



# TEST REPORT

**Test Report No. : UL-RPT-RP10258500JD01A V4.0**

**Manufacturer** : General Dynamics Broadband UK Ltd  
**Model No.** : APF  
**FCC ID** : PKTNODEBAPF  
**Technology** : LTE Band 14, 10 MHz Channel Bandwidth  
**Test Standard(s)** : FCC Parts 90.210(n), 90.539(d), 90.542(a)(3), 90.543(c),  
90.543(e)(1) & 90.543(f)

1. This test report shall not be reproduced in full or partial, without the written approval of UL VS LTD.
2. The results in this report apply only to the sample tested.
3. The 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 4.0 supersedes all previous versions.

**Date of Issue:** 08 May 2014

**Checked by:**

Sarah Williams  
Engineer, Radio Laboratory

**Issued by :**

pp

John Newell  
Group Quality Manager  
Basingstoke,  
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>	General Dynamics Broadband UK Ltd
<b>Address:</b>	Unit 7 Greenways Business Park Bellinger Close Chippenham Wilts SN15 1BN 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 Private Land Mobile Radio Services. Subpart R Regulations Governing the Licensing and Use of Frequencies in the 763-775 and 793-805 MHz Bands
<b>Site Registration:</b>	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>	17 March 2014 to 07 May 2014

### 2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
90.542(a)(3) / 2.1046	Transmitter Carrier Output Power and Effective Radiated Power (ERP)	
2.1049	Transmitter Occupied Bandwidth	
90.210(n) / 2.1051	Transmitter Conducted Emission Mask	
90.543(c) / 2.1051	Transmitter Conducted Emissions	
90.543(e)(1) / 2.1051	Transmitter Conducted Emissions Limitations	
90.543(c) / 2.1051	Transmitter Conducted Band Edge Emissions	
90.543(c) / 2.1053	Transmitter Radiated Emissions	
90.543(e)(1) / 90.543(f) / 2.1053	Transmitter Radiated Emissions Limitations	
90.543(c) / 2.1053	Transmitter Radiated Band Edge Emissions	
90.539(d) / 2.1055	Transmitter Frequency Stability	
<b>Key to Results</b>		
 = Complied  = Did not comply		

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

<b>Reference:</b>	ANSI/TIA-603-C-2004
<b>Title:</b>	Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards.
<b>Reference:</b>	KDB 971168 D01 v02r01 June 7, 2013
<b>Title:</b>	Measurement Guidance for Certification of Licensed Digital Transmitters
<b>Reference:</b>	KDB 662911 D01 v02r01 October 31, 2013
<b>Title:</b>	Emissions Testing of Transmitters with Multiple Outputs in the Same Band

### **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>	General Dynamics Broadband
<b>Model Name or Number:</b>	APF
<b>Test Sample Serial Number:</b>	APFHD16000V20
<b>Hardware Version Number:</b>	Pass 2
<b>Software Version Number:</b>	9.1.0
<b>FCC ID Number:</b>	PKTNODEBAPF

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

The equipment under test was a wireless LTE band 14 base station.

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

No modifications were applied to the EUT during testing.

#### **3.4. Additional Information Related to Testing**

<b>Tested Technology:</b>	LTE	
<b>Type of Equipment</b>	eNodeB	
<b>Channel Bandwidth:</b>	10 MHz	
<b>Modulation Type:</b>	QPSK, 16QAM & 64QAM	
<b>Duty Cycle:</b>	100 %	
<b>Antenna Gain:</b>	20.0 dBi (maximum)	
<b>Power Supply Requirement:</b>	Nominal	-48.0 VDC
	Minimum	-40.8 VDC
	Maximum	-55.2 VDC
<b>Transmit Frequency Range:</b>	758 MHz to 768 MHz	
<b>Transmit Channels Tested:</b>	<b>N<sub>ut</sub></b>	<b>Channel Frequency (MHz)</b>
	5330	763.0

#### **3.5. Support Equipment**

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

<b>Description:</b>	Laptop
<b>Brand Name:</b>	Sony
<b>Model Name or Number:</b>	PCG-9W6M
<b>Serial Number:</b>	28196160 5603019

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

### **4.1. Operating Modes**

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

- Transmit Mode – the EUT was set to transmit with maximum output power using a 10 MHz channel bandwidth. QPSK, 16QAM and 64QAM modulations were tested.

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

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

- The EUT was controlled via a laptop PC, using bespoke software supplied by the customer. The customer supplied test instructions, which were followed to place the unit into the correct test mode.
- The EUT was connected to the test laptop via 8thernet.
- The EUT has two transmitter RF ports. The port not being used whilst testing was being performed was terminated with a 50 Ohm load.
- The EUT was configured for 50 Resource Blocks as defined in 3GPP 36.141 Rel 8.
- The EUT was configured using the following E-UTRA Test Models as defined in 3GPP 36.141 Rel 8:
  - E-TM1.1 for QPSK modulation
  - E-TM3.2 for 16QAM modulation
  - E-TM3.1 for 64QAM modulation
- The customer declared that the EUT is in a permanent transceiver state, therefore no receive/idle testing has been performed.



## **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****5.2.1. Transmitter Carrier Output Power and Effective Radiated Power (ERP)****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	07 May 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Parts 90.542(a)(3) and 2.1046
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 5.4, 5.4.1 and 5.6

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	41

**Note(s):**

1. Power from both antenna ports was measured and combined using the measure-and-sum method stated in FCC KDB 662911 D01.
2. The ERP limit of 1000W/MHz has been converted to dBm/MHz, giving a limit of 60 dBm/MHz.
3. The customer stated that the EUT is designed to operate with a maximum antenna gain of 20 dBi. As the limit is an ERP limit the gain in dBi has been converted to dBd. The dBd value was calculated as:

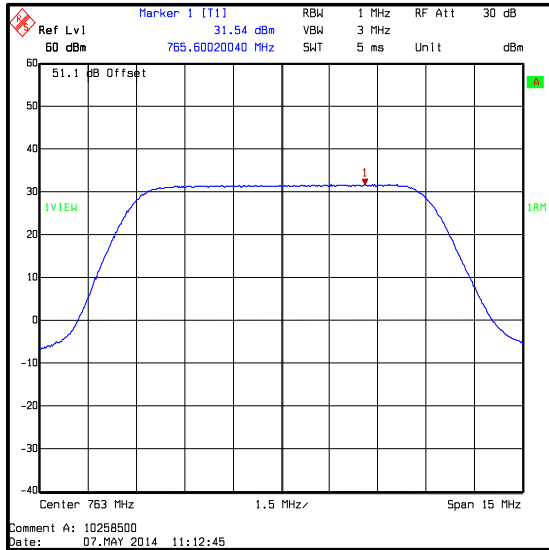
$$20 \text{ dBi} - 2.15 \text{ dB} = 17.85 \text{ dBd.}$$

**Transmitter Carrier Output Power and Effective Radiated Power (ERP) (continued)**

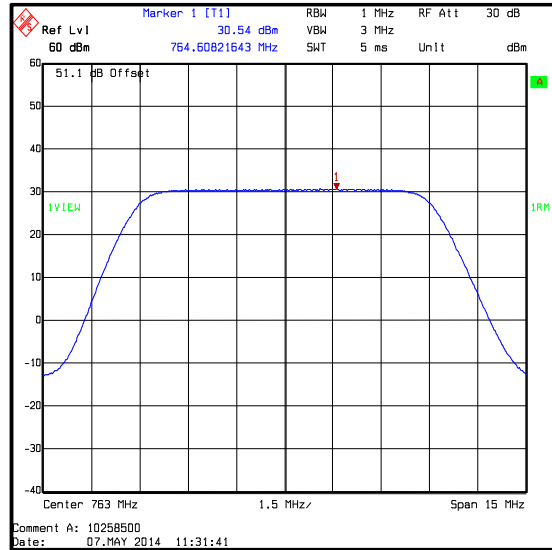
**Results: 10 MHz Channel Bandwidth**

Frequency (MHz)	Modulation	Conducted RF Power at Port 1 (dBm/MHz)	Conducted RF Power at Port 2 (dBm/MHz)	Combined Conducted RF Power (dBm/MHz)
763.0	QPSK	31.5	30.5	34.0

Frequency (MHz)	Modulation	Combined Conducted RF Power (dBm/MHz)	Antenna Gain (dBd)	ERP (dBm/MHz)	ERP Limit (dBm/MHz)	Margin (dB)	Result
763.0	QPSK	34.0	17.85	51.85	60.0	8.15	Complied



Port 1



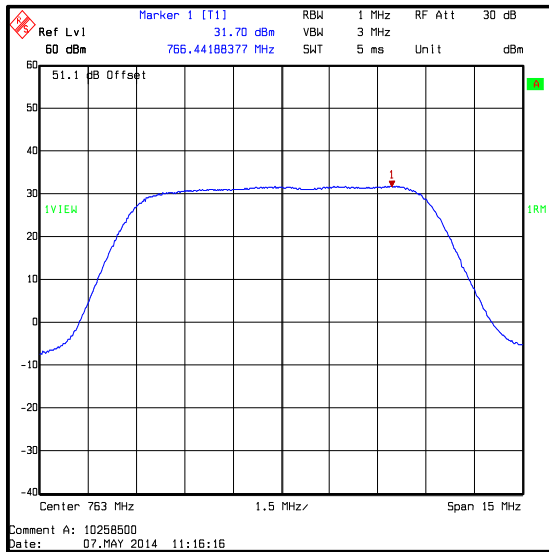
Port 2

**Transmitter Carrier Output Power and Effective Radiated Power (ERP) (continued)**

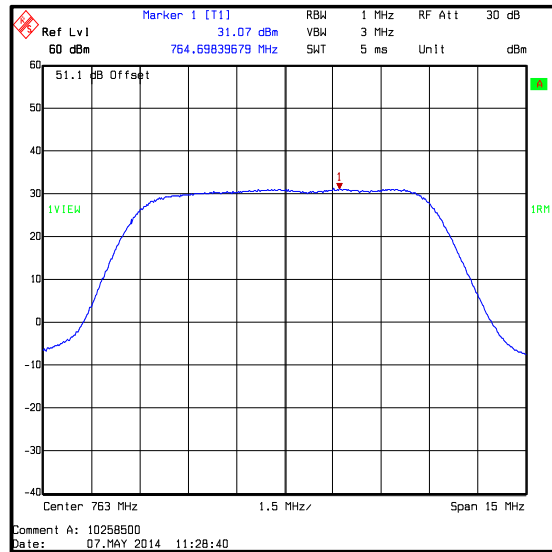
**Results: 10 MHz Channel Bandwidth**

Frequency (MHz)	Modulation	Conducted RF Power at Port 1 (dBm/MHz)	Conducted RF Power at Port 2 (dBm/MHz)	Combined Conducted RF Power (dBm/MHz)
763.0	16QAM	31.7	31.1	34.4

Frequency (MHz)	Modulation	Combined Conducted RF Power (dBm/MHz)	Antenna Gain (dBd)	ERP (dBm/MHz)	ERP Limit (dBm/MHz)	Margin (dB)	Result
763.0	16QAM	34.4	17.85	52.25	60.0	7.75	Complied



Port 1



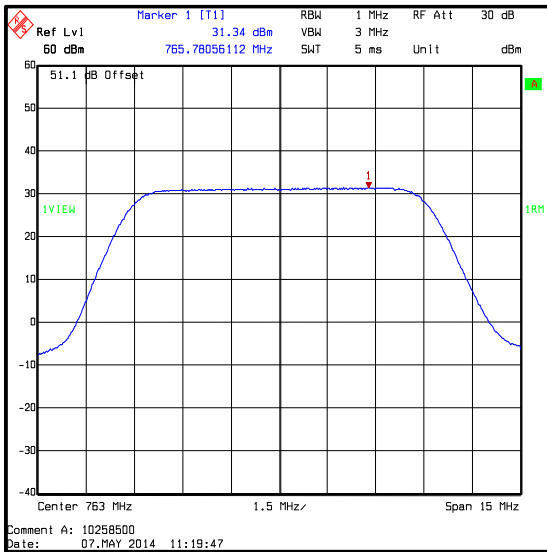
Port 2

**Transmitter Carrier Output Power and Effective Radiated Power (ERP) (continued)**

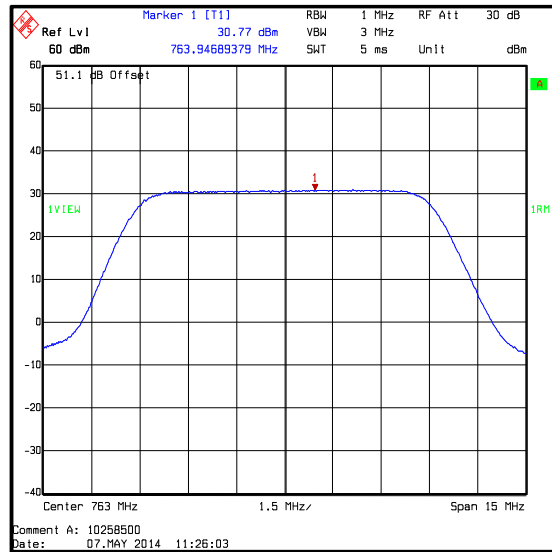
**Results: 10 MHz Channel Bandwidth**

Frequency (MHz)	Modulation	Conducted RF Power at Port 1 (dBm/MHz)	Conducted RF Power at Port 2 (dBm/MHz)	Combined Conducted RF Power (dBm/MHz)
763.0	64QAM	31.3	30.8	34.1

Frequency (MHz)	Modulation	Combined Conducted RF Power (dBm/MHz)	Antenna Gain (dBd)	ERP (dBm/MHz)	ERP Limit (dBm/MHz)	Margin (dB)	Result
763.0	64QAM	34.1	17.85	51.95	60.0	8.05	Complied



Port 1



Port 2

**Transmitter Carrier Output Power and Effective Radiated Power (ERP) (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1658	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016	19 Aug 2014	12
A1999	Attenuator	Huber + Suhner	6820.17.B	07101	05 Apr 2014	12
A2006	Attenuator	Narda	769-30	06588	Calibrated before use	-
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	24 Apr 2015	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	08 Apr 2016	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	23 Apr 2016	24
A1317	Termination	Narda	376BNM	0103	Calibration not required	-
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-

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

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	17 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Part 2.1049
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 4.2

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	42

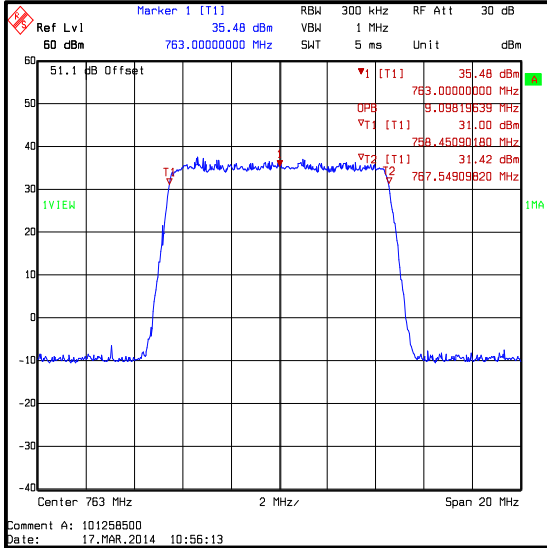
**Note(s):**

1. Measurements were performed with the EUT transmitting with QPSK, 16QAM and 64QAM modulation schemes, with resource blocks 50.
2. All plots show an incorrect job number.

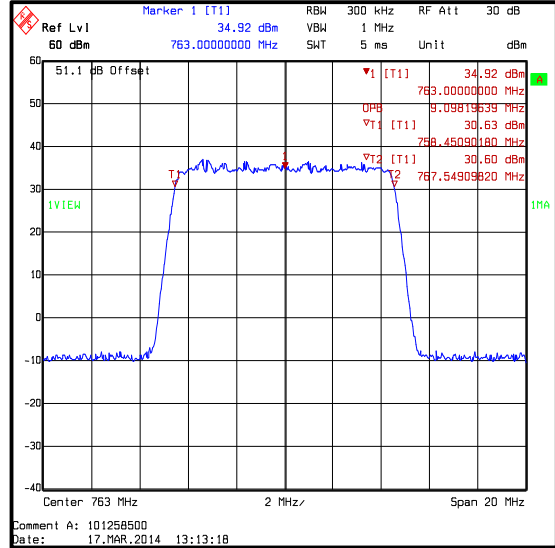
**Transmitter Occupied Bandwidth (continued)**

**Results: 10 MHz Channel Bandwidth / QPSK**

Frequency	Resolution Bandwidth (kHz)	Video Bandwidth (kHz)	Occupied Bandwidth Port 1 (MHz)	Occupied Bandwidth Port 2 (MHz)
763	300	1000	9.098	9.098



**QPSK / Port 1**



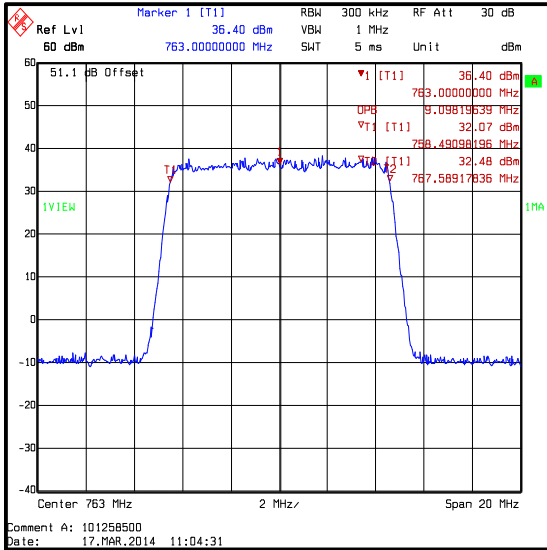
**QPSK / Port 2**



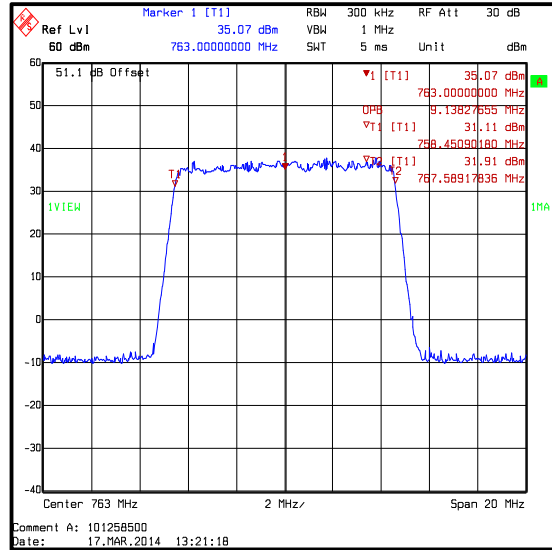
**Transmitter Occupied Bandwidth (continued)**

**Results: 10 MHz Channel Bandwidth / 16QAM**

Frequency	Resolution Bandwidth (kHz)	Video Bandwidth (kHz)	Occupied Bandwidth Port 1 (MHz)	Occupied Bandwidth Port 2 (MHz)
763	300	1000	9.098	9.138



**16QAM / Port 1**

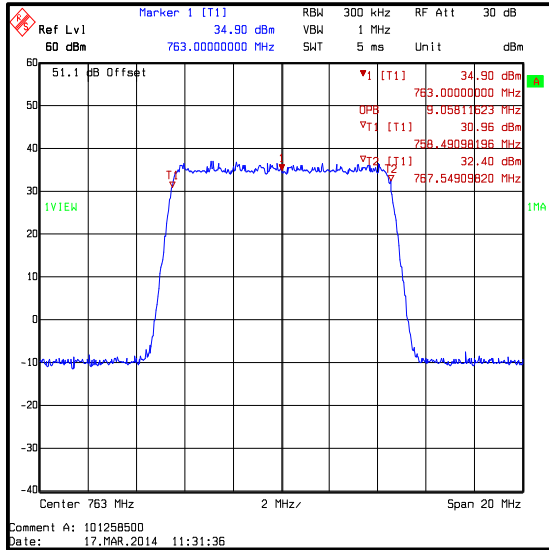


**16QAM / Port 2**

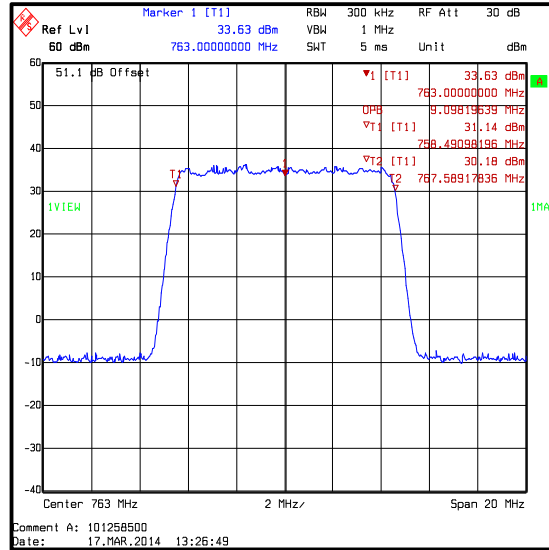
**Transmitter Occupied Bandwidth (continued)**

**Results: 10 MHz Channel Bandwidth / 64QAM**

Frequency	Resolution Bandwidth (kHz)	Video Bandwidth (kHz)	Occupied Bandwidth Port 1 (MHz)	Occupied Bandwidth Port 2 (MHz)
763	300	1000	9.058	9.098



64QAM / Port 1



64QAM / Port 2

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1657	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	14 Mar 2015	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016	19 Aug 2014	12
A1999	Attenuator	Huber + Suhner	6820.17.B	07101	05 Apr 2014	12
A2006	Attenuator	Narda	769-30	06588	Calibrated before use	-
A1317	Termination	Narda	376BNM	0103	Calibration not required	-
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-

**5.2.3. Transmitter Conducted Emission Mask****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	17 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Parts 90.210(n) and 2.1051
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 6.0 with deviations as specified in Part 90.210

**Environmental Conditions:**

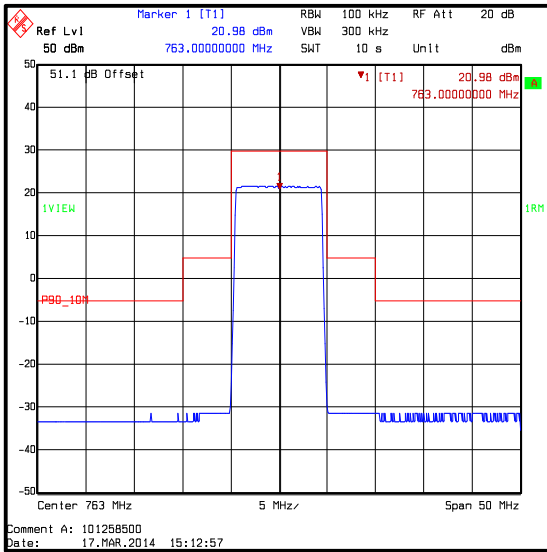
<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	42

**Note(s):**

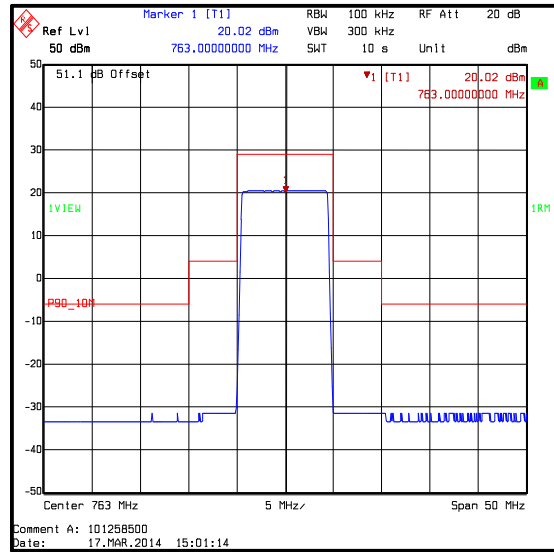
1. The measurement was performed with the EUT antenna port coupled to a spectrum analyser via suitable attenuation and cable. The power of the modulated signal was measured on a spectrum analyser using an RMS detector and 10 second sweep time in order to maximise the level.
2. Measurements were performed with the EUT transmitting with QPSK, 16QAM and 64QAM modulation schemes, with resource blocks of 50.
3. Part 90.210 emissions mask B was applied to all measurements.
4. As the EUT is unable to produce a full power un-modulated carrier, the mask was referenced to the total power contained in the channel bandwidth.
5. All plots show an incorrect job number.

### Transmitter Conducted Emission Mask (continued)

#### Results: 10 MHz Channel Bandwidth / QPSK

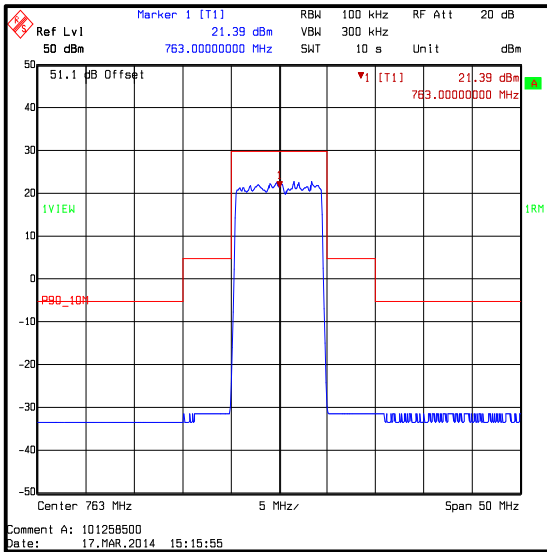


QPSK / Port 1

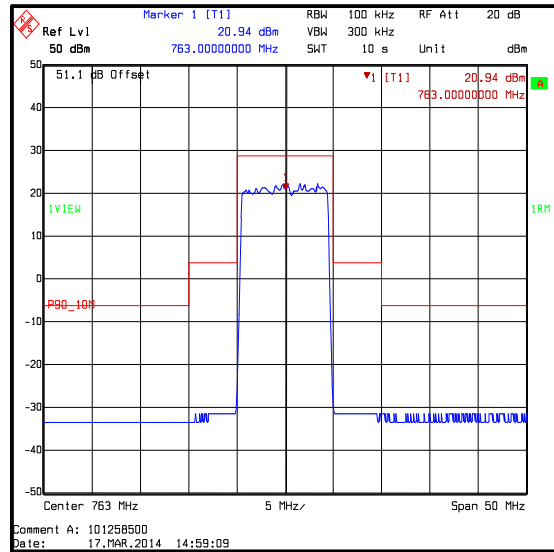


QPSK / Port 2

#### Results: 10 MHz Channel Bandwidth / 16QAM



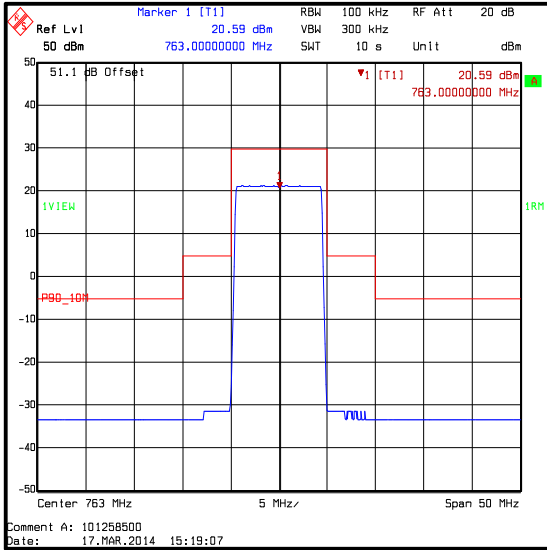
16QAM / Port 1



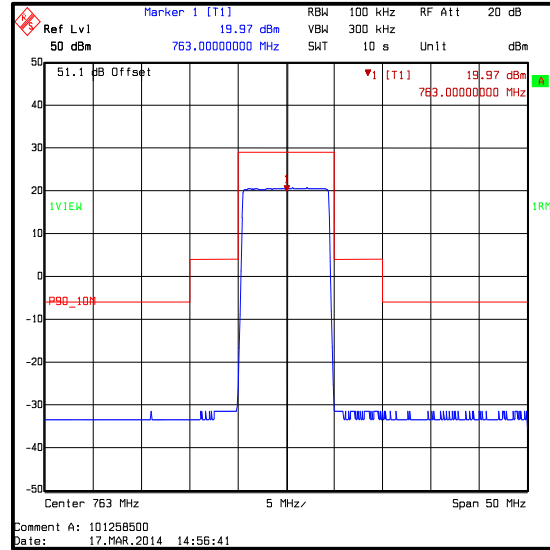
16QAM / Port 2

**Transmitter Conducted Emission Mask (continued)**

**Results: 10 MHz Channel Bandwidth / 64QAM**



**64QAM / Port 1**



**64QAM / Port 2**

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1657	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	14 Mar 2015	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016	19 Aug 2014	12
A1999	Attenuator	Huber + Suhner	6820.17.B	07101	05 Apr 2014	12
A2006	Attenuator	Narda	769-30	06588	Calibrated before use	-
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	25 Jun 2014	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	15 May 2014	12
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	14 May 2014	12
A1317	Termination	Narda	376BNM	0103	Calibration not required	-
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-

**5.2.4. Transmitter Conducted Emissions****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	20 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Parts 90.543(c) and 2.1051
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 6.0 referencing FCC Part 2.1051
<b>Frequency Range:</b>	9 kHz to 10 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	39

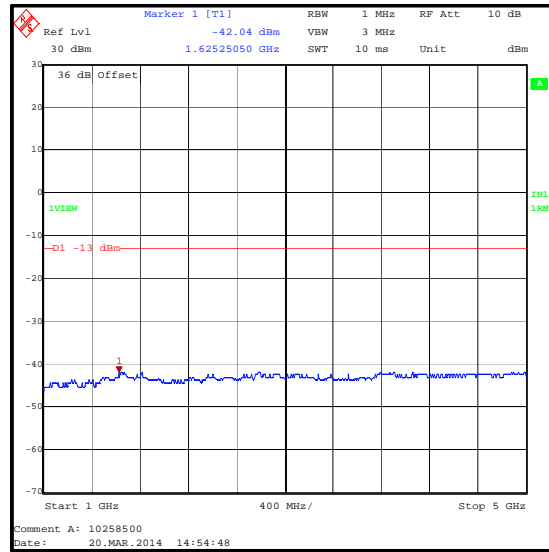
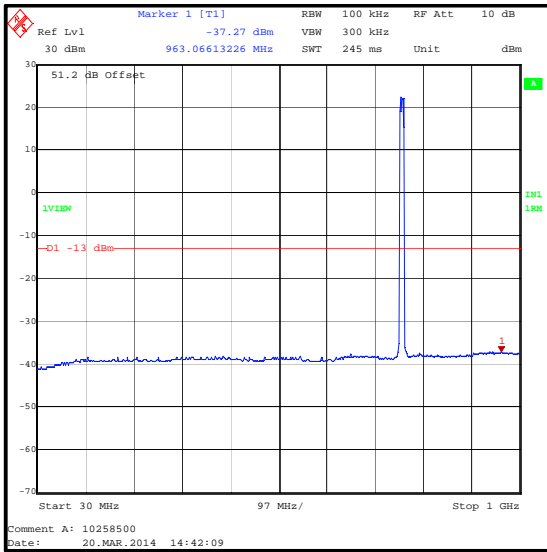
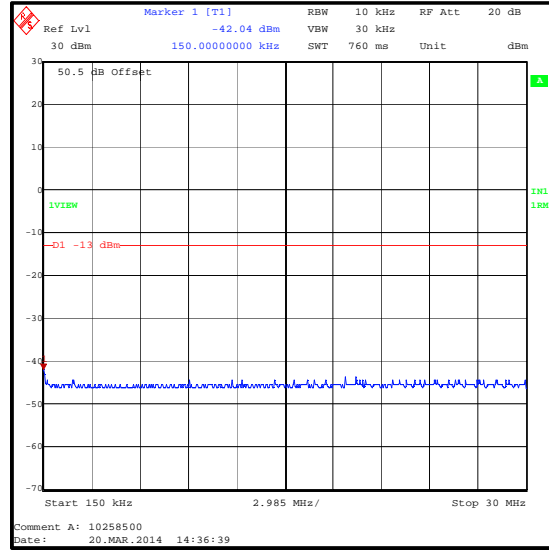
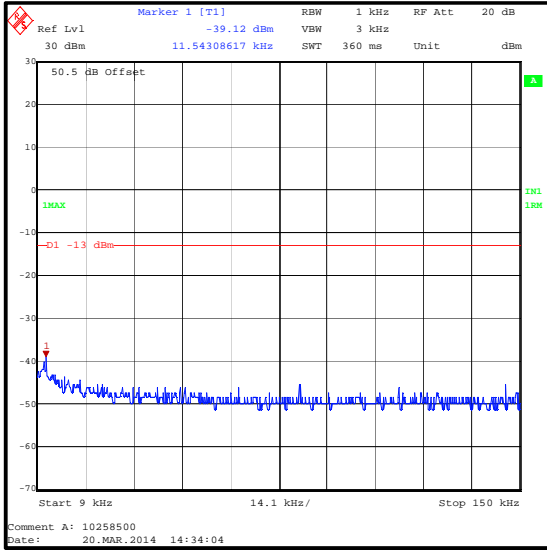
**Note(s):**

1. Pre-scans were performed with the EUT transmitting at maximum power with QPSK modulation scheme, as this was found to produce the highest output level and therefore deemed worst case.
2. Testing was performed to 10 GHz, as the customer declared the highest internally generated clock or oscillator frequency to be 951.5 MHz.
3. Measurements were made on RF Port 1, as this produced the highest power out of the two ports.
4. The emission seen on the 30 MHz to 1 GHz plot at approximately 763.0 MHz is the EUT carrier.
5. All emissions were >20 dB below the applicable limit or below the level of the noise floor of the measuring receiver, therefore the highest level of noise floor has been recorded in the table below.

**Results: 10 MHz Channel Bandwidth / QPSK**

Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
963.066	-37.3	-13.0	24.3	Complied

**Transmitter Conducted Emissions (continued)**







**5.2.5. Transmitter Conducted Emissions Limitations****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	24 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Parts 90.543(e)(1) and 2.1051
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 6.0 referencing FCC Part 2.1051
<b>Frequency Ranges:</b>	769 MHz to 775 MHz 799 MHz to 805 MHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	39

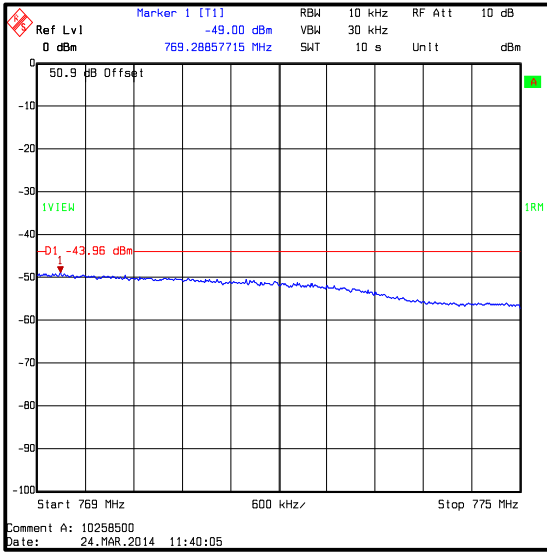
**Note(s):**

1. Measurements were performed with the EUT transmitting with QPSK, 16QAM and 64QAM modulation schemes, with resource blocks of 50.
2. All other emissions were >20 dB below the applicable limit or below the level of the noise floor of the measuring receiver.
3. The limit for 90.543(e)(1) is  $76 + 10\log_{10}(P) = -46.0$  dBm in a 6.25 kHz bandwidth. As it was not possible to set the resolution bandwidth on the test equipment, the bandwidth was set to 10 kHz. The limit was adjusted by  $10 \log_{10}(10 \text{ kHz} / 6.25 \text{ kHz}) = 2.04$  dB. The limit shown in the plots for the 769 MHz to 799 MHz and 799 MHz to 805 MHz bands was set to  $-46 \text{ dBm} + 2.04 \text{ dB} = -43.96$  dBm.

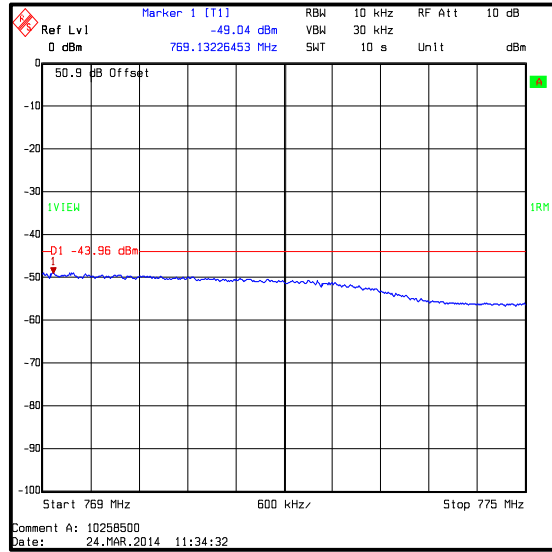
**Transmitter Conducted Emissions Limitations (continued)**

**Results: 769 MHz to 775 MHz / Port 1**

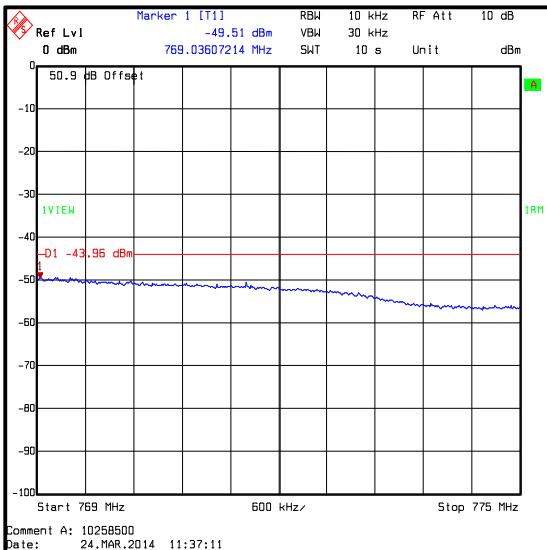
Modulation	Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
QPSK	769.289	-49.00	-43.96	5.04	Complied
16QAM	769.132	-49.04	-43.96	5.08	Complied
64QAM	769.036	-49.51	-43.96	5.55	Complied



**QPSK**



**16QAM**

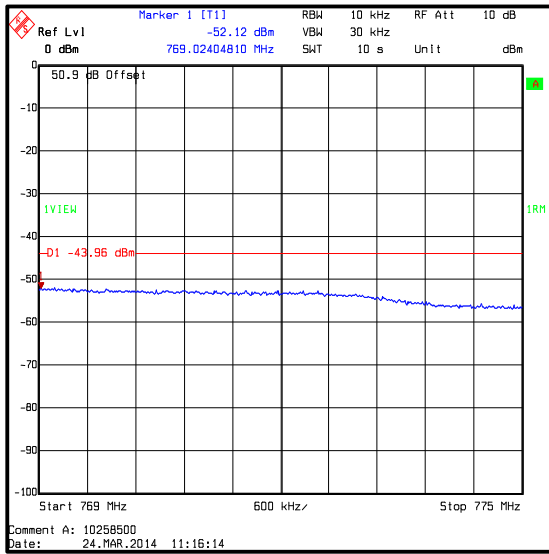


**64QAM**

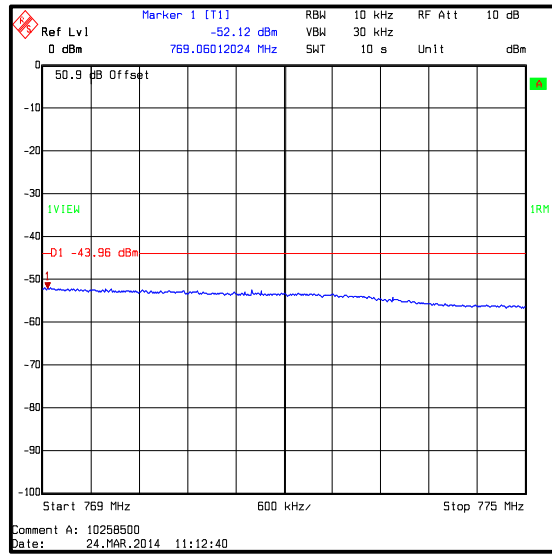
**Transmitter Conducted Emissions Limitations (continued)**

**Results: 769 MHz to 775 MHz / Port 2**

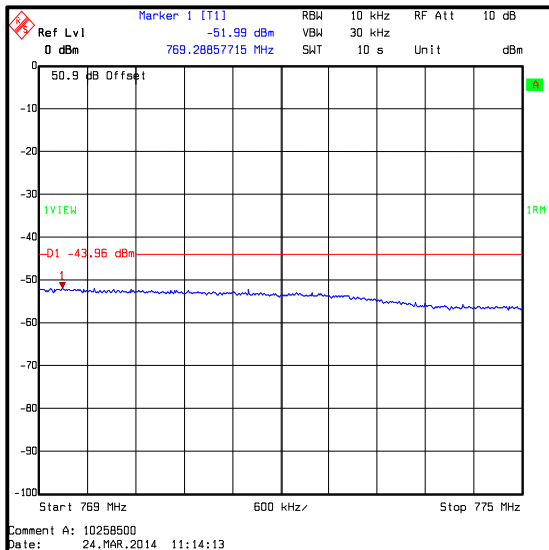
Modulation	Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
QPSK	769.024	-52.12	-43.96	8.16	Complied
16QAM	769.060	-52.12	-43.96	8.16	Complied
64QAM	769.289	-51.99	-43.96	8.03	Complied



**QPSK**



**16QAM**

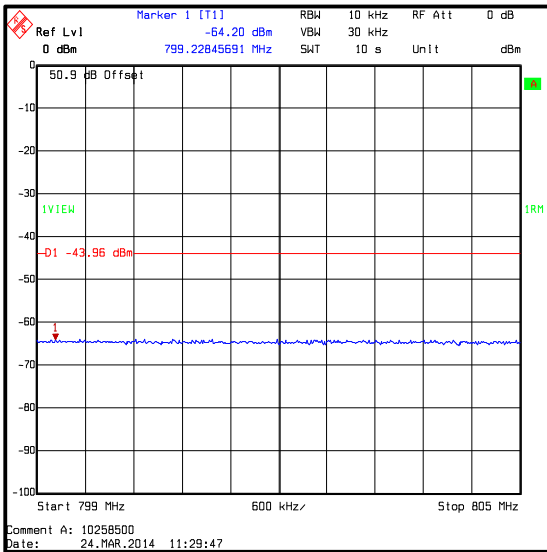


**64QAM**

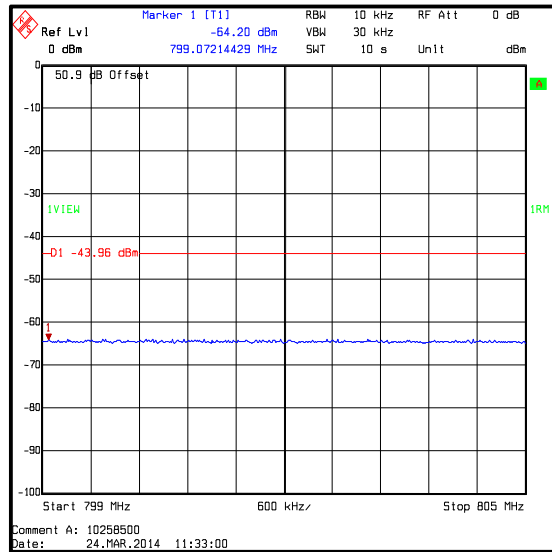
**Transmitter Conducted Emissions Limitations (continued)**

**Results: 799 MHz to 805 MHz / Port 1**

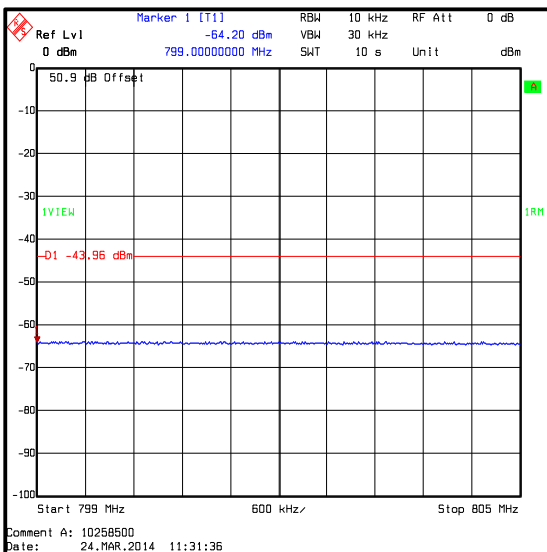
Modulation	Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
QPSK	799.228	-64.20	-43.96	20.24	Complied
16QAM	799.072	-64.20	-43.96	20.24	Complied
64QAM	799.000	-64.20	-43.96	20.24	Complied



**QPSK**



**16QAM**

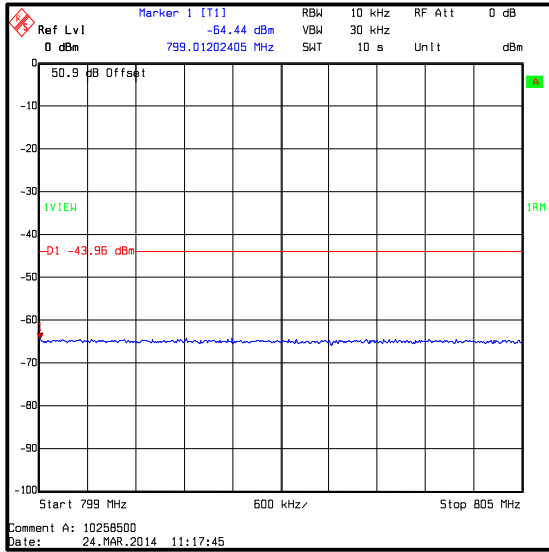


**64QAM**

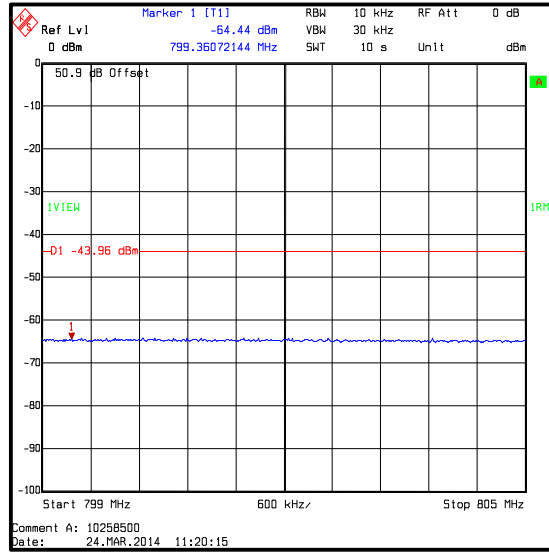
**Transmitter Conducted Emissions Limitations (continued)**

**Results: 799 MHz to 805 MHz / Port 2**

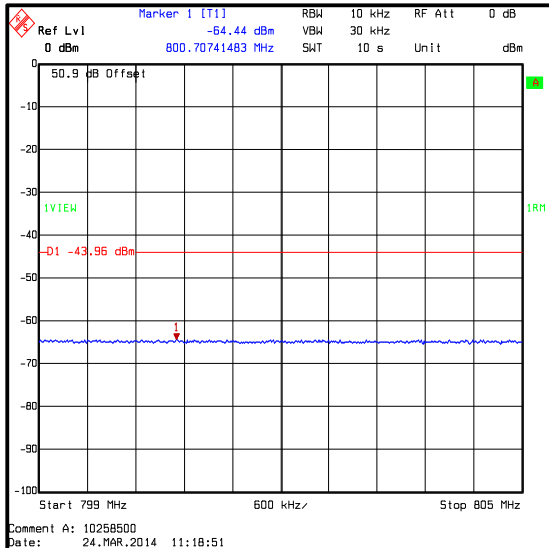
Modulation	Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
QPSK	799.012	-64.44	-43.96	20.48	Complied
16QAM	799.361	-64.44	-43.96	20.48	Complied
64QAM	800.707	-64.44	-43.96	20.48	Complied



**QPSK**



**16QAM**



**64QAM**

**Transmitter Conducted Emissions Limitations (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>
M1657	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016	19 Aug 2014	12
A1999	Attenuator	Huber + Suhner	6820.17.B	07101	05 Apr 2015	12
A2006	Attenuator	Narda	769-30	06588	Calibrated before use	-
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	25 Jun 2014	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	15 May 2014	12
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	14 May 2014	12
A1317	Termination	Narda	376BNM	0103	Calibration not required	-
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-

**5.2.6. Transmitter Conducted Emissions at Band Edge****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	20 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Parts 90.543(c) and 2.1051
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 6.0 referencing FCC Part 2.1051

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	39

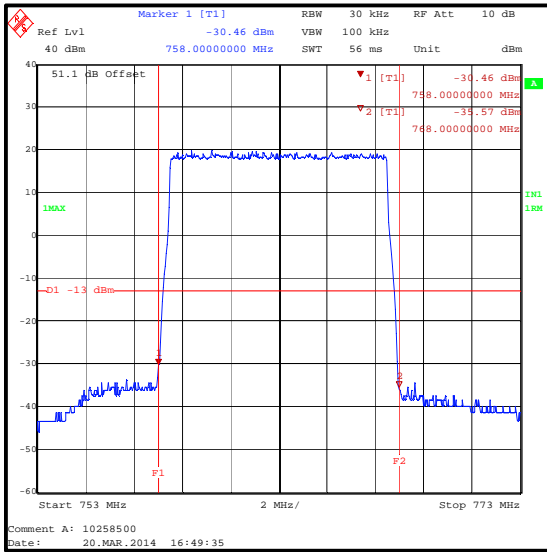
**Note(s):**

1. Measurements were performed with the EUT transmitting with QPSK, 16QAM and 64QAM modulation schemes, with resource blocks of 50.
2. As per 90.543(e)(5), a resolution bandwidth of 30 kHz has been employed.
3. Band edge emissions from both antenna ports was measured and combined using the measure-and-sum method stated in FCC KDB 662911 D01.

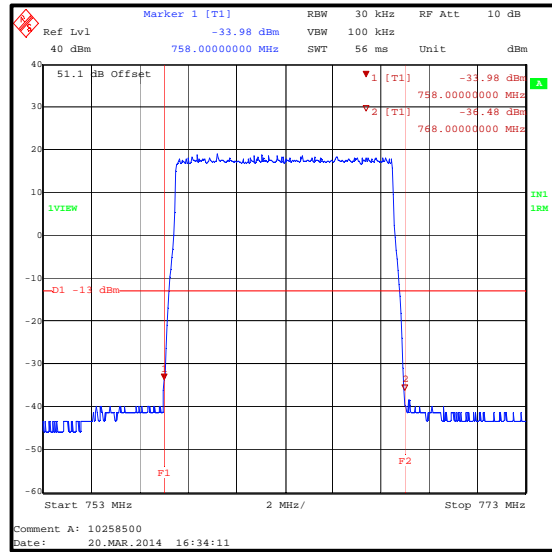
**Transmitter Conducted Emissions at Band Edges (continued)**

**Results: 10 MHz Channel Bandwidth**

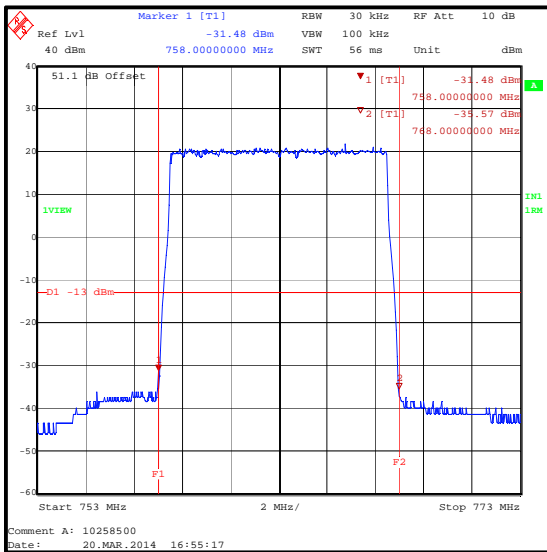
Frequency (MHz)	Modulation Scheme	Port 1 Emission Level (dBm)	Port 2 Emission Level (dBm)	Combined Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
758	QPSK	-30.5	-34.0	-28.9	-13.0	15.9	Complied
768	QPSK	-35.6	-36.5	-33.0	-13.0	20.0	Complied
758	16QAM	-31.5	-34.7	-29.8	-13.0	16.8	Complied
768	16QAM	-35.6	-34.7	-32.1	-13.0	19.1	Complied



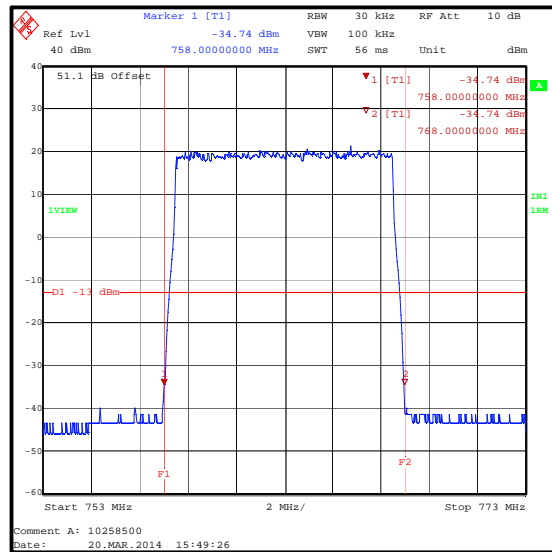
**QPSK / Port 1**



**QPSK / Port 2**



**16QAM / Port 1**



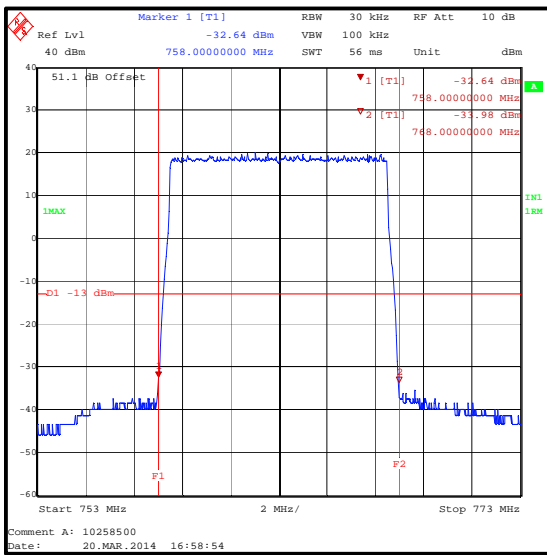
**16QAM / Port 2**



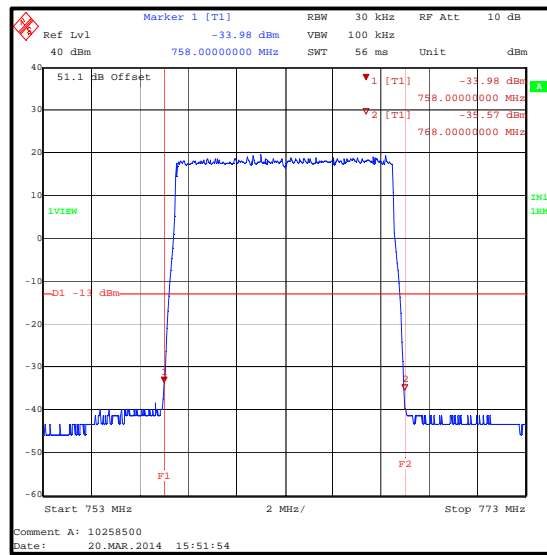
**Transmitter Conducted Emissions at Band Edges (continued)**

**Results: 10 MHz Channel Bandwidth**

Frequency (MHz)	Modulation Scheme	Port 1 Emission Level (dBm)	Port 2 Emission Level (dBm)	Combined Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
758	64QAM	-32.6	-34.0	-30.2	-13.0	17.2	Complied
768	64QAM	-34.0	-35.6	-31.7	-13.0	18.7	Complied



64QAM / Port 1



64QAM / Port 2

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1657	Thermohyrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016	19 Aug 2014	12
A1999	Attenuator	Huber + Suhner	6820.17.B	07101	05 Apr 2015	12
A2006	Attenuator	Narda	769-30	06588	Calibrated before use	-
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	25 Jun 2014	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	15 May 2014	12
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	14 May 2014	12
A1317	Termination	Narda	376BNM	0103	Calibration not required	-
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-

**5.2.7. Transmitter Radiated Emissions****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Dates:</b>	19 March 2014 & 20 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Parts 90.543(c) and 2.1053
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 5.8. referencing FCC Part 2.1053
<b>Frequency Range:</b>	30 MHz to 10 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	33 to 37

**Note(s):**

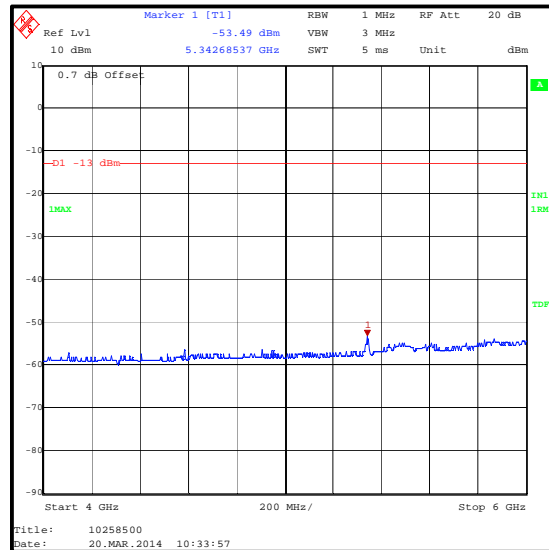
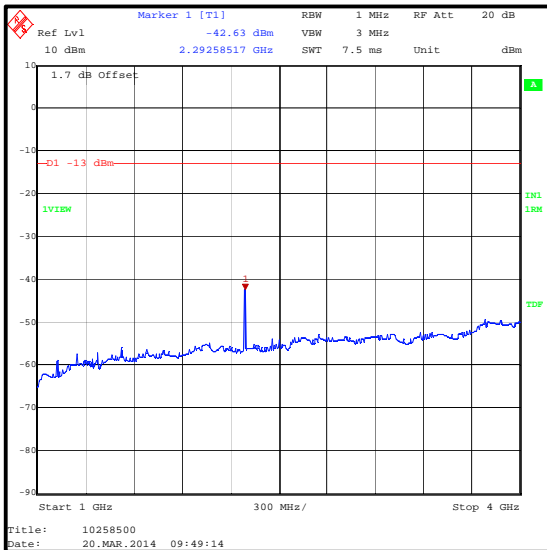
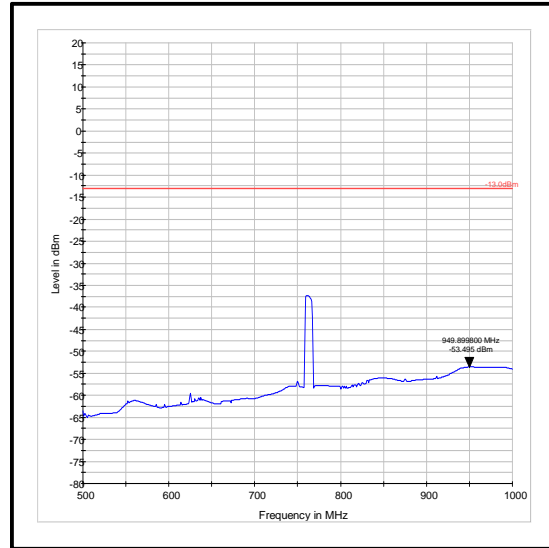
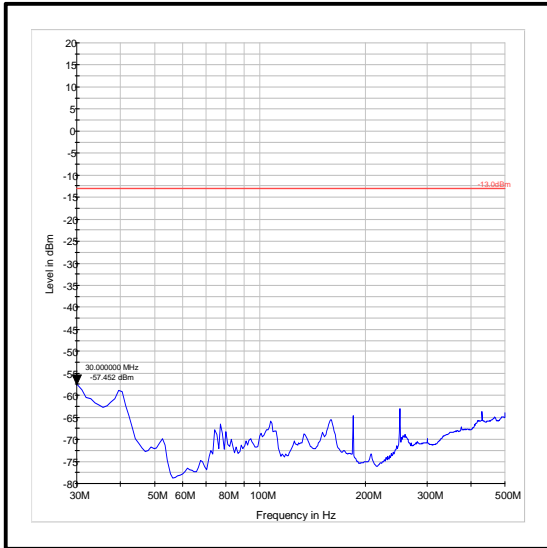
1. The EUT was set to transmit with QPSK modulation applied, as this was found to have the highest output power and was therefore deemed worst case.
2. Testing was performed to 10 GHz, as the customer declared the highest internally generated clock or oscillator frequency to be 951.5 MHz.
3. The emission seen on the 30 MHz to 1 GHz plot at approximately 763.0 MHz is the EUT carrier.
4. The EUT was set to transmit out of both ports and both were terminated by suitable 50 ohm loads.
5. All other emissions were investigated and found to be at least 20 dB below the specification limit or below the measurement system noise floor.
6. 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.
7. 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. Final measurements above 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.

**Results:**

Frequency (MHz)	Antenna Polarisation	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2292.585	Vertical	-42.6	-13.0	29.6	Complied

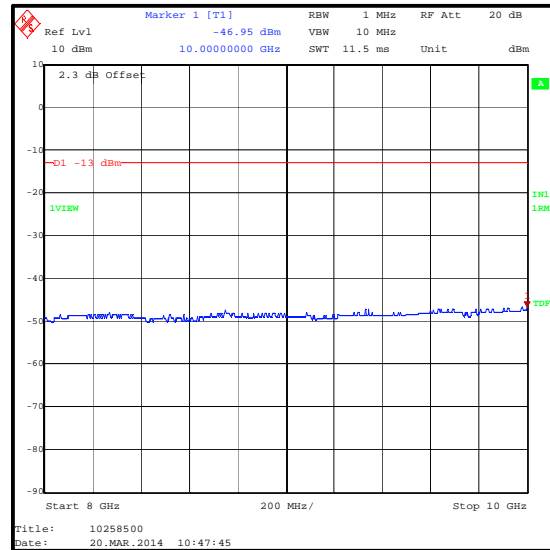
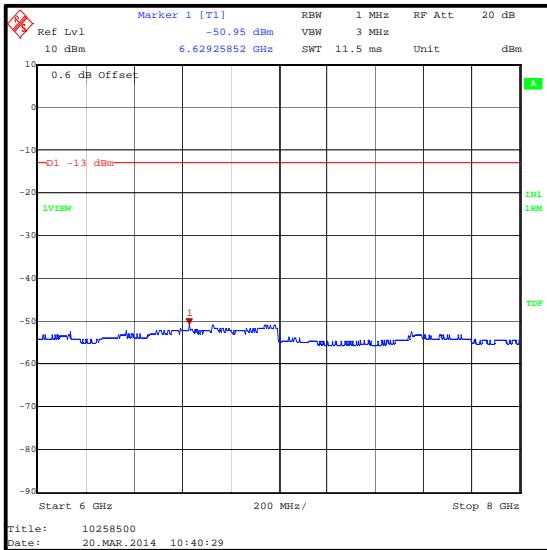
### Transmitter Radiated Emissions (continued)

#### Results:



**Transmitter Radiated Emissions (continued)**

**Results:**



**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1622	Thermohygrometer	JM Handelspunkt	30.5015.06	None stated	31 Dec 2014	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	26 Nov 2014	12
A490	Antenna	Chase	CBL6111A	1590	18 Apr 2014	12
G0543	Pre Amplifier	Sonoma	310N	230801	18 May 2014	3
A1834	Attenuator	Hewlett Packard	8491B	10444	15 Nov 2014	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	11 Feb 2015	12
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Nov 2014	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046K	01 Oct 2014	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	14 Nov 2014	12
A1818	Antenna	EMCO	3115	00075692	14 Nov 2014	12
A253	Antenna	Flann Microwave	12240-20	128	14 Nov 2014	12
A254	Antenna	Flann Microwave	14240-20	139	14 Nov 2014	12
A255	Antenna	Flann Microwave	16240-20	519	14 Nov 2014	12
A1317	Termination	Narda	376BNM	0103	Calibration not required	-
A1318	Termination	Narda	374BNM	0006	Calibration not required	-
A296	Attenuator	Narda	766-20	167	Calibrated before use	-
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-

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

<b>Test Engineer:</b>	Nick Steele	<b>Test Dates:</b>	20 March 2014 & 24 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Parts 90.543(e)(1), 90.543(f) and 2.1053
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 5.8. referencing FCC Part 2.1053
<b>Frequency Ranges:</b>	769 MHz to 775 MHz 799 MHz to 805 MHz 1559 MHz to 1610 MHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	22 to 23
<b>Relative Humidity (%):</b>	37 to 39

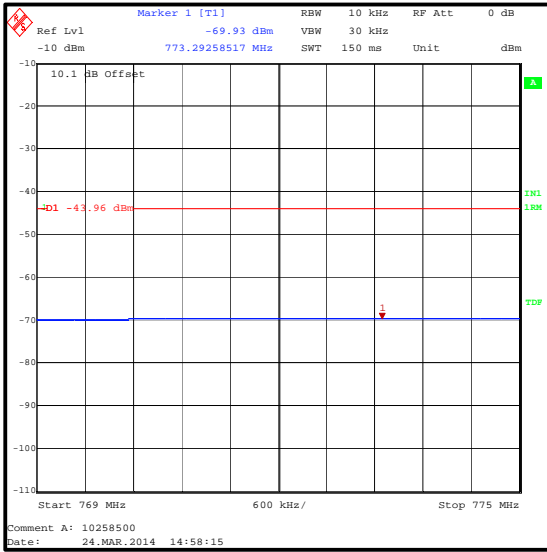
**Note(s):**

- Measurements were performed with the EUT transmitting with QPSK, 16QAM and 64QAM modulation schemes, with resource blocks of 50.
- The EUT was set to transmit out of both ports and both were terminated by suitable 50 ohm loads.
- All other emissions were >20 dB below the applicable limit or below the level of the noise floor of the measuring receiver.
- The limit for 90.543(e)(1) is  $76 + 10\log_{10}(P) = -46$  dBm in a 6.25 kHz bandwidth. As it was not possible to set the resolution bandwidth on the test equipment, the bandwidth was set to 10 kHz. The limit was adjusted by  $10 \log_{10}(10 \text{ kHz} / 6.25 \text{ kHz}) = 2.04$  dB. The limit shown in the plots for the 769 MHz to 799 MHz and 799 MHz to 805 MHz bands was set to  $-46 \text{ dBm} + 2.04 \text{ dB} = -43.96$  dBm.
- The limit for 90.543(f) states emissions in the band 1559 MHz to 1610 MHz shall be limited to -70 dBW/MHz (-40 dBm) equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP (-50 dBm) for discrete emissions of less than 700 Hz bandwidth.
- 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.
- 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. Final measurements above 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.

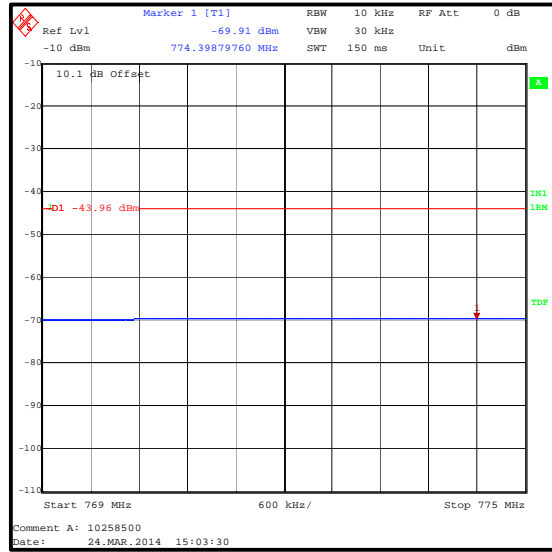
**Transmitter Radiated Emissions Limitations (continued)**

**Results: 769 MHz to 775 MHz**

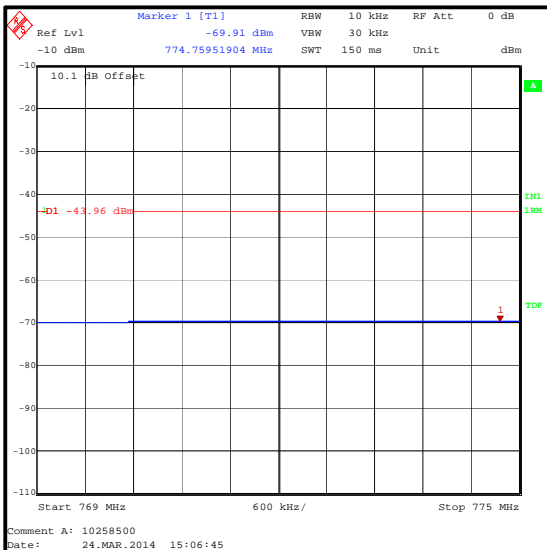
Modulation Scheme	Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
QPSK	773.293	-69.93	-43.96	25.97	Complied
16QAM	774.399	-69.91	-43.96	25.95	Complied
64QAM	774.760	-69.91	-43.96	25.95	Complied



**QPSK**



**16QAM**

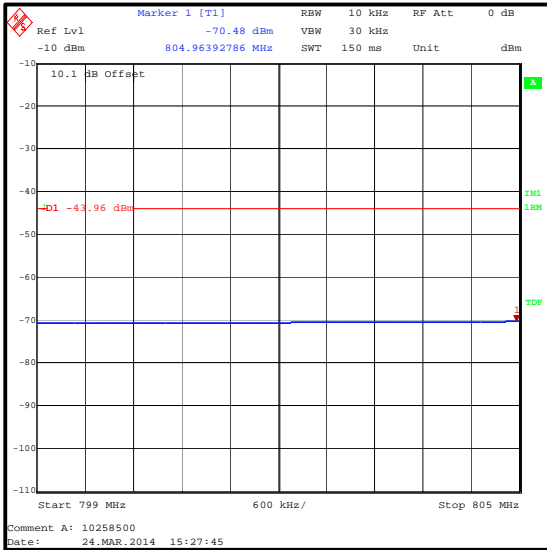


**64QAM**

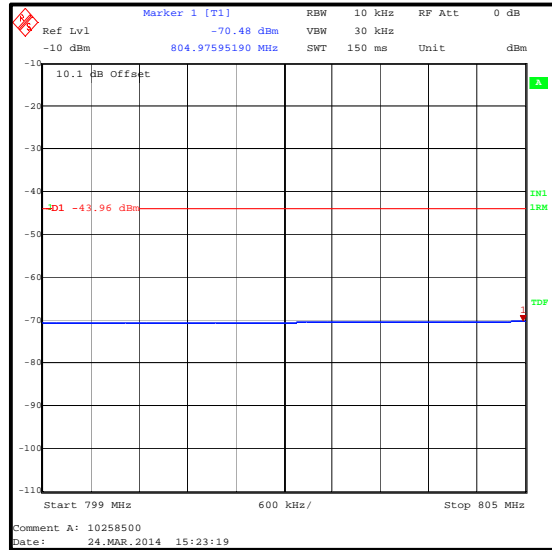
**Transmitter Radiated Emissions Limitations (continued)**

**Results: 799 MHz to 805 MHz**

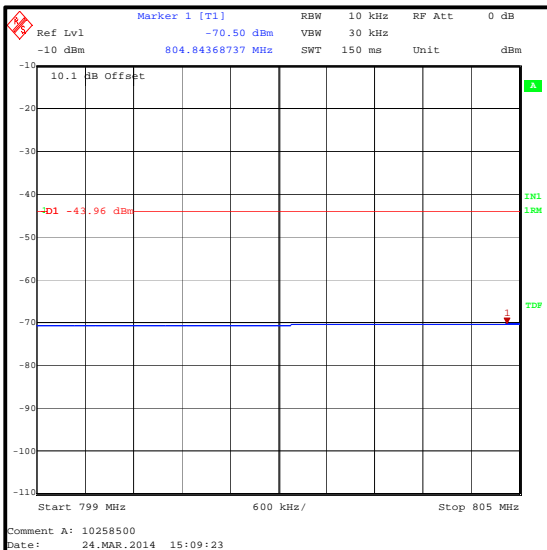
Modulation Scheme	Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
QPSK	804.964	-70.48	-43.96	26.52	Complied
16QAM	804.976	-70.48	-43.96	26.52	Complied
64QAM	804.844	-70.50	-43.96	26.54	Complied



**QPSK**



**16QAM**

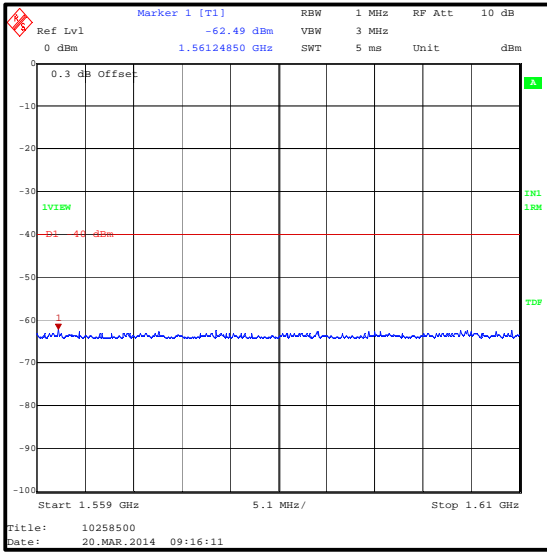


**64QAM**

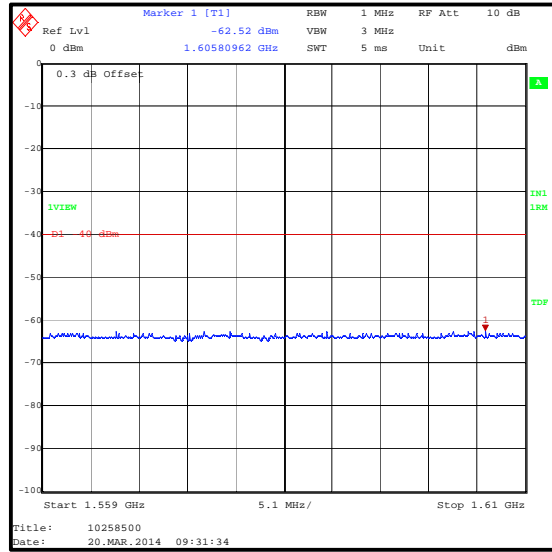
**Transmitter Radiated Emissions Limitations (continued)**

**Results: 1559 MHz to 1610 MHz**

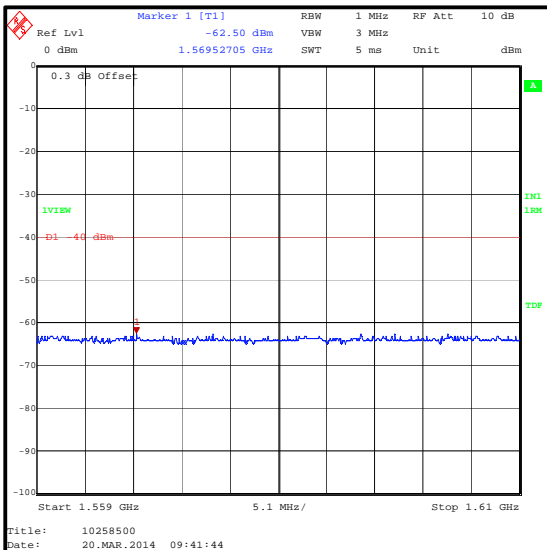
Modulation Scheme	Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
QPSK	1561.249	-62.5	-40.0	22.5	Complied
16QAM	1605.810	-62.5	-40.0	22.5	Complied
64QAM	1569.527	-62.5	-40.0	22.5	Complied



**QPSK**



**16QAM**



**64QAM**



**Transmitter Radiated Emissions Limitations (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1622	Thermohygrometer	JM Handelspunkt	30.5015.06	None stated	31 Dec 2014	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	26 Nov 2014	12
A490	Antenna	Chase	CBL6111A	1590	18 Apr 2014	12
G0543	Pre Amplifier	Sonoma	310N	230801	18 May 2014	3
A1834	Attenuator	Hewlett Packard	8491B	10444	15 Nov 2014	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	11 Feb 2015	12
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Nov 2014	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046K	01 Oct 2014	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	14 Nov 2014	12
A1818	Antenna	EMCO	3115	00075692	14 Nov 2014	12
A1317	Termination	Narda	376BNM	0103	Calibration not required	-
A1318	Termination	Narda	374BNM	0006	Calibration not required	-
A296	Attenuator	Narda	766-20	167	Calibrated before use	-
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-

**5.2.9. Transmitter Radiated Emissions at Band Edges****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	20 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Parts 90.543(c) and 2.1053
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 5.8. referencing FCC Part 2.1053

**Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	33

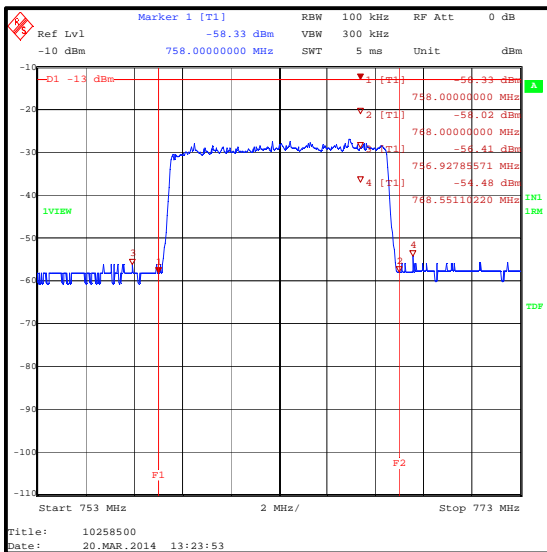
**Note(s):**

1. Measurements were performed with the EUT transmitting with QPSK, 16QAM and 64QAM modulation schemes, with resource blocks of 50.
2. As per 90.543(e)(5), a resolution bandwidth of 30 kHz has been employed.

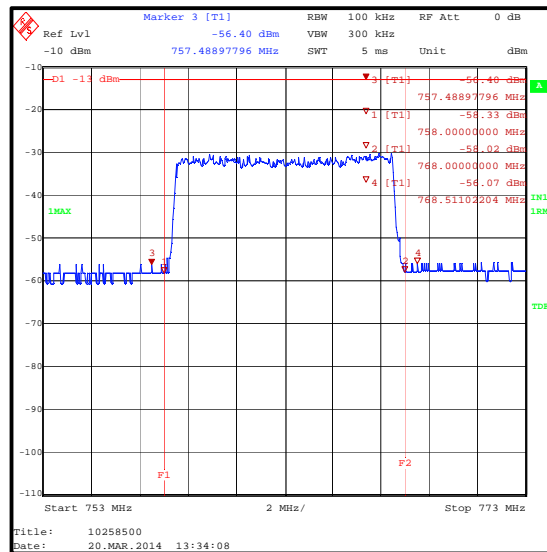
**Transmitter Radiated Emissions at Band Edges (continued)**

**Results: 10 MHz Channel Bandwidth**

Frequency (MHz)	Modulation Scheme	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
756.928	QPSK	-56.4	-13.0	43.4	Complied
758.000	QPSK	-58.3	-13.0	45.3	Complied
768.000	QPSK	-58.0	-13.0	45.0	Complied
768.551	QPSK	-54.5	-13.0	41.5	Complied
757.489	16QAM	-56.4	-13.0	43.4	Complied
758.000	16QAM	-58.3	-13.0	45.3	Complied
768.000	16QAM	-58.0	-13.0	45.0	Complied
768.511	16QAM	-56.1	-13.0	43.1	Complied



**QPSK**

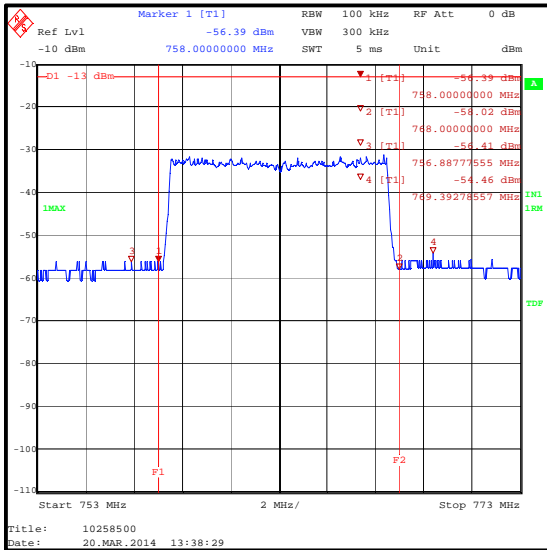


**16QAM**

**Transmitter Radiated Emissions at Band Edges (continued)**

**Results: 10 MHz Channel Bandwidth**

Frequency (MHz)	Modulation Scheme	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
756.888	64QAM	-56.4	-13.0	43.4	Complied
758.000	64QAM	-56.4	-13.0	43.4	Complied
768.000	64QAM	-58.0	-13.0	45.0	Complied
769.393	64QAM	-54.5	-13.0	41.5	Complied



**64QAM**

**Transmitter Radiated Emissions at Band Edges (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>
M1622	Thermohygrometer	JM Handelspunkt	30.5015.06	None stated	31 Dec 2014	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	26 Nov 2014	12
A490	Antenna	Chase	CBL6111A	1590	18 Apr 2014	12
G0543	Pre Amplifier	Sonoma	310N	230801	18 May 2014	3
A1834	Attenuator	Hewlett Packard	8491B	10444	15 Nov 2014	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	11 Feb 2015	12
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Nov 2014	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046K	01 Oct 2014	12
A1317	Termination	Narda	376BNM	0103	Calibration not required	-
A1318	Termination	Narda	374BNM	0006	Calibration not required	-
A296	Attenuator	Narda	766-20	167	Calibrated before use	-
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-

**5.2.10. Transmitter Frequency Stability (Temperature Variation)****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Dates:</b>	18 March 2014 & 19 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	Parts 90.539(d) and 2.1055
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 9.0 referencing FCC CFR Part 2.1055

**Environmental Conditions:**

<b>Ambient Temperature (°C):</b>	22 to 23
<b>Ambient Relative Humidity (%):</b>	33 to 37

**Note(s):**

1. Temperature was monitored throughout the test with a calibrated digital thermometer.
2. An external GPS antenna was connected to port RF1 of the EUT, using the customers bespoke software, it was seen that the EUT was frequency locked to 4 satellites.
3. The EUT was configured to transmit an un-modulated CW test tone in order to measure the frequency stability.
4. Measurements were made using the frequency count function of the test receiver.

**Transmitter Frequency Stability (Temperature Variation) (continued)****Results:**

Temperature (°C)	Time after Start-up					
	0 minutes (MHz)	1 minute (MHz)	2 minutes (MHz)	3 minutes (MHz)	4 minutes (MHz)	5 minutes (MHz)
-30	763.000012	763.000011	763.000011	763.000012	763.000012	763.000011
-20	763.000017	763.000017	763.000015	763.000017	763.000015	763.000017
-10	763.000019	763.000019	763.000017	763.000019	763.000018	763.000018
0	763.000014	763.000013	763.000013	763.000014	763.000014	763.000013
10	763.000009	763.000009	763.000008	763.000009	763.000008	763.000008
20	763.000006	763.000006	763.000005	763.000006	763.000005	763.000005
30	763.000003	763.000002	763.000002	763.000001	763.000002	763.000001
40	762.999996	762.999996	762.999997	762.999996	762.999997	762.999997
50	762.999996	762.999996	762.999997	762.999997	762.999996	762.999997

Temperature (°C)	Time after Start-up				
	6 minutes (MHz)	7 minutes (MHz)	8 minutes (MHz)	9 minutes (MHz)	10 minutes (MHz)
-30	763.000010	763.000012	763.000012	763.000010	763.000010
-20	763.000017	763.000017	763.000016	763.000017	763.000015
-10	763.000017	763.000017	763.000018	763.000017	763.000016
0	763.000014	763.000002	763.000014	763.000012	763.000012
10	763.000009	763.000009	763.000008	763.000009	763.000008
20	763.000005	763.000005	763.000005	763.000005	763.000005
30	763.000000	763.000001	763.000001	763.000001	763.000000
40	762.999997	762.999997	762.999997	762.999996	762.999997
50	762.999996	762.999997	762.999996	762.999996	762.999997

Frequency with Worst Case Deviation (MHz)	Frequency Error (Hz)	Frequency Error (ppm)	Limit (ppm)	Margin (ppm)	Result
763.000019	19	0.0249	1.0	0.9751	Complied

**Transmitter Frequency Stability (Temperature Variation) (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	None stated	14 Mar 2015	12
M1630	Test Receiver	Rohde & Schwarz	FSV 30	100854	23 May 2014	12
E0518	Environmental Chamber	TAS	LTCL 1200	24000107	Calibrated before use	-
M1068	Thermometer	Iso-Tech	RS55	93102884	19 Apr 2014	12
A1317	Termination	Narda	376BNM	0103	Calibration not required	-
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-



**5.2.11. Transmitter Frequency Stability (Voltage Variation)****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	19 March 2014
<b>Test Sample Serial Number:</b>	APFHD16000V20		

<b>FCC Reference:</b>	90.539(d) and 2.1055
<b>Test Method Used:</b>	As detailed in KDB 971168 D01 Section 9.0 referencing FCC CFR Part 2.1055

**Environmental Conditions:**

<b>Ambient Temperature (°C):</b>	23
<b>Ambient Relative Humidity (%):</b>	37

**Note(s):**

1. Voltage was monitored throughout the test with a calibrated digital voltmeter.
2. An external GPS antenna was connected to port RF1 of the EUT, using the customers bespoke software, it was seen that the EUT was frequency locked to 4 satellites.
3. The EUT was configured to transmit an un-modulated CW test tone in order to measure the frequency stability.
4. Measurements were made using the frequency count function of the test receiver.

**Results:**

Supply Voltage (VDC)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)	Limit (ppm)	Margin (ppm)	Result
-40.8	763.000006	6	0.0079	1.0	0.9921	Complied
-55.2	763.000006	6	0.0079	1.0	0.9921	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	14 Mar 2015	12
M1630	Test Receiver	Rohde & Schwarz	FSV 30	100854	23 May 2014	12
G0565	DC Power Supply	Hewlett Packard	E4356A	US39290102	Calibrated before use	-
M122	Digital Voltmeter	Fluke	77	64910017	26 Jun 2014	12
A1317	Termination	Narda	376BNM	0103	Calibration not required	-

## **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>
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±4.69 dB
Occupied Bandwidth	758 MHz to 768 MHz	95%	±3.92 %
Conducted Carrier Output Power	758 MHz to 768 MHz	95%	±1.13 dB
Transmitter Conducted Emissions Mask	758 MHz to 768 MHz	95%	±1.13 dB
Conducted Emissions	9 kHz to 10 GHz	95%	±2.62 dB
Radiated Emissions	30 MHz to 1 GHz	95%	±5.65 dB
Radiated Emissions	1 GHz to 10 GHz	95%	±2.94 dB
Frequency Stability	758 MHz to 768 MHz	95%	±0.92 ppm

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
2.0	-	-	Update to table headings in section 5.2.1
3.0	-	-	Formatting issues and removal of second report and order
4.0	10 to 14	5.2.1	Power measurements updated.

--- END OF REPORT ---