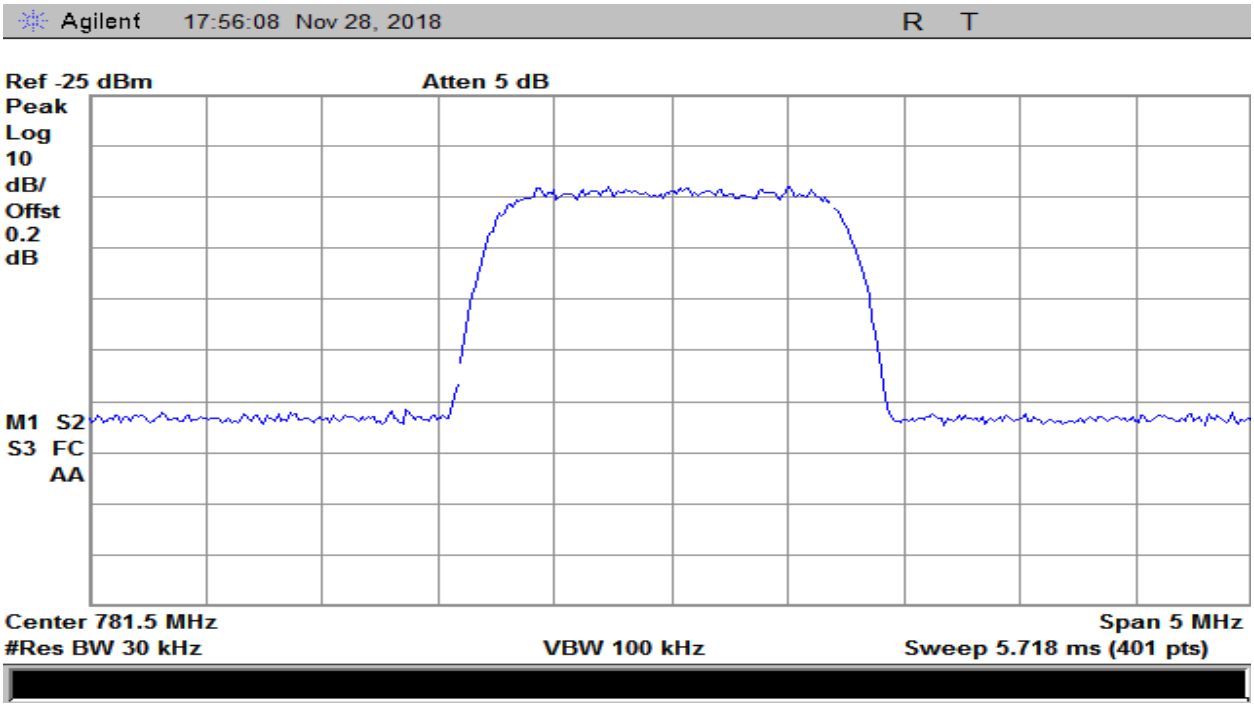
Plot 160 – 2110-2155MHz Band – Downlink Output – GSM



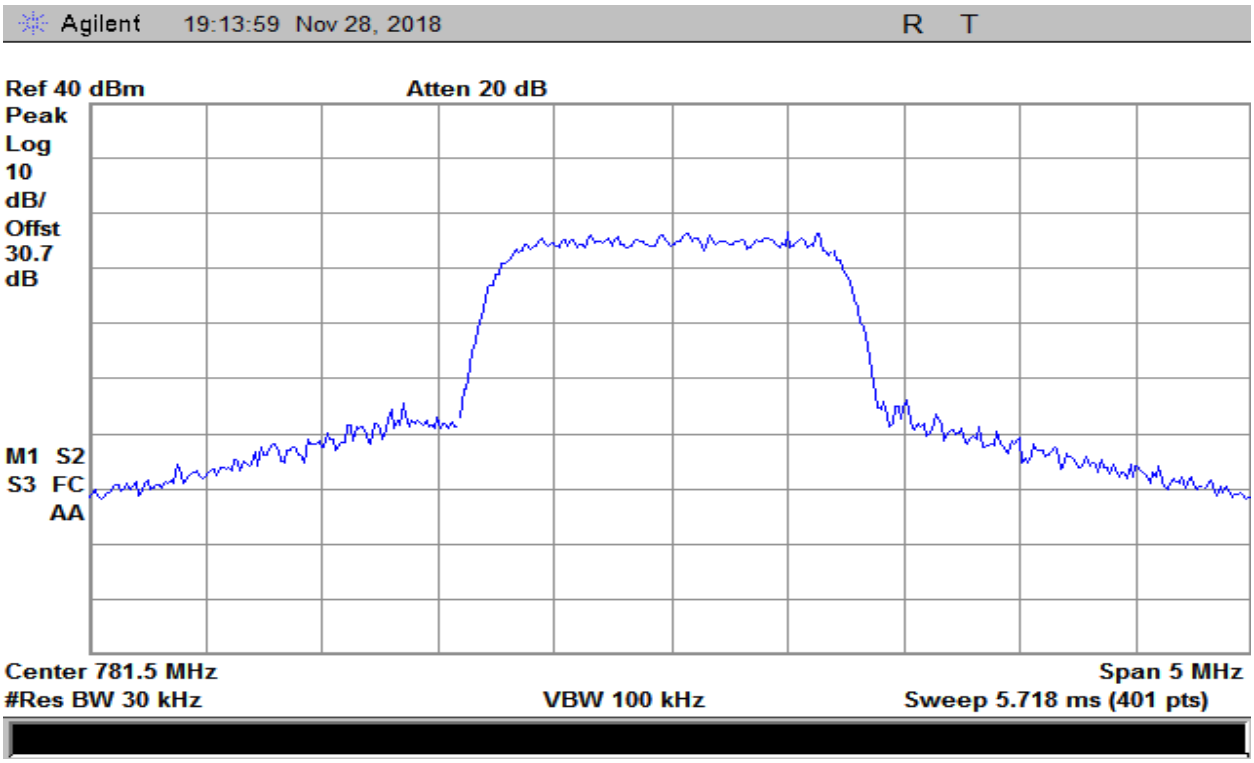
Plot 161 – 698-716MHz Band – Uplink Input – CDMA



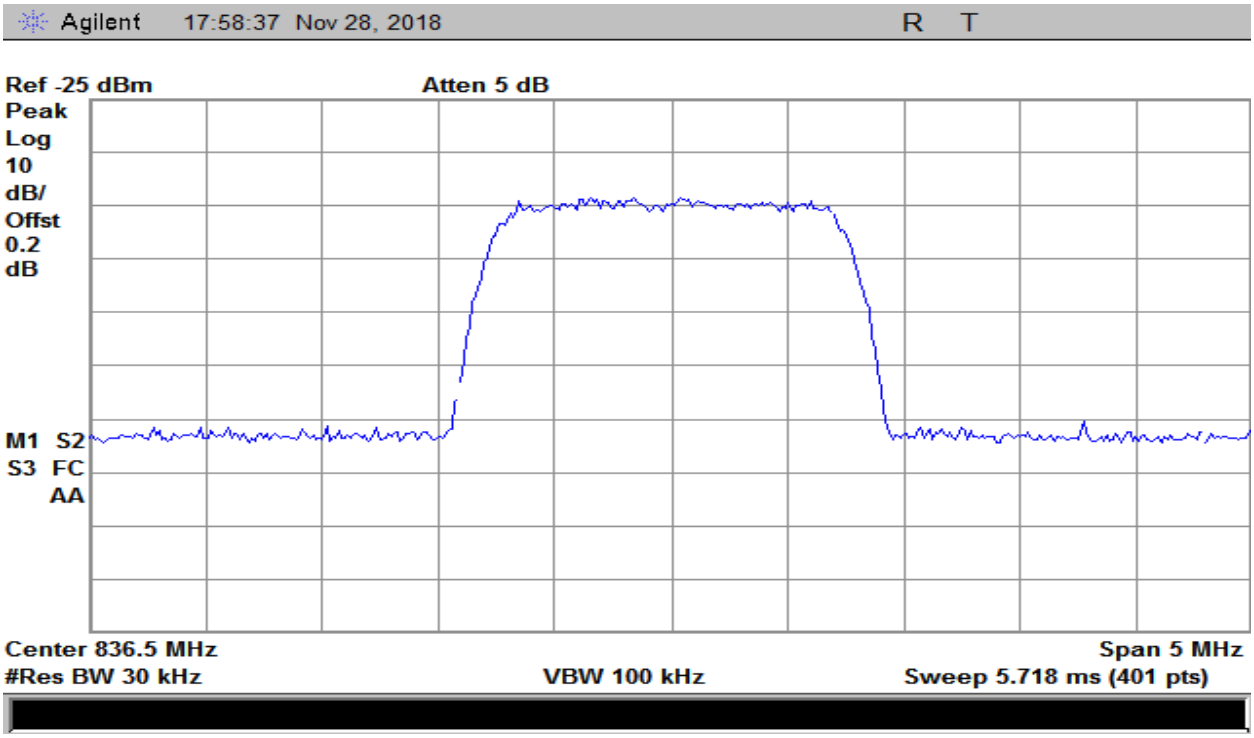
Plot 162 – 698-716MHz Band – Uplink Output – CDMA



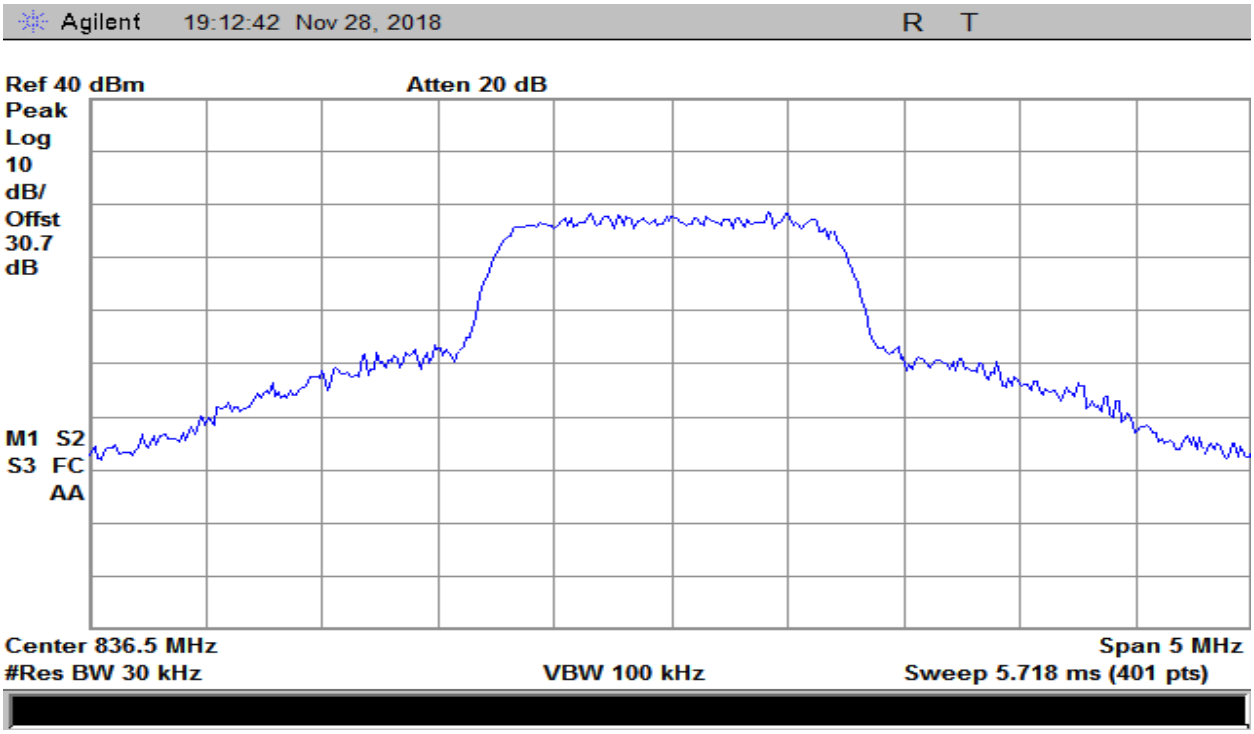
Plot 163 – 776-787MHz Band – Uplink Input – CDMA



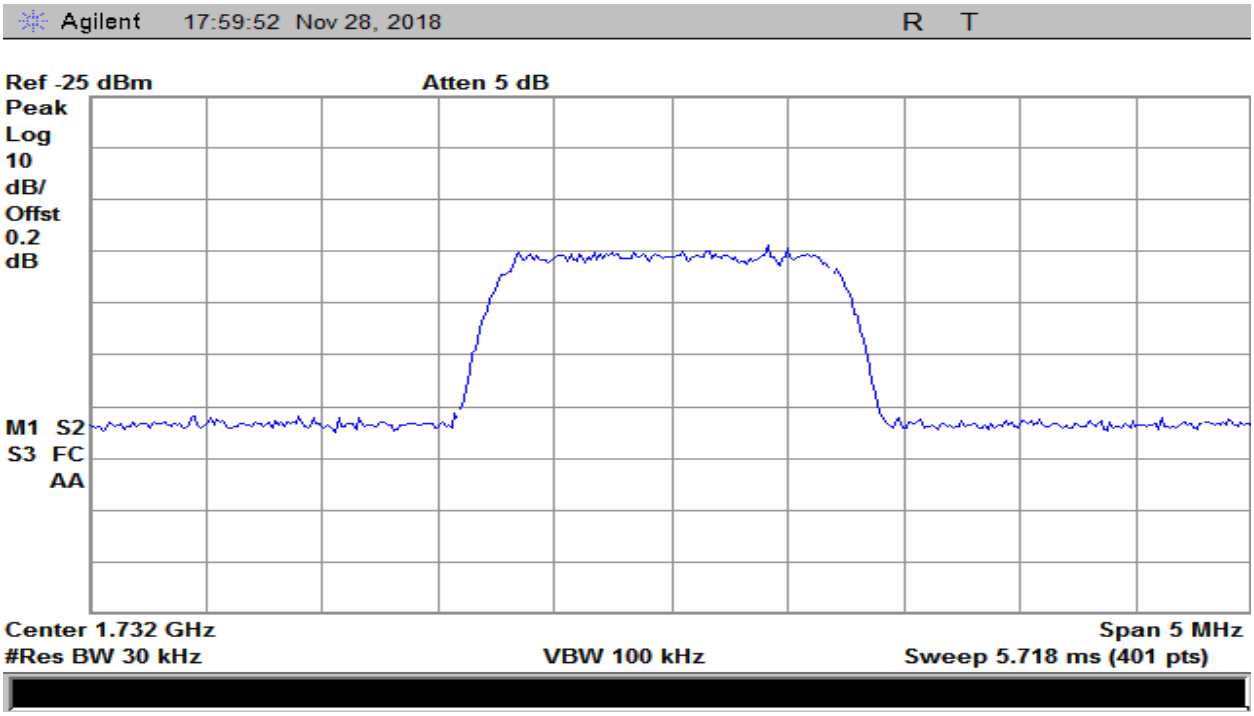
Plot 164 – 776-787MHz Band – Uplink Output – CDMA



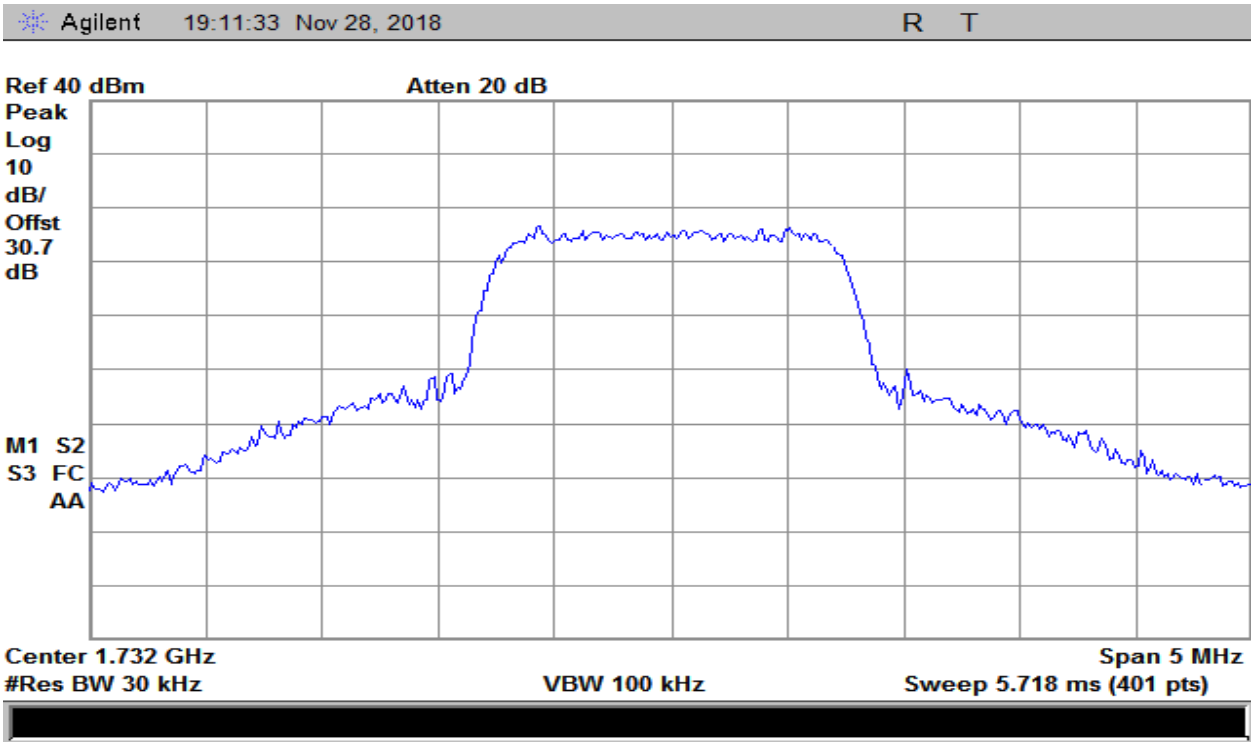
Plot 165 – 824-849MHz Band – Uplink Input – CDMA



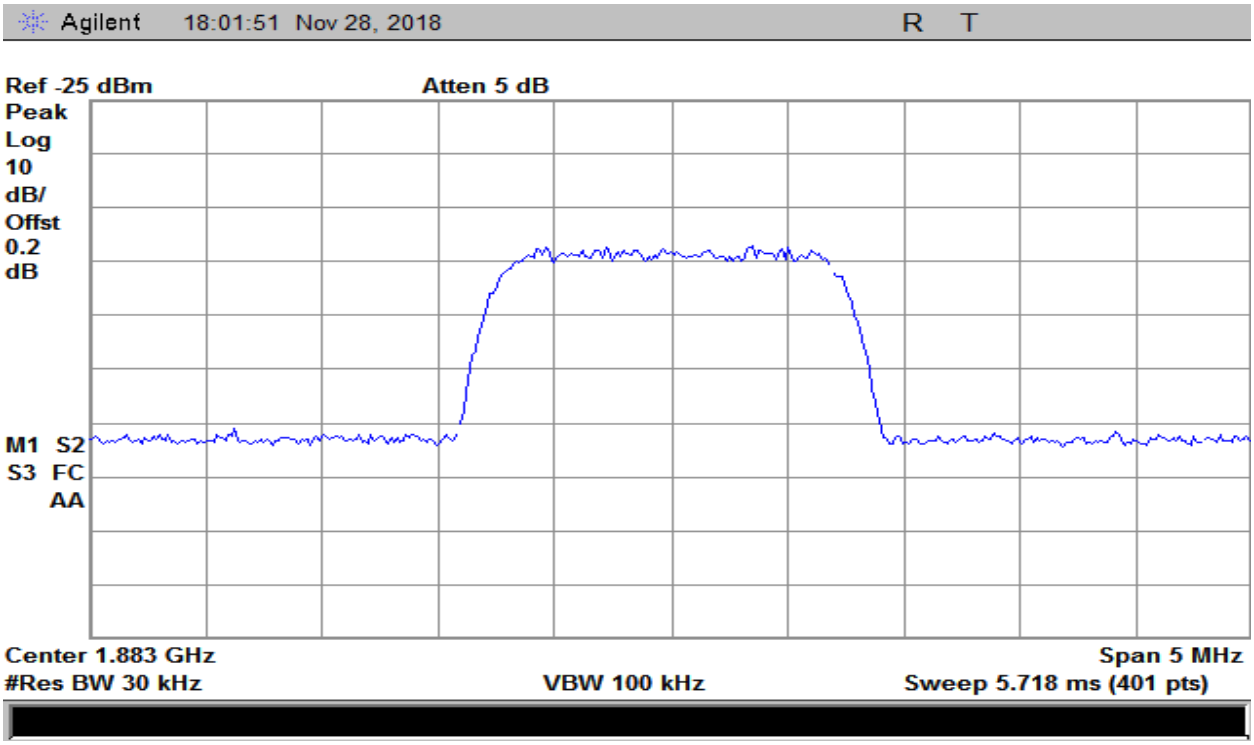
Plot 166 – 824-849MHz Band – Uplink Output – CDMA



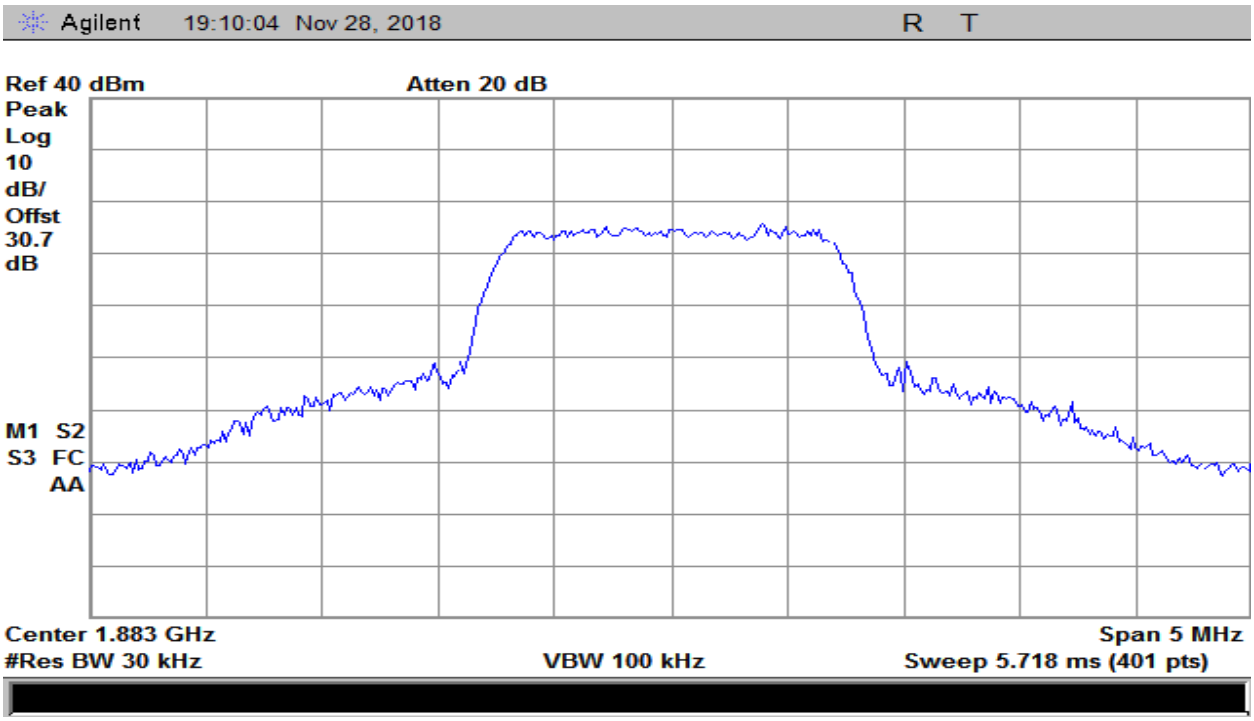
Plot 167 – 1710-1755MHz Band – Uplink Input – CDMA



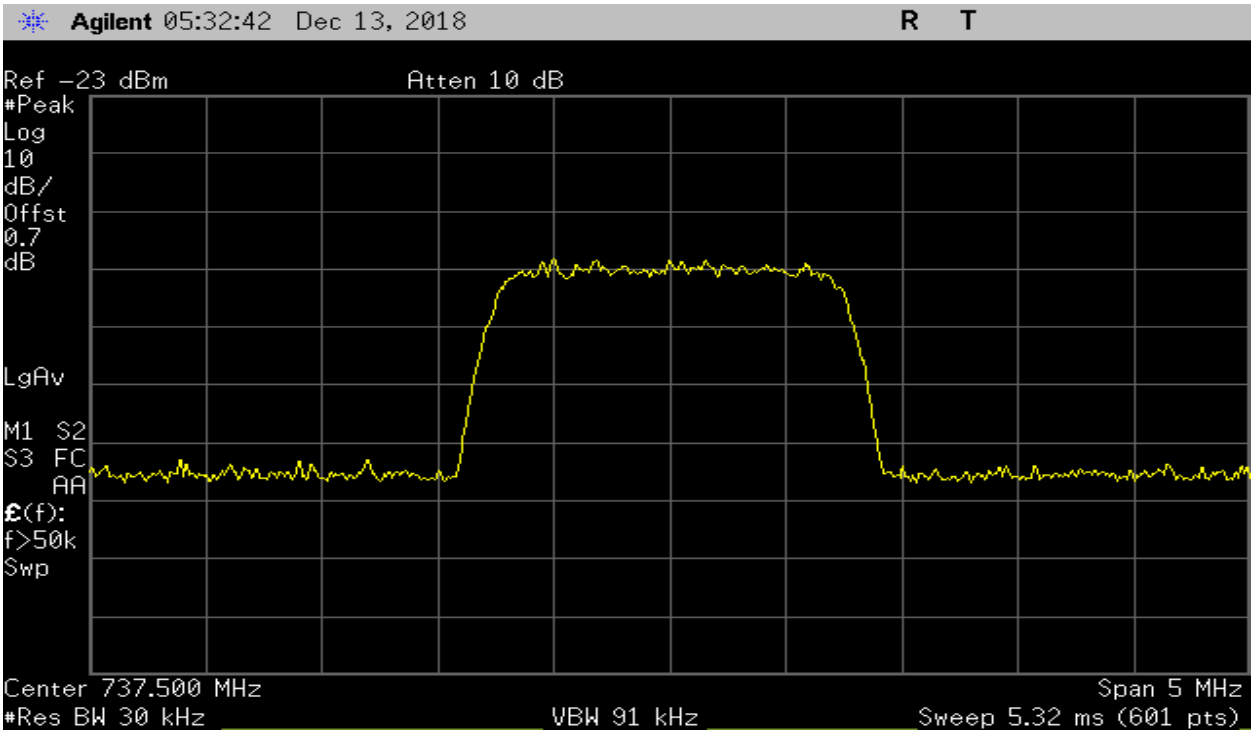
Plot 168 – 1710-1755MHz Band – Uplink Output – CDMA



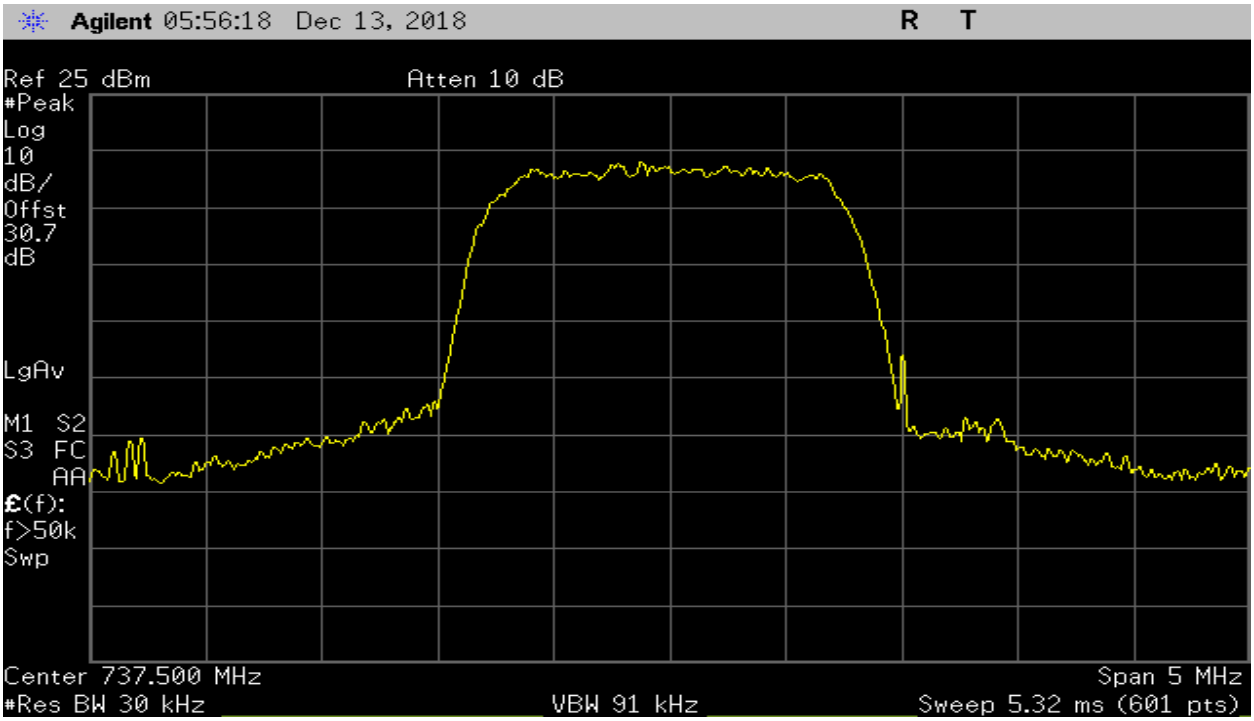
Plot 169 – 1850-1915MHz Band – Uplink Input – CDMA



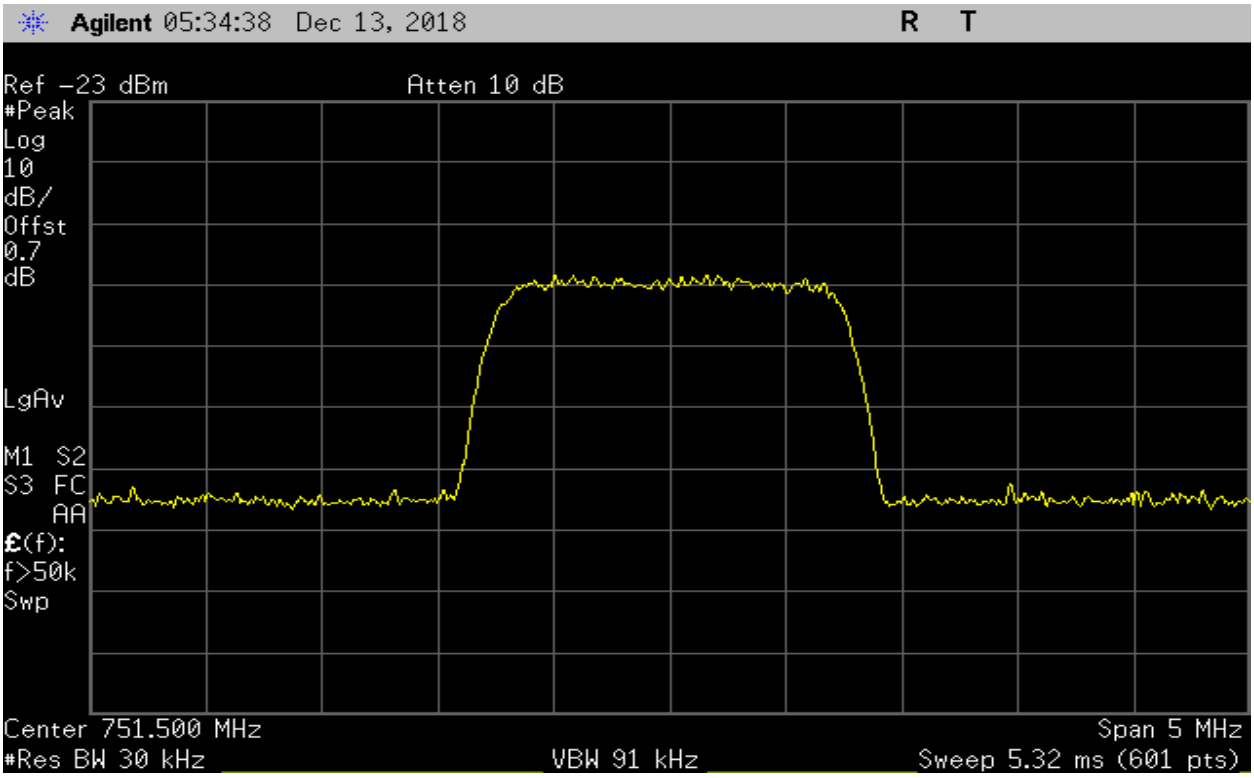
Plot 170 – 1850-1915MHz Band – Uplink Output – CDMA



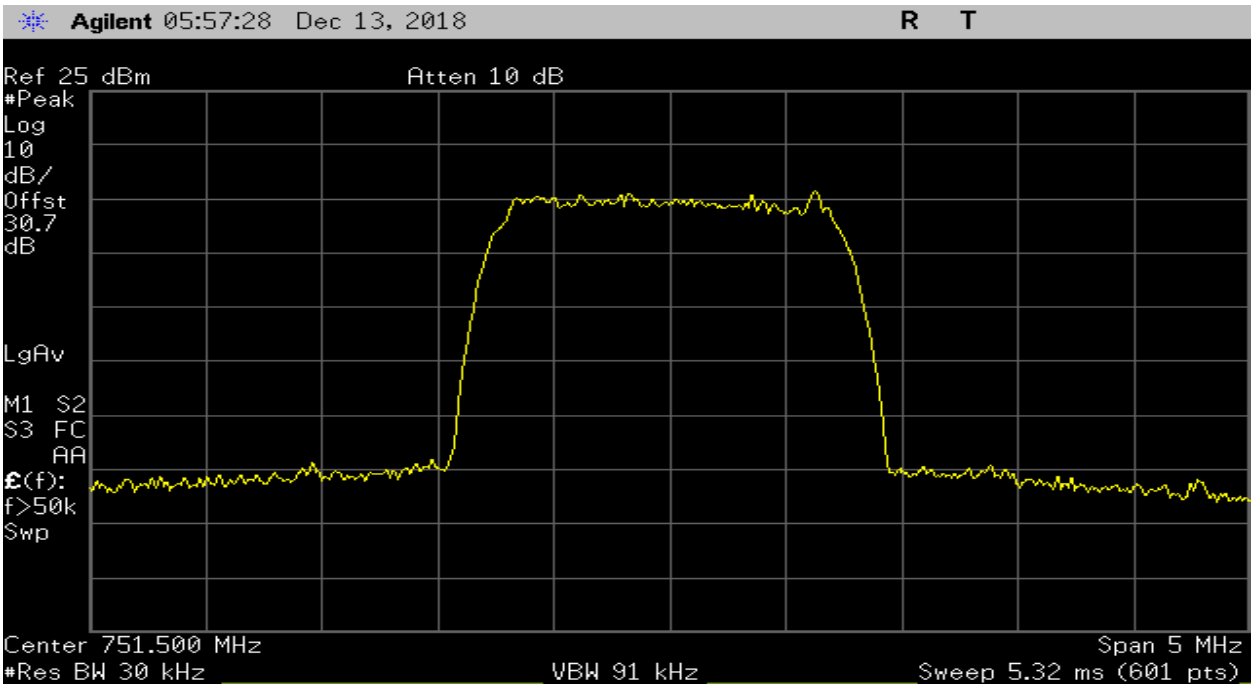
Plot 171 – 728-746MHz Band – Downlink Input – CDMA



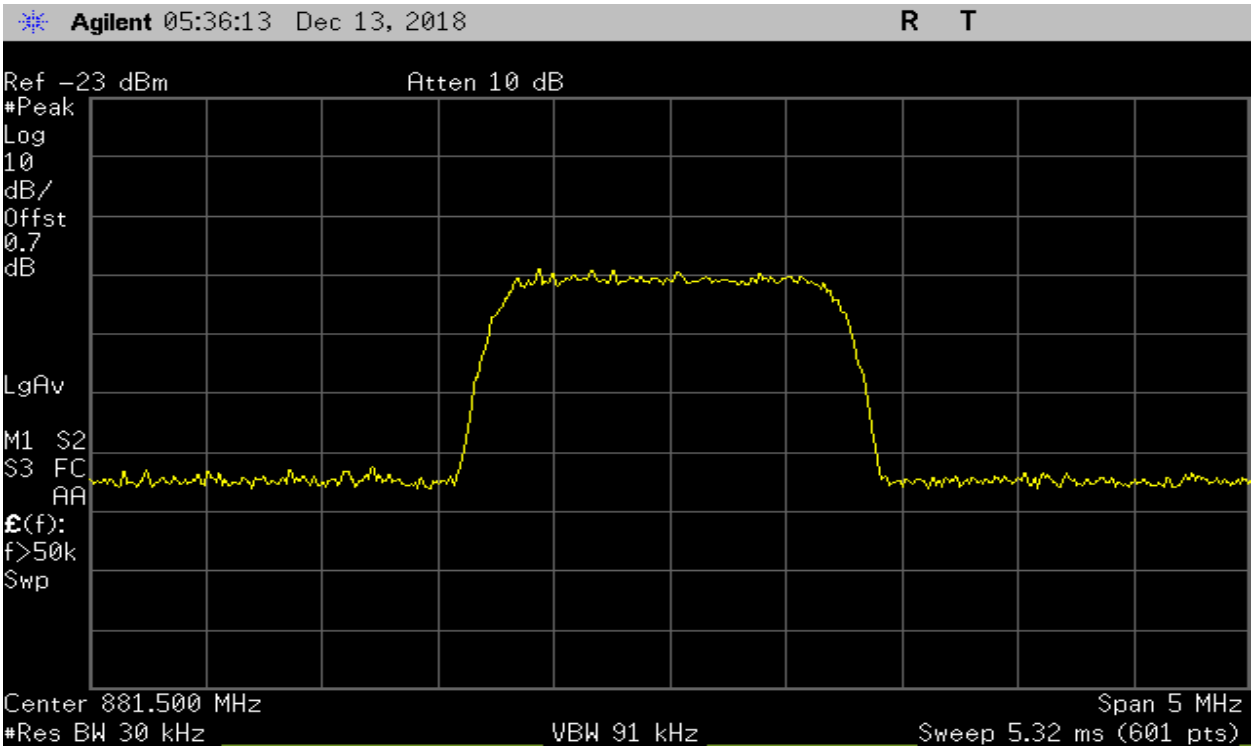
Plot 172 – 728-746MHz Band – Downlink Output – CDMA



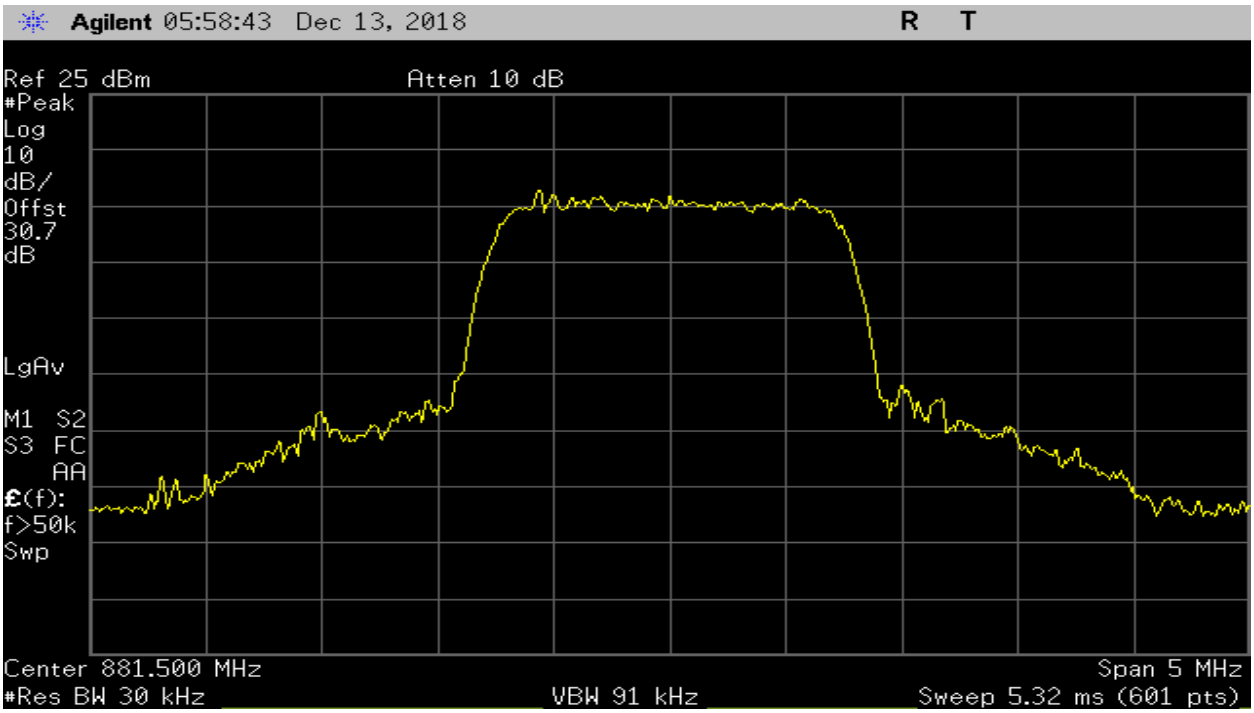
Plot 173 – 746-757MHz Band – Downlink Input – CDMA



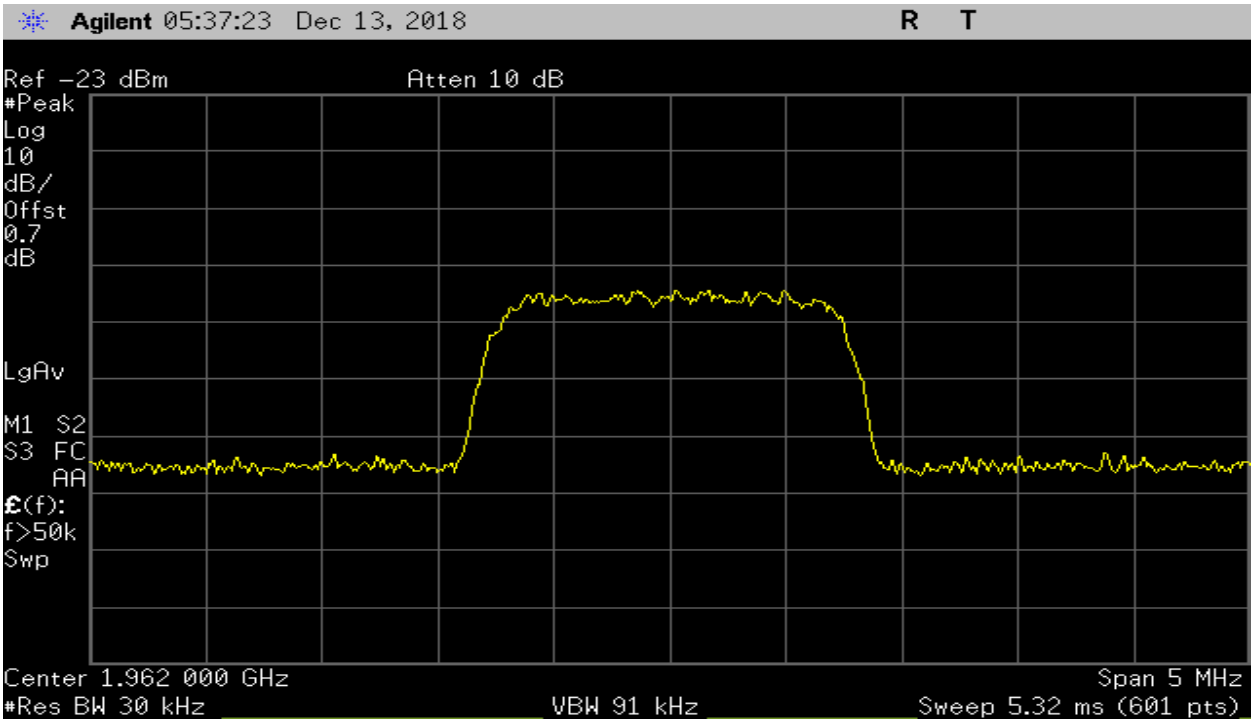
Plot 174 – 746-757MHz Band – Downlink Output – CDMA



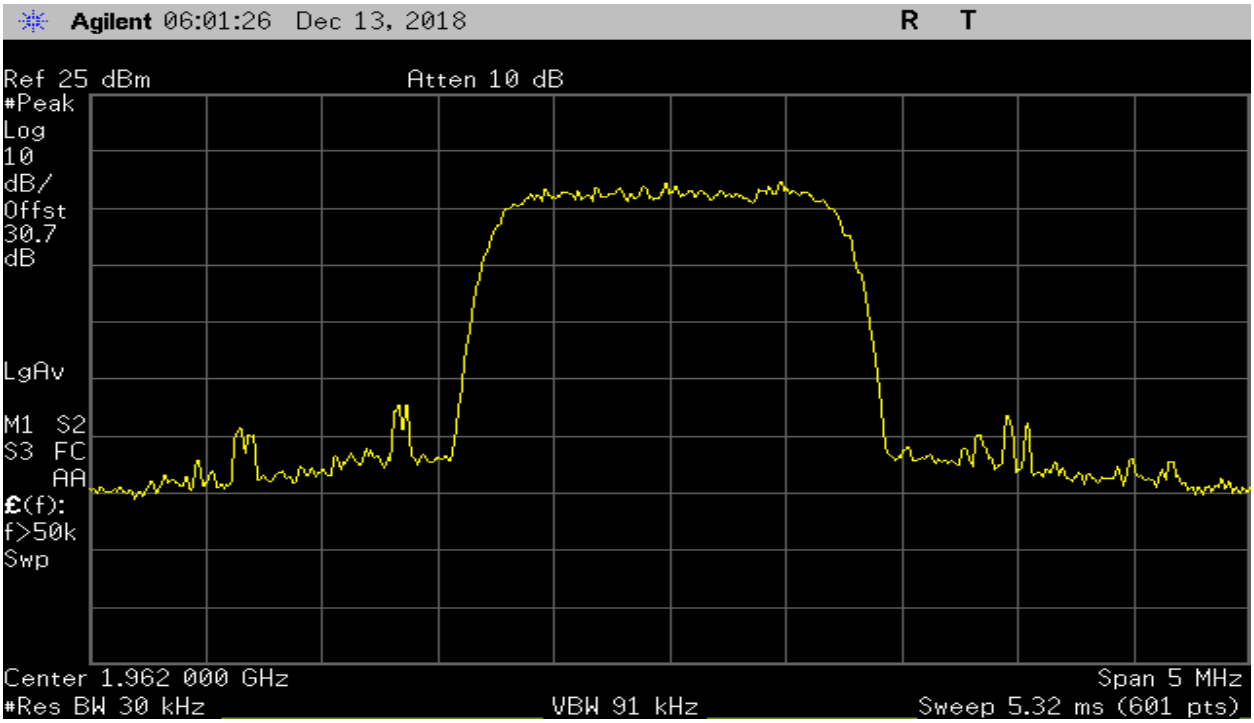
Plot 175 – 869-894MHz Band – Downlink Input – CDMA



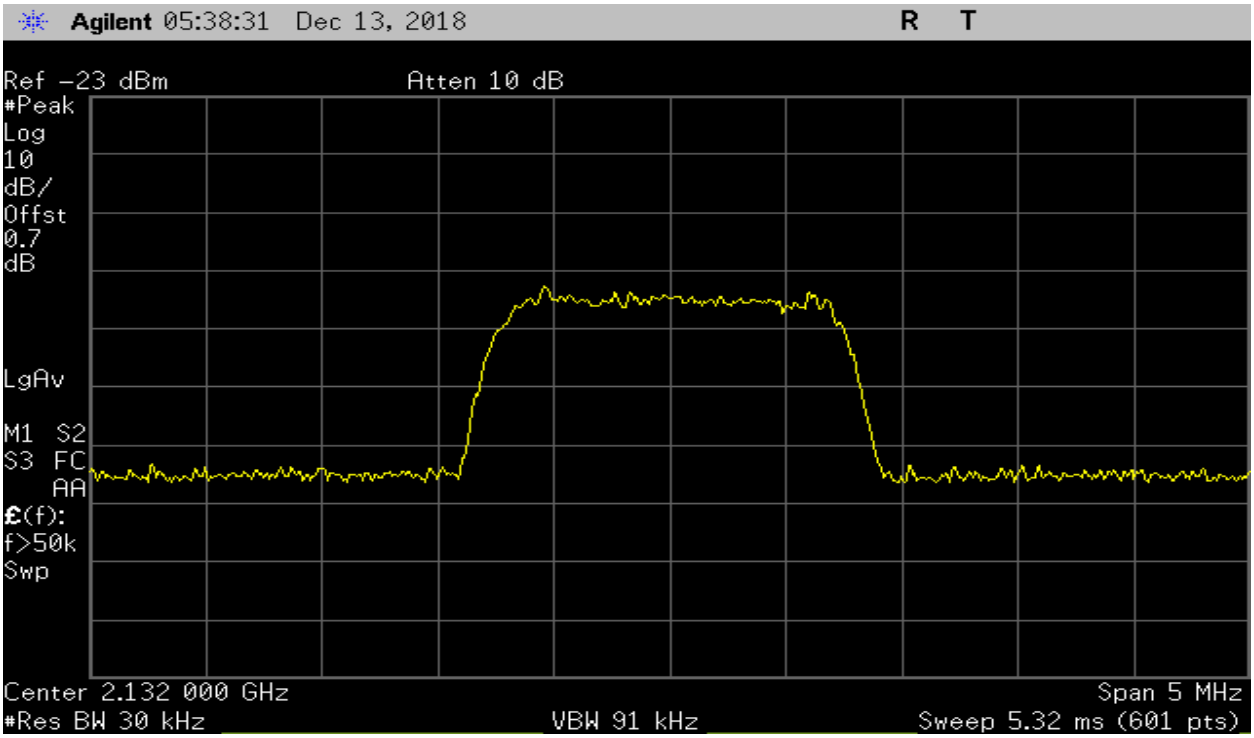
Plot 176 – 869-894MHz Band – Downlink Output – CDMA



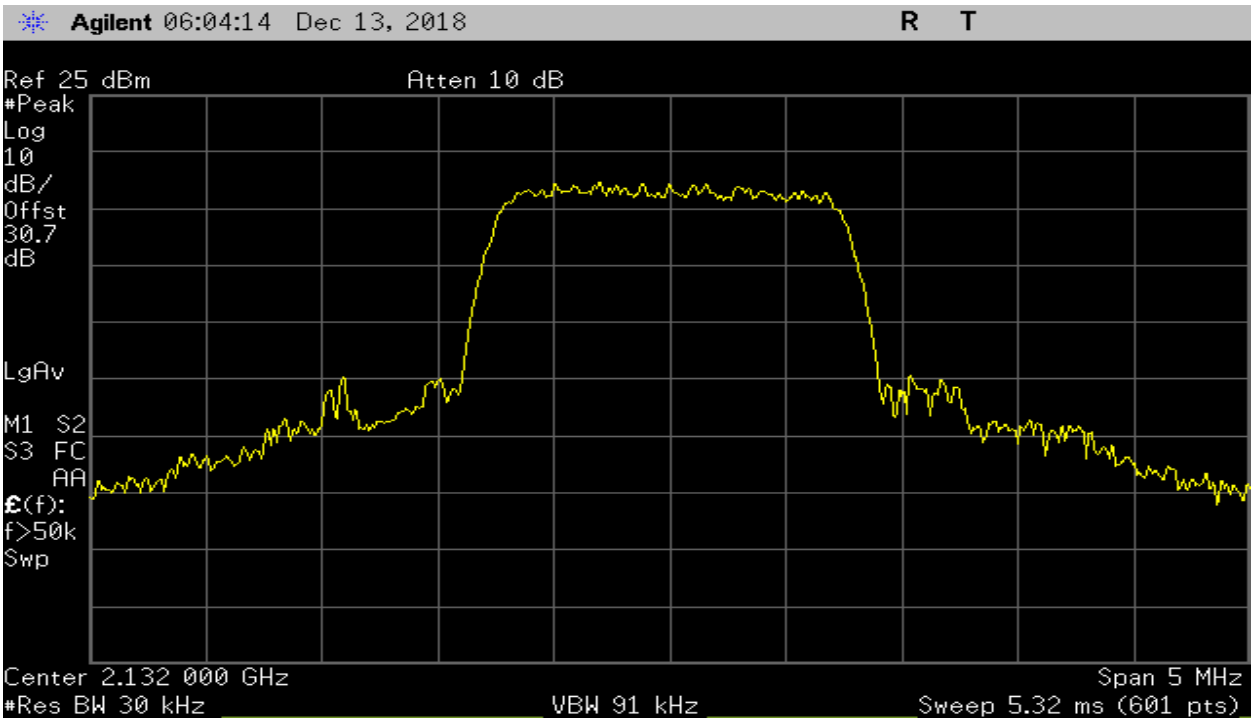
Plot 177 – 1930-1995MHz Band – Downlink Input – CDMA



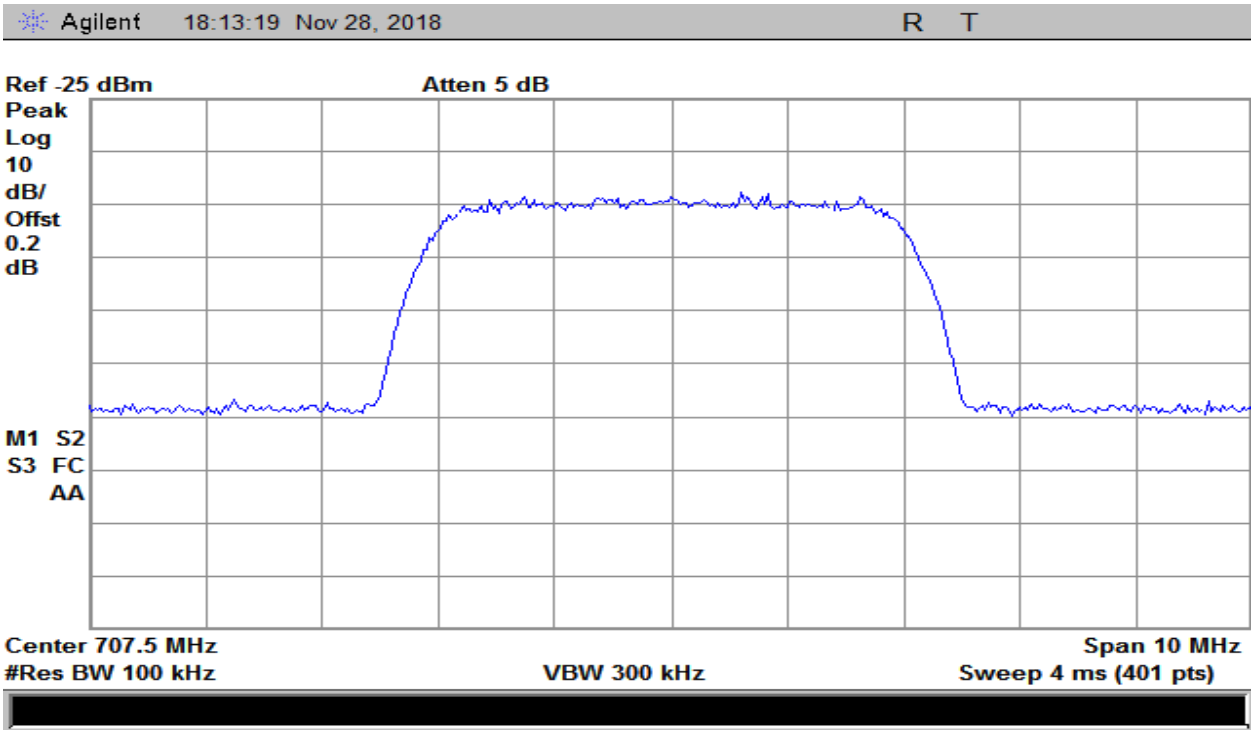
Plot 178 – 1930-1995MHz Band – Downlink Output – CDMA



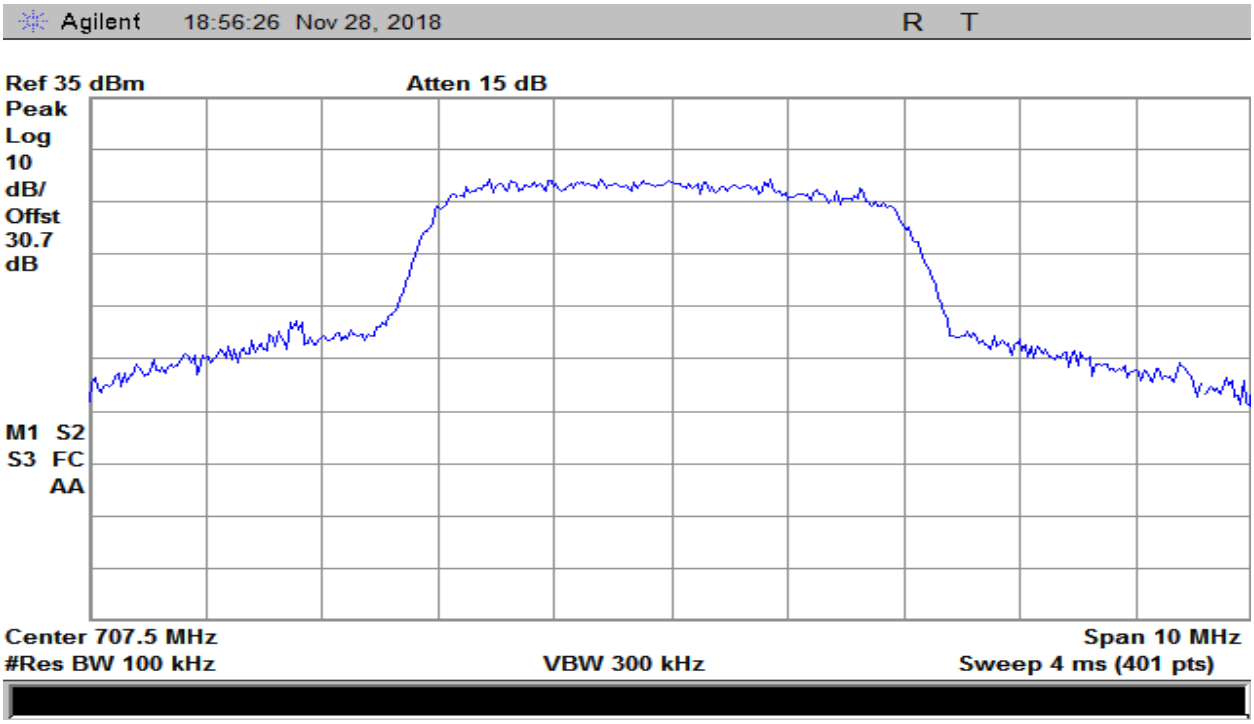
Plot 179 – 2110-2155MHz Band – Downlink Input – CDMA



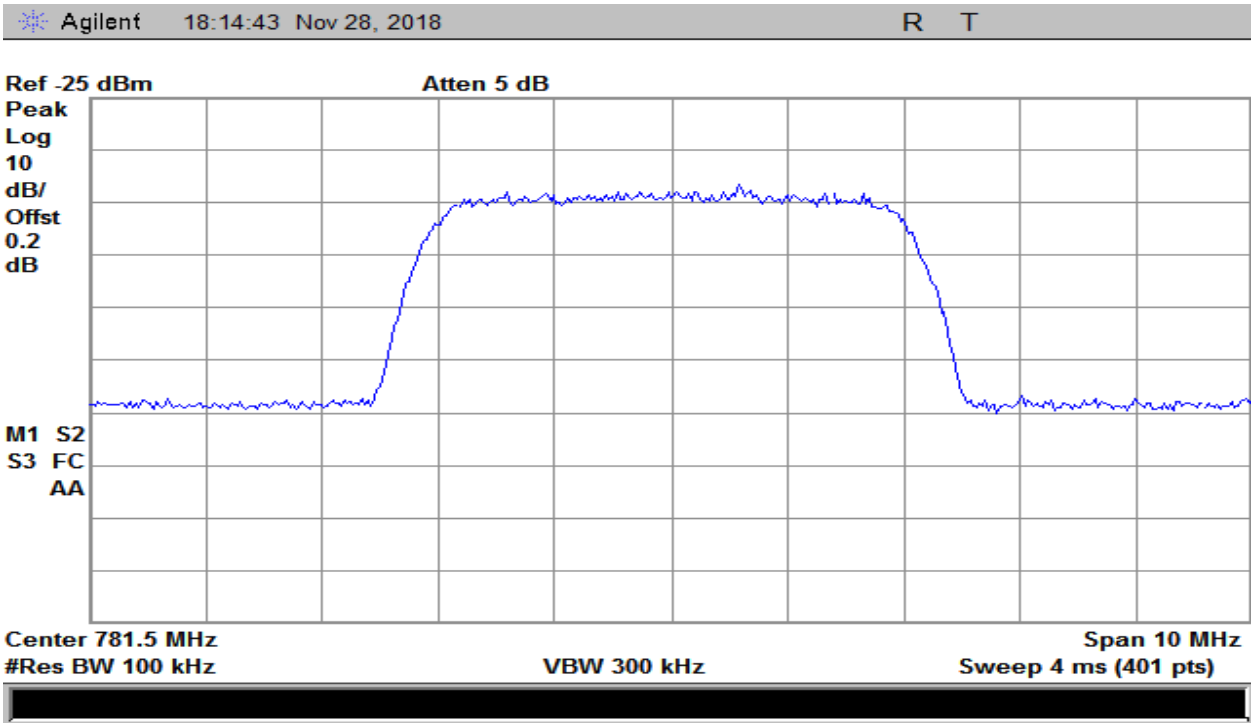
Plot 180 – 2110-2155MHz Band – Downlink Output – CDMA



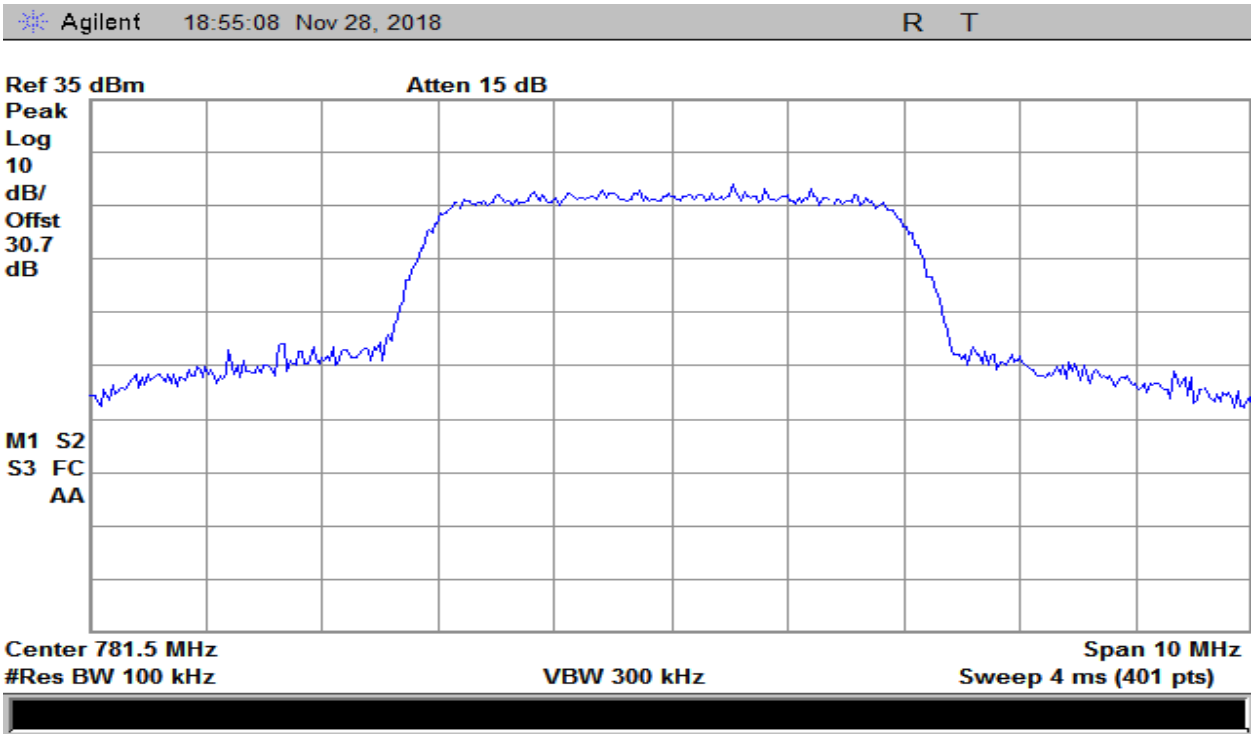
Plot 181 – 698-716MHz Band – Uplink Input – LTE



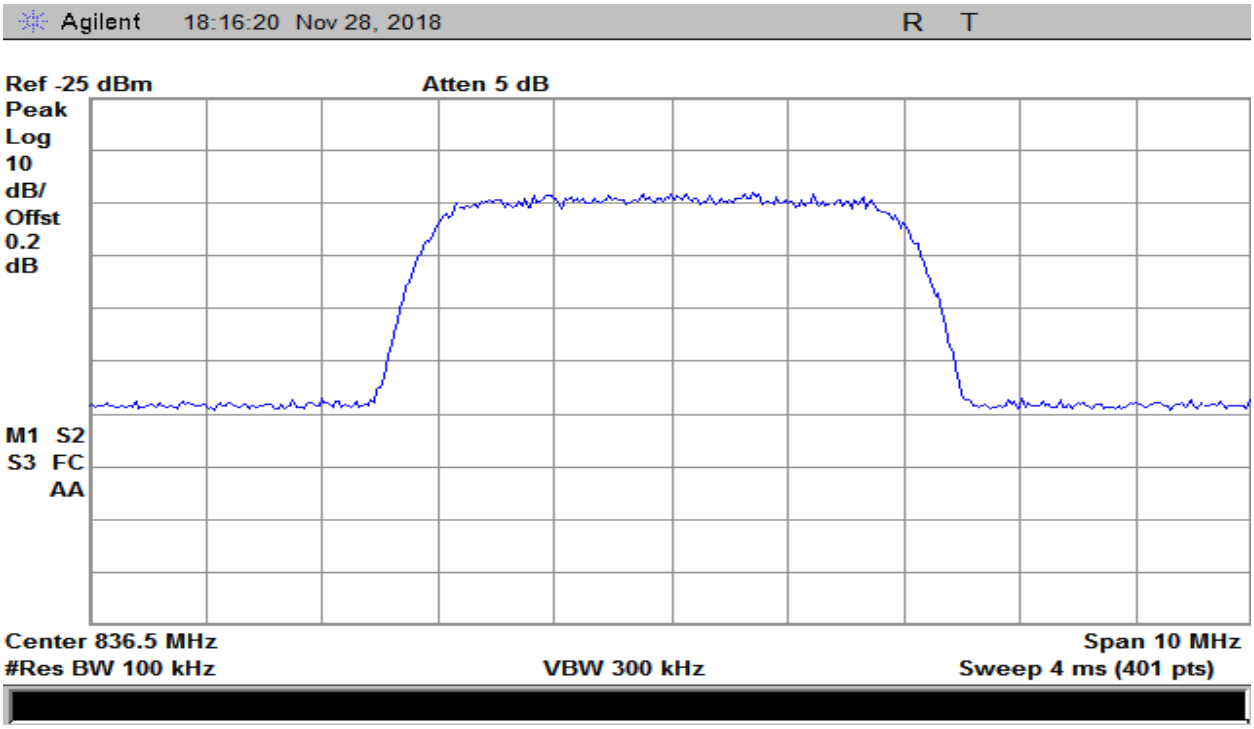
Plot 182 – 698-716MHz Band – Uplink Output – LTE



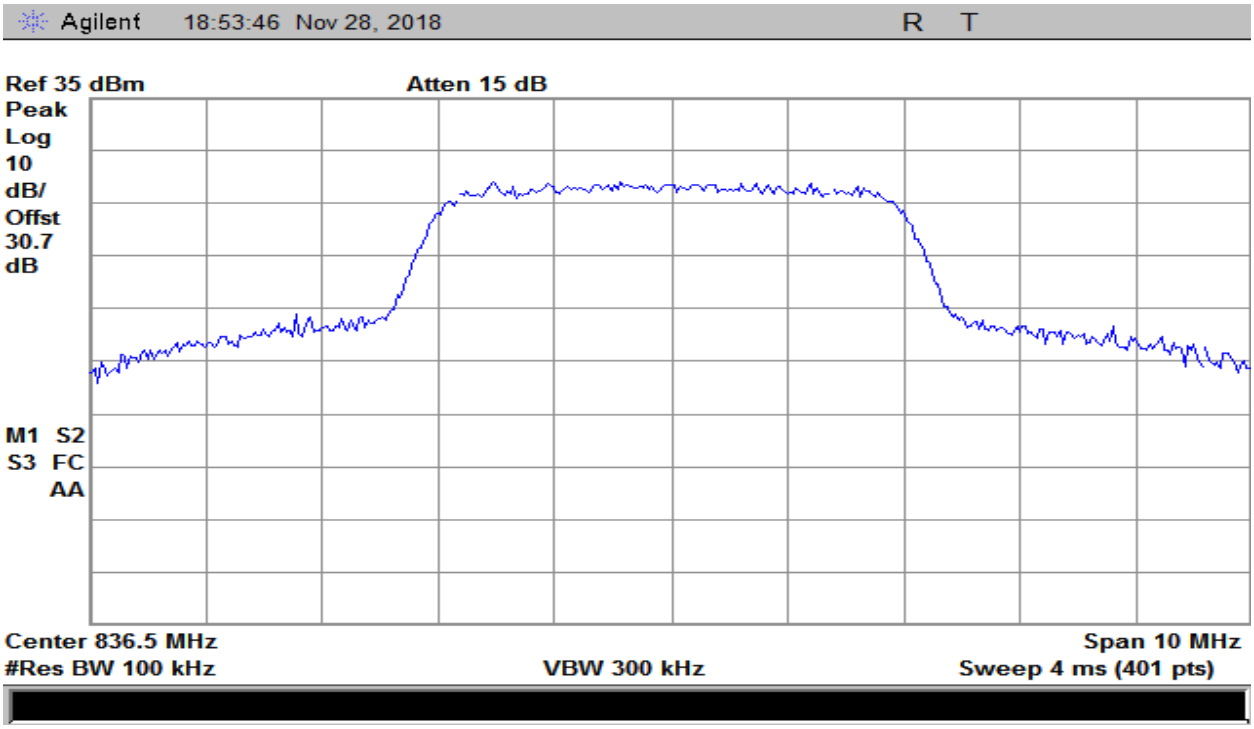
Plot 183 – 776-787MHz Band – Uplink Input – LTE



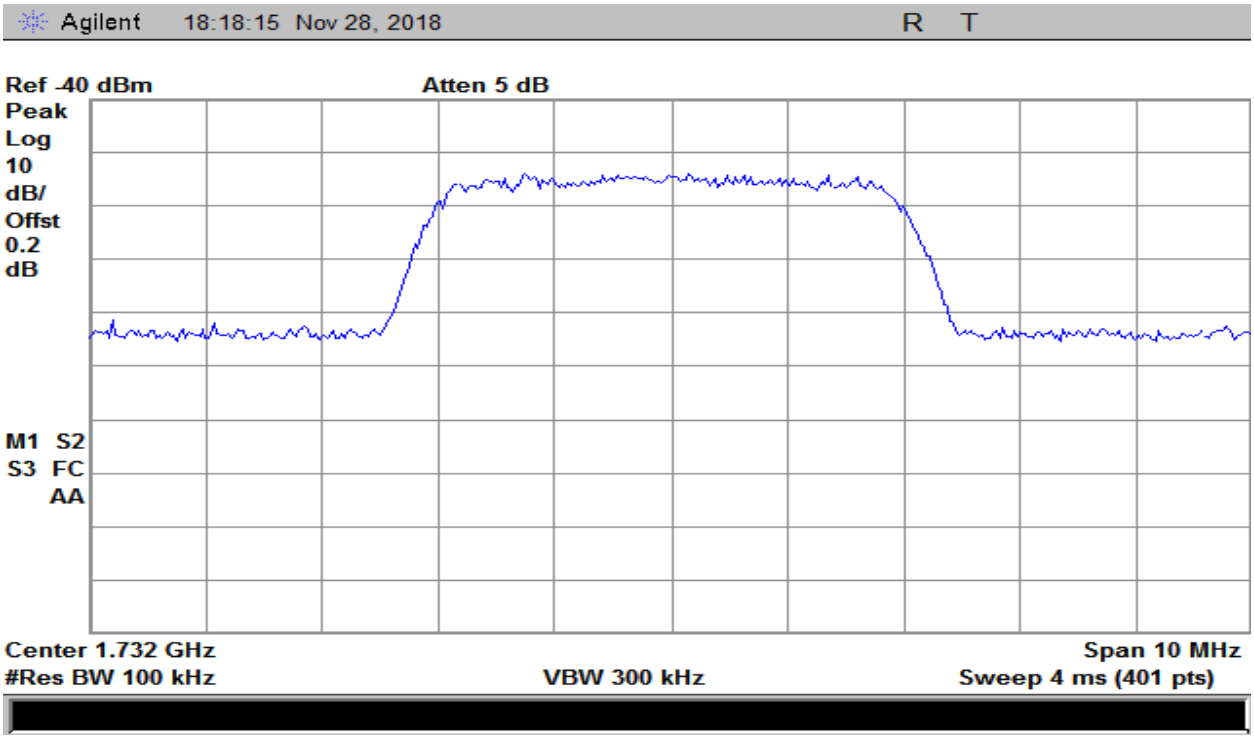
Plot 184 – 776-787MHz Band – Uplink Output – LTE



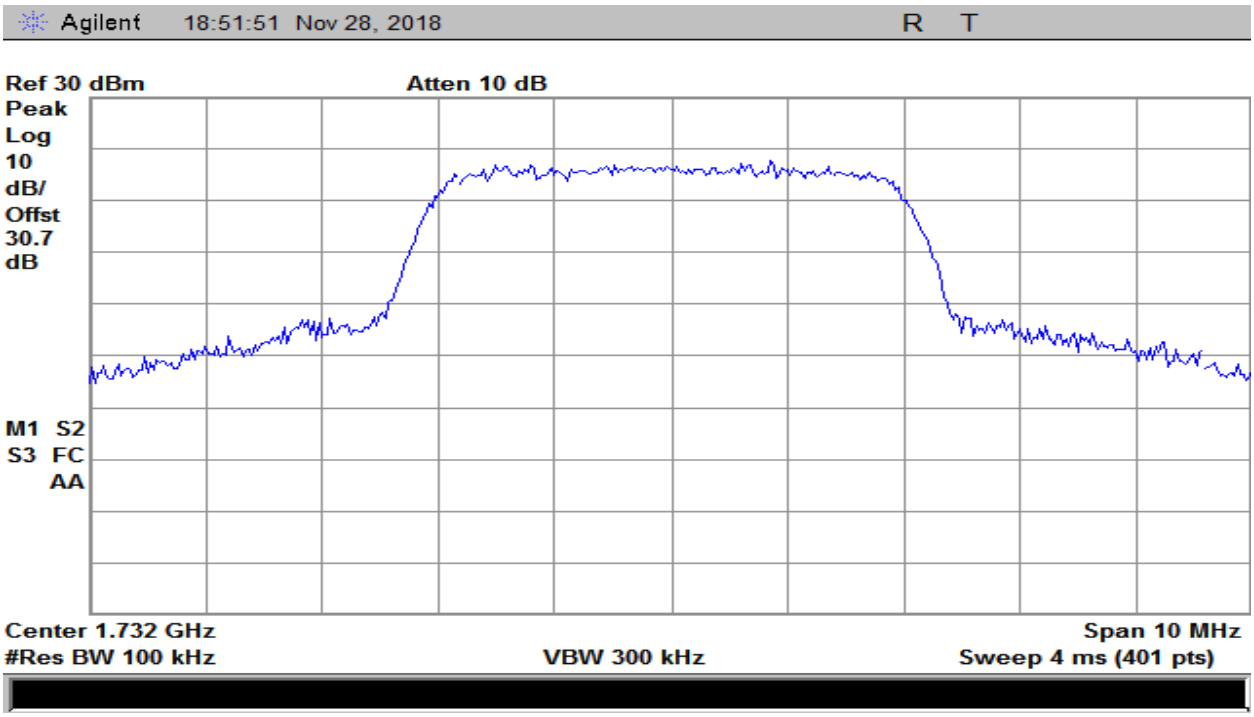
Plot 185 – 824-849MHz Band – Uplink Input – LTE



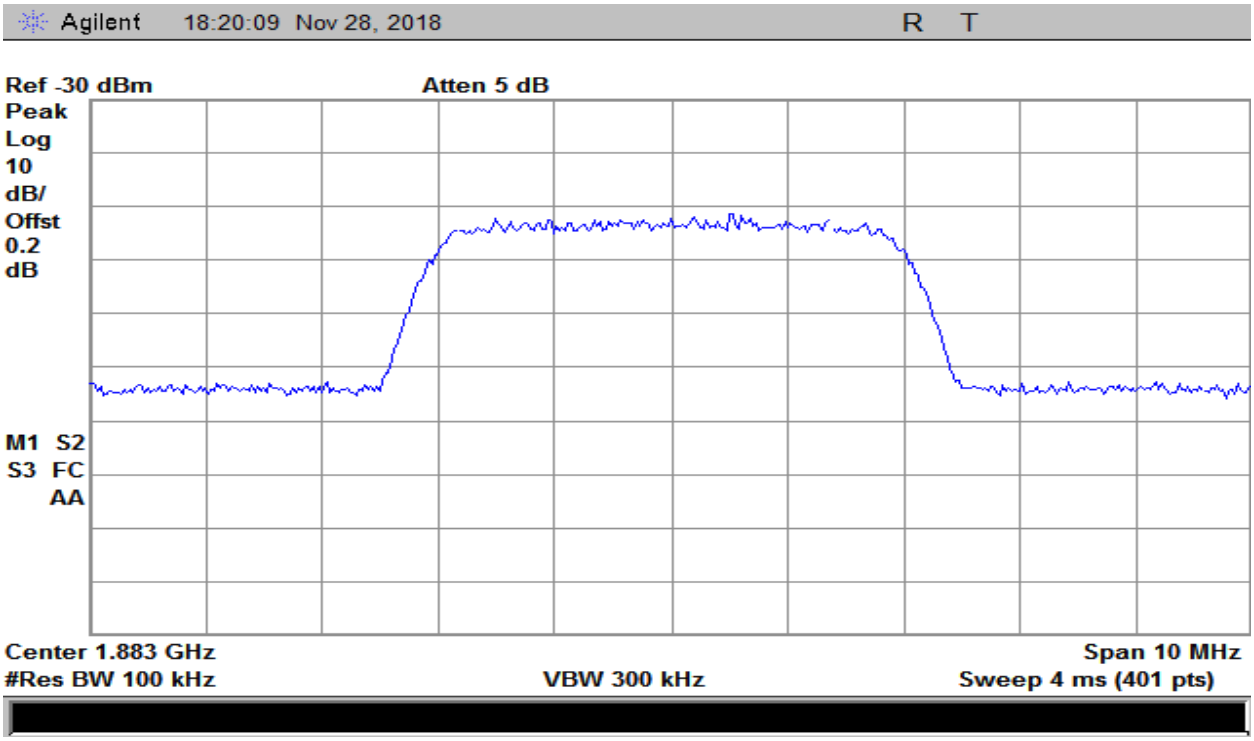
Plot 186 – 824-849MHz Band – Uplink Output – LTE



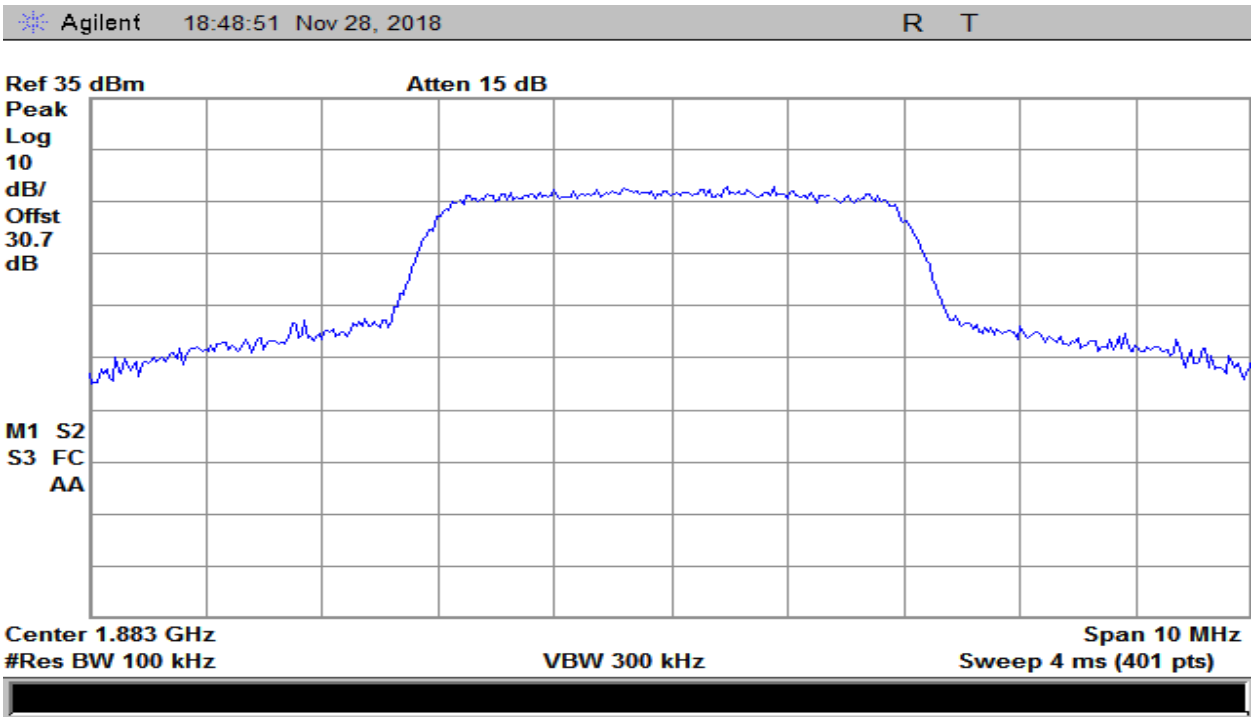
Plot 187 – 1710-1755MHz Band – Uplink Input – LTE



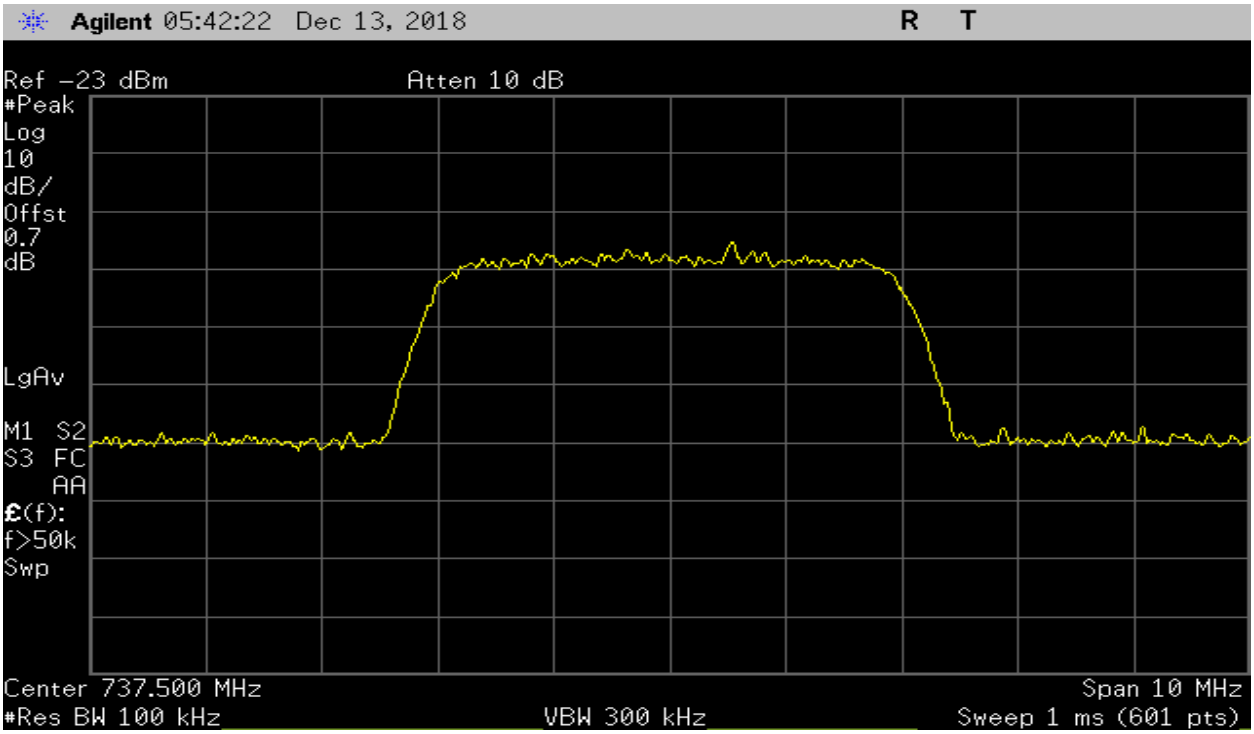
Plot 188 – 1710-1755MHz Band – Uplink Output – LTE



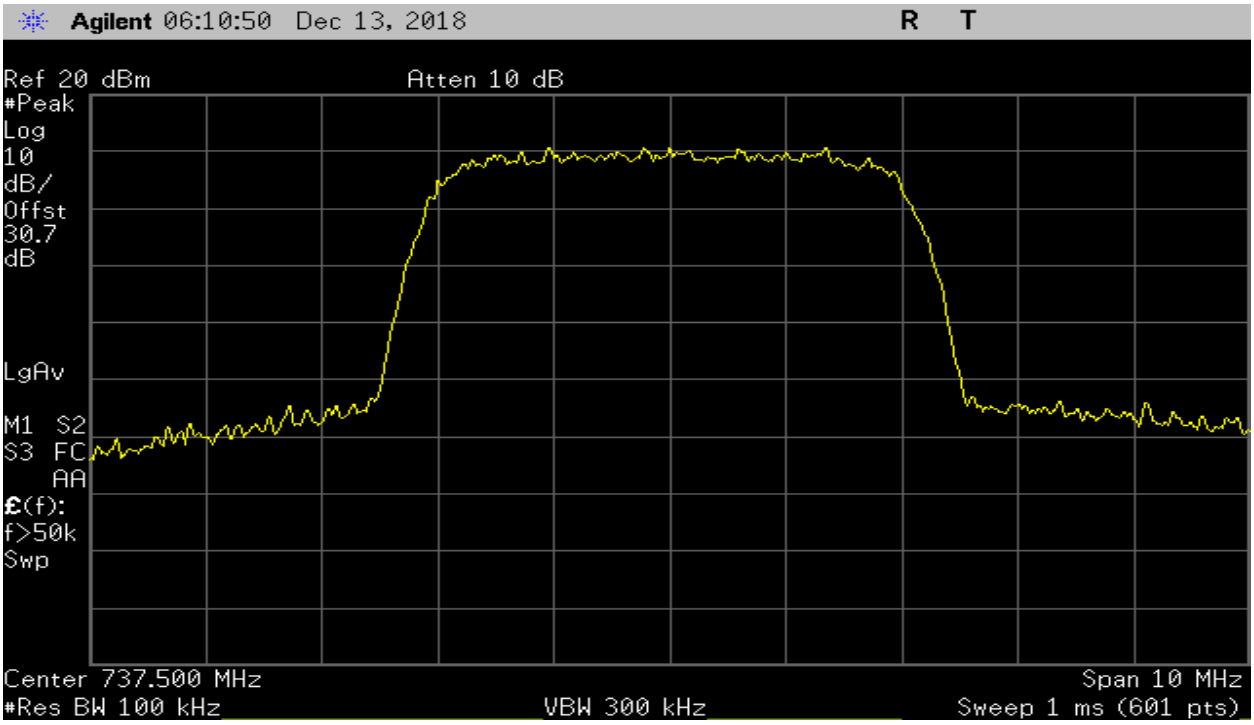
Plot 189 – 1850-1915MHz Band – Uplink Input – LTE



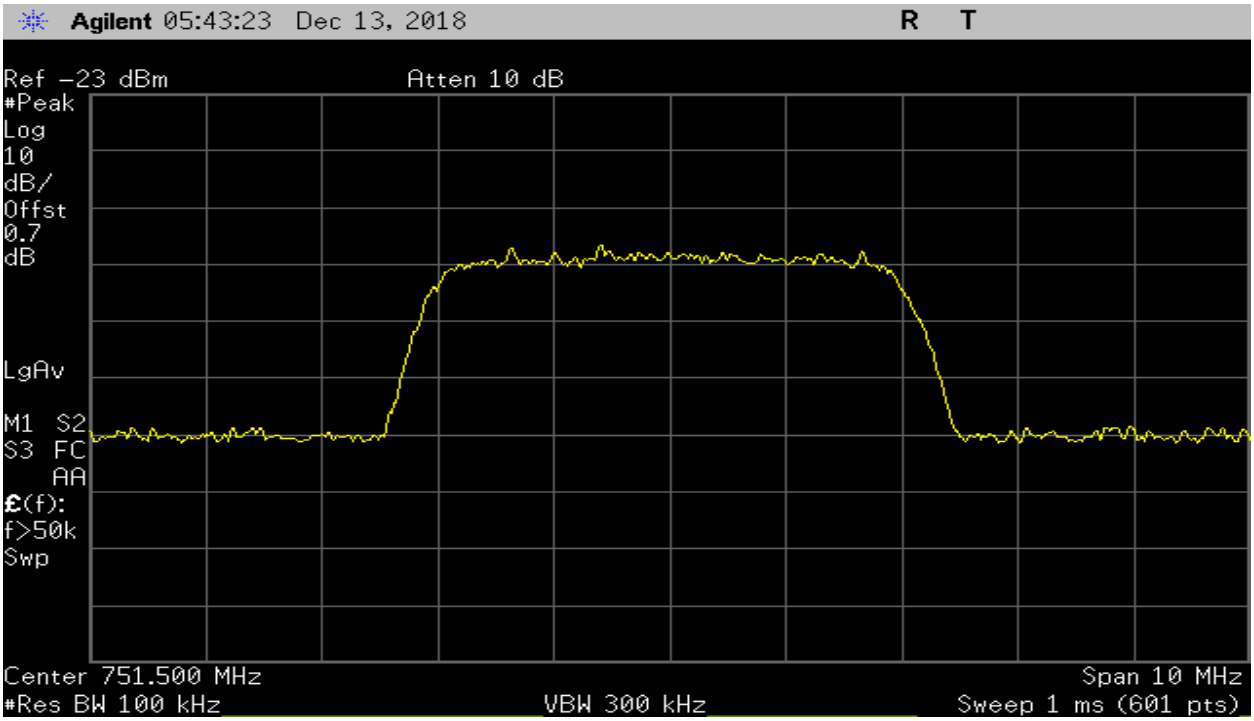
Plot 190 – 1850-1915MHz Band – Uplink Output – LTE



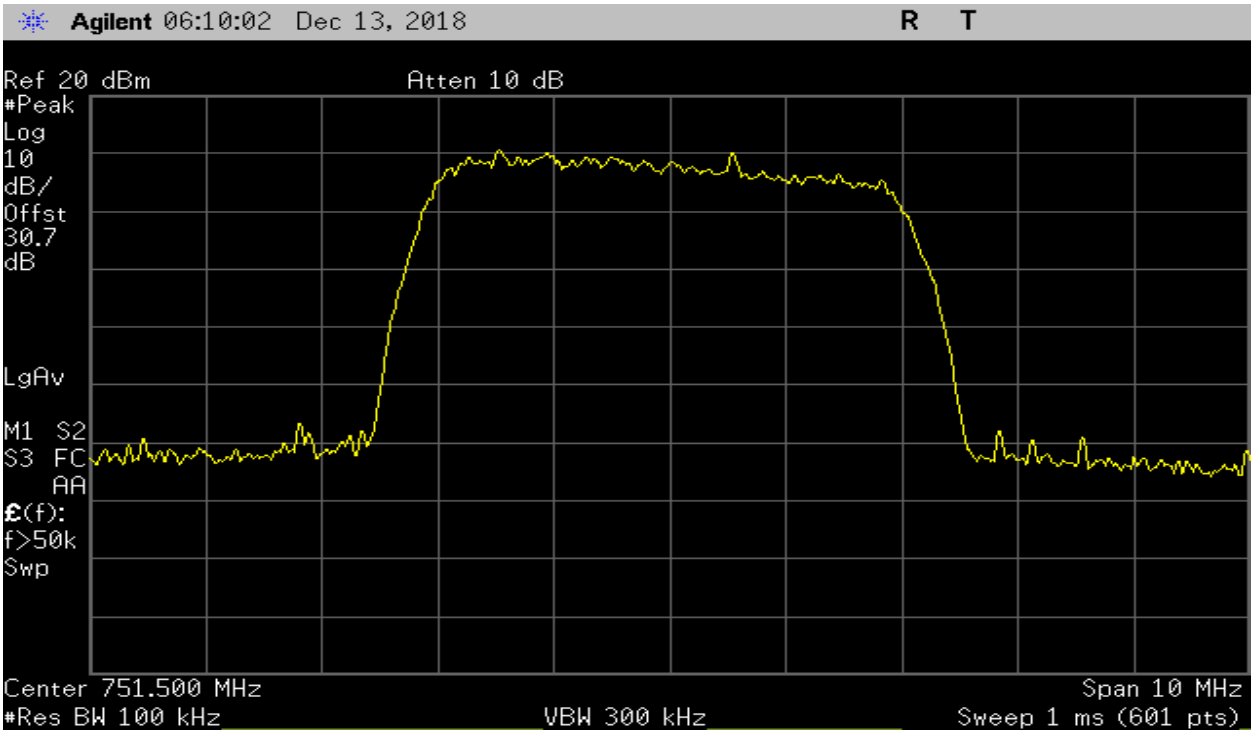
Plot 191 – 728-746MHz Band – Downlink Input – LTE



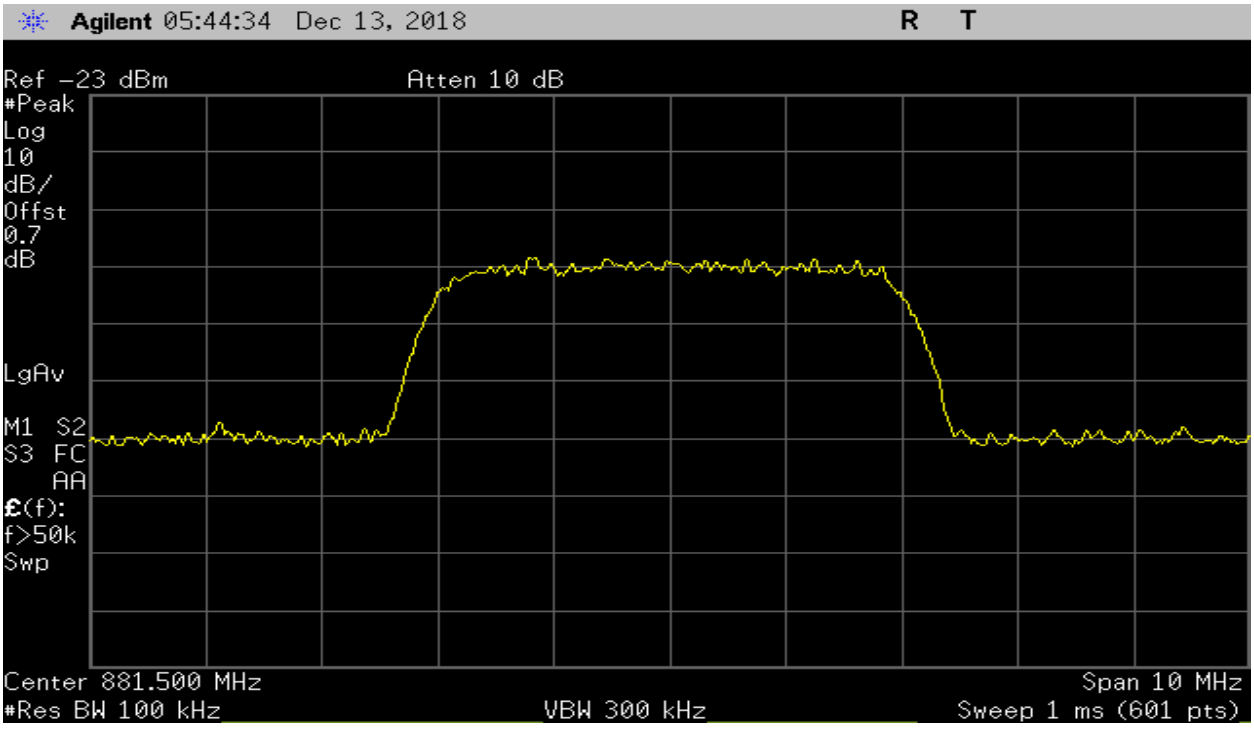
Plot 192 – 728-746MHz Band – Downlink Output – LTE



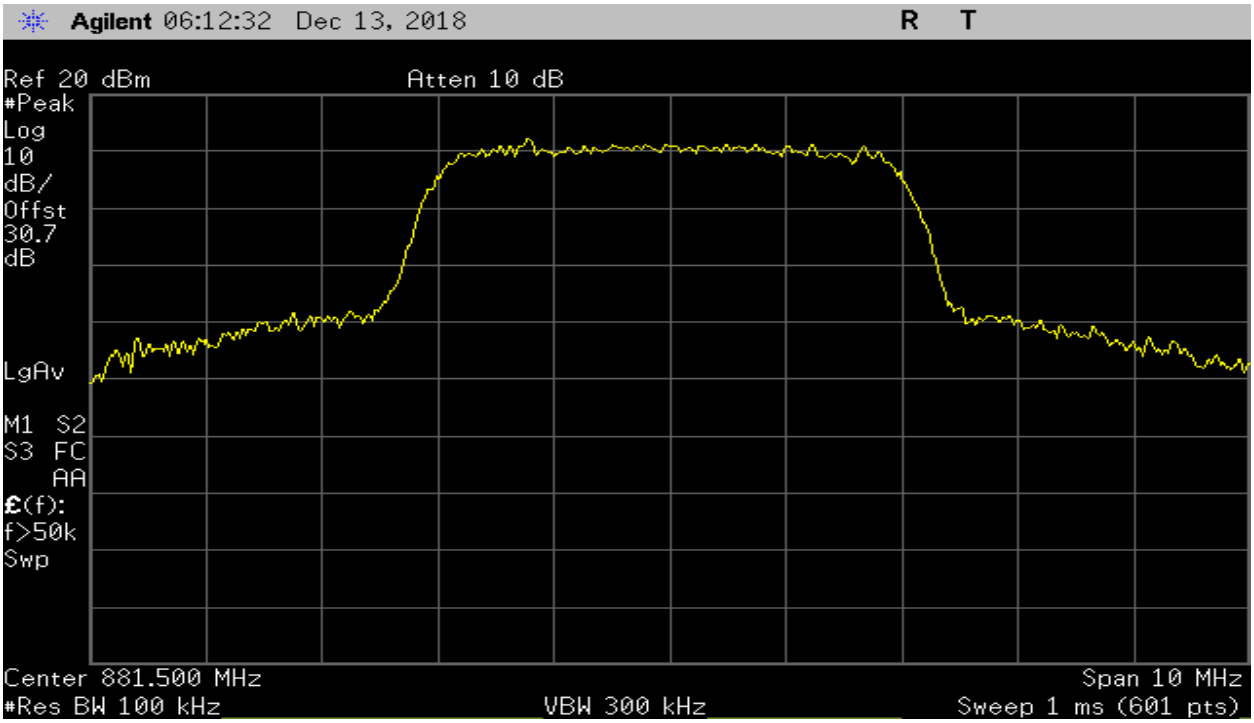
Plot 193 – 746-757MHz Band – Downlink Input – LTE



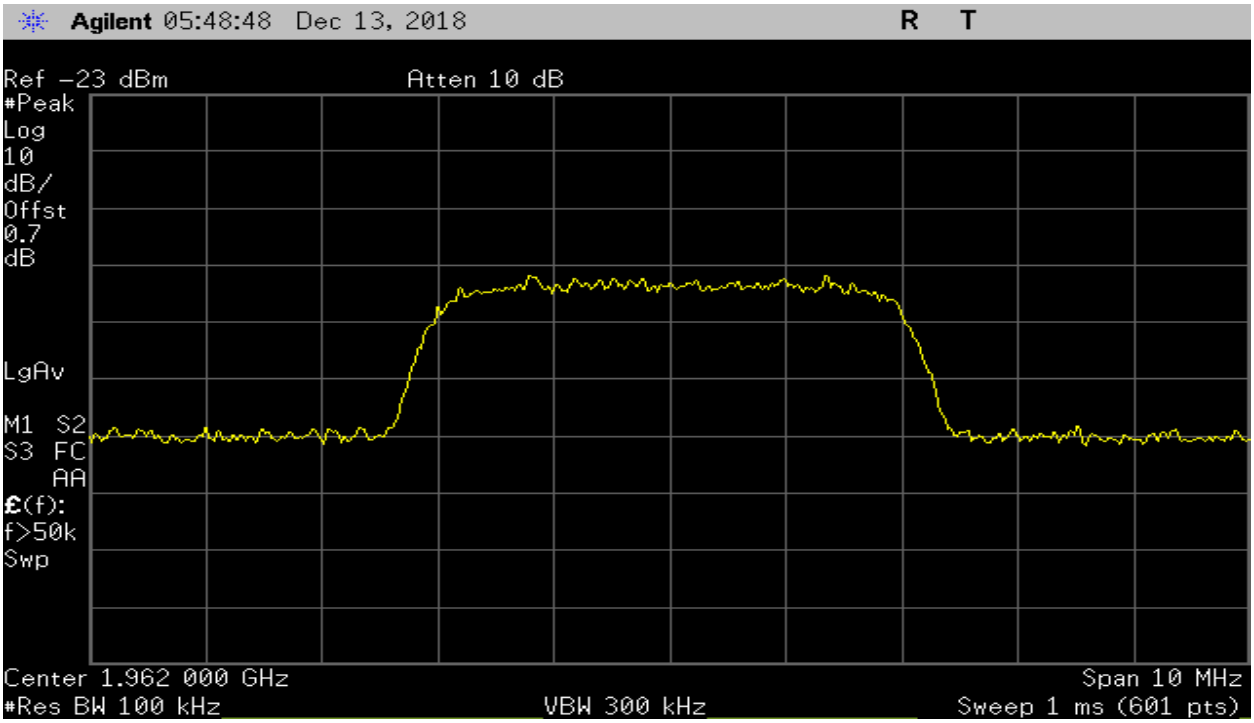
Plot 194 – 746-757MHz Band – Downlink Output – LTE



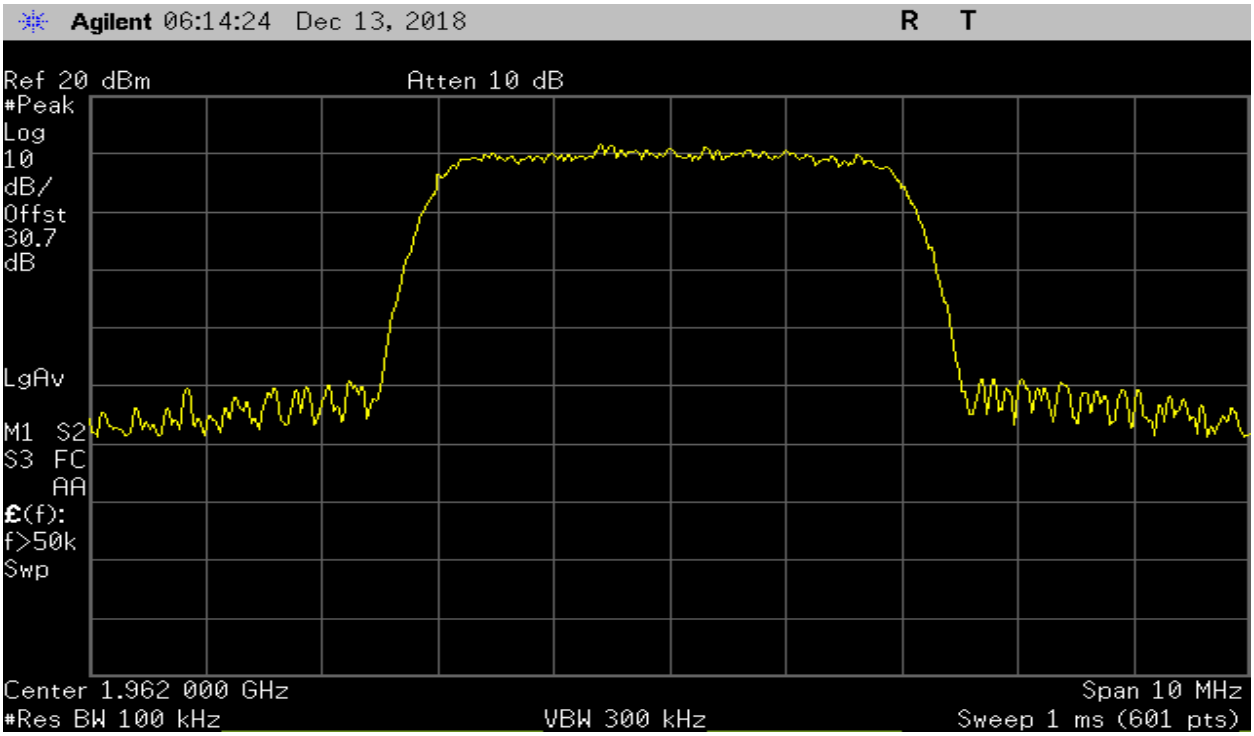
Plot 195 – 869-894MHz Band – Downlink Input – LTE



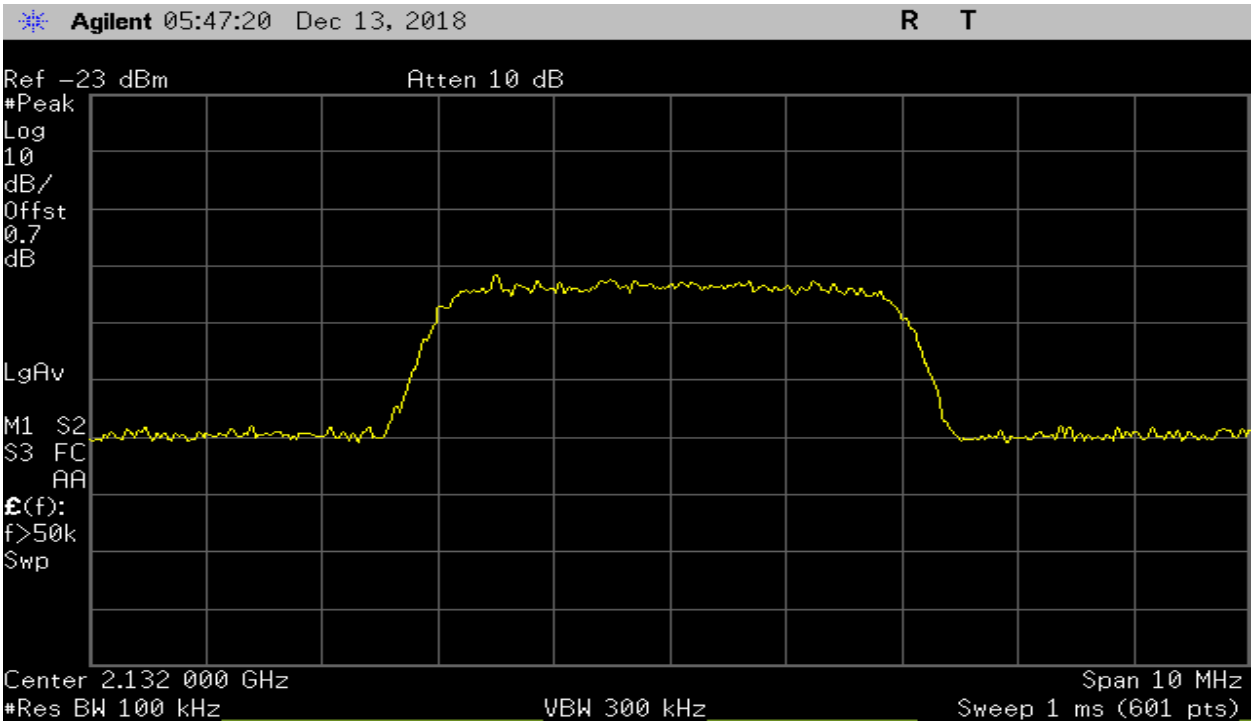
Plot 196 – 869-894MHz Band – Downlink Output – LTE



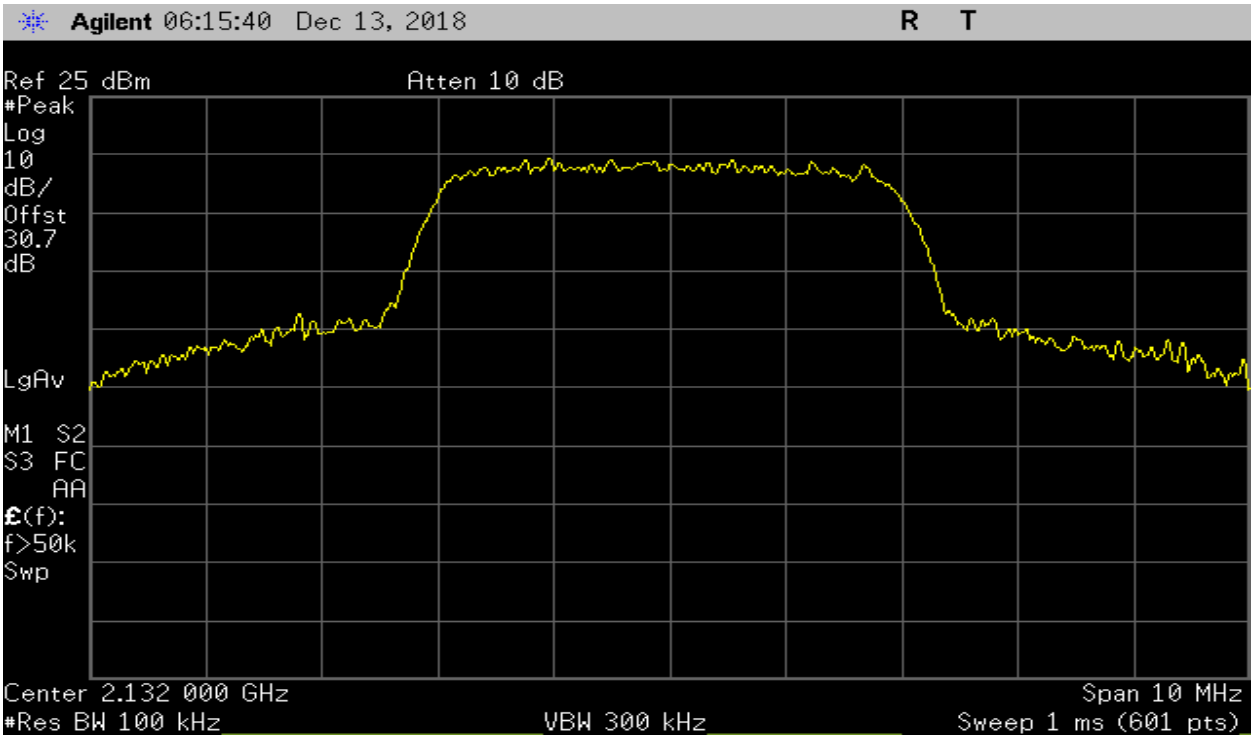
Plot 197 – 1930-1995MHz Band – Downlink Input – LTE



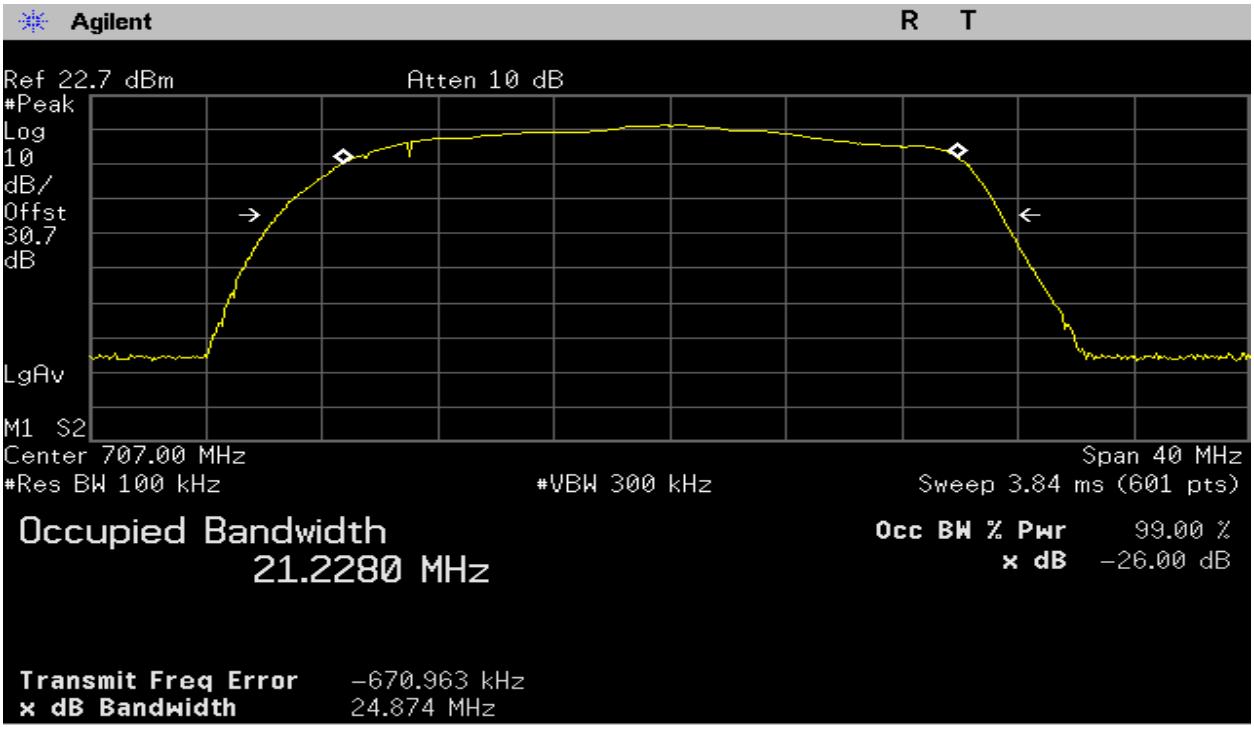
Plot 198 – 1930-1995MHz Band – Downlink Output – LTE



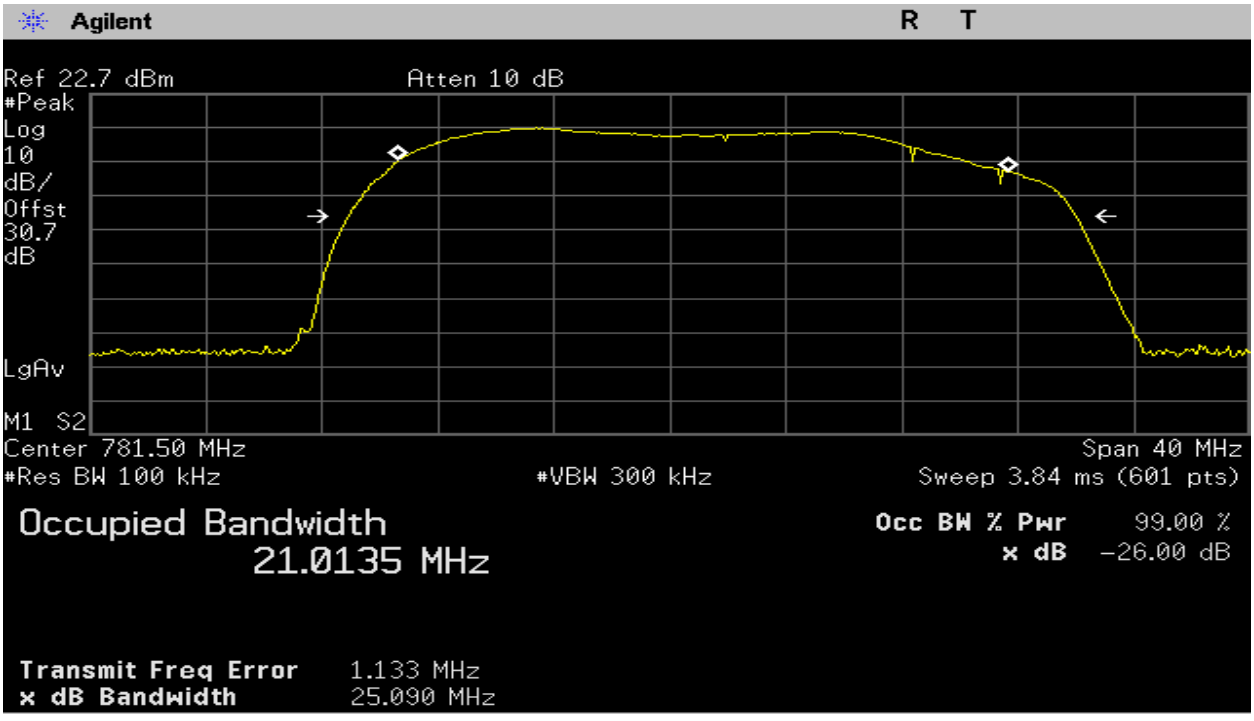
Plot 199 – 2110-2155MHz Band – Downlink Input – LTE



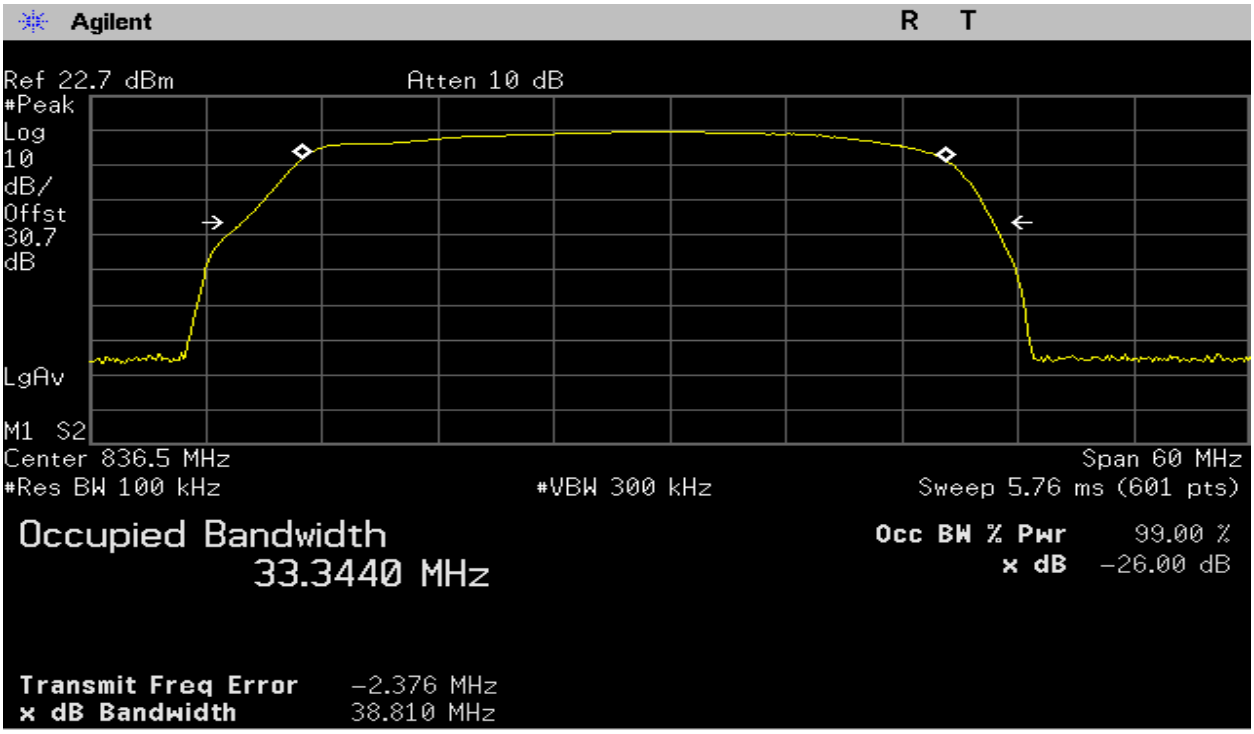
Plot 200 – 2110-2155MHz Band – Downlink Output – LTE



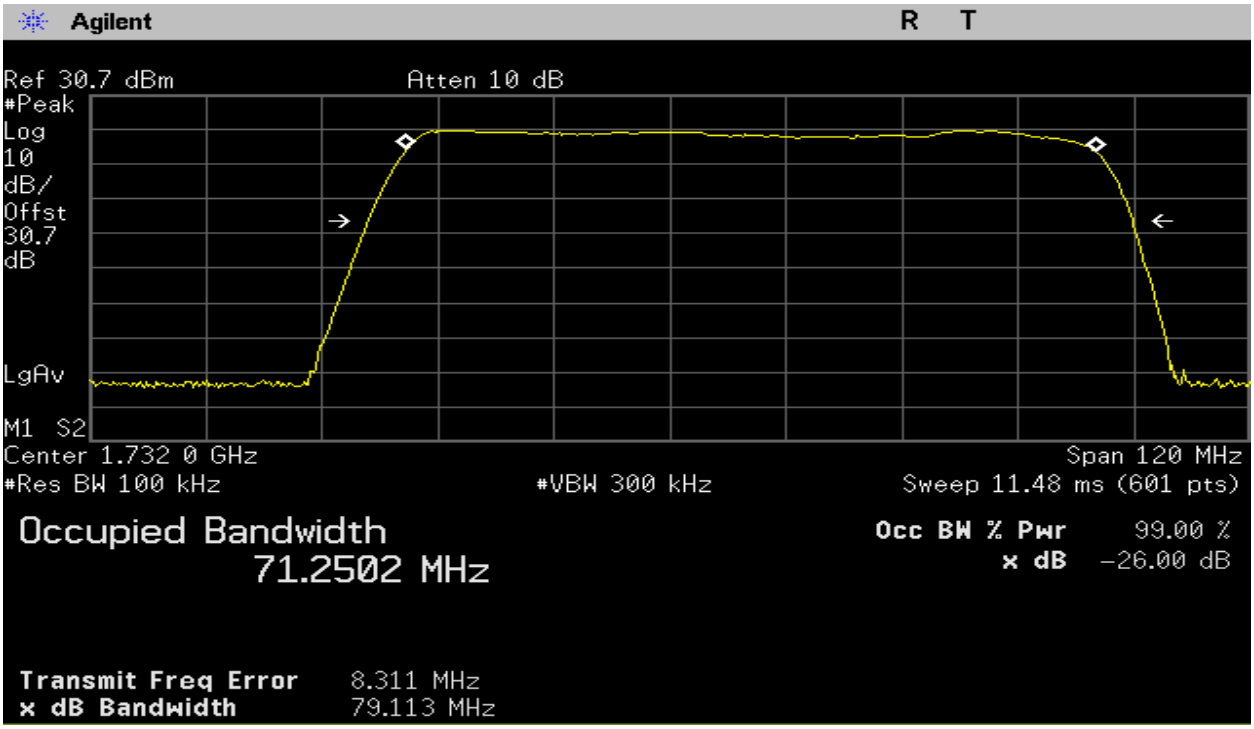
Plot 201 – 698-716MHz Band – Uplink – 99% BW for ISED (Canada)



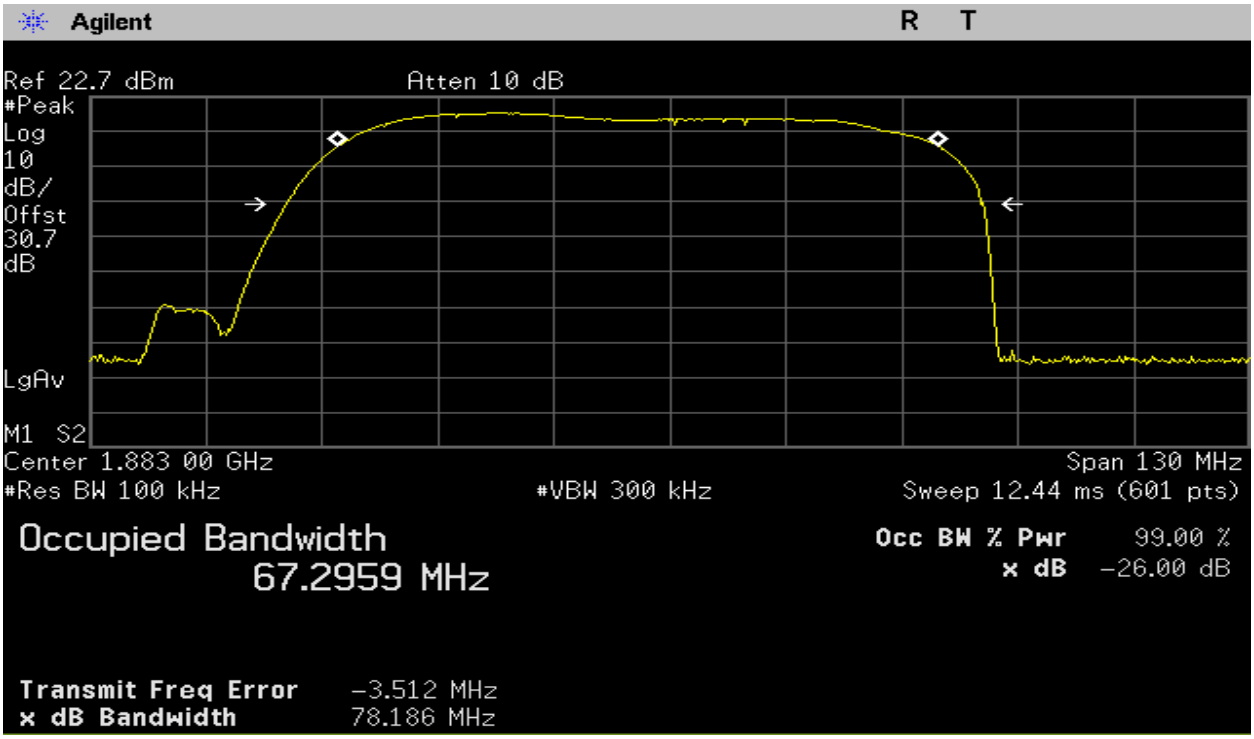
Plot 202 – 776-787MHz Band – Uplink – 99% BW for ISED (Canada)



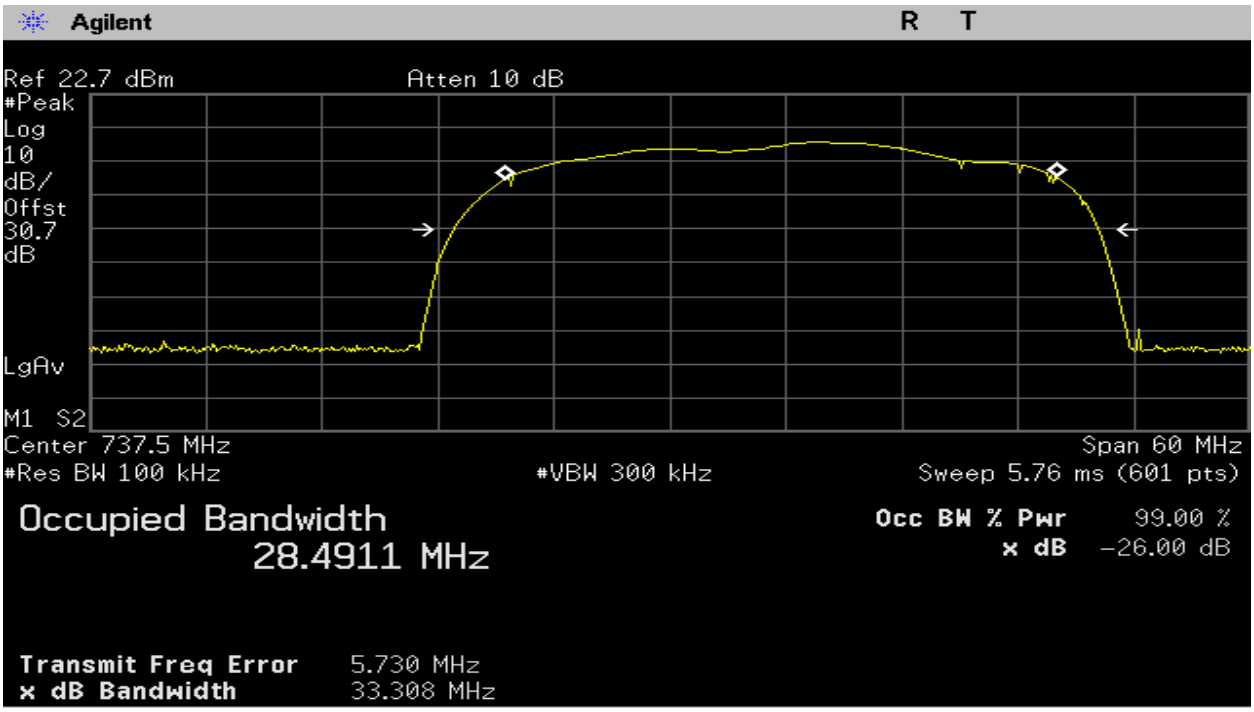
Plot 203 – 824-849MHz Band – Uplink – 99% BW for ISED (Canada)



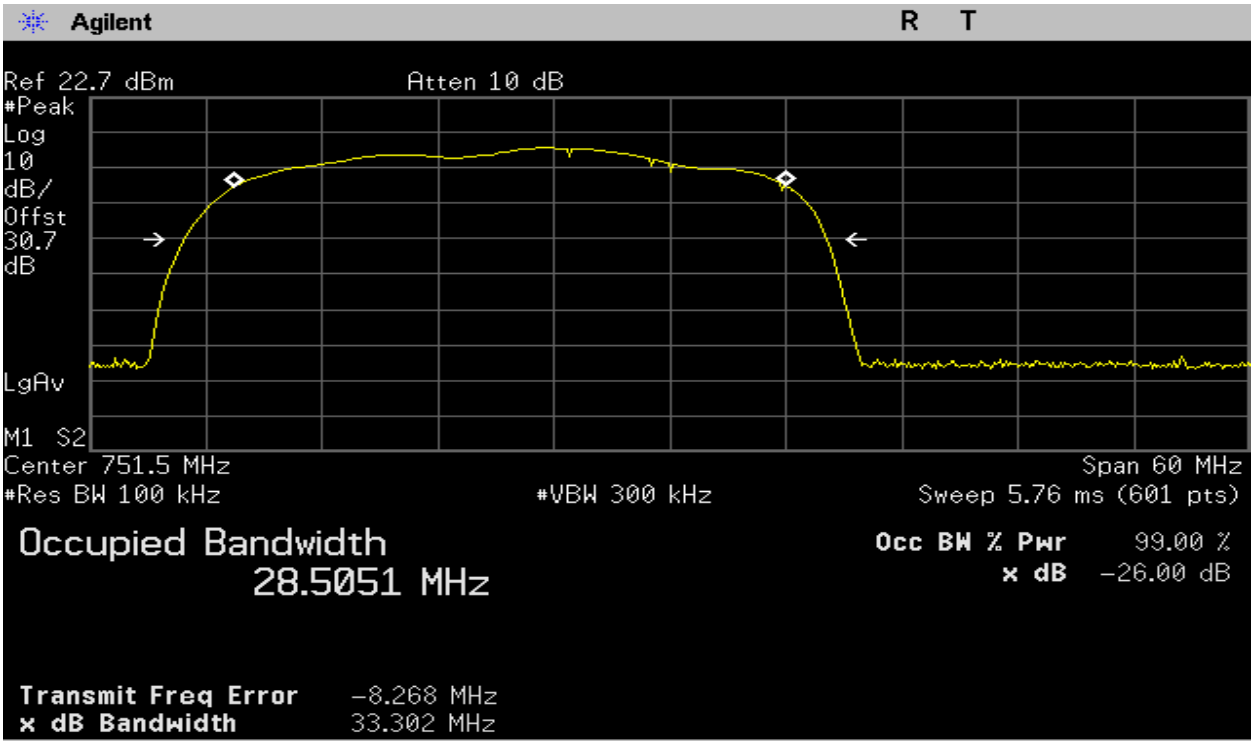
Plot 204 – 1710-1755MHz Band – Uplink – 99% BW for ISED (Canada)



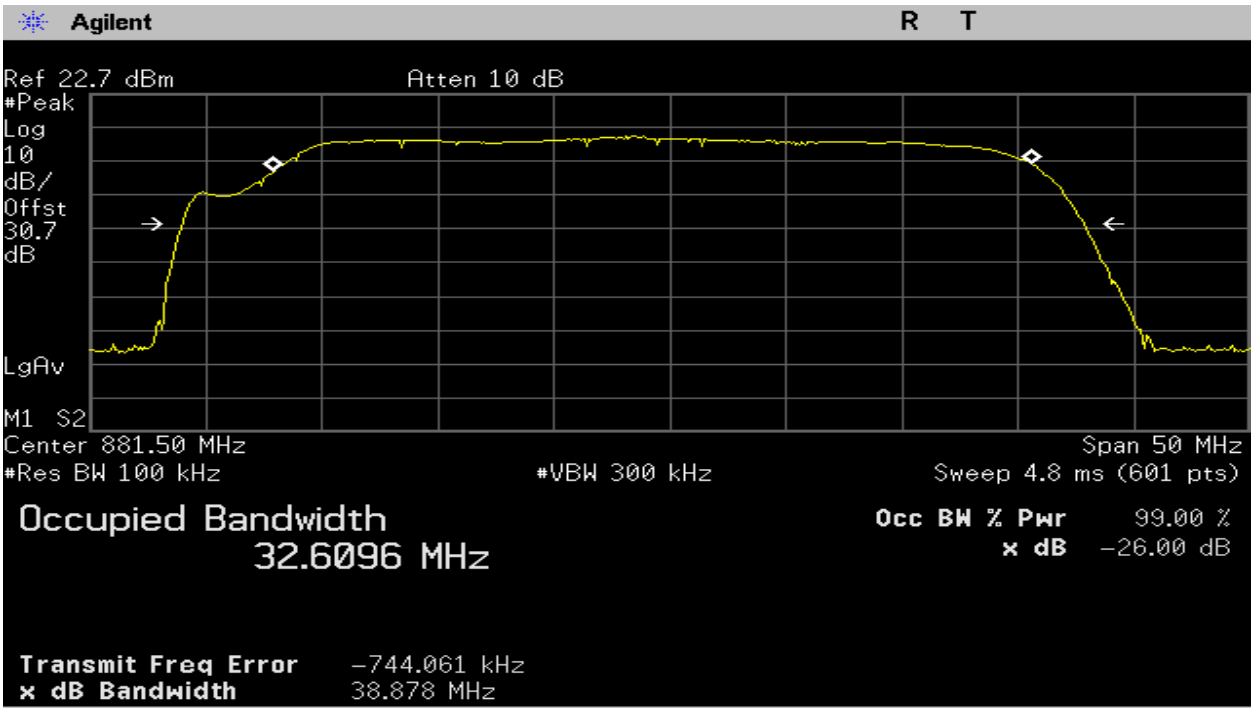
Plot 205 – 1850-1915MHz Band – Uplink – 99% BW for ISED (Canada)



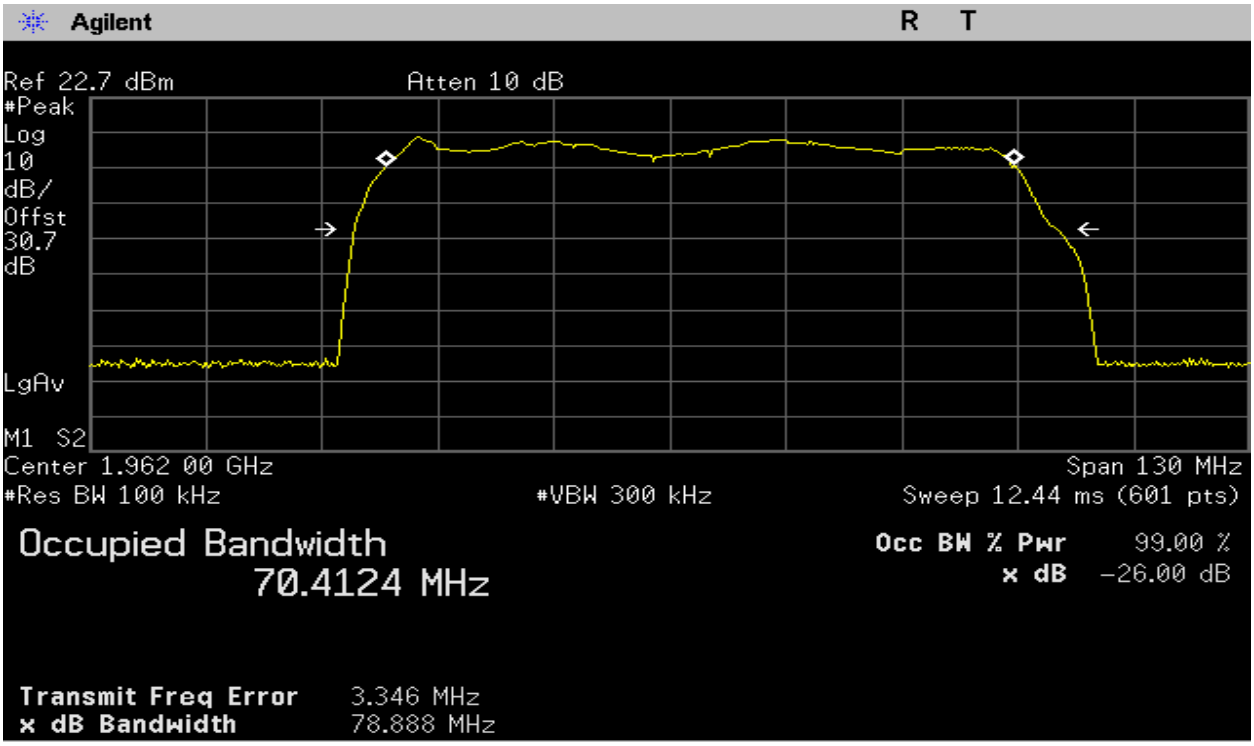
Plot 206 – 728-746MHz Band – Downlink – 99% BW for ISED (Canada)



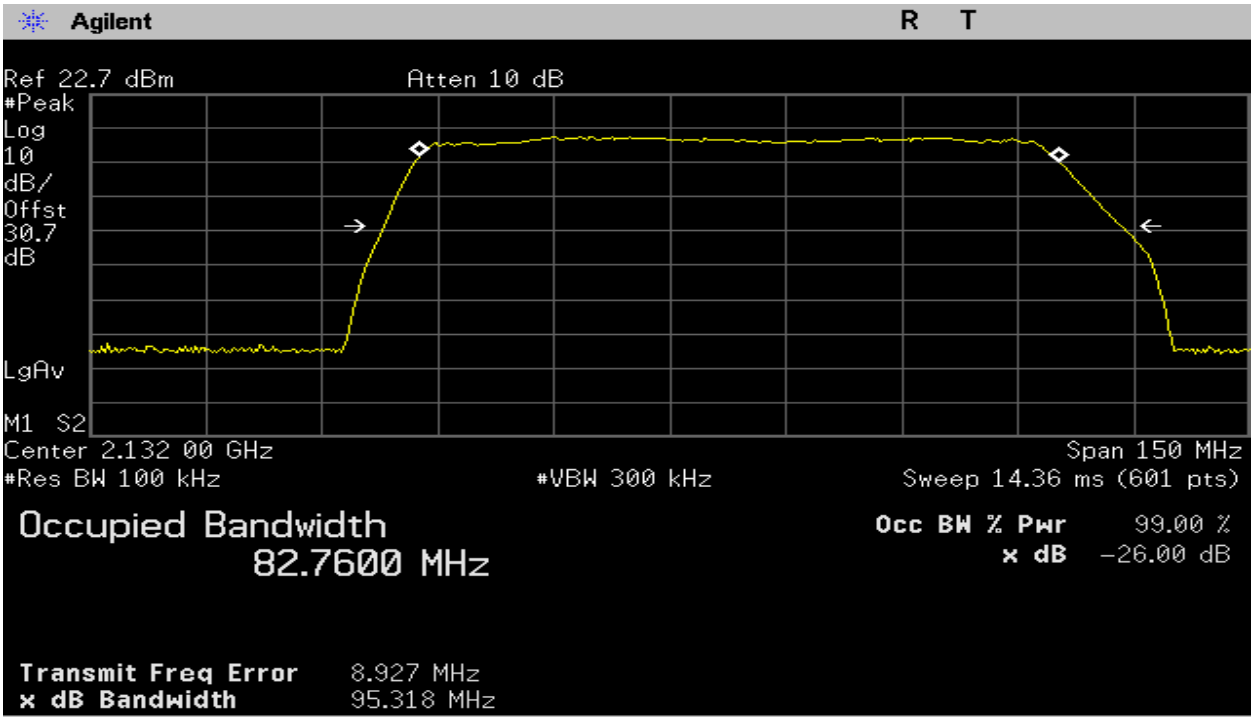
Plot 207 – 746-757MHz Band – Downlink – 99% BW for ISED (Canada)



Plot 208 – 869-894MHz Band – Downlink – 99% BW for ISED (Canada)



Plot 209 – 1930-1995MHz Band – Downlink – 99% BW for ISED (Canada)



Plot 210 – 2110-2155MHz Band – Downlink – 99% BW for ISED (Canada)

9. Oscillation Detection

Test Requirement(s):	§20.21(e)(8)(ii)(A	Test Engineer(s):	Hoosam B.
Test Results:	Pass	Test Date(s):	Nov/29/2018

Test Procedures: As required by 47 §20.21(e)(8)(ii)(A), Oscillation detection measurement were made at the RF antenna output terminals of the EUT.

The EUT output was connected to the spectrum analyzer through a 30dB coupled directional coupler. The measurements were made as per procedure defined in KDB 935210 D03 §7.11.

Detector Setting	Resolution Bandwidth	Video Bandwidth	Sweep Time
Peak	≥1 MHz	>3X RBW	Auto

Table 34 – Analyzer settings – Oscillation Detection

Detector Setting	Resolution Bandwidth	Video Bandwidth	Sweep Time
RMS (Power Averaging)	30 kHz	>3X RBW	≥ 2 x Span/RBW

Table 35 – Analyzer settings – Oscillation Mitigation or Shutdown

Test Setup:

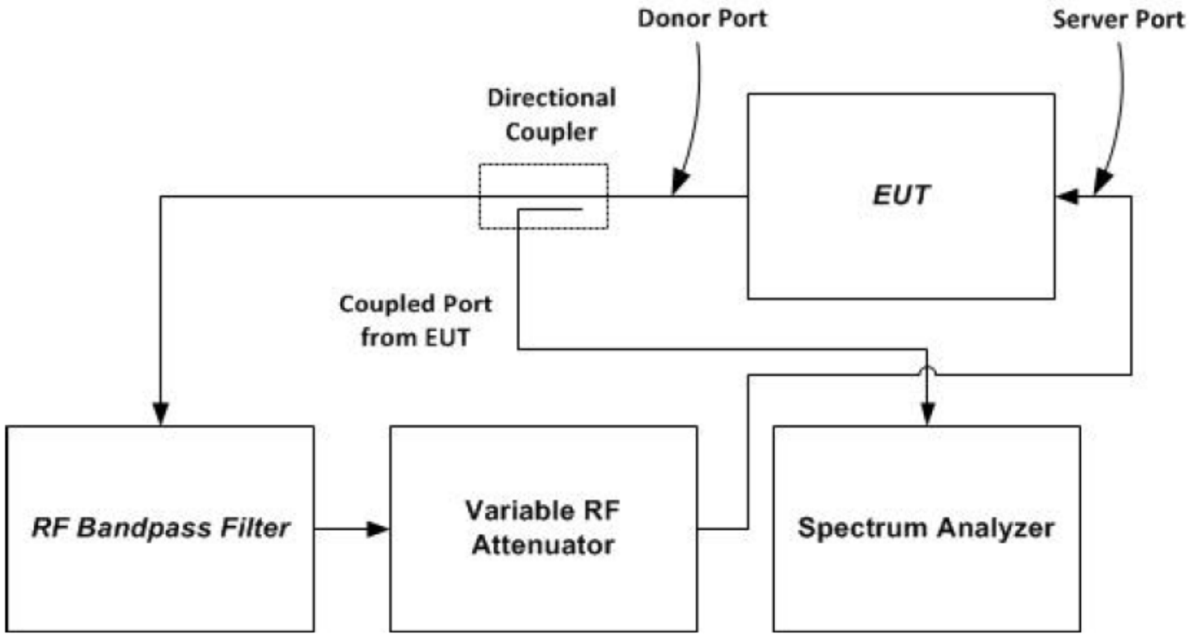


Figure 4 – Oscillation detection

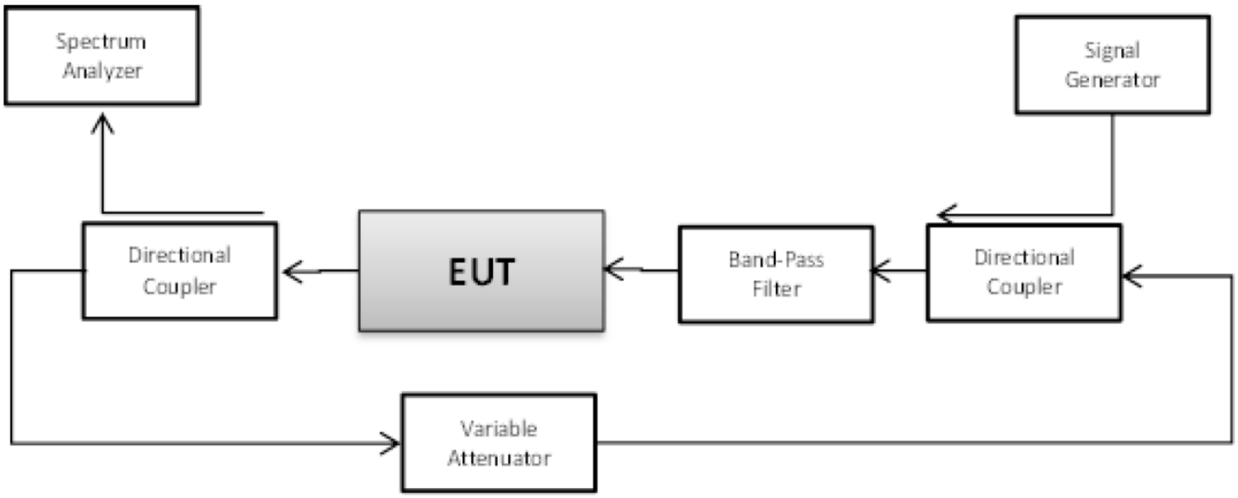


Figure 5 – Oscillation mitigation/shutdown

Frequency Band (MHz)	Measured Time (mS)	Limit (mS)
698-716	192.5	300
776-787	198.8	300
824-849	142.5	300
1710-1755	146.2	300
1850-1915	156.2	300

Table 36 –Uplink Detection Time – Summary

Frequency Band (MHz)	Measured Time (Second)	Limit (Second)
728-746	0.198	1.0
746-757	0.198	1.0
869-894	0.200	1.0
1930-1995	0.199	1.0
2110-2155	0.202	1.0

Table 37 –Downlink Detection Time – Summary

Frequency Band (MHz)	Measured Time (Second)	Limit (Second)
698-716	69.98	≥60
776-787	69.97	≥60
824-849	69.97	≥60
1710-1755	69.98	≥60
1850-1915	70.42	≥60

Table 38 –Uplink Restart Time – Summary

Frequency Band (MHz)	Measured Time (Second)	Limit (Second)
728-746	69.75	≥60
746-757	69.75	≥60
869-894	69.75	≥60
1930-1995	69.75	≥60
2110-2155	71.5	≥60

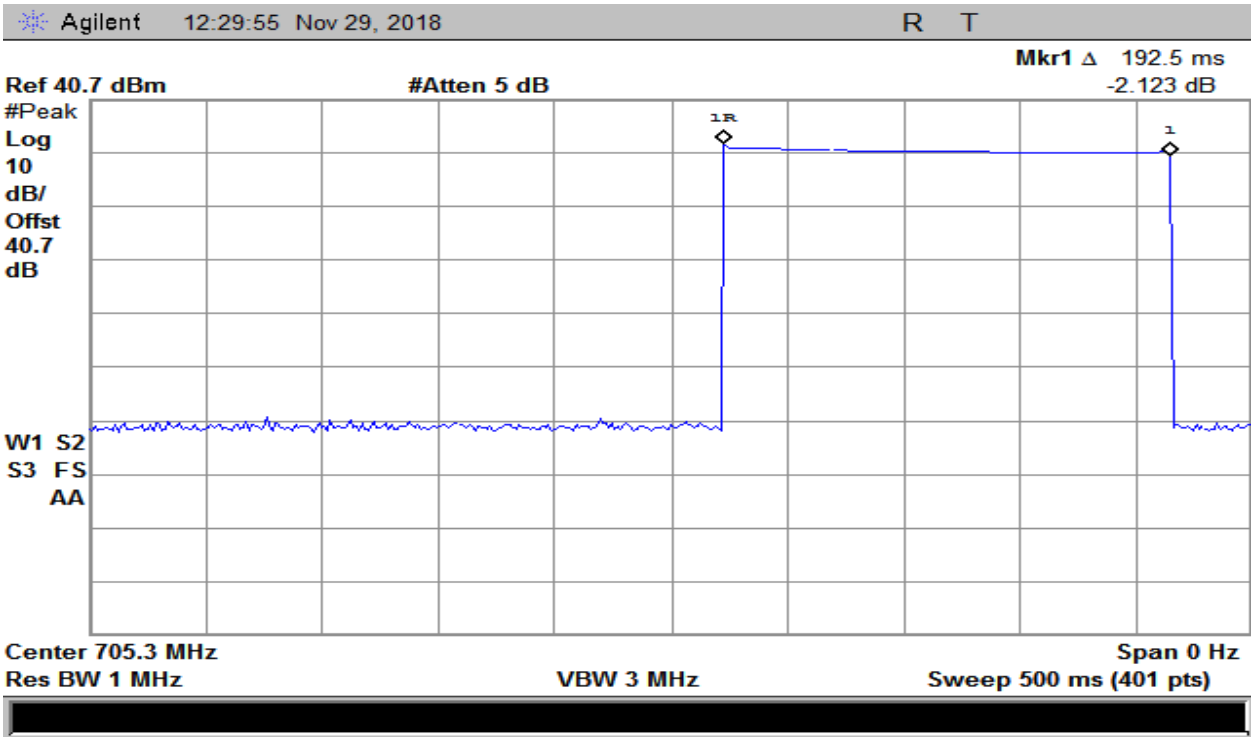
Table 39 –Downlink Restart Time – Summary

Frequency Band (MHz)	Restart	Limit
698-716	5	≤5
776-787	4	≤5
824-849	5	≤5
1710-1755	5	≤5
1850-1915	5	≤5

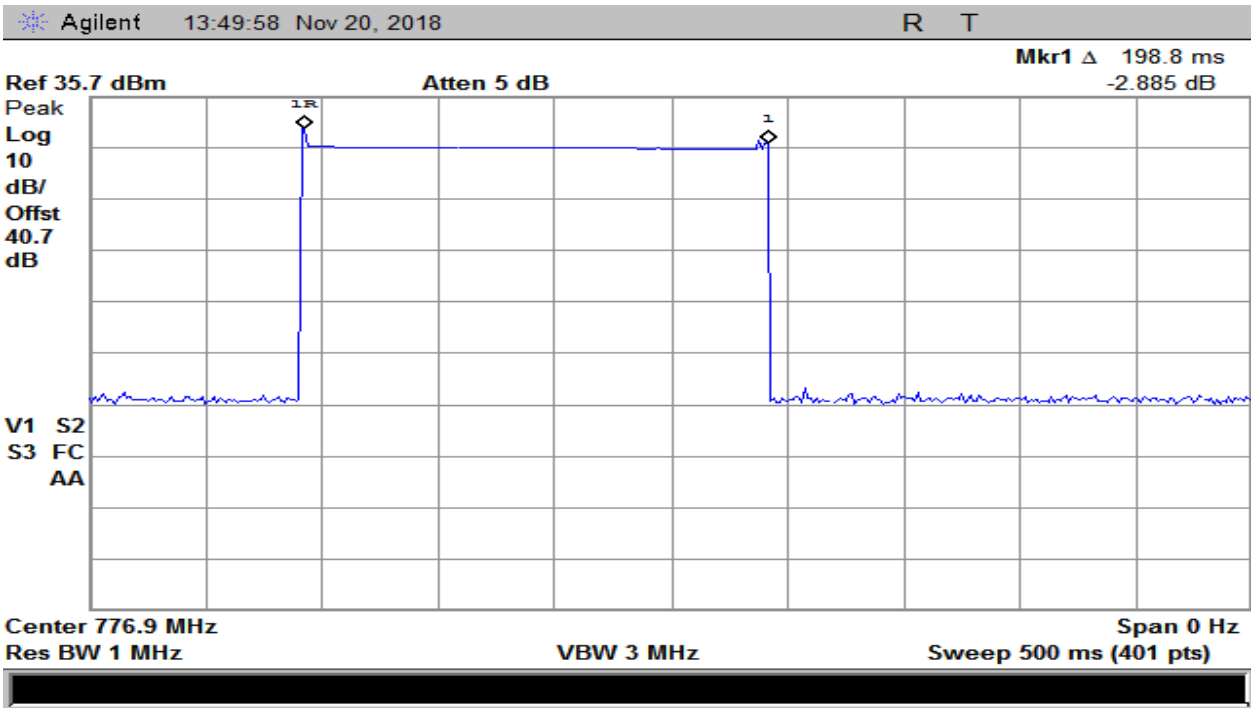
Table 40 –Uplink Restart Count – Summary

Frequency Band (MHz)	Restart	Limit
728-746	5	≤5
746-757	5	≤5
869-894	5	≤5
1930-1995	5	≤5
2110-2155	5	≤5

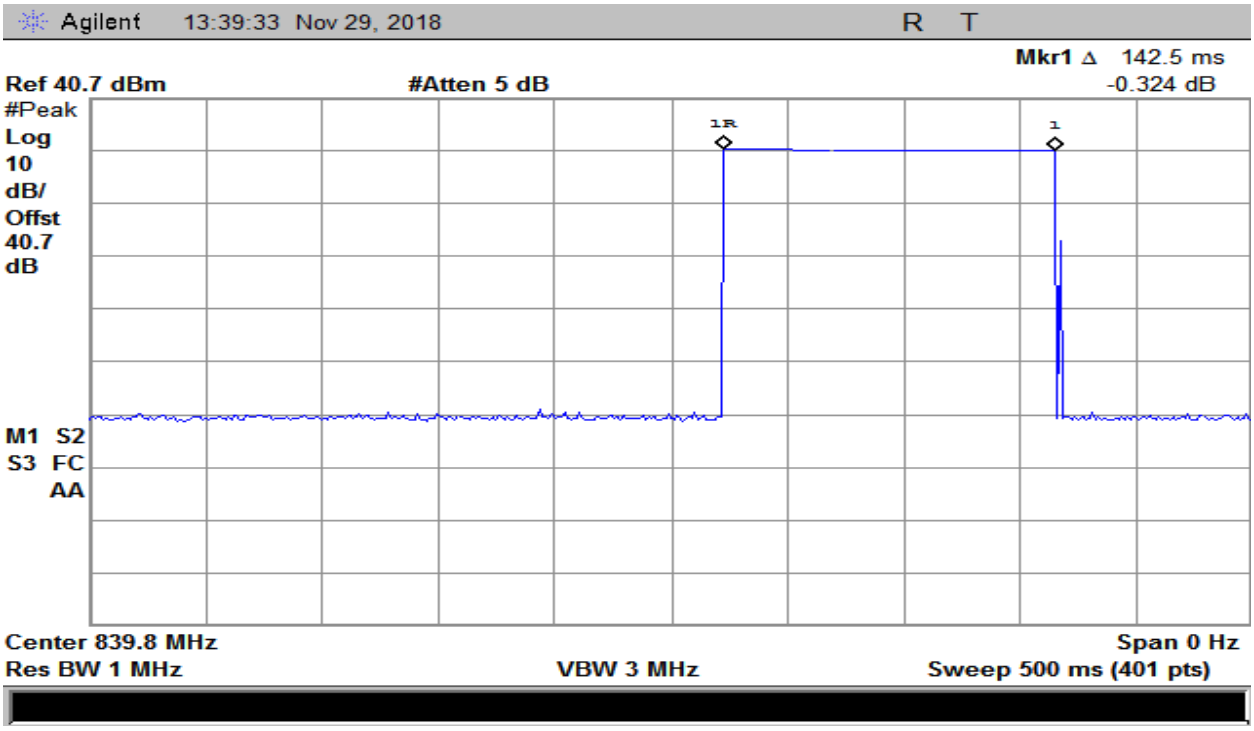
Table 41 –Downlink Restart Count – Summary



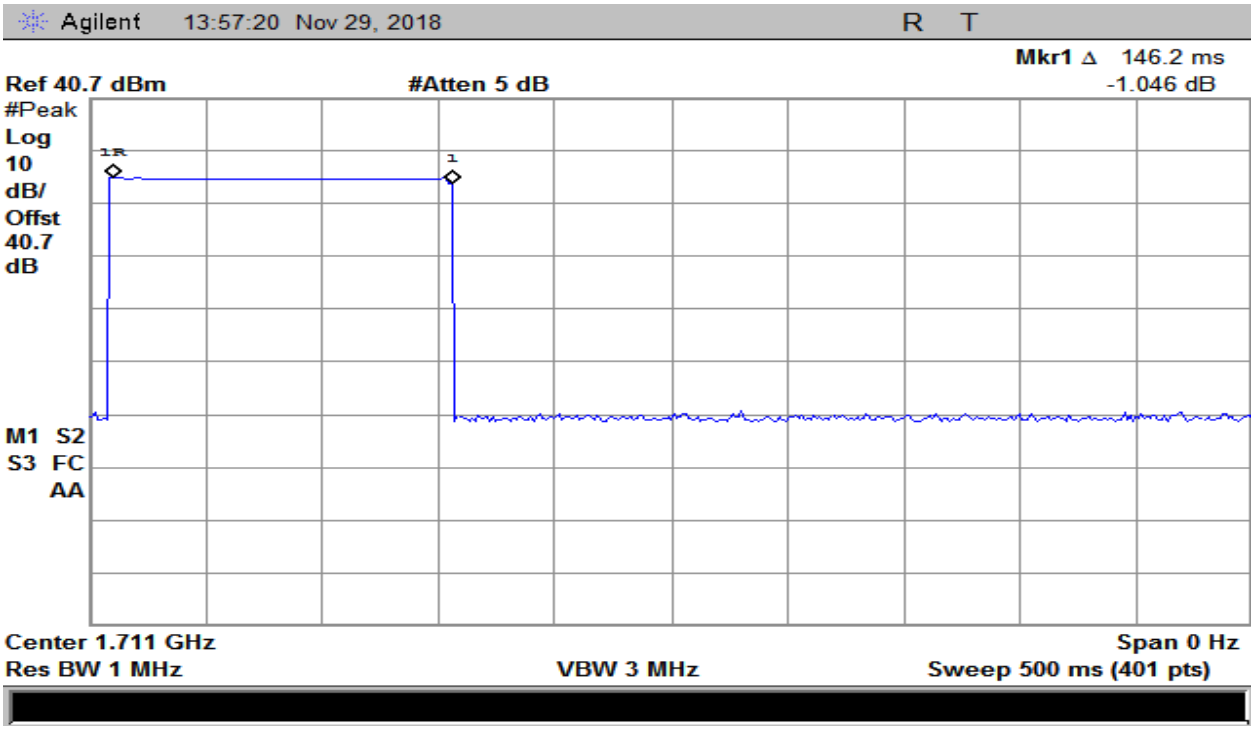
Plot 211 – 698-716MHz Band – Uplink Oscillation Detection Time



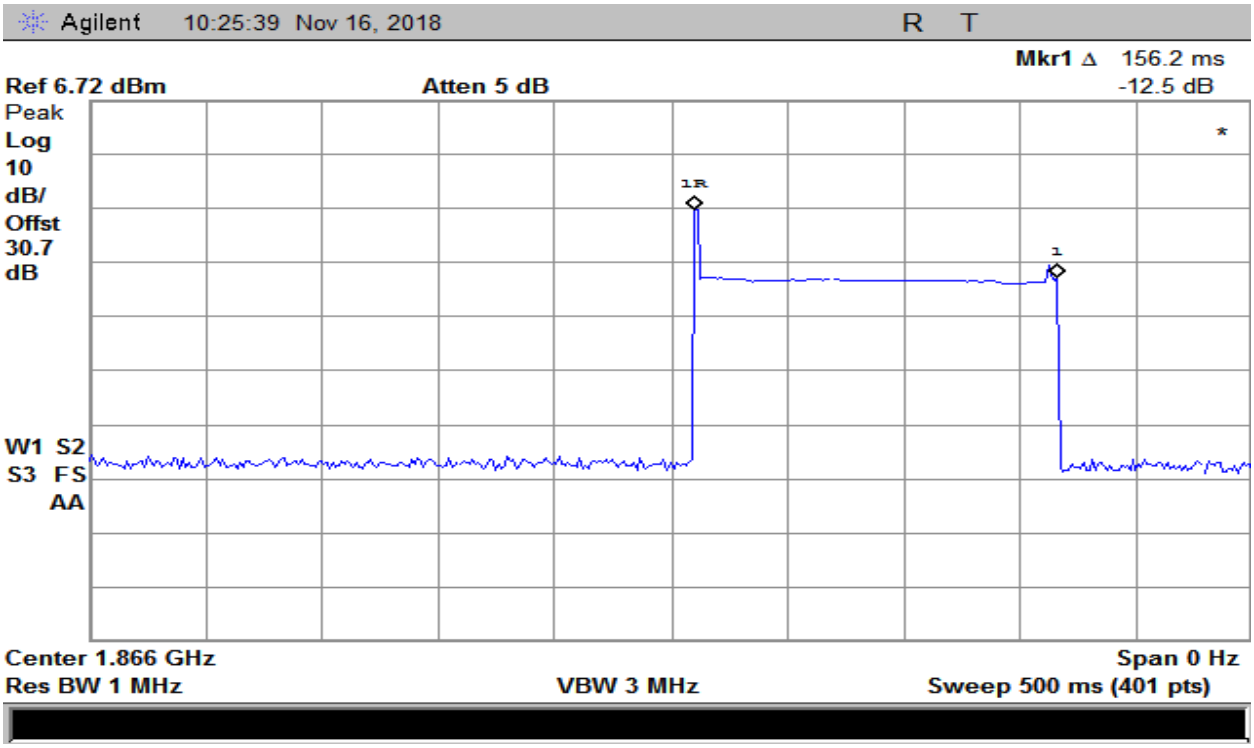
Plot 212 – 776-787MHz Band – Uplink Oscillation Detection Time



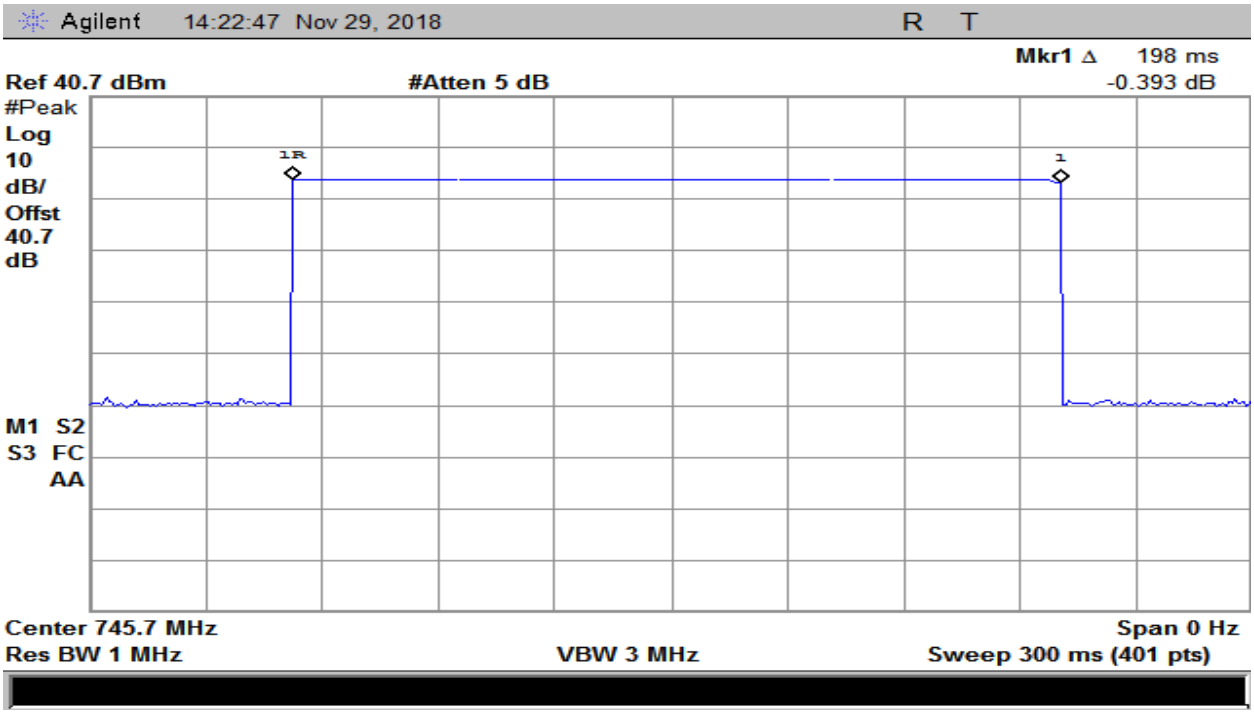
Plot 213 – 824-849MHz Band – Uplink Oscillation Detection Time



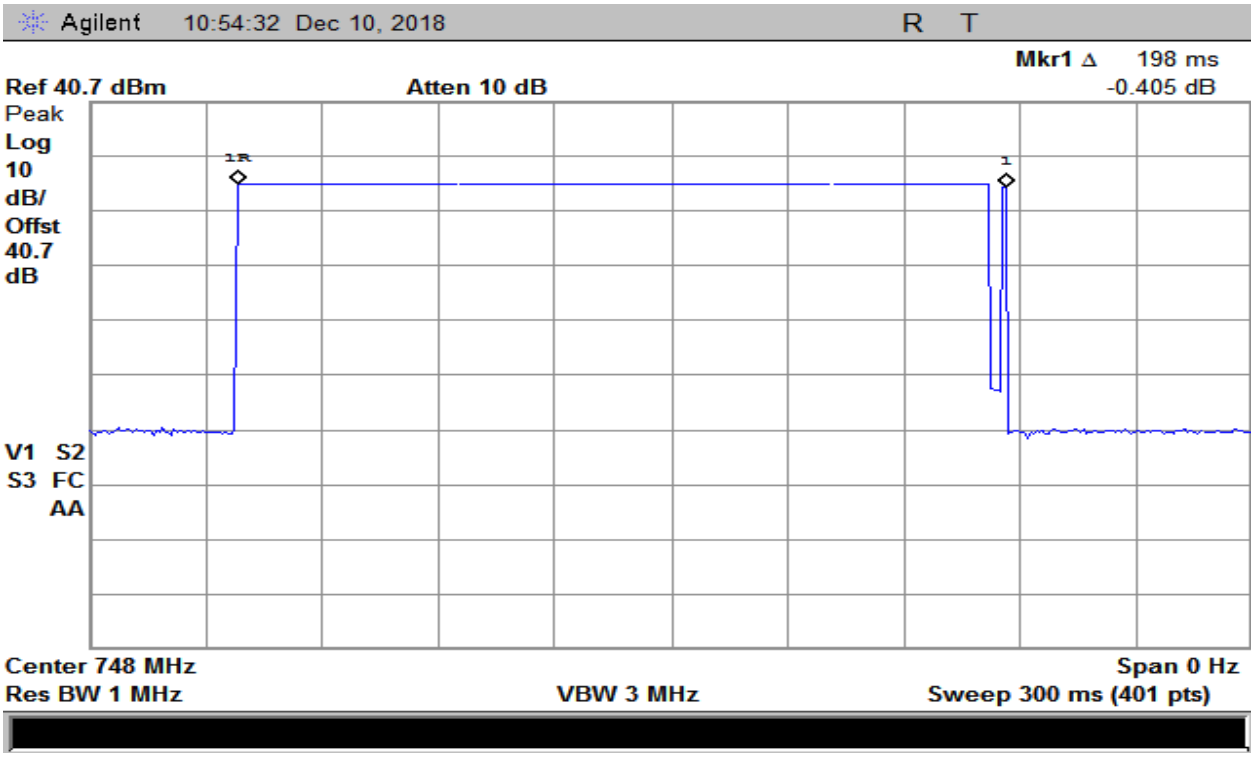
Plot 214 – 1710-1755MHz Band – Uplink Oscillation Detection Time



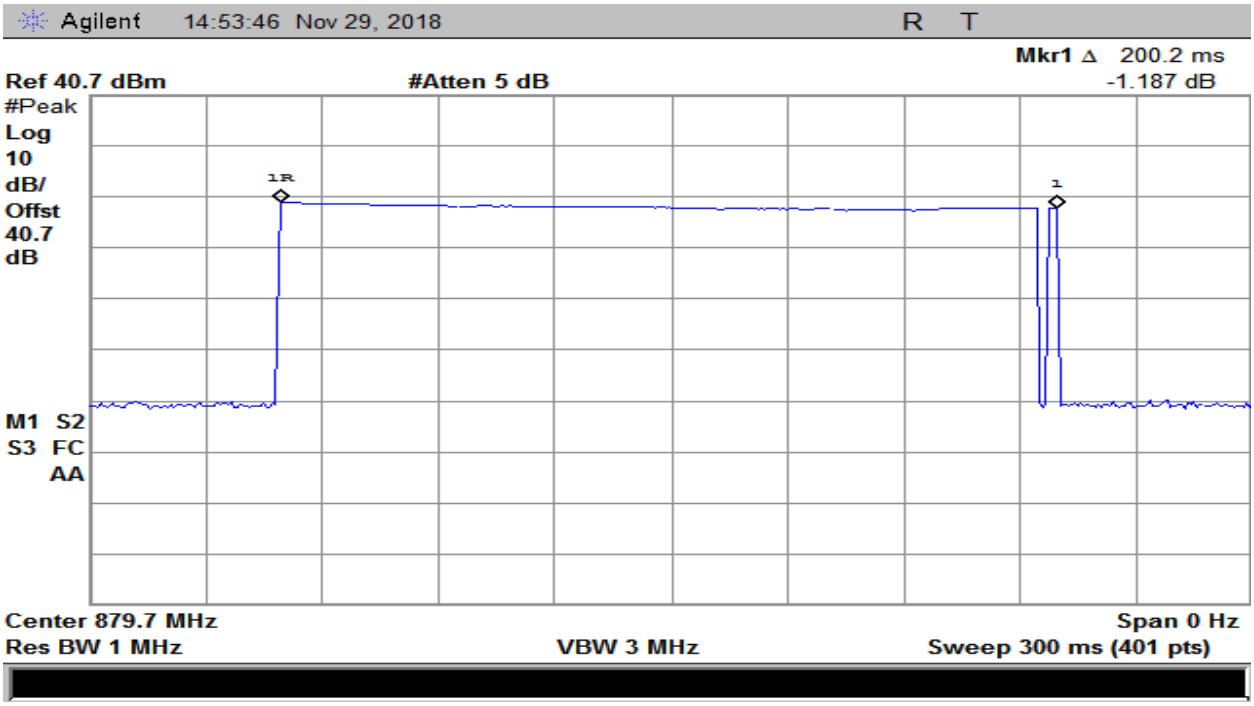
Plot 215 – 1850-1915MHz Band – Uplink Oscillation Detection Time



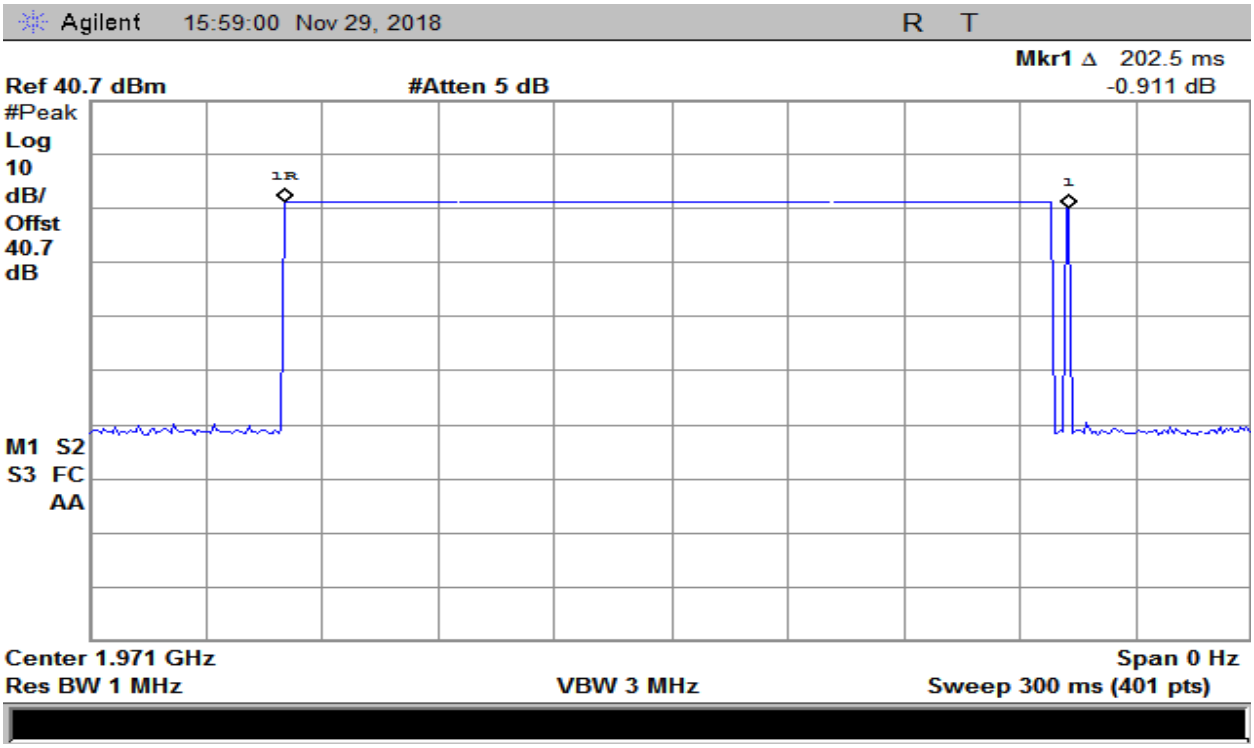
Plot 216 – 728-746MHz Band – Downlink Oscillation Detection Time



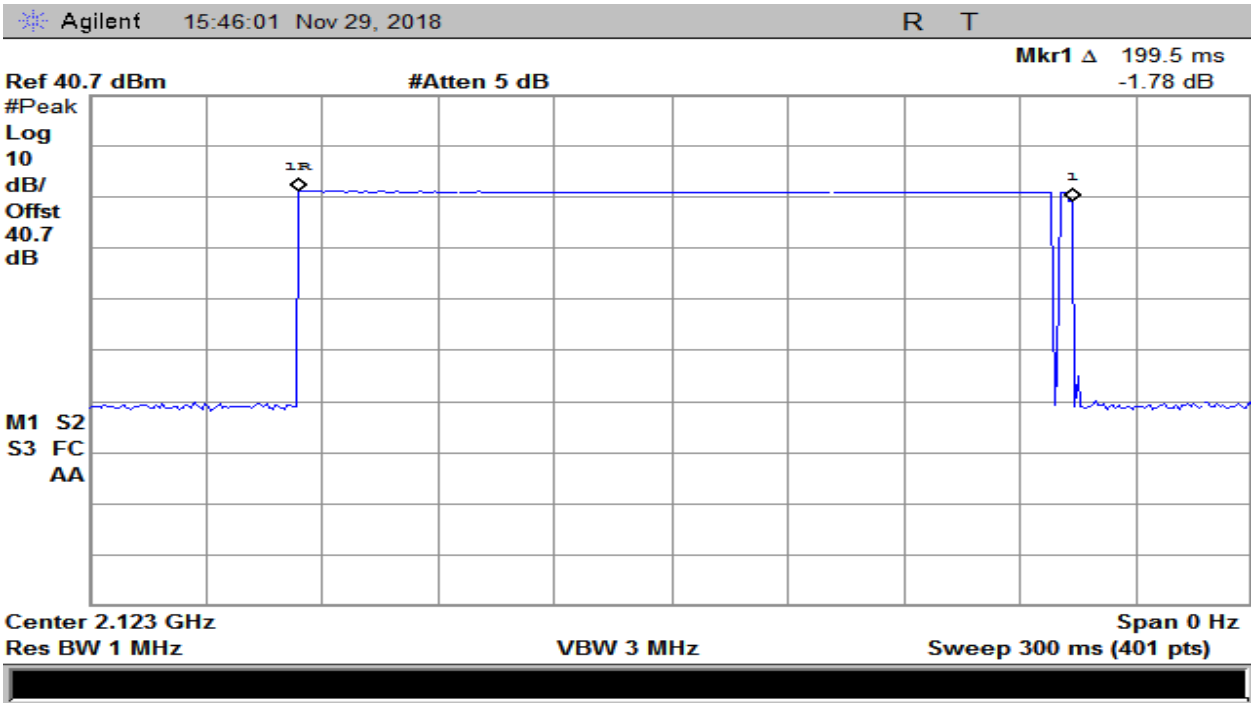
Plot 217 – 746-757MHz Band – Downlink Oscillation Detection Time



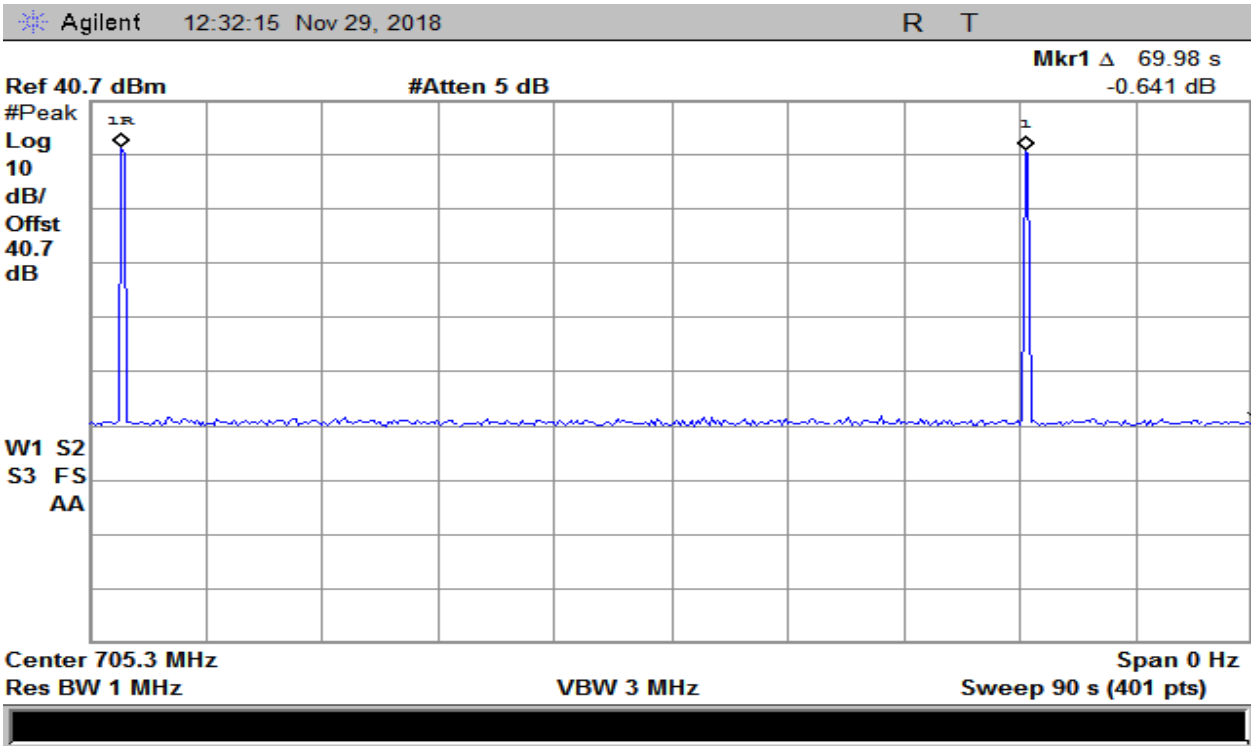
Plot 218 – 869-894MHz Band – Downlink Oscillation Detection Time



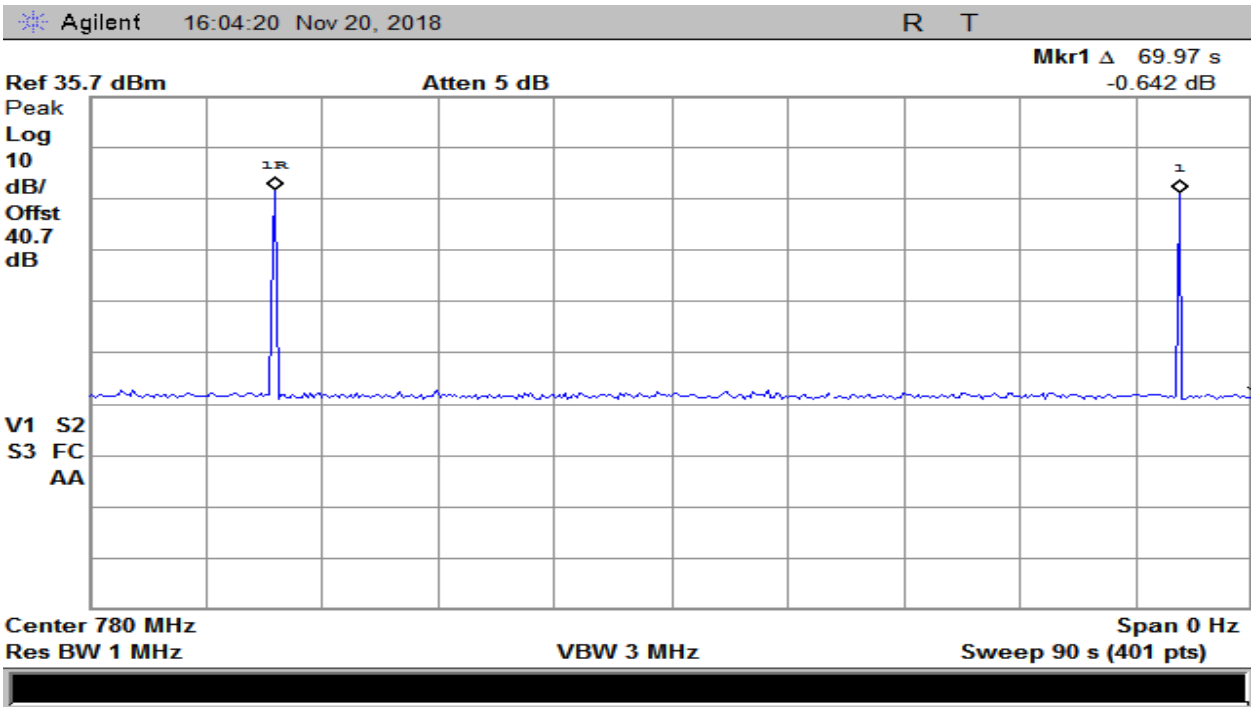
Plot 219 – 1930-1995MHz Band – Downlink Oscillation Detection Time



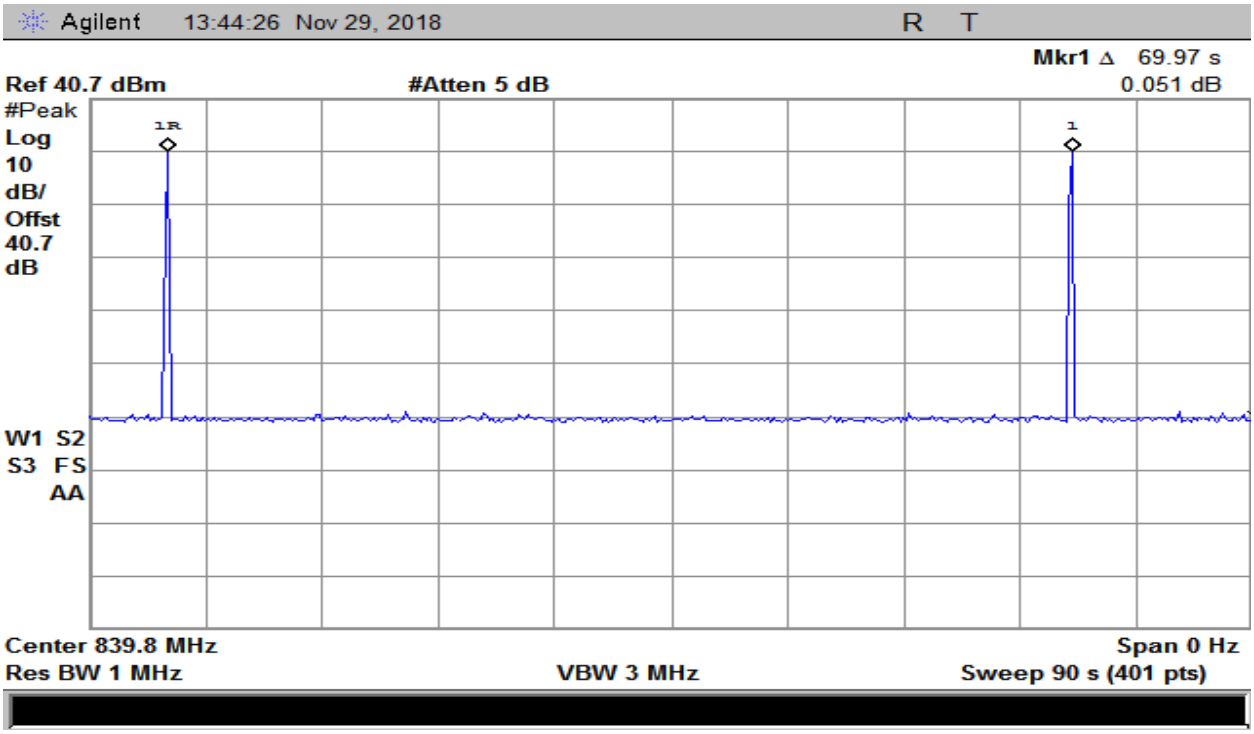
Plot 220 – 2110-2155MHz Band – Downlink Oscillation Detection Time



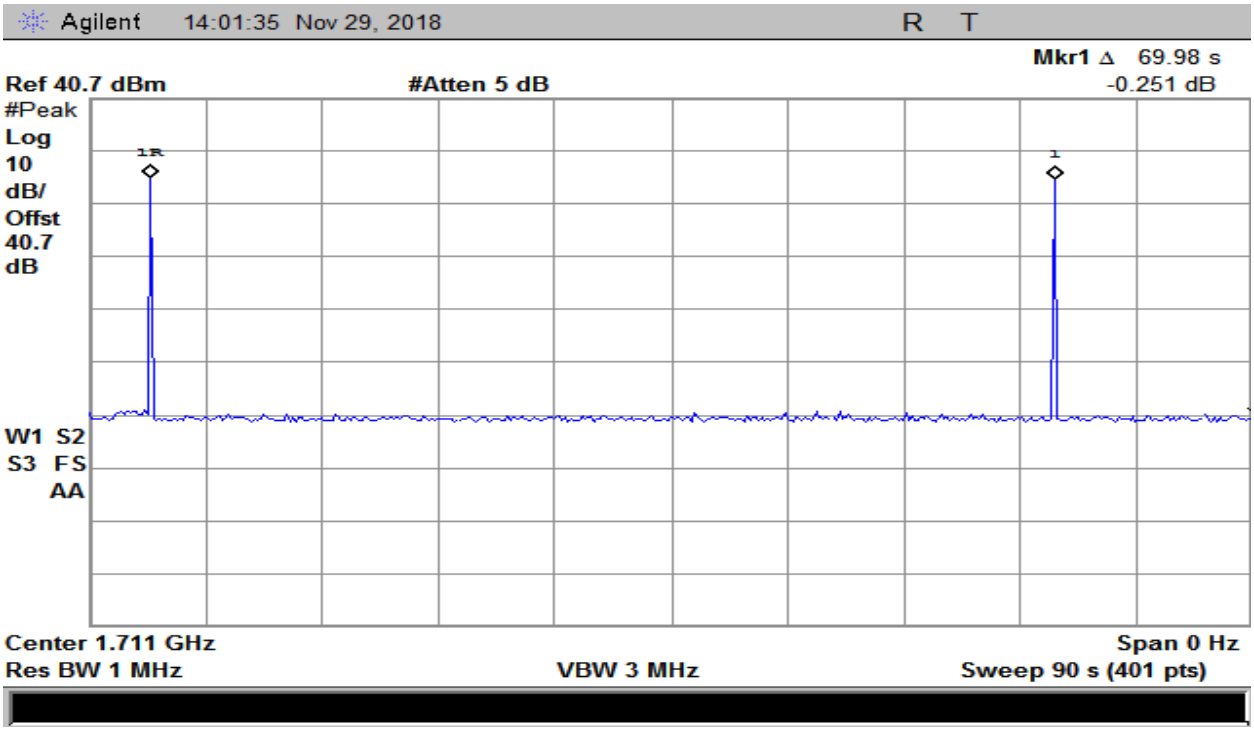
Plot 221 – 698-716MHz Band –Uplink Restart Time



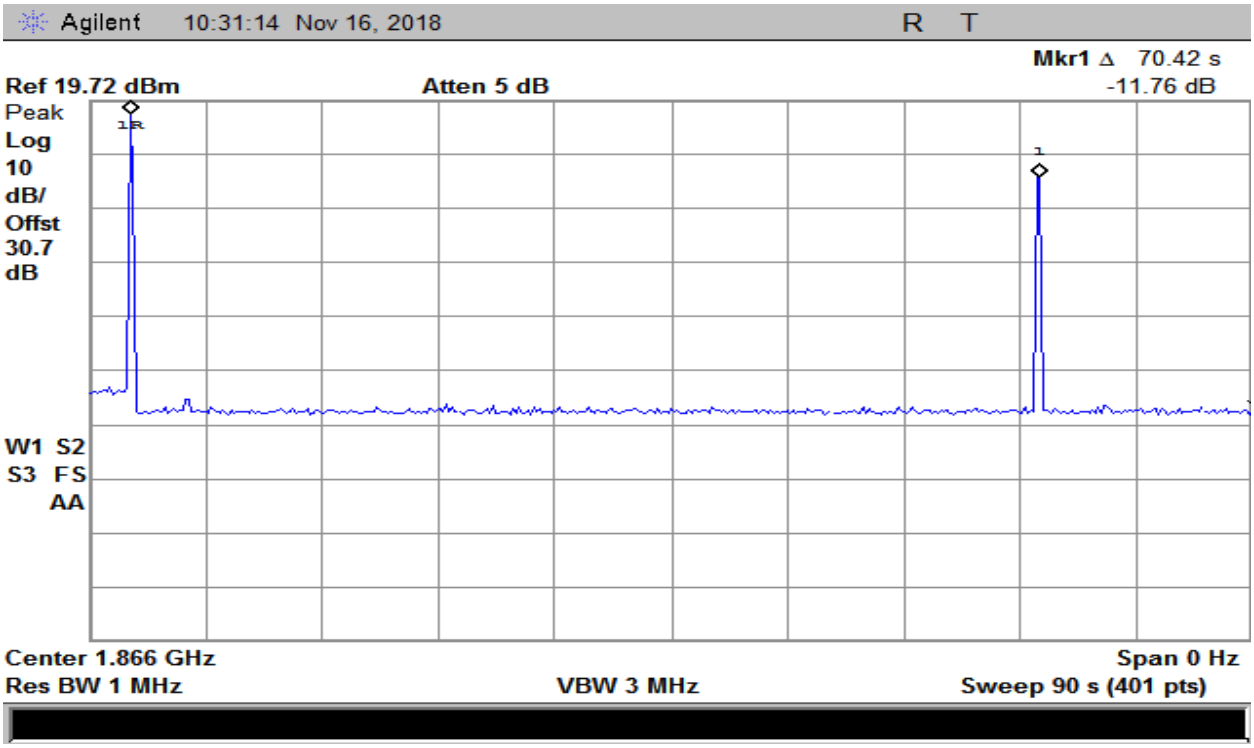
Plot 222 – 776-787MHz Band –Uplink Restart Time



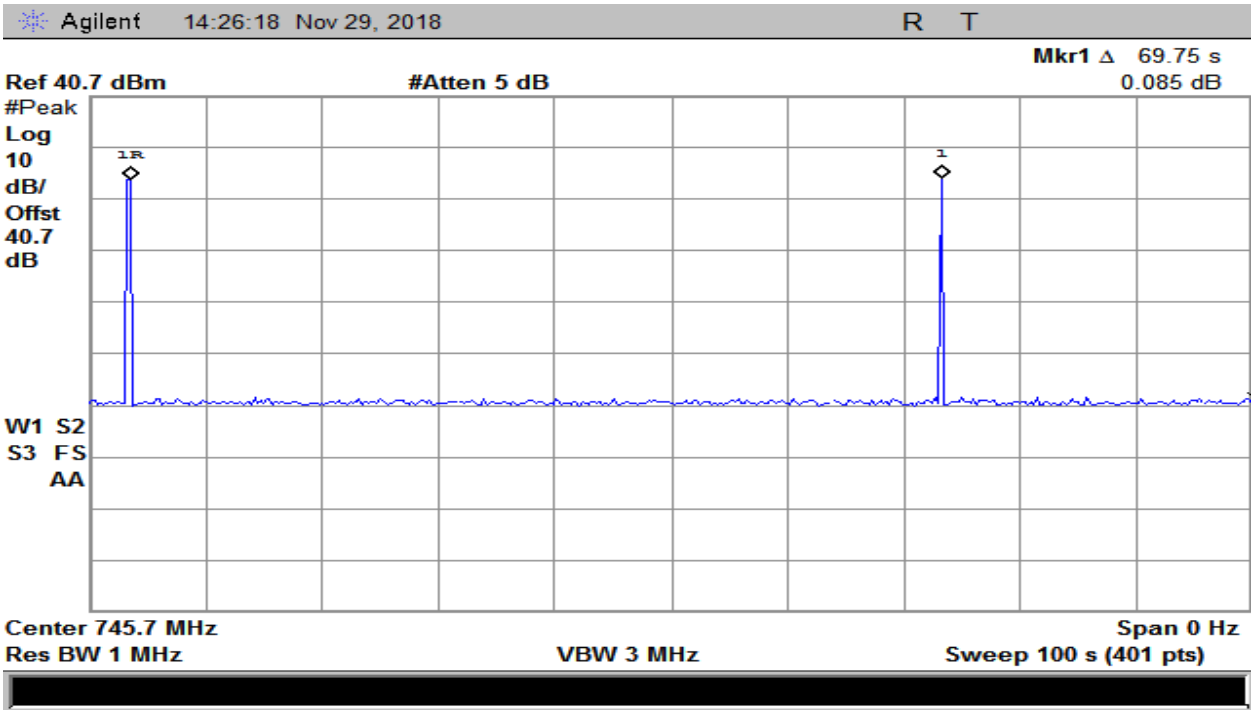
Plot 223 – 824-849MHz Band –Uplink Restart Time



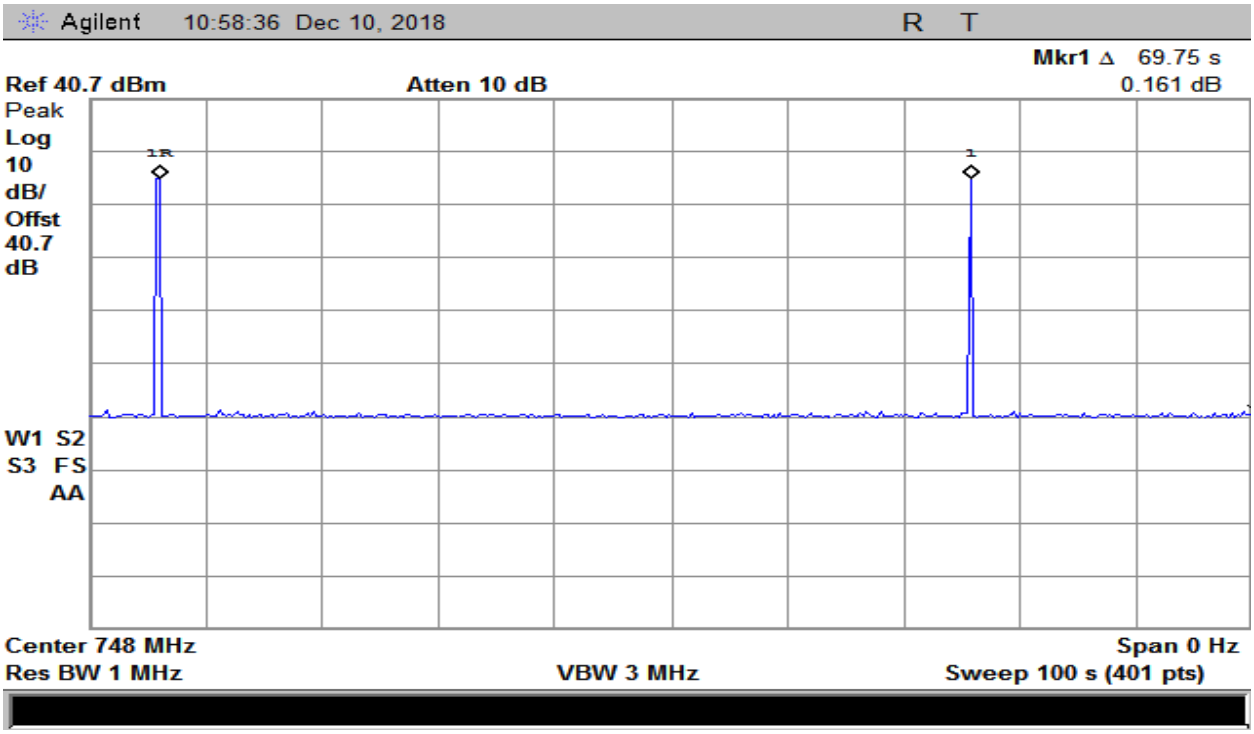
Plot 224 – 1710-1755MHz Band –Uplink Restart Time



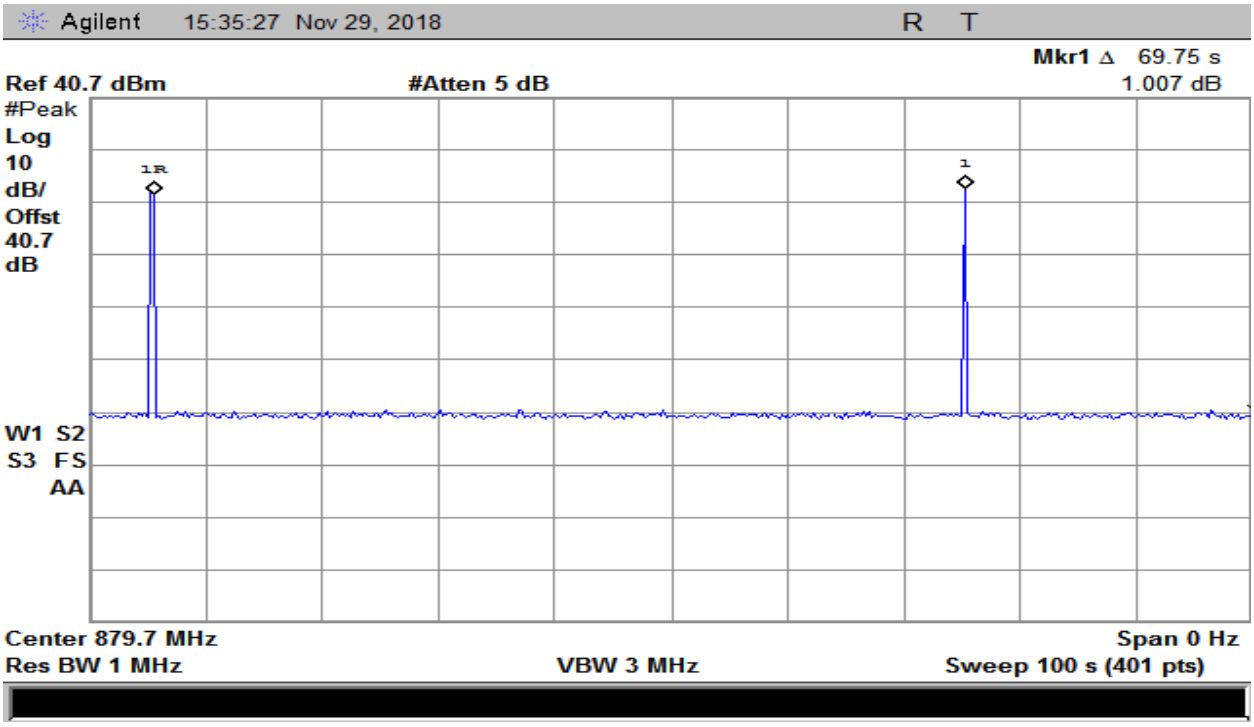
Plot 225 – 1850-1915MHz Band –Uplink Restart Time



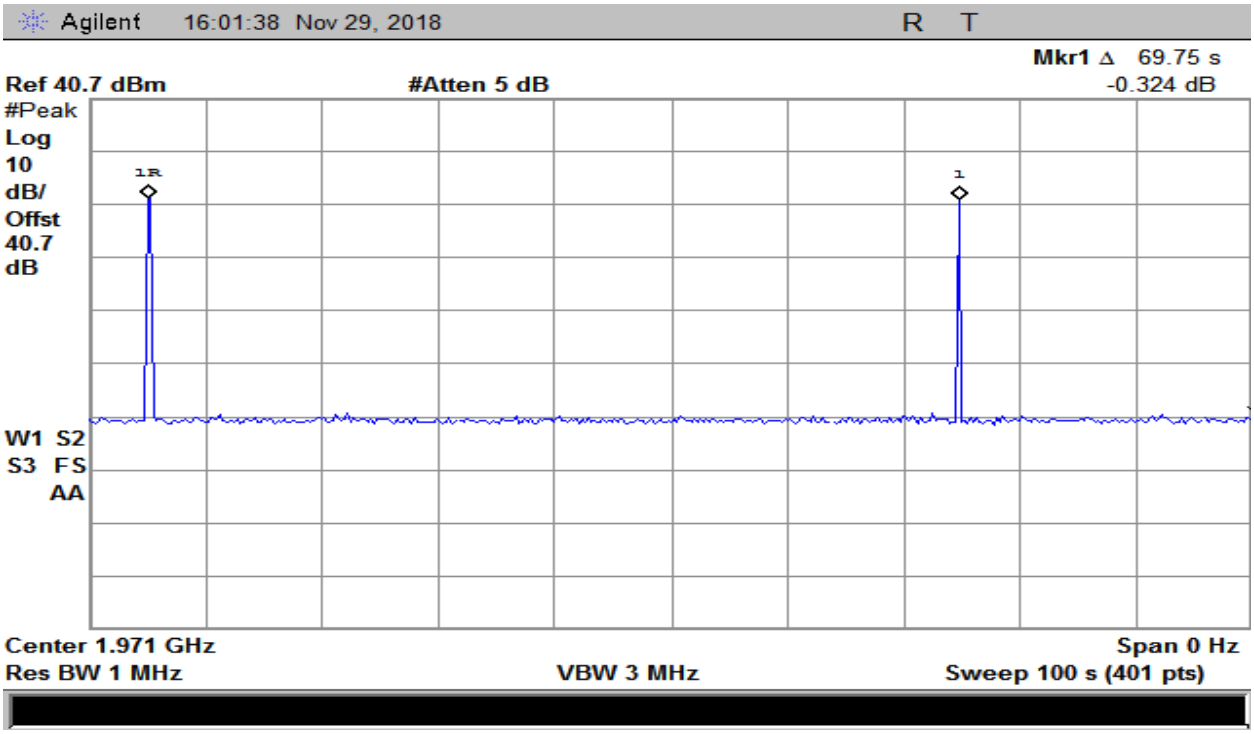
Plot 226 – 728-746MHz Band –Downlink Restart Time



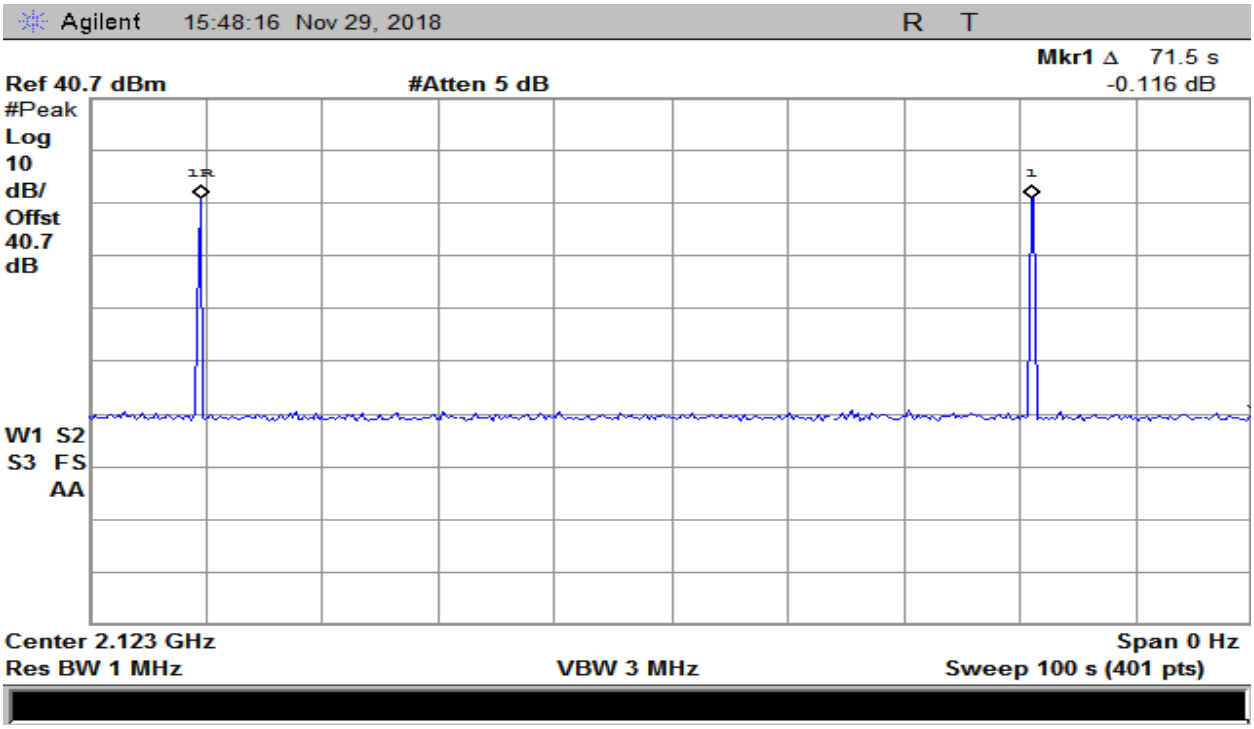
Plot 227 – 746-757MHz Band –Downlink Restart Time



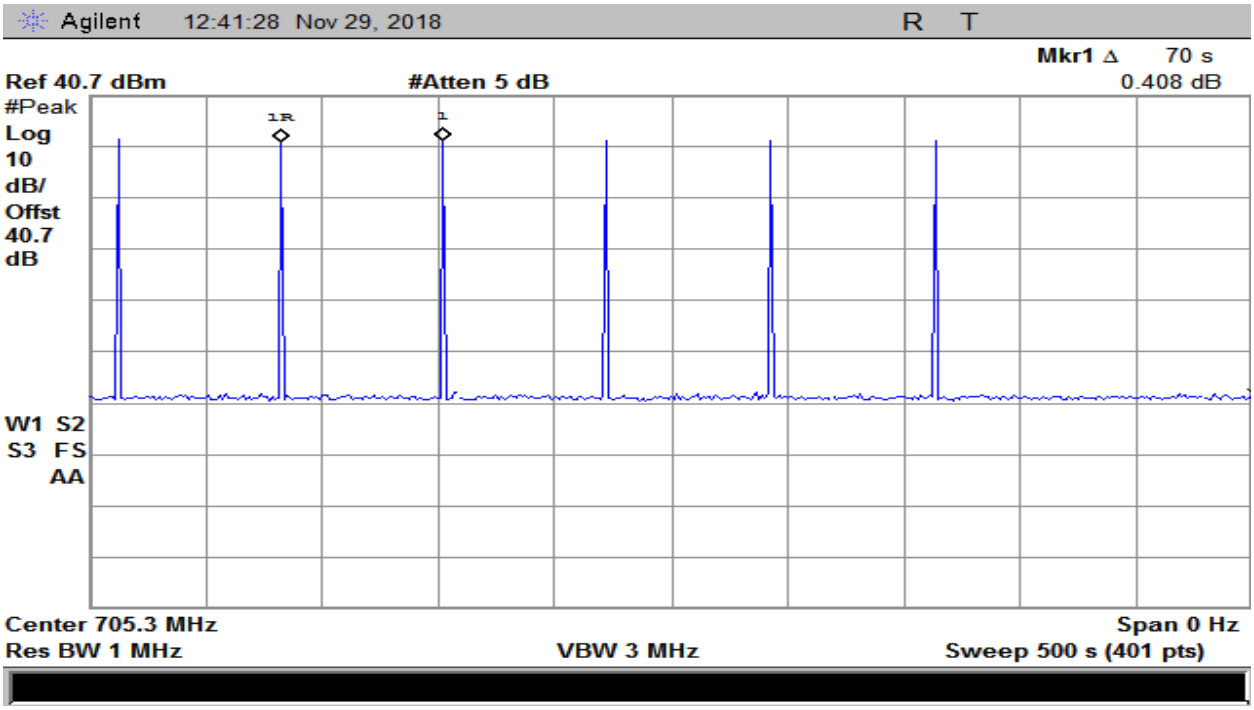
Plot 228 – 869-894MHz Band –Downlink Restart Time



Plot 229 – 1930-1995MHz Band –Downlink Restart Time

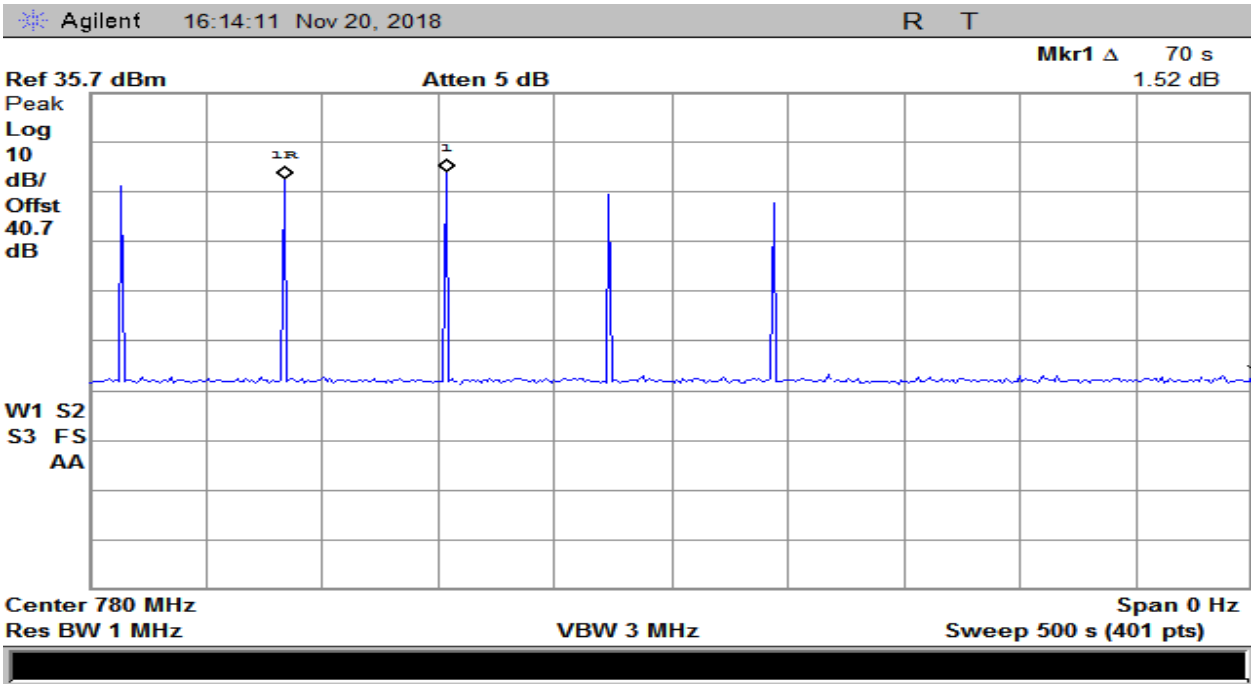


Plot 230 – 2110-2155MHz Band –Downlink Restart Time

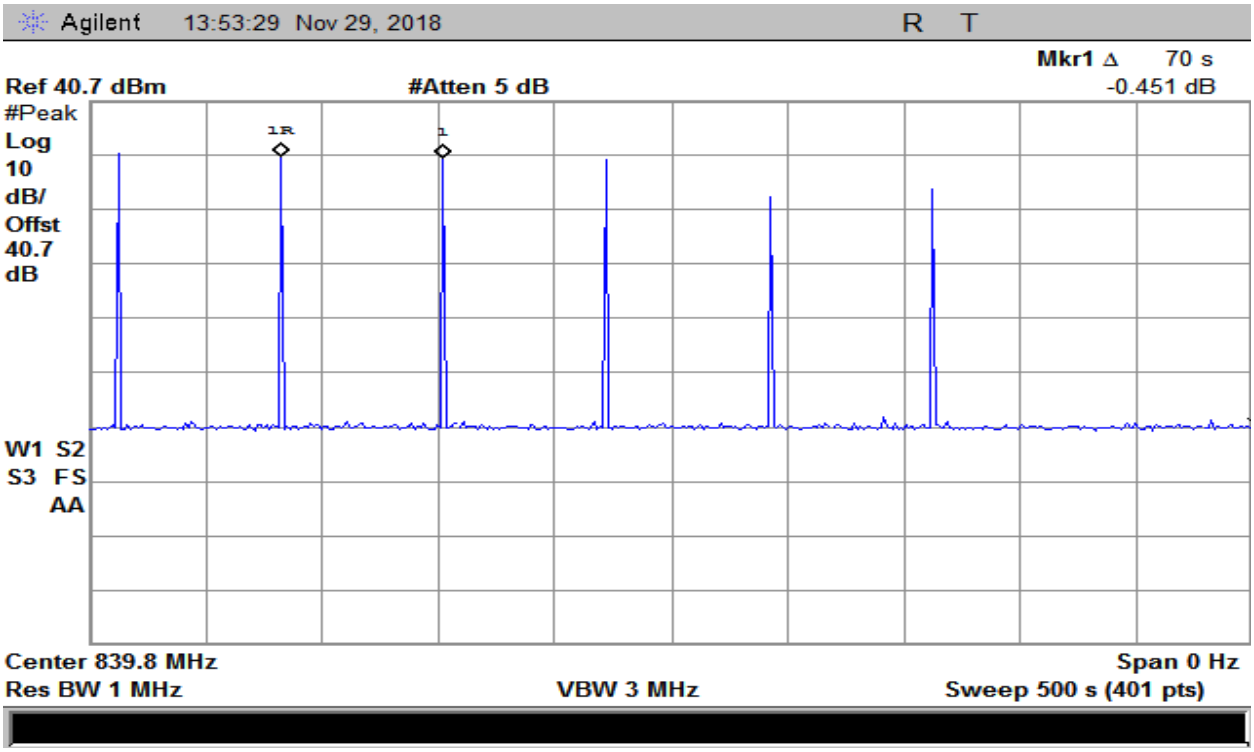


Plot 231 – 698-716MHz Band – Uplink # of Restart Time

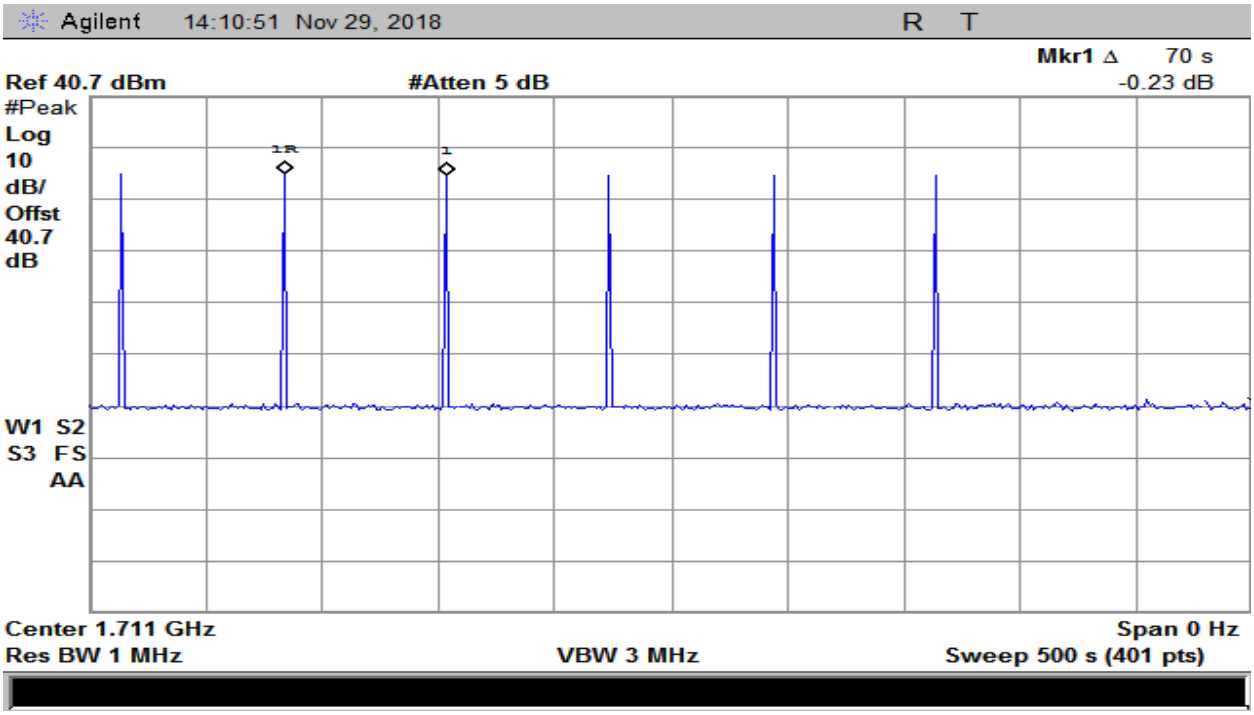
Note: The first pulse is Oscillation Shutdown and startup. Rest are the restart attempts



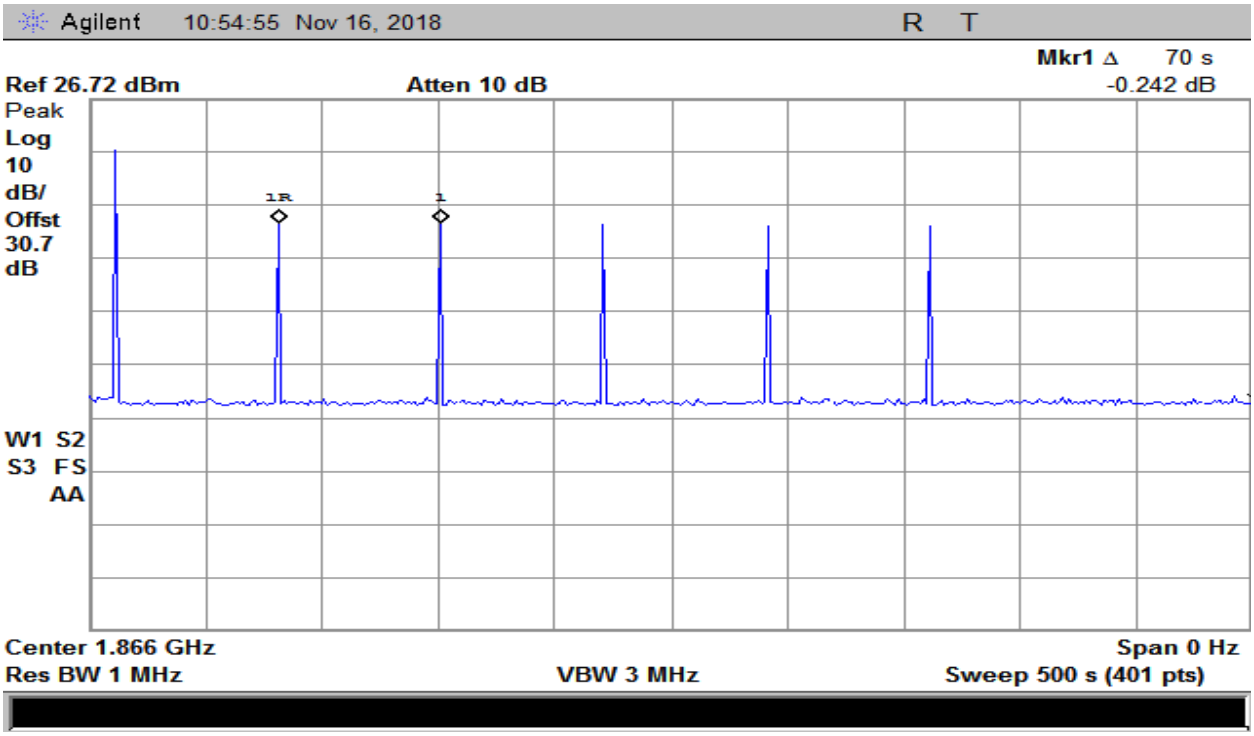
Plot 232 – 776-787MHz Band – Uplink # of Restart Time



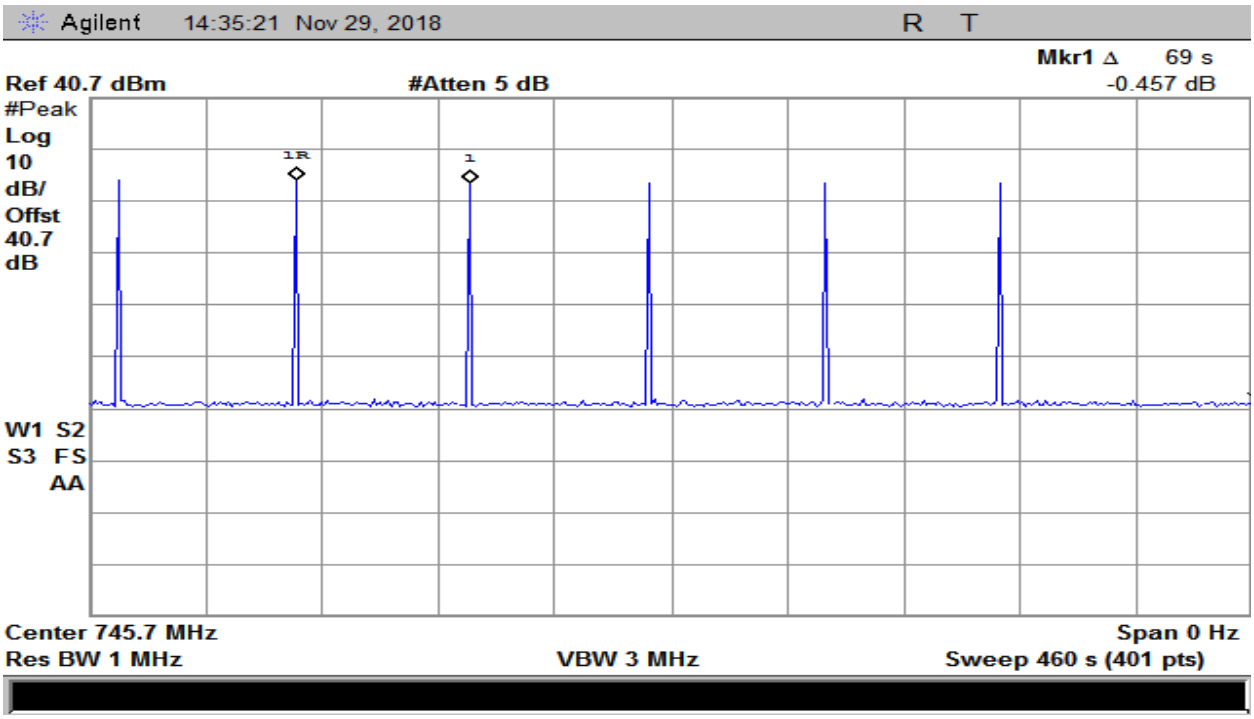
Plot 233 – 824-849MHz Band – Uplink # of Restart Time



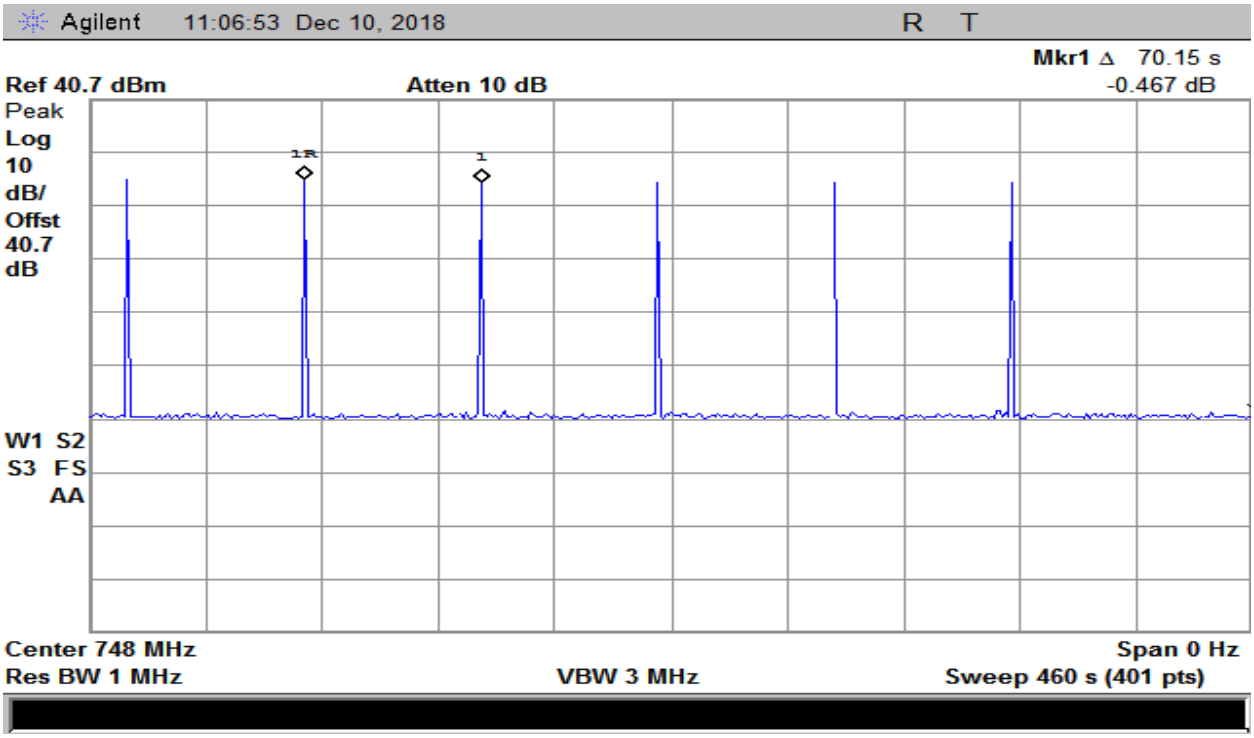
Plot 234 – 1710-1755MHz Band – Uplink # of Restart Time



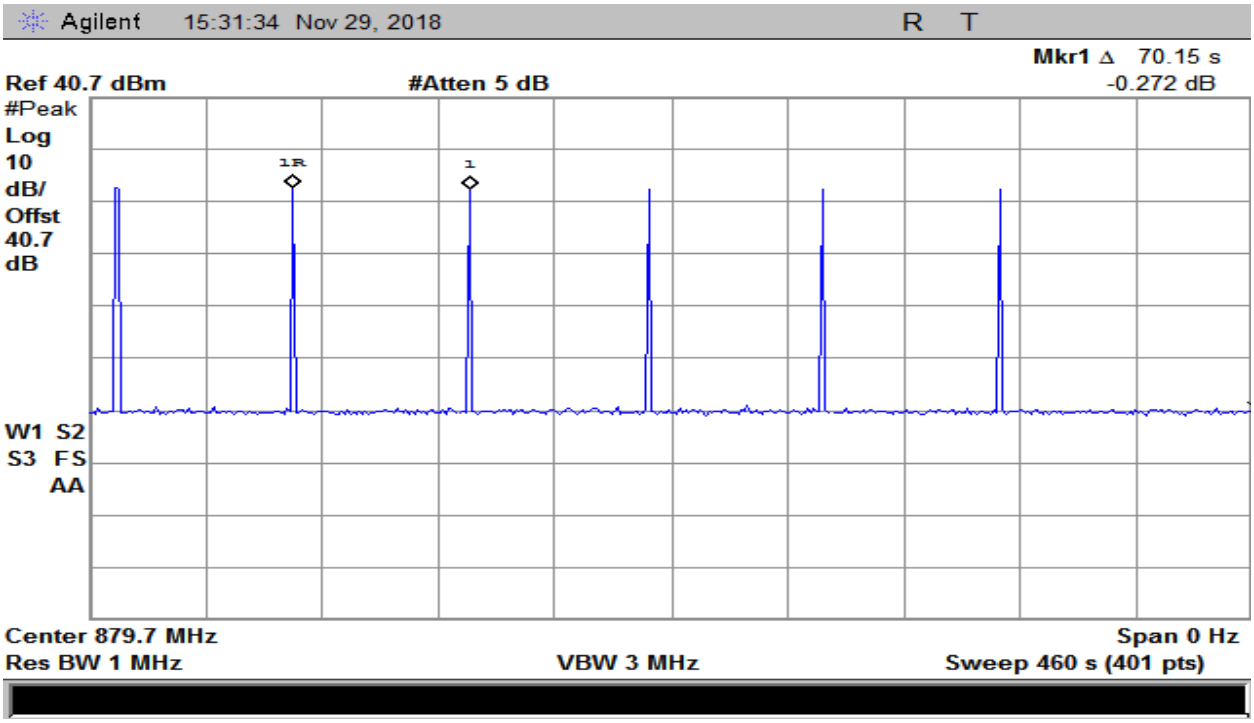
Plot 235 – 1850-1915MHz Band – Uplink # of Restart Time



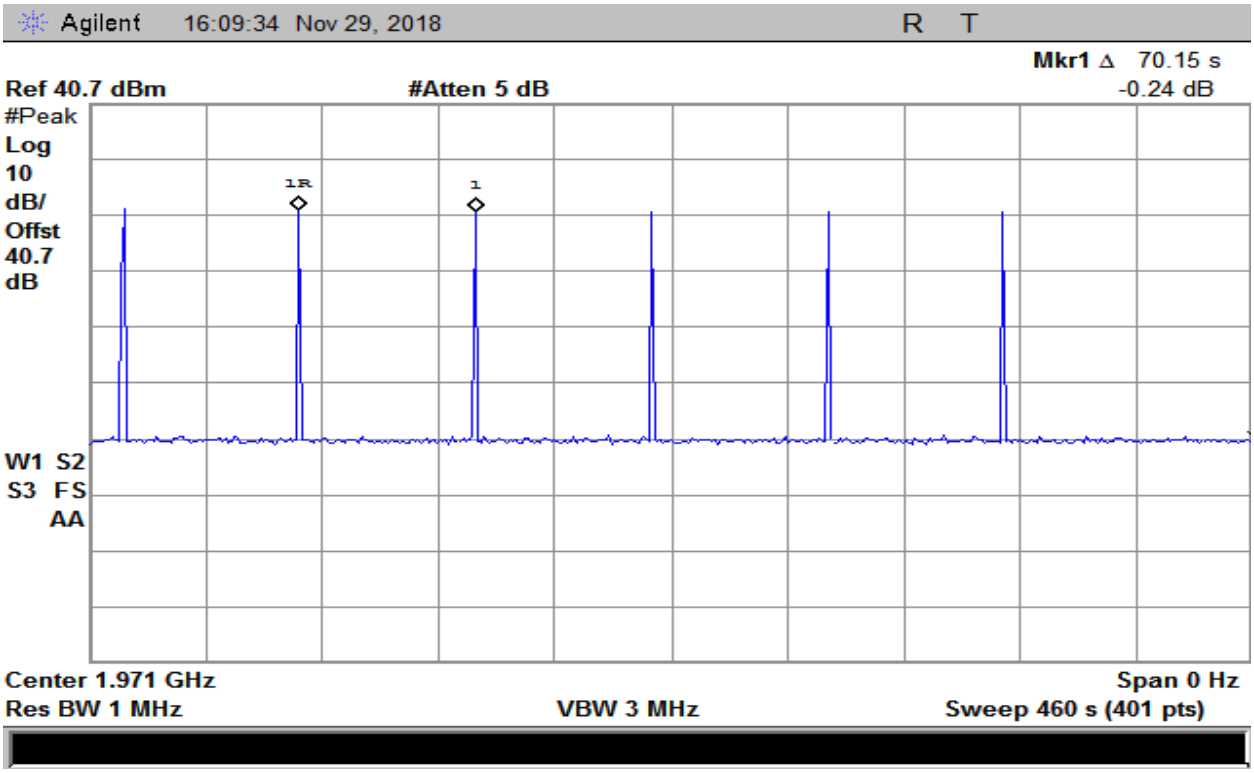
Plot 236 – 728-746MHz Band – Downlink # of Restart Time



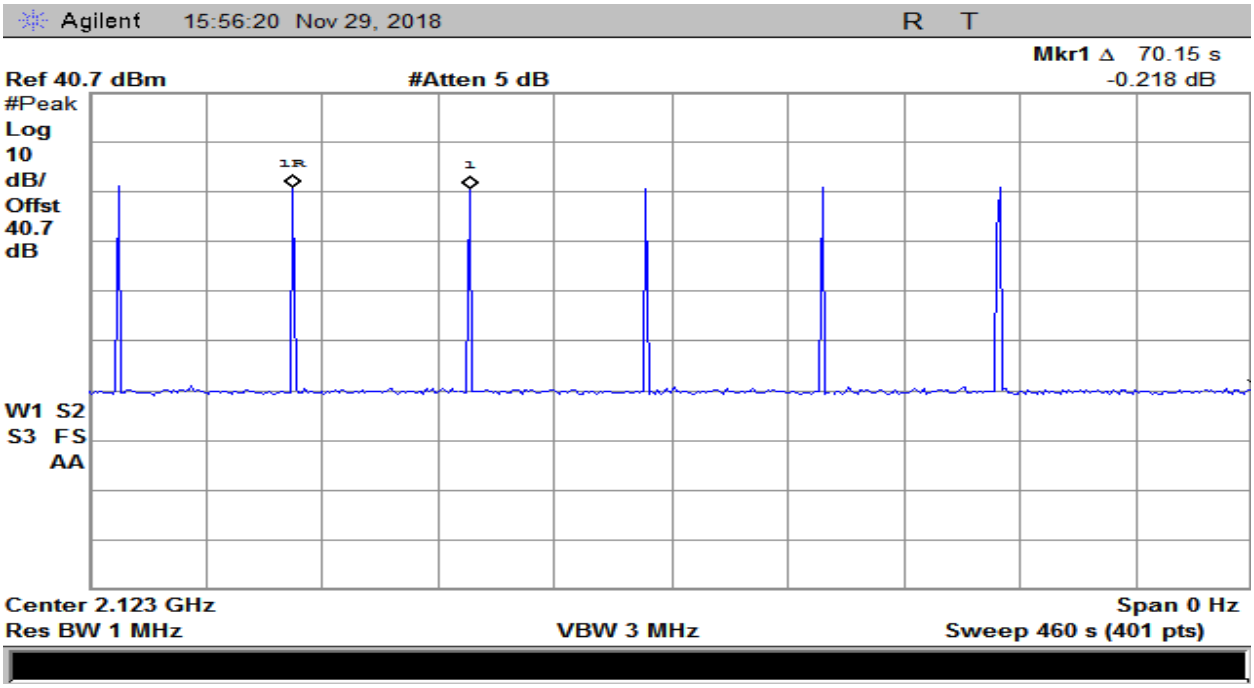
Plot 237 – 746-757MHz Band – Downlink # of Restart Time



Plot 238 – 869-894MHz Band – Downlink # of Restart Time



Plot 239 – 1930-1995MHz Band – Downlink # of Restart Time



Plot 240 – 2110-2155MHz Band – Downlink # of Restart Time

Oscillation Mitigation / Shutdown

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	-54.55	-58.15	3.6	12
+4dB	-54.47	-59.1	4.63	12
+3dB	-55.9	-59.2	3.3	12
+2dB	-55.65	-58.4	2.75	12
+1dB	-55.1	-58.8	3.7	12
0dB	-56.3	-59.6	3.3	12
-1dB	-55.7	-59.1	3.4	12
-2dB	-57	-59.4	2.4	12
-3dB	-56.55	-59.4	2.85	12
-4dB	-56.7	-59.1	2.4	12
-5dB	-57.5	-59.2	1.7	12

Table 42 – 698-716MHz Uplink Band – Mitigation/Shutdown Test Data

**** The device shuts down immediately**

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	-53.2	-58.5	5.3	12
+4dB	-53.4	-58.5	5.1	12
+3dB	-54.2	-58.9	4.7	12
+2dB	-54.1	-59.2	5.1	12
+1dB	-54.2	-59.1	4.9	12
0dB	-56.2	-59.3	3.1	12
-1dB	-56.8	-59.4	2.6	12
-2dB	-55.8	-58.7	2.9	12
-3dB	-56.5	-59.4	2.9	12
-4dB	-56.5	-58.9	2.4	12
-5dB	-56.8	-59.3	2.5	12

Table 43 – 776-787MHz Uplink Band – Oscillation/Shutdown Test Data

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	-54.8	-58.06	3.26	12
+4dB	-53.9	-58.3	4.4	12
+3dB	-55.07	-58.5	3.43	12
+2dB	-54.9	-58.6	3.7	12
+1dB	-56.13	-58.4	2.27	12
0dB	-55.7	-58.7	3	12
-1dB	-56.7	-59	2.3	12
-2dB	-56.4	-58.86	2.46	12
-3dB	-56.3	-59.1	2.8	12
-4dB	-56.9	-58.8	1.9	12
-5dB	-57.1	-58.9	1.8	12

Table 44 – 824-849MHz Uplink Band – Oscillation/Shutdown Test Data

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	**Shutdown	-	-	12
+4dB	-	-	-	12
+3dB	-	-	-	12
+2dB	-	-	-	12
+1dB	-	-	-	12
0dB	-	-	-	12
-1dB	-	-	-	12
-2dB	-	-	-	12
-3dB	-	-	-	12
-4dB	-	-	-	12
-5dB	-	-	-	12

Table 45 – 1710-1755MHz Uplink Band – Oscillation/Shutdown Test Data

**** The device shuts down immediately**

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	-52.01	-56.5	4.49	12
+4dB	-47.2	-56	8.8	12
+3dB	-51.7	-56.3	4.6	12
+2dB	-51.2	-56.4	5.2	12
+1dB	-49.6	-56.1	6.5	12
0dB	**Shutdown	-	-	12
-1dB	-	-	-	12
-2dB	-	-	-	12
-3dB	-	-	-	12
-4dB	-	-	-	12
-5dB	-	-	-	12

Table 46 – 1850-1915MHz Uplink Band – Oscillation/Shutdown Test Data

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	-54.5	-58.8	4.3	12
+4dB	-53.9	-59.1	5.2	12
+3dB	-55.4	-59.4	4	12
+2dB	-54.6	-59.2	4.6	12
+1dB	-56.1	-59.3	3.2	12
0dB	-56.1	-59.1	3	12
-1dB	-56.9	-59.5	2.6	12
-2dB	-57.1	-59.6	2.5	12
-3dB	-56.5	-59.2	2.7	12
-4dB	-57.18	-59.4	2.22	12
-5dB	-57.4	-59.4	2	12

Table 47 – 728-746MHz Downlink Band – Oscillation/Shutdown Test Data

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	-55.5	-58.9	-	12
+4dB	-55.4	-58.5	3.1	12
+3dB	-57.1	-59.47	2.37	12
+2dB	-55.9	-59.2	3.3	12
+1dB	-56.5	-59.4	2.9	12
0dB	-56.8	-59.2	2.4	12
-1dB	-57.1	-59.6	2.5	12
-2dB	-56.7	-59.5	2.8	12
-3dB	-57.2	-59.4	2.2	12
-4dB	-57.1	-59.4	2.3	12
-5dB	-57.3	-59.8	2.5	12

Table 48 – 746-757MHz Downlink Band – Oscillation/Shutdown Test Data

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	-54.4	-58	3.6	12
+4dB	-53.9	-58.01	4.11	12
+3dB	-53.1	-57.9	4.8	12
+2dB	-53.2	-58.2	5	12
+1dB	-54.67	-58.43	3.76	12
0dB	-54.2	-58.47	4.27	12
-1dB	-55.4	-58.5	3.1	12
-2dB	-55.1	-58.8	3.7	12
-3dB	-55.5	-58.7	3.2	12
-4dB	-55.2	-58.6	3.4	12
-5dB	-56.2	-58.9	2.7	12

Table 49 – 869-894MHz Downlink Band – Oscillation/Shutdown Test Data

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	-84.05	-88.56	4.51	12
+4dB	-84.16	-88.5	4.34	12
+3dB	-84.06	-88.6	4.54	12
+2dB	-84.09	-88.5	4.41	12
+1dB	-83.9	-88.6	4.7	12
0dB	-84.03	-88.4	4.37	12
-1dB	-83.87	-88.39	4.52	12
-2dB	-83.71	-88.29	4.58	12
-3dB	-83.7	-88.39	4.69	12
-4dB	-83.66	-88.46	4.8	12
-5dB	-83.6	-88.4	4.8	12

Table 50 – 1930-1995MHz Downlink Band – Oscillation/Shutdown Test Data

Max Gain (dB)	Peak (dBm)	Min (dBm)	Difference (dB)	Limit (dB)
+5dB	-50.58	-61.4	10.82	12
+4dB	-52.9	-62.7	9.8	12
+3dB	-55.4	-64.7	9.3	12
+2dB	-54.8	-64.8	10	12
+1dB	-57.6	-66.82	9.22	12
0dB	-59.1	-68.7	9.6	12
-1dB	**Shutdown	-	-	12
-2dB	-	-	-	12
-3dB	-	-	-	12
-4dB	-	-	-	12
+5dB	-	-	-	12

Table 51 – 2110-2155MHz Downlink Band – Oscillation/Shutdown

10. Radiated Spurious Emissions

Test Requirement(s):	§2.1053	**Test Engineer(s):**	Keith T.
Test Results:	Pass	**Test Date(s):**	Dec/05/2018

Test Procedures: As required by 47 §2.1053, Radiated Spurious Emissions measurement were made in accordance with the procedures of TIA-603 and KDB 935210 D03 §7.12.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was transmitting into a 50Ω non-radiating load which was directly connected to the EUT antenna port as shown in figure 4.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3 orthogonal axis. The frequency range up to the 10^{th} harmonic was investigated.

Spurious attenuation limit in dB = P1- (43 + 10 $\log_{10}$ (P2) = -13dBm

Where P1 = Transmitter Power in dBm and P2= Power in Watt

Test Setup:

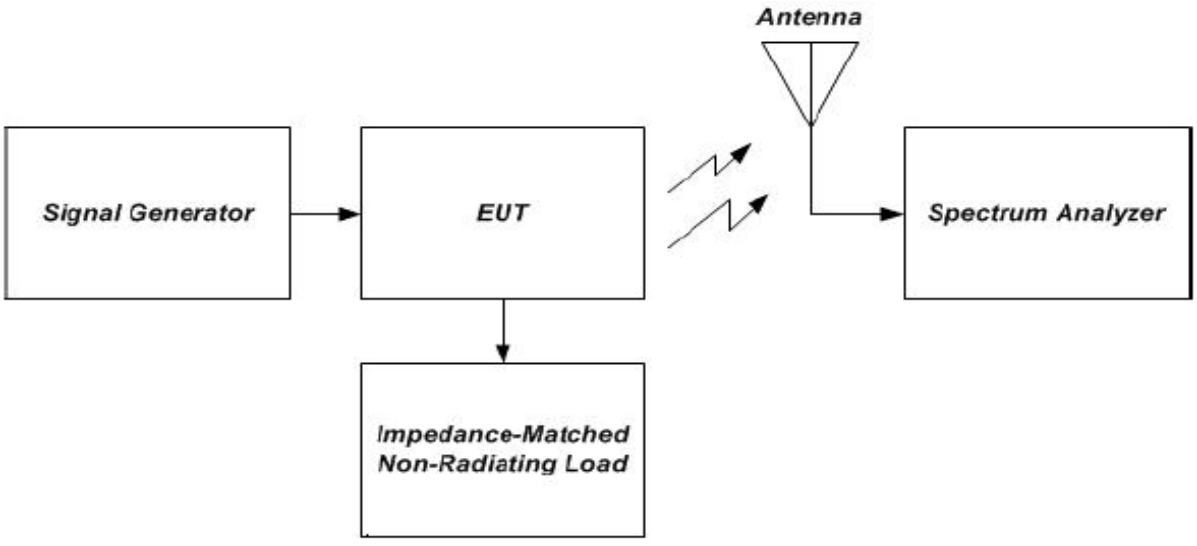
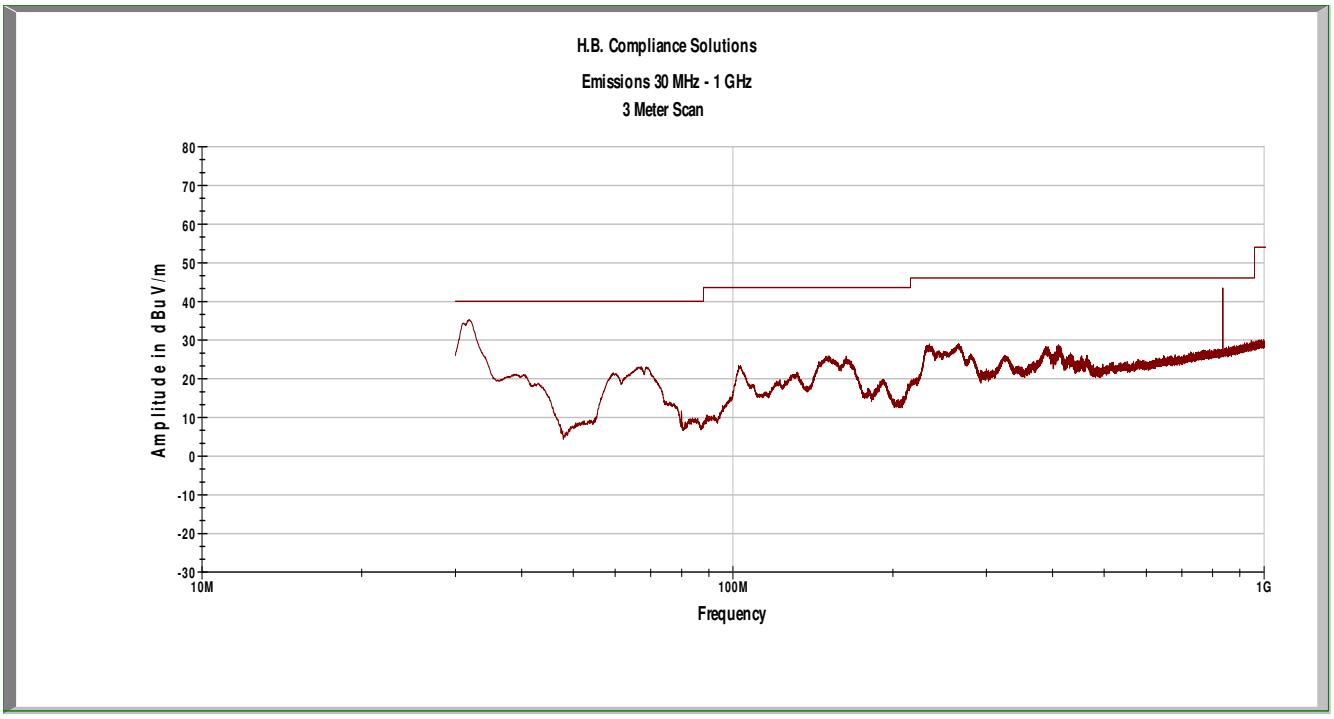


Figure 6 – Radiated Spurious Emission Test Setup



Plot 241 – Radiated Emissions – 30MHz to 1GHz

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
1673	-60.87	-13	-52.87
2509	-63.87	-13	-51.33
3346	-62.53	-13	-49.2

Table 52 – 824-849MHz Uplink Band – Radiated Spurious Test Data

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
3765	-62.2	-13	-48.91
5647	-62.37	-13	-49.25
7530	-59.87	-13	-45.93

Table 53 – 1850-1915MHz Uplink Band – Radiated Spurious Test Data

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
3465	-52.37	-13	-53.02
5197	-62.53	-13	-53.61
6930	-59.03	-13	-46.03

Table 54 – 1710-1755MHz Uplink Band – Radiated Spurious Test Data

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
1415	-63.87	-13	-49.83
2122.5	-32.53	-13	-26.36
2830	-63.2	-13	-49.83

Table 55 – 698-716MHz Uplink Band – Radiated Spurious Test Data

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
1563	-63.53	-13	-47.17
2344	-64.2	-13	-46.0
3126	-60.87	-13	-51.17

Table 56 – 776-787MHz Uplink Band – Radiated Spurious Test Data

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
1763	-64.37	-13	-50.83
2644	-62.37	-13	-47.46
3526	-62.2	-13	-45.58

Table 57 – 869-894MHz Downlink Band – Radiated Spurious Test Data

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
3925	-63.2	-13	-42.39
5887	-63.37	-13	-40.83
7850	-61.03	-13	-37.67

Table 58 – 1930-1995MHz Downlink Band – Radiated Spurious Test Data

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
4265	-62.7	-13	-43.06
6397	-61.53	-13	-41.73
8530	-61.37	-13	-36.28

Table 59 – 2110-2155MHz Downlink Band – Radiated Spurious Test Data

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
1474	-64.7	-13	-49.5
2211	-65.2	-13	-48.29
2948	-60.37	-13	-47.13

Table 60 – 728-746MHz Downlink Band – Radiated Spurious Test Data

Frequency Band (MHz)	Measured Level (dBm)	Limit (dBm)	Margin (dBm)
1503	-63.2	-13	-52.1
2254	-64.7	-13	-47.3
3006	-61.37	-13	-45.07

Table 61 – 746-757MHz Downlink Band – Radiated Spurious Test Data

NOTE: There were no detectable emissions above the 2nd harmonic. Measurement was made above 2nd harmonic to show the Receiver Noise Floor (N.F)

I. Test Equipment

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Due Date
Spectrum Analyzer	Agilent	E4402B	US41192757	Mar/19/18	Mar/19/19
Spectrum Analyzer	Hewlett Packard	8563E	3821A09316	Jan/30/18	Jan/30/19
Directional Coupler	Andrew	C-10-CPUS-N	150503142544	NCR	None
Attenuator 20dB	Weinschel	41-20-12	86332	NCR	None
Variable Attenuator	JFW	50R-320-SMA	7054221439	NCR	None
Signal Generator	Agilent	E4432B	US40053021	NCR	None
Signal Generator	Agilent	E4432B	US38220446	NCR	None
Horn Antenna	Com-Power	AHA-118	071150	Nov/14/18	Nov/14/19
Horn Antenna	Com-Power	AH-118	71350	NCR	None
Antenna	EMCO	GTEM 5417	1063	Verified	None
Attenuator 10dB	Huber+Suhner	6810.17.A	747300	NCR	None
Digital Multimeter	Fluke	77 III	72550270	Jan/30/18	Jan/30/20
Power Supply	Hewlett Packard	6236B	2735A-19608	NCR	None

Table 62 – Test Equipment List

***Statement of Traceability:** Test equipment is maintained and calibrated on a regular basis. All calibrations have been performed by a 17025 accredited test facility, traceable to National Institute of Standards and Technology (NIST)

END OF TEST REPORT