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February 6, 2015

F. Scott Yeager
Universal Repeater
P.O. Box 912
Llano, TX 78743

Dear Scott:

Thank you for allowing Professional Testing (EMI), Inc. an opportunity to perform testing for Universal Repeater LLC. Enclosed is the Wireless Certification Report for the SatMAX. This report can be used to demonstrate compliance with FCC requirements for wireless devices in the United States.

If you have any questions, please contact me.

Sincerely,

Jeffrey A. Lenk
President

Attachment

Project 14426-10

SatMAX

Wireless Certification Report

Prepared for:

Universal Repeater LLC

By

Professional Testing (EMI), Inc.
1601 North A.W. Grimes Blvd., Suite B
Round Rock, Texas 78665

February 6, 2015

Written by

A handwritten signature in black ink, appearing to read "Eric Lifsey". The signature is stylized with a large, looping "E" and a cursive "Lifsey".

Eric Lifsey
Test Engineer

Revision History

Revision Number	Description	Date
00	Draft 2	April 22, 2013
03	Revised to ACB comments	February 11, 2014
04	Revised per ACB comments	March 7, 2014
05	Revised per ACB comments	September 5, 2014
06	Revised per ACB comments	February 6, 2015

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NOTICE:

(1) This Report must not be used to claim product endorsement, by NVLAP, NIST, the FCC or any other Agency. This report also does not warrant certification by NVLAP or NIST.

(2) This report shall not be reproduced except in full, without the written approval of Professional Testing (EMI), Inc.

(3) The significance of this report is dependent on the representative character of the test sample submitted for evaluation and the results apply only in reference to the sample tested. The manufacturer must continuously implement the changes shown herein to attain and maintain the required degree of compliance.



Certificate of Compliance

Applicant: Universal Repeater LLC
 Applicant's Address: P.O. Box 912
 Llano, TX 78743

FCC ID: 05NURSATMAX3UIRID
 Model: SatMAX
 Project Number: 14426-10

The **SatMAX Transceiver** by **Universal Repeater LLC**, was tested utilizing the following documents and found to be in compliance with the required criteria on the indicated test date.

47 CFR, Part 25, 24.202(a)(4)(i)		
Section Reference	Parameter	Date
25.204(a), 25.216(f), 2.1046	Conducted Output Power	February 5, 2014
25.216(f), 25.216(i)	Spurious Low Edge, Conducted at Antenna Terminals	March 4, 2013
25.202(f)(3), 2.1051	Conducted Spurious/Harmonic Emissions at Antenna Terminals	March 4, 2013
2.1053	Field Strength of Radiated Spurious/Harmonic Emissions (1 GHz to 17 GHz)	February 15, 2013
15.107	Mains Conducted Emissions, Class A	February 15, 2013
2.1091(c)	Maximum Permissible Exposure	January 31, 2014
-	Amplifier Overload & Bandwidth	February 4, 2014

I, Jeffrey A. Lenk, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures, have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.

Jeffrey A. Lenk
 President

This report has been reviewed and accepted by Universal Repeater LLC. The undersigned is responsible for ensuring that the SatMAX Transceiver by Universal Repeater LLC, will continue to comply with the applicable rules.

Representative of Universal Repeater LLC

1.0 Introduction

1.1 Scope

This report describes the extent to which the equipment under test (EUT) conformed to the intentional radiator requirements of the United States.

Professional Testing (EMI), Inc., (PTI) follows the guidelines of National Institute of Standards and Technology (NIST) for all uncertainty calculations, estimates, and expressions thereof for electromagnetic compatibility testing. The procedures of TIA/EIA 603 were used for making all radiated enclosure and mains emission measurements.

1.2 EUT Description

The EUT is the **SatMAX** by **Universal Repeater LLC**, a device to extend the range of Iridium satellite cellular devices into buildings or structures that would otherwise present excessive loss to satellite signals. It is composed of two individual analog RF amplifiers, designated Uplink and Downlink, housed in a portable enclosure. The enclosure includes an AC power supply/charger and backup battery. It is supplied with four external Iridium antennas and long RF cables with separation requirements to avoid RF feedback. The system as tested consisted of the following:

Table 1.2.1: Equipment Under Test

Manufacturer	Model	Serial #	Description
Universal Repeater LLC	SatMAX	None	Satellite repeater

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations. The two RF amplifiers operate over identical bands of frequencies but have significantly different power outputs.

The 1st amplifier receives Iridium satellite signals on the outdoor downlink antenna (commonly on the roof of the host structure), then drives another antenna positioned inside the structure to radiate the signals to Iridium phones. Due to proximity of the Iridium phones, this amplifier has a much lower power output than the other amplifier.

The 2nd amplifier provides the reverse signal path up to the satellite. The received signals from Iridium phones inside the structure are amplified and sent to the outdoor uplink antenna to the Iridium satellites. This amplifier has a much higher power output to overcome the greater path loss. As this antenna is only effective on the roof of a structure, the exposure to its RF fields are limited to that area.

Cavity bandpass filtering is added to the outputs of both RF amplifiers to suppress unwanted harmonic or spurious emissions.

No frequency conversion takes place. No RF oscillators are present in the design.

The SatMAX is housed in a durable portable enclosure to allow rapid deployment in adverse environmental conditions.



Photograph 1.3.1: EUT Front and Back

1.4 Modifications to Equipment

No modifications were made to the EUT during the performance of the test program.

1.5 Test Site

Measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 459644, IC 3036B-1) in Austin, Texas. The site is registered with the FCC under Section 2.948 and Industry Canada per RS-212, and is subsequently confirmed by laboratory accreditation (NVLAP). The test site is located at 11400 Burnet Road, Austin, Texas 78758, while the main office is located at 1601 North A.W. Grimes Boulevard, Suite B, Round Rock, Texas, 78665.

2.0 Applicable Documents and Clauses

This device operates on frequencies assigned to the Iridium satellite communication services, as such 47 CFR, Part 25, applies as shown below.

Table 2.0.1: Applicable Documents

Document #	Title/Description
47 CFR	Part 25 – Satellite Communications
47 CFR	Part 15 – 15.107 AC Mains Conducted Emissions
TIA/EIA-603C 2004	Land Mobile FM or PM Communications Equipment, Measurement and Performance Standards

Table 2.0.2: Applicable Clauses

Clause Subject	Section References	Required?	Result
Conducted Output Power	25.204(a), 25.216, 2.1046	Yes	Pass
Spurious Low Edge, Conducted at Terminals	25.216(f)	Yes	Pass
Conducted Spurious/Harmonic Emissions at Antenna Terminals	25.202(f), 2.1051	Yes	Pass
Field Strength of Radiated Spurious/Harmonic Emissions (1 GHz to 17 GHz)	25.202(f), 2.1053	Yes	Pass
Mains Conducted Emissions, Class A ¹	15.107	Yes	Pass
Frequency Stability ²	25.202(d), 2.1055	N/A	N/A
Occupied Bandwidth, 20 dB ²	2.1049	N/A	N/A
Maximum Permissible Exposure ³	Reported separately.	Yes	Pass
Application Report Requirements	2.1033(c)	Yes	N/A
Amplifier Overload & Bandwidth	-	Yes	Yes

¹This device generates and uses RF energy in the form of a switching power supply, such that 47 CFR, Part 15, applies. Therefore conducted emissions were measured.

²This device uses RF signals by amplification only and does not contain any oscillators, modulators, or mixing stages. Therefore a measurement of frequency stability and occupied bandwidth is not applicable. However, additional tests of input vs output bandwidth are presented.

³This device operates at 1.6 GHz such that the FCC 2.1091(c) criteria for Part 25 devices apply as follows: “... operate at frequencies above 1.5 GHz and their ERP is 3 watts or more.”

3.0 Conducted Output Power

Conducted output power measurements were made on the two sections of the EUT. The lowest, center, and highest operating frequency channels of the Iridium band were investigated for each.

3.1 Test Procedure

The test configuration for one amplifier setup is diagrammed in Figure 3.1.1. Except for radiated emission tests, the Source signal for the EUT was supplied by an Iridium simulator card. The simulator card was controlled by a laptop PC which allowed channel selection. Attenuation of the Source signal was required to emulate the path loss of an actual application and drive the amplifier to full output. Output attenuation was provided to protect the Spectrum Analyzer from excessive power.

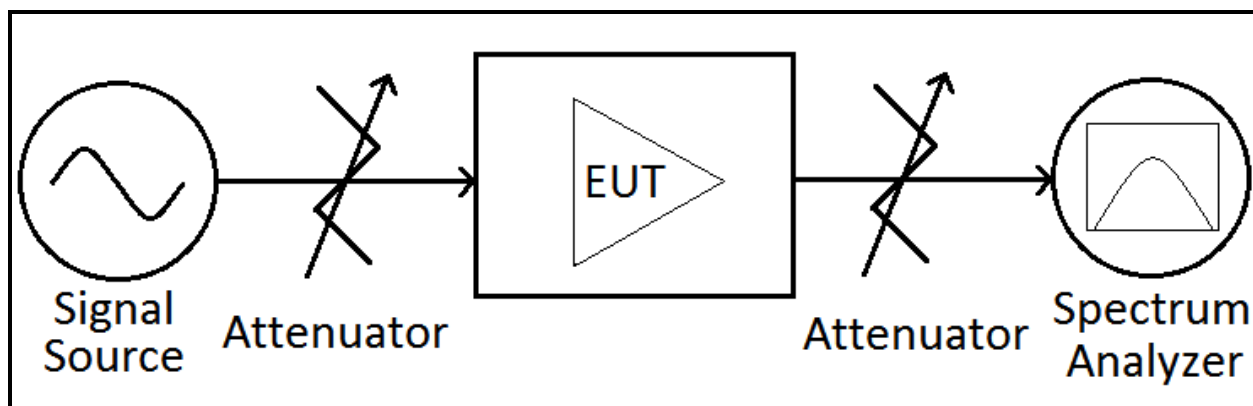


Figure 3.1.1: Conducted Power Output Test Setup

In the case of radiated spurious emission tests, the USB Iridium emulator proved to be a source of high unwanted emissions and so a signal generator was substituted.

3.2 Test Criteria

Section Reference	Parameter	Date(s)
25.204(a), 25.216, 2.1046	Conducted Output Power	February 5, 2014

3.3 Test Results

The conducted output power measurements for the EUT were taken on the date(s) cited above. Measured maximum output power, taken from the overload measurement of each amplifier, is added to antenna gain to arrive at EIRP level and compared to the limit.

The EUT was found to be in compliance with the applicable requirements.

3.3.1 Uplink

Uplink at Saturation*						
Channel MHz	Corrected Peak Power (dBm)	Antenna Gain (dBi)	Power With Antenna Gain (dBm)	Power In Limit Terms (dBW)	Limit EIRP (dbW)	Margin (dB)
1616	36.0	4.4	40.4	10.4 dBW	40	-29.6
1621	38.4	4.4	42.8	12.8 dBW	40	-27.2
1626.5	38.1	4.4	42.5	12.5 dBW	40	-27.5

*Measured at point of no change or saturation.

3.3.2 Downlink

Downlink at Saturation*						
Channel MHz	Corrected Peak Power (dBm)	Antenna Gain (dBi)	Power With Antenna Gain (dBm)	Power In Limit Terms (dBW)	Limit EIRP (dbW)	Margin (dB)
1616	9.1	4.4	13.5	-16.5 dBW	40	-56.5
1621	13.9	4.4	18.3	-11.7 dBW	40	-51.7
1626.5	13.6	4.4	18.0	-12.0 dBW	40	-52.0

*Measured at point of no change or saturation.

3.3.3 Antenna

Antenna Manufacturer and Model	Specifications
Antcom Corporation S3IR16RR-P-XT-1	Frequency: 1610.0-1626.5 MHz Polarization: RHCP Gain: +4.4 dBi Axial Ratio: 2.0dB Impedance: 50 OHMS Size: 3.50 in diameter (88.90 mm) Height: 0.583 in. (14.81 mm)
Source: http://www.iridium.com/	

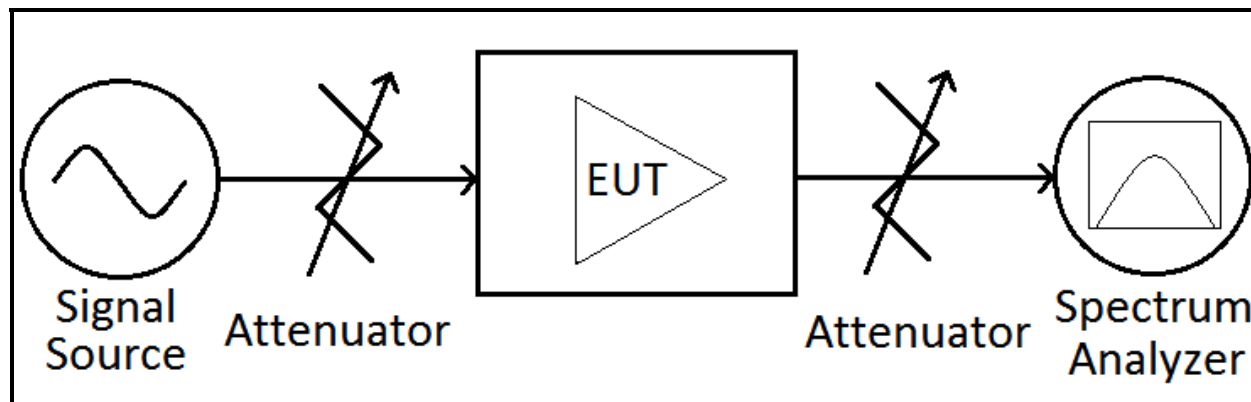


4.0 Spurious Emission Low Edge

Measurements of spurious emissions per the required limits at antenna terminals were taken on the EUT to determine the compliance as follows.

4.1 Test Procedure

The test configuration for one section is diagrammed below. The Source signal for the EUT was supplied by an Iridium simulator card. The simulator card was controlled by a laptop PC which allowed channel selection. Attenuation of the Source signal was required to emulate the path loss of an actual application and drive the amplifier to full output. Output attenuation was provided to protect the Spectrum Analyzer from excessive power.



4.2 Test Criteria

Section Reference	Parameter	Date
25.216(c), 25.216(f)	Emission Bottom Edge, Conducted at Terminals	March 4, 2013

This test limits unwanted emissions on two specified bands below the lowest operating frequency. The first band for 25.216(c) is a flat limit while the 2nd band for 25.216(f) has a sloping limit. The limit is expressed in units of dBW and converted below to dBm. This measurement is done for non-discrete emissions using resolution bandwidth of 1 MHz with video bandwidth of 3 MHz. Results are adjusted upward by antenna gain of 4.4 dBi.

The EUT has no signal generating capability, no oscillators, and consequently no mixing products possible. Therefore the 700 Hz bandwidth discrete signal measurement of 25.216(c) is not applicable.

Section Reference	Frequency Range	Limit (/MHz)
25.216(c)	1.559 to 1.605 GHz	-70 dBW (-40 dBm)
25.216(f)	1.605 to 1.610 GHz	-70 dBW to -10 dBW (linear interpolation)

The sloping limits from 1.605 to 1.610 GHz were interpolated and a minimum of four frequencies were selected to investigate.

4.3 Test Results

For the downlink amplifier, it was found that no signals could be seen and instead the noise floor levels were recorded.

4.3.1 Uplink

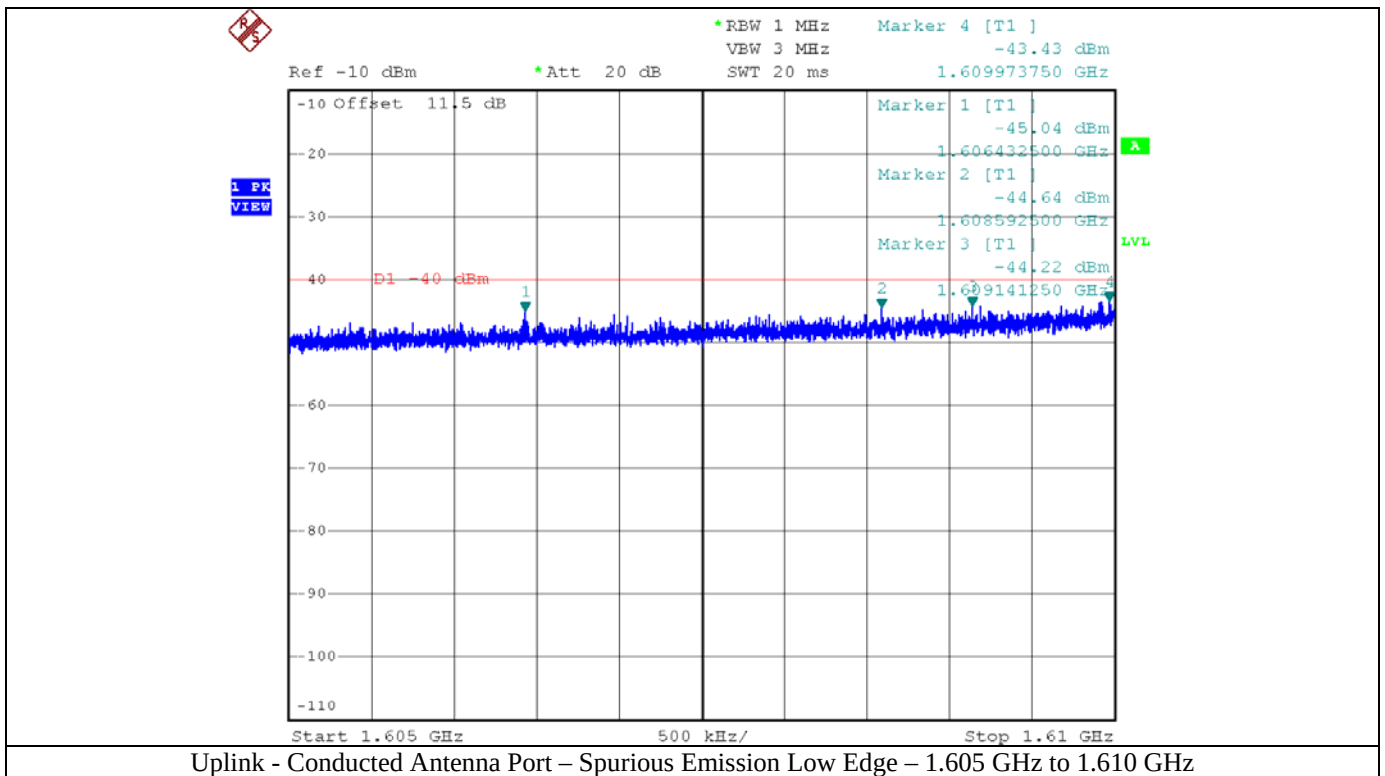
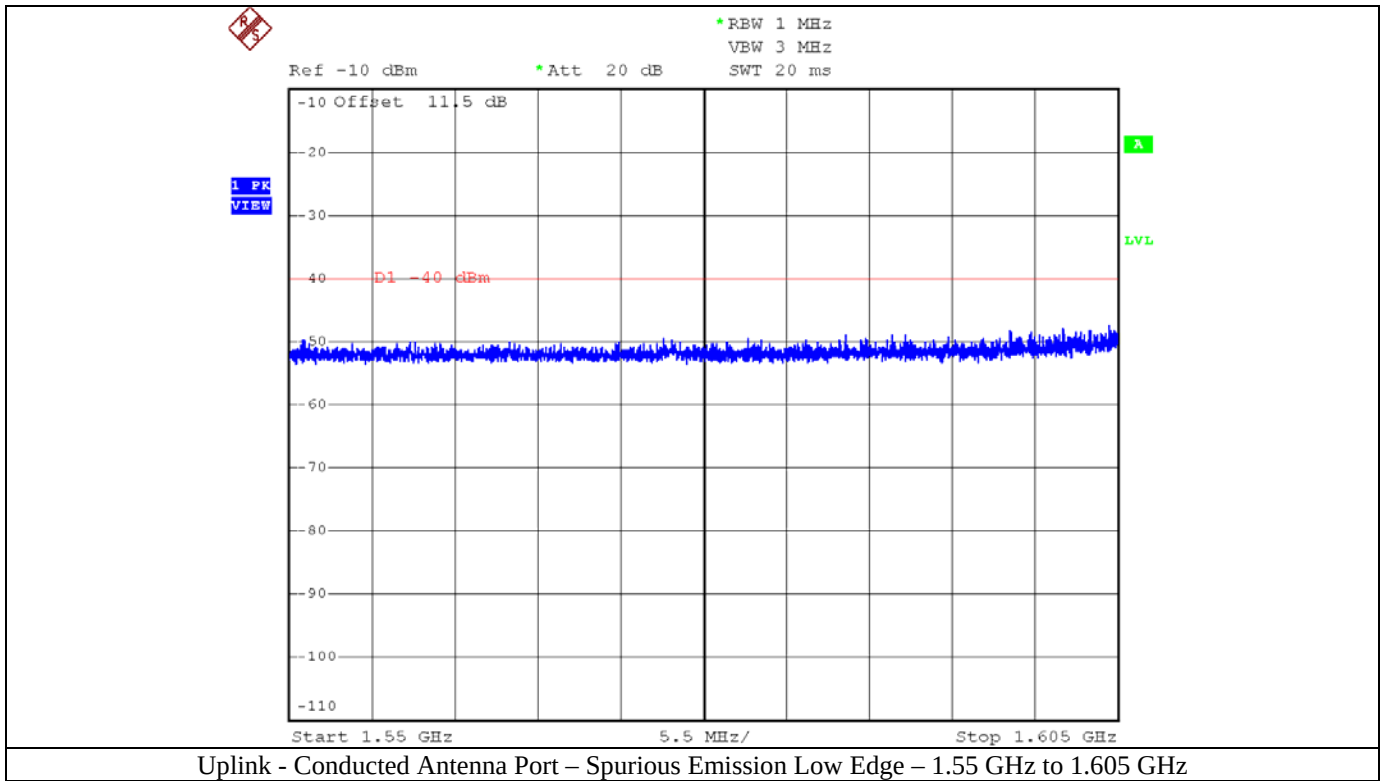
In this test measurement factors were directly added to the spectrum analyzer amplitude offset. This includes external attenuation and cable loss. The results can be seen directly on the plots below with highest points selected for the table below.

Frequency (GHz)	Measured Level (dBm)	Antenna Gain*** Added (dBm)	Clause Limit (dBW/MHz)	Restated Limit (dBm)	Margin (dB)
1.60000*	-48.00*	-43.60	-70.00	-40.00	-3.60
1.60643	-45.02	-40.62	-52.84**	-22.84**	-17.8
1.60859	-44.65	-40.25	-26.92**	3.08**	-43.3
1.60914	-44.22	-39.82	-20.32**	9.68**	-49.5
1.60997	-43.43	-39.03	-10.36**	19.64**	-58.7

*Visually taken from plot as highest signal over the whole plot.

** Calculated limit from interpolation of 25.216(f) limits.

*** Antenna gain 4.4 dBi.



Note that the -40 dBm (-70 dBW) limit line appears above but is only relevant at the lowest edge of the plot as the limit slopes upward with increasing frequency.

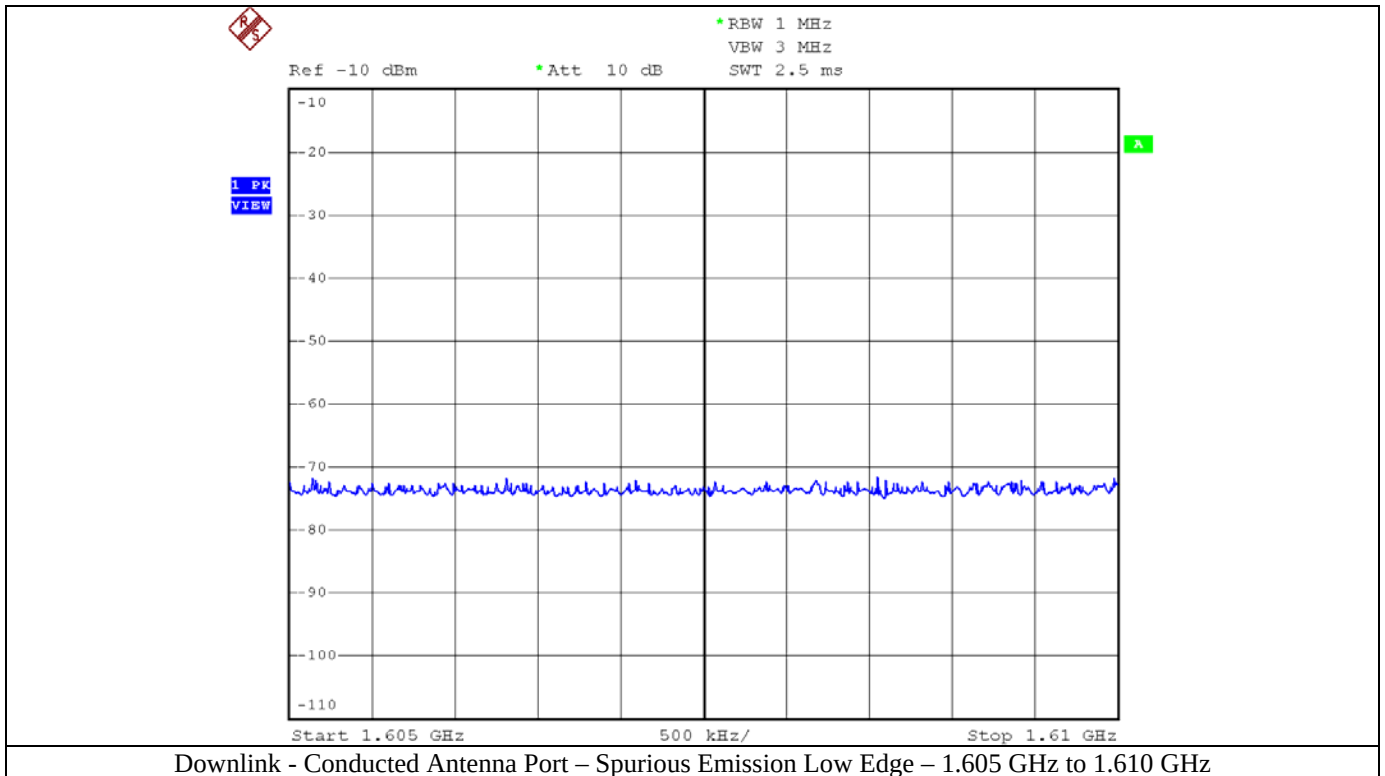
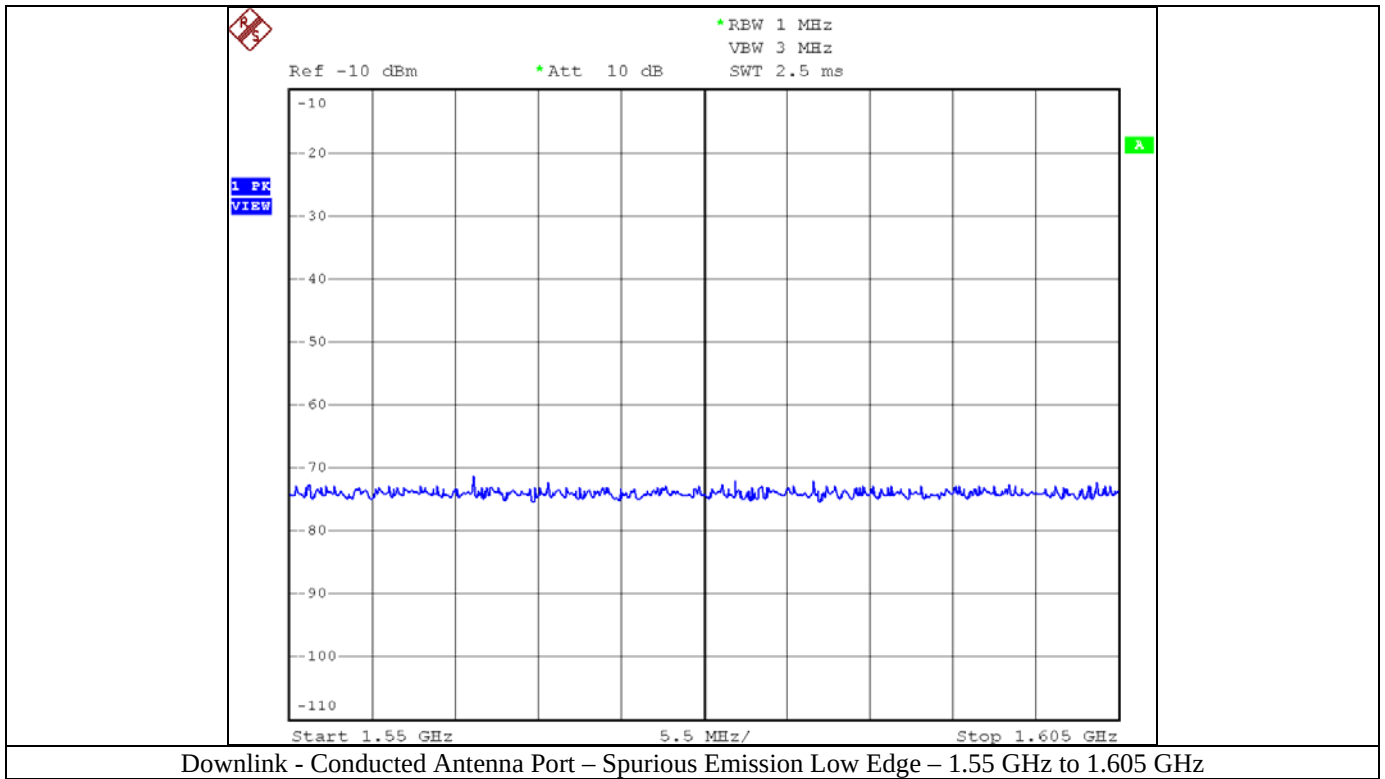
4.3.2 Downlink

In this test factors were added to uncorrected spectrum analyzer measurements using a spreadsheet. The power levels were low such that external attenuation was not required.

Professional Testing (EMI), Inc.								
Conducted RF Port Measurements: DOWNLINK								
Client: Universal Repeater			Preamp: 2					
Test Date: March 4, 2013			EUT: Downlink Amplifier					
Voltage: 110 VAC 60 Hz			Serial #: 0					
Frequency: n/a			Project #: 14426					
Technician: Eric Lifsey			Test Type: 25.216(c)(f)			Class:	N/A	
Corrected Level = Recorded Level - Amplifier Gain + Antenna Factor + Cable Loss								
Frequency (GHz)	FCC Section	Recorded Level (dBm)	Attenuator Loss (dB)	Cable Loss (dB)	Corrected Level dBm	Limit (dBm)	Margin (dB)	Detector Function
1.605	25.216(f)	-71	0.0	1.52	-69.5	-40	-29.5	peak
1.606	25.216(f)	-71	0.0	1.52	-69.5	-28	-41.5	peak
1.607	25.216(f)	-71	0.0	1.53	-69.5	-16	-53.5	peak
1.608	25.216(f)	-71	0.0	1.53	-69.5	-4	-65.5	peak
1.609	25.216(f)	-71	0.0	1.53	-69.5	8	-77.5	peak
1.610	25.216(f)	-71	0.0	1.53	-69.5	20	-89.5	peak

No signals were present so noise floor levels were recorded above.

The measurements shown in the table above does not include the antenna gain of 4.4 dBi. Since the worse-case margin would be -25.1 dB with antenna gain added, the exercise of adding antenna gain to the measurements is omitted.



5.0 Spurious Emissions at Antenna Terminals

Measurements of spurious emissions at antenna terminals were taken on the EUT to determine the compliance as follows.

5.1 Test Procedure

The test configuration for one section is diagrammed in Figure 5.1.1. The Source signal for the EUT was supplied by an Iridium simulator card. The simulator card was controlled by a laptop PC which allowed channel selection. Attenuation of the Source signal was required to emulate the path loss of an actual application and drive the amplifier to full output. Output attenuation was provided to protect the Spectrum Analyzer from excessive power.

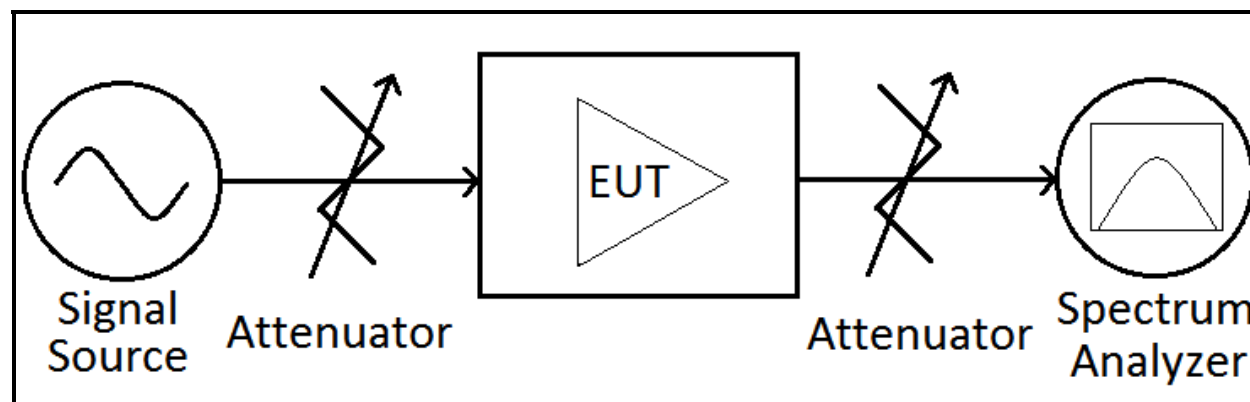


Figure 5.1.1: Spurious Emissions at Antenna Terminals Test Setup

5.2 Test Criteria

Guideline	Section Number	Required?	Result
Conducted Spurious/Harmonic Emissions at Antenna Terminals	25.202(f)(3), 2.1051	Yes	Pass

Per 25.202(f)(3) applicable clause, emissions in any 4 kHz band, outside 250% of the authorized bandwidth, are to be attenuated by $43 + 10 \log(\text{Power})$ in dB. Attenuation is determined below:

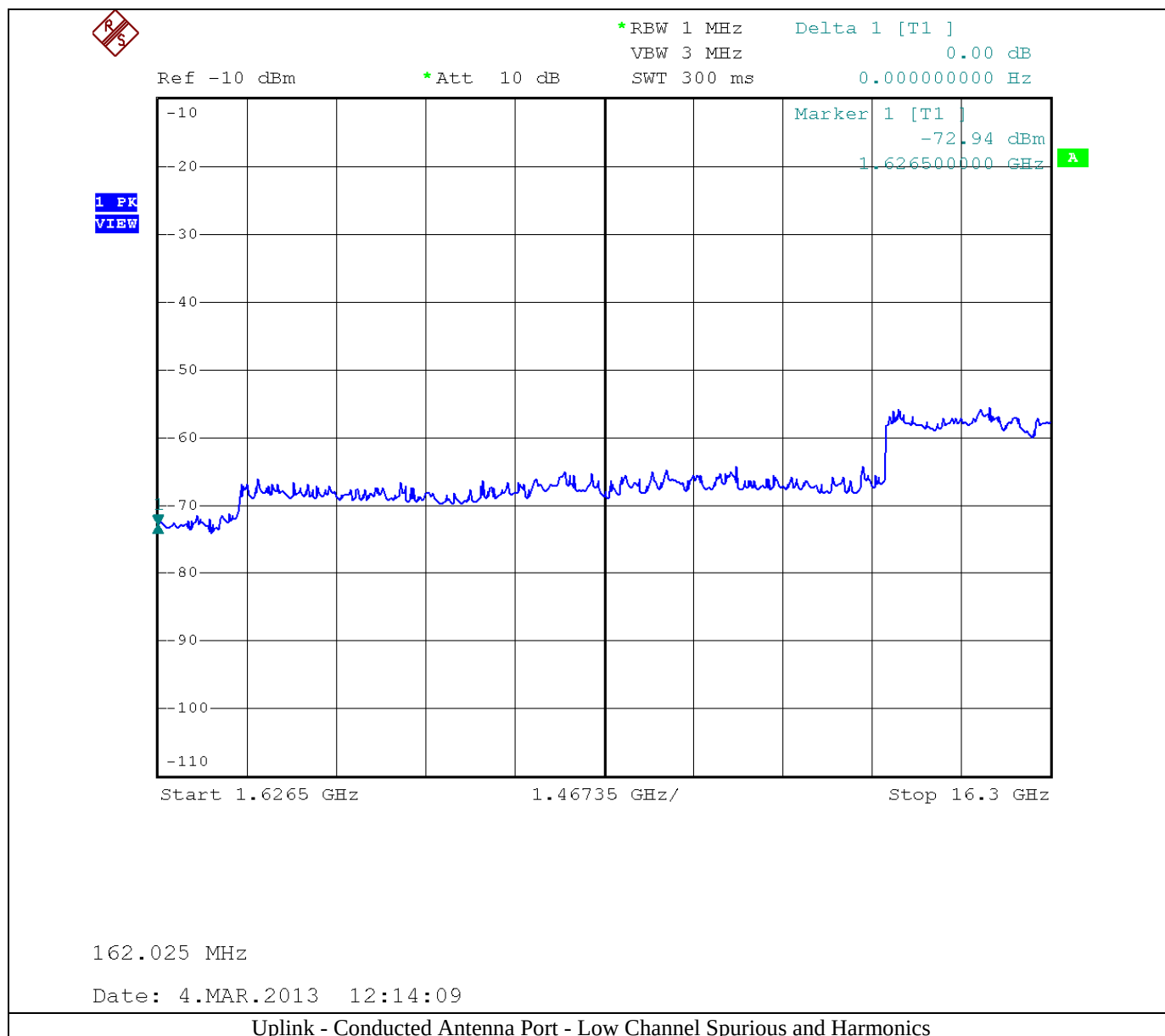
EUT Section	Measured Power (dBm)	Correction Factors Attn(dB)+Cable(dB)	Corrected Power (dBm)	Power In Linear Terms	25.202(f)(3) Attenuation (dB)	Limit Per 25.202(f)(3) (dBm)
Uplink	-12.00	$40.35 + 1.54 = 41.89$	29.89	975 mW	42.9	-13
Downlink	-16.28	$0 + 1.54 = 1.54$	-14.74	33.6 mW	28.26	-43

Note that per 25.216(f), protection of aeronautical radio navigation, specifies the limit of -70dBW also applies which converts to -40 dBm and is applied to the frequency range of 1605 to 1610 MHz.

5.3 Test Results

EUT was found to be in compliance with applicable requirements.

5.3.1 Uplink



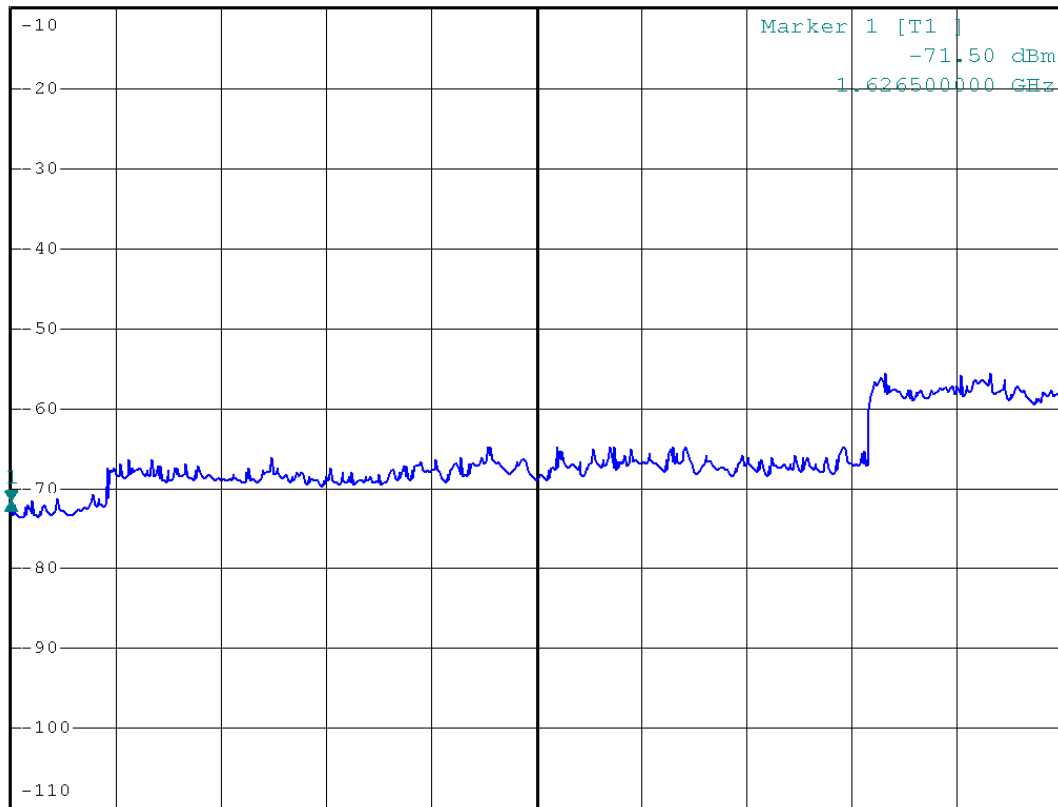


*RBW 1 MHz Delta 1 [T1]
VBW 3 MHz 0.00 dB
SWT 300 ms 0.000000000 Hz

Ref -10 dBm

*Att 10 dB

1 PK
VIEW



Start 1.6265 GHz

1.46735 GHz/

Stop 16.3 GHz

162.025 MHz

Date: 4.MAR.2013 12:13:03

Uplink - Conducted Antenna Port - Center Channel Spurious and Harmonics

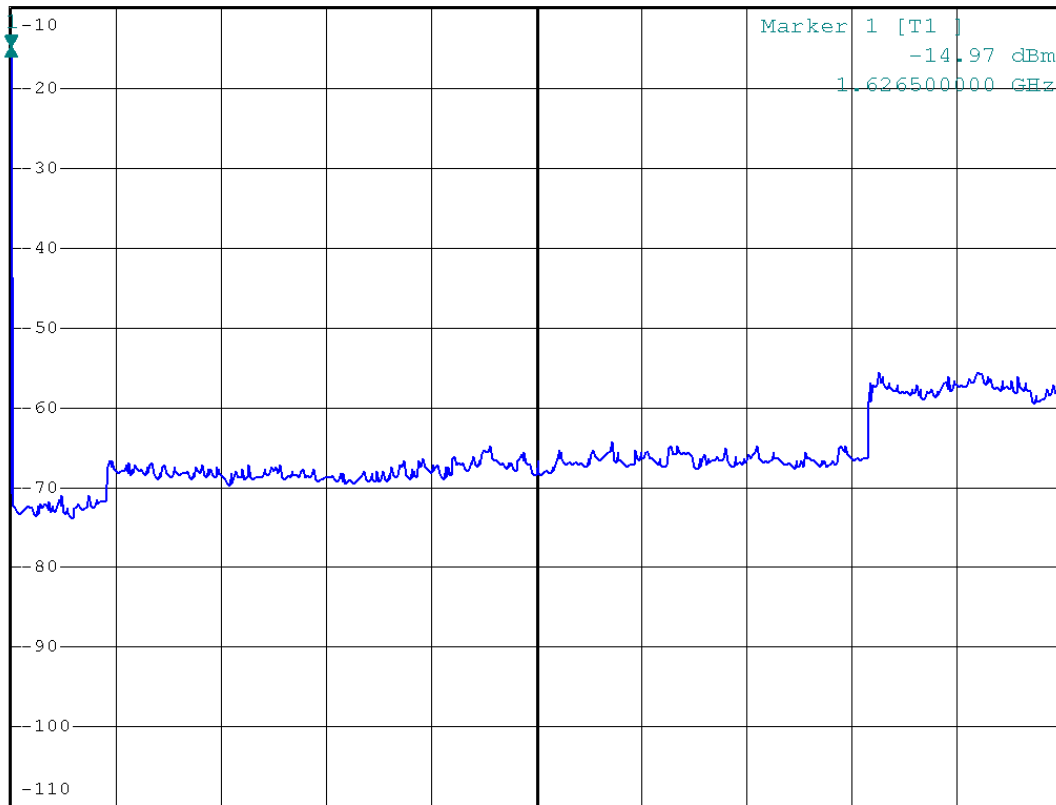


*RBW 1 MHz Delta 1 [T1]
 VBW 3 MHz 0.00 dB
 SWT 300 ms 0.000000000 Hz

Ref -10 dBm

*Att 10 dB

1 PK
 VIEW



Start 1.6265 GHz

1.46735 GHz/

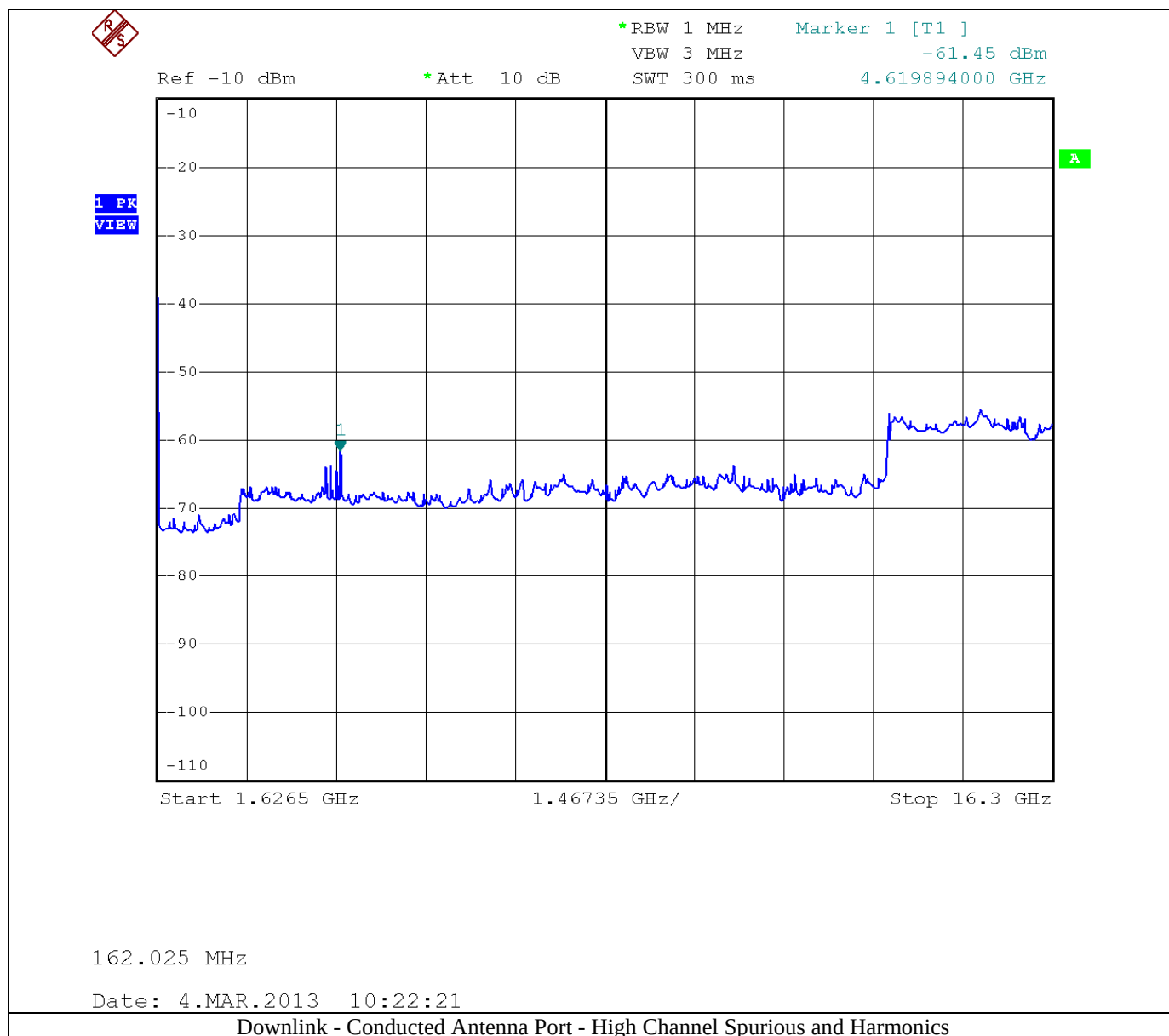
Stop 16.3 GHz

162.025 MHz

Date: 4.MAR.2013 12:11:24

Uplink - Conducted Antenna Port - High Channel Spurious and Harmonics

5.3.2 Downlink



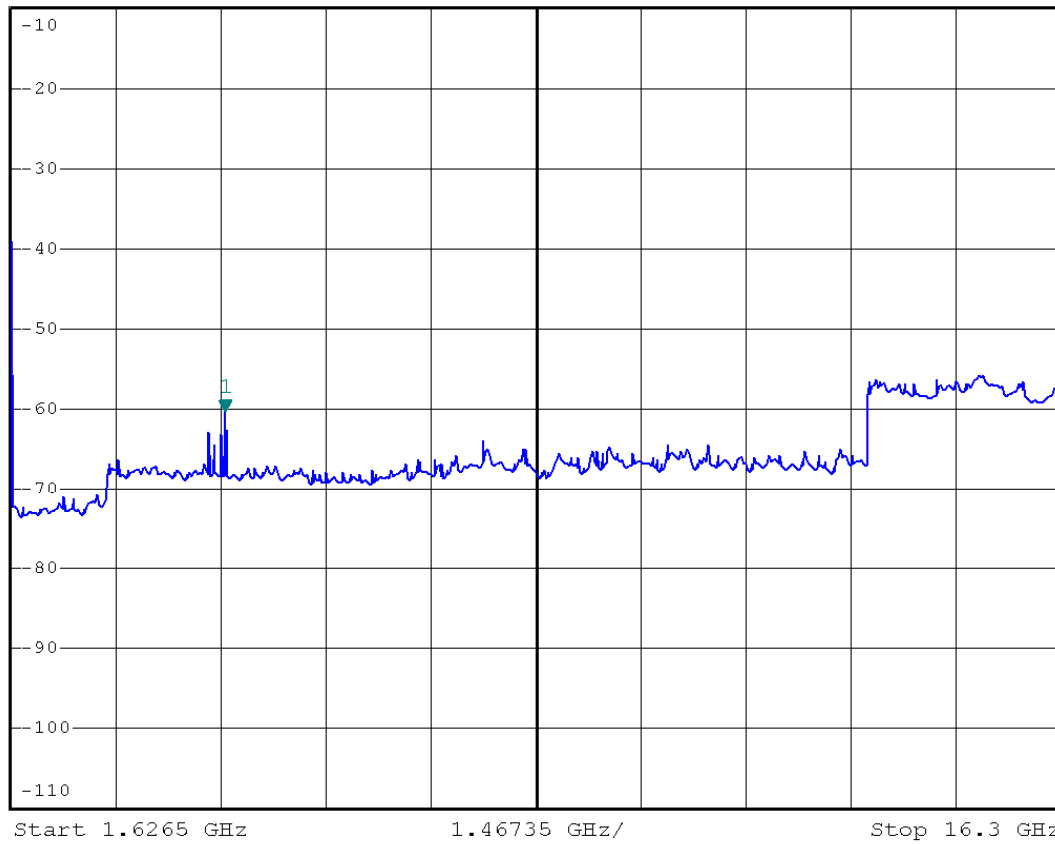


*RBW 1 MHz Marker 1 [T1]
VBW 3 MHz -60.19 dBm
SWT 300 ms 4.619894000 GHz

Ref -10 dBm

*Att 10 dB

1 PK
VIEW



162.025 MHz

Date: 4.MAR.2013 10:20:29

Downlink - Conducted Antenna Port - Low Channel Spurious and Harmonics

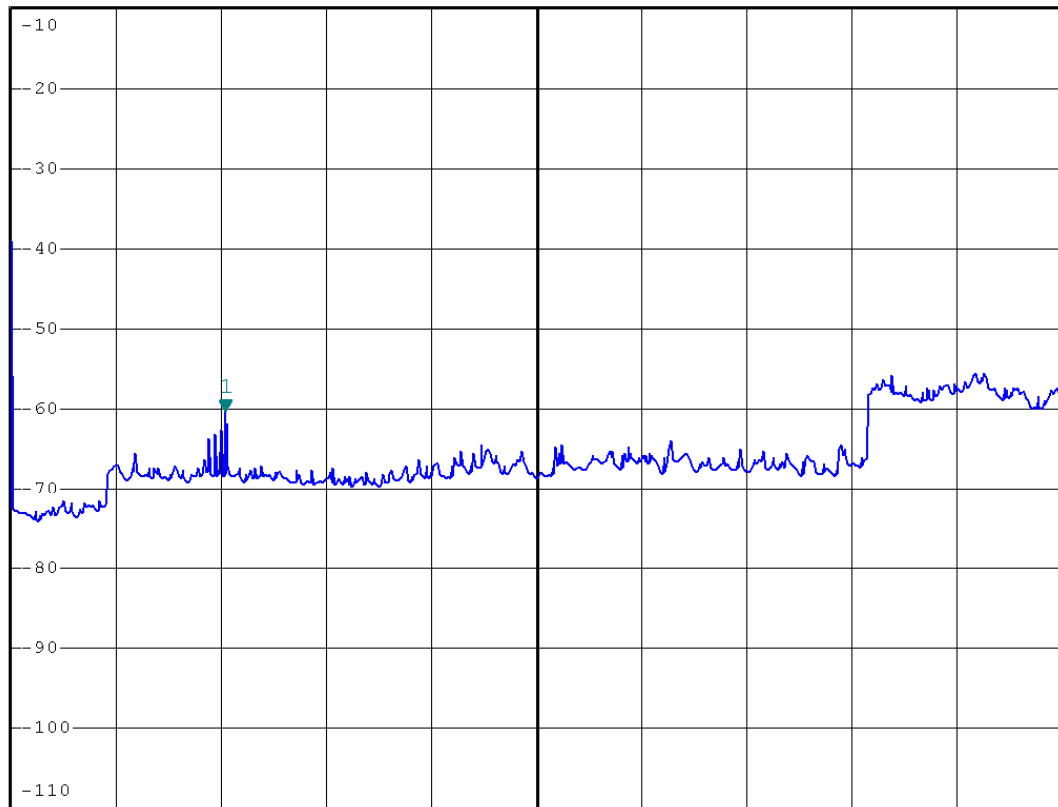


*RBW 1 MHz Marker 1 [T1]
VBW 3 MHz -60.21 dBm
SWT 300 ms 4.619894000 GHz

Ref -10 dBm

*Att 10 dB

1 PK
VIEW



Start 1.6265 GHz

1.46735 GHz/

Stop 16.3 GHz

162.025 MHz

Date: 4.MAR.2013 10:16:52

Downlink - Conducted Antenna Port - Center Channel Spurious and Harmonics

6.0 Field Strength of Spurious Emissions

Out of band spurious/harmonic emissions measurements were performed on the EUT to determine compliance to 47 CFR, Part 25.

6.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a rotating turntable at a distance of 3 meters from the measurement antenna.

The EUT transmit ports are terminated in a non-radiating fashion as this test is to measure radio frequency emissions radiated from the enclosure. The source signal was supplied by a signal generator located in the sub-chamber room below the turntable.

Spurious/harmonic emissions above 1 GHz peak were measured with average and peak detection with a resolution bandwidth of 1 MHz and measured at a distance of 3 meters. A diagram showing the test setup is given as Figure 7.1.1.

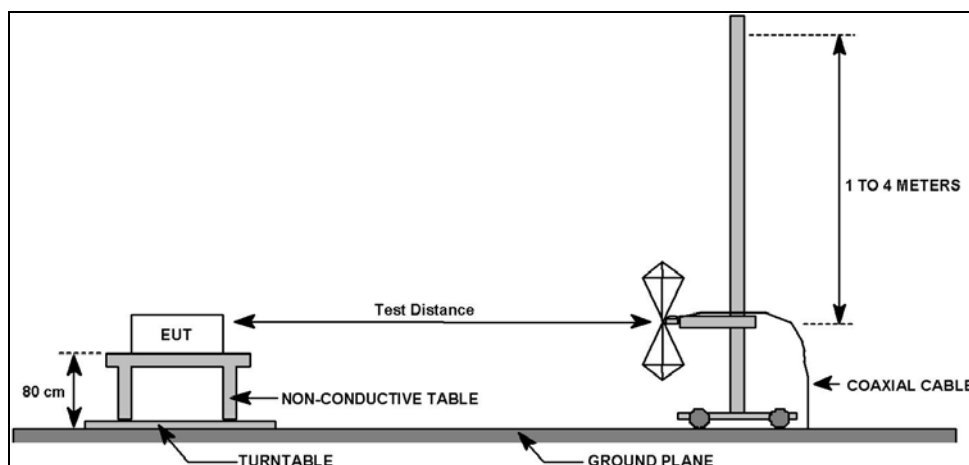


Figure 7.1.1: Field Strength of Spurious Emissions Test Setup

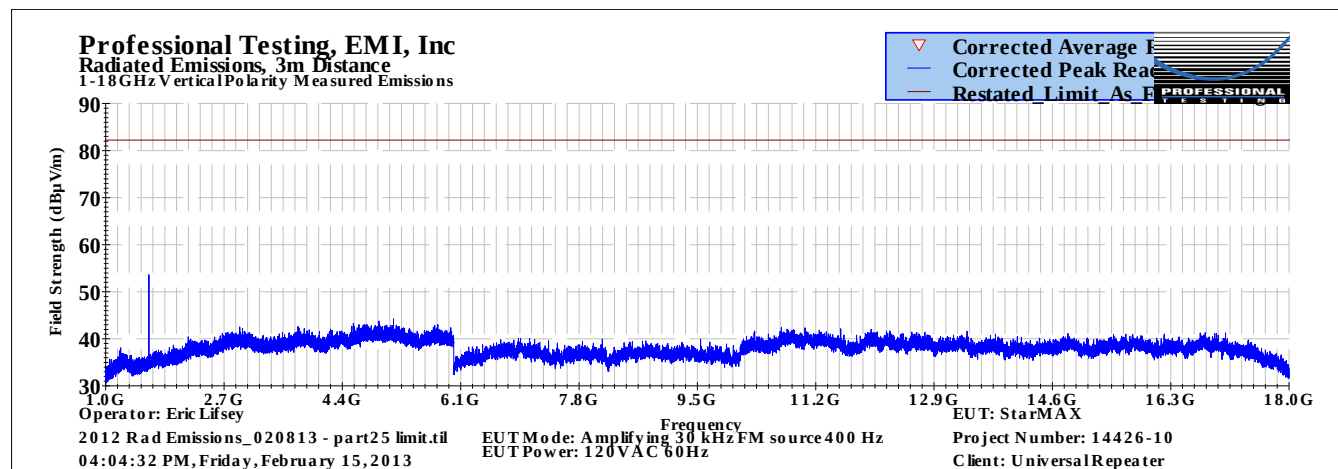
6.2 Test Criteria

Clause Subject	Section Number	Required?	Result
Field Strength of Radiated Spurious/Harmonic Emissions (1 GHz to 17 GHz)	25.202(f), 2.1053	Yes	Pass

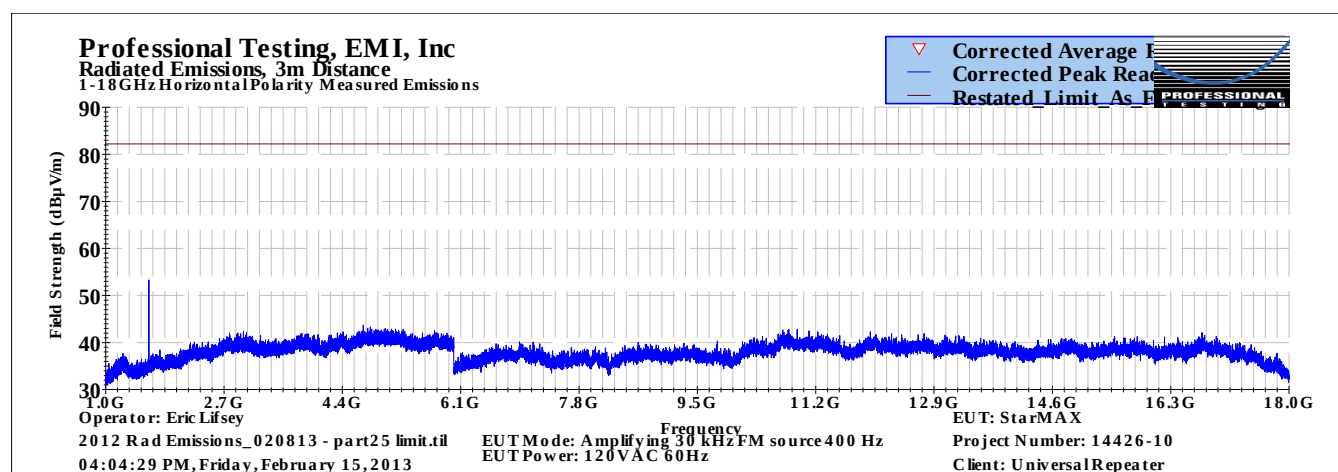
Conducted Port Emission Limit dBm	Limit Restated as Field Strength At 3 meters dBμV/m
-13.0	82.2

6.3 Test Results

Emissions were measured and compared to the limit stated as field strength. No emissions were found within 20 dB of the limit; as such antenna substitution measurements were not necessary.

Table 7.3.1: Field Strength of Spurious Emissions, 1 to 18 GHz, Vertical Polarity

No signals detected other than in-band intentional signal.

Table 7.3.2: Field Strength of Spurious Emissions, 1 to 18 GHz, Horizontal Polarity

No signals detected other than in-band intentional signal.

7.0 Mains Conducted Emissions

Measurements of mains conducted emissions were taken on the EUT to determine the compliance to CFR 47, Part 15.

7.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor and 0.4 meters from the conductive reference plane (wall). The EUT is powered through a line impedance stabilization network (LISN) that provides a measurement tap and a termination approximating 50 Ohms in the measurement range of 150 kHz to 30 MHz. A spectrum analyzer is connected, in turn, to each mains line measurement tap and software is employed to measure the radio frequency noise generated by the EUT.

The EUT transmit ports are terminated in a non-radiating fashion as this test is to measure radio frequency emissions conducted on the mains.

7.2 Test Criteria

Clause Subject	Section Number	Required?	Result
Mains Conducted Emissions, Class A	15.107	Yes	Pass

7.3 Test Results

Table 8.3.1: Mains Conducted Emissions, Neutral Line

Professional Testing, EMI, Inc.									
Test Method:		ANSI C63.4–2009: Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (incorporated by reference, see §15.38).							
In accordance with:		FCC Part 15.107 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Conducted Emissions Limits							
Section:		15.107							
Test Date(s):		2/15/2013			EUT Serial #:		none		
Customer:		Universal Repeater			EUT Part #:		none		
Project Number:		14426-10			Test Technician:		Eric Lifsey		
Purchase Order #:		0			Supervisor:		Rob McCollough		
Equip. Under Test:		SatMAX			Witness' Name:		Charlie Thompson		
Conducted Emissions Test Results Data Sheet - Neutral Lead							Page: 1 of 2		
EUT Line Voltage:			120	VAC	EUT Line Frequency:			60	Hz
Frequency Measured (MHz)	Peak Detector Reading (dBµV)	Quasi-peak Detector Reading (dBµV)	Quasi-peak Detector Limit (dBµV)	Quasi-peak Detector Margin (dB)	Quasi-peak Detector Test Results	Average Detector Reading (dBµV)	Average Detector Limit (dBµV)	Average Detector Margin (dB)	Average Detector Test Results
0.45569	52.2	49	56.8	-7.8	PASS	31.5	46.8	-15.3	PASS
0.4574	52.4	49.3	56.7	-7.4	PASS	31.6	46.7	-15.2	PASS
0.45858	52.2	49.3	56.7	-7.4	PASS	31.9	46.7	-14.8	PASS
0.50016	43.7	34.9	56	-21.1	PASS	11.7	46	-34.3	PASS
0.5697	43.5	36.9	56	-19.1	PASS	20.5	46	-25.5	PASS
0.6812	34.3	30.1	56	-25.9	PASS	11.1	46	-34.9	PASS
7.4158	41.1	39.5	60	-20.5	PASS	37.9	50	-12.1	PASS
7.575	42.8	40.7	60	-19.3	PASS	39.5	50	-10.5	PASS
8.045	41.7	39.5	60	-20.5	PASS	38.4	50	-11.6	PASS
8.2026	41.8	40.1	60	-19.9	PASS	39.1	50	-10.9	PASS

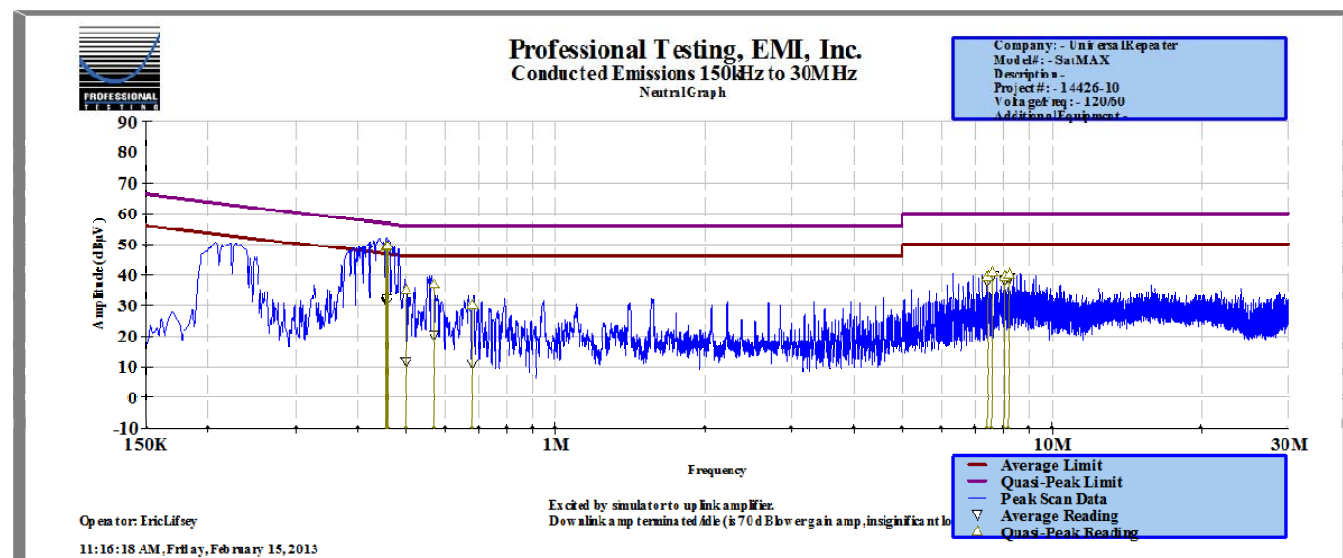
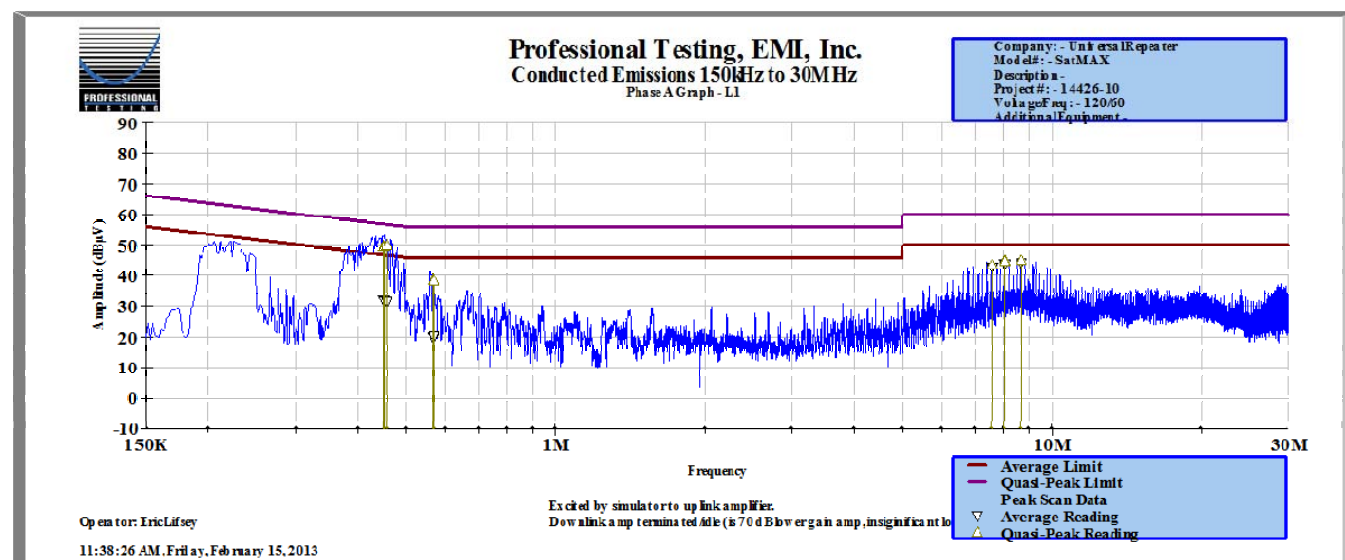


Table 8.3.2: Mains Conducted Emissions, Phase Line

Professional Testing, EMI, Inc.									
Test Method:		ANSI C63.4-2009: Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (incorporated by reference, see §15.38).							
In accordance with:		FCC Part 15.107 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Conducted Emissions Limits							
Section:		15.107							
Test Date(s):		2/15/2013			EUT Serial #:		none		
Customer:		Universal Repeater			EUT Part #:		none		
Project Number:		14426-10			Test Technician:		Eric Lifsey		
Purchase Order #:		0			Supervisor:		Rob McCollough		
Equip. Under Test:		SatMAX			Witness' Name:		Charlie Thompson		
Conducted Emissions Test Results Data Sheet - Phase Lead (Line 1)							Page: 2 of 2		
EUT Line Voltage:			120	VAC	EUT Line Frequency:			60	Hz
Frequency Measured (MHz)	Peak Detector Reading (dBμV)	Quasi-peak Detector Reading (dBμV)	Quasi-peak Detector Limit (dBμV)	Quasi-peak Detector Margin (dB)	Quasi-peak Detector Test Results	Average Detector Reading (dBμV)	Average Detector Limit (dBμV)	Average Detector Margin (dB)	Average Detector Test Results
0.45061	53.5	49.7	56.9	-7.2	PASS	31.9	46.9	-14.9	PASS
0.45175	53.4	49.5	56.8	-7.4	PASS	31.7	46.8	-15.2	PASS
0.45727	53.4	49.8	56.7	-6.9	PASS	31.5	46.7	-15.3	PASS
0.5678	44	38.6	56	-17.4	PASS	20.3	46	-25.7	PASS
0.5681	42.1	38.5	56	-17.5	PASS	19.8	46	-26.2	PASS
0.5696	42.1	38.4	56	-17.6	PASS	20.4	46	-25.6	PASS
7.5708	45	43.6	60	-16.4	PASS	43	50	-7	PASS
8.0438	45.8	45	60	-15	PASS	43.9	50	-6.1	PASS
8.044	45.1	44.6	60	-15.4	PASS	43.9	50	-6.1	PASS
8.674	46.2	45	60	-15	PASS	44.4	50	-5.6	PASS



8.0 Equipment Lists

8.1 Spurious Radiated Emissions

Test Date(s): 2/15/2013			EUT Serial #: 0		
Customer: Universal Repeater			EUT Part #: 0		
Project Number: 14426-10			Test Technician: Eric Lifsey		
Purchase Order #: 0			Supervisor: Rob McCollough		
Equip. Under Test: SatMAX			Witness' Name: Charlie Thompson		
Radiated Emissions Test Equipment List					
Tile! Software Version:			4.2.A, May 23, 2010, 08:38:52 AM		
Test Profile:			Radiated Emissions_Profile Version October 12, 2011		
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1509A	Narda	3022	Coupler, Bi-Directional 1-4GHz	40063	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	00110313	2/4/2014
1930	Agilent	E4440A-239	Spectrum Analyzer, 3 Hz - 26.5 GHz	MY45304903	6/19/2013
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
C027	N/A	LMR-400	Cable Coax, N-N, 0.6m	none	11/1/2013
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
0942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
1509B	HP	8491B-003	Attenuator, N, 3dB	21897	N/A
1594	Miteq	AFS44-00102650	Amplifier, 1-26.5GHz, 42dB	none	10/15/2013
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, .1-18GHz	0	11/26/2013
C030	N/A	LMR-400	Cable Coax, N-N, 2.5m	none	N/A

8.2 Mains Conducted Emissions

Professional Testing, EMI, Inc.					
Test Method: ANSI C63.4–2009: Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (incorporated by reference, FCC Part 15.107 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators,					
In accordance with: Conducted Emissions Limits					
Section: 15.107					
Test Date(s): 2/15/2013		EUT Serial #: none			
Customer: Universal Repeater		EUT Part #: none			
Project Number: 14426-10		Test Technician: Eric Lifsey			
Purchase Order #: 0		Supervisor: Rob McCollough			
Equip. Under Test: SatMAX		Witness' Name: Charlie Thompson			
Conducted Emissions Test Equipment List					
Title! Software Version: 4.1.A.0, April 14, 2009, 11:01:00PM					
Test Profile: Profile#: CE_2010.til, dated December 16, 2010					
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
991	HP	8568B	Spectrum Analyzer 100Hz-1.5GHz	2633A00659	3/14/2013
992	HP	85662A	Spec Anal Dsply for AN0991 6dB	2152A03784	N/A
0990	HP	85685A	RF Preselector	3010A01119	7/3/2013
1281	HP	85650A	Quasi Peak Adapter (use with AN 1270)	HP	3/27/2013
27	EMCO	3825/2	LISN, 10kHz-100MHz	9010-1708	9/17/2013
1173	PTI	100k HPF	Filter, High Pass, 100kHz	none	CBU
1087	PTI	PTI-ALF3	Attenuator Limiter Filter	none	5/6/2014
C149	PTI	None	Cable, RF, N-N, 30', Black	none	9/4/2013
C174	none	none	Cable, RF, N-SMA, 16", Black	none	9/4/2013
C107	N/A	0	Cable, N-N, 10m	none	8/31/2013
C108	N/A	none	Cable, BNC, 3m	none	CBU

8.3 Conducted Port Measurements

The following equipment was used to measure output power, bandwidth, and conducted spurious emissions.

Conducted Port Measurements Equipment List					
Asset #	Manufacturer	Model #	Description	Serial Number	Calibration Due
1342	Rohde & Schwarz	FSP30	Spectrum Analyzer	100218	January 29, 2014
C247	Pasternack		Cable ~1.7m		October 24, 2013
C249	Pasternack		Cable ~0.5m		February 6, 2014
C250	Pasternack		Cable ~0.5m		February 6, 2014
0856	Narda	702-60	Step Attenuator, 60 dB, DC-12.4 GHz	04105	February 6, 2014

8.4 Support Equipment

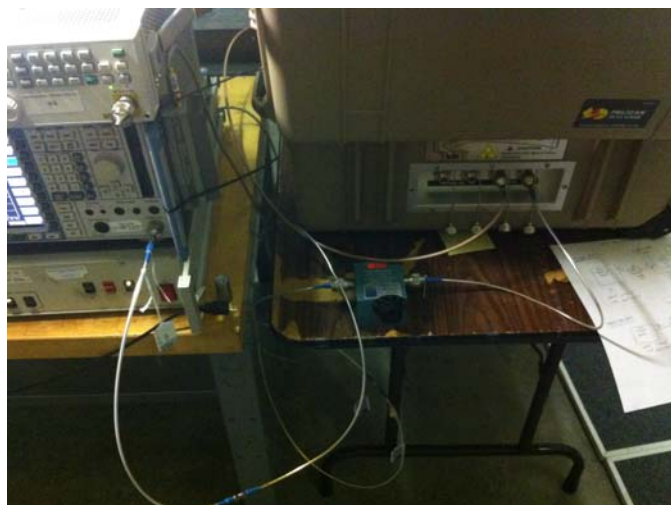
The following equipment supplied and/or controlled the source signal used to drive the amplifiers to rated output power.

Asset #	Description	Model	S/N	Calibration Due
Customer	Laptop	Dell unspecified	Unspecified	Not Required
Customer	9253 USB Iridium Emulator Card & Software	Unspecified	Unspecified	Not Required
Customer	100 dB Step Attenuator	Unspecified	Unspecified	Not Required
Customer	Cables, misc	None	None	Not Required

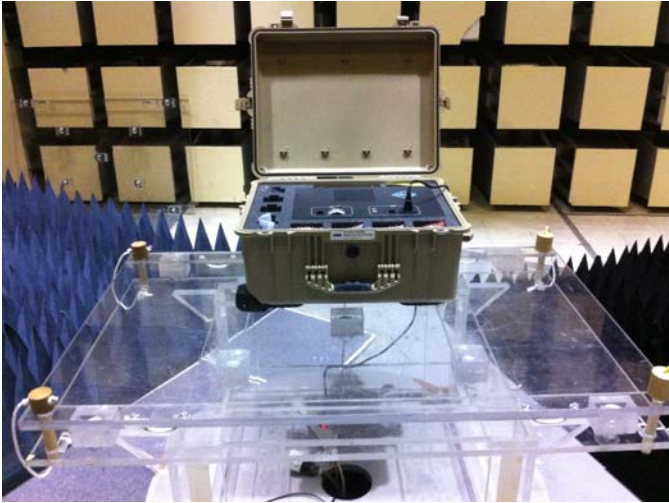
8.5 Setup Photographs



Conducted Output Tests (Power, BW, Spurious)



Conducted Output Tests (Power, BW, Spurious)



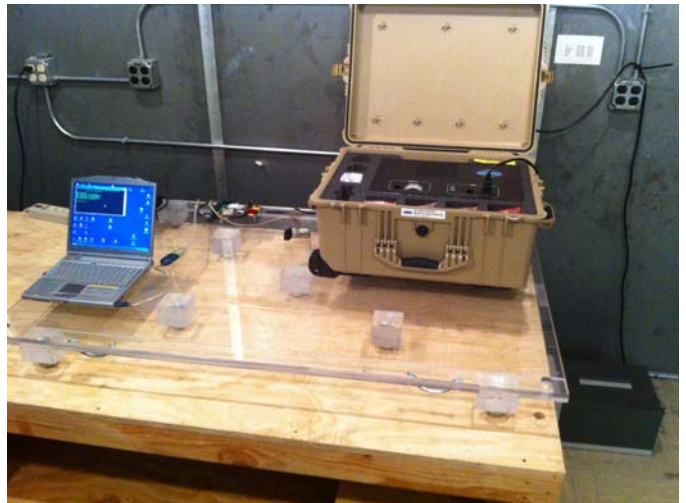
Radiated Spurious Tests



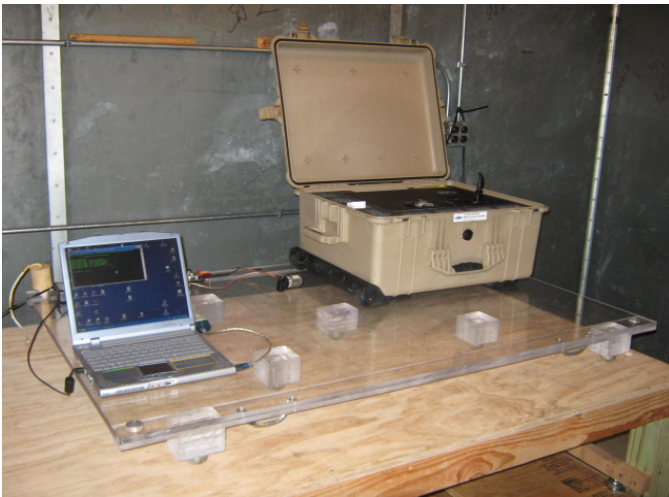
Radiated Spurious Tests



Signal Source for Radiated Spurious Tests



Mains Conducted Emission Test



Mains Conducted Emission Test



Mains Conducted Emission Test

9.0 Amplifier Overload

Performance of harmonic suppression was measured while subject to overload conditions.

9.1 Criteria

Limit is -13 dBm for conducted port emissions.

9.2 Procedure

For each amplifier section, and each of 3 standard channels, apply an unmodulated CW signal from a signal generator and increase the level in 1 dB steps to find the point where output power no longer increases by a corresponding 1 dB; record this level. Continue to apply 1 dB increases until the point where output power no longer changes, record this level as No Output Change (NOC) level.

Increase the signal generator by 10 dB above the NOC level. Record the conducted emissions in the harmonic range to 17 GHz for each of the 3 channels.

Measure the harmonic spectrum using 10 kHz resolution bandwidth for better detection of harmonics.

9.3 Results

The EUT suppresses output harmonics even when driven 10 dB beyond the point of no output change. See details below.

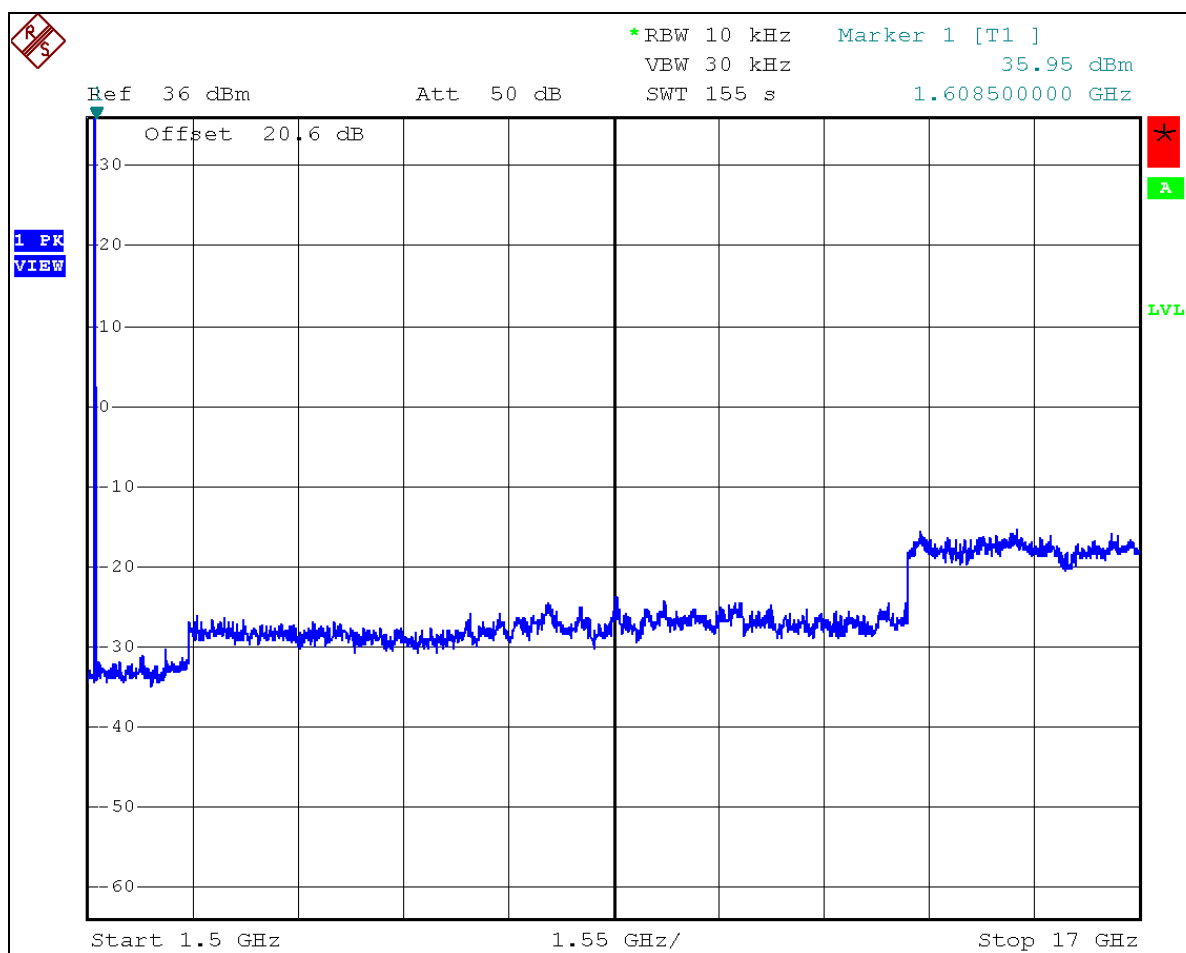
20 dB of external attenuation was employed. The losses were added as 20.6 dB to the spectrum analyzer displayed as an amplitude offset as can be confirmed in the upper left corner of the plot area. When a harmonic is measured, the additional losses are added numerically.

These measurements were performed from January 31, 2014 to February 5, 2014.

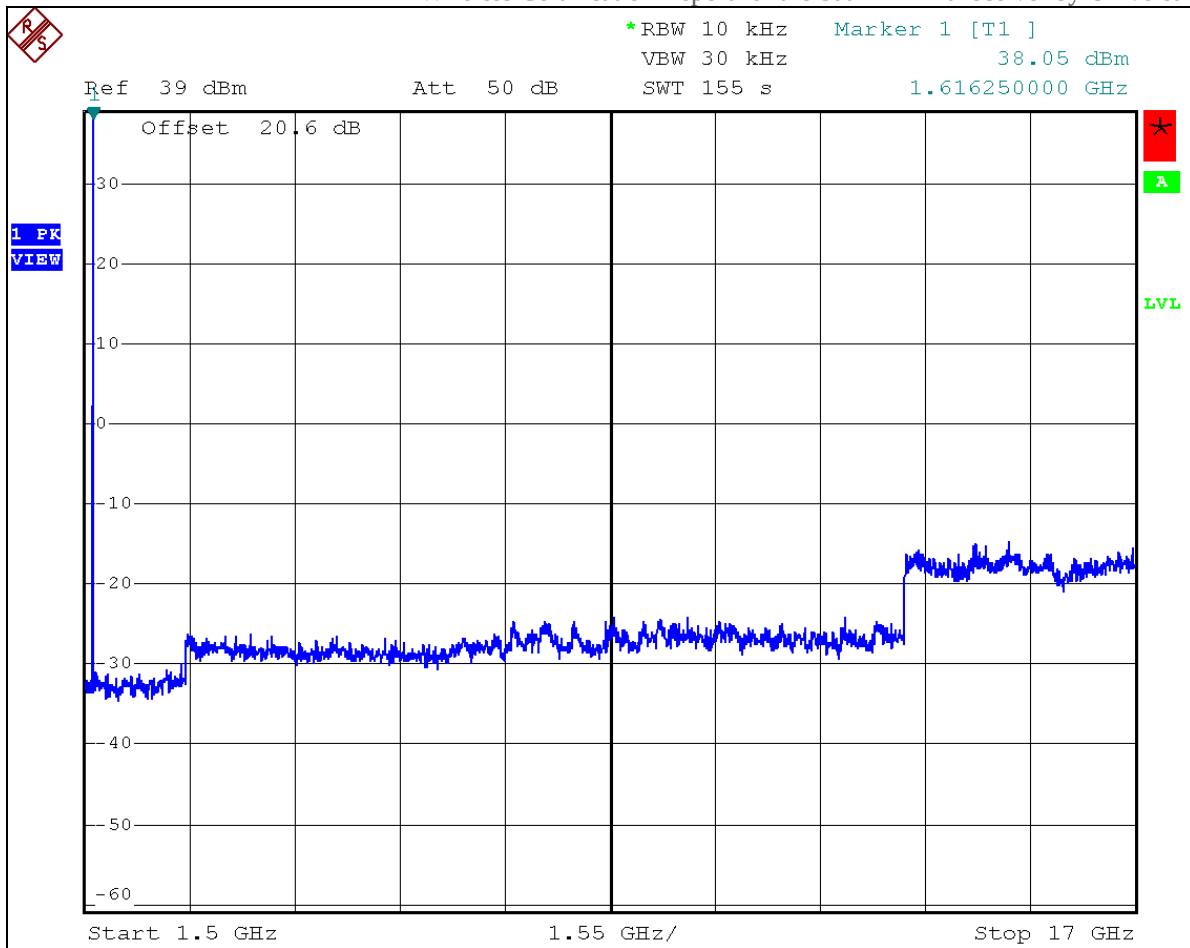
9.3.1 Uplink Amplifier

Uplink Amplifier Table of Input vs Output At Gain Compression and Overload				
Frequency MHz	Input at Gain Compression Detected dBm	Input at No Output Change Point dBm	Power Output at No Output Change Point dBm	Input for 10dB Overload Test Level dBm
1616.0	-33	-26	36.0	-16
1621.0	-34	-27	38.4	-17
1626.5	-34	-26	38.1	-16

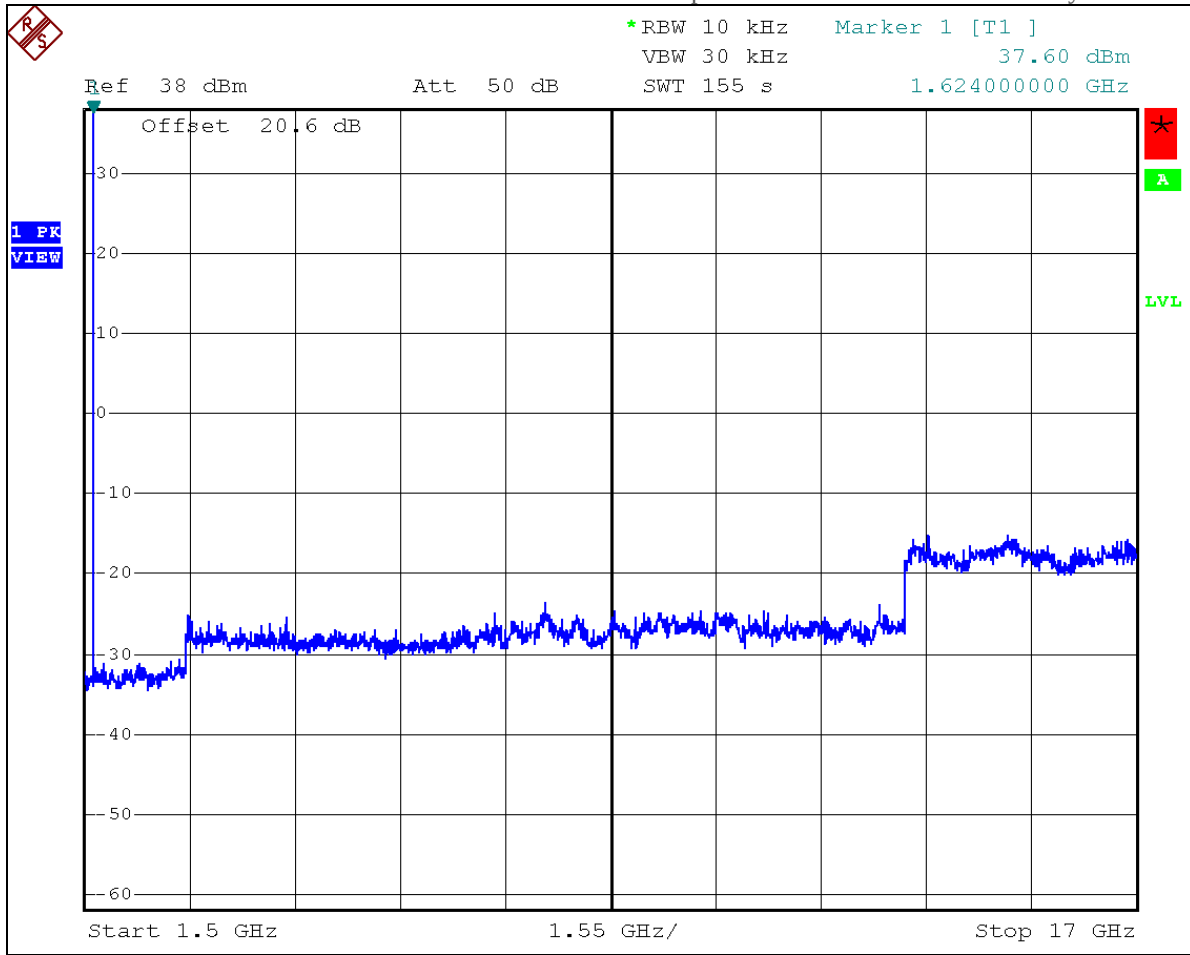
No harmonics were detected over the amplitude range of -50 to -60 dBc.



Low Channel (Fundamental visible on left.)



Middle Channel (Fundamental visible on left.)



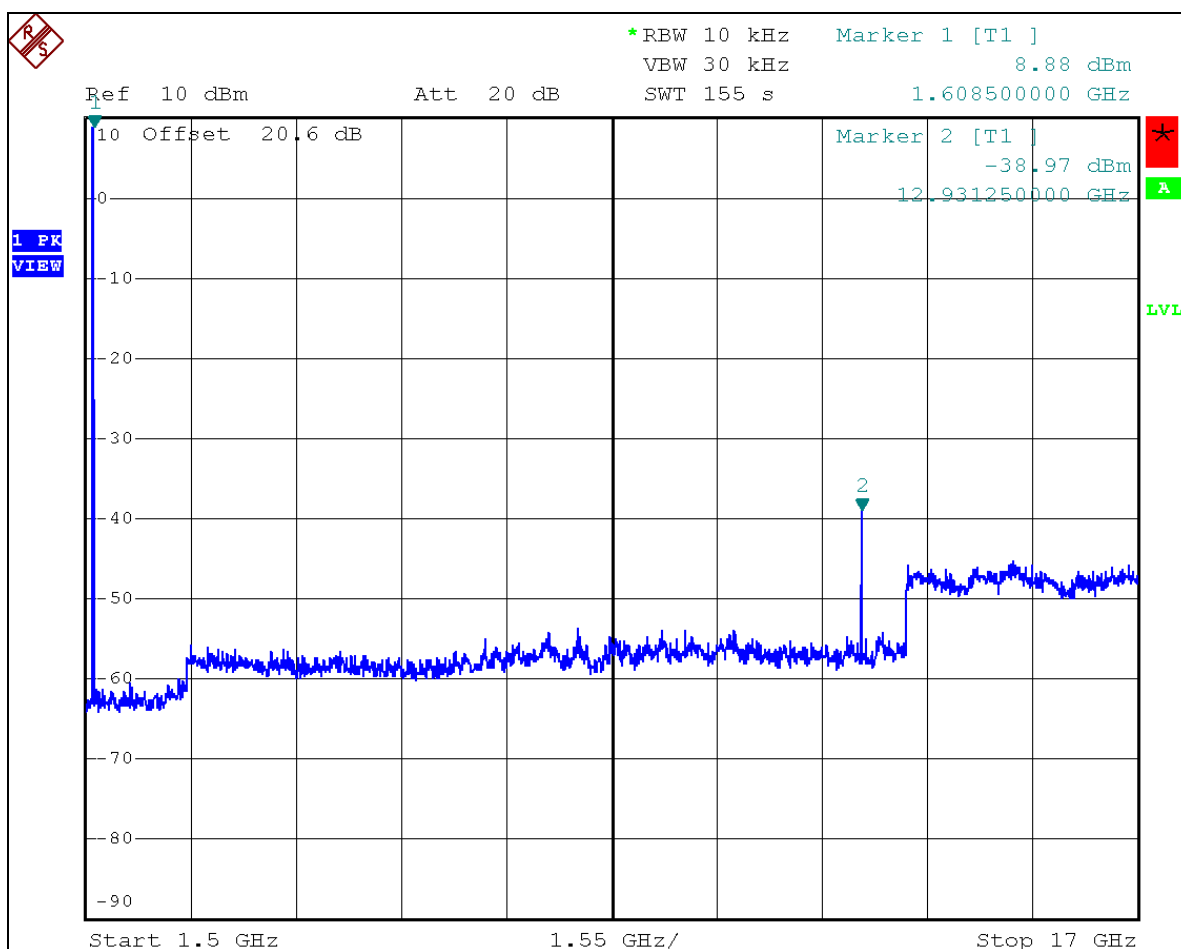
High Channel (Fundamental visible on left.)

9.3.2 Downlink Amplifier

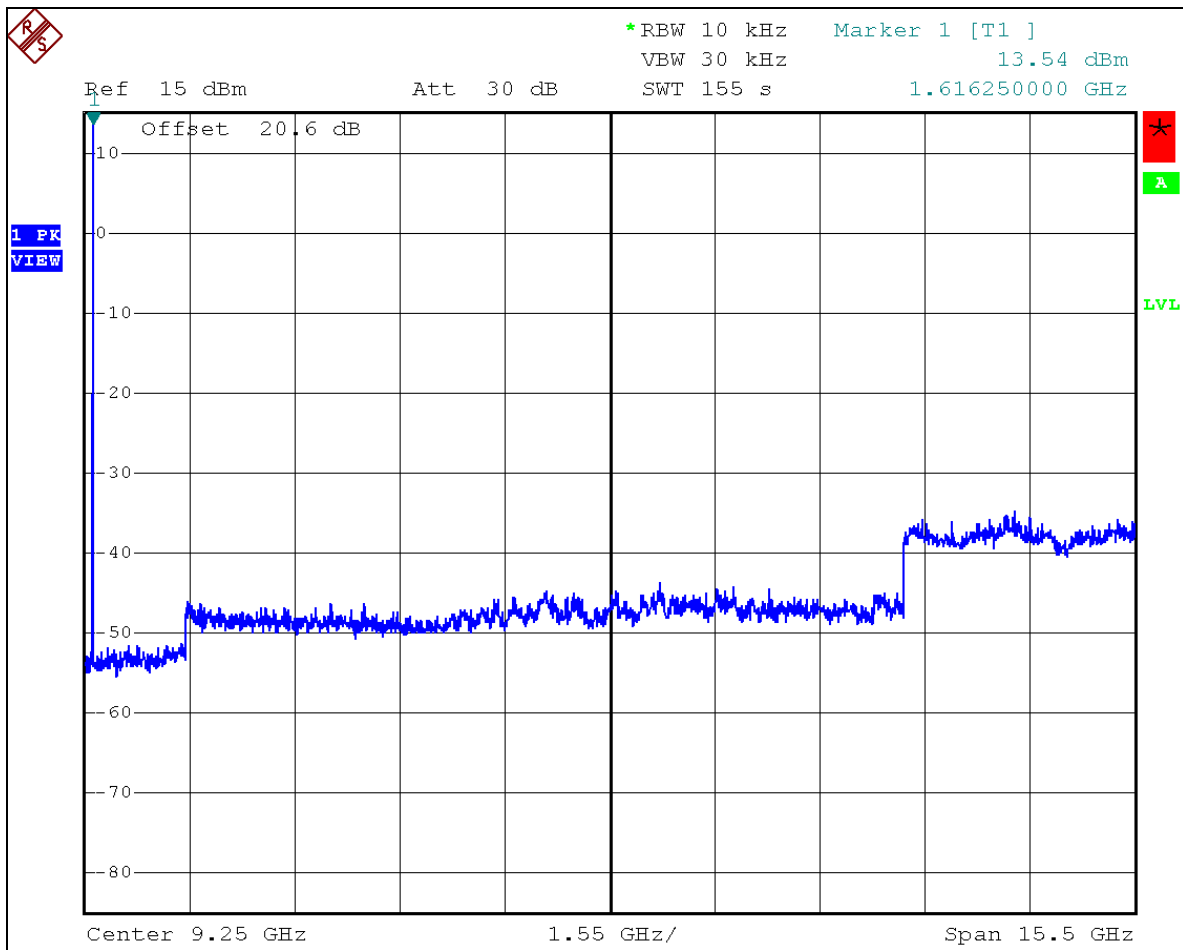
Downlink Amplifier Table of Input vs Output At Gain Compression and Overload				
Frequency MHz	Input at Gain Compression Detected dBm	Input at No Output Change Point dBm	Power Output at No Output Change Point dBm	Input for 10dB Overload Test Level dBm
1616.0	-56	-35	9.1	-25
1621.0	-56	-35	13.9	-25
1626.5	-56	-35	13.6	-25

Downlink Amplifier - Table of Harmonics Detected					
Frequency MHz	Measured Raw dBm	Additional Cable Factor dB	Corrected Level dBm	Reference Power Output Level dBm	Suppressed Below Carrier dBc
12931	-38.9	2.3	-36.6	8.9	-45.5
13218	-43.7	2.3	-41.4	8.9	-50.3

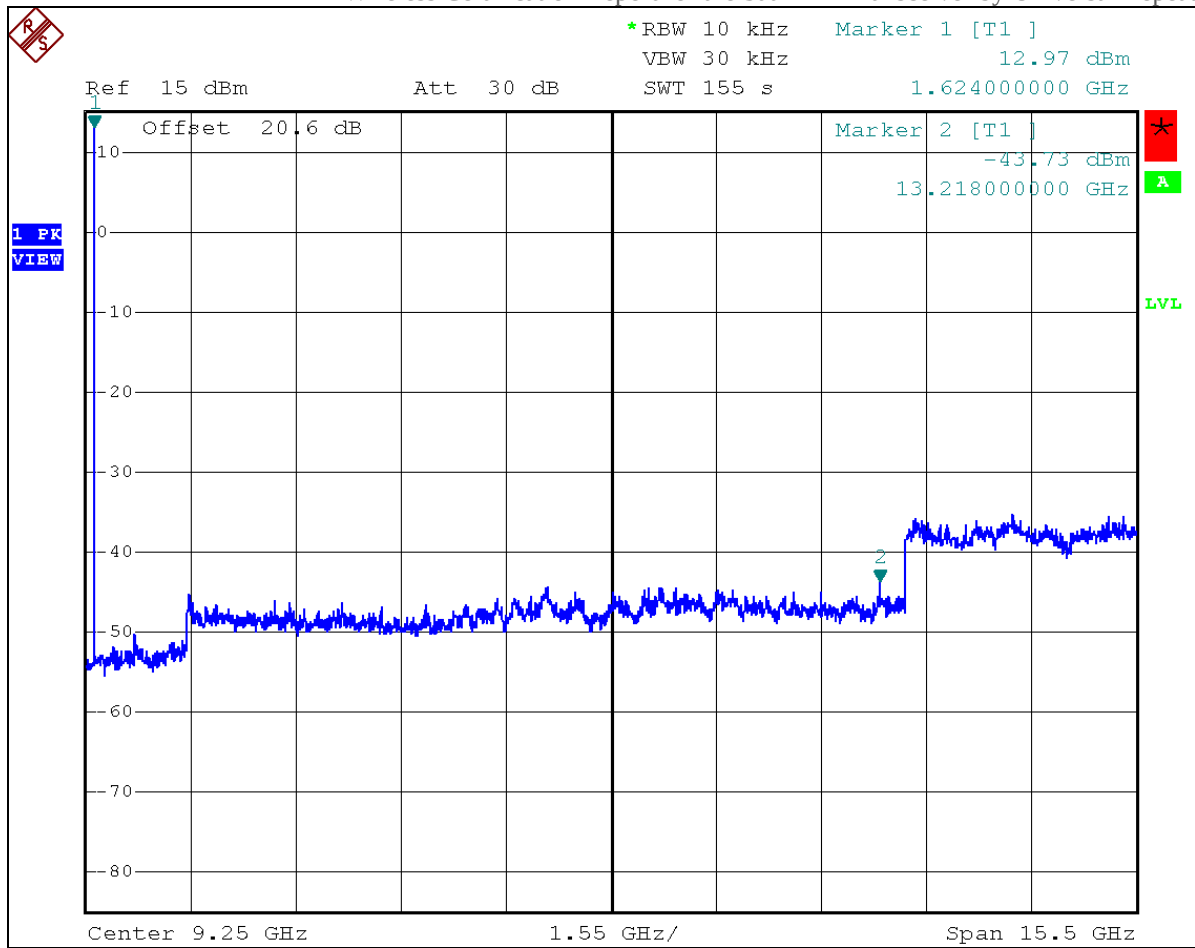
Signals in the table above are outside of restricted bands.



Low Channel (Fundamental visible on left.)



Middle Channel (Fundamental visible on left.)

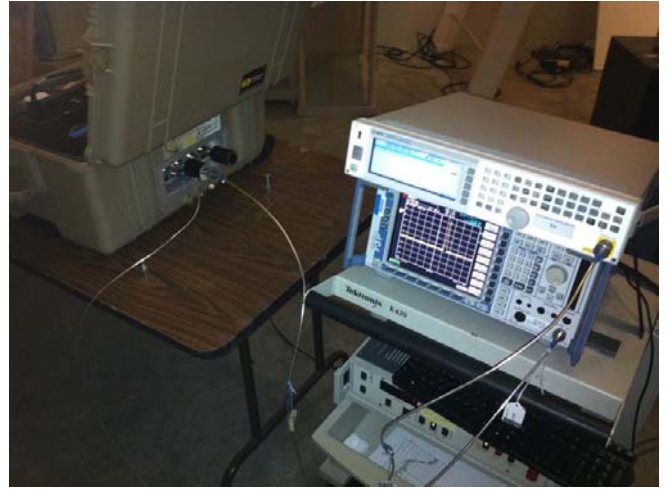


High Channel (Fundamental visible on left.)

9.4 Setup Photographs



Overload, EUT



Overload, Equipment Setup

9.5 Equipment List

Equipment List				
Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
1816	Agilent	N5181A	Signal Generator	2014-09-27
A105	Narda	768A-20	20 dB 20 W Power Attenuator	2014-02-15
C248	Pasternack	Cable	Cable, low loss	2014-03-13

10.0 Bandwidth Input/output

Performance of bandwidth output vs input is compared.

10.1 Criteria

Bandwidth of the output signal should be closely the same as the input bandwidth.

10.2 Procedure

For each amplifier section, and each of 3 standard channels, apply a 1000 Hz tone with 300 kHz deviation FM modulated signal from a signal generator and set it to the amplitude recorded previously as the No Output Change (NOC) level. Record the bandwidth as 20 dB.

Record the bandwidth for the source signal for each of the 3 channels and compare.

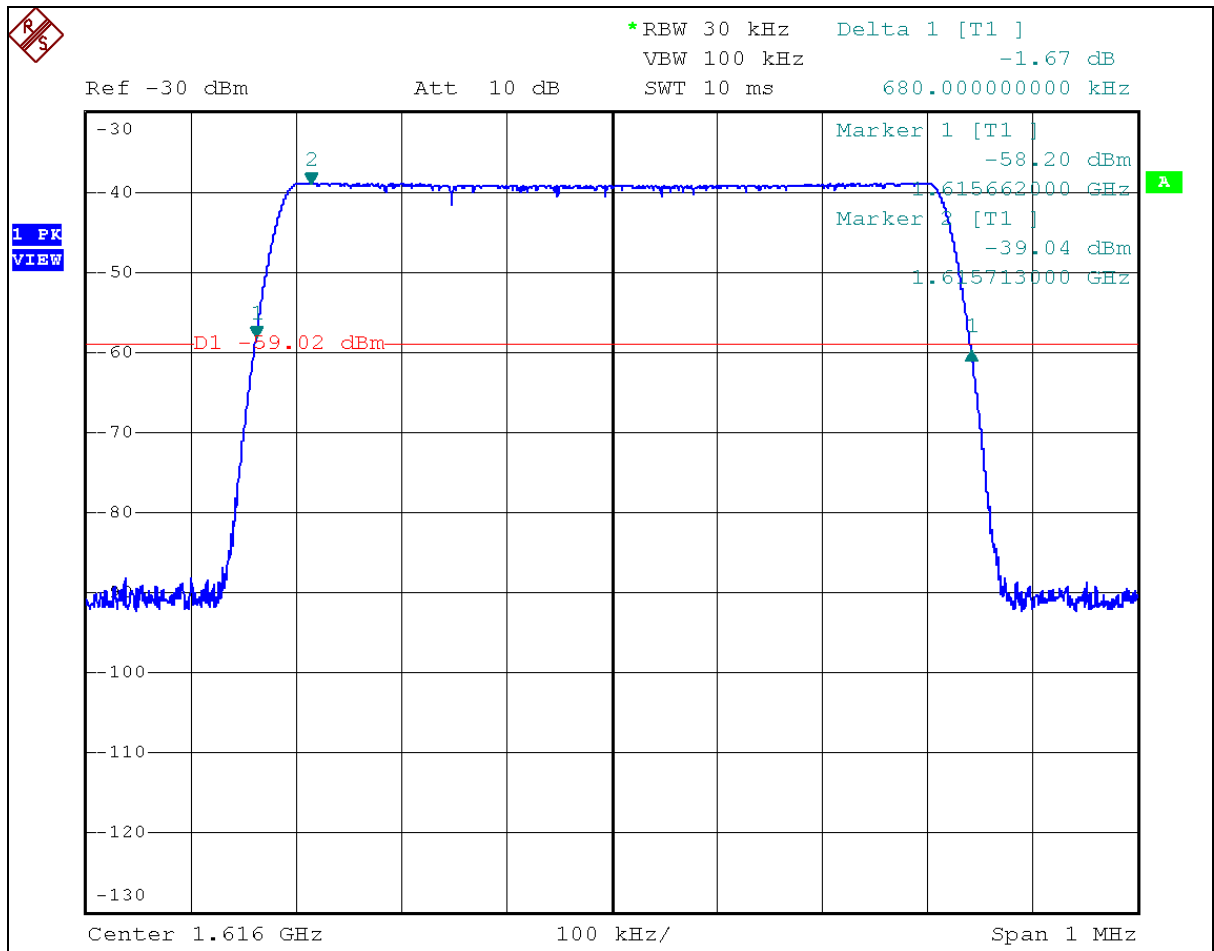
10.3 Results

No significant departure in bandwidth was recorded in the output of the amplifiers when compared to the original signal generator source signal.

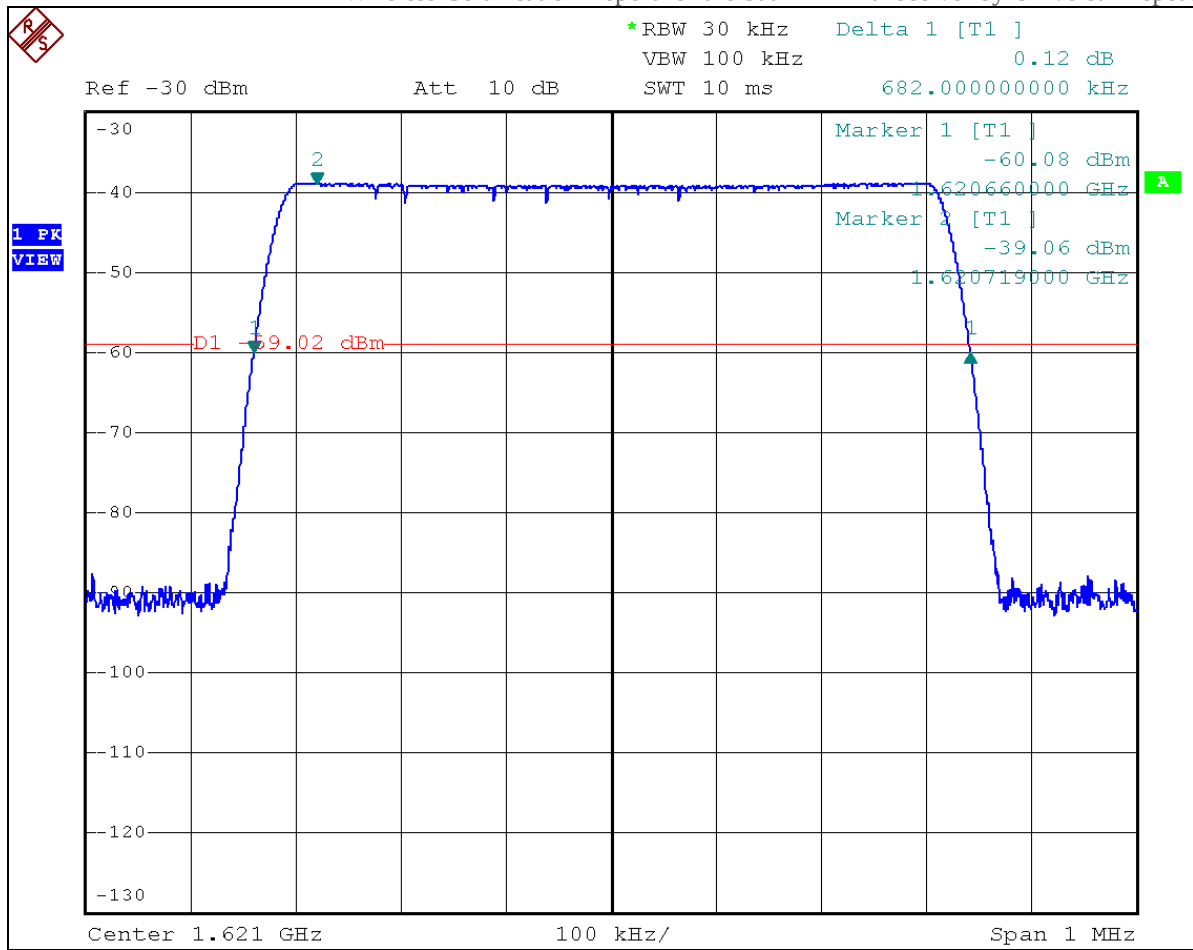
Uplink Amplifier - Table of Bandwidth Measurements			
Frequency MHz	Generator Sourced Input Bandwidth kHz	Uplink Amplifier Output Bandwidth kHz	Downlink Amplifier Output Bandwidth kHz
1616	680	678*	674*
1621	682	680	680
1626.5	680	680	680

*Note that it was discovered after test that the low channel frequency should have been 1616.5 MHz instead of 1616.0 MHz. This explains the sloping output obtained on the low output channel of both amplifiers and the slight influence on bandwidth; it is likely the effects of being near the cavity filter band-stops.

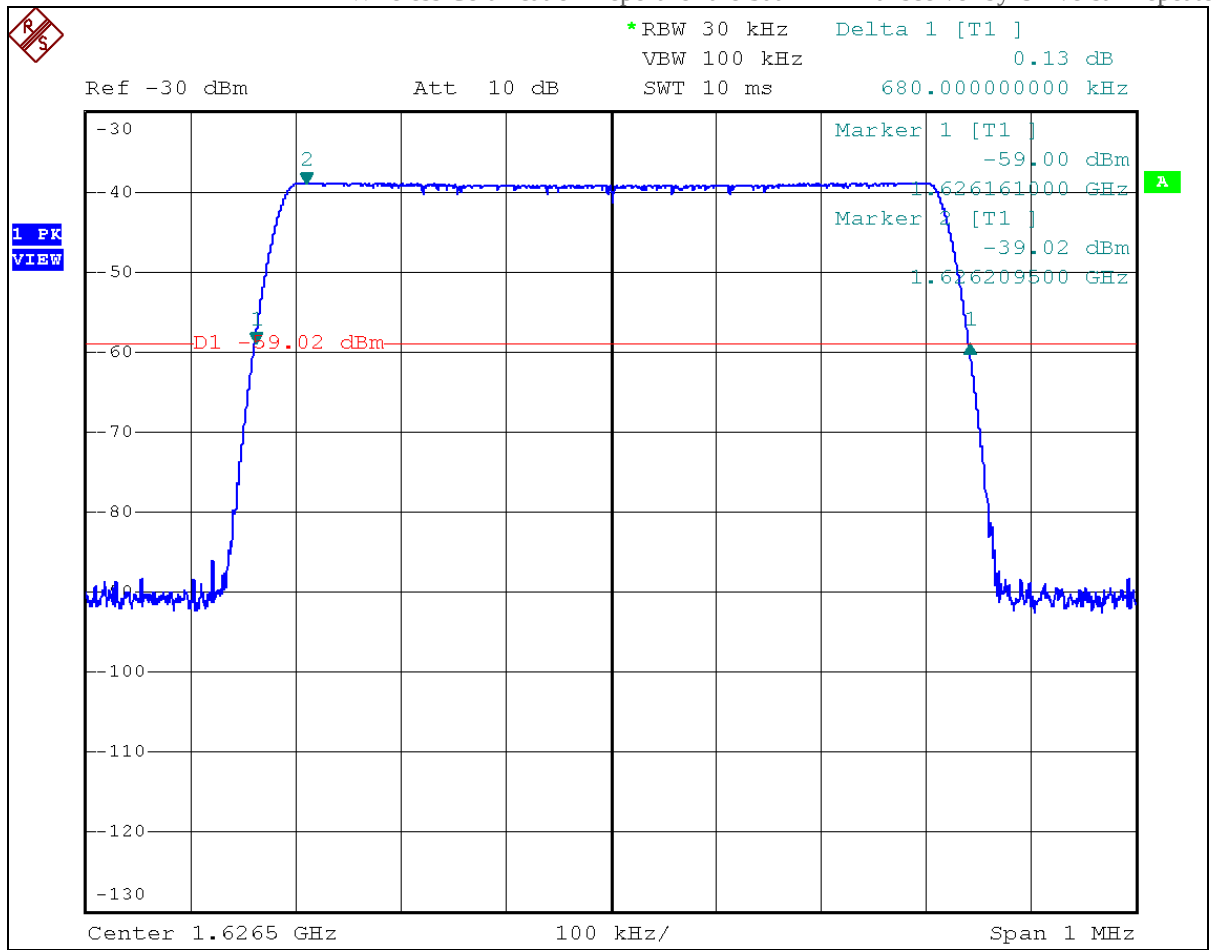
10.3.1 Source Signal Bandwidth



Source Signal Bandwidth –Low Channel

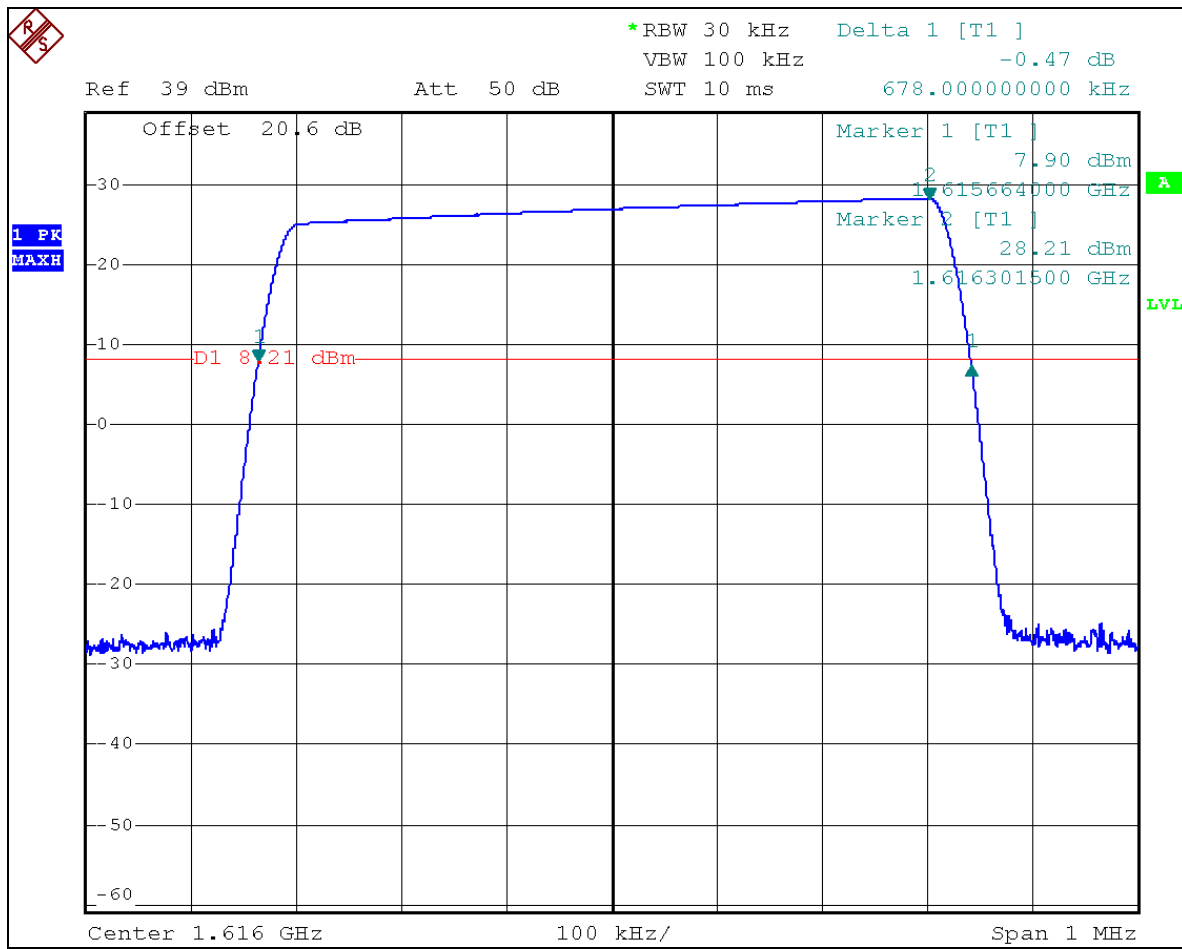


Source Signal Bandwidth -Middle Channel

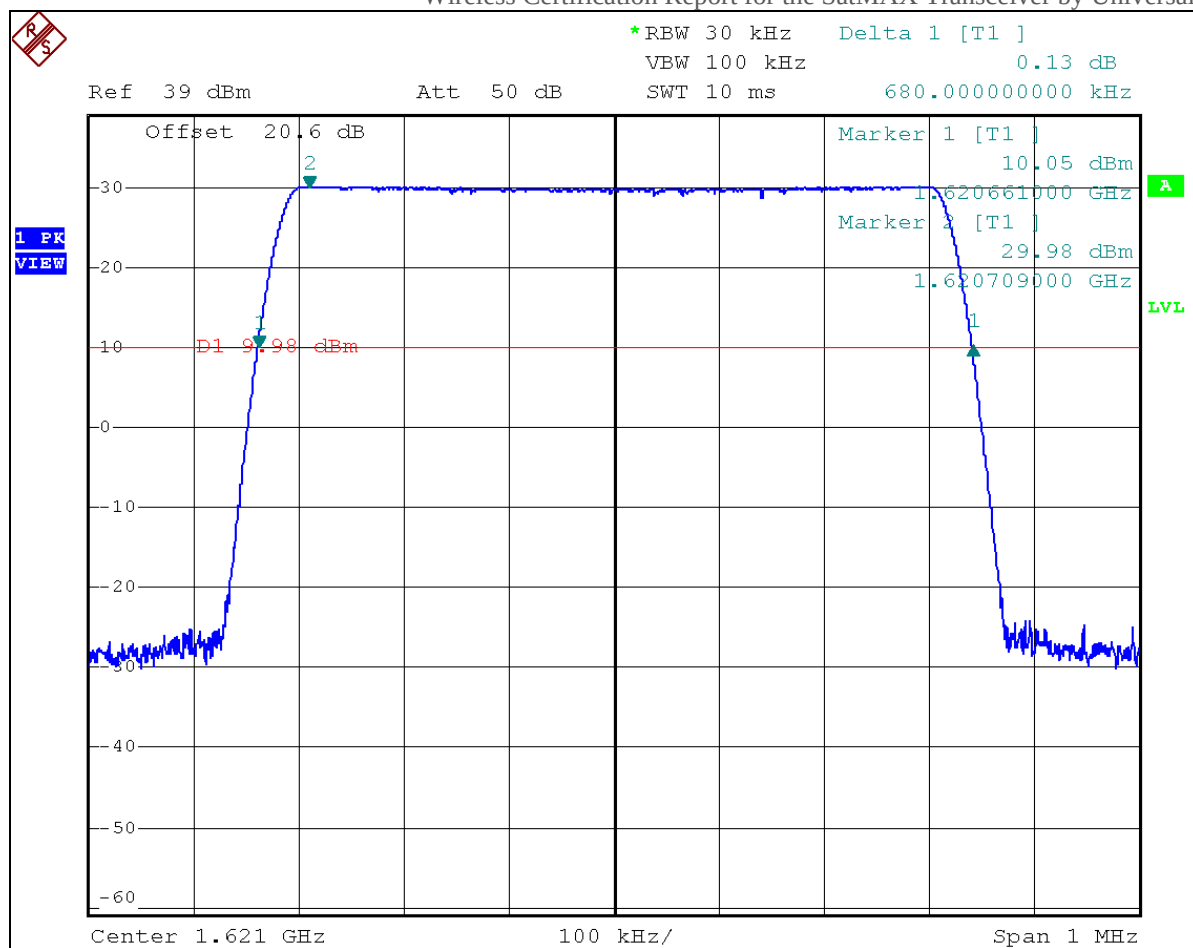


Source Signal Bandwidth – High Channel

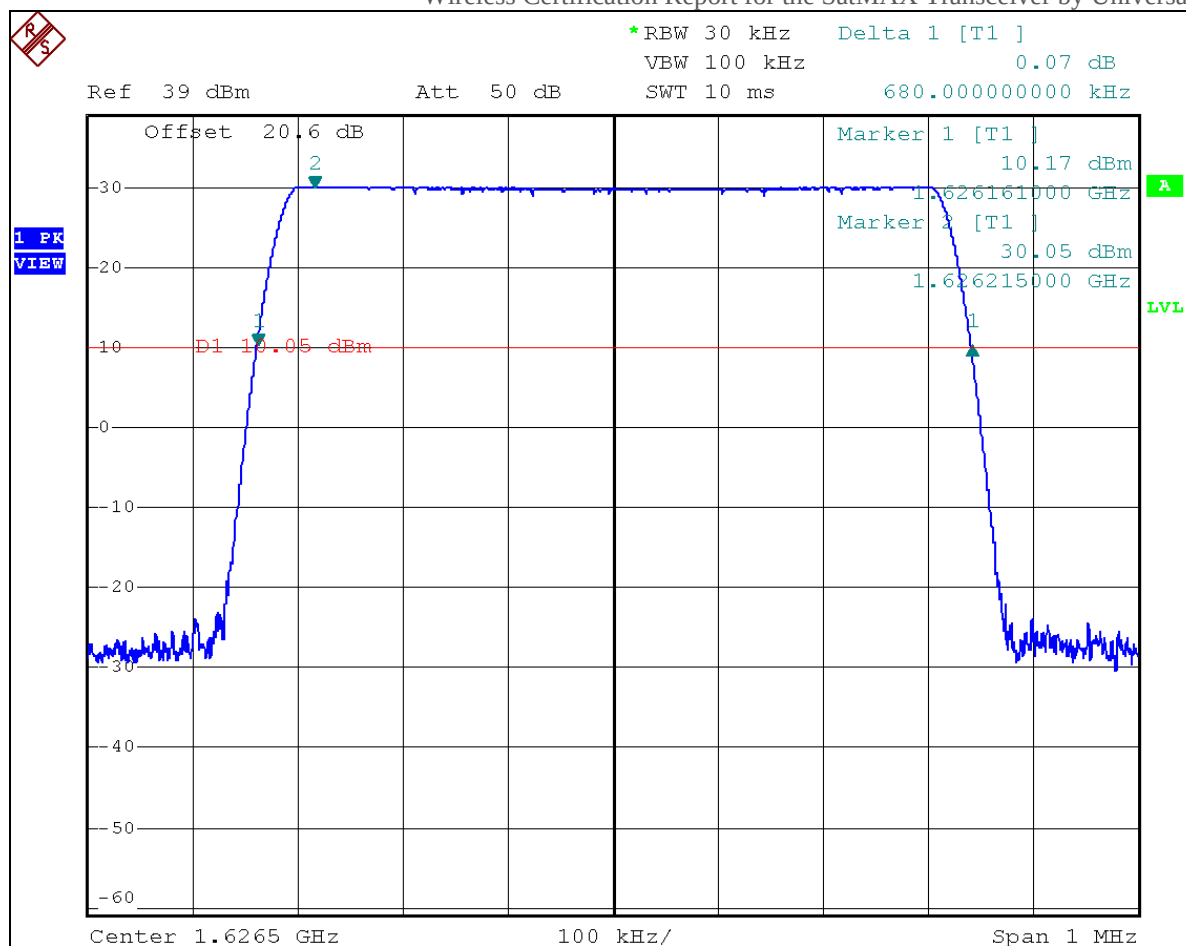
10.3.2 Uplink Output Bandwidth



Uplink Output Bandwidth – Low Channel

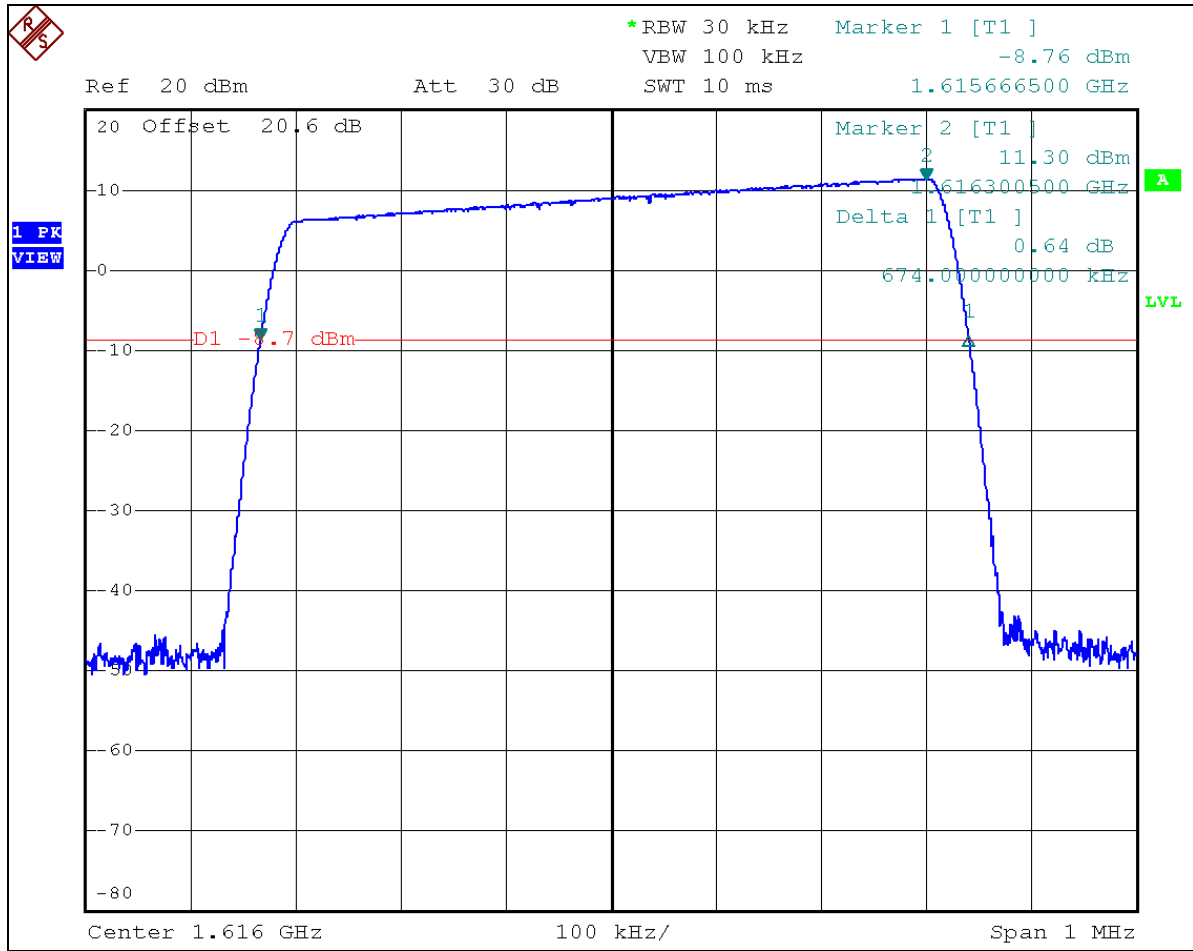


Uplink Output Bandwidth – Middle Channel

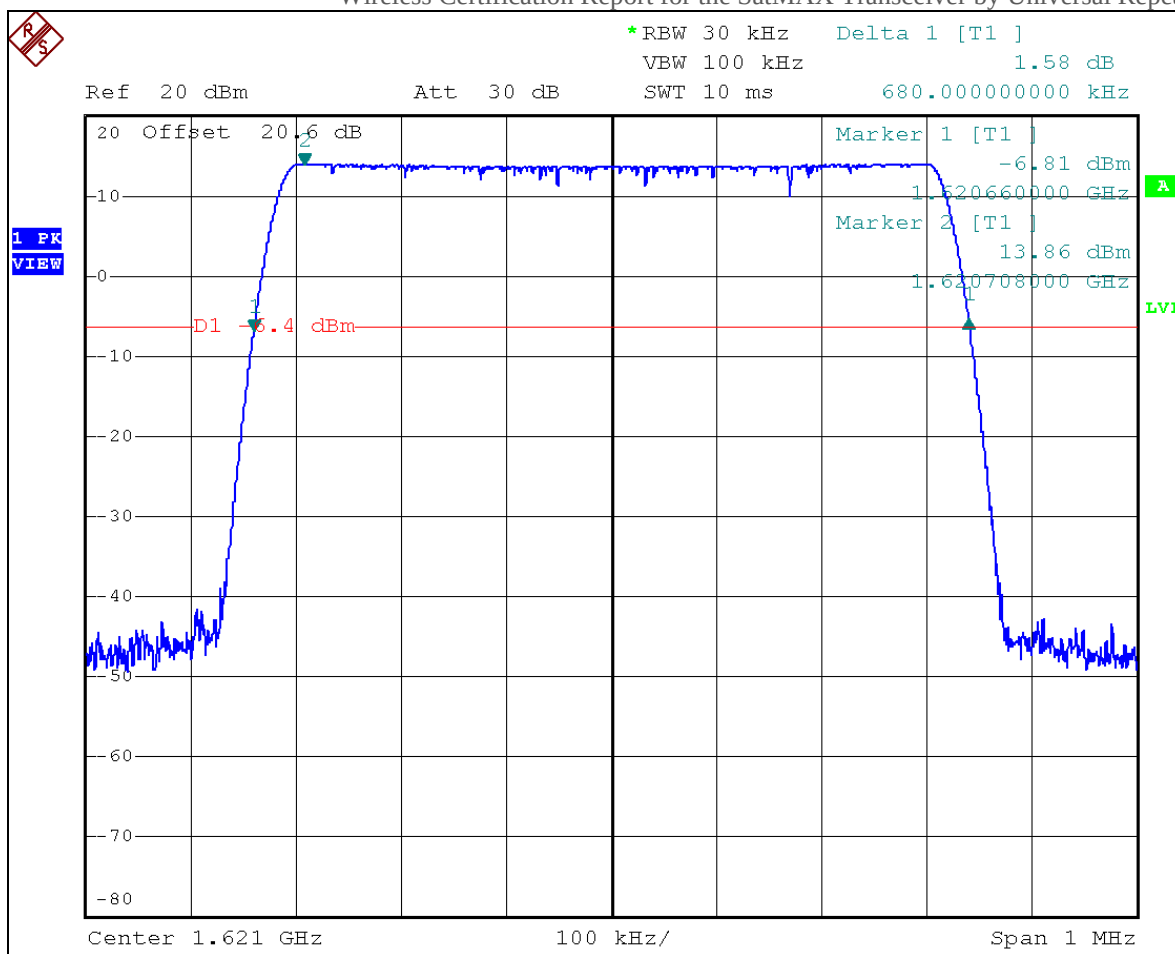


Uplink Output Bandwidth – High Channel

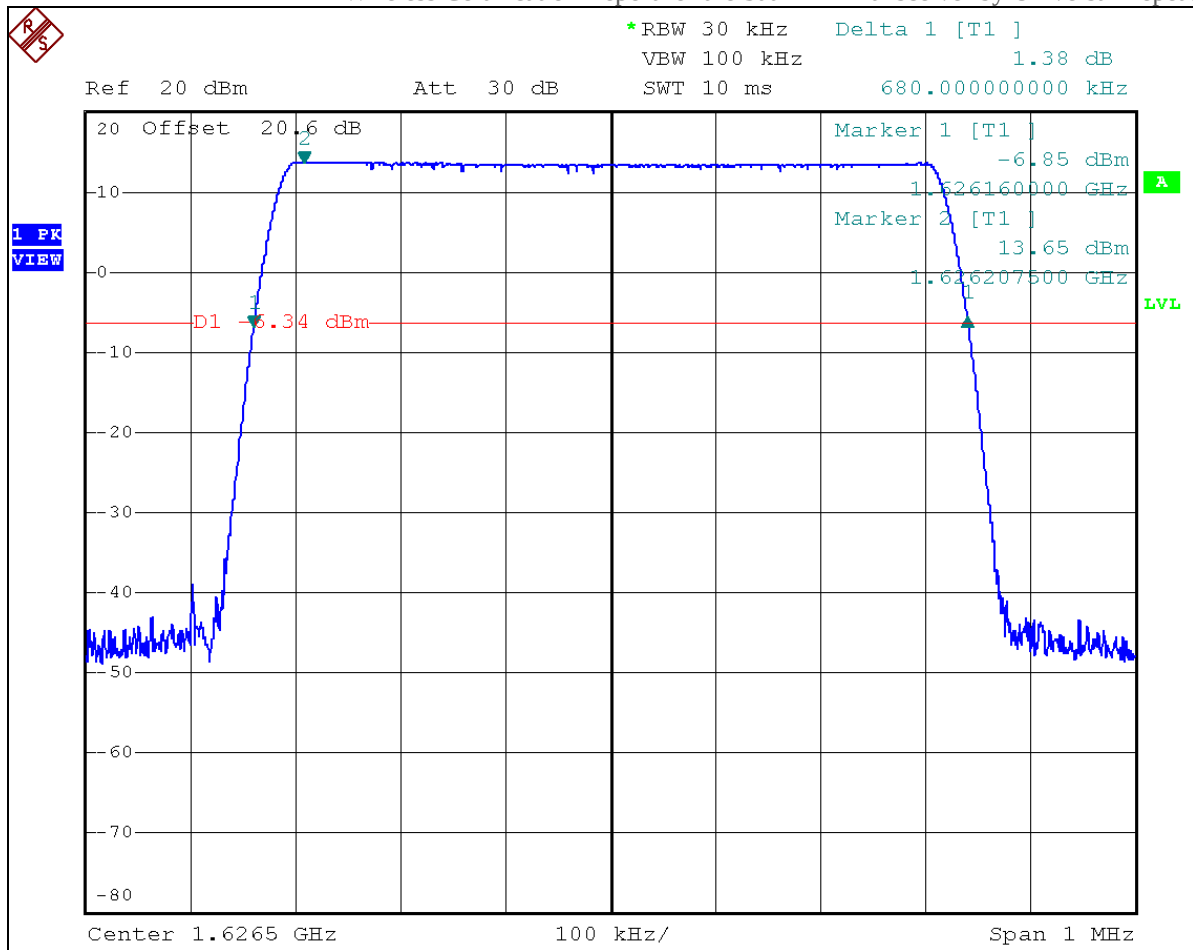
10.3.3 Downlink Output Bandwidth



Downlink Output Bandwidth – Low Channel



Uplink Output Bandwidth – Middle Channel

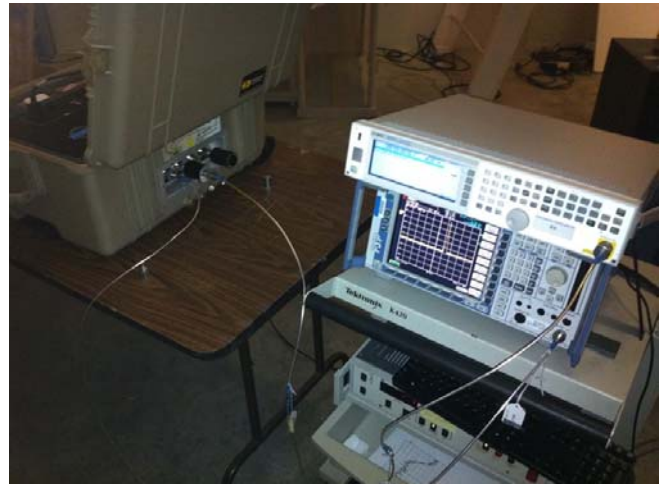


Uplink Output Bandwidth – High Channel

10.4 Setup Photographs



Bandwidth, EUT



Bandwidth, Equipment Setup

10.5 Equipment List

Equipment List				
Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
1816	Agilent	N5181A	Signal Generator	2014-09-27

11.0 Amplifier DC Power Requirement

11.1 Criteria

Report measured voltage and current input to the amplifier output stage.

11.2 Procedure

Apply a full NOC signal level as determined previously to the amplifier input with resistive termination of the output. Then directly measure DC current and voltage for the amplifier(s) and record.

11.3 Results

The amplifiers are modules and the final stage could not be isolated from the entire module. Therefore the module power requirement is reported below. Also note that the fans for the uplink module were powered on the same circuit.

Table of DC Power Requirements		
Amplifier Section	Voltage (V)	Current (mA)
Uplink	11.6	2610
Downlink	11.6	130

11.4 Equipment List

Equipment List				
Asset #	Manufacturer	Model #	Description	Calibration Due
1096	Extech	380941	AC/DC Clamp Multimeter	2014-09-18
1816	Agilent	N5181A	Signal Generator	2014-09-27

12.0 Carrier-Off State Emissions

12.1 Criteria

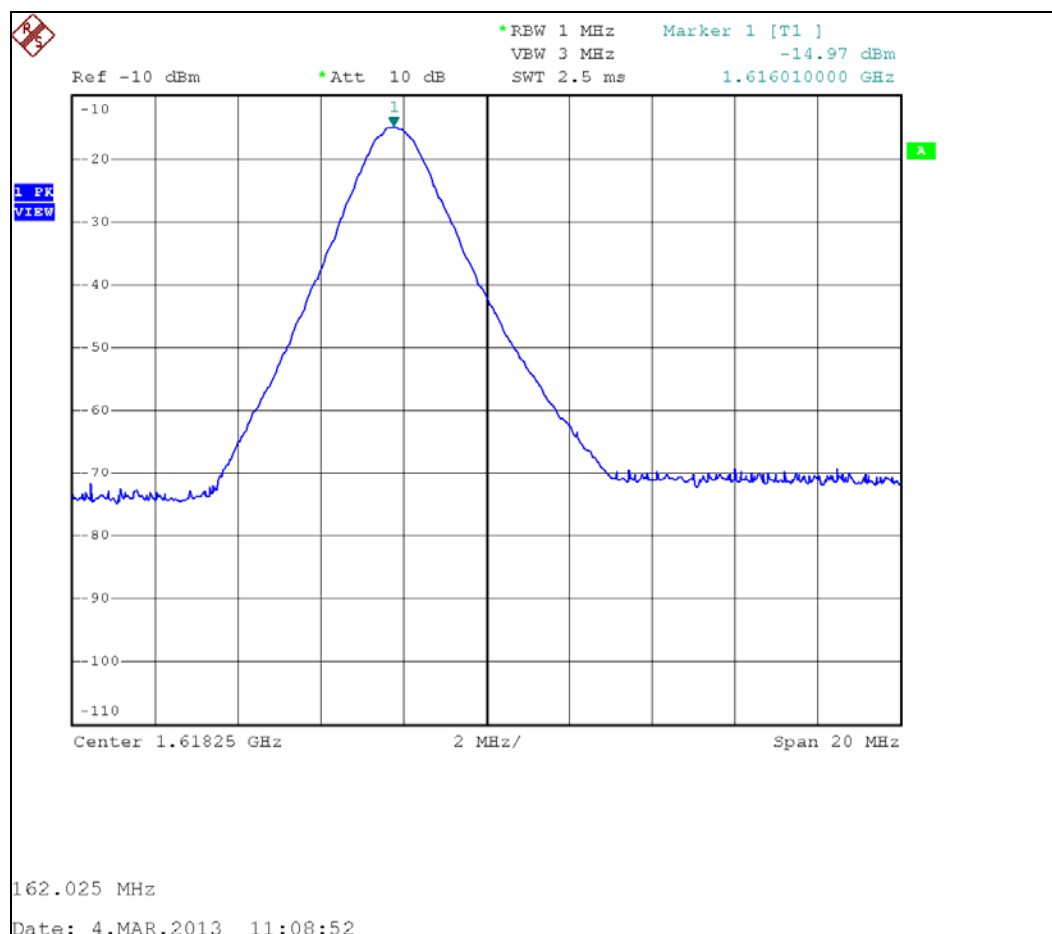
Per 25.216(i) the limit on carrier-off state emissions is -80 dBW/MHz in the 1559-1610 MHz band and averaged over any two millisecond interval. An RMS detector shall be employed.

12.2 Procedure

Emissions are measured to insure there is no signal above the limit in the frequency band of interest when the carrier signal is removed.

12.3 Results

There is no capacity in this amplifier to generate signals other than noise floor. The noise floor can be deduced with high confidence from a measurement taken while the amplifier was in the active state with a signal near the low end of the band. The recorded measurement (below) shows an in-band signal at 1616 MHz. The sweep begins at 1608.25 MHz. Observe the noise floor presented at the left of the plot as it is below -60 dBm (-90 dBW) with carrier. (Add 11.5 dB for coupler + cable loss.) With carrier off, the noise could be lower but not higher. Also, the noise floor on the left of the signal is lower than on the right of the signal; this is from the nearby cavity filters low skirt. Further attenuation of noise can be expected. Since there is no capability to produce narrowband signals nor additional noise, any emission lower than 1608.25 MHz can be safely predicted to be no higher than shown. The EUT satisfies the criteria.



Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11: 2007, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements is shown as Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1: Summary of Measurement Uncertainties for Site 45

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Mains Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	2.8
Radiated Emissions	30 to 1,000 MHz	10 m	4.8
	1 to 18 GHz	3 m	5.7

End of Report

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