



# TEST REPORT

**Test Report No. : UL-RPT-RP88424JD09A**

**Manufacturer** : Axell Wireless Limited  
**Model No.** : MBF-3707-3708-PS  
**FCC ID** : NEOA218SERIES  
**Test Standard(s)** : FCC Part 90.219

1. This report may not be reproduced other than in full, except with the prior written approval of UL.
2. The results in this report apply only to the sample(s) tested.
3. This sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 1.0.

**Date of Issue:** 06 April 2016

**Checked by:**

Sarah Williams  
Engineer, Radio Laboratory

**Company Signatory:**

Steven White  
Service Lead, Radio Laboratory,  
UL VS LTD



This laboratory is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

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## UL VS LTD

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**1. Customer Information**



















<b>Company Name:</b>	Axell Wireless Limited
<b>Address:</b>	Aerial House Asheridge Road Chesham Buckinghamshire HP5 2QD United Kingdom

## **2. Summary of Testing**

### **2.1. General Information**

<b>Specification Reference:</b>	47CFR90
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 90 (47CFR90): Private Land Mobile Radio Services. Subpart R—Regulations Governing the Licensing and Use of Frequencies in the 763-775 and 793-805 MHz Bands Subpart S—Regulations Governing Licensing and Use of Frequencies in the 806-824, 851-869, 896-901 and 935-940 MHz Bands Part 90.219 Use of signal boosters
<b>Site Registration:</b>	FCC: 209735
<b>Location of Testing:</b>	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
<b>Test Dates:</b>	18 September 2012 to 24 March 2016

**2.2. Summary of Test Results**

FCC Reference (47CFR)	Measurement	Result
<b>763-775 MHz frequency band</b>		
Parts 2.1046(a) / 90.219(e)(1) / 90.219(e)(4)	Transmitter Output Power and AGC Threshold	
Parts 2.1049 / 90.219(e)(4)	Transmitter Occupied Bandwidth	
Parts 2.1049 / 90.219(e)(4)	PLMRS Out-of-Band Rejection	
Parts 2.1049 / 90.210(b)	Emission Mask	
Part 90.219(d)(6)(ii)	Transmitter Noise Figure	
Parts 2.1051/ 90.219(e)(3)	Transmitter Conducted Spurious Emissions: Intermodulation Products	
Parts 2.1051/ 90.219(e)(3)	Transmitter Conducted Spurious Emissions	
Parts 2.1053/ 90.219(e)(3)	Transmitter Radiated Spurious Emissions	
Parts 2.1055 / 90.539(d) / 90.213 / 90.219(e)(4)(i)	Transmitter Frequency Stability	Note 1
<b>851-862 MHz frequency band</b>		
Parts 2.1046(a) / 90.219(e)(1) / 90.219(e)(4)	Transmitter Output Power and AGC Threshold	
Parts 2.1049 / 90.219(e)(4)	Transmitter Occupied Bandwidth	
Parts 2.1049 / 90.219(e)(4)	PLMRS Out-of-Band Rejection	
Parts 2.1049 / 90.210(b) / 90.210(g)	Emission Mask	
Part 90.219(d)(6)(ii)	Transmitter Noise Figure	
Parts 2.1051/ 90.219(e)(3)	Transmitter Conducted Spurious Emissions: Intermodulation Products	
Parts 2.1051/ 90.219(e)(3)	Transmitter Conducted Spurious Emissions	
Parts 2.1053/ 90.219(e)(3)	Transmitter Radiated Spurious Emissions	
Parts 2.1055/ 90.213(a) / 90.219(e)(4)(i)	Transmitter Frequency Stability	Note 1
<b>Key to Results</b>		
 = Complied  = Did not comply		

**Note(s)**

1. The EUT does not alter the input signal frequency in any way when it is retransmitted. Therefore frequency stability measurements are not included in this test report (FCC KDB 935210 Section 4.8).

### **2.3. Methods and Procedures**

<b>Reference:</b>	ANSI/TIA-603-C-2004
<b>Title:</b>	Land Mobile Communications Equipment, Measurements and performance Standards
<b>Reference:</b>	FCC KDB 971168 D01 v02r02, October 17, 2014
<b>Title:</b>	MEASUREMENT GUIDANCE FOR CERTIFICATION OF LICENSED DIGITAL TRANSMITTERS
<b>Reference:</b>	FCC KDB 935210 D05 v01r01, February 12, 2016
<b>Title:</b>	MEASUREMENTS GUIDANCE FOR INDUSTRIAL AND NON-CONSUMER SIGNAL BOOSTER, REPEATER, AND AMPLIFIER DEVICES
<b>Reference:</b>	Agilent E4438C signal generator user and measurement guide
<b>Title:</b>	Agilent 5990-6793EN iDEN measurement guide.pdf, Date October 14, 2010

### **2.4. Deviations from the Test Specification**

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

### **3. Equipment Under Test (EUT)**

#### **3.1. Identification of Equipment Under Test (EUT)**

<b>Brand Name:</b>	Axell Wireless Limited
<b>Model Name or Number:</b>	MBF-3707-3708-PS
<b>Test Sample Serial Number:</b>	8K5A
<b>Hardware Version:</b>	A
<b>Software Version:</b>	System 1.2.9 Common 1.8.5 target 1.2.2
<b>FCC ID:</b>	NEOA218SERIES

<b>Description:</b>	Optical Master Unit
<b>Brand Name:</b>	Axell Wireless Limited
<b>Model Name or Number:</b>	A1820011
<b>Test Sample Serial Number:</b>	91F0
<b>Hardware Version:</b>	C

#### **3.2. Description of EUT**

The Equipment Under Test was a fixed Class B Signal Booster using a Distributed Antenna System (DAS). It is a fibre optic fed booster that provides extended radio coverage for APCO P25 and FM networks in the 763 to 775 MHz (downlink) / 793 to 805 MHz (uplink) and iDEN, APCO P25 and FM in the 806 to 817 MHz (uplink) / 851 to 862 MHz (downlink) bands. It has approximately 30 dB of gain for both uplink and downlink. The Radio Head and Optical Master Unit are interconnected with fibre optic cables. The uplink signals feed into fibre optic cables.

There is no frequency band change and no frequency translation.

#### **3.3. Modifications Incorporated in the EUT**

No modifications were applied to the EUT during testing.



**3.4. Additional Information Related to Testing**

<b>Type of Radio Device:</b>	Dual band MBF booster		
<b>Power Supply Requirement(s):</b>	Nominal	120 VAC 60 Hz	
<b>Technology Tested:</b>	iDEN		
<b>Channel Spacing:</b>	25 kHz		
<b>Modulation Type:</b>	16QAM (Voice application)		
<b>Downlink Frequency Range:</b>	851 to 862 MHz		
<b>Downlink Channels Tested:</b>	<b>Channel ID</b>	<b>850 MHz Band Frequency (MHz)</b>	
	Bottom	851.0	
	Middle	856.5	
	Top	862.0	
<b>Technology Tested:</b>	APCO P25 Phase 1		
<b>Channel Spacing:</b>	12.5 kHz		
<b>Modulation Type:</b>	C4FM		
<b>Downlink Frequency Range:</b>	763 to 775 MHz and 851 to 862 MHz		
<b>Downlink Channels Tested:</b>	<b>Channel ID</b>	<b>700 MHz Band Frequency (MHz)</b>	<b>850 MHz Band Frequency (MHz)</b>
	Bottom	763.0	851.0
	Middle	769.0	856.5
	Top	775.0	862.0

**Additional Information Related to Testing (continued)**

<b>Technology Tested:</b>	APCO P25 Phase 2		
<b>Channel Spacing:</b>	12.5 kHz		
<b>Modulation Type:</b>	$\pi/4$ -DQPSK		
<b>Downlink Frequency Range:</b>	763 to 775 MHz and 851 to 862 MHz		
<b>Downlink Channels Tested:</b>	<b>Channel ID</b>	<b>700 MHz Band Frequency (MHz)</b>	<b>850 MHz Band Frequency (MHz)</b>
	Bottom	763.0	851.0
	Middle	769.0	856.5
	Top	775.0	862.0
<b>Technology Tested:</b>	FM		
<b>Channel Spacing:</b>	12.5 and 25 kHz		
<b>Downlink Frequency Range:</b>	763 to 775 MHz and 851 to 862 MHz		
<b>Downlink Channels Tested:</b>	<b>Channel ID</b>	<b>700 MHz Band Frequency (MHz)</b>	<b>850 MHz Band Frequency (MHz)</b>
	Bottom	763.0	851.0
	Middle	769.0	856.5
	Top	775.0	862.0

### **3.5. Support Equipment**

The following support equipment was used to exercise the EUT during testing:

<b>Description:</b>	Laptop PC
<b>Brand Name:</b>	Dell
<b>Model Name or Number:</b>	Latitude D610
<b>Serial Number:</b>	UL VS LTD Asset No. 00373

<b>Description:</b>	RS232C cable – DB9 male to DB9 female / length 3 metres
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	Low Noise Amplifier
<b>Brand Name:</b>	Axell Wireless
<b>Model Name or Number:</b>	11-006902-5
<b>Serial Number:</b>	150429

## **4. Operation and Monitoring of the EUT during Testing**

### **4.1. Operating Modes**

The EUT was tested in the following operating mode(s):

- Transmitting on the downlink at maximum power unless otherwise stated.

### **4.2. Configuration and Peripherals**

The EUT was tested in the following configuration(s):

- The EUT was powered from a 120 VAC 60 Hz power supply for all tests.
- A laptop PC with Axell Wireless Repeater Maintenance Console – RMC 2.330 application was connected through an RS232 interface to the EUT for configuration purposes. The EUT was configured in accordance with instructions contained in the Optical Master Unit Product Description and User's Manual for Axell OMU Unit REV. A01 supplied by the manufacturer.
- The EUT was operating at maximum power and maximum gain throughout testing unless otherwise stated.
- The Optical Master Unit (OMU) was connected to the MBF via optical fibre at all times during testing.
- The input signal(s) was fed into the downlink port (DL) on the OMU and the output port (SERVER) of the booster was connected to a spectrum analyser using suitable RF cables and attenuators. A Low Noise Amplifier (LNA) was supplied by the customer and fitted to the signal generator output when performing iDEN tests. The LNA was used to increase the signal level as the Agilent E4438C signal generator output was not sufficiently high to reach 3 dB above the EUT's AGC threshold.
- iDEN tests: An Agilent E4438C signal generator was used. Agilent (now trading as Keysight) provided an IDEN\_FULL\_RES waveform file (Dated 20 January 2016) and this was used during all iDEN tests. The signal generator was configured in accordance with instructions contained in Agilent 5990-6793EN iDEN measurement guide.pdf, Date October 14, 2010.
- Radiated spurious emissions tests: unused ports were terminated into RF loads or typical peripheral devices.

## **5. Measurements, Examinations and Derived Results**

### **5.1. General Comments**

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6. Measurement Uncertainty* for details.

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

## **5.2. Test Results 763-775 MHz frequency band**

### **5.2.1. Transmitter Output Power and AGC Threshold**

#### **Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Dates:</b>	12 January 2016 to 24 March 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1046(a) / 90.219(e)(1) / 90.219(e)(4)
<b>Test Method Used:</b>	FCC KDB 935210 D05 Sections 4.2 & 4.5.3 and Notes below

#### **Environmental Conditions:**

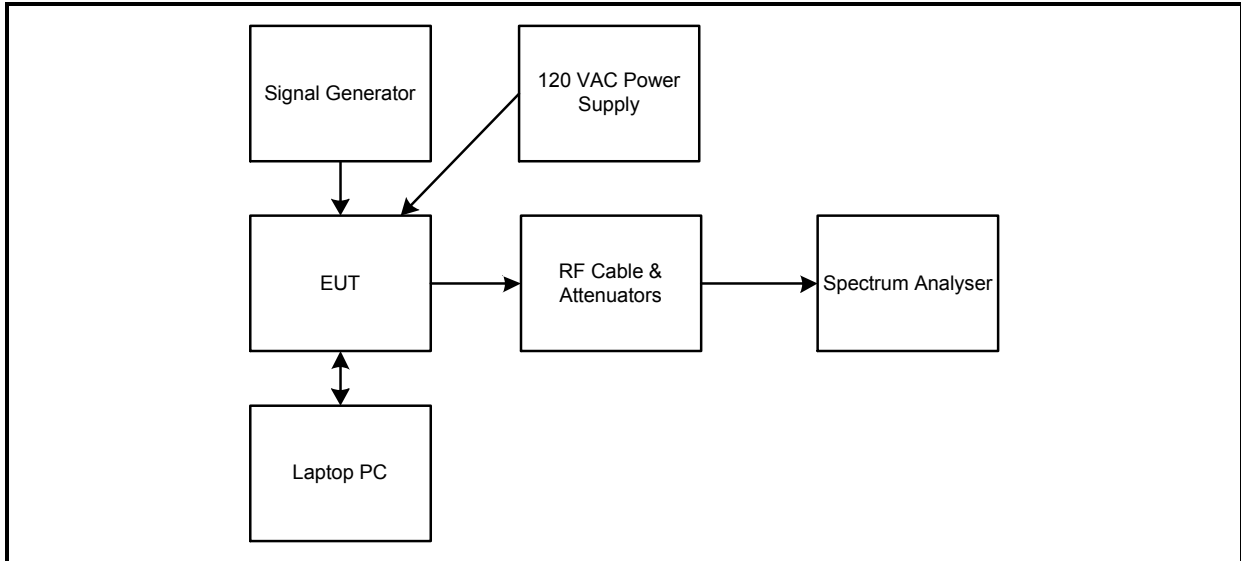
<b>Temperature (°C):</b>	24 to 26
<b>Relative Humidity (%):</b>	30 to 35

#### **Note(s):**

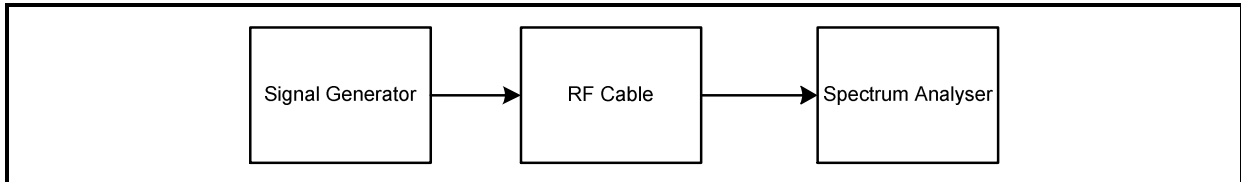
1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
2. A signal generator was connected to the downlink input (DL port) of the EUT via an RF cable. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and 30 dB attenuators. The combined path loss of the cable and attenuators was 31.7 dB. This loss was entered as an RF level offset on the spectrum analyser.
3. Output power measurements were performed in units of dBm. The conducted power was compared to the ERP limit of 5 Watts (37 dBm) for each retransmitted channel. The maximum measured conducted power was 4.68 Watts (36.7 dBm) giving a margin of 0.32 Watts when compared to the limit. No antenna gain has been stated, therefore an antenna gain of 0 dBd has been assumed. The EUT uses Automatic Gain Control. It was confirmed by measurement that the maximum output power in all modes remained constant when the EUT is operated in saturation (input signal  $\geq 3$  dB above the level that produces the maximum output signal). The EUT Repeater Maintenance Console application also indicated a warning to show the amplifier was at saturation when the input levels were above the AGC threshold.
4. The EUT supports multi-channel operation. Additional tests were performed with two equal level input signals (769 MHz and 769.5 MHz) provided by a two port signal generator (UL VS LTD Asset No. M1801) via a combining network. The EUT output was measured at the AGC threshold and with the input levels at 3 dB above the AGC threshold level. Markers were placed on the peak of each signal. The composite output remained below the 5 Watt ERP limit under normal and overload conditions.

**Transmitter Output Power and AGC Threshold (continued)**

**Test setup for transmitter output power and AGC threshold measurements:**



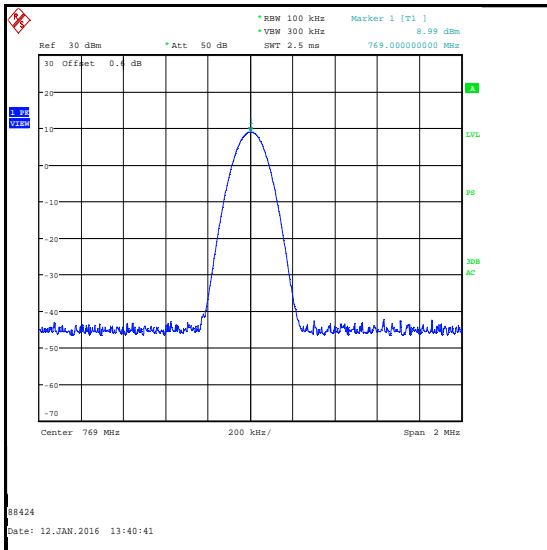
**Test setup for transmitter input power and AGC threshold measurements:**



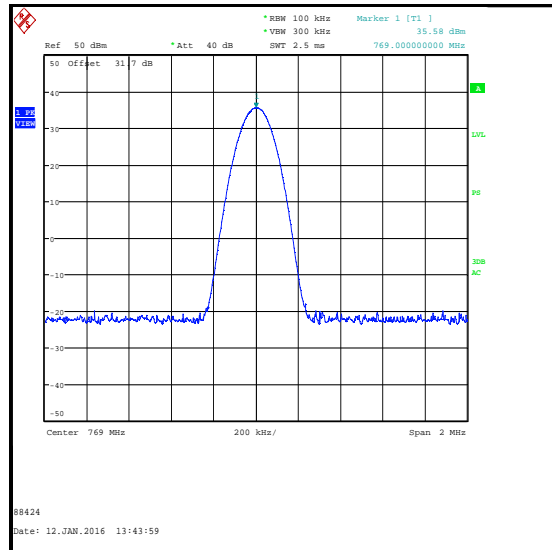
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / CW**

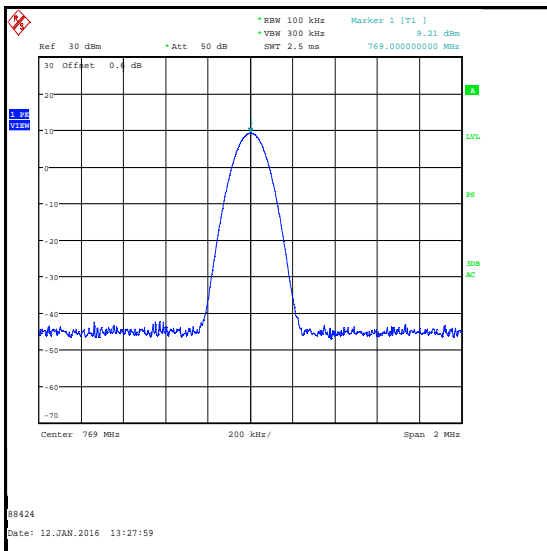
700 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
None (CW)	9.0	35.6	9.2	36.0	37.0	1.0	Complied



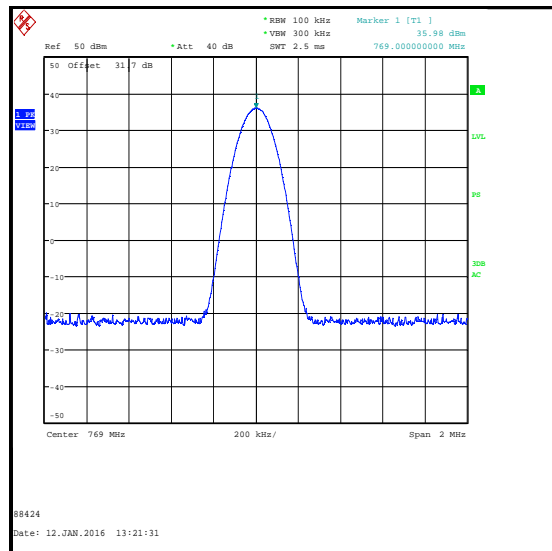
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**



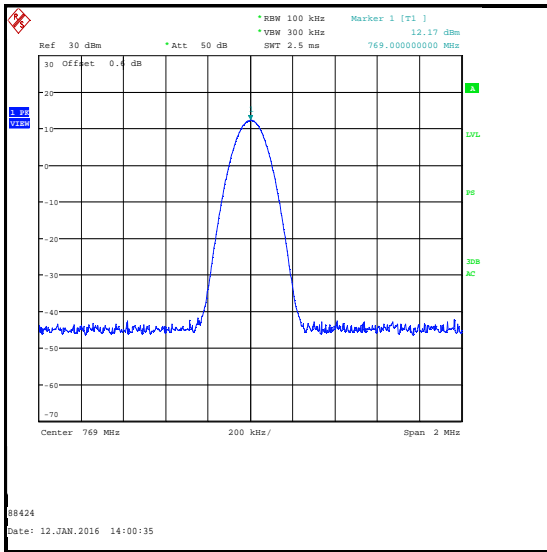
**Maximum Output Power**



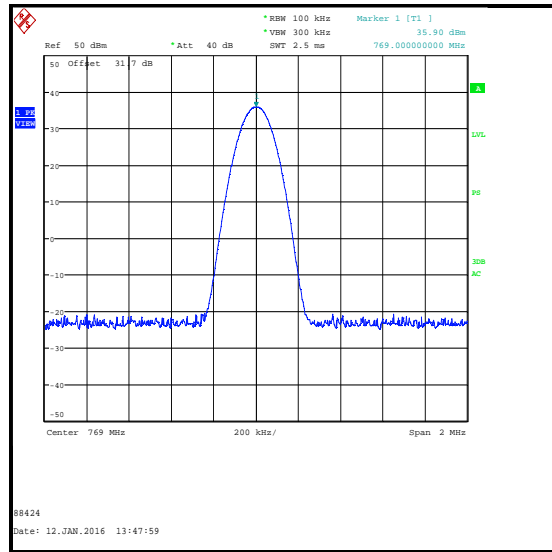
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / CW**

700 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
None (CW)	12.2	35.9	37.0	1.1	Complied



**Input Power at AGC Threshold +3 dB**

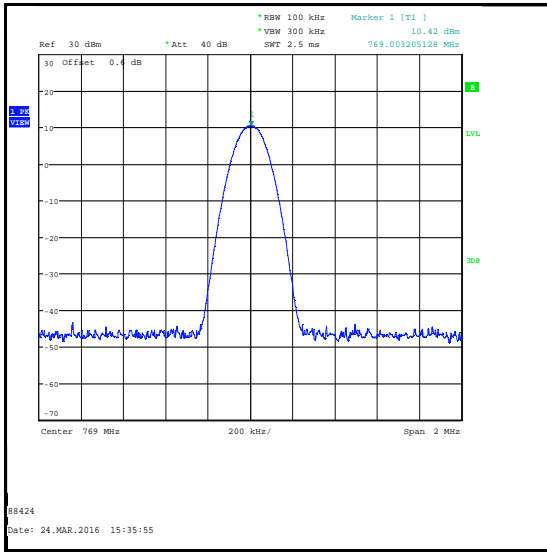


**Output Power**

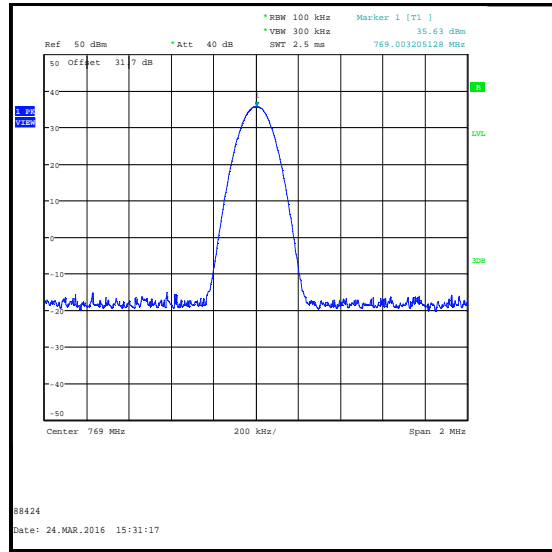
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / 11K3F3E / 1 kHz Audio Frequency**

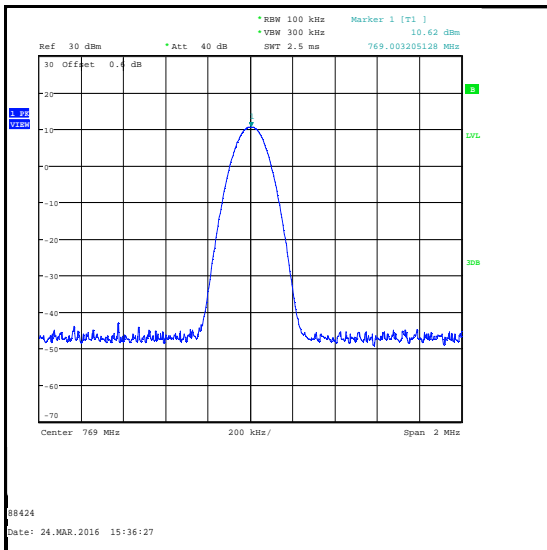
700 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
FM	10.4	35.6	10.6	35.8	37.0	1.2	Complied



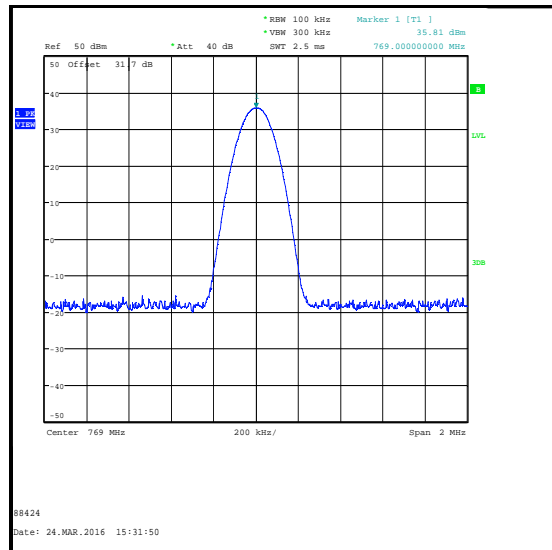
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**

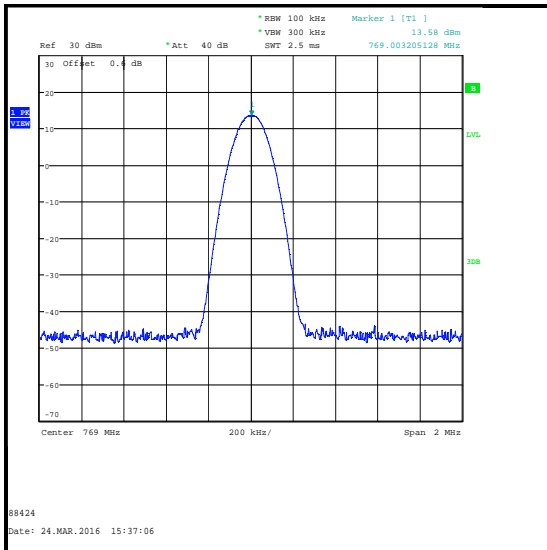


**Maximum Output Power**

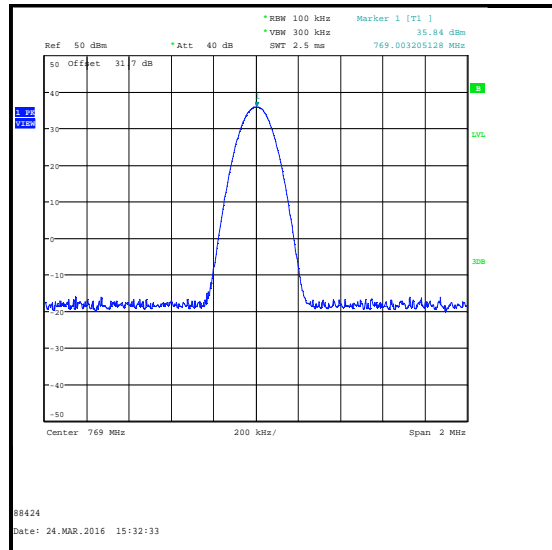
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / 11K3F3E / 1 kHz Audio Frequency**

700 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
FM	13.6	35.8	37.0	1.2	Complied



**Input Power at AGC Threshold +3 dB**

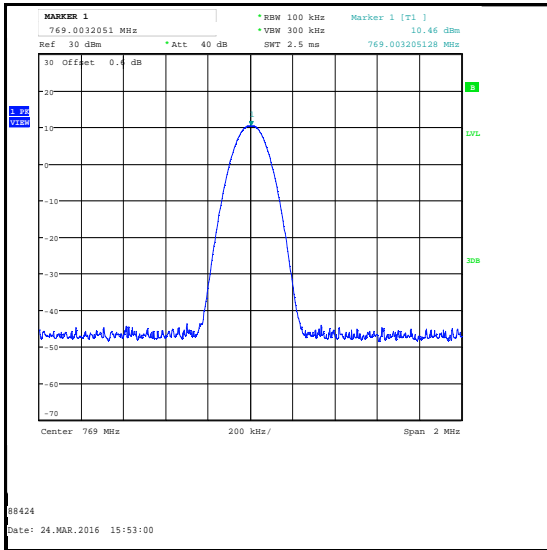


**Output Power**

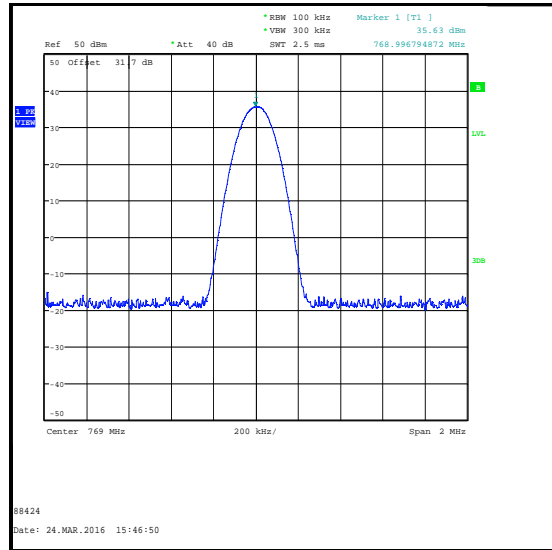
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / 16K0F3E / 1 kHz Audio Frequency**

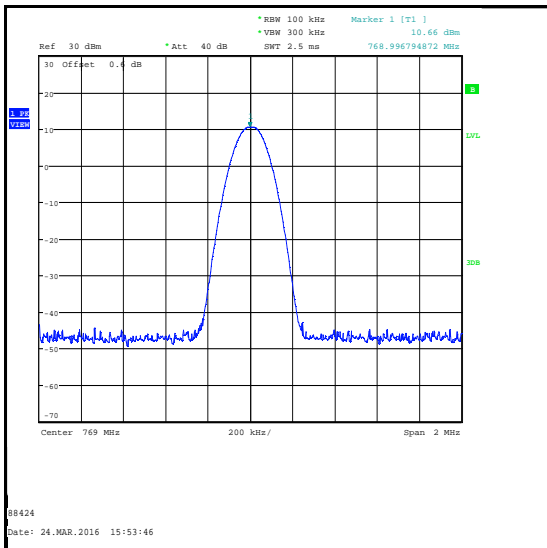
700 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
FM	10.5	35.6	10.7	35.9	37.0	1.1	Complied



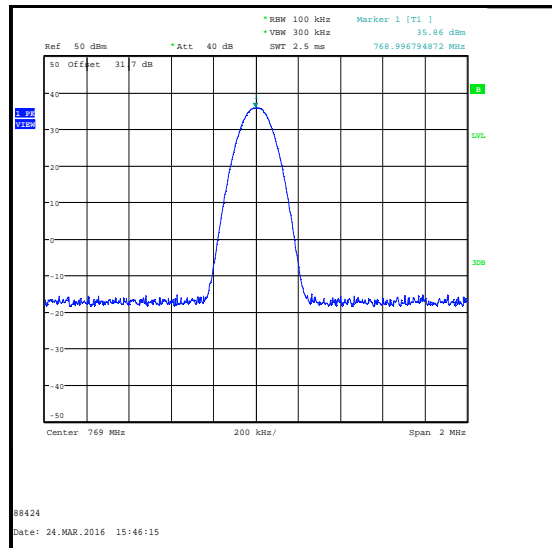
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**

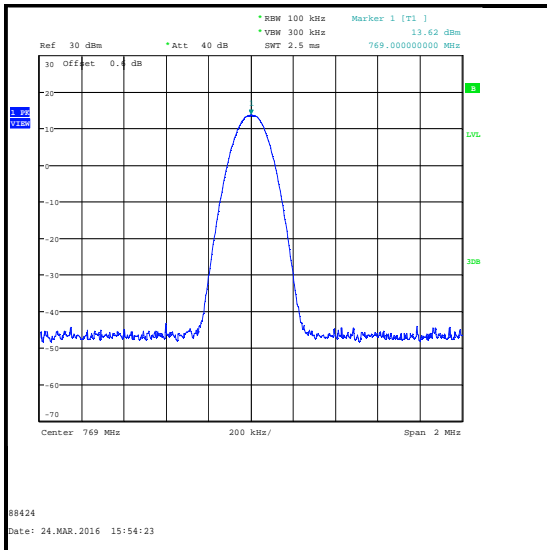


**Maximum Output Power**

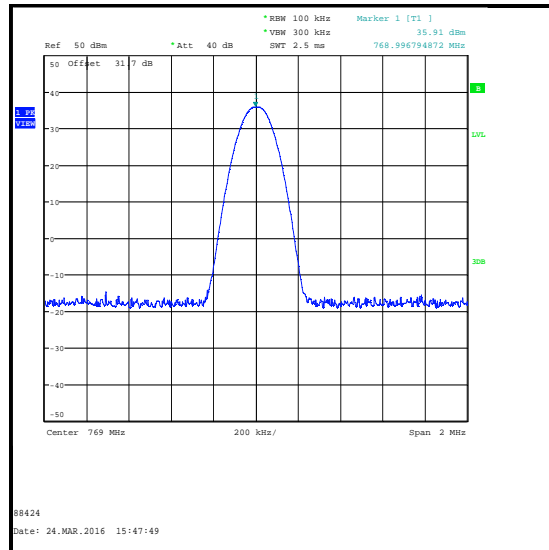
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / 16K0F3E / 1 kHz Audio Frequency**

700 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
FM	13.6	35.9	37.0	1.1	Complied



**Input Power at AGC Threshold +3 dB**

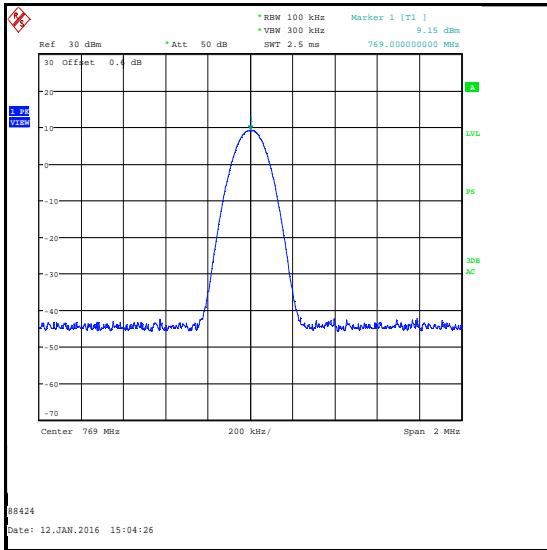


**Output Power**

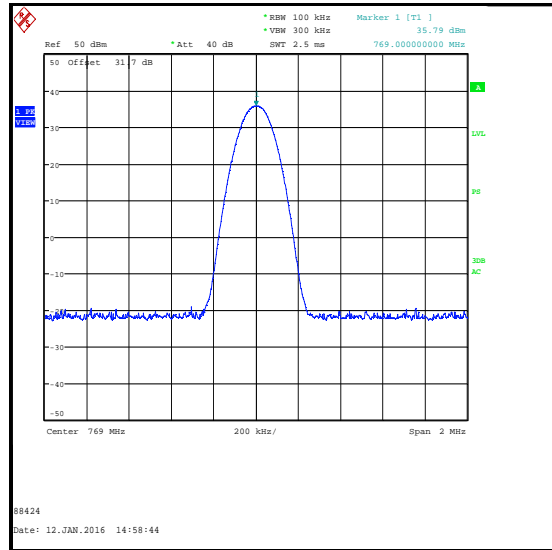
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / APCO P25 Phase 1**

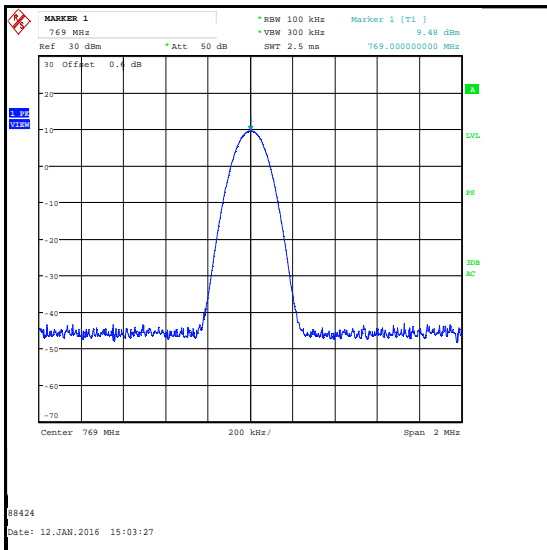
700 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
C4FM	9.2	35.8	9.5	36.1	37.0	0.9	Complied



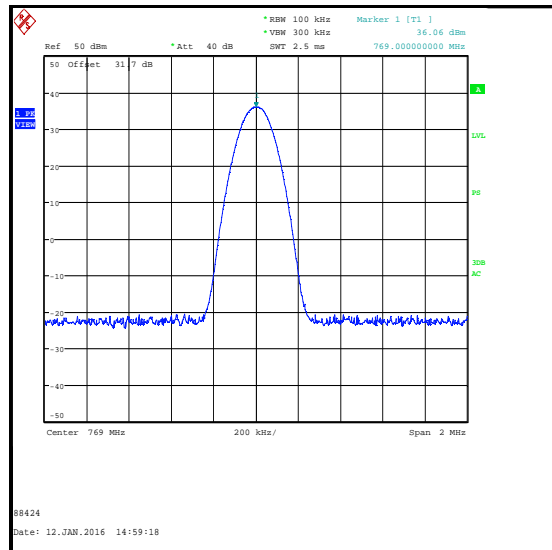
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**

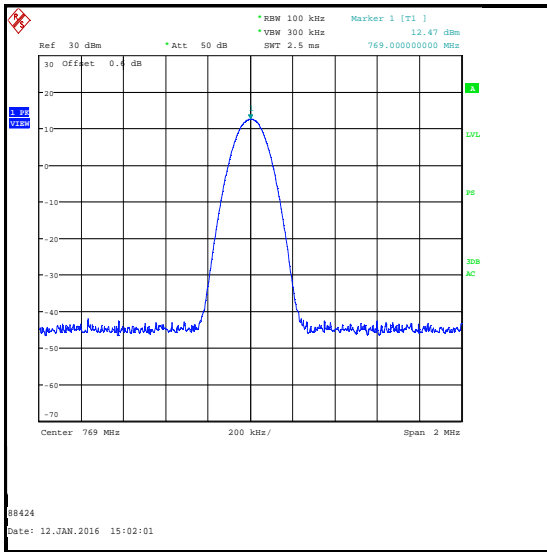


**Maximum Output Power**

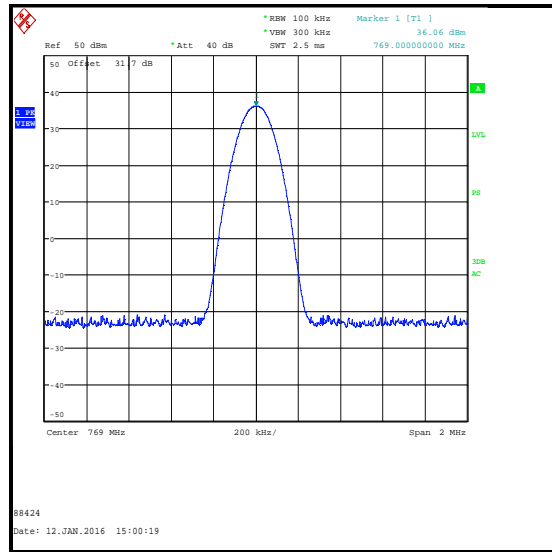
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / APCO P25 Phase 1**

700 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
C4FM	12.5	36.1	37.0	0.9	Complied



**Input Power at AGC Threshold +3 dB**

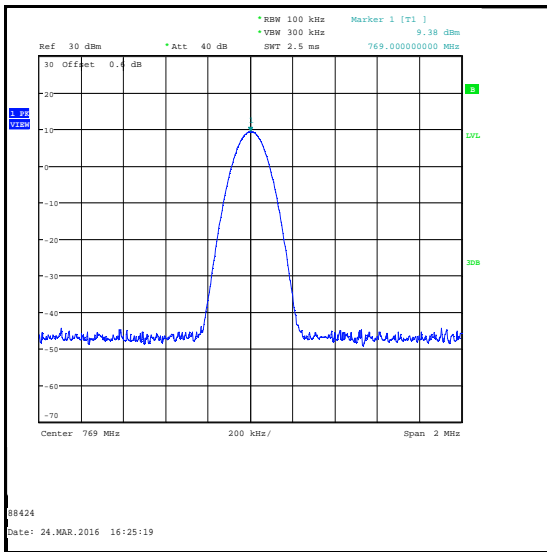


**Output Power**

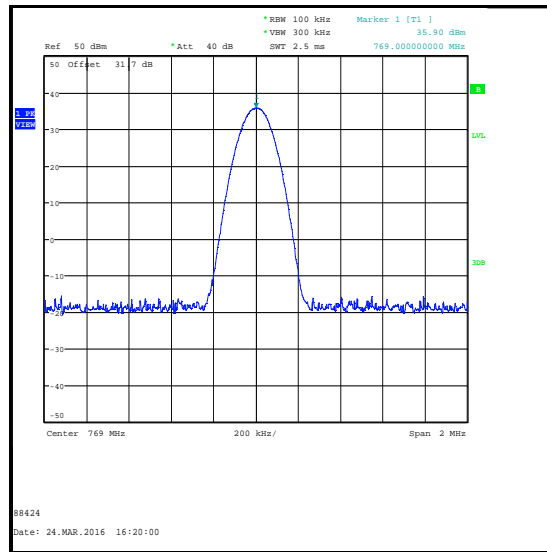
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / APCO P25 Phase 2**

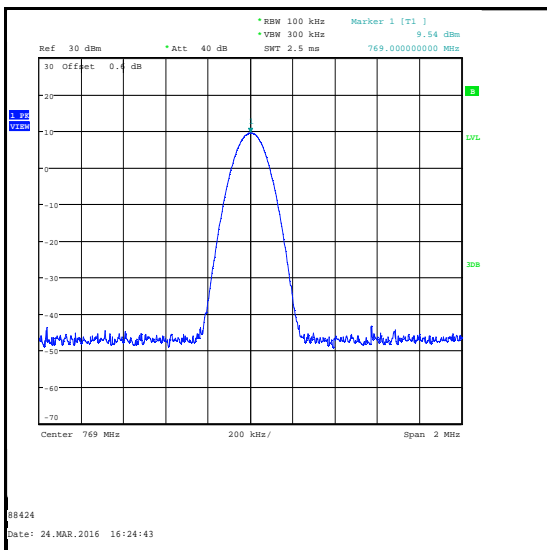
700 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
$\pi/4$ -DQPSK	9.4	35.9	9.5	36.1	37.0	0.9	Complied



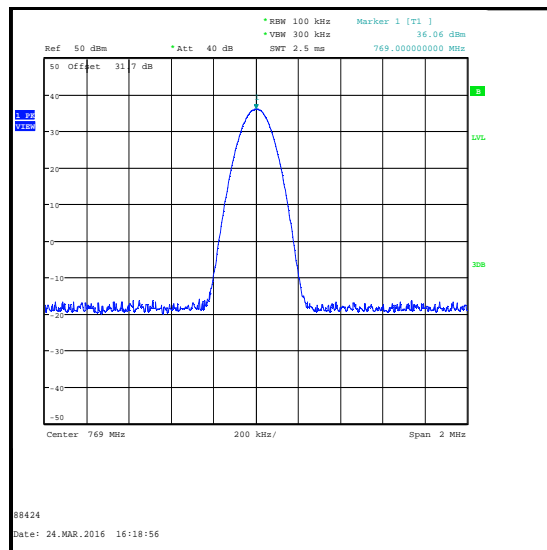
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**



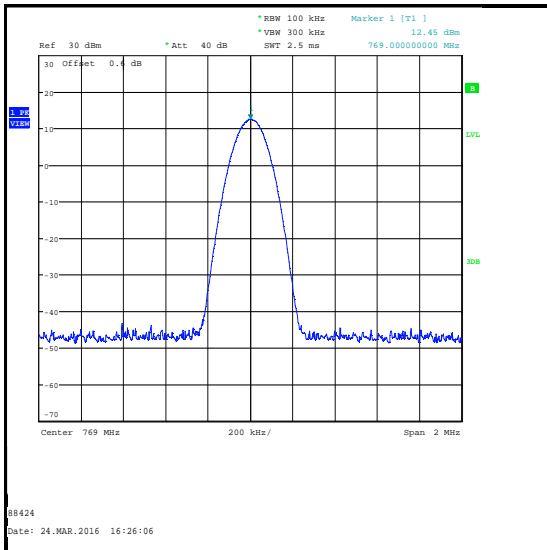
**Maximum Output Power**



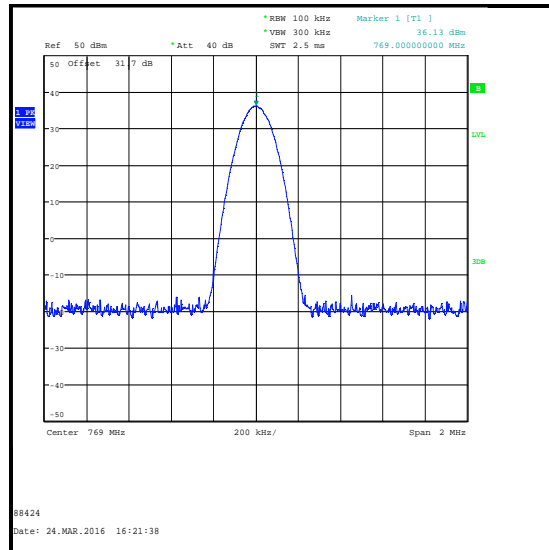
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 769 MHz / APCO P25 Phase 2**

700 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
$\pi/4$ -DQPSK	12.5	36.1	37.0	0.9	Complied



**Input Power at AGC Threshold +3 dB**

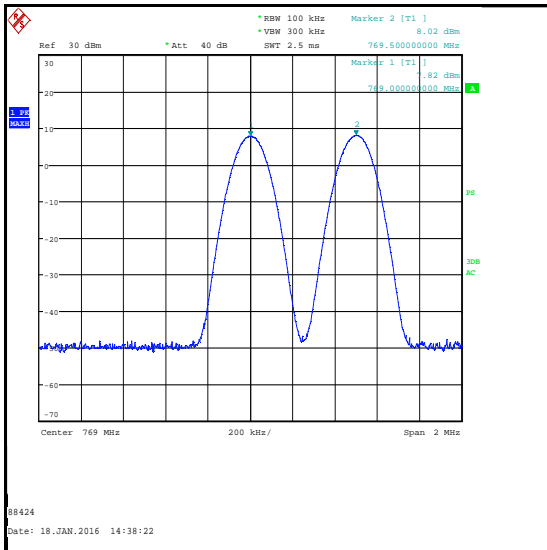


**Output Power**

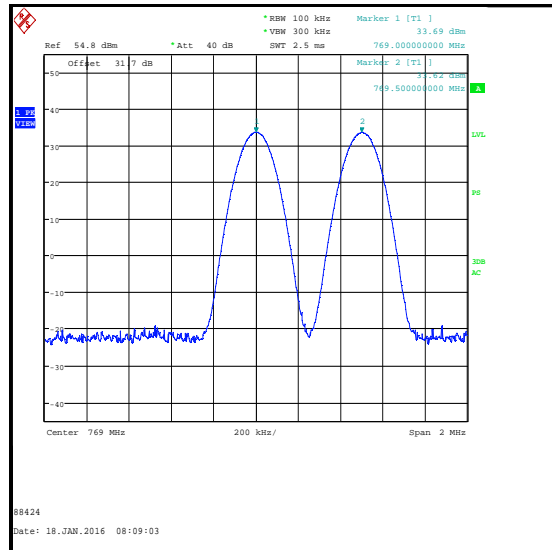
**Transmitter Output Power and AGC Threshold (continued)**

**Results: CW / Two channel operation**

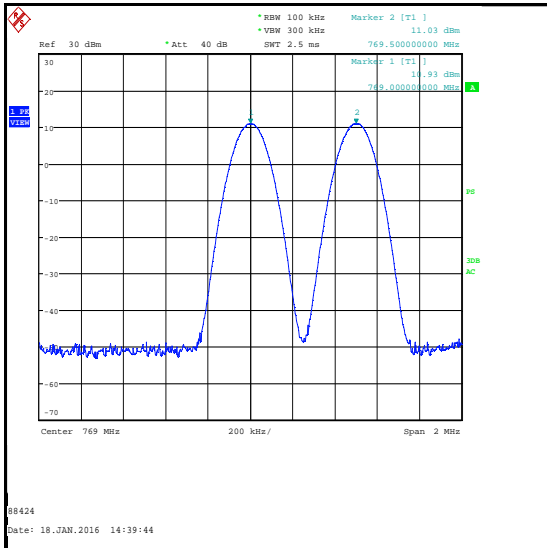
700 MHz Band / Downlink							
Modulation Type	Composite Input Power at AGC Threshold (dBm)	Composite Output Power at AGC Threshold (dBm)	Composite Input Power at AGC Threshold +3 dB (dBm)	Composite Output Power at AGC Threshold +3 dB (dBm)	Limit (dBm)	Margin (dB)	Result
None (CW)	10.9	36.7	14.0	36.7	37.0	0.3	Complied



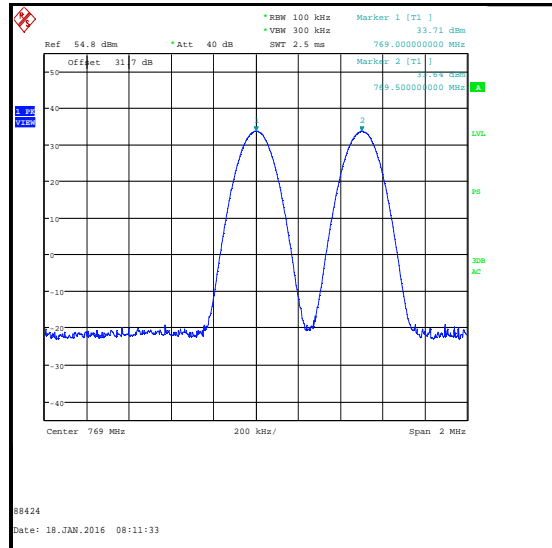
**Input Power at AGC Threshold**



**Output Power at AGC Threshold**



**Input Power at AGC Threshold +3 dB**



**Output Power at AGC Threshold +3 dB**

**Transmitter Output Power and AGC Threshold (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handlungspunkt	30.5015.13	Not stated	23 Apr 2016	12
G0607	Vector Signal Generator	Rohde & Schwarz	SMU 200A	100943	18 Jul 2016	36
A1398	20 dB Attenuator	Weinschel	WA46-20	A129	Calibrated before use	-
A1399	10 dB Attenuator	Weinschel	WA46-10	A126	Calibrated before use	-
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
M1794	Spectrum Analyser	Rohde & Schwarz	FSU	100027	09 Feb 2018	24
M1801	Vector Signal Generator	Rohde & Schwarz	SMU 200A	103606	Calibrated before use	-
G047	Signal Generator	Rohde & Schwarz	SMY01	843215/015	24 Jul 2016	12

**5.2.2. Transmitter Occupied Bandwidth**

**Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Date:</b>	05 January 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1049 / 90.219(e)(4)(i) & 90.219(e)(4)(ii)
<b>Test Method Used:</b>	FCC KDB 971168 D01 Section 4.2 and Notes below

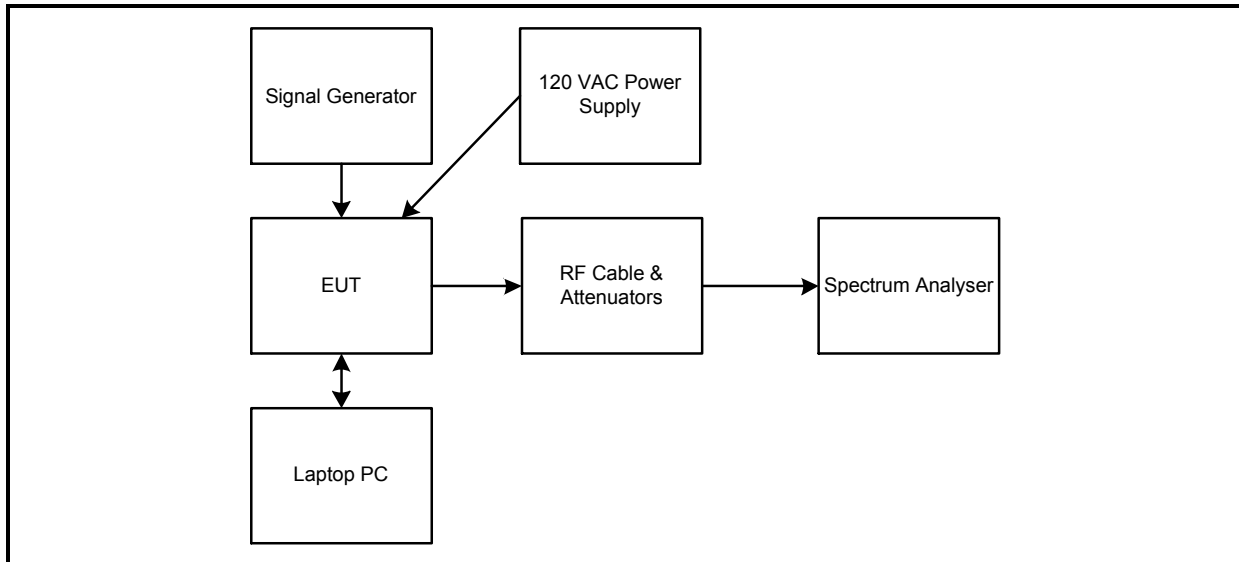
**Environmental Conditions:**

<b>Temperature (°C):</b>	24 to 26
<b>Relative Humidity (%):</b>	35

**Note(s):**

1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
2. A signal generator was connected to the downlink input (DL port) of the EUT via an RF cable. Modulated signals for all supported technologies were applied to the input of the EUT. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and 30 dB of attenuation. The combined path loss of the cable and attenuators was 30.8 dB. This loss was entered as an RF level offset on the spectrum analyser.
3. Input (from signal generator) and output (from EUT) 99% occupied bandwidths of a single channel for each supported technology were measured using the occupied bandwidth function of a spectrum analyser. There was no change in the occupied bandwidth of the retransmitted signals. The spectral shape of the output signal is similar to the spectral shape of the input signal for all modulations. The noise-like characteristics of digital signals were tested, caused minor differences between input and output occupied bandwidths.
4. FM Tests: A 3 kHz AF tone was used. This produces a wider occupied bandwidth than a 1 kHz tone.

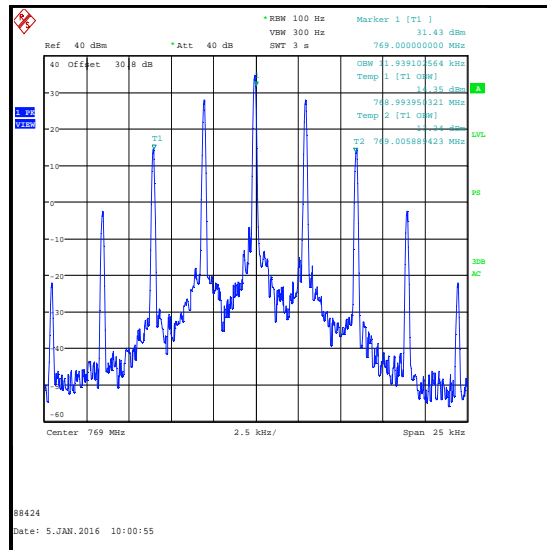
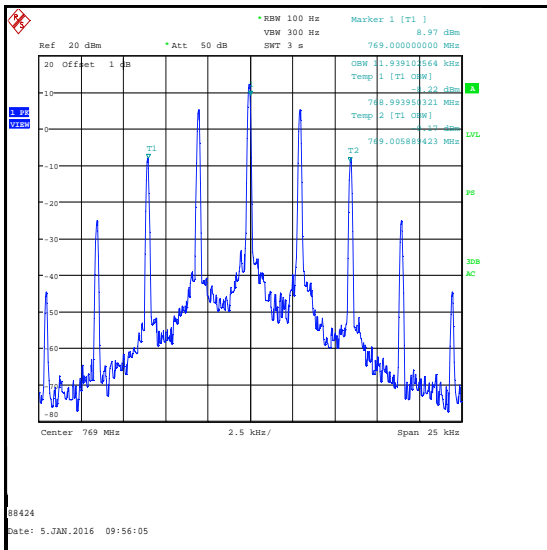
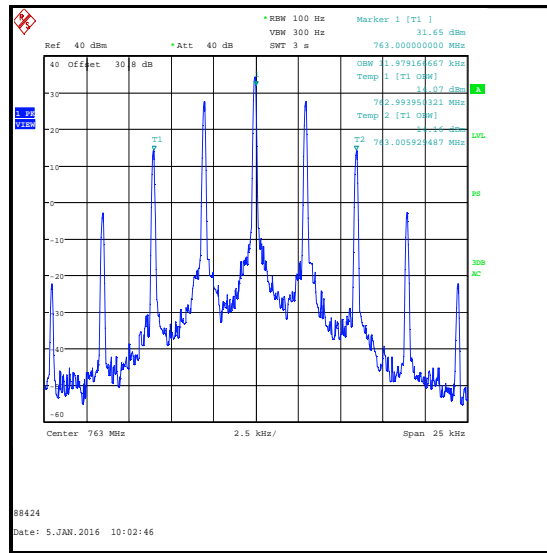
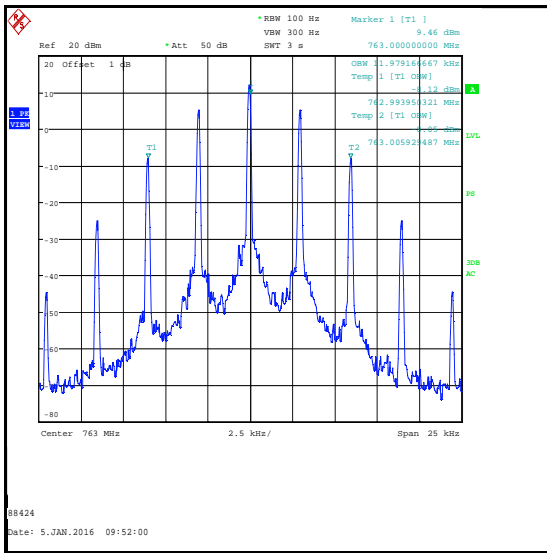
**Test setup for transmitter occupied bandwidth measurements:**



**Transmitter Occupied Bandwidth (continued)**

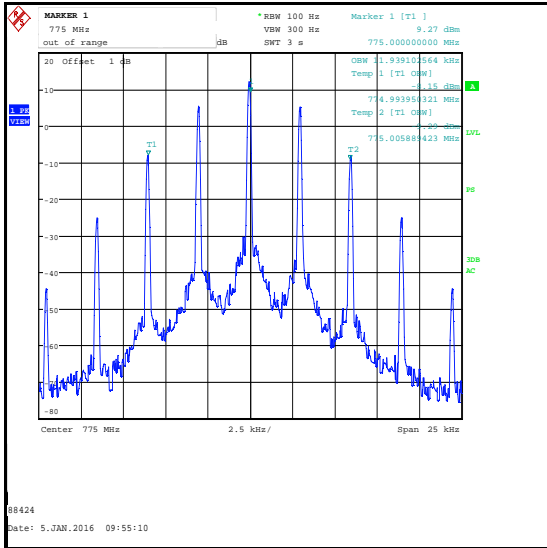
**Results: FM / 12.5 kHz Channel**

700 MHz Band / Downlink					
Frequency (MHz)	Emission Designator	Modulation Type	Input 99% Emission Bandwidth (kHz)	Output 99% Emission Bandwidth (kHz)	Difference between Input and Output Bandwidth (kHz)
763	11K3F3E	FM	11.979	11.979	0.0
769	11K3F3E	FM	11.939	11.939	0.0
775	11K3F3E	FM	11.939	11.939	0.0

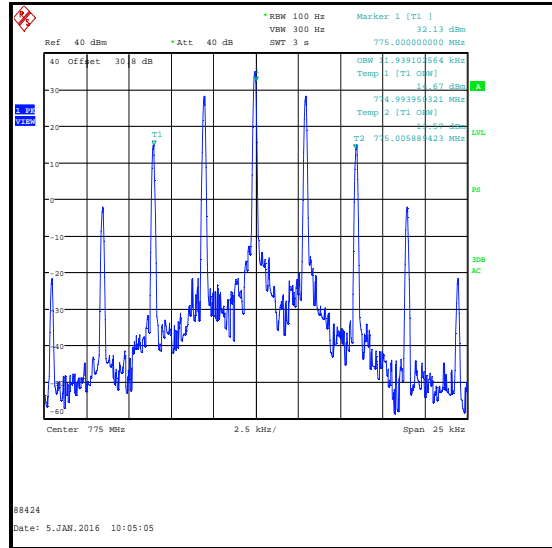


**Transmitter Occupied Bandwidth (continued)**

**Results: FM / 12.5 kHz Channel**



**Top Channel /  
Input 99% Emission Bandwidth**

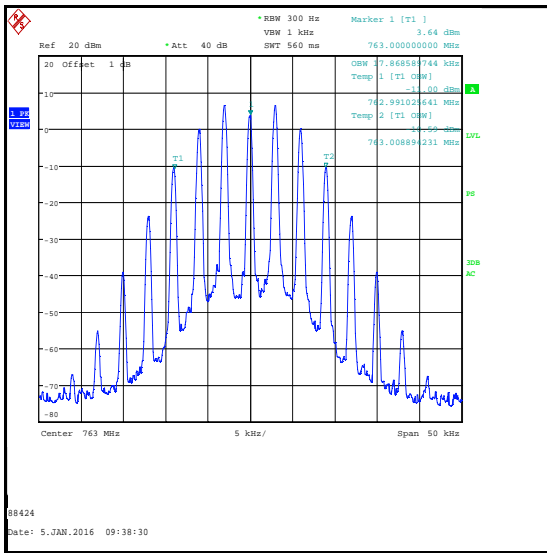


**Top Channel /  
Output 99% Emission Bandwidth**

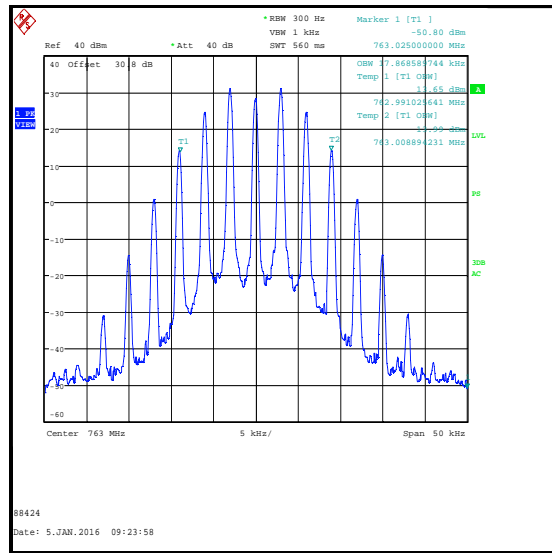
**Transmitter Occupied Bandwidth (continued)**

**Results: FM / 25 kHz Channel**

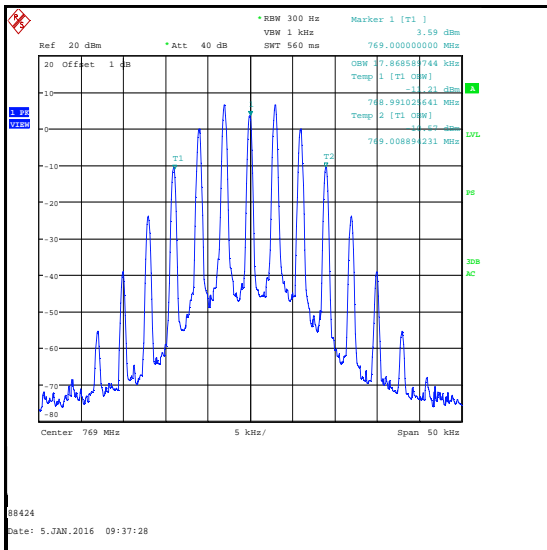
700 MHz Band / Downlink					
Frequency (MHz)	Emission Designator	Modulation Type	Input 99% Emission Bandwidth (kHz)	Output 99% Emission Bandwidth (kHz)	Difference between Input and Output Bandwidth (kHz)
763	16K0F3E	FM	17.869	17.869	0.0
769	16K0F3E	FM	17.869	17.869	0.0
775	16K0F3E	FM	17.869	17.869	0.0



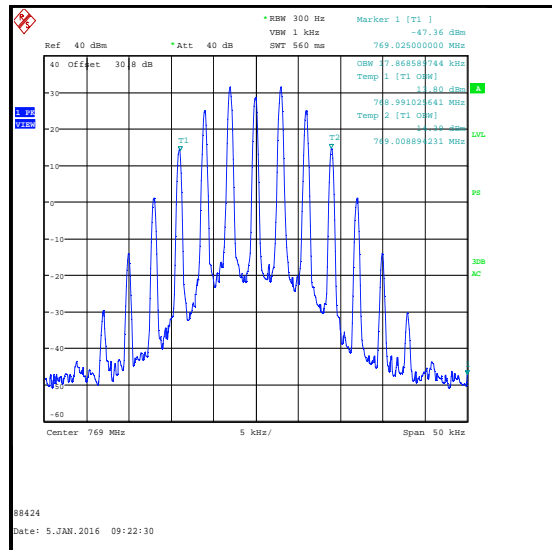
**Bottom Channel /  
Input 99% Emission Bandwidth**



**Bottom Channel /  
Output 99% Emission Bandwidth**



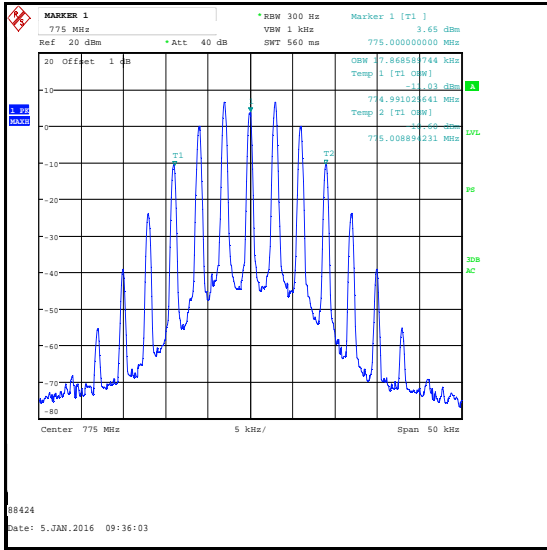
**Middle Channel /  
Input 99% Emission Bandwidth**



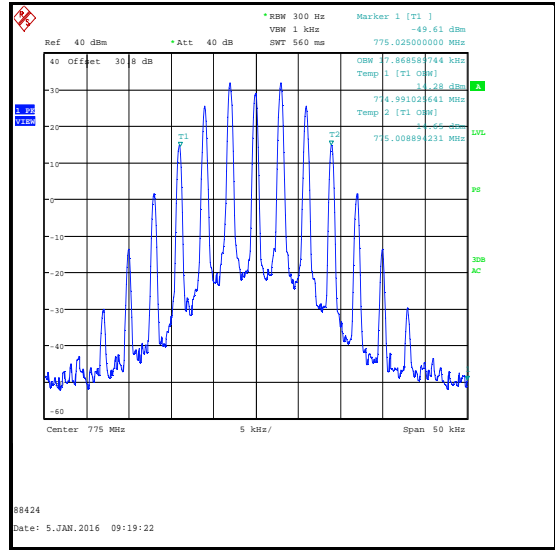
**Middle Channel /  
Output 99% Emission Bandwidth**

**Transmitter Occupied Bandwidth (continued)**

**Results: FM / 25 kHz Channel**



**Top Channel /  
Input 99% Emission Bandwidth**



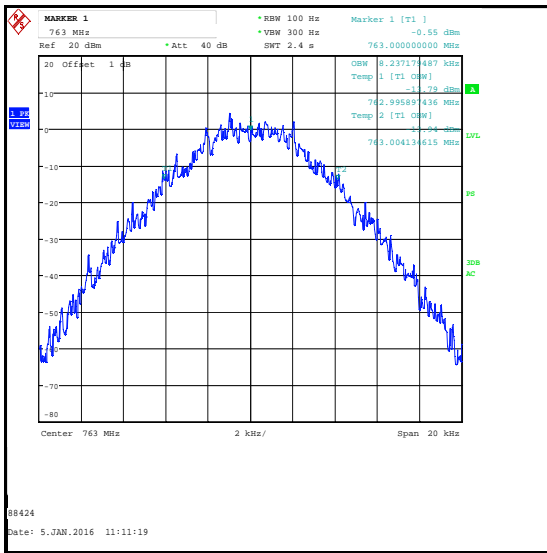
**Top Channel /  
Output 99% Emission Bandwidth**



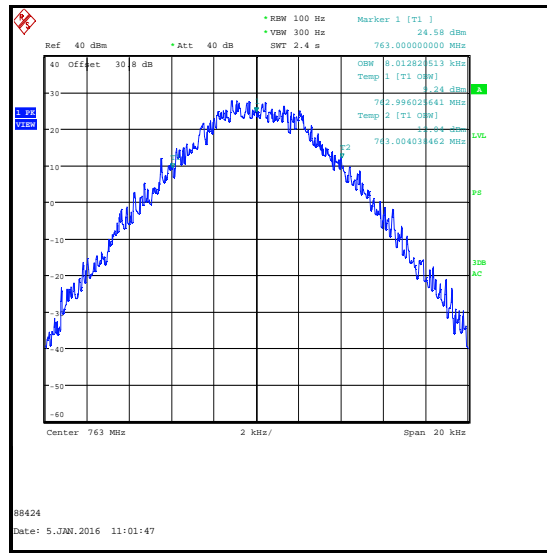
**Transmitter Occupied Bandwidth (continued)**

**Results: APCO 25 Phase 1**

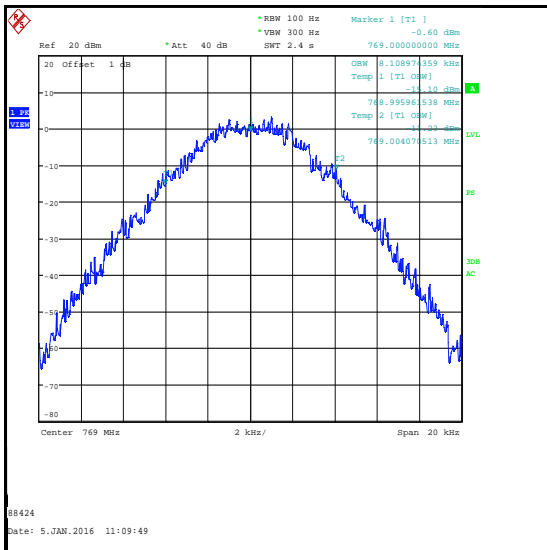
700 MHz Band / Downlink					
Frequency (MHz)	Emission Designator	Modulation Type	Input 99% Emission Bandwidth (kHz)	Output 99% Emission Bandwidth (kHz)	Difference between Input and Output Bandwidth (kHz)
763	8K10F1D	C4FM	8.237	8.013	0.224
769	8K10F1D	C4FM	8.109	8.013	0.096
775	8K10F1D	C4FM	8.205	8.205	0.0



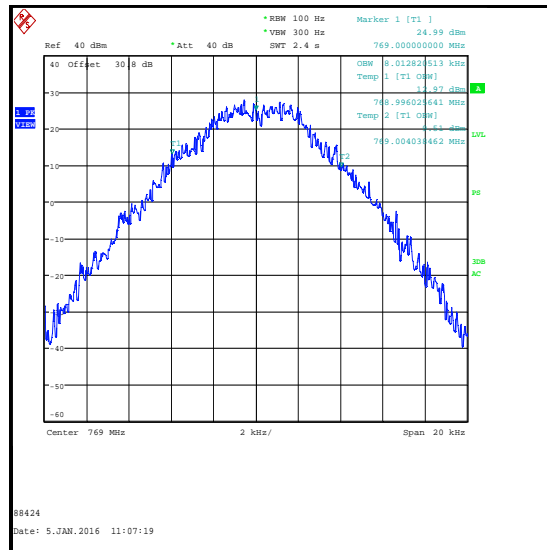
**Bottom Channel /  
Input 99% Emission Bandwidth**



**Bottom Channel /  
Output 99% Emission Bandwidth**



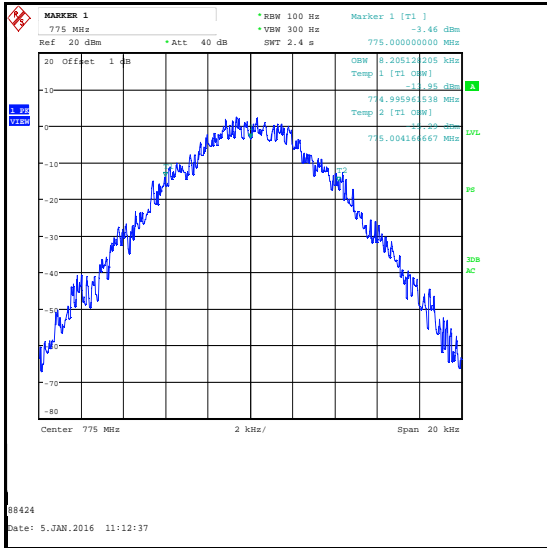
**Middle Channel /  
Input 99% Emission Bandwidth**



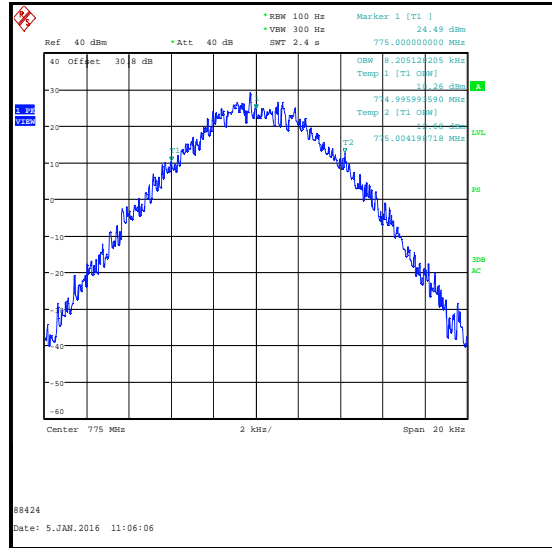
**Middle Channel /  
Output 99% Emission Bandwidth**

**Transmitter Occupied Bandwidth (continued)**

**Results: APCO P25 Phase 1**



**Top Channel /  
Input 99% Emission Bandwidth**

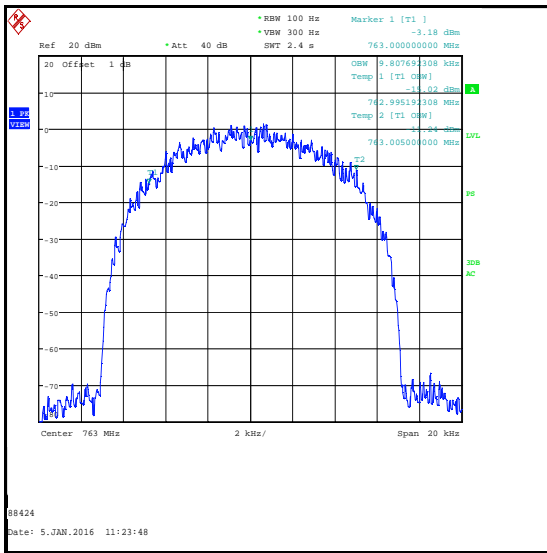


**Top Channel /  
Output 99% Emission Bandwidth**

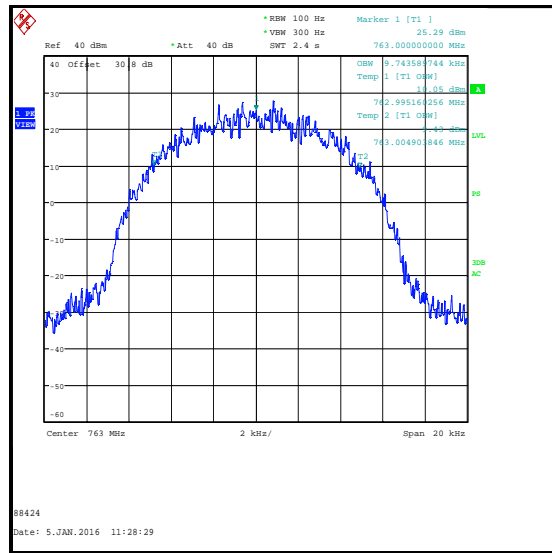
**Transmitter Occupied Bandwidth (continued)**

**Results: APCO P25 Phase 2**

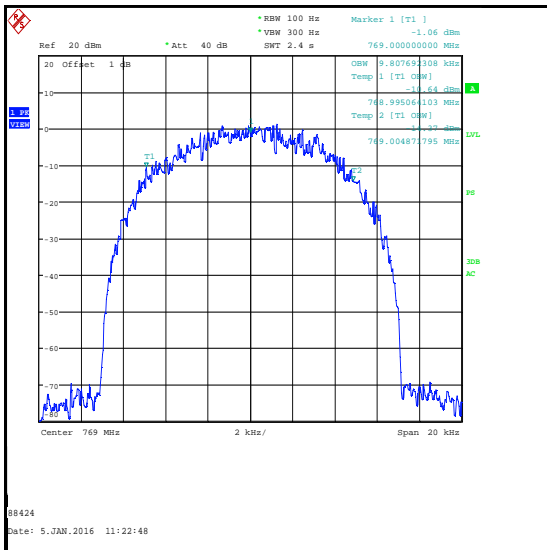
700 MHz Band / Downlink					
Frequency (MHz)	Emission Designator	Modulation Type	Input 99% Emission Bandwidth (kHz)	Output 99% Emission Bandwidth (kHz)	Difference between Input and Output Bandwidth (kHz)
763	9K80F1D	$\pi/4$ -DQPSK	9.808	9.744	0.064
769	9K80F1D	$\pi/4$ -DQPSK	9.808	9.808	0.0
775	9K80F1D	$\pi/4$ -DQPSK	9.744	9.712	0.032



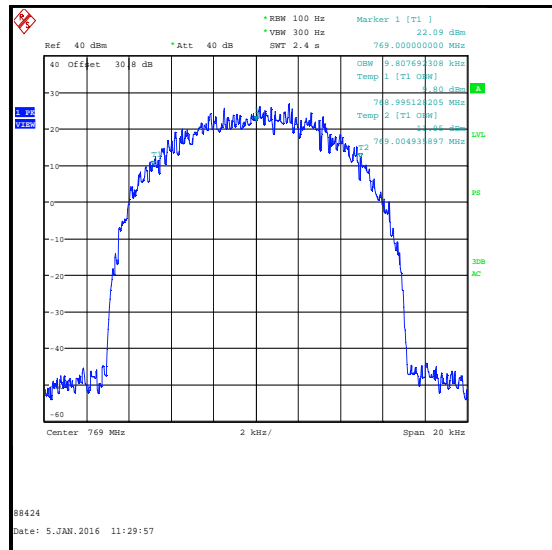
**Bottom Channel /  
Input 99% Emission Bandwidth**



**Bottom Channel /  
Output 99% Emission Bandwidth**



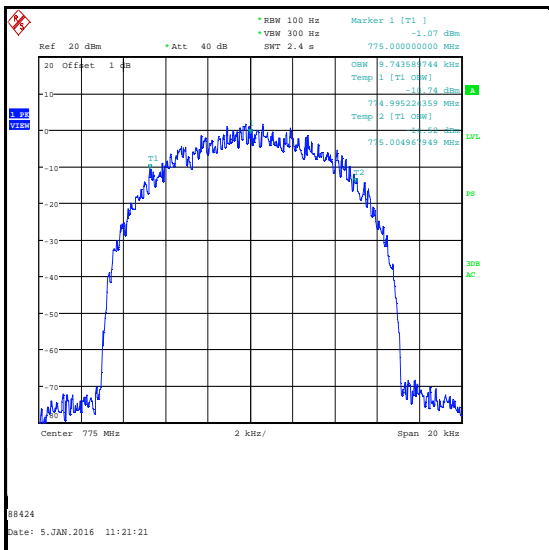
**Middle Channel /  
Input 99% Emission Bandwidth**



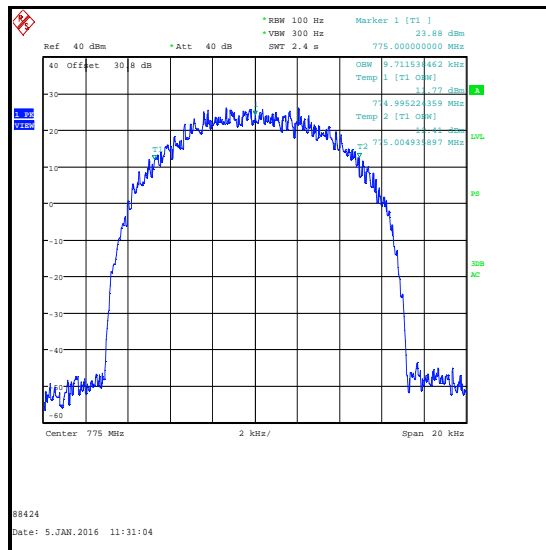
**Middle Channel /  
Output 99% Emission Bandwidth**

**Transmitter Occupied Bandwidth (continued)**

**Results: APCO P25 Phase 2**



**Top Channel /  
Input 99% Emission Bandwidth**



**Top Channel /  
Output 99% Emission Bandwidth**

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelpunkt	30.5015.13	Not stated	23 Apr 2016	12
G0607	Vector Signal Generator	Rohde & Schwarz	SMU 200A	100943	18 Jul 2016	36
A2527	20 dB Attenuator	AtlanTecRF	AN18W5-20	832828#2	Calibrated before use	-
A2524	10 dB Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
G047	Signal Generator	Rohde & Schwarz	SMY01	843215/015	24 Jul 2016	12

**5.2.3. PLMRS Out-of-Band Rejection****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Date:</b>	13 January 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

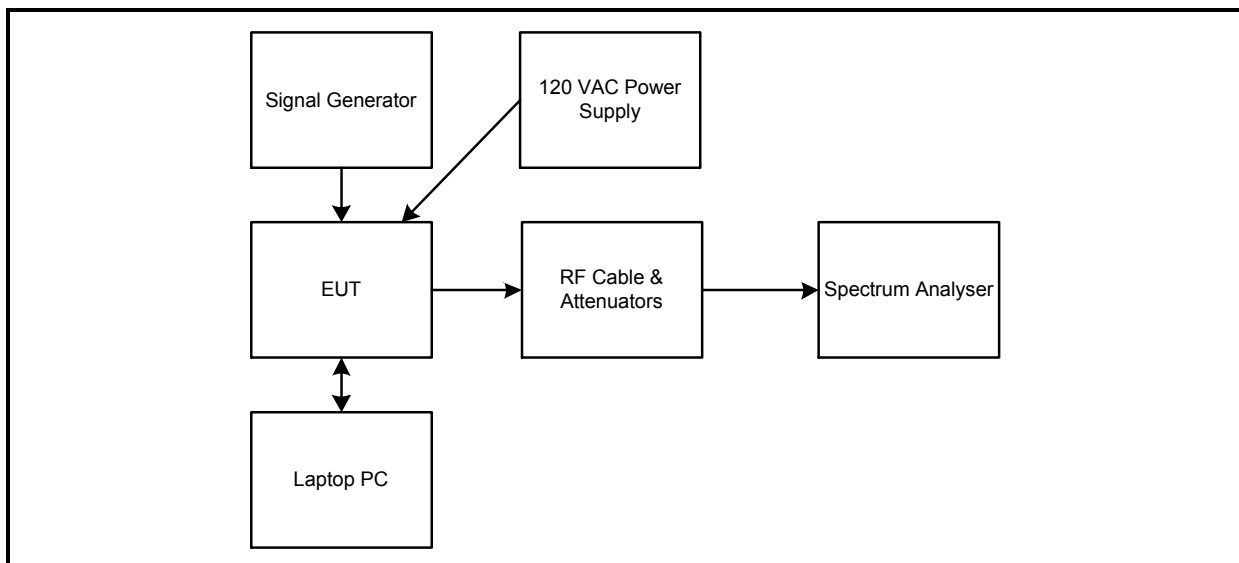
<b>FCC Reference:</b>	Parts 2.1049 & 90.219(e)(4)
<b>Test Method Used:</b>	FCC KDB 935210 D05 Section 4.3 and Notes below

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	35

**Note(s):**

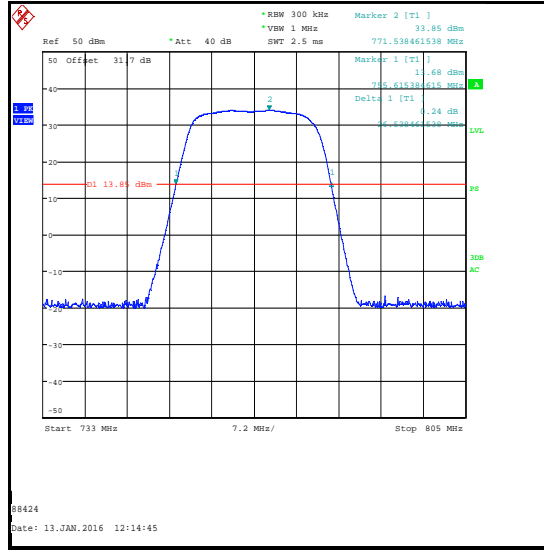
1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
2. A signal generator was connected to the downlink input (DL port) of the EUT via an RF cable. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and 30 dB attenuators. The combined path loss of the cable and attenuators was 31.7 dB. This loss was entered as an RF level offset on the spectrum analyser.
3. The signal generator was swept across the required frequency range using a 10 ms dwell time and 50 kHz frequency steps to show the frequency response of the EUT filter at the -20 dBc points. The signal generator output level was set to 3 dB below the EUT's AGC threshold level.
4. Bandwidth measurements were performed with the spectrum analyser resolution bandwidth set to 300 kHz which is >1 % and <5 % of the EUT passband. The video bandwidth was set to 1 MHz which is >3 x RBW and the nearest to 3 x RBW that the instrument allowed.

**Test setup for PLMRS Out-of-Band Rejection measurements:**

**PLMRS Out-of-Band Rejection (continued)**

**Results:**

Band (MHz)	Port	Modulation Type	Measured 20 dB Bandwidth (MHz)
763 - 775	Server	None (CW)	26.538



**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handlungspunkt	30.5015.13	Not stated	23 Apr 2016	12
A1398	20 dB Attenuator	Weinschel	WA46-20	A129	Calibrated before use	-
A1399	10 dB Attenuator	Weinschel	WA46-10	A126	Calibrated before use	-
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	27 Apr 2016	12

**5.2.4. Emission Mask****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Dates:</b>	07 January 2016 to 11 January 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1049 / 90.210(b)
<b>Test Method Used:</b>	FCC KDB 935210 D05 Section 4.4

**Environmental Conditions:**

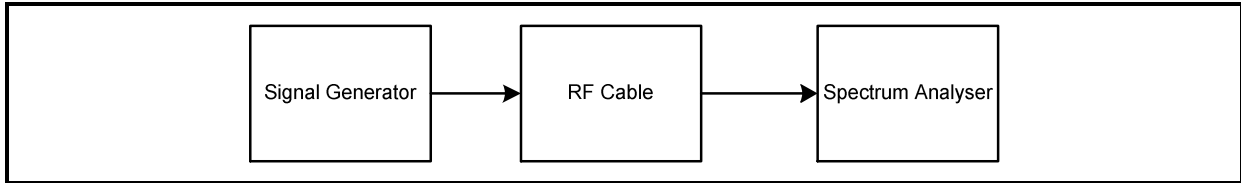
<b>Temperature (°C):</b>	21 to 23
<b>Relative Humidity (%):</b>	38 to 40

**Note(s):**

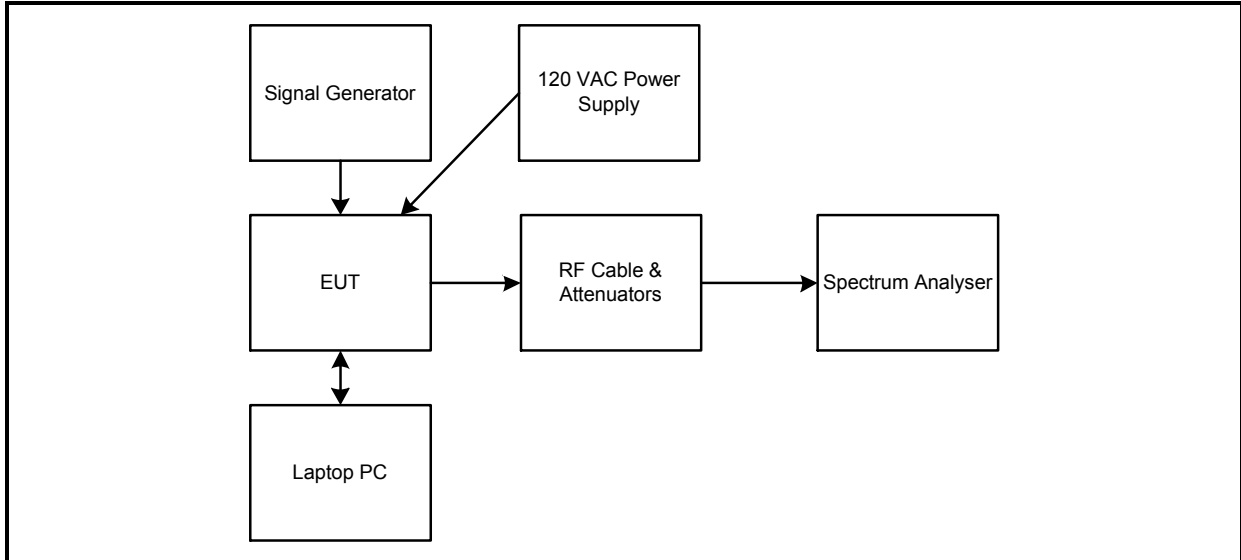
1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
2. Input signal spectra measurements: A signal generator was connected to the RF Input of a spectrum analyser via an RF cable. Modulated signals for all supported technologies were applied to the input of the EUT.
3. Output signal spectra measurements: A signal generator was connected to the downlink input (DL port) of the EUT via an RF cable. Modulated signals for all supported technologies were applied to the input of the EUT. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and attenuators. The combined path loss of the cable and attenuators was 30.8 dB. This loss was entered as an RF level offset on the spectrum analyser.
4. Power measurements were initially performed using a CW signal. These unmodulated carrier test results were used to establish the FCC Part 90.210(b) mask reference levels.
5. No mask incursions were observed. The EUT is compliant.

**Emission Mask (continued)**

**Test setup for emission mask input signal spectra measurements:**



**Test setup for emission mask output signal spectra measurements:**

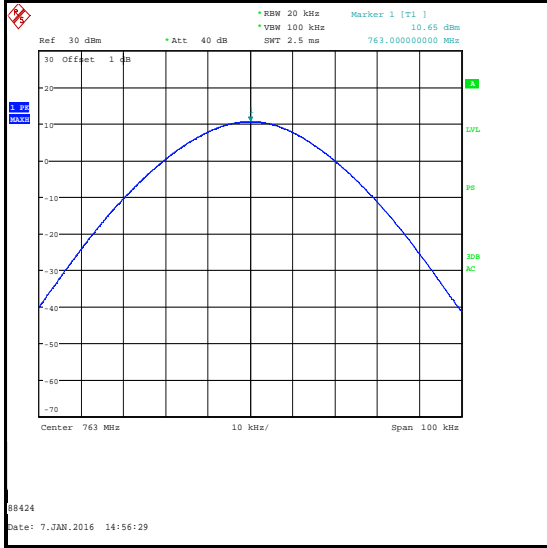




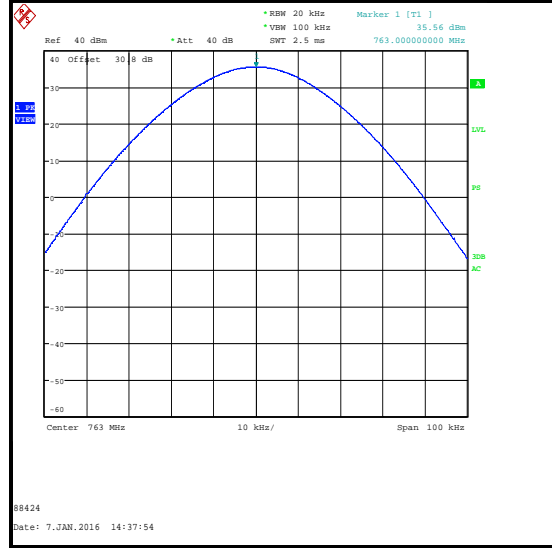
**Emission Mask (continued)**

**Results: Output Power**

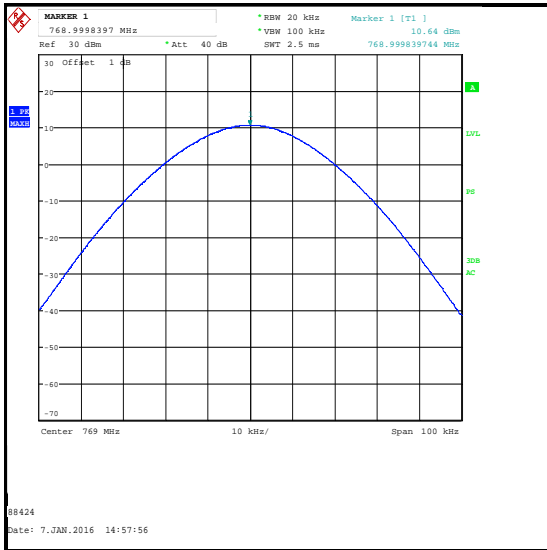
**Signal just below AGC threshold / unmodulated carrier power**



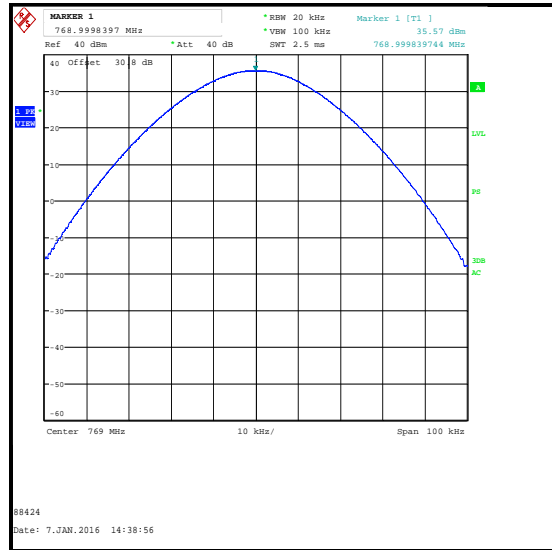
**Bottom Channel / Input Signal Power**



**Bottom Channel / Output Signal Power**



**Middle Channel / Input Signal Power**

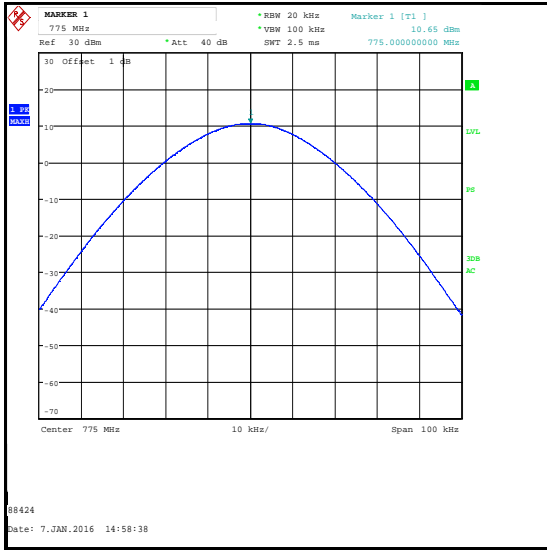


**Middle Channel / Output Signal Power**

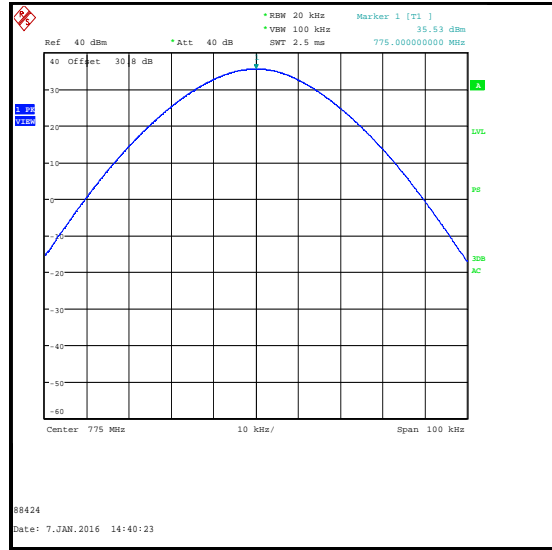
**Emission Mask (continued)**

**Results: Output Power**

**Signal just below AGC threshold / unmodulated carrier power**



**Top Channel / Input Signal Power**

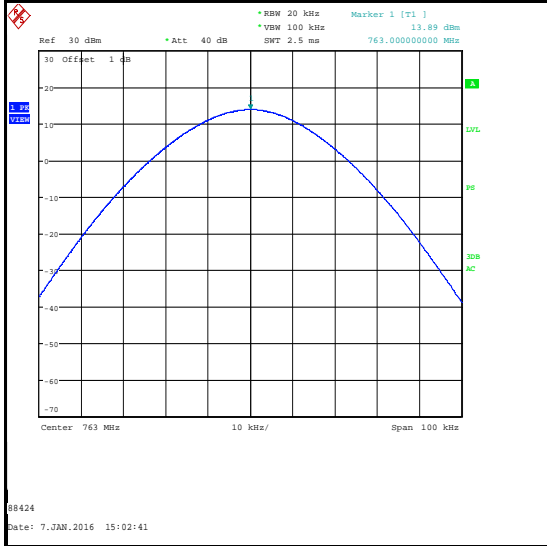


**Top Channel / Output Signal Power**

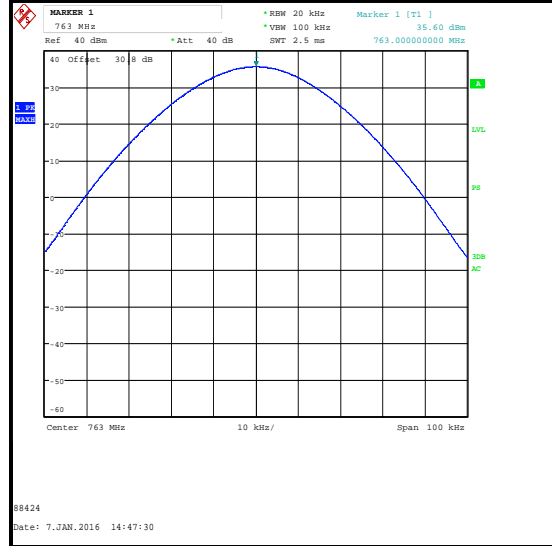
**Emission Mask (continued)**

**Results: Output Power**

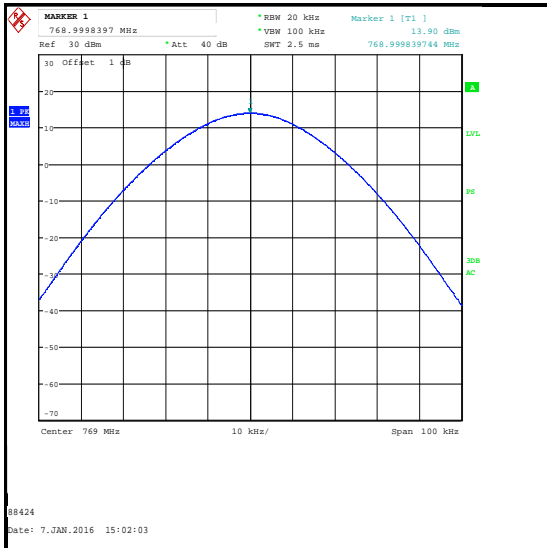
**Input signal 3 dB above AGC threshold / unmodulated carrier power**



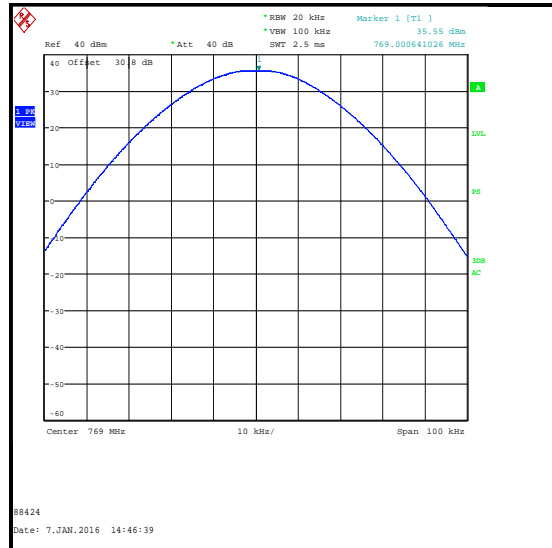
**Bottom Channel / Input Signal Power**



**Bottom Channel / Output Signal Power**



**Middle Channel / Input Signal Power**

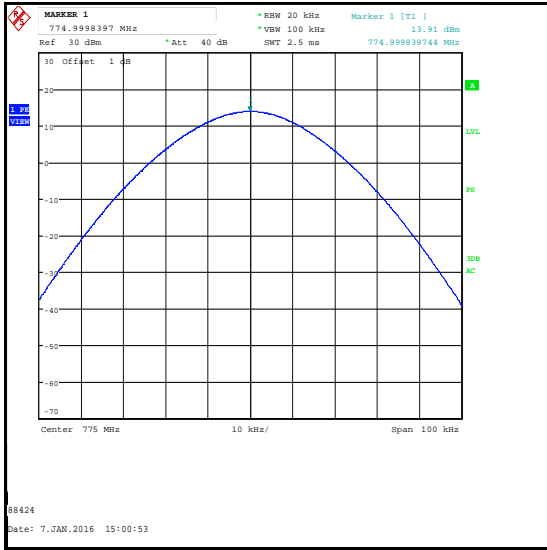


**Middle Channel / Output Signal Power**

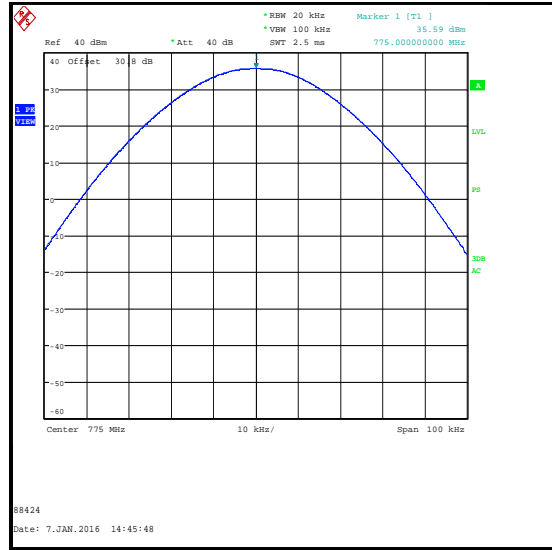
**Emission Mask (continued)**

**Results: Output Power**

**Input signal 3 dB above AGC threshold / unmodulated carrier power**



**Top Channel / Input Signal Power**

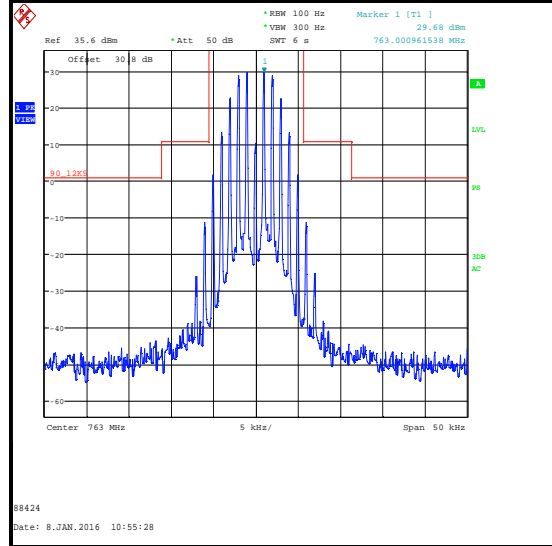
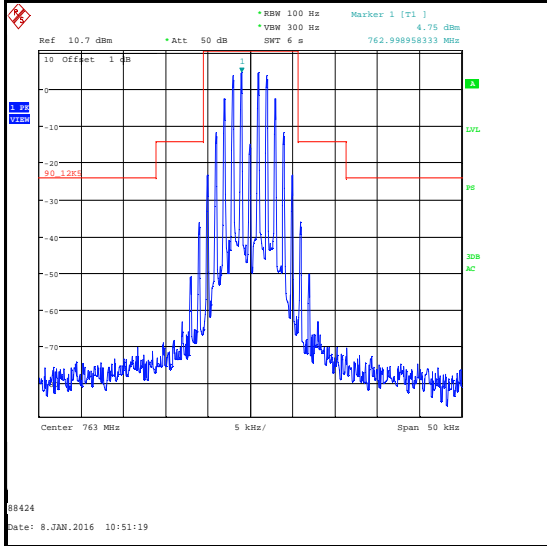


**Top Channel / Output Signal Power**

**Emission Mask (continued)**

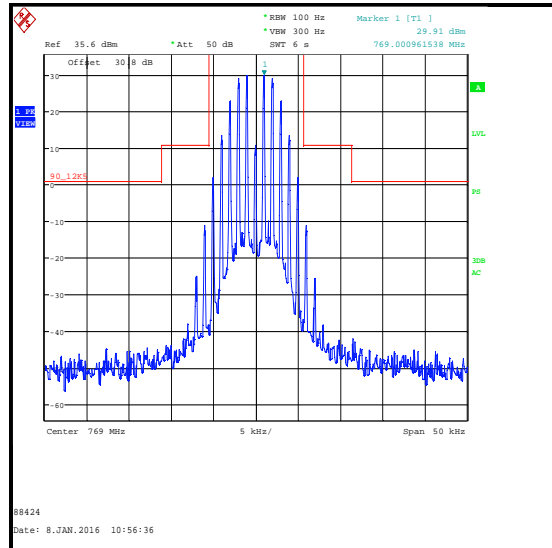
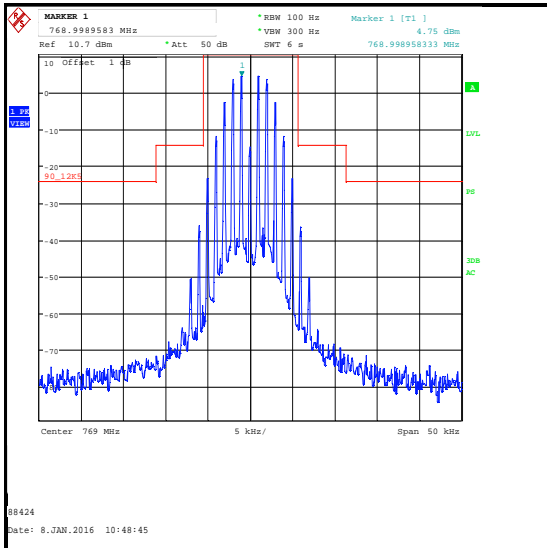
**Results: 12.5 kHz Channel Bandwidth / 11K3F3E / Audio Frequency 1 kHz**

**Signal just below AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



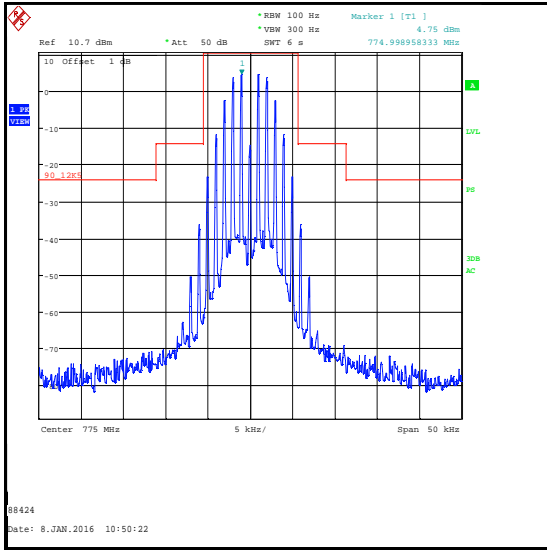
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

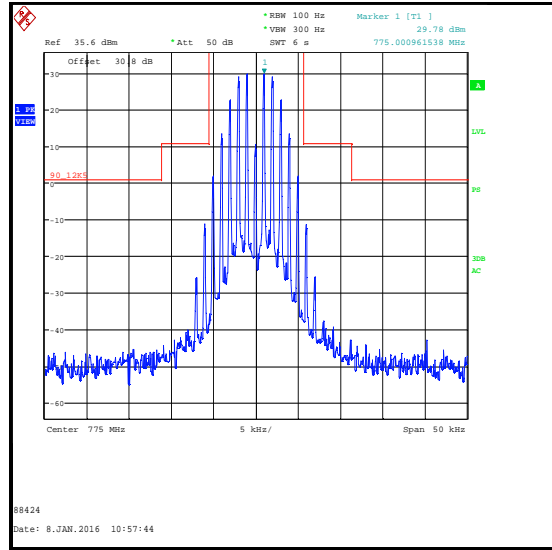
**Emission Mask (continued)**

**Results: 12.5 kHz Channel Bandwidth / 11K3F3E / Audio Frequency 1 kHz**

**Signal just below AGC threshold**



**Top Channel / Input Signal Spectra**



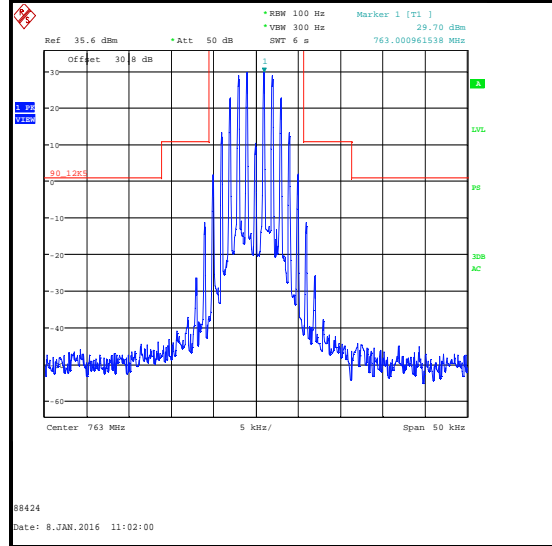
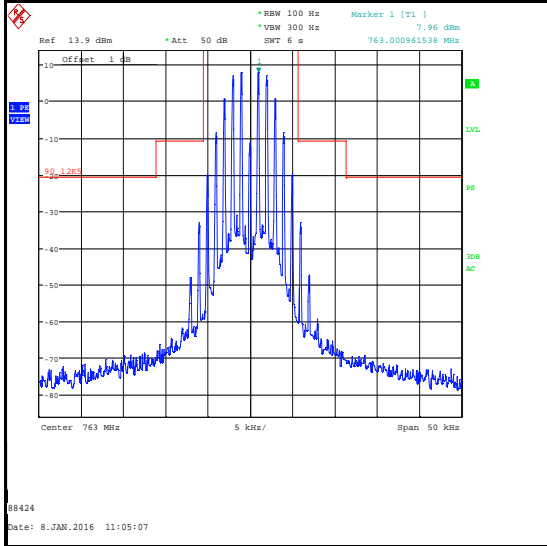
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	762.998958	763.000962
Middle	768.998958	769.000962
Top	774.998958	775.000962

**Emission Mask (continued)**

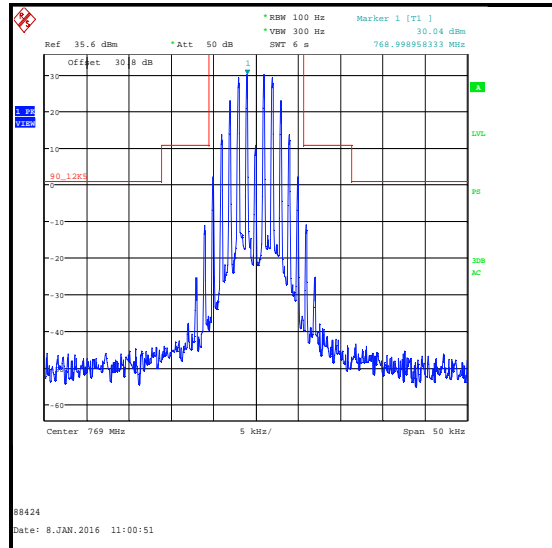
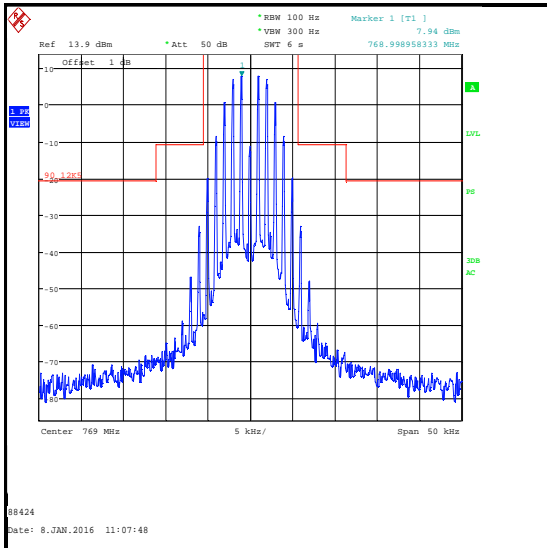
**Results: 12.5 kHz Channel Bandwidth / 11K3F3E / Audio Frequency 1 kHz**

**Input signal 3 dB above AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



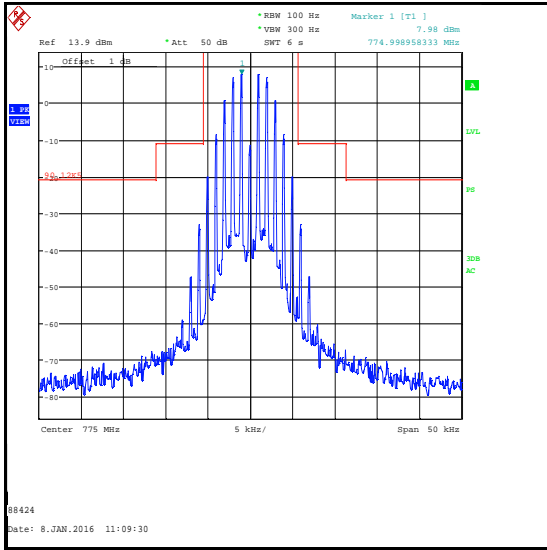
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

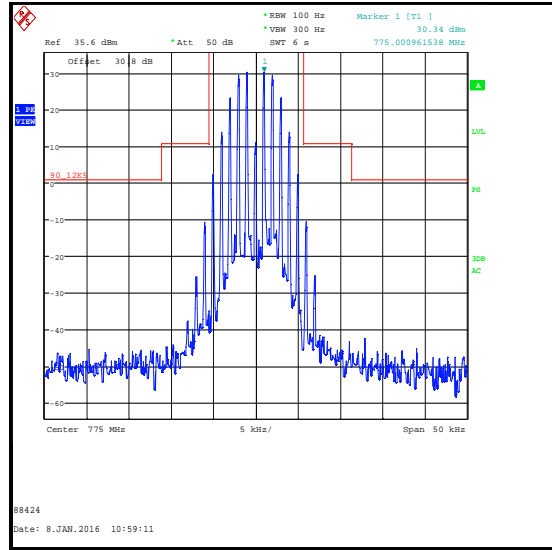
**Emission Mask (continued)**

**Results: 12.5 kHz Channel Bandwidth / 11K3F3E / Audio Frequency 1 kHz**

**Input signal 3 dB above AGC threshold**



**Top Channel / Input Signal Spectra**



**Top Channel / Output Signal Spectra**

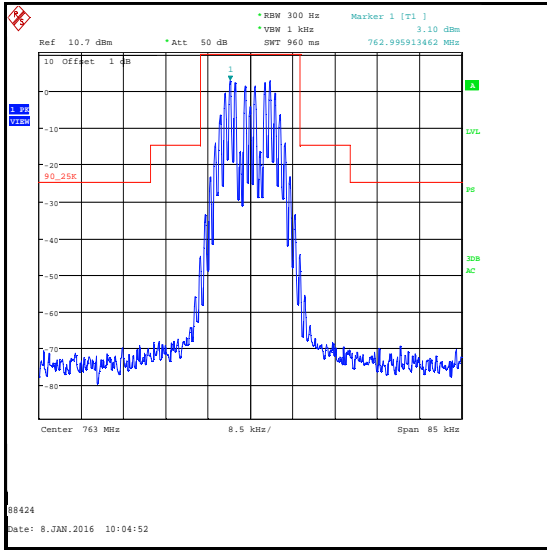
Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	763.000962	763.000962
Middle	768.998958	768.998958
Top	774.998958	775.000962



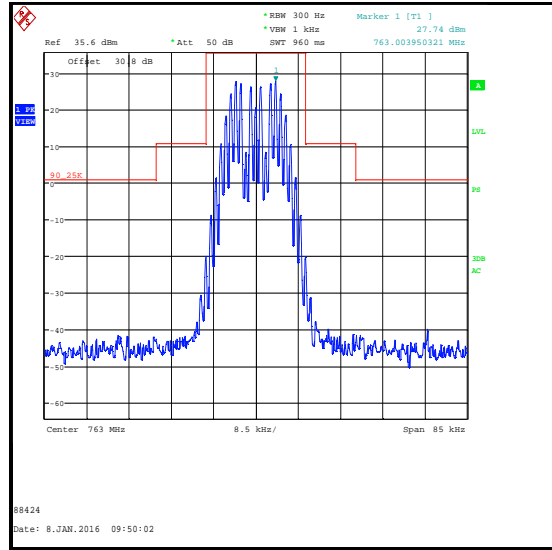
**Emission Mask (continued)**

**Results: 25 kHz Channel Bandwidth / 16K0F3E / Audio Frequency 1 kHz**

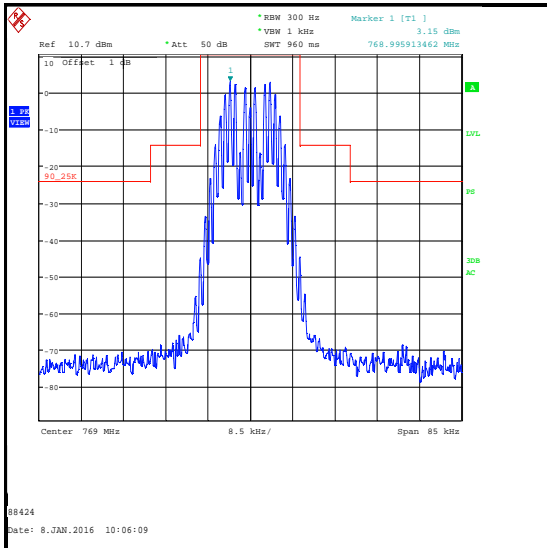
**Signal just below AGC threshold**



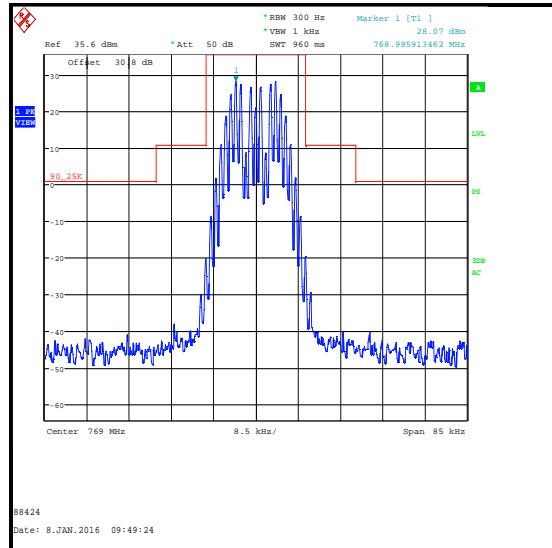
**Bottom Channel / Input Signal Spectra**



**Bottom Channel / Output Signal Spectra**



**Middle Channel / Input Signal Spectra**

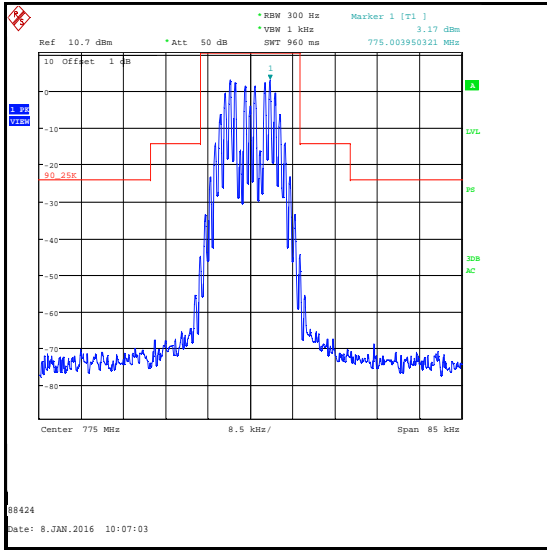


**Middle Channel / Output Signal Spectra**

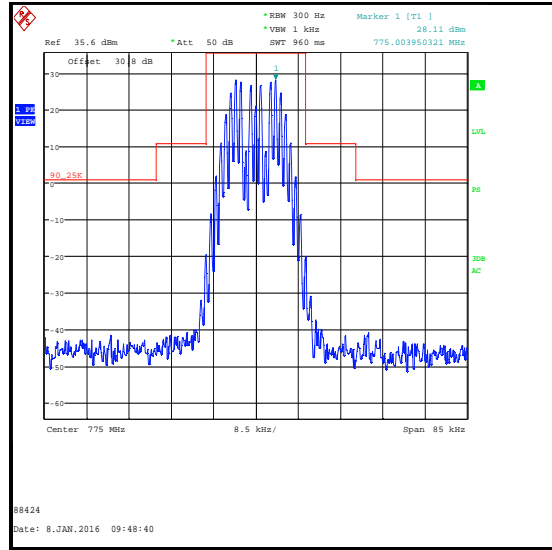
**Emission Mask (continued)**

**Results: 25 kHz Channel Bandwidth / 16K0F3E / Audio Frequency 1 kHz**

**Signal just below AGC threshold**



**Top Channel / Input Signal Spectra**



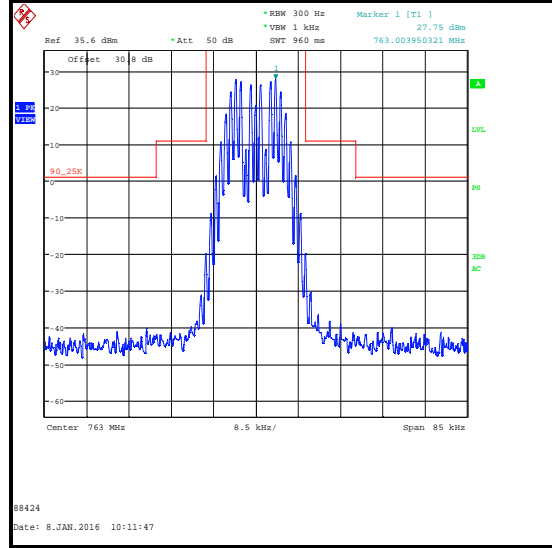
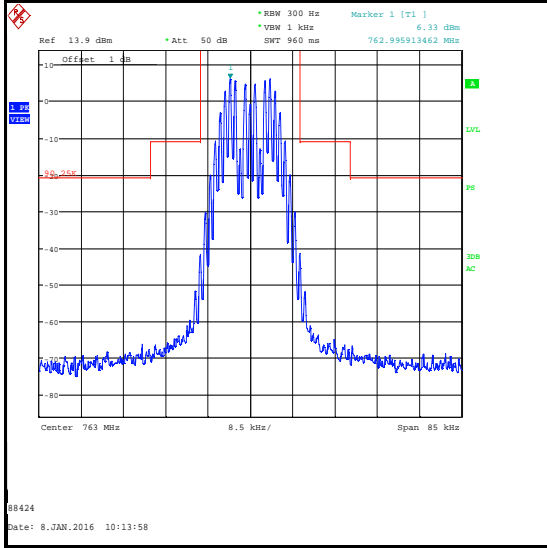
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	762.995913	763.003950
Middle	768.995913	768.995913
Top	775.003950	775.003950

**Emission Mask (continued)**

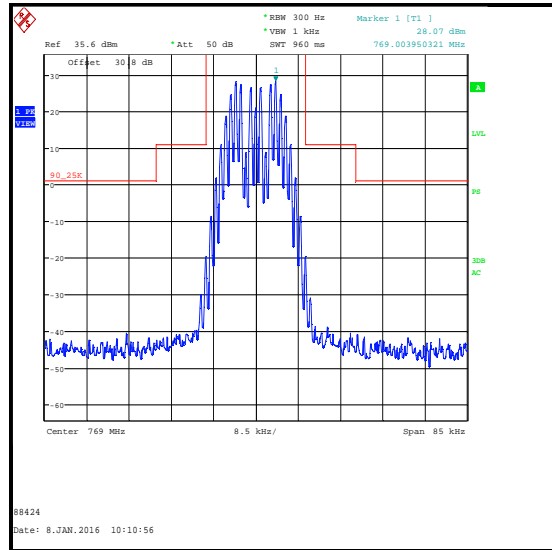
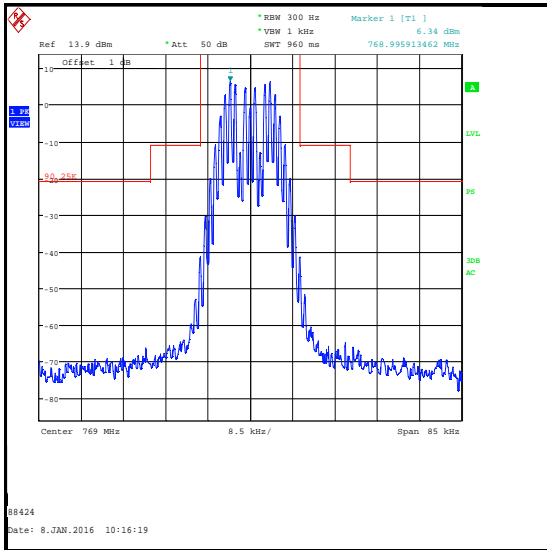
**Results: 25 kHz Channel Bandwidth / 16K0F3E / Audio Frequency 1 kHz**

**Input signal 3 dB above AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



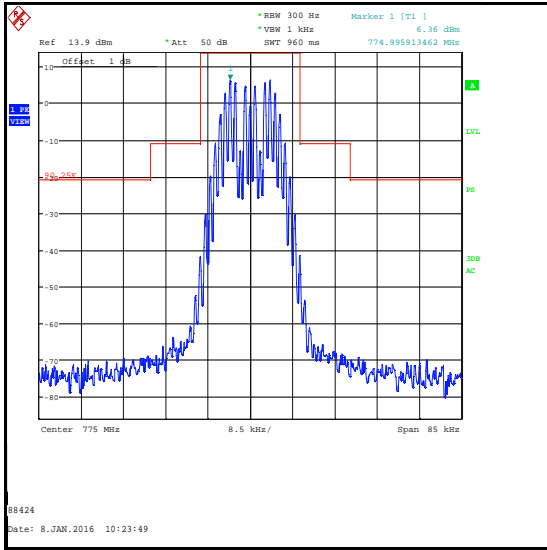
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

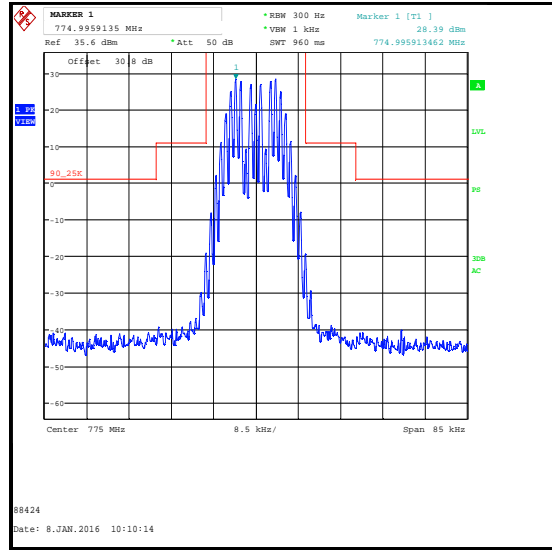
**Emission Mask (continued)**

**Results: 25 kHz Channel Bandwidth / 16K0F3E / Audio Frequency 1 kHz**

**Input signal 3 dB above AGC threshold**



**Top Channel / Input Signal Spectra**



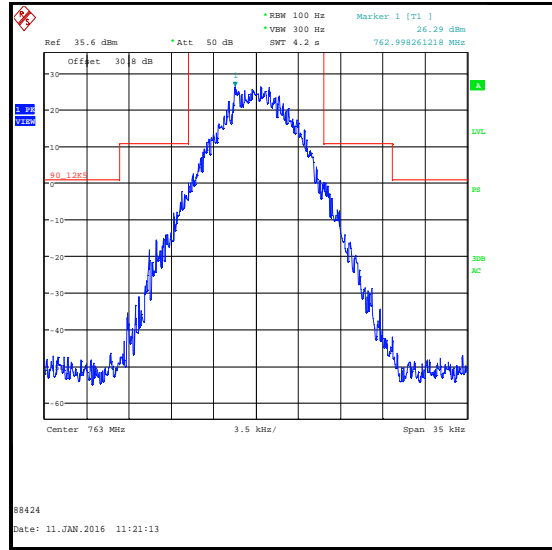
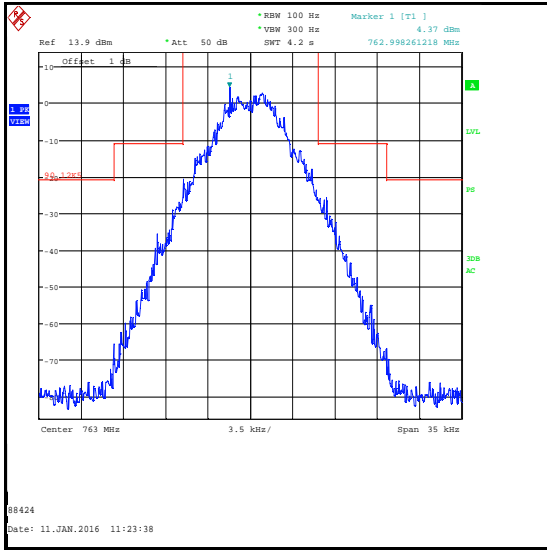
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	762.995913	763.003950
Middle	768.995913	769.003950
Top	774.995913	774.995913

**Emission Mask (continued)**

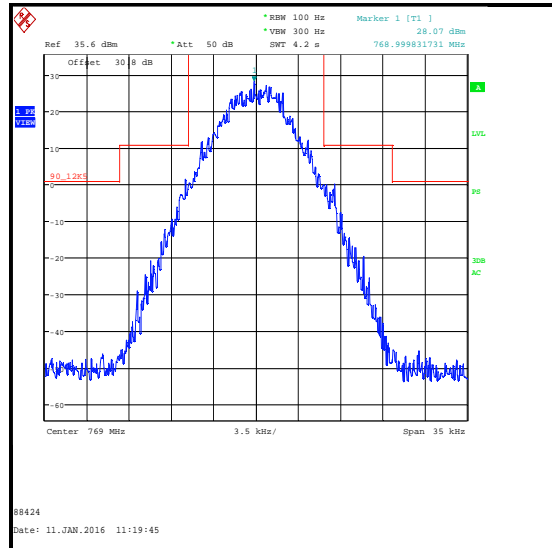
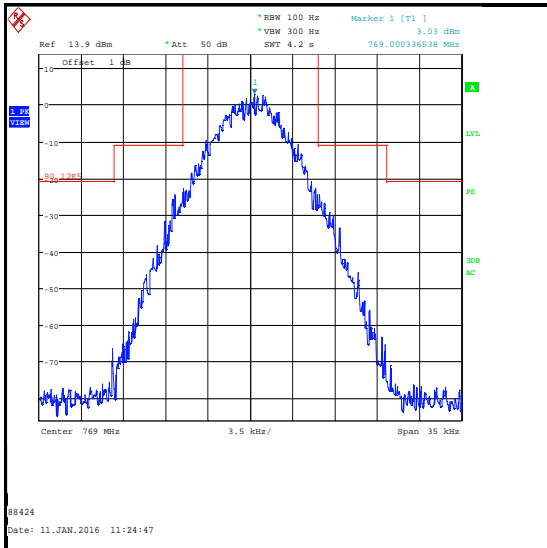
**Results: APCO P25 Phase 1 / C4FM**

**Signal just below AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



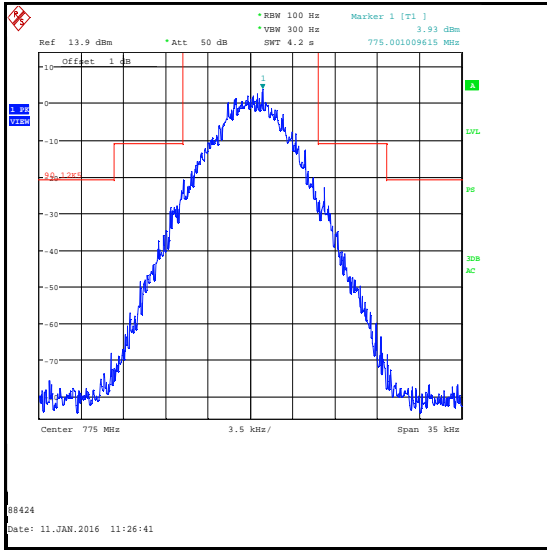
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

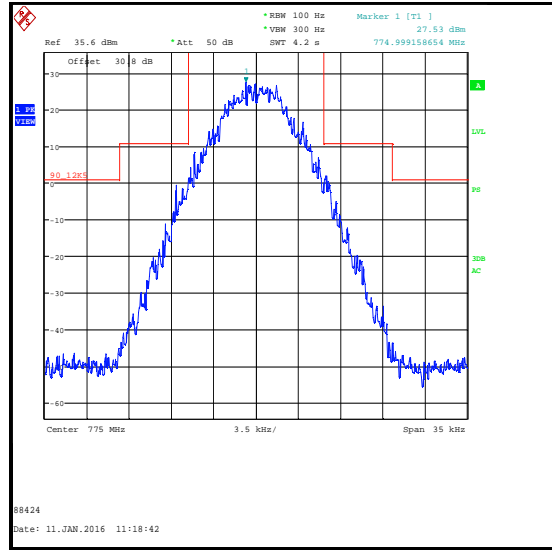
**Emission Mask (continued)**

**Results: APCO P25 Phase 1 / C4FM**

**Signal just below AGC threshold**



**Top Channel / Input Signal Spectra**



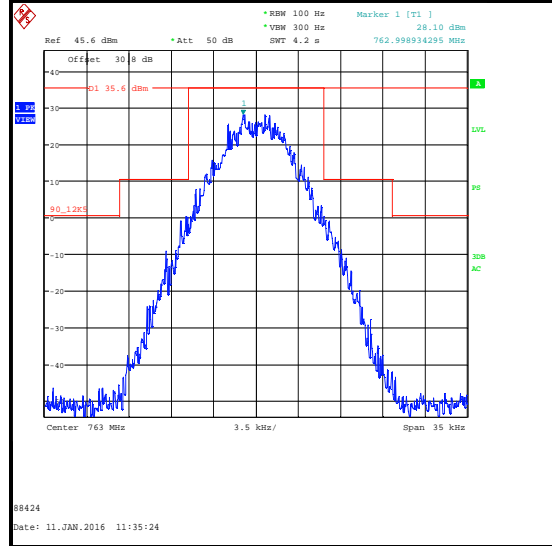
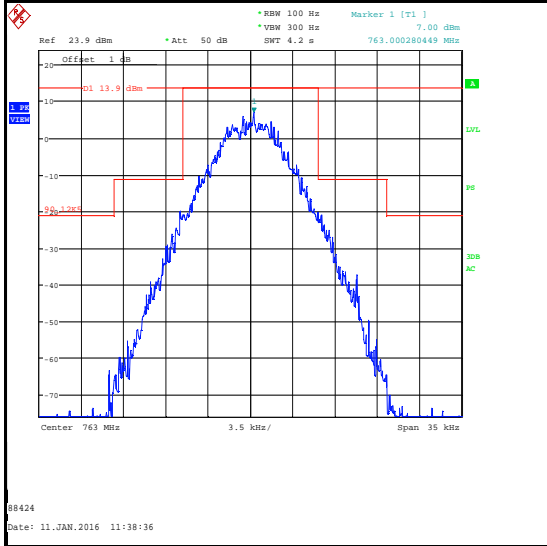
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	762.998261	762.998261
Middle	769.000337	768.999832
Top	775.001010	774.999159

**Emission Mask (continued)**

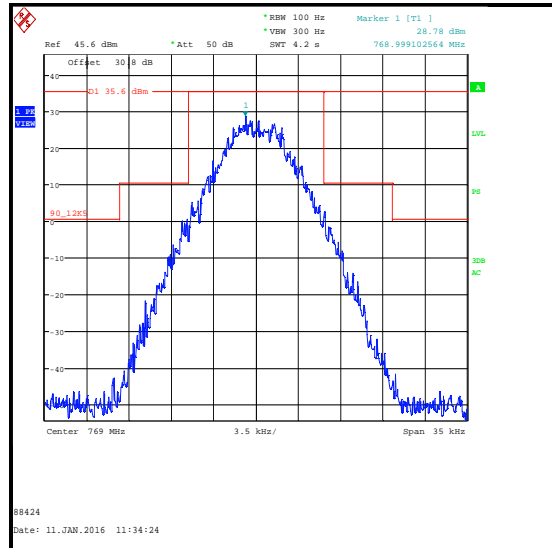
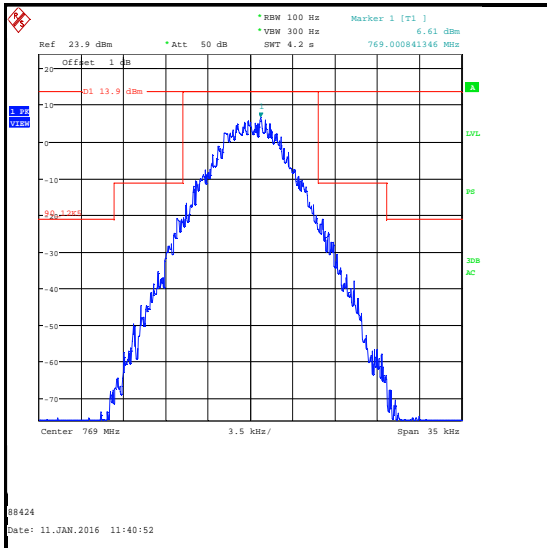
**Results: APCO P25 Phase 1 / C4FM**

**Input signal 3 dB above AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



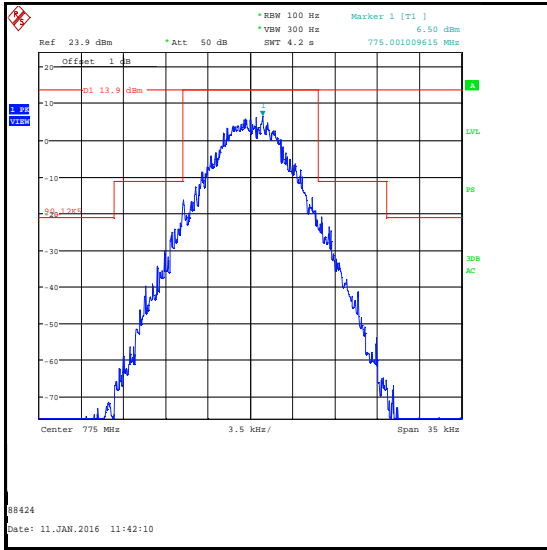
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

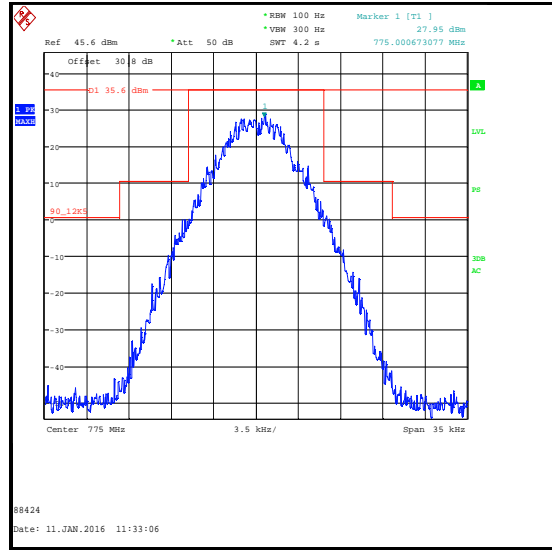
**Emission Mask (continued)**

**Results: APCO P25 Phase 1 / C4FM**

**Input signal 3 dB above AGC threshold**



**Top Channel / Input Signal Spectra**



**Top Channel / Output Signal Spectra**

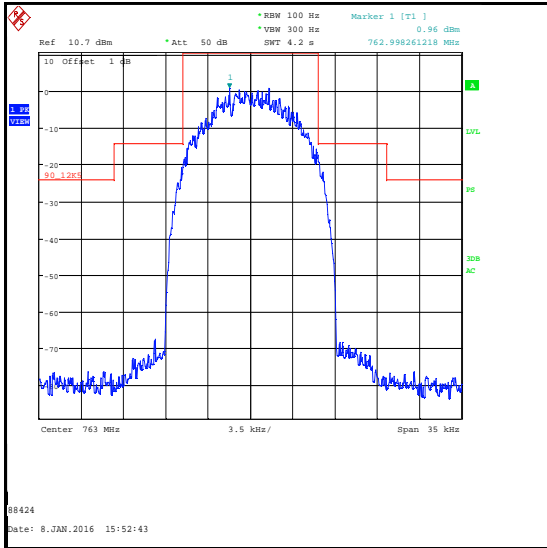
Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	763.000280	762.998934
Middle	769.000841	768.999103
Top	775.001010	775.000673



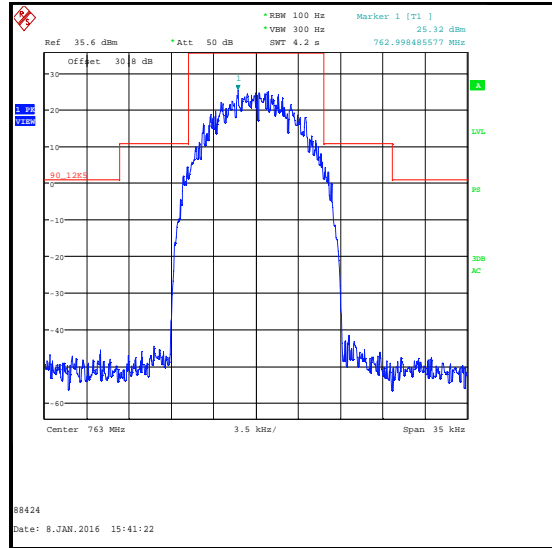
**Emission Mask (continued)**

**Results: APCO P25 Phase 2 /  $\pi/4$ -DQPSK**

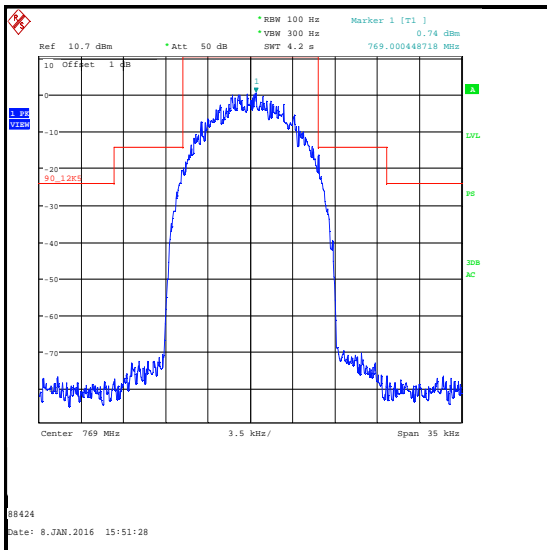
**Signal just below AGC threshold**



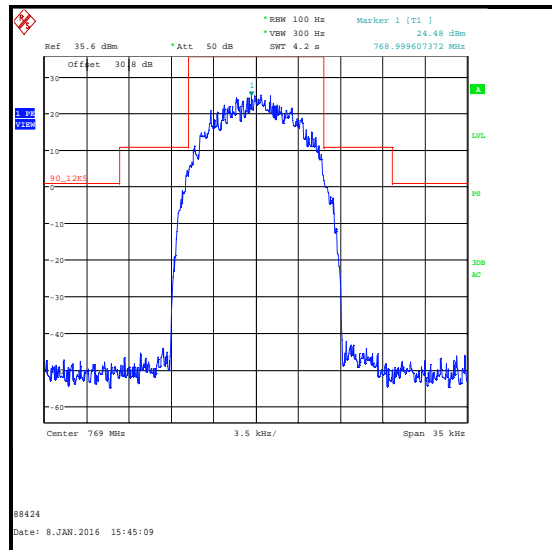
**Bottom Channel / Input Signal Spectra**



**Bottom Channel / Output Signal Spectra**



**Middle Channel / Input Signal Spectra**

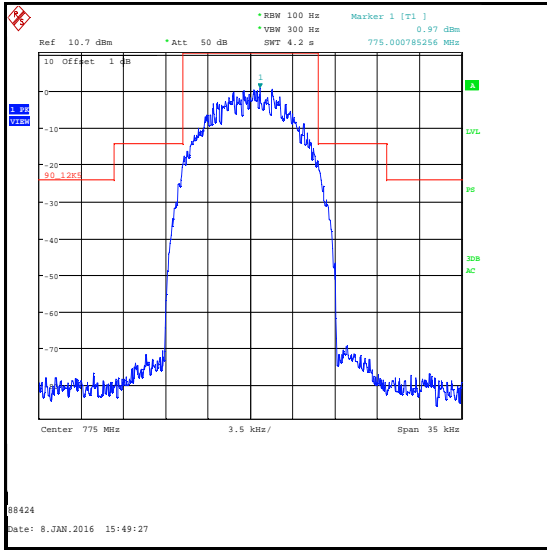


**Middle Channel / Output Signal Spectra**

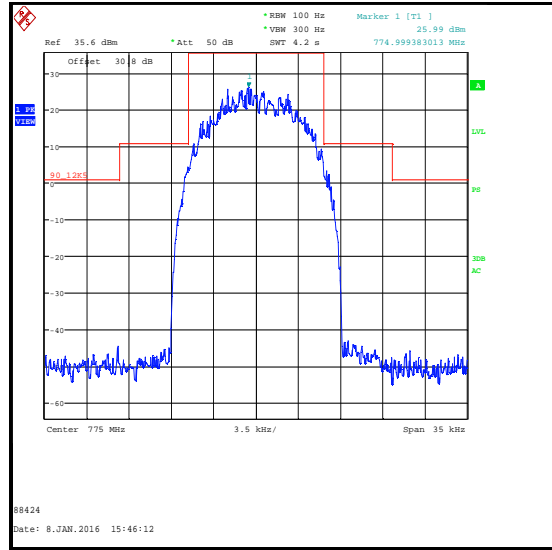
**Emission Mask (continued)**

**Results: APCO P25 Phase 2 /  $\pi/4$ -DQPSK**

**Signal just below AGC threshold**



**Top Channel / Input Signal Spectra**



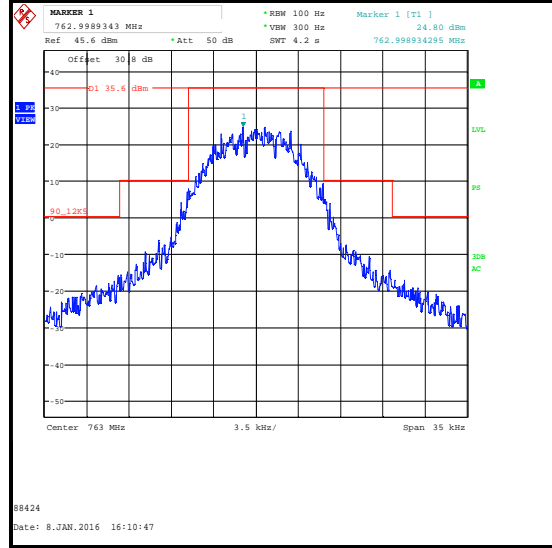
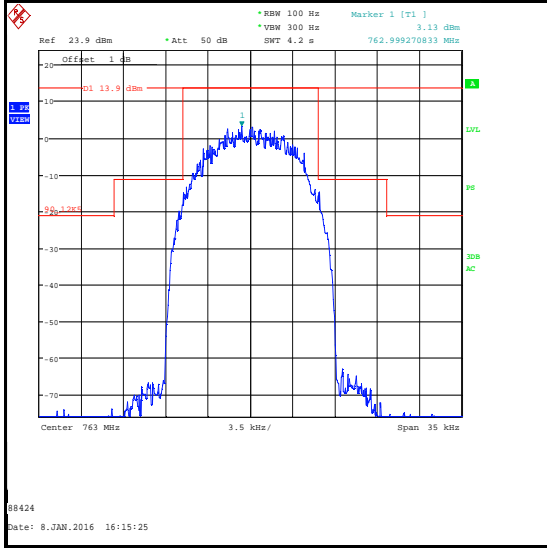
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	762.998261	762.998486
Middle	769.000449	768.999607
Top	775.000785	774.999383

**Emission Mask (continued)**

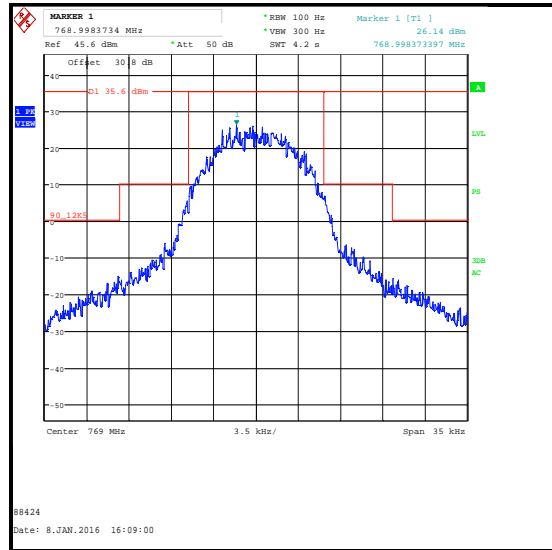
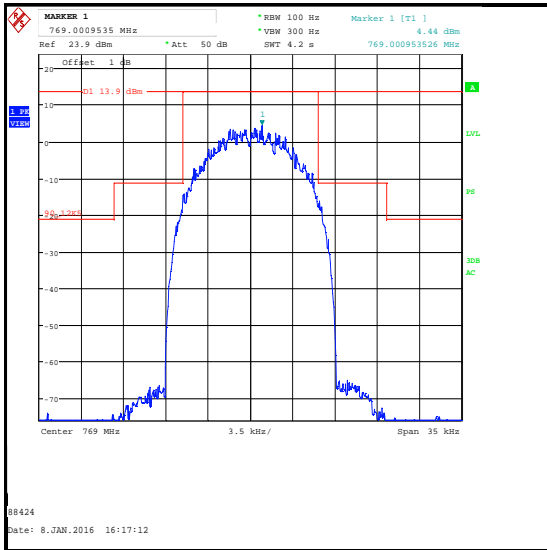
**Results: APCO P25 Phase 2 /  $\pi/4$ -DQPSK**

**Input signal 3 dB above AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



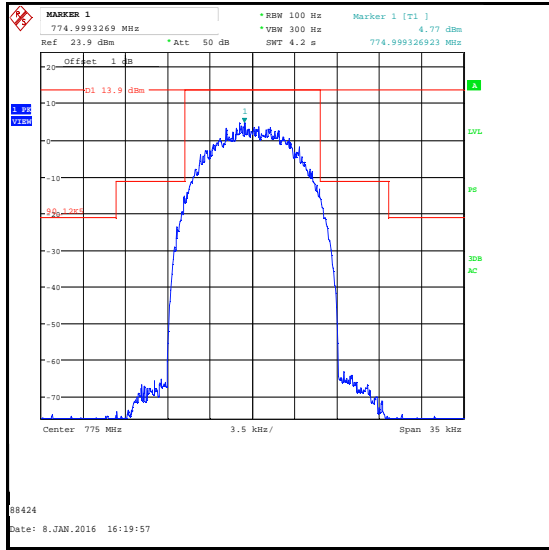
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

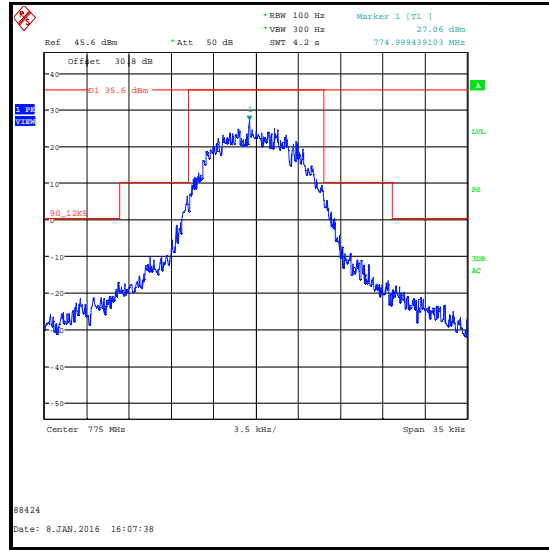
**Emission Mask (continued)**

**Results: APCO P25 Phase 2 /  $\pi/4$ -DQPSK**

**Input signal 3 dB above AGC threshold**



Top Channel / Input Signal Spectra



Top Channel / Output Signal Spectra

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	762.999271	762.998934
Middle	769.000954	768.998373
Top	774.999327	774.999439

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohyrometer	JM Handelpunkt	30.5015.13	Not stated	23 Apr 2016	12
G0607	Vector Signal Generator	Rohde & Schwarz	SMU 200A	100943	18 Jul 2016	36
A2527	20 dB Attenuator	AtlanTecRF	AN18W5-20	832828#2	Calibrated before use	-
A2524	10 dB Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
G047	Signal Generator	Rohde & Schwarz	SMY01	843215/015	24 Jul 2016	12

**5.2.5. Transmitter Noise Figure****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Date:</b>	10 October 2014
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

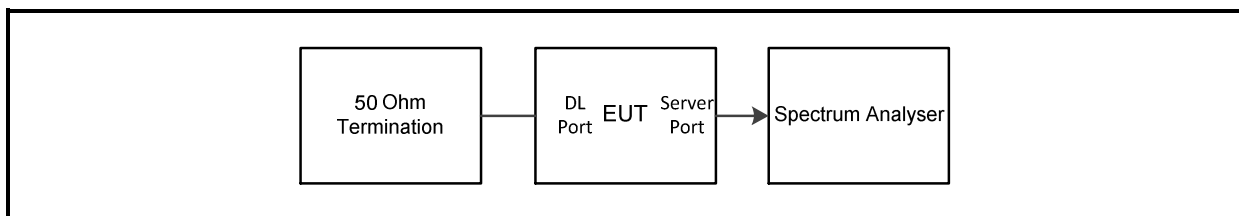
<b>FCC Reference:</b>	90.219(d)(6)(ii)
<b>Test Method Used:</b>	See Notes below

**Environmental Conditions:**

<b>Temperature (°C):</b>	21
<b>Relative Humidity (%):</b>	53

**Note(s):**

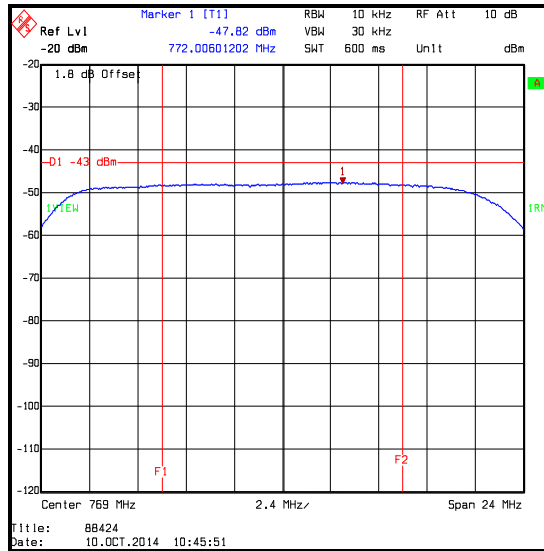
- For this EUT, FCC OET confirmed it is acceptable to submit compliance information and test data for the downlink path consistent with 90.219(d)(6)(ii) in place of 90.219(e)(2).
- The test was performed as a conducted measurement and the EUT was connected to the test equipment as shown in the diagram below.
- An RF level offset of 1.8 dB was entered on the spectrum analyser to compensate for the loss of the RF cable connecting the Server port on the EUT to the spectrum analyser.
- The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
- FCC Part 90.219(d)(6)(ii) states "In general, the ERP of noise within the passband should not exceed -43 dBm in 10 kHz measurement bandwidth". The spectrum analyser RBW was set to 10 kHz and VBW set to 30 kHz which is three times the resolution bandwidth. Sweep time was set to auto.
- The spectrum analyser span was set to 24 MHz which is two times the bandwidth of the operating band. The centre frequency was set to 769 MHz which is the centre frequency of the 763 to 775 MHz operating band. Frequency lines were placed at the upper and lower operating band frequencies.
- An RMS detector with trace averaging over 100 sweeps was used. A marker was placed on the highest point on the trace and the value recorded. This was compared to the 90.219(d)(6)(ii) limit of -43 dBm/10 kHz to obtain the margin.
- All test equipment was within the calibration period on the date of testing.

**Test setup for transmitter noise figure measurements:**

**Transmitter Noise Figure (continued)**

**Results:**

700 MHz Band / Downlink				
Frequency (MHz)	Measured Noise (dBm/10 kHz)	Noise Limit (dBm/10 kHz ERP)	Margin (dB)	Result
763 - 775	-47.8	-43.0	4.8	Complied



**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1782	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	21 Mar 2015	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB	842659/016	30 Sep 2015	12
A162	50 Ohm Load	Narda	3768NM	5204	Calibration not required	-
G0608	Signal Generator	Rohde & Schwarz	SMIQ06B	838341/033	14 Feb 2015	12

**5.2.6. Transmitter Spurious Conducted Emissions: Intermodulation Products****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Date:</b>	19 February 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1051 & 90.219(e)(3)
<b>Test Method Used:</b>	FCC KDB 935210 Section 4.7.2 and Notes below

**Environmental Conditions:**

<b>Temperature (°C):</b>	20
<b>Relative Humidity (%):</b>	33

**Note(s):**

1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
2. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and attenuators with a combined value of 30 dB. The combined path loss of the cable and attenuators was 32.7 dB. This loss was entered as an RF level offset on the spectrum analyser.
3. Measurements were centred on the low and high channel frequencies. Tests were performed using 12.5 kHz and 25 kHz channel spacings. The two CW signals used for intermodulation tests were positioned half a channel spacing above and below the channel centre frequency.
4. Two RF outputs of a signal generator were connected to an RF combiner network. The output from the combiner network was connected to the EUT input port (DL) via a high pass filter acting as a band pass filter. The purpose of the filter was to suppress levels of second harmonics in order to minimise intermodulation products caused by the signal generator/combiner network and therefore present at the EUT input. The passband of the filter was the operating band of the EUT. The signal generator output levels were balanced and adjusted until the EUT maximum output level was achieved. The signal generator outputs were slightly reduced so that the EUT was operating just below the AGC threshold and the intermodulation products at the EUT output were measured. The signal generator levels were then increased so that the composite input level was 3 dB above the AGC threshold and the intermodulation products at the EUT output were measured. The highest level intermodulation products within a span of 100 kHz under both conditions were recorded in the results table and compared to an out-of-band/out-of-block limit of  $43 + 10 \log (P)$  dB.

**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)****Signal Generator Frequencies used for Intermodulation Product Tests:**

12.5 kHz Channel Spacing		Downlink / Bottom Channel / 763 MHz
Signal Generator Frequencies (MHz)	Frequency 1 ( $f_0 - 6.25$ kHz)	762.993750 MHz
	Frequency 2 ( $f_0 + 6.25$ kHz)	763.006250 MHz

12.5 kHz Channel Spacing		Downlink / Top Channel / 775 MHz
Signal Generator Frequencies (MHz)	Frequency 1 ( $f_0 - 6.25$ kHz)	774.993750 MHz
	Frequency 2 ( $f_0 + 6.25$ kHz)	775.006250 MHz

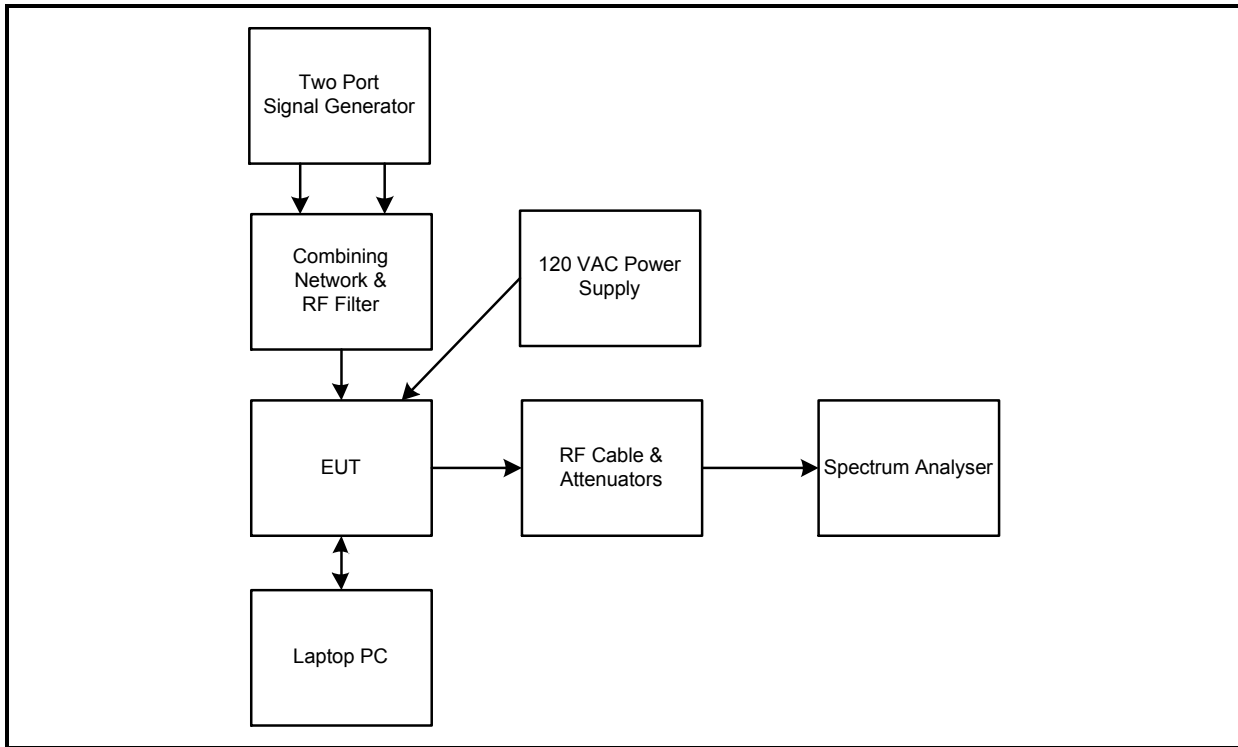
25 kHz Channel Spacing		Downlink / Bottom Channel / 763 MHz
Signal Generator Frequencies (MHz)	Frequency 1 ( $f_0 - 12.5$ kHz)	762.987500 MHz
	Frequency 2 ( $f_0 + 12.5$ kHz)	763.012500 MHz

25 kHz Channel Spacing		Downlink / Top Channel / 775 MHz
Signal Generator Frequencies (MHz)	Frequency 1 ( $f_0 - 12.5$ kHz)	774.987500 MHz
	Frequency 2 ( $f_0 + 12.5$ kHz)	775.012500 MHz



**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)**

**Test setup for conducted intermodulation tests:**



**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)**

**Results: 12.5 kHz Channel Spacing / CW signal / Downlink / Input just below AGC threshold**

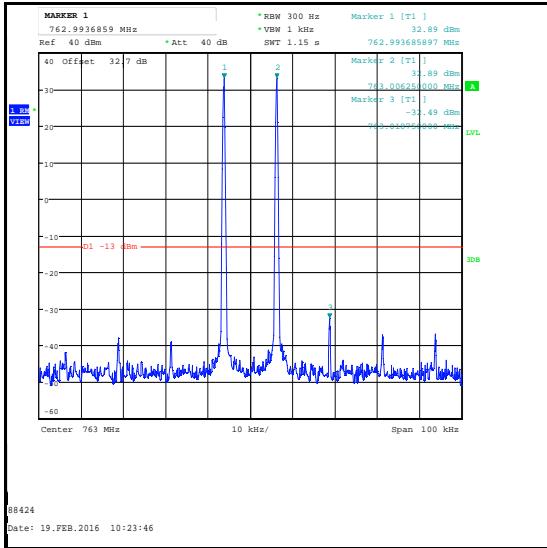
700 MHz Band / Downlink					
Channel	Highest Intermodulation product frequency (MHz)	Highest Intermodulation product amplitude (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	763.018750	-32.5	-13.0	19.5	Complied
Top	775.018718	-28.7	-13.0	15.7	Complied

**Results: 12.5 kHz Channel Spacing / CW signal / Downlink / Input 3 dB above AGC threshold**

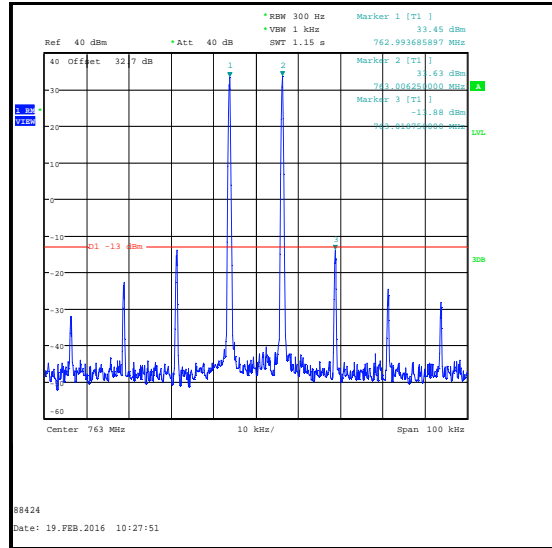
700 MHz Band / Downlink					
Channel	Highest Intermodulation product frequency (MHz)	Highest Intermodulation product amplitude (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	763.018750	-13.9	-13.0	0.9	Complied
Top	774.981250	-13.6	-13.0	0.6	Complied

### Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)

#### Results: 12.5 kHz Channel Spacing / Bottom channel / Downlink / Output Spectra

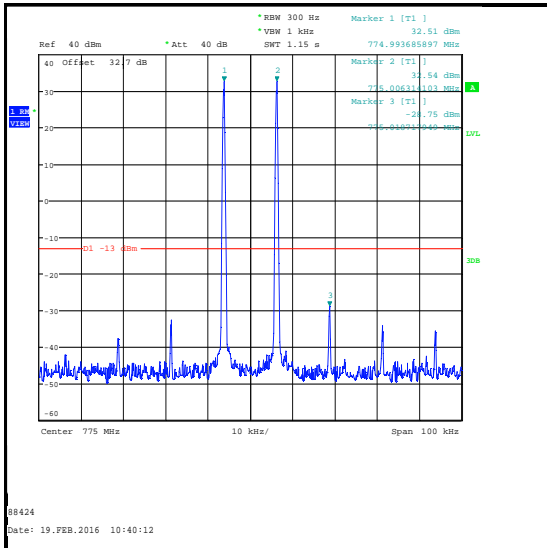


Input Power at just below AGC Threshold

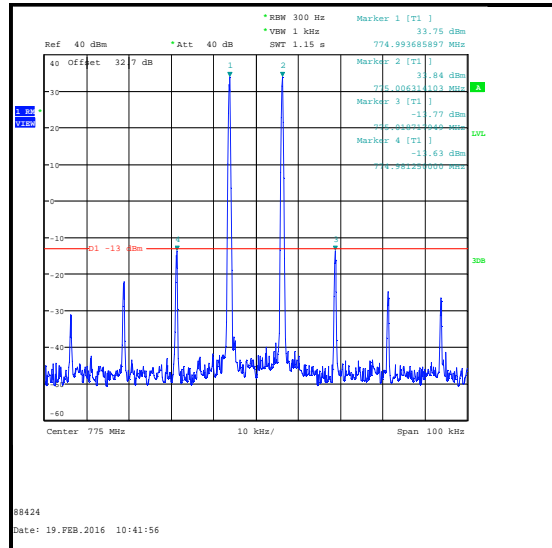


Composite Input Power at AGC Threshold +3 dB

#### Results: 12.5 kHz Channel Spacing / Top channel / Downlink / Output Spectra



Input Power at just below AGC Threshold



Composite Input Power at AGC Threshold +3 dB

**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)****Results: 25 kHz Channel Spacing / CW signal / Downlink / Input just below AGC threshold**

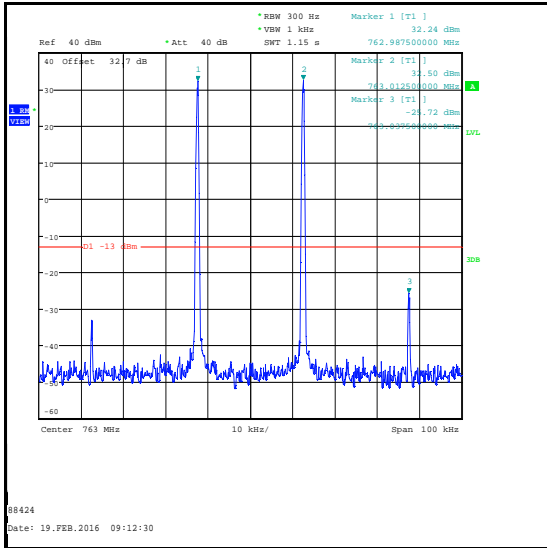
700 MHz Band / Downlink					
Channel	Highest Intermodulation product frequency (MHz)	Highest Intermodulation product amplitude (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	763.037500	-25.7	-13.0	12.7	Complied
Top	775.037532	-28.5	-13.0	15.5	Complied

**Results: 25 kHz Channel Spacing / CW signal / Downlink / Input 3 dB above AGC threshold**

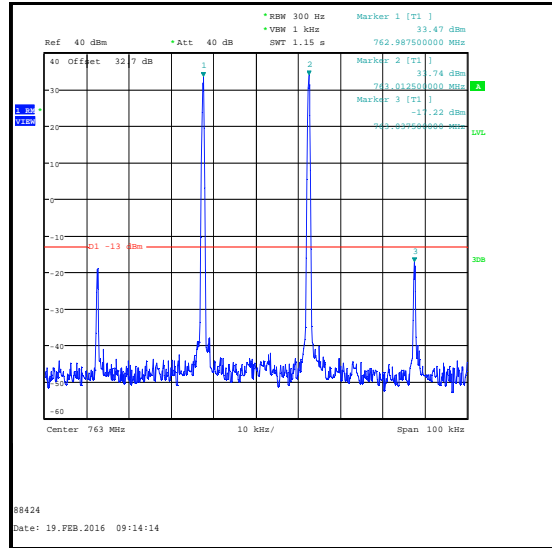
700 MHz Band / Downlink					
Channel	Highest Intermodulation product frequency (MHz)	Highest Intermodulation product amplitude (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	763.037500	-17.2	-13.0	4.2	Complied
Top	775.037532	-22.0	-13.0	9.0	Complied

**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)**

**Results: 25 kHz Channel Spacing / Bottom channel / Downlink / Output Spectra**

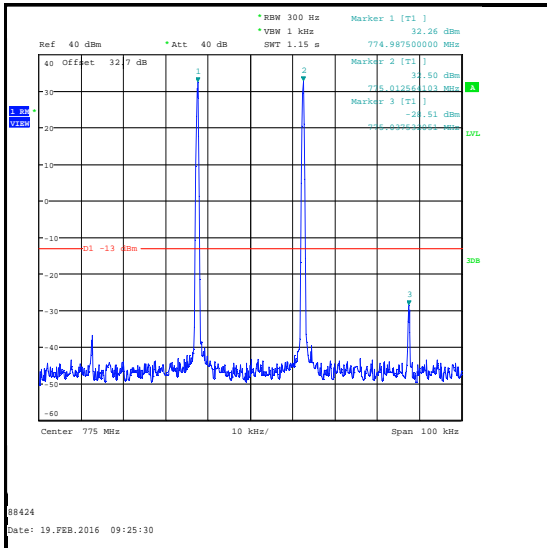


**Input Power at just below AGC Threshold**

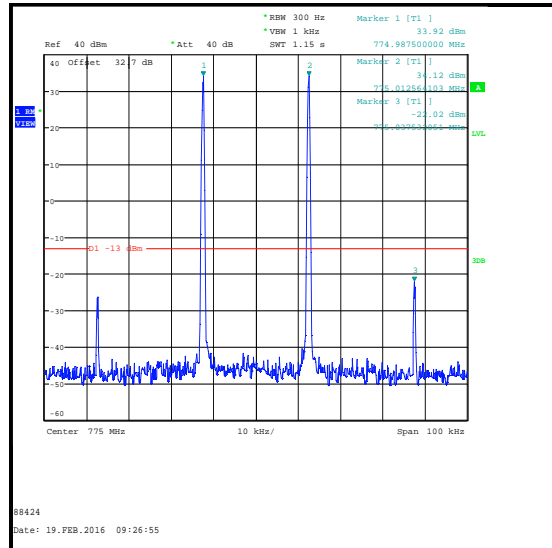


**Composite Input Power at AGC Threshold +3 dB**

**Results: 25 kHz Channel Spacing / Top channel / Downlink / Output Spectra**



**Input Power at just below AGC Threshold**



**Composite Input Power at AGC Threshold +3 dB**

**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelpunkt	30.5015.13	Not stated	23 Apr 2016	12
M1801	Vector Signal Generator	Rohde & Schwarz	SMU 200A	103606	Calibrated before use	-
A1398	20 dB Attenuator	Weinschel	WA46-20	A129	Calibrated before use	-
A1399	10 dB Attenuator	Weinschel	WA46-10	A126	Calibrated before use	-
A539	Power Splitter	Rohde & Schwarz	RVZ 800	838123/022	Calibrated before use	-
A043	RF Filter	AFL	HP-230-5N	3745B	14 May 2017	24
M1794	Spectrum Analyser	Rohde & Schwarz	FSU26	100027	30 Jun 2017	24

**5.2.7. Transmitter Conducted Spurious Emissions****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Date:</b>	12 January 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

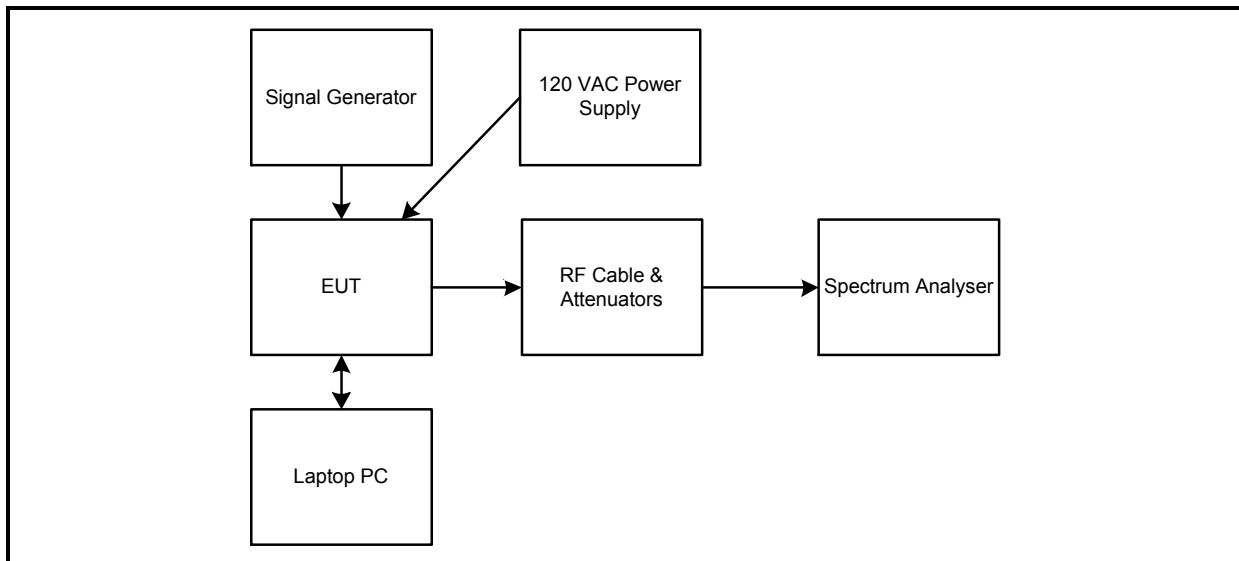
<b>FCC Reference:</b>	Parts 2.1051 & 90.219(e)(3)
<b>Test Method Used:</b>	FCC KDB 935210 D05 Section 4.7.3 and Notes below
<b>Frequency Range:</b>	9 kHz to 7.75 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	21
<b>Relative Humidity (%):</b>	36

**Note(s):**

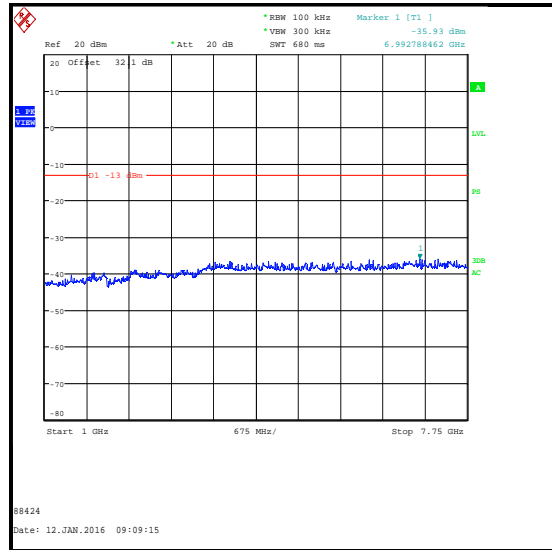
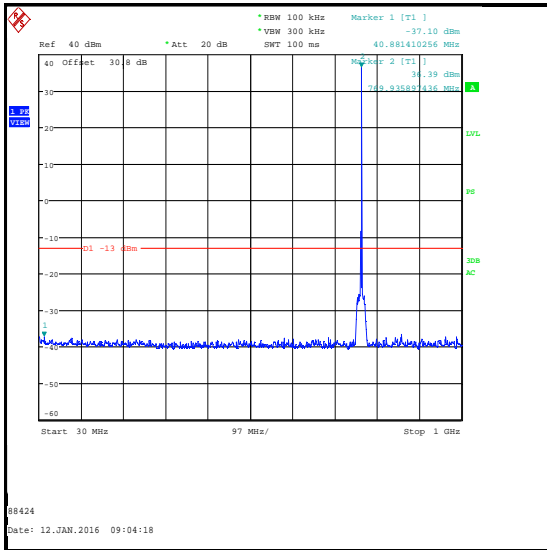
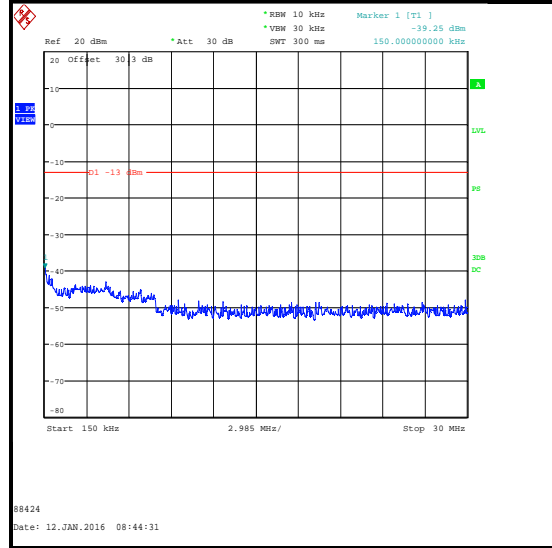
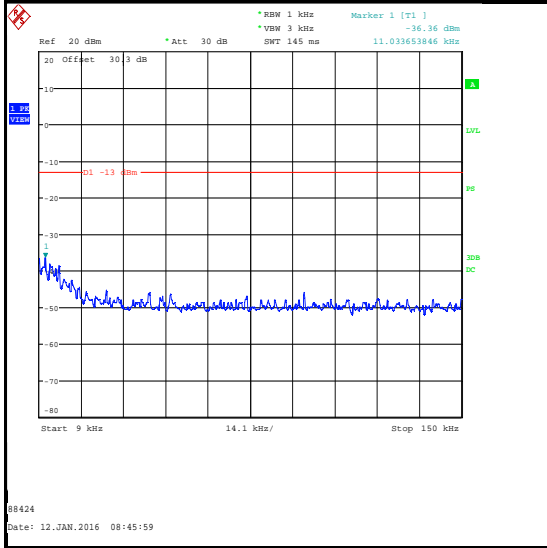
1. A signal generator was connected to the DL port (input/donor) on the EUT via an RF cable. The EUT output power was set to maximum on the EUT Repeater Maintenance Console (Attenuation setting = 0). The SERVER port (output) on the EUT was connected to a spectrum analyser via two RF attenuators and an RF cable. The attenuators and RF cable were calibrated prior to testing and the path loss entered as an RF level offset on the spectrum analyser.
2. The EUT input level was adjusted to give an output power just below the AGC threshold.
3. The spectrum analyser was configured as follows: 9 kHz to 150 kHz measurements, a resolution bandwidth of 1 kHz and video bandwidth of 3 kHz were used; 150 kHz to 30 MHz measurements, a resolution bandwidth of 10 kHz and video bandwidth of 30 kHz were used; 30 MHz to 7.75 GHz measurements, a resolution bandwidth of 100 kHz and video bandwidth of 300 kHz were used. The spectrum analyser was left to sweep repeatedly on Max Hold to maximise the emission levels. No spurious emissions were observed above the noise floor of the measurement system. Markers were placed on the highest noise floor levels on each measured frequency range and the highest noise floor level was recorded in the table below.

**Test setup for conducted spurious emissions measurements:**

**Transmitter Conducted Spurious Emissions (continued)**

**Results: CW Signal / Downlink**

Frequency (MHz)	Maximum Level (dBm)	Limit (dBm)	Margin (dB)	Result
6992.788	-35.9	-13.0	22.9	Complied





**Transmitter Conducted Spurious Emissions (continued)****Test Equipment Used:**

<b>Asset No.</b>	<b>Instrument</b>	<b>Manufacturer</b>	<b>Type No.</b>	<b>Serial No.</b>	<b>Date Calibration Due</b>	<b>Cal. Interval (Months)</b>
M1659	Thermohygrometer	JM Handlungspunkt	30.5015.13	Not stated	23 Apr 2016	12
A2527	20 dB Attenuator	AtlanTecRF	AN18W5-20	832828#2	Calibrated before use	-
A2524	10 dB Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	27 Apr 2016	12

**5.2.8. Transmitter Radiated Spurious Emissions****Test Summary:**

<b>Test Engineers:</b>	David Doyle & Andrew Edwards	<b>Test Dates:</b>	18 September 2012 to 07 January 2013
<b>Test Sample Serial Number:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1053 and 90.219(e)(3)
<b>Test Method Used:</b>	ANSI TIA-603-C-2004 Section 2.2.12
<b>Frequency Range:</b>	30 MHz to 8.1 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	21 to 26
<b>Relative Humidity (%):</b>	36 to 43

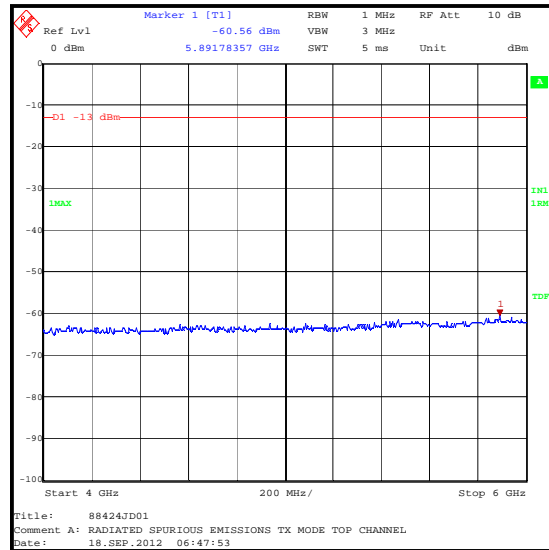
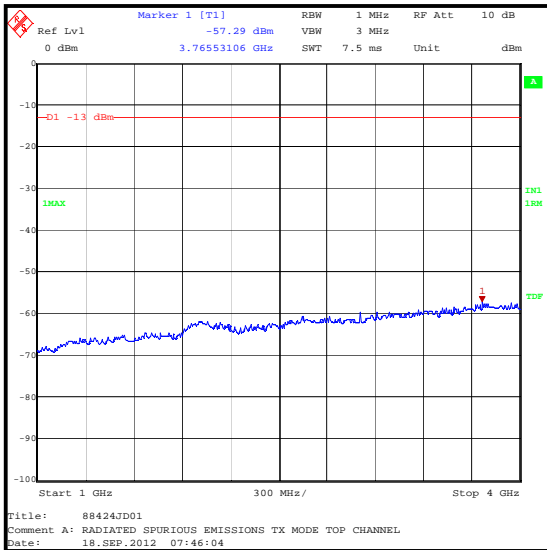
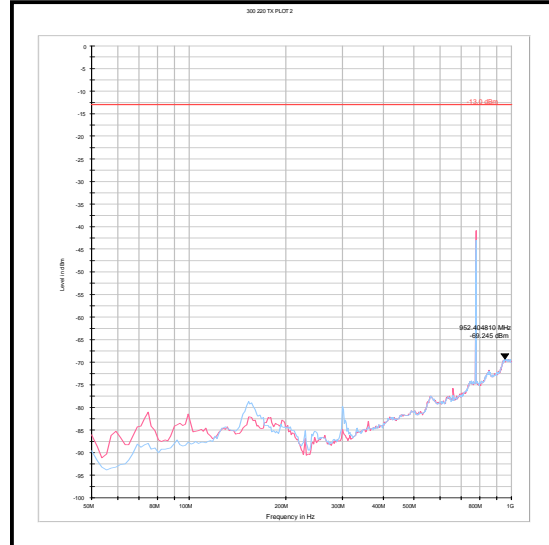
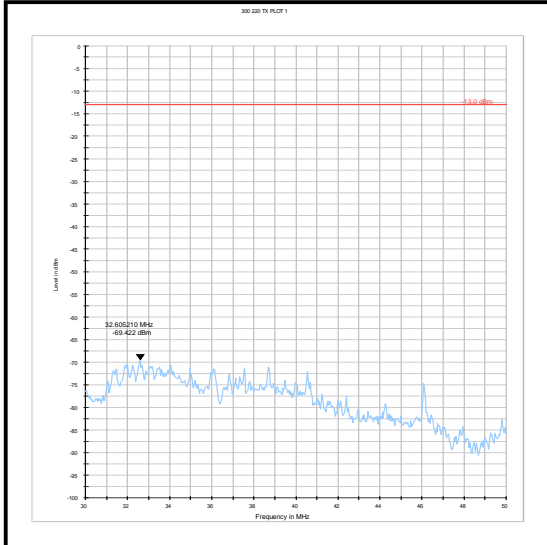
**Note(s):**

1. A signal generator was connected to the input port of the EUT using a suitable RF cable. The signal generator was located outside the anechoic chamber. The RF output of the EUT was terminated into a suitable 50 Ohm load. The signal generator was set to output a CW signal at the maximum input level for the EUT. Pre-scans were performed with the signal generator frequency set to the top channel of the 700 band downlink (775.0 MHz) band.
2. The emission seen on the 30 MHz to 1 GHz plot at approximately 775 MHz is the input signal.
3. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0002) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT.
5. Any emissions were below the noise floor of the measurement system. The highest noise floor level was recorded.
6. All test equipment was within the calibration period on the date of testing.

**Transmitter Radiated Emissions (continued)**

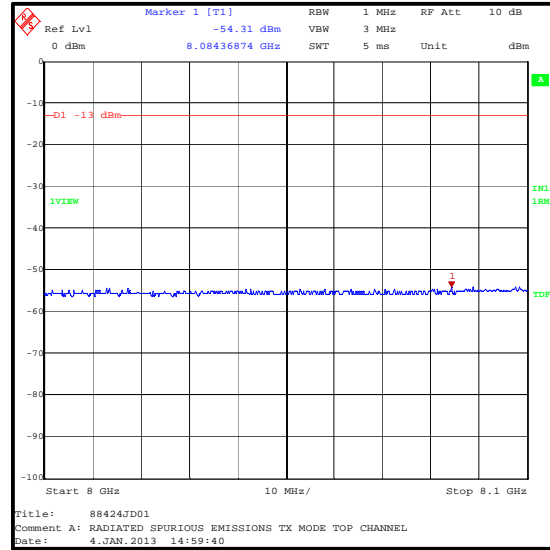
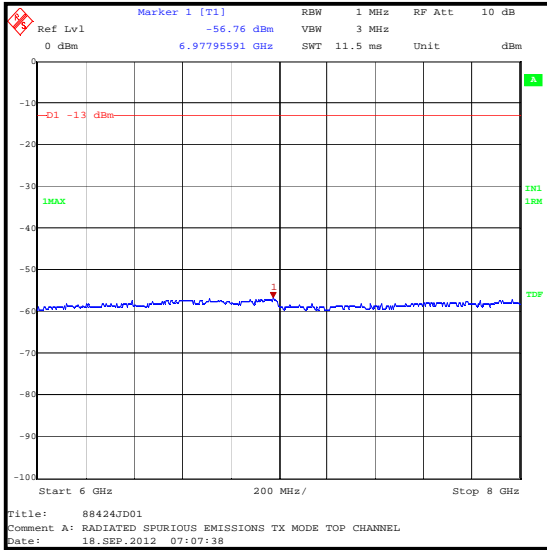
**Results: Downlink**

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
8084.369	-54.3	-13.0	41.3	Complied



**Transmitter Radiated Emissions (continued)**

**Results: Downlink**



**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	04 Nov 2013	12
A1818	Antenna	EMCO	3115	00075692	04 Nov 2013	12
A1834	Attenuator	Hewlett Packard	8491B	10444	29 Jan 2013	12
A253	Antenna	Flann Microwave	12240-20	128	04 Nov 2013	12
A254	Antenna	Flann Microwave	14240-20	139	04 Nov 2013	12
A255	Antenna	Flann Microwave	16240-20	519	04 Nov 2013	12
A2000	Attenuator	Huber & Suhner	6830.17.B	301623	03 Apr 2013	12
A553	Antenna	Chase	CBL6111A	1593	15 Feb 2013	12
G0543	Amplifier	Sonoma	310N	230801	03 Apr 2013	3
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	24 Oct 2013	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	04 Nov 2013	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046K	14 Aug 2013	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	08 Feb 2013	12

### **5.3. Test Results 851-862 MHz frequency band**

#### **5.3.1. Transmitter Output Power and AGC Threshold**

##### **Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Dates:</b>	13 January 2016 to 24 March 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1046(a) / 90.219(e)(1) / 90.219(e)(4)
<b>Test Method Used:</b>	FCC KDB 935210 D05 Sections 4.2, 4.5.3, 4.5.4 and Notes below

##### **Environmental Conditions:**

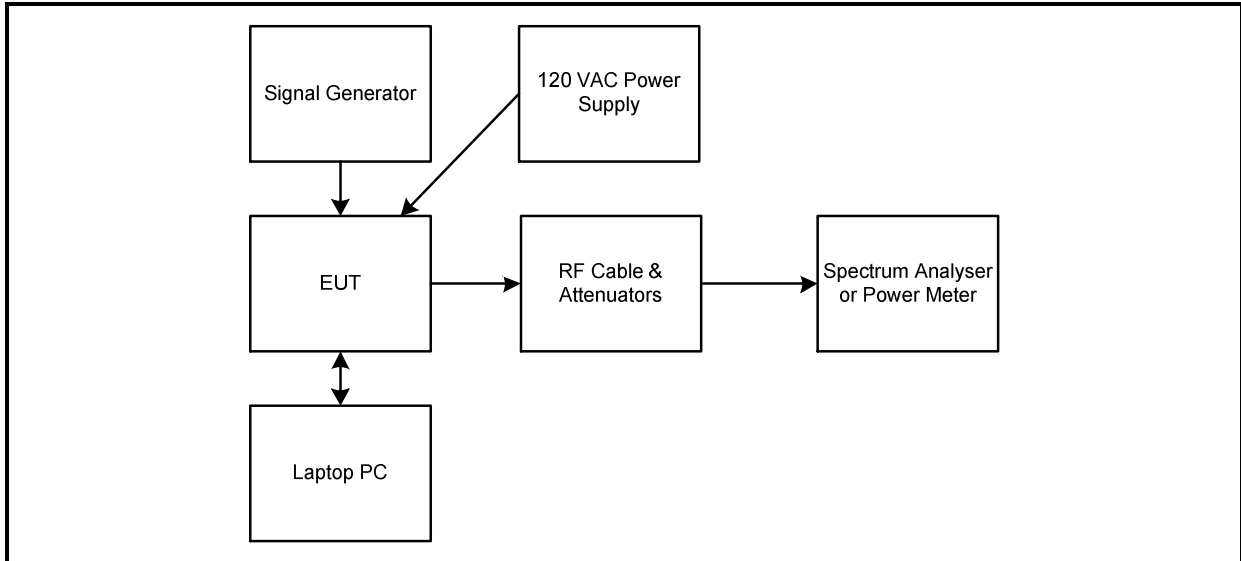
<b>Temperature (°C):</b>	23 to 26
<b>Relative Humidity (%):</b>	29 to 34

##### **Note(s):**

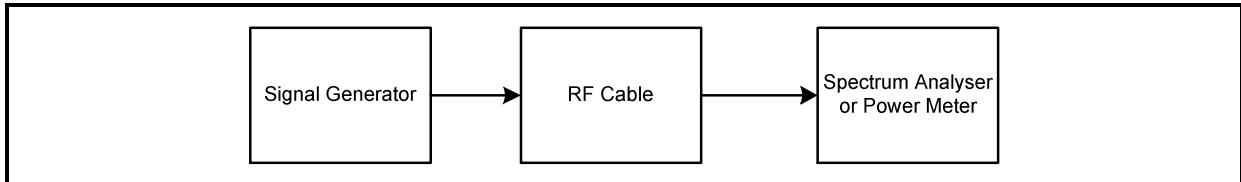
1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test. Only results for the middle channel are reported. Spot checks were performed on the bottom and top channels and the measured levels are identical to the middle channel.
2. A signal generator was connected to the downlink input (DL port) of the EUT via an RF cable. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and attenuators. The combined path loss of the cable and attenuators was entered as an RF level offset on the spectrum analyser.
3. Output power measurements were performed in units of dBm. The conducted power was compared to the ERP limit of 5 Watts (37 dBm) for each retransmitted channel. The maximum measured conducted power was 4.57 Watts (36.6 dBm) giving a margin of 0.43 Watts when compared to the limit. No antenna gain has been stated, therefore an antenna gain of 0 dBd has been assumed. The EUT uses Automatic Gain Control. It was confirmed by measurement that the maximum output power in all modes remained constant when the EUT is operated in saturation (input signal  $\geq 3$  dB above the level that produces the maximum output signal). The EUT Repeater Maintenance Console application also indicated a warning to show the amplifier was at saturation when the input levels were above the AGC threshold.
4. iDEN: Power was measured using a power meter with associated power sensor in accordance with KDB 935210 D05 Section 4.5.4. A Low Noise Amplifier (LNA) was fitted to the signal generator output. The LNA was used to increase the signal level as the signal generator output was not sufficiently high to reach 3 dB above the EUT's AGC threshold. The EUT stops transmitting when in a 3 dB overload condition.
5. The EUT supports multi-channel operation. Additional tests were performed with two equal level input signals (856.5 MHz and 857 MHz) provided by a two port signal generator (UL VS LTD Asset No. M1801) via a combining network. The EUT output was measured at the AGC threshold and with the input levels at 3 dB above the AGC threshold level. Markers were placed on the peak of each signal. The composite output remained below the 5 Watt ERP limit under normal and overload conditions.

**Transmitter Output Power and AGC Threshold (continued)**

**Test setup for transmitter output power and AGC threshold measurements:**



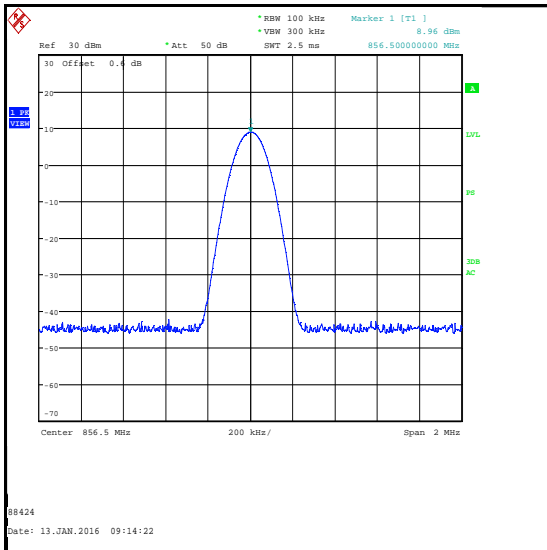
**Test setup for transmitter input power and AGC threshold measurements:**



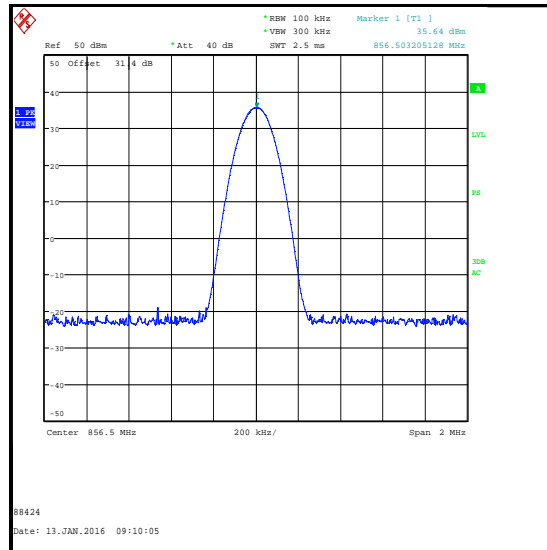
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / CW**

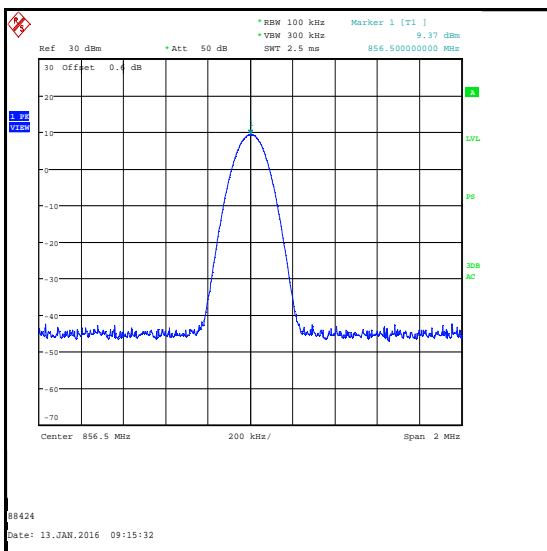
850 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
None (CW)	9.0	35.6	9.4	36.1	37.0	0.9	Complied



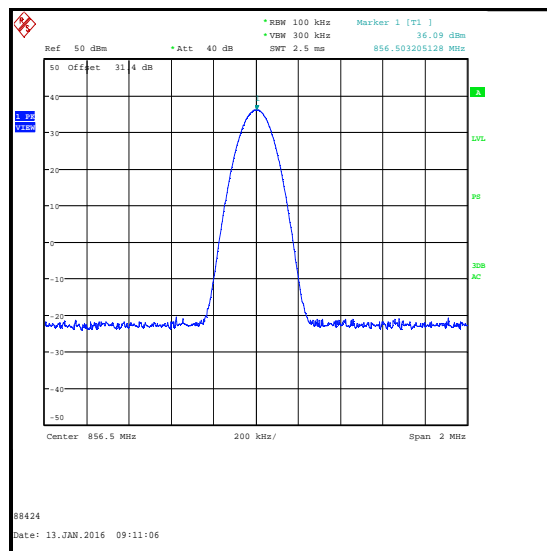
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**

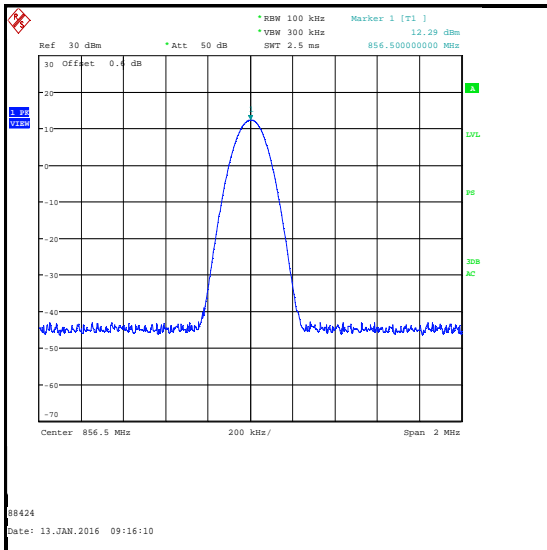


**Maximum Output Power**

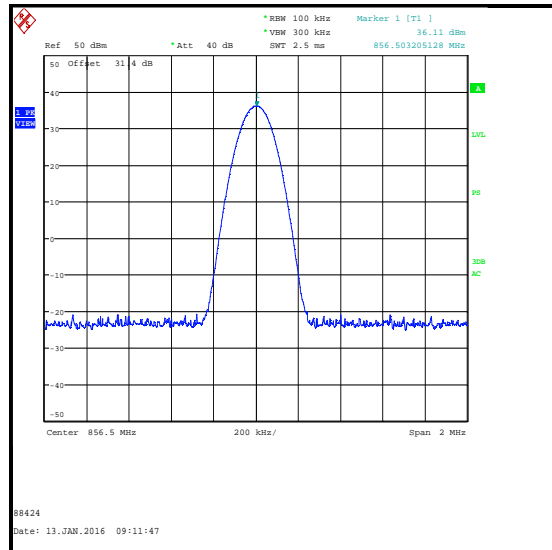
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / CW**

850 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
None (CW)	12.3	36.1	37.0	0.9	Complied



**Input Power at AGC Threshold +3 dB**



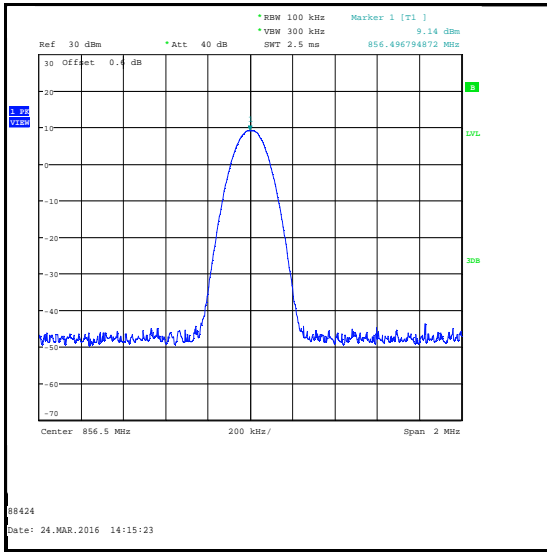
**Output Power**



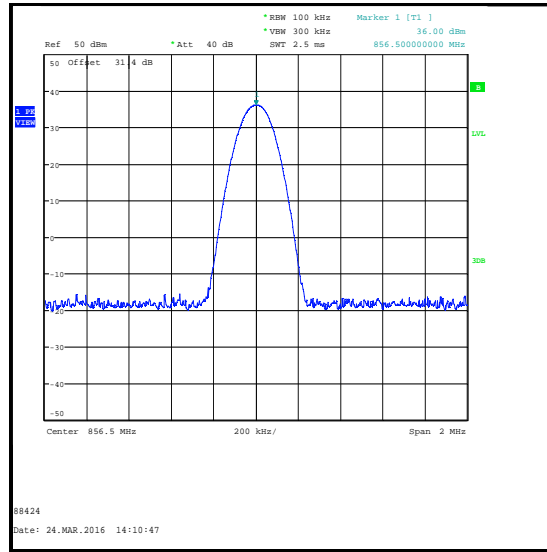
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / 11K3F3E / 1 kHz Audio Frequency**

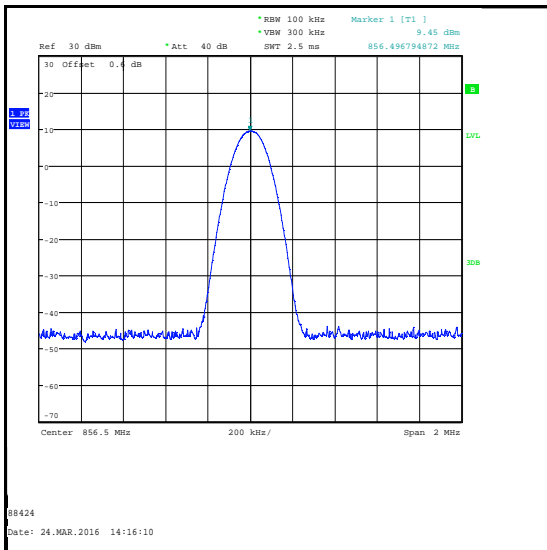
850 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
FM	9.1	36.0	9.5	36.1	37.0	0.9	Complied



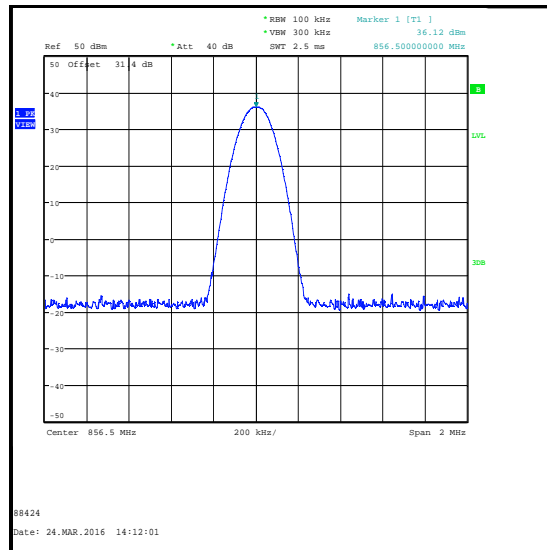
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**

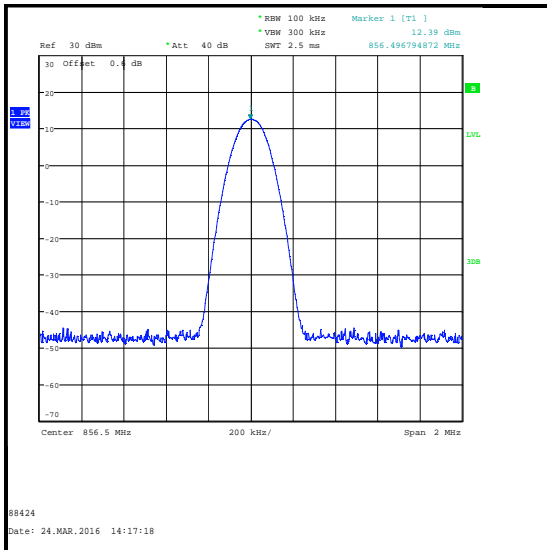


**Maximum Output Power**

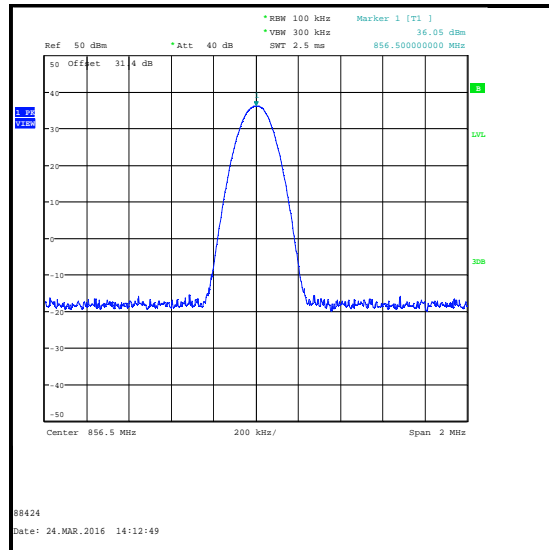
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / 11K3F3E / 1 kHz Audio Frequency**

850 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
FM	12.4	36.1	37.0	0.9	Complied



**Input Power at AGC Threshold +3 dB**

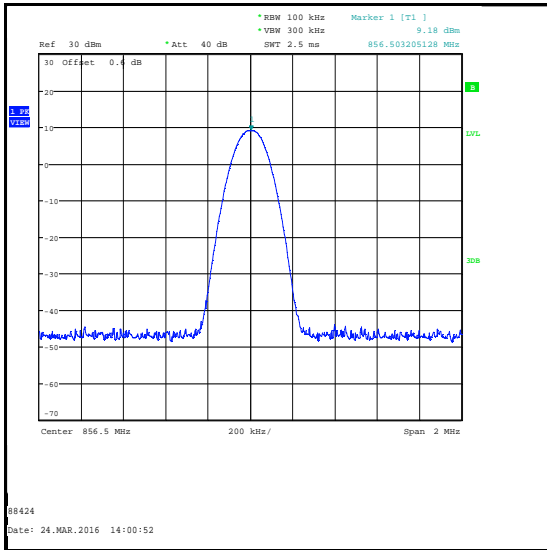


**Output Power**

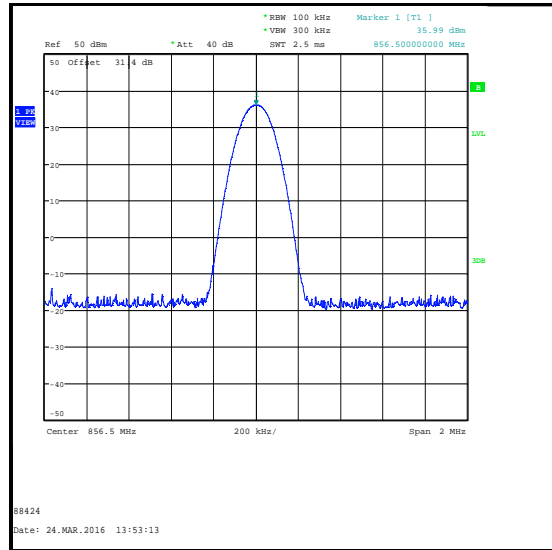
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / 16K0F3E / 1 kHz Audio Frequency**

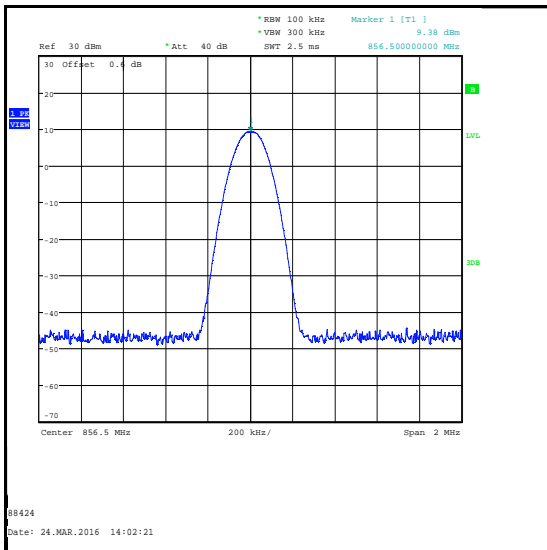
850 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
FM	9.2	36.0	9.4	36.2	37.0	0.8	Complied



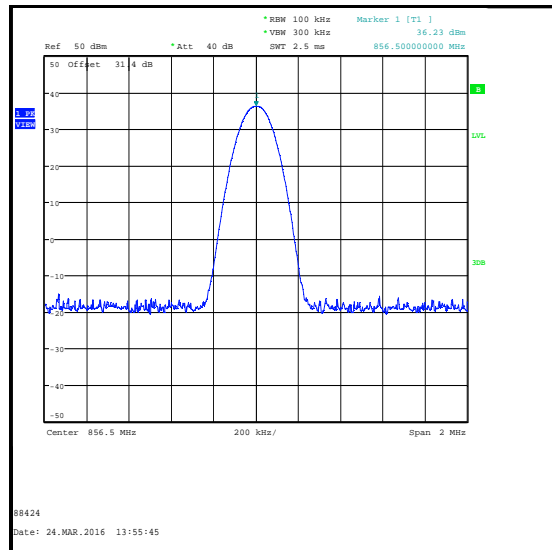
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**

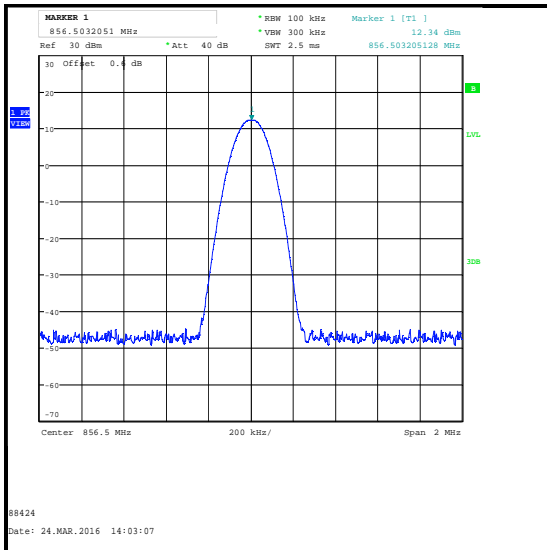


**Maximum Output Power**

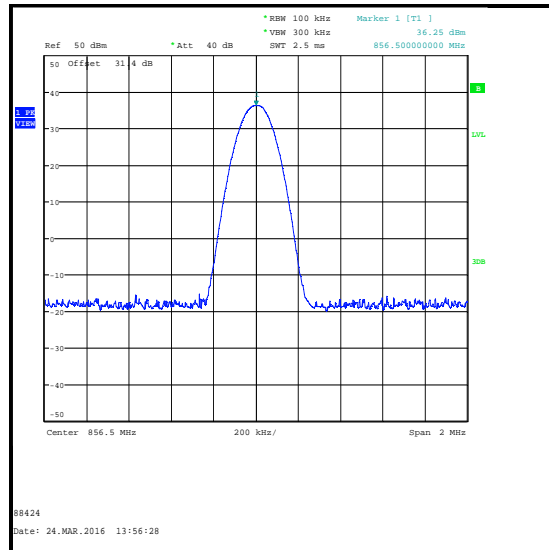
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / 16K0F3E / 1 kHz Audio Frequency**

850 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
FM	12.3	36.3	37.0	0.7	Complied



**Input Power at AGC Threshold +3 dB**

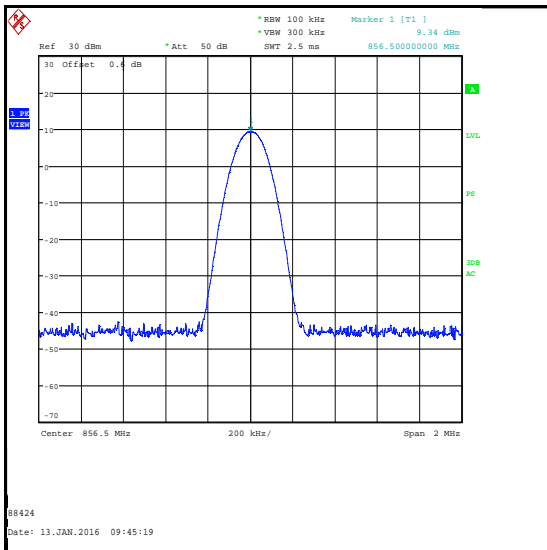


**Output Power**

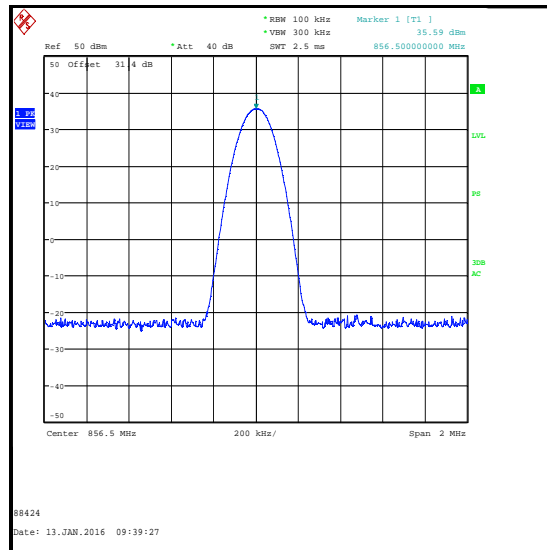
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / APCO P25 Phase 1**

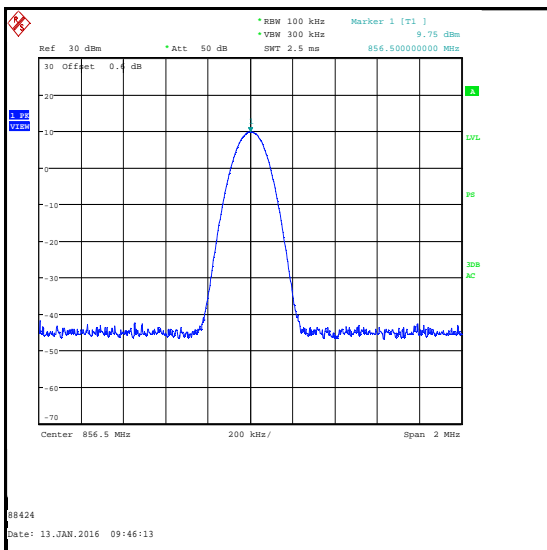
850 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
C4FM	9.3	35.6	9.8	35.9	37.0	1.1	Complied



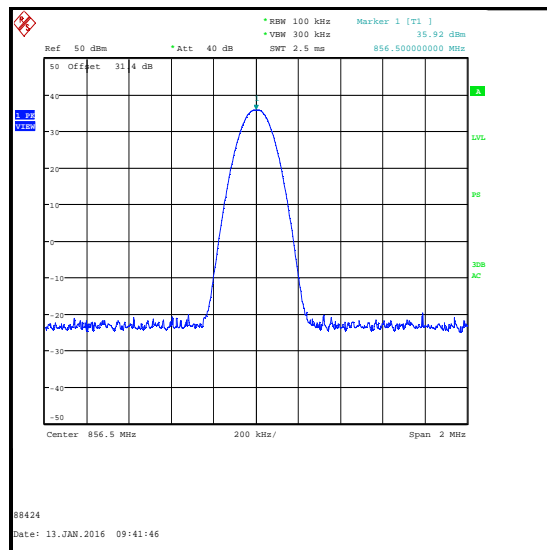
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**

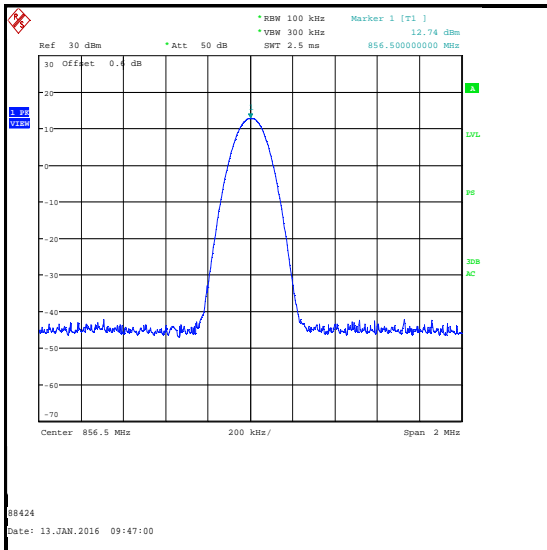


**Maximum Output Power**

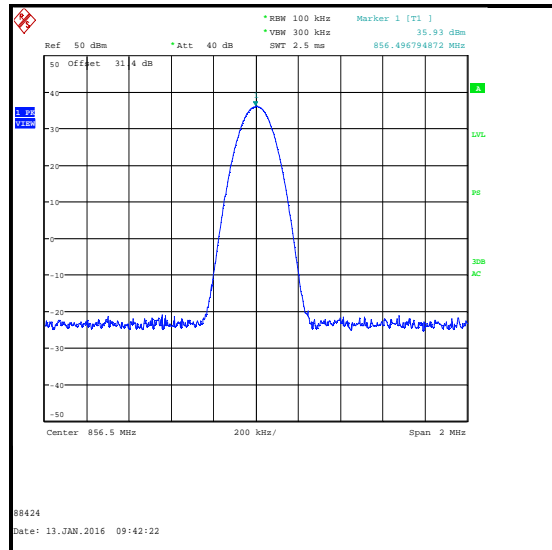
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / APCO P25 Phase 1**

850 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
C4FM	12.7	35.9	37.0	1.1	Complied



**Input Power at AGC Threshold +3 dB**

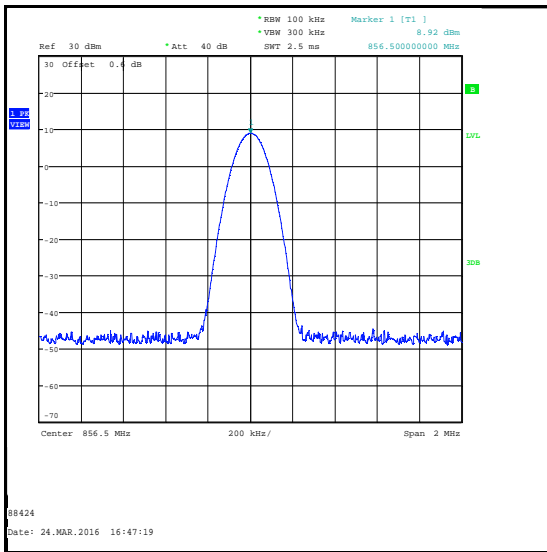


**Output Power**

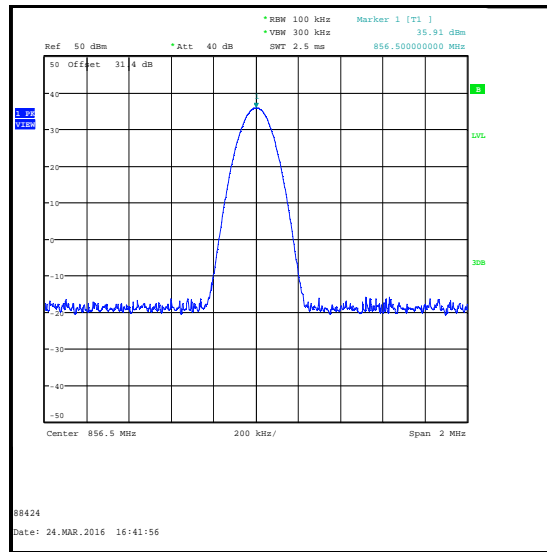
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / APCO P25 Phase 2**

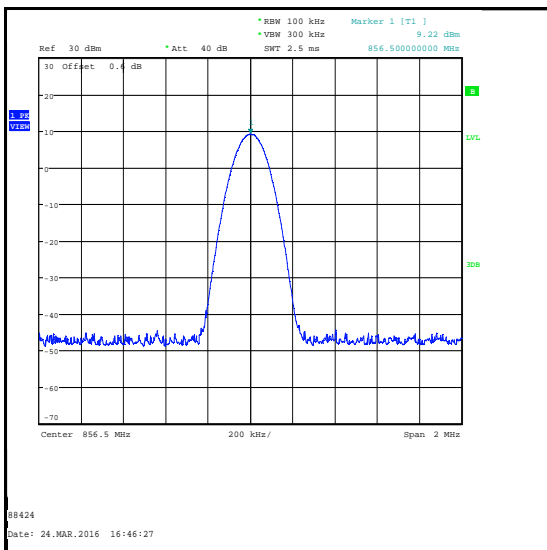
850 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
$\pi/4$ -DQPSK	8.9	35.9	9.2	36.2	37.0	0.8	Complied



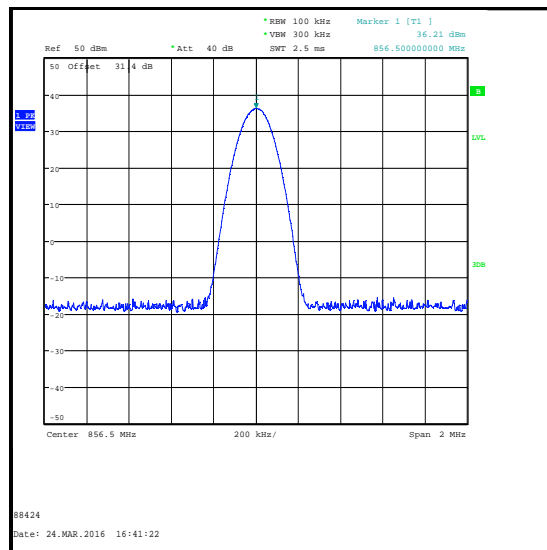
**Input Power at just below AGC Threshold**



**Output Power at just below AGC Threshold**



**Input Power at Maximum Output Power**

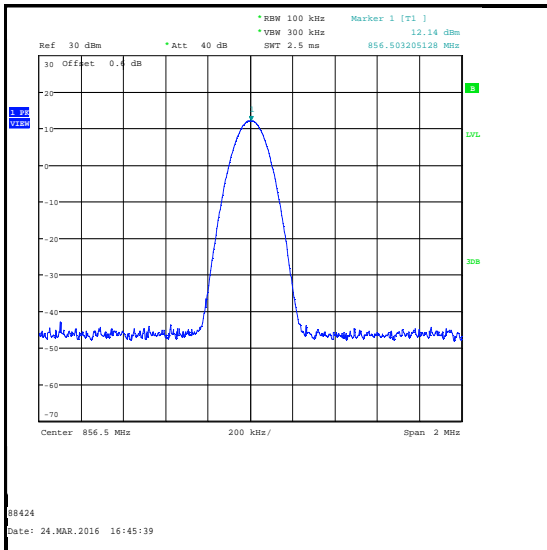


**Maximum Output Power**

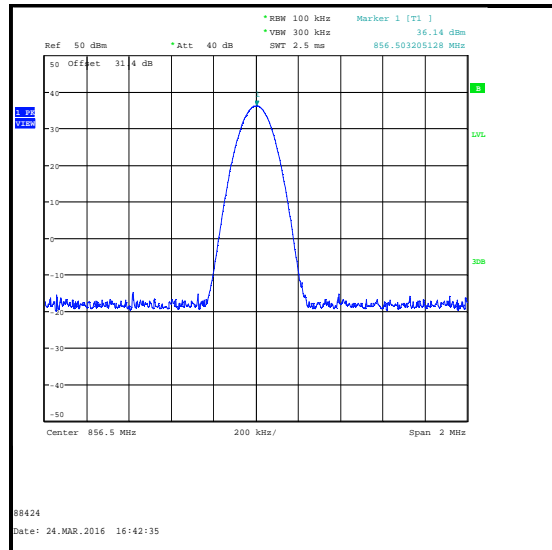
**Transmitter Output Power and AGC Threshold (continued)**

**Results: 856.5 MHz / APCO P25 Phase 2**

850 MHz Band / Downlink					
Modulation Type	Input Power at 3 dB above AGC Threshold Level (dBm)	Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
$\pi/4$ -DQPSK	12.1	36.1	37.0	0.9	Complied



**Input Power at AGC Threshold +3 dB**



**Output Power**



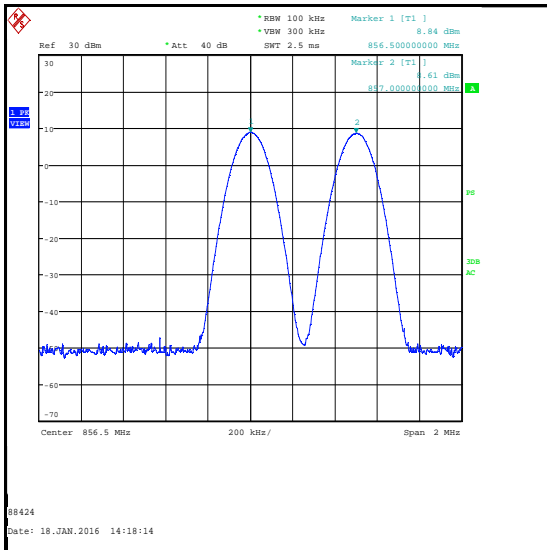
**Transmitter Output Power and AGC Threshold (continued)****Results: 856.5 MHz / iDEN**

850 MHz Band / Downlink							
Modulation Type	Input Power at just below AGC Threshold (dBm)	Output Power at just below AGC Threshold (dBm)	Input Power at Maximum Output Power (dBm)	Maximum Output Power (dBm)	Limit (dBm)	Margin (dB)	Result
16QAM	6.8	26.9	7.0	27.1	37.0	9.9	Complied

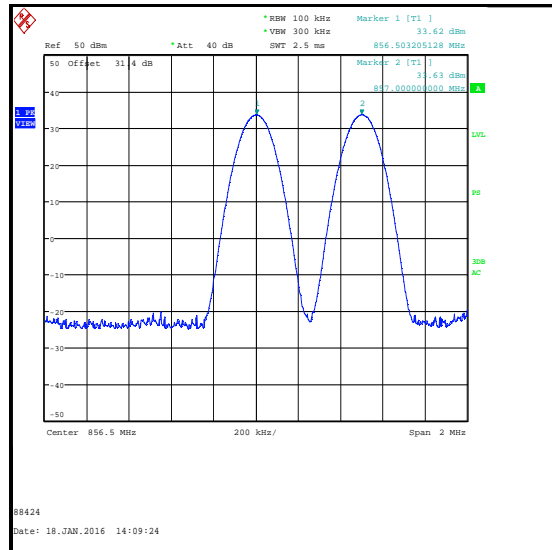
**Transmitter Output Power and AGC Threshold (continued)**

**Results: CW / Two channel operation**

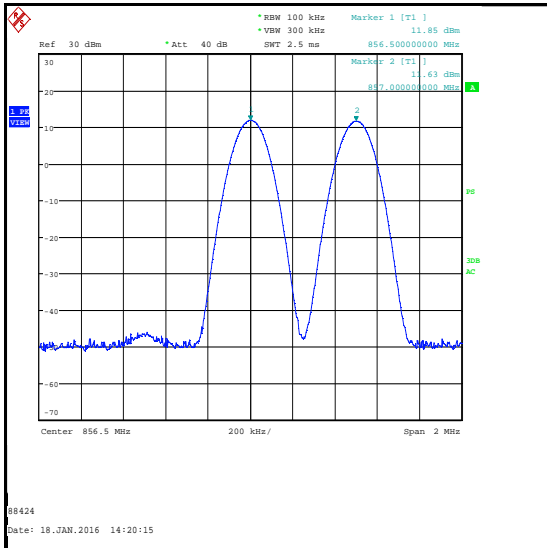
850 MHz Band / Downlink							
Modulation Type	Composite Input Power at AGC Threshold (dBm)	Composite Output Power at AGC Threshold (dBm)	Composite Input Power at AGC Threshold +3 dB (dBm)	Composite Output Power at AGC Threshold +3 dB (dBm)	Limit (dBm)	Margin (dB)	Result
None (CW)	11.7	36.6	14.8	36.6	37.0	0.4	Complied



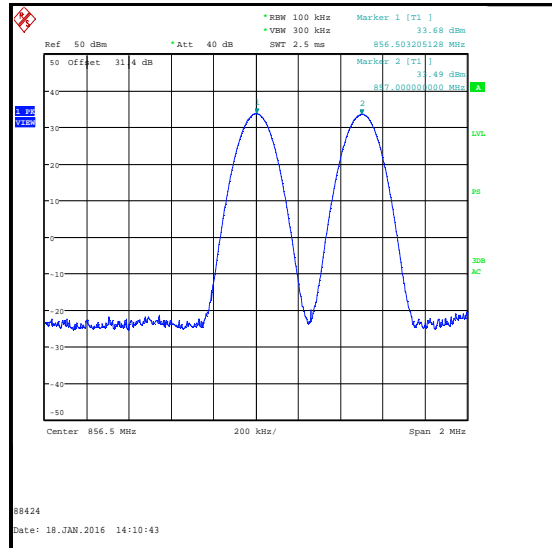
**Input Power at AGC Threshold**



**Output Power at AGC Threshold**



**Input Power at AGC Threshold +3 dB**



**Output Power at AGC Threshold +3 dB**

**Transmitter Output Power and AGC Threshold (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	23 Apr 2016	12
G0607	Vector Signal Generator	Rohde & Schwarz	SMU 200A	100943	18 Jul 2016	36
A1398	20 dB Attenuator	Weinschel	WA46-20	A129	Calibrated before use	-
A1399	10 dB Attenuator	Weinschel	WA46-10	A126	Calibrated before use	-
A1395	6 dB Attenuator	Huber + Suhner	6806.17.B	753459	Calibrated before use	-
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
M1794	Spectrum Analyser	Rohde & Schwarz	FSU	100027	09 Feb 2018	24
M1801	Vector Signal Generator	Rohde & Schwarz	SMU 200A	103606	Calibrated before use	-
G047	Signal Generator	Rohde & Schwarz	SMY01	843215/015	24 Jul 2016	12
M1592	Power Sensor	Hewlett Packard	8487A	3318A02094	22 Sep 2016	12
M1435	Power Meter	Hewlett Packard	437B	3125U14631	24 Apr 2016	12

**5.3.2. Transmitter Occupied Bandwidth****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Dates:</b>	05 January 2016 to 24 March 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1049 / 90.219(e)(4)(i) & 90.219(e)(4)(ii)
<b>Test Method Used:</b>	FCC KDB 971168 D01 Section 4.2 and Notes below

**Environmental Conditions:**

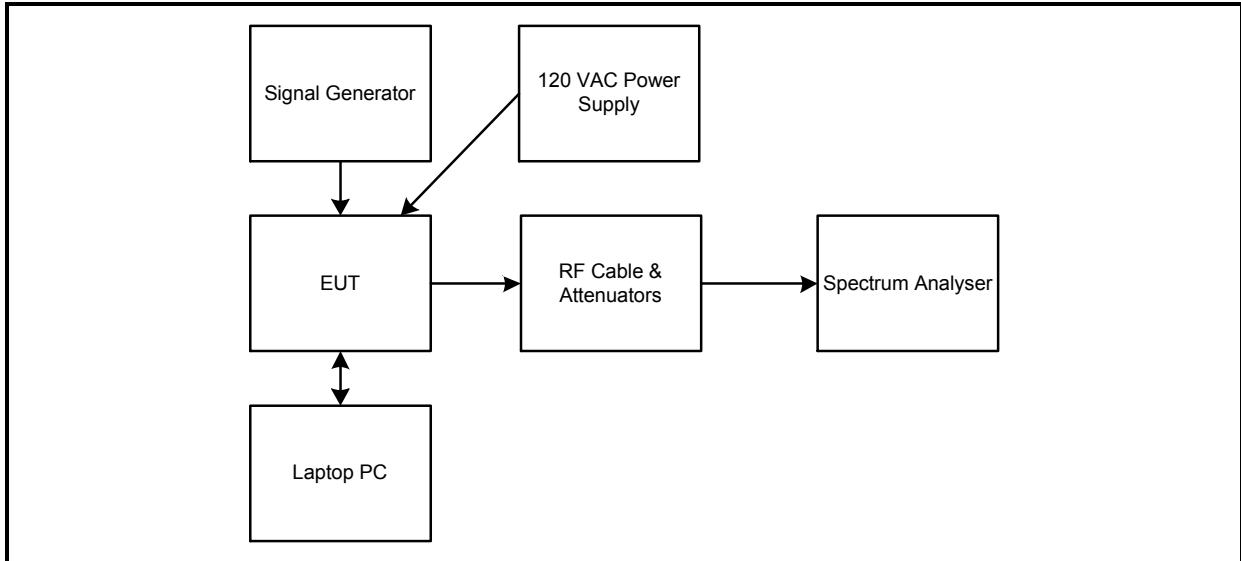
<b>Temperature (°C):</b>	22 to 26
<b>Relative Humidity (%):</b>	31 to 35

**Note(s):**

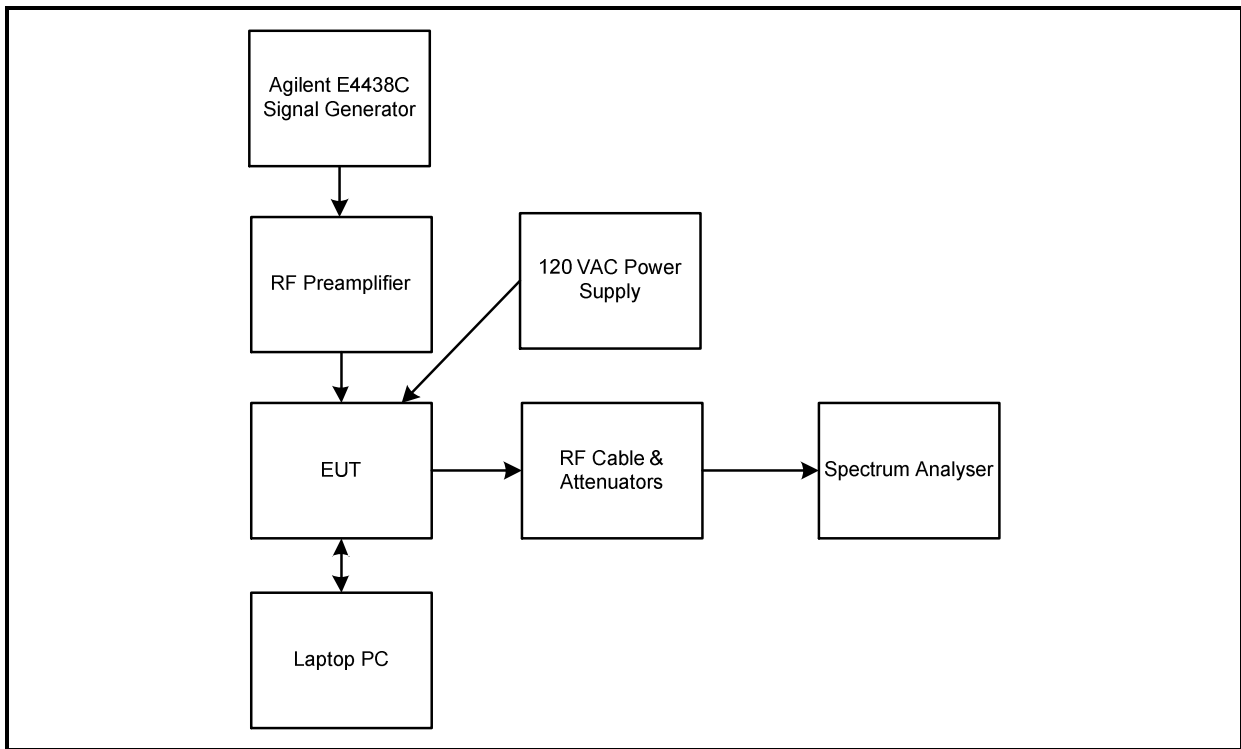
1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
2. A signal generator was connected to the downlink input (DL port) of the EUT via an RF cable. Modulated signals for all supported technologies were applied to the input of the EUT. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and 30 dB of attenuation. The combined path loss of the cable and attenuators was 30.8 dB. This loss was entered as an RF level offset on the spectrum analyser.
3. Input (from signal generator or signal generator and RF Preamplifier) and output (from EUT) 99% occupied bandwidths of a single channel for each supported technology were measured using the occupied bandwidth function of a spectrum analyser. There was no change in the occupied bandwidth of the retransmitted signals. The spectral shape of the output signal is similar to the spectral shape of the input signal for all modulations. The noise-like characteristics of digital signals where tested, caused minor differences between input and output occupied bandwidths.
4. FM Tests: A 3 kHz AF tone was used. This produces a wider occupied bandwidth than a 1 kHz tone.

**Transmitter Occupied Bandwidth (continued)**

**Test setup for transmitter occupied bandwidth measurements:**



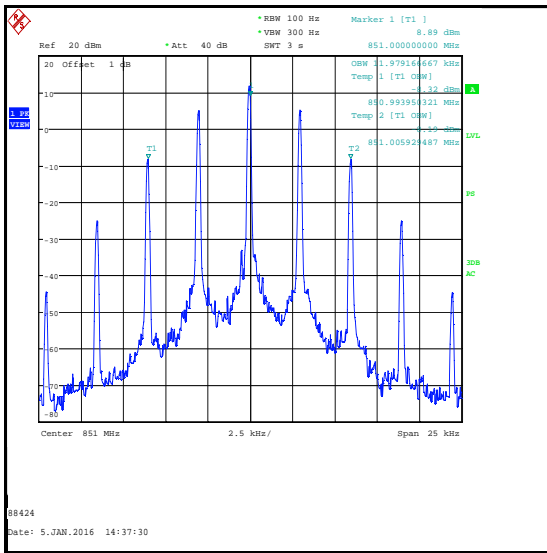
**Test setup for transmitter occupied bandwidth measurements (iDEN only):**



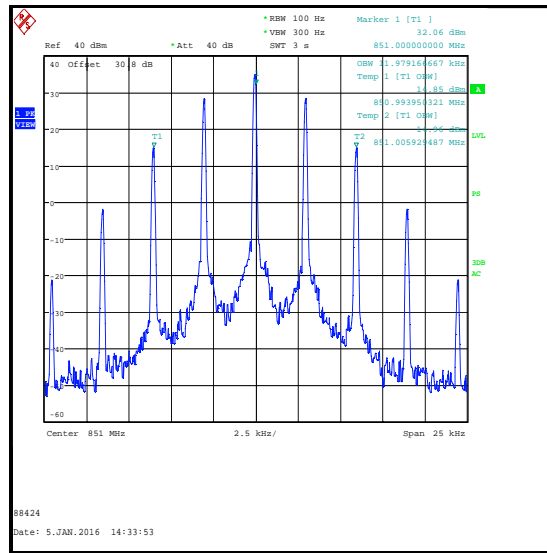
**Transmitter Occupied Bandwidth (continued)**

**Results: FM / 12.5 kHz Channel**

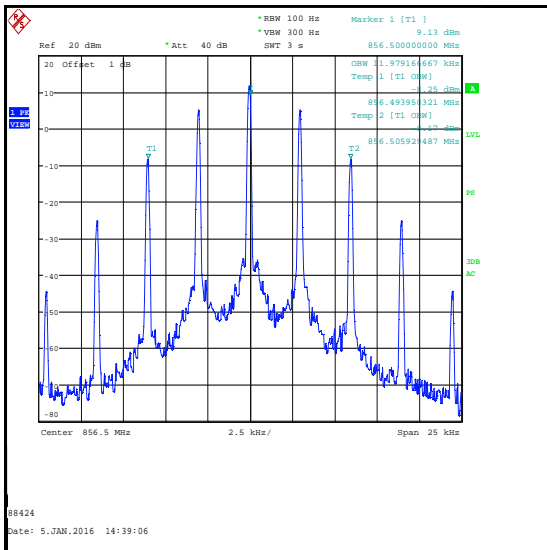
850 MHz Band / Downlink					
Frequency (MHz)	Emission Designator	Modulation Type	Input 99% Emission Bandwidth (kHz)	Output 99% Emission Bandwidth (kHz)	Difference between Input and Output Bandwidth (kHz)
851	11K3F3E	FM	11.979	11.979	0.0
856.5	11K3F3E	FM	11.979	11.979	0.0
862	11K3F3E	FM	11.979	11.979	0.0



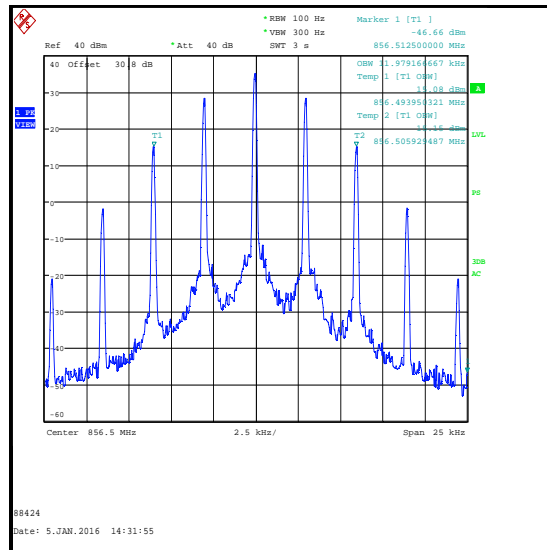
**Bottom Channel /  
Input 99% Emission Bandwidth**



**Bottom Channel /  
Output 99% Emission Bandwidth**



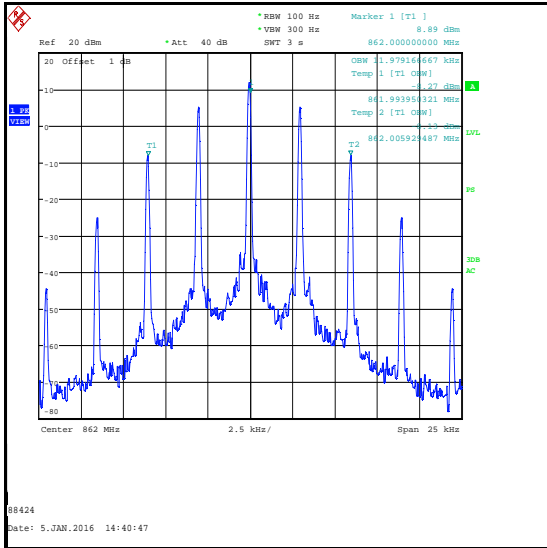
**Middle Channel /  
Input 99% Emission Bandwidth**



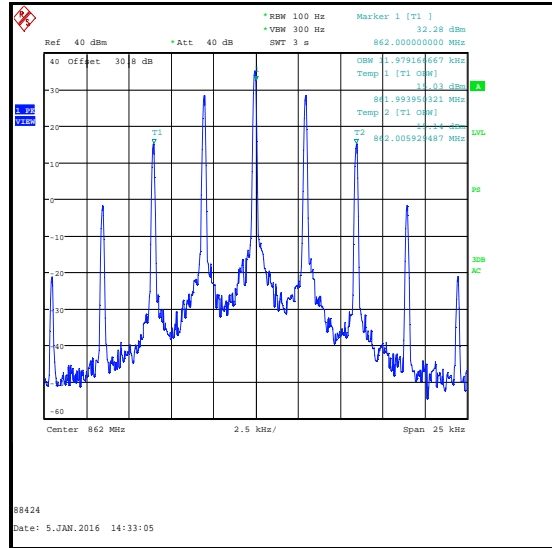
**Middle Channel /  
Output 99% Emission Bandwidth**

**Transmitter Occupied Bandwidth (continued)**

**Results: FM / 12.5 kHz Channel**



**Top Channel /  
Input 99% Emission Bandwidth**

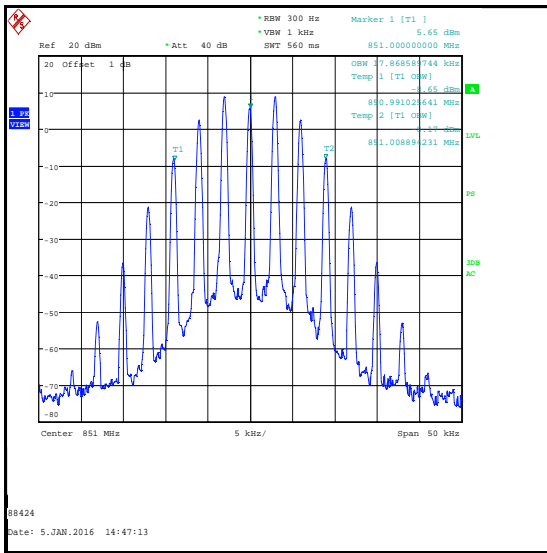


**Top Channel /  
Output 99% Emission Bandwidth**

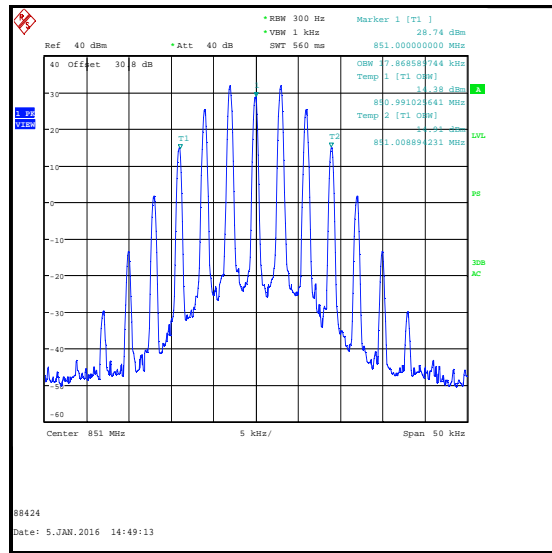
**Transmitter Occupied Bandwidth (continued)**

**Results: FM / 25 kHz Channel**

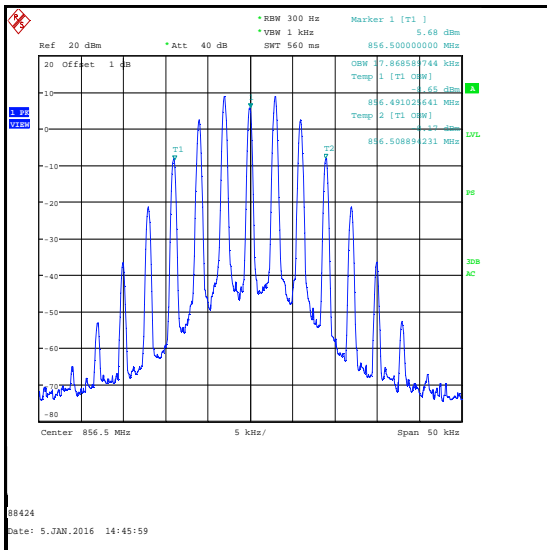
850 MHz Band / Downlink					
Frequency (MHz)	Emission Designator	Modulation Type	Input 99% Emission Bandwidth (kHz)	Output 99% Emission Bandwidth (kHz)	Difference between Input and Output Bandwidth (kHz)
851	16K0F3E	FM	17.869	17.869	0.0
856.5	16K0F3E	FM	17.869	17.869	0.0
862	16K0F3E	FM	17.869	17.869	0.0



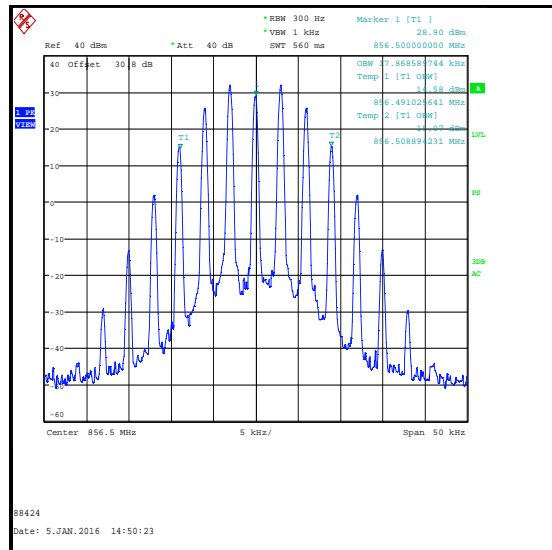
**Bottom Channel /  
 Input 99% Emission Bandwidth**



**Bottom Channel /  
 Output 99% Emission Bandwidth**



**Middle Channel /  
 Input 99% Emission Bandwidth**

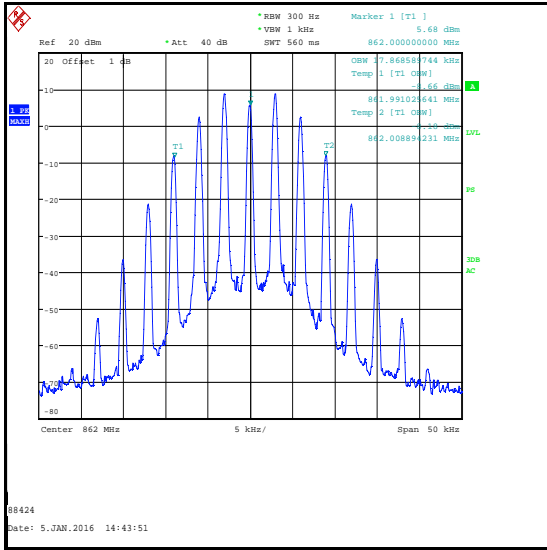


**Middle Channel /  
 Output 99% Emission Bandwidth**

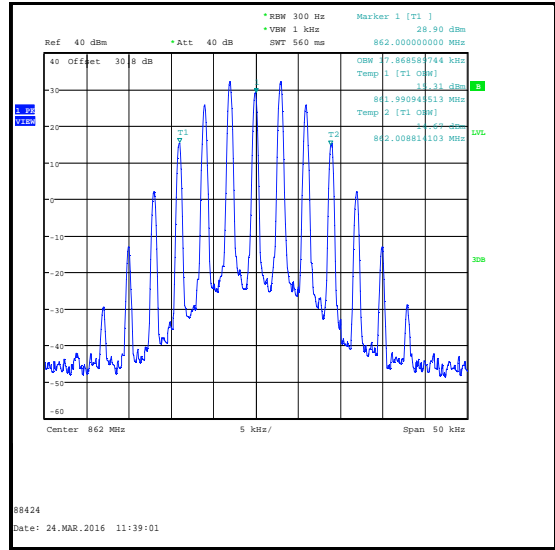


**Transmitter Occupied Bandwidth (continued)**

**Results: FM / 25 kHz Channel**



**Top Channel /  
Input 99% Emission Bandwidth**

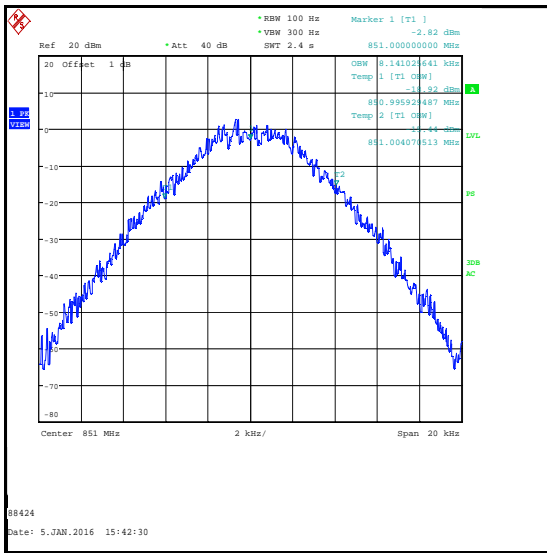


**Top Channel /  
Output 99% Emission Bandwidth**

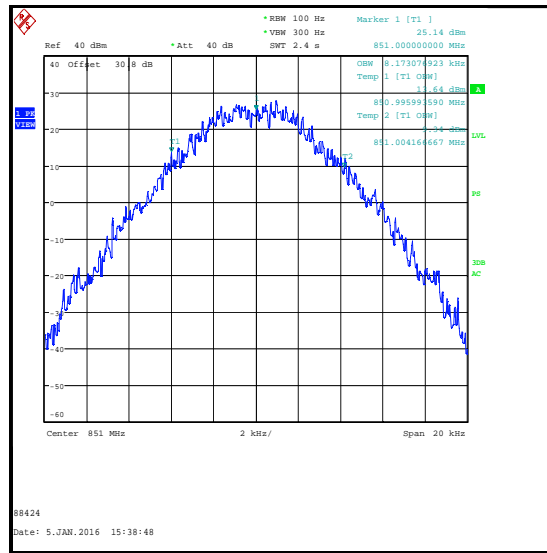
**Transmitter Occupied Bandwidth (continued)**

**Results: APCO P25 Phase 1**

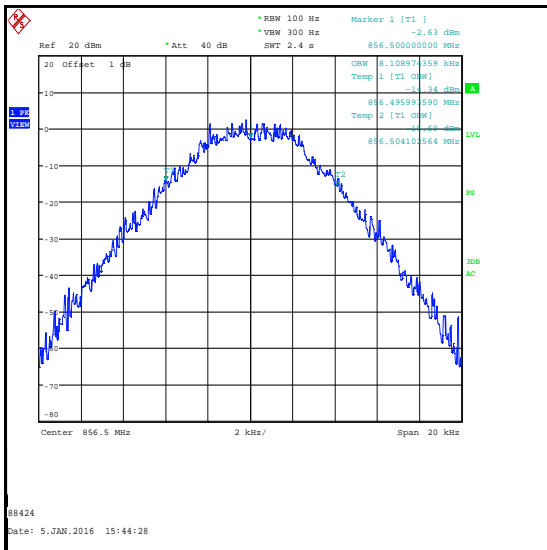
850 MHz Band / Downlink					
Frequency (MHz)	Emission Designator	Modulation Type	Input 99% Emission Bandwidth (kHz)	Output 99% Emission Bandwidth (kHz)	Difference between Input and Output Bandwidth (kHz)
851	8K10F1D	C4FM	8.141	8.173	0.032
856.5	8K10F1D	C4FM	8.109	8.301	0.192
862	8K10F1D	C4FM	8.141	8.237	0.096



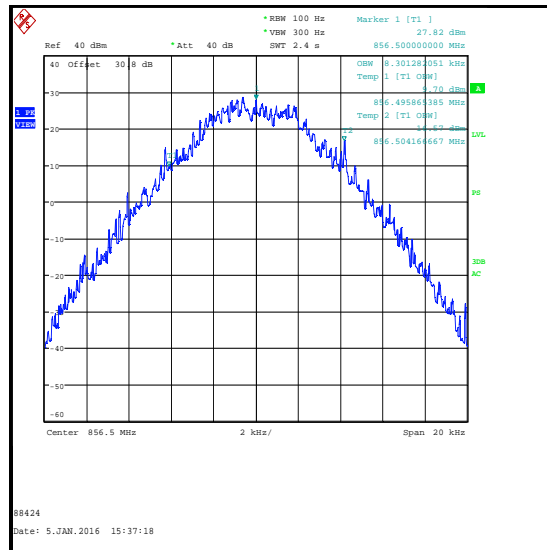
**Bottom Channel /  
Input 99% Emission Bandwidth**



**Bottom Channel /  
Output 99% Emission Bandwidth**



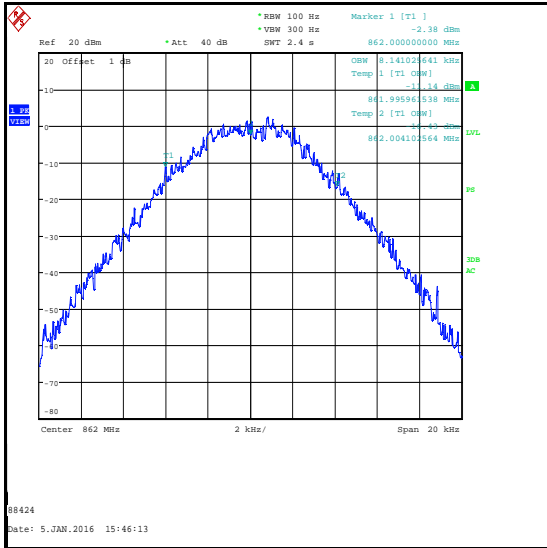
**Middle Channel /  
Input 99% Emission Bandwidth**



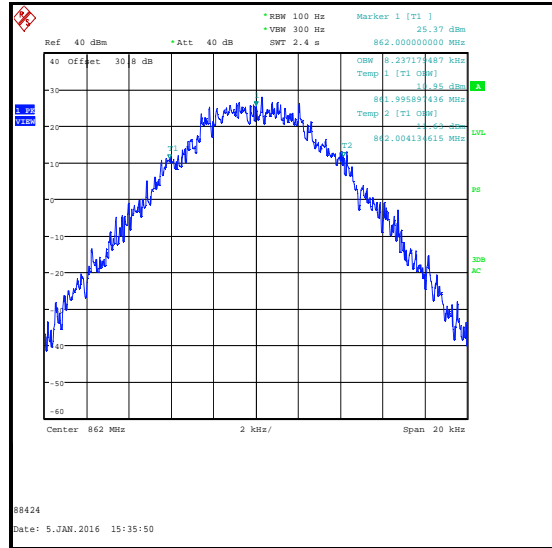
**Middle Channel /  
Output 99% Emission Bandwidth**

**Transmitter Occupied Bandwidth (continued)**

**Results: APCO P25 Phase 1**



**Top Channel /  
Input 99% Emission Bandwidth**

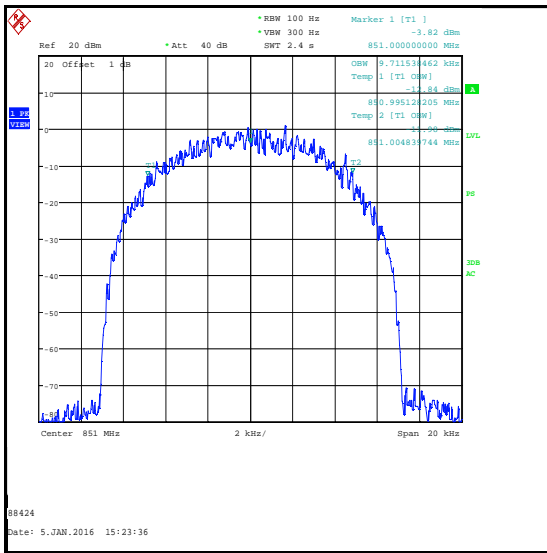


**Top Channel /  
Output 99% Emission Bandwidth**

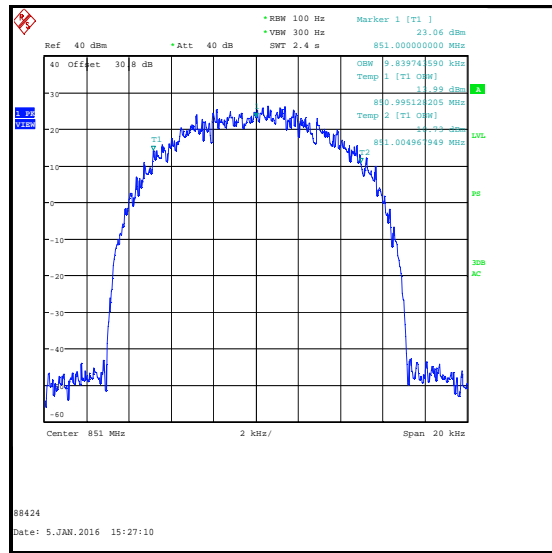
**Transmitter Occupied Bandwidth (continued)**

**Results: APCO P25 Phase 2**

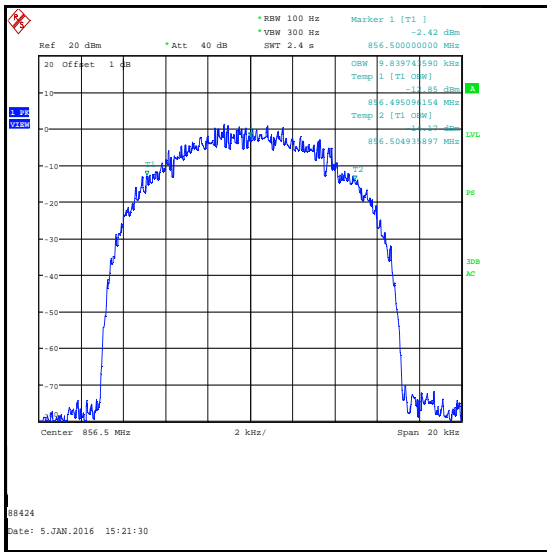
850 MHz Band / Downlink					
Frequency (MHz)	Emission Designator	Modulation Type	Input 99% Emission Bandwidth (kHz)	Output 99% Emission Bandwidth (kHz)	Difference between Input and Output Bandwidth (kHz)
851	9K80F1D	$\pi/4$ -DQPSK	9.712	9.840	0.128
856.5	9K80F1D	$\pi/4$ -DQPSK	9.840	9.776	0.064
862	9K80F1D	$\pi/4$ -DQPSK	9.776	9.712	0.064



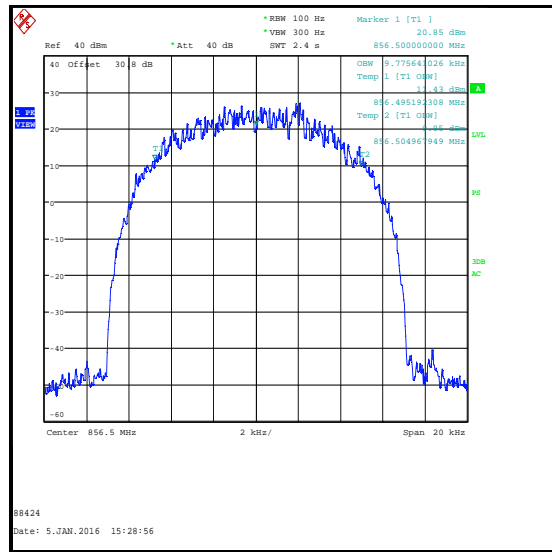
**Bottom Channel /  
Input 99% Emission Bandwidth**



**Bottom Channel /  
Output 99% Emission Bandwidth**



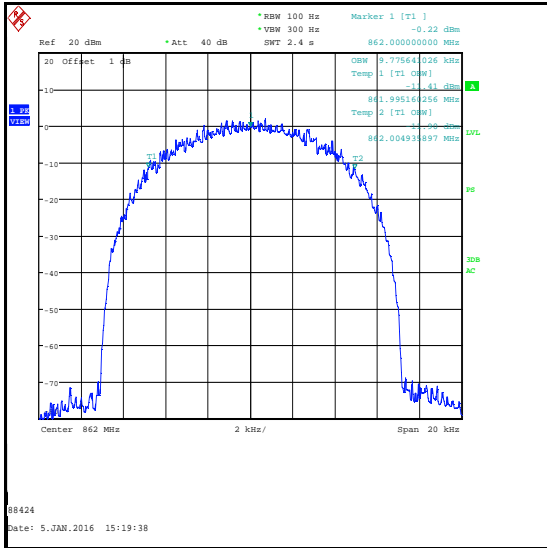
**Middle Channel /  
Input 99% Emission Bandwidth**



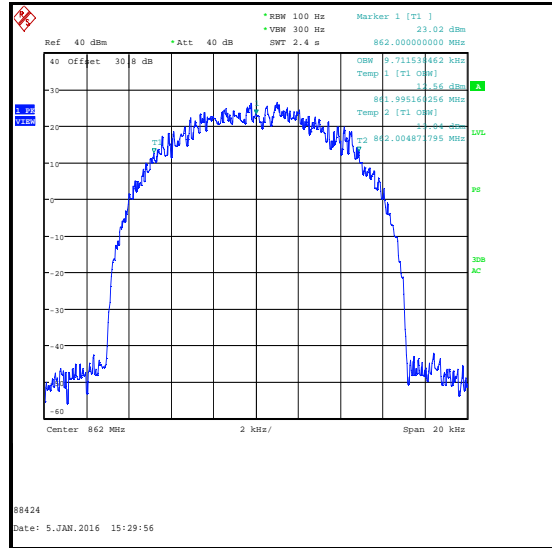
**Middle Channel /  
Output 99% Emission Bandwidth**

**Transmitter Occupied Bandwidth (continued)**

**Results: APCO P25 Phase 2**



**Top Channel /  
Input 99% Emission Bandwidth**

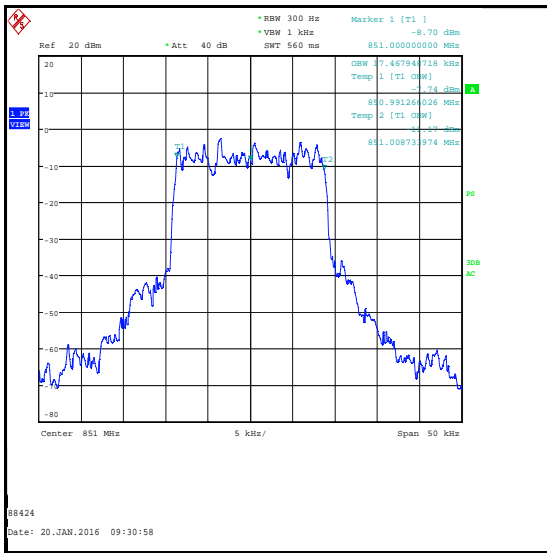


**Top Channel /  
Output 99% Emission Bandwidth**

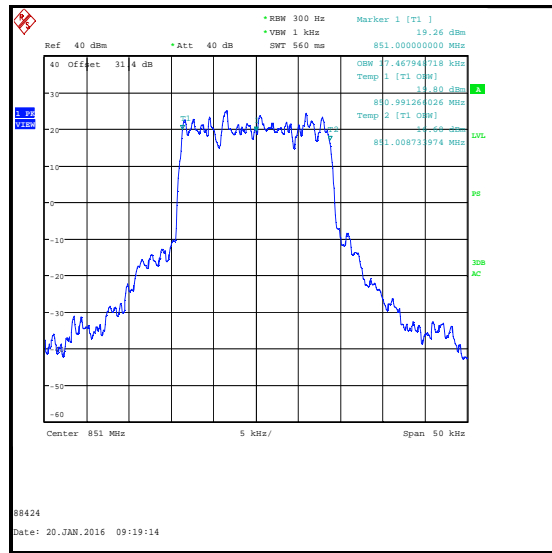
**Transmitter Occupied Bandwidth (continued)**

**Results: iDEN**

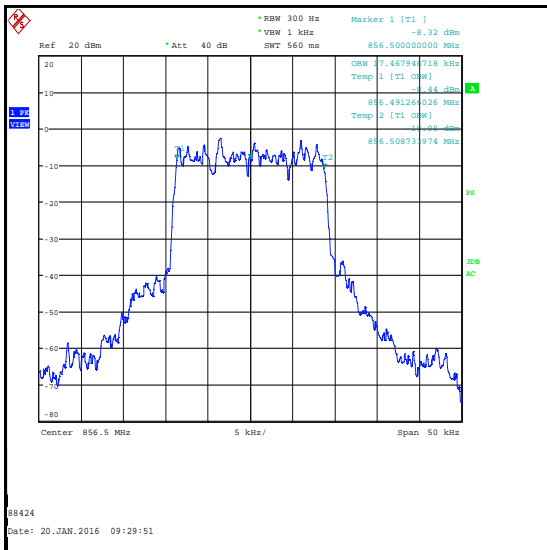
850 MHz Band / Downlink					
Frequency (MHz)	Emission Designator	Modulation Type	Input 99% Emission Bandwidth (kHz)	Output 99% Emission Bandwidth (kHz)	Difference between Input and Output Bandwidth (kHz)
851	17K5W7W	16QAM	17.468	17.468	0.0
856.5	17K5W7W	16QAM	17.468	17.468	0.0
862	17K5W7W	16QAM	17.548	17.548	0.0



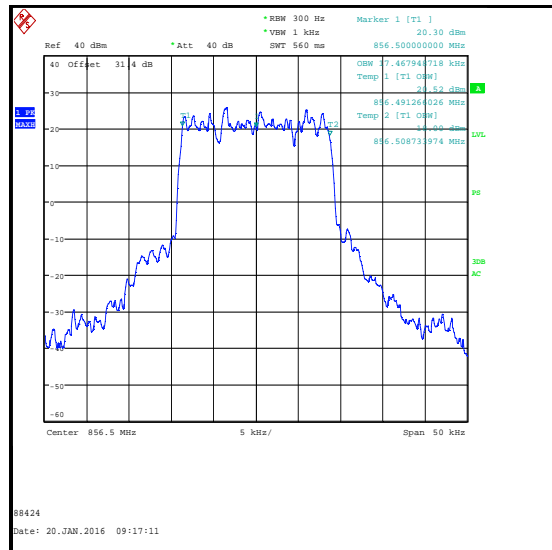
**Bottom Channel /  
Input 99% Emission Bandwidth**



**Bottom Channel /  
Output 99% Emission Bandwidth**



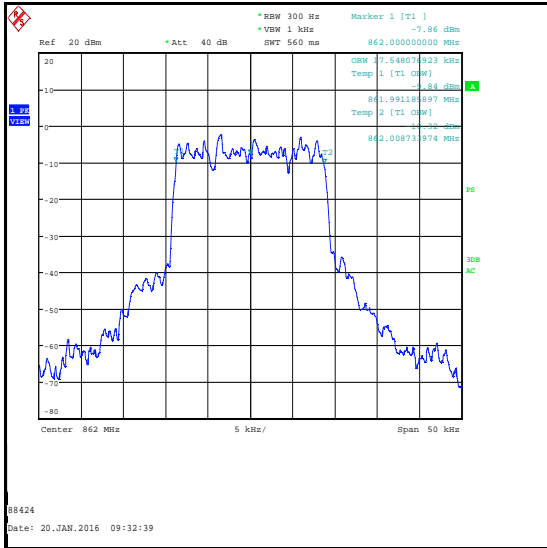
**Middle Channel /  
Input 99% Emission Bandwidth**



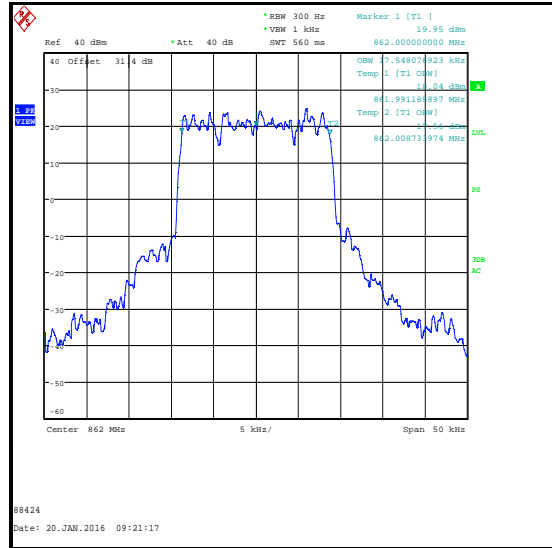
**Middle Channel /  
Output 99% Emission Bandwidth**

### Transmitter Occupied Bandwidth (continued)

#### Results: iDEN



Top Channel /  
Input 99% Emission Bandwidth



Top Channel /  
Output 99% Emission Bandwidth

**Transmitter Occupied Bandwidth (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handlungspunkt	30.5015.13	Not stated	23 Apr 2016	12
G0607	Vector Signal Generator	Rohde & Schwarz	SMU 200A	100943	18 Jul 2016	36
A1398	20 dB Attenuator	Weinschel	WA46-20	A129	Calibrated before use	-
A1399	10 dB Attenuator	Weinschel	WA46-10	A126	Calibrated before use	-
A2527	20 dB Attenuator	AtlanTecRF	AN18W5-20	832828#2	Calibrated before use	-
A2524	10 dB Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
M1794	Spectrum Analyser	Rohde & Schwarz	FSU	100027	09 Feb 2018	24
A2863	RF Preamplifier	Agilent	E8449B	3008A02100	Calibrated before use	-
G0590	Signal Generator	Agilent	E4438C	MY49071333	30 Jul 2016	12
G047	Signal Generator	Rohde & Schwarz	SMY01	843215/015	24 Jul 2016	12



**5.3.3. PLMRS Out-of-Band Rejection****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Date:</b>	13 January 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

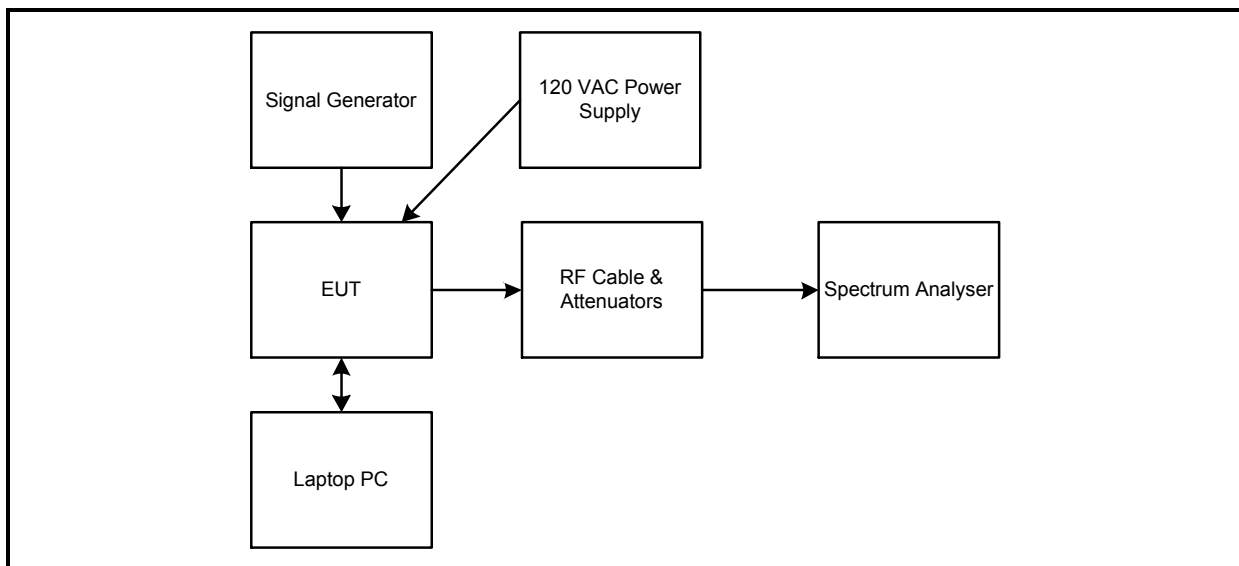
<b>FCC Reference:</b>	Parts 2.1049 & 90.219(e)(4)
<b>Test Method Used:</b>	FCC KDB 935210 D05 Section 4.3 and Notes below

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	35

**Note(s):**

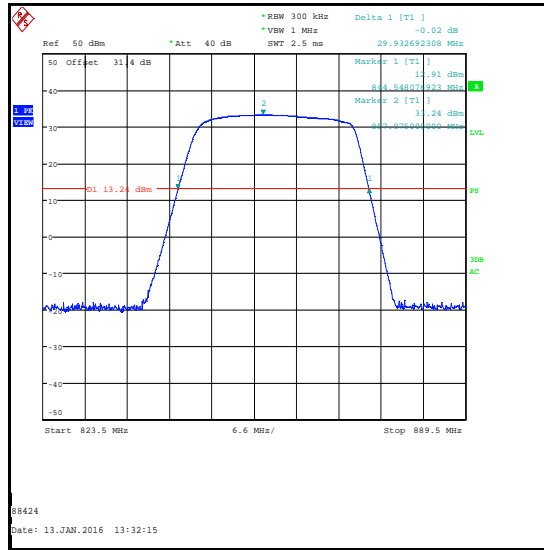
1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
2. A signal generator was connected to the downlink input (DL port) of the EUT via an RF cable. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and 30 dB attenuators. The combined path loss of the cable and attenuators was 31.4 dB. This loss was entered as an RF level offset on the spectrum analyser.
3. The signal generator was swept across the required frequency range using a 10 ms dwell time and 50 kHz frequency steps to show the frequency response of the EUT filter at the -20 dBc points. The signal generator output level was set to 3 dB below the EUT's AGC threshold level.
4. Bandwidth measurements were performed with the spectrum analyser resolution bandwidth set to 300 kHz which is >1 % and <5 % of the EUT passband. The video bandwidth was set to 1 MHz which is >3 x RBW and the nearest to 3 x RBW that the instrument allowed.

**Test setup for PLMRS Out-of-Band Rejection measurements:**

**PLMRS Out-of-Band Rejection (continued)**

**Results:**

Band (MHz)	Port	Modulation Type	Measured 20 dB Bandwidth (MHz)
851 - 862	Server	None (CW)	29.933



**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handlungspunkt	30.5015.13	Not stated	23 Apr 2016	12
A1398	20 dB Attenuator	Weinschel	WA46-20	A129	Calibrated before use	-
A1399	10 dB Attenuator	Weinschel	WA46-10	A126	Calibrated before use	-
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	27 Apr 2016	12

**5.3.4. Emission Mask****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Dates:</b>	07 January 2016 to 23 March 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1049 / 90.210(b) & 90.210(g)
<b>Test Method Used:</b>	FCC KDB 935210 D05 Section 4.4

**Environmental Conditions:**

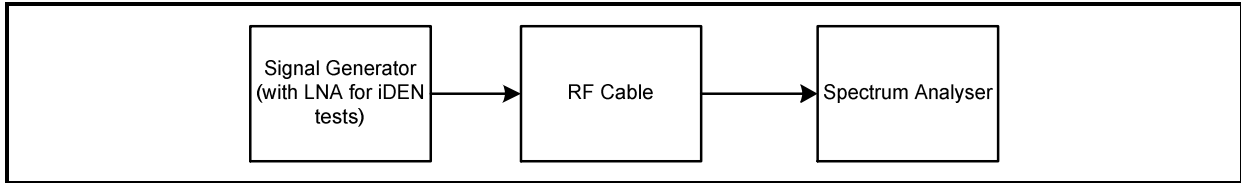
<b>Temperature (°C):</b>	21 to 26
<b>Relative Humidity (%):</b>	38 to 40

**Note(s):**

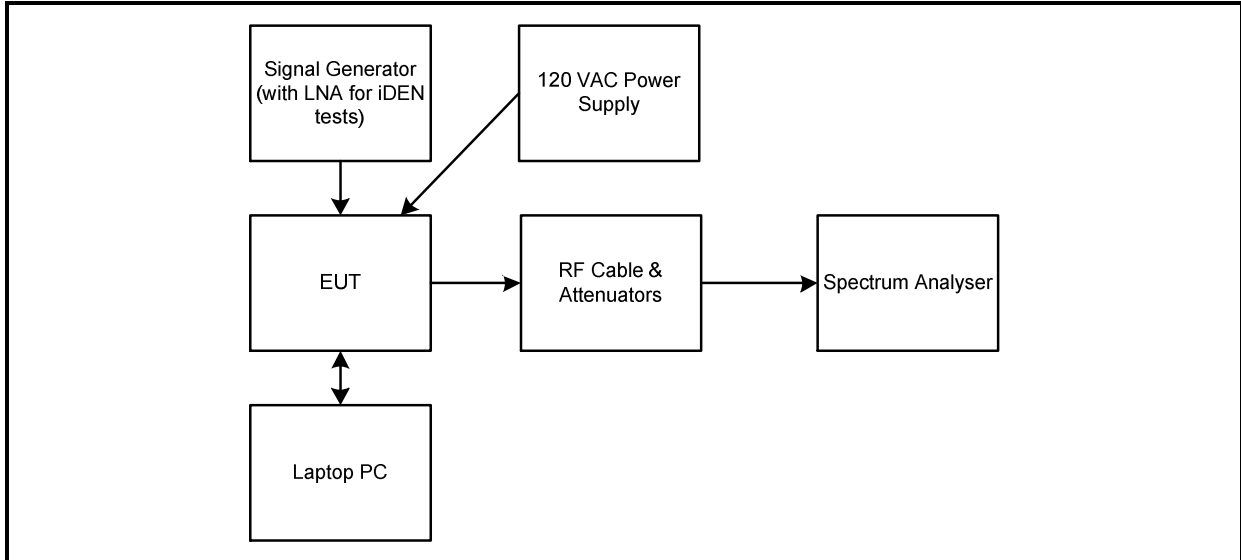
1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
2. Input signal spectra measurements: A signal generator was connected to the RF Input of a spectrum analyser via an RF cable. Modulated signals for all supported technologies were applied to the input of the EUT.
3. Output signal spectra measurements: A signal generator was connected to the downlink input (DL port) of the EUT via an RF cable. Modulated signals for all supported technologies were applied to the input of the EUT. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and attenuators. The combined path loss of the cable and attenuators for all tests apart from iDEN was 30.8 dB. The combined path loss of the cable and attenuators for iDEN tests was 36.7 dB. Path losses were entered as an RF level offset on the spectrum analyser.
4. Measurements were initially performed using a CW signal. These unmodulated carrier test results were used to establish the FCC Part 90.210(b) and 90.210(g) mask reference levels. Mask B was used for tests on all signal types apart from iDEN which uses Mask G.
5. A Low Noise Amplifier (LNA) was fitted to the signal generator output when performing iDEN tests. The LNA was used to increase the signal level as the signal generator output was not sufficiently high to reach 3 dB above the EUT's AGC threshold.
6. No mask incursions were observed. The EUT is compliant.

**Emission Mask (continued)**

**Test setup for emission mask input signal spectra measurements:**



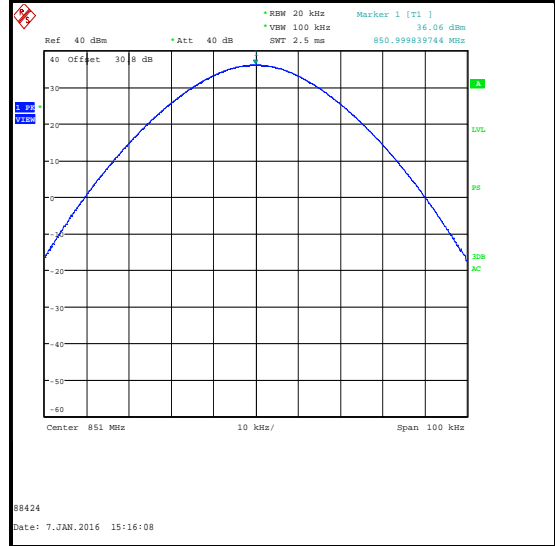
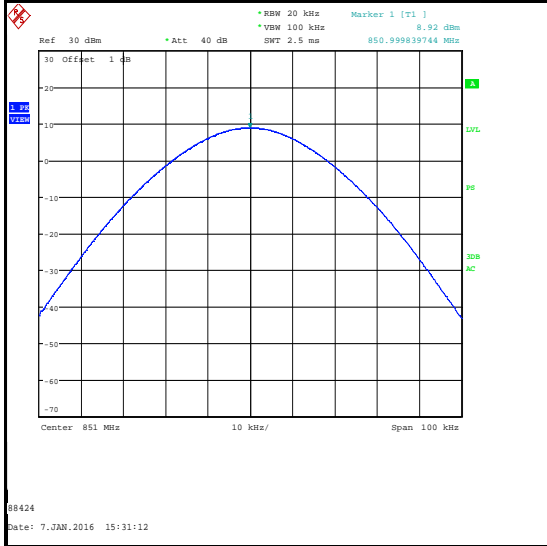
**Test setup for emission mask output signal spectra measurements:**



**Emission Mask (continued)**

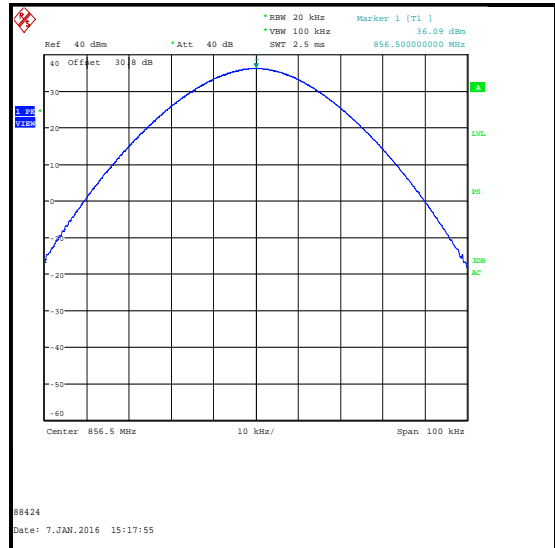
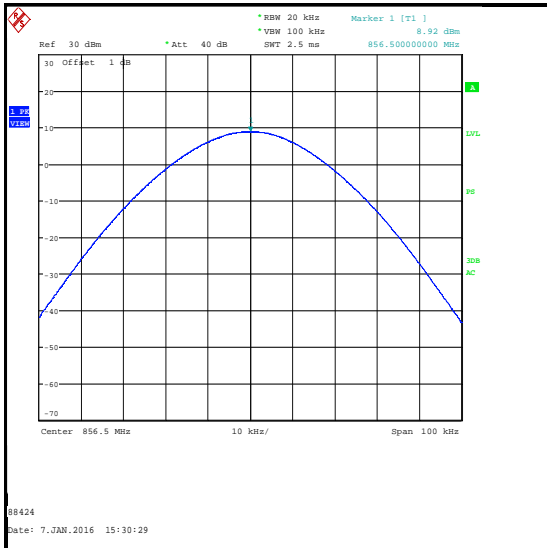
**Results: Output Power**

**Signal just below AGC threshold / unmodulated carrier power**



**Bottom Channel / Input Signal Power**

**Bottom Channel / Output Signal Power**



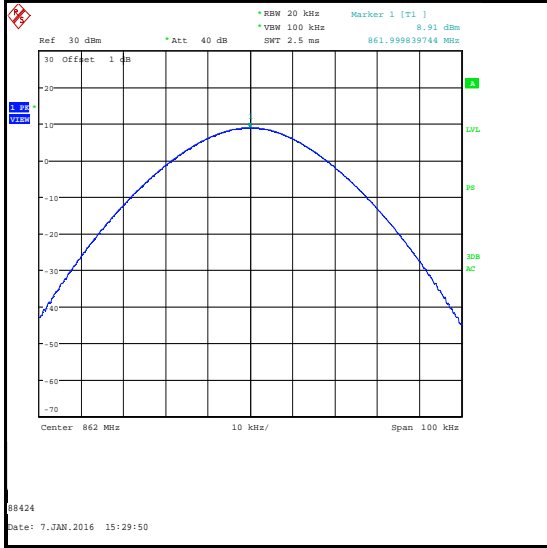
**Middle Channel / Input Signal Power**

**Middle Channel / Output Signal Power**

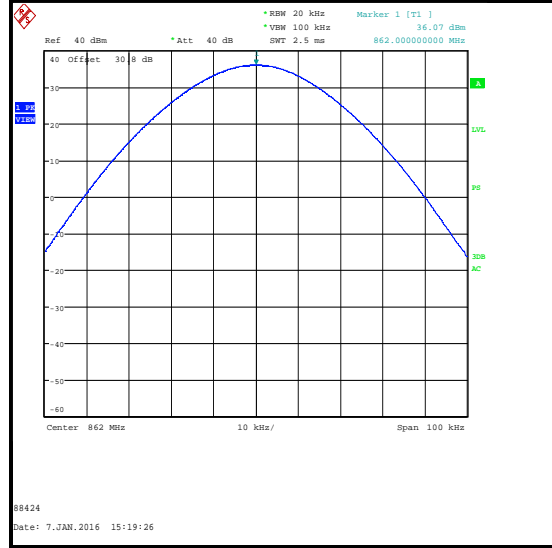
**Emission Mask (continued)**

**Results: Output Power**

**Signal just below AGC threshold / unmodulated carrier power**



**Top Channel / Input Signal Power**

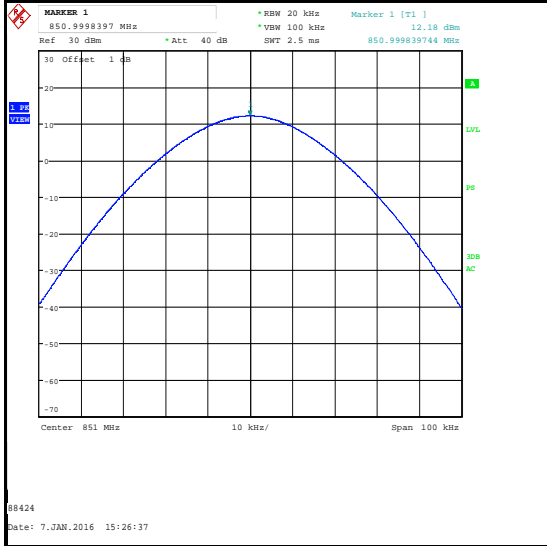


**Top Channel / Output Signal Power**

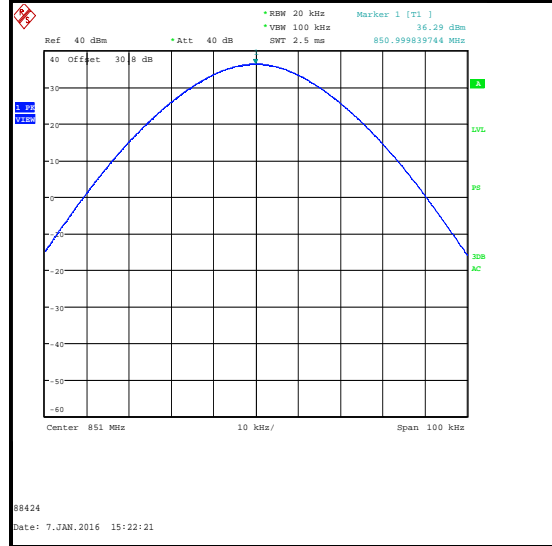
**Emission Mask (continued)**

**Results: Output Power**

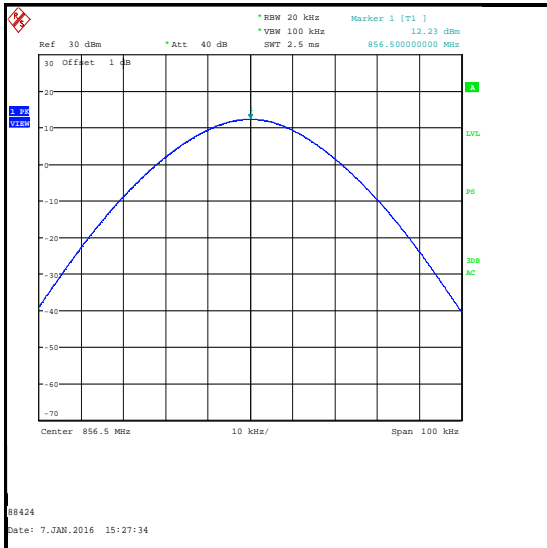
**Input signal 3 dB above AGC threshold / unmodulated carrier power**



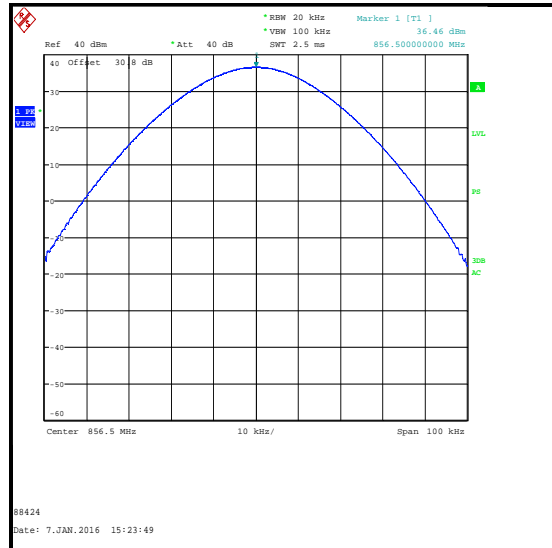
**Bottom Channel / Input Signal Power**



**Bottom Channel / Output Signal Power**



**Middle Channel / Input Signal Power**

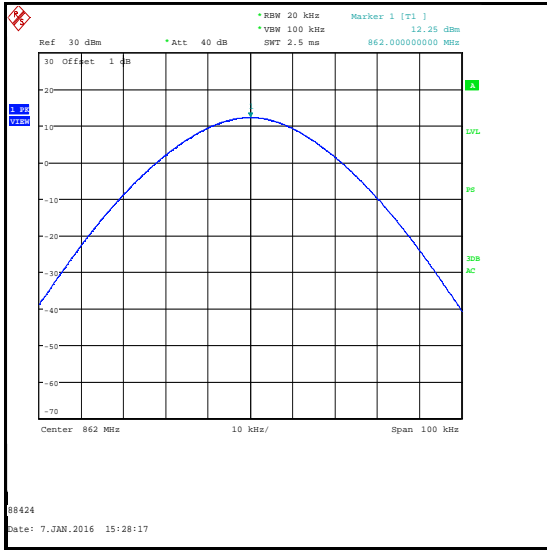


**Middle Channel / Output Signal Power**

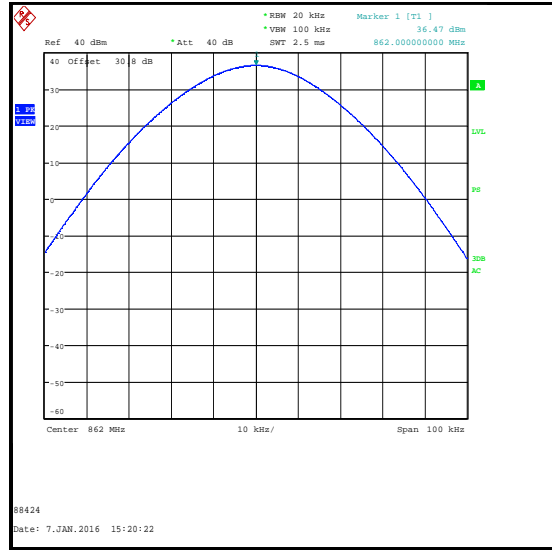
**Emission Mask (continued)**

**Results: Output Power**

**Input signal 3 dB above AGC threshold / unmodulated carrier power**



**Top Channel / Input Signal Power**



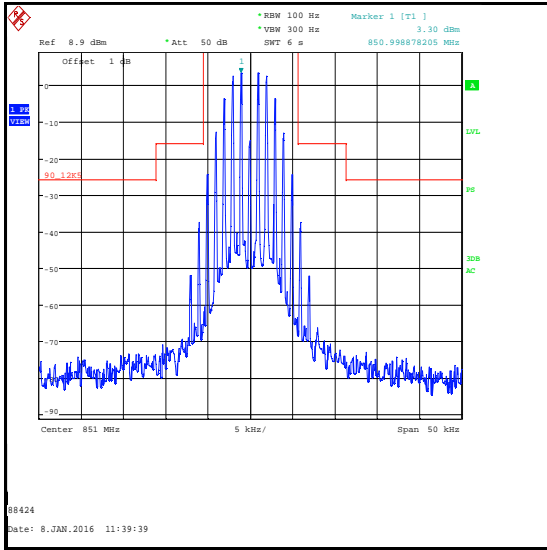
**Top Channel / Output Signal Power**



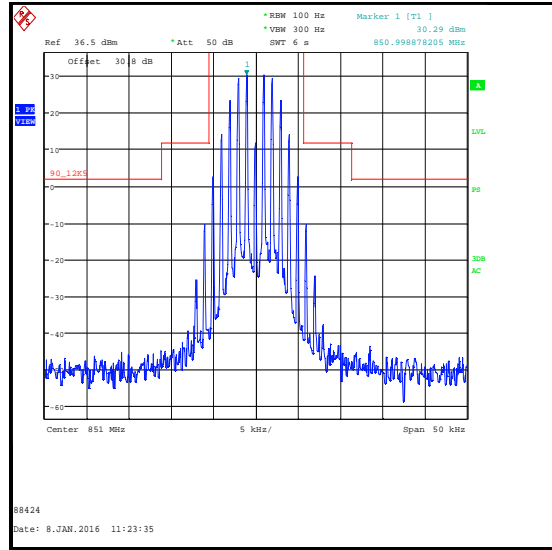
**Emission Mask (continued)**

**Results: 12.5 kHz Channel Bandwidth / 11K3F3E / Audio Frequency 1 kHz**

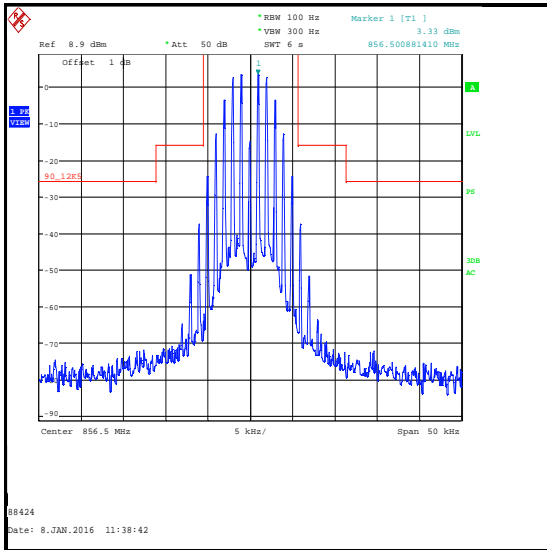
**Signal just below AGC threshold**



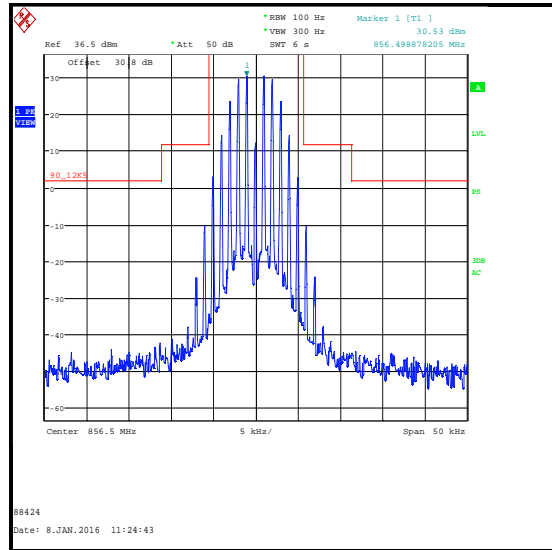
**Bottom Channel / Input Signal Spectra**



**Bottom Channel / Output Signal Spectra**



**Middle Channel / Input Signal Spectra**

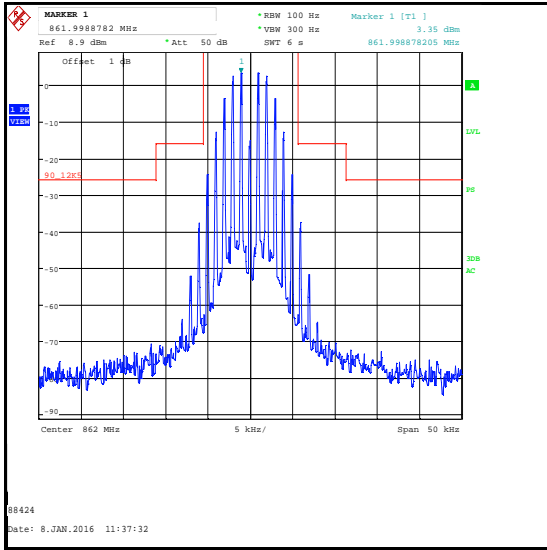


**Middle Channel / Output Signal Spectra**

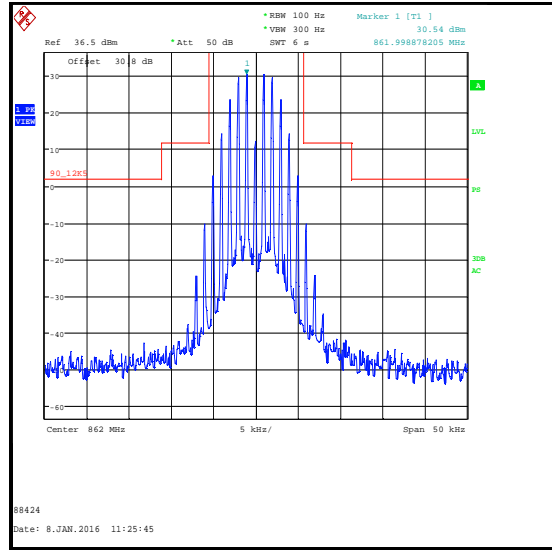
**Emission Mask (continued)**

**Results: 12.5 kHz Channel Bandwidth / 11K3F3E / Audio Frequency 1 kHz**

**Signal just below AGC threshold**



**Top Channel / Input Signal Spectra**



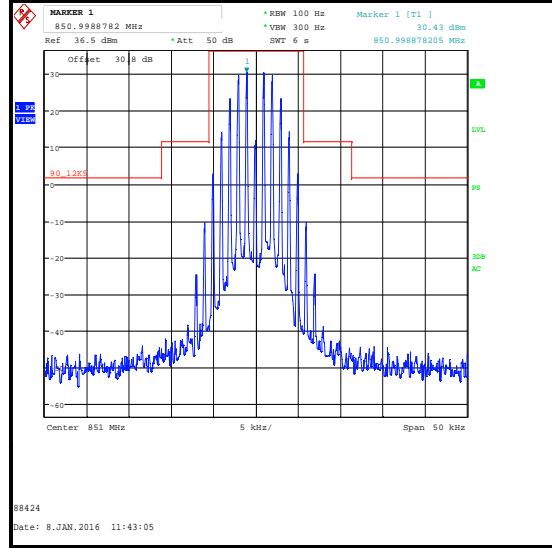
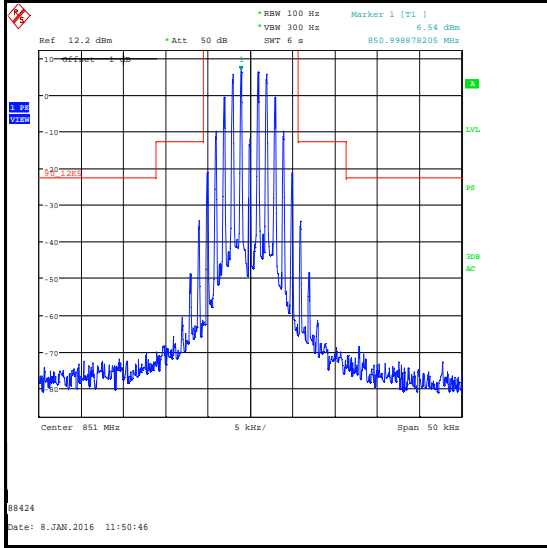
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	850.998878	850.998878
Middle	856.500881	856.498878
Top	861.998878	861.998878

**Emission Mask (continued)**

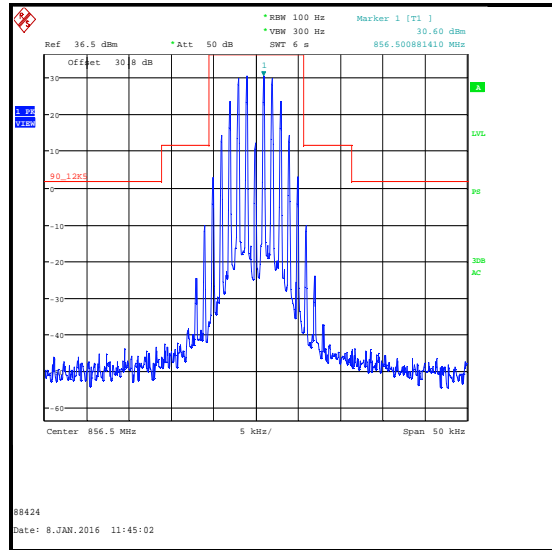
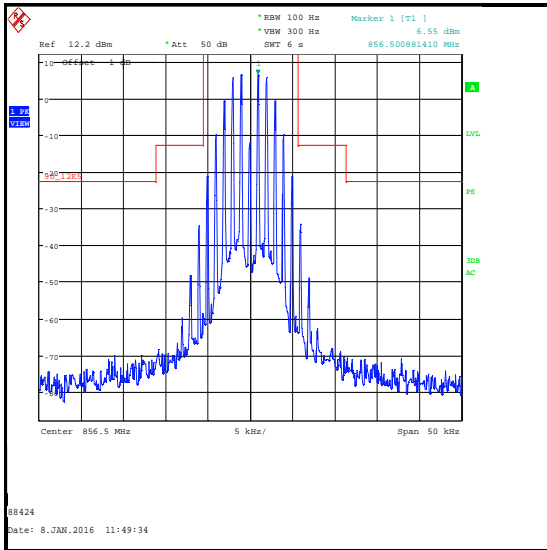
**Results: 12.5 kHz Channel Bandwidth / 11K3F3E / Audio Frequency 1 kHz**

**Input signal 3 dB above AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



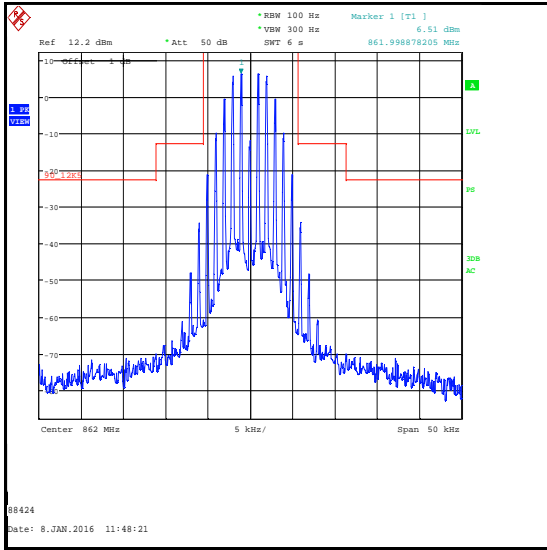
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

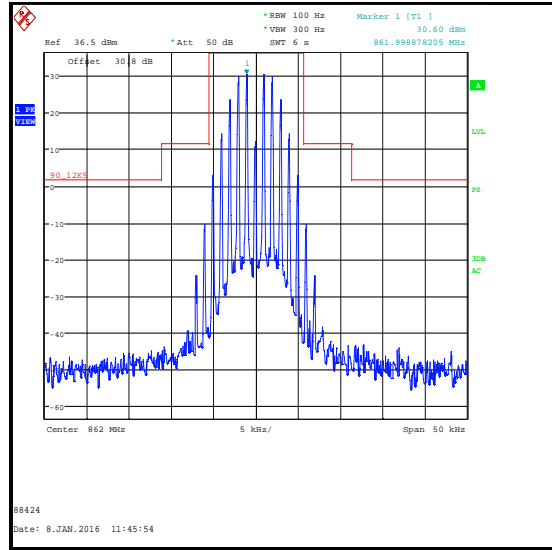
**Emission Mask (continued)**

**Results: 12.5 kHz Channel Bandwidth / 11K3F3E / Audio Frequency 1 kHz**

**Input signal 3 dB above AGC threshold**



**Top Channel / Input Signal Spectra**



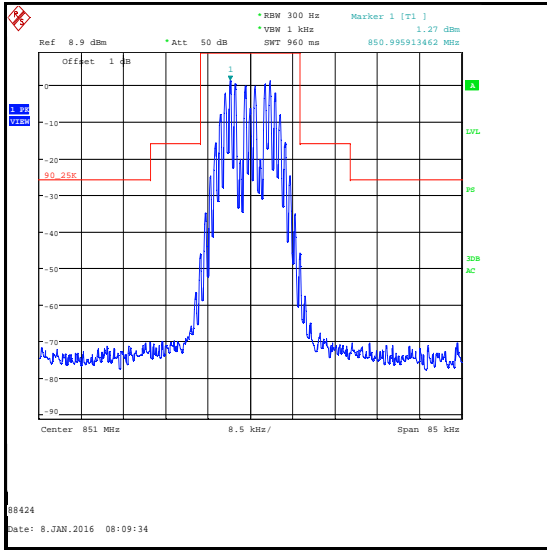
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	850.998878	850.998878
Middle	856.500881	856.500881
Top	861.998878	861.998878

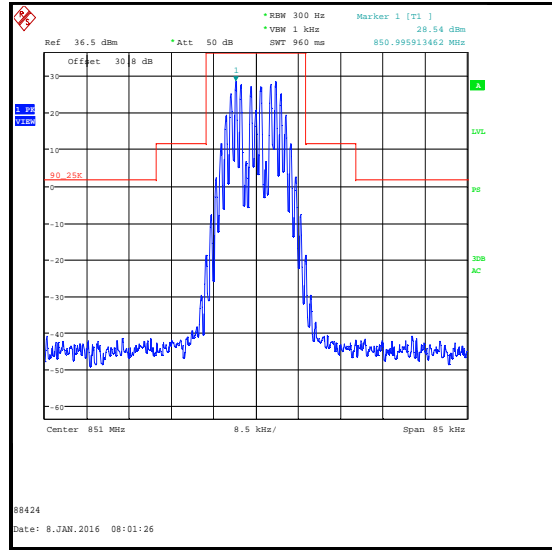
**Emission Mask (continued)**

**Results: 25 kHz Channel Bandwidth / 16K0F3E / Audio Frequency 1 kHz**

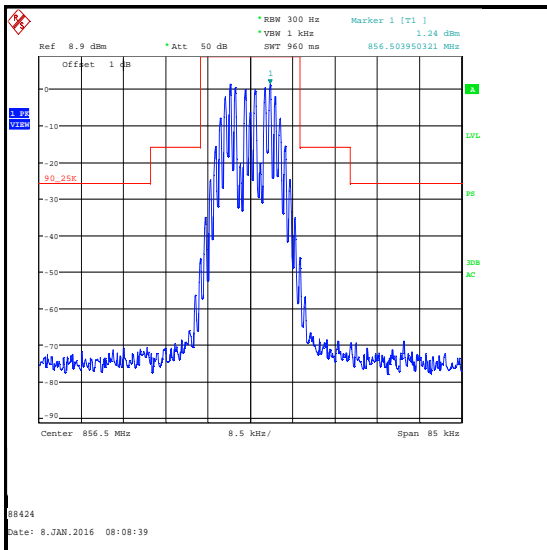
**Signal just below AGC threshold**



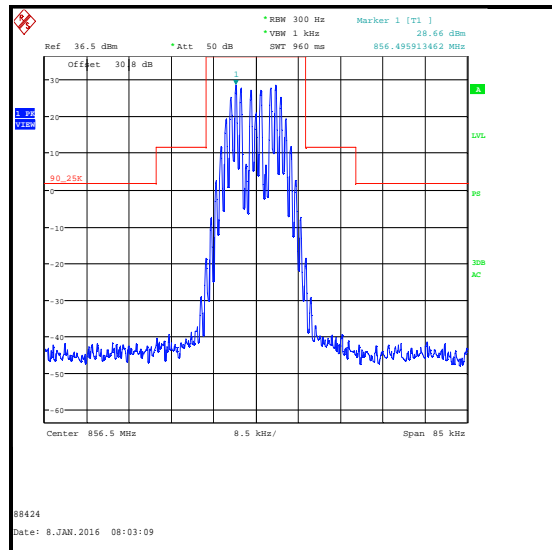
**Bottom Channel / Input Signal Spectra**



**Bottom Channel / Output Signal Spectra**



**Middle Channel / Input Signal Spectra**

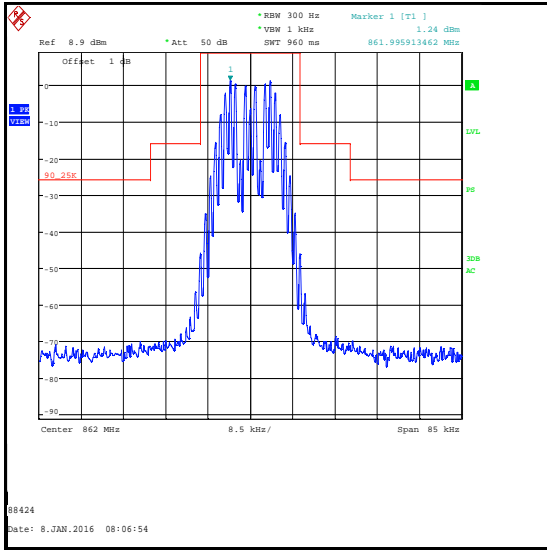


**Middle Channel / Output Signal Spectra**

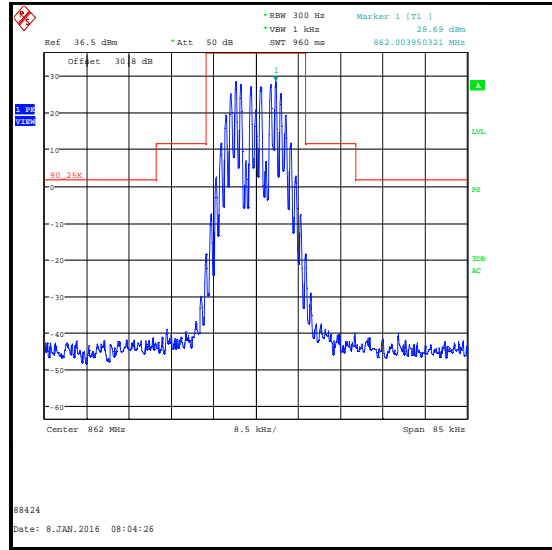
**Emission Mask (continued)**

**Results: 25 kHz Channel Bandwidth / 16K0F3E / Audio Frequency 1 kHz**

**Signal just below AGC threshold**



**Top Channel / Input Signal Spectra**



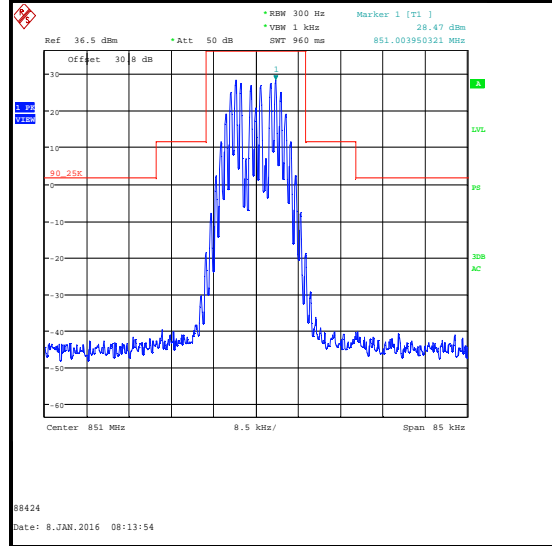
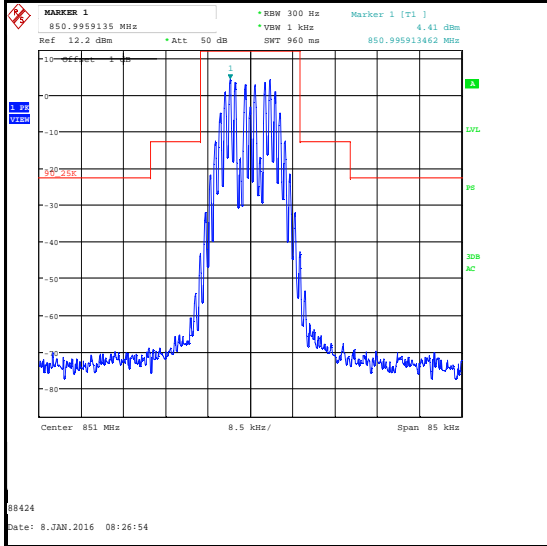
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	850.995913	850.995913
Middle	856.503950	856.495913
Top	861.995913	862.003950

**Emission Mask (continued)**

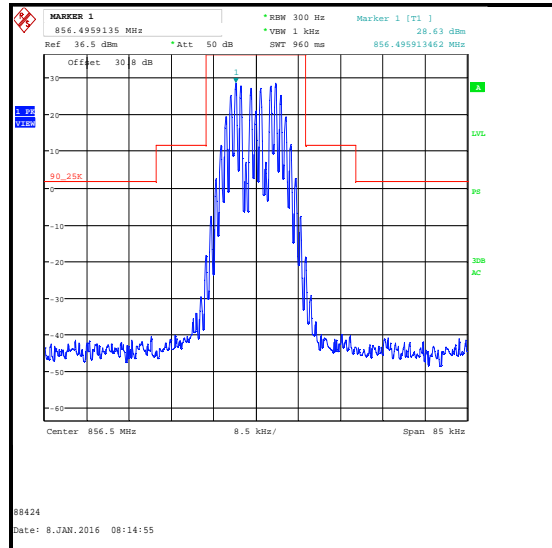
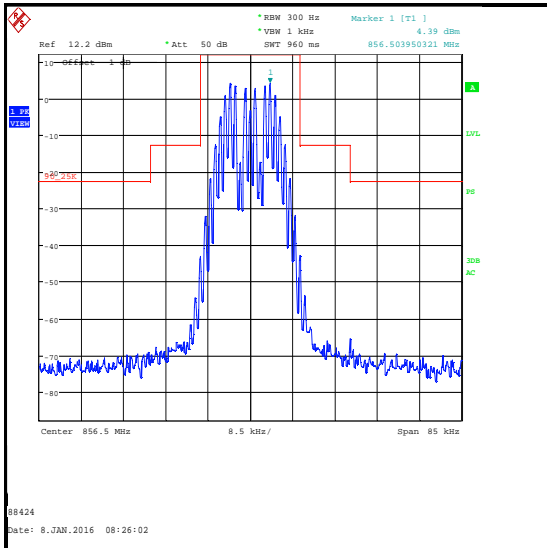
**Results: 25 kHz Channel Bandwidth / 16K0F3E / Audio Frequency 1 kHz**

**Input signal 3 dB above AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



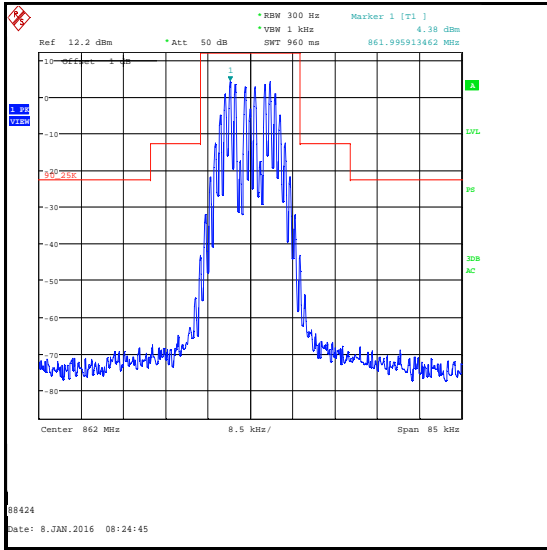
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

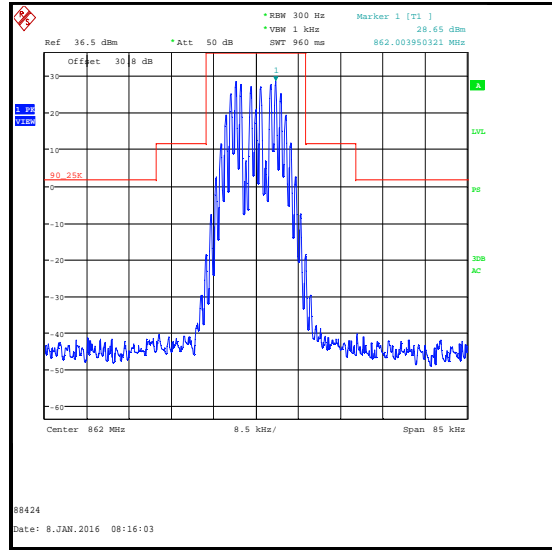
**Emission Mask (continued)**

**Results: 25 kHz Channel Bandwidth / 16K0F3E / Audio Frequency 1 kHz**

**Input signal 3 dB above AGC threshold**



**Top Channel / Input Signal Spectra**



**Top Channel / Output Signal Spectra**

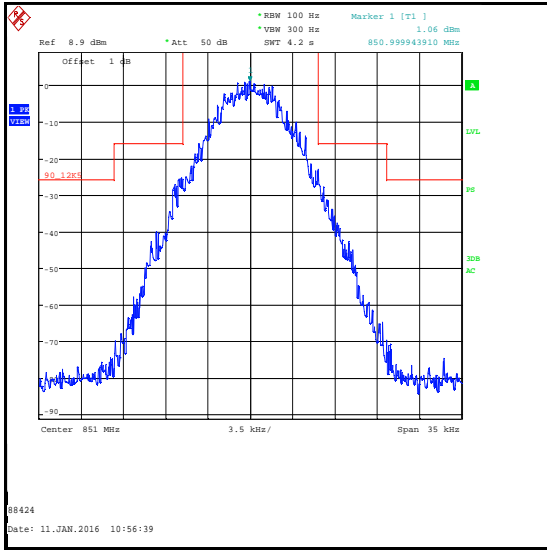
Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	850.995913	851.003950
Middle	856.503950	856.495913
Top	861.995913	862.003950



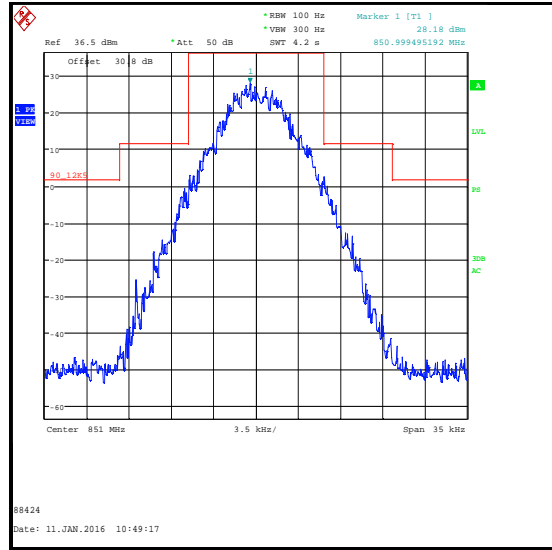
**Emission Mask (continued)**

**Results: APCO P25 Phase 1 / C4FM**

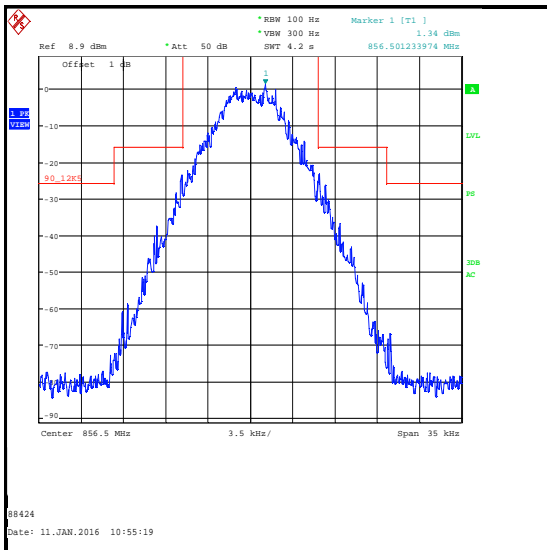
**Signal just below AGC threshold**



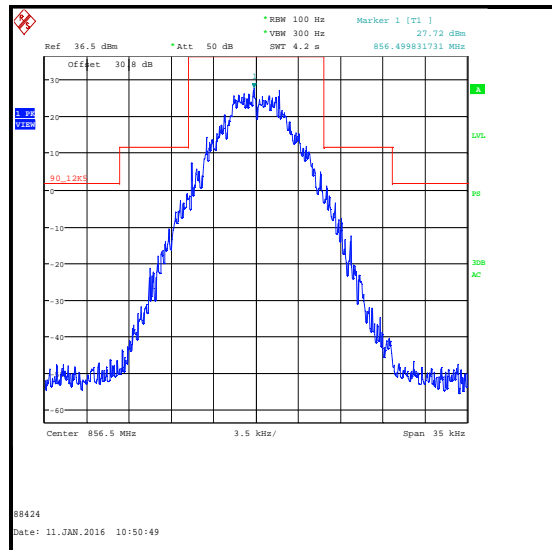
**Bottom Channel / Input Signal Spectra**



**Bottom Channel / Output Signal Spectra**



**Middle Channel / Input Signal Spectra**

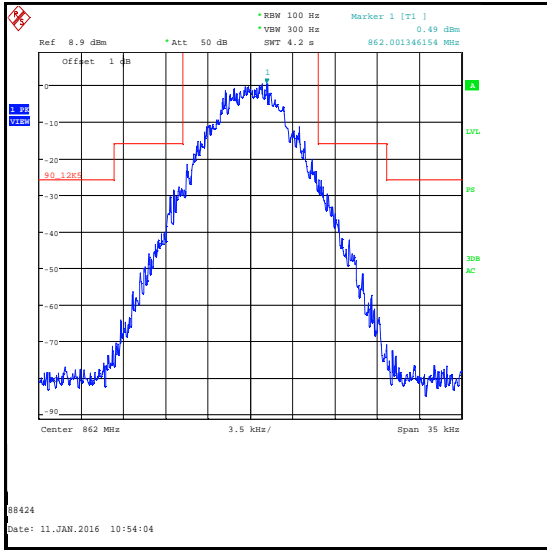


**Middle Channel / Output Signal Spectra**

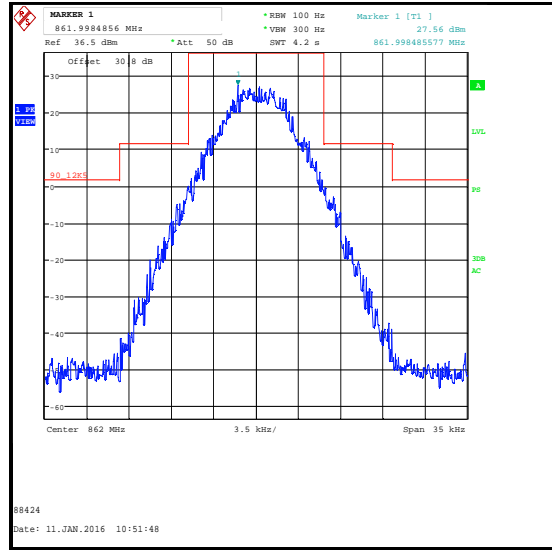
**Emission Mask (continued)**

**Results: APCO P25 Phase 1 / C4FM**

**Signal just below AGC threshold**



**Top Channel / Input Signal Spectra**



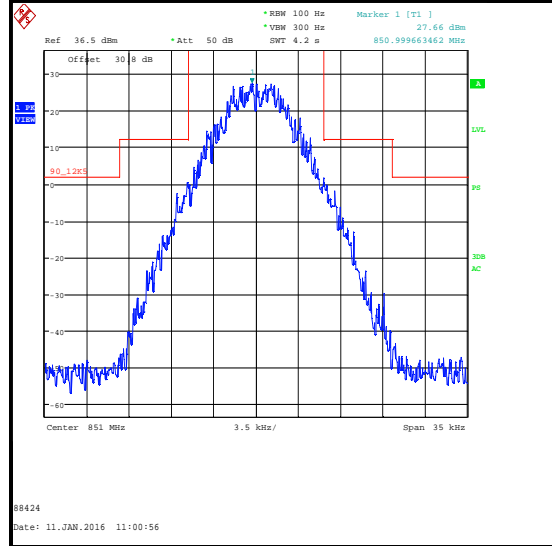
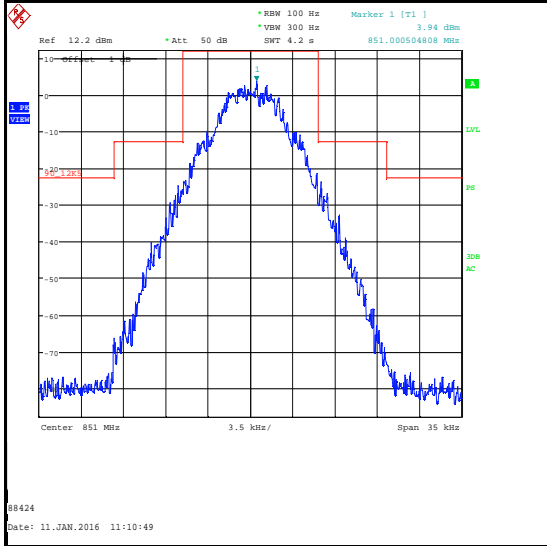
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	850.999944	850.999495
Middle	856.501234	856.499832
Top	862.001346	861.998486

**Emission Mask (continued)**

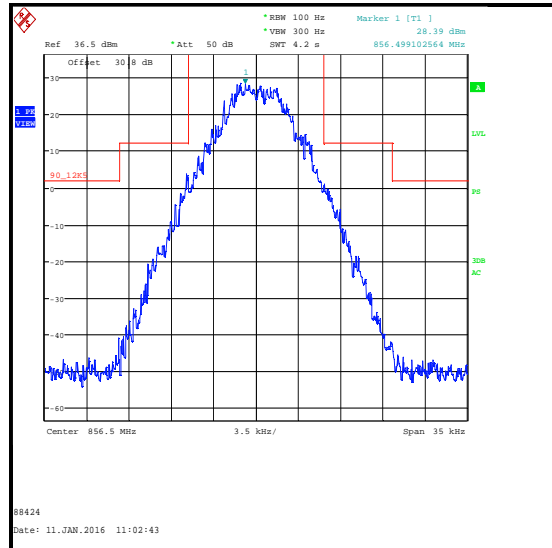
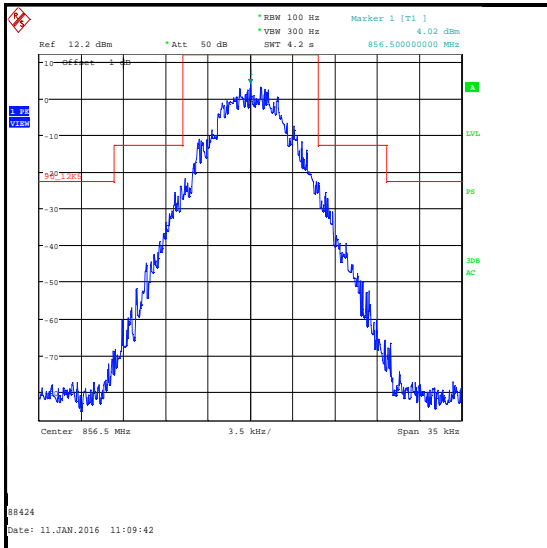
**Results: APCO P25 Phase 1 / C4FM**

**Input signal 3 dB above AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



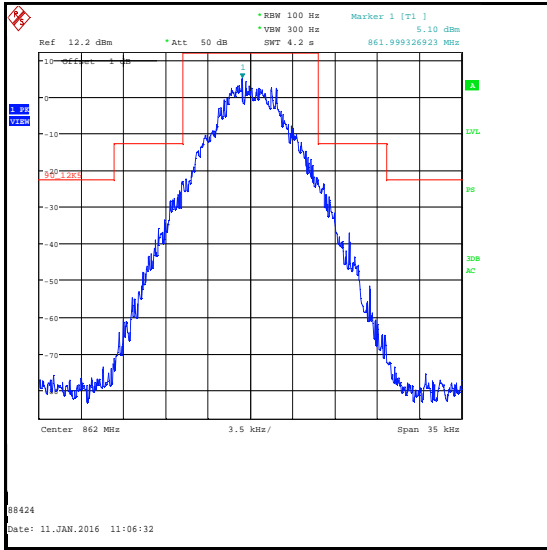
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

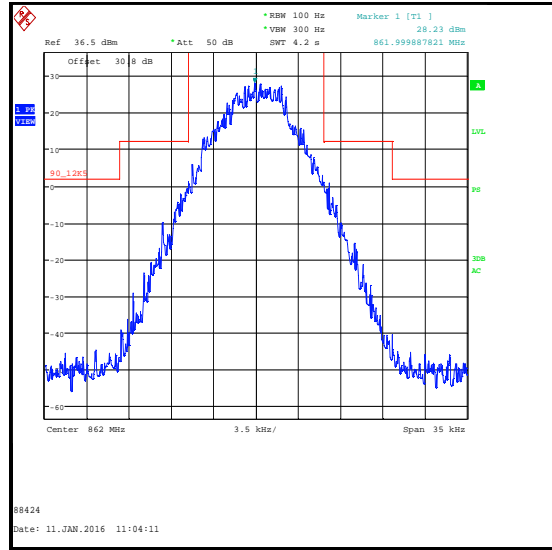
**Emission Mask (continued)**

**Results: APCO P25 Phase 1 / C4FM**

**Input signal 3 dB above AGC threshold**



**Top Channel / Input Signal Spectra**



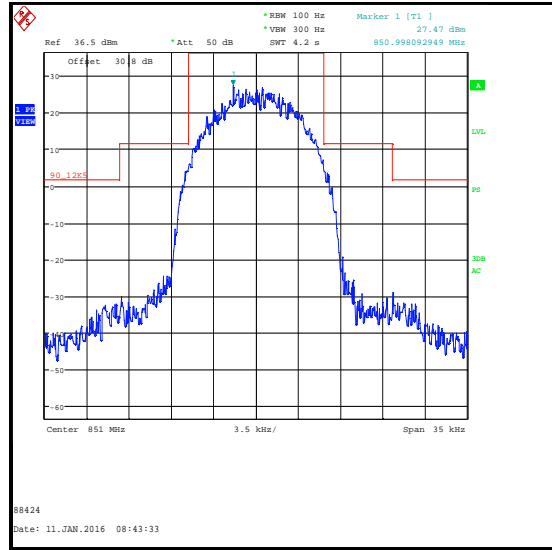
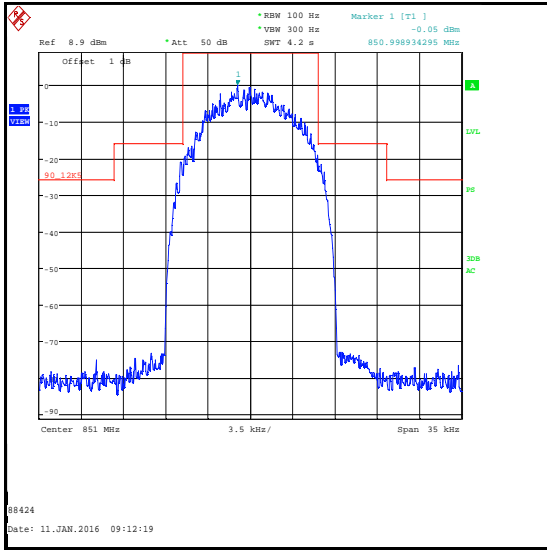
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	851.000505	850.999663
Middle	856.500000	856.499103
Top	861.999327	861.999888

**Emission Mask (continued)**

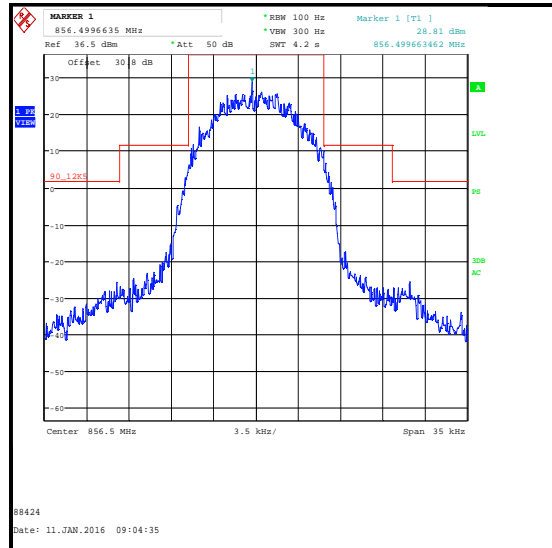
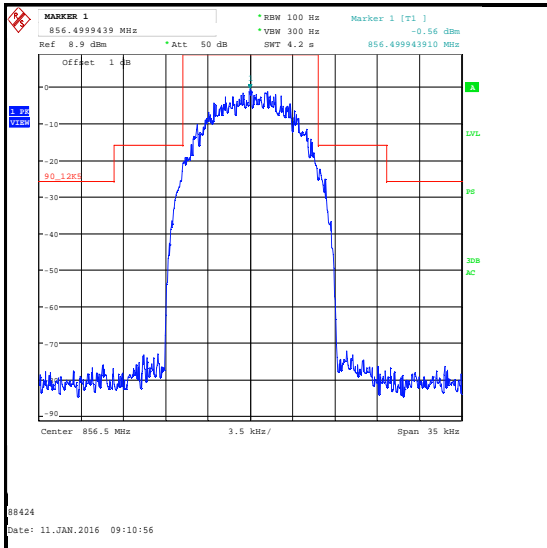
**Results: APCO P25 Phase 2 /  $\pi/4$ -DQPSK**

**Signal just below AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



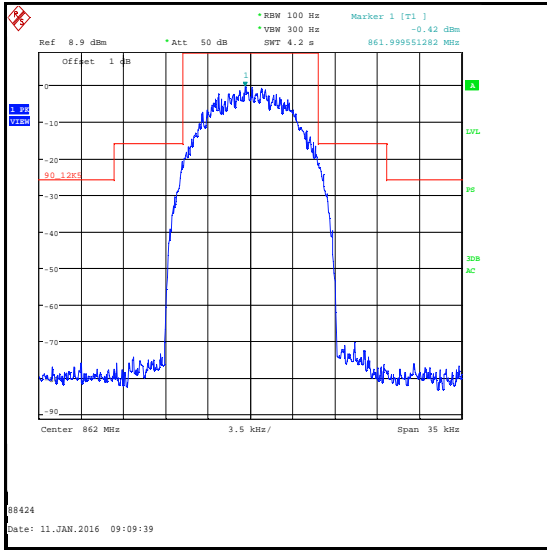
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

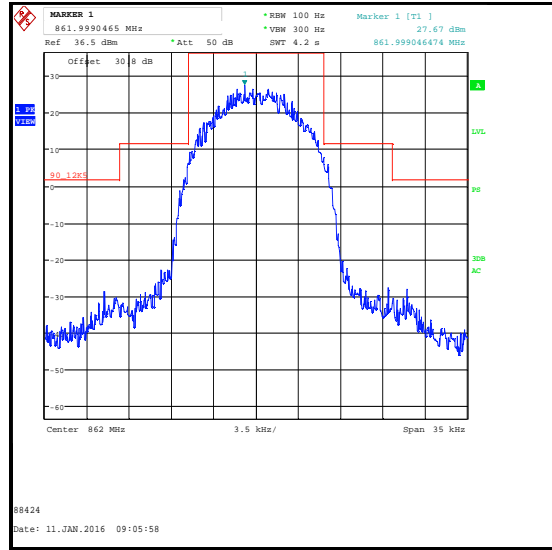
**Emission Mask (continued)**

**Results: APCO P25 Phase 2 /  $\pi/4$ -DQPSK**

**Signal just below AGC threshold**



**Top Channel / Input Signal Spectra**



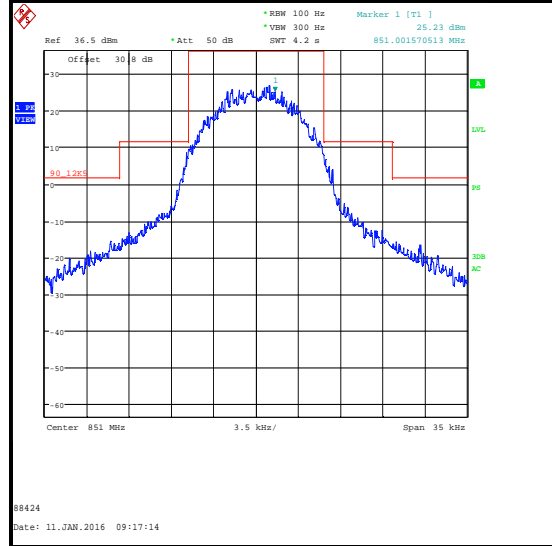
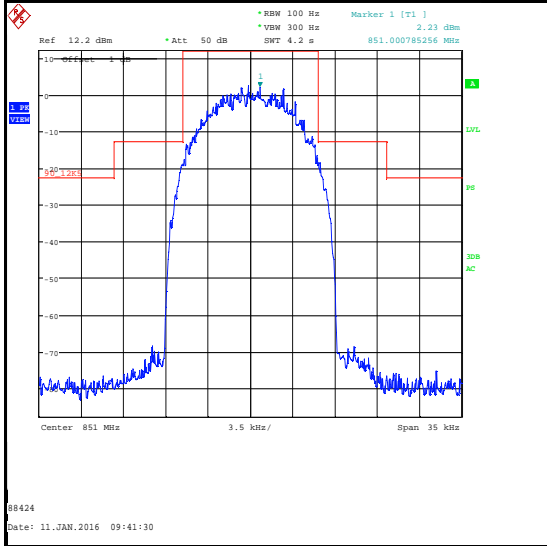
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	850.998934	850.998093
Middle	856.499944	856.499663
Top	861.999551	861.999046

**Emission Mask (continued)**

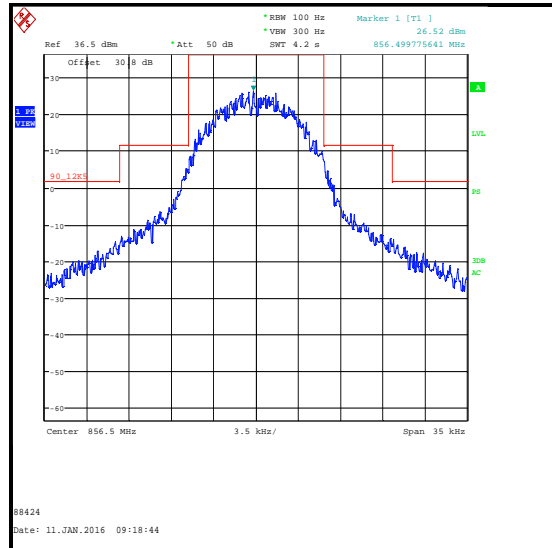
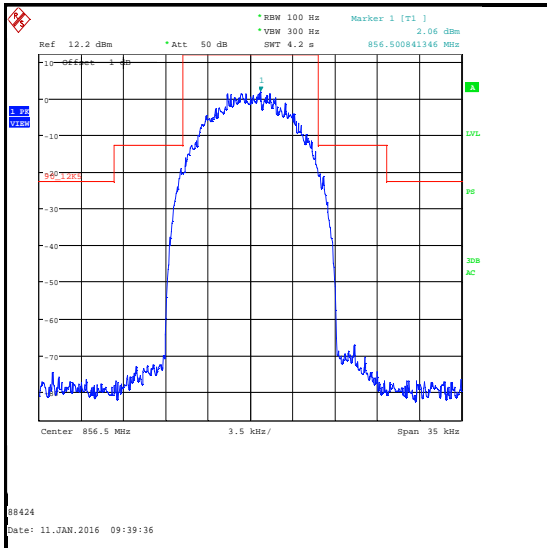
**Results: APCO P25 Phase 2 /  $\pi/4$ -DQPSK**

**Input signal 3 dB above AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



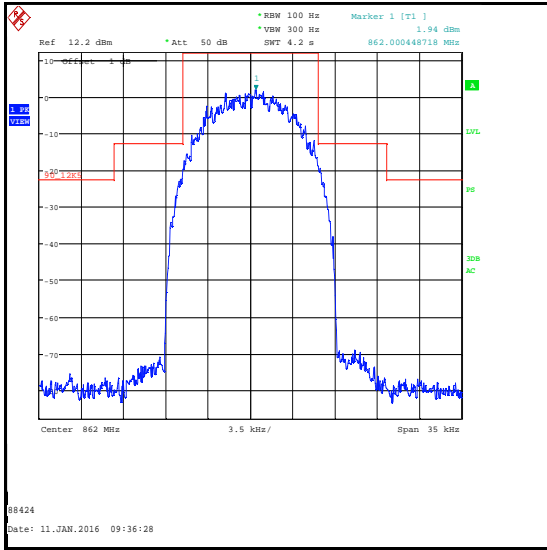
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

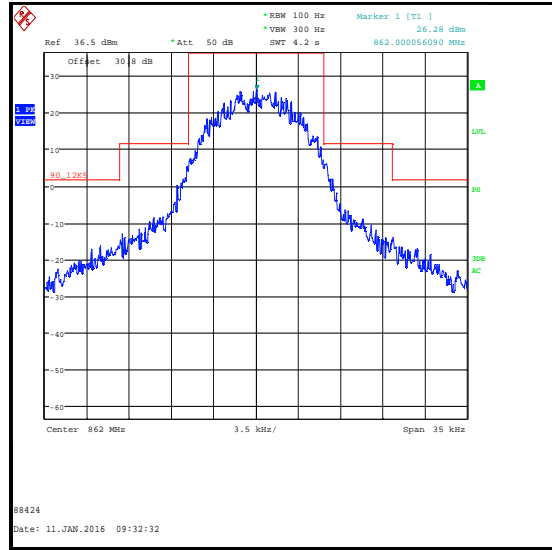
**Emission Mask (continued)**

**Results: APCO P25 Phase 2 /  $\pi/4$ -DQPSK**

**Input signal 3 dB above AGC threshold**



**Top Channel / Input Signal Spectra**



**Top Channel / Output Signal Spectra**

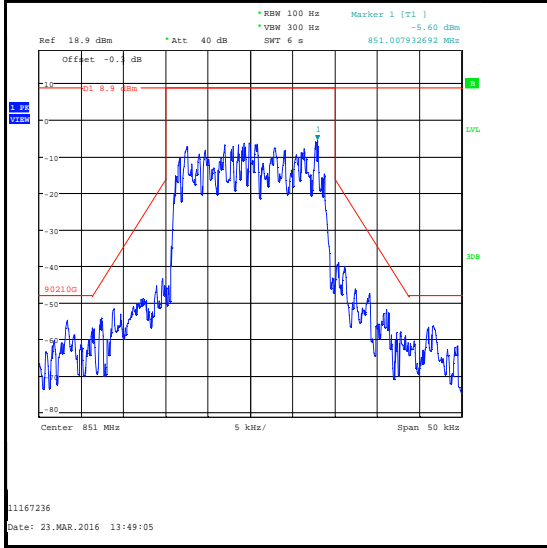
Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	851.000785	851.001571
Middle	856.500841	856.499776
Top	862.000449	862.000056



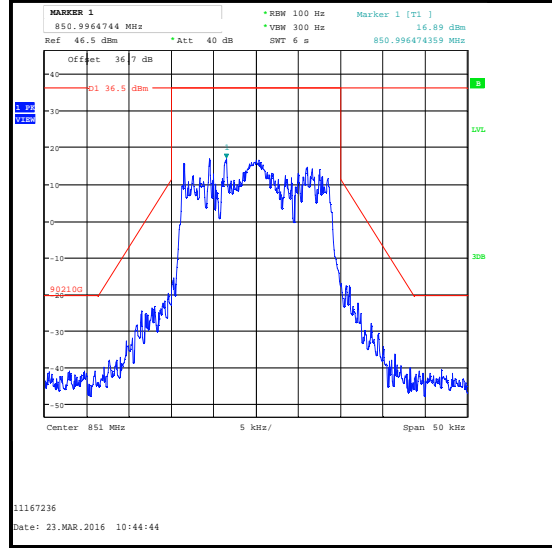
**Emission Mask (continued)**

**Results: iDEN**

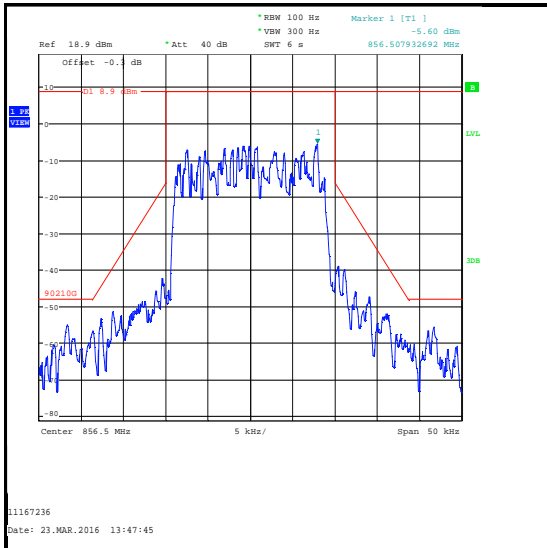
**Signal just below AGC threshold**



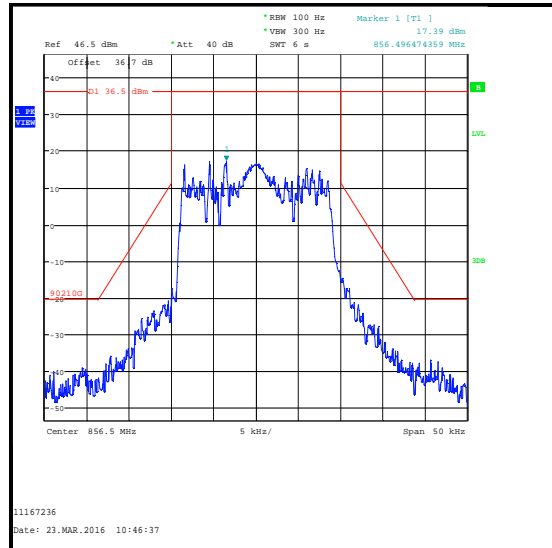
**Bottom Channel / Input Signal Spectra**



**Bottom Channel / Output Signal Spectra**



**Middle Channel / Input Signal Spectra**

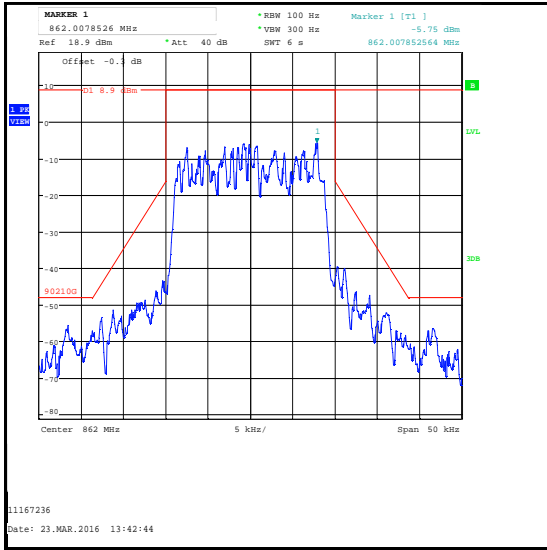


**Middle Channel / Output Signal Spectra**

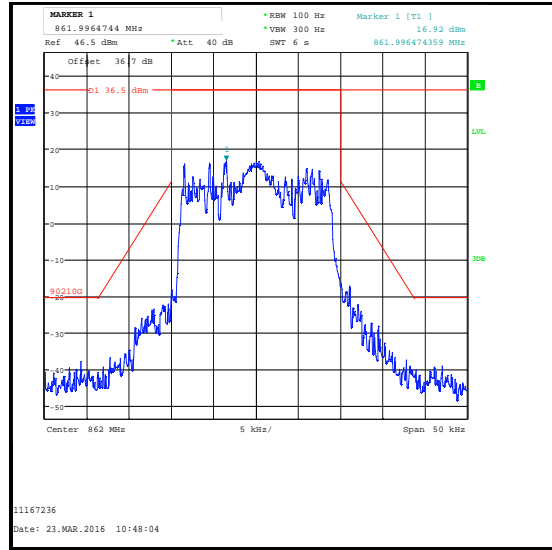
**Emission Mask (continued)**

**Results: iDEN**

**Signal just below AGC threshold**



**Top Channel / Input Signal Spectra**



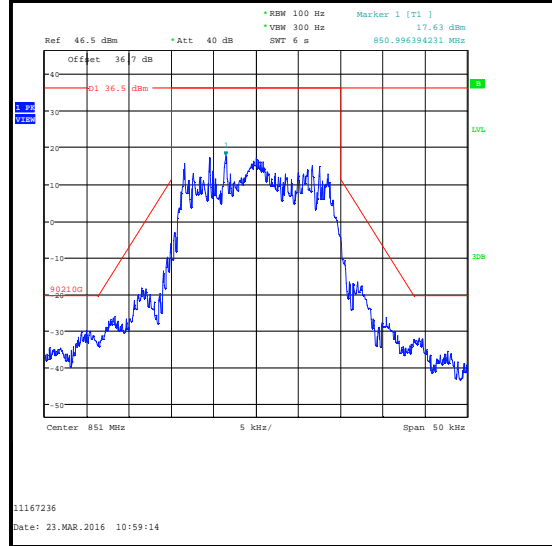
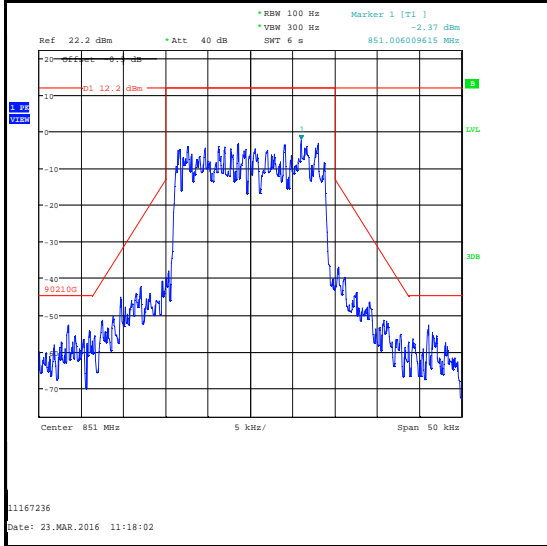
**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	851.007933	850.996474
Middle	856.507933	856.496474
Top	862.007853	861.996474

**Emission Mask (continued)**

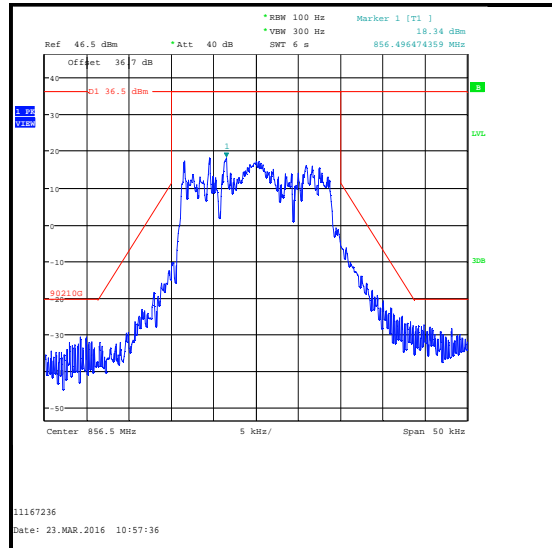
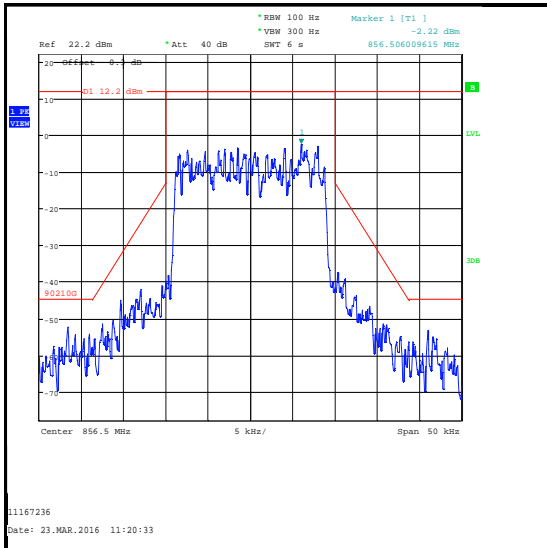
**Results: iDEN**

**Input signal 3 dB above AGC threshold**



**Bottom Channel / Input Signal Spectra**

**Bottom Channel / Output Signal Spectra**



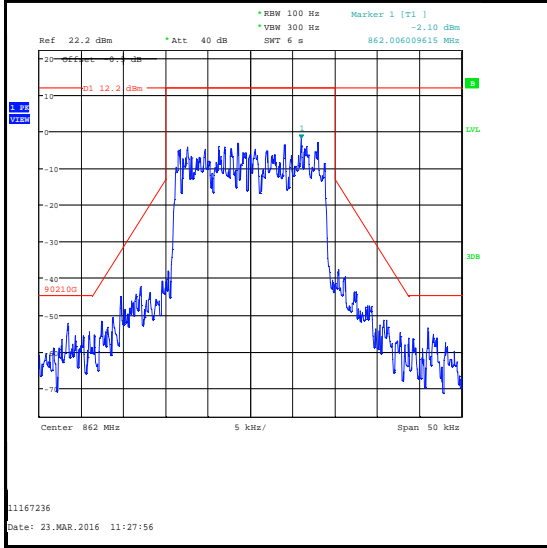
**Middle Channel / Input Signal Spectra**

**Middle Channel / Output Signal Spectra**

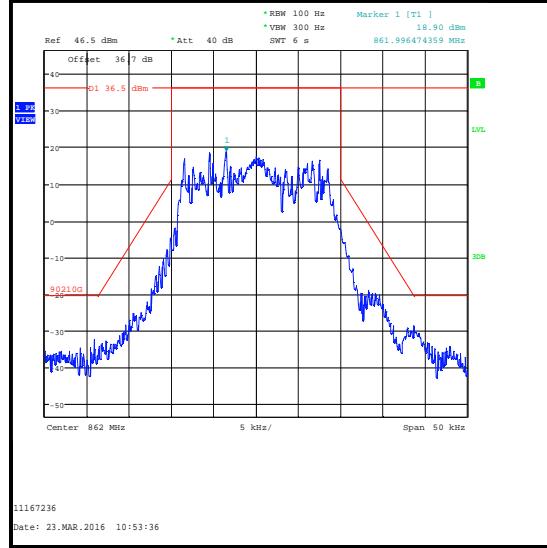
**Emission Mask (continued)**

**Results: iDEN**

**Input signal 3 dB above AGC threshold**



**Top Channel / Input Signal Spectra**



**Top Channel / Output Signal Spectra**

Channel	Input Signal $f_0$ (MHz)	Output Signal $f_0$ (MHz)
Bottom	851.006010	850.996394
Middle	856.506010	856.496474
Top	862.006010	861.996474

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohyrometer	JM Handelpunkt	30.5015.13	Not stated	23 Apr 2016	12
G0607	Vector Signal Generator	Rohde & Schwarz	SMU 200A	100943	18 Jul 2016	36
A2527	20 dB Attenuator	AtlanTecRF	AN18W5-20	832828#2	Calibrated before use	-
A2524	10 dB Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
A1395	6 dB Attenuator	Huber + Suhner	6806.17.B	753459	Calibrated before use	-
M1794	Spectrum Analyser	Rohde & Schwarz	FSU	100027	09 Feb 2018	24
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
G047	Signal Generator	Rohde & Schwarz	SMY01	843215/015	24 Jul 2016	12

**5.3.5. Transmitter Noise Figure****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Date:</b>	10 October 2014
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

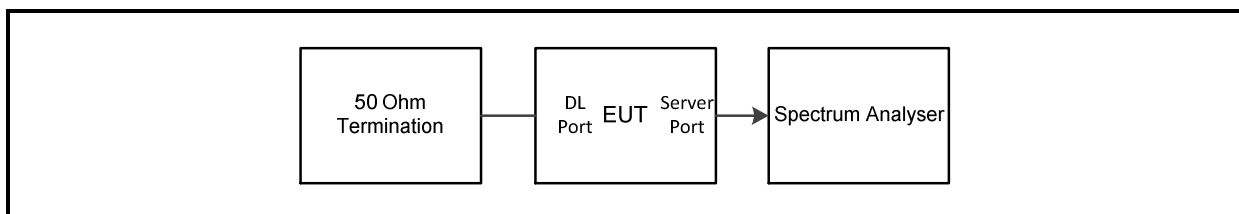
<b>FCC Reference:</b>	90.219(d)(6)(ii)
<b>Test Method Used:</b>	See Notes below

**Environmental Conditions:**

<b>Temperature (°C):</b>	21
<b>Relative Humidity (%):</b>	53

**Note(s):**

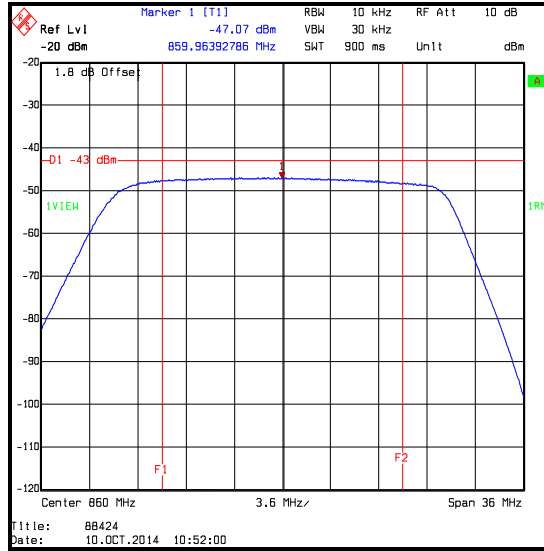
- For this EUT, FCC OET confirmed it is acceptable to submit compliance information and test data for the downlink path consistent with 90.219(d)(6)(ii) in place of 90.219(e)(2).
- The test was performed as a conducted measurement and the EUT was connected to the test equipment as shown on the following page.
- An RF level offset of 1.8 dB was entered on the spectrum analyser to compensate for the loss of the RF cable connecting the Server port on the EUT to the spectrum analyser.
- The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
- FCC Part 90.219(d)(6)(ii) states "In general, the ERP of noise within the passband should not exceed -43 dBm in 10 kHz measurement bandwidth". The spectrum analyser RBW was set to 10 kHz and VBW set to 30 kHz which is three times the resolution bandwidth. Sweep time was set to auto.
- The spectrum analyser span was set to 36 MHz which is two times the bandwidth of the operating band. The centre frequency was set to 860 MHz which is approximately the centre frequency of the 851 to 862 MHz operating band. Frequency lines were placed at the upper and lower operating band frequencies. 10 dB internal attenuation was used.
- An RMS detector with trace averaging over 100 sweeps was used. A marker was placed on the highest point on the trace and the value recorded. This was compared to the 90.219(d)(6)(ii) limit of -43 dBm/10 kHz to obtain the margin.
- All test equipment was within the calibration period on the date of testing.

**Test setup for transmitter noise figure measurements:**

**Transmitter Noise Figure (continued)**

**Results:**

850 MHz Band / Downlink				
Frequency (MHz)	Measured Noise (dBm/10 kHz)	Noise Limit (dBm/10 kHz ERP)	Margin (dB)	Result
851 to 862	-47.1	-43.0	4.1	Complied



**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1782	Thermohygrometer	JM Handelpunkt	30.5015.13	Not stated	21 Mar 2015	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB	842659/016	30 Sep 2015	12
A162	50 Ohm Load	Narda	3768NM	5204	Calibration not required	-
G0608	Signal Generator	Rohde & Schwarz	SMIQ06B	838341/033	14 Feb 2015	12

**5.3.6. Transmitter Spurious Conducted Emissions: Intermodulation Products****Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Date:</b>	19 February 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1051 & 90.219(e)(3)
<b>Test Method Used:</b>	FCC KDB 935210 Section 4.7.2 and Notes below

**Environmental Conditions:**

<b>Temperature (°C):</b>	20
<b>Relative Humidity (%):</b>	33

**Note(s):**

1. The EUT power amplifier gain was set to the maximum setting (0 dB Attenuation) on the Repeater Maintenance Console application throughout this test.
2. The output of the EUT (SERVER port) was connected to a spectrum analyser via an RF cable and attenuators with a combined value of 30 dB. The combined path loss of the cable and attenuators was 32.7 dB. This loss was entered as an RF level offset on the spectrum analyser.
3. Measurements were centred on the low and high channel frequencies. Tests were performed using 12.5 kHz and 25 kHz channel spacings. The two CW signals used for intermodulation tests were positioned half a channel spacing above and below the channel centre frequency.
4. Two RF outputs of a signal generator were connected to an RF combiner network. The output from the combiner network was connected to the EUT input port (DL) via a high pass filter acting as a band pass filter. The purpose of the filter was to suppress levels of second harmonics in order to minimise intermodulation products caused by the signal generator/combiner network and therefore present at the EUT input. The passband of the filter was the operating band of the EUT. The signal generator output levels were balanced and adjusted until the EUT maximum output level was achieved. The signal generator outputs were slightly reduced so that the EUT was operating just below the AGC threshold and the intermodulation products at the EUT output were measured. The signal generator levels were then increased so that the composite input level was 3 dB above the AGC threshold and the intermodulation products at the EUT output were measured. The highest level intermodulation products within a span of 100 kHz under both conditions were recorded in the results table and compared to an out-of-band/out-of-block limit of  $43 + 10 \log (P)$  dB.

**Signal Generator Frequencies used for Intermodulation Product Tests:**

12.5 kHz Channel Spacing		Downlink / Bottom Channel / 851 MHz
Signal Generator Frequencies (MHz)	Frequency 1 ( $f_0 - 6.25$ kHz)	850.993750 MHz
	Frequency 2 ( $f_0 + 6.25$ kHz)	851.006250 MHz

12.5 kHz Channel Spacing		Downlink / Top Channel / 862 MHz
Signal Generator Frequencies (MHz)	Frequency 1 ( $f_0 - 6.25$ kHz)	861.993750 MHz
	Frequency 2 ( $f_0 + 6.25$ kHz)	862.006250 MHz

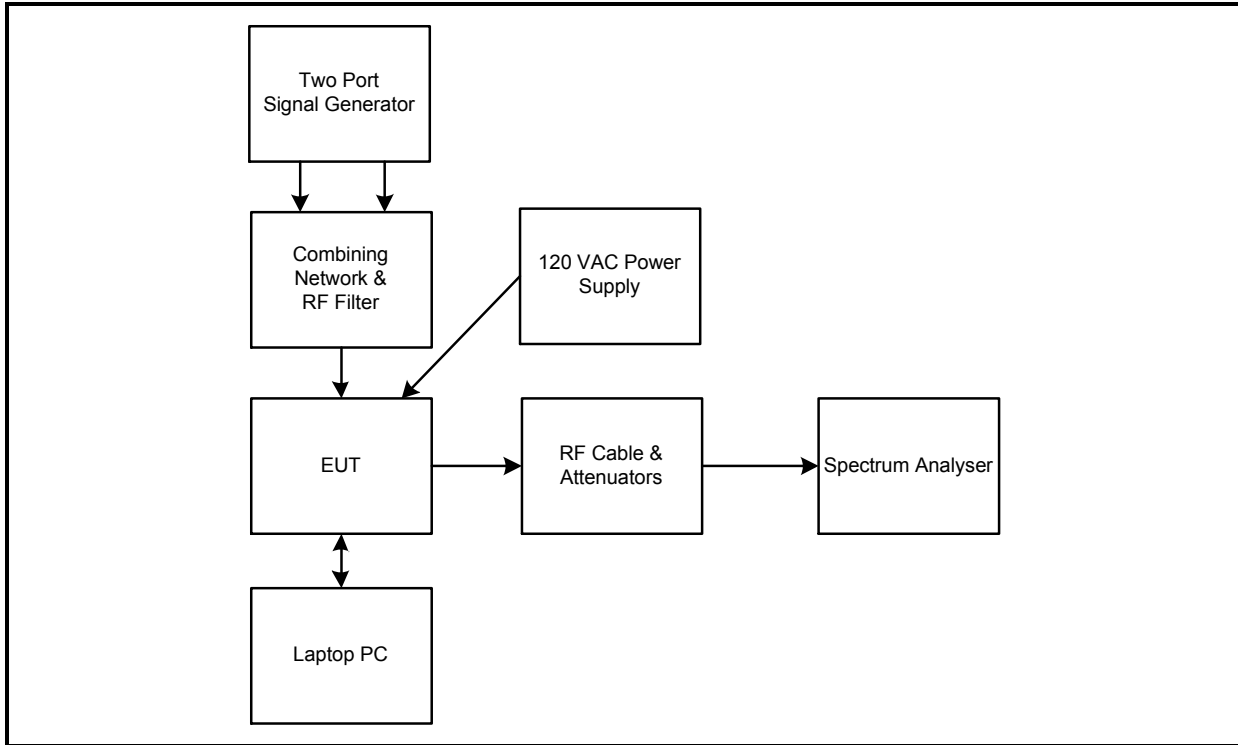
25 kHz Channel Spacing		Downlink / Bottom Channel / 851 MHz
Signal Generator Frequencies (MHz)	Frequency 1 ( $f_0 - 12.5$ kHz)	850.987500 MHz
	Frequency 2 ( $f_0 + 12.5$ kHz)	851.012500 MHz

25 kHz Channel Spacing		Downlink / Top Channel / 862 MHz
Signal Generator Frequencies (MHz)	Frequency 1 ( $f_0 - 12.5$ kHz)	861.987500 MHz
	Frequency 2 ( $f_0 + 12.5$ kHz)	862.012500 MHz



**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)**

**Test setup for conducted intermodulation tests:**



**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)****Results: 12.5 kHz Channel Spacing / CW signal / Downlink / Input just below AGC threshold**

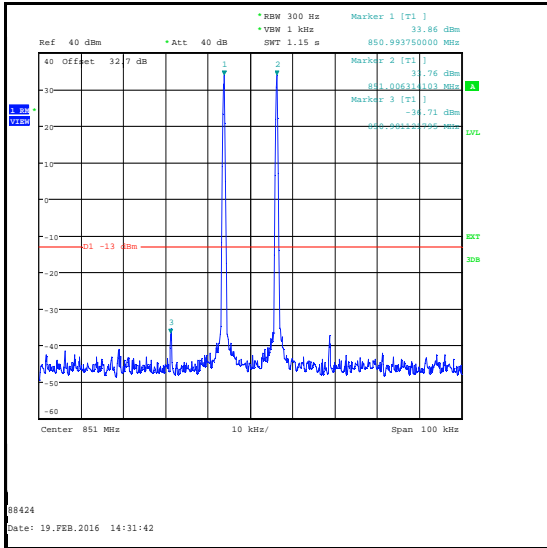
850 MHz Band / Downlink					
Channel	Highest Intermodulation product frequency (MHz)	Highest Intermodulation product amplitude (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	850.981122	-36.7	-13.0	23.7	Complied
Top	862.018686	-33.8	-13.0	20.8	Complied

**Results: 12.5 kHz Channel Spacing / CW signal / Downlink / Input 3 dB above AGC threshold**

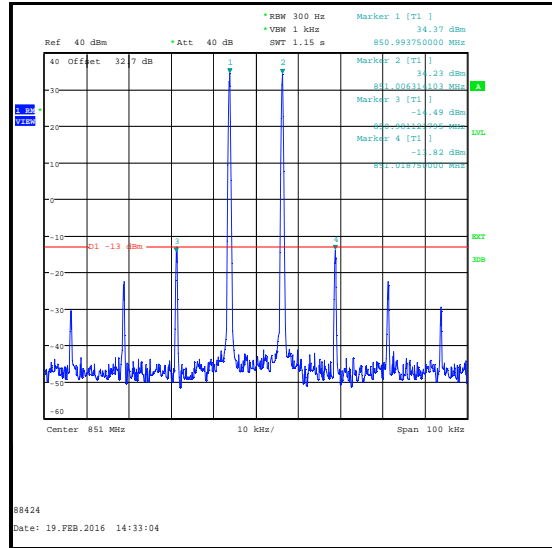
850 MHz Band / Downlink					
Channel	Highest Intermodulation product frequency (MHz)	Highest Intermodulation product amplitude (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	851.018750	-13.8	-13.0	0.8	Complied
Top	862.018686	-13.8	-13.0	0.8	Complied

**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)**

**Results: 12.5 kHz Channel Spacing / Bottom channel / Downlink / Output Spectra**

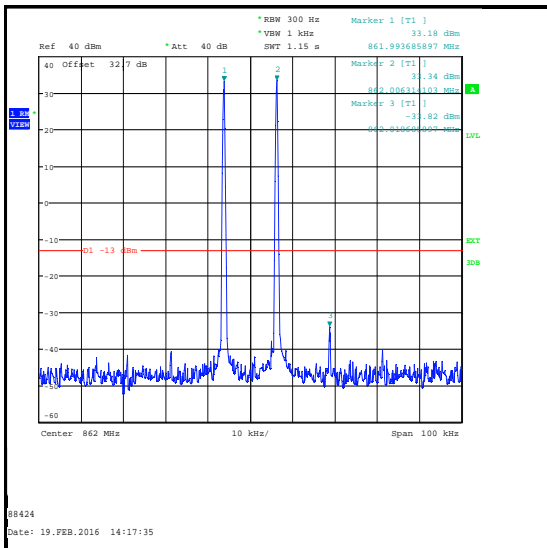


Input Power at just below AGC Threshold

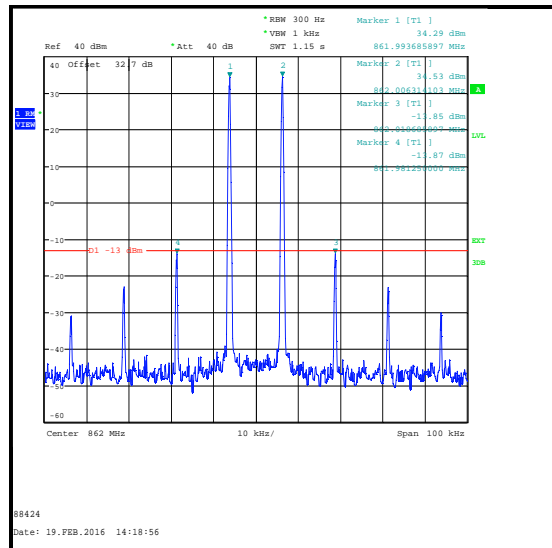


Composite Input Power at AGC Threshold +3 dB

**Results: 12.5 kHz Channel Spacing / Top channel / Downlink / Output Spectra**



Input Power at just below AGC Threshold



Composite Input Power at AGC Threshold +3 dB

**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)****Results: 25 kHz Channel Spacing / CW signal / Downlink / Input just below AGC threshold**

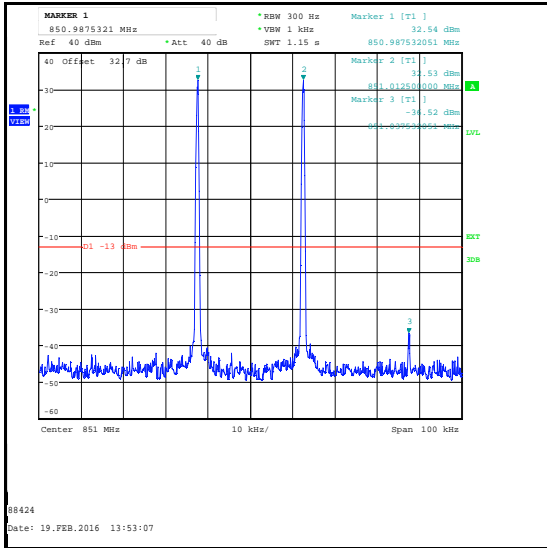
850 MHz Band / Downlink					
Channel	Highest Intermodulation product frequency (MHz)	Highest Intermodulation product amplitude (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	851.037532	-36.5	-13.0	23.5	Complied
Top	862.037596	-34.4	-13.0	21.4	Complied

**Results: 25 kHz Channel Spacing / CW signal / Downlink / Input 3 dB above AGC threshold**

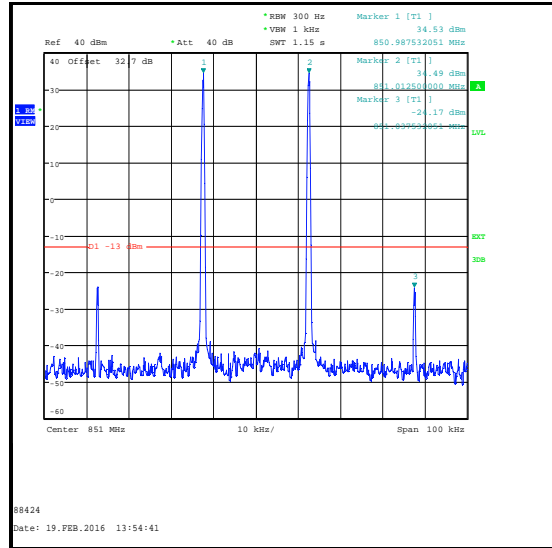
850 MHz Band / Downlink					
Channel	Highest Intermodulation product frequency (MHz)	Highest Intermodulation product amplitude (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	851.037532	-24.2	-13.0	11.2	Complied
Top	862.037596	-24.1	-13.0	11.1	Complied

**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)**

**Results: 25 kHz Channel Spacing / Bottom channel / Downlink / Output Spectra**

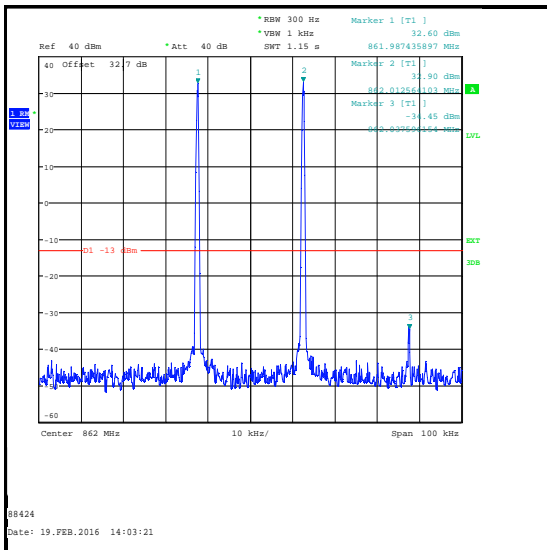


**Input Power at just below AGC Threshold**

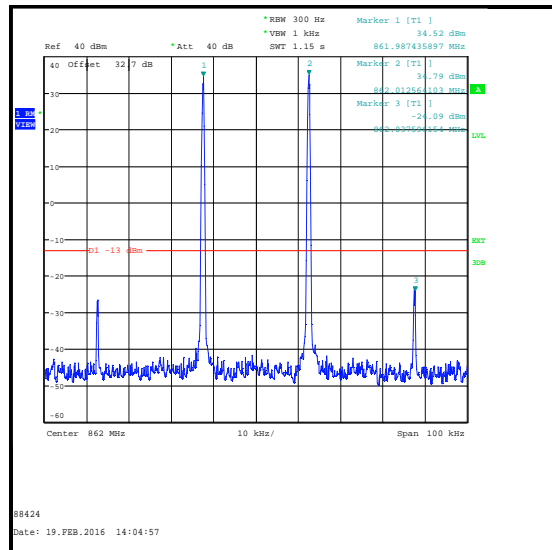


**Composite Input Power at AGC Threshold +3 dB**

**Results: 25 kHz Channel Spacing / Top channel / Downlink / Output Spectra**



**Input Power at just below AGC Threshold**



**Composite Input Power at AGC Threshold +3 dB**

**Transmitter Conducted Spurious Emissions: Intermodulation Products (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	23 Apr 2016	12
M1801	Vector Signal Generator	Rohde & Schwarz	SMU 200A	103606	Calibrated before use	-
A1398	20 dB Attenuator	Weinschel	WA46-20	A129	Calibrated before use	-
A1399	10 dB Attenuator	Weinschel	WA46-10	A126	Calibrated before use	-
A539	Power Splitter	Rohde & Schwarz	RVZ 800	838123/022	Calibrated before use	-
A043	RF Filter	AFL	HP-230-5N	3745B	14 May 2017	24
M1794	Spectrum Analyser	Rohde & Schwarz	FSU26	100027	30 Jun 2017	24

**5.3.7. Transmitter Conducted Spurious Emissions**

**Test Summary:**

<b>Test Engineer:</b>	Ian Watch	<b>Test Date:</b>	12 January 2016
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1051 & 90.219(e)(3)
<b>Test Method Used:</b>	FCC KDB 935210 D05 Section 4.7.3 and Notes below
<b>Frequency Range:</b>	9 kHz to 8.62 GHz

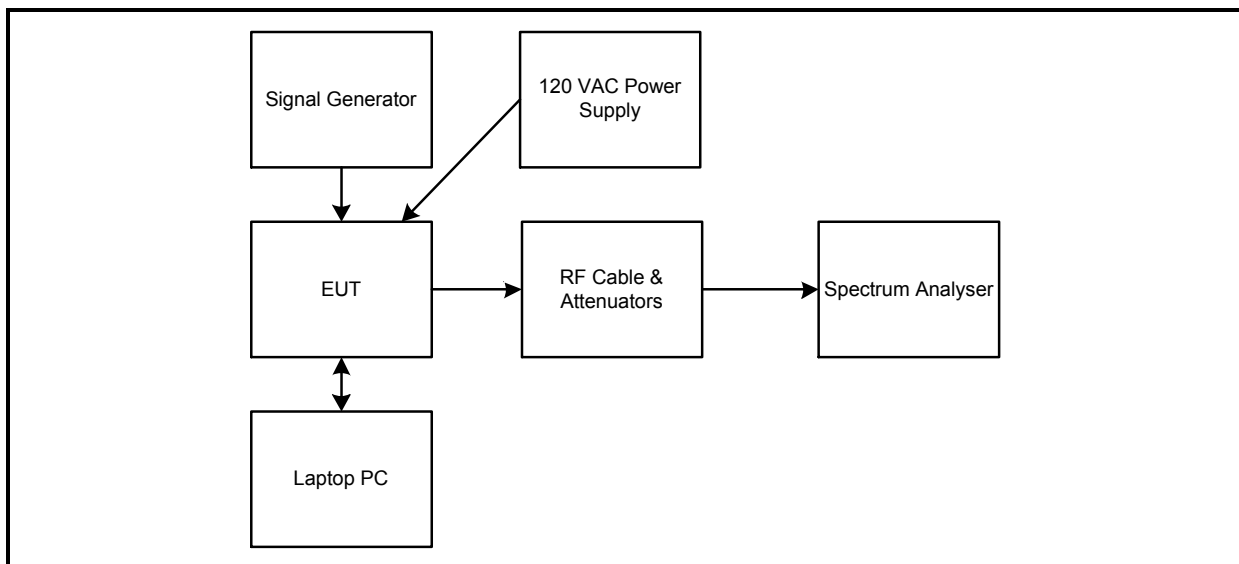
**Environmental Conditions:**

<b>Temperature (°C):</b>	21
<b>Relative Humidity (%):</b>	36

**Note(s):**

1. A signal generator was connected to the DL port (input/donor) on the EUT via an RF cable. The EUT output power was set to maximum on the EUT Repeater Maintenance Console (Attenuation setting = 0). The SERVER port (output) on the EUT was connected to a spectrum analyser via two RF attenuators and an RF cable. The attenuators and RF cable were calibrated prior to testing and the path loss entered as an RF level offset on the spectrum analyser.
2. The EUT input level was adjusted to give an output power just below the AGC threshold.
3. The spectrum analyser was configured as follows: 9 kHz to 150 kHz measurements, a resolution bandwidth of 1 kHz and video bandwidth of 3 kHz were used; 150 kHz to 30 MHz measurements, a resolution bandwidth of 10 kHz and video bandwidth of 30 kHz were used; 30 MHz to 8.62 GHz measurements, a resolution bandwidth of 100 kHz and video bandwidth of 300 kHz were used. The spectrum analyser was left to sweep repeatedly on Max Hold to maximise the emission levels. No spurious emissions were observed. Markers were placed on the highest noise floor levels on each measured frequency range and the highest noise floor level was recorded in the table below.

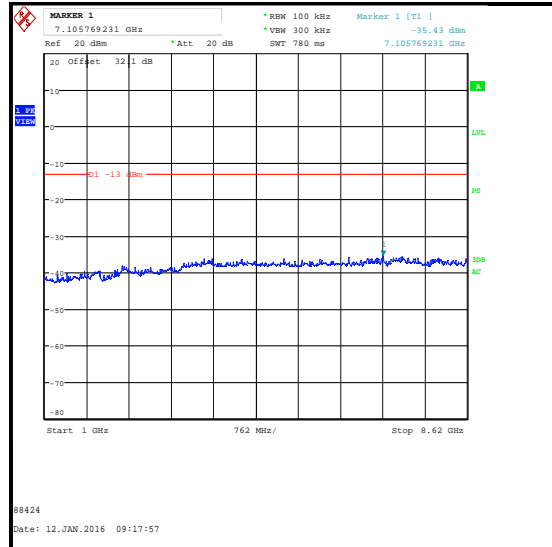
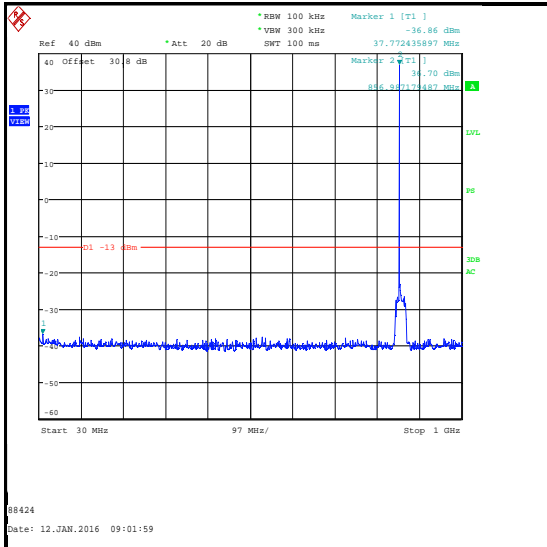
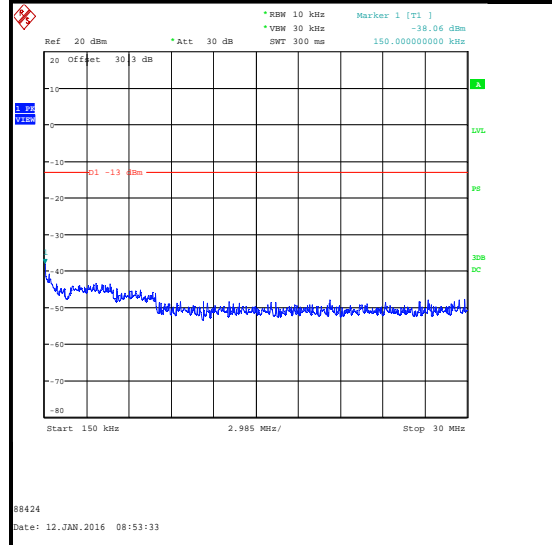
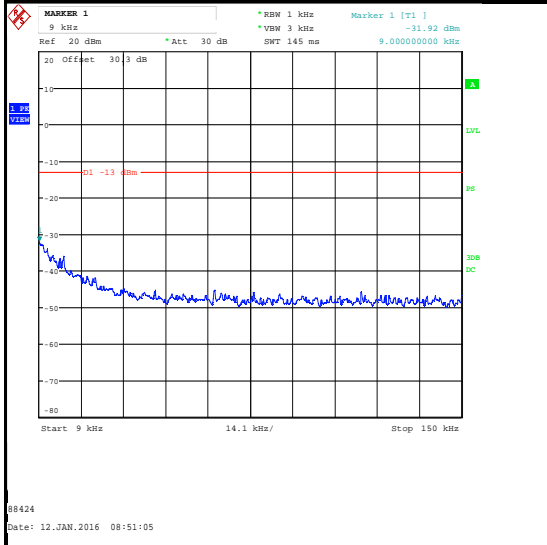
**Test setup for conducted spurious emissions measurements:**



**Transmitter Conducted Spurious Emissions (continued)**

**Results: CW Signal / Downlink**

Frequency (MHz)	Maximum Level (dBm)	Limit (dBm)	Margin (dB)	Result
0.009	-31.9	-13.0	18.9	Complied





**Transmitter Conducted Spurious Emissions (continued)****Test Equipment Used:**

<b>Asset No.</b>	<b>Instrument</b>	<b>Manufacturer</b>	<b>Type No.</b>	<b>Serial No.</b>	<b>Date Calibration Due</b>	<b>Cal. Interval (Months)</b>
M1659	Thermohygrometer	JM Handelpunkt	30.5015.13	Not stated	23 Apr 2016	12
A2527	20 dB Attenuator	AtlanTecRF	AN18W5-20	832828#2	Calibrated before use	-
A2524	10 dB Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
M1886	Spectrum Analyser	Rohde & Schwarz	ESU26	100554	21 May 2016	12
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	27 Apr 2016	12

**5.3.8. Transmitter Radiated Spurious Emissions****Test Summary:**

<b>Test Engineers:</b>	David Doyle & Andrew Edwards	<b>Test Date:</b>	18 September 2012
<b>Test Sample Serial Numbers:</b>	8K5A (Radio head) & 91F0 (OMU)		

<b>FCC Reference:</b>	Parts 2.1053 and 90.219(e)(3)
<b>Test Method Used:</b>	ANSI TIA-603-C-2004 Section 2.2.12
<b>Frequency Range:</b>	30 MHz to 9 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	23 to 26
<b>Relative Humidity (%):</b>	36 to 43

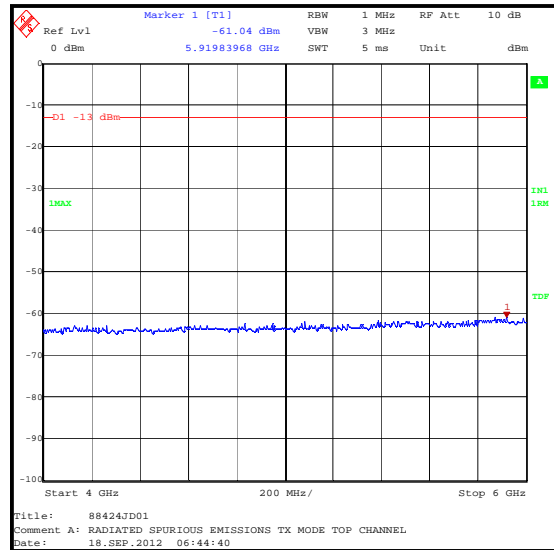
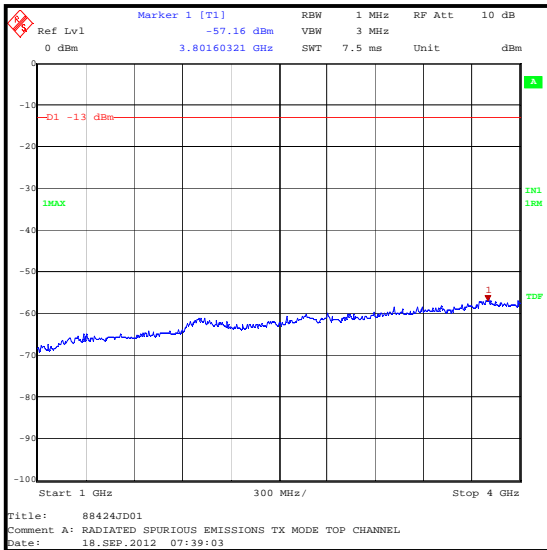
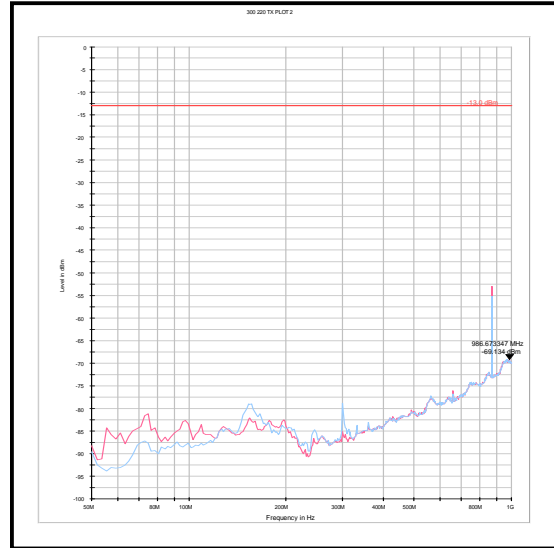
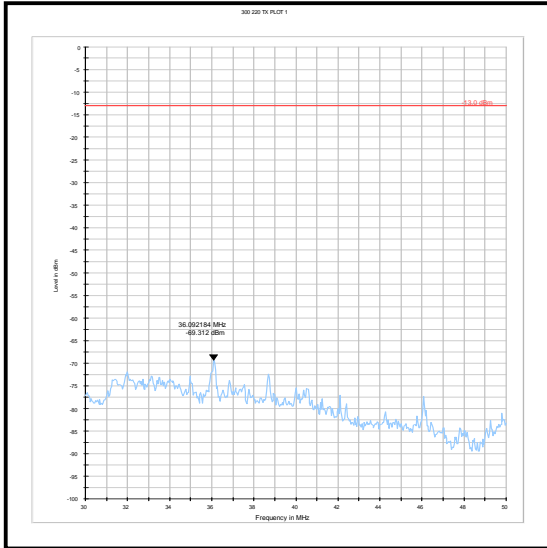
**Note(s):**

1. A signal generator was connected to the input port of the EUT using a suitable RF cable. The signal generator was located outside the anechoic chamber. The RF output of the EUT was terminated into a suitable 50 Ohm load. The signal generator was set to output a CW signal at the maximum input level for the EUT.
2. The emission seen on the 30 MHz to 1 GHz downlink plot at approximately 856 MHz is the input signal.
3. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0002) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT.
5. Any emissions were below the noise floor of the measurement system. The highest noise floor level was recorded.
6. All test equipment was within the calibration period on the date of testing.

**Transmitter Radiated Emissions (continued)**

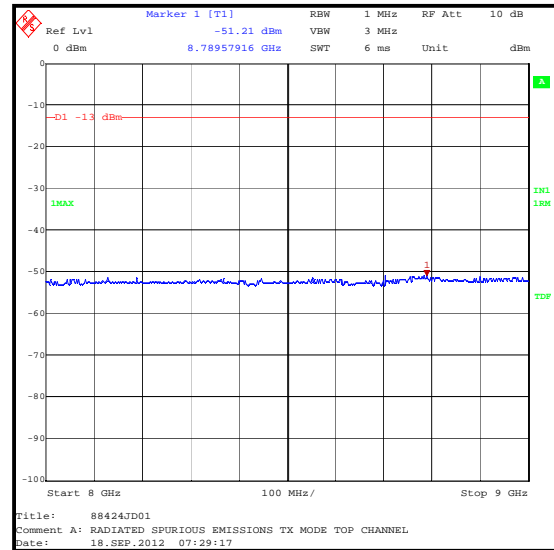
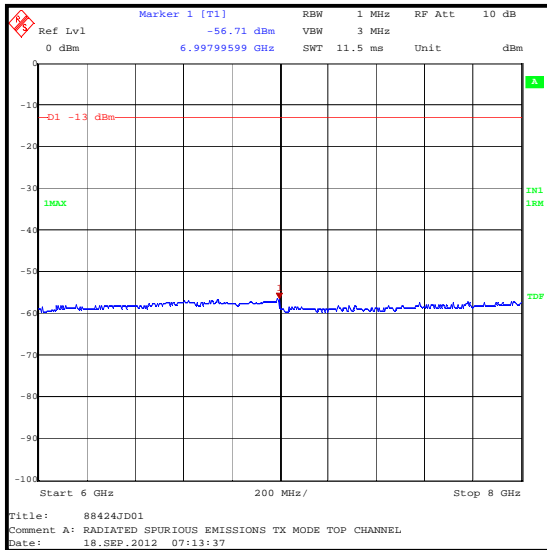
**Results: Downlink**

Frequency (MHz)	Antenna Polarisation	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
8789.579	Vertical	-51.2	-13.0	38.2	Complied



**Transmitter Radiated Emissions (continued)**

**Results: Downlink**



**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	04 Nov 2013	12
A1818	Antenna	EMCO	3115	00075692	04 Nov 2013	12
A1834	Attenuator	Hewlett Packard	8491B	10444	29 Jan 2013	12
A253	Antenna	Flann Microwave	12240-20	128	04 Nov 2013	12
A254	Antenna	Flann Microwave	14240-20	139	04 Nov 2013	12
A255	Antenna	Flann Microwave	16240-20	519	04 Nov 2013	12
A2000	Attenuator	Huber & Suhner	6830.17.B	301623	03 Apr 2013	12
A553	Antenna	Chase	CBL6111A	1593	15 Feb 2013	12
G0543	Amplifier	Sonoma	310N	230801	03 Apr 2013	3
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	24 Oct 2013	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	04 Nov 2013	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046K	14 Aug 2013	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	08 Feb 2013	12

## **6. Measurement Uncertainty**

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

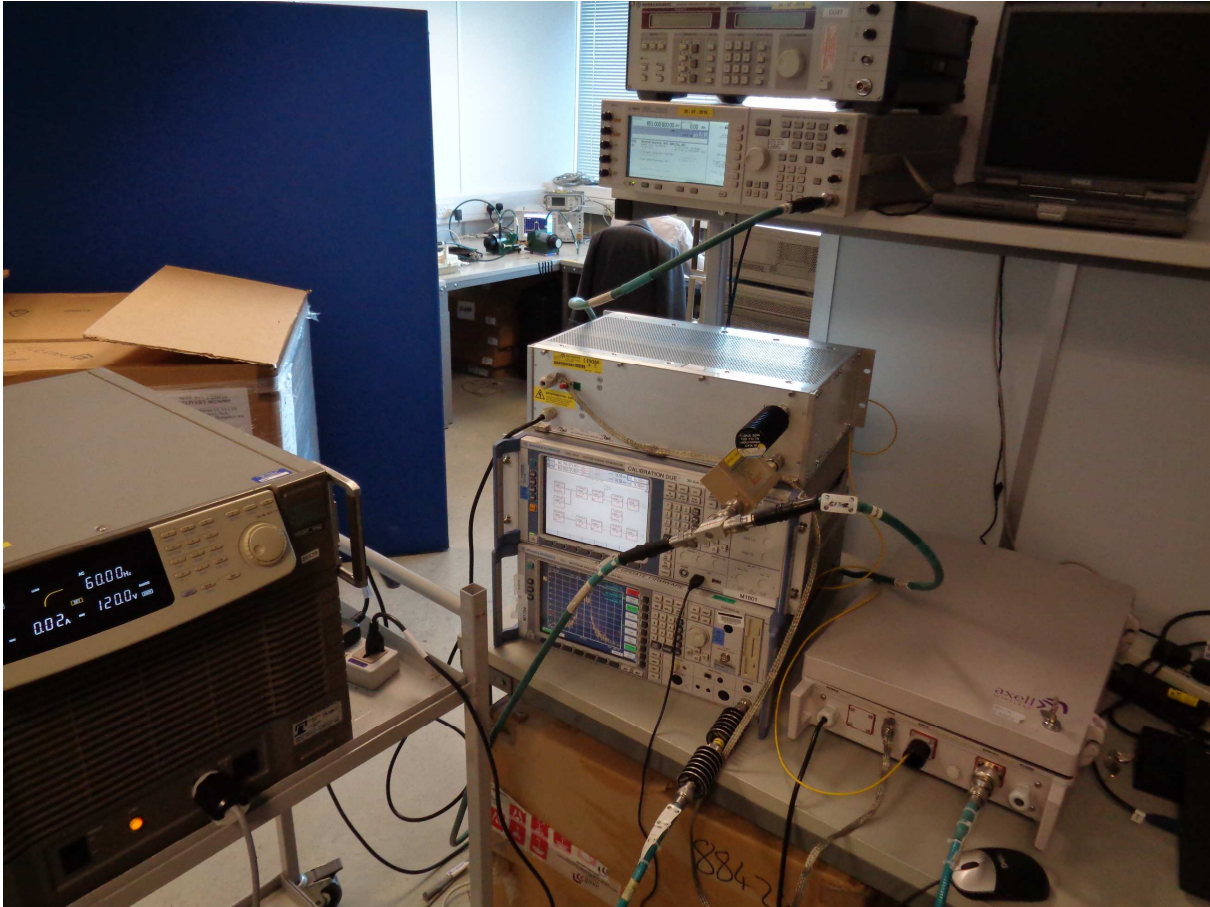
<b>Measurement Type</b>	<b>Range</b>	<b>Confidence Level (%)</b>	<b>Calculated Uncertainty</b>
Output Power	763.0 MHz to 862.0 MHz	95%	±1.13 dB
Occupied Bandwidth	763.0 MHz to 862.0 MHz	95%	±3.92 %
Noise Figure	745.0 MHz to 878.0 MHz	95%	±0.46 dB
Transmitter Conducted Emissions	9 kHz to 9 GHz	95%	±0.46 dB
Transmitter Radiated Emissions	30 MHz to 9 GHz	95%	±2.94 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

## **7. Report Revision History**

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version

**Appendix 1. Test Setup Photograph**



**EUT configuration for conducted measurements**

**--- END OF REPORT ---**